User's Guide MCF8329A Tuning Guide



ABSTRACT

This tuning guide provides step-by-step guidance to setup the MCF8329EVM, connect the MCF8329EVM to Motor Studio, and tune a 3-phase brushless DC motor using the MCF8329A motor driver.

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1 Introduction

The MCF8329A is a 4.5-V to 60-V, three-phase brushless-DC (BLDC) gate driver IC with code-free sensorless field oriented control (FOC) for motor drive applications. The device integrates a single shunt current sense amplifier (CSA) along with an external shunt resistance to sense the motor current. This document helps customers to set up the MCF8329A, enabling them to experience the devices' powerful performance and flexible programmability.



Figure 1-1. Tuning Sequence of Events

Note

Before proceeding through this tuning guide make sure to do the following:

- 1. Read the MCF8329A Sensorless Field Oriented Control (FOC) Three-phase BLDC Gate Driver Data Sheet, MCF8329EVM User's Guide, and watch the quick start video.
- 2. Get a MCF8329EVM board.
- 3. Install the Motor Studio application.



2 Hardware Design and Setup

The goal of this section is to help users select appropriate components for the external power stage components of the MCF8329A and set up the user configurable settings of the MCF8329EVM.

2.1 Board Design

The following sections provide equations and guidelines for selecting power stage components to achieve desired performance from the motor driver system.

2.1.1 External MOSFET Selection

The MOSFETs for the external half bridge that can be supported by the MCF8329A can be determined by inputting the MOSFET gate charge, output PWM switching frequency, and PVDD voltage into the Max Qg MOSFET Calcualtor Tool available on ti.com.

2.1.2 Gate Resistor Selection

Selection of an appropriate gate resistance to limit the gate drive current so that the drain-to-source voltage slew rate (VDS) is set to an appropriate level for the external MOSFETS is essential to achieving good system performance. For more information on the importance of and how to select an appropriate gate resistor value, see the *Gate Drive Current and Gate Resistor Selection* sections in the *MCF8329A Sensorless Field Oriented Control (FOC) Three-phase BLDC Gate Driver Data Sheet*. To simplify the gate resistance selection process, the Gate Resistor Calculator can be used to estimate the gate resistance required to achieve a desired VDS rise and fall time with an accuracy of ±30%.

2.1.3 Bootstrap and GVDD Capacitor Selection

The bootstrap and GVDD capacitors must both be sized appropriately to maintain the bootstrap voltage above the under-voltage lockout threshold during normal operation. For instructions to determine an appropriate capacitance for both the bootstrap capacitors and GVDD capacitor, see the *Bootstrap Capacitor and GVDD Capacitor Selection* sections of the *MCF8329A Sensorless Field Oriented Control (FOC) Three-phase BLDC Gate Driver Data Sheet*.

2.1.4 Current Shunt Resistor Selection

The internal FOC algorithm uses the output of the internal current sense amplifier (CSA) in its computations. It is recommended to set the max measurable current of the internal CSA to 10% above the motors stall current. To determine an appropriate value for the CSA gain and external low-side shunt resistor, see section 7.3.5 of the *MCF8329A Sensorless Field Oriented Control (FOC) Three-phase BLDC Gate Driver Data Sheet*.

2.1.5 VREG MOSFET Selection

The GCTRL pin can be used to drive an external MOSFET that can be used as a voltage regulator to provide power to the VREG pin to reduce power dissipation within the MCF8329A. Instructions on how to select an appropriate MOSFET are provided in section 8.2.1 of the *MCF8329A Sensorless Field Oriented Control (FOC) Three-phase BLDC Gate Driver Data Sheet*.

2.1.6 Additional External Power Stage Components

For additional considerations for external components of the MCF8329A and for high power systems, see the System Considerations in High Power Designs, Capacitor Voltage Ratings, and External Power Stage Components sections of the MCF8329A Sensorless Field Oriented Control (FOC) Three-phase BLDC Gate Driver Data Sheet.



3 Connecting to the GUI

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Before connecting the MCF8329EVM to the computer, start up the Motor Studio application and select MCF8329A from the drop down. Click on *Proceed* and then click on the *Setup Now* button for instructions on how to connect power, connect a motor, and configure the jumpers and switches on the EVM.

Motor Studio File Options Tools Help Documents	
	Hardware Setup
Exection Rescar Rescar Could Spin Could Spin	Connect more phases to A. B. C on connector J11 Dende timore phases to A. B. C on connector J11 Dende timore phases to A. B. C on connector J10 Dende timore phases to A. B. C on connector J10 Select J40 b9/L208 and J8b 3/VCCMb power MSP400 hon USB power supply Connect more USB and one than connector J10 Dende timore USB and J8b 3/VCCMb power MSP400 hon USB power supply Connect more timore USB and J8b 3/VCCMb power MSP400 hon USB power supply Connect more USB and J8b 3/VCCMb power MSP400 hon USB power supply Connect more USB power supply
Advanced Tuning Access all your centrol in one single page.	7. Fig the awitch SW1 to kit to configure SPEED/WAKE pin to SPEED mode and DACOUT/SOx/SPEED_ANA.pin to DACOUT mode. Note that flipping the witch SW1 to right will configure SPEED/WAKE pin to WAKE mode and DACOUT/SOX/SPEED_ANA.pin to SPEED_NAM.mode. WHOM SW1 is flipped and right, switch 34 can be used to put the device in SLEEP or WAKE mode and potentimeter RA7 can be used to apply amiling voltage to the DACOUT/SOX/SPEED_ANA.pin to International provided and provided and potentiation.
Register Map Full interactive device register map.	Select J12 to helmost postion(closer to C6) to apply AVDD to VERC9 Select J12 to helmost postion to apply analysis vitiliapil tiom potentionnet RR1 to SPEEDVIAKE pin To Turi on the note poster schedule schedule schedule to the selective to disable the motor driver, change the through a particular to the control user to accurate the selective to disable the motor driver, change the discloser and party a traits to the motic Ciptorality use the QUI (as shown in Section 6) to monitor real-time speed of the discloser and party a traits to the motic Ciptorality use the QUI (as shown in Section 6) to monitor real-time speed of the discloser and the section of the section schedule of the motor driver.
60	motor, put the NCF8329A into a low-power sleep mode, and read status of the LEDs. Hardware setup has been done manually Kotup Now 3

Figure 3-1. EVM Hardware Setup

Once the hardware setup is completed, turn on the power supply connected to the EVM. After the PVDD LED D3 lights up connect a micro-USB to USB cable between the EVM and PC. After a few seconds, Motor Studio should connect to the EVM and the two icons outlined in Figure 3-2 will turn green. If the EVM is not connecting click the *Re-Scan* button.

Notor	Studio						- 0 ×
Moto	or Studio	File O	ptions	Tools	Help	Documents	
ŵ	Select Device MCF8329A		•				Hardware Setup
\otimes	MCF8329/	6					
	EVM Conne Device Dete	cted : MCF8329	A				
Ó							
1:1	Proceed	ack					
¢.	Quick S Get your	pin motor spining in	n just few step	N	ext		
	Go here	ation Wizard	spin consister	atly.			Connect motor phases to A, B, C on connector J11 Do not turn on the power supply vet. Connect motor supply to PVDD and GND on connector J10
»	Advance Access a	ed Tuning	i one single pa	ge.			Select J8 to 5V_USB and J8 to 3V3COM to power MSP430 from USB power supply Connect the micro-USB cable into the computer Turn the potentiometer fully clockwise to set the motor to zero speed upon powerup
Θ	Full inter	r Map active device reș	gister map.				E. Flip the switch S1 to the top to configure BRAKE = RUN, switch S2 to the top to configure DRVDFF = ON, switch S3 to the bottom to configure DIR = ABC, and switch S4 to the bottom to configure to WAKE O The Hardware setup is done Reconfigure

Figure 3-2. EVM Connected Indicators

Note

If the GUI is not able to connect to the GUI after a minute, disconnect the EVM from the PC, restart the Motor Studio GUI. After Motor Studio has started again, reconnect the EVM to the PC.



4 Spinning Into Closed Loop

This section provides standardized steps to tune the MCF8329A's settings so that the motor can successfully spin-up and enter closed loop control.

The general steps to tune the MCF8329A's registers so the motor can spin-up and enter closed loop control are outlined in Figure 4-1.



Figure 4-1. Essential Controls Flow Chart

4.1 Essential Configuration

4.1.1 Loading Recommended Default Values

Select the *Quick Spin* option on the Motor Studio Home page or on the menu on the left side of the window. Using the *Select Preset* drop down menu in the *Load Default* section select a register configuration which is most similar to the application use case or the *Default MCF8329A Registers* option. After selecting the desired register configuration, click on the *Load Preset Values* button.



Figure 4-2. Load Default Register Configuration

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4.1.2 Setting Base Current

Using the shunt resistor value and CSA gain value determined in Section 2.1.4, use Equation 1 to calculate the max measurable current of the internal CSA.

$$\frac{1.5}{RSENSE} \times \frac{32768}{1200}$$
(1)

After converting the result from Equation 1 into a hexadecimal value, input the result into the BASE_CURRENT bit field in register GD_CONFIG2 using the *Register Map* page.

earch registers by name address or bitlie	Id name Q Show bits		Regis	ers •	Controls Faults	Charts	Logs
Register Name	Address	Value	Field View	120	C CONTROLS		
Algorithm Configuration		v	GD_CONFIG2	Sp 120	eed Control via I2C C Target Address (GUI side)	Disabled	
ault Configuration		~	0x 0	0			Find Addre
			RESERVED	120	C Speed Command Percenta	ge (%)	0.00
iternal Algorithm Configuration		×	RESERVED	0%	6 25% 50%	75% 100%	1 Former
ardware Configuration		^	PARITY	мс	OTOR STATUS	Auto Read Motor S	Status 🗰 I
PIN_CONFIG	0x000000A4	0x00000000	PARITY	Sta	atus Select		
DEVICE_CONFIG1	0x00000A6	0x00000000		Alg	gonthm State DTOR_IDLE	VM Voltage 00.0 V	
DEVICE_CONFIG2	0x000000A8	0x00000000		Re 00.	eference for Speed Loop .0 Hz	Speed FDBK 00.0 Hz	
PERI_CONFIG1	0x000000AA	0x00000000					
GD_CONFIG1	0x000000AC	0x00000000					
GD_CONFIG2	0x000000AE	0x00000000					
Fault Status		×	-				
System Status		v					
Device Control		~					

Figure 4-3. BASE_CURRENT Bit Field



4.1.3 Setting Current Limits

All the current limits within the MCF8329A are set as a percent of the value programmed into the BASE_CURRENT bit field. For example, if BASE_CURRENT is set to 37.5A and ILIMIT is set to 50%, then the current limit set by ILIMIT will be 18.75A.

HW_LOCK_ILIMIT and LOCK_ILIMIT are configurable current limits intended to protect the system from damage. It is recommended to set these limits to two times higher than the motors rated peak phase current. If the motors rated peak phase current falls between two adjacent limit settings in the configuration, choose the higher of the two settings.

Pre-Starture Motor Startup Oper Loop and Handel Devel Leve More Step Auto Read All Registers Control Configuration- Open Loop Control Configuration- Open Loop Control Configuration- Open Loop	1: s	2C CONTROLS	
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Loninedaga Paul Receive (Mole (ML, VML, MOLE) Overndaga Faul Receive (Mole (ML, VML, MOLE) Automatic clear if voltage in bounds No Limt	~		

Figure 4-4. Current Protection Limits

ILIMIT, OL_ILIMIT, ALIGN_OR_SLOW_CURRENT_ILIMIT, and IPD_CURR_THR are the max current that are used by the motor driver during the various stages of motor operation. It is recommended to set these values to less than or equal to the rated max phase current of the motor.

Мо	tor Studio	File Options	Tools	Help	Documents							
☆ ⊗ 荘 ぐ	Pre-Startup Mot	or Startup Open L	xop and Han	doff	Closed Leep Motor SI	op'	Show Advance Settings Show Modified Registers Auto Read All Registers		> Controls I2C CONT Speed Contro I2C Target A	Faults	Charts Disabled	Logs
•	Control Configu	TR_STARTUP]	ip Station	Align or si 25 A/s	aw first cycle oursent ramp rate (AUGN_SLOW_RAWP_R]	Align time (ALIGN_TIME)3 s	~	0x0 12C Speed Co 0% 25'	mmand Percenta	ge (%) 75% 100	Find Address
#	- Align or slow first cycle o 30 %	urrent limit (A) (ALIGN_OR_SLO	V_CURR	100 Hz	Frequency (IPD_CLK_FREQ)		IPD Current Threshold (A) [IPD_CURR_THR]	~	MOTOR S	TATUS	Auto Read Motor	Status 🔵 Disable
	IPD release mode (IPD_ Enable	RLS_MODE)		- IPD advan 90°	ce zogle [IPD_ADV_ANGLE]	1	Number of times IPD is executed [IPD_REPEAT]	~	Status Select			~
	Align Time (ALIGN_ANG 90 deg	LE]	~	Calculated F	requency of First Cycle (Hz)		Prequency of first cycle in close loop startup (% of MAX_SPEED 0.7%	ш. ~	Algorithm Stal MOTOR_IDLE Reference for 00.0 Hz	e Speed Loop	VM Voltage 00.0 V Speed FDBK 00.0 Hz	
	Starting frequency of firs	t cycle (FIRST_CYCLE_FREQ_S	ELJ	IPD high a	esolution enable [PD_HIGH_RESOLUTION_EN] Disable							
	Control Configu	ration-Motor Parar	neters E>	traction	Tool(MPET)			~				
	Control Configu	ration-Motor Parar	neters					~				
	Control Configu	ration- Open Loop						^				
>>	Open loop current limit o Open loop	enfguration (OL_ILIMIT_CONFIG current limit defined by C	I L_ILIMIT	le ramp de	wn after transition to close loop (IQ_RAMP_EN) Enable ig ramp down		Open Loop current limit (A) (OL_JLIWIT) 40 %	~				
G	Open loop acceleration 25 Hz/s	coefficient A1 (OL_ACC_A1)	~	Open loop 10 Hz/s	acceleration coefficient A2 (OL_ACC_A2)	•]	Auto Handoff Enable (AUTO_HANDOFF_EN)		EEPROM	Controls		EEPROM ·

Figure 4-5. OL_ILIMIT, ALIGN_OR_SLOW_CURRENT_ILIMIT, and IPD_CURR_THR Current Limits

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			Show Advance Settings		> Controls Faults	Charts	Logs
re-Startup Motor Startup Open Loop		Closed Loop Motor S	Auto Read All Registers	P	I2C CONTROLS Speed Control via I2C I2C Target Address (GUI s	Enabled	,
Control Configuration- Open Loop				~	0x0		Find Address
Control Configuration- Control Fault	Settings			~	I2C Speed Command Perce	intage (%)	0.00
Control Configuration- Closed Loop					0% 25% 50%	75% 100	196
Closed loop acceleration rate (CL_ACC) 500	~	Closed loop deceleration select [CL_DEC_CONFIG] Closed loop deceleration defined by CL_AC	Closed loop deceleration rate [CL_DEC]	×	MOTOR STATUS	Auto Read Moto	r Status 🔵 Disab
- Kp coefficient for current liq and ld loop [CURR_LOOP_KP] — 0		KI coefficient for current lig and ld loop (CURR_LOOP_KI)	Kp coefficient for speed loop (SPD_LOOP_KP)	ž	Algorithm State	VM Voltage	
Min Range: 0. Max Range: 255 Ki coefficient for speed loop [SPD_LOOP_K]		Min Range: 0; Max Range: 255000 Reference for Torque PI Loop (A) [LIWIT]	Min Range: 0, Max Range: 2.55 Flux Weskening Ka (FLUX, WEAKENING_KP)		Reference for Speed Loop 0.0000 Hz	Speed FDBK 0.0000 Hz	
0	•	60 %	- 1.6	0			
Min Narge 0, Max Hange 25.5		Close loop acceleration when estimator is not yet fully aligned (Hz.	Min Nange: 0, Max Hange: 25.5				
160 Min Banos 0 May Rance 2550		200	 100 Nin Rance: 0. May Rance: 3070 	•			
Enable Maximum Tarque Per Ampere Operation (MTPA_EN) MTPA disabled		Response_to_change_st_DIR_still_status (DIR_CHANGE_MODE) Change the direction through Reverse Drive while continuously driving the motor	PLUX WEAKENING REFERENCE (FLUX_WEAKENIN) 95%	o_REFERE ~			
Control mode [CTRL_MODE]	~						

Figure 4-6. ILIMIT Current Limit

4.1.4 Setting Voltage Limits

BUS_VOLT is used to normalize the modulation algorithm that will be used by the MCF8329A. To improve the resolution of the modulation algorithm at lower motor voltages set the BUS_VOLT to the closest value that is still greater than the expected DC bus voltage or phase voltage. Make sure to account for voltage spikes on the phase node when determining the max expected voltage value.

In applications where the motor voltage cannot go above a certain level, MAX_VM_MOTOR can be used to set the desired voltage limit.

Mo	tor Studio File Options Tools	Help Documents			
4 ③ 平 《	Pre-Startup Motor Startup Open Loop and H	andoff Closed Loop. Motor Stop	Show Advance Settings Show Modified Registers Auto Read All Registers	Controls Faults	Charts Logs
• •	System Level Configuration Enables Over modulation [OVERMODULATION_ENABLE] Disable Over Modulation	PVM output frequency (PVM_FREQ_OUT)	PVMI modulation (PVM_MODE) Continues Space Vector Modulation	0x0 I2C Speed Command Percent 0% 25% 50%	Find Address age (%) 0.00 \$ 75% 100%
	F6 select [F0_SEL] Output F6 in ISD.open loop and closed loop (F6 output BEMF threshold [F0_BEMF_THR] +/- 10mV	FG Division factor (FG_DIV) Divide by 1 (2-pole motor mechanical speed) AVS enable (AVS_EN) Enable	F6 autput centiguration [F0_CONFIG] F6 active till BEMF drops below BEMF threshold defined by F6_BEMF_THR Deattime compensation enable (DEADTIME_COMP_EN) Disable	MOTOR STATUS Status Select Agorithm State	Auto Read Motor Status Disable
	Minimum voitage for runing motor(V) [MIN_VM_MOTOR]	Undervoltage Fault Recovery Mode [MIN_VM_MODE] Automatic clear if voltage in bounds	No Limit	Reference for Speed Loop 0.0000 Hz	Speed FDBK 0.0000 Hz
	Overostage Fault Recovery Mode (MAX_VM_MODE) Automatic clear if voltage in bounds Dynamic voltage Gain adjust (DYNAMIC_VOLTAGE_GAIN_EN) Dynamic Voltage Gain is Disabled	Maximum Bus Votage Configuration (BUS_VOLT) 60 V Spread Spectrum Modulation Disable (SPREAD_SPECTRUM_MO SSM is Disabled	Dynamic CSA Gain aduat (DYNAMIC_CSA_GAIN_EN) Disable MCC DEAD TIME [MCC_DEAD_TIME] 500 ns		
	Bus Current Lint (BUS_CURRENT_LIMIT)	Bus Current Limit Enable (BUS_CURRENT_LIMIT_ENABLE) Disable	Current Sanse Amplifier's Gain [CSA_GAIN]		
>>	Driver Configuration-Gate Driver Settings		~		
Θ	Driver Configuration-Gate Driver Fault Se	ttings	*	EEPROM Controls	EEPROM -

Figure 4-7. Voltage Limits



4.1.5 Input the Motor's Phase Resistance and Inductance

Using the instructions in the motor parameters FAQ, find the motors phase resistance and inductance. Once these values are found, input the phase resistance into the *Motor Phase Resistance* box and the phase inductance into both the *Lq* and *Ld* boxes in the *Motor Parameters* tab on the *Advanced Tuning* page.

Motor Studio File Options Tools Help Documents						
Show Advance Setting: Show Advance Setting: Show Advance Setting: Show Advance Setting: Show Modified Register Ado Read All Registers.	15	Controls Faults Charts L I2C CONTROLS Seed Control (120 C Target Address (001 stdt)) To Find Address (001 stdt) To Find Address (001 stdt) 0 Find Address (001 stdt)) To Find Address (001 stdt) To Find Address (001 stdt) To Find Address (001 stdt) 0 Find Address (001 stdt)) To Find Address (001 stdt)) To Find Address (001 stdt) To Find Address (001 stdt)) 0 Find Address (001 stdt)) To Find Address (001 stdt)) To Find Address (001 stdt)) To Find Address (001 stdt)) 0 Find Address (001 stdt)) To Find Address (001 stdt)) To Find Address (001 stdt)) To Find Address (001 stdt))				
System Level Configuration Driver Configuration-Gate Driver Settings	* *					
Driver Configuration-Gate Driver Fault Settings Device and Pin Configuration	* *	MOTOR STATUS Auto Read Motor Status C I				
Control Configuration-Reverse Drive Settings Control Configuration-Pre-Startup	* *	Algorithm State V14 Voltage MOTOR_IDLE 8.000 V Reference for Speed Loop Speed FOBK				
Control Configuration-Motor Stop Control Configuration-Motor Startup Stationary	* *					
Control Configuration-Motor Parameters Extraction Tool(MPET) Control Configuration-Motor Parameters	~					
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Figure 4-8. Motor Resistance and Inductance

4.1.6 Maximum Electrical Speed (Hz)

Go to the *Motor Information* Section of the GUI on the *Quick Spin* tab and use the following steps to set the motor's max speed:

- 1. Select Speed in RPM or Speed in Hz depending on the unit of speed provided by the motor's data sheet.
- 2. Input the speed in the Max Speed box. If inputting a speed in RPM, also input the number of pole pairs the motor has using the *Pole Pairs* box.



Figure 4-9. Motor Max Speed

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Note

Determining number of motor poles without a motor data sheet:

- 1. Use a lab power supply and make sure it's current limit is set to less than the motor rated current. Do not turn on the supply.
- 2. Connect V+ of the supply to phase A and V- of the supply to phase B of the motor. Any 2 of the 3 phases can be chosen at random if they are not labeled.
- 3. Turn on supply. The rotor should have settled at one position with the injecting current.
- 4. Manually rotate the rotor until rotor snaps to another settle position. It will have several settledown positions around one mechanical cycle.
- 5. Count the number of settle-down positions for one fully mechanical cycle, which is the number of pole pairs. Multiplying by two calculates the number of poles.

Be careful of gearing systems within a motor. The gear ratio determines how many rotor revolutions correlate to the shaft's mechanical revolution.

4.1.7 Run MPET to Identify Motor Parameters

Once all the other settings covered in the Section 4.1 section are set, the MPET algorithm within the MCF8329A can be used to measure the BEMF constant and speed loop gains needed to spin the motor in closed loop. Before running MPET, go to the *MPET* page and check that the IPD and open loop current limits are set according to the instructions in Section 4.1.3. Next, enable the *Measure Motor BEMF* Constant and *Measure Motor Mechanical Parameter* switches and click the *Run MPET* button. The motor should begin to spin. After the motor stops spinning, MPET has completed measuring. Click the *Write MPET Results To Shadow Registers* button to use the results measured by MPET.

Motor Studio File Options Tools Help Documents				
			> Controls Faults	Charts Logs
Motor Parameters	Result Section		I2C CONTROLS	~
System Settings Memory Base Manual Buildings Memory Base Solution Solu	MPET Results	Configured Values	Speed Control via I2C	Enabled
IPD Settings MPET IPD Parameter select	MPET motor BEMF constant	Motor BEMF Constant	0x0	Find Address
PD Current Threehold (A) Number of times IPD is executed 20 % 1 time 2. Check Current Limits	0.000 mV/Hz	0.000 \$ mV/Hz	12C Speed Command Percent	0.00 ¢
Open Loop Settings Open Loop Settings Open Loop Speed Reference (A) Open Loop Speed Reference			MOTOR STATUS	Auto Read Motor Status 🜰 Disable
30% Voter Loop Streth Rate for MPET (Hoos)	Speed Loop Kp	Kp coefficient for speed loop	Status Select	~
Closed Loop Settings			Algorithm State MOTOR_IDLE	VM Voltage 0.0000 V
60 %	Speed Loop Ki 0.000 5. Write MPET Re	Ki coefficient for speed loop	Reference for Speed Loop 0.0000 Hz	Speed FDBK 0.0000 Hz
MPET Sel 3. Enable both Measurements Measure Motor revenance voltage wender wood mouthing Image: Constant Measure Motor EEMF Measure Motor Mechanical Image: Constant	Write MPET Results	To Shedow Registers		
Rem MPET 4. Run MPET				
©			EEPROM Controls	EEPROM ·
	Measurements			

Figure 4-10. How to Run MPET

Note If a fault is reported or MPET cannot measure the BEMF constant, go to Section 6 for assistance.



4.1.7.1 Skipping MPET Measurements

MPET measurement of the BEMF constant or speed loop gains can be skipped by making sure the register for the parameter is filled with a non-zero value and the measurement switch is disabled.

Use the following steps to disable BEMF constant measurement:

- 1. Fill in the Motor BEMF constant with a non-zero value, preferably with the value from the motor data sheet or a hand measured value.
- 2. Disable the Measure Motor BEMF Constant switch.

Use the following steps to disable measurement of the speed loop gains:

- 1. Fill in the Kp and Ki coefficient for speed loop with non-zero values.
- 2. Disable the Measure Motor Mechanical Parameter.

			> Controls Faults Charts L	ogs
Motor Parameters System Settings Merrom Back Vitage Carlocator 200.000 C 60 V V	Result Section	Configured Values	I2C CONTROLS Speed Control via I2C Enabled I2C Target Address (GUI side)	
PD Settings MPET IPD Parameter solect C PD Conset Treshold (A) 20 % V I time V	MPET motor BEMF constant 0.000 mV/Hz	Motor BEMF Constant	0x0 Find Ad I2C Speed Command Percentage (%) 0.00 0% 25% 50% 75% 100%	dress
Conclusor Settings: MPET span kop parameter resistance Conclusor Set and Set a	S. I. Input non-zero value	Kp coefficient for speed loop	MOTOR STATUS Auto Read Motor Statur C Status Select Motor Rice 9000000	Dis
Reference In Torus Pi Lago (A) 60 % MPET Sel 2. Disable Measurement	Speed Loop Ki	Ki coefficient for speed loop	Reference for Speed Loop Speed FDBK 0.0000 Hz	
Weasure Molor Nersouence Communication Annoise Molor Mechanical Com Aveasure Molor Alexane Molor Mechanical Com Parameter	Logs No Logs available	e	0	
Run MPET				

Figure 4-11. How to Skip MPET



4.2 Testing for Successful Startup Into Closed Loop

- 1. Apply a nonzero speed command using the slider or text box within the *Spin Motor* section of the Quick Spin page. Once a speed command is provided, the motor should begin to spin and accelerate until the motor reaches the target speed.
- 2. After the motor stops accelerating check that the values in *Reference for Speed Loop* and *Speed FDBK* under the *Motor* Status section are close to the same value.
- 3. Check for any faults if the *Faults* tab shows a red circle. If a fault has been reported, go to Section 6 and follow the debug steps to correct the fault.
- 4. Once the motor is able to spin into closed loop and not trigger any faults, stop the motor and save the register configuration to a json file by clicking on *File -> Save Registers*. In the window that pops up, select *Json File* and click on the *Save* Button.
- 5. To have configuration for the registers covered in section 7.7 of the MCF8329A data sheet load when the device powers-up these register values can be loaded into EEPROM. To write the configured register values to EEPROM, click the *EEPROM* drop down located at the bottom right of Motor Studio and select the *Write To EEPROM* option. Click the *Yes* button in the window that pops up.

ග _බ 4. Save Reg	ister Configuration ૠ Optimization Wizards	🔹 Advanced Tuning	I Check if Fault	has Occurred Faults	Charts Logs	
Quick Spin 年 ① Load De Click the 1	sfault .oad Preset values" button to load the recommended default valu	Select Preset" MCF8329A_Default.	Load Preset Values	I2C CONTROLS Speed Control via I2C Enabled I2C Target Address (GUI side)		
	An and a series of the series	SP0_LOOP_KP 0.00	1. Enter Speed Command mViHz 2. Check if Values are Close	0x0 12C Speed Command Percent 0% 25% 0% 50% MOTOR STATUS Status Select Algorithm State MOTOR_IDLE Reference for Speed Loop 8,0000 Hz	Auto Read Motor Status VM Voltage 0.000 V Speed FDBK 0.000 Hz	
3 Spin Mo Move the s	tor lider to control the speed of the motor Command Percentage (%) 5% 50% 75% 100% 0.00 (\$)	Logs 12:40:35:462 : Default register settings loaded.	0	5. Save Confi EEPROM Controls	guration to EEPROM	

Figure 4-12. Closed Loop Spin Test Steps



5 Basic Controls

This section provides tuning guidance for optimizing the motors performance for many use-case needs.

Note

It s expected to skip the subsection use-cases and scenarios that do not apply to the system or end equipment.

5.1 Speed Input Mode

The MCF8329A offers four options to control the speed of the motor: PWM, frequency, Analog, and I2C. The desired speed mode can be set by changing the value of the SPEED_MODE register on the *Advanced Tuning* page. A description of how to configure these control methods is provided in the *Motor Control Input Options* section of the *MCF8329A Sensorless Field Oriented Control (FOC) Three-phase BLDC Gate Driver Data Sheet*.

Mo	otor Studio File Options Tools H	elp Documents						
G ⊗ 井 O	Pre-Startup Motor Startup Open Loop and Handolf	2	Controls I2C CONTR Speed Control v I2C Target Add	Faults CLS ia I2C C ress (GUI side)	Charts Disebled	Logs		
. :1	System Level Configuration			~	0			Find Address
•	Driver Configuration-Gate Driver Settings	~	12C Speed Command Percentage (%)					
	Driver Configuration-Gate Driver Fault Settings	× _	MOTOR STA	TUS	Auto Read Motor	Status 🕋 Disable		
	Device and Pin Configuration	^	Status Select					
	Bresk_Pin_overnide (BRAKE_INPUT) Hardware Pin BRAKE	eed_Control_Mode_Select [SPEED_MODE] ~~	Pin_J8_Configuration (DAC_SOX_ANA_CONFIG)		Algorithm State		VM Voltage 00.0 V	
	0	eep Entry Time (SLEEP_ENTRY_TIME) leep entry when SPEED pin remains low for 5 Y	Dev Mode Select (DEV_MCDE) Standby Mode		Reference for Sp 00.0 Hz	xeed Loop	Speed FDBK 00.0 Hz	
	Mn Range: 0. Max Range: 1000000 Clock Select (CLK_SEL) Internal Oscillator	Jernal Clock Configuration (EXT_CLK_ER) Disable	Enternel Clock Mode (EXT_CLK_CONFIG) 8KHz					
	DF_PR_Override [DIR_INPUT] Re Hardware Pin DIR V	Follow motor stop options and ISD routine on detecting DIR change	Speed input PWM frequency range selection (SPEED_RANGE_SEL) 325Hz to 100KHz speed PWM input					
	Control Configuration-Reverse Drive Settings	Control Configuration-Reverse Drive Settings						
>>	Control Configuration-Pre-Startup			*				
œ	Control Configuration-Motor Stop			•	EEPROM C	ontrols		EEPROM ·

Figure 5-1. Speed Mode Selection

If I2C speed input is chosen, flip SW1 away from the other switches, see Figure 5-2, this will provide a the wake switch signal to the SPEED/WAKE pin to keep the MCF8329A out of sleep/standby mode. If a speed mode other than I2C is being used, flip the switch to the opposite as what is shown in Figure 5-2 to connect the speed pin to J13. For information on how to set J13, see the *Description of User-Selectable Settings on MCF8329EVM (Default in Bold)* table in the *MCF8329EVM User's Guide*.



Figure 5-2. SW1 Position for I2C Speed Mode

5.2 Preventing Back Spin of Rotor During Startup

Option 1: Initial Position Detection (IPD):

- 1. Go to *Optimal Startup* in the *Optimization Wizards* page, select IPD, and click the *Next* button for instructions to set up the IPD start up method.
- 2. Set the IPD Advance Angle [IPD_ADV_ANGLE] to 90° to get maximum startup torque. If there is sudden jerk observed during startup, then it is recommended to reduce the angle to 60° or 30° for a smoother startup.

Note

Device triggers IPD timeout fault [IPD_T1_FAULT] for motors with very high inductance, or if the motor is not connected. If this fault gets triggered, it is recommended to check if motor is connected to the device.

Device triggers IPD Frequency fault [IPD_FREQ_FAULT] if the IPD clock frequency is set too high. If this fault gets triggered, it is recommended to decrease the IPD Clock value [IPD_CLK_FREQ].



Option 2: Slow First Cycle:

1. Go to *Optimal Startup* in the *Optimization Wizards* page, select slow first cycle, and click the *Next* button for instructions to set up the slow first cycle startup method.

Мс	tor Studio File Options Tools	Help Documents					
c 🛇 👭 🔇 🔹 📽 🖩	OptimizationWizards > OptimalStartup Optimal Start-up This wizard helps you configure fast and robust r Pre-Startup Motor Startup Open Loop and Handoff	notor startup.	Motor Stop	Motor startup options [MTR_STARTUP] Align Double Align e Slow first cycle	1) IPD	> Controls Faults I2C CONTROLS Speed Control via I2C I2C Target Address (GUI side 12C Speed Command Percentr 0% 25% 50%	Charts Logs Disabled •) ① • Find Address age (%) • •
	IPD (Initial Position Detection) can be used in such applications therefore can allow for a faster motor start-up sequence. IPD w	where reverse rotation o orks by pulsing current in Align	f the motor is unacceptab to the motor and hence c Double Align	btable. IPD does not wait for the motor to align with the commutation and ce can generate undesirable acoustics.		MOTOR STATUS Status Select Algorithm State MOTOR_IDLE Reference for Speed Loop on N+-	Auto Read Motor Status Disable
	Reverse Rotation During Startup	Poor	Poor	Good	Average	00.0112	00.0112
	Acoustic Noise	Good	Average	Poor	Good		
	Startup Torque	Good	Good	Good	Average		
	Startup Time	Average	Poor	Good	Average		
»	DC Bus Spike	Good	Good	Average	Good		
e					Next	EEPROM Controls	EEPROM -

Figure 5-3. Optimal Startup Page

5.3 Faster Startup Timing

Option 1: Initial Position Detection (IPD):

- 1. Go to Optimal Startup in the Optimization Wizards page, select IPD, and click the Next button.
- 2. Increase IPD current threshold (A) [IPD_CURR_THR] to the rated current of the motor.
- 3. Increase IPD clock value [IPD_CLK_FREQ] to a higher frequency up to a value where the device does not trigger IPD frequency fault.
- 4. Set IPD repeating times [IPD_REPEAT] to 1 time.
- 5. Set Open loop current limit configuration [OL_ILIMIT_CONFIG] to Open loop current limit defined by ILIMIT.
- 6. Increase Open loop acceleration coefficient A1 [OL_ACC_A1] and Open loop acceleration coefficient A2 [OL_ACC_A2].

Note

A1 and A2 can be increased until open loop current reaches Lock detection current threshold [LOCK_ILIMIT]. Open loop current can be measured using oscilloscope.

Increasing Open loop acceleration coefficient A1 [OL_ACC_A1] and Open loop acceleration coefficient A2 [OL_ACC_A2] might trigger LOCK_LIMIT fault. If this happens, reduce A1 and A2 until LOCK_LIMIT fault no longer triggers.

- 7. For ultra-fast startup time (less than 100 ms) it is recommended to follow below steps.
 - a. Disable auto-handoff [AUTO_HANDOFF].
 - b. Configure open to closed loop handoff threshold [OPN_CL_HANDOFF_THR] to a value lesser than or equal to 20 Hz.
- 8. For startup times above 100ms, it is recommended to follow below steps:
 - a. Enable auto-handoff [AUTO_HANDOFF].



Note

If Abnormal speed fault [ABN_SPEED] gets triggered, it is recommended to decrease open loop acceleration constants [OL_ACC_A1] and [OL_ACC_A2] and also retune IPD by increasing the IPD current threshold [IPD_CURR_THR] and IPD repeat times [IPD_REPEAT].

9. Increase Closed loop acceleration rate [CL_ACC].

LOCK_LIMIT fault handling:

Closed loop acceleration rate [CL_ACC] can be increased until closed loop current reaches Lock detection current threshold [LOCK_ILIMIT]. Closed loop current can be measured using oscilloscope. Increasing closed loop acceleration rate [CL_ACC] might trigger LOCK_LIMIT. If this happens, reduce closed loop acceleration rate [CL_ACC] until no longer triggers.

Note

Option 2: Align

- 1. Go to *Optimal Startup* in the *Optimization Wizards* page, select Align, and click the *Next* button for instructions to set up the Align startup method.
- 2. Configure align time [ALIGN_TIME] to 10 ms.
- 3. Follow Step 6 to Step 9 in Option 1.

Figure 5-4 shows FG, phase current and motor electrical speed waveform. Motor takes 50 ms to reach target speed from zero speed.



Figure 5-4. Phase Current, FG and Motor Speed - Faster Startup Time

Note

If Abnormal speed fault [ABN_SPEED] or Loss of sync [LOSS_OF_SYNC] fault gets triggered, it is recommended to follow below debug steps:

- 1. Select Double align as the motor startup method in [MTR_STARTUP].
- 2. Increase align time [ALIGN_TIME].
- 3. Configure align current threshold [ALIGN_OR_SLOW_CURRENT_ILIMIT] to 50% of ILIMIT.
- 4. Configure First cycle frequency select [FIRST_CYCLE_FREQ_SEL] to 0.



5.4 Improving Speed Regulation

For applications that require better speed regulation, it is recommended to tune Speed loop PI controllers [SPD LOOP KP] and [SPD LOOP KI]. Kp coefficient of speed loop [SPD LOOP KP] controls the settling time and speed overshoots. Ki coefficient of Speed loop [SPD LOOP KI] controls speed overshoot and ensures regulation of speed at set value and drives the error to zero. Speed loop PI controller gains can either be auto-tuned by MCF8329A or tuned manually.

Auto Tuning: MCF8329A auto calculates the Speed loop PI controller gains when [SPD LOOP KP] and [SPD LOOP KI] are set to zero.

Manual Tuning: Use the following steps to tune Speed loop PI controller gains manually:

- 1. Set the control mode [CTRL MODE] to modulation index control (11b).
- 2. Issue non-zero speed command to start the motor (refer to Section 4.2, step 1 on how to issue non-zero speed command). Motor will spin in open loop.
- 3. Allow the open loop current to settle down and then measure the peak open loop current.
- 4. Stop the motor and set the control mode [CTRL MODE] to current control.
- 5. Slowly increase the speed command until the motor speed reaches the max speed. Note down the lg ref value being reported in the IQ REF CLOSED LOOP register.
- 6. Speed loop Kp [SPD_LOOP_KP] is calculated using Equation 2.

	Speed loop $Kp = \frac{Iq \ reference \ at \ maximum \ speed}{Maximum \ Electrical \ Speed \ in \ Hz}$	(2)
7.	Speed loop Ki [SPD_LOOP_KI] is calculated using Equation 3.	
	Speed loop $Ki = 0.1 \times Speed$ loop Kp	(3)

Speed loop $Ki = 0.1 \times Speed loop Kp$

8. Stop the motor and set the control mode [CTRL MODE] to speed control.

Note

Tuning speed loop Kp and Ki is experimental. If the above recommendation doesn't work, then we recommend to manually tune Speed loop Kp and Ki till the desired results are achieved.



5.5 Limiting and Regulating Supply Power

MCF8329A provides options to limit and regulate supply power. This feature can be utilized in battery powered motor driver applications such as cordless vacuum cleaners, power tools etc.

Use the following steps to limit supply power. In this mode, supply power is only limited to reference power and not actively regulated.

- 1. Configure CTRL_MODE to power control (1b).
- Configure MAX_POWER. This sets the maximum power that MCF8329A can draw from the DC input supply at 100% duty command. For example, if MAX_POWER is configured to 25 W, MCF8329A draws 12.5 W from power supply at 50% duty command.
- 3. The power control loop uses the same PI controller parameters as in the speed loop mode. Kp and Ki coefficients are configured through SPD_POWER_KP and SPD_POWER_KI. Tuning SPD_POWER_KP and SPD_POWER_KI is experimental. The recommendation is to manually tune both parameters until the desired results are achieved.

	\wedge		Show Advance Settings		Controls Faults	Charts Logs	
Pre-Startup Motor Startup Open L	oop and Ha	ndoff Closed Loop Motor Stop	Auto Read All Registers		I2C CONTROLS Speed Control via I2C Disabled		
Control Configuration- Open Loop				~	0x0	Find Address	
Control Configuration- Control Fat	ult Setting	js		~	I2C Speed Command Percenta	ige (%)	
Control Configuration- Closed Loc	p	Cleared lass developming colori (CL_DEC_CONE(Q)	Olegation deplacements (CL_DECL	^	MOTOR STATUS	Auto Read Motor Status 🜑 Disabl	
Closed loop acceleration rate [CL_ACC]	~	Closed loop deceleration defined by CL_DEC	7.5	~	Status Select	~	
 Kp coefficient for current lq and ld loop [CURR_LOOP_K] 0.73 	\$	Ki coefficient for current lq and ld loop [CURR_LOOP_Ki]	 Kp coefficient for speed loop [SPD_LOOP_KP] 1.28 	5	Algorithm State	VM Voltage	
Min Range: 0, Max Range: 255		Min Range: 0, Max Range: 255000	Min Range: 0, Max Range: 2.55	- i	Reference for Speed Loop	Speed FDBK	
10	٢	90 %		0	00.0 HZ	00.0 Hz	
Min Range: 0, Max Range: 25.5			Min Range: 0, Max Range: 25.5				
Flux Weakening Ki (FLUX_WEAKENING_KI)	\$	Close loop acceleration when estimator is not yet fully aligned (Hz / 0.1 V	Maximum Power [Maximum Power] 100	•			
Enable Maximum Torque Per Ampere Operation (MTPA_3	[N]	Response_to_change_of_DIR_pin_status [DIR_CHANGE_MODE] Follow motor stop options and ISD routine on detecting DIR change	FLUX WEAKENING REFERENCE [FLUX_WEAKENING_REFE	* *			
- Control mode [CTRL_MODE]	~						

Figure 5-5. Power Control Settings



5.6 MTPA Tuning

Maximum torque per ampere (MTPA) is a feature in the MCF8329A to maximize the torque generated per ampere of current for salient motors. To enable MTPA, set MTPA_EN to 1b and set the SALIENCY_PERCENTAGE to a non-zero value by setting the Lq and Ld values if they are provided in the device-specific data sheet.

Pre-Startup Motor Startup	Open Loo	p and Handoff Closed Loc	p Motor Stop	Show Advance Settings Show Modified Registers Auto Read All Registers	
Control Configuration-Motor Paramet	ers	780	Le 1010 0.07 2 Von Range & Max Range 20	Meter BEMF Constant (MOTOR_BEMF] 35 Min Range: 0, Max Range: 2000	k
397.833333333333 Min Range: 0. Max Range: 2736.5 Control Configuration- Open Loop	5				
Control Configuration- Control Fault	3ettings				
Closed loop acceleration rate [CL_ACC]	✓ Cier	ed loop deceleration select [CL_DEC_CONFIG] Closed loop deceleration defined by CL_DEC	Closed loop deceleration rate [CL_DEC]	Kp coefficient for current lig and id loop [CURR_LOOP_KP]	
60					1
	C 1.2	eathclient for speed loop (SPD_LOOP_KP)	Ki coefficient for speed loop (SPD_LOOP_KI) 10	Reference for Torque PI Loop (A) ()LIM(T) 90 %	
60 - N celficer for current is and ki loss (CURR_LOCP_V); D Min Range 0. Mar Range 25500 - Plan Visamenny 10 (FLOL, VISARDING_UP) D D D D D D D D D D D D D	C 1.2 Min C 1.2	Adeficient for speed loog (SPD_LOOP_XEP) 8 Renge G. Main Rangel 2 55 Vitablemong 10 (FLUX_VIEAKENING_XC) Renge G. Main Rangel 2455	No coefficient for speed loop (SPO_LOOP_JO) 10 (2) Non Range 5. Nair Range 25.5 Cose loop accessition when estimator a not yet fully aligned (Hz i esc) 0.1 V	Reference for Torque PF Loop (A) (LLIMT) 90 % Maximum Power (Maximum Power) 100 Done for Marc Boxer (M3)	

Figure 5-6. MTPA Settings

Note

If the motors Ld or saliency percentage is not known, the approximate SALIENCY_PERCENTAGE can be determined by following the steps below:

- 1. Set the SALIENCY_PERCENTAGE to 0x1h
- 2. Set the CTRL_MODE to Current Control mode
- 3. Provide a speed command.
- 4. While the motor is spinning, increment the SALIENCY_PERCENTAGE value by 1h until the motors speed begins to decrease.

Mc	otor Studio File Option	ons Tools Help Documents				
ŵ	Search registers by name,address or bitfi	eld name Q Show bits		Registers +	> Controls Faults	Charts Logs
©	Register Name	Address	Value	Field View	I2C CONTROLS	^
¢.	Algorithm Configuration		~		Speed Control via I2C I2C Target Address (GUI side)	Disabled
;;]	Fault Configuration		*		0x0 I2C Speed Command Percentage	Find Address
\$	Internal Algorithm Configuration		~	CTRL_MODE Power Control *	0% 25% 50%	75% 100%
	Hardware Configuration		^	FLUX_WEAKENING_REFERENCE	MOTOR STATUS	Auto Read Motor Status 💼 Disable
	PIN_CONFIG	0x000000A4	0x00032000	- 70% *	Status Select	×
	DEVICE_CONFIG1	0x000000A6	0x00000000	RESERVED	Algorithm State MOTOR_IDLE	VM Voltage 00.0 V
	DEVICE_CONFIG2	0x000000A8	0x00000000	SPD_RANGE_SELECT	Reference for Speed Loop 00.0 Hz	Speed FDBK 00.0 Hz
	PERI_CONFIG1	0x000000AA	0x00000010	ACTIVE_BRAKE_MOD_INDEX_LIMIT		
	GD_CONFIG1	0x00000AC	0x000600FC			
	GD_CONFIG2	0x000000AE	0x00000000	ACTIVE_BRAKE_SPEED_DELTA_LIM 2.5%		
	Fault Status		~	SELF_TEST_ENABLE		
>>	System Status		~	DIR_CHANGE_MODE		
GÐ	Device Control		×	Follow motor stop options and IS	EEPROM Controls	EEPROM *

Figure 5-7. Saliency Register



5.7 Motor Studio Optimization Wizards

For step-by-step guidance on configuring the MCF8329A for additional use-cases and optimization features, see the *Optimization Wizards* page on Motor Studio.

Motor Studio File Options Tools Help Docume	nts	
A Open Loop 환 Motor Pre-Startup Motor Startup Open Loop	and Handoff Closed Loop Motor Stop	Controls Faults Charts Logs I2C CONTROLS Speed Control via I2C Disabled I2C Target Address (GUI side)
Initial Speed Detection Initial Speed Detection This wizard helps Initial speed detection of motor reliable motor resynchronization.	Unidirectional motor drive detecting This wizard helps you in Unidirectional motor drive detecting backward spin	12C Speed Command Percentage (%) 0.00 0% 25% 50% 75% 100%
Direction and Brake pin override (15) This wizard helps you in Direction and Brake pin override Motor Startup		Status Select Algorithm State MOTOR_JDLE 00.0 V Reference for Speed Loop 00.0 Hz
Optimal Startup This wizard helps you configure fast and robust motor startup.		
Open Loop and Handoff		
Gradual and smooth start up motion This wizard helps for applications thatrequire slow and gradual startup.		
co ··		EEPROM Controls

Figure 5-8. Optimization Wizards Page



6 Fault Handling

To see which fault has been reported by the MCF8329A, go to the *Faults* tab and check if any faults with red circles appear. If a fault is shown in this tab, see the section below that has a title similar to the reported fault.

Мс	tor Studio File Options Tools Help Documents							
· # ③ 한	Pre-Startup Motor Startup Open Loop and Handoff Closed Loop Motor Stop	 Show Advance Settings Show Modified Registers Auto Read All Registers 	»	Controls Auto Read Fau Read Faults	Faults Faults Clear Faults Cont	Charts	Logs Show Faults List	
	System Level Configuration	~		CONTRO BABN_BEI				
\$0	Driver Configuration-Gate Driver Settings	~						
	Driver Configuration-Gate Driver Fault Settings	Y						
	Device and Pin Configuration	~	ĵ.					
	Control Configuration-Reverse Drive Settings	~						
	Control Configuration-Pre-Startup	~						
	Control Configuration-Motor Stop	~						
	Control Configuration-Motor Startup Stationary	*						
	Control Configuration-Motor Parameters Extraction Tool(MPET)	~						
	Control Configuration-Motor Parameters	~						
	Control Configuration- Open Loop	~						
>>	Control Configuration- Control Fault Settings	~						
œ	Control Configuration- Closed Loop	*	1					

Figure 6-1. Faults Tab



6.1 MPET BEMF FAULT [MPET_BEMF_FAULT]

A MPET_BEMF_FAULT gets reported when the meased BEMF is less than the threshold set in STAT_DETECT_THR. If this fault is triggered, go the *MPET* page in Motor Studio and follow the suggestions below:

- 1. Enable MPET Open Loop Parameter Resistance.
- 2. Increase the Open Loop Current Reference value.
- 3. Decrease the Open Loop Slew Rate for MPET value.
- 4. If the fault still persists, see the Motor Parameters FAQ for instructions on how to obtain the motor's BEMF constant through the motor's data sheet for through hand measurement. Once the motor's BEMF constant value is found, input the BEMF constant value into the *Motor BEMF Constant* box in the *Configured Values* section on the *MPET* page.

Мс	otor Studio	Options Tools Help	Documents					li interneti internet
ଜ	Motor Parameter Extractio	n Tool (MPET)				>	Controls Faults	Charts Logs
🚳 👬 🔕	Motor Parameters System Settings Maximum Speed 200.000	Maximum Bus Veitage Configur 60 V	ation	Result Section	Configured Values		I2C CONTROLS Speed Control via I2C I2C Target Address (GUI s	Enabled ide)
 ¢,	IPD Settings IPD Current Threshold (A) 20 %	MPET IPD Param Number of times IPD is execute 1 time	eter select	MPET motor BEMF constant	Motor BEMF Constant 0.000 CMV/Hz	4	0 I2C Speed Command Perco 0% 25% 50%	Find Address entage (%) 75% 100%
" 2 3	Open Loop Settings Open Loop Current Reference (A) 30% Open Loop Set/ Rate for MPE F (R28) 20 Hz/s	MPET open loop parameter Open Loop Speed Retarence 25%	resistance	Speed Loop Kp	Kp coefficient for speed loop		MOTOR STATUS Status Select	Auto Read Motor Status 🖜 Disable 🗸
	Closed Loop Settings Reference for Torque P(Loop (A) 60 %	~		Speed Loop Ki	Ki coefficient for speed loop		Algorithm State MOTOR_IDLE Reference for Speed Loop 0.0000 Hz	VM Voltage 0.0000 V Speed FDBK 0.0000 Hz
	MPET Select Measure Motor Resistance Measure Motor BEMF Constant	Measure Motor Inductance (Measure Motor Mechanical Parameter	30	Write MPET Re	sults To Shadow Registers	0		
**	Run MPET							
G							EEPROM Controls	EEPROM +

Figure 6-2. MPET_BEMF_FAULT



6.2 Abnormal BEMF Fault [ABN_BEMF]

This fault gets triggered when the difference between the estimated BEMF voltage exceeds the threshold set by ABNORMAL_BEMF_THR. If this fault is triggered, then go the *Control Fault Settings* tab in the *Advanced Tuning* page in Motor Studio and follow the below suggestions:

- 1. For applications with load dynamics (sudden change in load), it is recommended to set the Abnormal BEMF threshold to 70% to avoid triggering this fault.
- 2. This fault can get triggered if the programmed BEMF constant is inaccurate. Follow steps recommended in step 4 of Section 6.1 to obtain accurate BEMF constant.

Мо	tor Studio File Options Tools	Help	Documents					
(c) 注 (C) む	Pre-Startup Motor Startup Open Loop and P	Handoff	Closed Loop Motor Stop	Show Advance Settings Show Modified Registers Auto Read All Registers	> Controls I2C CON Speed Control I2C Target A	Faults	 Charts Enabled T 	Logs
.:1	Control Configuration- Open Loop			~	0			Find Address
٥,	Control Configuration- Control Fault Setti	A	I2C Speed Command Percentage (%) 0.00 ♀ 0% 25% 50% 75% 100%					
	80 %	75 %		Fault automatically cleared after LCK_RETRY t ~	MOTOR S	TATUS	Auto Read Motor St	atus 🌰 Disable
	Lock Detection current limit deglitch time [LOCK_ILIMIT_DEG]	Lock dete	ction retry time [LCK_RETRY]	Motor Lock Mode [MTR_LCK_MODE]	Status Selec	t		~
	IPD timeout fault Enable (IPD_TIMEOUT_FAULT_EN) Timeout fault Enable	IPD frequ	ency fault Enable [IPD_FREQ_FAULT_EN] Enable	Lock 1 (Abnormal Speed) Enable [LOCK1_EN]	Algorithm St. MOTOR_IDLE	ite	VM Voltage 0.0000 V	
	Lock 2 (Abnormal BEMF) Enable [LOCK2_EN] C Enable	Lock 3 (N	o Motor) Enable [LOCK3_EN] Enable	Calculated Abnormal Speed Lock Threshold (Hz) 0.00	Reference fo	r Speed Loop	Speed FDBK 0.0000 Hz	
	Abnormal speed lock threshold [LOCK_ABN_SPEED] 130%	Abnornal 70%	BEMF lock threshold (% of expected BEMF) (ABNORMA \neg	No motor lock threshold (A) [NO_MTR_THR]				
	- Hardware Lock Detection current limit mode [HW_LOCK_JUMIT_M Fault automatically cleared after LCK_RETRY t ~	Hardware 2 us	Lock Detection current limit deglitch time [HW_LOCK_ILI	[VM_UV_OV_HYS] 1V for UV and 2V for OV				
	Undervoltage Fault Recovery Mode [MIN_VM_MODE] Automatic clear if voltage in bounds	Overvoita	ge Fault Recovery Mode [MAX_VM_MODE] Automatic clear if voltage in bounds	Automatic retry attempts (AUTO_RETRY_TIMES)				
>>	Control Configuration- Closed Loop			*				
Θ	Algorithm Configuration- Reference Profi	le		~	EEPROM	Controls		EEPROM ·

Figure 6-3. ABNORMAL_BEMF_THR



6.3 Lock Current Limit [LOCK_LIMIT]

This fault gets triggered when the phase current exceeds the LOCK_ILIMIT threshold. If this fault is triggered, check the motor data sheet for stall torque and load the motor below the stall torque specified in the data sheet. If the load torque is still within the stall torque, go to the *Control Fault Settings* tab in the *Advanced Tuning* page and increase the value of LOCK_ILIMIT.

Мс	otor Studio File Options Tools	Help	Documents				
(c) 計 (c) む	Pre-Startup Motor Startup Open Loop and I	landoff	Closed Loop Motor Stop	Show Advance Settings Show Modified Registers Auto Read All Registers	 Controls Faults Charts L I2C CONTROLS Speed Control via I2C I2C Target Address (GUI side) To		
.:l	Control Configuration- Open Loop			~	0	Find Address	
¢₀	Control Configuration- Control Fault Setti	ngs	^	12C Speed Command Percentage (%)			
	Hardware Lock detection current limit (A) [HW_LOCK_ILIMIT]	Lock dete	ction current threshold (A) [LOCK_/LIMIT]	Lock current Limit Mede [LOCK_ILIMIT_MODE]	MOTOR STATUS	Auto Read Motor Status 🜑 Disable	
	Lock Detection current limit degitch time [LOCK_ILIMIT_DEG]	Lock dete	ction retry time [LCK_RETRY]	Motor Lock Mode [MTR_LCK_MODE] Fault automatically cleared after LCK_RETRY t V	Status Select	~	
	IPD timeout fault Enable (IPD_TIMEOUT_FAULT_EN) Enable	IPD frequ	ency fault Enable [IPD_FREQ_FAULT_EN] Enable	Lock 1 (Abnormal Speed) Enable [LOCK1_EN]	Algorithm State MOTOR_IDLE	VM Voltage 0.0000 V	
	Lock 2 (Abnormal BEMF) Enable [LOCK2_EN] Enable	Lock 3 (M	o Motor) Enable [LOCK3_EN] Enable	Calculated Abnormal Speed Lock Threshold (Hz) 0.00	Reference for Speed Loop 0.0000 Hz	Speed FDBK 0.0000 Hz	
	Abnormal speed lock threshold [LOCK_ABN_SPEED]	Abnornal 70%	BEMF lock threshold (% of expected BEMF) (ABNORMA	No motor lock threshold (A) [NO_MTR_THR]			
	Hardware Lock Detection current limit mode [HW_LOCK_ILIMIT_M Fault automatically cleared after LCK_RETRY t V	Aardware 2 us	Lock Detection current limit deglitch time [HW_LOCK_ILI ~	[VM_UV_OV_HYS] 1V for UV and 2V for OV			
	Undervoltage Fault Recovery Mode [MIN_VM_MODE] Automatic clear if voltage in bounds	Overvolta	ge Fault Recovery Mode [MAX_VM_MODE] Automatic clear if voltage in bounds	Automatic retry attempts (AUTO_RETRY_TIMES) Vo Limit			
»	Control Configuration- Closed Loop						
Θ	Algorithm Configuration- Reference Profi	e		v	EEPROM Controls	EEPROM •	

Figure 6-4. LOCK_ILIMIT



6.4 Hardware Lock Current Limit [HW_LOCK_LIMIT]

This fault gets triggered when the phase current exceeds the HW_LOCK_ILIMIT threshold. If this fault is triggered, use the following recommendations:

- 1. Using the fields circled in Figure 6-5, set SPD_LOOP_KP, SPD_LOOP_KI, CURR_LOOP_KP, and CURR_LOOP_KI to zero. This enables the MCF8329A to automatically calculate the speed loop and current loop PI controller gains.
- 2. If the fault still persists, check the continuity across phase-to-phase, phase-to-GND, and PVDD-to-GND to make sure there is no short across these terminals.

tor Studio	File Options	Tools	Help	Documents							
Pre-Startup Motor Startup Open Licep and Handoff Closed Loop Motor Startup Coven Licep and Handoff Closed Loop					2	Controls Auto Read Fa Read Faults	Faults autorite Status	Charts Log			
Control Configu	ration-Motor Para	meters				~					
Control Configu	Control Configuration- Open Loop					~	-				
Control Configuration- Control Fault Settings						~					
Control Configu	ration- Closed Loo	op ~	Closed loop	election select (CL_DEC_CONFIG) losed loop deceleration defined by CL_ACC	Closed loop deceleration rate [CL_DEC]500	~		0-			
Kp coefficient for current 0 Min Range: 0, Max Rang	ig and id loop [CURR_LOOP_K	¢]	- Ki coefficient 0 Min Range: I	for current lq and id loop [CURR_LOOP_K0]	Kp coefficient for speed loop (SPD_LOOP_KP) 0 Min Range: 0, Max Range: 2.55	:		8			
Ki coefficient for speed to O Min Rence: 0, Max Rance	200 [SPD_LOOP_KI]	:	Reference to 60 %	e Torque Pi Loop (A) (ILIMIT)	Flux Weakening Kp (FLUX_WEAKENING_KP) 1.6 Min Rance: 0. Max Rance: 25.5	:		No Fault	s Detected		
- Flux Weakening KI (FLU) 160	X_WEAKENING_KI]	5	- Close loop a 200	cceleration when estimator is not yet fully aligned (Hz /	- Maximum Power (Maximum Power) 100	•					
Enable Maximum Torque	re: 2050 Per Ampere Operation (MTPA_ bled	EN]	Response_tr)_change_of_DiR_pin_status [DiR_CHANGE_MODE] hange the direction through Reverse Drive hile continuously driving the motor	MIT RAINGE 0, MAX RAINE 3070 - FLUX WEAKENING REFERENCE [FLUX_WEAKENING_REFI 95%	ERE					
Control mode [CTRL_MC Speed Control	DDE]	~									

Figure 6-5. HW_LOCK_LIMIT

6.5 No Motor Fault [NO_MTR]

This fault gets triggered when the phase current is below the no motor lock threshold for 500ms during open loop. When this fault gets triggered, use the following recommendations:

- 1. Make sure the motor phases are securely connected to the OUTA, OUTB, and OUTC test points or the connector block J11.
- 2. If the fault persists, set the no motor lock current threshold [NO_MTR_THR] to 5%.
- 3. For low inductance motors, increase PWM switching frequency [PWM_FREQ_OUT].

Iotor Studio File Options Too	ols Help	Documents				
Pre-Startup Motor Startup Oper Loop an	d Handoff	Closed Loop Motor Stop	 Show Advance Settings Show Modified Registers Auto Read All Registers 	>	Controls Fault Auto Read Fault Status Read Faults Clear Fau	Charts Logs
Control Configuration- Open Loop				~		
Control Configuration- Control Fault Se	ttings			^		
Hardware Lock detection current limit (A) [HW_LOCK_ILIMIT]	 ✓ Lock dete 75 % 	ection current threshold (A) [LOCK_JLIMIT]	- Lock current Limit Mede [LOCK_LLIMIT_MODE] Fault automatically cleared after LCK_RETRY t ~			
Lock Detection current limit deglitch time [LOCK_ILIMIT_DEG] 5 ms	✓ Lock dete 2 s	ction retry time [LCK_RETRY]	Notor Lock Mode [MTR_LCK_MODE]			
IPD timeout fauit Enable [IPD_TIMEOUT_FAULT_EN] Chable	IPD frequ	ency fault Enable (IPD_FREQ_FAULT_EN) Enable	Lock 1 (Abnormal Speed) Enable [LOCK1_EN]			
Lock 2 (Abnormal BEMF) Enable [LOCK2_EN] Enable	Lock 3 (N	to Motor) Enable [LOCK3_EN] Enable	Calculated Abnormal Speed Lock Threshold (Hz) 0.00			
Abnormal speed lock threshold [LOCK_ABN_SPEED]	 Abnornal 70% 	BEMF lock threshold (% of expected BEMF) (ABNORMA	- No motor lock threshold (A) [NO_MTR_THR]	1	No	Faults Detected
- Hardware Lock Detection current limit mode [HW_LOCK_ILIMIT_M Fault automatically cleared after LCK_RETRY t	 Hardware 2 us 	ELOCK Detection current limit deglitch time [HW_LOCK_IL	IVM_UV_OV_HVSj			
Undervoltage Fault Recovery Mode [MIN_VM_MODE] Automatic clear if voltage in bounds	Overvoita	ige Fault Recovery Mode (MAX_VM_MODE) Automatic clear if voltage in bounds	Automatic retry attempts (AUTO_RETRY_TIMES) Vo Limit			
> Control Configuration- Closed Loop				~		
P Algorithm Configuration- Reference Pro	ofile			~		

Figure 6-6. NO_MTR

Note

The MCF8329A might trigger loss of sync [LOSS_OF_SYNC] when motor phases are disconnected while the motor is spinning.





6.6 Abnormal Speed [ABN_SPEED]

This fault gets triggered when motor speed exceeds abnormal speed threshold [LOCK_ABN_SPEED]. When this fault gets triggered, use the following recommendations:

- Increase align time [ALIGN_TIME], decrease slow first cycle frequency [SLOW_FIRST_CYC_FREQ], or increase the IPD current threshold [IPD_CURR_THR] and IPD repeat times [IPD_REPEAT] depending on the start-up mode selected.
- 2. Decrease open loop acceleration A1 [OL_ACC_A1] and open loop acceleration A2 [OL_ACC_A2].
- 3. Decrease closed loop acceleration [CL_ACC].

Iotor Studio File Options Tool	ls Help Documents				
Pre-Startup Motor Startup Open Loop and	Handoft Closed Leep Motor Step	Show Advance Settings Show Modified Registers Auto Read All Registers	Controls Faults Charts Logs Auto Read Fault Status Charts Logs Read Fault Status Clear Faults Configure		
Control Configuration-Motor Startup Stat	Align or slow first cycle current ramp rate (ALIGN_SLOW_RAMP_R	Align time [ALIGN_TIME]			
Align or slow first cycle current limit (A) [ALIGN_OR_SLOW_CURR. 20 %	- IPD Clock Frequency (IPD_CLK_FREQ)	✓ PP Current Threshold (A) [IPD_CURR_THR] 20 % ✓			
IPD release mode (IPD_RLS_MODE) Disable	PD advance angle [IPD_ADV_ANGLE]	Number of times IPD is executed [IPD_REPEAT] 1 time			
Align Time (ALIGN_ANGLE)	Calculated Frequency of First Cycle (Hz) 0.00	Prequency of first cycle in close loop startup (% of MAX_SPEED) { 0.1%			
Starting frequency of first cycle [FIRST_CYCLE_FREQ_SEL]	No Faulto Deserved				
Control Configuration-Motor Parameters	NO Faults Detected				
Control Configuration- Open Loop	*				
Control Configuration- Control Fault Sett					
Control Configuration- Closed Loop	~				
Algorithm Configuration- Reference Prof	file	× _			

Figure 6-7. ABN_SPEED

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