User's Guide
SNVU608–December 2018

LM5155EVM-BST User's Guide

The LM5155EVM-BST evaluation module showcases the features and performance of the LM5155 device, wide input voltage, non-synchronous boost controller. The standard configuration is designed to provide a regulate output of 24 V at 48 W from an input of 6 V to 18 V, switching at a frequency of 440 kHz. The module is designed for ease of configuration, enabling a user to evaluate different applications on the same module. Functionality includes external clock synchronization, programmable slope compensation, adjustable soft-start, programmable cycle-by-cycle current limit and output over voltage protection.

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Trademarks

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1 Features and Electrical Performance

The LM5155EVM-BST supports the following features and performance capabilities:

- Tightly regulated output voltage of 24 V with 1% accurate reference voltage
- High conversion efficiency of > 93% at full load.
- Constant cycle-by-cycle peak inductor current limit over input voltage range
- User adjustable soft-start time using C_{SS}
- Output over-voltage protection
- Multiple BIAS pin and VCC pin connections to test multiple configurations
  - BIAS connect to VCC
  - BIAS supplied with external power supply
  - VCC supplied by external power supply
  - BIAS supplied by output voltage
- Power good (PGOOD) indicator with selectable pull-up source
- 440kHz Switching frequency
- External clock synchronization
- Programable slope compensation

1.1 Electrical Parameters

Table 1. Electrical Performance Standard Configuration

Parameter	Test Conditions	MIN	TYP	MAX	UNIT
INPUT CHARACTERISTICS					
Input voltage Range V_{IN}	Operation	6	12	18	V
Input voltage turn on $V_{IN(ON)}$	Adjusted by the UVLO/SYNC resistors		5.8		V
Input voltage turn off $V_{IN(OFF)}$			5.5		V
OUTPUT CHARACTERISTICS					
Output Voltage V_{OUT}			24		V
Maximum Output Current I_{OUT}			2		A
Output Over-voltage V_{OUT_OV}			26.9		V
SYSTEM CHARACTERISTICS					
Switching frequency			440		kHz
External Clock Synchronization		375		505	kHz
Full load efficiency	V_{IN} =6V, I_{OUT} = 2A		93.3		%
Junction Temperature, T_J		-40		150	C

1.2 Configuration Points

Table 2 indicates the available test points and configuration jumpers. These points offer flexibility in configuring the evaluation module and include but are not limited to;

- BIAS pin to be connected to:
  - External supply (VAUX)
  - Input voltage (VIN)
  - Regulated output voltage (VOUT)
  - VCC pin
- PGOOD pin to be supplied by either VCC or VAUX
- External clock synchronization
- Shut-down signal by pulling the UVLO pin low.

Table 2. Jumper Description

Jumper	Pin	Description
TP1	VIN	Positive input voltage sense connection
TP2	SW	Probe point for the switch node of the LM5155 boost circuit
TP3	VOUT	Positive output voltage sense connection
TP4	VIN-	Negative input voltage sense connection
TP5	GND	Negative output voltage sense connection
TP6	VCCext	Supply VCC from and external supply. Note VCCext must be less than the voltage on the BIAS pin.
TP7	VAUX	Supply the BIAS pin from and external supply. R12 also connect to this rail
TP8	VOUT+	Loop response positive injection point
TP9	VOUT-	Loop response negative injection point
TP10	SYNC	Input for external clock synchronization
TP11	SD	High signal pulls UVLO pin to ground entering shutdown mode
J6	Pin 1 to pin 2	Connect VOUT to the BIAS pin of the LM5155 through D3
	Pin 2 to pin 3	Directly connect VOUT to BIAS pin of the LM5155
J7	Pin 1 to pin 2	Connect VIN to the BIAS pin of the LM5155 through D4
	Pin 2 to pin 3	Directly connect VIN to BIAS pin of the LM5155
J8	Pin 1 to pin 2	Directly Connect VCC to the BIAS pin
J9	Pin 1 to pin 2	Directly connect VAUX to the BIAS pin
J10	VCC (Pin 1)	Monitor the VCC pin
	BIAS-IC (Pin 2)	Monitor the BIAS pin
	PGOOD (Pin 3)	Monitor the PGOOD pin
	COMP (Pin 4)	Monitor the COMP pin
	SS (Pin 5)	Monitor the SS pin
	UVLO (Pin 6)	Monitor the UVLO pin
	AGND (Pin 7)	Connection to AGND plan

2 Application Schematic

The LM5155EVM-BST is capable of multiple configurations. Figure 1 shows the standard configuration of the LM5155EVM-BST for which the parameters in Table 1 are valid. Section 4.2 describes the correct jumper settings and measurement locations recreate the data presented in Section 5.

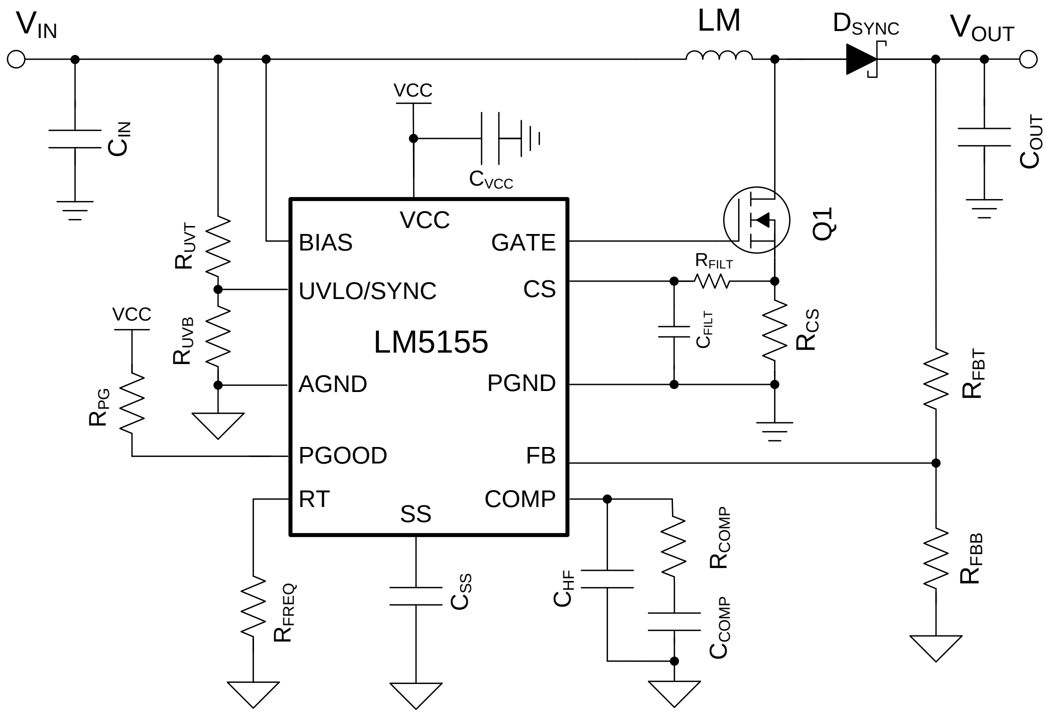

Figure 1. Application Circuit

3 EVM Photo

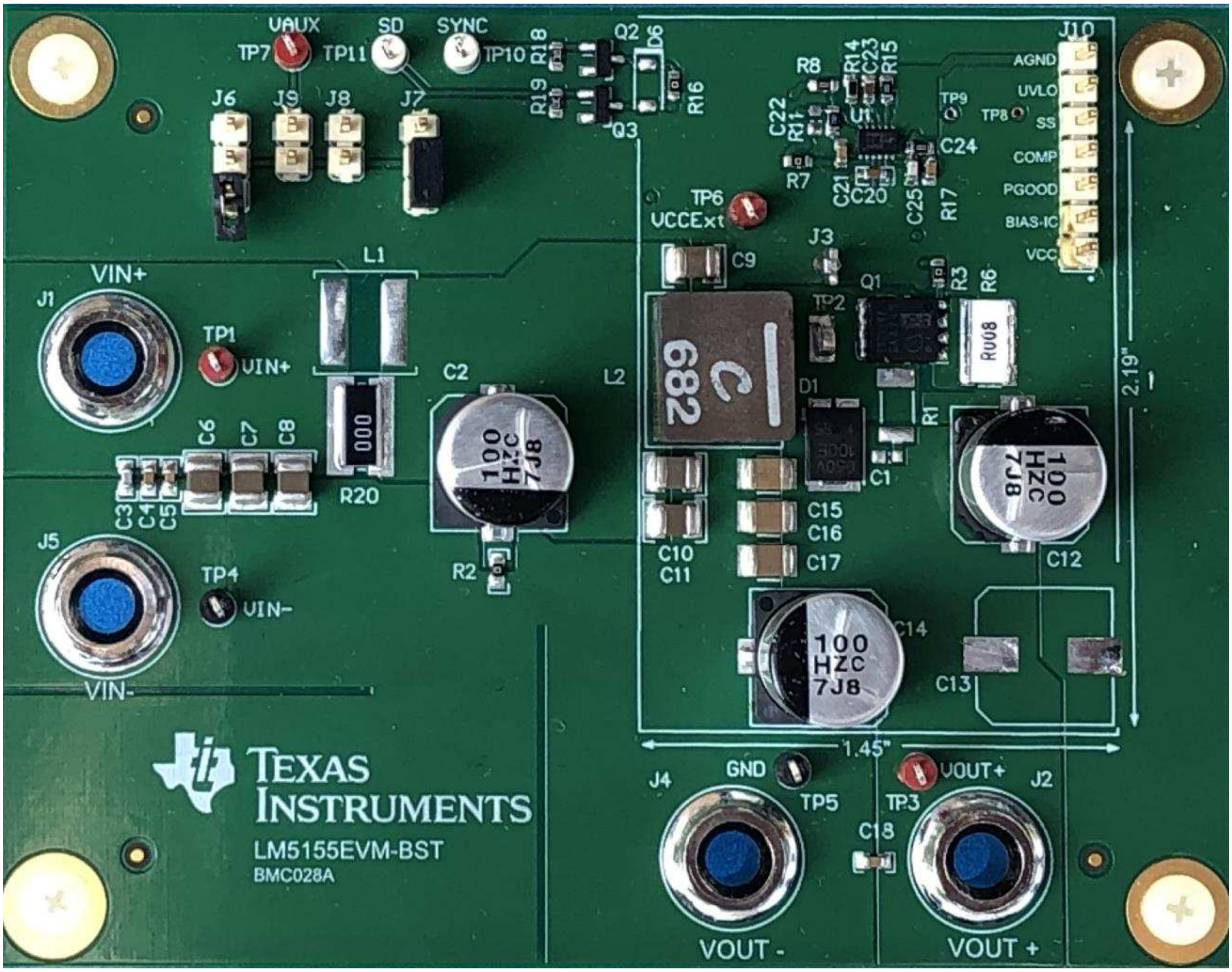

Figure 2. EVM Photo

4 Test Setup and Procedure

4.1 Test Setup

Figure 3 shows the correct jumper positions to configure the evaluation module for the typical application, as shown in Figure 1. The correct equipment connections and measurement points are shown in Table 3

Table 3. Standard Configuration Jumper Connections

Jumper	Position
J6	Jumper from pin 1 to pin 2

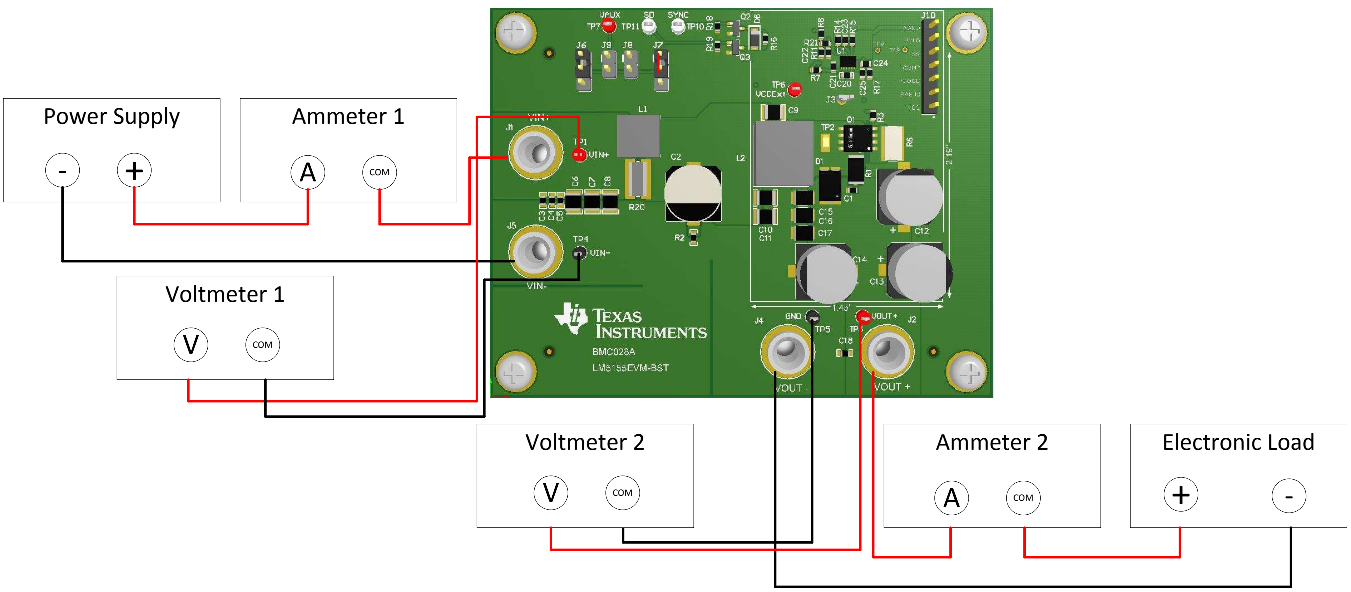

Figure 3. Test Setup

4.2 Test Equipment

Power Supply: The input voltage source (VIN) should be a variable supply capable of 0V to 20V and source at least 15A.

Multi-meters:

- Voltmeter 1: Input voltage, connect from VIN to VIN-
- Voltmeter 2: Output voltage, connect from VOUT to GND
- Ammeter 1: Input current, must be able to handle 15A. Shunt resistor can be used as needed.
- Ammeter 2: Output current, must be able to handle 2A. Shunt resistor can be used as needed.

Electronic Load: The load should be constant resistance (CR) or constant current (CC) capable. It should safely handle 2A at 24V.

Oscilloscope: 20-MHz bandwidth and AC coupling. Measure the output voltage ripple directly across an output capacitor with a short ground lead. It is not recommended to use a long-leaded ground connection due to the possibility of noise being coupled into the signal. To measure other waveforms, adjust the oscilloscope as needed.

5 Test Results

Figure 4 through Figure 19 present the typical performance of the LM5155EVM-BST according to the BOM and the configuration described in Section 4. Based on measurement techniques and environmental variables measurements might differ slightly than the data presented.

5.1 Efficiency Curves

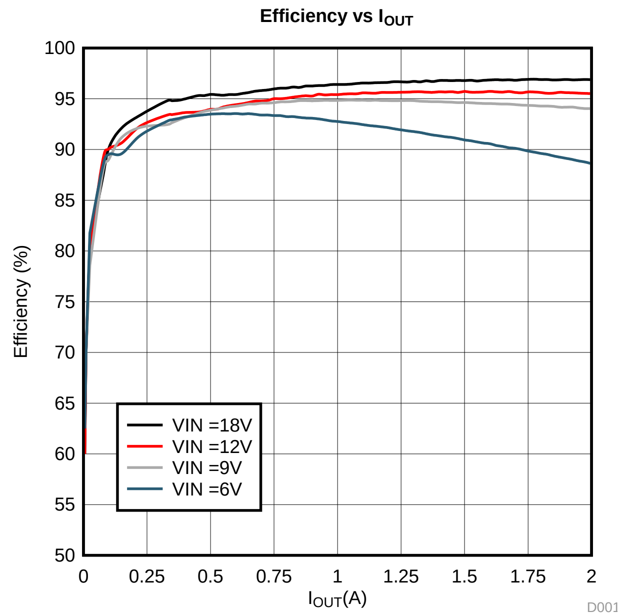

Figure 4. Efficiency vs Load

5.2 Load Regulation Curves

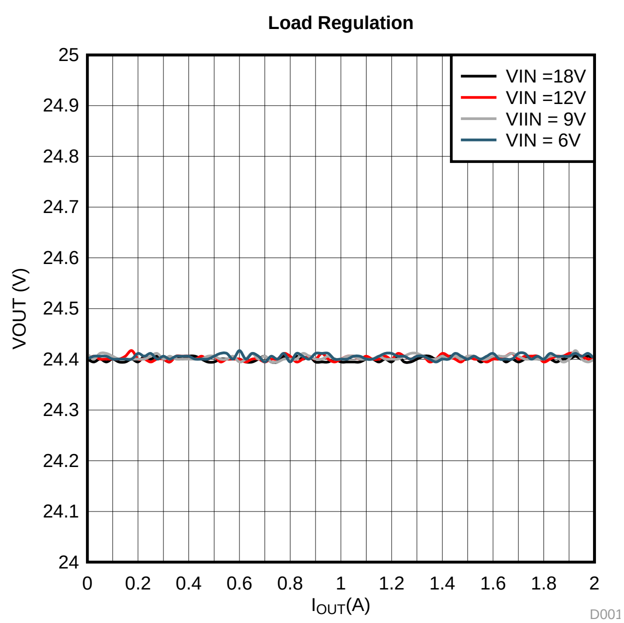

Figure 5. Load Regulation

5.3 Thermal Performance

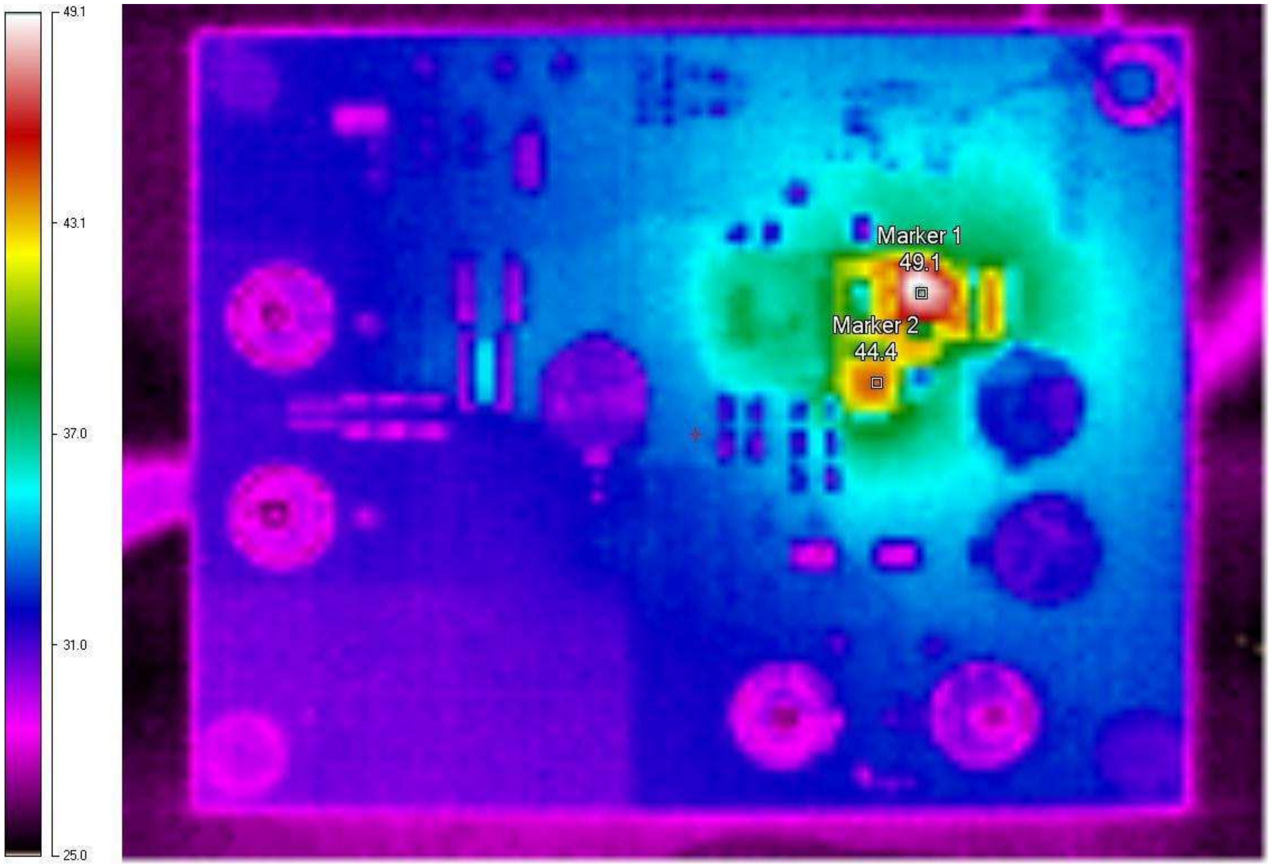

Figure 6. Thermal Image V_{IN} = 6 V I_{OUT} = 2 A, No forced air cooling

5.4 Steady State Waveforms

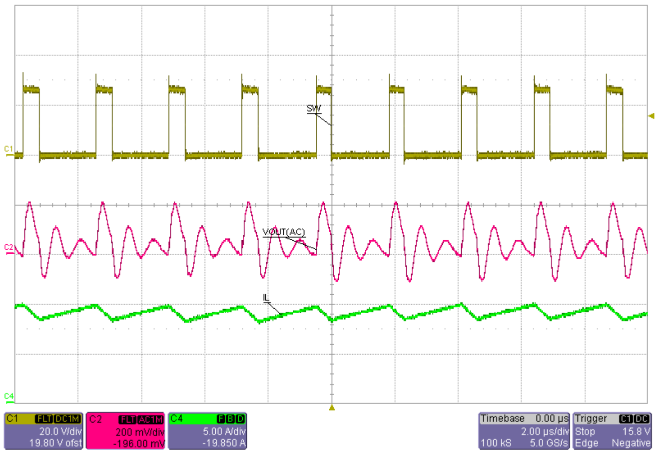

Figure 7. Steady State, V_{IN} = 6 V, I_{OUT} = 2 A

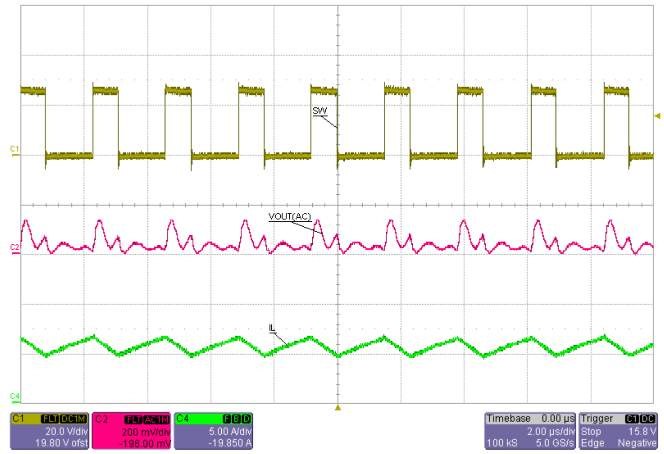

Figure 8. Steady State, V_{IN} = 9 V, I_{OUT} = 2 A

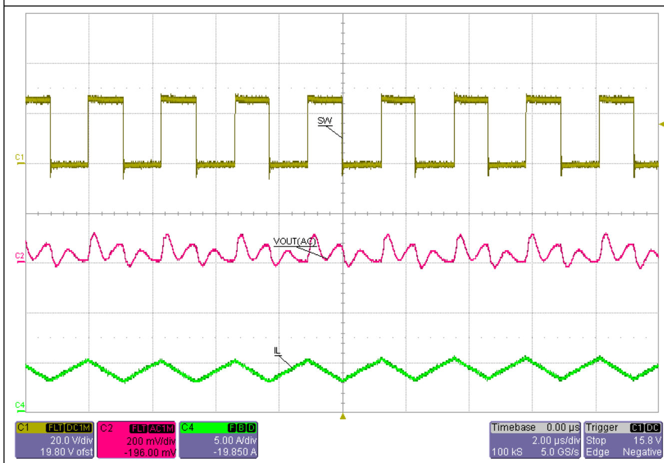

Figure 9. Steady State, V_{IN} = 12 V, I_{OUT} = 2 A

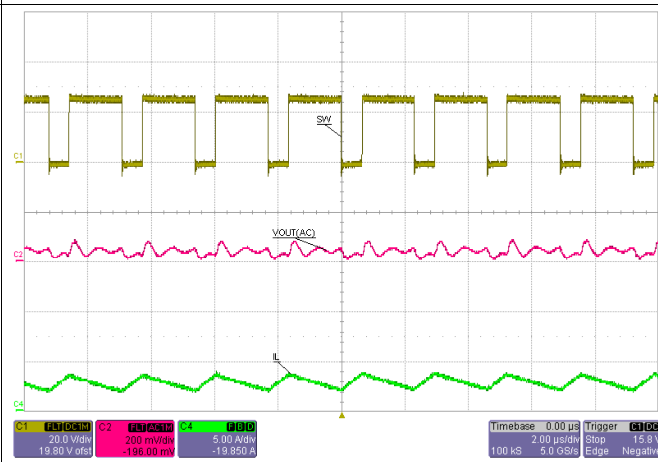

Figure 10. Steady State, V_{IN} = 18 V, I_{OUT} = 2 A

5.5 Start-Up Waveforms

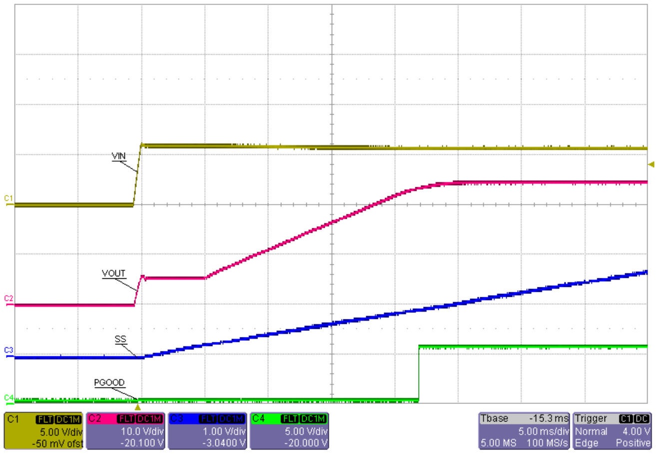

Figure 11. Start-Up, V_{IN} = 6 V, I_{OUT} = 2 A

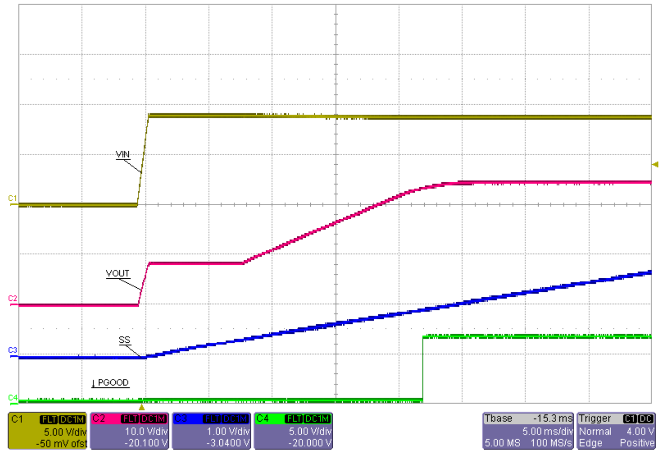

Figure 12. Start-Up, V_{IN} = 9 V, I_{OUT} = 2 A

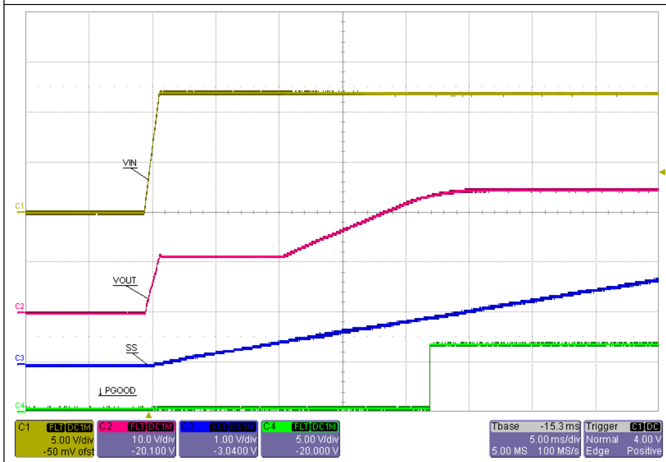

Figure 13. Start-Up, V_{IN} = 12 V, I_{OUT} = 2 A

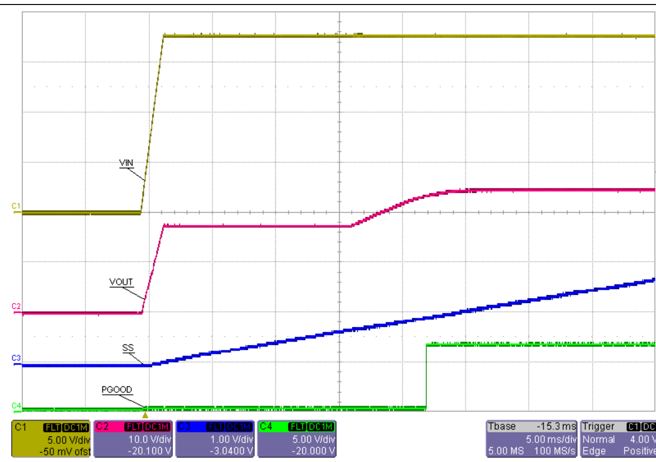

Figure 14. Start-Up, V_{IN} = 18 V, I_{OUT} = 2 A

5.6 Load Transient Waveforms

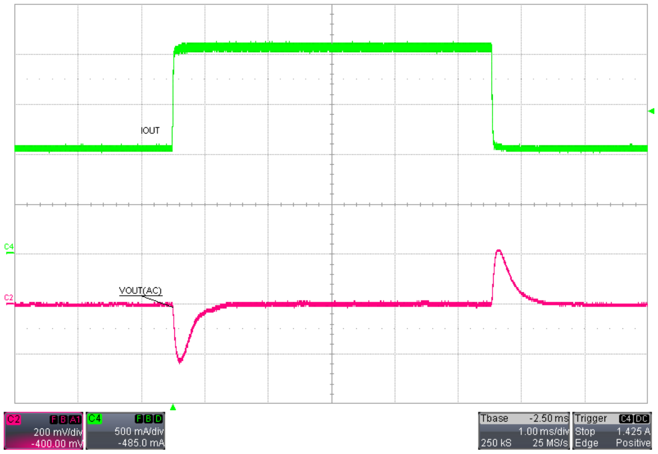

Figure 15. Load Transient, V_{IN} = 6 V, I_{OUT} = 1 A to 2 A

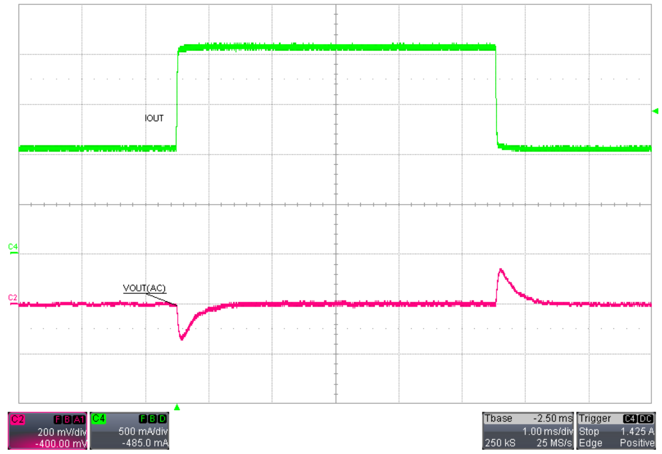

Figure 16. Load Transient, V_{IN} = 9 V, I_{OUT} = 1 A to 2 A

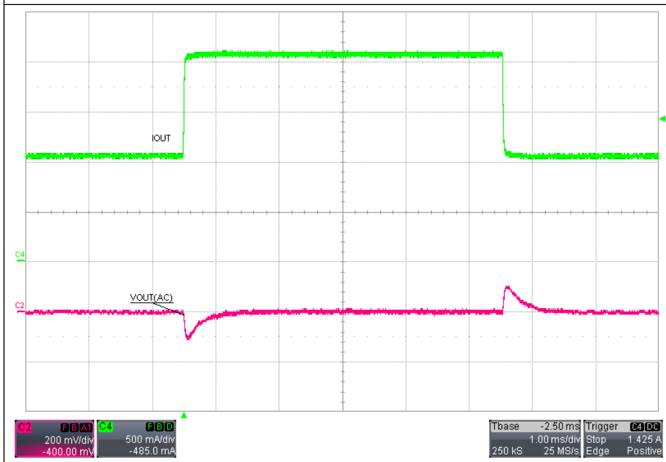

Figure 17. Load Transient, V_{IN} = 12 V, I_{OUT} = 1 A to 2 A

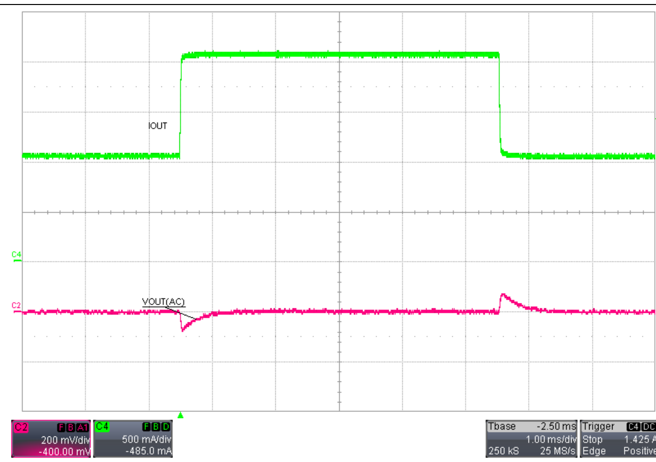

Figure 18. Load Transient, V_{IN} = 18 V, I_{OUT} = 1 A to 2 A

5.7 AC Loop Response Curves

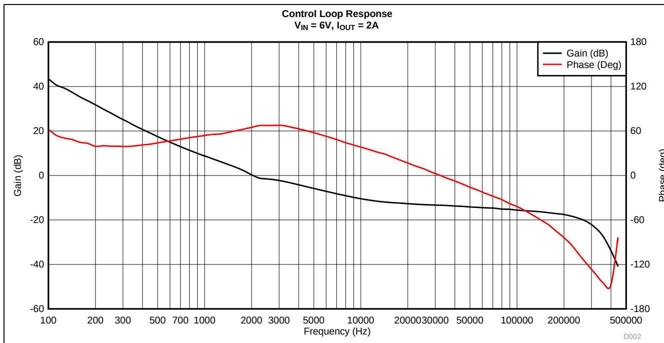

Figure 19. Control Loop Response, V_{IN} = 6 V, I_{OUT} = 2A

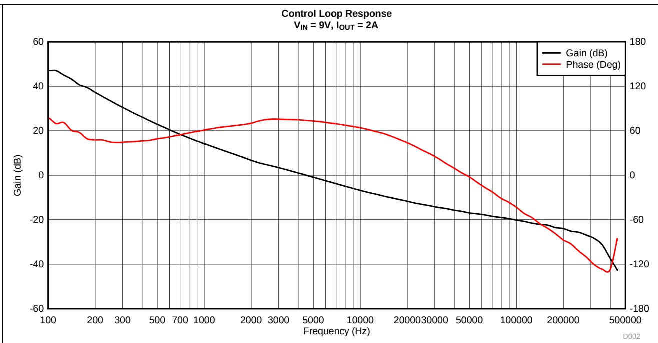

Figure 20. Control Loop Response, V_{IN} = 9 V, I_{OUT} = 2 A

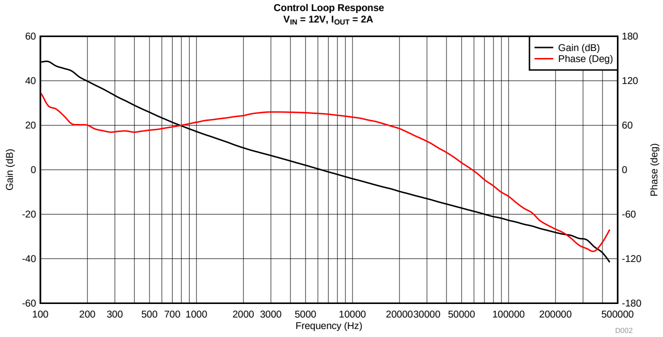

Figure 21. Control Loop Response, V_{IN} = 12 V, I_{OUT} = 2 A

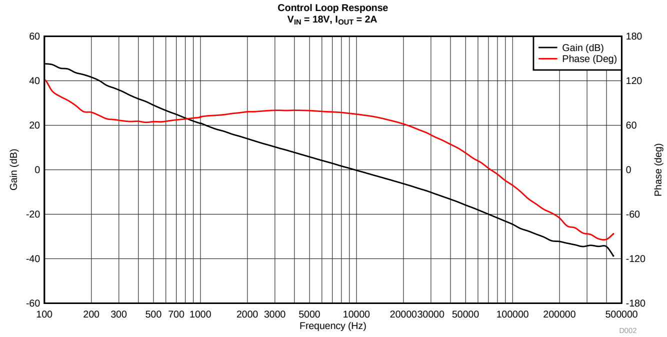

Figure 22. Control Loop Response, V_{IN} = 18 V, I_{OUT} = 2 A

6 Design Files

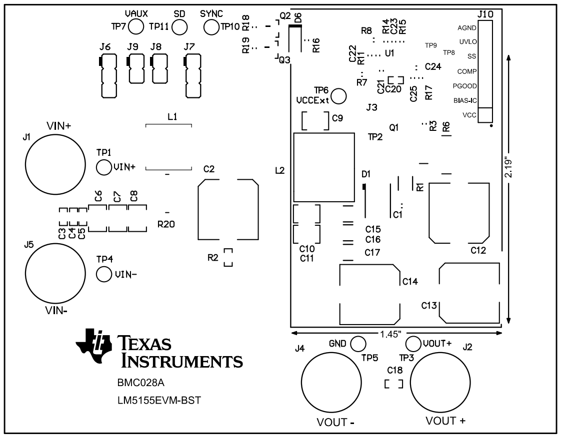

Figure 23. Top Silkscreen

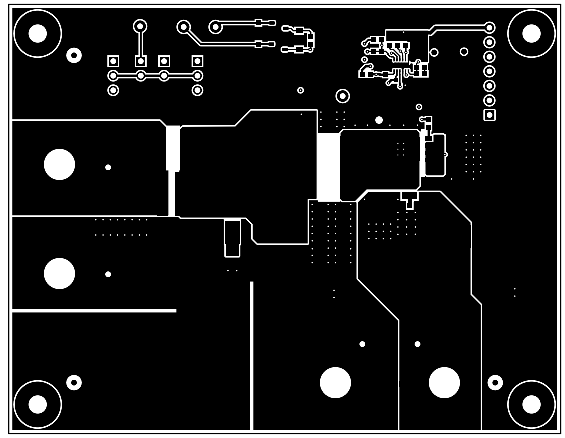

Figure 24. Top Layer

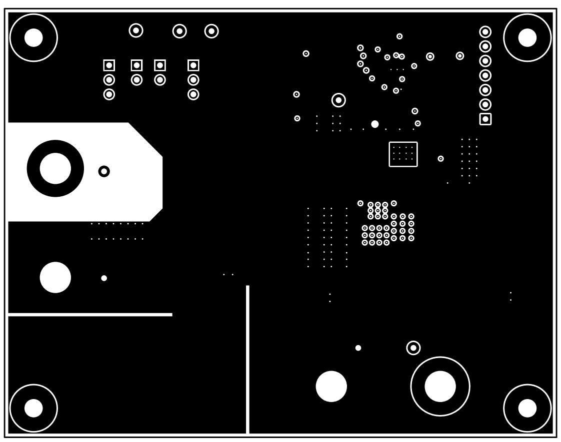

Figure 25. Signal Layer 1

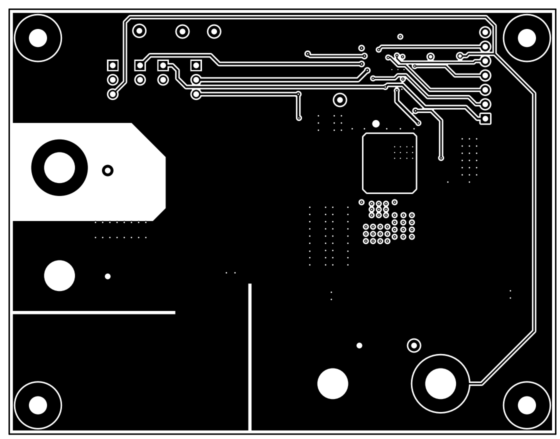

Figure 26. Signal Layer 2

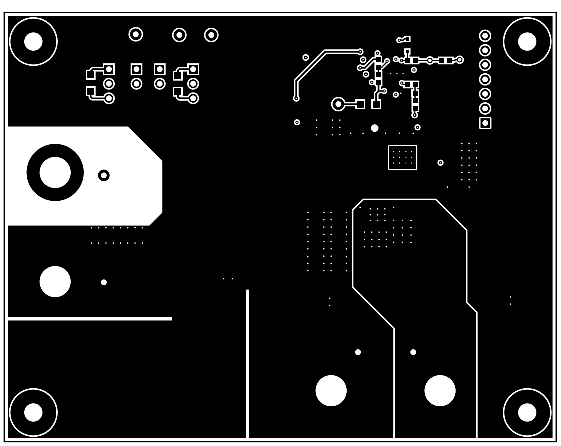

Figure 27. Bottom Layer

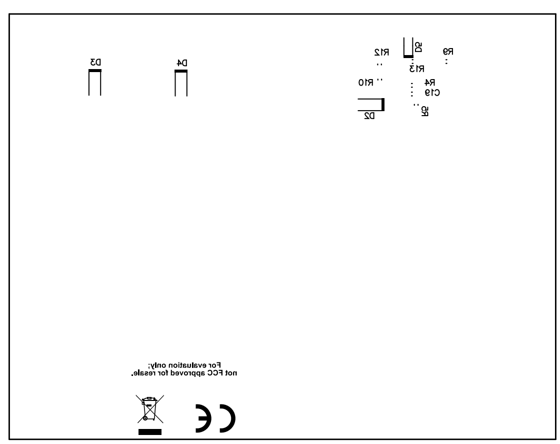

Figure 28. Bottom Silkscreen

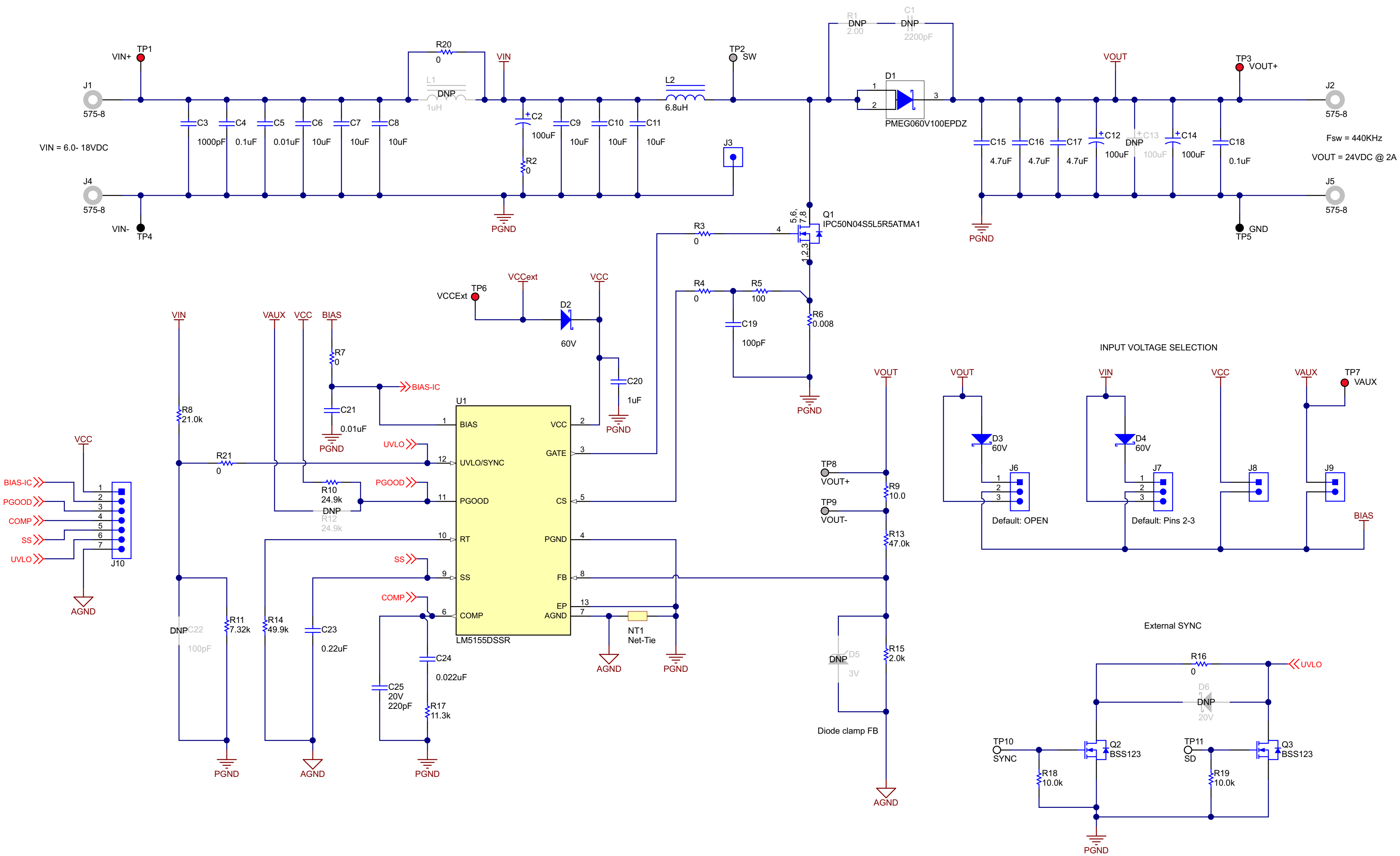

Figure 29. LM5155EVM-BST Schematic

Table 4. LM5155EVM-BST Bill of Materials

Designator	Qty	Value	Description	PackageReference	PartNumber	Manufacturer
!PCB1	1		Printed Circuit Board		BMC028	Any
C2	1	100uF	CAP, Polymer Hybrid, 100 uF, 50 V, +/- 20%, 28 ohm, 10x10 SMD	10x10	EEHZC1H101P	Panasonic
C3	1	1000pF	CAP, CERM, 1000 pF, 50 V, +/- 10%, X7R, 0603	0603	C0603X102K5RACTU	Kemet
C4, C18	2	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, 0603	0603	C1608X7R1H104K080AA	TDK
C5, C21	2	0.01uF	CAP, CERM, 0.01 uF, 50 V, +/- 10%, X7R, 0603	0603	CL10B103KB8NCNC	Samsung Electro-Mechanics
C6, C7, C8, C9, C10, C11	6	10uF	CAP, CERM, 10 uF, 50 V, +/- 10%, X7R, 1210	1210	GRM32ER71H106KA12L	MuRata
C12, C14	2	100uF	CAP, Aluminum Polymer, 100 uF, 50 V, +/- 20%, 0.025 ohm, AEC-Q200 Grade 2, D10xL10mm SMD	D10xL10mm	HHXB500ARA101MJA0G	Chemi-Con
C15, C16, C17	3	4.7uF	CAP, CERM, 4.7 uF, 50 V, +/- 10%, X7R, 1210	1210	C3225X7R1H475K250AB	TDK
C19	1	100pF	CAP, CERM, 100 pF, 50 V,+/- 1%, C0G/NP0, 0603	0603	C0603C101F5GACTU	Kemet
C20	1	1uF	CAP, CERM, 1 uF, 16 V, +/- 20%, X7R, AEC-Q200 Grade 1, 0603	0603	GCM188R71C105MA64D	MuRata
C23	1	0.22uF	CAP, CERM, 0.22 uF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0603	0603	CGA3E3X7R1H224K080AB	TDK
C24	1	0.022uF	'CAP, CERM, 0.022 uF, 100 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0603	0603	CGA3E2C0G1H221J080AA	TDK
C25	1	220pF	'CAP, CERM, 220 pF, 20 V, +/- 5%, C0G/NP0, AEC-Q200 Grade 1, 0603	0603	CGA3E2C0G1H221J080AA	TDK
D1	1	60V	'Diode, Schottky, 60 V, 10 A, AEC-Q101, CFP15	CFP15	PMEG060V100EPDZ	Nexperia
D2, D3, D4	3	60V	Diode, Schottky, 60 V, 1 A, SOD-123F	SOD-123F	PMEG6010CEH,115	Nexperia

Table 4. LM5155EVM-BST Bill of Materials (continued)

H1, H2, H3, H4	4		Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	Screw	NY PMS 440 0025 PH	B&F Fastener Supply
H5, H6, H7, H8	4		Standoff, Hex, 0.5-inch L #4-40 Nylon	Standoff	1902C	Keystone
J1, J2, J4, J5	4		Standard Banana Jack, Uninsulated, 8.9mm	Keystone575-8	575-8	Keystone
J3	1		TEST POINT SLOTTED .118 inch, TH	Test point, TH Slot Test point	1040	Keystone
J6, J7	2		Header, 2.54 mm, 3x1, Gold, TH	Header, 2.54 mm, 3x1, TH	GBC03SAAN	Sullins Connector Solutions
J8, J9	2		Header, 2.54 mm, 2x1, Gold, TH	Header, 2.54 mm, 2x1, TH	GBC02SAAN	Sullins Connector Solutions
J10	1		Header, 100mil, 7x1, Gold, TH	7x1 Header	TSW-107-07-G-S	Samtec
L2	1	6.8uH	Inductor, Shielded, Composite, 6.8 uH, 18.5 A, 0.01 ohm, SMD	Inductor, 11.3x10x10mm	XAL1010-682MEB	Coilcraft
Q1	1	40V	MOSFET, N-CH, 40 V, 50 A, AEC-Q101, SON-8	SON-8	IPC50N04S5L5R5ATMA1	Infineon Technologies
Q2, Q3	2	100V	MOSFET, N-CH, 100 V, 0.17 A, SOT-23	SOT-23	BSS123	Fairchild Semiconductor
R2, R7, R21	3	0	RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	ERJ-3GEY0R00V	Panasonic
R3, R4, R16	3	0	RES, 0, 5%, 0.1 W, 0603	0603	RC0603JR-070RL	Yageo
R5	1	100	RES, 100, 1%, 0.1 W, 0603	0603	RC0603FR-07100RL	Yageo
R6	1	0.008	RES, 0.008, 1%, 3 W, AEC-Q200 Grade 0, 2512 WIDE	2512 WIDE	KRL6432E-M-R008-F-T1	Susumu Co Ltd
R8	1	21.0k	RES, 21.0 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060321K0FKEA	Vishay-Dale
R9	1	10.0	RES, 10.0, 1%, 0.1 W, 0603	0603	RC0603FR-0710RL	Yageo
R10	1	24.9k	RES, 24.9 k, 1%, 0.1 W, 0603	0603	RC0603FR-0724K9L	Yageo
R11	1	7.32k	RES, 7.32 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW06037K32FKEA	Vishay-Dale
R13	1	47.0k	RES, 47.0 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060347K0FKEA	Vishay-Dale

Table 4. LM5155EVM-BST Bill of Materials (continued)

R14	1	49.9k	RES, 49.9 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060349K9FKEA	Vishay-Dale
R15	1	2.0k	RES, 2.0 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW06032K00JNEA	Vishay-Dale
R17	1	11.3k	RES, 11.3 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060311K3FKEA	Vishay-Dale
R18, R19	2	10.0k	RES, 10.0 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060310K0FKEA	Vishay-Dale
R20	1	0	RES, 0, 5%, 2 W, 2512 WIDE	2512 WIDE	RCL12250000Z0EG	Vishay Draloric
SH-J1	1		Single Operation 2.54mm Pitch Open Top Jumper Socket	Single Operation 2.54mm Pitch Open Top Jumper Socket	M7582-05	Harwin
TP1, TP3, TP6, TP7	4		Test Point, Miniature, Red, TH	Red Miniature Testpoint	5000	Keystone
TP4, TP5	2		Test Point, Miniature, Black, TH	Black Miniature Testpoint	5001	Keystone
TP10, TP11	2		Test Point, Miniature, White, TH	White Miniature Testpoint	5002	Keystone
U1	1		2.2-MHz Wide Input Nonsynchronous Boost, Sepic, Flyback Controller, DSS0012B (WSON-12)	DSS0012B	LM5155DSSR	Texas Instruments

IMPORTANT NOTICE AND DISCLAIMER

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