EVAL-M1-IM818-A user guide

Modular application design kit (MADK) of IM818

IM818-XCC, IM818-MCC, IM818-LCC

About this document

Scope and purpose

This application note provides an overview of the evaluation board EVAL-M1-IM818-A including its main features, key data, pin assignments and mechanical dimensions.

EVAL-M1-IM818-A is a complete evaluation board including a 3-phase CIPOS™ Maxi Intelligent Power Module (IPM) for motor drive application. In combination with control-boards equipped with the M1 20pin interface connector, like EVAL-M1-101T, it features and demonstrates Infineon's CIPOS™ Maxi IPM technology for motor drive.

The evaluation board EVAL-M1-IM818-A was developed to support customers during their first steps designing applications with CIPOS™ Maxi IPM. It includes IM818-SCC，IM818-MCC and IM818-LCC. They are focusing on AC380V input, and 1~4.8 kW output application.

The default of CIPOS™ Maxi IPM in this board is IM818-MCC which has 3-phase inverter with 1200 V TRENCHSTOP™ IGBTs and Emitter Controlled diodes are combined with an optimized 6-channel SOI gate driver. It is optimized to industrial applications like Ventilation and Air Conditioning and motor drive.

All CIPOS™ Maxi IPM IM818 series can directly replace the test on the board.

Intended audience

This user guide is intended for all technical specialists who know motor control, middle- and low-power electronics converters. The board is intended to be used under laboratory conditions.

Evaluation Board

This board will be used during design in, for evaluation and measurement of characteristics, and proof of data sheet specifications.

Note: PCB and auxiliary circuits are NOT optimized for final customer design.

EVAL-M1-IM818-A user guide
Evaluation power board with MAKD M1 connector
Important notice

Important notice

"Evaluation Boards and Reference Boards" shall mean products embedded on a printed circuit board (PCB) for demonstration and/or evaluation purposes, which include, without limitation, demonstration, reference and evaluation boards, kits and design (collectively referred to as "Reference Board").

Environmental conditions have been considered in the design of the Evaluation Boards and Reference Boards provided by Infineon Technologies. The design of the Evaluation Boards and Reference Boards has been tested by Infineon Technologies only as described in this document. The design is not qualified in terms of safety requirements, manufacturing and operation over the entire operating temperature range or lifetime.

The Evaluation Boards and Reference Boards provided by Infineon Technologies are subject to functional testing only under typical load conditions. Evaluation Boards and Reference 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 and Reference Boards are not commercialized products, and are solely intended for evaluation and testing purposes. In particular, they shall not be used for reliability testing or production. The Evaluation Boards and Reference Boards may therefore not comply with CE or similar standards (including but not limited to the EMC Directive 2004/EC/108 and the EMC Act) and may not fulfill other requirements of the country in which they are operated by the customer. The customer shall ensure that all Evaluation Boards and Reference Boards will be handled in a way which is compliant with the relevant requirements and standards of the country in which they are operated.

The Evaluation Boards and Reference Boards as well as the information provided in this document are addressed only to qualified and skilled technical staff, for laboratory usage, and shall be used and managed according to the terms and conditions set forth in this document and in other related documentation supplied with the respective Evaluation Board or Reference Board.

It is the responsibility of the customer's technical departments to evaluate the suitability of the Evaluation Boards and Reference Boards for the intended application, and to evaluate the completeness and correctness of the information provided in this document with respect to such application.

The customer is obliged to ensure that the use of the Evaluation Boards and Reference Boards does not cause any harm to persons or third party property.
The Evaluation Boards and Reference Boards and any information in this document is provided "as is" and Infineon Technologies disclaims any warranties, express or implied, including but not limited to warranties of non-infringement of third party rights and implied warranties of fitness for any purpose, or for merchantability.

Infineon Technologies shall not be responsible for any damages resulting from the use of the Evaluation Boards and Reference Boards and/or from any information provided in this document. The customer is obliged to defend, indemnify and hold Infineon Technologies harmless from and against any claims or damages arising out of or resulting from any use thereof.

Infineon Technologies reserves the right to modify this document and/or any information provided herein at any time without further notice.

Safety precautions

Note: *Please note the following warnings regarding the hazards associated with development systems.*

Table 1 **Safety precautions**

⚠	**Warning:** *The DC link potential of this board is up to 1000 VDC. When measuring voltage waveforms by oscilloscope, high voltage differential probes must be used. Failure to do so may result in personal injury or death.*
⚠	**Warning***: The evaluation or reference board contains DC bus capacitors which take time to discharge after removal of the main supply. Before working on the drive system, wait five 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.*
⚠	**Warning:** *The evaluation or reference board is connected to the grid input during testing. Hence, high-voltage differential probes must be used when measuring voltage waveforms by oscilloscope. 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.*
⚠	**Warning:** *Remove or disconnect power from the drive before you disconnect or reconnect wires, or perform maintenance work. Wait five 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.*
⚠	**Caution:** *The heat sink and device surfaces of the evaluation or reference board may become hot during testing. Hence, necessary precautions are required while handling the board. Failure to comply may cause injury.*
⚠	**Caution:** *Only personnel familiar with the drive, power electronics and associated machinery should plan, install, commission and subsequently service the system. Failure to comply may result in personal injury and/or equipment damage.*
⚠	**Caution:** *The evaluation or reference board contains parts and assemblies sensitive to electrostatic discharge (ESD). Electrostatic control precautions are required when installing, testing, servicing or repairing the assembly. Component damage may result if ESD control procedures are not followed. If you are not familiar with electrostatic control procedures, refer to the applicable ESD protection handbooks and guidelines.*
⚠	**Caution:** *A drive that is incorrectly applied or installed can lead to component damage or reduction in product lifetime. Wiring or application errors such as undersizing the motor, supplying an incorrect or inadequate AC supply, or excessive ambient temperatures may result in system malfunction.*
⚠	**Caution:** *The evaluation or reference board is shipped with packing materials that need to be removed prior to installation. Failure to remove all packing materials that are unnecessary for system installation may result in overheating or abnormal operating conditions.*
⚠	**Caution:** *EVAL-M1-IM818-A is evaluation board of IM818 series IPM and it is only default for IM818-MCC. Don't guarantee hardware change.*

Table of contents

EVAL-M1-IM818-A user guide
Evaluation power board with MADK M1 connector
The board at a glance

1 The board at a glance

The EVAL-M1-IM818-A 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 easily be interfaced through the iMOTION™ MADK M1 interface connector which is 20-pin connector.

This evaluation board is designed to give easy-to-use power stage based on the Infineon's CIPOS™ Maxi Intelligent Power Module (IPM). The board is equipped with all assembly circuit for sensorless field-oriented control (FOC). It provides a single-phase AC-connector, rectifier and 3-phase output for connecting the motor. The power stage also contains emitter (leg) shunts for current sensing and a voltage divider for DC-link voltage measurement.

The EVAL-M1-IM818-A evaluation board is available through regular Infineon distribution partners as well as on Infineon's website. 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.
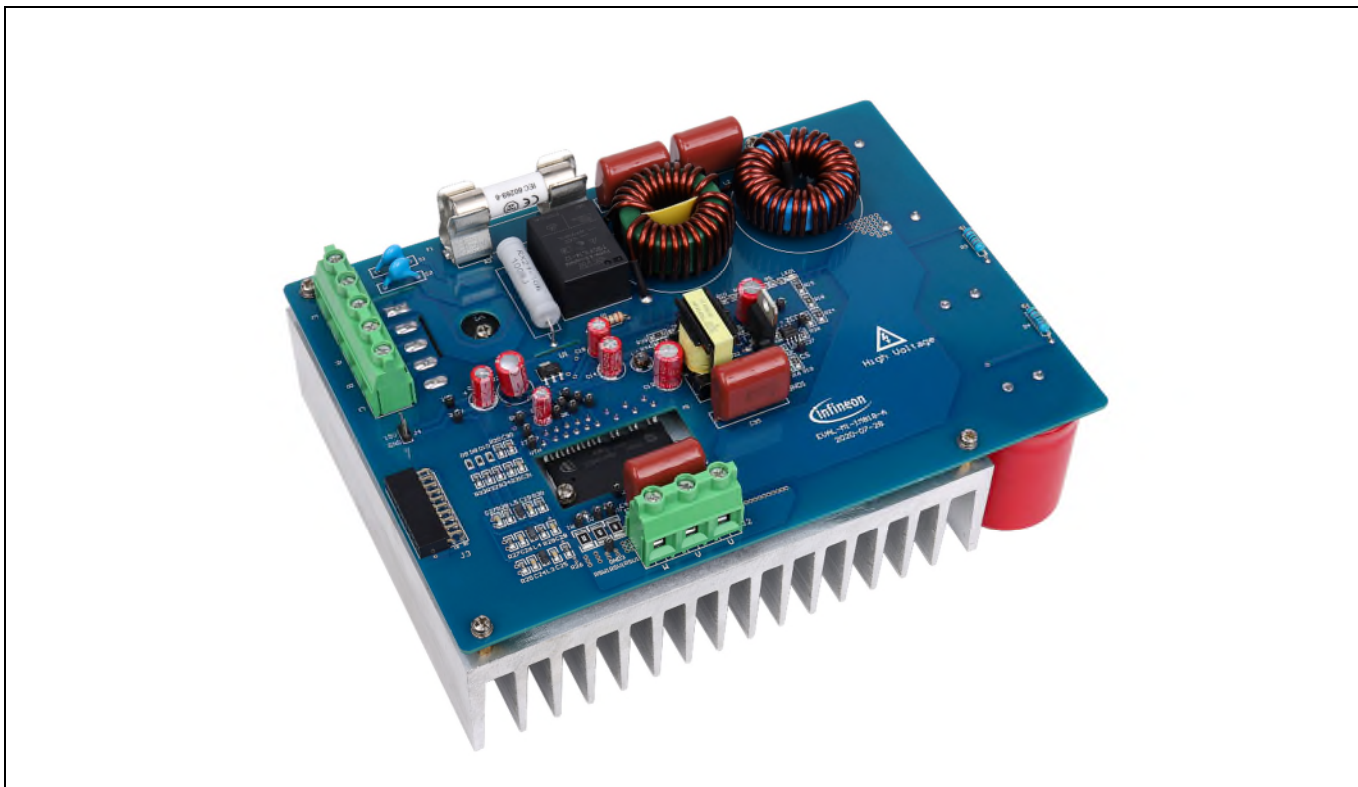

Figure 1   **EVAL-M1-IM818-A**

Environmental conditions were considered in the design of the EVAL-M1-IM818-A. The design was tested as described in this document (AN2018-35) 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 and by trained specialists only.

EVAL-M1-IM818-A user guide
Evaluation power board with MADK M1 connector
The board at a glance

1.1 Delivery content

The scope of supply comprises only the board, as shown in Figure 1. The detailed ordering information is inducted in Table 2.

Table 2 **Ordering information**

Base Part Number	Package	Standard Pack		Orderable Part Number
		Form	Quantity	
EVAL-M1-IM818-A	EVAL	Boxed	1	EVAL-M1-IM818-A
IM818-MCC	DIP 36X23D	TUBE	280	IM818MCCXKMA1
IM818-LCC	DIP 36x23D	TUBE	280	IM818LCCXKMA1
IM818-SCC	DIP 36X23D	TUBE	280	IM818SCCXKMA1
IRS2505LTRPBF	SOT23	TAPE & REEL	3000	IRS2505LTRPBF
BAS3005A02V	SC79	TAPE & REEL	3000	BAS3005A02VH6327XTSA1

1.2 Block diagram

The block diagram of the EVAL-M1-IM818-A is depicted in Figure 2. This evaluation board includes a DC EMI filter, soft power up circuit, 20-pin iMOTION™ MADK-M1 interface connector, an auxiliary power supply to provide 15 V and 3.3 V, and the CIPOS™ Maxi IPM IM818-MCC.
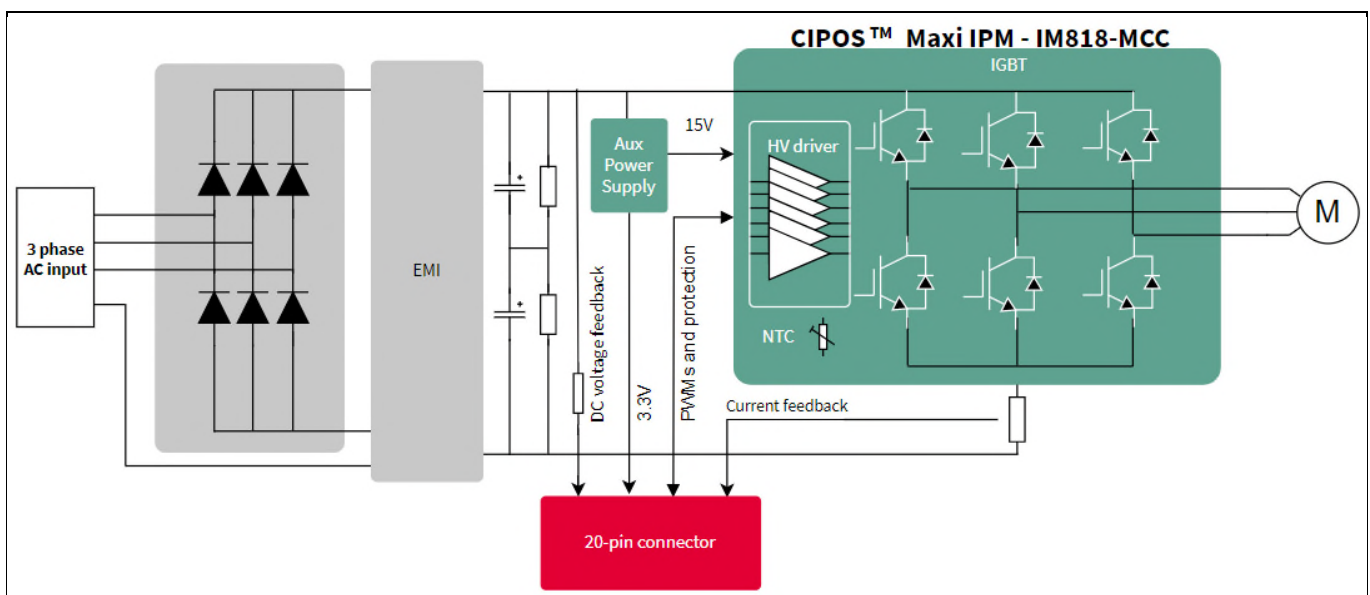

Figure 2   **The Block Diagram of the EVAL-M1-IM818-A**

The default of CIPOS™ Maxi IPM in this board is IM818-MCC which has 1200 V of voltage and 10 A of current rating. It is optimized 6-channel SOI gate driver for excellent electrical performance. It is designed to control 3-phase AC motors and permanent magnet motors in variable speed drives applications such as low-power motor drives.

1.3 Main features

EVAL-M1-IM818-A is an evaluation board for motor drive applications based on a 3-phase IPM. Combined with one of the available MADK control board options, it demonstrates Infineon's IPM technology for motor drives. The kit demonstrates Infineon's IPM technology for motor drives.

Main features of CIPOS™ Maxi IPM IM818-MCC are:

- 1200 V TRENCHSTOP™ IGBT4
- Maximum blocking voltage V_{CES} = 1200 V
- Maximum output current at 25°C case temperature I_C = 16
- Rugged 1200 V SOI gate driver technology with stability against transient and negative voltage
- Allowable negative VS potential up to -11 V for signal transmission at VBS = 15 V
- Integrated bootstrap functionality
- Overcurrent shutdown
- Built-in NTC thermistor for temperature monitoring
- Under-voltage lockout at all channels
- Low side emitter pins accessible
- For all phase current monitoring (open emitter)
- Cross-conduction prevention
- All of 6 switches turn off during protection
- Programmable fault clear timing and enable input
- Lead-free terminal plating; RoHS compliant

The evaluation board characteristics are：

- Nominal input voltage 380 V_{AC}
- Default 2.4 kW motor power output
- On board EMI filter
- Current sensing for each leg configured by default
- Sensing of DC-link voltage
- Measurement test-points compatible to standard oscilloscope probes
- PCB size is 197 mm x 140 mm and has two layers with 35 µm copper each
- RoHS compliant

1.4 Board parameters and technical data

Table 3   Board specification

Parameter	Symbol	Conditions	Value		Unit
Input					
Voltage	V_{in}	±20% input	AC	DC	
			380 V_{rms}-3phase	520	V
Current	I_{in}	Ta=25°C@1600W output	6 A_{rms}	3	A

The board at a glance

Parameter	Symbol	Conditions	Value		Unit
Output					
Maximum output power （3 phase）	Power out	Input 380V_{AC}, f_{PWM} =6 kHz, Ta=25°C, TC=100°C, Natural convection	1600	IM818-SCC	W
			2400	IM818-MCC	W
			2700	IM818-LCC	W
Maximum output current （each-phase） （RMS）	Current output	Input 380 V_{AC}, f_{PWM} =6 kHz, T_a = 25°C, T_C = 100°C, Natural convection	3.2	IM818-SCC	A
			4.6	IM818-MCC	A
			5.2	IM818-LCC	A
DC BUS					
Maximum DC bus voltage	Vbus	Limited by electrolytic capacitor which max voltage is 900 V	820		V
Minimum DC bus voltage	Vbus	Aux power supply can start	400		V
Current feedback					
Current sensing	RSU, RSV, RSW	Two 50 mΩ in parallel for one leg	25 each phase		mΩ
Protections					
Output current trip level	I_{trip}	Current feedback to controller, so over current protection level is decided by controller. This I_{trip} level for IPM	20		A
Temperature trip level	IPM	Internal NTC temperature to controller. Recommend to set this level for protection	100		℃
On board power supply					
15V	15 V	Used for CIPOS™ IPM gate driver and LDO	15 V ± 5 %, max. 250 mA		mA
3.3V	3.3 V	Supplying the 3.3 V to the controller board	3.3 V ± 2 %, max. 200 mA		mA
PCB characteristics					
PCB board	Material	FR4, 1.6 mm thickness, 2 layers. 35 µm copper thickness.			
Dimension	Size	197 mm x 140 mm x 70mm			
System environment					
Ambient temperature	Ta	Non-condensing, maximum RH of 95 %	10 to 25°C		℃

EVAL-M1-IM818-A user guide
Evaluation power board with MADK M1 connector
System and functional description

2 System and functional description

2.1 Commissioning

EVAL-M1-IM818-A evaluation board is a power system without control part. It has a M1 connector with control input. Figure 3 is example system setup with Infineon iMOTION™ control board EVAL-M1-101T. This is motor control engine (MCE) evaluation board. When users try to drive the power board with it. Its' user manual AN2018-01 for the details of the control board.
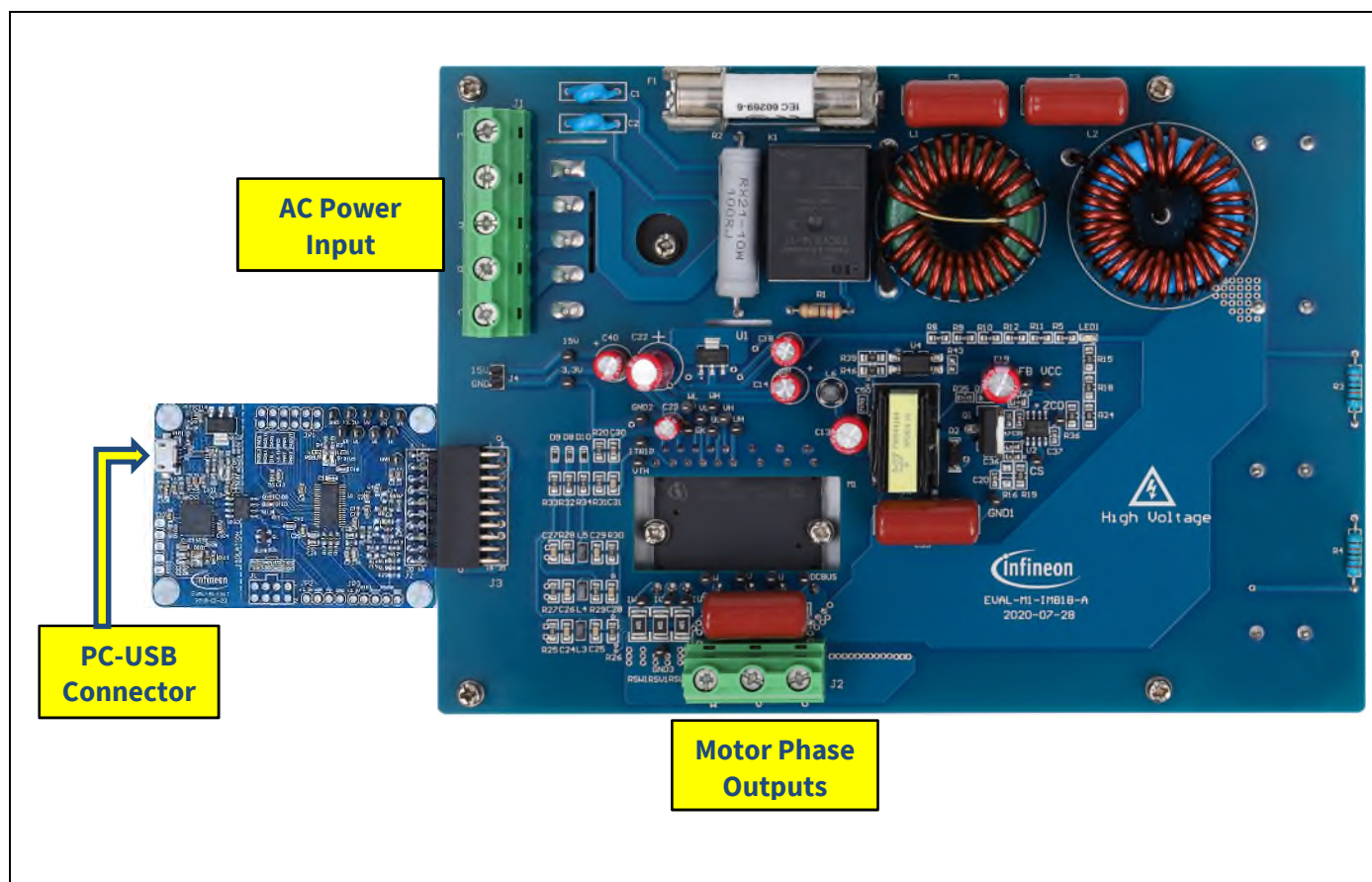
Figure 3 System connection example using EVAL-M1-IM818-A and EVAL-M1-101T

2.2 Getting Started with EVAL-M1-IM818-A

In order to run the motor system, a combination of the iMOTION™ MADK power board (EVAL-M1-IM818-A) and the matching MADK control board is required. The iMOTION™ Software Tools MCEDesigner and MCEWizard are also required in order to initial setup the system, as well as to control and fine-tune the system performance to match users' exact needs. This chapter provides more details on setting up the system and getting started with iMOTION™ MADK development platform.

EVAL-M1-IM818-A user guide
Evaluation power board with MADK M1 connector
System and functional description

2.3 Setting up the system

After downloading and installing the iMOTION™ PC Tools (MCEWizard and MCEDesigner), the following steps needs to be executed in order to run the motor. Refer to user manual for iMOTION™ MADK control board such as (EVAL-M1-101T), MCEWizard and MCEDesigner documentation for more information.

Figure 3 shows the system connection using EVAL-M1-IM818-A and control board (used control board EVAL-M1-101T for example).

Setting step:

1. Connect PC-USB connector on the on-board-debugger to the PC via USB cable.

2. Connect EVAL-M1-IM818-A's MADK M1 20-pin interface connector (J3) to control board (see figure 3).

3. Get the latest "IMC101T-T038 MCE Software Package" available on www.infineon.com/imotion-software web page. (Infineon iMOTION™ control IC IMC101T-T038 is used for control board EVAL-M1-101T).

4. Connect motor phase outputs to the motor.

5. Use MCEWizard to enter the motor and evaluation board hardware parameters and click button "Export to Designer file (.txt)" to system drive parameters file which will be used by MCEDesigner.

6. Connect AC power to power input connector (J1) and power on system.

7. Open MCEDesigner and open MCEDesigner default configuration file (.irc) for IMC101T devices (IMC101T_xx.irc) by clicking "File" menu and select "Open" in the pull-down list.

8. Import system drive parameters file (generated in step 5) into MCEDesigner by clicking "File" > "Import Drive Parameters". Select "Update All" radio button.

9. Program the MCE Firmware and system parameters into the internal Flash memory of iMOTION™ IC by clicking "Tools > Programmer "in the pull-down menu, and then clicking on the "Program Firmware and Parameter" radio button. See chapter MCEDesigner setup overview section 2.4 for more details. If the latest version of MCE firmware is already programmed into the IMC101T-T038 IC, then programming firmware can be skipped by selecting "Program Parameters" radio button option. Finally click "Start" button to program firmware and parameter (or parameters only when programming firmware was skipped).

10. Start the motor by clicking the green traffic light button in the control bar.

2.4 iMOTIOM™ development tools and software

The iMOTION™ Development Tool installers for MCEDesigner and MCEWizard are available for download via Infineon iMOTION™ website (http://www.infineon.com/imotion-software). All the available tools and software variants are listed there.

On-board debugger uses the SEGGER J-Link's driver for UART communication with IMC101T-T038. J-Link driver will be installed during the MCEDesigner installation. In case the driver is not installed properly, please go to SEGGER J-Link website to download and install the latest J-Link "Software and Documentation pack for Windows".

EVAL-M1-IM818-A user guide
Evaluation power board with MADK M1 connector
System and functional description

2.4.1   MCEWizard setup overview

After installing the MCEWizard, the shortcut for MCEWizard appears on the Windows desktop. Double click the shortcut to open the MCEWizard and configure the parameters for evaluation boards or motor. Figure4 shows the "Welcome Page" for MCEWizard, where the MADK control board or power board can be selected through the pull-down list. Infineon keeps releasing new MADK controller and power boards. Therefore, it could happen that some of the newest power boards are not pre-configured in the MCEWizard tool and cannot be selected through the pull-down menu. In that case, the user should select any other power board (as similar as possible) and follow the MCEWizard setup steps by entering the parameter values which are specific to the chosen board. Make sure both "I have modified the circuit board" and "Enable advanced question" checkmarks are selected. Please refer to the User Manual of the corresponding power board for additional information.

After selecting the MADK control and the power board, start the MCEWizard system setup procedure by clicking the "Next" button in the right bottom corner as shown in Figure 4.
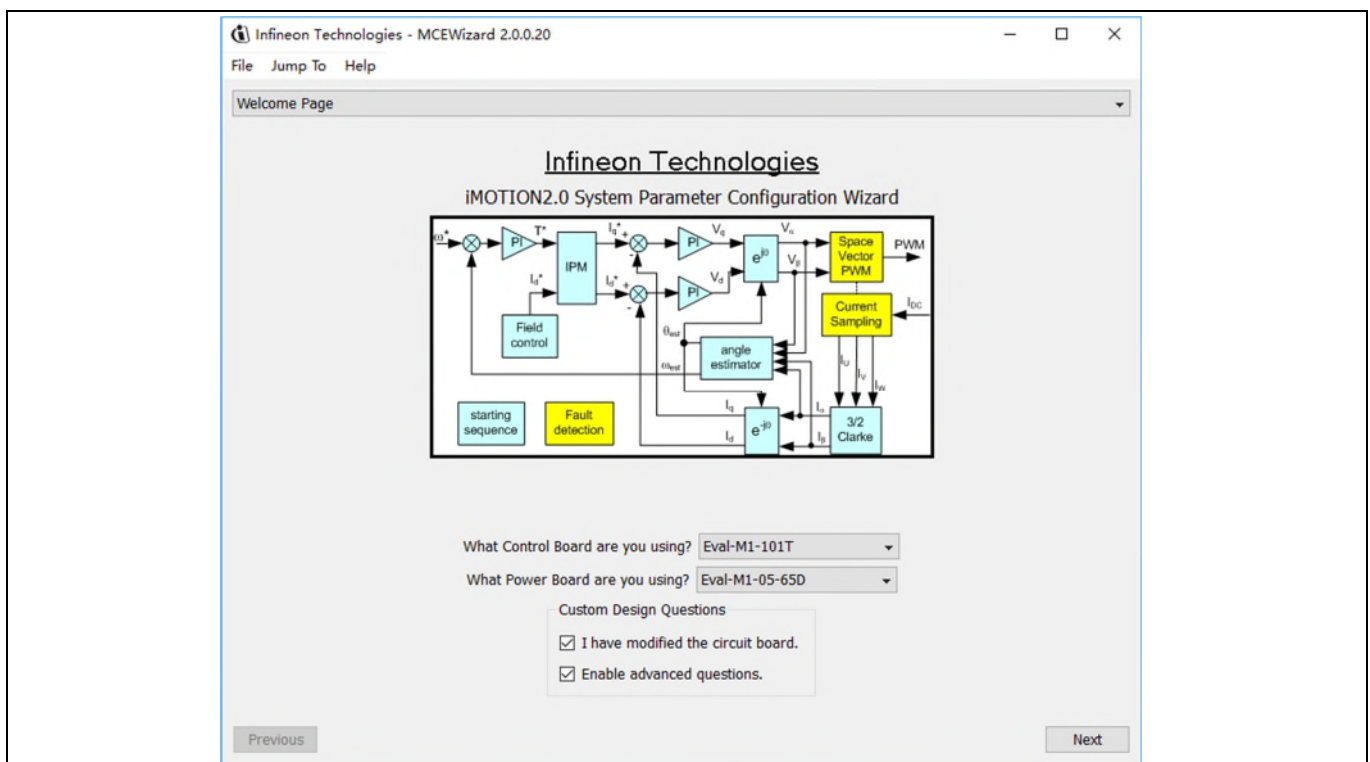

Figure 4   Welcome Page of MCEWizard

iMOTION™ MADK system enables users to easily test different combination of control and power board with their motors. User should be familiar with the system level parameters which are related to the motor used. There are very limited numbers of parameters which are specific to the control board or power board hardware.

Table 4 provides the MCEWizard setup overview for hardware related parameters specific to EVAL-M1-IM818-A power board. Similar tables will be available in each control board's User Manual. Combination of this table and the corresponding table of the control board provides enough information to setup the MADK-based motor drive system in shortest time.

EVAL-M1-IM818-A user guide
Evaluation power board with MADK M1 connector
System and functional description

Table 4   MCEWizard setup overview table

Page	Parameter	Value	Comment
Welcome Page	Control Board Selecting	EVAL-M1-101T for example	
Welcome Page	Power Board Selecting	EVAL-M1-IM818-A	If no, select similar power board to modify
Options Page	Motor 1 Shunt Configuration	Leg shunt	
Question 3	Controller Supply Voltage	+3.3 V	VDD is 3.3V by default
Question 19	Max DC Bus Voltage	820 V	
Question 23	DC Bus Sensing High Resistor	5000 kΩ	
Question 24	DC Bus Sensing Low Resistor	Refer to the control board user manual	
Question 54	NTC Temperature Shutdown value	Refer to the control board user manual	
Question 63	Gate Sense Low-Side Devices	High is true	
Question 64	Gate Sense High-Side Devices	High is true	
Question 69	Motor 1 Current Input	Calculated in the corresponding Section in control board user manual	

After all the MCEWizard questions are answered, the "Verify & Save Page" will be shown as in Figure 5.
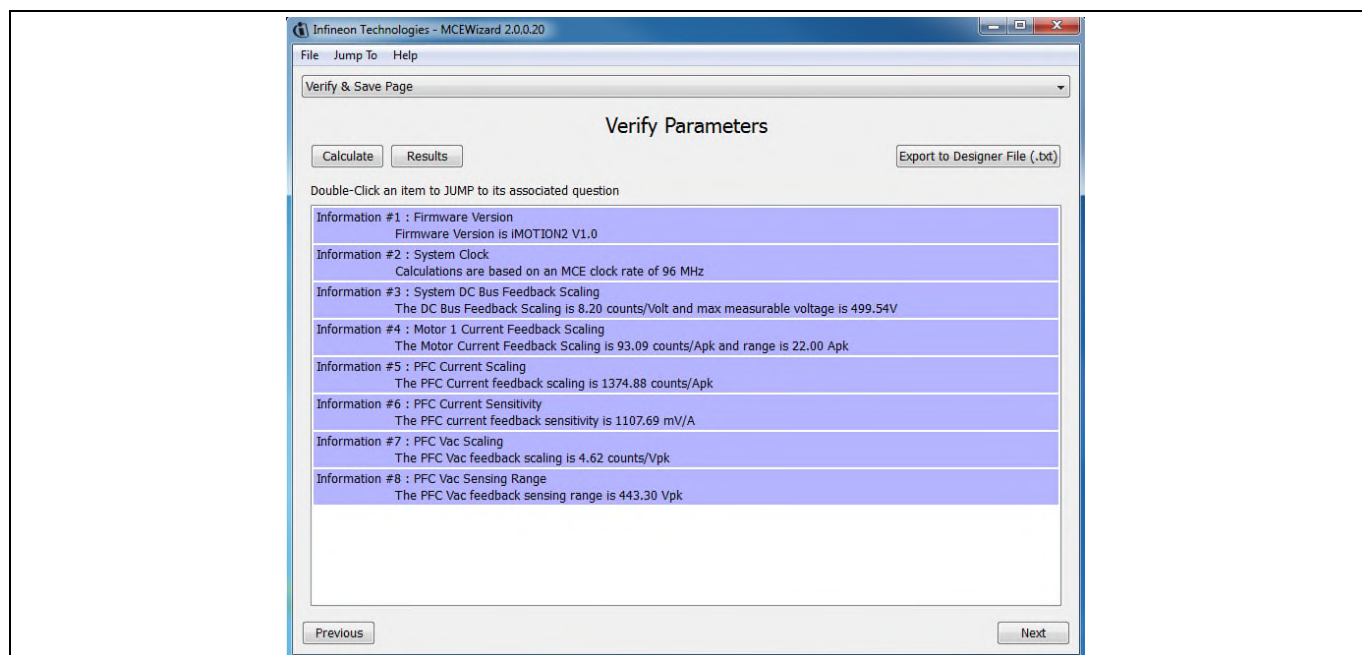
Figure 5   Verify and Save page for MCEWizard

Click "Calculate" button and "Export to Designer File (.txt)" button to save the parameter file which will be used by the MCEDesigner in the next steps.

2.4.2 MCEDesigner setup overview

After installing MCEDesigner installer, there is a shortcut for MCEDesigner on Windows desktop. Double click the shortcut to open MCEDesigner and then open "IMC101T_xx.irc" file as shown in Table 4.
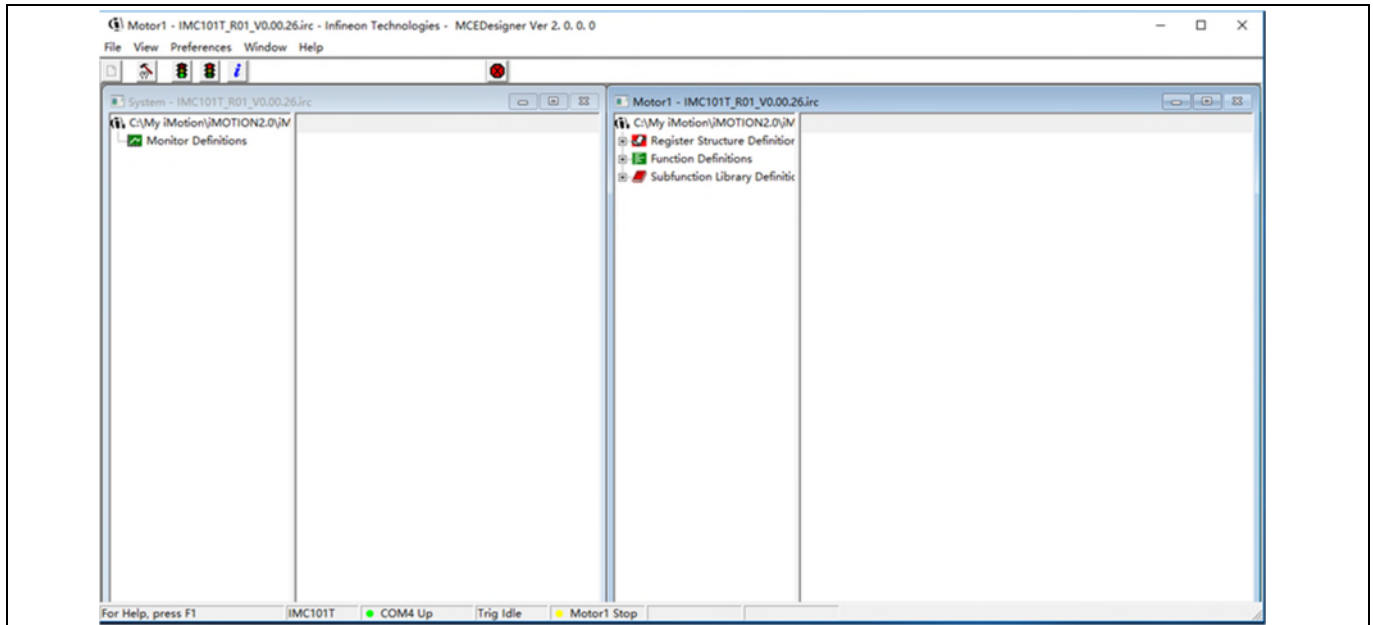

Figure 6   MCEDesigner's Main Display for EVAL-M1-101T

To program system drive parameters into IMC101T-T038, please click "Tools" menu and select "Programmer" in the pull-down list. The pop-up window "Program IMC controller" will show up as in Figure 7. Click on the "Program Parameters" radio button (this is the default option), and then select the Drive System Parameter file created using MCEWizard by clicking on "Browse". Finally, click on the "Start" button to program the parameter file into the IMC101T-T038 IC.
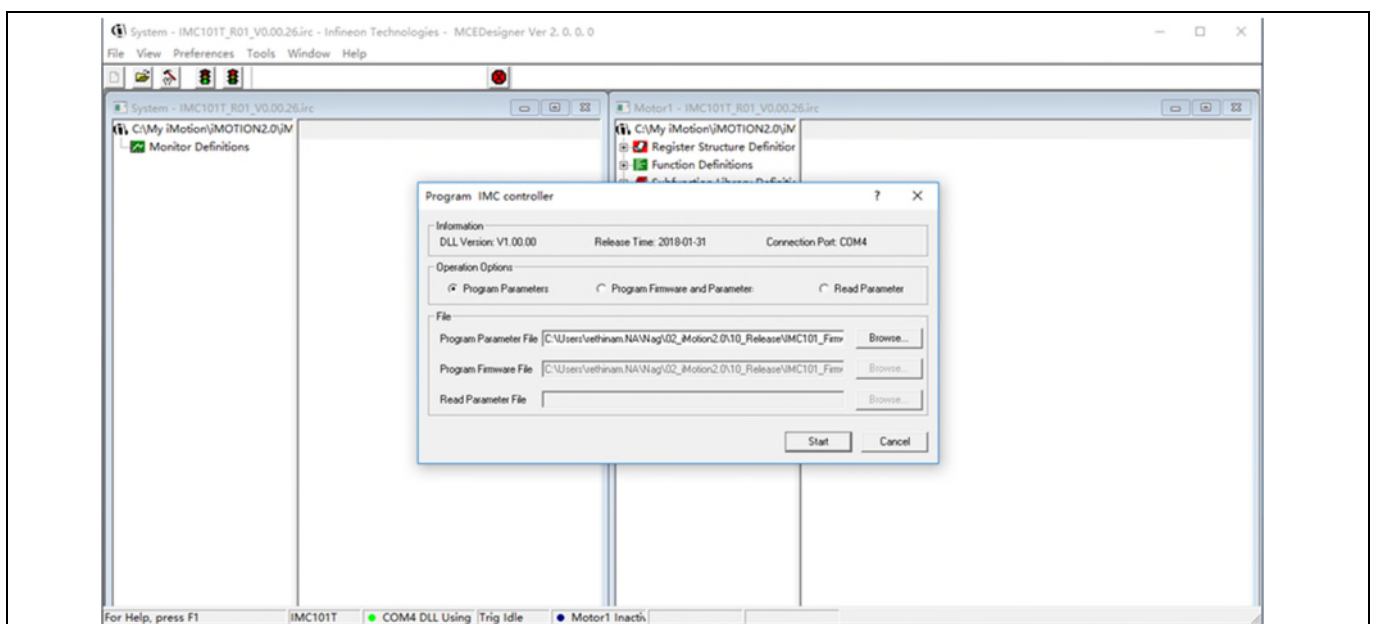
Figure 7   "Program IMC Controller" pop-up window

After Drive System Parameter file has been programmed into IMC101 controller, and the motor drive system is powered, the MCEDesigner can be used to start/stop the motor, display motor current traces, change the motor

speeds, modify drive parameters and many other functions. Please refer to the MCEDesigner documentation for more details.

Note: On-board Debugger portion of EVAL-M1-101T is galvanically isolated from the controller portion and the attached power board. In order to program the parameters or firmware to the IMC101T-T038 controller, the 3.3 V DC voltage needs to be supplied to the controller portion of the EVAL-M1-101T. This voltage can either be supplied by the power board (MADK power boards are designed to supply the 3.3 V to the control board through M1 connector) or by feeding the 3.3 V DC voltage to the control board through some of the available 3.3 V access/test points if the power board is not attached to the EVAL-M1-101T control board.

To program new firmware and Drive System Parameter into IMC101T-T038, please click "Tools" menu and select "Programmer" in the pull-down list. The pop-up window "Program IMC controller" will show up as in Figure 8. Click on the "Program Firmware and Parameter" radio button, and select the Drive System Parameter file created using MCEWizard by clicking on the "Browse" button on the row of "Program Parameter File", and then select the firmware file by clicking on the "Browse" button on the row of "Program Firmware File". Finally, click on the "Start" button to program the parameter file into the IMC101T-T038 IC.
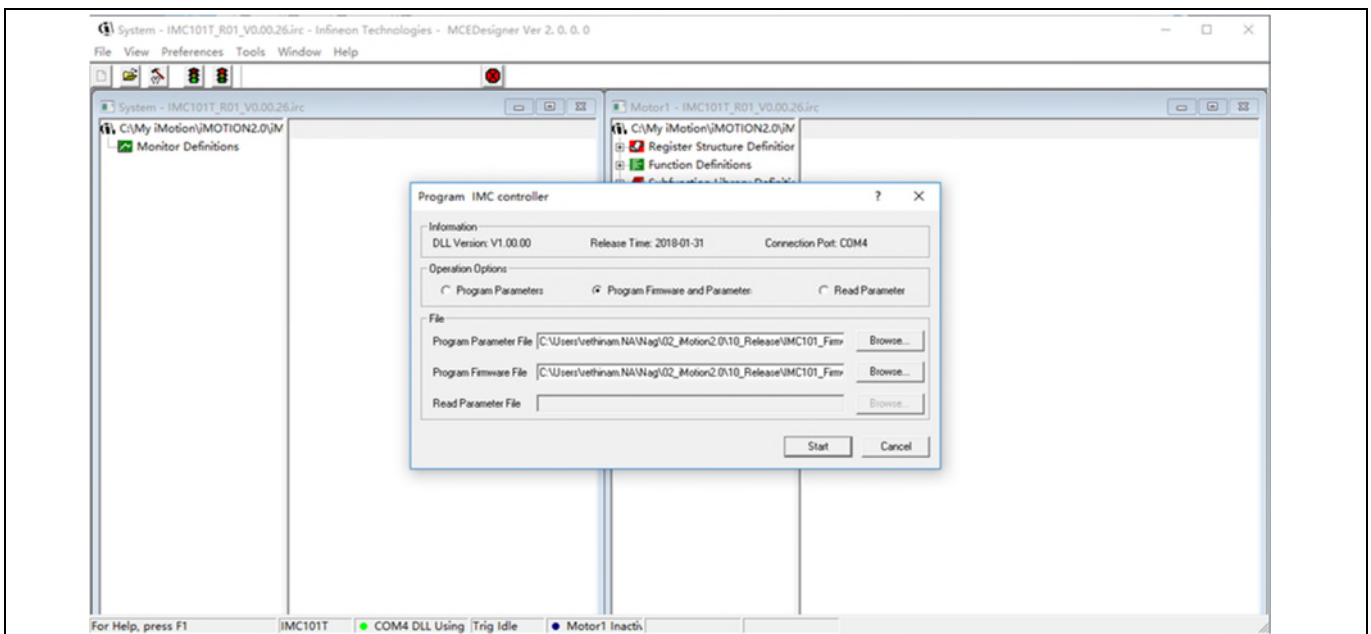

Figure 8   Program Firmware and Parameter in "Program IMC Controller" pop-up window

All the latest firmware files for different types of iMOTION™ motor control ICs are available for download via Infineon iMOTION™ website (http://www.infineon.com/imotion-software).

2.5   Description of the functional blocks

This chapter covers the hardware design of the EVAL-M1-IM818-A in more detail. It's includes the functional groups of this power board and interface definition. Engineers can use this board to evaluate the performance easily. And it is also helpful for users to develop their solution based on the evaluation board design.

EVAL-M1-IM818-A user guide
Evaluation power board with MADK M1 connector
System and functional description
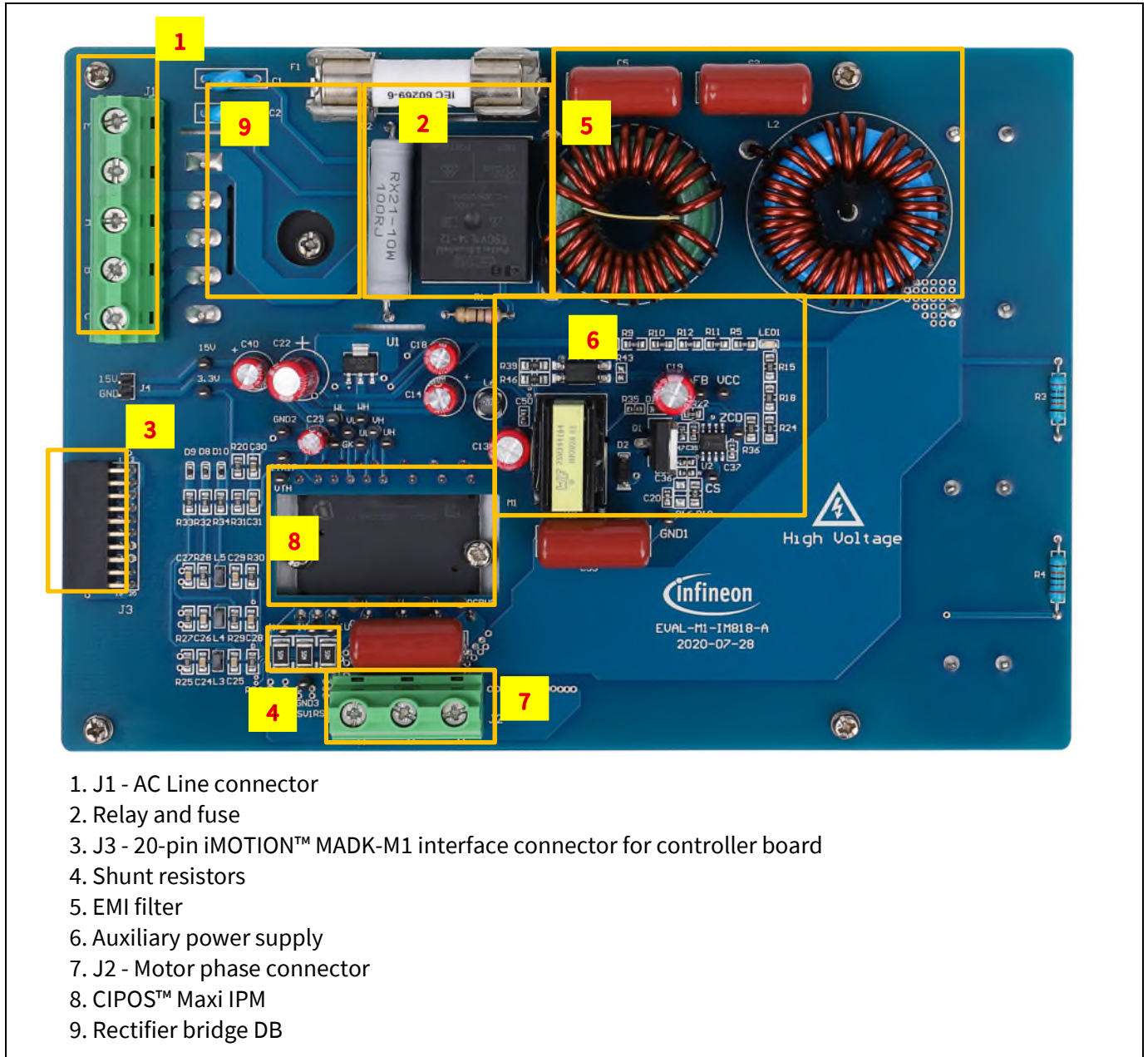
1. J1 - AC Line connector
2. Relay and fuse
3. J3 - 20-pin iMOTION™ MADK-M1 interface connector for controller board
4. Shunt resistors
5. EMI filter
6. Auxiliary power supply
7. J2 - Motor phase connector
8. CIPOS™ Maxi IPM
9. Rectifier bridge DB

Figure 9   **Functional groups of the EVAL-M1-IM818-A evaluation board's top side**

General information about the connectors of the EVAL-M1-IM818-A evaluation board is reported. Table 5 includes the details of the AC line connector J1.

Table 5   J1- AC Line connector

S. No.	Pin	Details
1	EARTH	Earth ground
2	Not used	Not used
3	A	AC line input (380 V)
4	B	AC line input (380 V)
5	C	AC line input (380 V)

EVAL-M1-IM818-A user guide
Evaluation power board with MADK M1 connector
System and functional description

Table 6 provides the pin assignments of the 20-pin iMOTION™ MADK-M1 interface connector J3. This connector is the interface to the controller board.

Table 6   **J2 - iMOTION™ MADK-M1 20-pin interface connector for controller board**

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

Table 7 denotes the details of the motor side connector J2.

Table 7   **J2- Motor side connector**

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

2.6   Hardware description of EVAL-M1-IM818-A

To meet individual customer requirements and make the EVAL-M1-IM818-A evaluation board a basis for development or modification, all necessary technical data like schematics, layout and components are included in this chapter.

EVAL-M1-IM818-A user guide
Evaluation power board with MADK M1 connector
System and functional description

2.6.1 DC bus Measurement and MCEWizard configuration

Pin 14 of connector J3 provides access to the DC-link voltage. Three possible feedback cases are associated with this pin. Figure 10 provides the DC bus sense resistor details. By default, the resistor R8 is mounted on EVAL-M1-IM818-A.
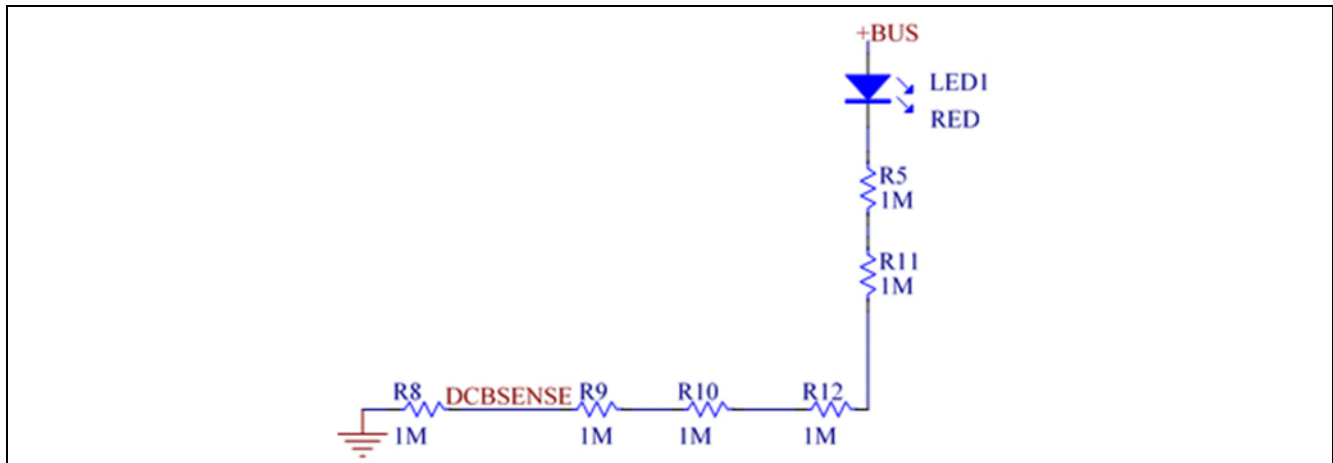

Figure 10   DC bus sense resistor on EVAL-M1-IM818-A evaluation board

The pull-down resistor R8 of 1 MΩ referred to ground is inserted on the EVAL-M1-IM818-A evaluation board to prevent the high BUS voltage +BUS directly connecting to the connector J3. And a pull-down resistor of 13.3 kΩ for EVAL-M1-101T or 4.87 kΩ for EVAL-M1-183M must be inserted on the control board, and then the DCBSENSE voltage results in the range of 0 to 3.3 V on the pin reflecting a DC bus voltage range of 0 to 800 V.

Figure 11   DC bus sensing configuration in MCEWizard

EVAL-M1-IM818-A user guide
Evaluation power board with MADK M1 connector
System and functional description

2.6.2 Motor External Current feedback configuration and calculation

The current input value is product of the shunt resistance in milliohms and gain of External current sense amplifier for EVAL-M1-101T as shown in Figure 12.
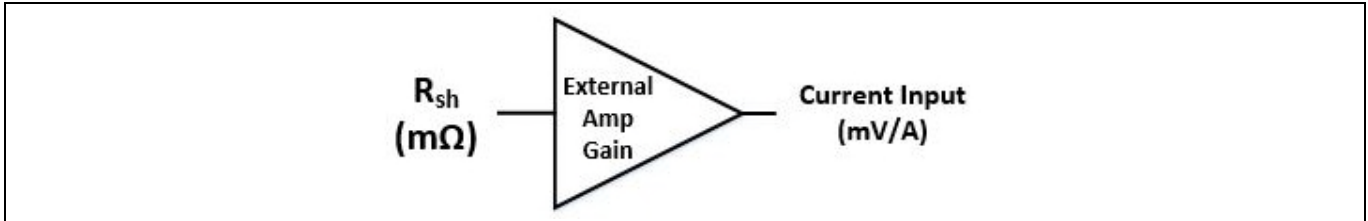

Figure 12   Current shunt feedback and sample timing for EVAL-M1-101T

The external amplifier gain circuit can be found in the schematics or user manual for the control board (For example, EVAL-M1-101T see Figure 13).

Figure 13 depicts IU+ current feedback sensing circuity on EVAL-M1-101T evaluation board. Please note that the default external amplification gain is less than 1 for current sense in this evaluation board.
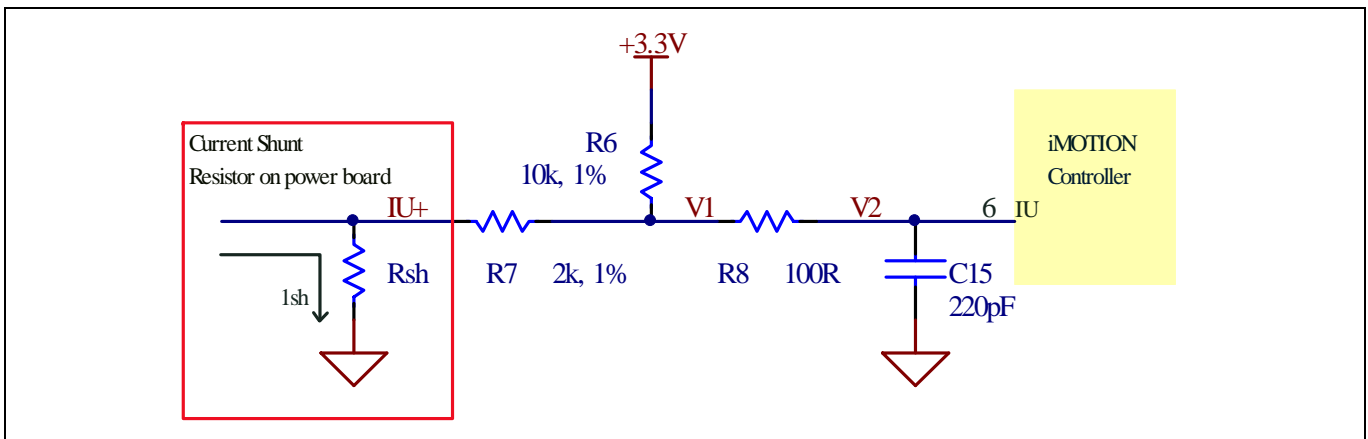
Figure 13   The part of Current feedback on the EVAL-M1-101T evaluation board

Based on the principle of Kirchhoff's voltage law,

$$V_2 \approx V_1 \approx (V_{DD} - I_{sh} * R_{sh}) * \frac{R_7}{R_6 + R_7} + I_{sh} * R_{sh} = \frac{R_7}{R_6 + R_7} V_{DD} + \frac{R_6}{R_6 + R_7} R_{sh} * I_{sh}$$

$$Current\ input = \frac{R_6}{R_6 + R_7} R_{sh} = \frac{5}{6} R_{sh}$$

Based on this calculation, the current input for the MADK combination of EVAL-M1-101T and EVAL-M1-IM818-A is 20.83 mV/A.

Please use same procedure to calculate the current input for other combinations of MADK boards and enter it into MCEWizard as shown in Figure 14
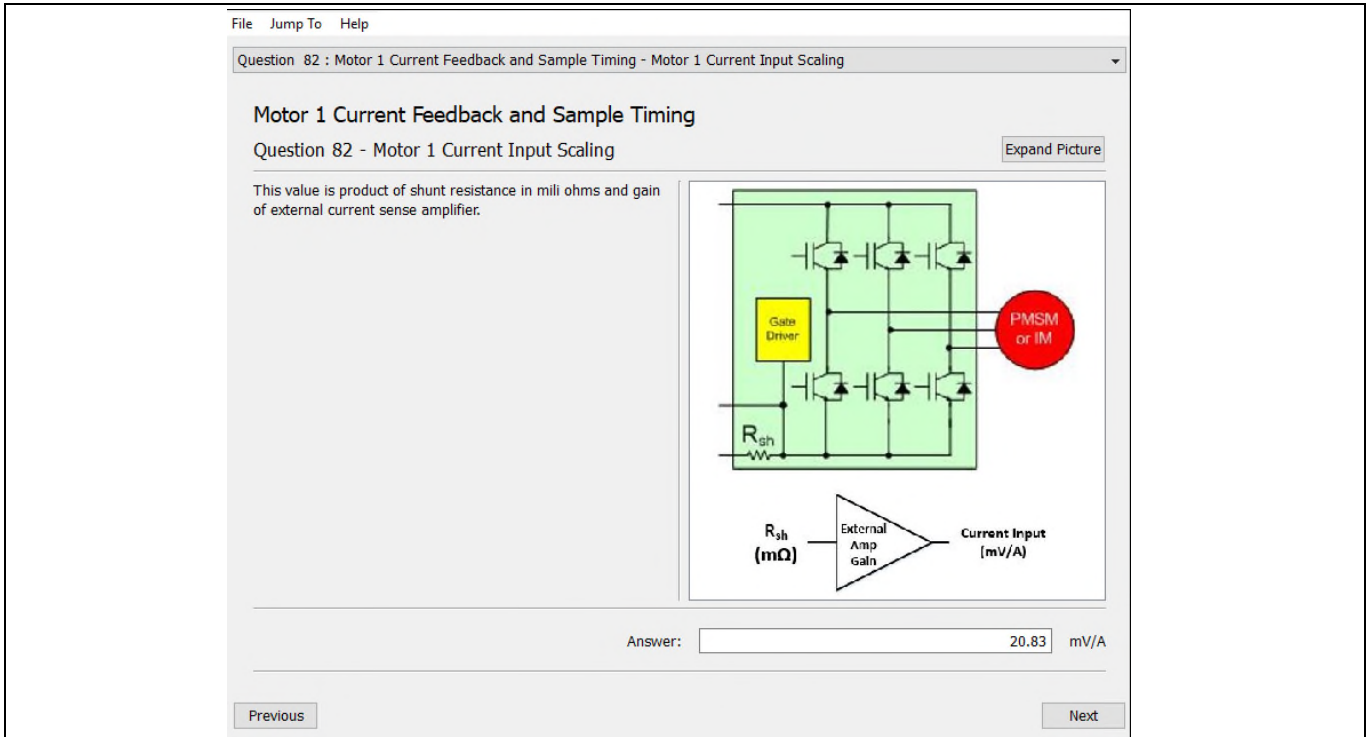
EVAL-M1-IM818-A user guide
Evaluation power board with MADK M1 connector
System and functional description

Figure 14   Current feedback configuration in MCEWizard for EVAL-M1-101T and EVAL-M1-IM818-A

2.6.3   ITRIP and GK setup
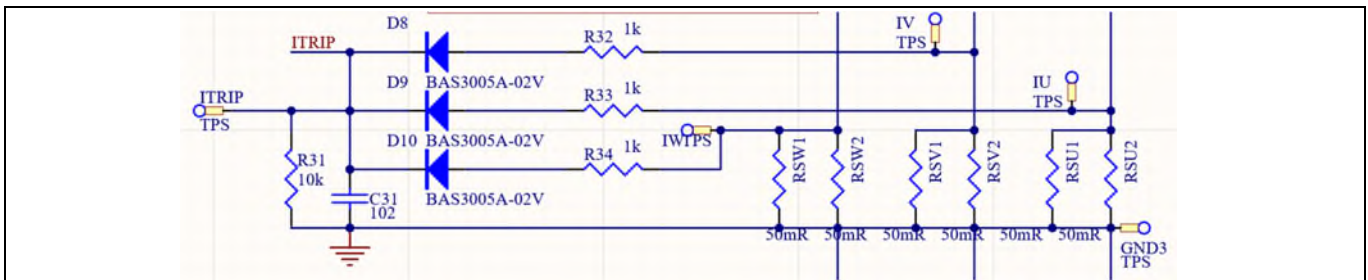
2.6.3.1   ITRIP setup

Figure 15   Over-current protection circuit and ITRIP signal

IM818 series provides an over-current detection function by connecting the ITRIP input with the shunt current feedback. The ITRIP comparator threshold (typ. 0.5 V) is referenced to VSS ground.

Set D8/9/10 drop is 0.15 V, then the typical over-current threshold (IOCP) is:

U phase: $I_{uOCP} = \dfrac{0.5 + 0.15}{\dfrac{0.05}{2} \times \dfrac{R31}{R31 + R33}} = 28.6A$

V phase: $I_{VOCP} = \dfrac{0.5 + 0.15}{\dfrac{0.05}{2} \times \dfrac{R31}{R31 + R32}} = 28.6A$

W phase: $I_{wOCP} = \dfrac{0.5 + 0.15}{\dfrac{0.05}{2} \times \dfrac{R31}{R31 + R34}} = 28.6A$

When the current is higher than 28.6 A, it will generate a shutdown for all outputs of the gate driver. The shutdown propagation delay is typically 1 μs.

EVAL-M1-IM818-A user guide
Evaluation power board with MADK M1 connector
System and functional description

2.6.3.2   PWM shut down and GK output

When over-current is detected, the ITRIP voltage is over the threshold value, then C30 will be discharged (GK is open drain), and GK drops to "0". This GK sends signal to control board via J3. GK "0" status is continuous for about 150 μs. After 150 μs, GK becomes open drain and charges C30 via R20. The R20 and C30 time constant is about 470 μs. Figure 16 shows the ITRIP and GK circuit.
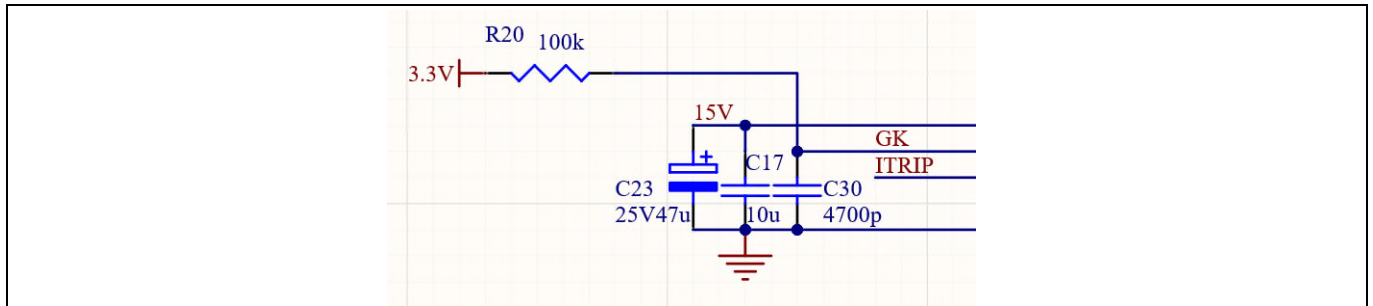
Figure 16   ITRIP & GK and fault-clear

2.6.4   NTC thermistor characteristics and over-heat protection calculation

This is NTC measurement circuit for EVAL-M1-101T as shown in Figure 12.
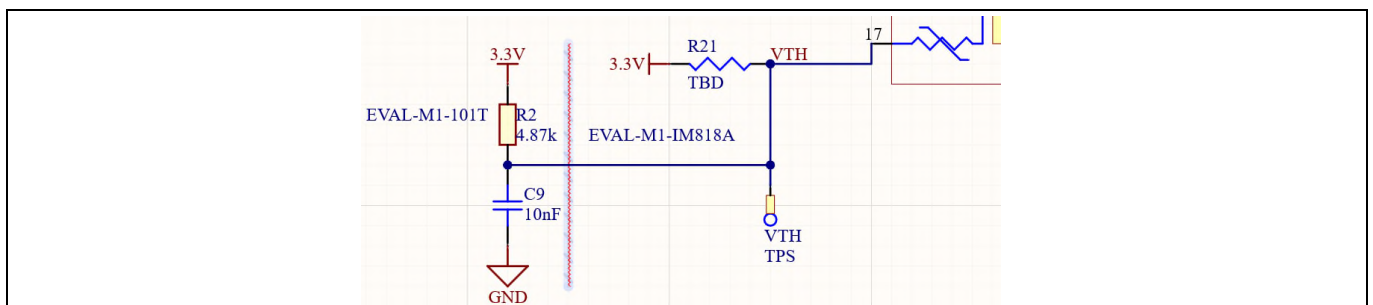
Figure 17   NTC (inside IM818 IPM) connect to EVAL-M1-101T via J3
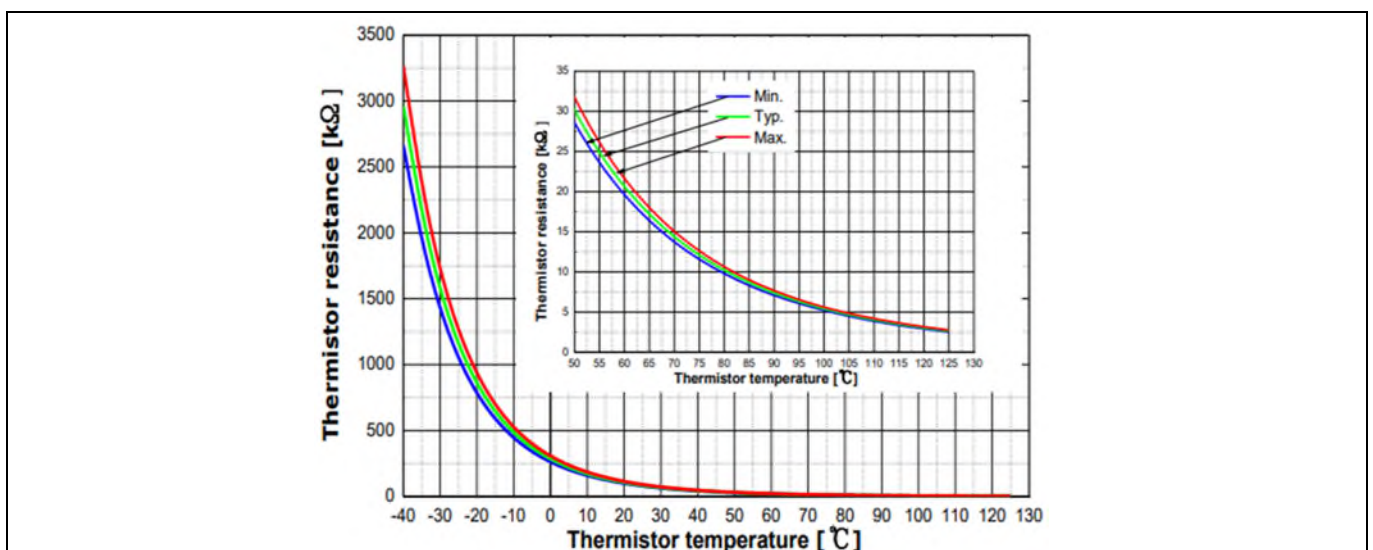
The NTC is 85 kΩ @ TNTC = 25℃, B-constant = 4092 K:

Figure 18   NTC temperature curve and table

Table 8   VTH output vs NTC to EVAL-M1-101T:

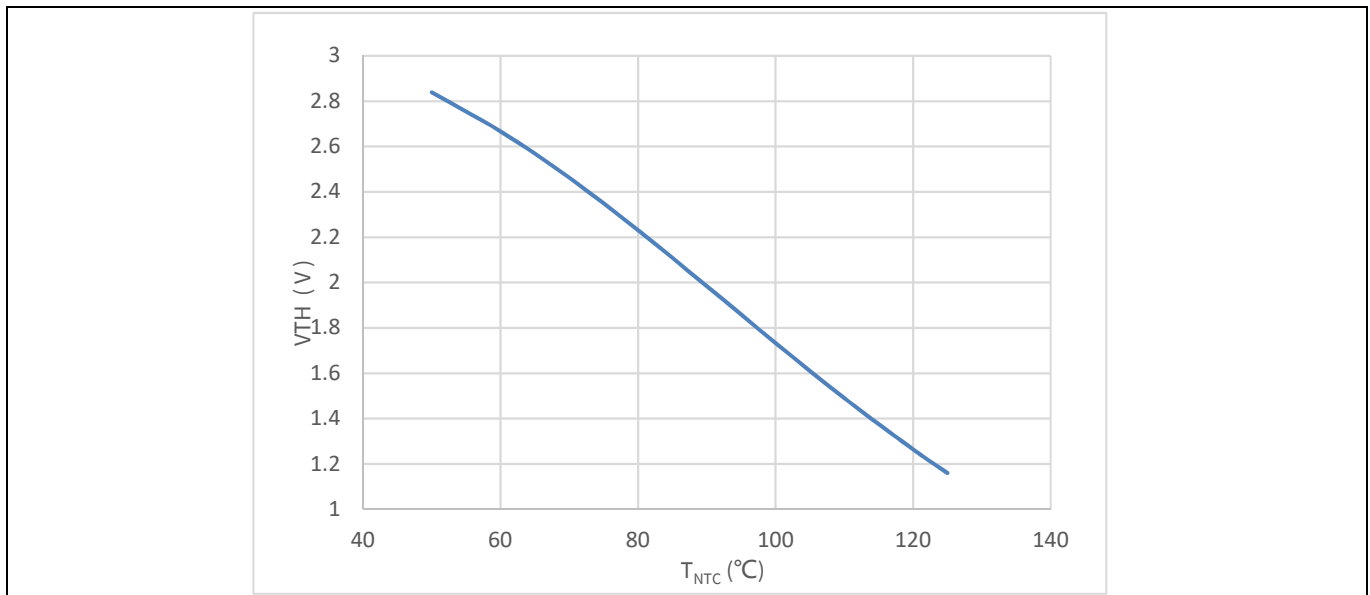| Temperature (°C)	NTC (kΩ)	VTH (V)
50	29.97	2.839
60	20.51	2.667
70	14.31	2.462
80	10.16	2.231
90	7.345	1.984
100	5.388	1.733
110	4.009	1.490
120	3.024	1.264
125	2.639	1.160

Figure 19   NTC output vs temperature
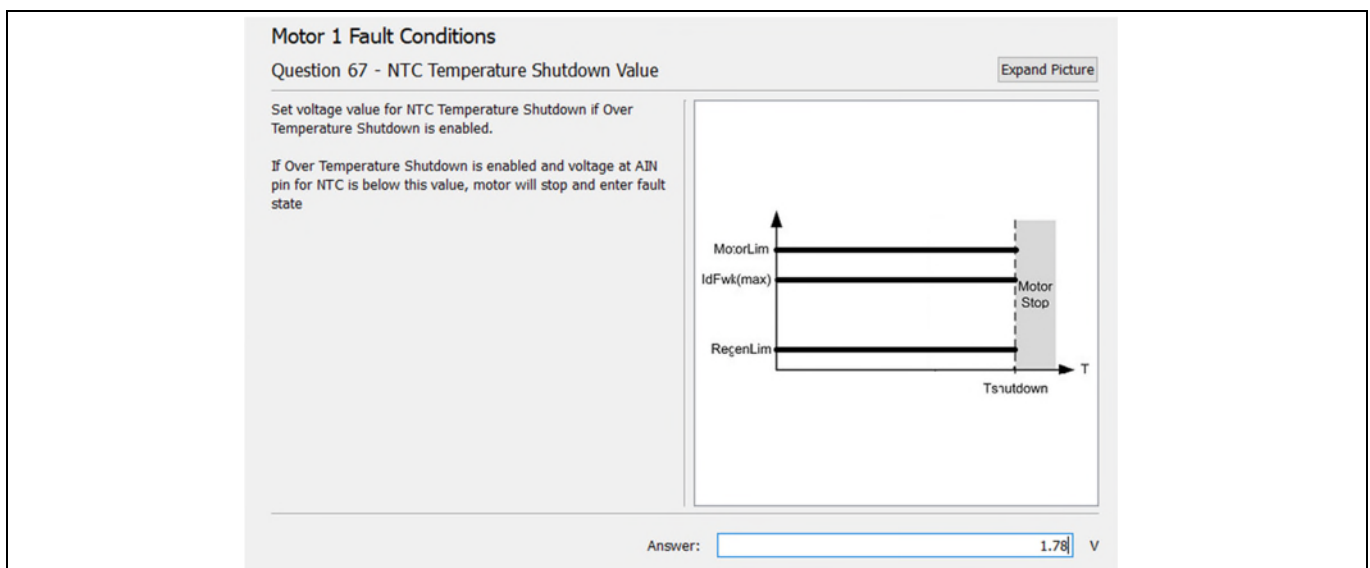
Figure 20   IPM temperature shutdown set to 100℃ in MCEWizard

EVAL-M1-IM818-A user guide
Evaluation power board with MADK M1 connector
System and functional description

2.6.5 EMI filter and soft power up circuit

Figure21 depicts the schematic from the AC line input connector J1 to the rectified DC bus voltage. This circuitry includes a passive EMI filter consisting of elements C1, C2, L1, L2 and a 40 A/1200 V rectifier block DB, a fuse F1 for inrush current protection, and a relay K1 for soft powering up and reducing conduction losses in steady state. Four electrolytic capacitors C6, C7, C8 and C9 are used for buffering the rectified DC bus voltage DCP.
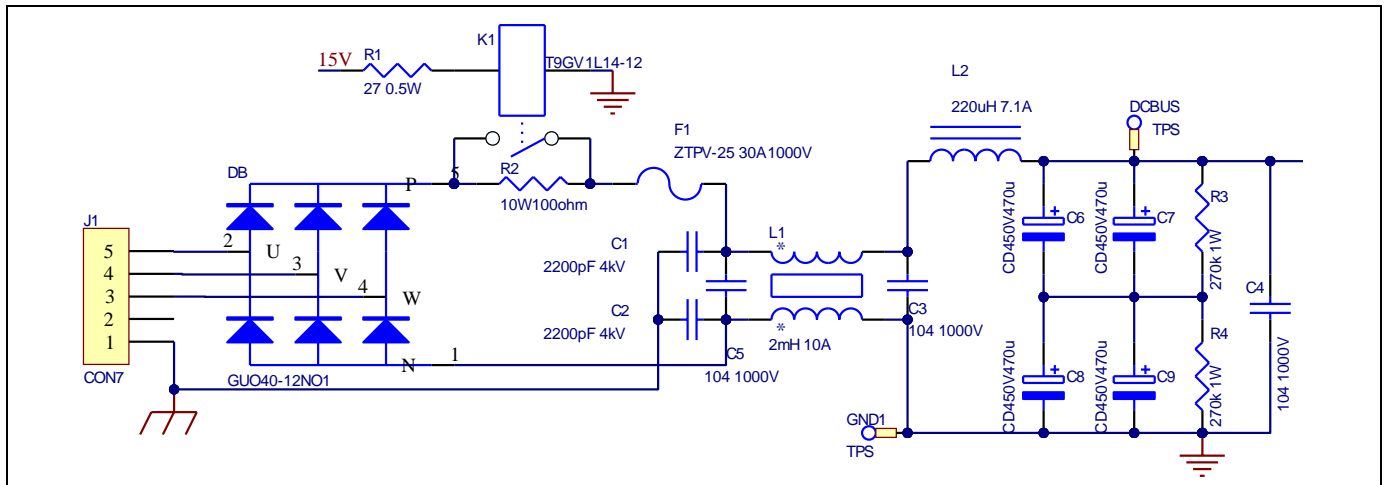

Figure 21   Current feedback configuration in MCEWizard for EVAL-M1-101T and EVAL-M1-IM818-A

EVAL-M1-IM818-A user guide
Evaluation power board with MADK M1 connector
Schematic for EMI filter and AC/DC section of the EVAL-M1-IM818-A evaluation board

3 Schematic for EMI filter and AC/DC section of the EVAL-M1-IM818-A evaluation board

Please find the complete schematics and more information, e.g. of the development tools on the board website of the EVAL-M1-IM818-A under www.infineon.com.

3.1 Inverter section using CIPOS™ Maxi IPM

Figure 22 shows the inverter section of the EVAL-M1-IM818-A that is implemented using the CIPOS™ Maxi IPM.

The module includes an optimized SOI gate driver and three phase inverter with 1200 V TRENCHSTOP™ IGBTs and Emitter Controlled diodes.

The three capacitors C10, C11 and C12 are used as bootstrap capacitors to provide the necessary floating supply voltages VBS1, VBS2 and VBS3 respectively.
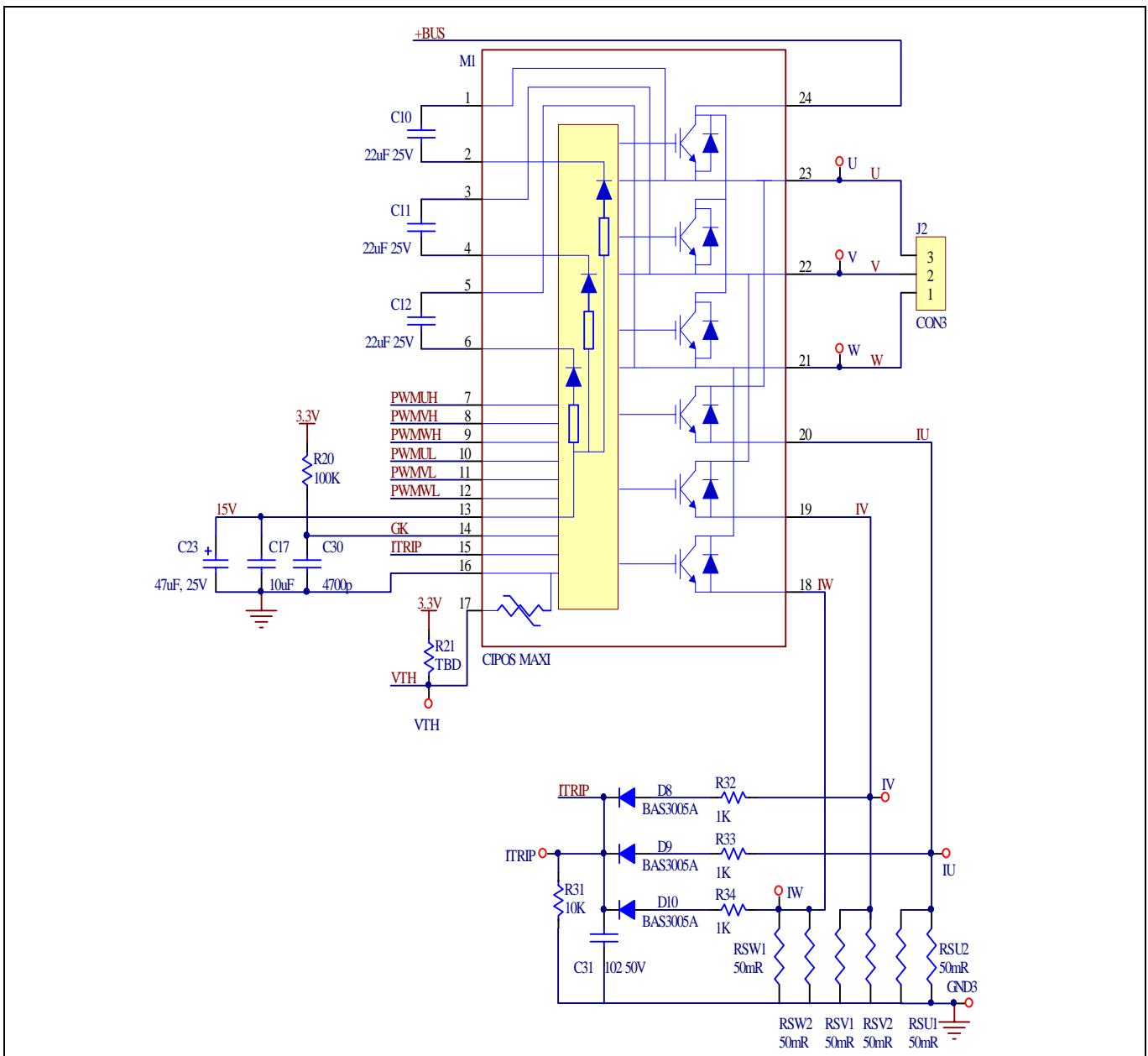

Figure 22   Schematic of the 3-phase inverter section using CIPOS™ Maxi IPM on EVAL-M1-IM818-A

EVAL-M1-IM818-A user guide
Evaluation power board with MADK M1 connector
Schematic for EMI filter and AC/DC section of the EVAL-M1-IM818-A evaluation board

3.2 Auxiliary power supply

Figure 23 depicts the schematic of the auxiliary power supply of the EVAL-M1-IM818-A board. The circuit includes the ICE5QSAG that is used to generate 15 V directly from the DC bus. VCC is connected to the gate drivers inside the CIPOS™ IPM.
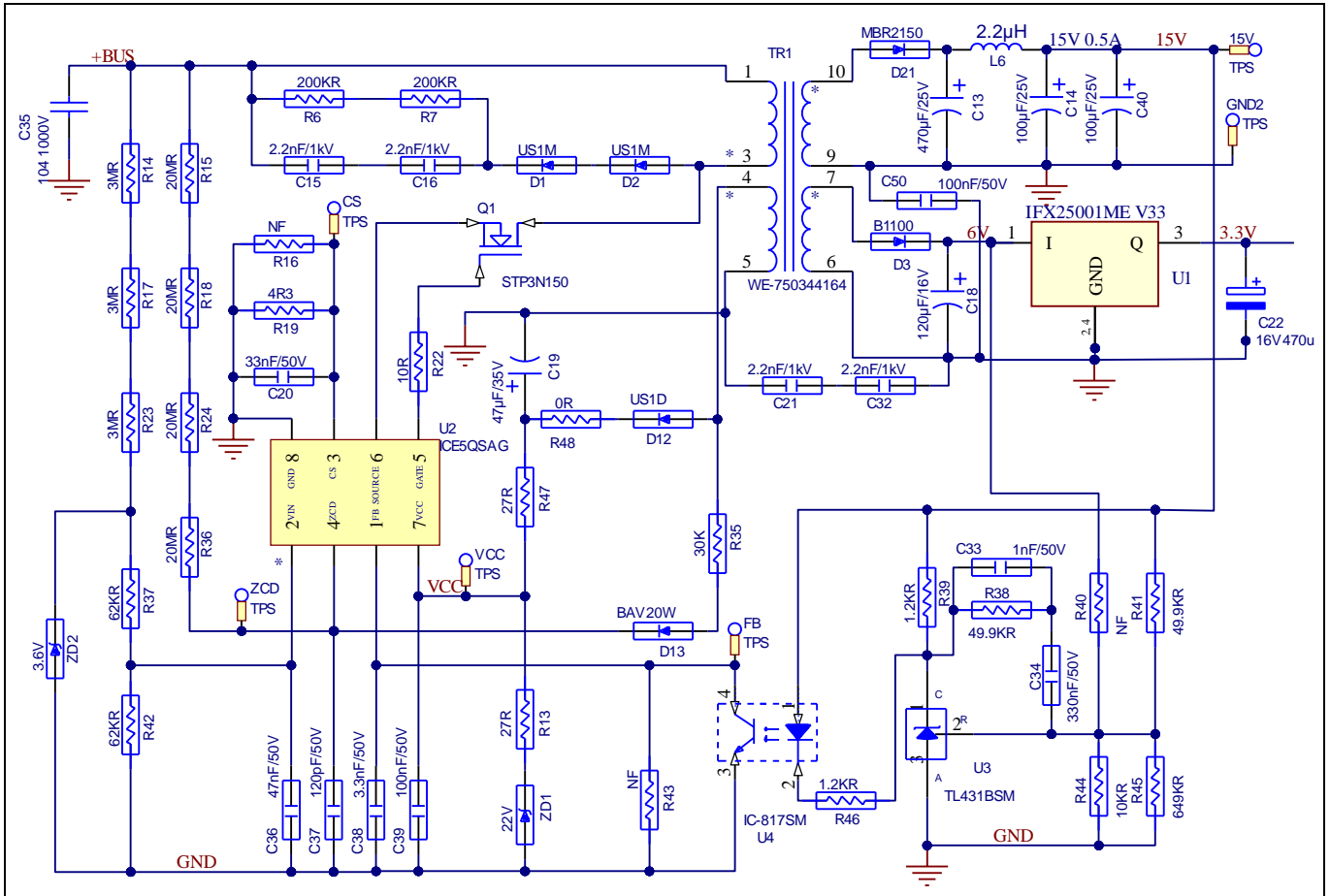

Figure 23   Schematic of the 3-phase inverter section using CIPOS™ Maxi IPM on EVAL-M1-IM818-A

The linear voltage regulator IFX25001ME V33 generates 3.3 V from a 15 V power supply VCC. Both VCC and 3.3 V are also present on the 20-pin interface connector J2 to power circuitry on the controller board.

EVAL-M1-IM818-A user guide
Evaluation power board with MADK M1 connector
Schematic for EMI filter and AC/DC section of the EVAL-M1-IM818-A evaluation board

3.3 Layout

The layout of this board can be used for different voltage or power classes. The PCB has two electrical layers with 35 μm copper by default and its size is 197 mm × 140 mm. The PCB board thickness is 1.6 mm. Get in contact with our technical support team to get more detailed information and the latest Gerber-files.

Figure 24 illustrates the top assembly print of the evaluation board.
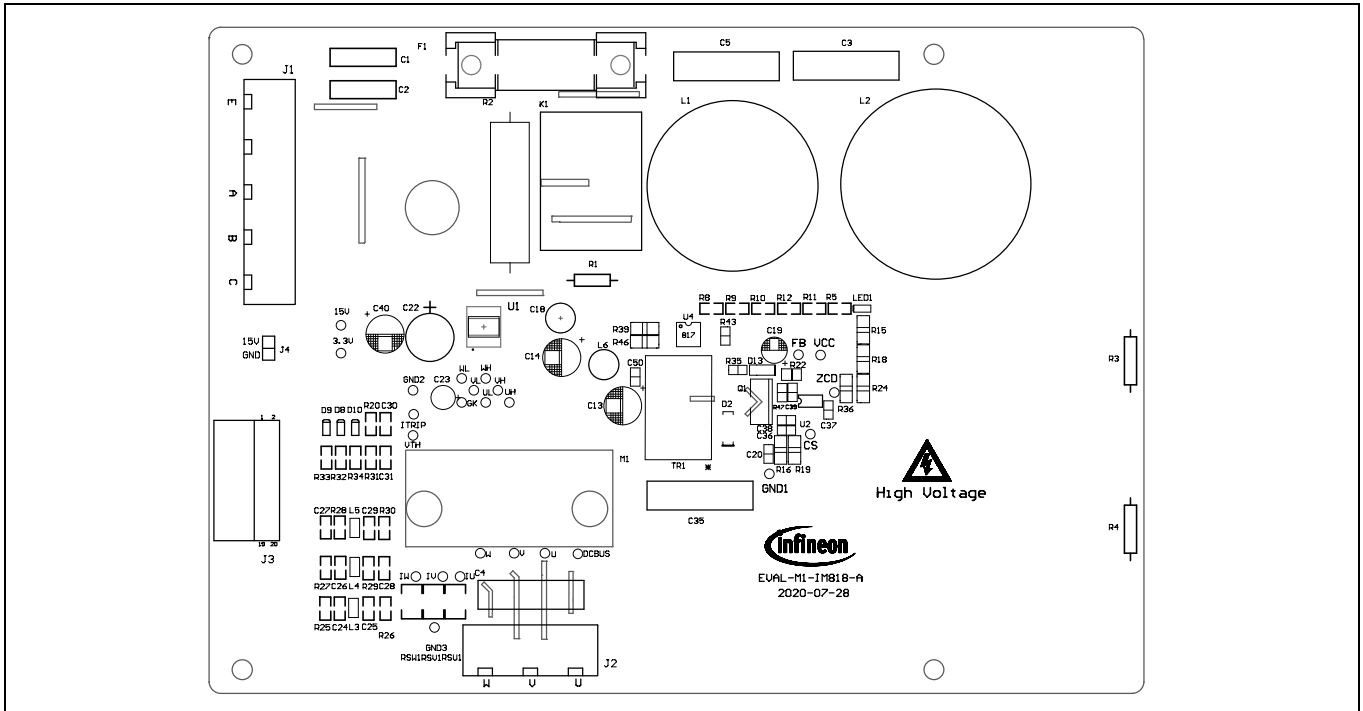
Figure 24   Top assembly print of the EVAL-M1-IM818-A evaluation board

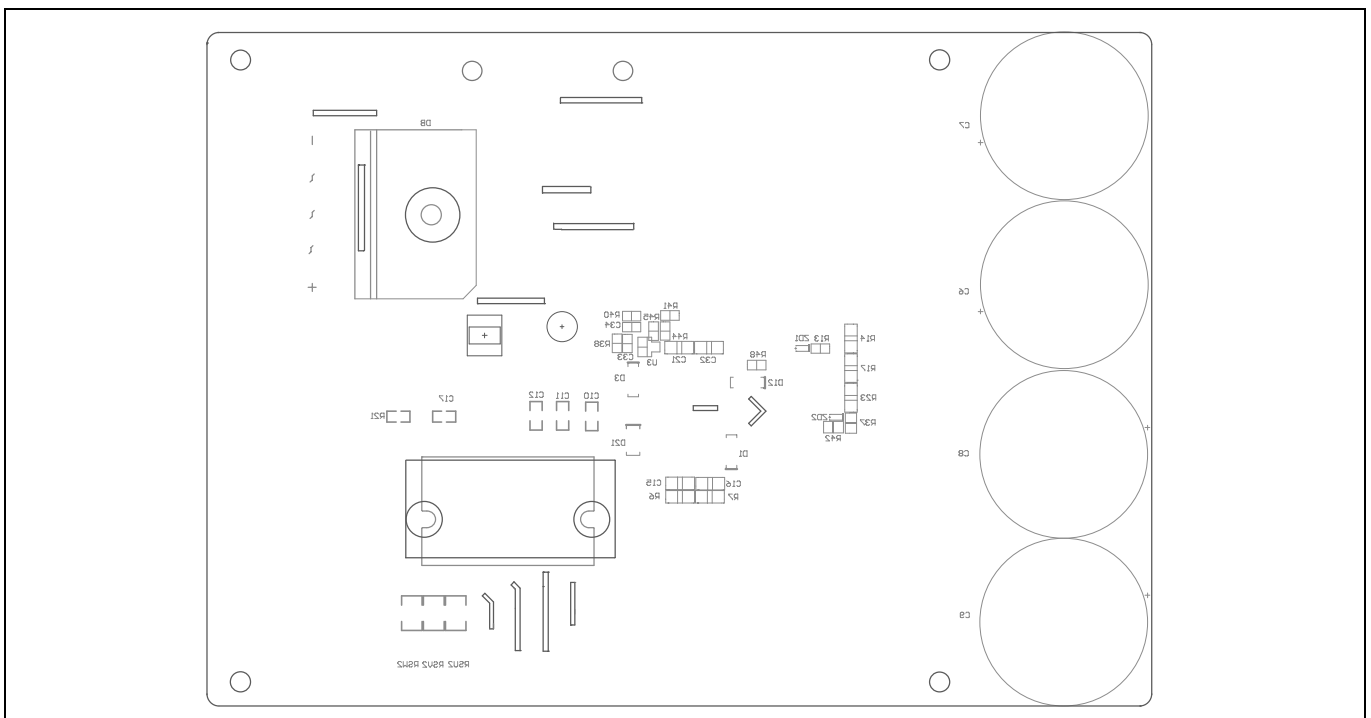Figure 25 depicts the bottom assembly print of the evaluation board.

Figure 25   Bottom assembly print of the EVAL-M1-IM818-A evaluation board

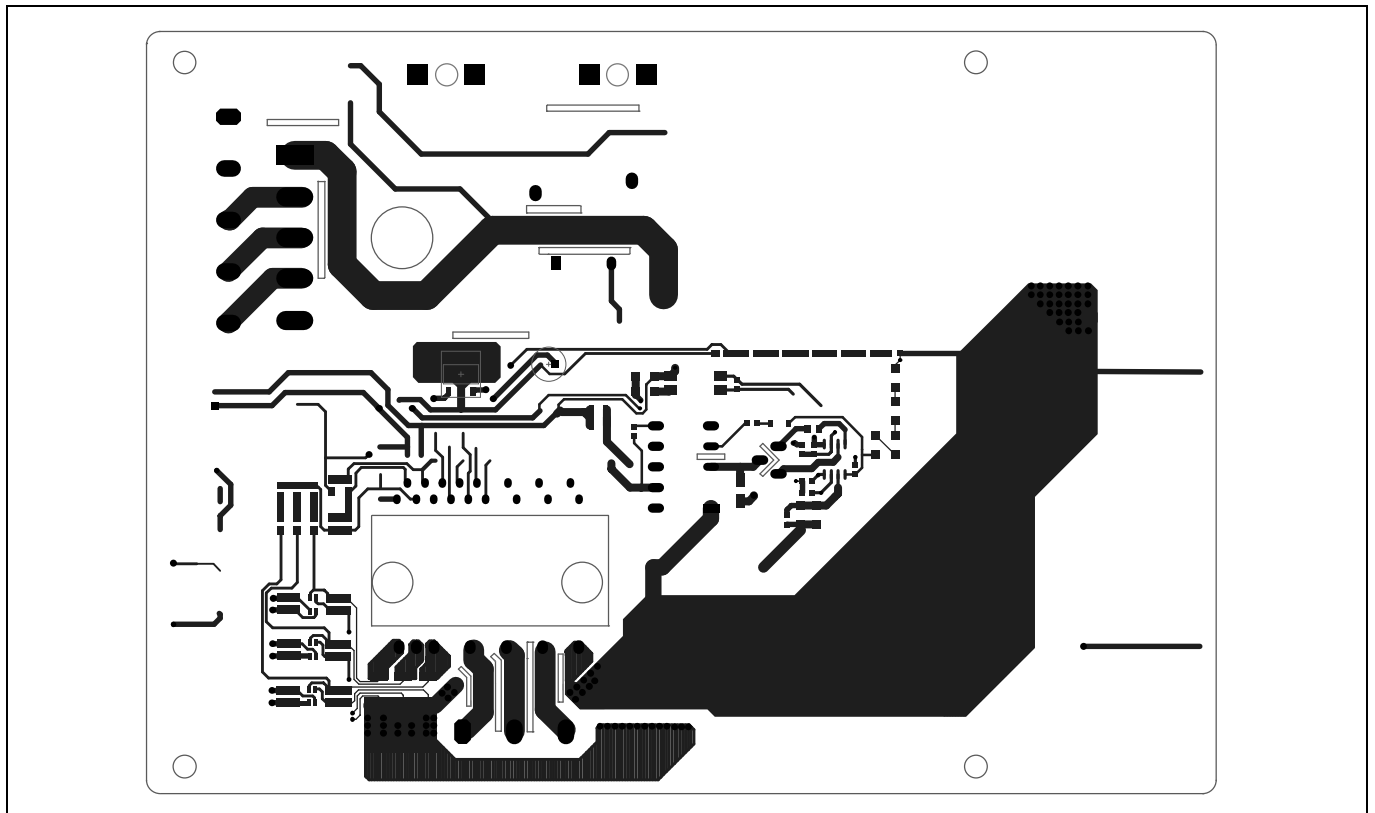The top layer routing of the PCB is provided in Figure 26.

Figure 26   Top layer routing of the EVAL-M1-IM818-A
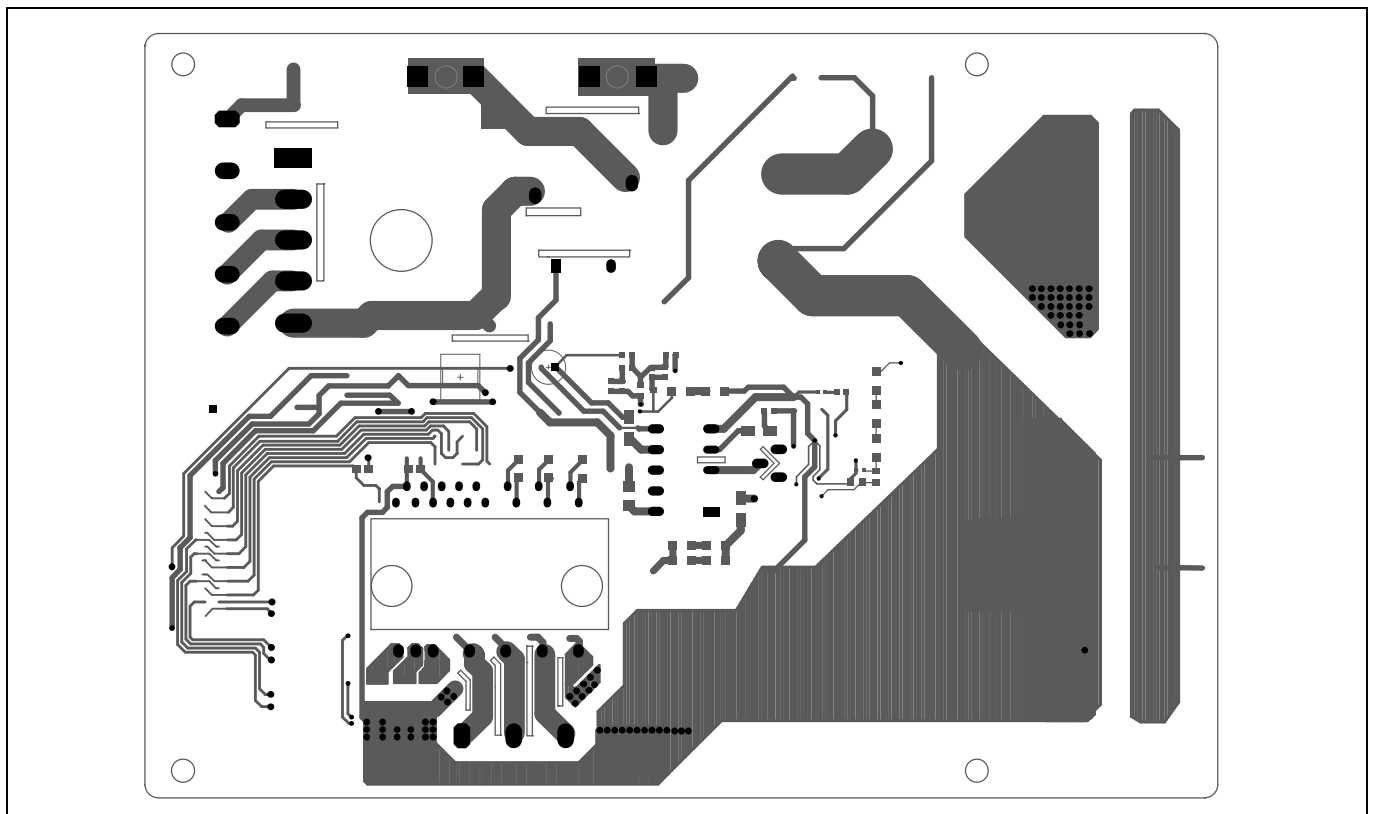
Figure 27 illustrates the bottom layer routing of the PCB.

Figure 27   Bottom layer routing of the EVAL-M1-IM818-A

3.4   Bill of material

The complete bill of material is available on the download section of the Infineon homepage. A log-in is required to download this material.

Table 9 provides the complete bill of materials of the evaluation board.

Table 9   BOM of the most important parts of the EVAL-M1-IM818-A

No.	Designator	Part description	Part number	Manufacturer
1	C6, C7, C8, C9	CD470UF 450V	861221486023	Wurth Electronics Inc.
2	C13	470uF 25V	860020474014	Wurth Electronics Inc.
3	C14, C40	100uF 25V	865090449009	Wurth Electronics Inc.
4	C18	120uF 16V	860010373007	Wurth Electronics Inc.
5	C19	47uF 35V	860010572005	Wurth Electronics Inc.
6	C22	470uF 16V	870025374007	Wurth Electronics Inc.
7	C23	47uF 25V	860080472002	Wurth Electronics Inc.
8	TR1	Transformer	750344164	Wurth Electronics Inc.
9	J1	CONN TERM BLOCK 5POS 9.52MM PCB	691250910003 691250910002	Wurth Electronics Inc.
10	J2	CONN TERM BLOCK 3POS 9.52MM PCB	691250910003	Wurth Electronics Inc.
11	J3	CONN RCPT .100" 20PS DL R/A GOLD	613020243121	Wurth Electronics Inc.
12	J4	CONN HEADER 2 POS 2.54	61300211121	Wurth Electronics Inc.
13	L2	220uH 7.1A	PI200385V1	POCO Holding Co.,LTD
14	L3, L4, L5	WE-CNSW SMD Common Mode Line Filter	744232101	Wurth Electronics Inc.
15	U1	IFX25001ME V33	IFX25001MEV33HTSA1	Infineon Technologies
16	D8, D9, D10	BAS3005A-02V	BAS3005A02VH6327XTSA1	Infineon Technologies
17	U2	ICE5QSAG	ICE5QSAGXUMA1	Infineon Technologies
18	M1	IM818-MCC	IM818MCCXKMA1	Infineon Technologies

EVAL-M1-IM818-A user guide
Evaluation power board with MADK M1 connector
System performance

4 System performance

The evaluation board EVAL-M1-IM818-A is general power demonstration platform with CIPOS™ Maxi IPM IM818 series. And focus on 380 V_{AC} input, and 1~4.8 kW output application. All test date is basic on the board with different IPM. For end user, it is only default for IM818-MCC. Other IPMs can be directly compatible and replaced **(Warning)**. But don't guarantee hardware change.

Warning:

EVAL-M1-IM818-A is only default for IM818-MCC, any hardware change will not be guaranteed.

All operations can be done only when the evaluation boards has been move away from the power for over 5 minutes and double check those all capacitance voltage are lower than 5V.

Operation only for those licensed professionals under qualified safety protection （including: person，equipment, ESD）.

For any re-install, it is necessary to clean the thermal conductive silicone grease and coating it again.

4.1 Test results for output ability

In order to test the total power capability of EVAL-M1-IM818-A, the IPM case temperature is tested with different input and output currents.

The test temperature T_a = 25°C

Note: EVAL board provides air cooling option, and set 15 V 200 mA for fan drive.

● Power setup:

400 V_{DC} (298 V_{AC} 50 Hz 3-phase input)

700 V_{DC} (518 V_{AC} 50 Hz 3-phase input)

380 V_{AC} (3-phase input)

● PWM frequency 6 kHz and 20 kHz three-phase modulation.

Figure 28 shows the IPM case temperature measured by an infrared camera. Run motor at 400 RPM and adjust motor load until the hottest point in the center of IM818-MCC top of Tcmac=105°C (temperature rise reaches 80°C), get the curve for temperature rise by different setup.

EVAL-M1-IM818-A user guide
Evaluation power board with MADK M1 connector
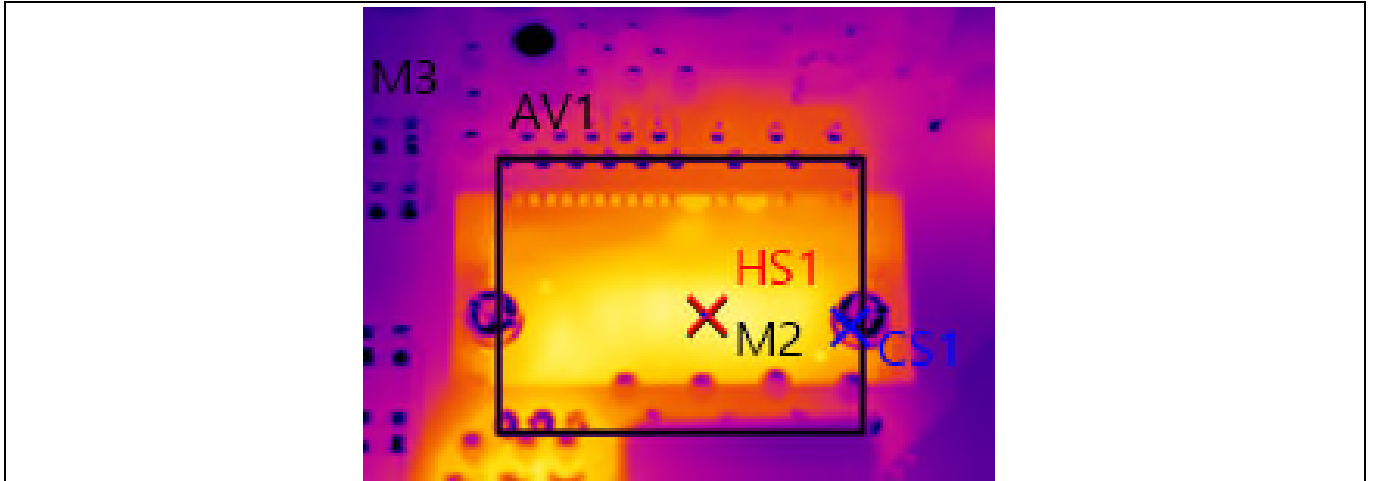**System performance**

Figure 28   Infrared camera image for IPM temperature test

4.2   Test range

Figure 29 is IM818-MCC output ability at different PWM frequency and power input, which are performed under the following conditions:
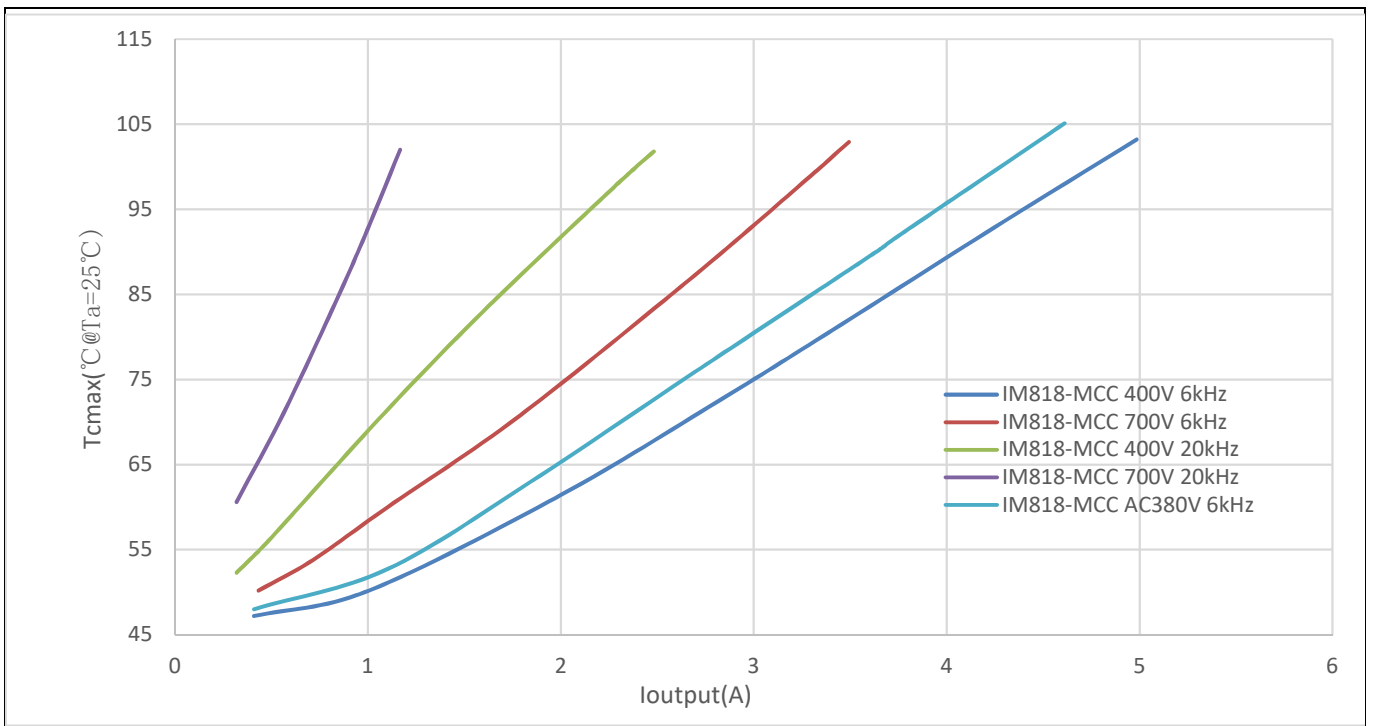

Figure 29   IM818-MCC Output current vs difference PWM frequency and power input

System performance

Figure 30 is IM818-LCC output ability at different PWM frequency and power input, which are performed under the following conditions:
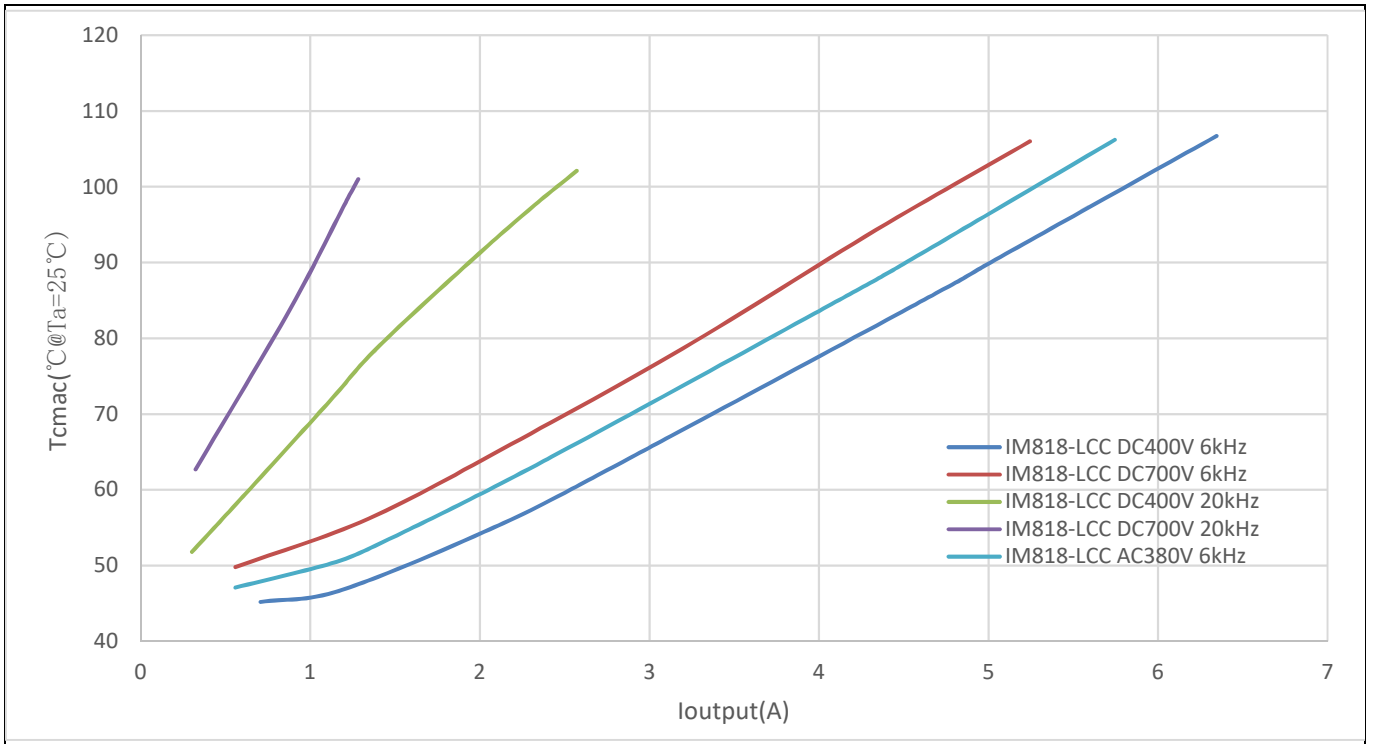

Figure 30   IM818-LCC Output current vs difference PWM frequency and power input

Figure 31 is IM818-SCC output ability at different PWM frequency and power input, which are performed under the following conditions:
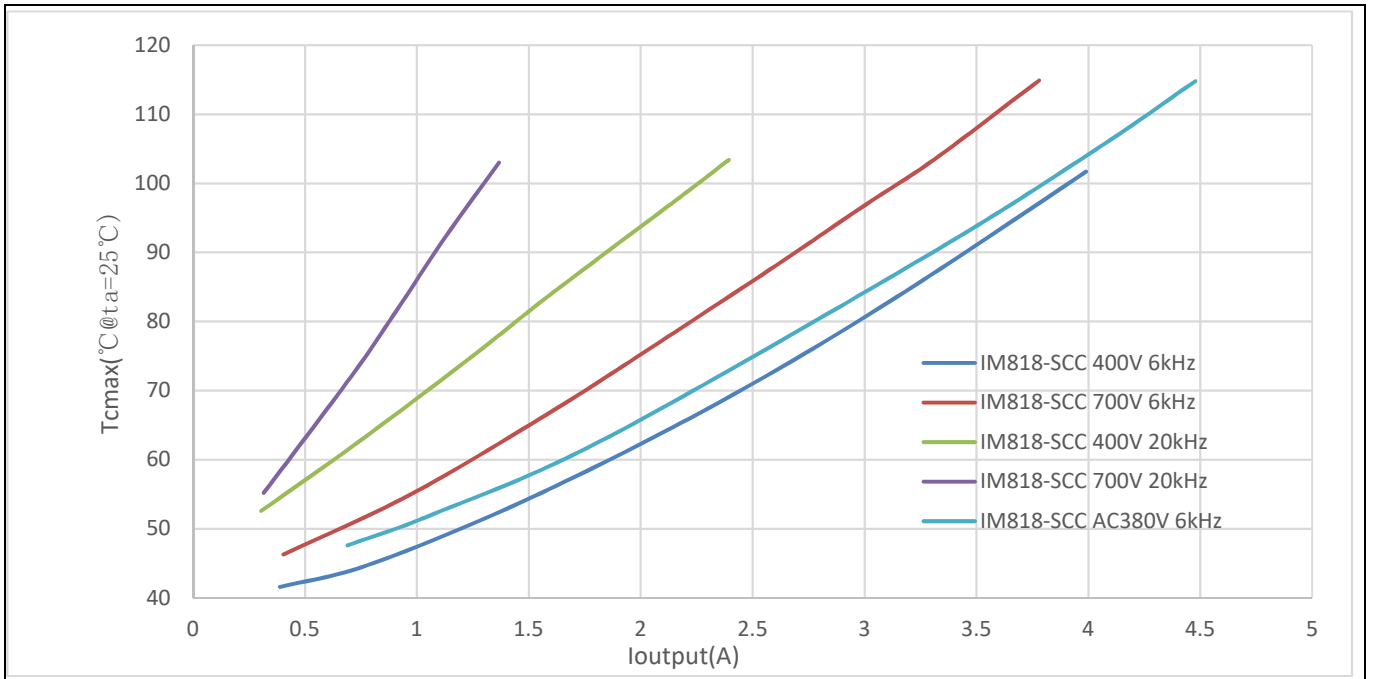

Figure 31   IM818-SCC Output current vs difference PWM frequency and power input

EVAL-M1-IM818-A user guide
Evaluation power board with MADK M1 connector
System performance

4.3   Test results of typical waveform

Figure 32 is typical current waveform of a sinusoidal brushless motor driven by the EVAL-M1-IM818-A and EVAL-M1-101T with iMOTIONTM software.
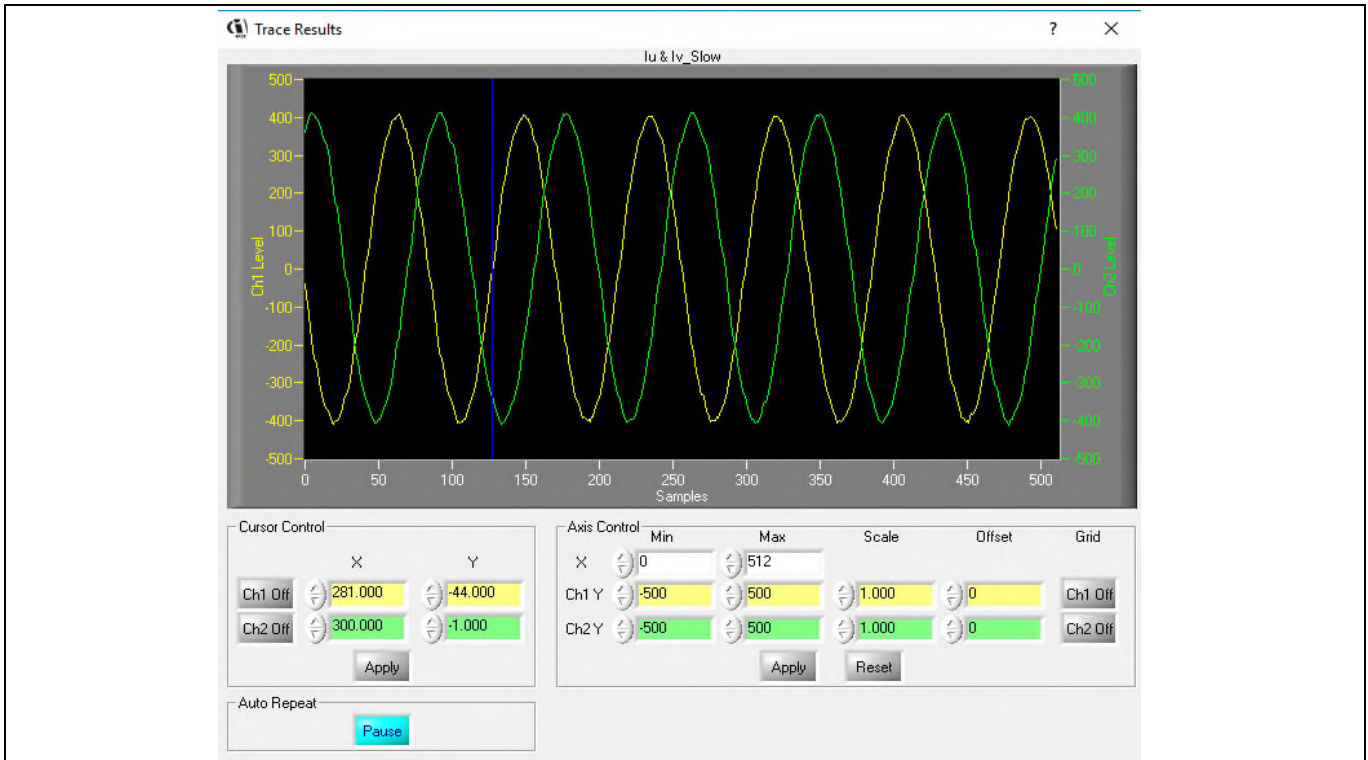

Figure 32   I$_U$ and I$_V$ current waveform. It is IM818-MCC work on AC380V input, PWM=6kHz, motor drive on 700rpm, Iphase=5A

Figure 33 is IPM typical switching dv/dt on "ON" and "OFF" time.

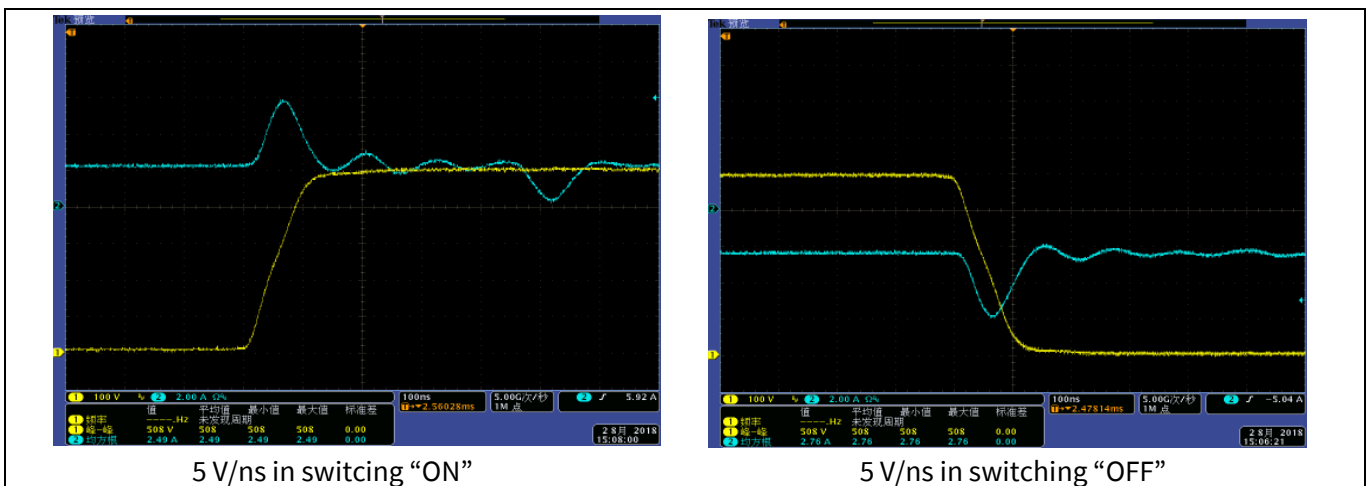| 5 V/ns in switcing "ON" | 5 V/ns in switching "OFF" |

Figure 33   Typical dv/dt test waveform. It is IM818-MCC work on 380 V$_{AC}$ input at switching current is 2A.

The dv/dt is very important parameter for motor drive. This is specially set for the application.

The cable connecting the motor can be regarded as an open inductor, which forms a complete electromagnetic radiation network with the capacitance of the motor winding to the ground. The parasitic combination emits high-frequency electromagnetic noise to the surroundings, if there is an excitation source.

System performance

According to Fourier expansion equation, PWM square wave can be regarded as composed of several sine waves with multiple frequencies and different initial phase angles. Changing the slope of square wave, the high frequency harmonic components are reduced. Balance between energy efficiency and electromagnetic compatibility by IPM design.

EVAL-M1-IM818-A user guide
Evaluation power board with MADK M1 connector
References and appendices

5 References and appendices

5.1 Abbreviations and definitions

Table 10   **Abbreviations**

Abbreviation	Meaning
CE	Conformité Européenne
EMI	Electromagnetic interference
UL	Underwriters Laboratories

5.2 References

[1]   Datasheet of Infineon CIPOS™ Maxi IM818, that is available for download on Infineon's website :

https://www.infineon.com/dgdl/Infineon-IM818-MCC-DataSheet-v02_02-EN.pdf?fileId=5546d46265f064ff0165f9e91e3c2e9e

[2]   Application Note AN2020-14 CIPOS Maxi Technical Description, that is available for download on Infineon's website:

https://www.infineon.com/dgdl/Infineon-AN2020-14_Bootstrap_circuit_design_for_the_CIPOS_IPM_series-ApplicationNotes-v01_00-EN.pdf?fileId=5546d46276fb756a0177007b985753fd

5.3 Additional information

The power board is now available for customers in small order quantities. In order to initiate the testing, customers are advised to order the following items:

Base Part Number	Package	Standard Pack		Orderable Part Number
		Form	**Quantity**	
EVAL-M1-IM818-A	EVAL	Boxed	1	EVAL-M1-IM818-A
IM818-MCC	DIP 36X23D	TUBE	280	IM818MCCXKMA1
IM818-LCC	DIP 36x23D	TUBE	280	IM818LCCXKMA1
IM818-SCC	DIP 36X23D	TUBE	280	IM818SCCXKMA1
ICE5QSAG	PG-DSO-8	TAPE & REEL	2500	ICE5QSAGXUMA1
IFX25001ME V33	PG-SOT-223-4	TAPE & REEL	1000	IFX25001MEV33HTSA1
BAS3005A02V	SC79	TAPE & REEL	3000	BAS3005A02VH6327XTSA1

Note: All listed reference materials are available for download on Infineon's website www.infineon.com.

All the iMOTION MADK evaluation board's User Manuals are available at www.infineon.com/MADK

Revision history

Document version	Date of release	Description of changes
1.0	2018-11-15	First release
1.1	2019-04-02	Change output power to 1500W and Current to 2.35 A. Optimization schematic
1.2	2021-03-03	Change current feedback sensing value to 20.83 mV/A
1.3	2021-05-06	BOM and SCH update
1.4	2021-09-10	Add IM818-LCC and IM818-SCC information

Trademarks
All referenced product or service names and trademarks are the property of their respective owners.