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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.

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1 Safety precautions

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

Table 1 Precautions

	***Attention: The ground potential of the EVAL-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***
	***Attention: Only personnel familiar with the drive and associated machinery should plan or implement the installation, start-up and subsequent maintenance of the system. Failure to comply may result in personal injury and/or equipment damage.***
	***Attention: The surfaces of the drive may become hot, which may cause injury.***
	***Attention: EVAL-M1-101T 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.***
	***Attention: A control board, incorrectly applied or installed, can result in component damage or reduction in product lifetime. Wiring or application errors such as under sizing the motor, supplying an incorrect or inadequate DC supply or excessive ambient temperatures may result in system malfunction.***
	***Attention: Remove or connect this control board from or to the power drive. Wait three minutes after removing power from the power drive to discharge the bus capacitors. Do not attempt to service the drive until the bus capacitors have discharged to zero. Failure to do so may result in personal injury or death.***
	***Attention: EVAL-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.***

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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.

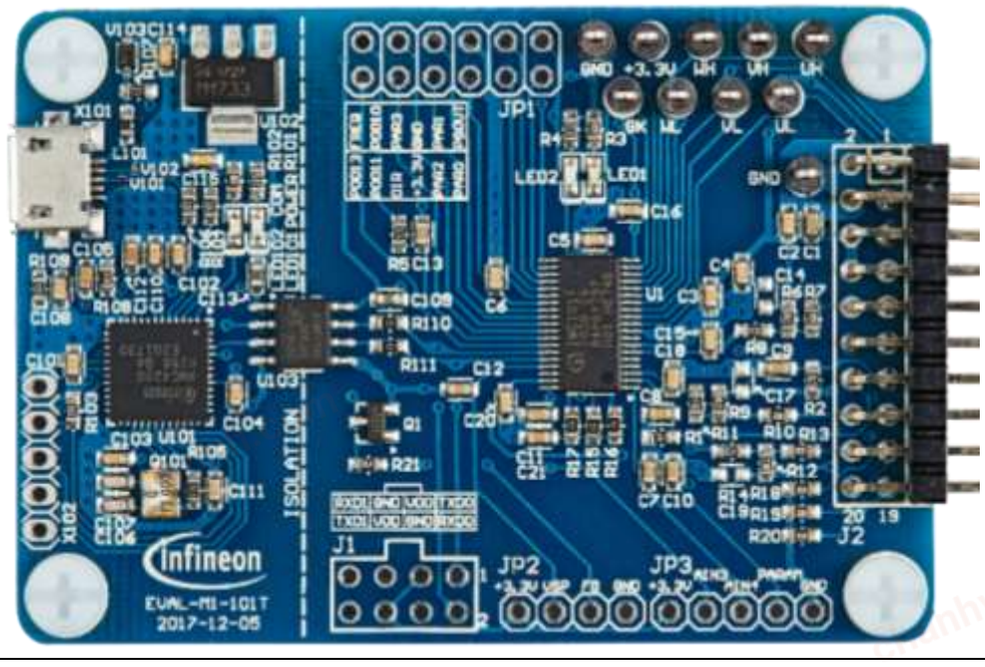


Figure 1 Evaluation board EVAL-M1-101T

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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 complaint
- PCB size is 65 x 45 mm

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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.

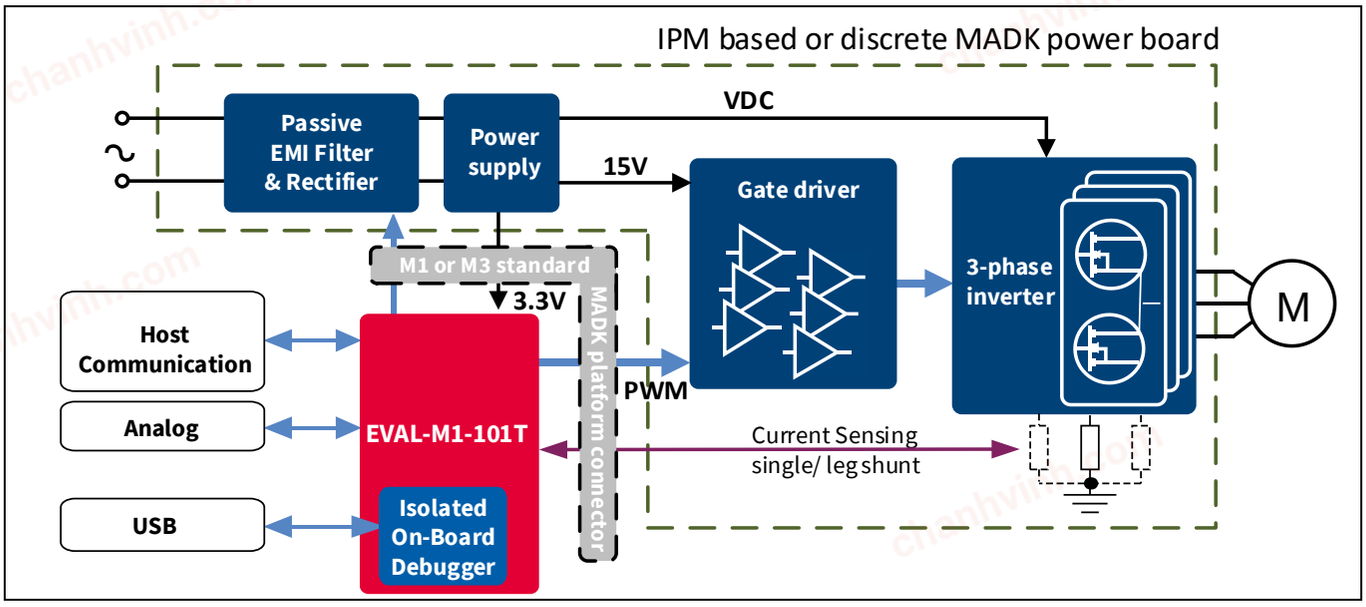


Figure 2 Typical Application Block Diagram Using IMC101T-T038

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.

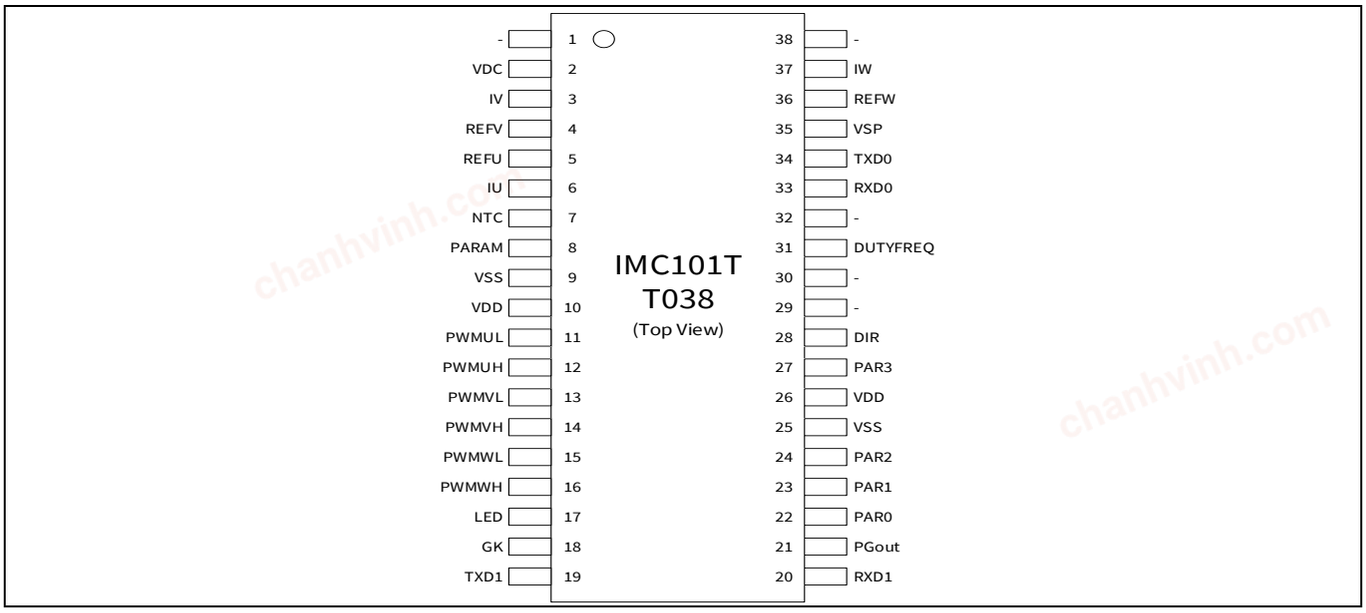


Figure 3 Pinout of IMC101T-T038

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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

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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	

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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

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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 connecter 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

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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 initialy 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.

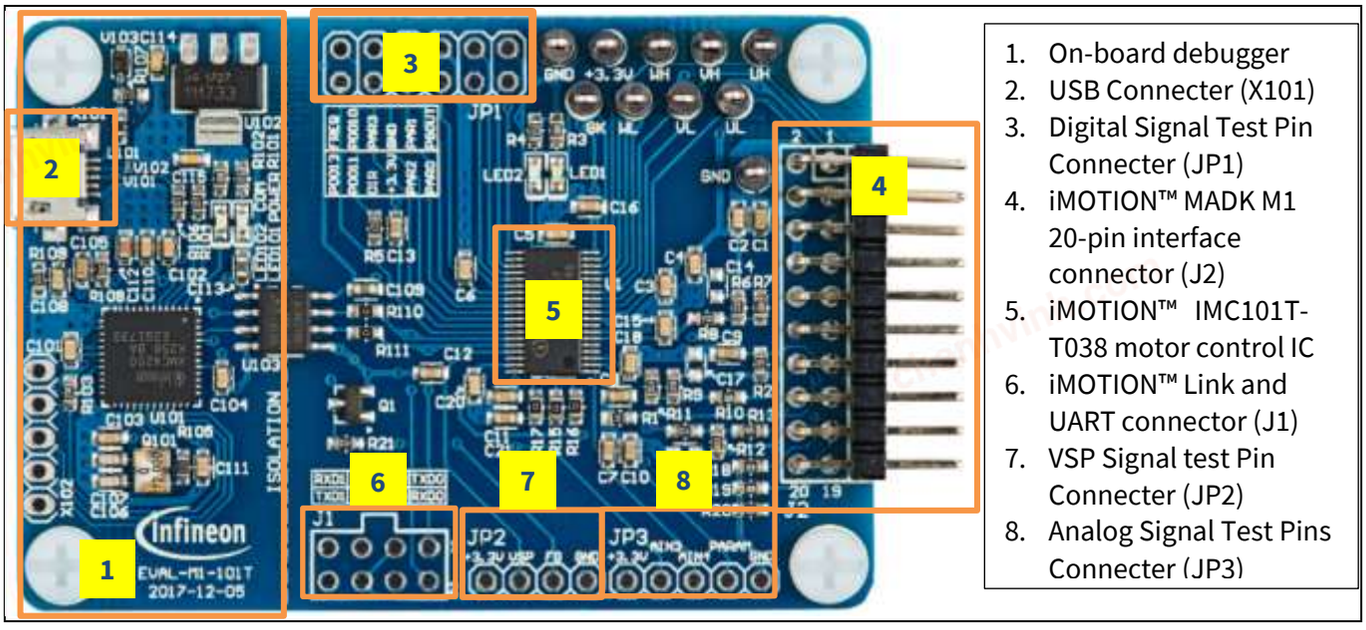


Figure 4 Functional groups of the EVAL-M1-101T evaluation board's top side

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.

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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 alredy 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.

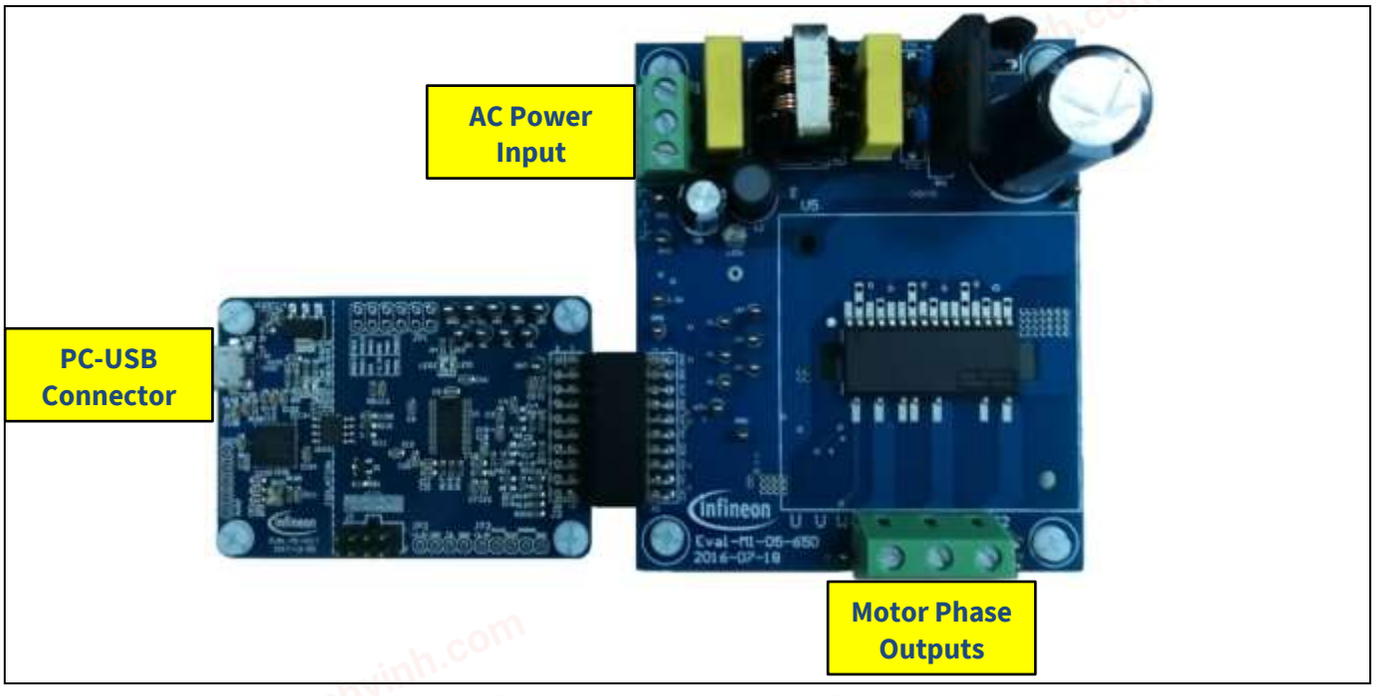


Figure 5 System connection example using EVAL-M1-101T and EVAL-M1-05-65D

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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 brigde 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.

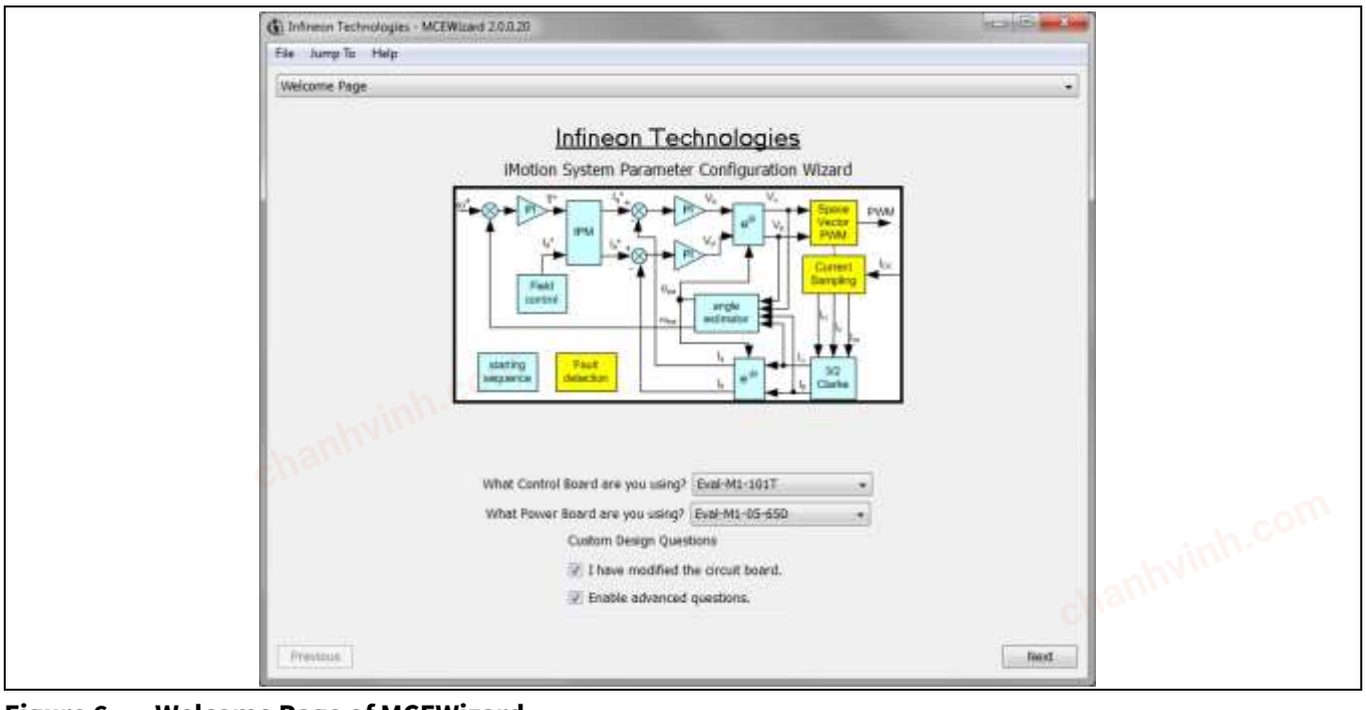


Figure 6 Welcome Page of MCEWizard

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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.

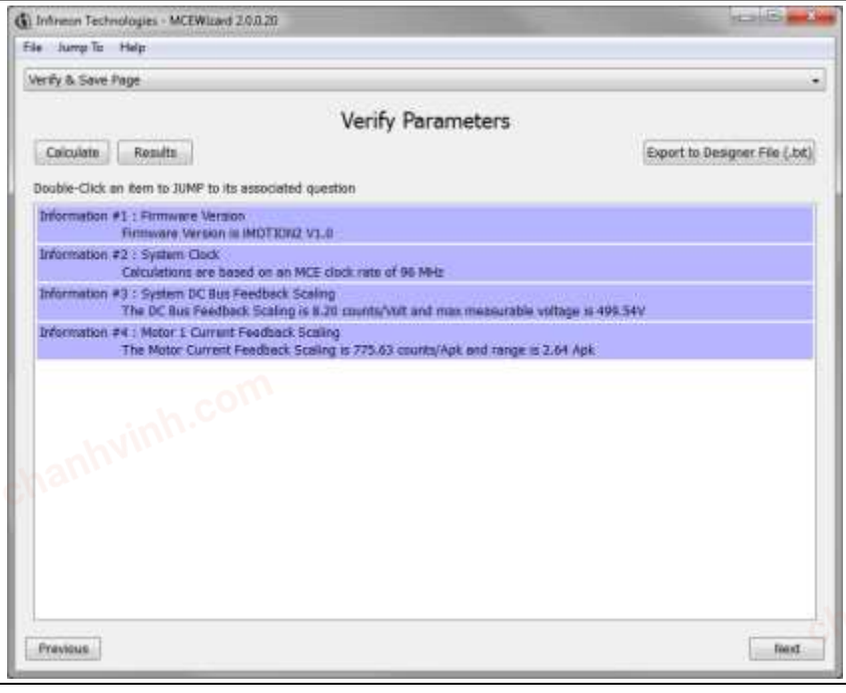


Figure 7 Verify and Save page for MCEWizard

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.

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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.

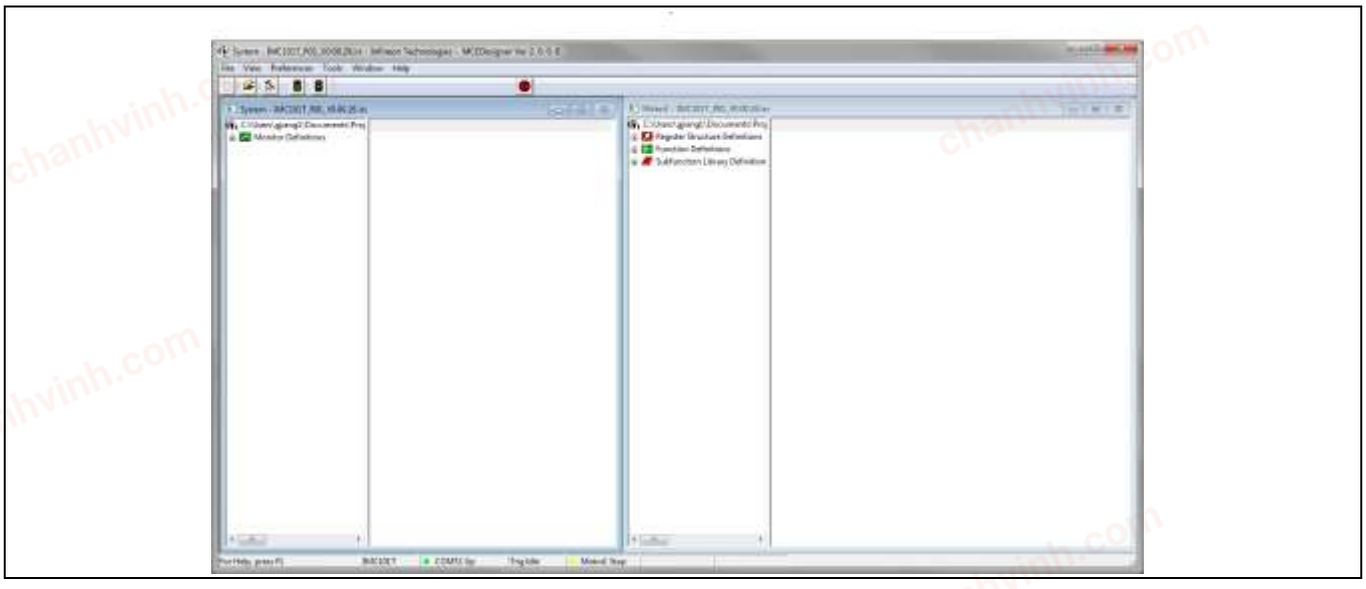


Figure 8 MCEDesigner’s Main Display for EVAL-M1-101T

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.

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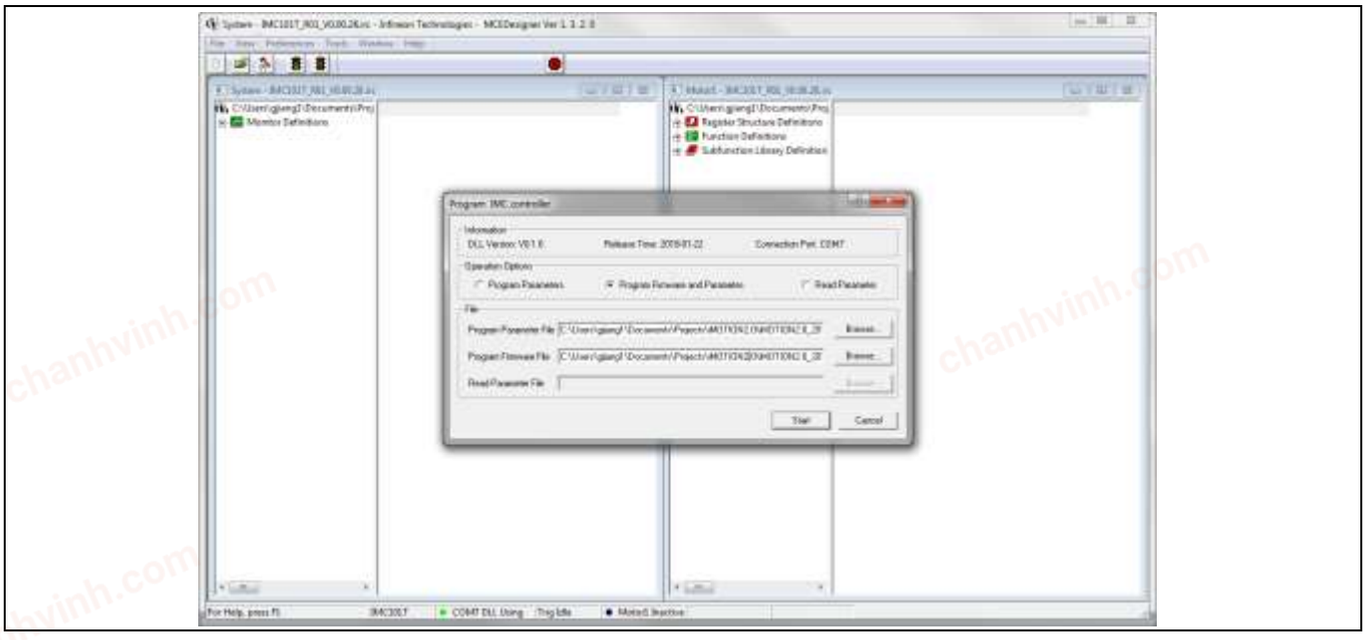


Figure 9 Program Firmware and Parameter in “Program IMC Controller” pop-up window

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.

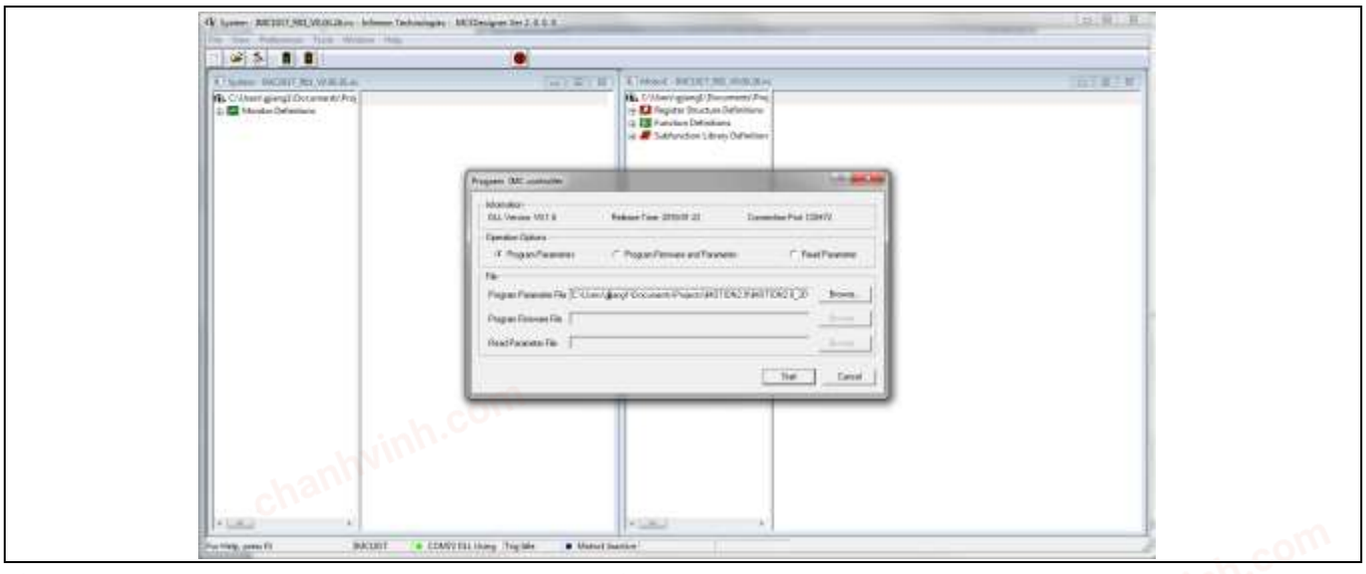


Figure 10 “Program IMC Controller” pop-up window

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.

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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).

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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.

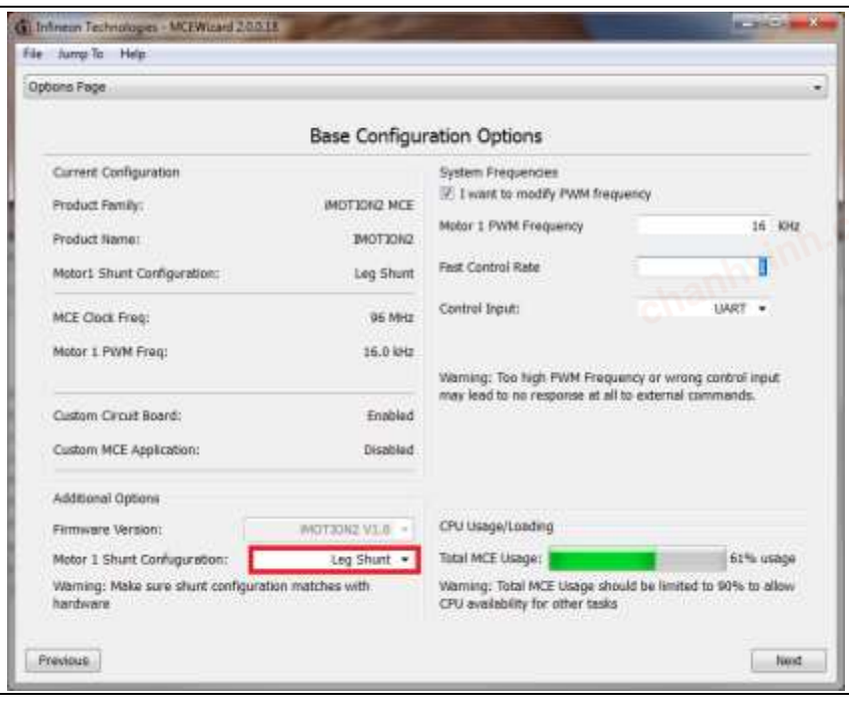


Figure 11 Shunt Configuration

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.

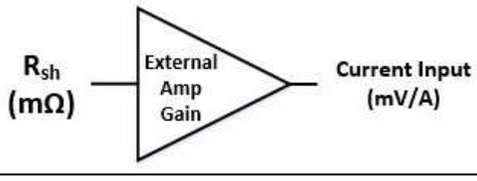


Figure 12 Current shunt feedback and sample timing

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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.

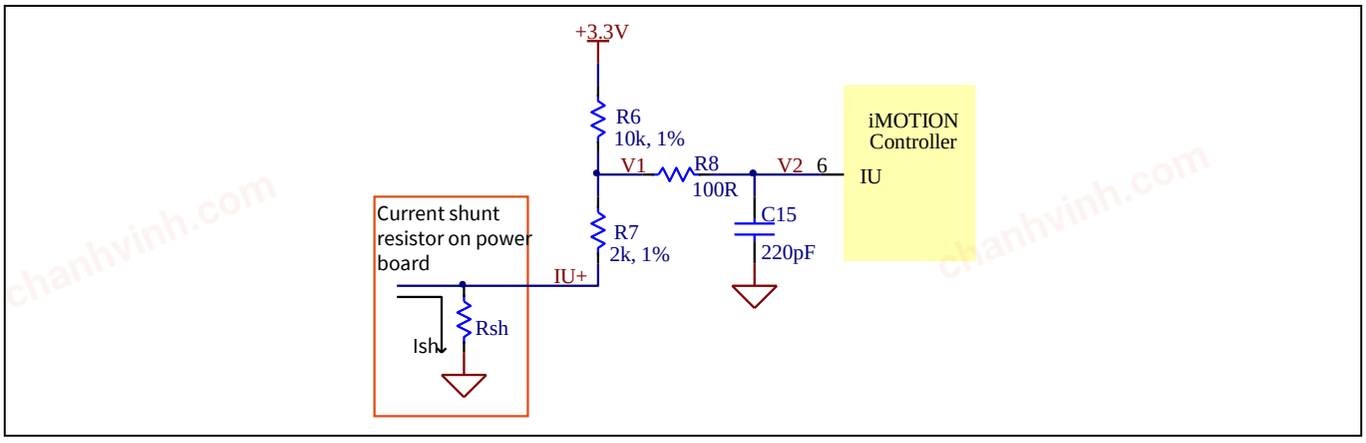


Figure 13 The part of Current feedback on the EVAL-M1-101T evaluation board

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-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.

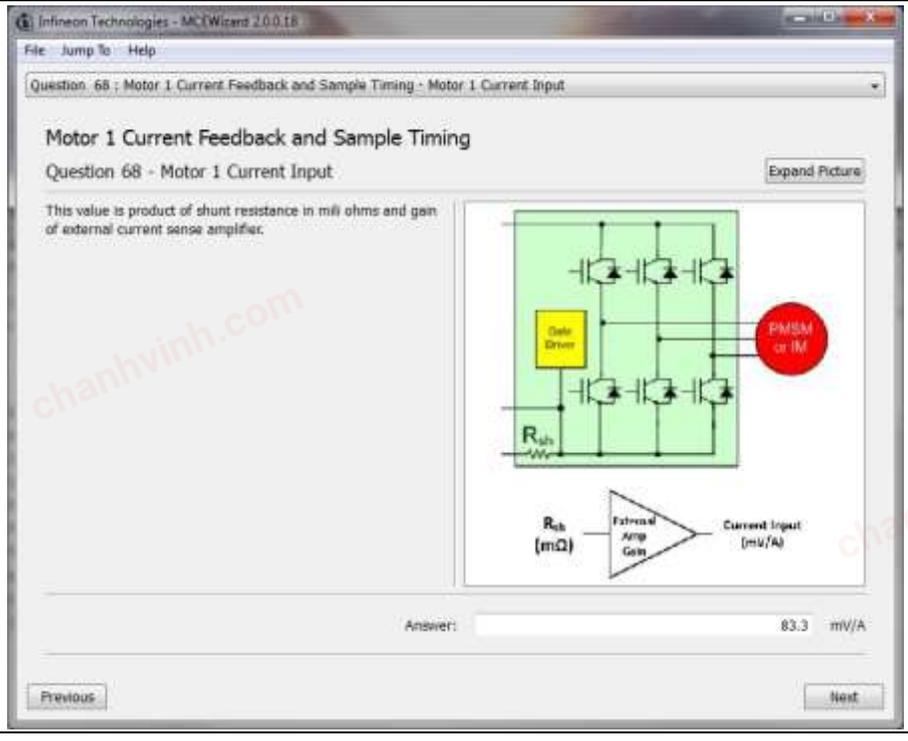


Figure 14 Current feedback configuration in MCEWizard for EVAL-M1-101T and EVAL-M1-CM610N3

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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.

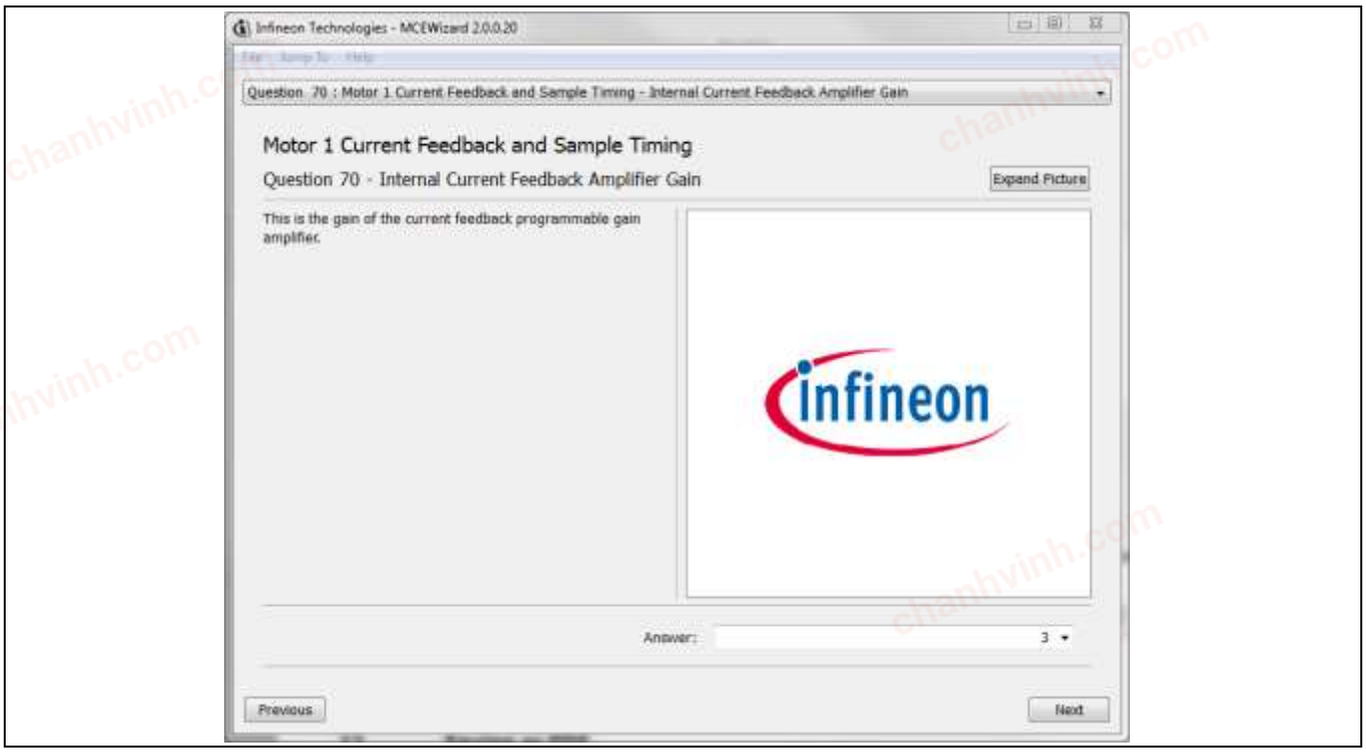


Figure 15 Internal current feedback amplifier gain configuration

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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.

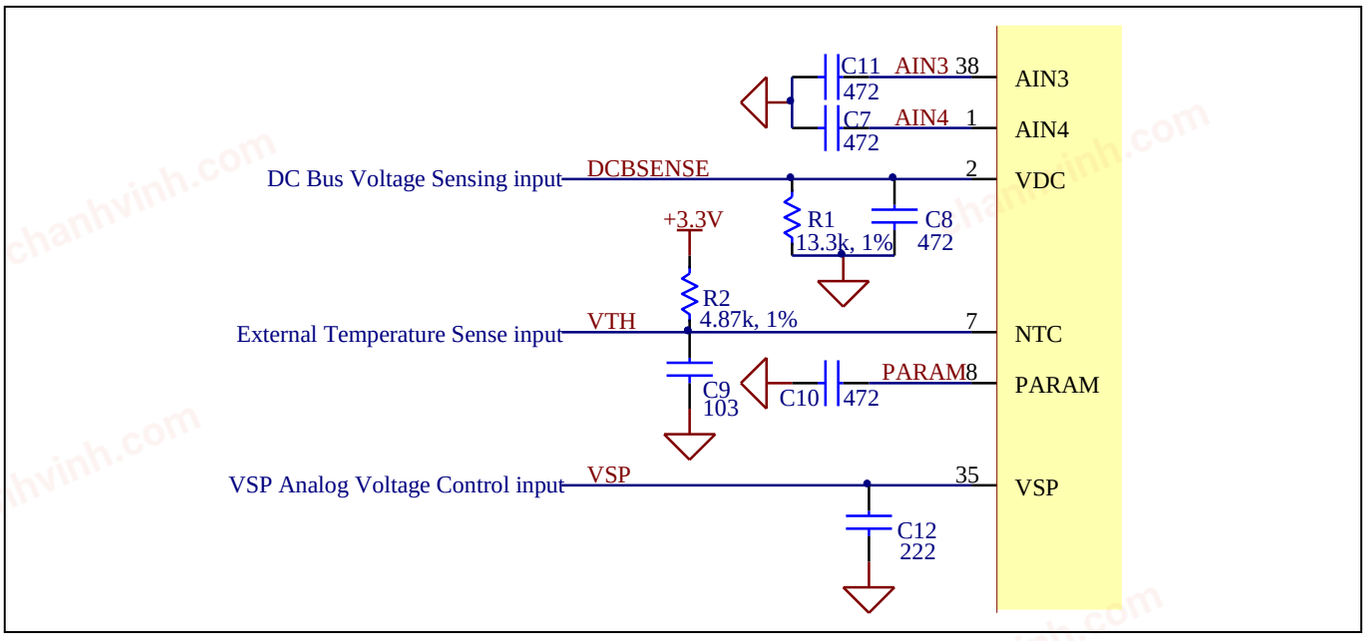


Figure 16 Analog inputs on the EVAL-M1-101T evaluation board

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 13.3kΩ, 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.

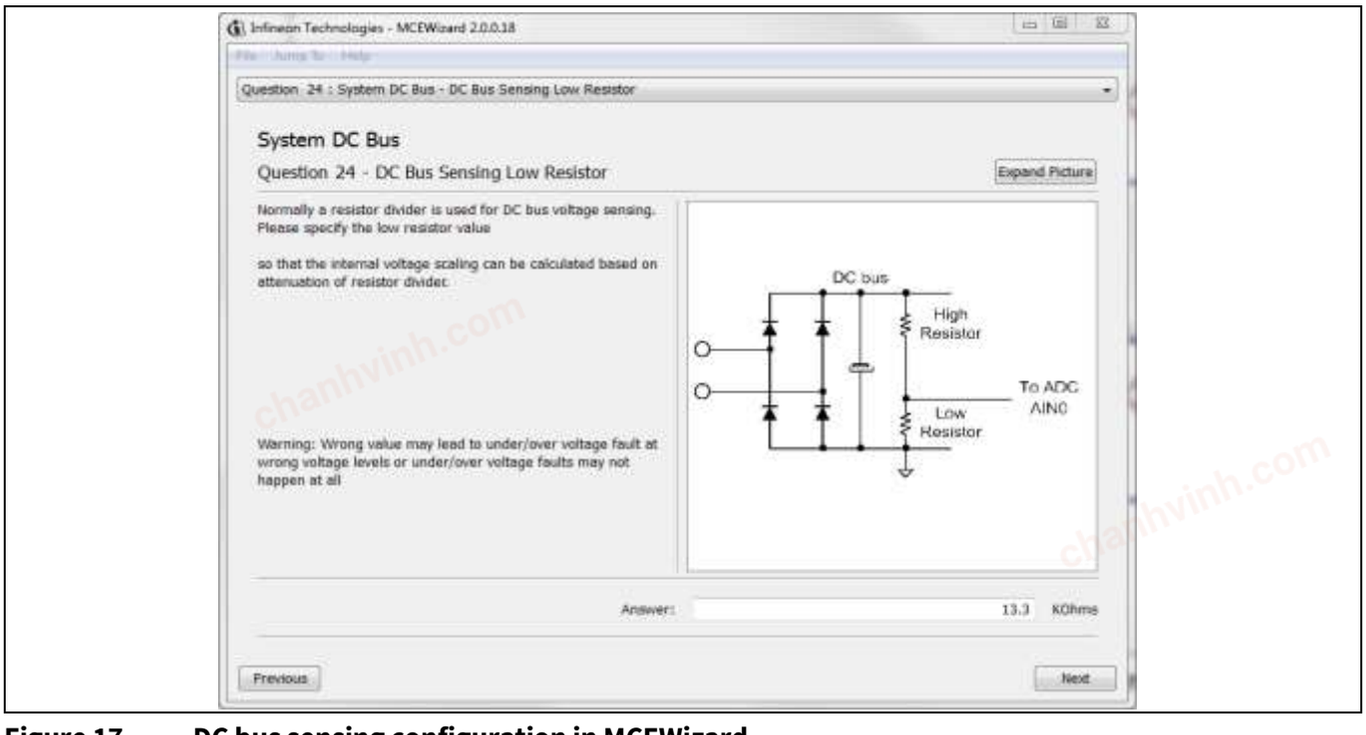


Figure 17 DC bus sensing configuration in MCEWizard

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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 5.6kΩ. So the total pull-up resistance calculates to be 2.605kΩ.

The typical value of R_{NTC} at 100°C is 5.388kΩ 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

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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.

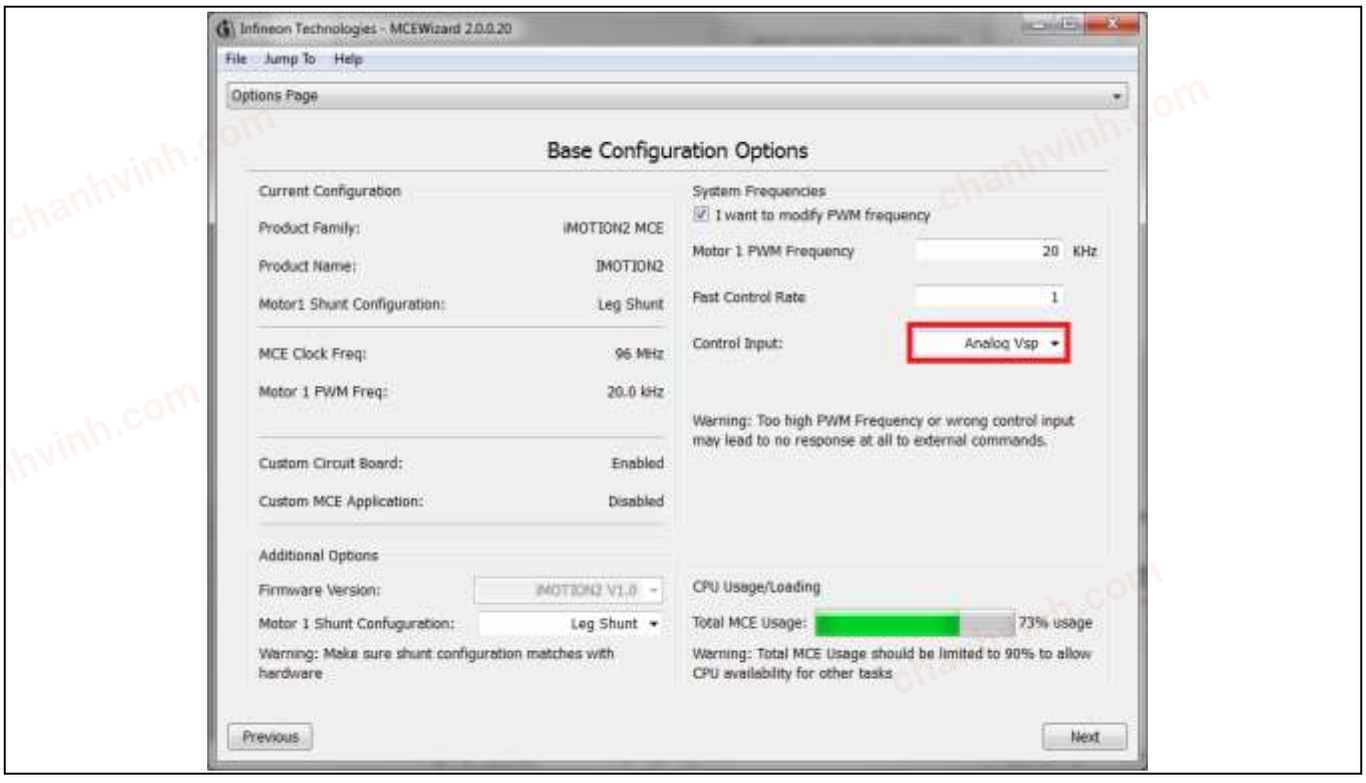


Figure 19 Analog VSP control input mode configuration

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.

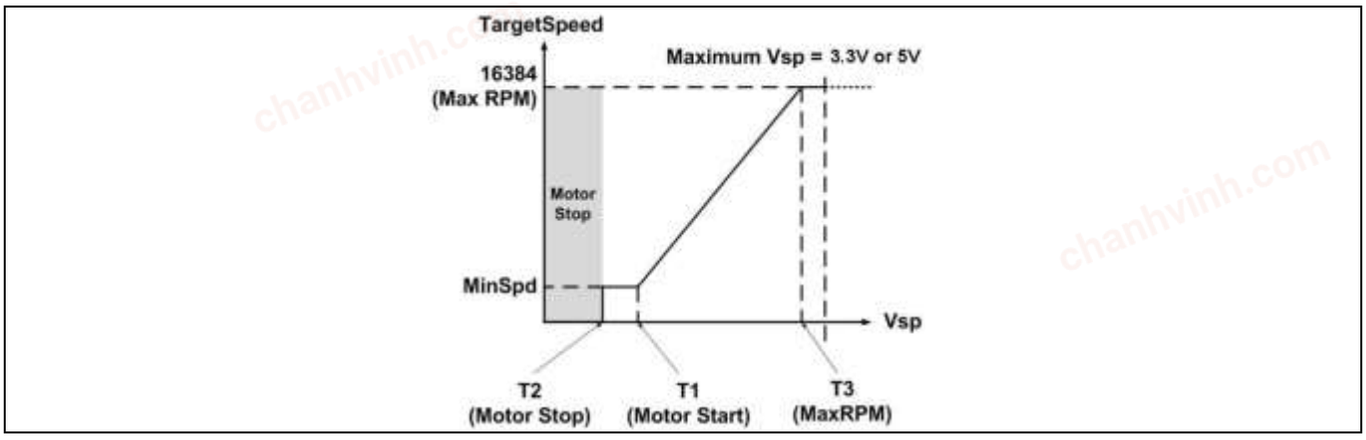


Figure 20 The relationship between VSP Analog Input voltage and TargetSpeed

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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, Question10 and Question 11.

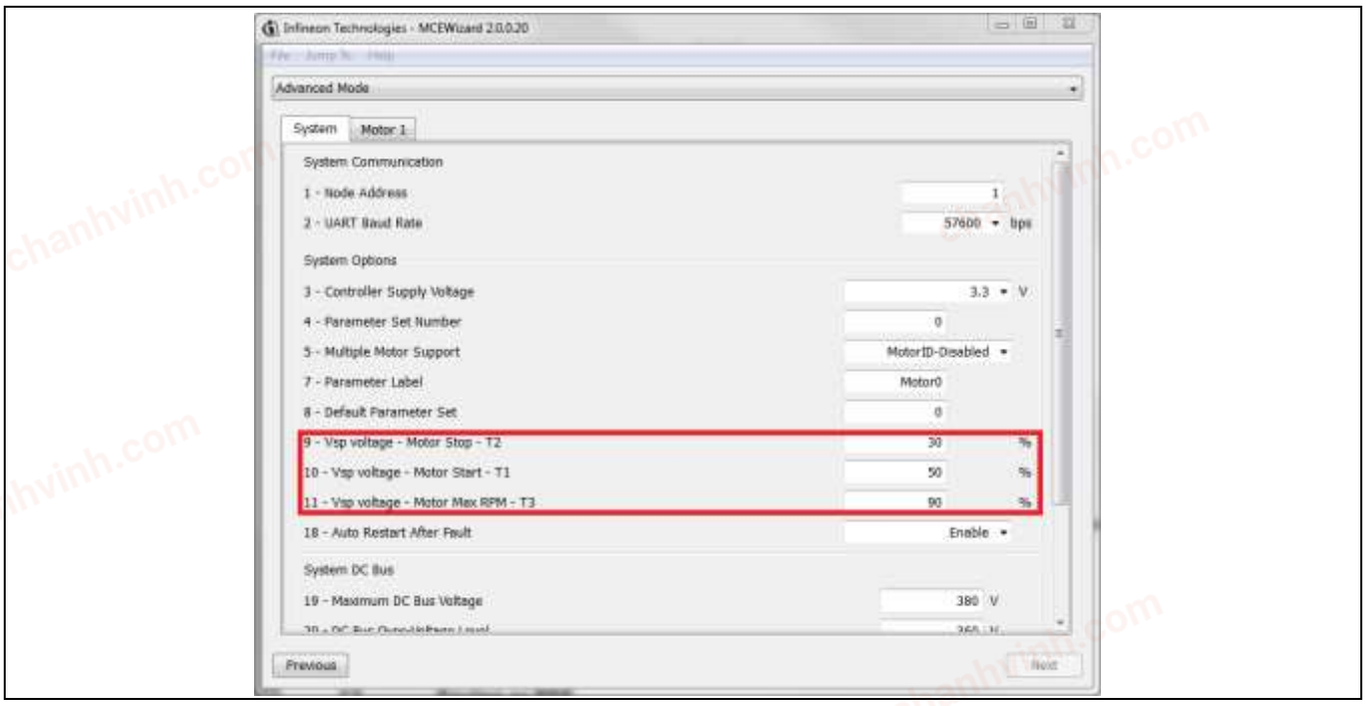


Figure 21 Three input thresholds configuration for VSP analog input control mode

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.

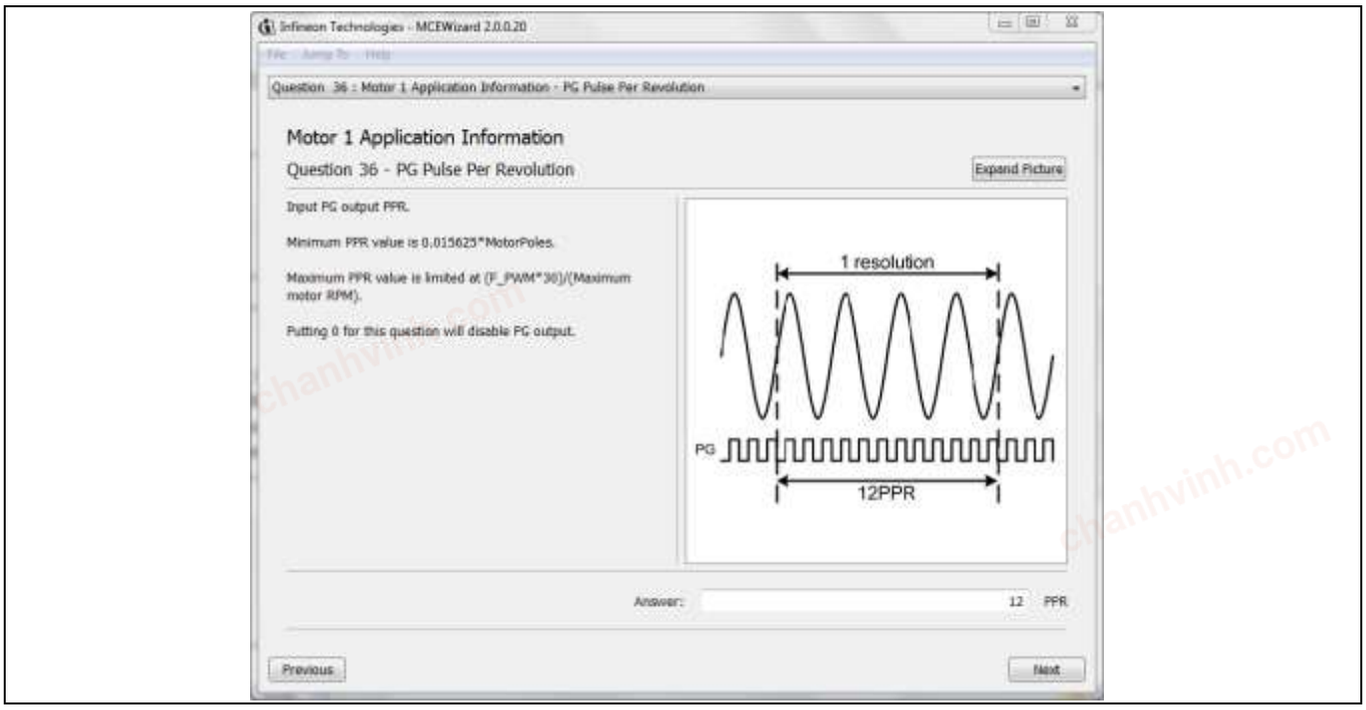


Figure 22 PG Pulse Per Revolution configuration

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Motor speed can be calculated as shown below.

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

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.

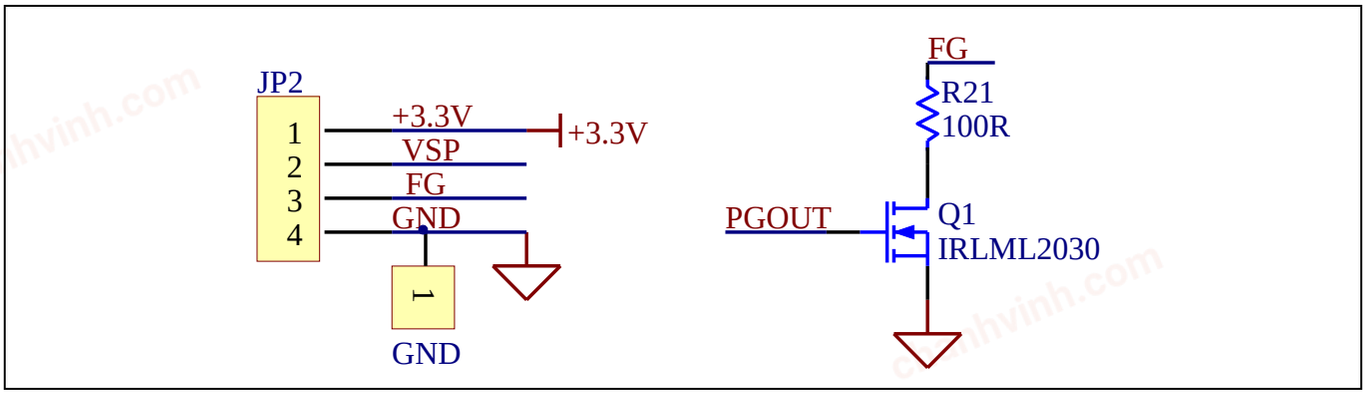


Figure 23 VSP Input Connector and level shit schematic for FG

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5.3 Schematics overview

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

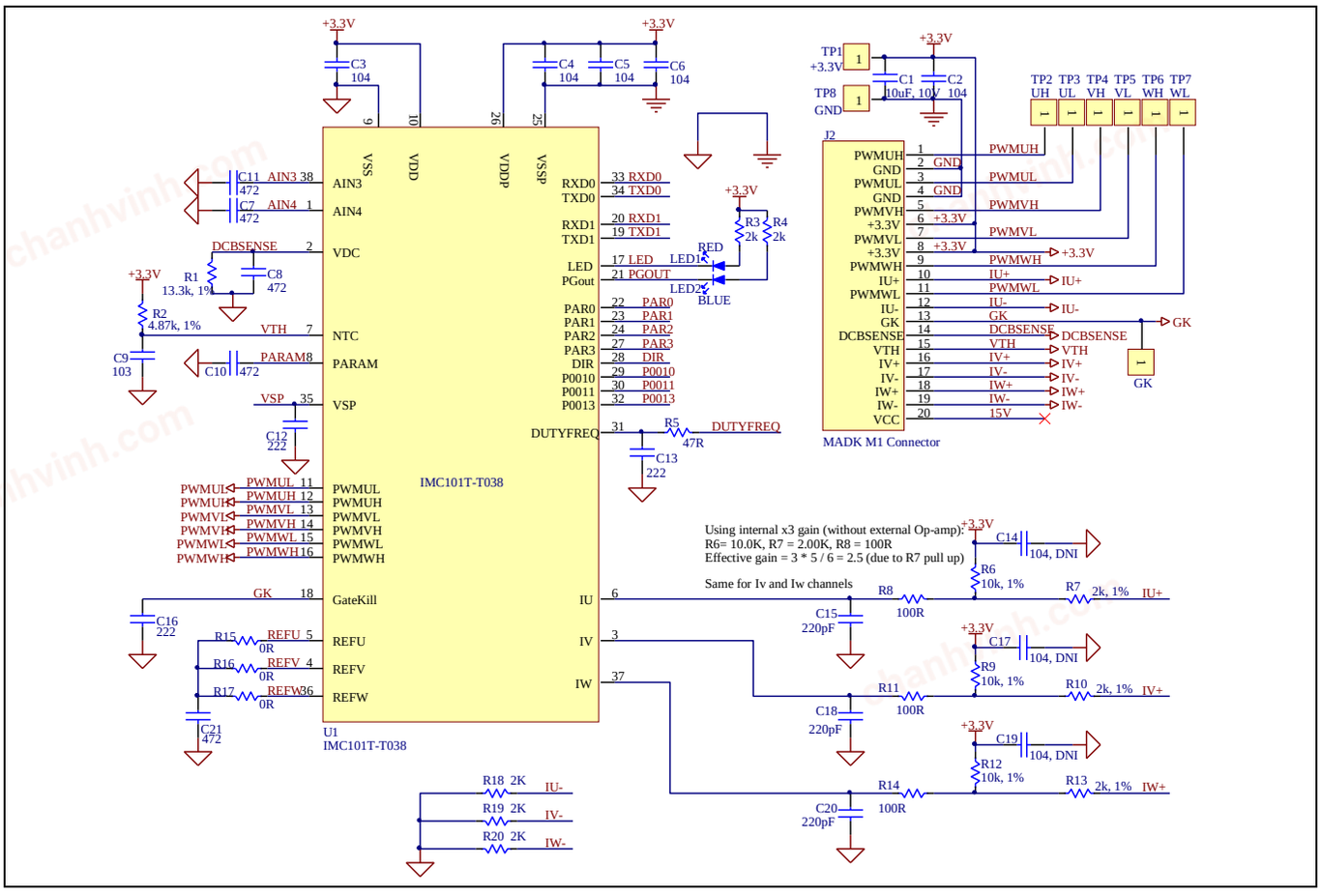


Figure 24 The schematics for the EVAL-M1-101T evaluation board

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

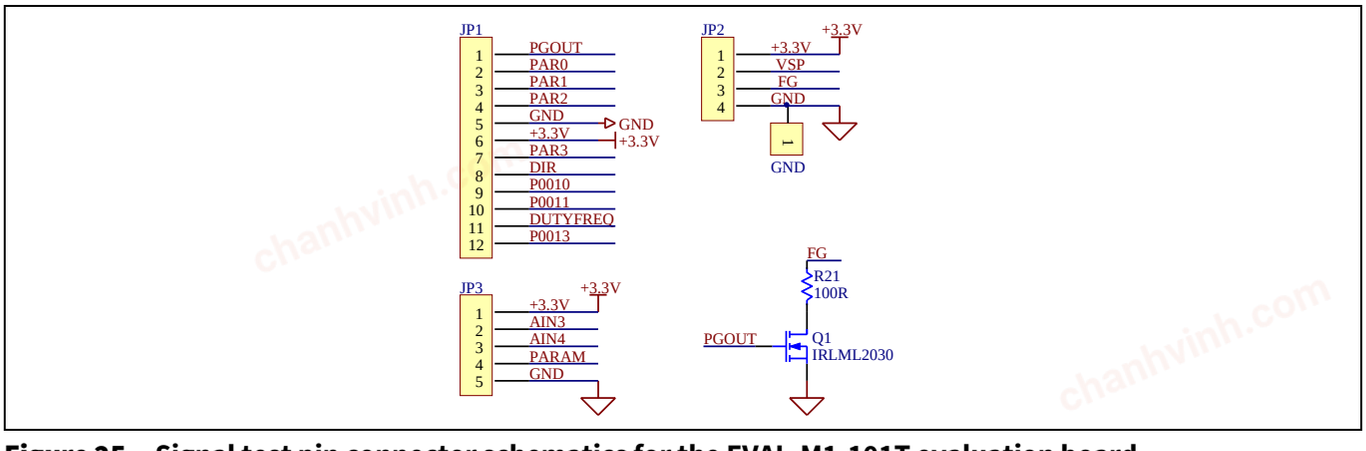


Figure 25 Signal test pin connector schematics for the EVAL-M1-101T evaluation board

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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 35µm copper by default and its size is 65 mm × 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.

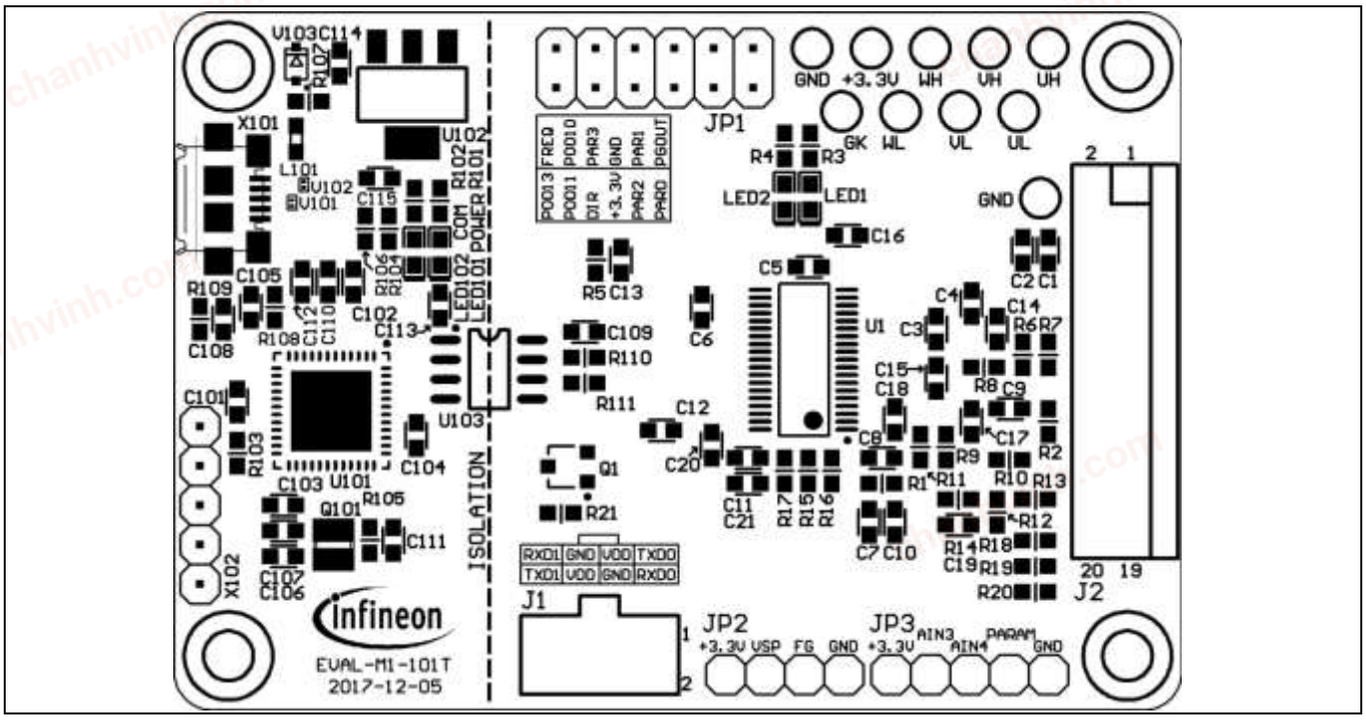


Figure 26 Top overlay print of the EVAL-M1-101T evaluation board

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

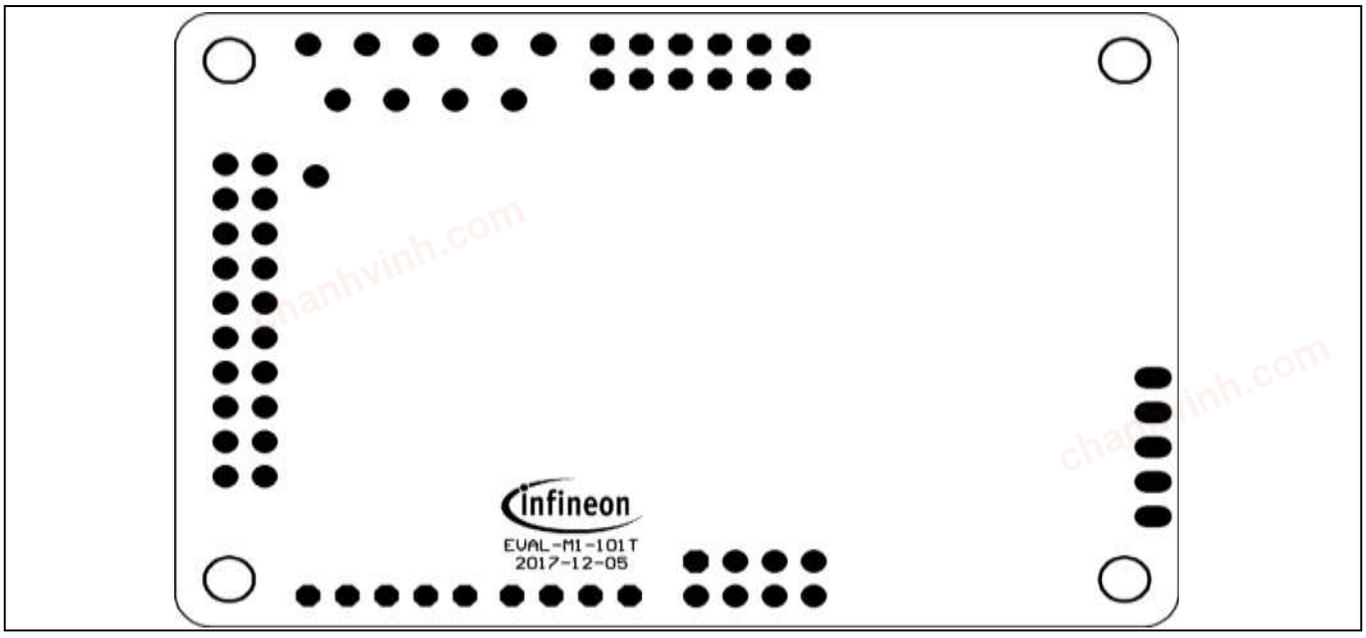


Figure 27 Bottom overlay print of the EVAL-M1-101T evaluation board

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

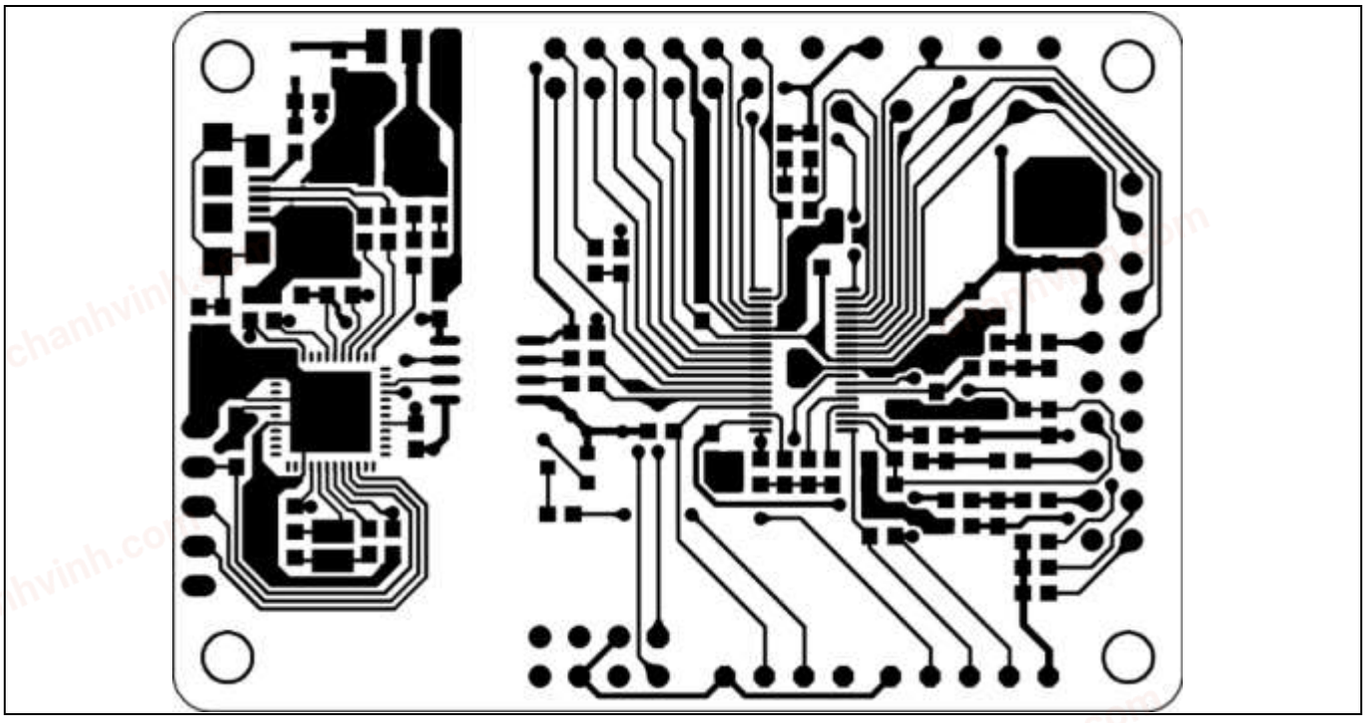


Figure 28 Top layer routing of the EVAL-M1-101T

Figure 29 illustrates the bottom layer routing of the PCB.

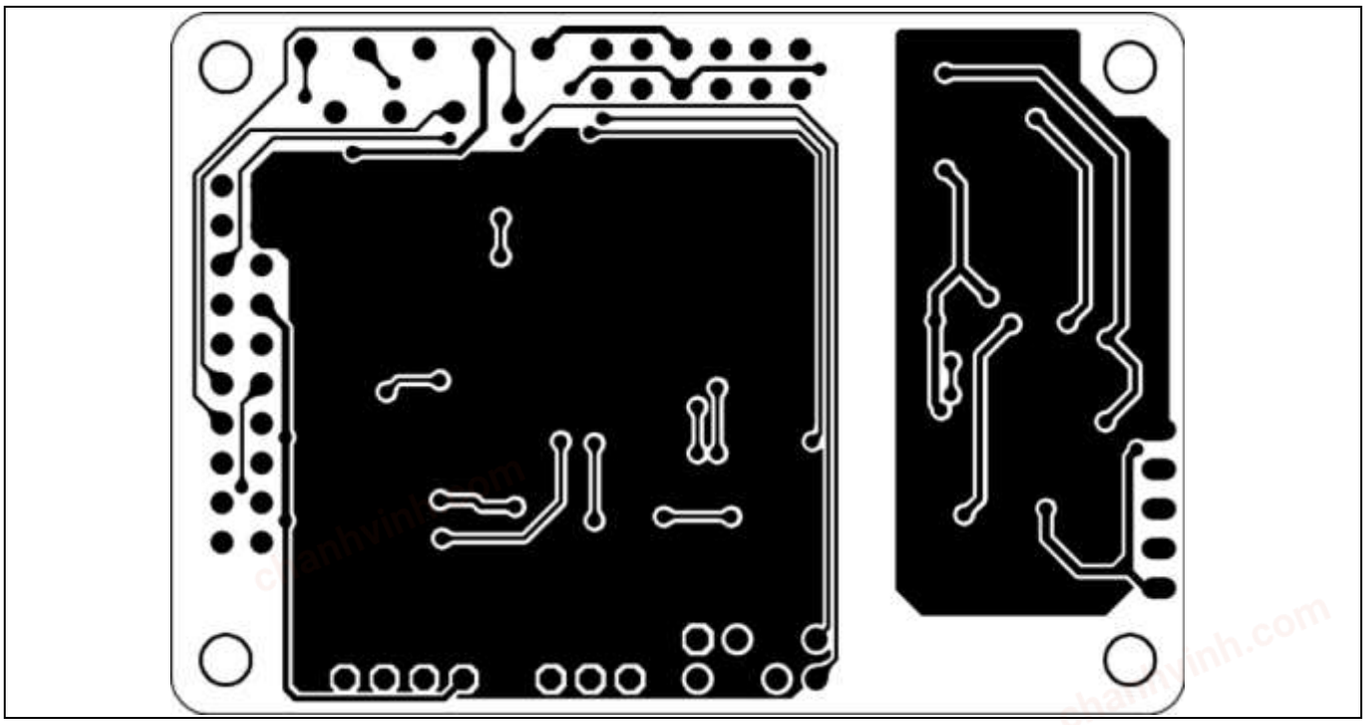


Figure 29 Bottom layer routing of the EVAL-M1-101T

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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

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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

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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

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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.

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