EVM-1001 User Manual

EVM020W12V with PerFET™ MOSFET in Synchronous buck converter

Content

1. EVM Performance Specifications 4
2. Application Circuit Diagram 5
3. Test Data and Performance Curves 6
4. EVM Photo 9
5. EVM Test setup 9
6. Documentation 10
7. Device and Documentation Support 16

WARNING

Please be sure to follow the setup and application instructions, including using all interface components within their recommended rated voltage and power ranges. Always take electrical safety precautions to ensure the personal safety of yourself and those working nearby.

Please keep all warnings and instructions properly for future reference.

The Evaluation Module (EVM) is an open-frame, non-enclosed printed circuit board assembly, intended exclusively for use in controlled development laboratory environments. It is intended to be operated solely by qualified professionals who have undergone appropriate training, possess the necessary technical expertise, and fully understand the safety hazards associated with high-voltage circuit design and operation.

Any use of the EVM outside its intended purpose is strictly prohibited by Taiwan Semiconductor Co., Ltd.(TSC).

Failure to adhere to the provided warnings and usage guidelines may lead to severe consequences, including serious personal injury, significant property damage, or fatal accidents resulting from electric shock or thermal burns.

Workspace Safety:

– Keep the workspace clean and organized, with a stable, non-conductive workbench surface.

– When the circuit is powered, a qualified observer must be present.

– The powered areas of the EVM and its interface electronic components must be equipped with effective barriers and signage indicating the presence of accessible high voltage to prevent accidental contact.

– All the circuits, evaluation modules, power supplies, meters, oscilloscopes, and other related equipment/instruments, used in development environments exceeding 75 VDC/50 VRMS must be placed on power panels equipped with Emergency Power Off protection features.

– Use adequately insulated clamps and wires to connect measurement probes and instruments. Avoid manual testing whenever possible.

Electrical Safety:

As a critical safety measure, always assume that all areas of the EVM may carry accessible high voltage and pose an electrical hazard.

– Power off the EVM and all its inputs, outputs, and electrical loads.
– Confirm that the EVM power is safely disconnected.
– Proceed with the necessary circuit configuration, wiring, and measurement setup.
– Once ready, power on the EVM as required.

Personal Safety Measures:

Appropriate personal protective equipment (PPE) must be worn at all times when operating or handling the EVM. This includes, but is not limited to, safety glasses with side shields and electrically insulated gloves. Optionally, place the EVM inside a transparent plastic enclosure with an interlock to prevent accidental contact.

Usage Limitations:

The EVM is intended strictly for evaluation, testing, and development purposes. It must not be incorporated into any commercial or production-level unit.

This EVM is designed for professionals with relevant technical training and may be powered by AC or high-voltage DC power supplies. Before operating this EVM, please read this user guide along with the safety documentation.

Failure to adhere to these requirements may result in serious personal injury, electrical hazards, or damage to equipment.

1. EVM Performance Specifications

Table 1. Electrical Performance Specifications.

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
INPUT CHARACTERISTICS					
Input voltage range, V_{IN}	Operating	16	24	54	V
Input voltage turnon, $V_{(ON)}$			14		V
Input voltage turnoff, $V_{(OFF)}$	Adjusted using EN/UVLO divider resistors		13		V
OUTPUT CHARACTERISTICS					
Output voltage, $V_{(OUT)}$	VIN = 16 V to 54 V, Airflow = 100LFM	11.8	12.0	12.2	V
Output current, $I_{(OUT)}$				12	A
Output voltage regulation, $V_{(OUT)}$	Line regulation V_{IN} = 18 V to 54 V			0.5	%
Output voltage ripple, $V_{(RIPPLE)}$	V_{IN} = 48 V		110		mV
Output overcurrent protection, $I_{(OCP)}$			18		A
SYSTEM CHARACTERISTICS (1)					
Switching frequency, $f_{(SW)}$	V_{IN} = 48 V		260		kHz
Half-load efficiency, $\eta_{(HL)}$	I_{OUT} = 6 A		94		%
Full-load efficiency, $\eta_{(FL)}$	I_{OUT} = 12 A		94.5		%

(1) The default output voltage of this EVM is 12 V.

2. Application Circuit Diagram

Figure 1 shows a simplified schematic of an LM5145-based synchronous buck regulator. The soft-start, current limit, and UVLO (EN/UVLO) components are included and can be configured according to the specific application requirements. The power MOSFET used is the **TQM063NH08CR** (80V / 6.3mΩ / PDFN56U), selected for a 54V input to 12V output conversion. To handle transient surges in the 54V input power system, the **SMAJ58CA** (TVS / 400W / SMA) is used. For reverse protection, the **TSUP5102** (100V / 5A / TO-277) Schottky diode is selected. Any other component ratings or options, please visit our website at Taiwan Semiconductor.

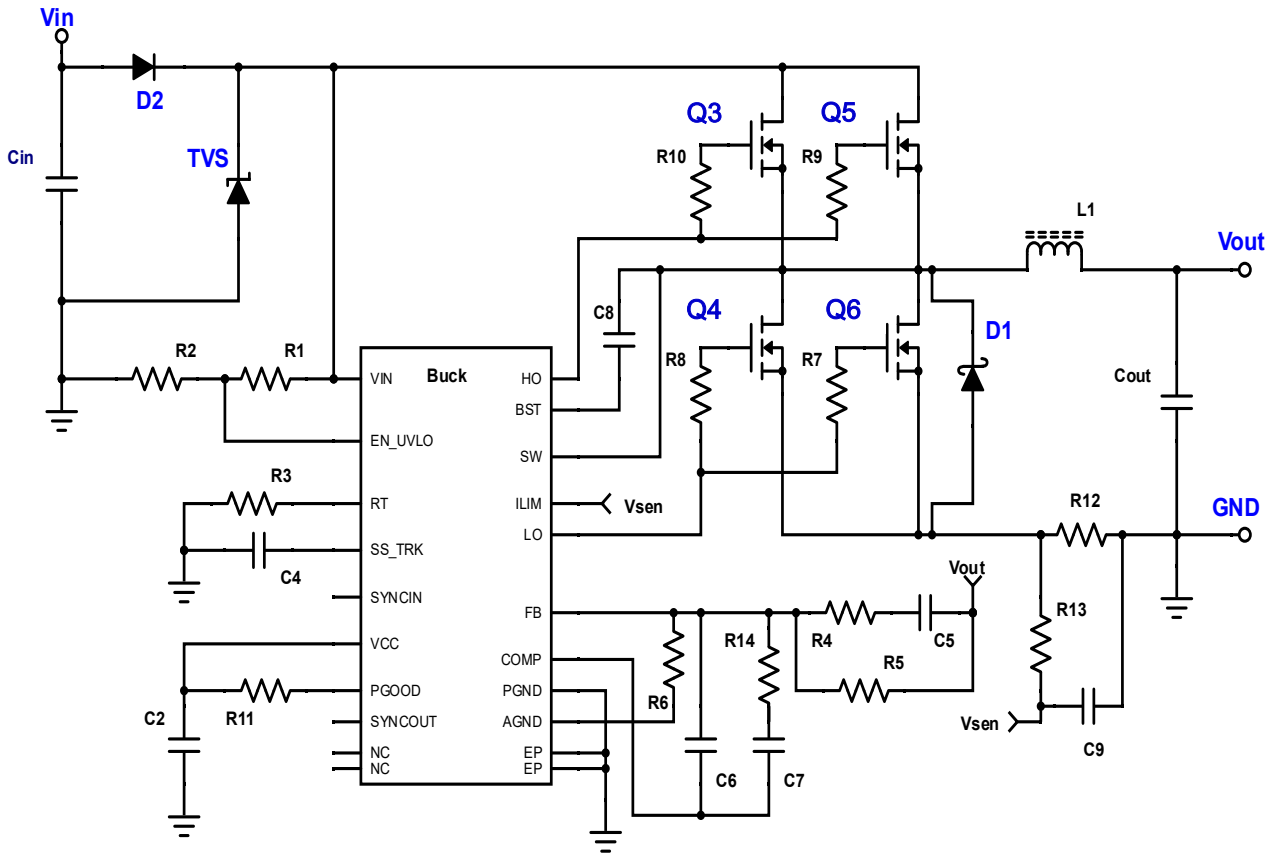

Figure 1. PerFET™ MOSFET Q3~Q6 apply in synchronous buck regulator simplified schematic

3. Test Data and Performance Curves

Figures 2 through 7 present the typical performance curves of the EVM020W12V. Please note that actual performance may vary due to measurement methodologies and environmental conditions; therefore, these curves are provided for reference only and may not accurately represent real-world results.

3.1 Conversion Efficiency

The output load ranges from 0 A to 12 A at 12 V, tested under input voltages of 24 V, 36 V, and 48 V.

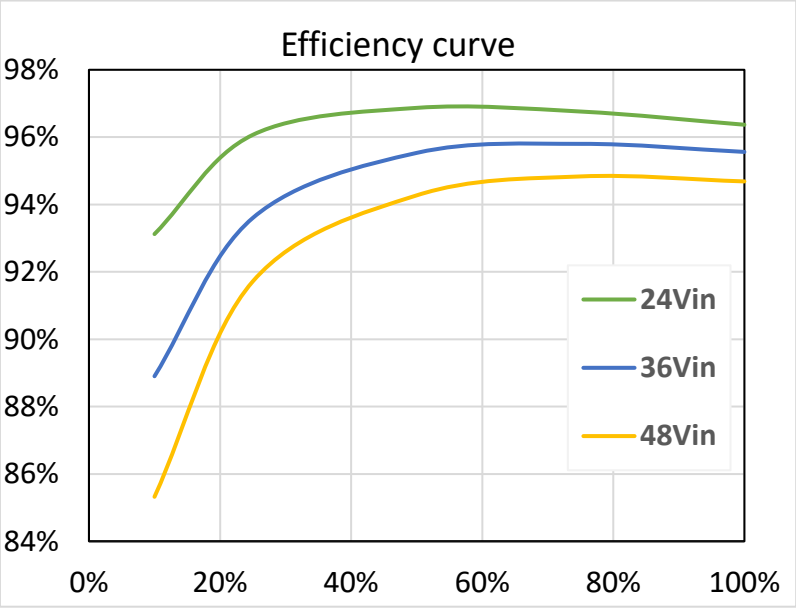

Figure 2. Efficiency curve at different input

3.2 Operating Waveforms

1. Switching

The PerFET™ MOSFET waveforms shown below are captured under input voltages of 24 V, 36 V, and 48 V DC.

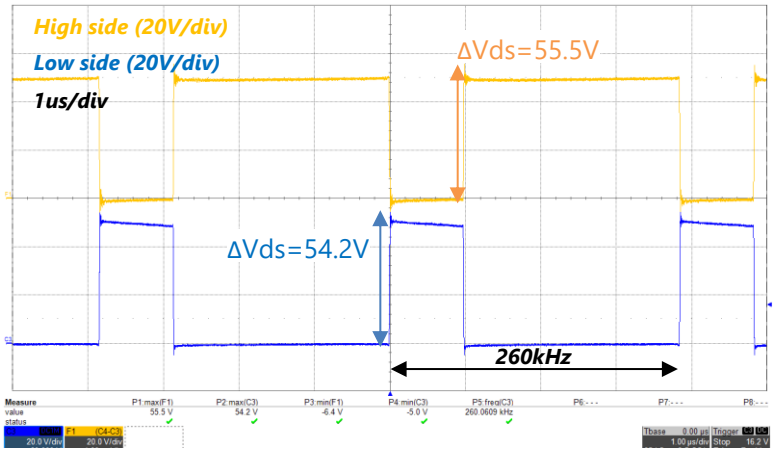

Figure 3. Drain to Source voltage at 48V input

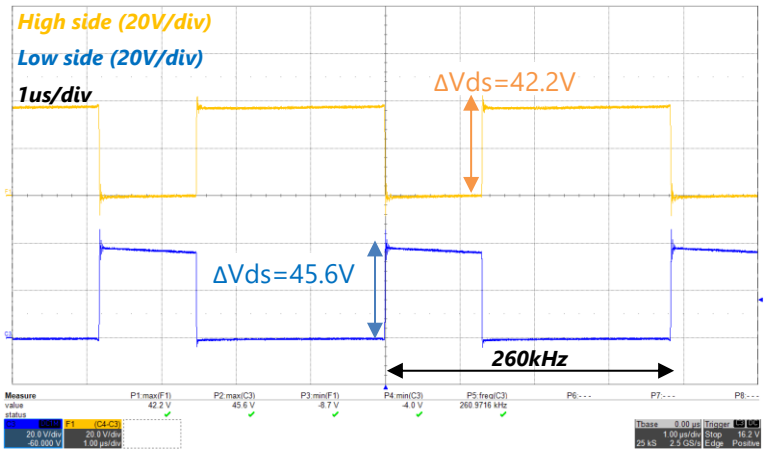

Figure 4. Drain to Source voltage at 36V input

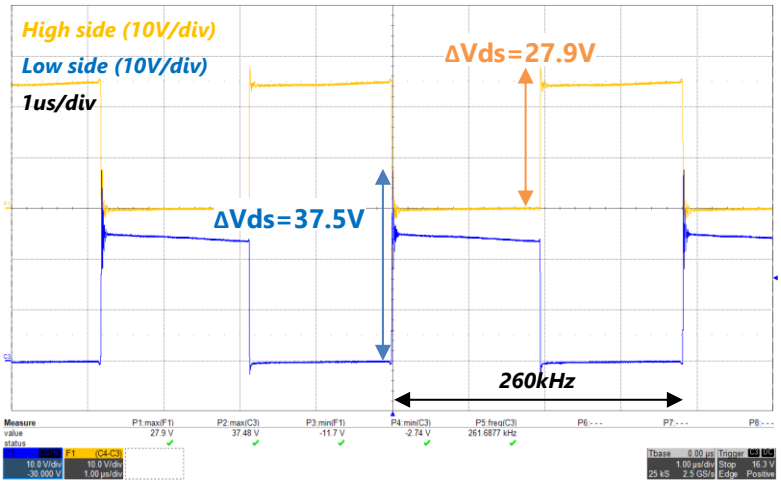

Figure 5. Drain to Source voltage at 24V input

2. Output Voltage Ripple

Measuring condition is input 48 V and the current output is 12Amp

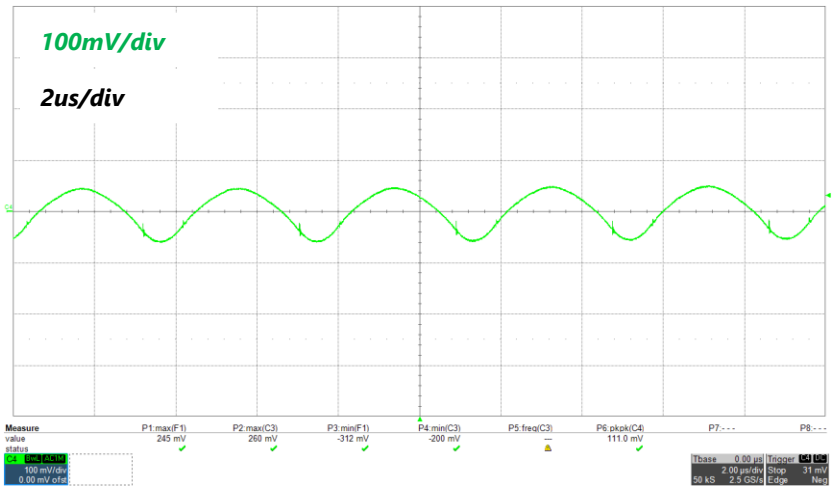

Figure 6. Output voltage ripple

3.3 Thermal Images at Full Load

Figure 7 shows the thermal images at full load with a 48V line voltage. The data was captured after a 30-minute thermal soak under fanless cooling conditions.

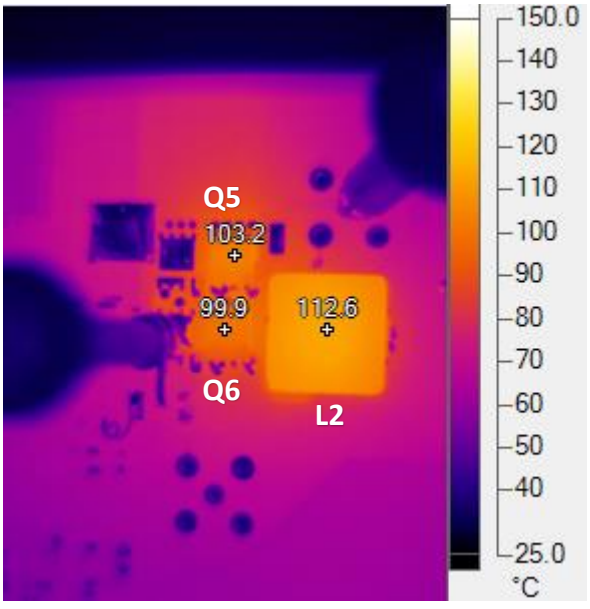

Figure 7. V_{IN} = 48V DC, Top Side

Thermal images are indicative only. Actual temperatures may vary based on ambient temperature and board orientation during testing.

4. EVM Photo

CAUTION
Caution Hot surface.
Contact may cause burns.

Figure 8. EVM020W12V Top Side

5. EVM Test setup

EVM12V is shown in Figure 9. When working at an ESD-protected workstation, ensure that all wrist straps, bootstraps, and mats are properly connected and grounded before applying power to the EVM.

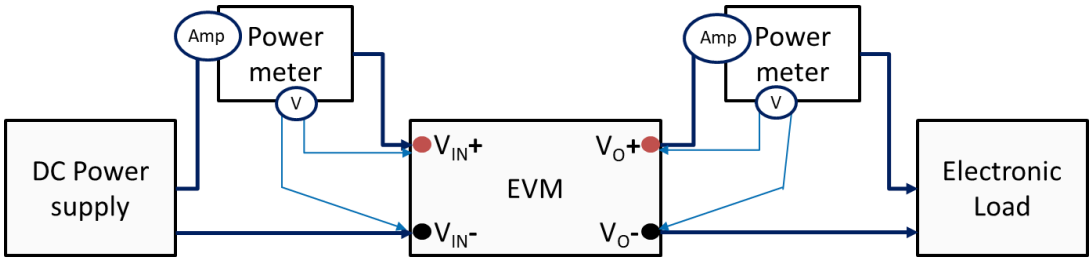

Figure 9 EVM Test setup

DC power supply:

The input voltage source V_{IN} should be a 0V to 54 V variable DC source capable of supplying 15 A.

Power meters:

- Voltmeter 1: Input voltage at V_{IN}+ to V_{IN}–.
- Voltmeter 2: Output voltage at V_O+ to V_O–.
- Ammeter 1: Input current.
- Ammeter 2: Output current.

Electronic Load:

The DC load should be a load capable of 0 A to 12 A at 12 V. For a no-load input current measurement, disconnect the electronic load as it may draw a small residual current.

Caution: Always treat all circuits as potentially energized and handle them with extreme care.

Note: Ensure EVM has been operated in an ESD-safe environment to prevent potential device damage. All measurements should be performed with properly calibrated equipment.

6. Documentation

6.1 Schematic

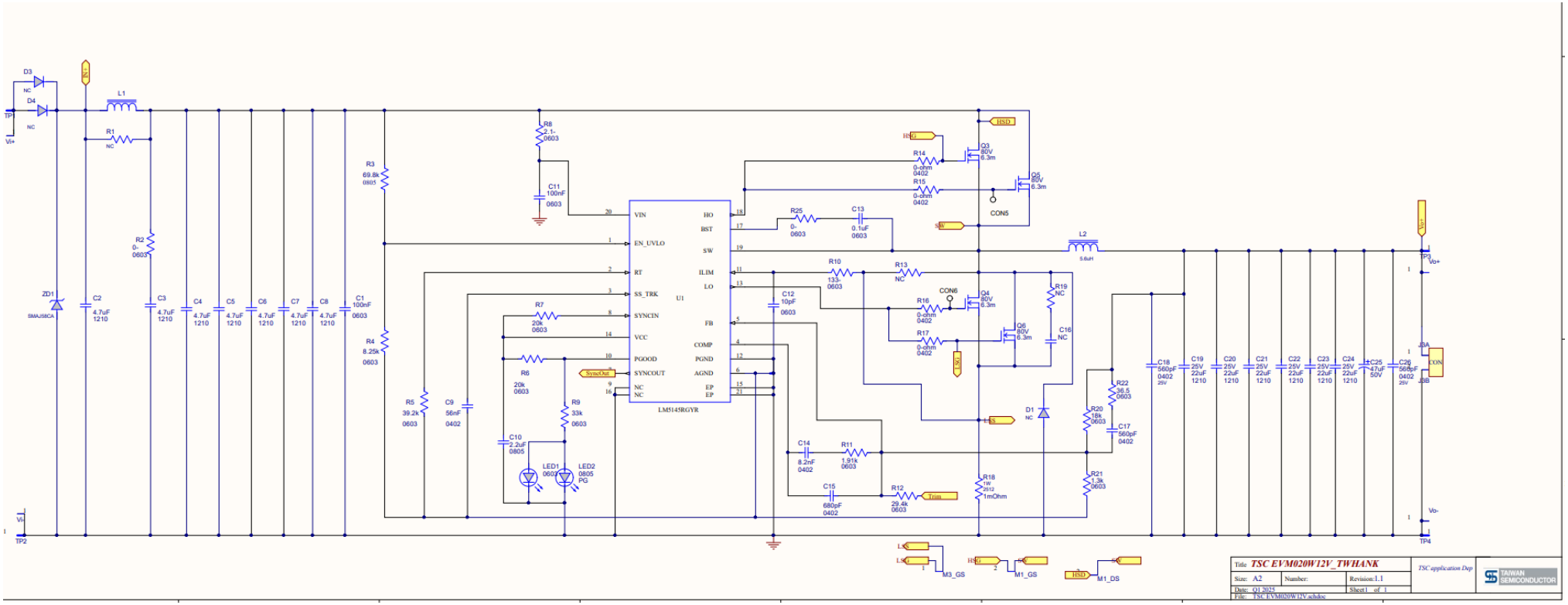

Figure 19. EVM Schematic

6.2 PCB Layout

Figure 11 through Figure 16 show the design of PerFET™ MOSFET using the EVM a 4-layer PCB with 2-oz copper thickness.

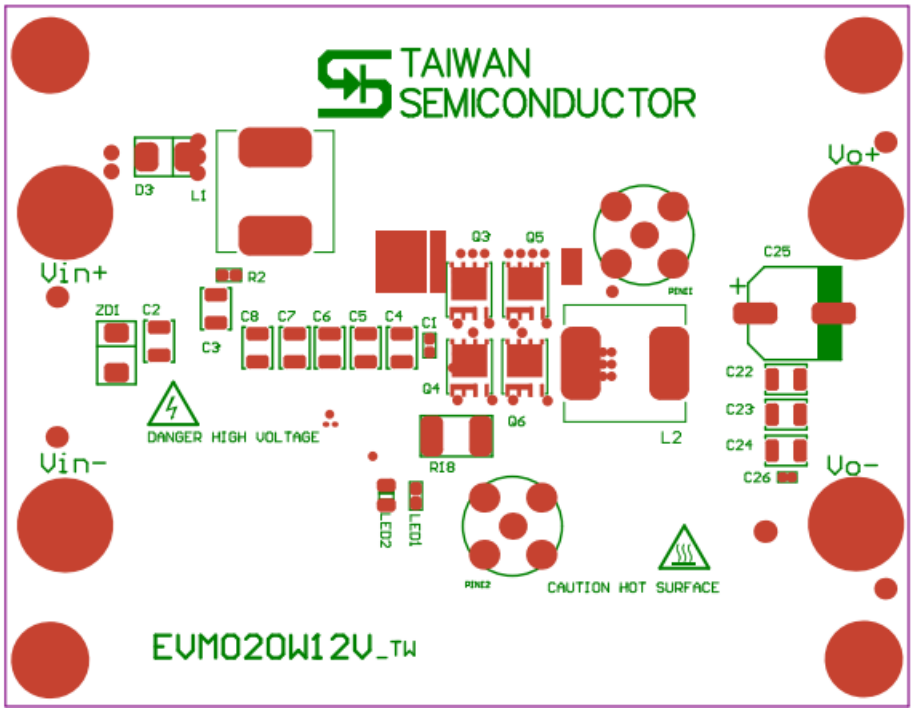

Figure 11. Top Component Drawing

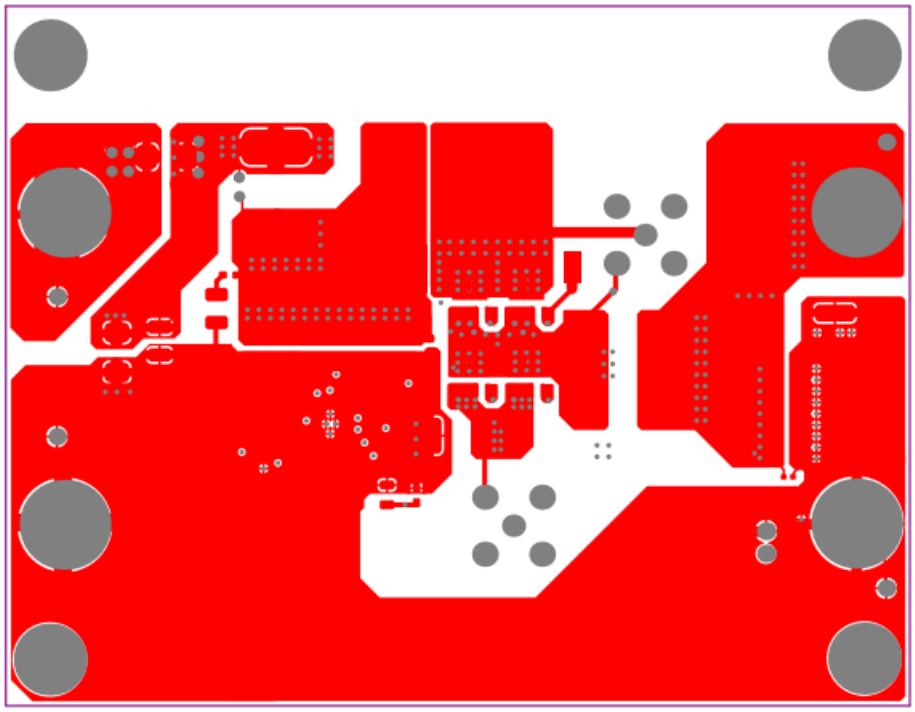

Figure 12. Top Copper

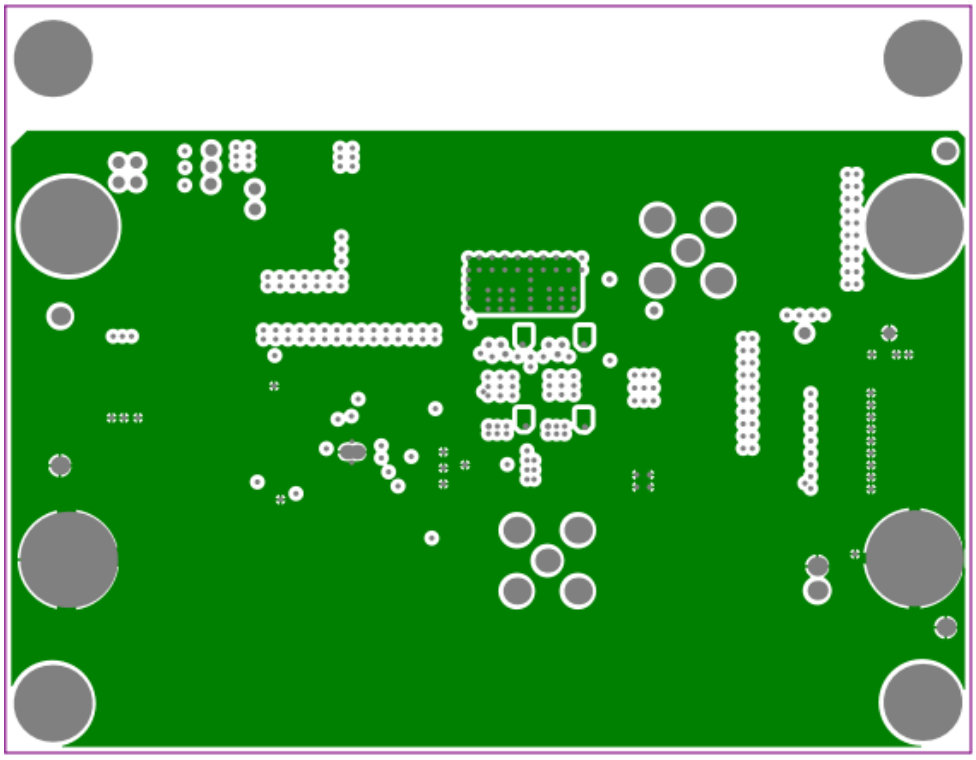

Figure 13. Layer 2 Copper

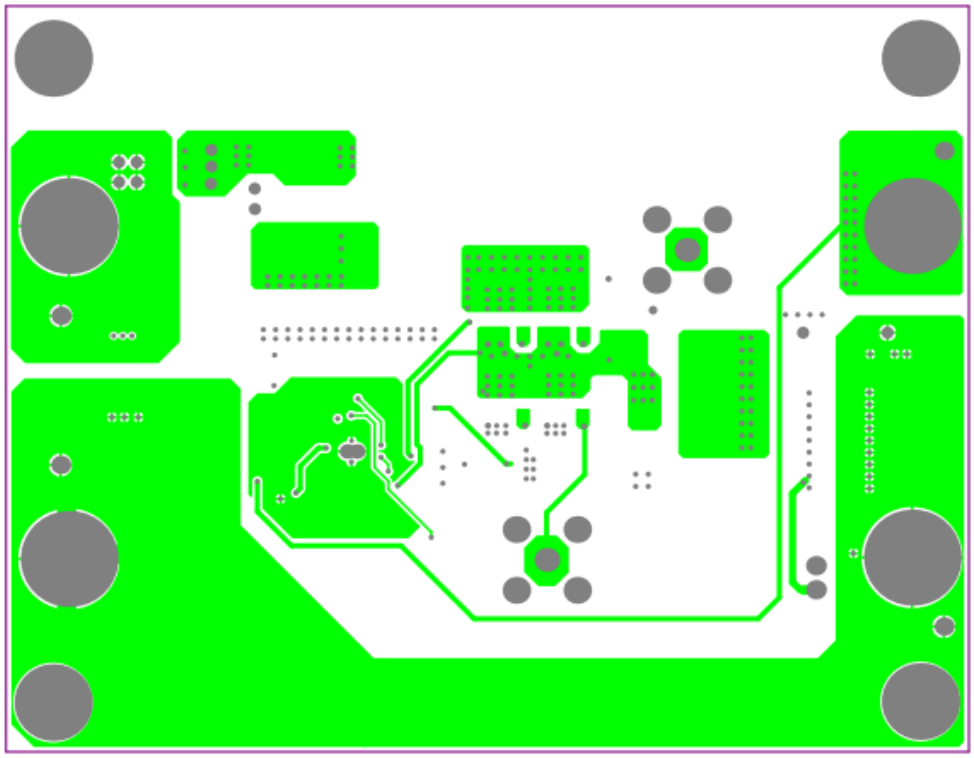

Figure 14. Layer 3 Copper

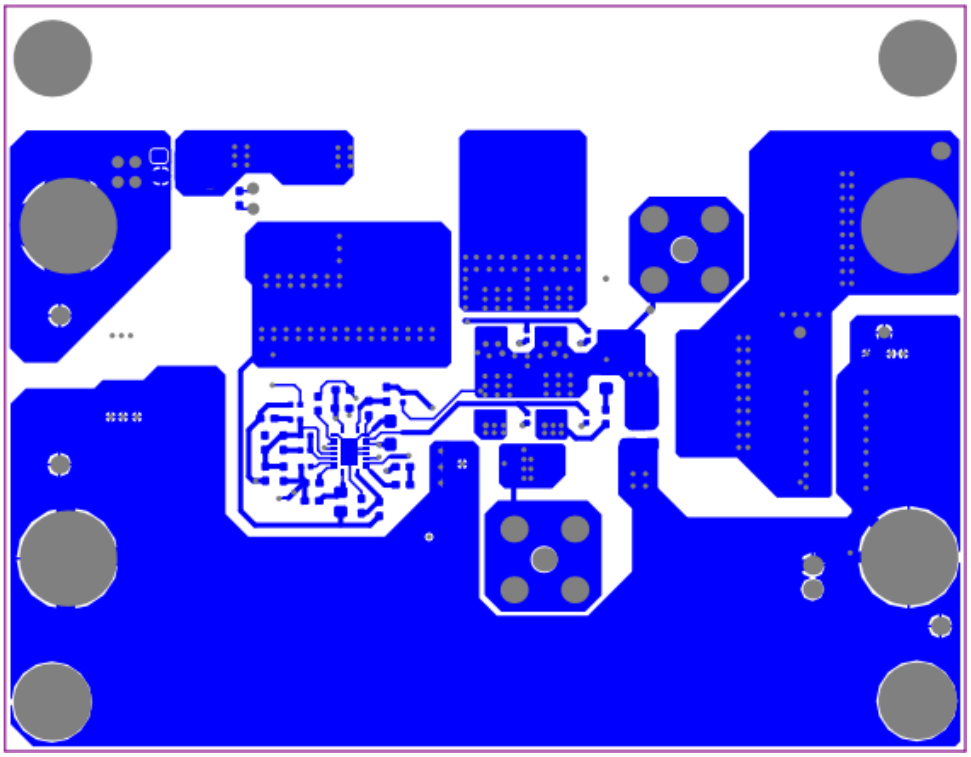

Figure 15. Bottom Copper

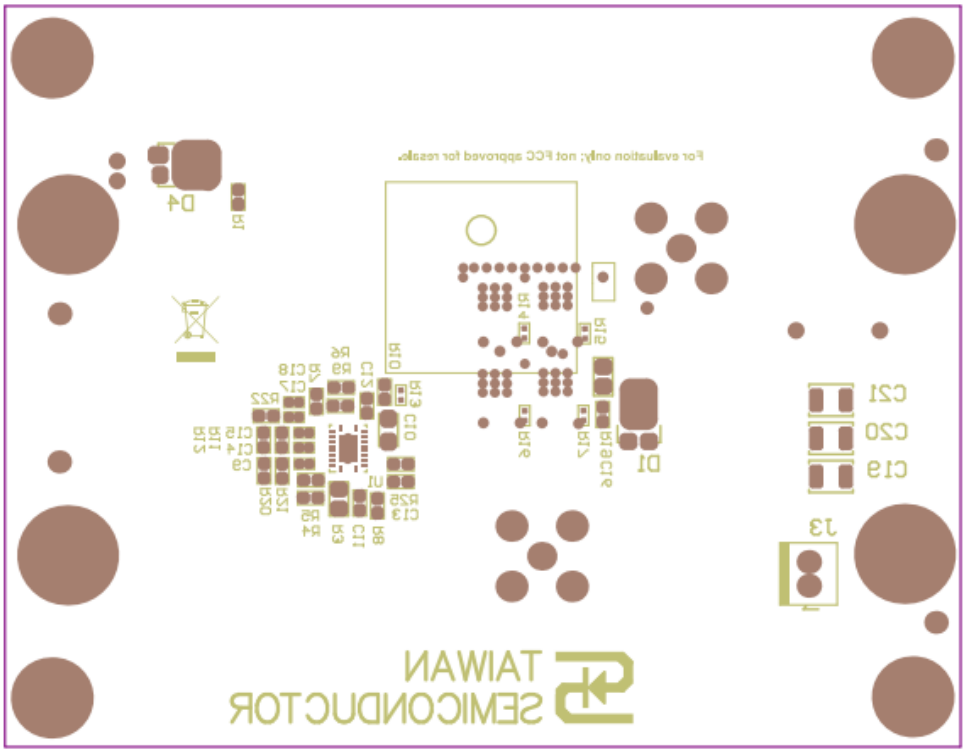

Figure 16. Bottom Component Drawing

6.3 Bill of materials

Location	Footprint	Description	Manufacturer	MPN	Quantity
C1, C11, C13, C28	C0603	CAP CER 100nF 50V X7R 0603	Std	Std	4
C2, C3, C4, C5, C6, C7, C8	C1210	CAP CER 1210 4.7UF 50V X7R 10%	Std	Std	7
C12	C0603	CAP CER 10PF 100V X7R 0603	Std	Std	1
C19, C20, C21, C22, C23, C24	C1210	CAP CER 1210 22UF 25V X7R 10%	Std	Std	6
C9	C0402	CAP CER 56nF 16V X7R 0402	Std	Std	1
C14	C0402	CAP CER 8.2nF 16V X7R 0402	Std	Std	1
C15	C0402	CAP CER 680PF 16V X7R 0402	Std	Std	1
C17	C0402	CAP CER 560PF 16V X7R 0402	Std	Std	1
C18, C26	C0402	CAP CER 560PF 25V X7R 0402	Std	Std	2
C10	C0402	CAP CER 2.2UF 25V X7R 10%	Std	Std	1
C29	C0805	CAP CER 10UF 25V X7R 10%	Std	Std	1
C25, C34	8D10L	CAP ALUM 47UF 20% 50V SMD	Std	Std	2
LED1	D0603	LED 0603 Green	Std	Std	1
Q5	PPAK5X6	PDFN56U, NMOS, 80V, 6.3mΩ	**Taiwan semi**	**TQM063NH08CR**	1
Q6	PPAK5X6	PDFN56U, NMOS, 80V, 6.3mΩ	**Taiwan semi**	**TQM063NH08CR**	1
R8	R0603	RES SMD 2.1 OHM 0.5% 1/10W 0603	Std	Std	2
R2, R24, R25	R0603	RES SMD 0- OHM 0.5% 1/10W 0603	Std	Std	3
R4	R0603	RES SMD 8.25K OHM 0.5% 1/10W 0603	Std	Std	1
R5	R0603	RES SMD 39.2K OHM 0.5% 1/10W 0603	Std	Std	1
R6, R7	R0603	RES SMD 20K OHM 0.5% 1/10W 0603	Std	Std	2
R9	R0603	RES SMD 33K OHM 0.5% 1/10W 0603	Std	Std	1
R10	R0603	RES SMD 133-OHM 0.5% 1/10W 0603	Std	Std	1
R11	R0603	RES SMD 1.91K OHM 0.5% 1/10W 0603	Std	Std	1
R12	R0603	RES SMD 29.4K OHM 0.5% 1/10W 0603	Std	Std	1
R20	R0603	RES SMD 18K OHM 0.5% 1/10W 0603	Std	Std	1
R21	R0603	RES SMD 1.3K OHM 0.5% 1/10W 0603	Std	Std	1
R22	R0603	RES SMD 36.5- OHM 0.5% 1/10W 0603	Std	Std	1
R23	R0603	RES SMD 10K OHM 0.5% 1/10W 0603	Std	Std	1
R3	R0805	RES SMD 69.8K OHM 0.5% 1/8W 0805	Std	Std	1
R14, R15, R16, R17	R0402	RES SMD 0- OHM 0.5% 1/16W	Std	Std	4
R18	R2512	RES SMD 500u OHM 1% 1W 2512	Std	Std	1
U1	RGY0020B	LM5145RGYR	TI	LM5145RGYR	1
L1	L-13.7*13	Inductor, 1μH ±20%, 1.2mΩ typ, 24A, 13.7*13, SMD	Gredmann	NMCB1365-1R0MA	1
L2	L-13.7*13	Inductor, 5.6μH ±20%, 6.5mΩ typ, 42A, 13.7*13, SMD	Gredmann	NMCB1365-5R6MA	1
D1	TO277	DIODE SCHOTTKY 100V 5A TO277	**Taiwan semi**	**TSUP5102**	1
D3	SMA	DIODE SCHOTTKY	**Taiwan semi**	**TSU1M45H**	0
D4	TO277	DIODE SCHOTTKY	**Taiwan semi**	**TSUP5102**	0
ZD1	SMB	TVS, Bi, Vwm 58V, VC 93.6V, 400W, SMA	**Taiwan semi**	**SMAJ58CA**	1

7. Device and Documentation Support

The EVM-1001 design is optimized for DC-DC power conversion in applications requiring high efficiency, such as telecom equipment, power modules, or embedded systems. For development support and sample requests, please contact our regional support through the Contact Us & Locations or marketing@ts.com.tw. For more products information, please visit website: Taiwan Semiconductor.

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