EVAL-M3-188 User Manual

iMOTION™ Modular Application Design Kit

About this document

Scope and purpose

This application note provides an overview of the evaluation board EVAL-M3-188 including its main features, key data, pin assignments, mechanical dimensions and its application.

EVAL-M3-188 is an evaluation-board as part of the iMOTION™ Modular Application Design Kit (MADK). This board features and demonstrates Infineon's advanced Motion Control Engine (MCE) for permanent magnet motors drive over the full speed range.

The evaluation board EVAL-M3-188 was developed to support customers during their first steps designing applications with running any permanent magnet motor via sensorless sinusoidal control.

Intended audience

This application note is intended for all technical specialists working for motor control with the EVAL-M3-188 board under laboratory conditions.

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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-M3-188 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 equipment damage or personal injury or death.***
	***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-M3-188 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 control board, 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 DC supply or excessive ambient temperatures may result in system malfunction.***
	***Attention: Remove or connect this control board from or to the power drive. Wait three minutes after removing power from the power drive 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-M3-188 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-M3-188 evaluation board is a part of the iMOTION™ **M**odular **A**pplication **D**esign **K**it for drives (iMOTION™ MADK). In order to run a motor, the mating power board is required to interface this evaluation board.

The MADK platform is intended to use various power stages with different control boards. These boards can easily be interfaced through the 20 pins iMOTION™ MADK-M1 or the 30 pins iMOTION™ MADK-M3 interface connector. This board is equipped with 30 pins connector.

This evaluation board is designed to give comprehensible solutions of sensorless control of permanent magnet motors over the full speed range, combined with boost PFC control. It consists of IRMCF188 Motor Control IC capable of 3-phase and three types of 2-phase modulation combined with boost PFC control, PFC shunt feedback, JTAG and UART interface which are isolated via opto-isolation box and needs a single 3.3V supply. Required isolation box MCETOOLV2 is not part of the EVAL-M3-188 kit and needs to be ordered separately. Details of isolation box please refer to its Application Note. Figure 1 shows the evaluation board EVAL-M3-188.This document explains the features and details of this board as well as IRMCF188-control IC.

The EVAL-M3-188 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-M3-188. 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.

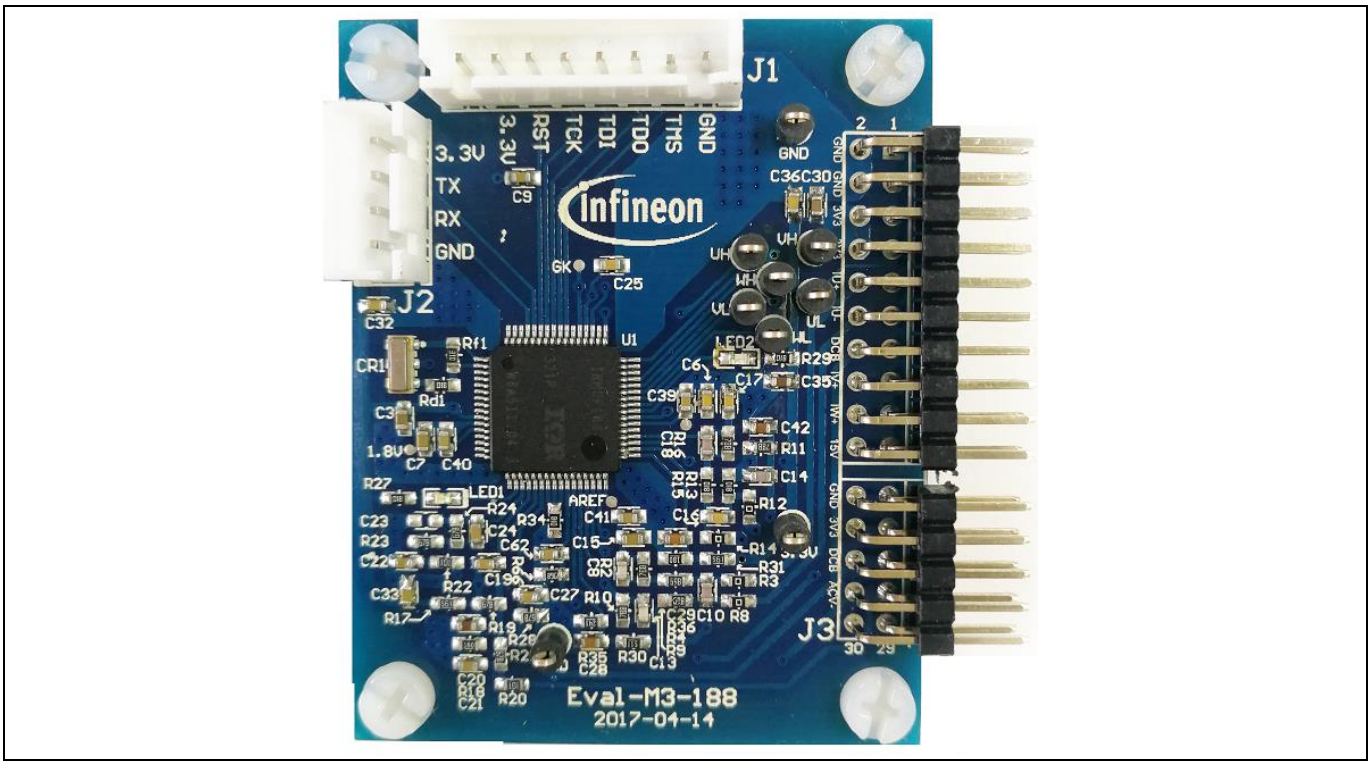


Figure 1 Evaluation board EVAL-M3-188

3 Main features

EVAL-M3-188 is a complete evaluation board for PM motor control as well as power factor control (PFC) application. The kit demonstrates Infineon's control IC technology.

Main features of Motion Control IC are:

- MCE™ (Flexible Motion Control Engine) - Dedicated computation engine for high efficiency sinusoidal sensorless permanent magnet motor control
- Supports both interior and surface permanent magnet motor
- Dedicated PFC PWM for digital PFC control
- Built-in hardware for single shunt or leg shunt current feedback reconstruction
- Loss minimization Space Vector PWM
- Three-channel analog output (PWM)
- Embedded 8-bit high speed microcontroller (8051) for flexible I/O and man-machine control
- JTAG programming port for emulation/ debugger
- Serial communication interface (UART)
- I2C/SPI serial interface
- Three general purpose timers/counters
- Two special timers: periodic timer, capture timer
- Internal 64 Kbyte flash memory
- 3.3V single supply

The evaluation board characteristics are:

- Complete kit for running any permanent magnet motor via sensorless sinusoidal control
- Power factor control for boost mode
- 3.3V single supply operation
- JTAG and UART interface, isolated via opto-isolation box
- 30 pins connector
- RoHS complaint
- PCB is 45x 55 mm and has two layers with 35 µm copper each

3.1 Key data

Figure 2 provides a typical application Block Diagram using the Eval-M3-188 in which IRMCF188 controller is used. The IRMCF188 provides a built-in closed loop sensorless control algorithm using the unique Flexible Motion Control Engine (MCE™) for permanent magnet motors as well as induction motors plus PFC control. The MCE™ consists of a collection of control elements, motion peripherals, a dedicated motion control sequencer and dual port RAM to map internal signal nodes. IRMCF188 also employs a unique single shunt or leg shunt current reconstruction circuit to eliminate additional analog/digital circuitry and enables a direct shunt resistor interface to the IC.

IRMCF188 contains 64K bytes of Flash program memory and comes in a 64-pin QFP package.

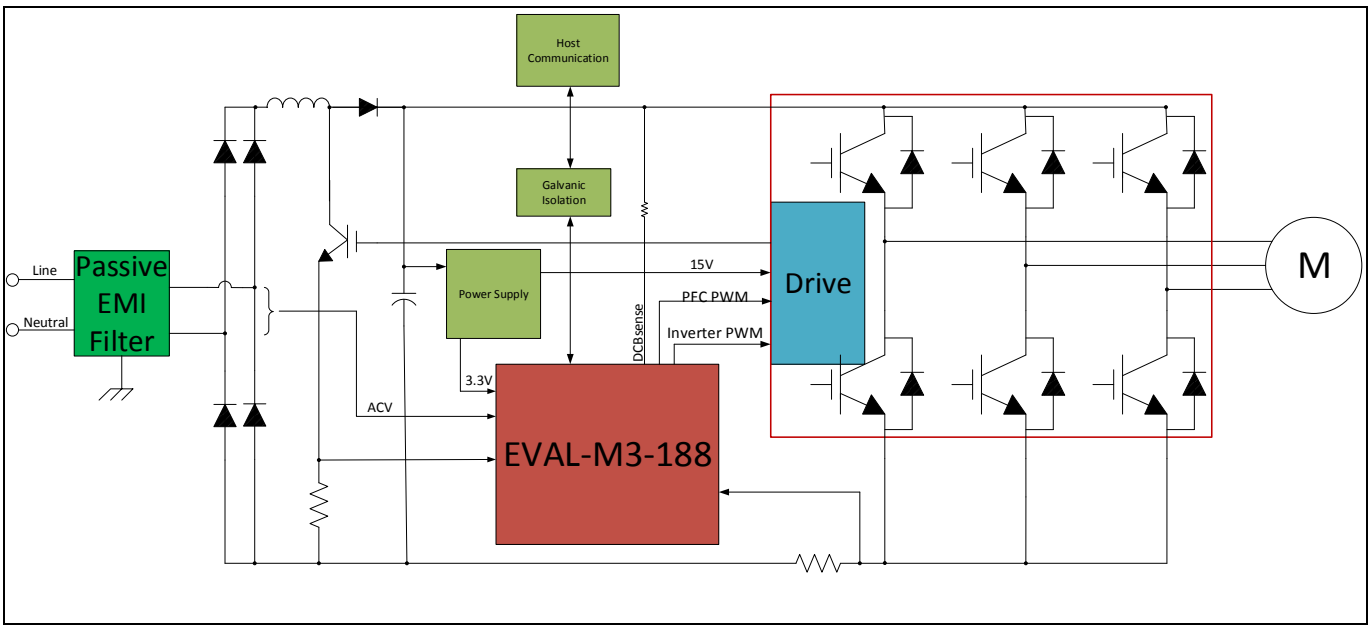


Figure 2 Typical Application Block Diagram Using Eval-M3-188

Table 2 depicts the important specifications of the evaluation board EVAL-M3-188.

Table 2 Eval-M3-188 board specifications

Parameters	Values	Conditions / comments
Host Interface (Non isolation)		
UART(TXD RXD)	3.3V	Typical 5.76 kbps. single ended
TMS TDI TCK TDO	3.3V	Interface with FS2 or MCETOOL V2
8 Bit 2 Channel	0-3.3V output	GPIO Configurable to DAC
12 Bit	0-1.2V	
Input		
Voltage	3.3V	Power supply
DC Bus		
DC Bus Scaling	8.29 counts/v	Power board has 2M ohm resistor
DC Bus sensing range	494.0V max	
Current feedback		
Current sensing device	Single shunt resistor Leg shunt resistor	Single shunt resistor Leg shunt resistor
Current Op-amp Configuration	Non-Inverting	
Current Op-amp Gain	1.302	
Resolution	12-bit	Power board may reduce the resolution
Latency	1 pwm cycle	
Protections		
Internal current trip level	1.2V Average	
PCB characteristics		
Material	FR4, 1.6MM thickness Copper thickness = 1oz (35um)	
Dimension	45mmx55mm	
System environment		
Ambient temperature	0-70°C	95%RH Max (Non-Condensing)

3.2 IRMCF188 installer

In order to run this evaluation board, the user has to download iMOTION™installer from Infineon iMOTION™ Web, it contains information about all the iMOTION™ control IC including IRMCF188 development software at Infineon web.

http://www.infineon.com/imotion-software - for 100 series installer software and demo project downloading, please select “Software & Tools” on right column. And all the updated version software is there.

Figure 3 hints out the functional groups of the EVAL-M3-188 evaluation board.

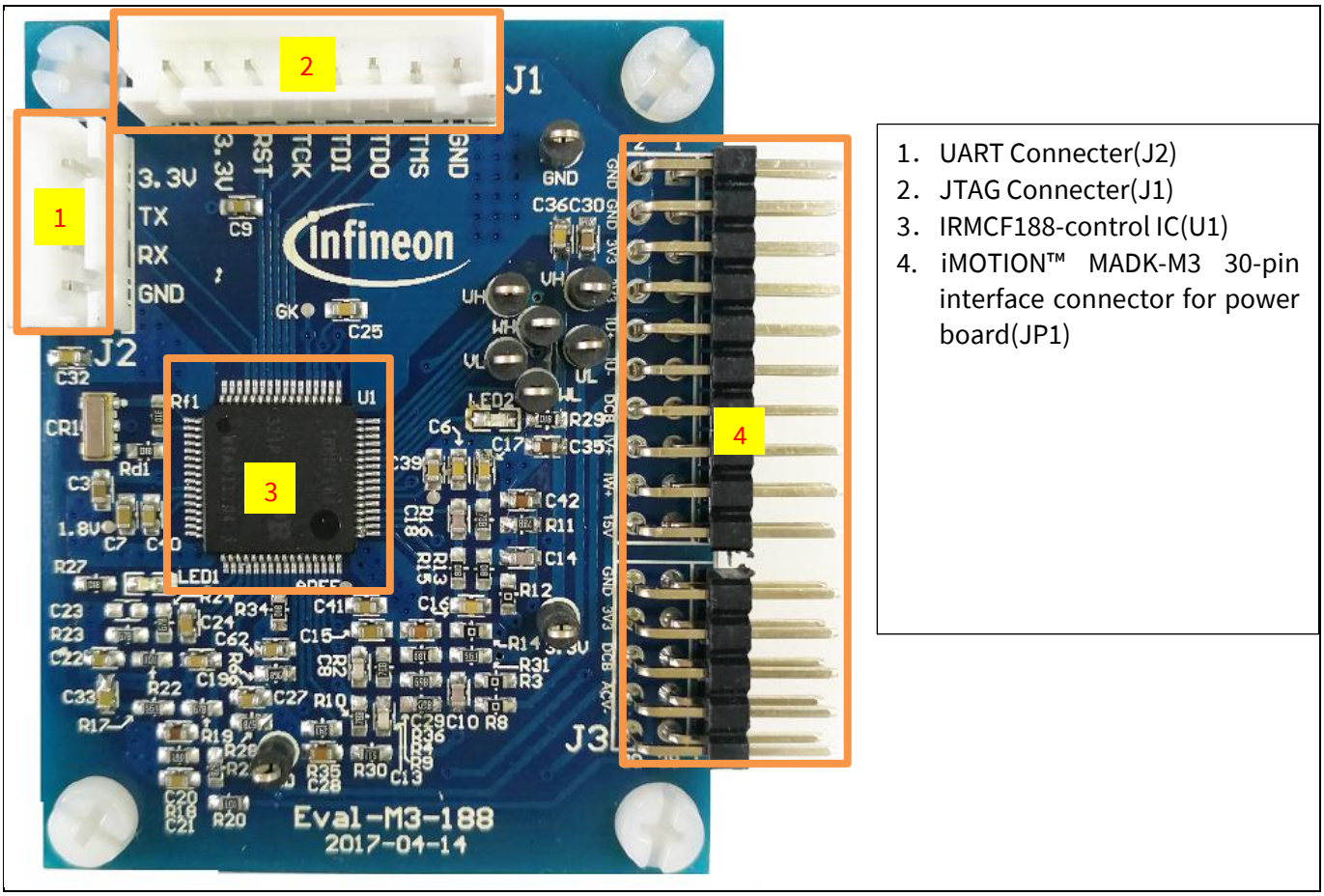


Figure 3 Top side of functional groups of the EVAL-M3-188 evaluation board

4 Pin assignments

General information about the connectors of the Eval-M3-188 evaluation board is reported.

Table 3 and Table 4 include the details of JTAG and UART connectors.

Table 3 J2- UART Connector

S. No.	Pin	Details
1	GND	Ground
2	RXD	Input, Receive data to IRMCF188, can be configured to GPIO pins
3	TXD	Output, Transmit data from IRMCF188, can be configured to GPIO pins
4	+3.3V	On board 3.3V supply

Table 4 J1-JTAG Connector

S. No.	Pin	Details
1	GND	Ground
2	TMS	TMS (test mode)
3	TDO	TDO (data output)
4	TDI	TDI (data input)
5	TCK	TCK (clock)
6	RST	IRMCF188 Reset
7	+3.3V	3.3V power supply(see Specification for max current)
8	VPP	Not Connected

Table 5 provides the pin assignments of the iMOTION™ MADK-M3 30-pins interface connector JP1. This connector is the interface to the power board.

Table 5 JP1- iMOTION™ MADK-M3 30-pin interface connector for power board

Pin	Name	Pin Name Connectors
1	PWMUH	3.3 V compatible logic output for high side gate driver-Phase U
2	GND	Ground
3	PWMUL	3.3 V compatible logic output for low side gate driver-Phase U
4	GND	Ground
5	PWMVH	3.3 V compatible logic output for high side gate driver-Phase V
6	+3.3V	3.3 V supply input
7	PWMVL	3.3 V compatible logic output for low side gate driver-Phase V
8	+3.3V	3.3 V supply input
9	PWMWH	3.3 V compatible logic output for high side gate driver-Phase W
10	IU+	Positive shunt voltage of phase U
11	PWMWL	3.3 V compatible logic output for low side gate driver-Phase W
12	IU-	Negative Shunt voltage of phase U or Ground if using single end current feedback
13	GK	Gate kill signal – active low when over current is detected

Pin assignments

Pin	Name	Pin Name Connectors
14	DCBSENSE	DC bus positive voltage, scaled in 0-3.3 V range by a voltage divider
15	VTH	Thermistor input
16	IV+	Positive shunt voltage of phase V
17	IV-	Negative Shunt voltage of phase V or Ground if using single end current feedback
18	IW+	Positive shunt voltage of phase W
19	IW-	Negative Shunt voltage of phase W or Ground if using single end current feedback
20	VCC	Not used
21	PFCG0	PFC control signal
22	GND	Ground
23	PFCG1	Not used
24	+3.3V	3.3 V supply input
25	PFCGK	Gate kill signal – active low when PFC over current is detected
26	DCB	DC bus positive voltage, scaled in 0-3.3 V range by a voltage divider
27	ACV+	AC voltage feedback
28	ACV-	AC voltage feedback
29	IPFC +	Positive PFC current shunt feedback
30	IPFC -	Negative PFC current shunt feedback

5 Schematics and Layout

To meet individual customer requirements and make the EVAL-M3-188 evaluation board a basis for development or modification, all necessary technical data like schematics, layout and components are included in this chapter.

5.1 Schematic Overview

Figure 4 shows the schematic of EVAL-M3-188 evaluation board with IRMCF188 controller.

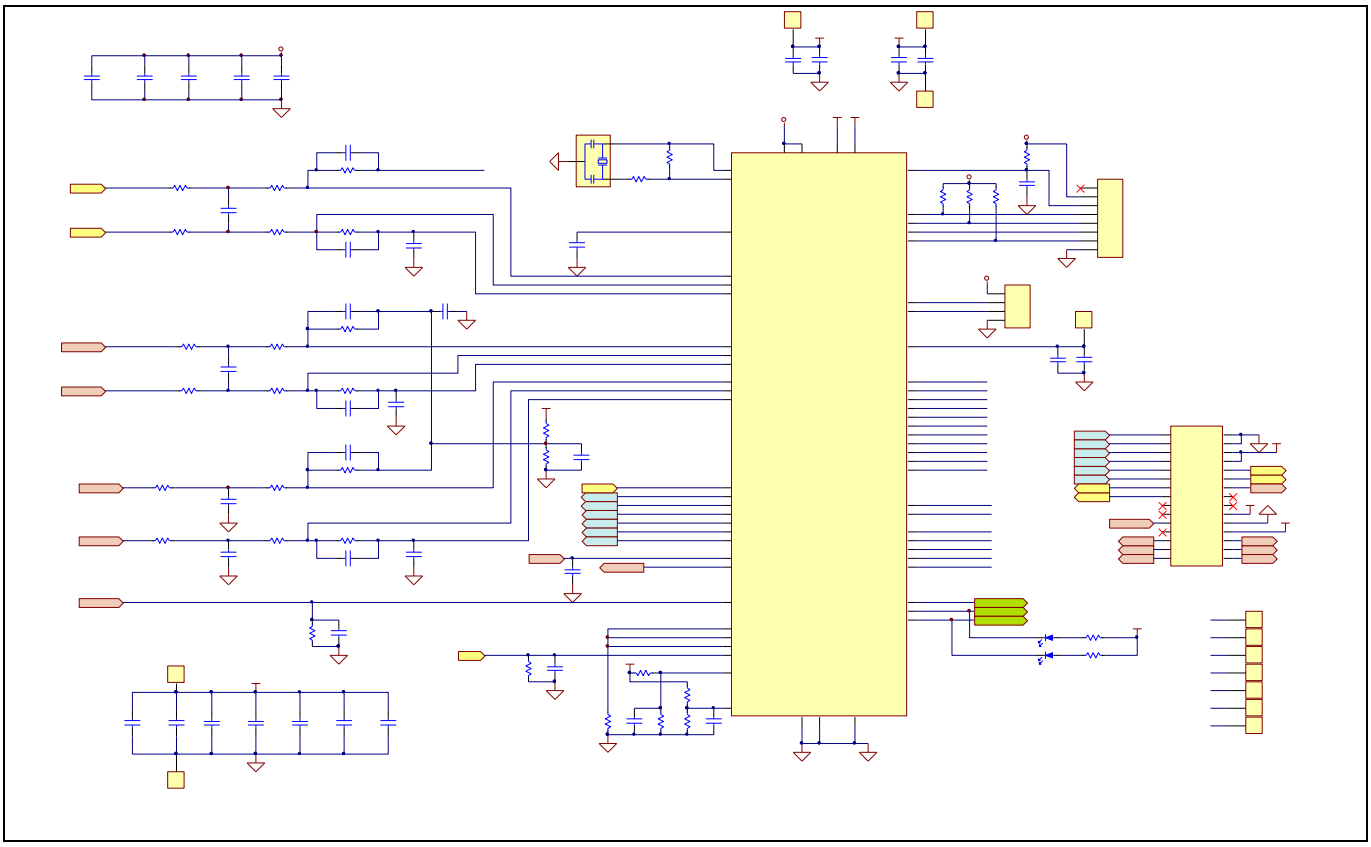


Figure 4 The schematics for the Eval-M3-188 evaluation board

5.2 Current feedback

Figure 5 depicts the single shunt or leg shunt current feedback.

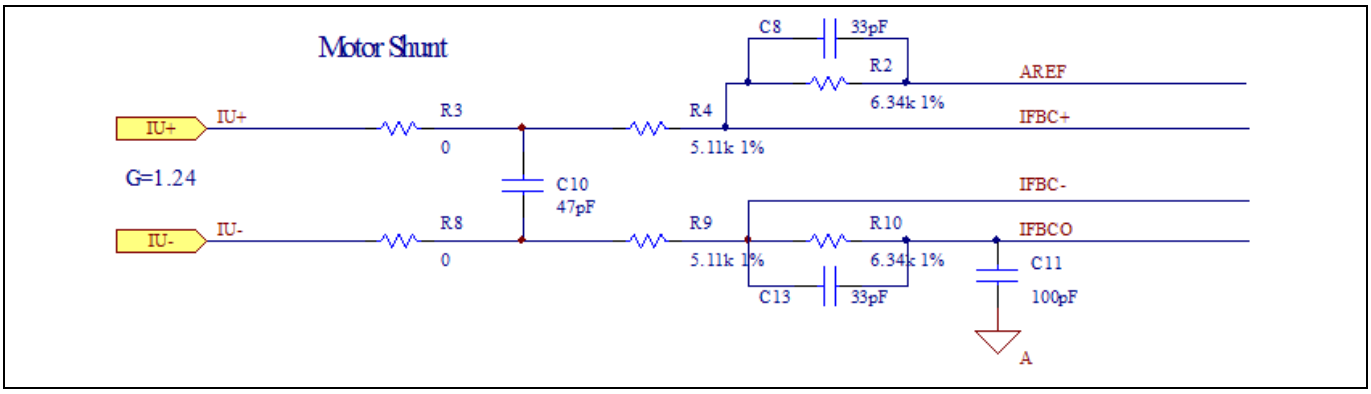


Figure 5 The part of Current feedback on the Eval-M3-188 evaluation board

5.3 PFC Sensing

Figure 6 displays the PFC sensing.

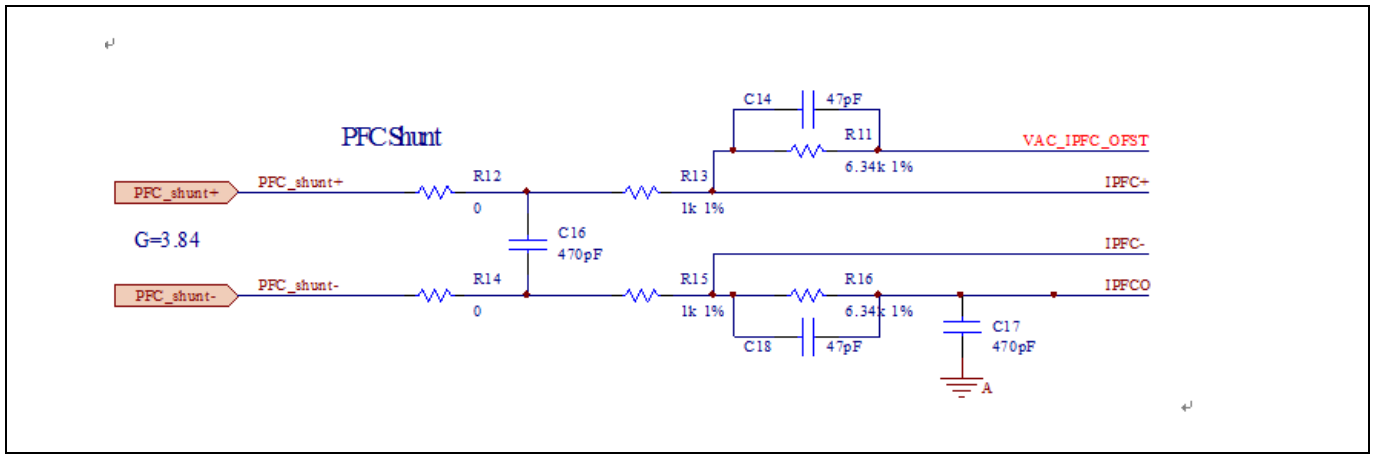


Figure 6 PFC Sensing on the Eval-M3-188 evaluation board

5.4 AC voltage sensing

Figure 7 provides AC voltage sensing.

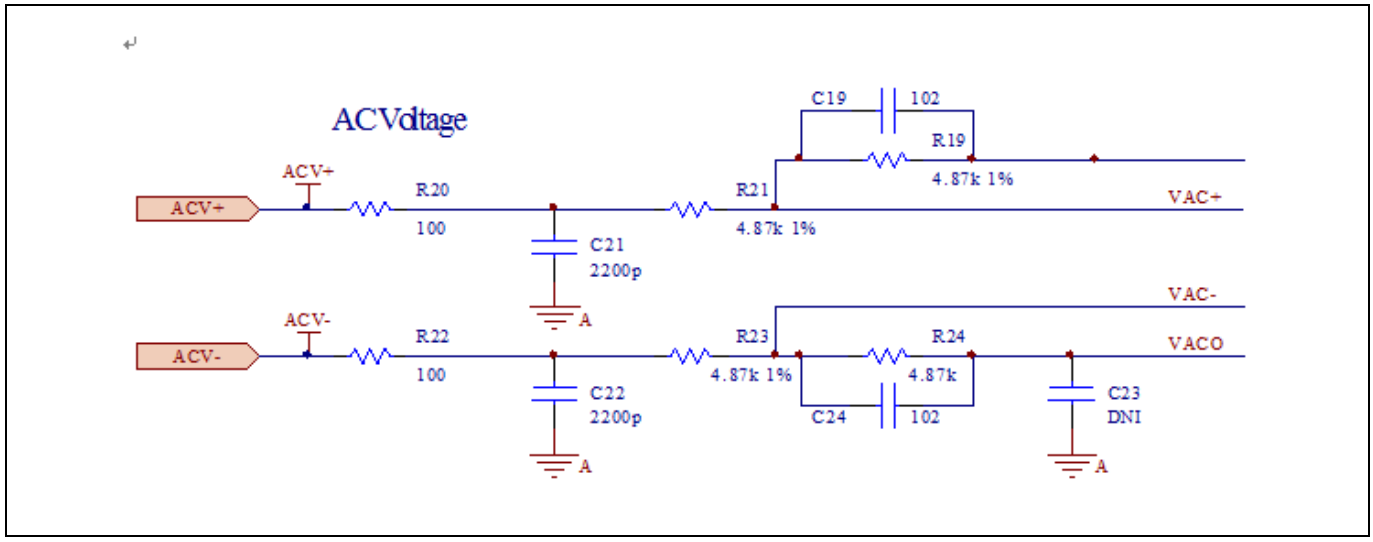


Figure 7 AC Voltage Sensing on the Eval-M3-188 evaluation board

5.5 PCB Layout

The layout of this board can be used for different voltage or power classes. The PCB has two electrical layers with 35µm copper by default and its size is 45 mm × 55 mm. The PCB board thickness is 1.6mm. Get in contact with our technical support team to get more detailed information and the latest Gerber-files.

Figure 8 illustrates the top assembly print of the Eval-M3-188 evaluation board.

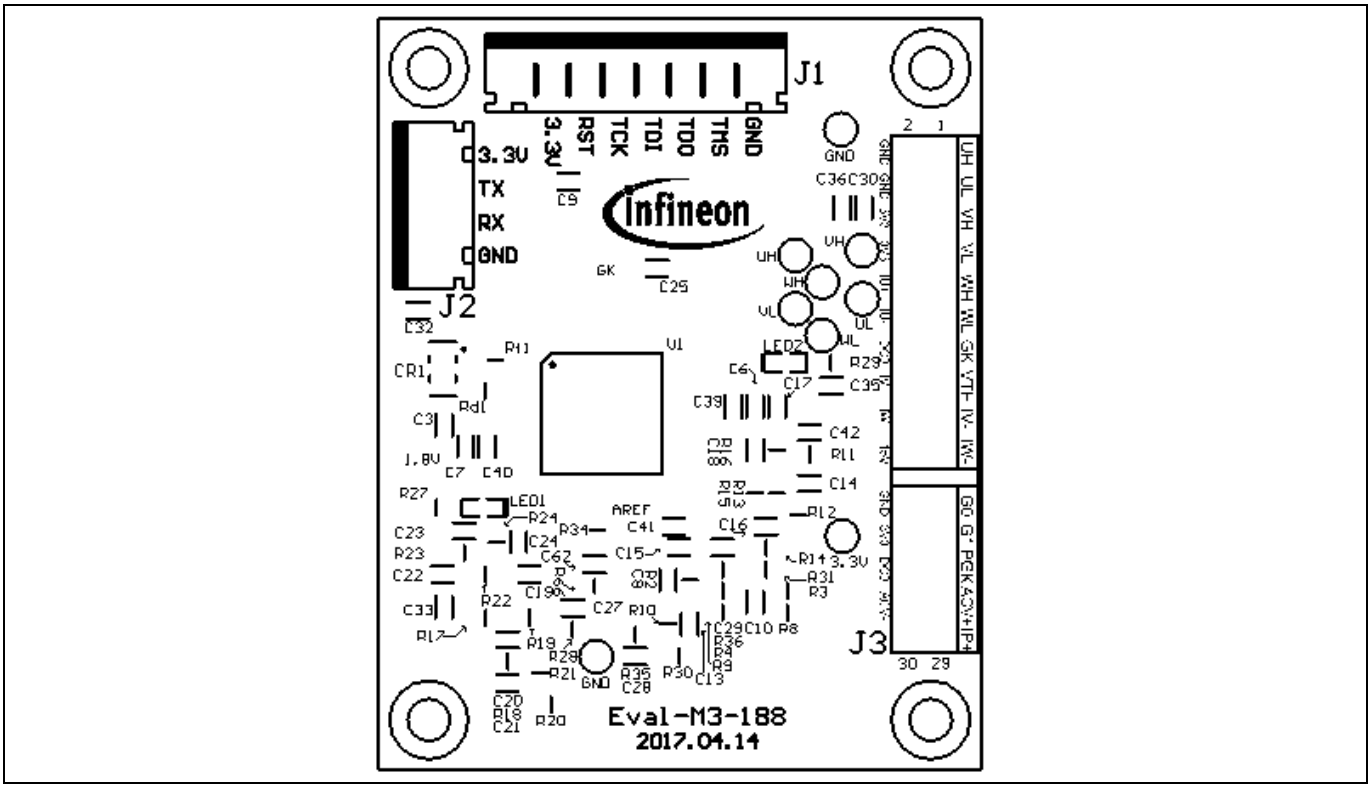


Figure 8 Top overlay print of the EVAL-M3-188 evaluation board

Figure 9 depicts the bottom assembly print of the evaluation board.

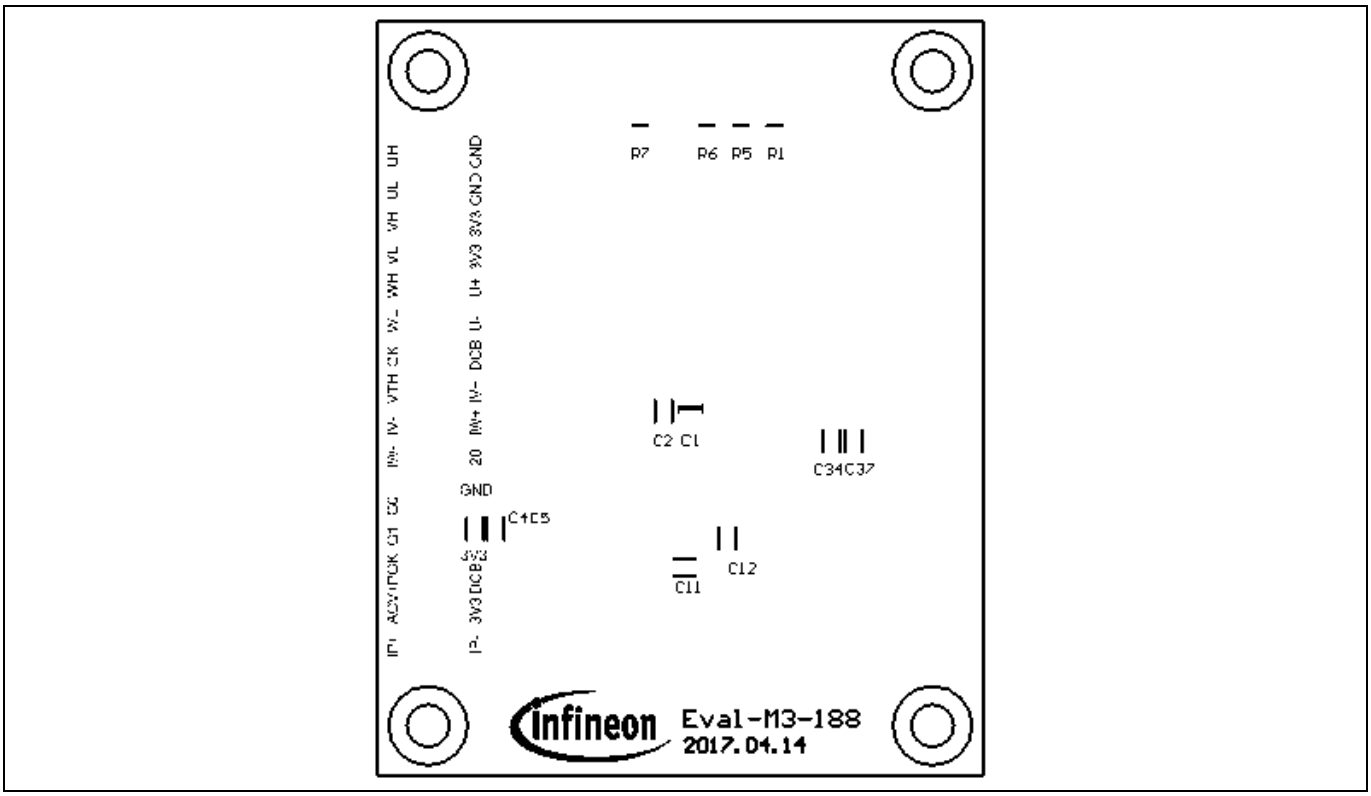


Figure 9 Bottom overlay print of the EVAL-M3-188 evaluation board

The top layer routing of the PCB is provided in the following Figure 10.

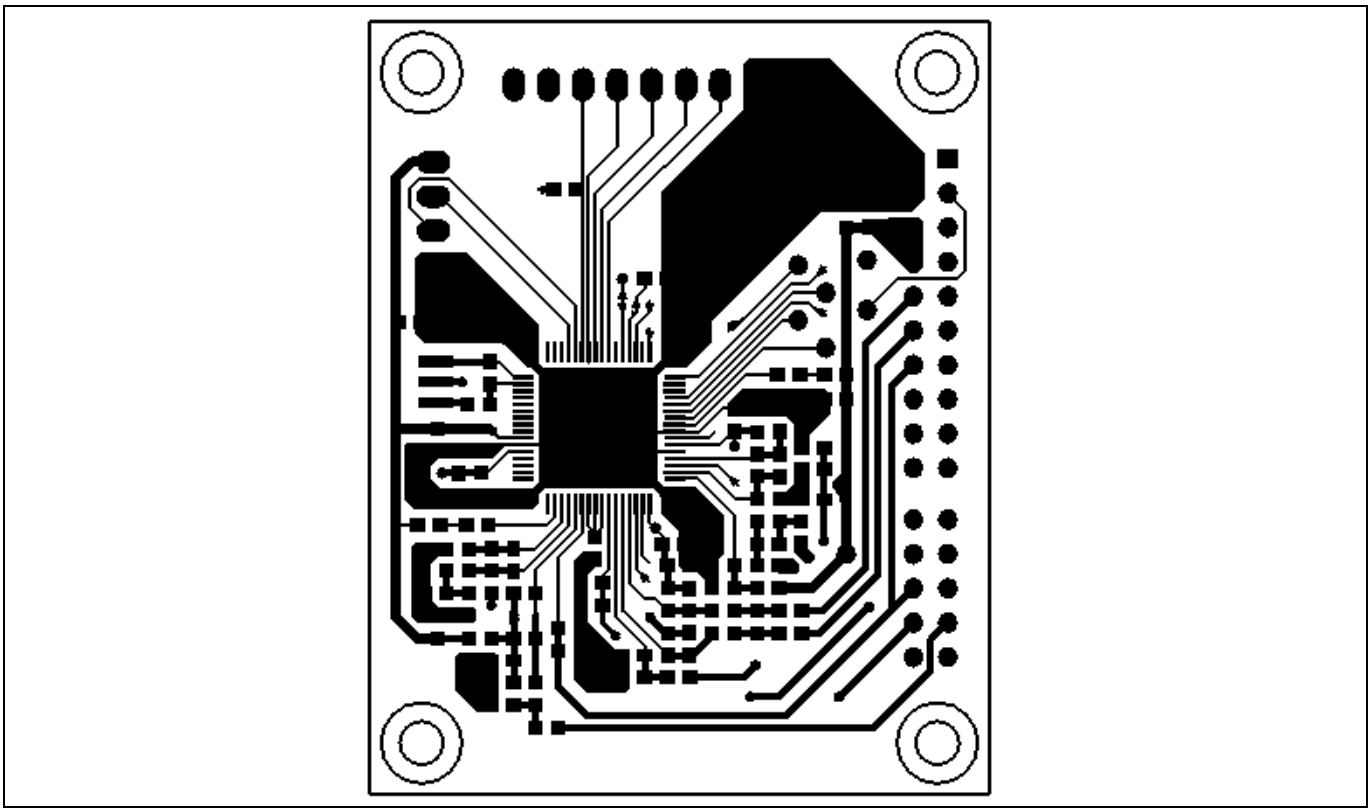


Figure 10 Top layer routing of the EVAL-M3-188

Figure 11 illustrates the bottom layer routing of the PCB.

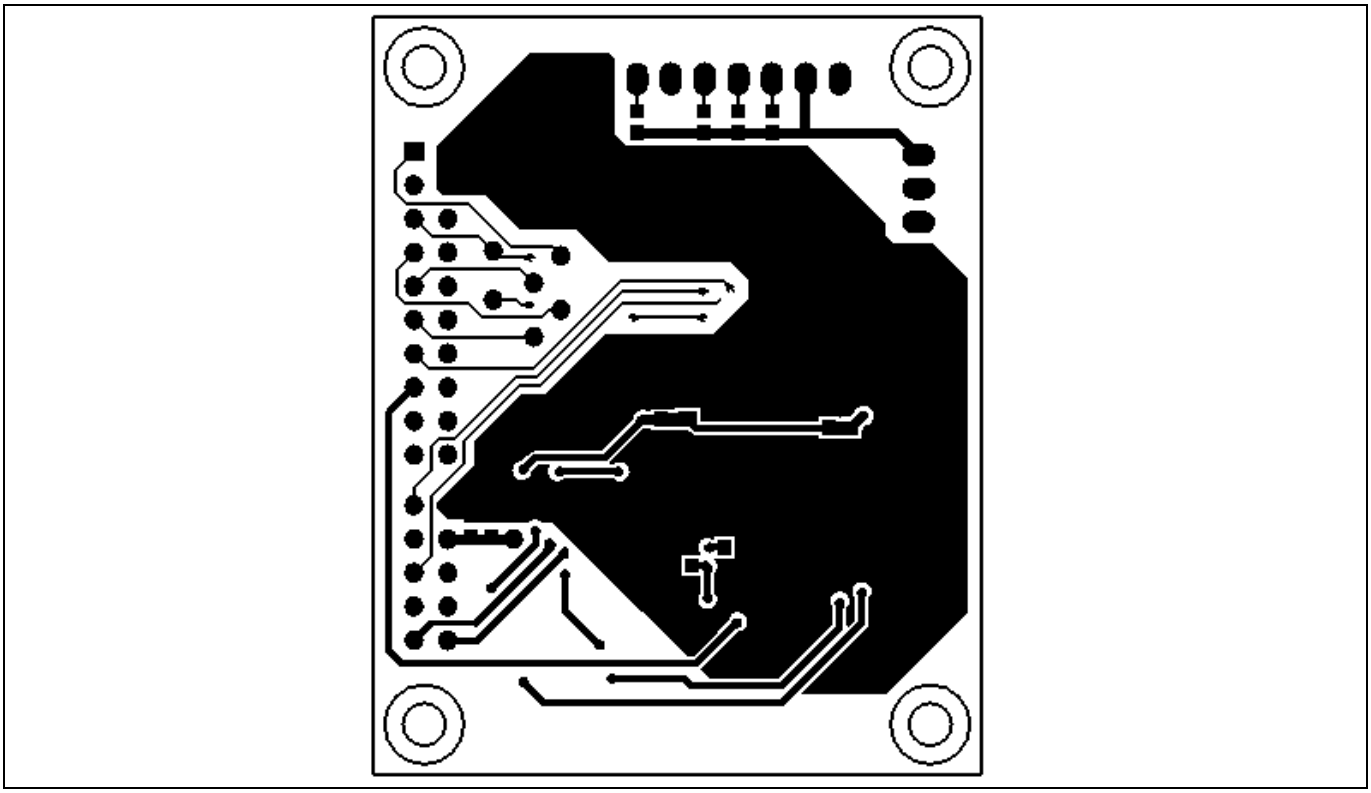


Figure 11 Bottom layer routing of the EVAL-M3-188

6 Bill of Materials of EVAL-M3-188

Table 6 provides the complete bill of materials for the EVAL-M3-188 board.

Table 6 Bill of materials

No.	Qty.	Part description	Designator	Part Number	Manufacturer
1	1	CAP CER 22µF 10V X5R 0805	C1	C0805C226M8PAC7800	Kemet
2	5	CAP CER 0.1µF 50V X7R 0603	C2,C4,C34,C35,C20	C0603C104M5RACTU	Kemet
3	1	CAP CER 22µF 16V X5R 0805	C3	CL21A226KOQNNNE	Samsung Electro-Mechanics America, Inc.
4	1	CAP CER 0.1µF 16V X7R 0603	C5	C0603C104k4RACTU	Kemet
5	4	CAP CER 10µF 16V X6S 0603	C6, C7, C12, C15	CL10X106MO8NRNC	Samsung Electro-Mechanics America, Inc.
6	2	CAP CER 33pF 50V NP0 0603	C8, C13	C0603C330J5GACTU	Kemet
7	1	CAP CER 10000pF 50V X7R 0603	C9	C0603C103K5RACTU	Kemet
8	2	CAP CER 47pF 50V NP0 0603	C8, C10	C0603C470J5GACTU	Kemet
9	1	CAP CER 100pF 50V NP0 0603	C11	C0603C101J5GACTU	Kemet
10	2	CAP CER 470pF 50V NP0 0603	C16, C17	C0603C471J5GACTU	Kemet
11	2	CAP CER 1000pF 50V X7R 0603	C19, C24	C0603C102K5RACTU	Kemet
12	5	CAP CER 2200pF 50V X7R 0603	C21, C22, C26, C27,C28	C0603C222K5RACTU	Kemet
13	1	DNI	C23		Kemet
14	1	CAP CER 220pF 50V X7R 0603	C25	C0603C221K5RACTU	Kemet
15	1	CAP CER 2200pF 50V X7R 0805	C29	C0805C222K5RACTU	Kemet
16	1	CAP CER 0.22µF 25V X7R 0805	C30	C0805C224K3RACAUTO	Kemet
17	1	CAP CER 0.1µF 25V Y5V 0805	C31	C0805C104Z3VACTU	Kemet
18	3	CAP CER 10µF 25V X5R 080 5	C32, C33, C38	C0805C106K3PAC7800	Kemet
19	3	CAP CER 10µF 16V X6S 0603	C36, C37, C39	CL10X106MO8NRNC	Samsung Electro-Mechanics America, Inc.
20	1	CER RES 4.0000MHZ 15PF SMD	CR1	CSTCR4M00G53-R0	Murata Electronics North America
21	1	CONN HEADER XH TOP	J1	B8B-XH-A(LF)(SN)	JST Sales America

No.	Qty.	Part description	Designator	Part Number	Manufacturer
		8POS 2.5MM			Inc
22	1	CONN HEADER XH TOP 4POS 2.5MM	J2	B4B-XH-A(LF)(SN)	JST Sales America Inc
23	1	CONN FEMALE 20POS DL .1" R/A TIN (Note1)	JP1-1	PPTC102LJBN-RC	Sullins Connector Solutions
	1	CONN FEMALE 10POS DL .1" R/A TIN	JP1-2	PPTC052LJBN-RC	Sullins Connector Solutions
24	1	LED RED CLEAR 0603 R/A SMD	LED1	LTST-S270EKT	Lite-On Inc.
25	1	LED GREEN CLEAR 0603 R/A SMD	LED2	LTST-S270EKT	Lite-On Inc.
26	4	RES SMD 4.7kΩ1% 1/10W 0603	R1, R5, R6, R7	ERJ-6RQF4R7V	Panasonic Electronic Components
27	4	RES SMD 6.34 kΩ1% 1/10W 0603	R2, R10, R11, R16	ERJ-3EKF6341V	Panasonic Electronic Components
28	2	RES SMD 5.11 kΩ1% 1/10W 0603	R4, R9	ERJ-3EKF5111V	Panasonic Electronic Components
29	7	RES SMD 1 kΩ1% 1/10W 0603	R13, R15, R32, R33, R34, R44, Rd1	ERJ-3EKF1001V	Panasonic Electronic Components
30	2	RES SMD 560 Ω 1% 1/10W 0603	R17,R31	ERJ-3EKF5600V	Panasonic Electronic Components
31	1	RES SMD 18Ω 1% 1/10W 0603	R18	ERJ-3EKF18R0V	Panasonic Electronic Components
32	6	RES SMD 4.87Ω 1% 1/10W 0603	R19, R21, R23, R26, R28,R24	ERJ-3EKF4871V	Panasonic Electronic Components
33	5	RES SMD 100Ω 1% 1/10W 0603	R20, R22, R25, R27, R29	ERJ-3EKF1000V	Panasonic Electronic Components
34	1	RES SMD 510Ω 1% 1/10W 0603	R30	ERJ-3EKF5100V	Panasonic Electronic Components
35	1	RES SMD 240Ω 1% 1/10W 0603	R35	ERJ-3EKF2400V	Panasonic Electronic Components
36	1	RES SMD 18Ω 5% 1/8W 0805	R36	ERJ-6GEYJ180V	Panasonic Electronic Components
37	3	RES SMD 300Ω 5% 1/4W	R39, R41, R43	ERJ-8GEYJ301V	Panasonic

No.	Qty.	Part description	Designator	Part Number	Manufacturer
		1206			Electronic Components
38	1	RES SMD 1MΩ 5% 1/10W 0603	Rf1	ERJ-3GEYJ105V	Panasonic Electronic Components
39	1	TEST POINT PC MINI .040"D WHITE	TP1	5002	Keystone Electronics
40	1	TEST POINT PC MINI .040"D WHITE	TP2	5002	Keystone Electronics
41	1	TEST POINT PC MINI .040"D WHITE	TP3	5002	Keystone Electronics
42	1	TEST POINT PC MINI .040"D WHITE	TP4,	5002	Keystone Electronics
43	1	TEST POINT PC MINI .040"D WHITE	TP7	5002	Keystone Electronics
44	1	TEST POINT PC MINI .040"D WHITE	TP8	5002	Keystone Electronics
45	1	TEST POINT PC MINI .040"D WHITE	TP9	5002	Keystone Electronics
46	1	TEST POINT PC MINI .040"D WHITE	TP10	5002	Keystone Electronics
47	1	TEST POINT PC MINI .040"D WHITE	TP11	5002	Keystone Electronics
48	1	TEST POINT PC MINI .040"D WHITE	TP12	5002	Keystone Electronics
49	1	TEST POINT PC MINI .040"D WHITE	TP13	5002	Keystone Electronics
50	1	TEST POINT PC MINI .040"D WHITE	TP15	5002	Keystone Electronics
51	1	TEST POINT PC MINI .040"D WHITE	TP17	5002	Keystone Electronics
52	1	Control IC	U1	IRMCF188	Infineon Technologies
53	1	Wide Input Range Low Noise 500mA LDO	U2	IFX1117-ME V33	Infineon Technologies

Note1: The distance between JP1-1 to JP1-2 is 1.27MM.

7 Reference

[1] Datasheet of Infineon IRMCF188

[2] Application Note of AN2016-24 for EVAL-M1-05-65D power board, is available for download on Infineon's website

[3] IRMCx100 Reference Manual

[4] IRMCx100 Software Developer's Guide

[5] IRMCx100 System Overview

Note2: Above all reference materials are available for download on Infineon's website www.infineon.com

Revision History

Major changes since the last revision

Version number	Revision Date	Revision description
1.0	2017-05-09	First release
1.1	2017-07-26	1. Remove MCETOOL v2 description 2. Software download link updated

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