AN-2125 LMZ23605/03, LMZ22005/03 Demonstration Board

1 Introduction

The LMZ23605/03, LMZ22005/03 demonstration boards are designed to be an easy-to-use platform to evaluate the basic capabilities of this family of SIMPLE SWITCHER® power modules. The PCB has excellent thermal performance and implements the most common applications for the product.

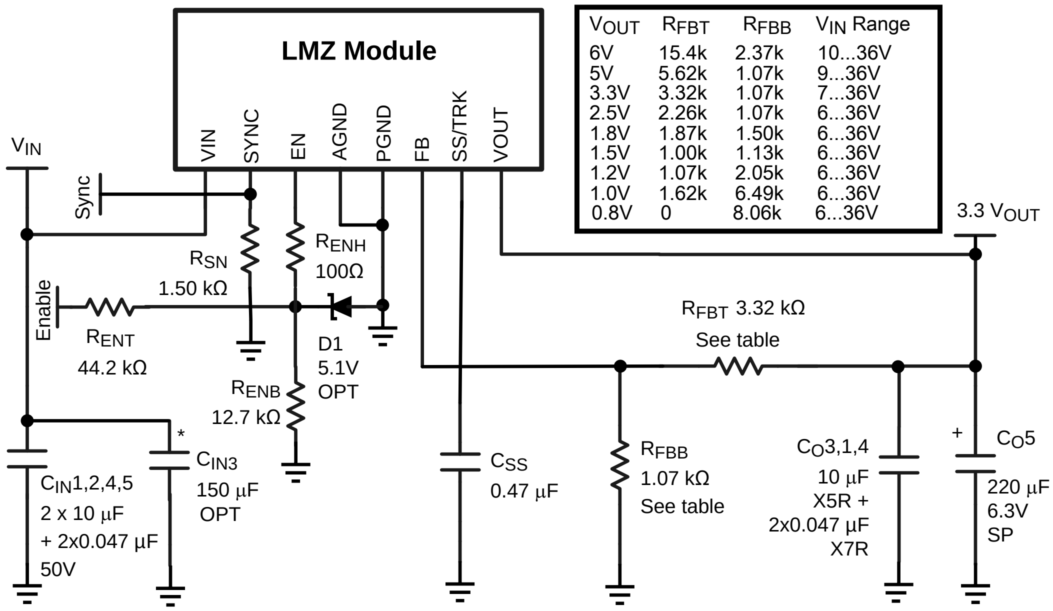
The LMZ23605/03 can accept an input voltage rail between 6V and 36V and the LMZ22005/03 can accept an input voltage rail between 6V and 20V. The devices can deliver an adjustable and highly accurate output voltage as low as 0.8V and as high as 6V. The internal control architecture is constant frequency 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. The external soft-start capacitor facilitates controlled output rise time at startup. The LMZ23605/03 and LMZ22005/03 family is a reliable and robust solution with loss-less 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. Free-running switching frequency is 812 kHz 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 (3A)
- θ_{JA} = 12°C / W, θ_{JC} = 1.9°C/W
- Max ambient temp of 70°C for 12Vin and 3.3Vout @ 5A
- Designed on four layers; Inner are 2 oz; Outer are 3 oz.
- Measures 3.5 in. × 3.5 in. (8.9 cm × 8.9 cm) and is 62mil (.062”) thick of FR4 laminate material

For additional circuit considerations, refer to the Applications Section of the LMZ23605/03 and LMZ22005/03 data sheets. For negative output voltage connections, see *AN-2027 Inverting Application for the LMZ14203 SIMPLE SWITCHER Power Module Application Report* (SNVA425).

3 Simplified Schematic

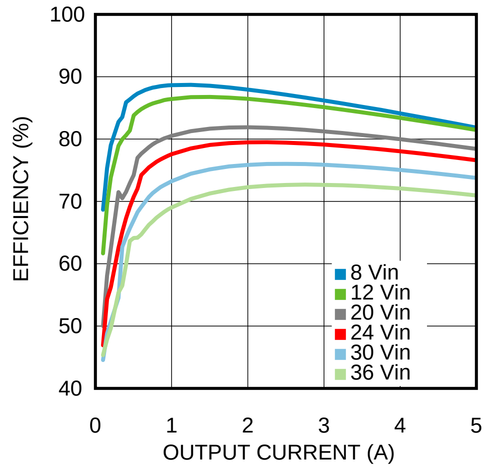


V_{OUT}	R_{FBT}	R_{FBB}	V_{IN} Range
6V	15.4k	2.37k	10...36V
5V	5.62k	1.07k	9...36V
3.3V	3.32k	1.07k	7...36V
2.5V	2.26k	1.07k	6...36V
1.8V	1.87k	1.50k	6...36V
1.5V	1.00k	1.13k	6...36V
1.2V	1.07k	2.05k	6...36V
1.0V	1.62k	6.49k	6...36V
0.8V	0	8.06k	6...36V

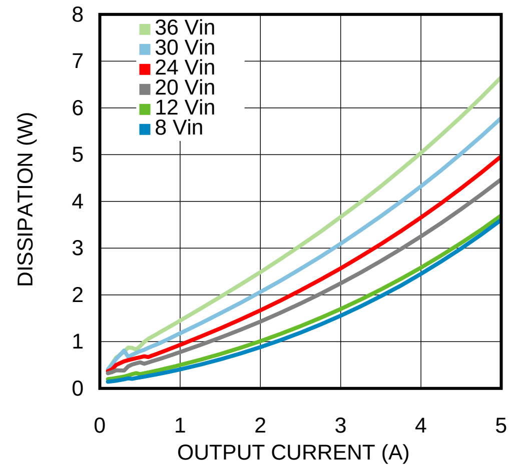
Figure 1. Demonstration Board Simplified Schematic

4 Performance Characteristics

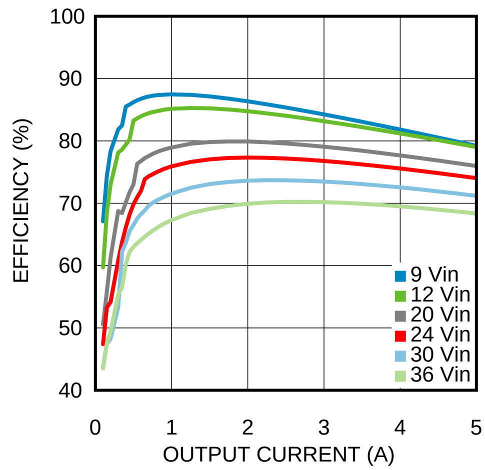
LMZ23605 Efficiency @ 25°C Ambient



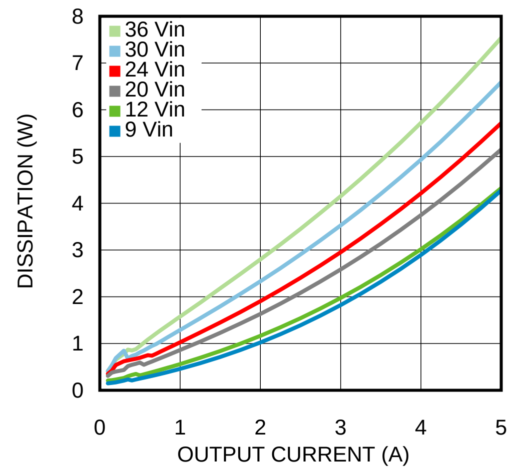
LMZ23605 Dissipation @ 25°C Ambient



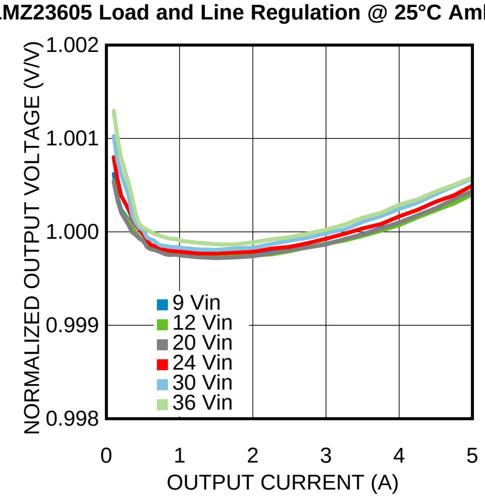
LMZ23605 Efficiency @ 85°C



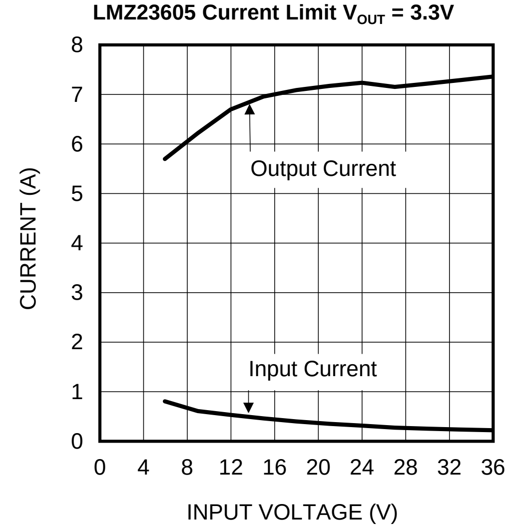
LMZ23605 Dissipation @ 85°C



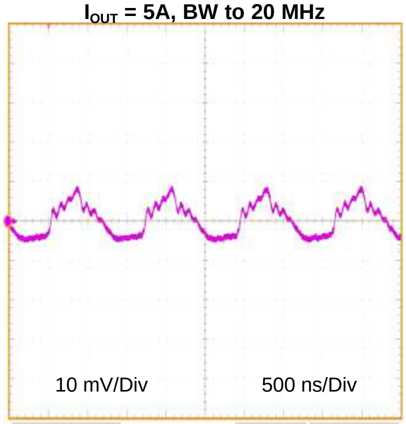
LMZ23605 Load and Line Regulation @ 25°C Ambient



LMZ23605 Current Limit V_{OUT} = 3.3V

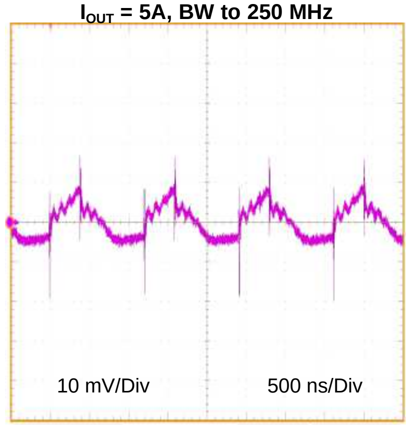


LMZ23605 Output Ripple V_{OUT} = 3.3V
I_{OUT} = 5A, BW to 20 MHz



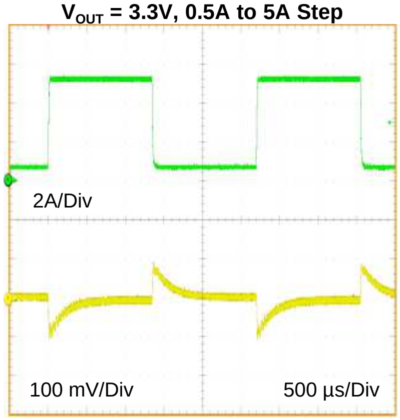
Cout = 220 µF Poscap + 10µF X5R + 2 × 0.047µF

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

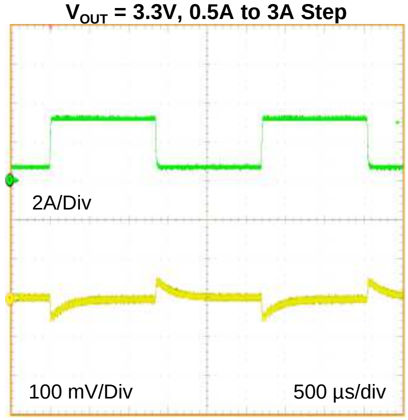


Cout = 220 µF Poscap + 10µF X5R + 2 × 0.047µF

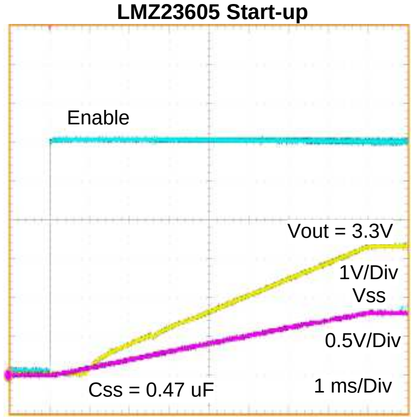
LMZ23605 Load Step Response V_{IN} = 12V
V_{OUT} = 3.3V, 0.5A to 5A Step



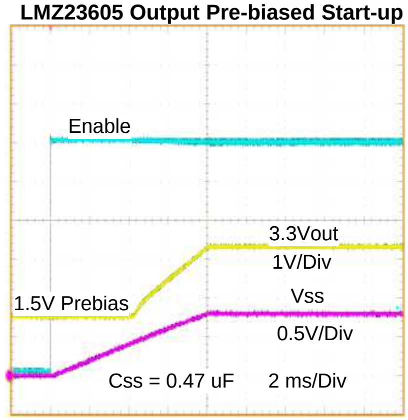
LMZ23603 Load Step Response V_{IN} = 12V
V_{OUT} = 3.3V, 0.5A to 3A Step

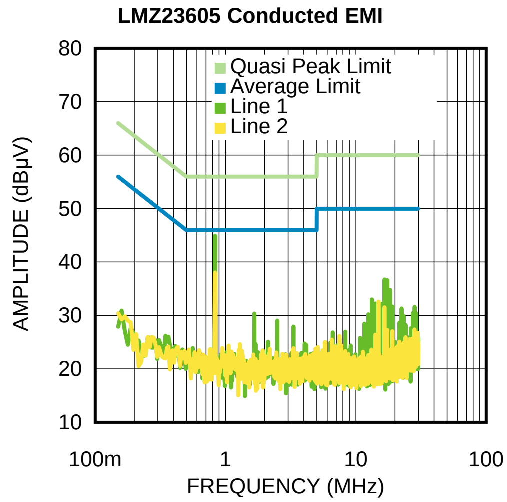


LMZ23605 Start-up

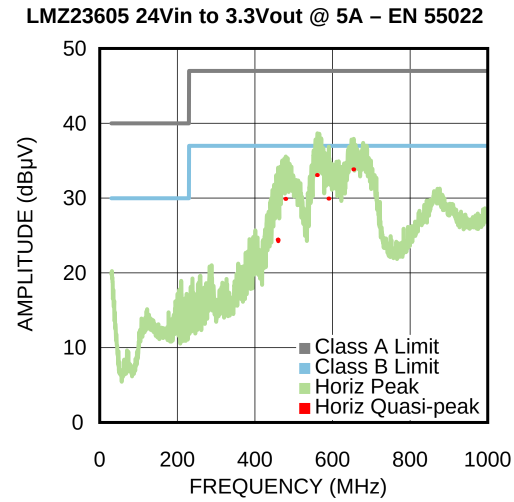


LMZ23605 Output Pre-biased Start-up

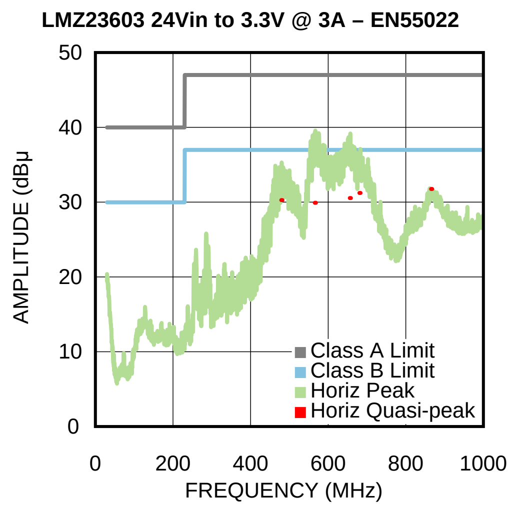




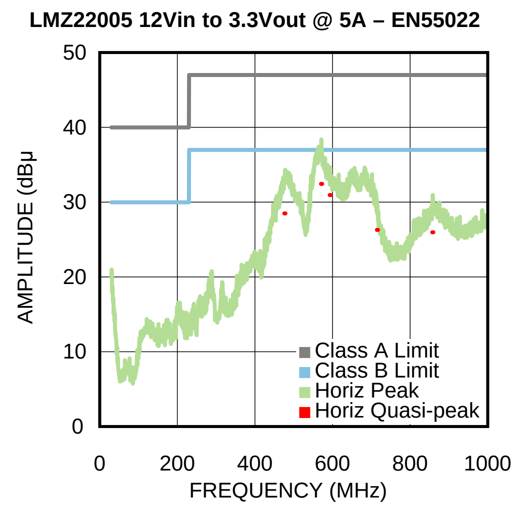
2.2 µH / 10 µF input LC filter
and 10uF in || w/ $C_{IN}1$



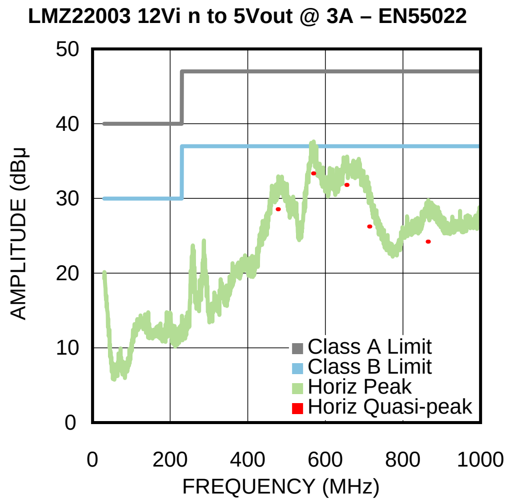
Cin = default +10 µF +3 × 0.01µF
C_O = default + 2 × 0.01µF



Cin = default +10 µF +3 × 0.01µF
C_O = default + 2 × 0.01µF



Cin = default +10 µF +3 × 0.01µF
C_O = default + 2 × 0.01µF



Cin = default +10 µF +3 × 0.01µF
C_O = default + 2 × 0.01µF

5 Notes

Solder turrets are located on the edge of the PCB assembly for demonstration 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 precision 5.7V 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 input voltage does not exceed 5.5V at maximum Vin then enable clamp zener D1 can be omitted.

Each implementation of the demonstration board is preset to 3.3V output; with current rating and maximum input voltage 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.

A turret is 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.

Inductor current can be observed by cutting the bottom side conducting etch connecting module pin 7 V_{OUT} and the Co array. 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 top side Vin 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 6 for corresponding schematic locations.

6 Gerber and CAD Files

Gerber and CAD files can be downloaded from the associated product folder.

7 PCB Layout Diagrams

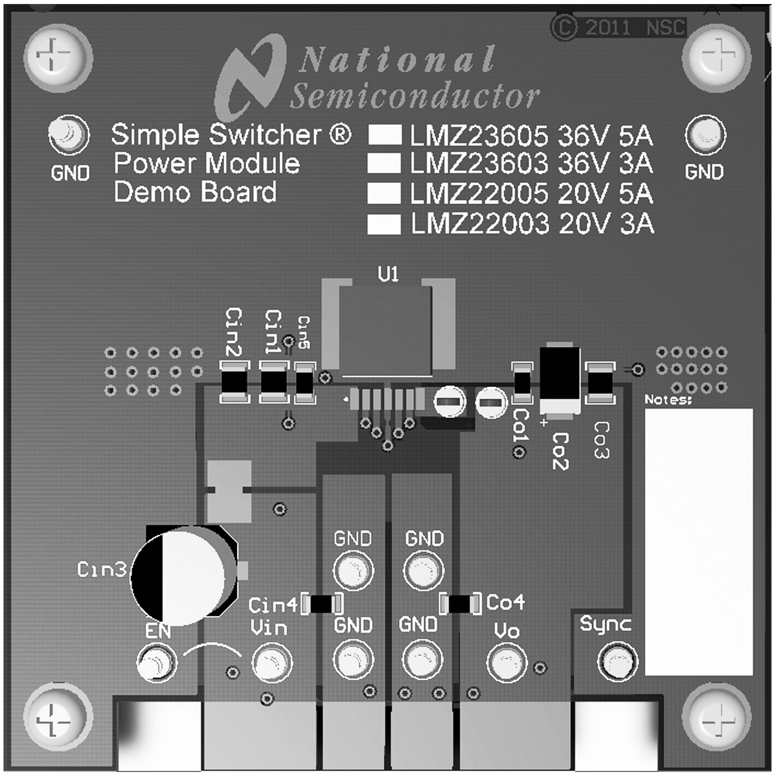


Figure 2. Top View of Assembly

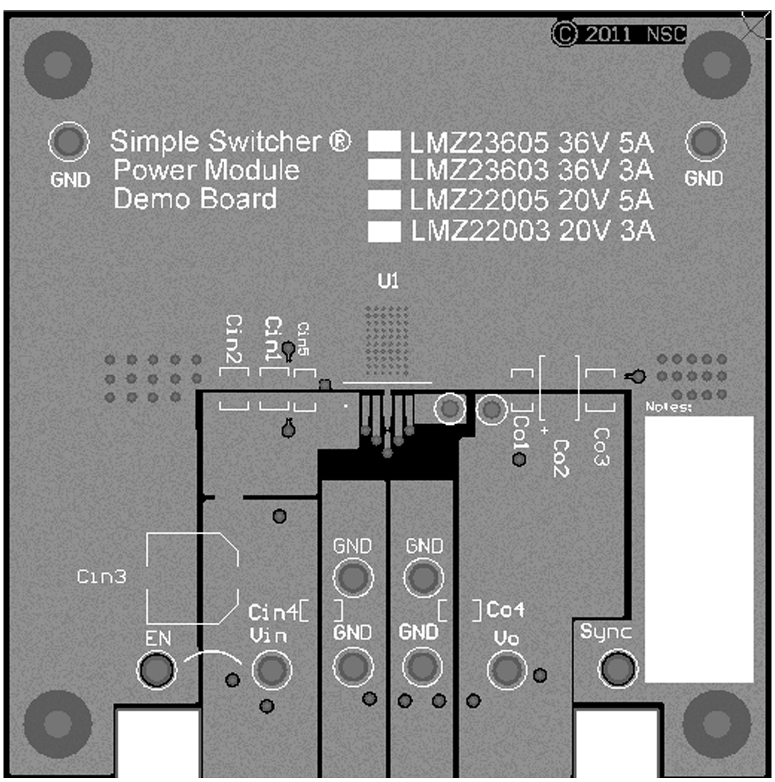


Figure 3. Top Layer

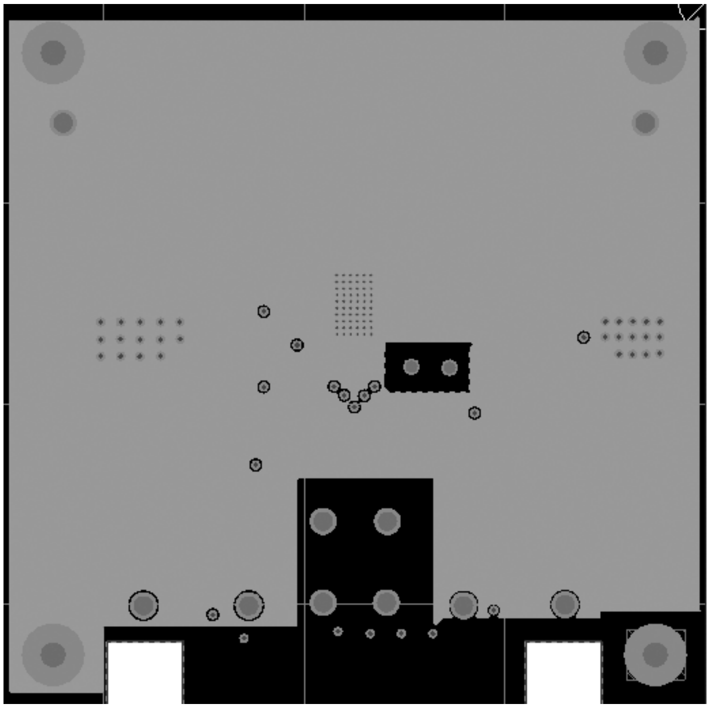


Figure 4. Internal Layer I (Ground)
Heat Sinking Layer

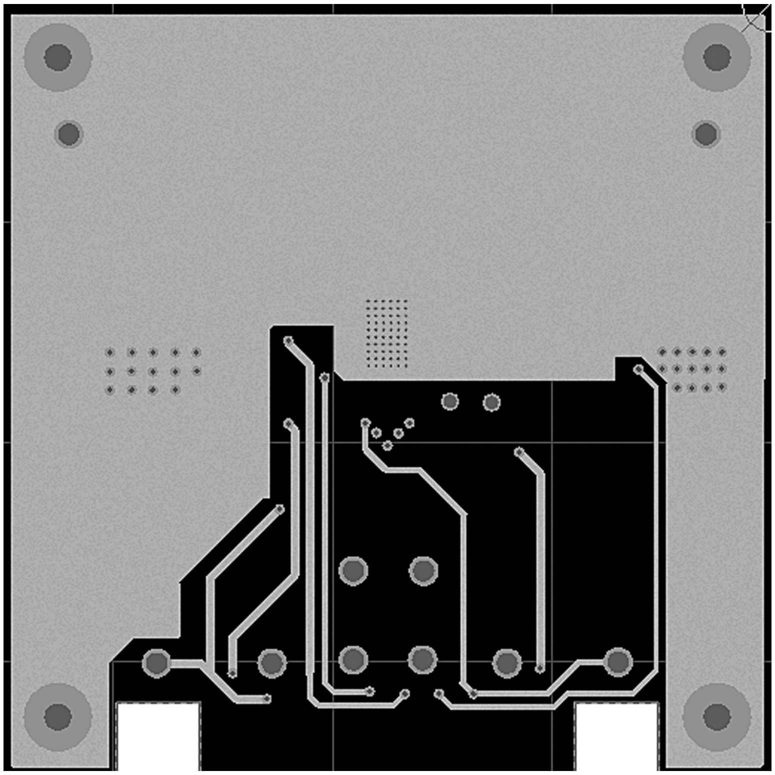


Figure 5. Internal Layer II (Ground and Routing)
Heat Sinking Layer

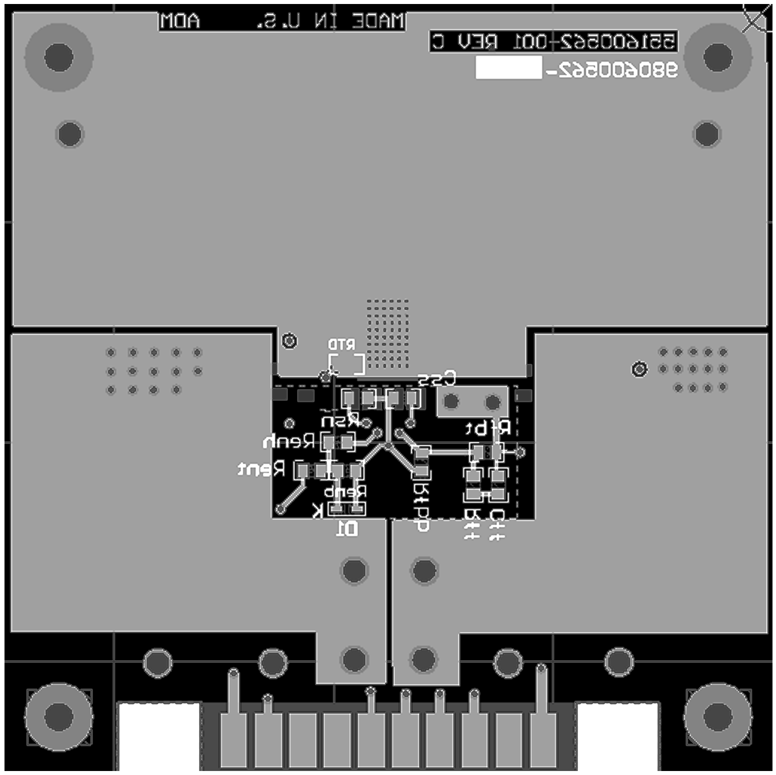
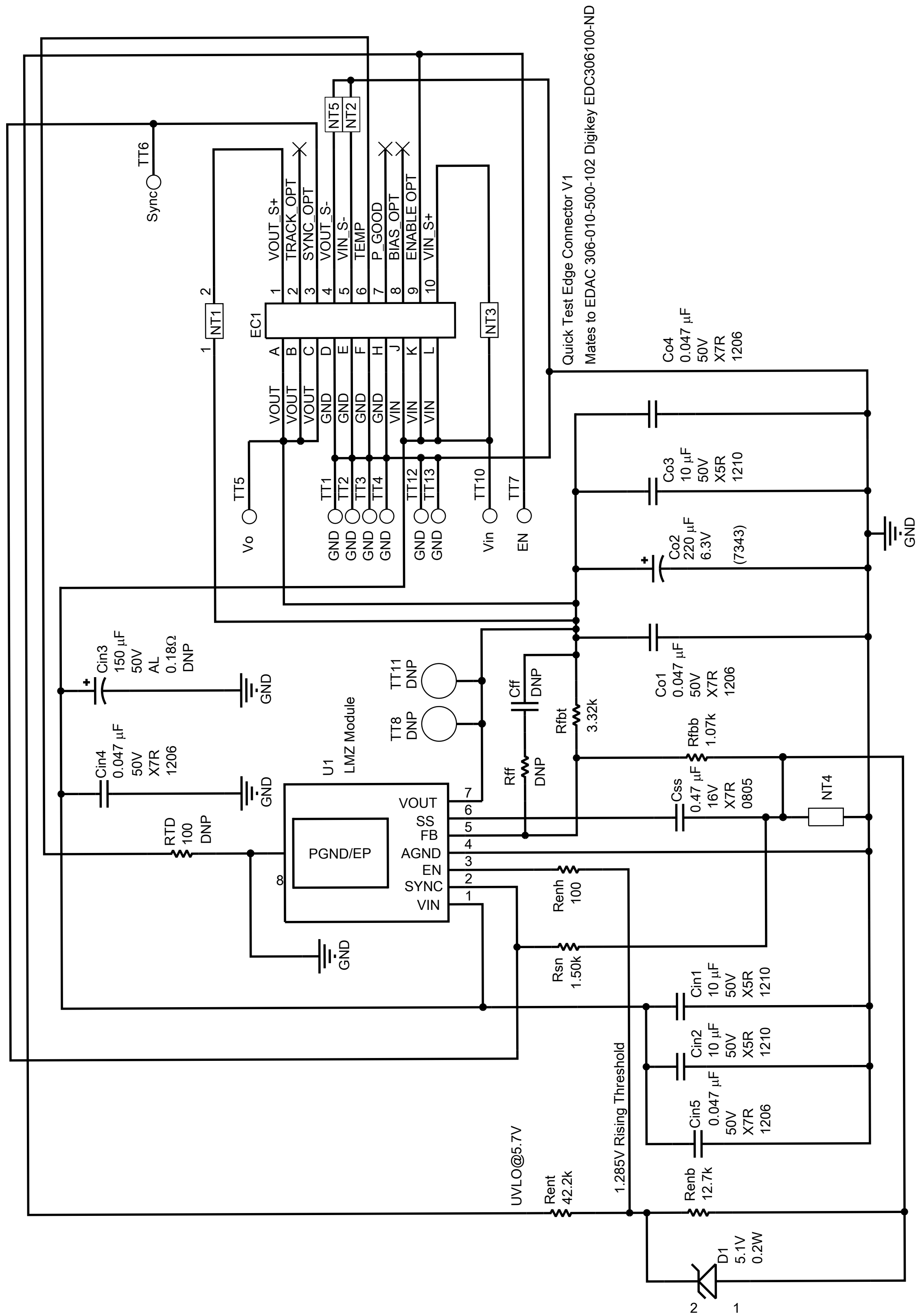


Figure 6. Bottom Layer (Ground) Heat Sinking Layer

8 Schematic



DNP = Component not populated

Figure 7. LMZ23605/03, LMZ22005/03 PCB CAD package schematic

9 Bill of Materials

Table 1. Bill of Materials (V_{IN} = 6V to Vmax 36V (20V), V_{OUT} = 3.3V, $I_{OUT\ (MAX)}$ = 5A (3A))[(1)]

Designator	Description	Case Size	Manufacturer	Manufacturer P/N	Qty
U1	SIMPLE SWITCHER®	PFM-7	Texas Instruments	LMZ23605, LMZ23603, LMZ22005, LMZ22003	1
C_{IN}4, C_{IN}5, C_O1, C_O4,	0.047 µF, X7R, 50V	1206	Yageo America	CC1206KZX7R9BB473	4
C_{IN}1, C_{IN}2	10 µF, X5R, 50V	1210	Taiyo Yuden	UMK325BJ106MM-T	2
C_{IN}3 OPT	150 µF,Aluminum Electrolytic, 50V	G	Panasonic	EEE-FK1H151P	1
C_O3	10 µF, X5R, 50V	1210	TDK	UMK325BJ106MM-T	1
C_O2	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_{FF}	DNP				
R_{SN}	1.50 kΩ	0805	Vishay-Dale	CRCW08051K50FKEA	1

(1) The same BOM applies to all implementations.