

EVAL-M1-099M-C User Manual

iMOTION™ Modular Application Design Kit

About this document

Scope and purpose

This application note provides an overview of the evaluation board EVAL-M1-099M including its main features, key data, pin assignments and mechanical dimensions.

EVAL-M1-099M is an evaluation-board as part of the iMOTION™ Modular Application Design Kit Platform. This board features and demonstrates Infineon's advanced Motion Control Engine (MCE) technology for permanent magnet motors drive over the full speed range.

The evaluation board EVAL-M1-099M was developed to support customers during their first steps designing applications with running any permanent magnet motor via sensorless sinusoidal control.

Important Note: EVAL-M1-099M-C is the orderable part number for the kit which contains only EVAL-M1-099M MADK Control Board. In order to program, configure and debug the motor control systems based on EVAL-M1-099M, an Isolated Debugger Tool MCETOOLV2 is required. **MCETOOLV2 is not part of the EVAL-M1-099M-C kit and needs to be ordered separately.**

Intended audience

This application note is intended for all technical specialists who know motor control and high power electronics converter and this board is intended to be used under laboratory conditions.

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Safety precautions

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**

| | |
|---|--|
|  | <p>Attention: <i>The ground potential of the EVAL-M1-099M 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 and equipment damage</i></p> |
|  | <p>Attention: <i>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.</i></p> |
|  | <p>Attention: <i>The surfaces of the drive may become hot, which may cause injury.</i></p> |
|  | <p>Attention: <i>EVAL-M1-099M 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.</i></p> |
|  | <p>Attention: <i>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.</i></p> |
|  | <p>Attention: <i>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.</i></p> |
|  | <p>Attention: <i>EVAL-M1-099M 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.</i></p> |

Introduction

2 Introduction

The EVAL-M1-099M evaluation board is a part of the iMOTION™ Modular Application Design Kit 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 20 pins connector and for motor control only.

This evaluation board is designed to give comprehensible solutions of sensorless control of permanent magnet motors over the full speed range. It consists of IRMCK099M Motor Control IC, capable of 3-phase and three types of 2-phase modulation, JTAG and UART interface which are isolated via opto-isolation box (MCETOOLV2), and needs a single 3.3V supply. Required Isolation Box MCETOOLV2 is not part of the EVAL-M1-099M-C kit and needs to be ordered separately. For details of the isolation box please refer to its Application Note.

The EVAL-M1-099M evaluation board is available from Infineon and its distribution partners. 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-M1-099M. 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 technical specialists only.

Figure 1 shows the evaluation board EVAL-M1-099M. This document explains the features and details of this board as well as control IC which is IRMCK099.

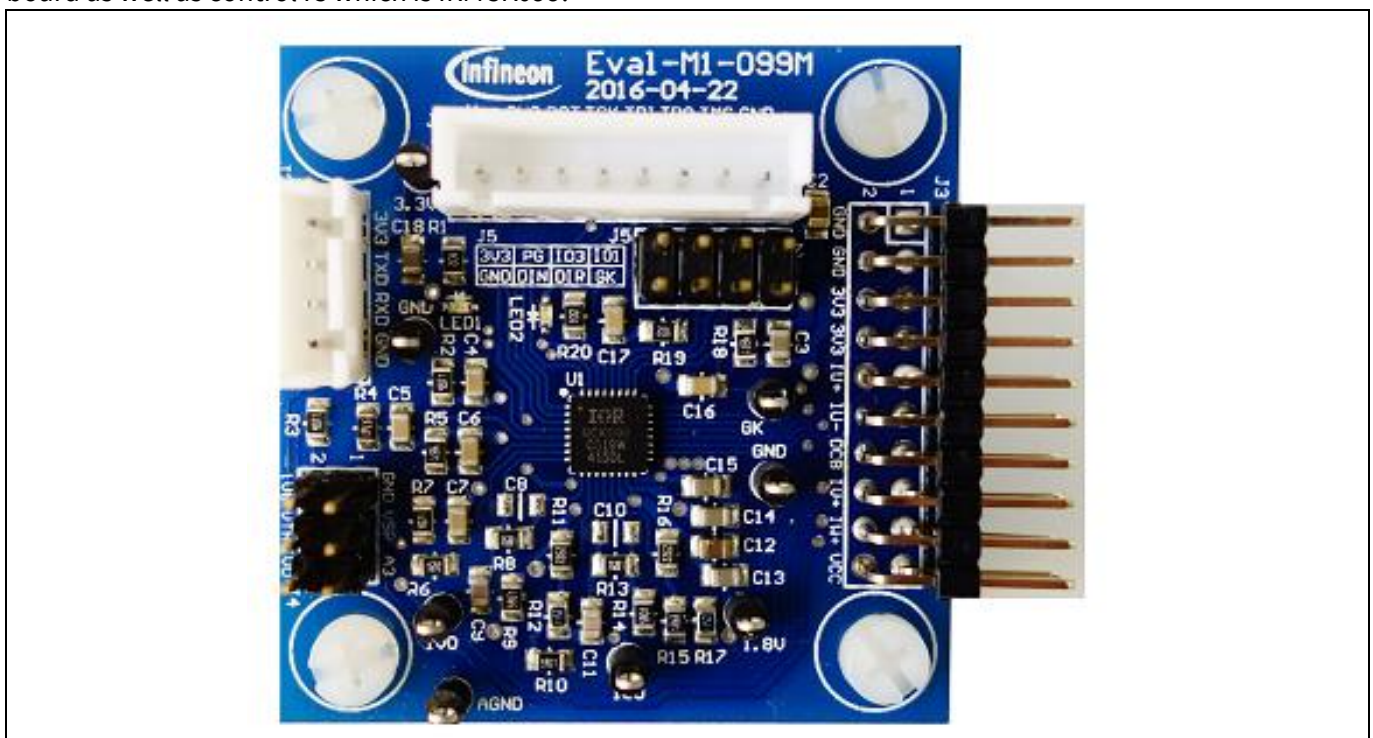


Figure 1 Evaluation board EVAL-M1-099M

Main features

3 Main features

EVAL-M1-099M is a control evaluation board for motor control application. The kit demonstrates Infineon's motion control IC technology.

Main features of Motion Control IC are:

- MCE (Motion Control Engine) - Dedicated computation engine for high efficiency sinusoidal sensorless motor control
- Supports both interior and surface permanent magnet motor
- Built-in hardware for single or leg shunt current feedback reconstruction
- Loss minimization Space Vector PWM
- Two-channel analog output
- JTAG programming port for emulation/ debugger
- Serial communication interface (UART)
- Internal 16 Kbyte OTP memory
- Multiple motor parameter support
- 3.3V single power supply
- V_{SP} control mode
- PG output
- Internal temperature sensing
- External NTC thermistor from power board temperature sensing support.

The evaluation board characteristics are:

- Complete kit for running any permanent magnet motor via sensorless sinusoidal control
- 3.3V single power supply
- JTAG and UART interface, isolated via opto-isolation box
- Capable of 3-phase and three types of 2-phase modulation
- RoHS complaint
- PCB is 45 x 45 mm and has two layers with 35 μ m copper each

Main features

3.1 Key data

Figure 2 shows a typical motor control application block diagram using the IRMCK099. The IRMCK099 provides a built-in closed loop sensorless control algorithm using the unique flexible Motion Control Engine (MCE) for permanent magnet motors. The MCE™ consists of a collection of control elements, motion peripherals, a dedicated motion control sequencer and internal memory to map internal signal nodes. IRMCK099 also employs a unique single shunt current reconstruction circuit in addition to two leg shunt current sensing circuit to eliminate additional analog/digital circuitry.

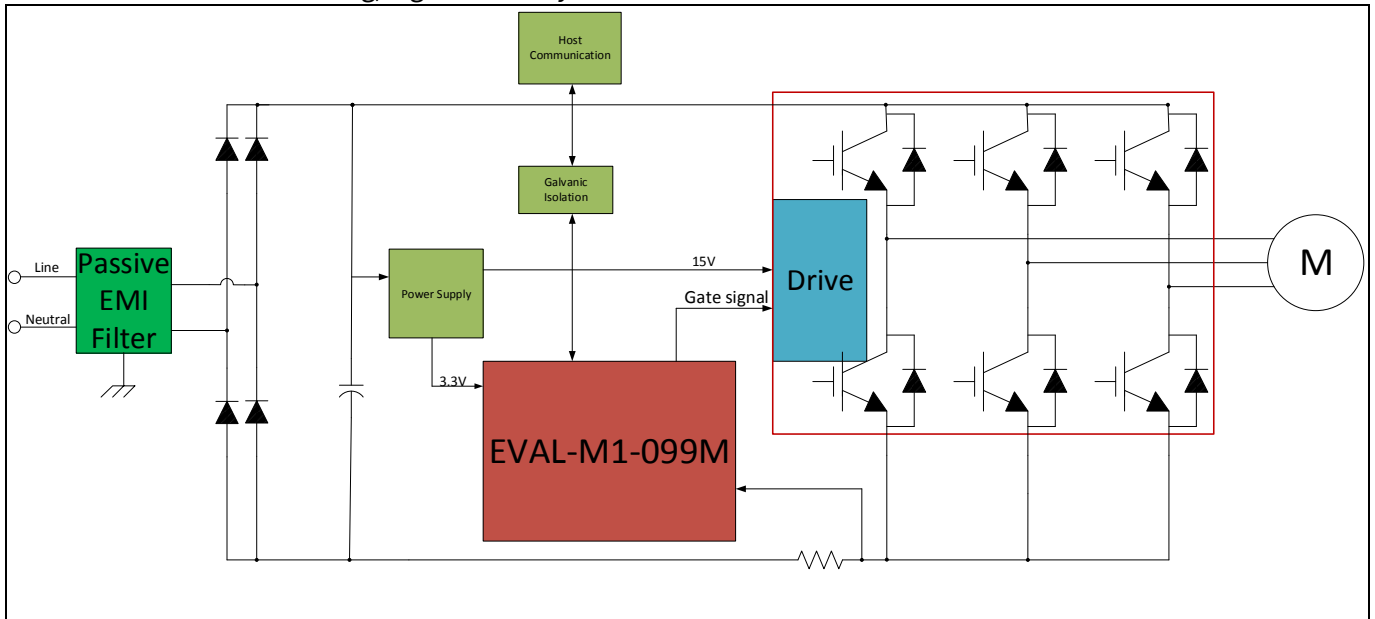


Figure 2 Typical Application Block Diagram Using IRMCK099

Main features

Figure 3 indicates pinout of IRMCK099. IRMCK099 contains 16 Kbytes of OTP program memory and comes in a compact 5mm x 5mm 32-pin QFN package.

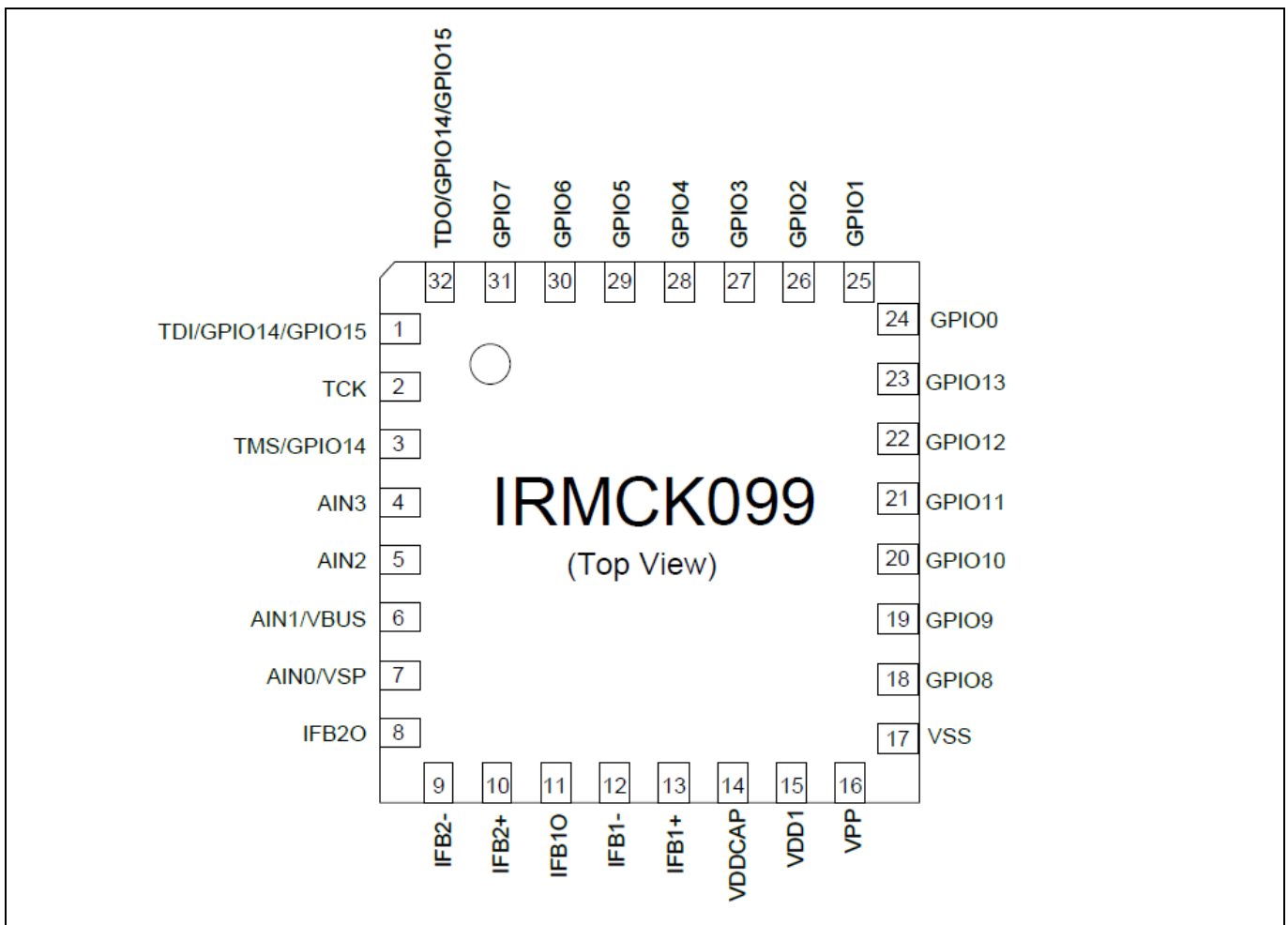


Figure 3 Pinout of IRMCK099

Table 2 depicts the important specifications of the evaluation board EVAL-M1-099M.

Table 2 Eval-M1-099M 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 MCETOOLV2.0 |
| 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 is supposed to have 2MΩ resistor |

Main features

| Parameters | Values | Conditions / comments |
|------------------------------|---|---|
| DC Bus sensing range | 494.0V max | |
| Current feedback | | |
| Current sensing device | 50mV – 1100mV | Single shunt resistor Leg shunt resistor |
| Current Op-amp Configuration | Non-Inverting | |
| Current Op-amp Gain | 1.302 | |
| Resolution | 12-bit | PCB design may reduce the resolution |
| Latency | 1 pwm cycle | |
| Protections | | |
| Internal current trip level | 1.2V Average | |
| On board power supply | | |
| 1.8V | 1.8V+/-5% | From IC for ADC reference |
| PCB characteristics | | |
| Material | FR4, 1.6MM thickness Copper thickness = 1oz (35um) | |
| Dimension | 45mmx45mm | |
| System environment | | |
| Ambient temperature | 0-70°C | 95%RH Max (Non-Condensing) |

Main features

3.2 IRMCK099 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 IRMCK099 development software at Infineon web.

To download supporting software, pls goes to <http://www.infineon.com/imotion-software>. And all the updated version software is saved there.

Note: Currently, the user can download V02_01 and the patch file. See below link.

Or user can open below link to download IRMCK099 Installer V02_01 package.

http://www.infineon.com/dgdl/Infineon-99serieskitmceinstaller-SW-v02_01-EN.exe?fileId=5546d46253f65057015437c4a4e44339

And download V2.1 Patch Kit to update the install package. Then overwrite installed demo project.

http://www.infineon.com/dgdl/Infineon-99+Series+V2_1+Patch+Kit-SW-v02_01-EN.zip?fileId=5546d46256fb43b30157034e5b754664

Figure 4 the functional groups of the EVAL-M1-099M evaluation board.

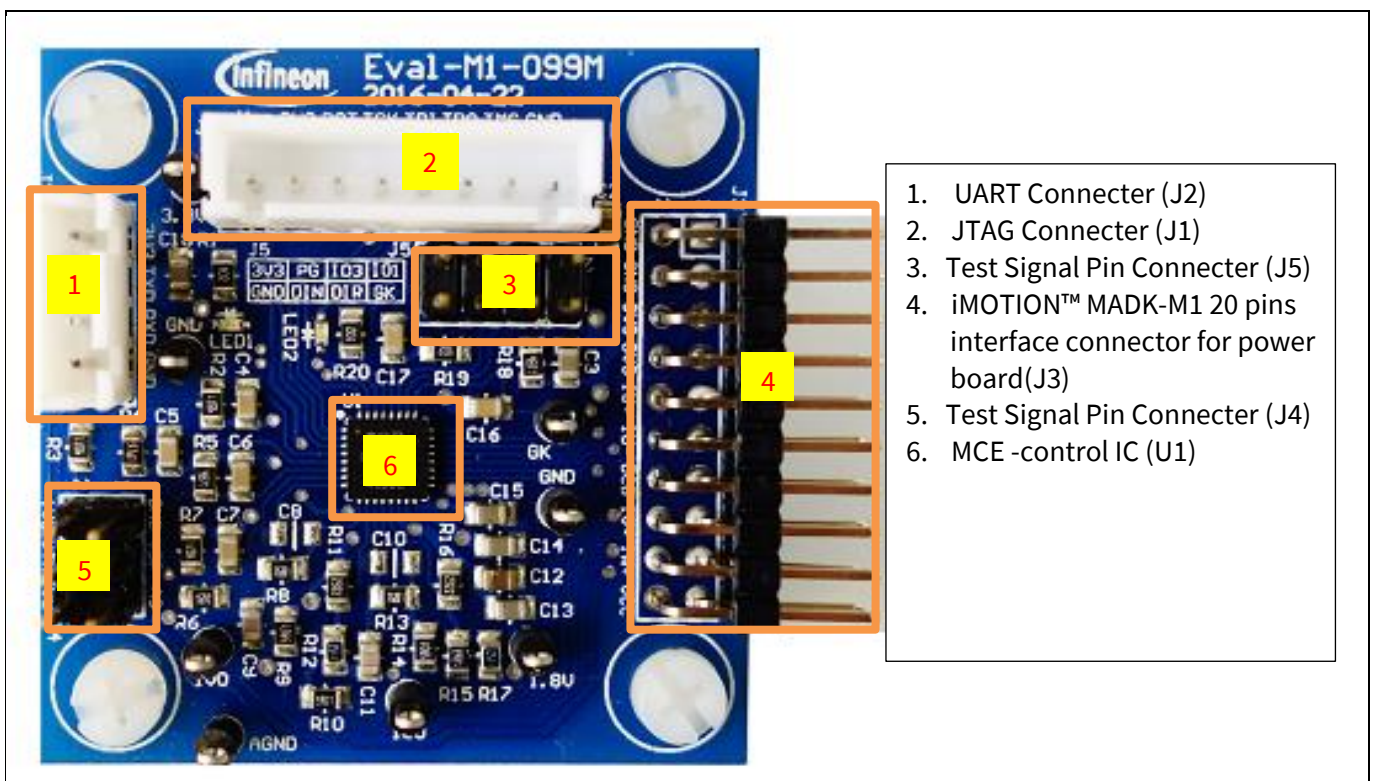


Figure 4 Functional groups of the EVAL-M1-099M evaluation board's top side

Pin assignments

4 Pin assignments

General information about the connectors of the Eval-M1-099M evaluation board is described below.

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

Table 3 J1- UART Connector

| S. No. | Pin | Details |
|--------|-------|---|
| 1 | GND | Ground |
| 2 | RXD | Input, Receive data to IRMCK099, can be configured to GPIO pins |
| 3 | TXD | Output, Transmit data from IRMCK099, can be configured to GPIO pins |
| 4 | +3.3V | +3.3V power supply |

Table 4 J2-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 | Not Connected |
| 7 | +3.3V | +3.3V power supply(see Specification for max current) |
| 8 | VPP | Input ,OTP Programming voltage (for IRMCK099) |

Table 5 provides the pin assignments of the iMOTION™ MADK-M1 20 pins interface connector J3. This connector is the interface to the power board.

Table 5 J3- iMOTION™ MADK-M1 20 pins 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-Phase1 U |
| 4 | GND | Ground |
| 5 | PWMVH | 3.3 V compatible logic output for high side gate driver-Phase V |
| 6 | +3.3V | On board 3.3 V supply |
| 7 | PWMVL | 3.3 V compatible logic output for low side gate driver-Phase V |
| 8 | +3.3V | On board 3.3 V supply |
| 9 | PWMWH | 3.3 V compatible logic output for high side gate driver-Phase W |
| 10 | IU+ | Shunt voltage phase U |
| 11 | PWMWL | 3.3 V compatible logic output for low side gate driver-Phase W |
| 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 |

Pin assignments

| Pin | Name | Pin Name Connectors |
|-----|------|--|
| 15 | VTH | Thermistor input |
| 16 | IV+ | Shunt voltage phase V |
| 17 | IV- | Ground |
| 18 | IW+ | Shunt voltage phase W |
| 19 | IW- | Ground |
| 20 | VCC | Defined for 15 V Power Supply (not used in this board) |

Table 6 and Table 7 include the details of test signal pin connectors.

Table 6 Test signals pin

| Pin | Name | Pin Name Connectors |
|-----|-------|--|
| 1 | GND | Ground |
| 2 | 1.8V | On board 1.8V supply |
| 3 | VSP | Input, Analog input channel 0 (0 – 1.25 V), also used for Standby Mode wake-up |
| 4 | VTH | Input, Voltage input of external temperature sense |
| 5 | AIN3 | Input, Analog input channel 3 (0 – 1.25 V), needs to be pulled down to VSS if unused |
| 6 | IFBVO | Operational amplifier output for 2nd leg shunt resistor current sensing |

Table 7 Test signals pin

| Pin | Name | Pin Name Connector |
|-----|-------|---------------------------------------|
| 1 | GK | Output, Gatekill |
| 2 | GPIO1 | Test IO pin |
| 3 | DIR | Input, motor direction select |
| 4 | GPIO3 | Input, User mode select |
| 5 | DIN | Input, for Frequency control function |
| 6 | PG | Output, Pulse generate |
| 7 | GND | Ground |
| 8 | +3.3V | +3.3 V power supply |

5 Schematics and Layout

To meet individual customer requirements and make the EVAL-M1-099M 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 5 shows the schematic of EVAL-M1-099M evaluation board with IRMCK099 controller.

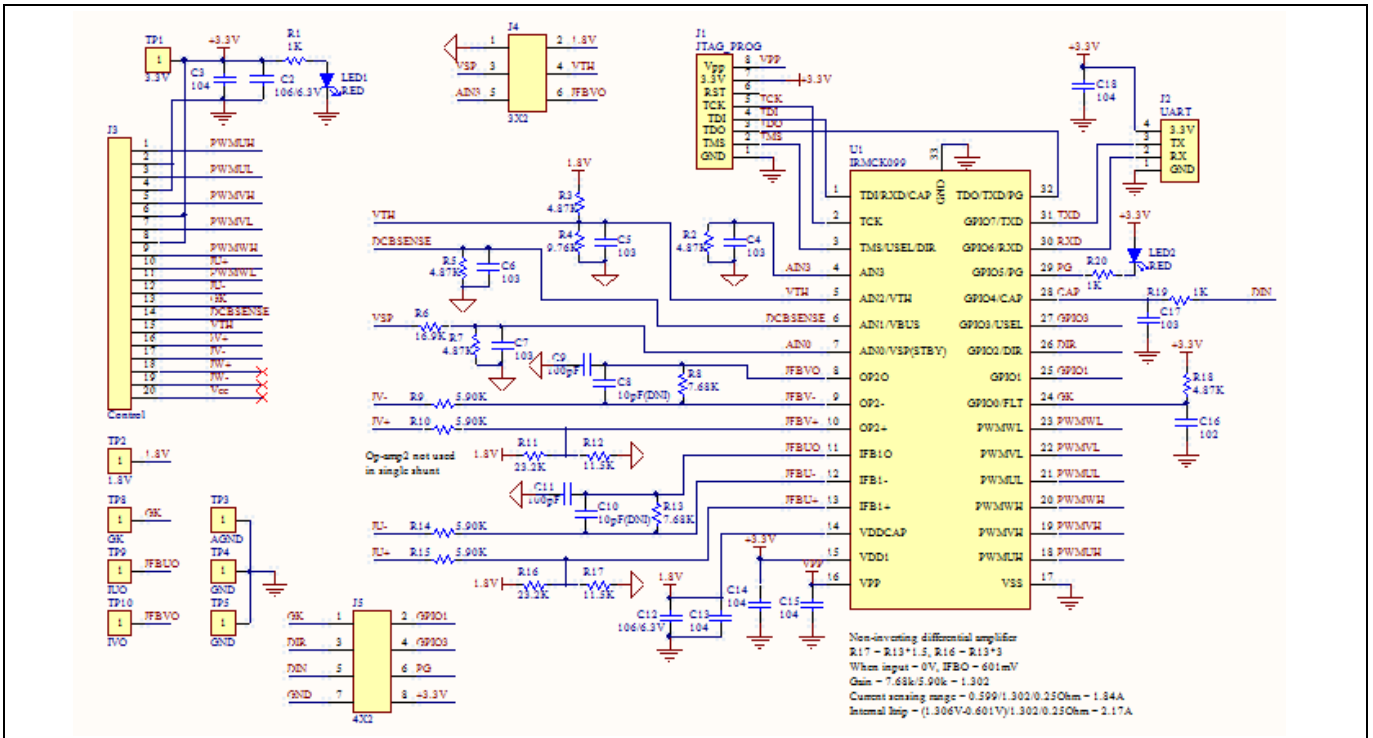


Figure 5 The schematics for the Eval-M1-099M evaluation board

5.2 Current feedback

Current Feedback Gain—the control on this board has an internal current feedback amplifier which has default gain. The user can use this gain to count the current sensing range and Internal Itrip. An example is shown in Figure 6. The sample resistor is 0.25Ω.

$$R17 = R13 * 1.5, \quad R16 = R13 * 3$$

When input = 0V, IFBO = 601mV

$$\text{Current Feedback Gain} = \frac{R13}{R14} = \frac{7.68K}{5.9K} = 1.302$$

Current sensing range is depending on current sample resistor.

$$\text{Current sensing range} = \frac{0.599}{\text{Current Gain} * \text{Sample resistor}}$$

$$\text{Current sensing range} = \frac{0.599}{1.302 * 0.25\Omega} = 1.84A$$

The part of protect circuit, when using single shunt: Iu current feedback OPAMP internal Itrip can protect overcurrent if the system response designed as demand.

$$\text{Internal Itrip} = \frac{\text{IC maximum specification Itrip level} - 0.601V}{\text{Current Gain} * \text{Sample register}}$$

$$\text{Internal Itrip} = \frac{1.306V - 0.601V}{1.302 * 0.25\Omega} = 2.17A$$

When using leg shunt. The gate kill signal from power module works. That is protected by outside IRMCK099.

When using single shunt. IV+ and IV- connect GND.

Figure 6 depicts the Eval-M1-099M evaluation board is suitable for single shunt and leg shunt for current feedback.

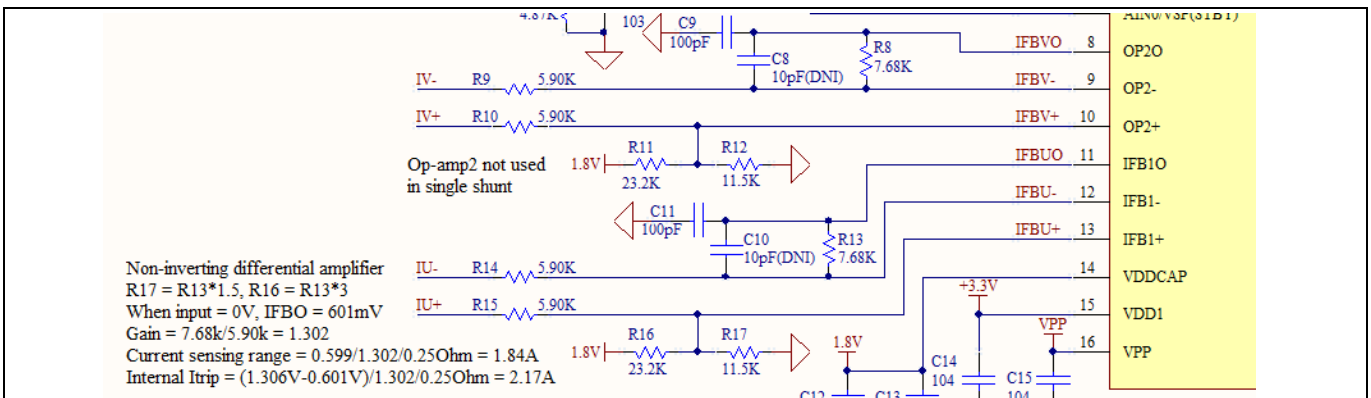


Figure 6 The part of Current feedback on the Eval-M1-099M evaluation board

5.3 AD port Input

Figure 7 depicts AD input for IRMCK099. Temperature input should fit to the design recommendation in the IRMCK099 application note.

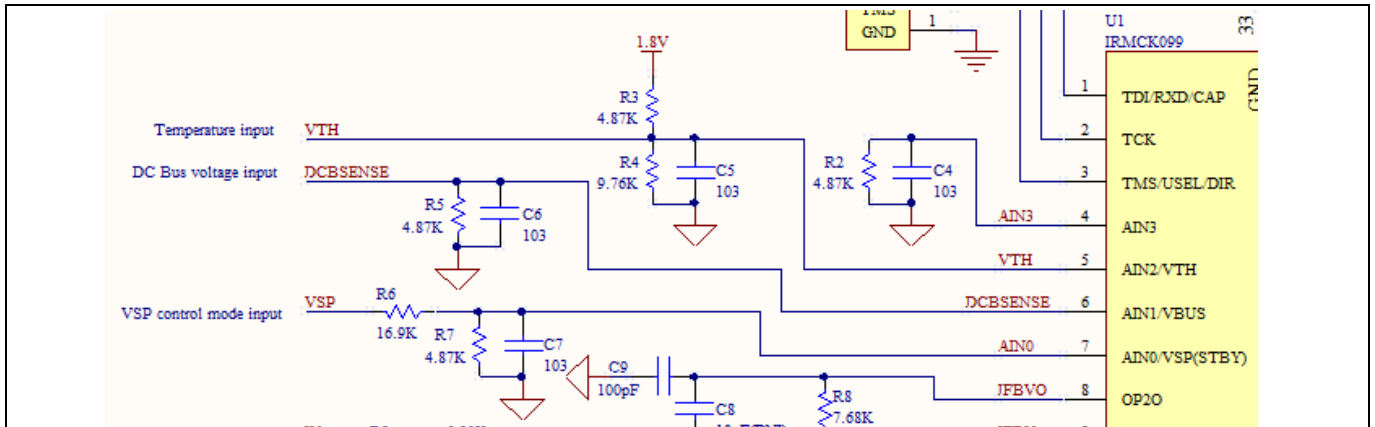


Figure 7 AD input on the Eval-M1-099M evaluation board

5.4 PCB Layout

The layout of this board can be used for different voltage or power classes of power board. The PCB has two electrical layers with 35µm copper by default and its size is 45 mm × 45 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 evaluation board.

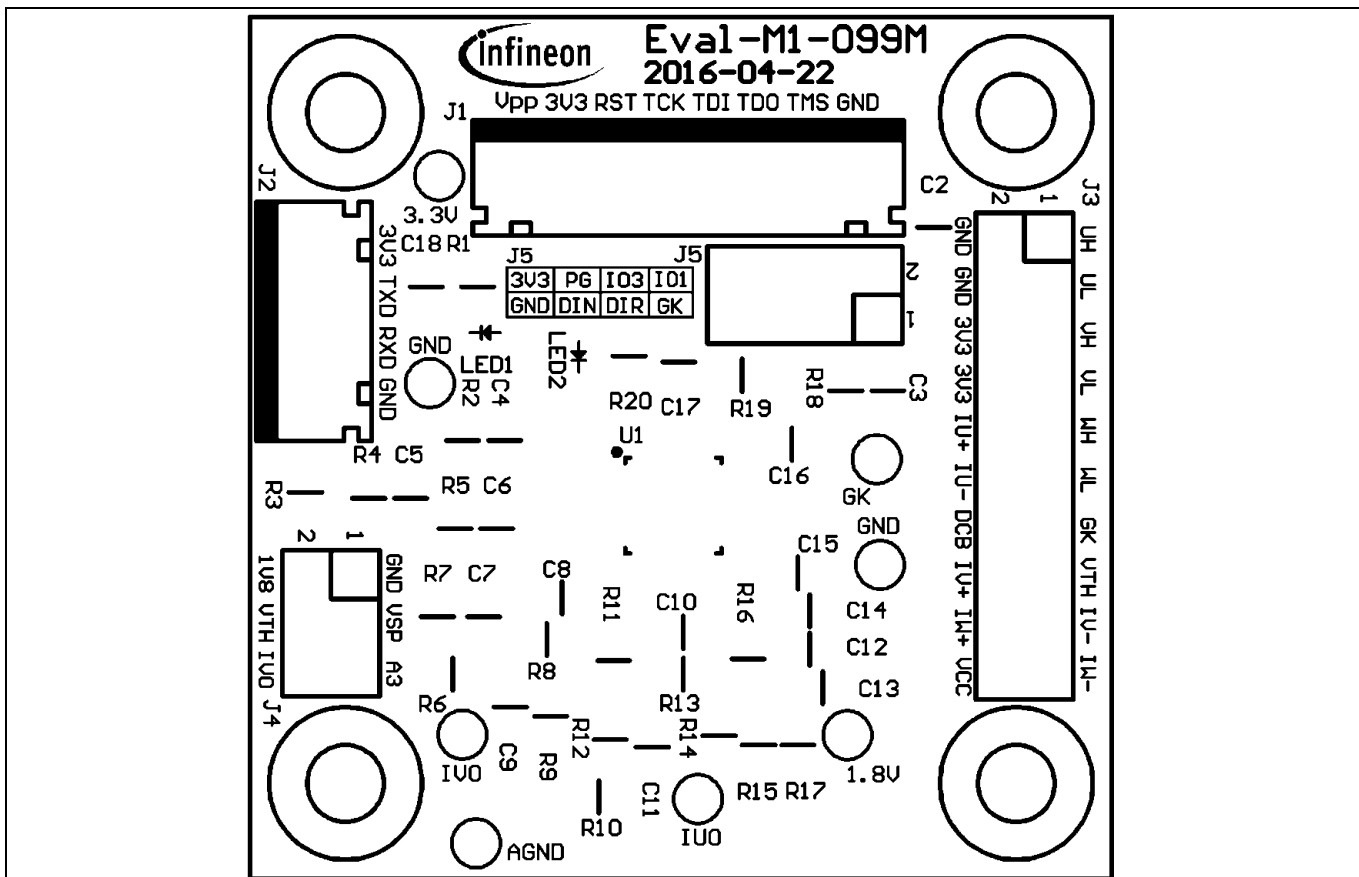


Figure 8 Top overlay print of the EVAL-M1-099M evaluation board

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

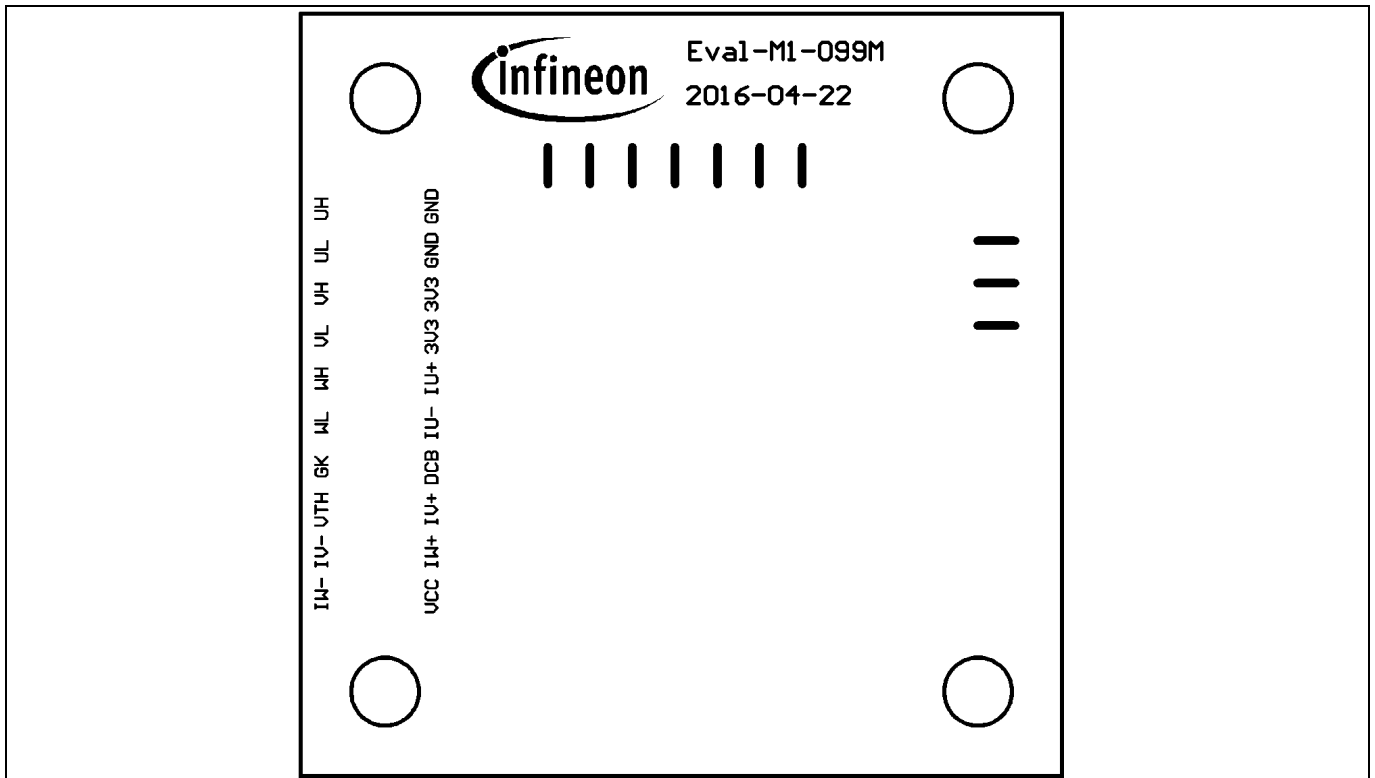


Figure 9 Bottom overlay print of the EVAL-M1-099M evaluation board

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

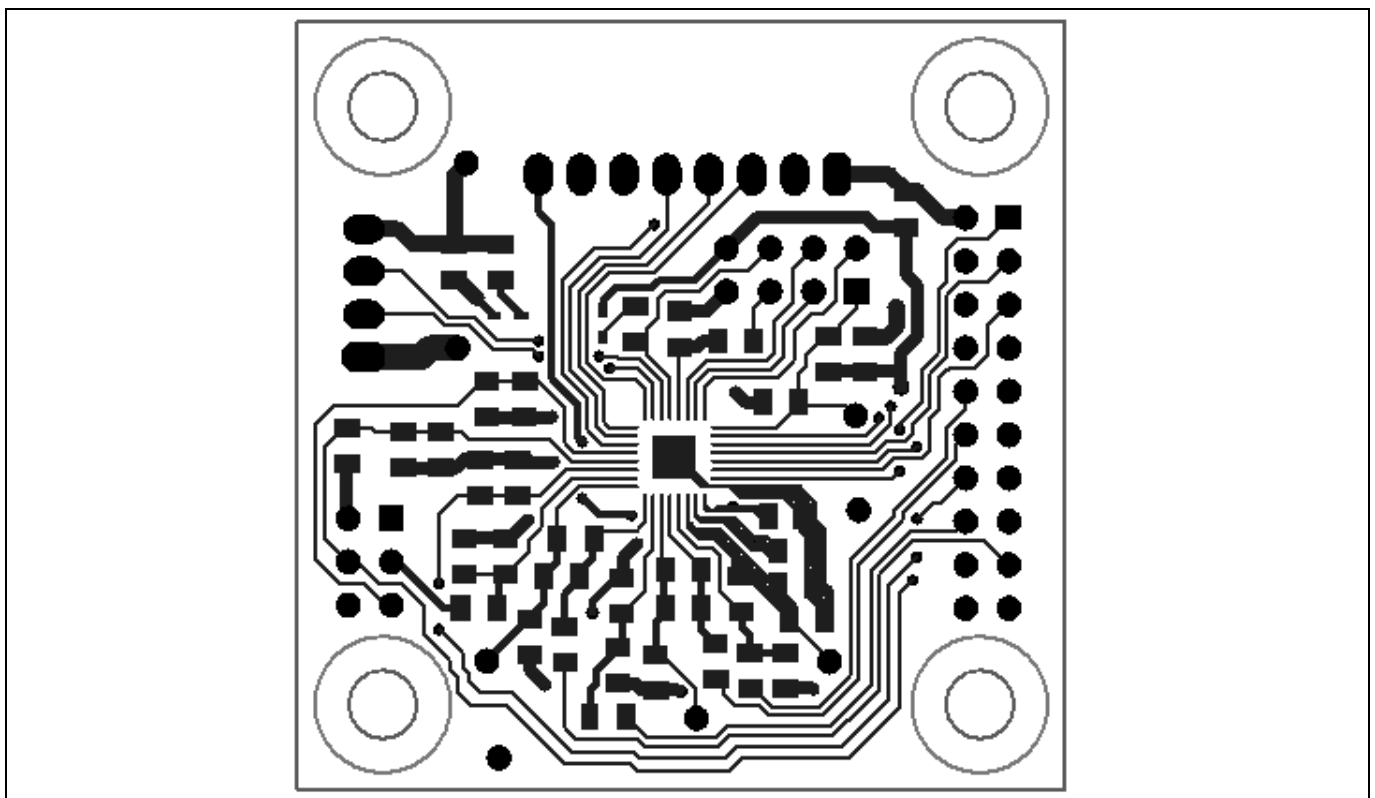


Figure 10 Top layer routing of the EVAL-M1-099M

Figure 11 illustrates the bottom layer routing of the PCB.

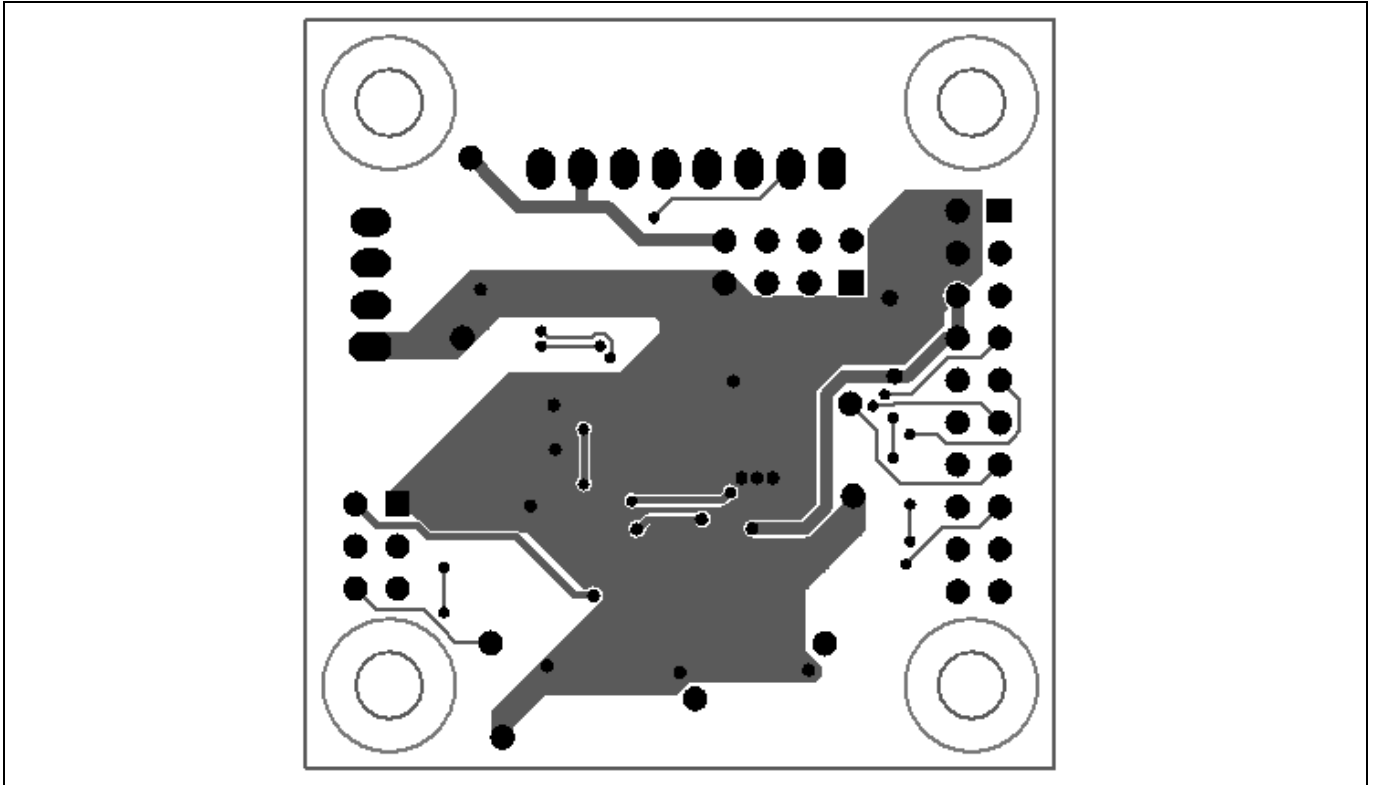


Figure 11 Bottom layer routing of the EVAL-M1-099M

6 Bill of Materials of EVAL-M1-099M

Table 8 provides the complete bill of materials for the EVAL-M1-099M board.

Table 8 Bill of materials

| No. | Qty. | Part description | Designator | Part Number | Manufacturer |
|-----|------|----------------------------------|------------------------|------------------|---|
| 1 | 2 | CAP CER 10µF 6.3V X7R 0805 | C2, C12 | CL21B106KQNNNE | Samsung Electro-Mechanics America, Inc. |
| 2 | 5 | CAP CER 0.1µF 50V X7R 0805 | C3, C13, C14, C15, C18 | 08055C104KAT2A | AVX Corporation |
| 3 | 5 | CAP CER 10000pF 50V X7R 0805 | C4, C5, C6, C7, C17 | C0805C103K5RACTU | Kemet |
| 4 | 2 | CAP CER 10pF 50V NP0 0805 | C8, C10 | C0805C100J5GACTU | Kemet |
| 5 | 2 | CAP CER 100pF 50V NP0 0805 | C9, C11 | C0805C101J5GACTU | Kemet |
| 6 | 1 | CAP CER 1000pF 50V X7R 0805 | C16 | C0805C102K5RACTU | Kemet |
| 7 | 1 | CONN HEADER XH TOP 8POS 2.5mm | J1 | B8B-XH-A(LF)(SN) | JST Sales America Inc |
| 8 | 1 | CONN HEADER XH TOP 4POS 2.5mm | J2 | B4B-XH-A(LF)(SN) | JST Sales America Inc |
| 9 | 1 | CONN HDR DUAL 20POS .100 R/A TIN | J3 | 0717640020 | Molex,LLC |
| 10 | 1 | CONN HEADER 6POS .100 STR 30AU | J4 | 67996-106HLF | Amphenol FCI |
| 11 | 1 | CONN HEADER 8POS .100 STR 30AU | J5 | 67997-108HLF | Amphenol FCI |
| 12 | 2 | LED RED CLEAR 0603 R/A SMD | LED1, LED2 | LTST-S270EKT | Lite-On Inc. |
| 13 | 3 | RES SMD 1 kΩ1% 1/8W 0805 | R1, R19, R20 | RC0805FR-071KL | Yageo |
| 14 | 5 | RES SMD 4.87 kΩ1% 1/8W 0805 | R2, R3, R5, R7, R18 | RC0805FR-074K87L | Yageo |
| 15 | 1 | RES SMD 9376 kΩ1% 1/8W 0805 | R4 | RC0805FR-079K76L | Yageo |
| 16 | 1 | RES SMD 16.9 kΩ1% 1/8W 0805 | R6 | RC0805FR-0716K9L | Yageo |
| 17 | 2 | RES SMD 7.68 kΩ1% 1/8W 0805 | R8, R13 | RC0805FR-077K68L | Yageo |
| 18 | 4 | RES SMD 5.9 kΩ1% 1/8W 0805 | R9, R10, R14, R15 | RC0805FR-075K9L | Yageo |
| 19 | 2 | RES SMD 23.2 kΩ1% 1/8W 0805 | R11, R16 | RC0805FR-0723K2L | Yageo |
| 20 | 2 | RES SMD 11.5 kΩ1% 1/8W 0805 | R12, R17 | RC0805FR-0711K5L | Yageo |
| 21 | 1 | TEST POINT PC MINI .040"D WHITE | TP1 | 5002 | Keystone Electronics |
| 22 | 1 | TEST POINT PC MINI .040"D WHITE | TP2 | 5002 | Keystone Electronics |
| 23 | 1 | TEST POINT PC MINI .040"D WHITE | TP3 | 5002 | Keystone Electronics |
| 24 | 2 | TEST POINT PC MINI .040"D | TP4, TP5 | 5002 | Keystone Electronics |

Bill of Materials of EVAL-M1-099M

| No. | Qty. | Part description | Designator | Part Number | Manufacturer |
|------------|-------------|------------------------------------|-------------------|--------------------|-----------------------|
| | | WHITE | | | |
| 25 | 1 | TEST POINT PC MINI .040"D WHITE | TP8 | 5002 | Keystone Electronics |
| 26 | 1 | TEST POINT PC MINI .040"D WHITE | TP9 | 5002 | Keystone Electronics |
| 27 | 1 | TEST POINT PC MINI .040"D WHITE | TP10 | 5002 | Keystone Electronics |
| 28 | 1 | IRMCK099 | U1 | Control IC | Infineon Technologies |

7 Reference

[1] Datasheet of Infineon IRMCK099M

[2] IRMCx100 Reference Manual

[3] IRMCx100 Software Developer's Guide

[4] IRMCx100 System Overview

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

[6] MCETOOLV2 user manual, is available on Infineon website.

Note1: 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 | 2017-08-21 | First release |
| | | |
| | | |

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AN2017-18 EVAL-M1-099M-C User
Document reference
Manual

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