AN-2085 LMZ23605/03, LMZ22005/03 Evaluation Board

1 Introduction

The LMZ23605/03, LMZ22005/03 evaluation boards are designed to be an easy-to-use platform to evaluate the full capabilities of this family of SIMPLE SWITCHER® power modules. The PCB construction has excellent thermal performance and includes extra locations for optional components that may not be required in the end application.

The LMZ23605/03 can accept an input voltage rail between 6V and 36V and the LMZ22005/03 can accept an input voltage rail between 6V and 20V. The devices can deliver an adjustable and highly accurate output voltage as low as 0.8V and as high as 6V. The control architecture is constant frequency PWM with emulated current mode sensing. The control loop operates well with low ESR output capacitors such as ceramics or specialty polymer. The precision enable input allows for programmable UVLO on the input supply or flexibility in sequencing. The external soft-start capacitor facilitates controlled output rise time at startup. The module family is a reliable and robust solution with cycle-by-cycle valley current limit to protect for over current or short-circuit faults. Additionally there is thermal shutdown protection, and they will start up into a pre-biased output. The free-running switching frequency is 812 kHz (typ) and a 650 kHz to 950 kHz synchronization range is supported.

2 Board Specifications

- V_{IN} = 6V to 36V (LMZ22005/03 limited to 20V)
- Enable UVLO = 5.7V
- V_{OUT} = 3.3V
- I_{OUT} = 0 to 5A (LMZ23603 and LMZ22003 limited to 3A)
- θ_{JA} = 12°C / W, θ_{JC} = 1.9°C/W
- PCB designed on four layers; Inner are 2 oz; Outer are 3 oz.
- Measures 3.5 in. x 3.5 in. (8.9 cm x 8.9 cm) and is 62mil (.062”) thick of FR4 laminate material
- Max ambient temp of 70°C at full 5A load (12 Vin)

For additional circuit considerations refer to the Applications Section of the LMZ23605/03 or LMZ22005/03 data sheets. For negative output voltage connections follow the method shown in AN-2027.

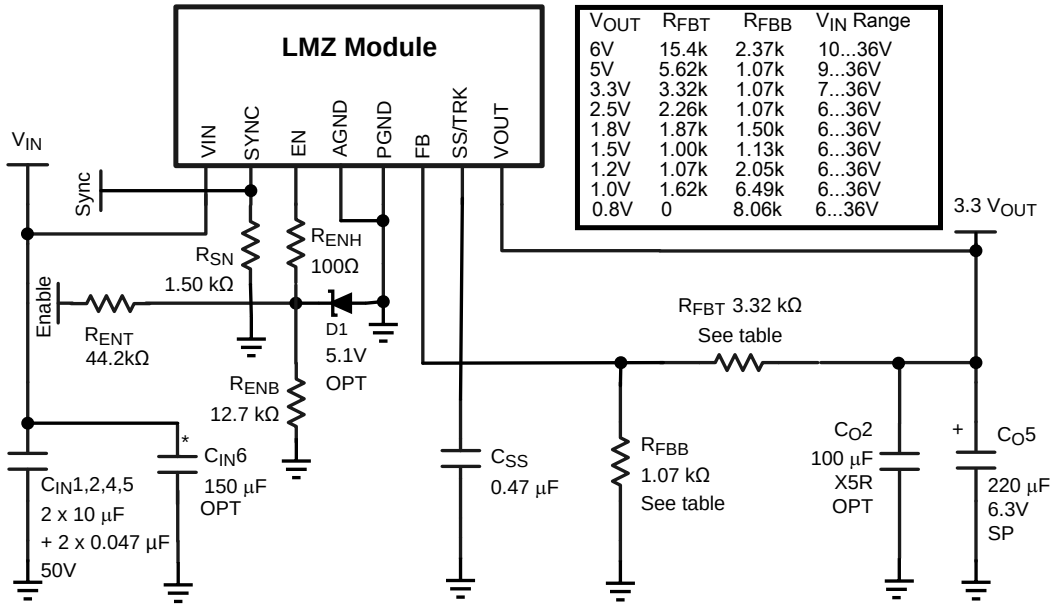
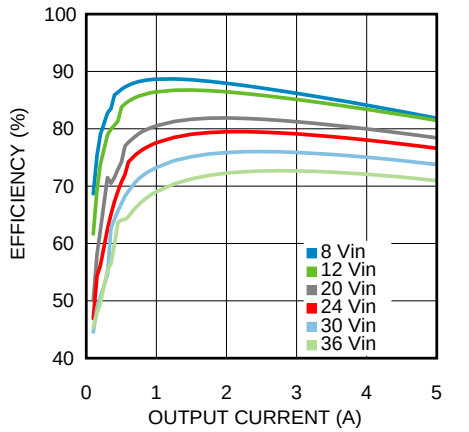


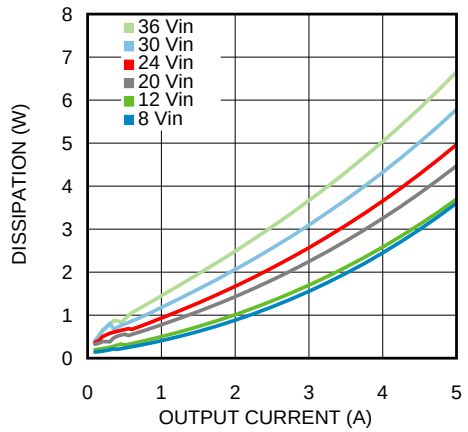
Figure 1. Evaluation Board Simplified Schematic

3 Performance Characteristics

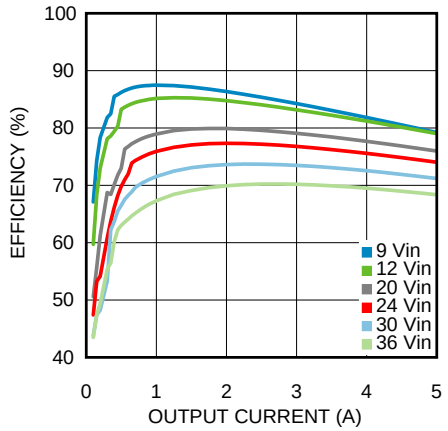
LMZ23605 3.3Vout Efficiency @ 25°C Ambient



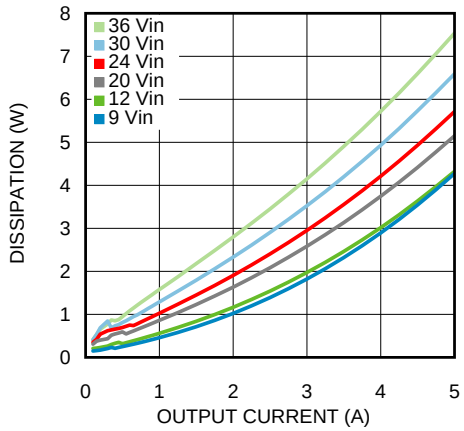
LMZ23605 3.3Vout Dissipation @ 25°C Ambient



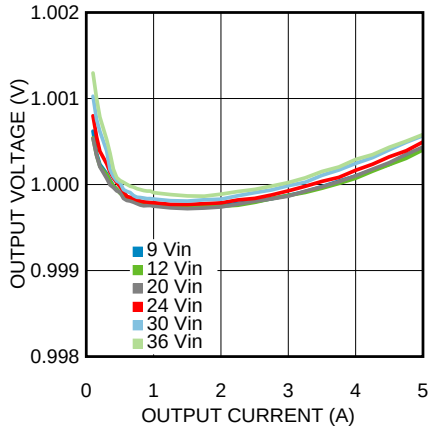
LMZ23605 3.3Vout Efficiency @ 85°C



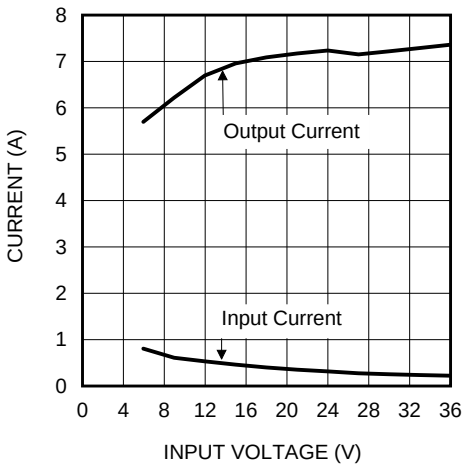
LMZ23605 3.3Vout Dissipation @ 85°C



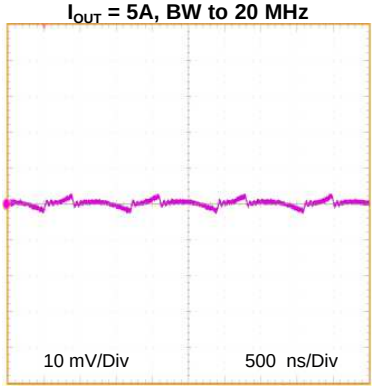
LMZ23605 Load and Line Regulation @ 25°C Ambient



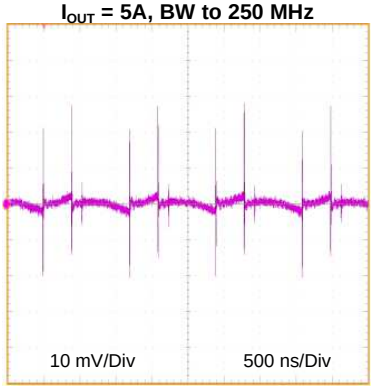
LMZ23605 Current Limit V_{OUT} = 3.3V



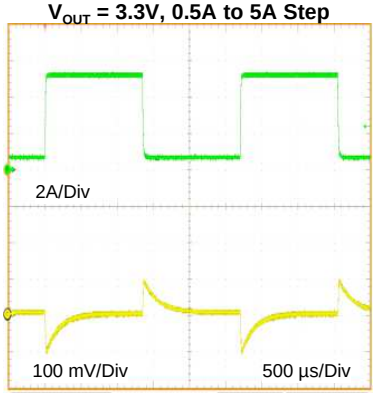
Output Ripple V_{OUT} = 3.3V
I_{OUT} = 5A, BW to 20 MHz



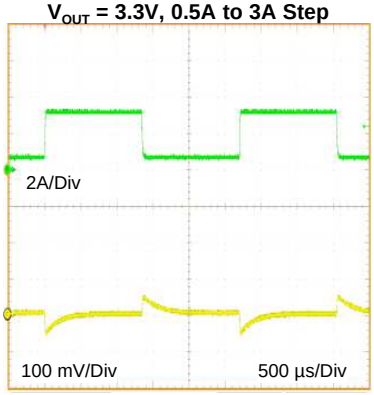
Output Ripple V_{OUT} = 3.3V
I_{OUT} = 5A, BW to 250 MHz



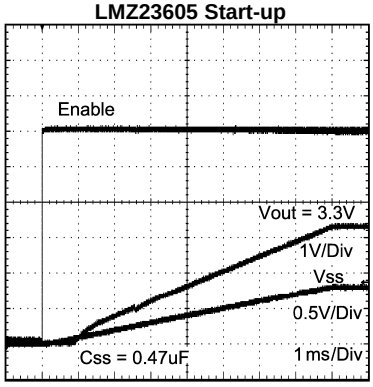
LMZ23605 Load Step Response V_{IN} = 12V
V_{OUT} = 3.3V, 0.5A to 5A Step



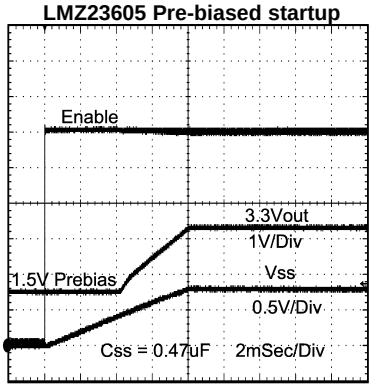
LMZ23603 Load Step Response V_{IN} = 12V
V_{OUT} = 3.3V, 0.5A to 3A Step



LMZ23605 Start-up



LMZ23605 Pre-biased startup



4 Notes

Solder turrets are located on the edge of the PCB assembly for evaluation hookup to bench test equipment. The Enable input turret is designed for direct connection to the V_{IN} turret. There is a resistive divider implemented on the board that establishes the 5.5V precision UVLO level of the board. A common user change to this divider is to raise the value of R_{ENT} to increase the operating UVLO to that of the target application. Refer to the respective data sheet for calculation. Note that if in the end application the module pin 3 enable voltage does not exceed 5.5V at maximum Vin, then enable clamp zener D1 can be omitted.

Each implementation of the evaluation board is preset to 3.3V output; with current rating and maximum input voltage rating dictated by the model of module installed. A common user change is to adjust the output voltage for different requirements. A table of suggested resistor pairs are listed in Figure 1 for quick reference.

Locations are provide for testing the operation as a coincident turn-on tracking supply (slave). To implement this feature, remove C_{SS} and install Rtkt and Rtkb. Calculations are suggested in the respective data sheets.

A turret is also provided for applying a clock to synchronize the module switching frequency anywhere between 650 kHz and 950 kHz. Note that a sustained “logic one” on this input corresponds to “zero hertz” and will cause the module to stop switching.

J1 and J2 are for input and output noise measurement. To implement this feature, populate the 1uF blocking capacitors and the 49.9 ohm source resistors. Install Amphenol coax connectors type 112404 (Digikey #ACX1051).The added R-C network forms a 2X scope probe when used in conjunction with an input termination of 50 ohms at the oscilloscope, providing 5 times more sensitivity than a conventional 10x probe.

J3 is for connection to a frequency response analyzer such as A/P Instruments (Ridley) or Venable Industries products. Refer to the FRA operating manual for this connection. Note: Do not place any type of shorting jumper to these three posts as that will cause a malfunction.

Inductor current can be monitored by connecting a loop of between module pin 7 (Vout) and the Co array. First cut the top side conducting etch between the two vias adjacent to pin 7, then install a 5” loop of 22 ga insulated wire in the two vias. Monitor the inductor sense loop with an AC/DC oscilloscope current probe.

The Vin input plane has solder mask openings where an input LC network can be placed to accommodate improved differential mode and conducted EMI performance.

Additional component mounting pads are available to experiment with alternative Cin and Cout combinations. See Figure 7 for corresponding schematic locations.

5 PCB View and layout diagrams

Gerber and CAD files can be downloaded from the LMZ23605 /03, LMZ22005/03 respective product folders.

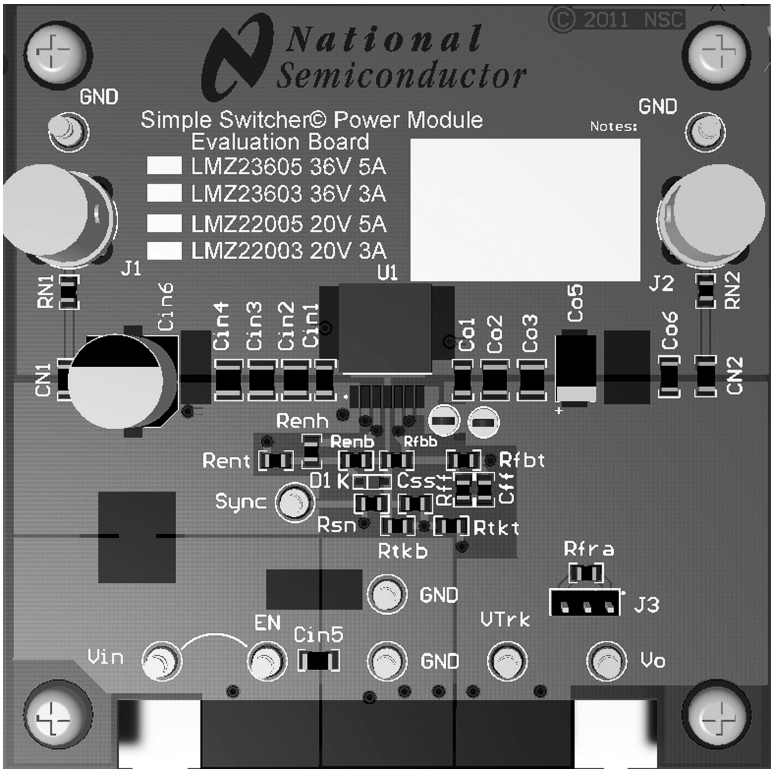


Figure 2. Top View of Assembly

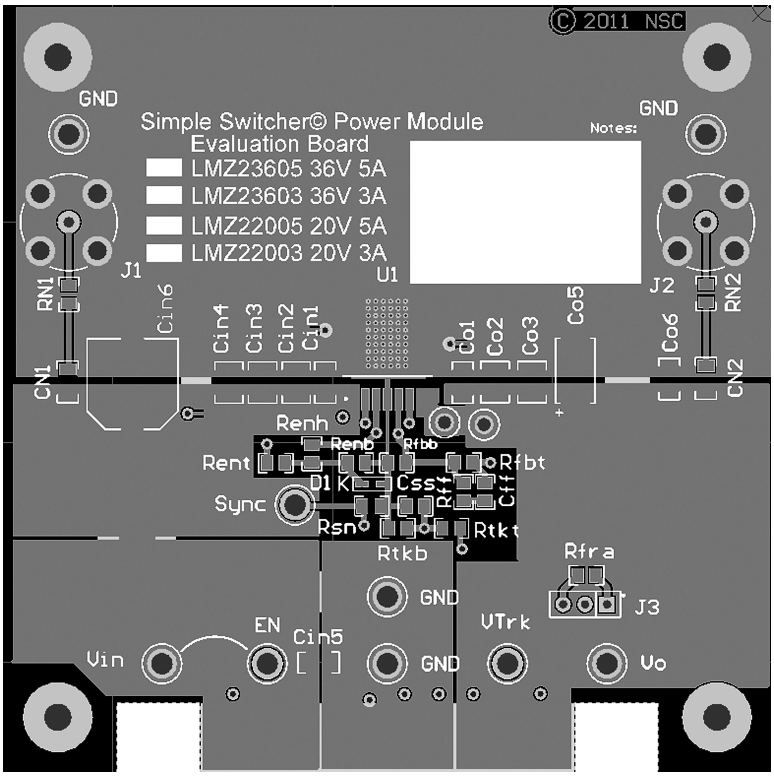


Figure 3. Top Layer

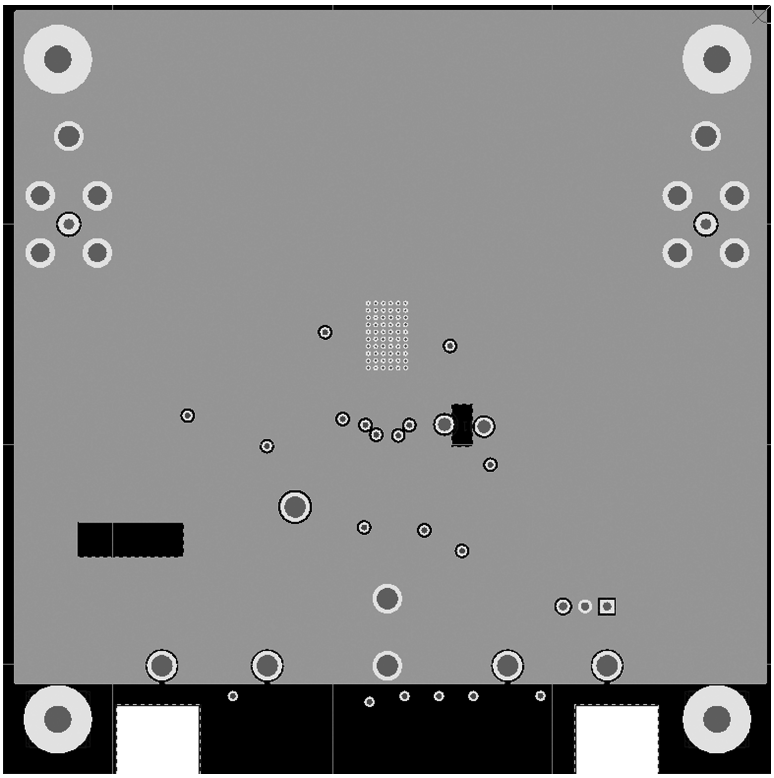


Figure 4. Internal Layer I (Ground)
Heat Sinking Layer

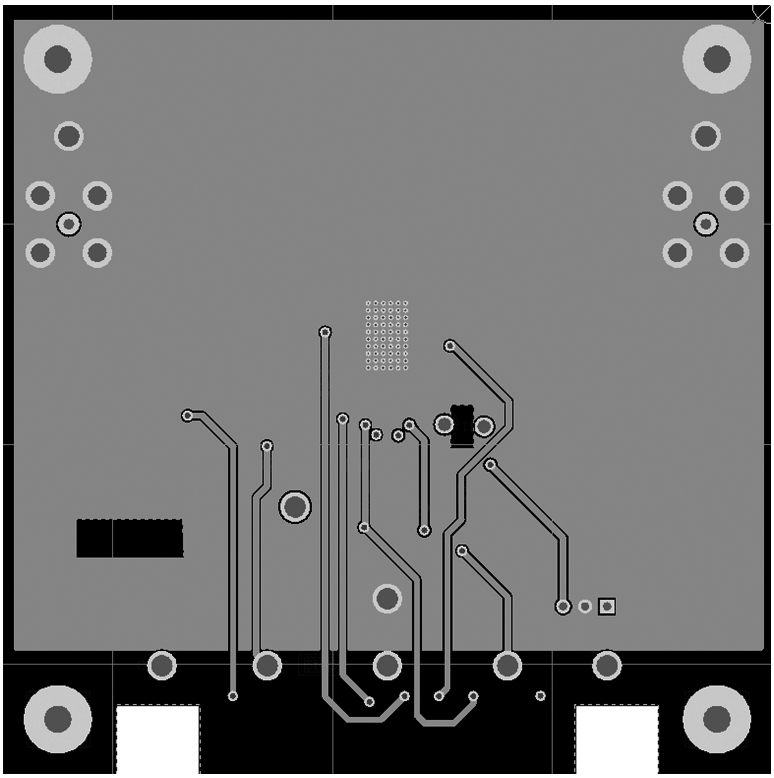


Figure 5. Internal Layer II (Ground and Routing)
Heat Sinking Layer

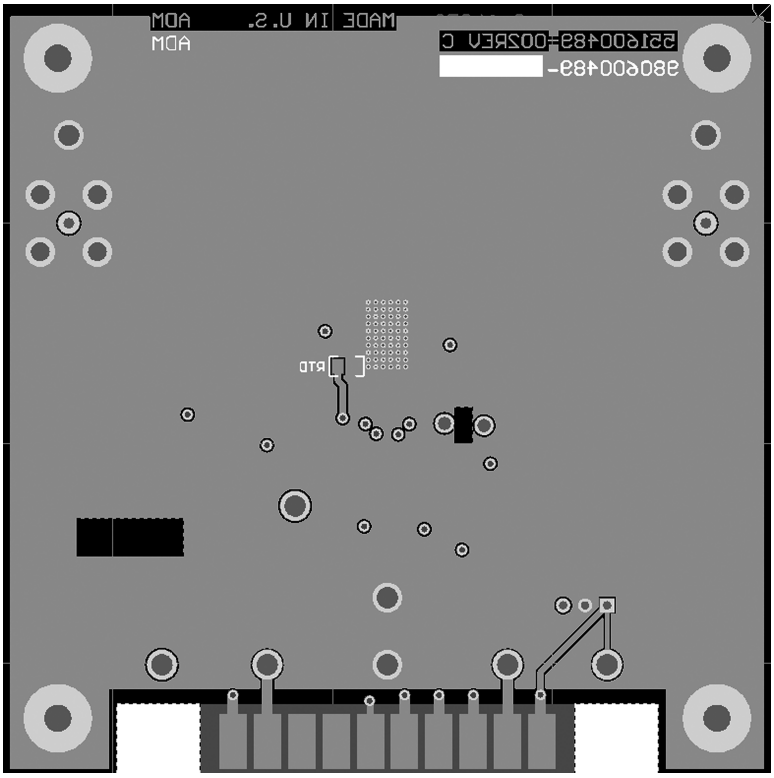
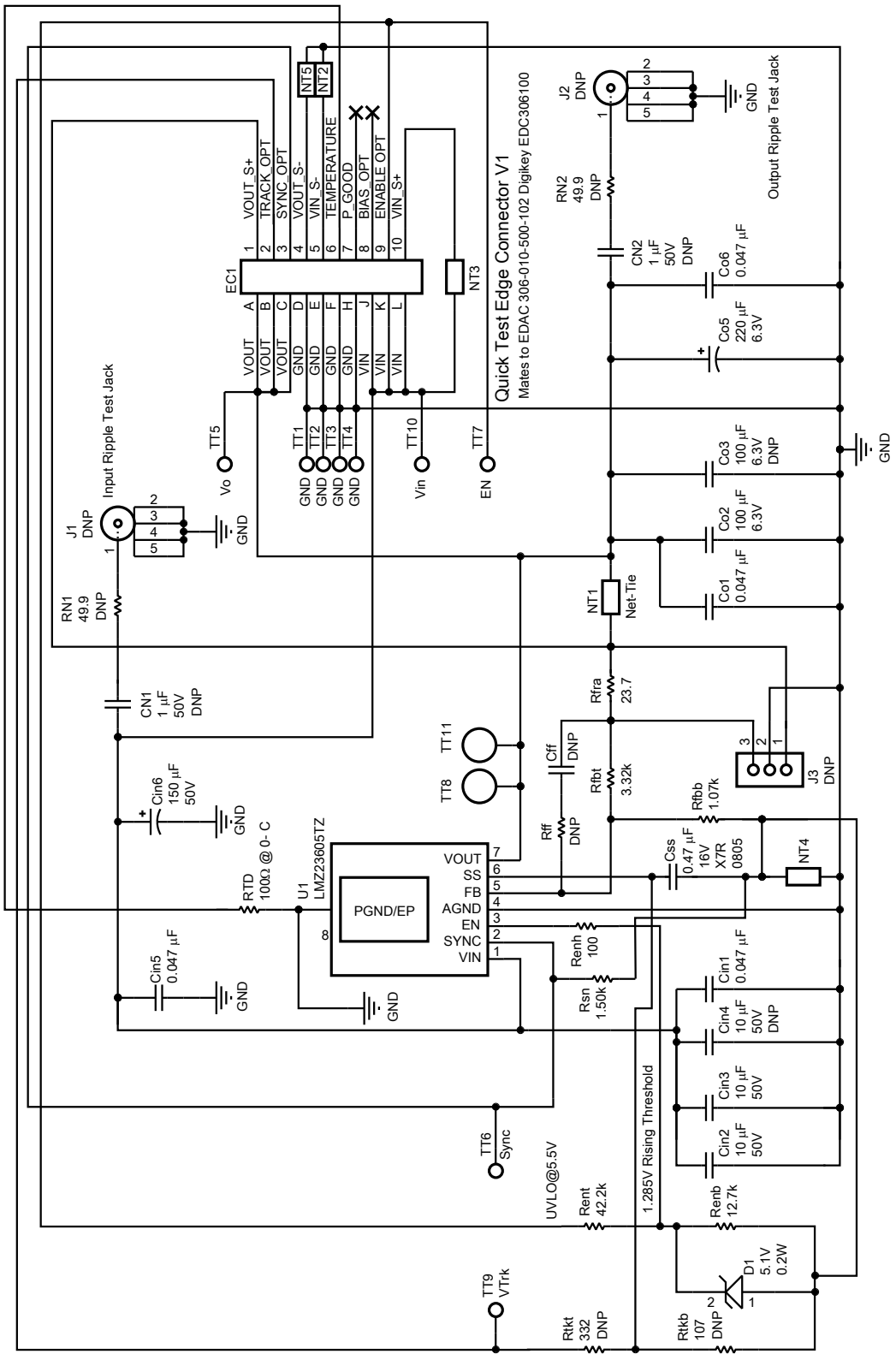


Figure 6. Bottom Layer (Ground)
Heat Sinking Layer



A DNP = Component not populated

Figure 7. LMZ2360x / LMZ2200x PCB CAD Package Schematic

Table 1. Bill of Materials[1][2]

Designator	Description	Case Size	Manufacturer	Manufacturer P/N	Quantity
U1	SIMPLE SWITCHER®	TO-PMOD-7	Texas Instruments	LMZ23605TZ or LMZ23603TZ or LMZ22005TZ or LMZ22003TZ	1
$C_{IN}1$ $C_{IN}5$ C_O1 C_O6	0.047 µF, X7R, 50V	1206	Yageo America	CC1206KRX7R9BB473	4
$C_{IN}2$ $C_{IN}3$	10 µF, X5R, 50V	1210	Taiyo Yuden	UMK325BJ106MM-T	2
$C_{IN}6$ OPT	150 µF,Aluminum Electrolytic, 50V	G	Panasonic	EEE-FK1H151P	1
C_O2 OPT	100 µF, X5R, 6.3V	1210	TDK	C3225X5R0J107M	1
C_O5	220 µF, Specialty Polymer, 6.3V		Panasonic	EEF-UE0J221LR	1
C_{FF}	DNP				
C_{SS}	0.47µF, X7R, 16V	0805	AVX	0805YC474KAT2A	1
D1	5.1V 200mW	SOD-323	Diodes Inc.	MMSZ5231BS-7-F	1
R_{ENB}	12.7 kΩ	0805	Panasonic	ERJ-6ENF1272V	1
R_{ENT}	42.2 kΩ	0805	Panasonic	ERJ-6ENF4222V	1
R_{ENH}	100 Ω	0805	Vishay-Dale	CRCW0805100RFKEA	1
R_{FBT}	3.32 kΩ	0805	Vishay-Dale	CRCW08053K32FKEA	1
R_{FBB}	1.07 kΩ	0805	Vishay-Dale	CRCW08051K07FKEA	1
R_{FRA}	23.7 Ω	0805	Vishay-Dale	CRCW080523R7FKEA	1
R_{FF}	DNP				
R_{SN}	1.50 kΩ	0805	Vishay-Dale	CRCW08051K50FKEA	1

(1) V_{IN} = 6V to 36V, V_{OUT} = 3.3V, $I_{OUT\ (MAX)}$ = 5A (3A)
(2) Note: The same BOM applies to all implementations

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