iMOTION™ MADK Sensorless FOC with XMC™

Getting Started Guide

XMC™ Microcontrollers

June 2016

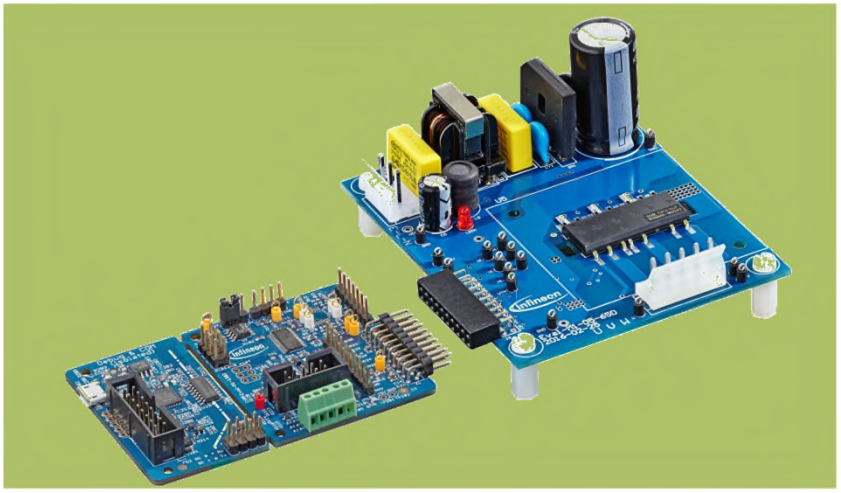
Agenda

1. iMOTION™ MADK Overview
2. Hardware and Software Overview
3. Tools Overview
4. Getting Started
5. Resource Listing

Agenda

1. iMOTION™ MADK Overview
2. Hardware and Software Overview
3. Tools Overview
4. Getting Started
5. Resource Listing

iMOTION™ MADK Platform Introduction



- **Compact and modular 3-phase motor drive** system solution platform up to 300 W with scalable controller and IPM™ inverter board options
- Designed for **sensorless or sensored** motor control
- **Spin your motor in less than 1 hour** thanks to provided motor control software and easy-to-use GUI for parametrization and tuning

iMOTION™ MADK Platform
Available Kits and Boards Overview

Controller Boards

Inverter Boards

Individual Boards

EVAL-M1-099M
IRMCK099
Control Card
SP001591856

EVAL-M1-1302
XMC1302
Control Card
SP001591894

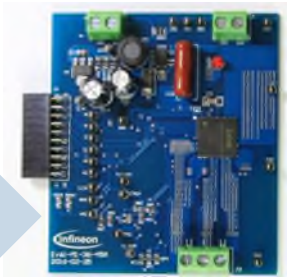
M1 Platform Interface

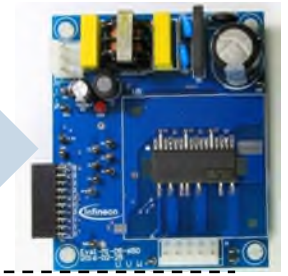
EVAL-M1-36-84A
µIPM™ power board
IRSM836-084MA 250V
SP001592062

EVAL-M1-36-45A
µIPM™ power board
IRSM836-045MA 500V
SP001592052

EVAL-M1-05-84D
aµIPM™-DIP power board
IRSM505-084DA2 250V
SP001591850

EVAL-M1-05-65D
µIPM™-DIP power board
IRSM505-065DA2 500V
SP001591474





Kits

EVAL-M1-1302_36-84A
XMC1302 Control Card + Powerstage based on IRSM836-084MA, µIPM™, 250V
SP001592044

EVAL-M1-1302_36-45A
XMC1302 Control Card + Powerstage based on IRSM836-045MA, µIPM™, 500V
SP001592034

EVAL-M1-1302_05-84D
XMC1302 Control Card + Powerstage based on IRSM505-084DA2, µIPM™-DIP, 250V
SP001591814

EVAL_M1-1302_05-65D
XMC1302 Control Card + Powerstage based on IRSM505-065DA2, µIPM™-DIP, 500V
SP001591902

More iMOTION™ MADK Controller and Inverter boards coming soon…

Agenda

1. iMOTION™ MADK Overview
2. Hardware and Software Overview
3. Tools Overview
4. Getting Started
5. Resource Listing

iMOTION™ MADK
System Overview (1/4)

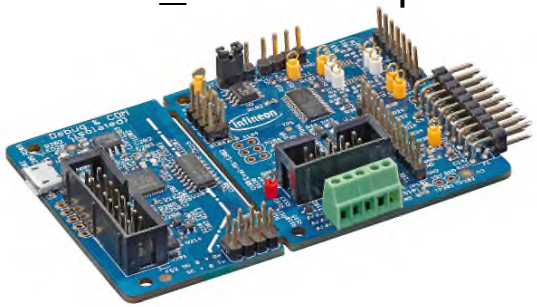
Each iMOTION™ MADK Kit with XMC™ consists of following components:

- **XMC1302 Control Card**
  - Based on XMC1302 ARM® Cortex®-M0 MCU enabling sensored and sensorless motor control
  - Control card supports HALL or latest innovation of 3D Magnetic Sensor
  - Includes J-Link debug interface by Segger
  - µC Probe-based GUI for parametrization and tuning
- **µIPM™ (12x12 mm) IRSM836 Series or µIPM™-DIP IRSM505 Series inverter boards**
  - 2 different MOSFET variants supporting 230 V or 110 V mains
  - All boards support 3-phase motor drive
- **Software package** (downloadable from www.infineon.com/MADK) for each individual kit
  - XMC™ Flasher
  - Micrium µC/Probe™ for XMC™
  - .zip file with project and configuration files for each individual kit (e.g. Eval-M1-1302_05-65D.zip)

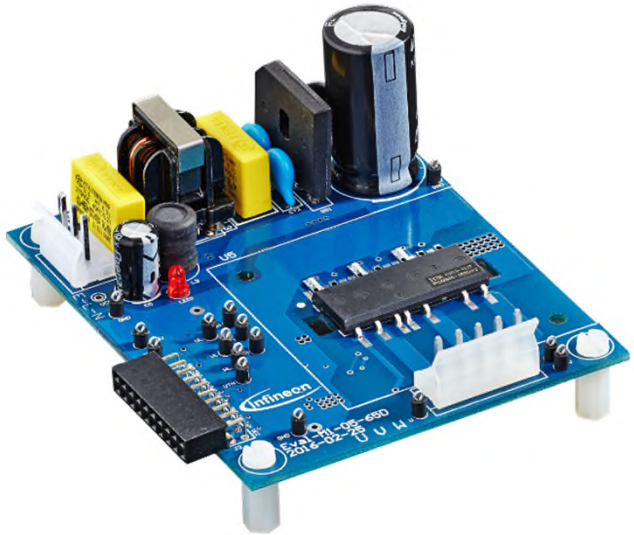
iMOTION™ MADK
System Overview (2/4)

For example the Eval-M1-1302_05-65D Kit consists of:

- **Hardware**
  - Eval-M1-1302 Control Card
  - Eval-M1-05-65D Inverter board with µIPM-DIP and 500 V MOSFET
  - Micro-B USB cable
- **Software package** (downloadable from www.infineon.com/MADK website)
  - XMC™ Flasher
  - Micrium µC/Probe™ for XMC™
  - Eval-M1-1302_05-65D.zip file



Eval-M1-1302 board



Eval-M1-05-65D board

iMOTION™ MADK
System Overview (3/4)

Each kit has its own version of s/w package. For example the Eval-M1-1302_05-65D.zip contains following files:

- Eval-M1-1302_05-65D.elf file
- Eval-M1-1302_05-65D.hex file
- Eval-M1-1302_05-65D.wspx µC/Probe™ file
- Eval-M1-1302_05-65D.xls Excel file

iMOTION™ MADK
System Overview (4/4)

Software package content description:

- **Eval-M1-1302_05-65D.hex** – a compiled FOC motor control code for XMC1302-TO380200 device. This code is configured to run with MADK kit for Motor control application. This firmware needs to be programed to XMC1300 Control Card via XMC™ Flasher tool
- **Eval-M1-1302_05-65D.elf** – a debugging file used by µC/Probe™ GUI tool
- **Eval-M1-1302_05-65D.wspx** – a µC/Probe™ project file for predefined GUI used for system parametrization and tuning
- **Eval-M1-1302_05-65D.xls** – an excel spreadsheet which used to convert physical motor and system parameters to equivalent digital values which need to entered through the µC/Probe™ GUI

iMOTION™ MADK
Hardware Overview (1/2)

Nr.	Kit Name	Kit Description	Order Number	Input Voltage/Output Power
1	Eval-M1-1302_05-65D	Eval-M1-1302, Eval-M1-05-65D, USB cable	EVALM113020565D TOBO1	100 - 230 Vac / 85 W @10kHz
2	Eval-M1-1302_05-84D	Eval-M1-1302, Eval-M1-05-84D, USB cable	EVALM113020584D TOBO1	100 – 120 Vac/ 95 W @10kHz
3	Eval-M1-1302_36-45A	Eval-M1-1302, Eval-M1-36-45A, USB cable	EVALM113023645A TOBO1	320 Vdc / 80 W
4	Eval-M1-1302_36-84A	Eval-M1-1302, Eval-M1-36-84A, USB cable	EVALM113023684A TOBO1	156 Vdc/ 80 W

For more details about individual boards (Control Cards and µIPM-based Inverters), please check the additional documentation on www.infineon.com/MADK

iMOTION™ MADK
Hardware Overview (2/2)

- Infineon parts utilized on Eval-M1-1302:

Infineon Parts	Order Number
XMC1300 Microcontroller	XMC1302-T038F0200
XMC4200 Microcontroller	XMC4200-Q48F256
5V regulator	IFX1763XEJV50
3V3 regulator	IFX1763XEJV33
Dual NPN transistors	SMBT3904S
TVS diode	ESD8V0L2B-03L
Schottky diode	BAS3010A-03W

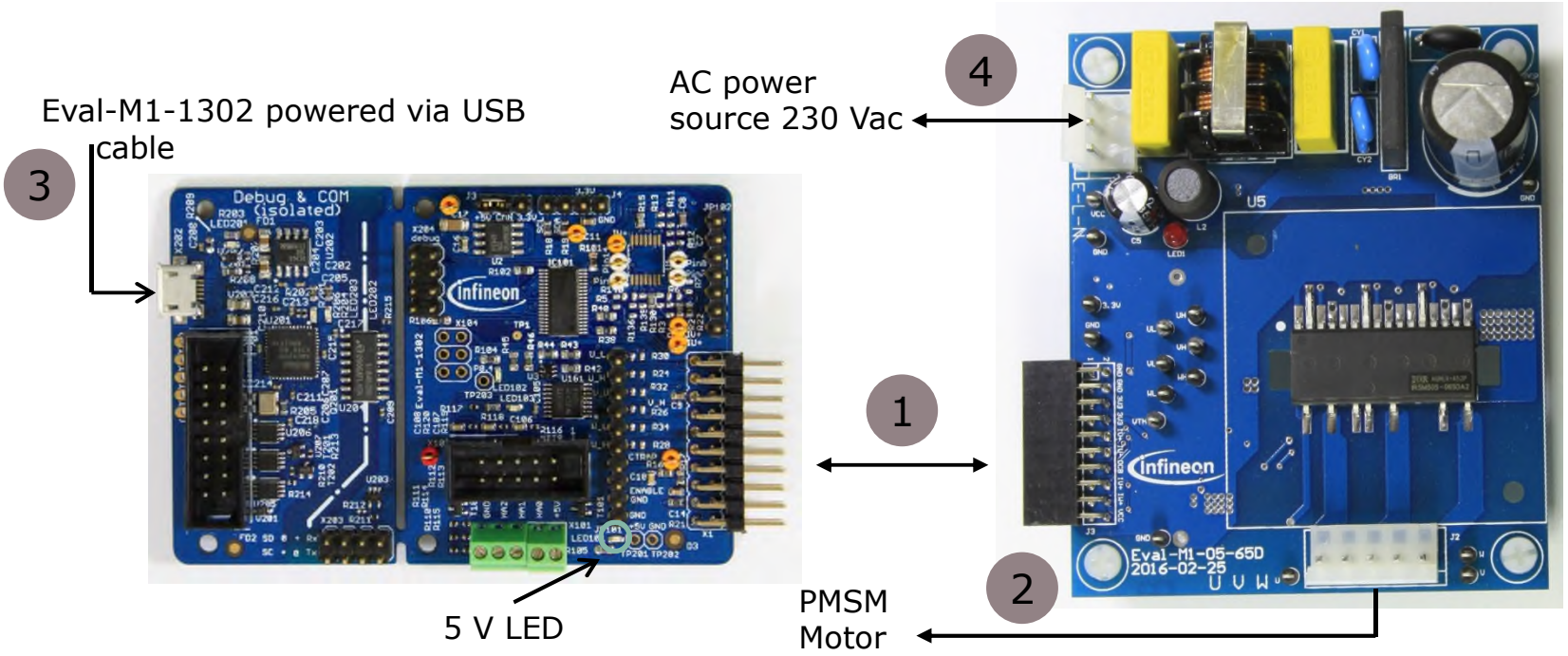
- Infineon parts utilized on µIPM™ Inverter Boards:

Inverter Board	Order Number
Eval-M1-05-65D	IRSM505-065DA2
Eval-M1-05-84D	IRSM505-084DA2
Eval-M1-36-45A	IRSM836-045MA
Eval-M1-36-84A	IRSM836-084MA

iMOTION™ MADK
Hardware Connections

To properly connect MADK Kit, follow these steps:

1. Connect Eval-M1-1302 to Eval-M1-05-65D via M1 connector
2. Connect 3 phase motor wiring to 'U V W' connector
3. Connect Eval-M1-1302 to PC via USB cable
4. Connect AC source to Eval-M1-05-65D (Power ON is indicated by the LED on the board)



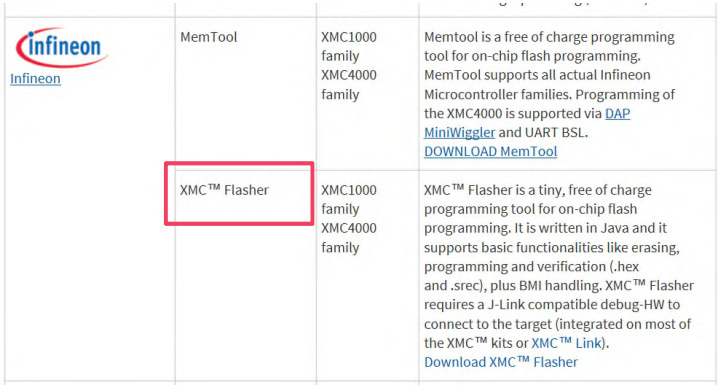
Agenda

1. iMOTION™ MADK Overview
2. Hardware and Software Overview
3. Tools Overview
4. Getting Started
5. Resource Listing

iMOTION™ MADK Tools Overview (1/2)
XMC™ Flasher

- **Download XMC™ Flasher installer package from:**

  www.infineon.com/xmcflasher



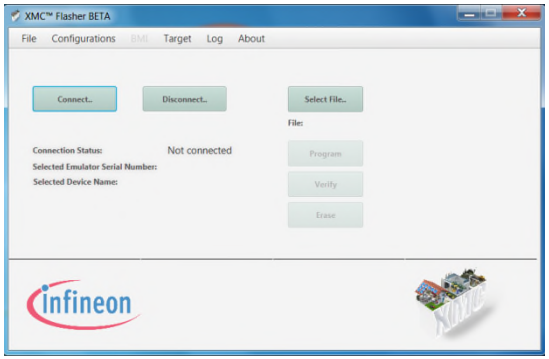
Infineon	MemTool	XMC1000 family XMC4000 family	Memtool is a free of charge programming tool for on-chip flash programming. MemTool supports all actual Infineon Microcontroller families. Programming of the XMC4000 is supported via DAP MiniWiggler and UART BSL. DOWNLOAD MemTool
	XMC™ Flasher	XMC1000 family XMC4000 family	XMC™ Flasher is a tiny, free of charge programming tool for on-chip flash programming. It is written in Java and it supports basic functionalities like erasing, programming and verification (.hex and .srec), plus BMI handling. XMC™ Flasher requires a J-Link compatible debug-HW to connect to the target (integrated on most of the XMC™ kits or XMC™ Link). Download XMC™ Flasher

- **Installation Requirements**

1. Oracle JAVA JRE 1.8.0_72 or higher
   - http://www.oracle.com/technetwork/java/javase/downloads/index.html

2. Segger JLINK software 5.10 or higher
   - https://www.segger.com/jlink-software.html

3. Windows 7 or higher



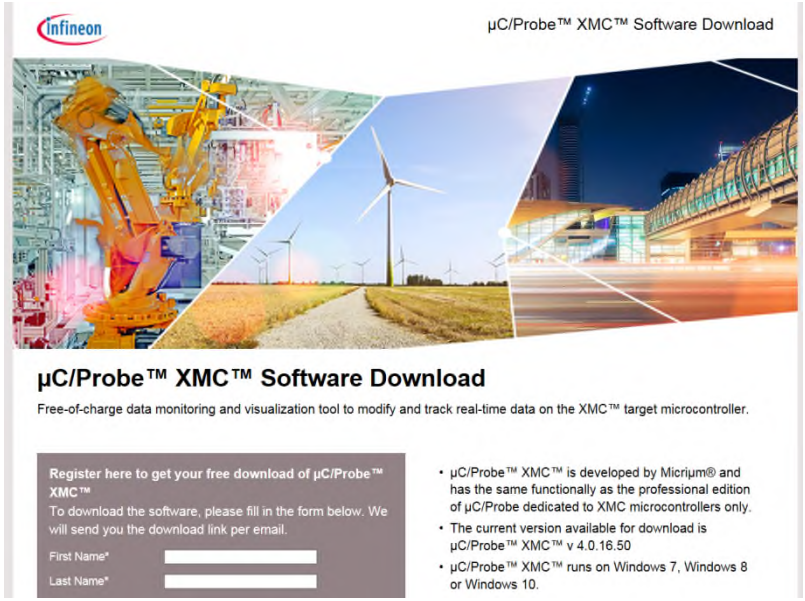
iMOTION™ MADK Tools Overview (2/2)
Micrium µC Probe™

- **Download Micrium µC Probe™ for XMC™ installer package from:**

  www.infineon.com/ucprobexmc

- **Installation Requirements:**

  1. PC with Windows Vista, Windows 7, Windows 8, Windows 10 – 32 bit & 64 bit
  2. RAM – 3 GB or more

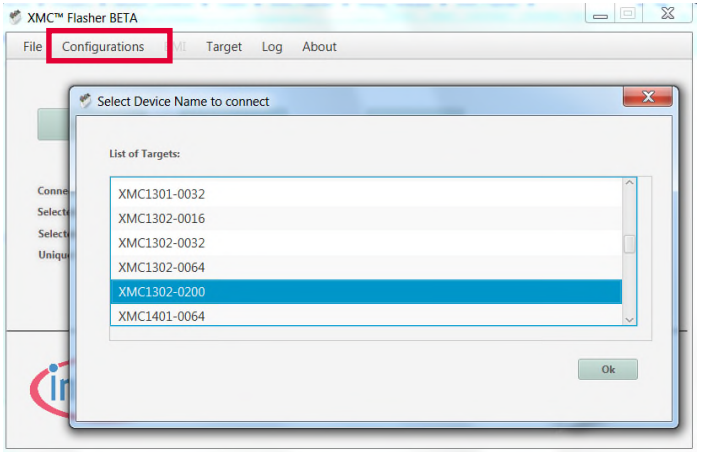


Agenda

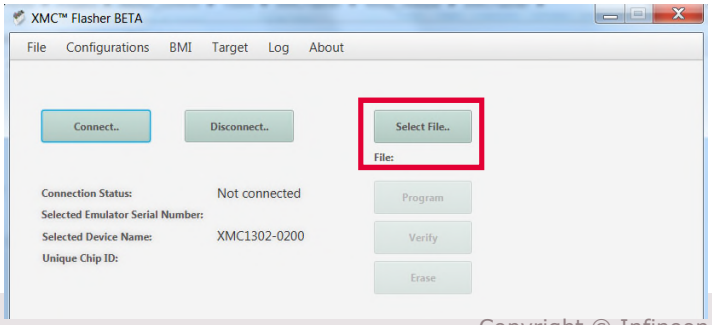
1. iMOTION™ MADK Overview
2. Hardware and Software Overview
3. Tools Overview
4. Getting Started
5. Resource Listing

iMOTION™ MADK Getting Started
Flashing the *.hex file (1/4)

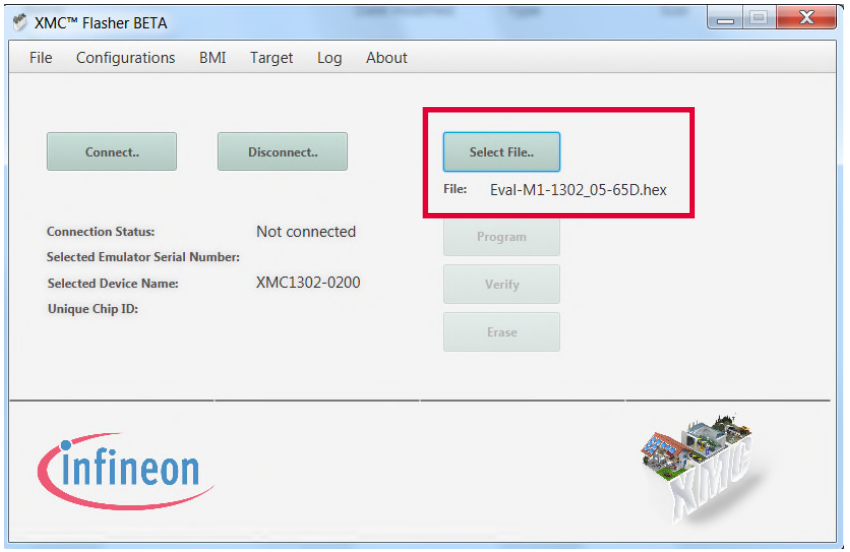
1. Power up inverter board
2. Open XMC™ Flasher's Configuration, select Change -> Device name –> XMC1302-0200



3. Click on Select and then select the the *.hex file downloaded

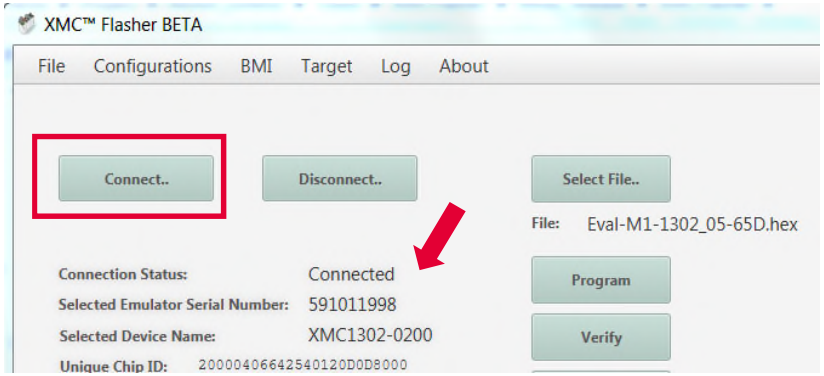


4. Make sure that selected *.hex file gets listed under File:

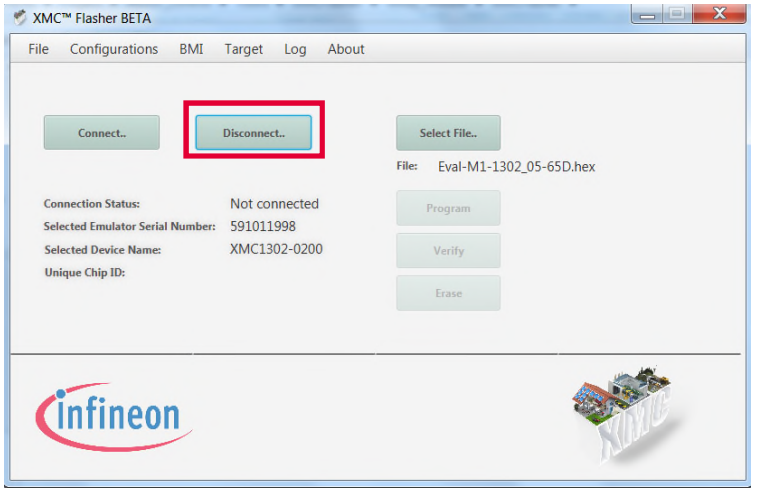


iMOTION™ MADK Getting Started
Flashing the *.hex file (2/4)

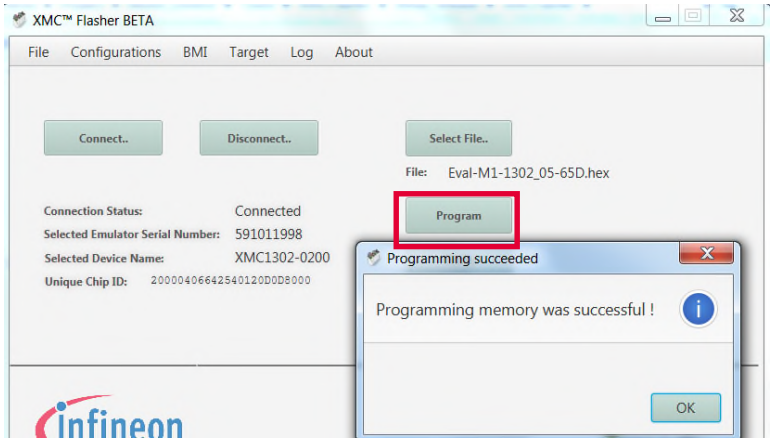
4. Click on 'Connect…' button and check if connection status is set to connected



6. Click on 'Disconnect..' button



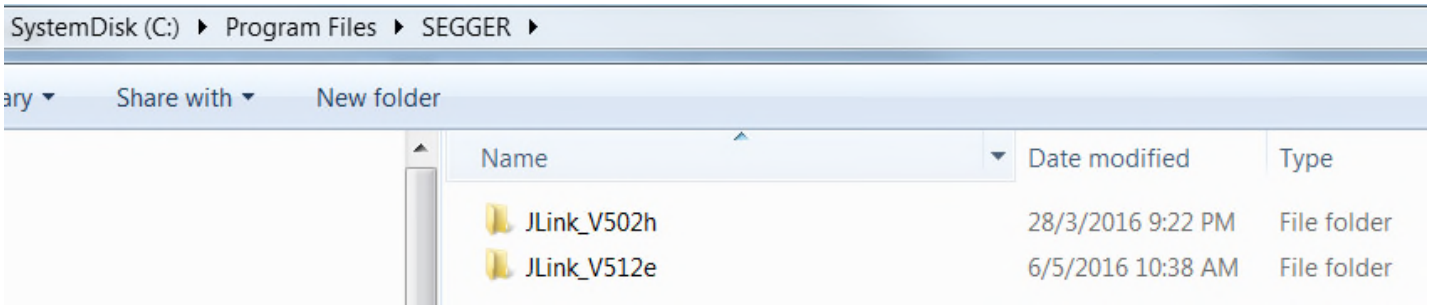
5. Click on 'Program' button



See next page if the connection is not established after step 4.

iMOTION™ MADK Getting Started
Flashing the *.hex code (3/4)

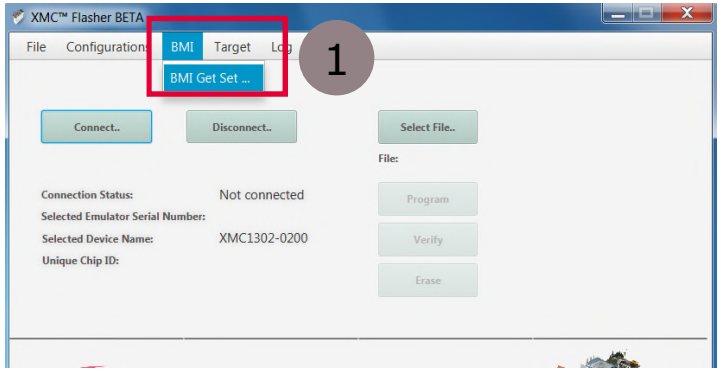
7. If XMC™ Flasher cannot connect to Eval-M1-1302 board, there are 2 possible reasons:
   - Segger JLINK software has not been properly installed. That can be checked by searching for SEGGER driver in c:\Program Files\SEGGER\ folder. Make sure at least JLINK 5.0 or higher is installed.

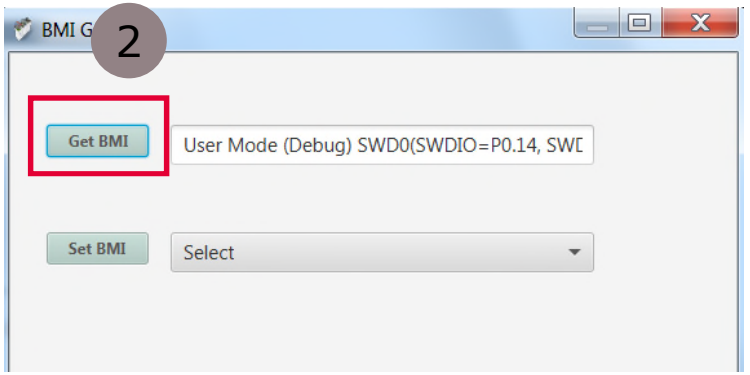


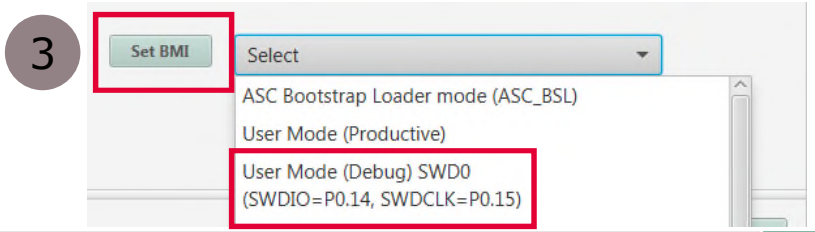
   - BMI (Boot Mode Index) value of the XMC1302 device is **not** set to User Mode (Debug) SWD0. See next page for description on how to check and set the BMI value by using XMC™ Flasher's BMI feature

iMOTION™ MADK Getting Started
Flashing the *.hex code (4/4)

8. To check the BMI (Boot Mode Index) value of the XMC1302 device, please do following steps:
   1. Power up the inverter board
   2. Click on BMI -> BMI Get Set
   3. Check the actual BMI value by clicking on Get BMI
   4. If BMI is not SWD0, then click on 'Set BMI' to change BMI to User Mode (Debug) SWD0

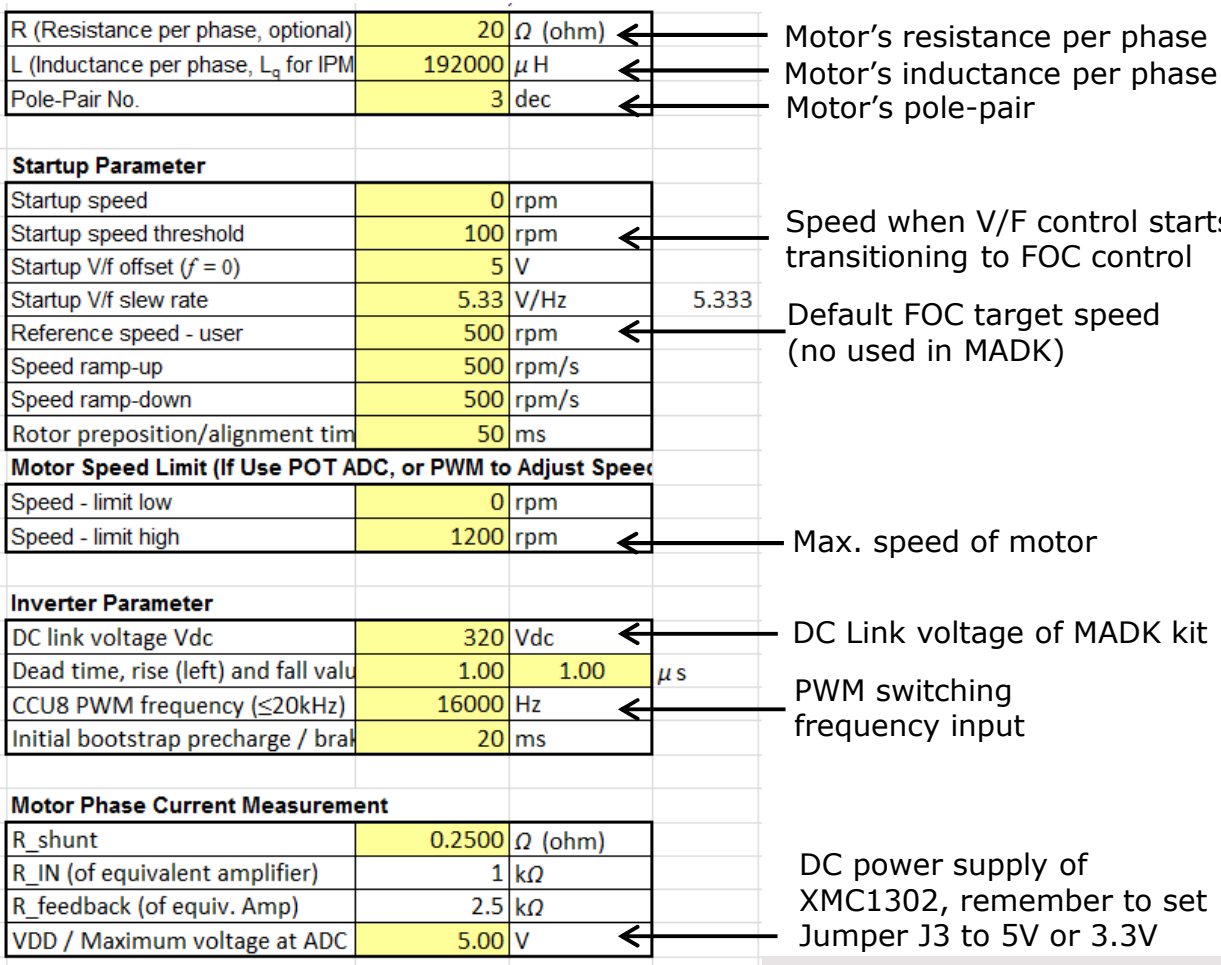






iMOTION™ MADK Getting Started Using Excel file (1/2)

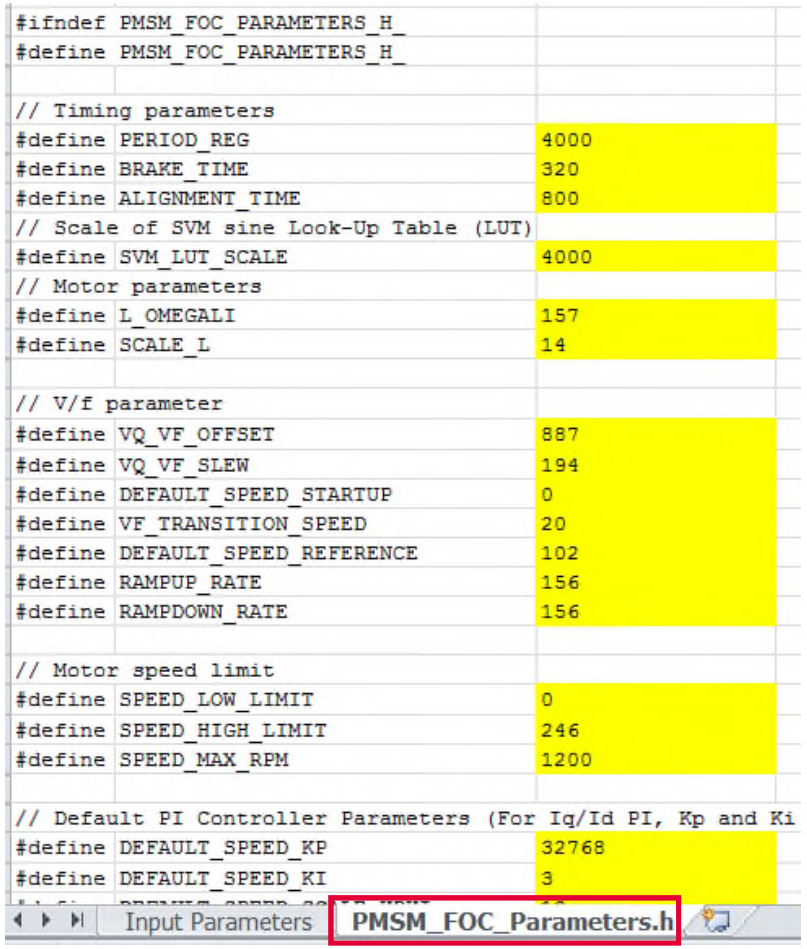
1. Open 'Input Parameters' sheet of *.xls
2. Enter target Motor and system parameters into yellow marked fields of the spread sheet



R (Resistance per phase, optional)	20	Ω (ohm)		Motor's resistance per phase
L (Inductance per phase, L_q for IPM	192000	μH		Motor's inductance per phase
Pole-Pair No.	3	dec		Motor's pole-pair
Startup Parameter				
Startup speed	0	rpm		
Startup speed threshold	100	rpm		Speed when V/F control starts transitioning to FOC control
Startup V/f offset (f = 0)	5	V		
Startup V/f slew rate	5.33	V/Hz	5.333	
Reference speed - user	500	rpm		Default FOC target speed (no used in MADK)
Speed ramp-up	500	rpm/s		
Speed ramp-down	500	rpm/s		
Rotor preposition/alignment tim	50	ms		
Motor Speed Limit (If Use POT ADC, or PWM to Adjust Speed				
Speed - limit low	0	rpm		
Speed - limit high	1200	rpm		Max. speed of motor
Inverter Parameter				
DC link voltage Vdc	320	Vdc		DC Link voltage of MADK kit
Dead time, rise (left) and fall valu	1.00	1.00	μs	
CCU8 PWM frequency (≤20kHz)	16000	Hz		PWM switching frequency input
Initial bootstrap precharge / brak	20	ms		
Motor Phase Current Measurement				
R_shunt	0.2500	Ω (ohm)		
R_IN (of equivalent amplifier)	1	kΩ		
R_feedback (of equiv. Amp)	2.5	kΩ		
VDD / Maximum voltage at ADC	5.00	V		DC power supply of XMC1302, remember to set Jumper J3 to 5V or 3.3V

iMOTION™ MADK Getting Started Using Excel file (2/2)

3. The scaled value of Motor parameters are generated in 'PMSM_FOC_Parameters.h' sheet
4. Values highlighted in yellow are required to be copied into the PMSM_FOC_Parameters tab of the µC/Probe™ GUI

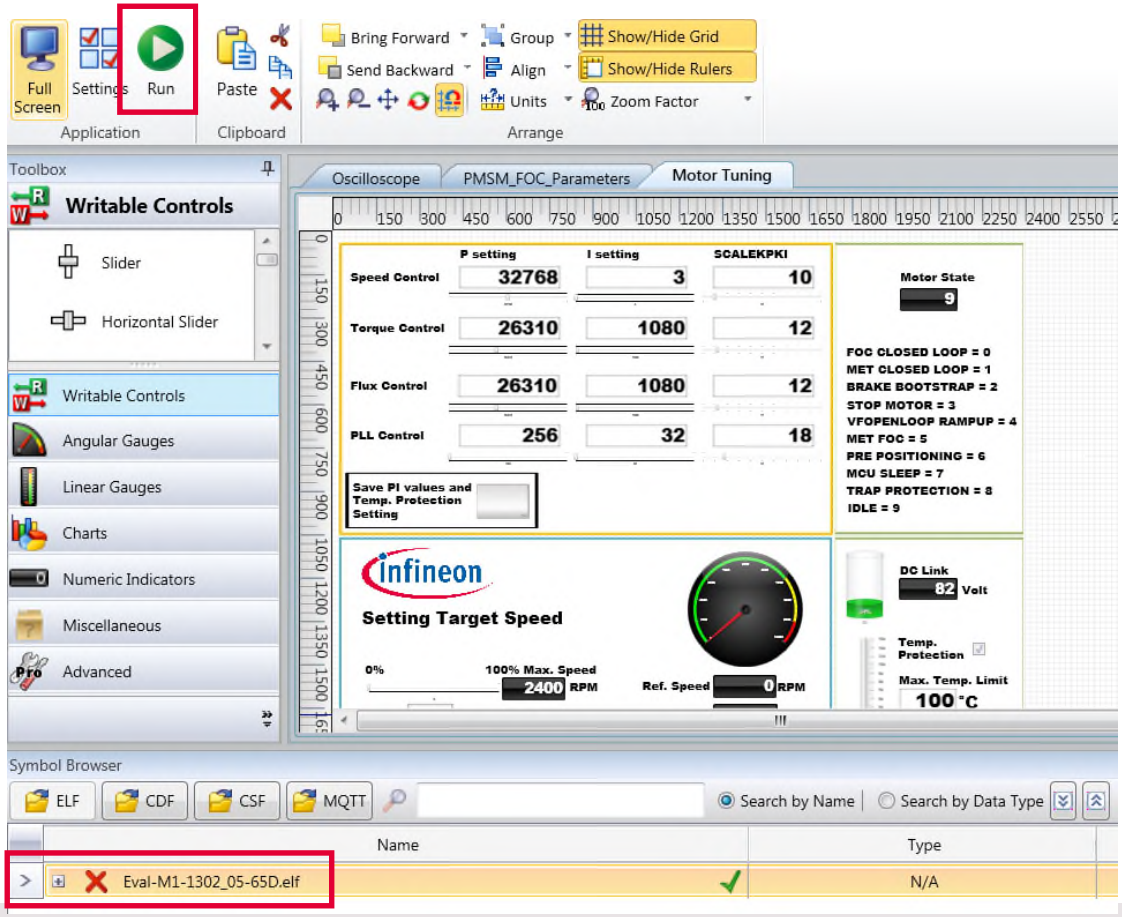


```
#ifndef PMSM_FOC_PARAMETERS_H_
#define PMSM_FOC_PARAMETERS_H_

// Timing parameters
#define PERIOD_REG                  4000
#define BRAKE_TIME                  320
#define ALIGNMENT_TIME              800
// Scale of SVM sine Look-Up Table (LUT)
#define SVM_LUT_SCALE               4000
// Motor parameters
#define L_OMEGALI                   157
#define SCALE_L                     14

// V/f parameter
#define VQ_VF_OFFSET                887
#define VQ_VF_SLEW                  194
#define DEFAULT_SPEED_STARTUP       0
#define VF_TRANSITION_SPEED         20
#define DEFAULT_SPEED_REFERENCE     102
#define RAMPUP_RATE                 156
#define RAMPDOWN_RATE               156

// Motor speed limit
#define SPEED_LOW_LIMIT             0
#define SPEED_HIGH_LIMIT            246
#define SPEED_MAX_RPM               1200

// Default PI Controller Parameters (For Iq/Id PI, Kp and Ki
#define DEFAULT_SPEED_KP            32768
#define DEFAULT_SPEED_KI            3
```

Input Parameters | PMSM_FOC_Parameters.h

iMOTION™ MADK Getting Started Using µC/Probe™ GUI(1/7)

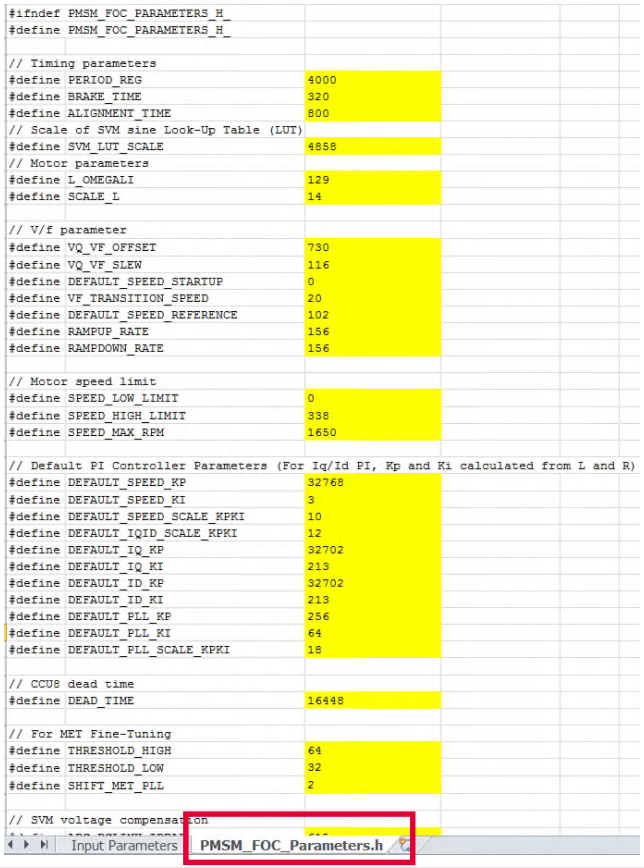
1. Open *.wspx µC/Probe™ project by double click on *.wspx file
2. Check the *.elf file is attached to µC/Probe™ project
3. Click the 'Run' button



iMOTION™ MADK Getting Started Using µC/Probe™ GUI(2/7)

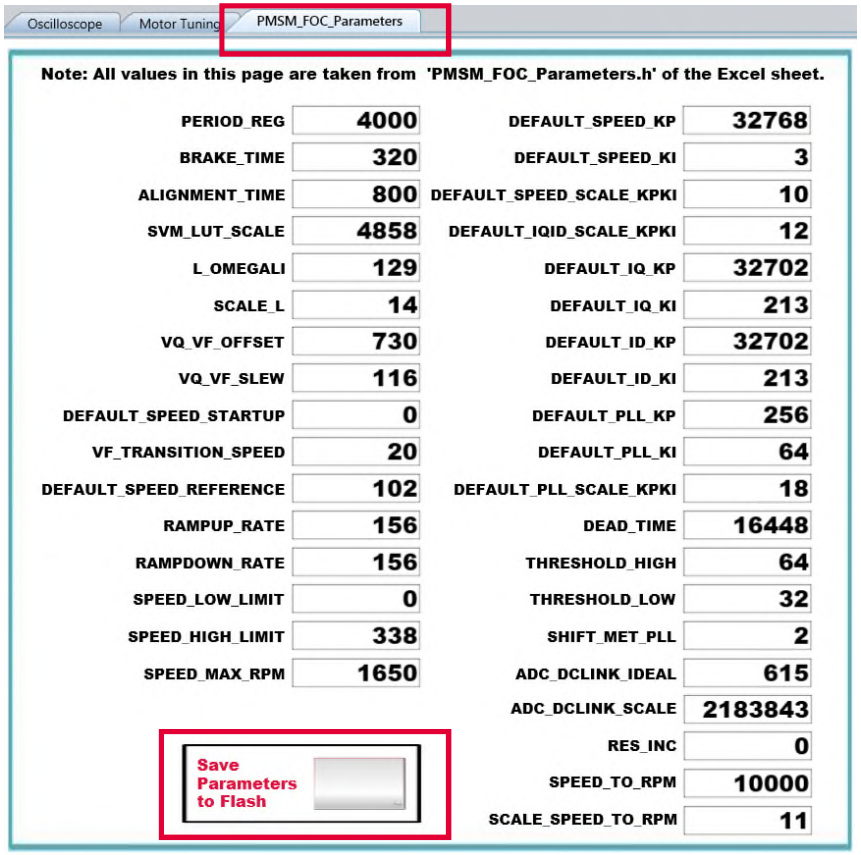
3. Manually copy all the values from the spreadsheet's 'PMSM_FOC_Parameters.h' tab (highlighted in yellow) to the GUI sheet below

4. SAVE the parameters to Flash



```
#ifndef PMSM_FOC_PARAMETERS_H_
#define PMSM_FOC_PARAMETERS_H_

// Timing parameters
#define PERIOD_REG                  4000
#define BRAKE_TIME                  320
#define ALIGNMENT_TIME              800
// Scale of SVM sine Look-Up Table (LUT)
#define SVM_LUT_SCALE               4858
// Motor parameters
#define L_OMEGALI                   129
#define SCALE_L                     14

// V/f parameter
#define VQ_VF_OFFSET                730
#define VQ_VF_SLEW                  116
#define DEFAULT_SPEED_STARTUP       0
#define VF_TRANSITION_SPEED         20
#define DEFAULT_SPEED_REFERENCE     102
#define RAMPUP_RATE                 156
#define RAMPDOWN_RATE               156

// Motor speed limit
#define SPEED_LOW_LIMIT             0
#define SPEED_HIGH_LIMIT            338
#define SPEED_MAX_RPM               1650

// Default PI Controller Parameters (For Iq/Id PI, Kp and Ki calculated from L and R)
#define DEFAULT_SPEED_KP            32768
#define DEFAULT_SPEED_KI            3
#define DEFAULT_SPEED_SCALE_KPKI    10
#define DEFAULT_IQID_SCALE_KPKI     12
#define DEFAULT_IQ_KP               32702
#define DEFAULT_IQ_KI               213
#define DEFAULT_ID_KP               32702
#define DEFAULT_ID_KI               213
#define DEFAULT_PLL_KP              256
#define DEFAULT_PLL_KI              64
#define DEFAULT_PLL_SCALE_KPKI      18

// CCU8 dead time
#define DEAD_TIME                   16448

// For MET Fine-Tuning
#define THRESHOLD_HIGH              64
#define THRESHOLD_LOW               32
#define SHIFT_MET_PLL               2

// SVM voltage compensation
```

Input Parameters | PMSM_FOC_Parameters.h



Oscilloscope | Motor Tuning | PMSM_FOC_Parameters

Note: All values in this page are taken from 'PMSM_FOC_Parameters.h' of the Excel sheet.

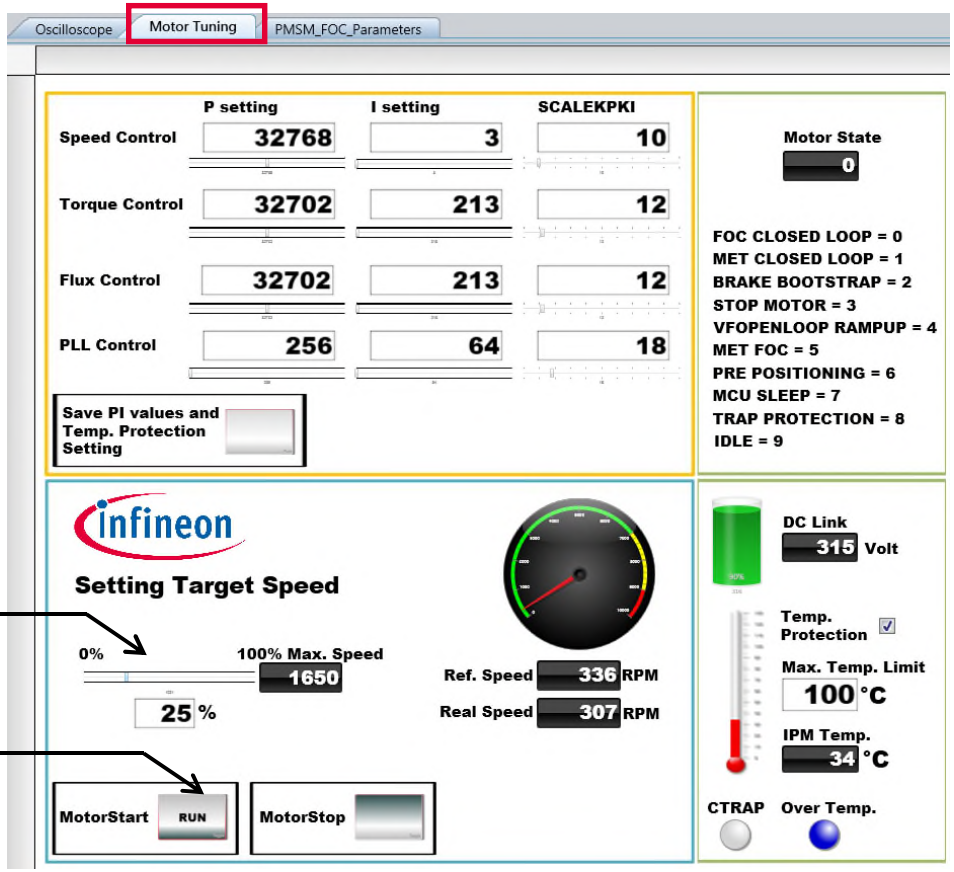
PERIOD_REG	4000	DEFAULT_SPEED_KP	32768
BRAKE_TIME	320	DEFAULT_SPEED_KI	3
ALIGNMENT_TIME	800	DEFAULT_SPEED_SCALE_KPKI	10
SVM_LUT_SCALE	4858	DEFAULT_IQID_SCALE_KPKI	12
L_OMEGALI	129	DEFAULT_IQ_KP	32702
SCALE_L	14	DEFAULT_IQ_KI	213
VQ_VF_OFFSET	730	DEFAULT_ID_KP	32702
VQ_VF_SLEW	116	DEFAULT_ID_KI	213
DEFAULT_SPEED_STARTUP	0	DEFAULT_PLL_KP	256
VF_TRANSITION_SPEED	20	DEFAULT_PLL_KI	64
DEFAULT_SPEED_REFERENCE	102	DEFAULT_PLL_SCALE_KPKI	18
RAMPUP_RATE	156	DEAD_TIME	16448
RAMPDOWN_RATE	156	THRESHOLD_HIGH	64
SPEED_LOW_LIMIT	0	THRESHOLD_LOW	32
SPEED_HIGH_LIMIT	338	SHIFT_MET_PLL	2
SPEED_MAX_RPM	1650	ADC_DCLINK_IDEAL	615
		ADC_DCLINK_SCALE	2183843
		RES_INC	0
		SPEED_TO_RPM	10000
		SCALE_SPEED_TO_RPM	11

Save Parameters to Flash

iMOTION™ MADK Getting Started Using µC/Probe™ GUI(3/7)

5. The default KP, KI values from the PMSM_FOC_Parameters sheet automatically will be copied to the Motor Tuning page

6. Use the Target Speed slider to set the percentage of Max. speed desired. Then, click **MotorStart** button => Motor starts to spin

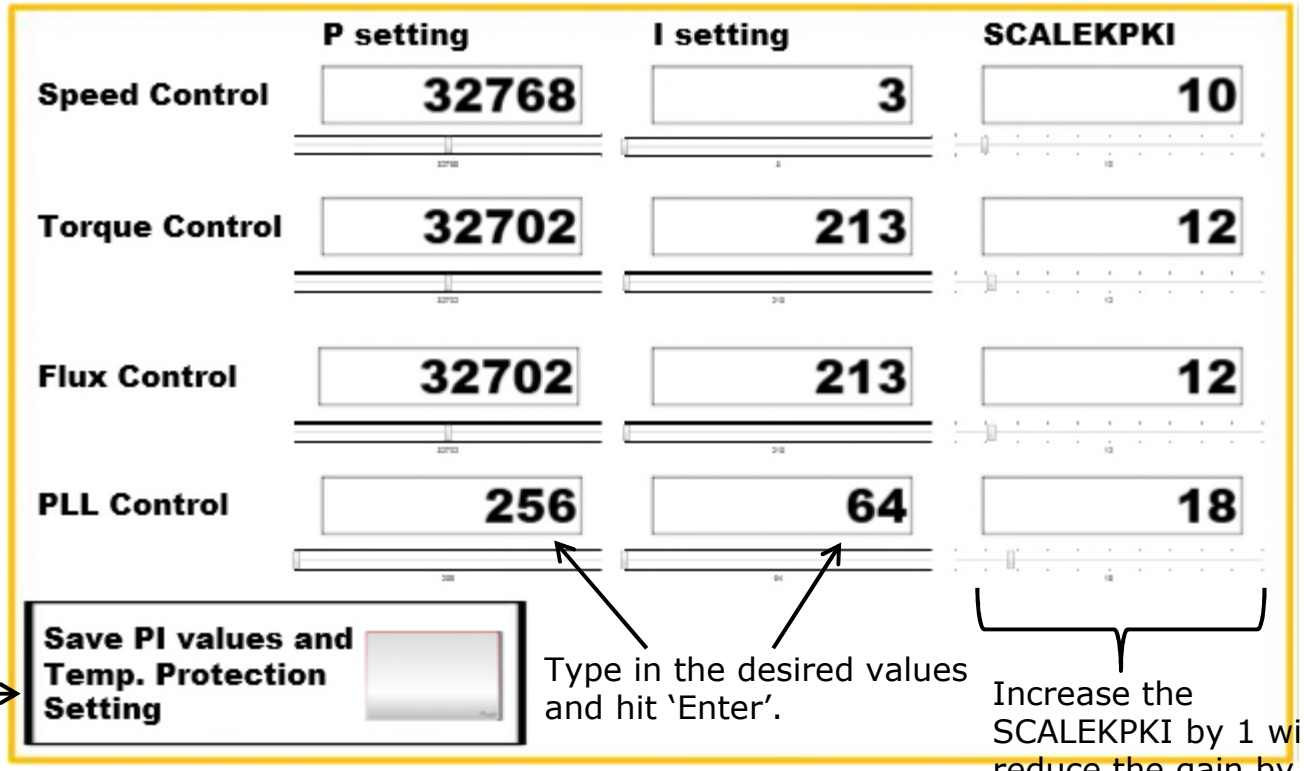


1 Move the slider to desire speed (rpm)

2 When click, Motor start to run

iMOTION™ MADK Getting Started Using µC/Probe™ GUI(4/7)

7. Under the ‘P setting’ column are the KP value for the 4 control loops.
8. Under the ‘I setting’ column are the KI value for the 4 control loops.



Modify the KP, KI and SCALEKPKI values of the 4 control loops to get optimum motor behaviour

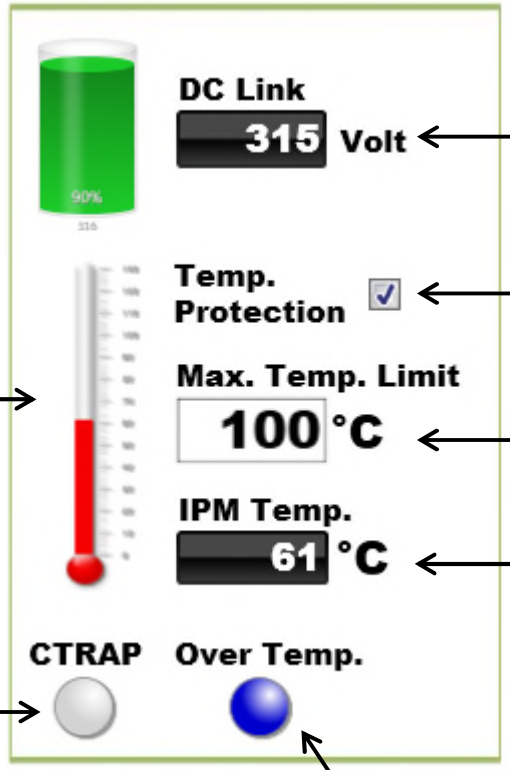
Click this button to save KP, KI, SCALEKPKI values and Temp. setting to Flash. Motor will stop.

Type in the desired values and hit ‘Enter’.

Increase the SCALEKPKI by 1 will reduce the gain by half.

iMOTION™ MADK Getting Started Using µC/Probe™ GUI(5/7)

› Over-current and Over-temperature protections



DC Link voltage

To enable/disable 'Temp. Protection'

Set Max. Temp limit for µIPM™ device to operate

Junction temperature of µIPM™ device on the Inverter Power board

Please note the 'Temperature Protection' feature is **not** available in Eval-M1-1302_05-45A and Eval-M1-1302_05-84A kits.

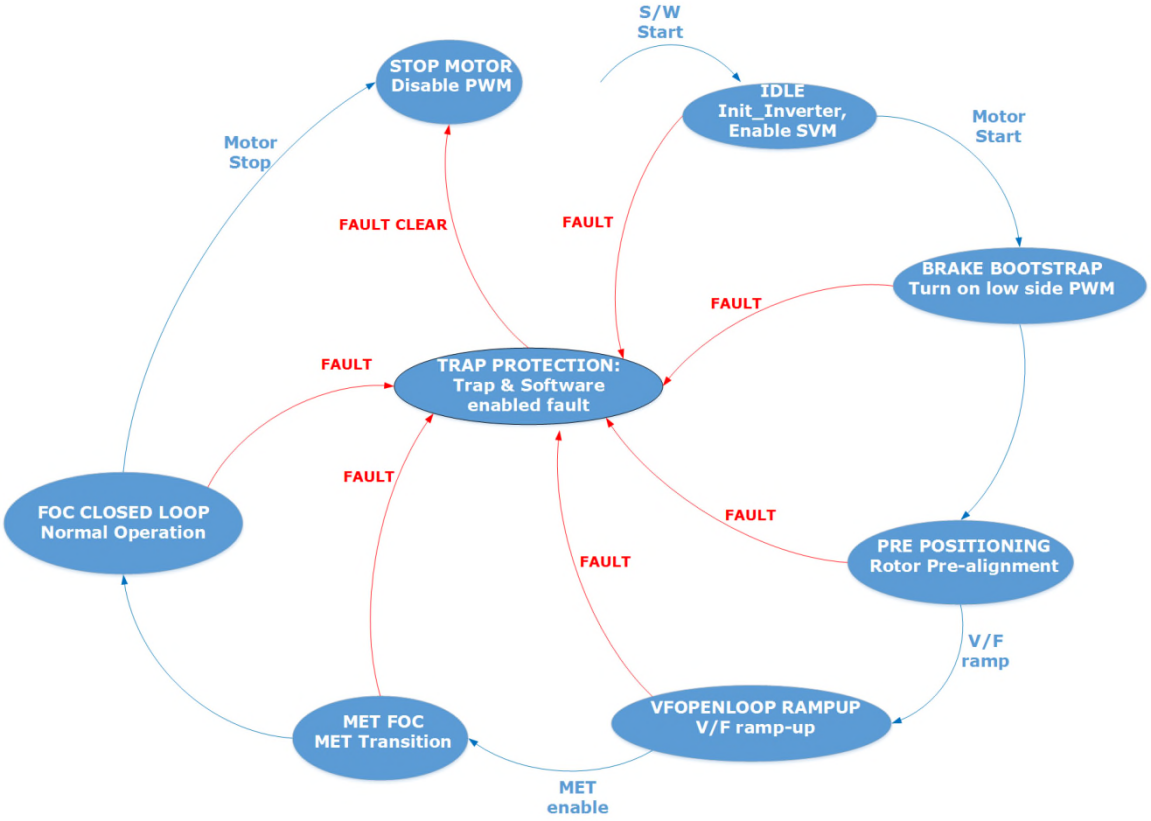
If over-current happens, CTRAP turn RED and blinking. Motor stop.

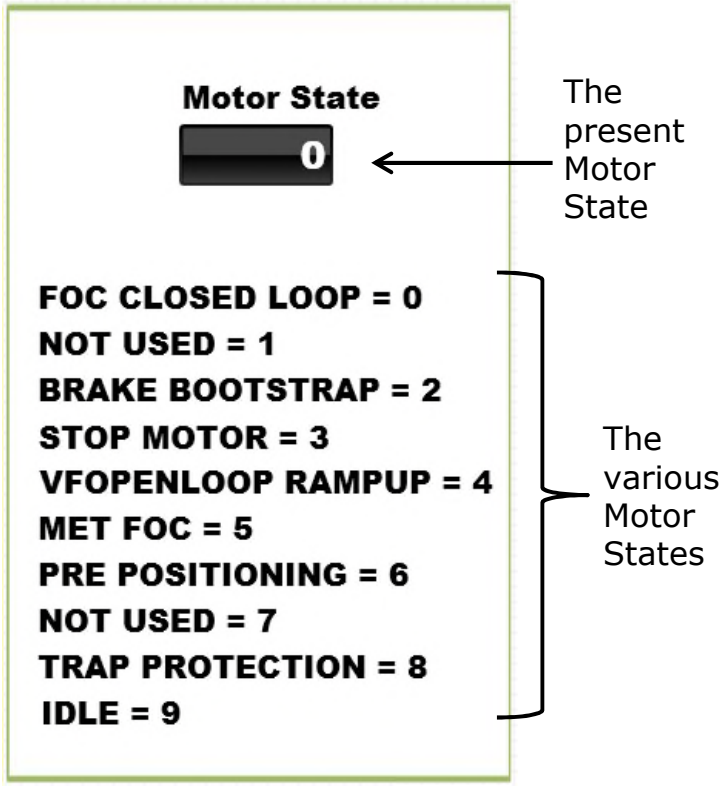
On the µIPM™ Inverter board, the trip current is set to 2.47 A for Eval-M1-05-xxD board. The trip current of Eval-M1-36-xxA board is set to 1.2 A. When the 3 phase motor currents exceed its trip current, CTRAP signal is activated and over-current detected

If 'Temp. Protection' is checked, when µIPM™ Temp. is higher than Max. Temp. , then 'Over Temp.' indicator turn RED and Motor stop

iMOTION™ MADK Getting Started Using µC/Probe™ GUI(6/7)

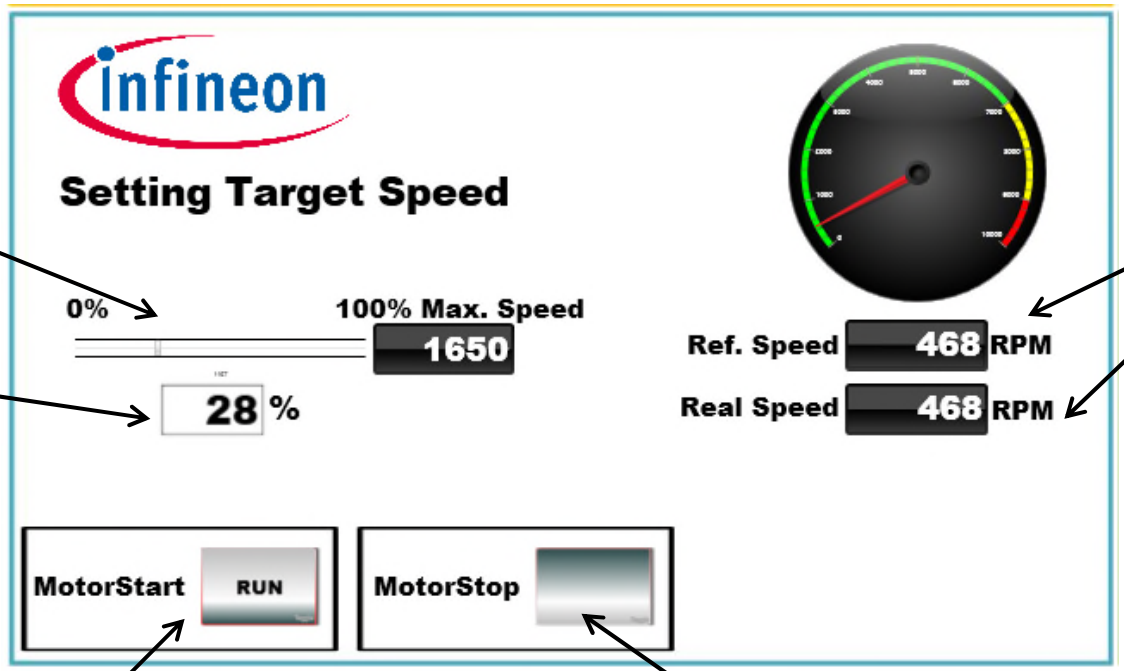
› Motor State Indicator Panel





iMOTION™ MADK Getting Started Using µC/Probe™ GUI(7/7)

› Motor Speed, Motor Start/Stop Control Panel



Use the slider to set the desired speed (rpm)

The desired speed (rpm) in % of the max. speed of the motor

The target speed

The actual speed

Click this button to run the motor after setting the desired speed

Click this button to stop the motor

iMOTION™ MADK Getting Started
Tuning motor parameters for V/F open loop

- The FOC software starts the motor with V/F control (open loop), and then transitions to FOC control (closed loop)
- If 'MotorStart' button was clicked and motor does not spin, user can increase the 'Startup V/f offset' value in 'Input Parameters' spread sheet and copy the generated VQ_VF_OFFSET value from PMSM_FOC_Parameters.h spread sheet to 'PMSM_FOC_Parameters' page of µC/Probe™ GUI.
- If the ramp-up speed is too slow, increase the 'Speed ramp-up' value in 'Input Parameters' spreadsheet and copy 'RAMPUP_RATE' value from 'PMSM_FOC_Parameters.h' to uC/Probe 'PMSM_FOC_Parameter' Page. Remember to save setting.
- If the motor starts with V/F control but after transition to FOC control motor stops, then P, I, SCALEKPKI settings of the control loops need to be tuned. See next pages…

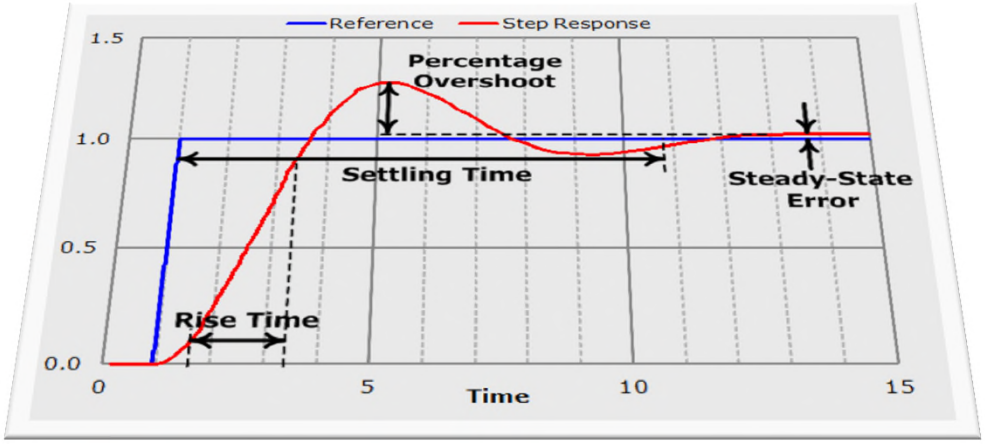
Getting Started – Tuning of K_p, K_i value using the uC/Probe (1/4)

› Effects of increasing proportional gain K_p or integral gain K_i of PI controller independently

	Gain Change	Effects on Step Response Characteristics			
		Rise Time	Overshoot	Settling Time	Steady-State Error
1	K_p ↑ K_i unchanged	↓ ☺	↑ ☹	Minor Change 😐	↓ ☺
2	K_i ↑ K_p unchanged	↓ ☺	↑ ☹	↑ ☹	Eliminate ☺

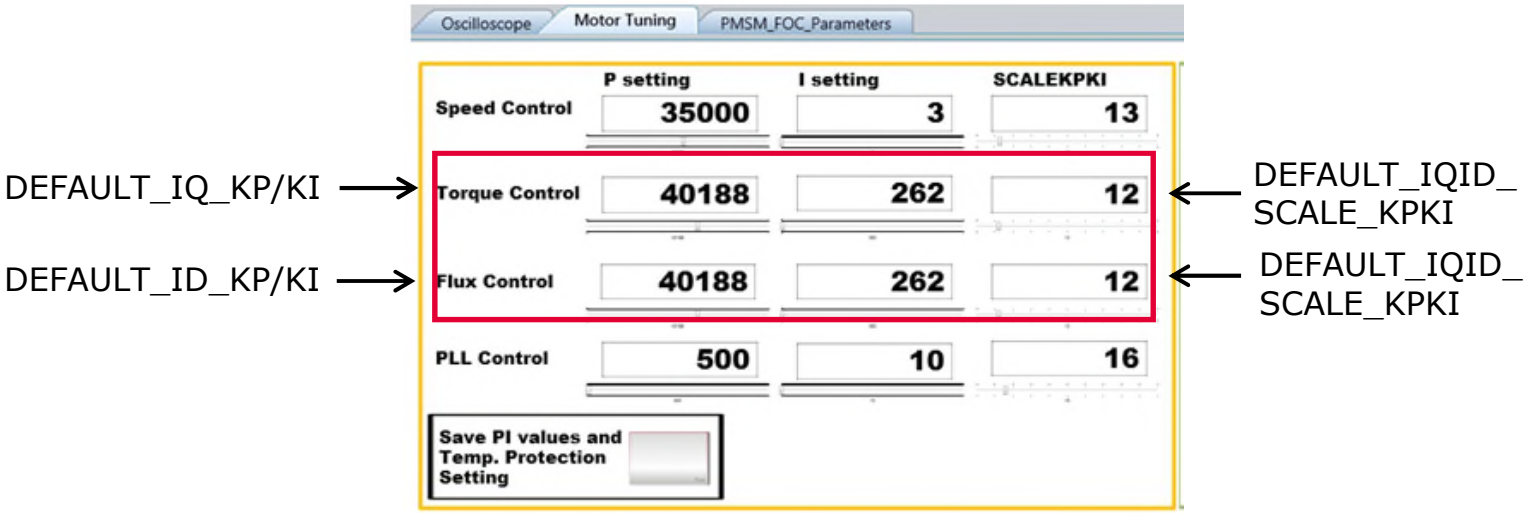
↑ Increase

↓ Decrease



Getting Started – Tuning of Kp, Ki value using the uC/Probe (2/4)

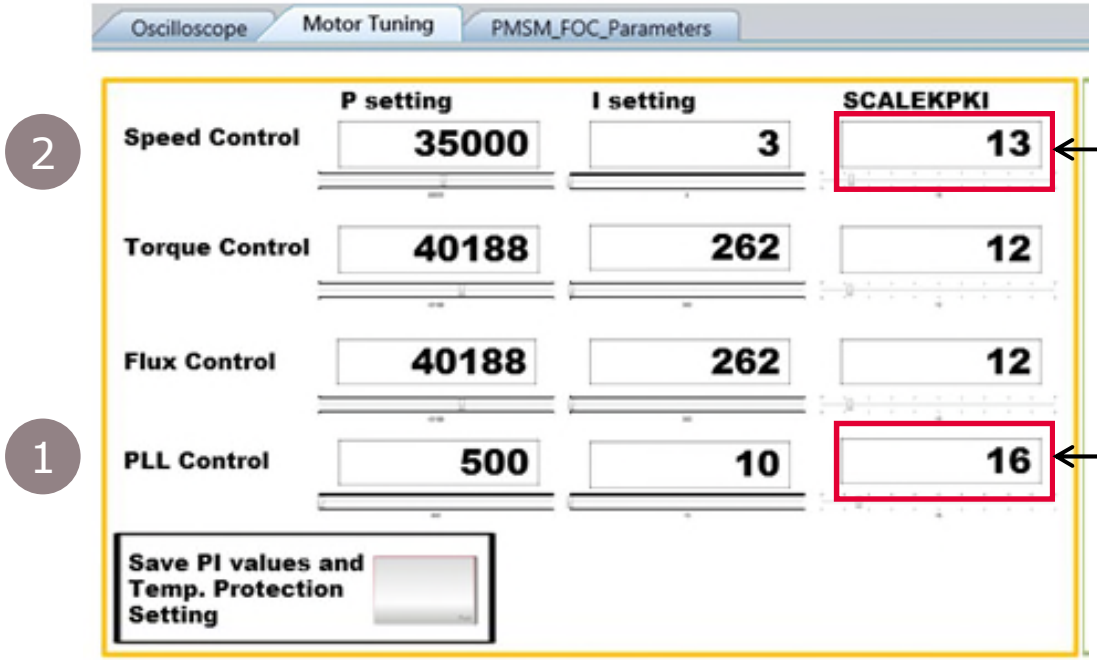
1. The values P setting, I setting and SCALEKPKI for Torque and Flux PI Controllers are calculated from the physical motor and system parameters, and typically don't need to be tuned in the first iteration.
2. The Speed Control and PLL Control parameters should start to be modified if the motor cannot transit from V/F open-loop to FOC closed-loop smoothly
3. Remember to save setting



Getting Started – Tuning of Kp, Ki value using the uC/Probe (3/4)

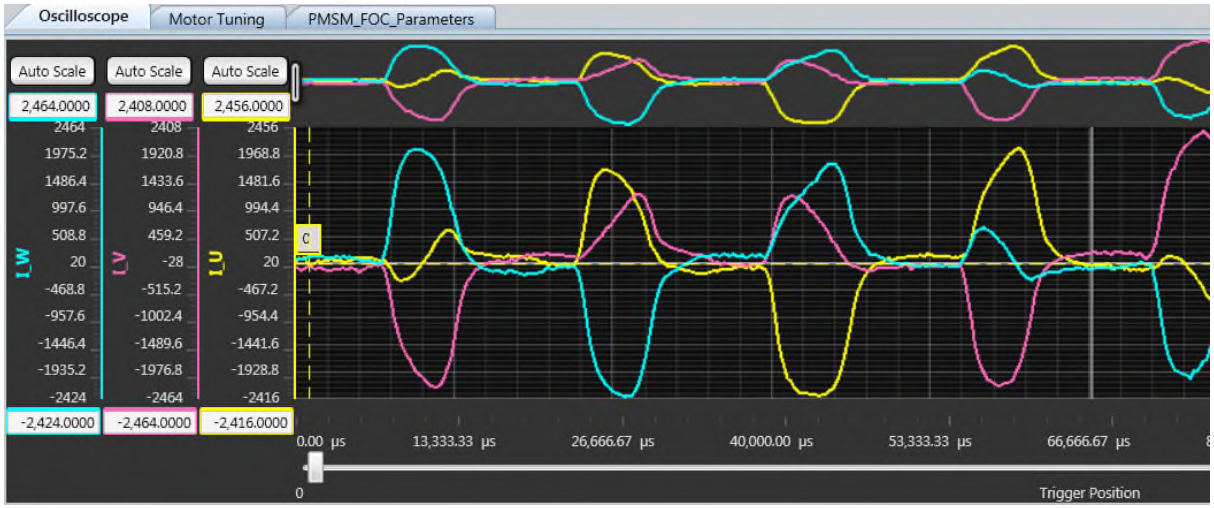
3. If the motor does not spin in FOC close loop, ↑ the SCALEKPKI of PLL Control and check the motor behaviour. If motor start to move slowly, ↑ the SCALEKPKI further. Else, ↓ the SCALEKPKI
4. Apply similar tactic for the tuning of Speed Control

PI gains: $K_p = \frac{P\ setting}{2^{SCALEKPKI}}$, $K_i = \frac{I\ setting}{2^{SCALEKPKI}}$

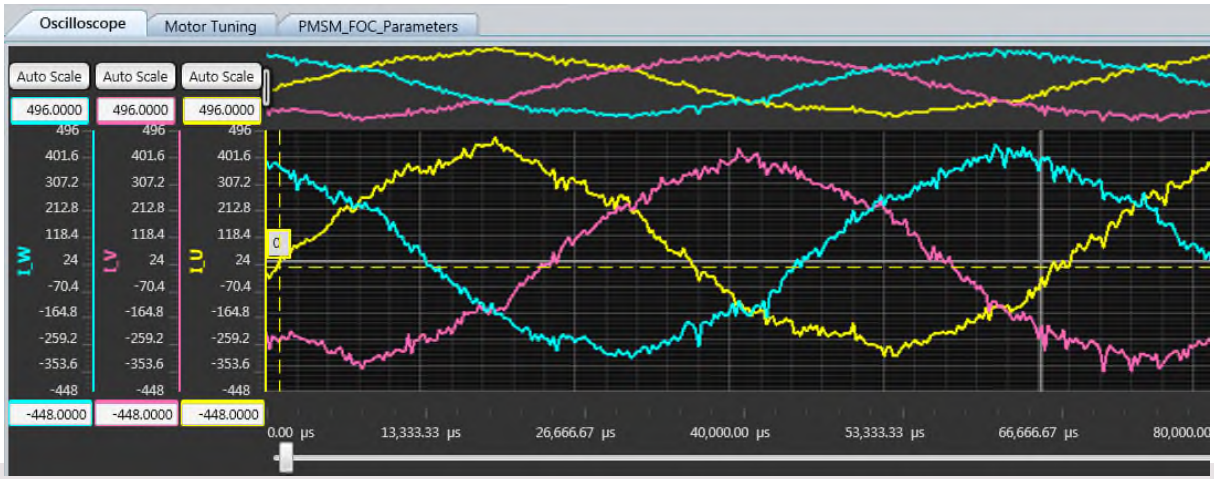


Getting Started – Tuning of Kp, Ki value using the µC/Probe™ (4/4)

5. Adjust P and I setting of PLL Control/Speed Control for finer tuning of Motor behaviour. The final goal is to achieve **sinusoidal** current waveform in the Oscilloscope page of the µC/Probe GUI.



The P, I, SCALEKPKI values are not optimized or fine-tuned, so the 3 motor currents I_U, I_V, I_W are **not sinusoidal**



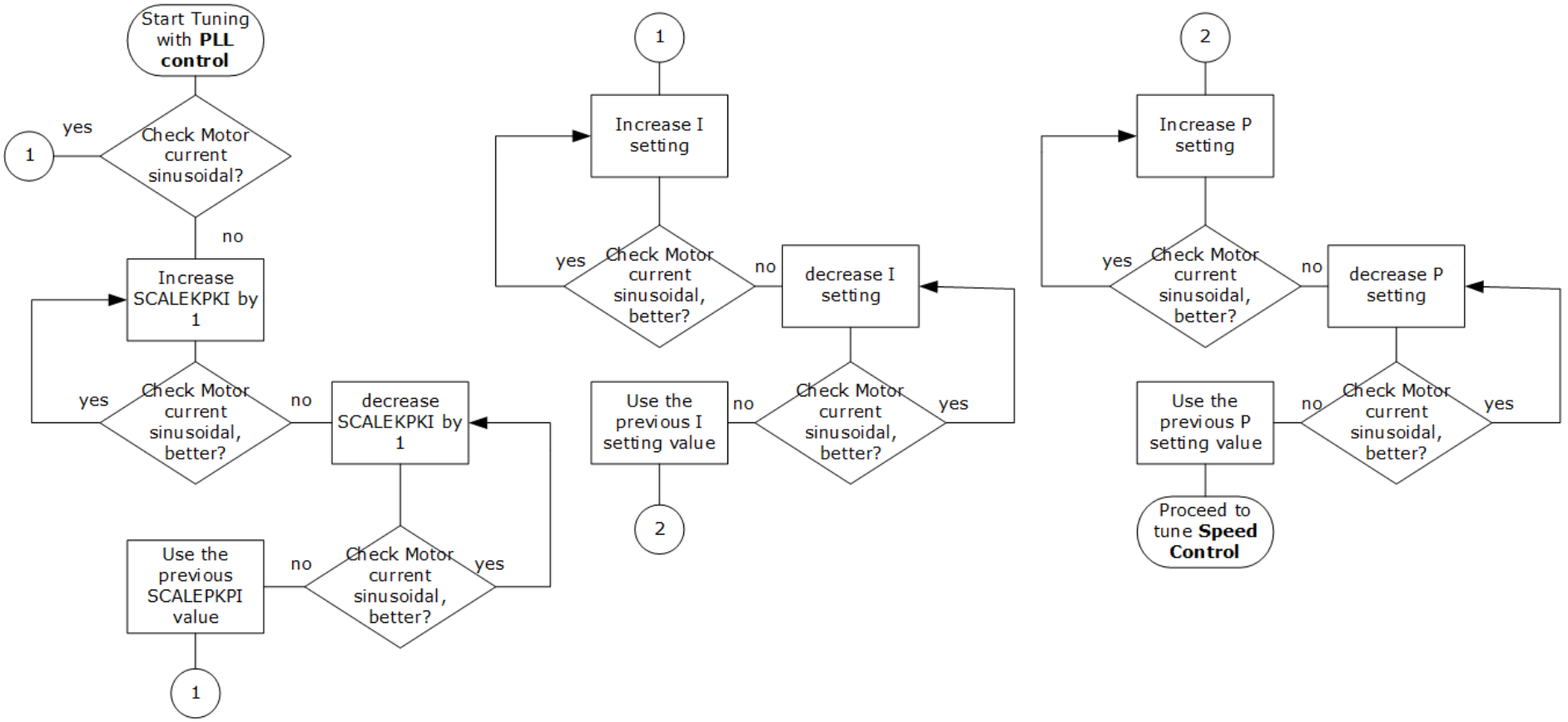
Target of tuning the P, I and SCALEKPKI values of the control loops is to achieve the target motor performance and get **sinusoidal** current shapes for the 3 motor currents I_U, I_V, I_W

General hints on tuning of SCALEKPKI, P, I value using the uC/Probe (1/2)

1. If the motor can start from V/f open loop control and then run to target speed in FOC closed loop control, but the transition from open loop to closed loop is not smooth, the user should try following:
   - ↑ 'Speed ramp-up' and 'Speed ramp-down' value and ↓ the 'Startup speed threshold' value of the 'Input Parameters' excel sheet. This will force the motor to transit to FOC control loop faster

2. For the FOC control tuning, the next page shows the procedure in form of an algorithm block diagram on how to tune PLL loop for FOC control. For Speed Control tuning the user should follow the same flow. Typically, only these 2 PI control loops need to be tuned with the FOC software for iMOTION™ MADK.

General hints on tuning of SCALEKPKI, P, I value using the uC/Probe (2/2)



iMOTION™ MADK Getting Started
Further Software Development Support

- Once the motor control system using iMOTION™ MADK has met the target performance for their applications, users may require the DAVE™ project files including the XMC™ motor control source code for further application development
- DAVE™ project files corresponding to .hex file for each particular iMOTION™ MADK kit will be made available for download at www.infineon.com/MADK, as well as through DAVE example projects repository

  http://www.infineon.com/cms/en/product/promopages/aim-mc/dave_downloads.html
- Infineon is constantly improving FOC control algorithm and the firmware code and example projects will be updated regularly
- If source code you requested is not available, please contact the nearest Infineon sales office or support team

Agenda

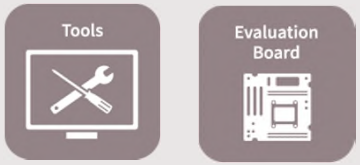
1. iMOTION™ MADK Overview
2. Hardware and Software Overview
3. Tools Overview
4. Getting Started
5. Resource Listing

Resource Listing

- Kit documentation:
  - EVAL-M1-1302 User Manual
  - EVAL-M1-36-(84A/45A) or EVAL-M1-05-(84D/65D) User Manuals

www.infineon.com/MADK

Support material:

Collaterals and Brochures 	– Product Briefs – Selection Guides – Application Brochures – Presentations – Press Releases, Ads	– www.infineon.com/XMC
Technical Material 	– Application Notes – Technical Articles – Simulation Models – Datasheets, MCDS Files – PCB Design Data	– www.infineon.com/XMC – Kits and Boards – DAVE™ – Software and Tool Ecosystem
Videos 	– Technical Videos – Product Information Videos	– Infineon Media Center – XMC Mediathek
Contact 	– Forums – Product Support	– Infineon Forums – Technical Assistance Center (TAC)

Glossary abbreviations

ADC	Analog-to-Digital Converter
FOC	Field-Oriented Control
IPM	Intelligent Power Modules
MADK	iMOTION™ Modular Application Design Kit
MET	Maximum Efficiency Tracking
PI Controller	Proportional–Integral Controller
PMSM	Permanent Magnet Synchronous Motor
PWM	Pulse Width Modulation
SVM	Space vector modulation
XMC™	Cross-Market Microcontrollers

Disclaimer

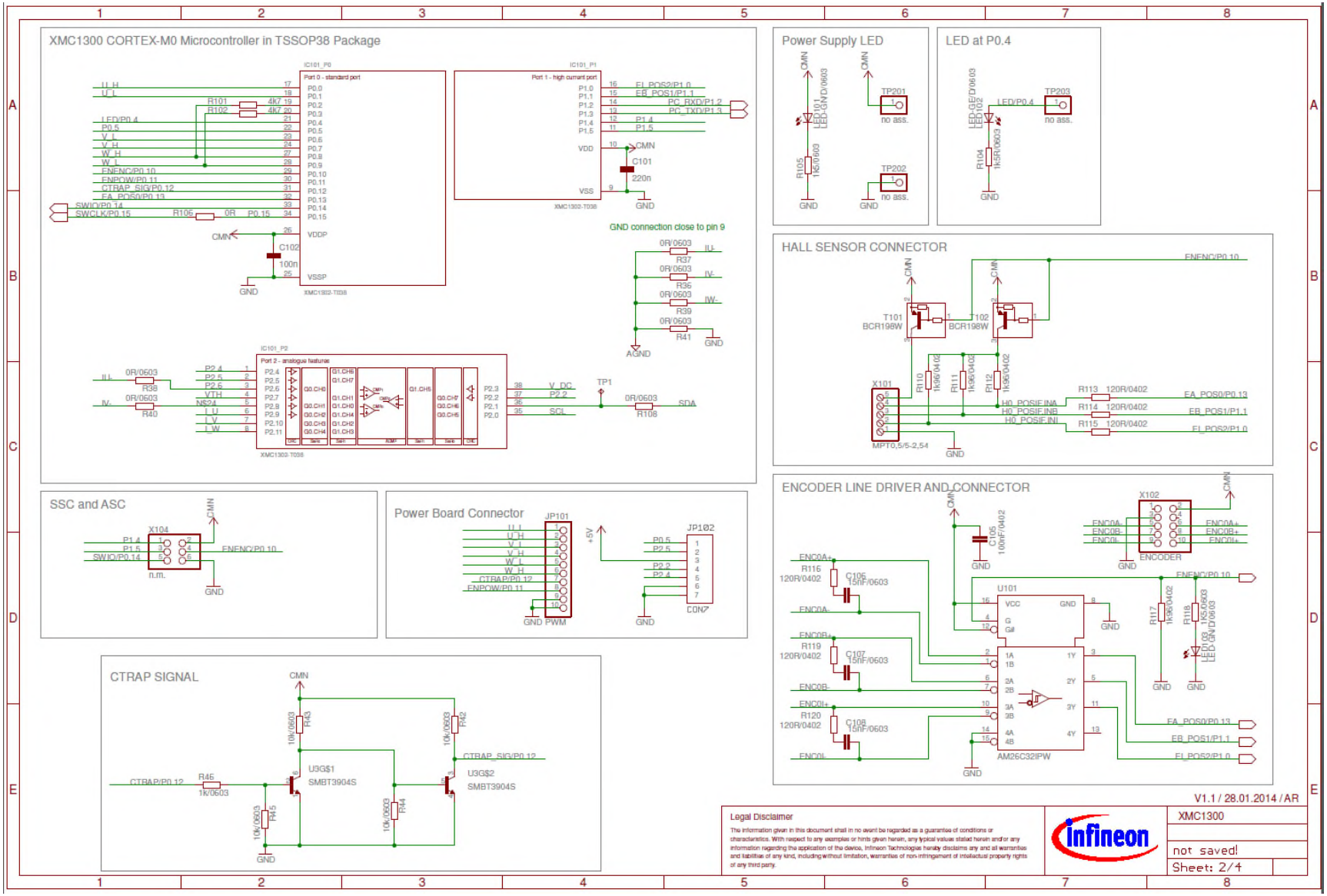
The information given in this training materials is given as a hint for the implementation of the Infineon Technologies component only and shall not be regarded as any description or warranty of a certain functionality, condition or quality of the Infineon Technologies component.

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 training material.

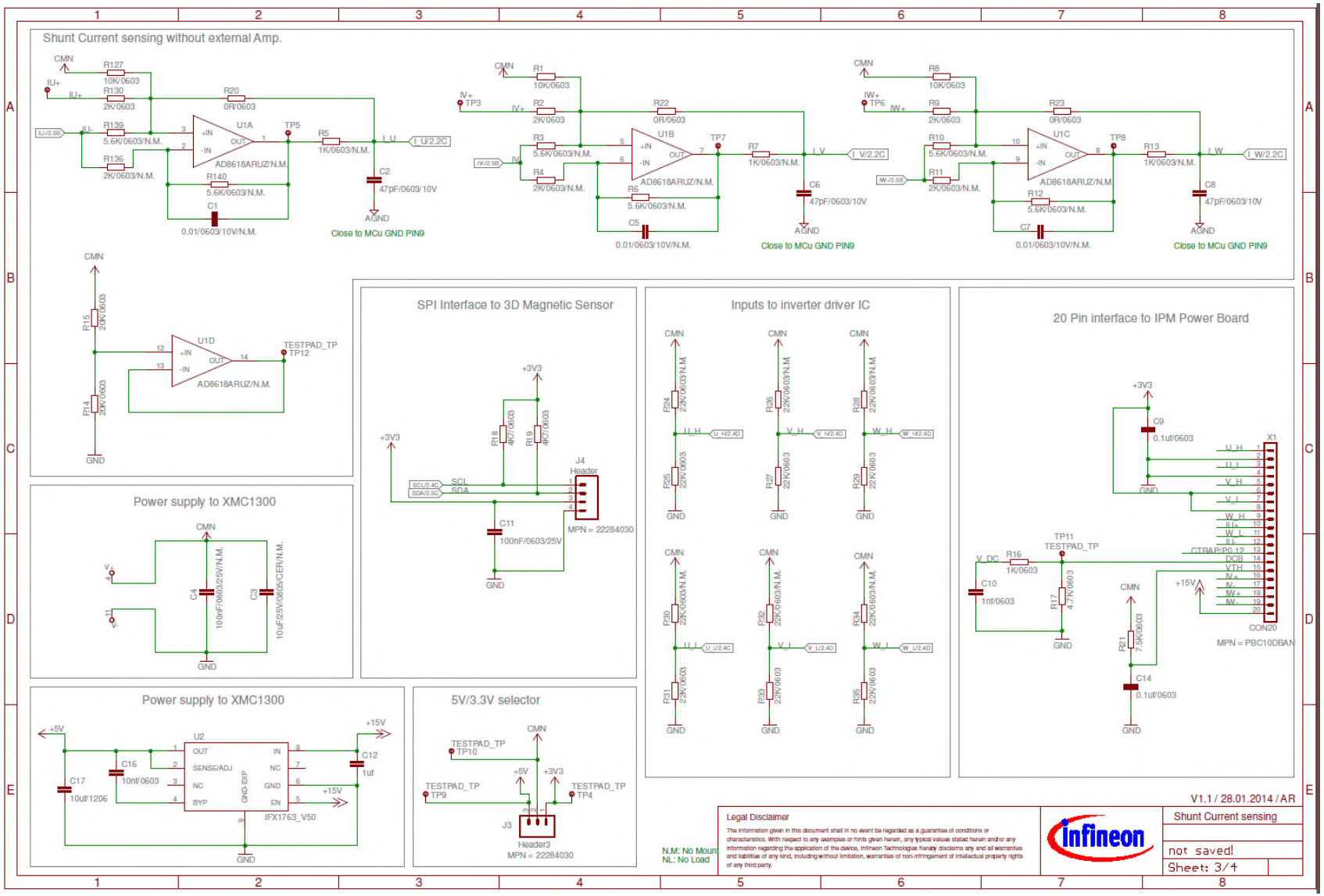
Part of your life. Part of tomorrow.

Infineon

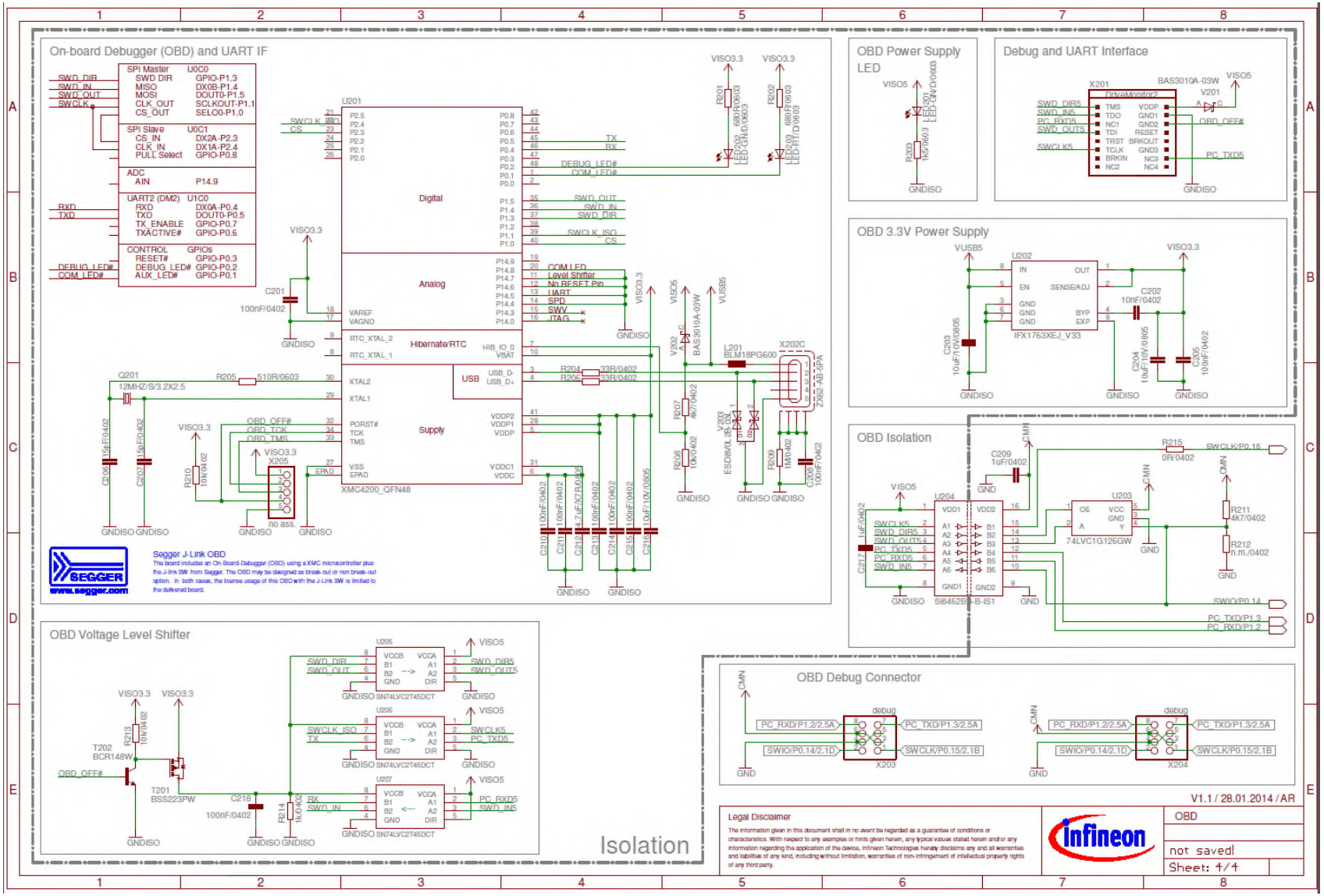
Schematic of Eval-M1-1302 board (1/3)



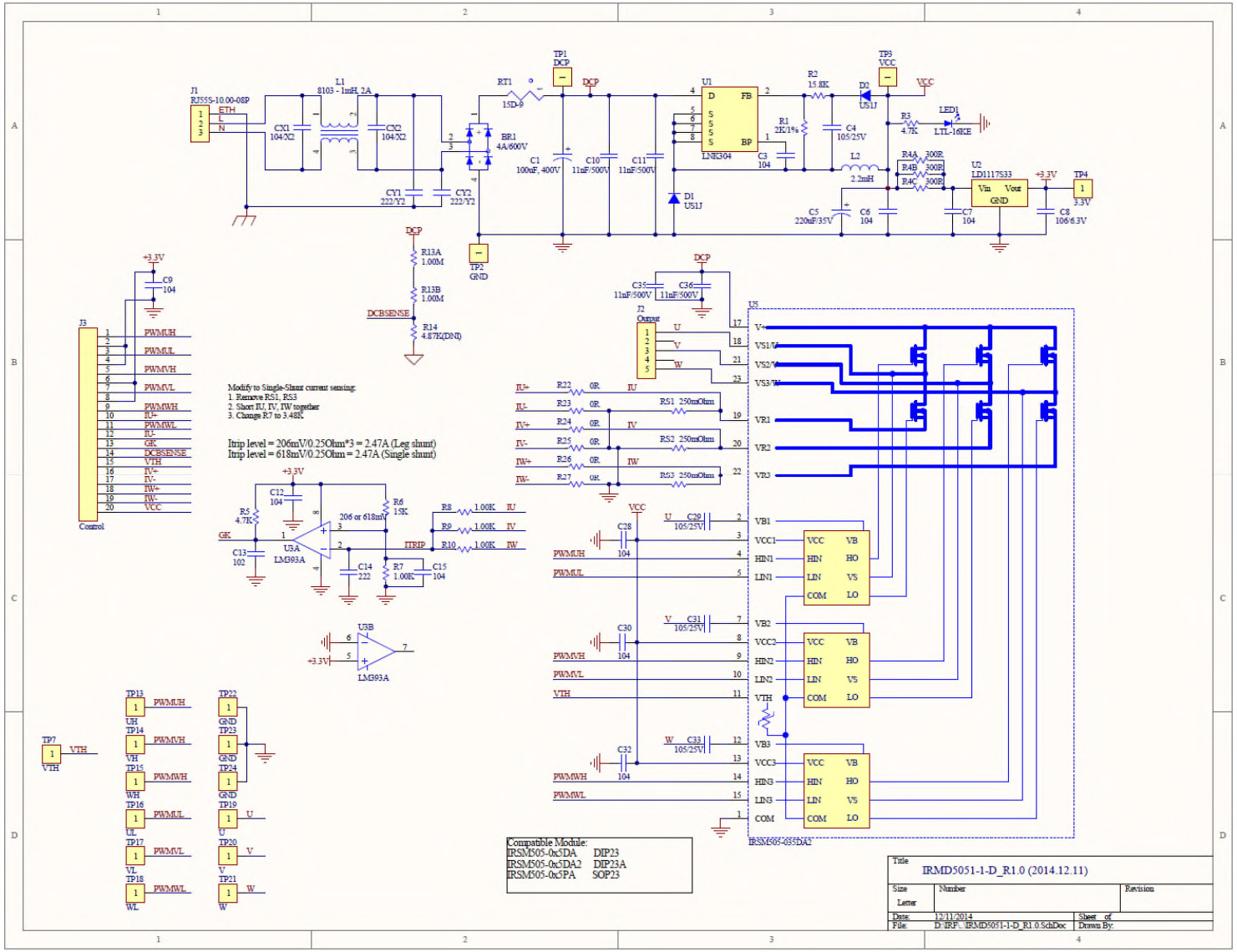
Schematic of Eval-M1-1302 board (2/3)



Schematic of Eval-M1-1302 board (3/3)



Schematic of Eval-M1-05-xxD



Schematic of Eval-M1-36-xxA