

EVAL-M1-101T User Manual

iMOTION™ Modular Application Design Kit

About this document

Scope and purpose

This application note provides an overview of the evaluation board EVAL-M1-101T including its main features, key data, pin assignments and mechanical dimensions.

EVAL-M1-101T is an evaluation-board as part of the iMOTION™ Modular Application Design Kit. This board features and demonstrates Infineon's Advanced Motion Control Engine (MCE 2.0) technology for permanent magnet motors drive over the full speed range.

The evaluation board EVAL-M1-101T 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 who know motor control and high power electronics converter and this board is intended to be used under laboratory conditions.

Table of contents

| | |
|---|-----------|
| About this document | 1 |
| Table of contents | 1 |
| 1 Safety precautions | 3 |
| 2 Introduction | 4 |
| 3 EVAL-M1-101T main features | 5 |
| 3.1 Functional description | 6 |
| 3.2 IMC101T-T038 pinout description | 6 |
| 3.3 EVAL-M1-101T board specifications | 8 |
| 3.4 Pin assignment..... | 9 |
| 4 Getting Started with EVAL-M1-101T | 11 |
| 4.1 Setting up the system..... | 11 |
| 4.2 iMOTION™ development tools and software | 13 |
| 4.2.1 MCEWizard setup overview..... | 13 |
| 4.2.2 MCEDesigner setup overview | 15 |
| 5 Hardware description of EVAL-M1-101T | 18 |
| 5.1 Current feedback circuitry | 18 |
| 5.1.1 Shunt configuration | 18 |
| 5.1.2 External Current feedback configuration and calculation | 18 |
| 5.1.3 Internal Current feedback amplifier gain configuration | 20 |
| 5.2 EVAL-M1-101T analog inputs and their MCEWizard setup | 21 |
| 5.2.1 DC bus sensing configuration | 21 |
| 5.2.2 NTC shutdown value calculation and configuration | 22 |
| 5.2.3 VSP analog input control mode and PGout configuration | 23 |
| 5.3 Schematics overview | 26 |
| 5.4 PCB layout overview | 27 |

Table of contents

| | | |
|----------|-------------------------------|-----------|
| 6 | Bill of material | 29 |
| 7 | Reference..... | 31 |
| | Revision history..... | 32 |

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: The ground potential of the EVAL-M1-101T 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</p> |
|  | <p>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.</p> |
|  | <p>Attention: The surfaces of the drive may become hot, which may cause injury.</p> |
|  | <p>Attention: EVAL-M1-101T 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.</p> |
|  | <p>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.</p> |
|  | <p>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.</p> |
|  | <p>Attention: EVAL-M1-101T 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.</p> |

2 Introduction

The EVAL-M1-101T 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-pin iMOTION™ MADK M1, or the 30-pin iMOTION™ MADK M3 interface connector. This board is equipped with 20-pin M1 connector and is intended for single 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 provides a capable of 3-phase and type 3 of 2-phase modulation, a micro-USB connector and on board debugger isolated by digital isolator, and UART interface.

The EVAL-M1-101T evaluation board is available from Infineon. The features of this board are described in the main features 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-M1-101T, but it is 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-M1-101T. This document explains the features and details of this board as well as control IC which is IMC101T-T038.

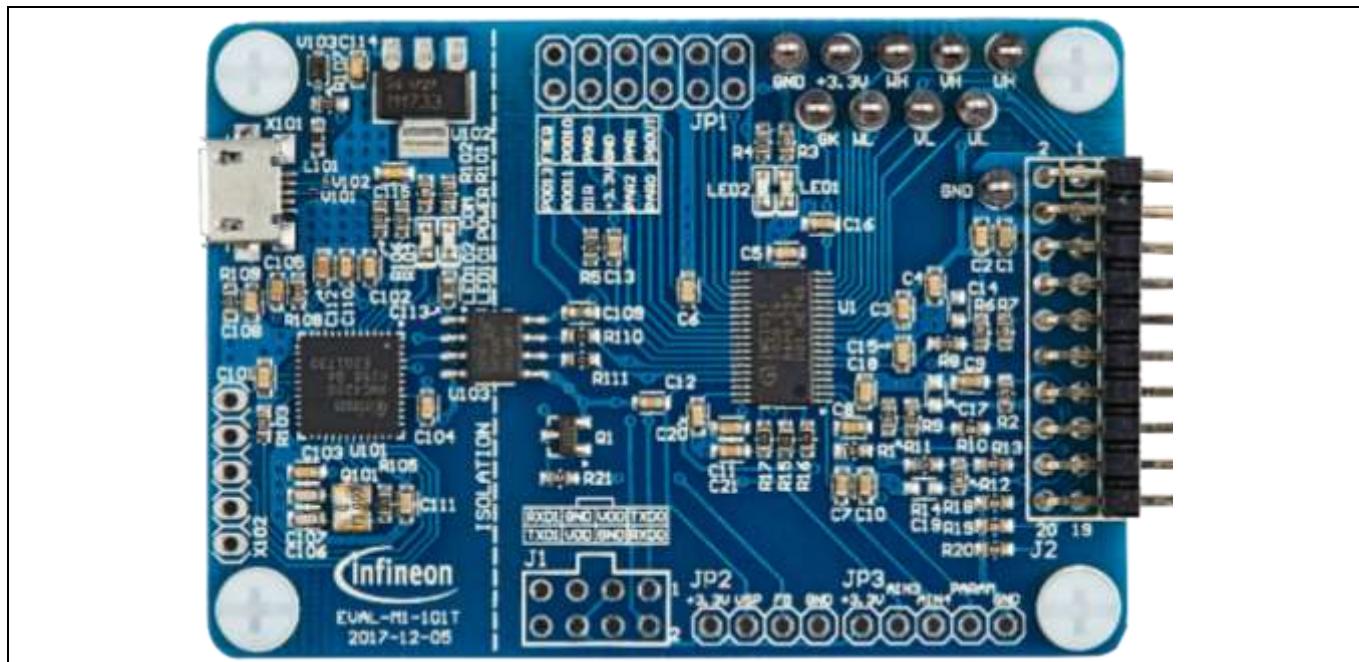


Figure 1 Evaluation board EVAL-M1-101T

3 EVAL-M1-101T main features

EVAL-M1-101T is an evaluation control board for motor control applications. The kit demonstrates Infineon's motion control IC technology.

Main features of the IMC101T-T038 Motion Control IC are:

- MCE (Motion Control Engine) as ready-to-use solution for variable speed drives
- Field oriented control (FOC) for permanent magnet synchronous motor (PMSM)
- Space vector PWM with sinusoidal commutation and integrated protection features
- Current sensing via single or leg shunt
- Sensorless operation
- Various serial communication interfaces (UART, I2C, SPI)
- Multiple motor parameter support
- 3.3V (default) or 5V VDD power supply
- Flexible host interface options for speed commands: UART, I2C, SPI, PWM or analog signal
- Support for IEC 60335 ('Class B')
- Scalable package options

The evaluation board characteristics are:

- Complete kit for running any permanent magnet motor via sensorless sinusoidal control
- 3.3V (default) or 5V VDD power supply
- Micro-USB connector and on-board debugger isolated by digital isolator
- Capable of 3-phase and type 3 of 2-phase modulation
- RoHS compliant
- PCB size is 65 x 45 mm

3.1 Functional description

Figure 2 shows a typical motor control application block diagram using the IMC101T-T038. The IMC101T-T038 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. IMC101T-T038 also employs a unique single shunt current reconstruction circuit in addition to leg shunt current sensing circuit to eliminate additional analog/digital circuitry.

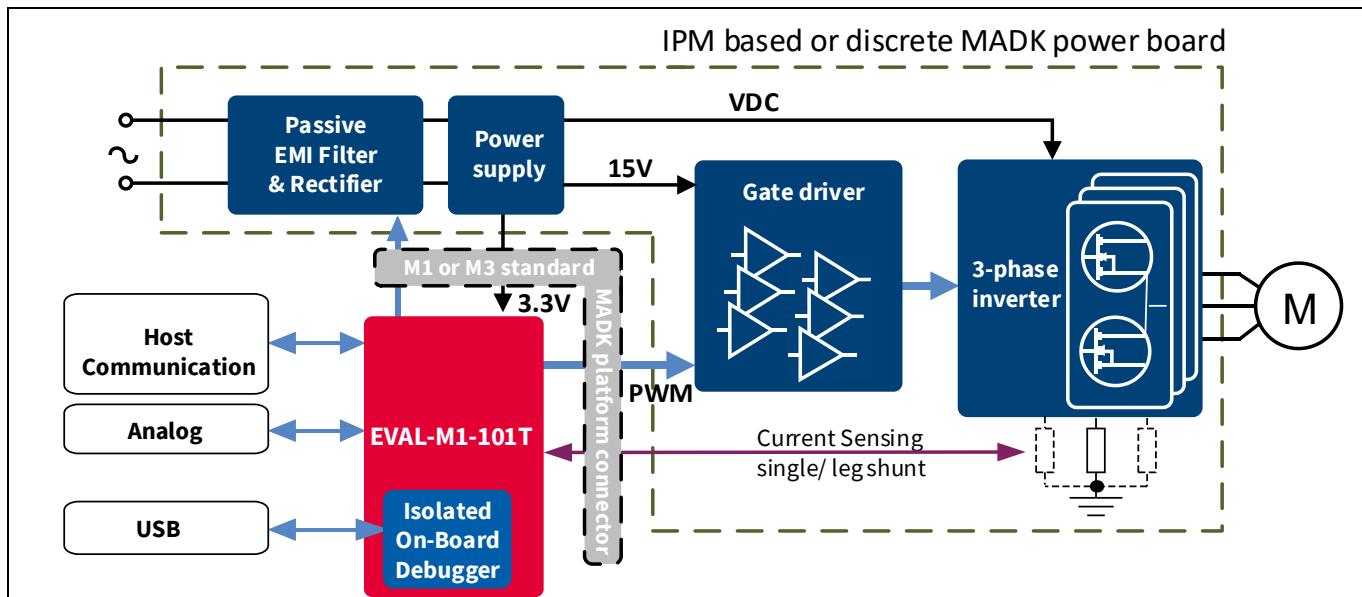


Figure 2 Typical Application Block Diagram Using IMC101T-T038

3.2 IMC101T-T038 pinout description

The main part of the EVAL-M1-101T MADK control board is the IMC101T-T038 iMOTION™ motor control IC. Figure 3 depicts the pinout of the IMC101T-T038 IC. IMC101T-T038 comes in a compact 9.7mm x 6.4mm 38-pin TSSOP package.

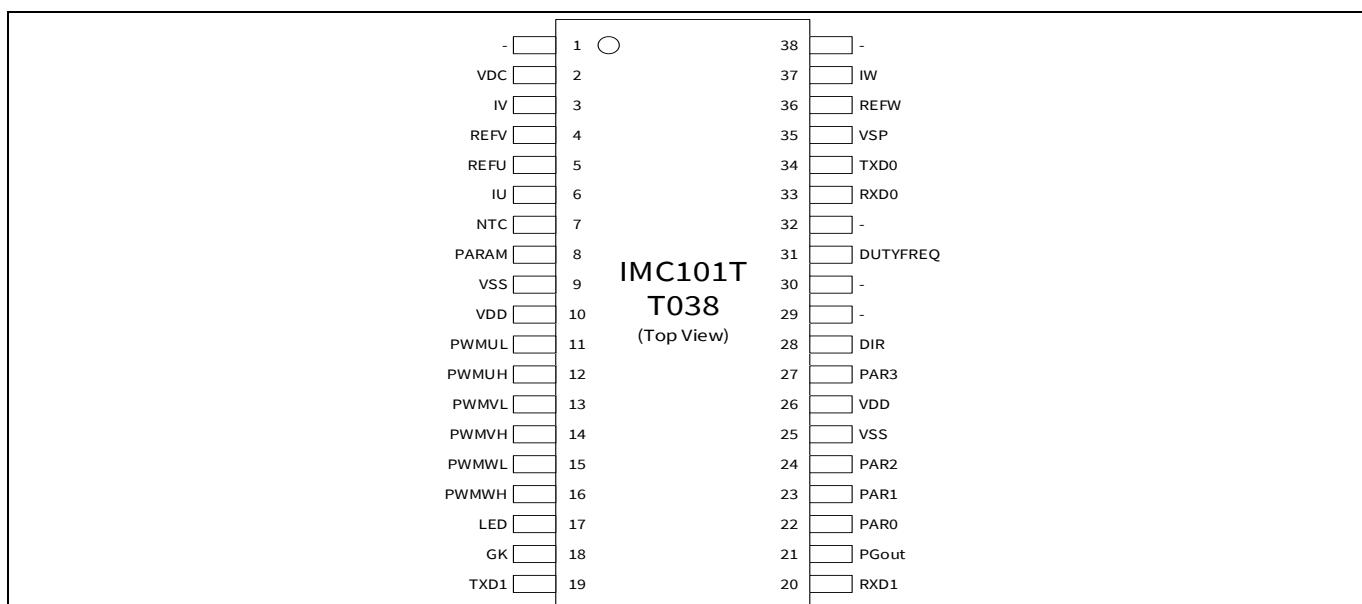


Figure 3 Pinout of IMC101T-T038

Table 2 lists the available pins of IMC101T-T038 with short descriptions. For more detailed information, please refer to the datasheet or User Manual for iMOTION™ IMC101T-T038 motor control IC.

Table 2 IMC101T-T038 pinout description

| Pin# | Type | Pin Name | Description |
|------|-------|-----------|---|
| 1 | - | - | not used |
| 2 | AIN | VDC | DC bus sensing input |
| 3 | AIN | IV/AIN6 | Phase V current leg sensing |
| 4 | AIN | REFV/AIN7 | Itrip phase V reference |
| 5 | AIN | REFU/AIN8 | Itrip phase U reference |
| 6 | AIN | IU | Phase U leg sensing or single shunt current sensing |
| 7 | AIN | NTC | external temp sense input |
| 8 | AIN | PARAM | Parameter table selection, analog |
| 9 | Power | VSS | ground |
| 10 | Power | VDD | VDD supply power |
| 11 | O | PWMUL | motor PWM phase U low side |
| 12 | O | PWMUH | motor PWM phase U high side |
| 13 | O | PWMVL | motor PWM phase V low side |
| 14 | O | PWMVH | motor PWM phase V high side |
| 15 | O | PWMWL | motor PWM phase W low side |
| 16 | O | PWMWH | motor PWM phase W high side |
| 17 | O | LED | Status LED |
| 18 | I | GK | Motor Gatekill input |
| 19 | O | TXD1 | UART1 Transmit for host interface |
| 20 | I | RXD1 | UART1 Receive for host interface |
| 21 | O | PGOUT | PG output |
| 22 | I | PAR0 | Parameter page select bit 0 |
| 23 | I | PAR1 | Parameter page select bit 1 |
| 24 | I | PAR2 | Parameter page select bit 2 |
| 25 | Power | VSS | ground |
| 26 | Power | VDD | VDD supply power |
| 27 | I | PAR3 | Parameter page select bit 3 |
| 28 | I | DIR | direction input |
| 29 | - | - | not used |
| 30 | - | - | not used |
| 31 | I | DUTYFREQ | Duty/Freq input for speed input |
| 32 | - | - | not used |
| 33 | I | RXD0 | UART0 Receive for SW download |
| 34 | O | TXD0 | UART0 Transmit for SW download |
| 35 | AIN | VSP | Analog speed reference input |

| | | | |
|----|-----|------|-----------------------------|
| 36 | AIN | REFW | Itrip phase W reference |
| 37 | AIN | IW | Phase W current leg sensing |
| 38 | - | - | not used |

3.3 EVAL-M1-101T board specifications

Table 3 depicts the important specifications of the evaluation board EVAL-M1-101T.

Table 3 EVAL-M1-101T board specifications

| Parameters | Values | Conditions / comments |
|--|---|--|
| Host Interface (Not isolated) | | |
| UART(TXD RXD) | 0 - VDD | Serial port 1 typical 57600 Bps |
| AIN | 0 - VDD | analog input |
| DIN | 0 - VDD | digital input |
| DOUT | 0 - VDD | digital output |
| FG | 0 - 30V | digital output with open drain structure |
| Input | | |
| VDD | 3.3V (default), 5V | Controller supply voltage |
| DC Bus | | |
| DC Bus Scaling | 8.20 counts/V | 13.3kΩ resistor on control board, and 2MΩ resistor on power board |
| DC Bus sensing range | 499.54V max | |
| Current feedback | | |
| Internal Current Feedback Amplifier Gain | 1, 3, 6, 12 | Configured by MCEWizard |
| Current sensing device | 0 - VDD/Gain | Single shunt resistor Leg shunt resistor |
| Current Op-amp Configuration | Non-Inverting | default setting |
| Current External Amplification Gain | 0.833 | |
| Resolution | 12-bit | PCB design may reduce the resolution |
| Latency | 1 pwm cycle | |
| Protections | | |
| NTC Temperature shutdown value | 0 - VDD (configured by MCEWizard) | |
| PCB characteristics | | |
| Material | FR4, 1.6MM thickness Copper thickness = 1oz (35um) | |
| Dimension | 65mmx45mm | |

| Parameters | Values | Conditions / comments |
|---------------------------|-------------|-----------------------|
| System environment | | |
| Ambient temperature | -40 - 105°C | |

3.4 Pin assignment

Essential information about the connections of the EVAL-M1-101T evaluation board is described below.

Table 4 includes the details of UART connectors.

Table 4 J1- UART Connector

| Pin Nr. | Pin | Details |
|---------|-------|---|
| 1 | TXD0 | Serial port 0 Output, IMC101T-T038 transmit data to master controller |
| 2 | RXD0 | Serial port 0 Input, IMC101T-T038 receive data from master controller |
| 3 | +3.3V | VDD power supply |
| 4 | GND | Ground |
| 5 | GND | Ground |
| 6 | +3.3V | VDD power supply |
| 7 | RXD1 | Serial port 1 Input, IMC101T-T038 receive data from master controller |
| 8 | TXD1 | Serial port 1 Output, IMC101T-T038 transmit data to master controller |

Table 5 provides the pin assignments of the iMOTION™ MADK-M1 20 pins interface connector J2. This connector is the interface to the power board.

Table 5 J2- iMOTION™ MADK-M1 20 pins interface connector for control board

| Pin | Name | Pin Name Connectors |
|-----|----------|---|
| 1 | PWMUH | VDD compatible logic output for high side gate driver-Phase U |
| 2 | GND | Ground |
| 3 | PWMUL | VDD compatible logic output for low side gate driver-Phase U |
| 4 | GND | Ground |
| 5 | PWMVH | VDD compatible logic output for high side gate driver-Phase V |
| 6 | +3.3V | On board VDD supply |
| 7 | PWMVL | VDD compatible logic output for low side gate driver-Phase V |
| 8 | +3.3V | On board VDD supply |
| 9 | PWMWH | VDD compatible logic output for high side gate driver-Phase W |
| 10 | IU+ | Shunt voltage phase U |
| 11 | PWMWL | VDD 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 - VDD range by a voltage divider |

| 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, Table 7 and Table 8 include the details of test signal pin connectors.

Table 6 Digital signal test pin connector JP1

| Pin | Name | Pin Name Connectors |
|-----|----------|--------------------------------------|
| 1 | PGOUT | PG (Pulse Generation) output |
| 2 | PAR0 | Parameter page select bit 0 |
| 3 | PAR1 | Parameter page select bit 1 |
| 4 | PAR2 | Parameter page select bit 2 |
| 5 | GND | Ground |
| 6 | +3.3V | VDD power supply |
| 7 | PAR3 | Parameter page select bit 3 |
| 8 | DIR | Direction input |
| 9 | - | not used |
| 10 | - | not used |
| 11 | DUTYFREQ | Duty/Frequency input for speed input |
| 12 | - | not used |

Table 7 VSP signal test pin connector JP2

| Pin | Name | Pin Name Connector |
|-----|-------|---|
| 1 | +3.3V | VDD power supply/ +3.3V by default |
| 2 | VSP | Analog speed reference input |
| 3 | FG | open drain output for speed as shown in Figure 23 |
| 4 | GND | Ground |

Table 8 Analog signal test pin connector JP3

| Pin | Name | Pin Name Connector |
|-----|-------|---------------------------|
| 1 | +3.3V | VDD power supply |
| 2 | - | not used |
| 3 | - | not used |
| 4 | PARAM | Parameter table selection |
| 5 | GND | Ground |

4 Getting Started with EVAL-M1-101T

In order to run the motor system, a combination of the iMOTION™ MADK control board (EVAL-M1-101T) and the matching MADK power board (with M1 connector) is required. The iMOTION™ Software Tools MCEDesigner and MCEWizard are also required in order to initially 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.

4.1 Setting up the system

EVAL-M1-101T consists of several functional groups which enable out-of-the-box, fully functional motor control system combined with additional interfaces and test points for more advanced use cases. Figure 4 shows the functional groups of the EVAL-M1-101T evaluation board.

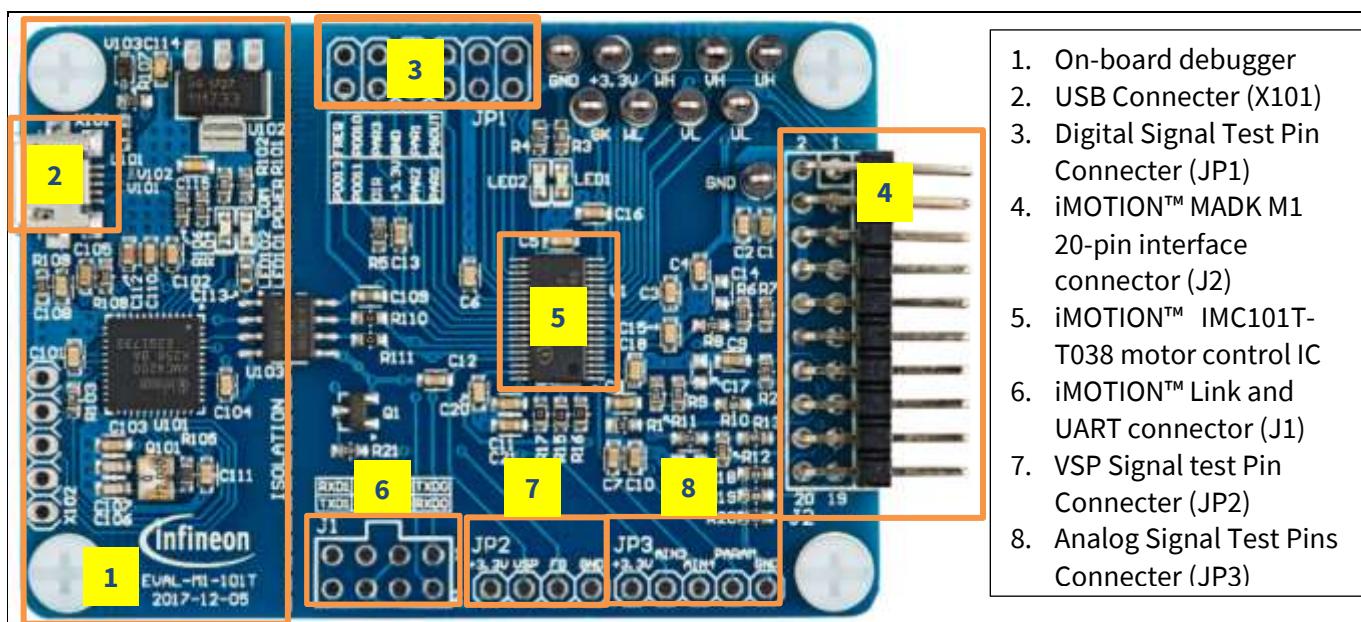


Figure 4 Functional groups of the EVAL-M1-101T evaluation board's top side

After downloading and installing the iMOTION™ PC Tools (MCEWizard and MCEDesigner), following steps need to be executed in order to run the motor. Refer to chapters 0 and 4.2.2 as well as MCEWizard and MCEDesigner documentation for more information.

1. Get the latest "IMC101T-T038 MCE Software Package" available on www.infineon.com/imotion-software web page.
2. Connect PC-USB connector on the on-board-debugger to the PC via USB cable.
3. Connect EVAL-M1-101T's M1 20-pin interface connector (J2) to power board (For example EVAL-M1-05-65D, see Figure 5).
4. Use MCEWizard to enter the target motor's system and operating parameters, as well as evaluation board's hardware parameters, which will then be used to calculate controller's digital parameter set representing complete motor drive system. First click "Calculate" button on the "Verify & Save Page" and then save the drive parameter set into your project directory by clicking "Export to Designer file (.txt)". Saved Drive System Parameter File will be later used by the MCEDesigner. Refer to Chapter 4.2.1 or MCEWizard User Guide for more details.
5. Connect motor phase outputs to the motor.
6. Connect AC power to power input connector and power on system.

7. Start MCEDesigner tool and open MCEDesigner default configuration file (.irc) for IMC101T-T038 controller (IMC101T_Vxxx.irc) by clicking “File” > “Open”. IMC101T_Vxxx.irc file is included in the “IMC101T-T038 MCE Software Package” downloaded in step 1.
8. MCEDesigner should automatically connect to the EVAL-M1-101T control board using default COM port (Indicated by green circle next to “COMx Up” status in the bottom frame of the MCEDesigner GUI). If it cannot establish the connection, change COM port by doing following steps: (“System” window active) > Preferences > Connection > Connect using (Chose one of the other available COM ports from the drop-down menu).
9. In case the IMC101T-T038 IC on the EVAL-M1-101T is empty (not programmed), which will be indicated by the pop-up window message after connecting to the MCEDesigner, then use following steps to program the firmware and the system parameters into the internal SRAM of iMOTION™ IC: Click “Tools” > “Programmer” and select “Program Firmware and Parameters”. Browse and select the IMC101T-T038_A_Vxxx.ldf file which was included in the IMC101T-T038 MCE Software Package” downloaded in step 1. Then browse and select the System Drive Parameters .txt file created in step 4. See chapter MCEDesigner setup overview 4.2.2 for more details.
10. In case the IMC101T-T038 IC firmware has already been loaded, use following steps to program the system parameters into the internal SRAM of iMOTION™ IC: Click “Tools” > “Programmer” and select “Program Parameters”. Browse and select the System Drive Parameters .txt file created in step 4.
11. Start the motor by clicking the green traffic light button in the control bar.

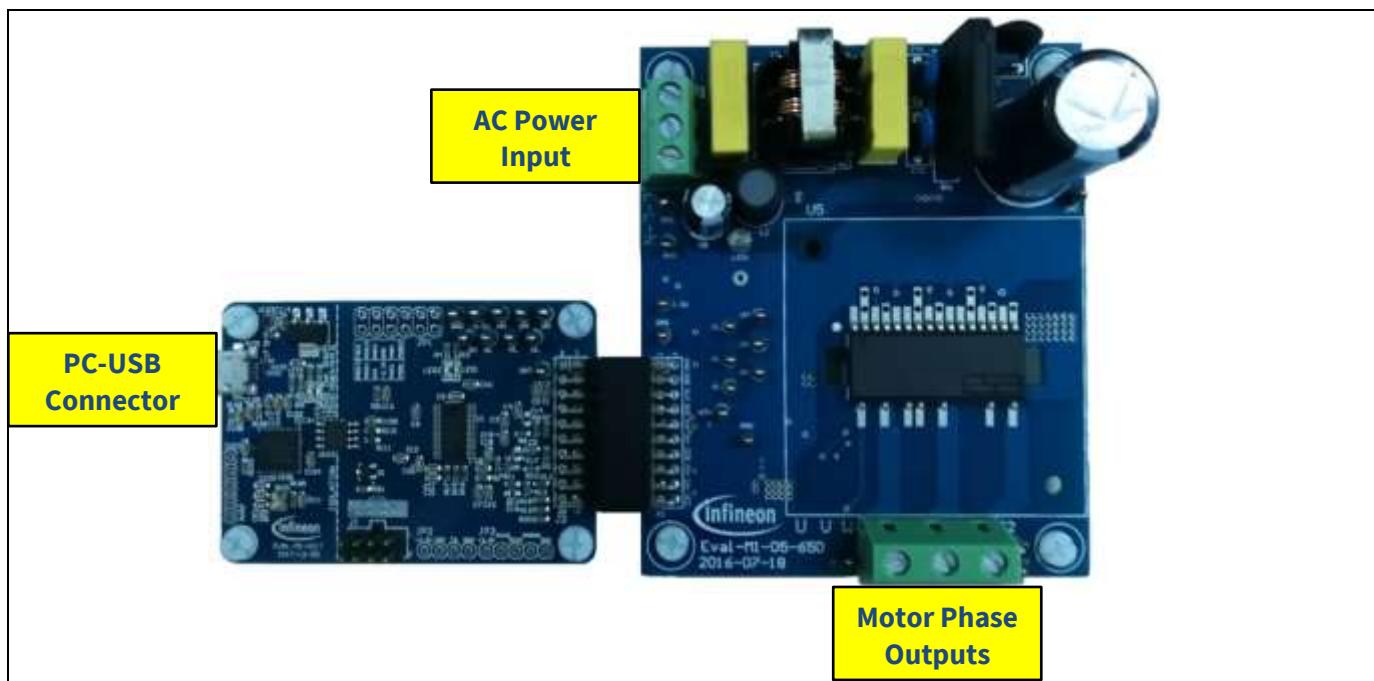


Figure 5 System connection example using EVAL-M1-101T and EVAL-M1-05-65D

4.2 iMOTION™ 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 supported tools and software variants are listed there. Please visit this page periodically to check for tool/software updates.

Isolated on-board debugger provides the USB to UART bridge between the PC and the target iMOTION™ device with 1kV DC galvanic isolation between the motor drive system (hot side) and the PC/debugger (cold) side. On-board debugger uses the SEGGER J-Link 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”.

4.2.1 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. Figure 6 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 Application Note 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 6.

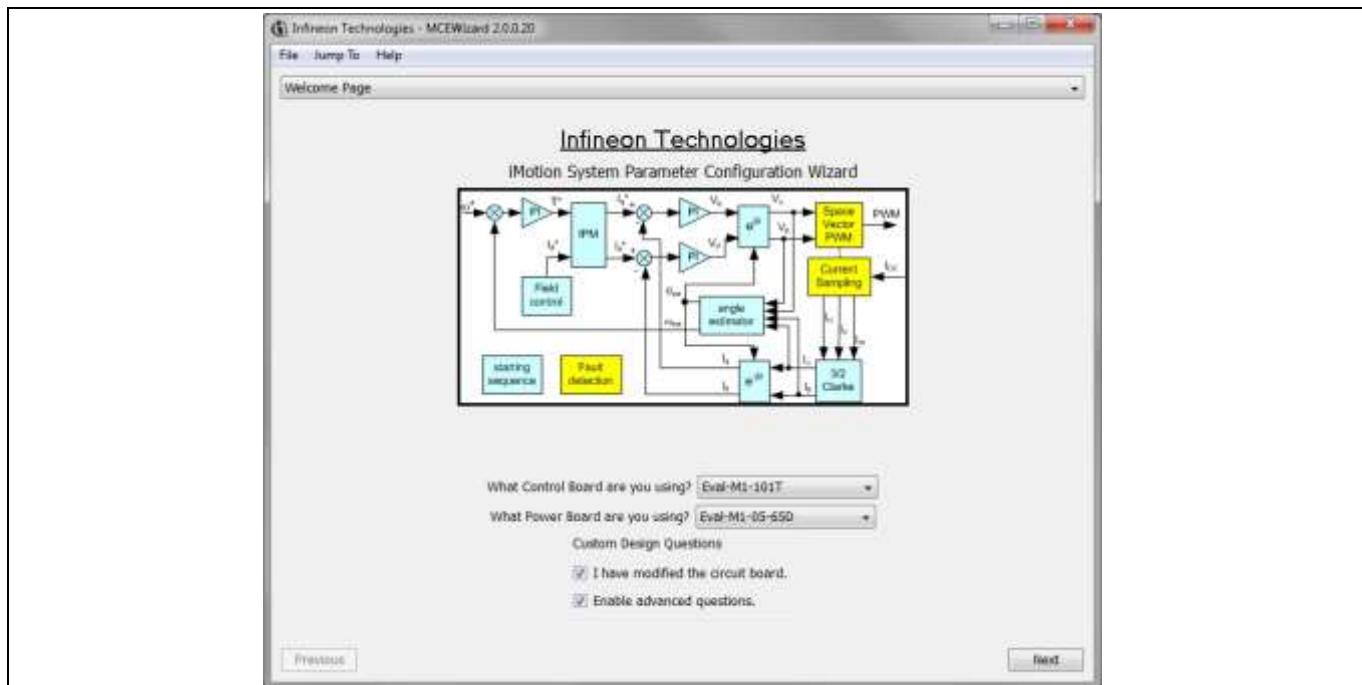


Figure 6 Welcome Page of MCEWizard

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 is a very limited number of parameters which are specific to the control board or power board hardware. Table 9 provides the MCEWizard setup overview for hardware related parameters. Similar tables will be available in each power board's Application Note. Combination of this table and the corresponding table of the power board provides enough information to setup the MADK-based motor drive system in shortest time.

Table 9 MCEWizard setup overview table

| Page | Parameter | Value | Comment |
|--------------|--------------------------------|-----------------------------------|---|
| Welcome Page | Power Board selecting | MADK power board name | If no, select similar power board to modify |
| Options Page | Motor 1 Shunt Configuration | Refer to the power board App Note | |
| Question 3 | Controller Supply Voltage | Refer to the power board App Note | VDD is 3.3V by default |
| Question 19 | Max DC Bus Voltage | Refer to the power board App Note | |
| Question 23 | DC Bus Sensing High Resistor | Refer to the power board App Note | |
| Question 24 | DC Bus Sensing Low Resistor | 13.3 kOhm | |
| Question 54 | NTC Temperature Shutdown value | Calculated as the Section 5.2.2 | Refer to the power board App Note |
| Question 63 | GateSense Low-Side Devices | Refer to the power board App Note | High is true by default |
| Question 64 | GateSense High-Side Devices | Refer to the power board App Note | High is true by default |
| Question 69 | Motor 1 Current Input | Calculated as the Section 5.1.2 | |

After all the MCEWizard questions are answered, the "Verify & Save Page" will be shown as in Figure 7.

**Figure 7 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.

4.2.2 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 Figure 8.

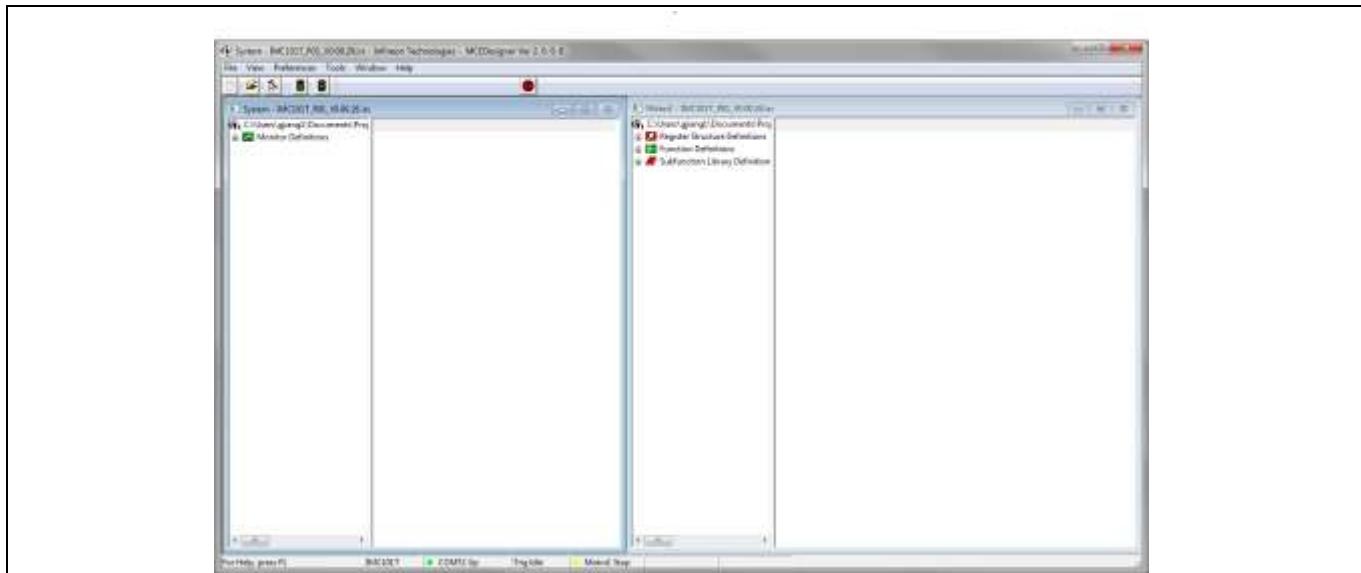


Figure 8 MCEDesigner’s Main Display for EVAL-M1-101T

MCEDesigner programmer function can be used to program IMC101T-T038 firmware and/or System parameters. To call this function, click on “Tools” menu and then select “Programmer” in the pull down list. The pop-up window “Program IMC controller” will show up as in Figure 9.

To program both firmware and Drive System Parameters into IMC101T-T038 (which can happen when programming for the first time the brand new devices with default factory setting, or when the new version of iMOTION™ firmware is being downloaded), first click on the “Program Firmware and Parameter” radio button in the “Program IMC controller” pop-up window. After that, select the Drive System Parameter file created using MCEWizard by clicking on the “Browse...” button at the end of the “Program Parameter File” row, and then also select the the IMC101T-T038_A_Vxxx.ldf file (which was included in the “IMC101T-T038 MCE Software Package”) by clicking on the “Browse...” button at the end of “Program Firmware File” row. Finally, click on the “Start” button to program the parameter file into the IMC101T-T038 IC.

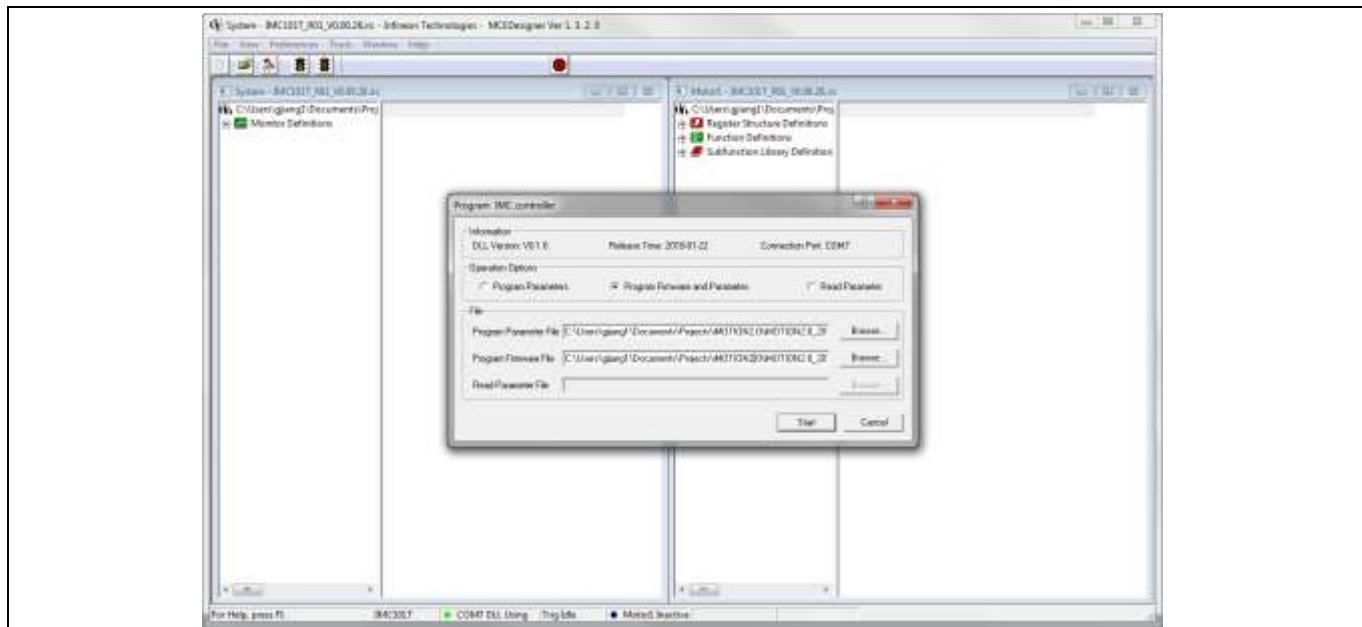


Figure 9 Program Firmware and Parameter in “Program IMC Controller” pop-up window

To program only Drive System Parameter file into IMC101T-T038, click on “Tools” menu and select “Programmer” in the pull down list. The pop-up window “Program IMC controller” will show up as in Figure 10. 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.

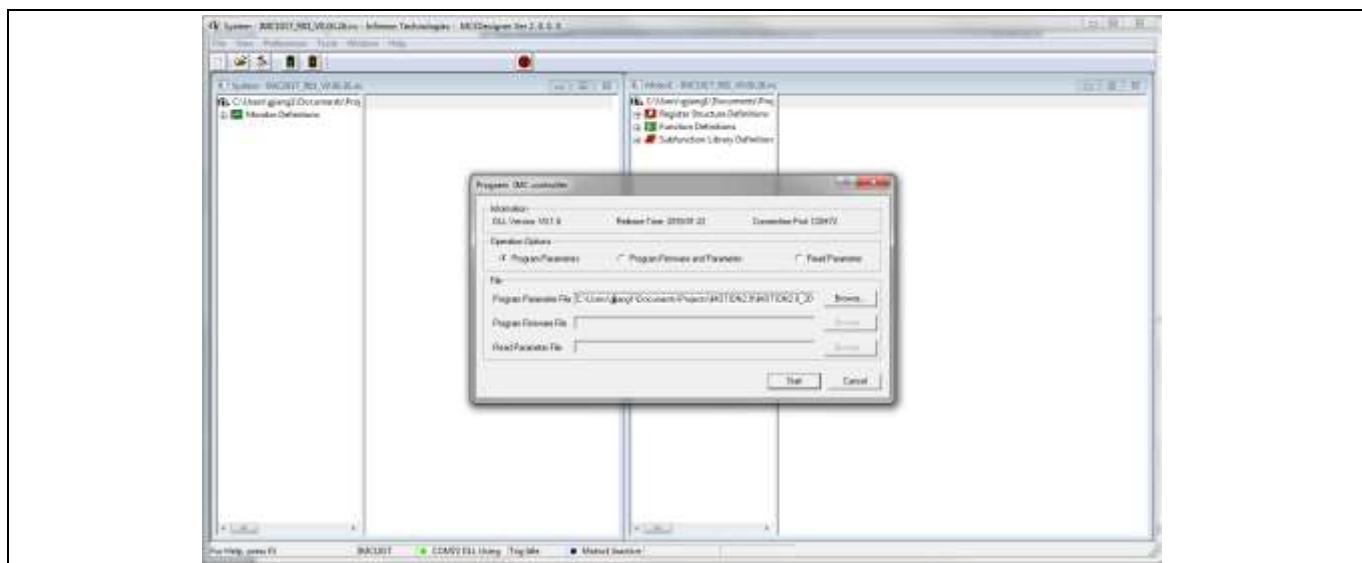


Figure 10 “Program IMC Controller” pop-up window

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 speed, 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 3.3V 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 3.3V to the control board through M1 or M3 connector) or by feeding the 3.3V DC voltage to the control board through some of the available 3.3V access/test points if the power board is not attached to the EVAL-M1-101T control board.*

All latest firmware file for different type of iMOTION™ control ICs are available for download via Infineon iMOTION™ website (<http://www.infineon.com/imotion-software>).

5 Hardware description of EVAL-M1-101T

This chapter covers hardware design of the EVAL-M1-101T in more details. To enable users to make the EVAL-M1-101T evaluation board a basis for a new development or modification of their own systems, all necessary technical data like schematics, layout and components are also included in this chapter.

5.1 Current feedback circuitry

5.1.1 Shunt configuration

Both single shunt and leg shunt topologies are supported by the EVAL-M1-101T control board. The user needs to make sure that the shunt configuration matches with power board hardware configuration. Please refer to the power board Application Note for details. The shunt configuration can be changed in MCEWizard by clicking and selecting in the pull down list marked with red box as shown in Figure 11.

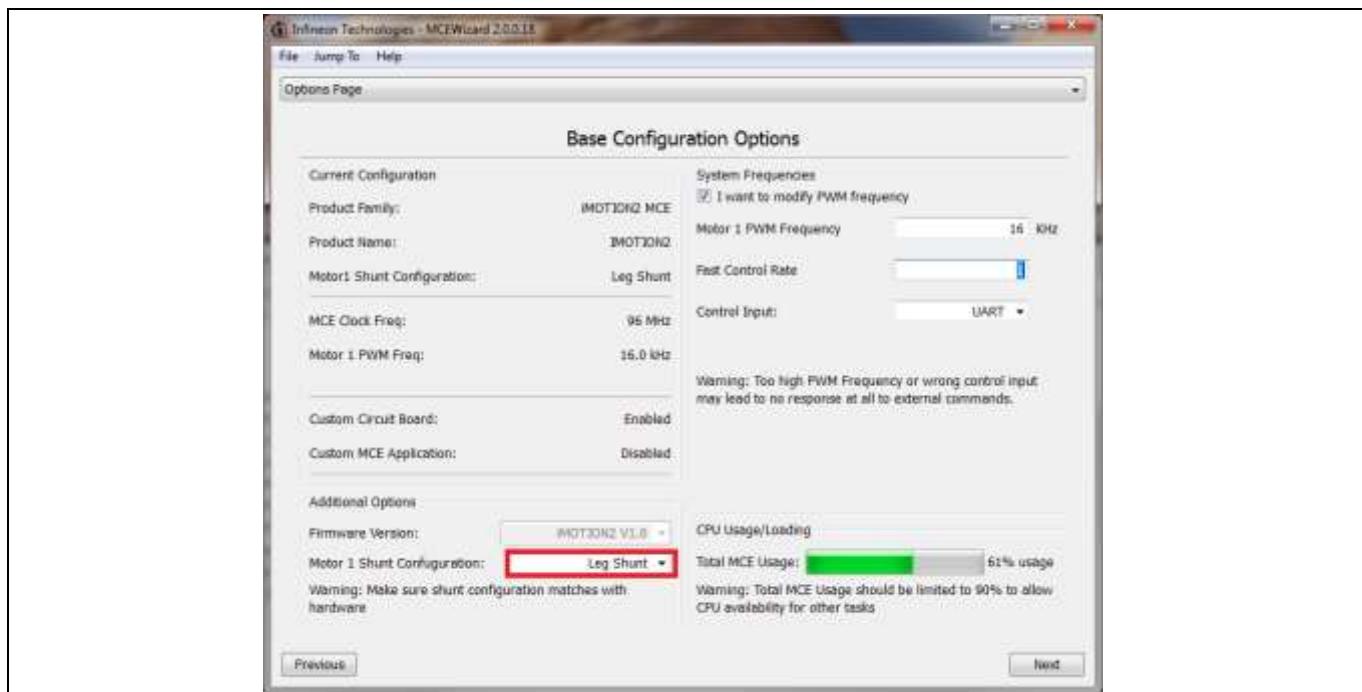


Figure 11 Shunt Configuration

5.1.2 External Current feedback configuration and calculation

The shunt resistance R_{sh} value can be found in the schematics or application note for the power board (For example, the leg shunt resistors are 100mΩ for EVAL-M1-CM610N3 and 250mΩ for EVAL-M1-05-65D).

The current input value is product of the shunt resistance in milliohms and gain of External current sense amplifier as shown in Figure 12.

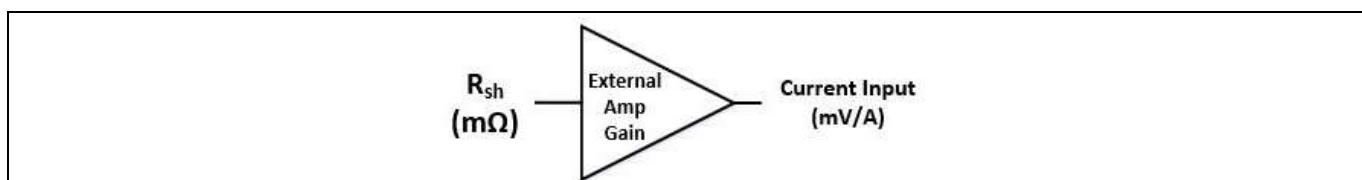


Figure 12 Current shunt feedback and sample timing

Figure 13 depicts IU+ current feedback sensing circuitry 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.

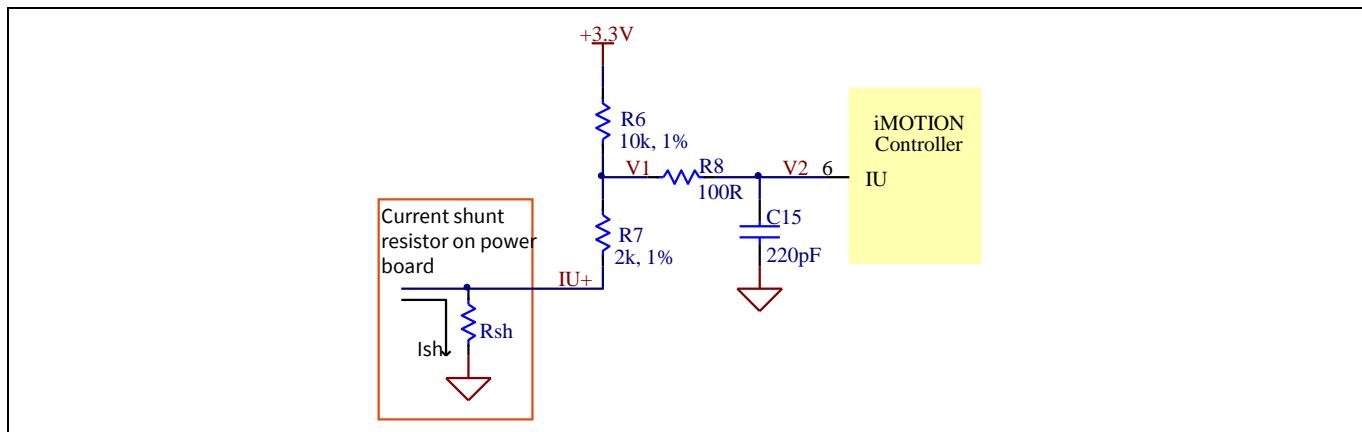


Figure 13 The part of Current feedback on the EVAL-M1-101T evaluation board

Based on the principle of Kirchhoff's voltage law,

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

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

Based on this calculation, the current input for the MADK combination of EVAL-M1-101T and EVAL-M1-CM610N3 is 83.3 mV/A, and for the combination of EVAL-M1-101T and EVAL-M1-05-65D it is 208.3 mV/A. Please use same procedure to calculate the current input for other combinations of MADK boards and enter it into MCEWizard.

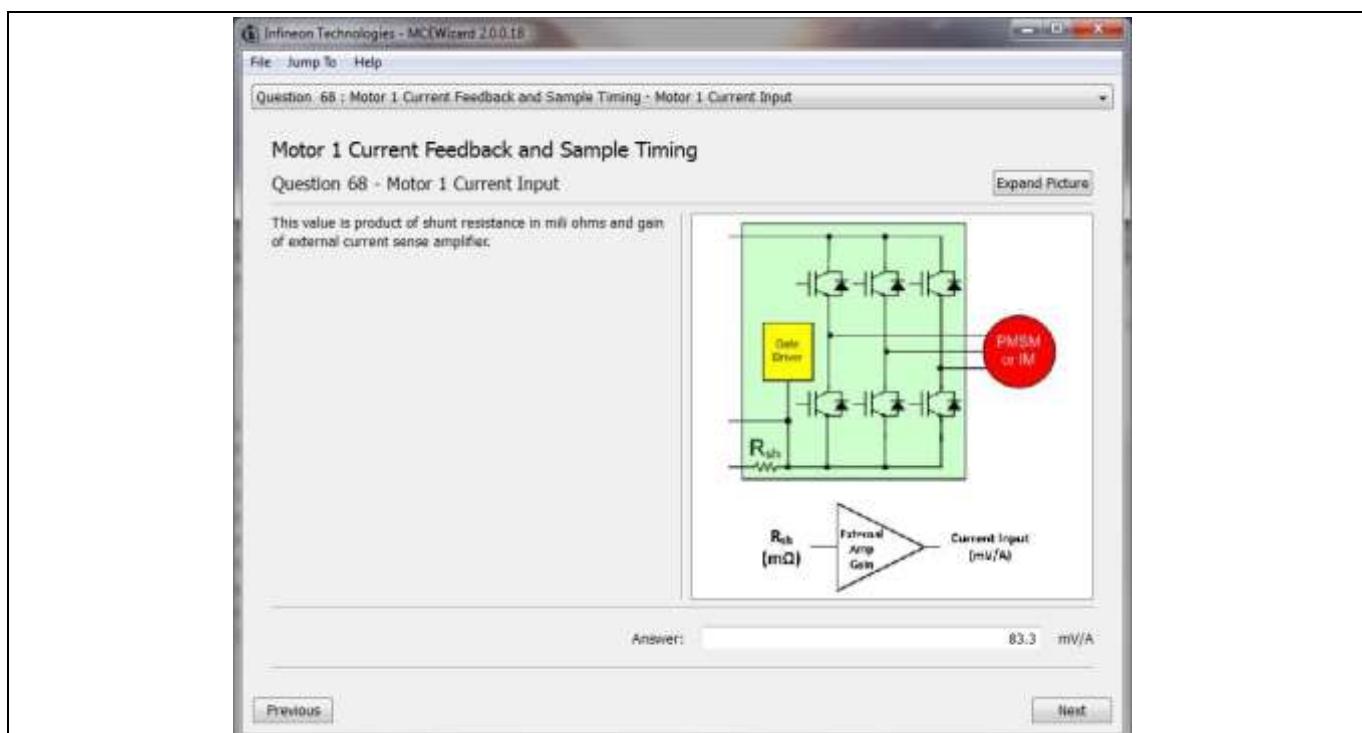


Figure 14 Current feedback configuration in MCEWizard for EVAL-M1-101T and EVAL-M1-CM610N3

5.1.3 Internal Current feedback amplifier gain configuration

The iMOTION™ controller on this board has the internal current feedback programmable gain amplifier which has four gain settings: 1x, 3x, 6x and 12x.

The internal Current feedback amplifier gain can be configured in MCEWizard as shown in Figure 15.

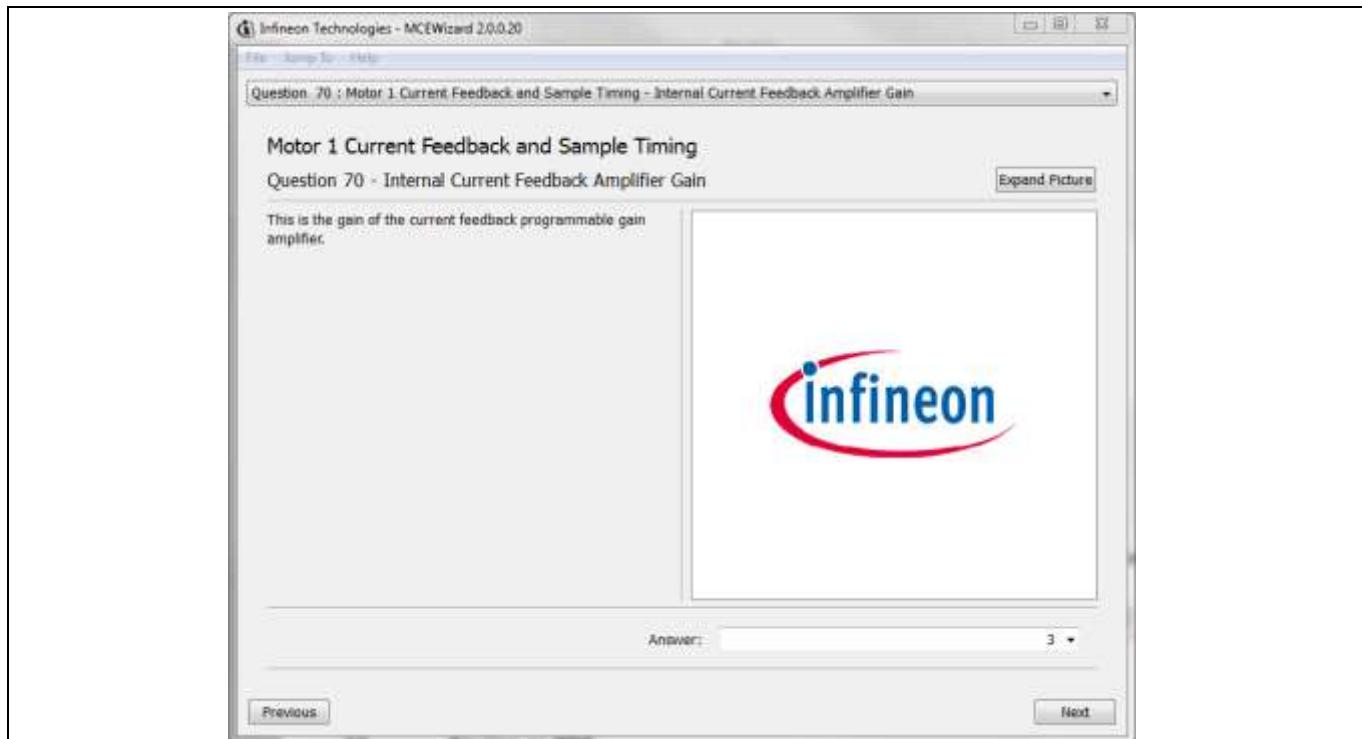


Figure 15 Internal current feedback amplifier gain configuration

5.2 EVAL-M1-101T analog inputs and their MCEWizard setup

Besides current sensing inputs, IMC101T-T038 provides number of analog inputs for different system functions. Figure 16 depicts analog inputs of the IMC101T-T038 except current sensing inputs.

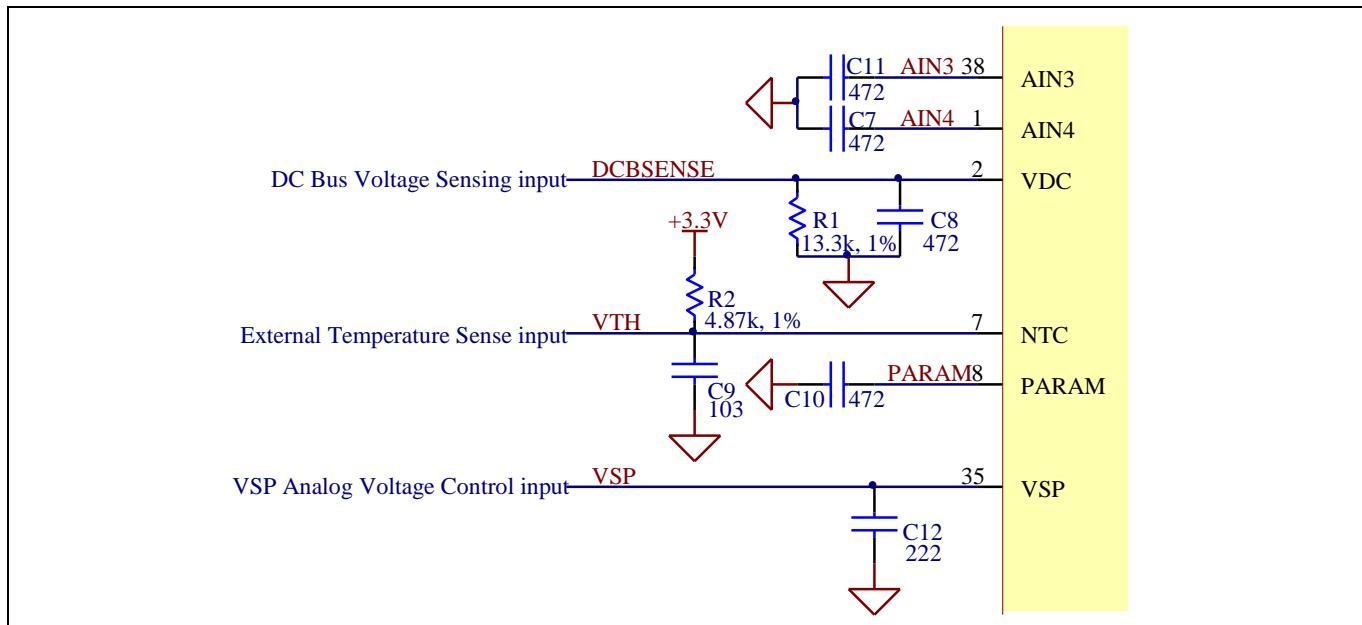


Figure 16 Analog inputs on the EVAL-M1-101T evaluation board

5.2.1 DC bus sensing configuration

The low side resistor R1 for the DC bus sensing resistor divider on the controller board EVAL-M1-101T is $13.3\text{k}\Omega$, and should be configured in MCEWizard as shown in Figure 17. For the high side resistor value, please refer to the Application Note of the corresponding power board.

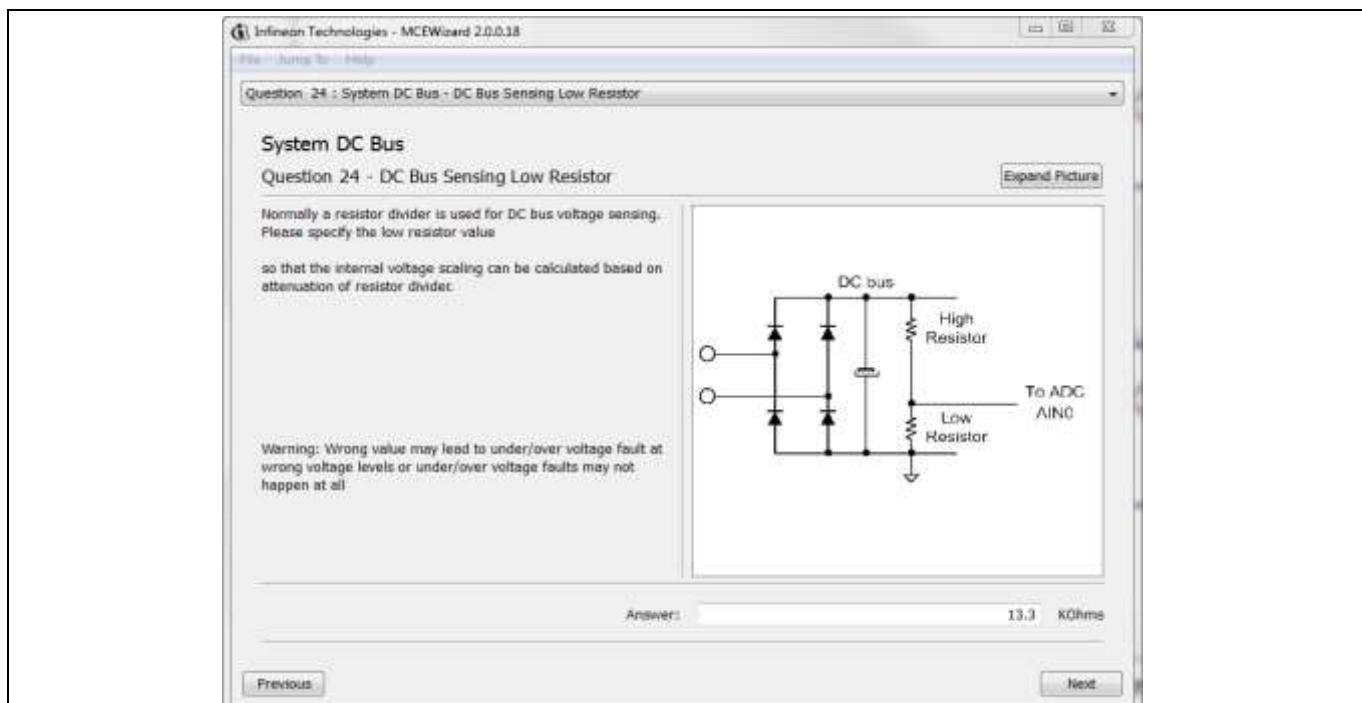


Figure 17 DC bus sensing configuration in MCEWizard

5.2.2 NTC shutdown value calculation and configuration

External NTC Temperature shutdown value can be calculated as shown below and configured in MCEWizard as shown in Figure 18. For pull-up resistor on evaluation power board and NTC value, please refer to the power board's Application Note. The value of pull-up resistor on EVAL-M1-101T is 4.87 kΩ (see Figure 16).

$$R_{total\ pull-up} = \frac{R_{pull-up\ on\ Control\ board} * R_{pull-up\ on\ Power\ board}}{R_{pull-up\ on\ Control\ board} + R_{pull-up\ on\ Power\ board}}$$

$$V_{shut\ down} = \frac{R_{NTC@setting\ temperature}}{R_{NTC@setting\ temperature} + R_{total\ pull-up}} V_{DD}$$

For example, for EVAL-M1-CM610N3, the pull-up resistor on the power board is 5.6 kΩ. So the total pull-up resistance calculates to be 2.605 kΩ.

The typical value of R_{NTC} at 100°C is 5.388 kΩ for IPM IKCM10H60GA which is used in EVAL-M1-CM610N3. If the setting temperature is 100°C, the shutdown value should be 2.22V.

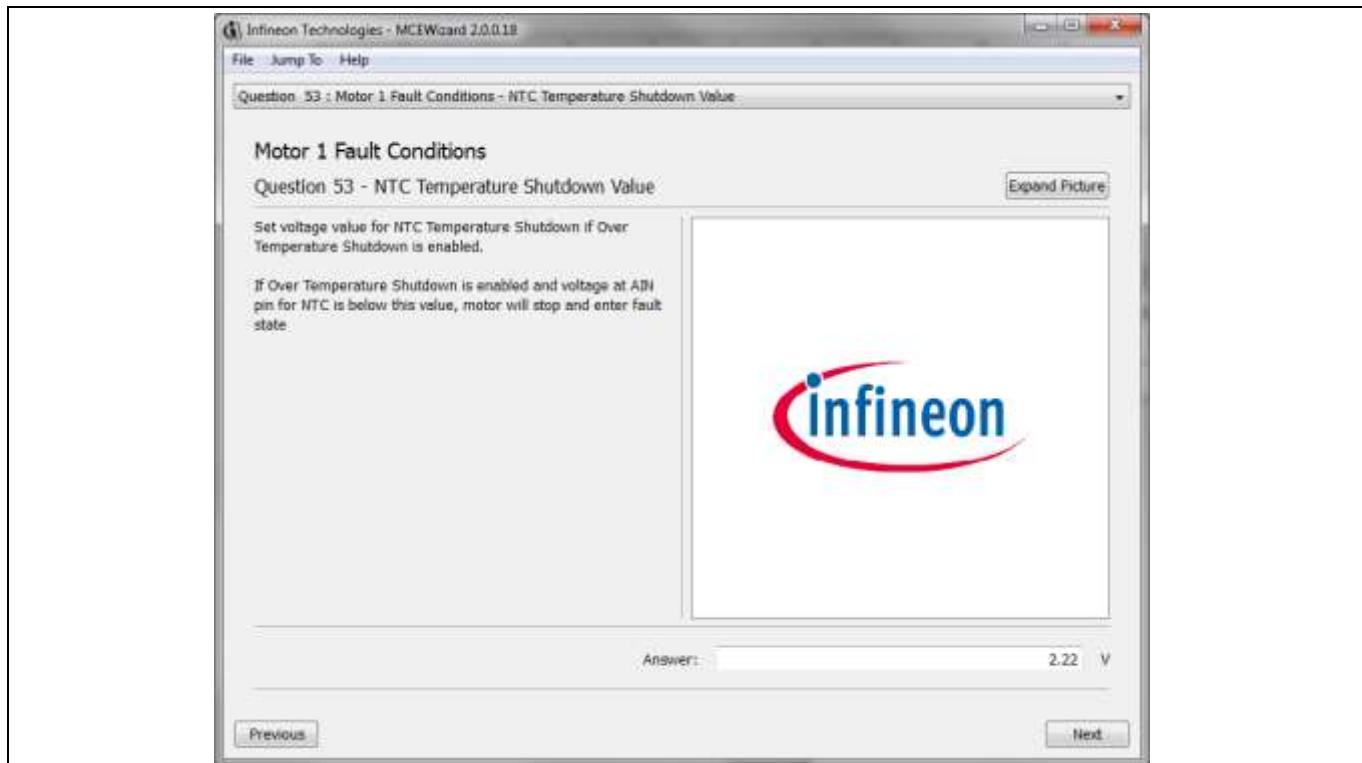


Figure 18 External temperature sense input configuration in MCEWizard

5.2.3 VSP analog input control mode and PGout configuration

VSP analog input control mode can be configured in the options page for MCEWizard by clicking and selecting in the pull down list marked with red box as shown in Figure 19.

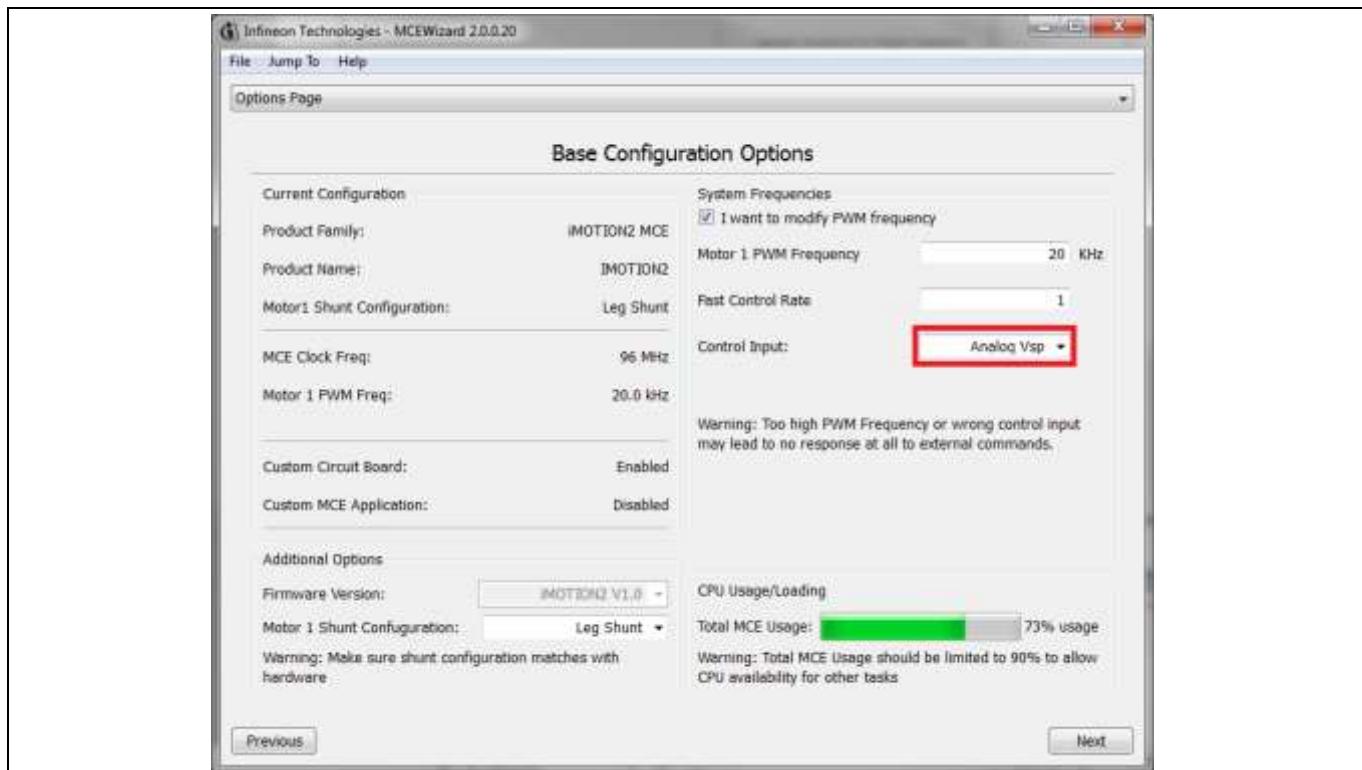


Figure 19 Analog VSP control input mode configuration

There are three input thresholds (percentage of controller supply voltage VDD) used to define the relationship between VSP input voltage and TargetSpeed.

1. T1 (Input threshold for motor start): if the VSP analog voltage is above this threshold, motor will start
2. T2 (Input threshold for motor stop): if the VSP analog voltage is below this threshold, motor will stop
3. T3 (Input threshold for Max RPM): if the VSP analog voltage is higher or equal to this threshold, TargetSpeed will be 16384 which is Max RPM.

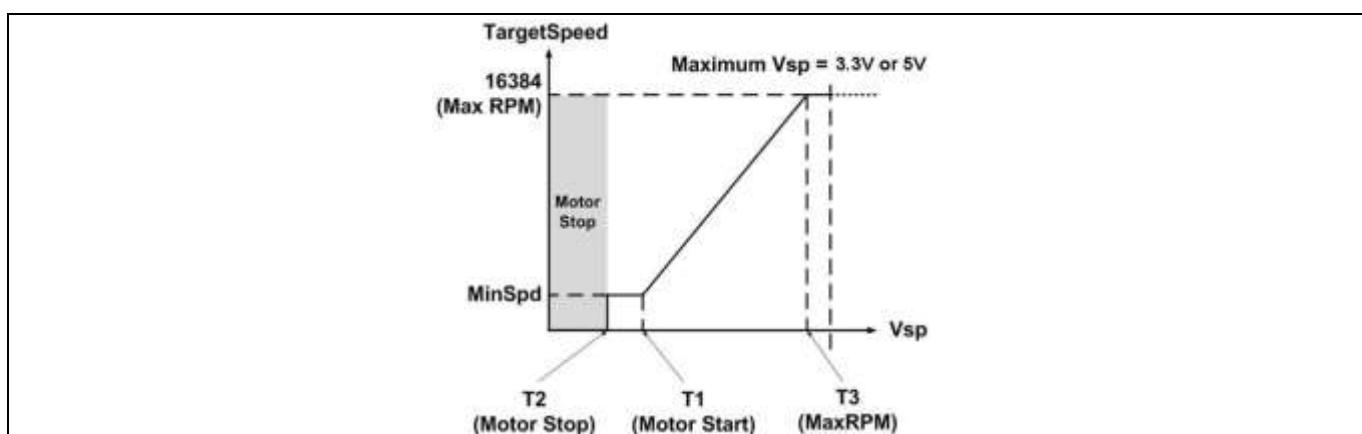


Figure 20 The relationship between VSP Analog Input voltage and TargetSpeed

After configured the Analog VSP control input mode, the three input thresholds can be set up in the input text box in MCEWizard marked with red box as shown in Figure 21, or in the pages for Question 9, Question 10 and Question 11.

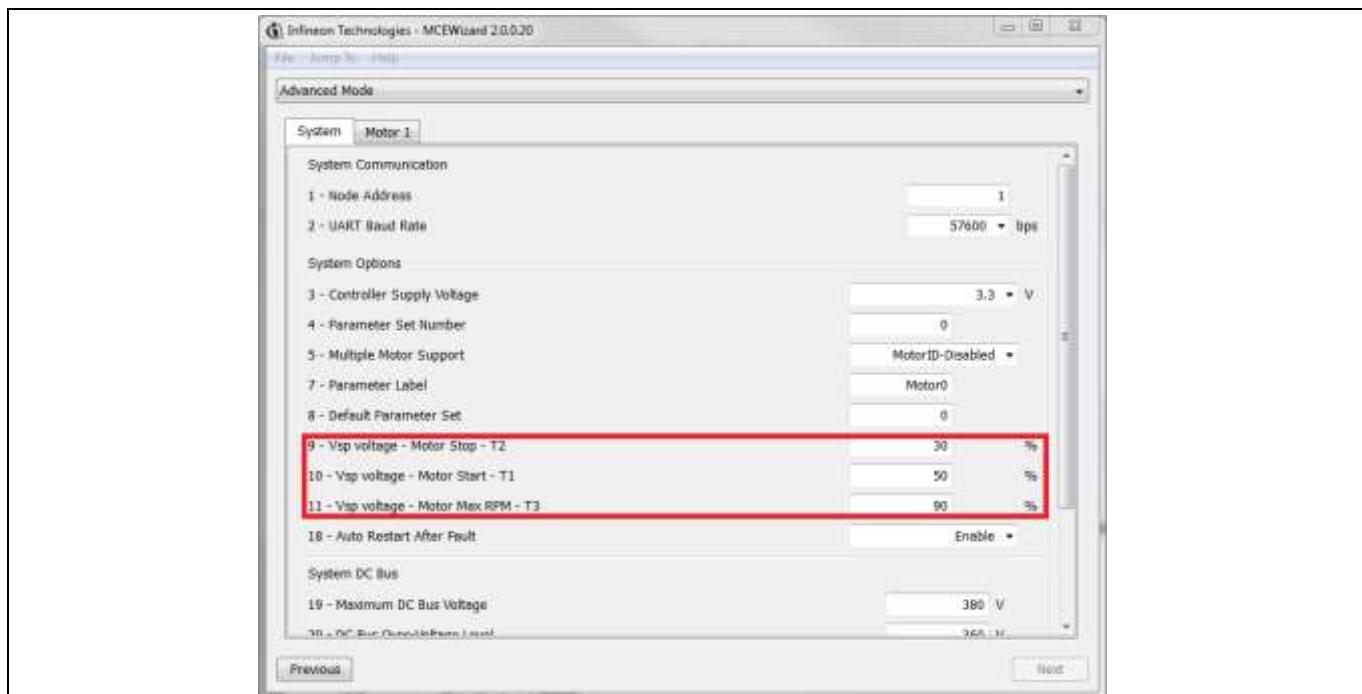


Figure 21 Three input thresholds configuration for VSP analog input control mode

For Analog VSP control input mode, the motor speed can be calculated by measuring the frequency of PGOUT signal output of control IC IMC101T-T038. And the pulse generation number per revolution for motor can be configured in MCEWizard as shown in Figure 22.

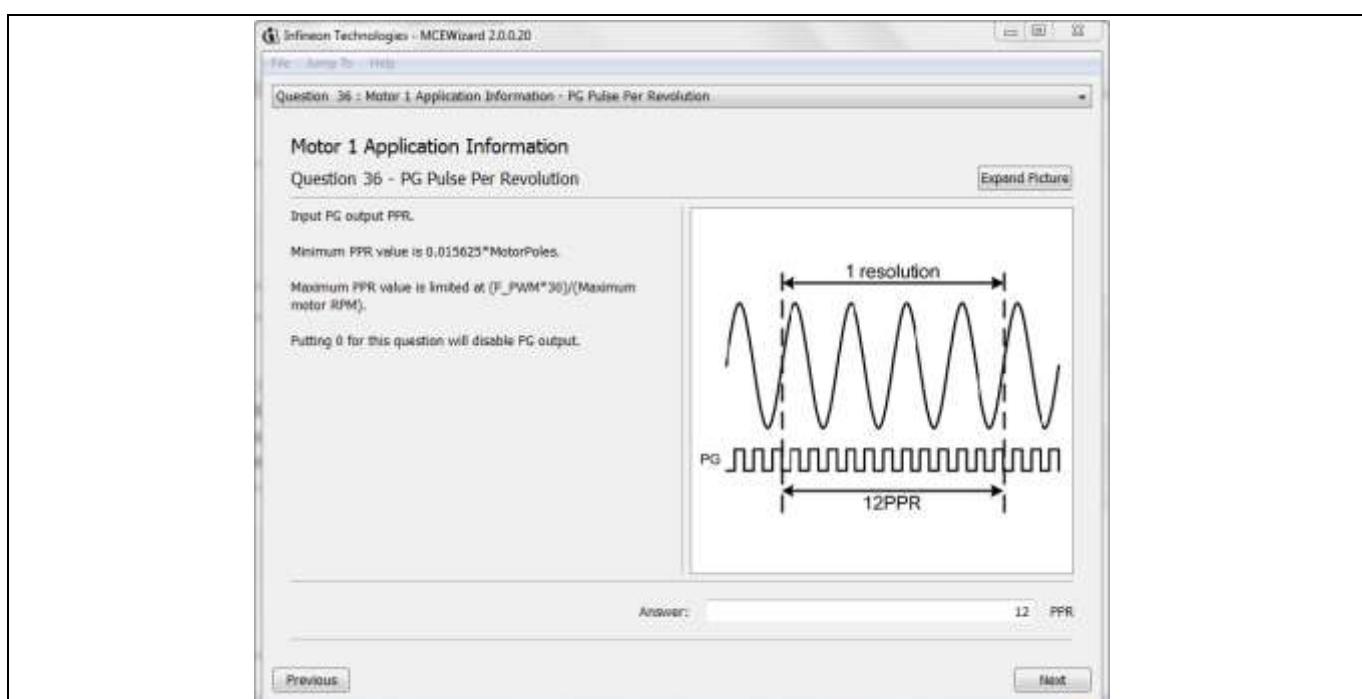


Figure 22 PG Pulse Per Revolution configuration

Motor speed can be calculated as shown below.

$$\text{Motor speed(RPM)} = \frac{\text{PGOUT Frequency(Hz)} * 60s}{\text{Pulse Per Revolution}}$$

For example, PGOUT frequency is about 80 Hz and Pulse per Revolution is 6, and then the motor speed will be 800 RPM.

By default, VDD is 3.3V for EVAL-M1-101T. The input of VSP and PGOUT (pulse generation output) should be limited within the voltage range of 0 and 3.3V. While for some application, PGOUT should be connected to speed measurement circuit. The evaluation board EVAL-M1-101T provides FG (Frequency Generation) signal with an open drain structure controlled by PGOUT as shown in Figure 23. And FG signal can be pull up to 30V.

The frequency of FG is the same as PGOUT, and the calculation equation for motor speed is the same.

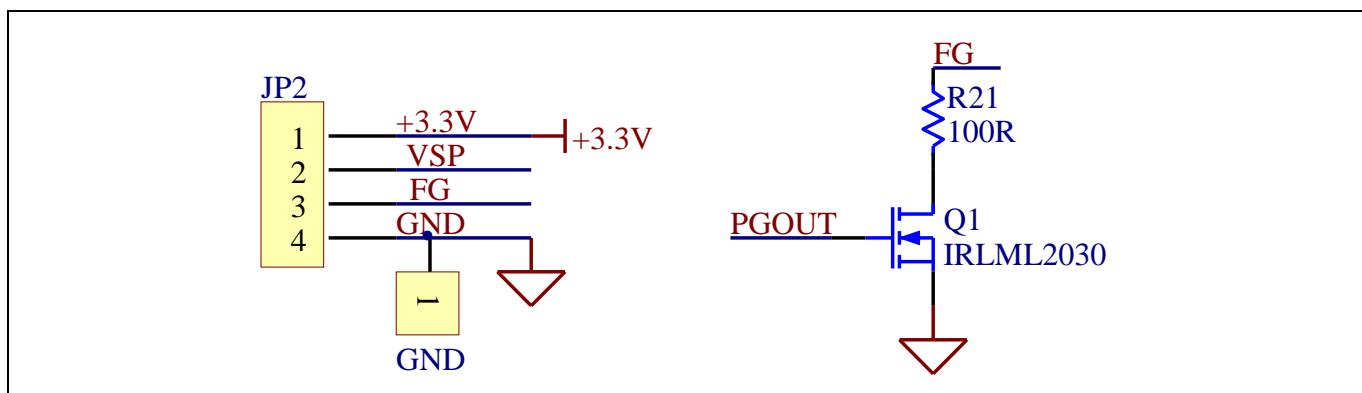


Figure 23 VSP Input Connector and level shifter schematic for FG

5.3 Schematics overview

Figure 24 shows the schematic of EVAL-M1-101T evaluation board with IMC101T-T038 controller.

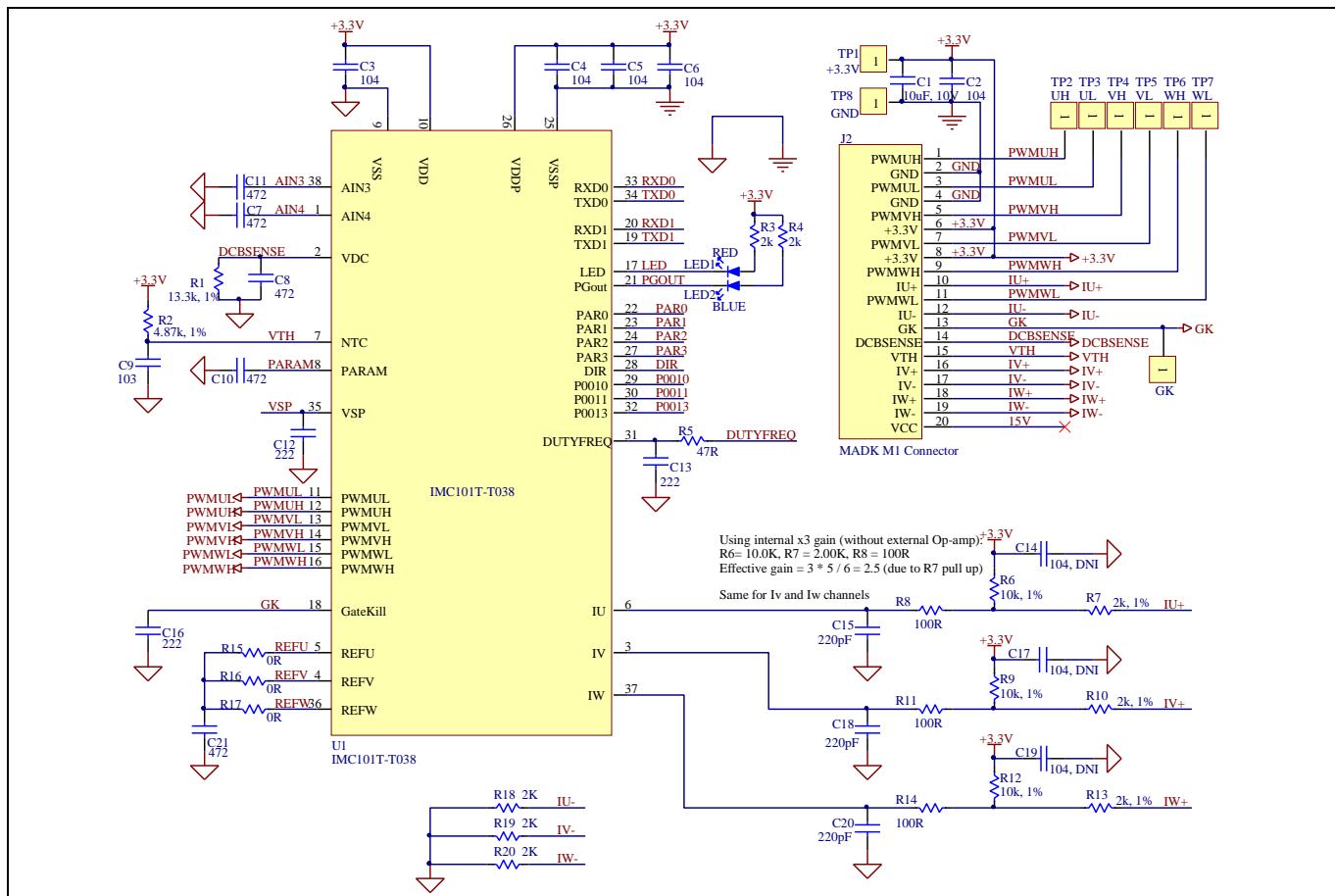


Figure 24 The schematics for the EVAL-M1-101T evaluation board

Figure 25 shows the signal test pin connector schematic for EVAL-M1-101T.

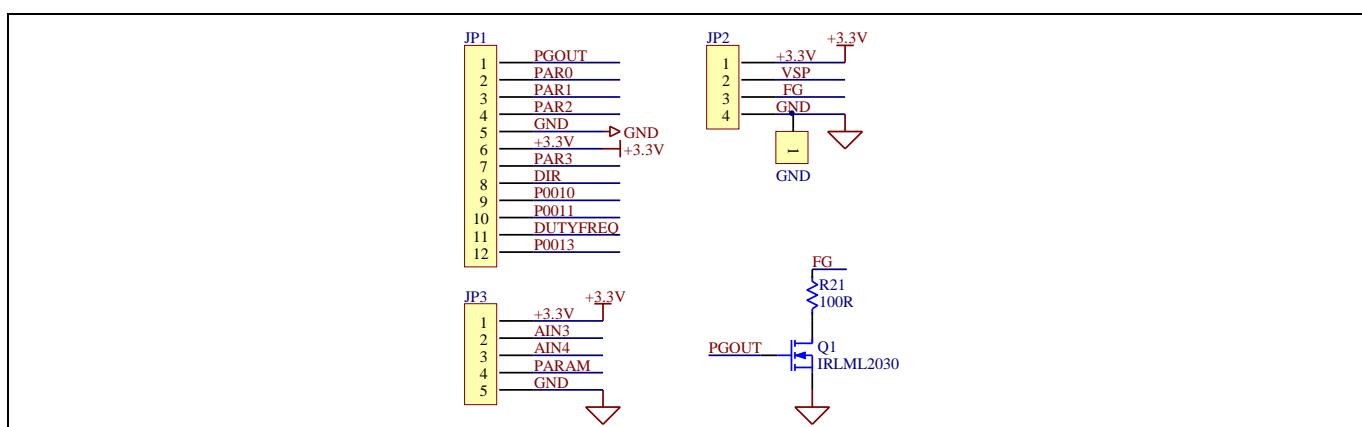


Figure 25 Signal test pin connector schematics for the EVAL-M1-101T evaluation board

5.4 PCB layout overview

The layout of this board can be used for different voltage or power classes of power board. The PCB has two electrical layers with 35 μ m copper by default and its size is 65 mm \times 45 mm. The PCB board thickness is 1.6mm. Check the Infineon's website or get in contact with Infineon's technical support team to get more detailed information and the latest Gerber-files.

Figure 26 illustrates the top assembly print and top paste layers of the evaluation board.

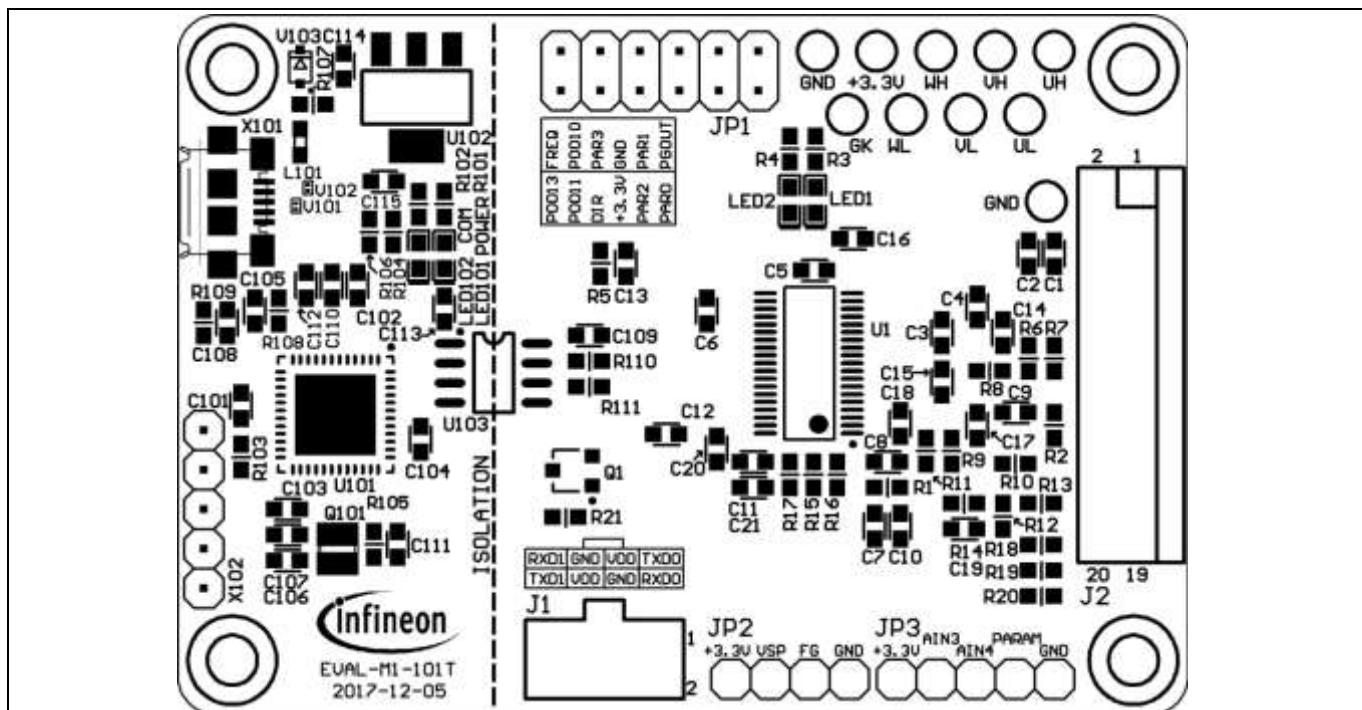


Figure 26 Top overlay print of the EVAL-M1-101T evaluation board

Figure 27 depicts the bottom assembly print of the evaluation board.

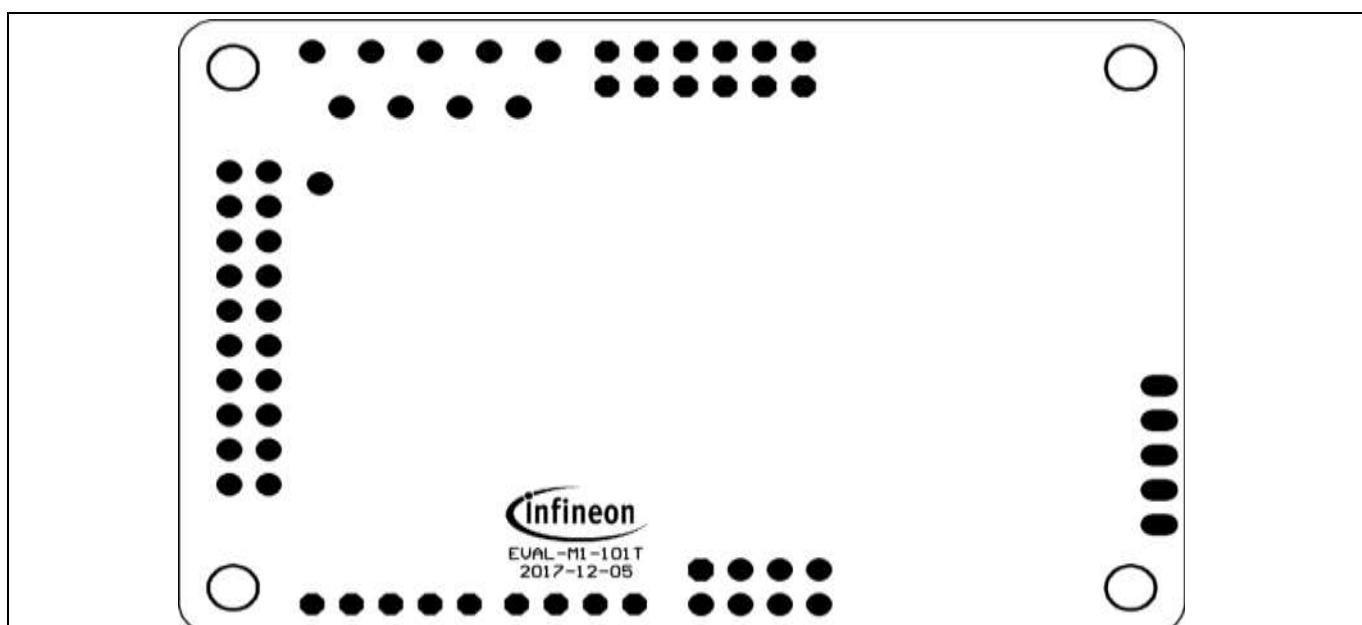


Figure 27 Bottom overlay print of the EVAL-M1-101T evaluation board

The top layer routing of the PCB is provided in the following Figure 28.

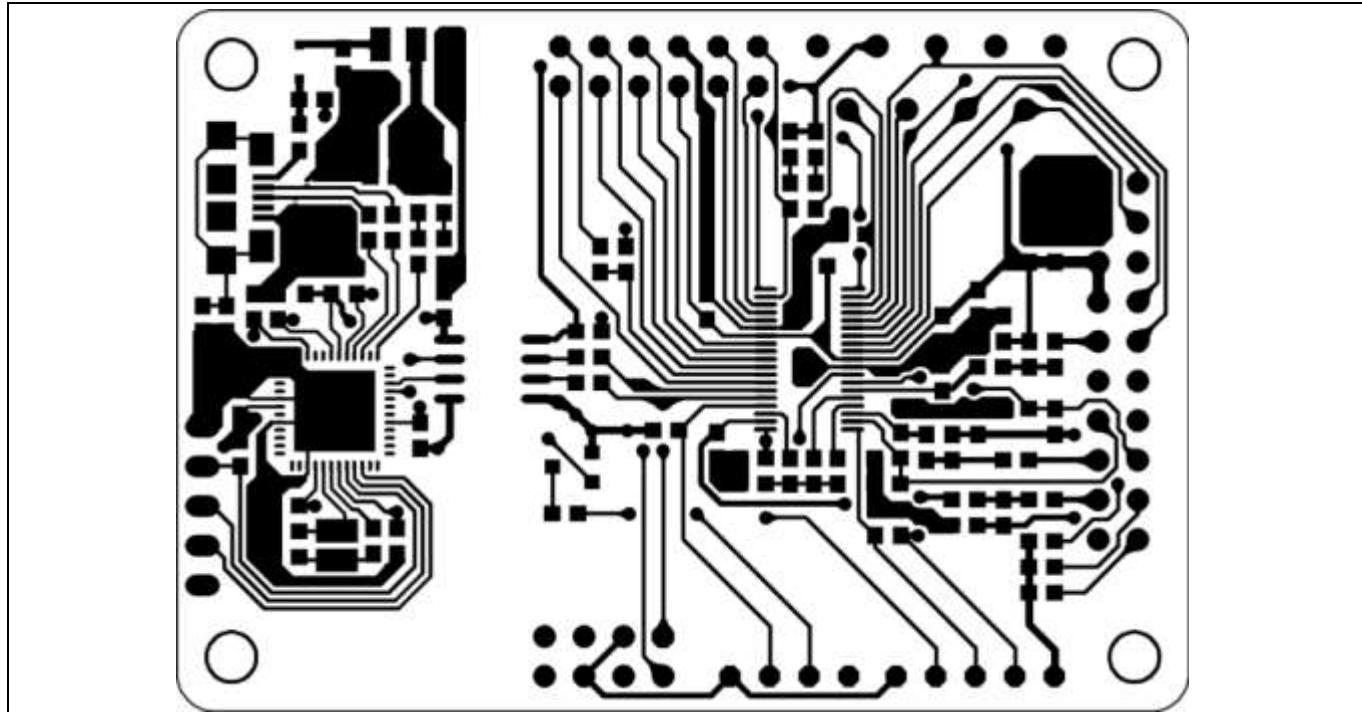


Figure 28 Top layer routing of the EVAL-M1-101T

Figure 29 illustrates the bottom layer routing of the PCB.

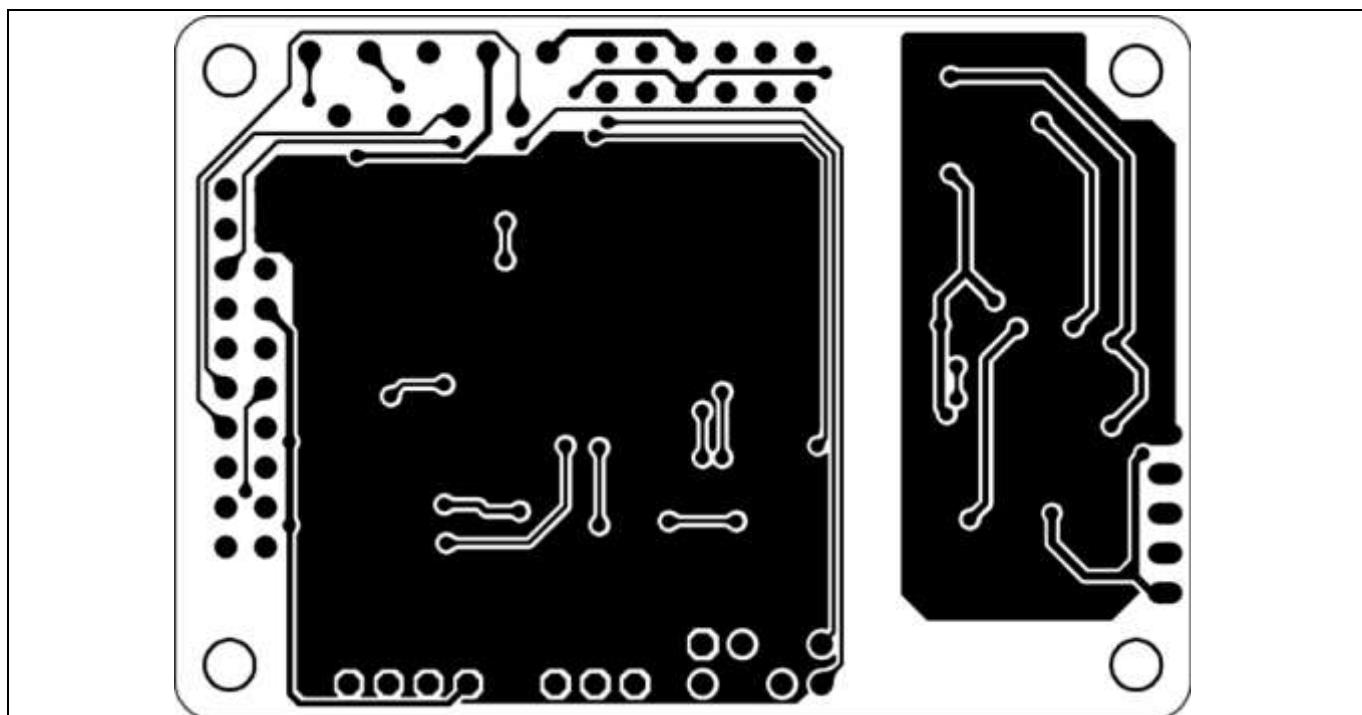


Figure 29 Bottom layer routing of the EVAL-M1-101T

Bill of material

6 Bill of material

Table 10 provides the complete bill of materials for the EVAL-M1-101T board.

Table 10 Bill of materials

| No. | Qty. | Part description | Designator | Part Number | Manufacturer |
|-----|------|--------------------------------------|--|-------------------|----------------------------------|
| 1 | 4 | CAP CER 10µF 10V X5R 0603 | C1, C105, C114, C115 | CC0603KRX5R6BB106 | Yageo |
| 2 | 5 | CAP CER 0.1µF 10V X7R 0603 | C2, C3, C4, C5, C6 | 885012206020 | Wurth Electronics Inc. |
| 3 | 5 | CAP CER 4700pF 10V X7R 0603 | C7, C8, C10, C11, C21 | 885012206012 | Wurth Electronics Inc. |
| 4 | 1 | CAP CER 10000pF 10V X7R 0603 | C9 | 885012206014 | Wurth Electronics Inc. |
| 5 | 3 | CAP CER 2200pF 10V X7R 0603 | C12, C13, C16 | 885012206010 | Wurth Electronics Inc. |
| 6 | 3 | no ass. / CAP CER 0.1µF 10V X7R 0603 | C14, C17, C19 | 885012206020 | Wurth Electronics Inc. |
| 7 | 3 | CAP CER 220pF 10V X7R 0603 | C15, C18, C20 | 885012206004 | Wurth Electronics Inc. |
| 8 | 7 | CAP CER 0.1µF 10V X7R 0603 | C101, C102, C103, C104, C108, C110, C111 | 885012206020 | Wurth Electronics Inc. |
| 9 | 2 | CAP CER 15pF 10V C0G/NP0 0603 | C106, C107 | 885012006003 | Wurth Electronics Inc. |
| 10 | 2 | CAP CER 1µF 10V X7R 0603 | C109, C113 | 885012206026 | Wurth Electronics Inc. |
| 11 | 1 | CAP CER 4.7µF 10V X5R 0603 | C112 | 885012106012 | Wurth Electronics Inc. |
| 12 | 1 | CONN HEADER VERT DUAL 8POS 2.54 | J1 | 61300821121 | Wurth Electronics Inc. |
| 13 | 1 | CONN HEADER DUAL 20 POS RA 2.54 | J2 | 61302021021 | Wurth Electronics Inc. |
| 14 | 1 | CONN HEADER VERT DUAL 12POS 2.54 | JP1 | 61301221121 | Wurth Electronics Inc. |
| 15 | 1 | CONN HEADER 4 POS 2.54 | JP2 | 61300411121 | Wurth Electronics Inc. |
| 16 | 1 | CONN HEADER 5 POS 2.54 | JP3 | 61300511121 | Wurth Electronics Inc. |
| 17 | 1 | FERRITE BEAD 60Ω 0603 1LN | L101 | BLM18PG600 | Murata Electronics North America |
| 18 | 1 | LED RED CLEAR 0603 SMD | LED1 | 150060RS75000 | Wurth Electronics Inc. |
| 19 | 2 | LED BLUE CLEAR 0603 SMD | LED102 | 150060BS75000 | Wurth Electronics Inc. |
| 20 | 1 | LED GREEN CLEAR 0603 SMD | LED2, LED101 | 150060GS75000 | Wurth Electronics Inc. |
| 21 | 1 | MOSFET N-CH 30V 2.7A SOT-23-3 | Q1 | IRLML2030 | Infineon Technologies |

| No. | Qty. | Part description | Designator | Part Number | Manufacturer |
|-----|------|-------------------------------------|---|-----------------------|------------------------|
| 22 | 1 | OSC 12.0000MHz SMD | Q101 | 12MHz/S/3.2X2.5 | Quarz |
| 23 | 1 | RES SMD 13.3kΩ 1% 1/10W 0603 | R1 | RC0603FR-0713K3L | Yageo |
| 24 | 1 | RES SMD 4.87kΩ 1% 1/10W 0603 | R2 | RC0603FR-074K87L | Yageo |
| 25 | 5 | RES SMD 2kΩ 5% 1/10W 0603 | R3, R18, R19, R20, R102 | RC0603JR-072KL | Yageo |
| 26 | 2 | RES SMD 9.1kΩ 5% 1/10W 0603 | R4, R101 | RC0603JR-079K1L | Yageo |
| 27 | 1 | RES SMD 47Ω 5% 1/10W 0603 | R5 | RC0603JR-0747RL | Yageo |
| 28 | 3 | RES SMD 10kΩ 1% 1/10W 0603 | R6, R9, R12 | RC0603FR-0710KL | Yageo |
| 29 | 3 | RES SMD 2kΩ 1% 1/10W 0603 | R7, R10, R13 | RC0603FR-072KL | Yageo |
| 30 | 4 | RES SMD 100Ω 5% 1/10W 0603 | R8, R11, R14, R21 | RC0603JR-07100RL | Yageo |
| 31 | 5 | RES SMD 0Ω JUMPER 1/10W 0603 | R15, R16, R17, R110, R111 | RC0603FR-070RL | Yageo |
| 32 | 2 | RES SMD 10kΩ 5% 1/10W 0603 | R103, R108 | RC0603JR-0710KL | Yageo |
| 33 | 2 | RES SMD 33Ω 5% 1/10W 0603 | R104, R106 | RC0603JR-0733RL | Yageo |
| 34 | 1 | RES SMD 510Ω 5% 1/10W 0603 | R105 | RC0603JR-07510RL | Yageo |
| 35 | 1 | RES SMD 4.7kΩ 5% 1/10W 0603 | R107 | RC0603JR-074K7L | Yageo |
| 36 | 1 | RES SMD 1MΩ 5% 1/10W 0603 | R109 | RC0603JR-071ML | Yageo |
| 37 | 10 | TEST POINT PC MINI .040"D BLACK | TP1/+3.3V, TP2/UH, TP3/UL, TP4/VH, TP5/VL, TP6/WH, TP7/WL, TP8/GND, TP9/GK, TP10/GND | 5001 | Keystone Electronics |
| 38 | 1 | IC MCU 32BIT 128KB FLASH 38TSSOP | U1 | IMC101T-T038 | Infineon Technologies |
| 39 | 1 | IC MCU 32BIT 256KB FLASH 48VQFN | U101 | XMC4200-Q48F256 BA | Infineon Technologies |
| 40 | 1 | IC REG LINEAR 3.3V 1A SOT223-4 | U102 | IFX1117-ME V33 | Infineon Technologies |
| 41 | 1 | DGTL ISO 3.75KV GEN PURP 8SOIC | U103 | SI8621EC-B-IS | Silicon Labs |
| 42 | 2 | TVS DIODE 17VC WLL-2-1 | V101, V102 | ESD237-B1-W0201 | Infineon Technologies |
| 43 | 1 | DIODE SCHOTTKY 30V 1A SOD323-2 | V103 | BAS3010A-03W | Infineon Technologies |
| 44 | 1 | CONN RCPT MICRO USB AB SMD R/A | X101 | ZX62-AB-5PA | Hirose Electric Co Ltd |

7 Reference

- [1] iMOTION™ IMC100 Series Datasheet
- [2] iMOTION™ IMC100 Software Reference Manual
- [3] MCEWizard User Guide
- [4] MCEDesigner User Guide

Note: All listed reference materials are available for download on Infineon's website www.infineon.com/imotion. All the iMOTION™ MADK power board's Application Notes are available at www.infineon.com/MADK

Revision history

| Document version | Date of release | Description of changes |
|-------------------------|------------------------|--|
| 1.0 | 2018-01-31 | First release |
| 1.1 | 2018-01-31 | Moved to latest template plus small modifications |
| 1.2 | 2018-02-09 | plus small modifications |
| 1.3 | 2018-03-02 | plus small modifications |
| 1.4 | 2018-03-29 | plus small modifications |
| 1.6 | 2018-11-27 | Modified MCEDesigner setup description in section 4.2.2. |

Trademarks

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

Edition 2018-11-27

Published by

Infineon Technologies AG
81726 Munich, Germany

© 2018 Infineon Technologies AG.
All Rights Reserved.

Do you have a question about this document?

Email: erratum@infineon.com

Document reference
AN2018-01

IMPORTANT NOTICE

The information contained in this application note is given as a hint for the implementation of the product only and shall in no event be regarded as a description or warranty of a certain functionality, condition or quality of the product. Before implementation of the product, the recipient of this application note must verify any function and other technical information given herein in the real application. Infineon Technologies hereby disclaims any and all warranties and liabilities of any kind (including without limitation warranties of non-infringement of intellectual property rights of any third party) with respect to any and all information given in this application note.

The data contained in this document is exclusively intended for technically trained staff. It is the responsibility of customer's technical departments to evaluate the suitability of the product for the intended application and the completeness of the product information given in this document with respect to such application.

For further information on the product, technology delivery terms and conditions and prices please contact your nearest Infineon Technologies office (www.infineon.com).

WARNINGS

Due to technical requirements products may contain dangerous substances. For information on the types in question please contact your nearest Infineon Technologies office.

Except as otherwise explicitly approved by Infineon Technologies in a written document signed by authorized representatives of Infineon Technologies, Infineon Technologies' products may not be used in any applications where a failure of the product or any consequences of the use thereof can reasonably be expected to result in personal injury.

Данный компонент на территории Российской Федерации**Вы можете приобрести в компании MosChip.**

Для оперативного оформления запроса Вам необходимо перейти по данной ссылке:

<http://moschip.ru/get-element>

Вы можете разместить у нас заказ для любого Вашего проекта, будь то серийное производство или разработка единичного прибора.

В нашем ассортименте представлены ведущие мировые производители активных и пассивных электронных компонентов.

Нашей специализацией является поставка электронной компонентной базы двойного назначения, продукции таких производителей как XILINX, Intel (ex.ALTERA), Vicor, Microchip, Texas Instruments, Analog Devices, Mini-Circuits, Amphenol, Glenair.

Сотрудничество с глобальными дистрибуторами электронных компонентов, предоставляет возможность заказывать и получать с международных складов практически любой перечень компонентов в оптимальные для Вас сроки.

На всех этапах разработки и производства наши партнеры могут получить квалифицированную поддержку опытных инженеров.

Система менеджмента качества компании отвечает требованиям в соответствии с ГОСТ Р ИСО 9001, ГОСТ Р В 0015-002 и ЭС РД 009

Офис по работе с юридическими лицами:

105318, г.Москва, ул.Щербаковская д.3, офис 1107, 1118, ДЦ «Щербаковский»

Телефон: +7 495 668-12-70 (многоканальный)

Факс: +7 495 668-12-70 (доб.304)

E-mail: info@moschip.ru

Skype отдела продаж:

moschip.ru

moschip.ru_4

moschip.ru_6

moschip.ru_9