EVAL-M1-36-45A

iMOTION™ Modular Application Design Kit

About this document

Scope and purpose

This application note provides an overview of the evaluation board EVAL-M1-36-45A including its main features, key data, pin assignments and mechanical dimensions.

The board is available in two versions.

EVAL-M1-36-45A is a complete evaluation-board including a 3-phase IPM for motor drive applications. Together with EVAL-M1-1302 or EVAL-M1-099M it features and demonstrates Infineon's IPM technology for motor drives.

The evaluation board EVAL-M1-36-45A for Intelligent Power Modules (IPM) was developed to support customers during their first steps designing applications with CIPOS™ nano power modules.

Intended audience

This application note is intended for all technical specialists working with the EVAL-M1-36-45A board.

Table of Contents

1 Safety precautions

In addition to the precautions listed throughout this manual, please read and understand the following statements regarding hazards associated with development systems.

Table 1 Precautions

	***Attention:*** ***The ground potential of the EVAL-M1-36-45A system is biased to a negative DC bus voltage potential. When measuring voltage waveform by oscilloscope, the scope's ground needs to be isolated. Failure to do so may result in personal injury or death. Darkened display LEDs are not an indication that capacitors have discharged to safe voltage levels.***
	***Attention:*** ***EVAL-M1-36-45A system contains DC bus capacitors which take time to discharge after removal of the main supply. Before working on the drive system, wait three minutes for capacitors to discharge to safe voltage levels. Failure to do so may result in personal injury or death. Darkened display LEDs are not an indication that capacitors have discharged to safe voltage levels.***
	***Attention:*** ***Only personnel familiar with the drive and associated machinery should plan or implement the installation, start-up and subsequent maintenance of the system. Failure to comply may result in personal injury and/or equipment damage.***
	***Attention:*** ***The surfaces of the drive may become hot, which may cause injury.***
	***Attention:*** ***EVAL-M1-36-45A system contains parts and assemblies sensitive to Electrostatic Discharge (ESD). Electrostatic control precautions are required when installing, testing, servicing or repairing this assembly. Component damage may result if ESD control procedures are not followed. If you are not familiar with electrostatic control procedures, refer to applicable ESD protection handbooks and guidelines.***
	***Attention:*** ***A drive, incorrectly applied or installed, can result in component damage or reduction in product lifetime. Wiring or application errors such as under sizing the motor, supplying an incorrect or inadequate AC supply or excessive ambient temperatures may result in system malfunction.***
	***Attention:*** ***Remove and lock out power from the drive before you disconnect or reconnect wires or perform service. Wait three minutes after removing power to discharge the bus capacitors. Do not attempt to service the drive until the bus capacitors have discharged to zero. Failure to do so may result in personal injury or death.***

Attention: ***EVAL-M1-36-45A system is shipped with packing materials that need to be removed prior to installation. Failure to remove all packing materials which are unnecessary for system installation may result in overheating or abnormal operating condition.***

2 Introduction

The EVAL-M1-36-45A evaluation board is a part of the iMOTION™ Modular Application Design Kit for drives (iMOTION™ MADK).

The MADK-platform is intended to use various power stages with different control boards. These boards can be easily interfaced through the 20 pin iMOTION™MADK-M1 interface connector.

This evaluation board was designed to give comprehensible solutions of a power stage featuring CIPOS™. The board is equipped with all assembly groups for sensor less field oriented control (FOC). DC-link is provided by direct DC-input to give direct control to DC-ripple by external source. It contains in every of three output phases emitter-shunts for current sensing and a voltage divider for DC-link voltage measurement.

The EVAL-M1-36-45A evaluation board is available from Infineon. The features of this board are described in the design feature chapter of this document, whereas the remaining paragraphs provide information to enable the customers to copy, modify and qualify the design for production, according to their own specific requirements.

Environmental conditions were considered in the design of the EVAL-M1-36-45A. The design was tested as described in this document but not qualified regarding safety requirements or manufacturing and operation over the whole operating temperature range or lifetime. The boards provided by Infineon are subject to functional testing only.

Evaluation boards are not subject to the same procedures as regular products regarding Returned Material Analysis (RMA), Process Change Notification (PCN) and Product Discontinuation (PD). Evaluation boards are intended to be used under laboratory conditions by specialists only.

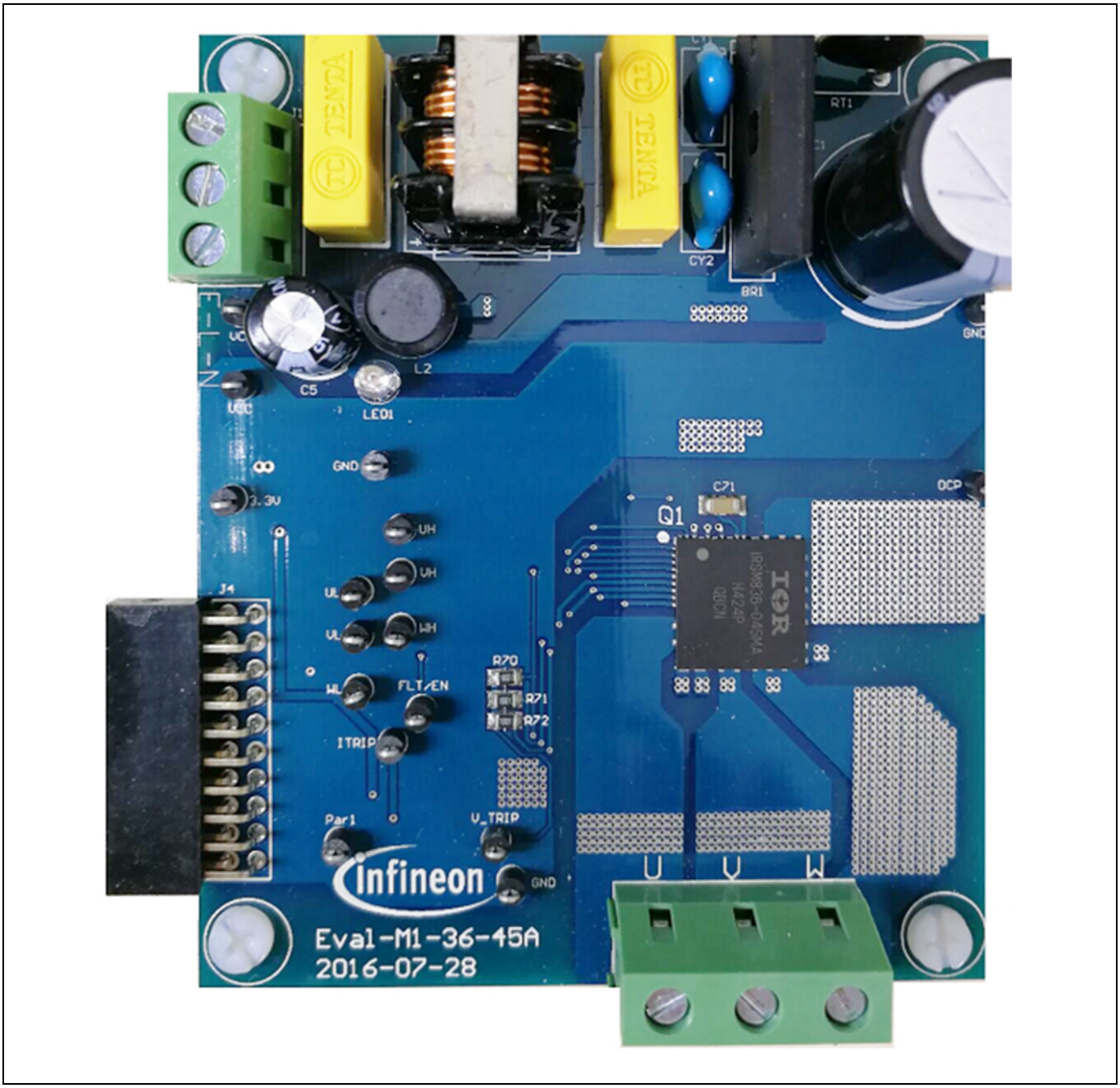


Figure 1 Evaluation-board EVAL-M1-36-45A

Figure 1 shows the evaluation board Eval-M1-36-45A. This board is compatible with all CIPOS™ modules. This document explains the features and details of CIPOS™ nano IRSM836-045MA. This module is rated 500 V. Ratings and other details of the board are explained in the subsequent sections.

3 Design features

The following sections provide an overview of the board including main attributes, key data, pin assignments and mechanical dimensions. EVAL-M1-36-45A is a complete evaluation board including a 3-phase IPM for motor drive applications. The board demonstrates Infineon's IPM technology for motor drives.

CIPOS™ nano Intelligent Power Module (IRSM836-045MA) features are:

- 3-phase inverter including high voltage gate drivers
- Integrated bootstrap functionality
- Trench FREDFET with 1.7 Ω @ 25°C $R_{DS(on)}$
- Under-voltage lockout for all channels
- Matched propagation delay for all channels
- Optimized dV/dt for loss and EMI trade off
- 3.3 V logic compatible and advanced input filter
- RoHS complaint
- Certified by UL - File Number E252584

The major functionalities of the board are:

- Nominal input voltage $320V_{DC}$
- Up to 85 W motor power without heatsink
- Current sensing for each phase configured
- Fault diagnostic output
- PCB is 90 x 75 mm and has two layers with 35 µm copper each

3.1 Key data

Figure 2 provides internal electrical schematics of IRSM836-045MA. For further information regarding these IPMs like static and dynamic electrical behavior, as well as thermal and mechanical characteristics please refer to the datasheet of the IRSM836-045MA.

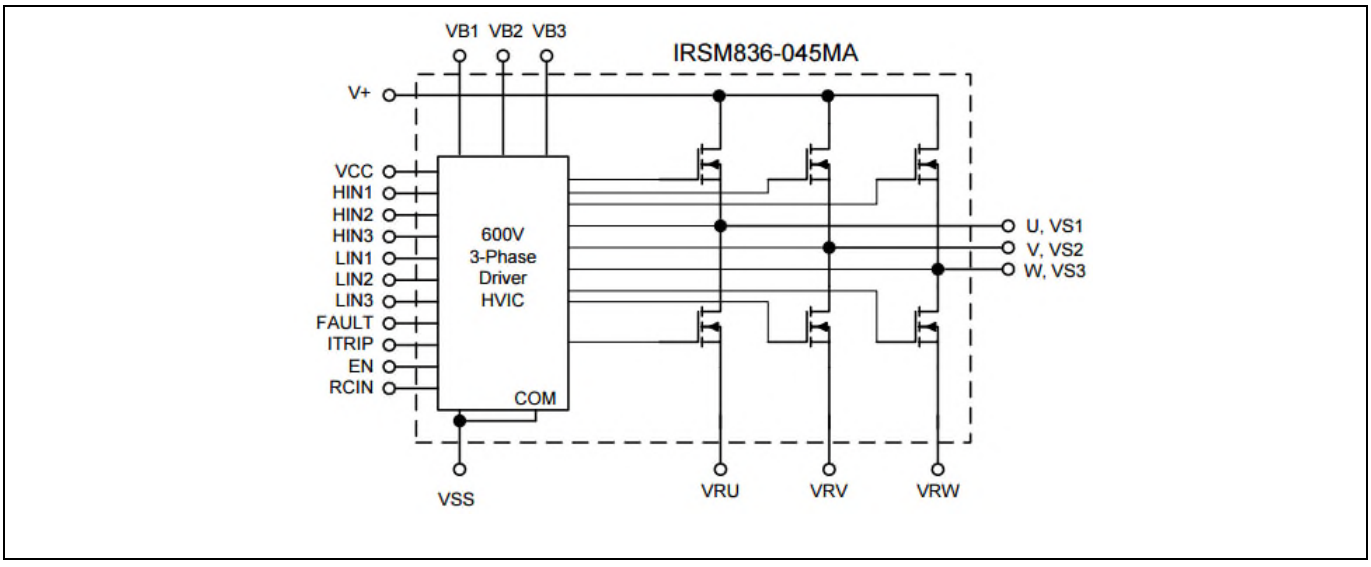


Figure 2 CIPOS™ nano internal electrical schematic

Table 2 lists major absolute maximum ratings of the IRSM836-045MA. Absolute maximum ratings are limitations which should not be less than minimum or higher than maximum ratings. Outside these limitations for safe operation, damage of the module should be expected.

Table 2 CIPOS™ nano Absolute Maximum Ratings of IRSM836-045MA

Symbol	Description	Min	Max	Unit
BV_{DSS}	MOSFET Blocking Voltage	---	500	V
I_O @ T=25°C	DC Output Current per MOSFET	---	4	A
P_d @ TC=25°C	Maximum Power Dissipation per MOSFET	---	24	W
V_{ISO}	Isolation Voltage (1min)	---	1500	V_{RMS}
T_J	Operating Junction Temperature	-40	150	°C
T_C	Operating Case Temperature	-40	150	°C
T_S	Storage Temperature	-40	150	°C
$V_{S1,2,3}$	High Side Floating Supply Offset Voltage	$V_{B1,2,3}$ - 20	$V_{B1,2,3}$ +0.3	V
$V_{B1,2,3}$	High Side Floating Supply Voltage	-0.3	500	V
V_{CC}	Low Side and Logic Supply voltage	-0.3	25	V
V_{IN}	Input Voltage of L_{IN}, H_{IN}	-0.3	V_{CC}+0.3	V

Table 3 depicts the recommended operating conditions of IRSM836-045MA.

Table 3 Recommended operating conditions of CIPOS™ nano IRSM836-045MA

Symbol	Description	Min	Max	Unit
V+	Positive DC Bus Input Voltage	---	400	V
$V_{S1,2,3}$	High Side Floating Supply Offset Voltage	---	400	V
$V_{B1,2,3}$	High Side Floating Supply Voltage	V_{Sx}+12	V_{Sx}+20	V
V_{CC}	Low Side and Logic Supply Voltage	13.5	16.5	V
V_{IN}	Input Voltage of L_{IN}, H_{IN}, I_{TRIP}, EN, FLT	0	5	V
F_{SW}	PWM Carrier Frequency	---	20	kHz

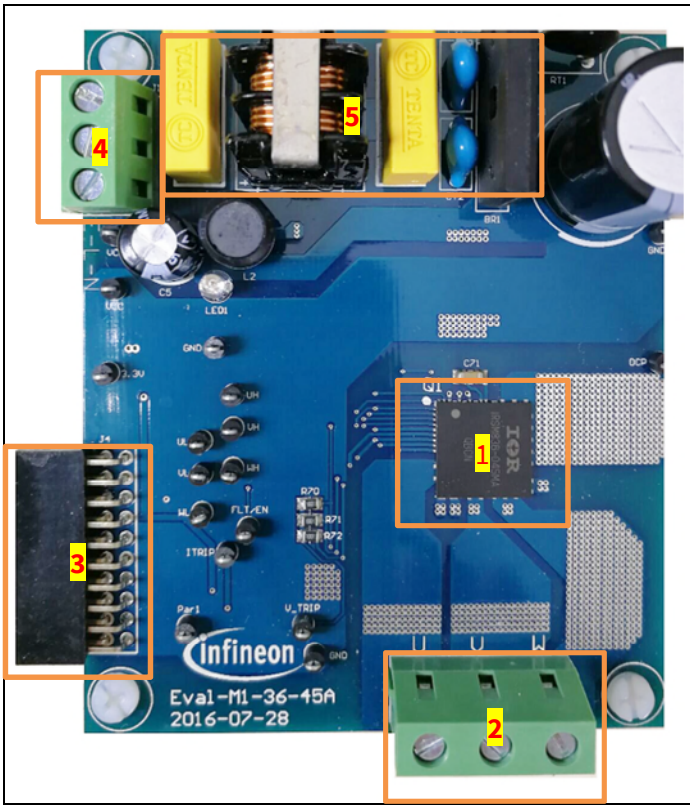
Design features

Table 4 shows the important specifications of the evaluation board EVAL-M1-36-45A.

Table 4 EVAL-M1-36-45A board specifications

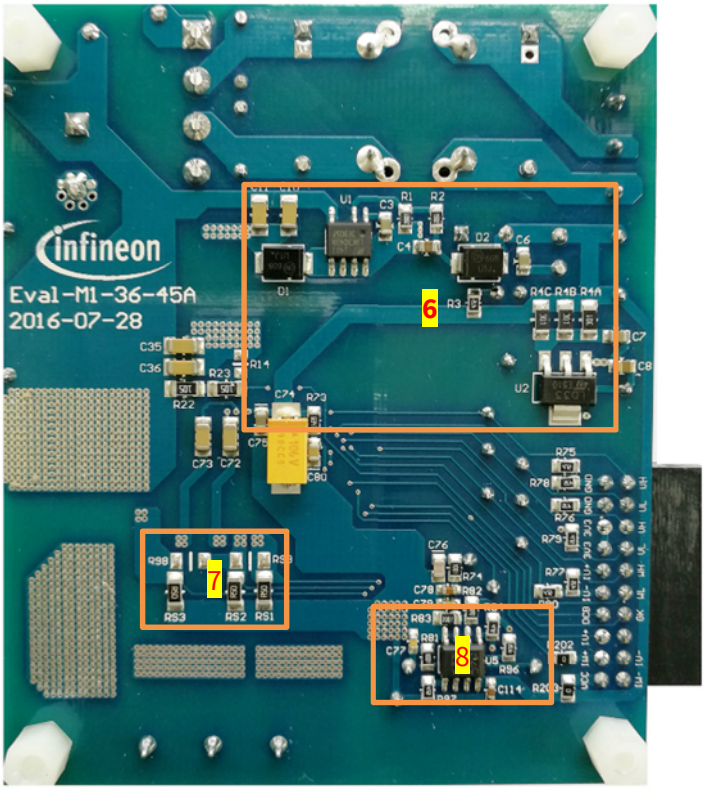
Parameters	Value	Conditions
Input		
Voltage	40 - 350 V_{DC}	
Input current	1 A	
Output		
Power(3phases)	85 W**	
Current per leg	500 mA*	
	*RMS, f_{PWM}=6 kHz, T_a=25°C, T_c=100°C, */**without heatsink	
DC Bus		
Maximum DC bus voltage	400 V	
Minimum DC bus voltage		
Current feedback		
Current sensing device RS1,RS2,RS3	0.25 Ω	Three emitter-shunts is the default configuration. To implement single shunt sensing RS1 and RS3 have to be removed IU+,IV+,IW+ have to be connected Change R7 to 3.48 kΩ
Protections		
Output current trip level	2.5A_{pk}	Configured by changing either shunt resistors RS1, RS2, RS3 or comparator threshold by resistor R7
On board power supply		
15V	15 V±5 %, Max 20 mA	Used for CIPOS™ gate driver power
3.3V	3.3 V±5 %, Max 50 mA	Used for interface signal with control board and alarm signals as I_{TRIP}, FLT/EN
PCB characteristics		
Material	FR4, 1.6 mm thickness, 2-layers. 35 µm Copper thickness	
Dimension	90 mm x 75 mm	
System environment		
Ambient temperature	From 0 to 70°C	95 % RH max. Non-condensing

Figure 3 and Figure 4 are indicating the functional groups of the EVAL-M1-36-45A evaluation board.



1. CIPOS™ nano module
2. Motor phase connector (J3)
3. iMOTION™ M1 20 pin connector (J4)
4. AC input connector (J1)
5. EMI filter and Rectifier group

Figure 3 Functional groups of the EVAL-M1-36-45A evaluation board's top side



6. On board power supply for 15 V and 3.3 V Generation
7. Shunt resistors
8. Over current protection

Figure 4 Functional groups of the EVAL-M1-36-45A evaluation board's bottom side

4 Pin Assignments

General information about the connectors of the EVAL-M1-36-45A evaluation board is reported. Table 5 includes the details of the line connector J1-AC. It is possible to connect DC voltage to the AC connector. In this case a permanent DC-current will be conducted through the rectifier bridge. Maximum ratings are valid for AC as well as DC conditions. It is recommended to observe the temperature of the rectifier bridge. Due to the rectifier, DC supply's polarity at the connector is of no concern.

The evaluation board doesn't have a fuse. An external fuse is highly recommended during testing.

Table 5 J1- AC Line Connector

S. No.	Pin	Details
1	ETH	Earth ground
2	L	AC neutral input
3	N	AC line input (110 V – 240 V)

Table 6 denotes the details of the motor side connector J2.

Table 6 J2- Motor side connector

S. No.	Pin	Details
1	U	Connected to motor phase U
2	V	Connected to motor phase V
3	W	Connected to motor phase W

Pin Assignments

Table 7 registered the pin assignments of J4, iMOTION™ -M1 20 pin interface connector. This connector is the interface to the controller board.

Table 7 J4 –iMOTION™ M1 20 pin interface connector to connect Eval-M1-36-45A to controller board

Pin	Name	Connectors
1	PWMUH	3.3 V compatible logic input for high side gate driver-Phase1
2	GND	Ground
3	PWMUL	3.3 V compatible logic input for low side gate driver-Phase1
4	GND	Ground
5	PWMVH	3.3 V compatible logic input for high side gate driver-Phase2
6	+3.3V	On board 3.3 V supply
7	PWMVL	3.3 V compatible logic input for low side gate driver-Phase2
8	+3.3V	On board 3.3 V supply
9	PWMWH	3.3 V compatible logic input for high side gate driver-Phase3
10	IU+	Shunt voltage phase U
11	PWMWL	3.3 V compatible logic input for low side gate driver-Phase3
12	IU-	Ground
13	GK	Gate kill signal – active low when over current is detected
14	DCBSENSE	DC bus positive voltage, scaled in 0-3.3 V range by a voltage divider
15	VTH	Thermistor Output
16	IV+	Shunt voltage phase V
17	IV-	Ground
18	IW+	Shunt voltage phase W
19	IW-	Ground
20	VCC	15 V Supply

Input signals are active high. Pull-down resistors are not inserted on the EVAL-M1-36-45A board and need to be assembled on control cards. iMOTION™ MADK control cards are already equipped with pull-down resistors.

1. *Gate Kill signal (GK) is pulled low during over current condition. Chapter 5.4 explains the details of this circuit.*

5 Schematics and Layout

To meet individual customer requirements and make the EVAL-M1-36-45A evaluation board a basis for development or modification, all essential technical data like schematics, layout and components are included in this chapter. Get in contact with our technical support team to get more detailed information and the latest Gerber-files.

5.1 Input circuit

Figure 5 depicts the input section of the circuit. The input section has a 0.1µF capacitor filter. If the system is driven from AC source it is mandatory to add an external rectifier. Also the board doesn't have any fuse protection; hence it is preferable to add an external fuse. An LED indicator is showing that the DC-link is charged in case it is on. In case it is off, it does not indicate that the DC-link is safely discharged.

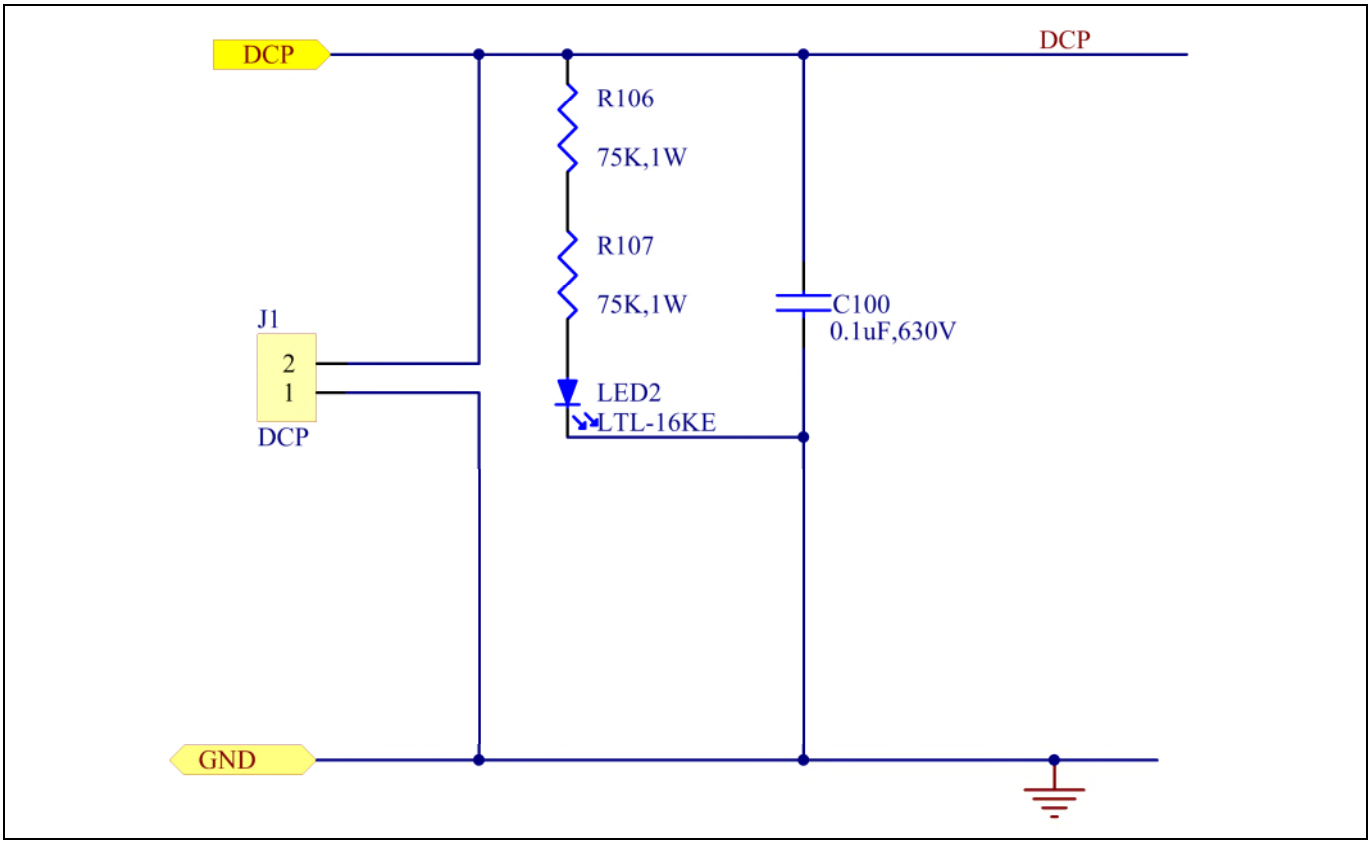


Figure 5 Schematic for EMI input filter of the EVAL-M1-36-45A evaluation board

5.2 DC-Link Voltage Measurement

Pin 14 of connector J4 provides access to the DC-link voltage. There must be a pull-down resistor mounted on the corresponding control card. If no feedback is desired on the DCBSENSE-pin, R22 or R23 should be removed to avoid high voltage on the connector.

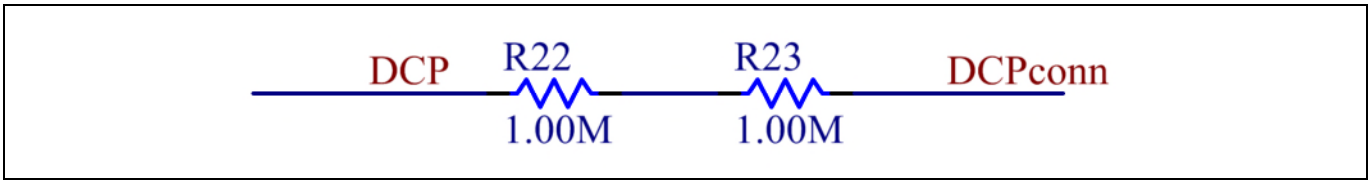


Figure 6 DC bus sense resistors in EVAL-M1-36-45A evaluation board

5.3 Inverter section using CIPOS™ nano IPM

The inverter section is implemented using the CIPOS™ as displayed in Figure 7. The module includes six power MOSFETs and three half bridge gate drivers.

The three capacitors C71, C72 and C73 are used as bootstrap capacitors to provide the necessary floating supply voltages V_{BS1}, V_{BS2} and V_{BS3} respectively.

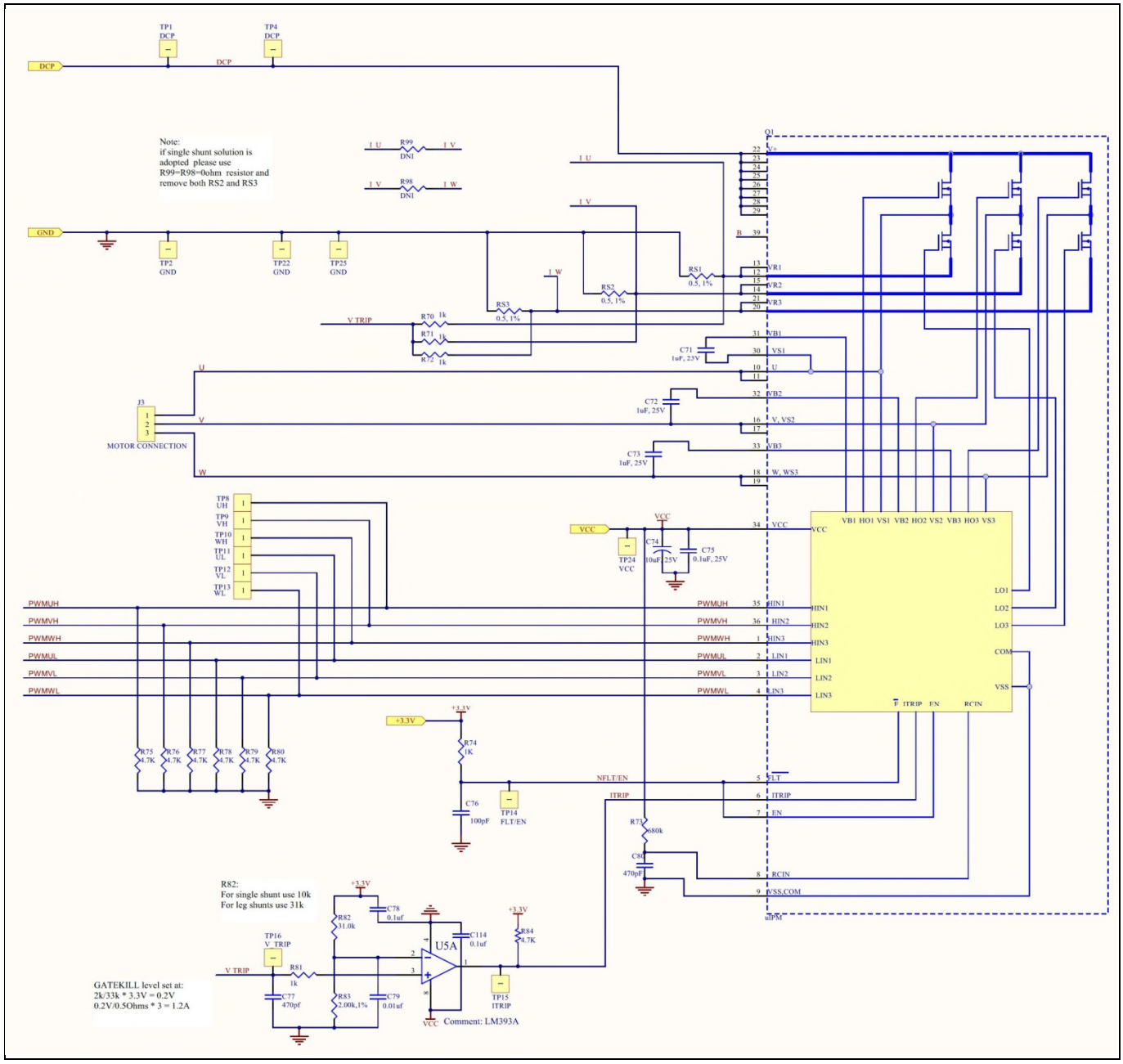


Figure 7 Schematic of the 3-phase inverter section using CIPOS™ nano IPM on Eval-M1-36-45A board

5.4 Current Measurement and Over Current Circuit

The resistors RS1 to RS3 are purposed to generate a voltage proportional to the emitter current. These voltages are available at 20 pin interface connector to give feedback to the controller. In combination with resistors R70

to R72 they are used to generate common current signal V_TRIP for all three phases. V_TRIP is always on highest level of all three phase current. This signal is used to generate gate-kill signal I_TRIP.

Figure 8 is the over current circuitry shown. Capacitor C77 and resistor R81 are filtering voltage spikes and noise on V_TRIP to avoid incident turn off.

The comparator threshold can be set through the voltage divider provided by resistors R82 and R83. By default for emitter-shunt trip, R7 is 1kΩ. In single shunt application R7 needs to be changed to 3.48kΩ.

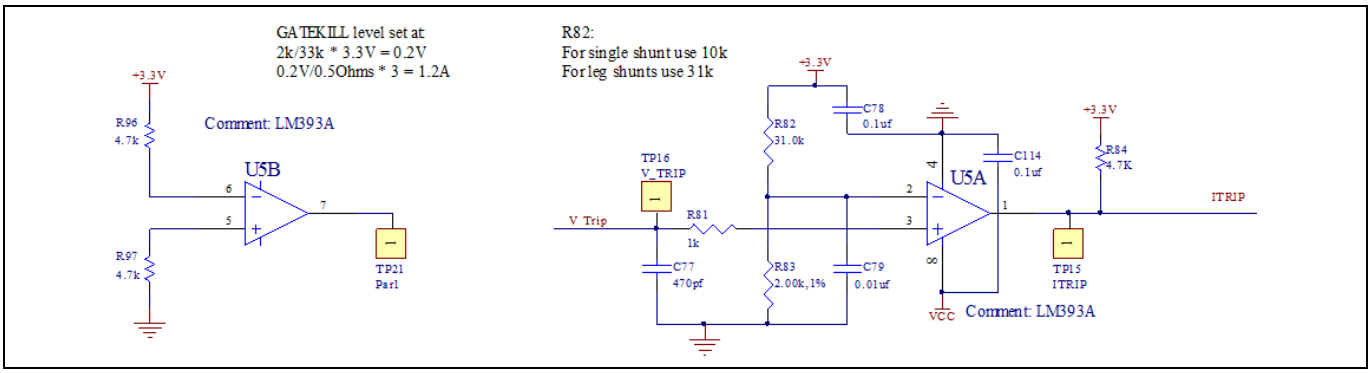


Figure 8 Over current protection circuit on the EVAL-M1-36-45A evaluation board

5.5 Auxiliary Power supply

Figure 9 reports the schematic of the power supply available on the EVAL-M1-36-45A board. The circuit includes LNK304 that is used to generate 15V (V_{CC}) directly from the DC bus. V_{CC} is connected to the gate drivers inside the CIPOS™ IPM.

The linear regulator LD1117S33 generates 3.3V from V_{CC}. The 3.3V power supply is used in the over current comparator circuit. LED1 is used to indicate whether the board is powered or not. Both V_{CC} and 3.3V are also provided on the 20 pin interface connector J4 to feed circuitry on the controller board.

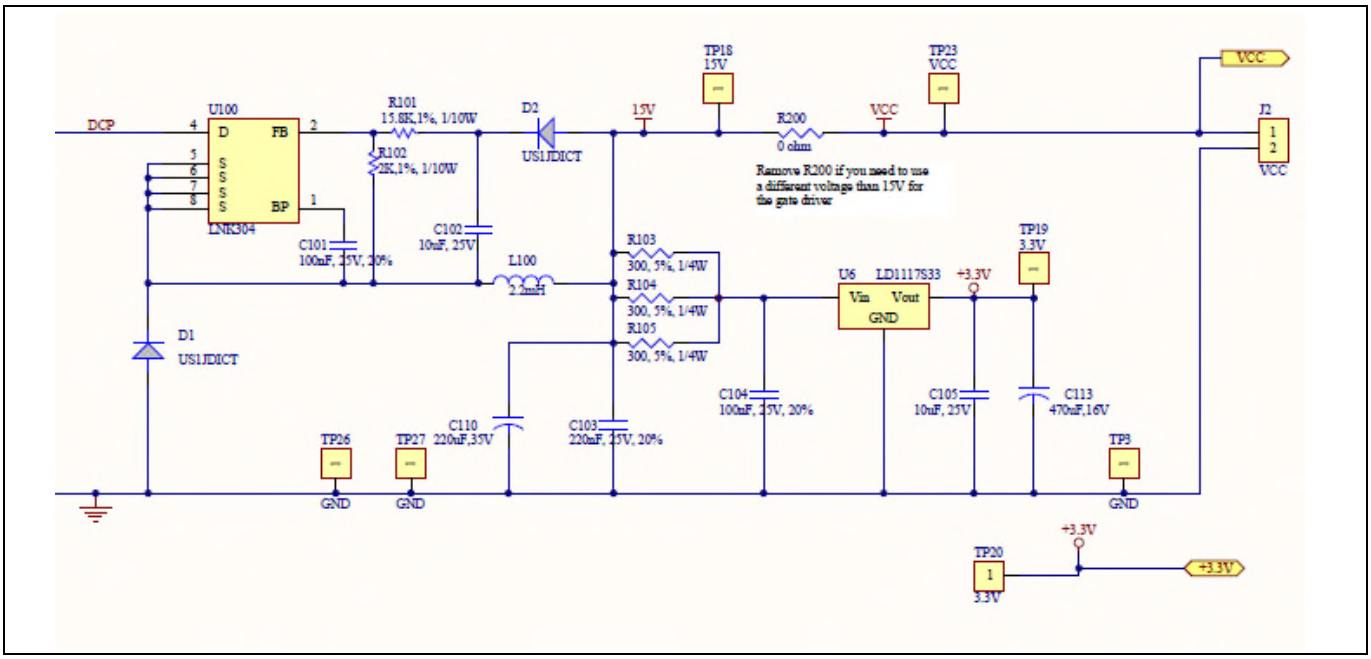


Figure 9 Power supply section of the EVAL-M1-36-45A evaluation board

5.6 PCB Layout

The layout of this board can be used for different voltage or power classes. The power PCB is a two layer PCB.

Get in contact with our technical support team to get more detailed information and the latest Gerber-files.

Figure 10 illustrates the top assembly print of the evaluation board.

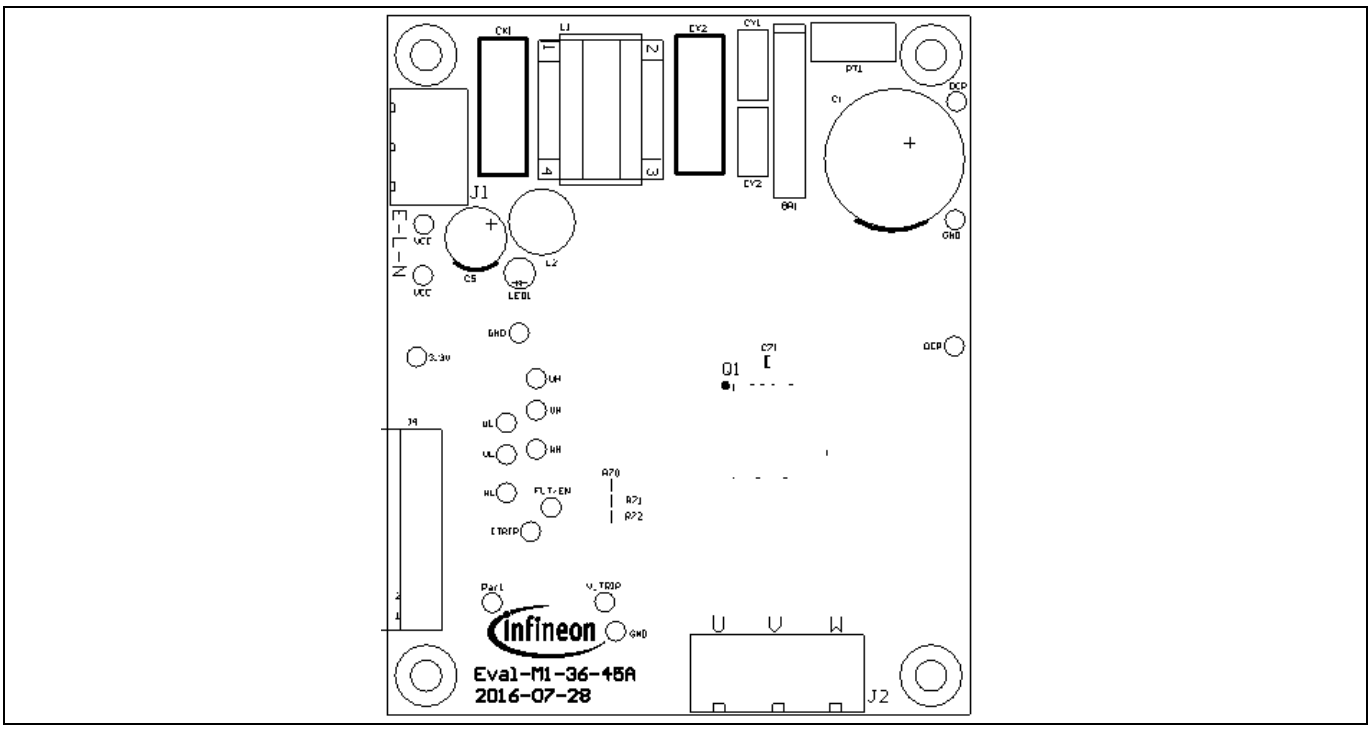


Figure 10 Top assembly print of the EVAL-M1-36-45A evaluation board

Figure 11 depicts the bottom assembly print of the evaluation board.

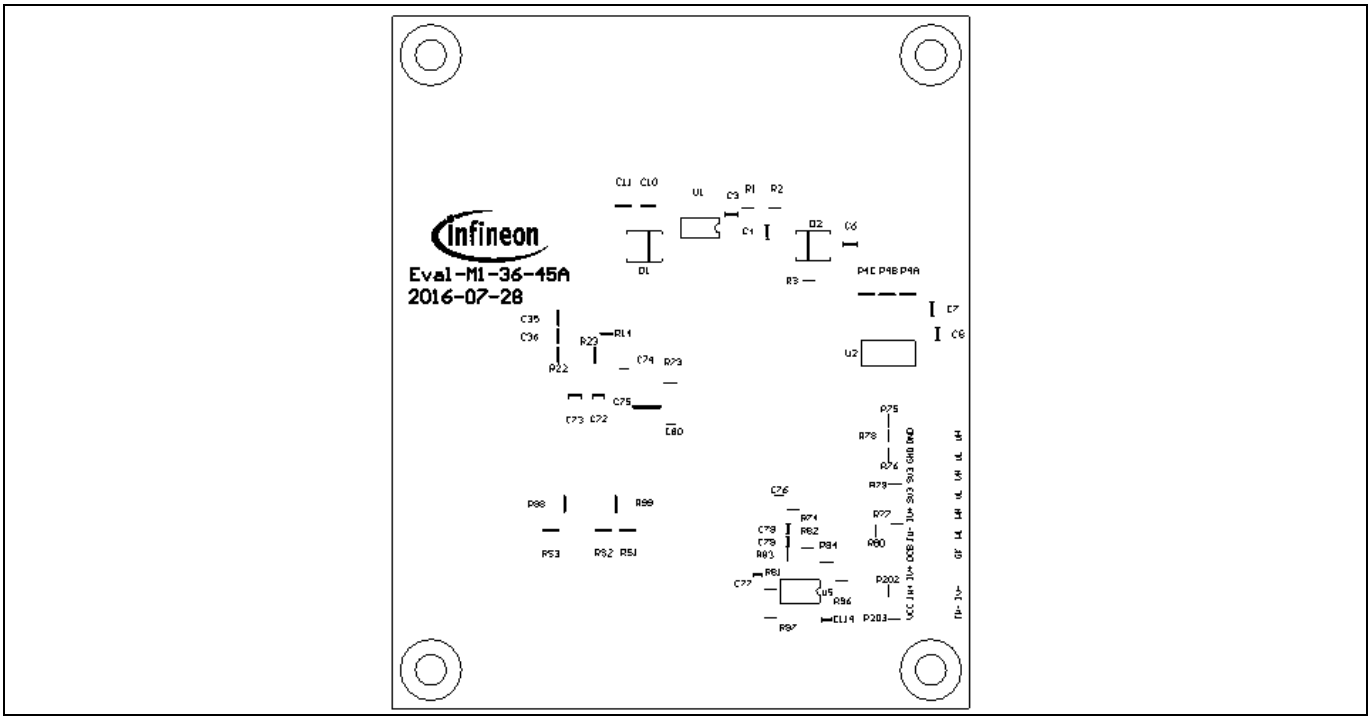


Figure 11 Bottom assembly print of the EVAL-M1-36-45A evaluation board

The top layer routing of the PCB is provided in Figure 12 .

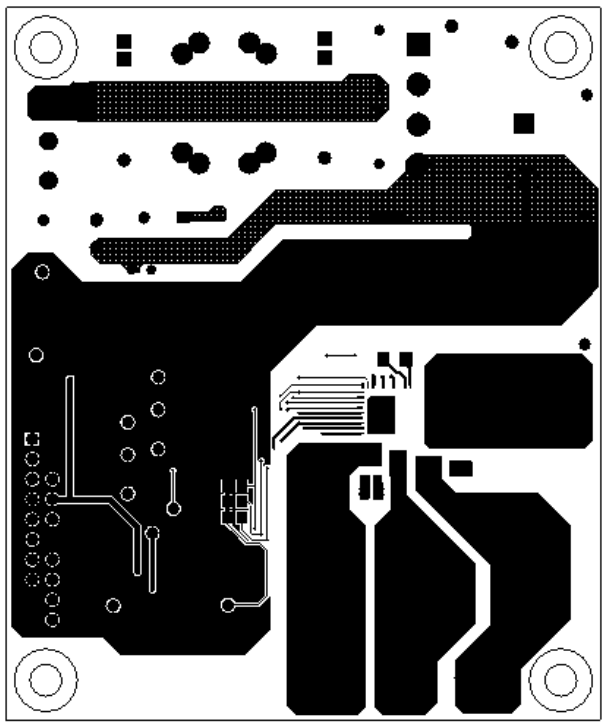


Figure 12 Top layer routing details of EVAL-M1-36-45A

Figure 13 illustrates the bottom layer routing details.

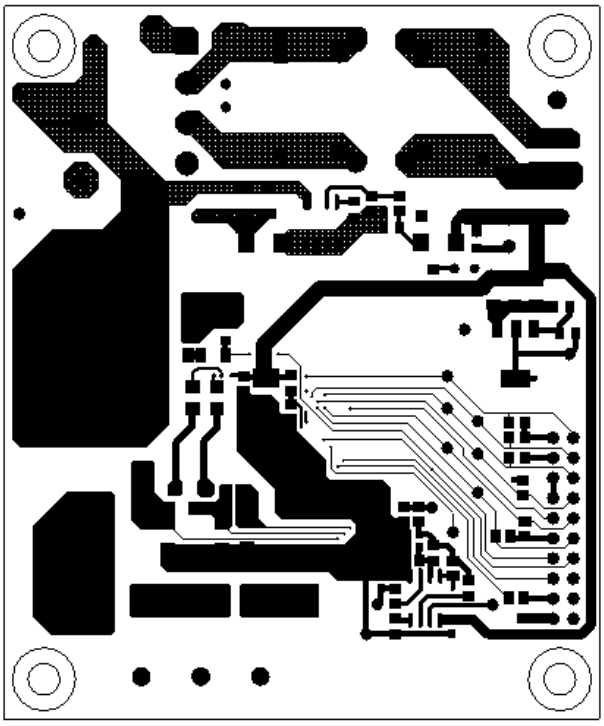


Figure 13 Bottom layer routing details of EVAL-M1-36-45A

6 Bill of Materials of EVAL-M1-36-45A

Table 8 provides the complete bill of materials of the evaluation board.

Table 8 Bill of materials

No.	Qty	Part description	Designator	Part number	Manufacturer
1	1	RECT BRIDGE GPP 4A 600V GBU	BR1	GBU406	DIODES INCORPORATED
2	1	CAP ALUM 100µF 20% 200V RADIAL	C1	200TXW100MEFC18X30	RUBYCON
3	1	CAP CER 1µF 25V X7R 0805	C4	CL21B105KAFNNNE	SAMSUNG ELECTROMECHANICS AMERICA,INC.
4	1	CAP ALUM 220µF 20% 35V RADIAL	C5	35ZLH220MEFC8X11.5	RUBYCON
5	1	CAP CER 10µF 6.3V X7R 0805	C8	CL21B106KQQNNNE	SAMSUNG ELECTROMECHANICS AMERICA,INC.
6	4	CAPACITOR, CERAMIC, MULTILAYER, 250 V, X7R, 0.011µF, SURFACE MOUNT, 1206	C10, C11, C35, C36	1206B113K501NT	NOVACAP
7	3	CAP CER 1µF 25V X7R 1206	C71, C72, C73	CC1206KKX7R8BB105	Yageo
8	1	CAP TANT 10µF 25V 10% 2917	C74	T491D106K025AT	Kemet
9	4	CAP CER 0.1µF 25V X7R 0805	C75,C3, C6, C7	CC0805KRX7R8BB104	Yageo
10	1	CAP CER 100pF 50V X7R 0805	C76	C0805C101K5RACTU	Kemet
11	1	CAP CER 470 pF 50V X7R 0603	C77	CC0603KRX7R9BB471	Yageo
12	2	CAP CER 0.1µF 25V X7R 0603	C78, C114	CC0603KRX7R8BB104	Yageo
13	1	CAP CER 10000 pF 25V X7R 0603	C79	CC0603KRX7R8BB103	Yageo
14	1	CAP CER 470pF 50V X7R 0805	C80	CC0805KRX7R9BB471	Yageo
15	2	CAP FILM 0.1µF 20% 275VAC RADIAL	CX1, CX2	PME271MB6100MR30	KEMET
16	2	CAP CER 2200pF 250VAC RADIAL	CY1, CY2	DE2E3KY222MN3AM02F	MURATA ELECTRONICS
17	2	DIODE GEN PURP 600V 1A	D1, D2	MURS160-13-F	Diodes Incorporated

Bill of Materials of EVAL-M1-36-45A

No.	Qty	Part description	Designator	Part number	Manufacturer
		SMA			
18	1	TERM BLOCK 5.08MM 3POS SIDE ENTY	J1	282837-3	TE Connectivity AMP Connectors
19	1	TERMINAL BLOCK 7.50MM 3POS PCB	J2	ED365/3	On-Shore Technology, Inc.
20	1	CONN FEMALE 20POS DL .1" R/A TIN	J4	SSW-110-02-S-D-RA	Samtec Inc.
21	1	8103-RC	L1	JWMILLER_8103	Bourns, Inc.
22	1	FIXED IND 2.2mH THROUGH HOLE	L2	RLB0914-222KL	Bourns Inc.
23	1	LED RED DIFF 3MM ROUND T/H	LED1	LTL-16KE	Lite-On Inc.
24	1	IC MOTOR DRIVER PAR 37-PQFN	Q1	IRSM836-045MA	Infineon Technologies
25	1	RES SMD 4.87kΩ 1% 1/8W 0805 NO ASS. (DIN)	R14	RMCF0805FT4K87	Stackpole Electronics Inc.
26	2	RES SMD 1MΩ 1/2W 1206 WIDE	R22, R23	RCL06121M00JNEA	Vishay Dale
27	5	RES SMD 1kΩ 1% 1/8W 0805	R70, R71, R72, R74, R81	RC0805FR-071KL	Yageo
28	1	RES SMD 680kΩ 5% 1/8W 0805	R73	RC0805JR-07680KL	Yageo
29	10	RES SMD 4.7kΩ 1/4W 0805 WIDE	R3, R75, R76, R77, R78, R79, R80, R84, R96, R97	LTR10EZPJ472	Rohm Semiconductor
30	1	RES THICK FILM SMD 0805 1% 31kΩ	R82	RMCF0805FT31K6	Stackpole Electronics Inc. (SEI)
31	2	RES SMD 2kΩ 1% 1/8W 0805	R83,R1	RC0805FR-072KL	Yageo
32	1	RES SMD 15.8kΩ 1% 1/8W 0805	R2	RC0805FR-0715K8L	Yageo
33	3	RES SMD 300Ω 5% 1/4W 1206	R4A, R4B, R4C	RC1206JR-07300RL	Yageo
34	2	RES SMD 0Ω 1% 1/8W 0805	R202, R203	0805J0000T5E	Vishay Dale
35	3	RES SMD 0.5Ω 1% 1/4W 1206	RS1, RS2, RS3	RL1206FR-070R5L	Yageo
36	1	NTC 15Ω 9MM DIA	RT1	NTC15D-9	SHIN-HANG
37	1	IC OFFLINE SWIT OCP 8SOIC	U1	LNK304DN	Power Integrations
38	1	Wide Input Range Low	U2	IFX1763XEJ V33	Infineon Technologies

Bill of Materials of EVAL-M1-36-45A

No.	Qty	Part description	Designator	Part number	Manufacturer
		Noise 500mA LDO			
39	1	IC DUAL DIFF COMPARATOR 8-SOIC	U5	LM393ADR	Texas Instruments
40	18	TEST POINT PC MINI .040"D WHITE	TP1, TP4, 'TP2, TP3, TP5, 'TP8,'TP9,'TP10,'TP11,'TP12,'TP13,'TP14,'TP15,'TP16, 'TP21, TP24, TP22, TP25,	5002	Keystone Electronics

7 Reference

[1] Datasheet of Infineon IPM, “http://www.irf.com/product-info/datasheets/data/IRSM836-045MA.pdf”

[2] The AN2009-10: Using the NTC inside a power electronic module’, is available on Infineon website.

Revision History

Major changes since the last revision

Version number	Revision Date	Revision description
1.0	2017-03-20	First release

Edition 2017-03-20

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Do you have a question about this document?

Email: erratum@infineon.com

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