XMC1000 / XMC4000 Motor Control Application Kit

Getting Started 01 v1.0

Induction Motor V/F Control App (ACIM_FREQ_CTRL)





Induction Motor V/F Control App





Induction Motor V/F Control App





Kit composition – XMC 1300 Boot Kit





Kit composition – PMSM LV 15W Card





Kit composition – connection XMC1300





Kit composition – XMC4400 Enterprise Kit



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Kit composition – General Purpose Motor Drive



ACT connector to CPU Card (e.g. CPU_44A)



Kit composition – connection XMC4400





Induction Motor V/F Control App





Development Tool: DAVE[™] version 4

- > DAVE[™] is a free development platform for code generation by Infineon
- The Software package: DAVE[™], Examples, Videos, Apps, XMCLib... can be downloaded from
- http://www.infineon.com/DAVE
- > This Getting started is based on DAVETM v. 4.1.2





Induction Motor V/F Control App





Getting started limitations

- > The following example shows the default usage of the App.
- This Getting Started shows how to create an example with the default settings.
 Only the used App configurations are described. More information about the spectrum of the App can be found in the Help or an Application Note.
- The creation is described in steps. If a step is specific to XMC1300 or XMC4400 it is mentioned in the title and a sub-step e.g. 2.a, 2.b. Variation of the example (e.g. with adjustable speed) based on the main example.
- The following examples based on ACIM_FREQ_CTRL/ACIM_FREQ_CTRL APP v.
 4.0.5 beta

Step 1: create new project

- **Open Dave** >
- Select a workspace or use the default workspace >
- Click "OK" >

New

File \rightarrow New \rightarrow DAVE Project... >

DAVE IDE - DAVE™ - C:\Workspaces\DAVE-4.1\Motor

🌜 Workspace Launcher Select a workspace DAVE[™] stores your projects in a folder called a workspace. Choose a workspace folder to use for this session. Workspace: C:\Workspaces\DAVE-4.1\Motor • Browse... Copy Settings OK Cancel File Edit Source Refactor Navigate Project Search Run DAVE Window H

	Open File			Project	
	Close	Ctrl+W		Example	
	Close All Ctrl	+Shift+W		Other	Ctrl+N
e	Save	Ctrl+S			

Alt+Shift+N) 📸 DAVE Project...





Step 1: create new project

- Enter project name: e.g. GT_ACIM_XMC44_Example1_v1_0 >
- Select "DAVE CE Project" for Project Type >
- Click "Next >" >
- Select your microcontro >
 - **XMC1300**: XMC130 _

- XMC4400: XMC440 _
- Click "Finish" >

ntroller:	Create a new C/C++ project for Infineon tool chains					
.302-TO38X0200 400-F100x512	Project Name: GT_ACIM_XMC44_Example1_v1_0 Image: State of the state					
New DAVE Project	Project Type:	Tool Chain:				
Microcontroller Selection Page Select the microcontroller for which the project has to be created	 Infineon Projects ARM-GCC Application 	ARM-GCC Application				
▲ Witcrocontrollers ▲ W XMC400 → XMC4500 Series → W XMC4500 Series → W XMC400-F100x256 → XMC400-F100x256 → XMC400-F100x256 → XMC400-F100x256 → XMC402-F100x256 → XMC402-F100x2	 Easy Start Project Simple Main Project DAVE CE Project Empty Project ARM-GCC Library Empty Project Show project types and tool chains on 	ly if they are supported on the platform				
Linker Option Remove unused sections Runtime Library						
Library Newlib-nano Add floating point support for printf Add floating point support for scanf	? < Back	Next > Finish Cancel				
? < Back Next > Finish	Cancel					

New DAVE Project

DAVE Project

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Step 2: add APP

> Click "Add New App"



- Deactivate "Hide beta versions"
- > Enter in search filter "Motor Control"
- Select "ACIM_FREQ_CTRL"
- > Click "Add"
- Read the warning regarding beta versions and Click "OK" to confirm.
- Add in a new APP takes a few seconds
- Click "Close" to hide the "Add new APP" window







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Step 3: APP configuration

- Open "ACIM_FREQ_CTRL" by double click or right click → "Configure App instance"
- Open "Basic Control Scheme" tab
- Select "FB_RAMP_0"
- This will add the AUTOMATION APP. This can take a few seconds.





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Step 3



Step 3: APP configuration

- > Open "Power Board" tab
- Set "Dead time rising edge[ns]" to 1100
- > Set "Dead time falling edge[ns]" to 885

Control Algorithm	Basic Cont	rol Scheme	Control Parameters	Task Scheduler	Power Board	Mea
Power Board Con	figuration –					
DC link voltage [V]:	24				11
Dead time rising e	dge [ns]:	1100		PWM Tim Compare		~
Dead time falling	edge [ns]:	885		value	/	
Switch delay [ns]:		500		High Side		Ц
Inverter enable pir	n:	Active Hig	h 👻	PWM		
Bootstrap time [m	ns]:	0		Low Side PWM	•	H
Output polarity				Phase	:	
High side switch	nes:	Active Low	-	Voltage	: →	! !
Low side switch	es:	Active Low	-		:	
Current Amplifier	Configurati	on				
VADC reference [[V]:	3.3			Amplifier Bia	5
Rshunt [mOhms]]:	10		₽↓	Y	
Amplifier gain:		21			<pre>{</pre>	
		4.5.74.4005			I	

Step 4: Pin assignment

- > The pin allocation can be done in two ways:
 - 1) table view 🚺

Filter PWM_SVM_0 •			
APP Instance Name	APP Pin Name	Pin Number (Port)	
# PWM_SVM_0			
	PhaseU_High Pin	Not Selected	*
	PhaseV High Pin	Not Selected	
	PhaseW High Pin	Not Selected	*
	PhaseU Low Pin	Not Selected	-
	PhaseV Low Pin	Not Selected	
	PhaseW Low Pin	Not Selected	-
	Tran Pin	Not Selected	-
	Inverter Enable Din	Not Selected	-
	and the choice run	Not Selected	
		#17 (P0.0)	
		#18 (P0.1)	
		#19 (P0.2)	
		#20 (P0.3)	
		#21 (P0.4)	-
		#22 (P0.5)	
		#23 (P0.6)	
		#24 (P0.7)	
		#27 (PO.8)	
		#28 (P0.9)	
		#29 (P0.10)	
		#30 (P0.11)	
		#31 (P0.12)	
		#32 (P0.13)	
		#35 (P0.14)	
		#34 (P0.15)	
(1)		(#10(PLU)	









Step 4: Pin assignment- table view

The Pin Allocation can be done in two ways:

- Table view: >
 - Click "Manual Pin Allocator"



- Table: select the corresponding pin for each pin
- Click "Save" _

File	Edit	Navig	ate	Search	Project	Run	DAVE	Window	He
8(à 4	22	Þ	c 1	ta 🔤 🖡	C	9 (2 🛑 🏇	• :
₽ C	/C++	Project	s 🛙	陷 Proje	ect Explor	er 🚺	lanual P	in Allocato	or F

Manual Pin Allocator			X
Filter PWM_SVM_0 -			
APP Instance Name	APP Pin Name	Pin Number (Port)	
▲ PWM_SVM_0			
	PhaseU_High Pin	Not Selected	Ŧ
	PhaseV_High Pin	Not Selected	~
	PhaseW High Pin	Not Selected	-
	PhaseU_Low Pin	Not Selected	~
	PhaseV Low Pin	Not Selected	-
	PhaseW Low Pin	Not Selected	~
	Trap Pin	Not Selected	-
	Inverter Enable Pin	Not Selected	*
		Not Selected	*
		#17(P0.0)	
		#18 (PO.1)	
		#19 (P0.2)	
		#20 (P0.3)	=
		#21 (P0.4)	
		#22 (P0.5)	
		#24 (00 7)	
		#27 (P0.8)	_
		#28 (P0 9)	
		#29 (P0.10)	
		#30 (P0.11)	
		#31 (P0.12)	
		#32 (P0.13)	
		#33 (P0.14)	
		#34 (P0.15)	
		#16 (P1.0)	+
(?)		Save Reset	Close



Step 4: Pin assignment- graphical view

- Graphical view:
 - Click "Pin Mapping Perspective"
 - Select pin in the left table
 - Right click on a colored pin
 - Click "Assign"

🦆 DAVE CE - DAVE™ - C:\Wo	orkspaces\DAVE-4.1\Motor
File Edit Navigate Search	h Project Run DAVE Window Help
u 🤉 🗠 🚬 🌌 🄑 🗃 🕅	;; t. ≥. = 0 # 0 F <mark>●</mark> • - 1 @ @
💀 C/C++ Projects 🛛 🏠 Pro	oject Explorer 🔅 🗘 🖓 Pin Mapping Perspective
🛛 😂 GT_ACIM_XMC44_Exa	ample1_v1_0 [Active - Debug]
PinMapping - DAVE™ - C:\We	orkspaces\DAVE-4.1\Motor
File Edit Navigate Search	Project Run DAVE Window Help
📬 🕶 🖬 🕤 🗁 🚬 🌌	/> 🗟 🔞 👯 ኬ 🔤 📮 🗣 🔳 🕒 🗟 🌒 🍫 🕶 🚾
🐰 Virtual Pin View 📃 🗖	# Package View
Virtual Pin List	
▲ PWM_SVM_0	
Inverter Enable Pin	
PhaseU_High Pin	
PhaseU_Low Pin	P2.5 2
PhaseV_High Pin	P2.6 3
PhaseV_Low Pin	P2.7 L 4
PhaseW_High Pin	P2.8 5
Tran Din	P2 9 🔲 6
indp i m	P2.10
	P2.11 Assign
	VSS VSSP 9 TESODO

Note: See legend color code for additional information



Step 4a: Pin assignment - XMC1300

🚭 Manual Pin Allocator			X
Filter ALL 🔹			
			ĒĒ
APP Instance Name	APP Pin Name	Pin Number (Port)	
PWM_SVM_0			
	PhaseU_High Pin	#17 (P0.0)	Ŧ
	PhaseV_High Pin	#24 (P0.7)	Ŧ
	PhaseW_High Pin	#27 (P0.8)	Ŧ
	PhaseU_Low Pin	#18 (P0.1)	Ψ
	PhaseV_Low Pin	#23 (P0.6)	Ŧ
	PhaseW_Low Pin	#28 (P0.9)	Ŧ
	Trap Pin	#31 (P0.12)	-
	Inverter Enable Pin	#30 (P0.11)	Ŧ
?	Save	Reset	ose





Step 4b: Pin assignment- XMC4400

ilter ALL 🔻					
APP Instance Name	APP Pin Name	Pin Number (Port)			
PWM_SVM_0					
	PhaseU_High Pin	#97 (P0.5)	-		
	PhaseV_High Pin	#98 (P0.4)	v		
	PhaseW_High Pin	#99 (P0.3)	v		
	PhaseU_Low Pin	#100 (P0.2)	T		
	PhaseV_Low Pin	#1 (P0.1)	-		
	PhaseW_Low Pin	#2 (P0.0)	-		
	Trap Pin	#89 (P0.7)	.		
	Inverter Enable Pin	#68 (P1.15)	-		
				0 0 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	0011 3333 3354 440 007 111 111 111 111 111 111 111 111 11
(?)	S	ave Reset	Close	P0.1 1 P0.0 2	
0				P0.10 3 P0.9 4 P3.2 5 P3.2 5	
				P3.0 7 USB_DM 8 USB_DP 9	
				VBUS 10 VDDP 11 VDDC 12	XMC4400 LQFP100
				HIB_IO_1 13 HIB_IO_0 14 RTC_XTAL1 15	
				RTC_XTAL2 16 VBAT 17 P15.3 18	
				P15.2 19 P14.15 20 P14.14 21	

Step 5: Generate code

- > Click "Generate Code"
- Code Generation can take a few seconds.

÷	DAVE	CE - GT_ACI	M_XMC44	100_Examp	ole1_v	1_0/Dav	/e/Model//	APPS//	ACIM_I	REQ_C	TRL/v4_0)_5/Uin	nodel,
File	e Edit	Navigate	Search	Project	Run	DAVE	Window	Help)				
H	R Ł	🎽 🌌 🌽		- N B.	<u>э</u> .,	: হা	i 💣 i 🍇 i	t a 🕹				☆ ▼	2
Ra	C/C++	Projects %	Proje	ect Evolor	er	¢	-> @ F	1 🐁	∇ \Box		_ ∆ Gene	erate C	ode



Step 6: Add function



 Edit main.c by adding the following function call: ACIM_FREQ_CTRL_MotorStart(&ACIM_FREQ_CTRL_0);

```
23 int main(void)
24 {
25
     DAVE STATUS t status;
26
627
     status = DAVE Init();
                                     /* Initialization of DAVE APPs */
28
29
     if(status == DAVE_STATUS_FAILURE)
30
     {
31
       /* Placeholder for error handler code. The while loop below can be replaced with an user error handler. */
32
       XMC_DEBUG("DAVE APPs initialization failed\n");
33
34
       while(10)
35
       {
36
37
        }
38
     }
39
40
     ACIM_FREQ_CTRL_MotorStart(&ACIM_FREQ_CTRL_0);
41
     /* Placeholder for user application code. The while loop below can be replaced with user application code. */
42
     while(10)
43
     {
44
45
     }
46 }
47
```

Step 7: Build project



> Build Project



File	Edit	Navigate	Search	Run	Project	DAVE	Window
	r e	22 />	c 18	⁺∎ ≧	a 🚍 🙃	9	2 🜒 🏇 🤊
Ec (C/C++	Prc Build A	ctive Proj	ect kp	lorer	¢	⇒ @ ⊡

Step 8: Debug – create debug session



- > Click "Debug":
- › Double click "GDB SEGGER J-Link Debugging"
- > Click "Debug"
- The debugger is downloading the program

(See next slide)

Debug Configurations	Debug Configurations
Create, manage, and run configurations	Create, manage, and run configurations
Image: Second	Image: Statup Image: Statup
	Filter matched 2 of 19 items Apply Revert
	⑦ Close

Compare	100.0%	0.013s
Erase	0.0%	0.022s
Program	0.0%	
Verify	0.0%	

DAVE CE - GT_ACIM_XMC44_Example1_v1_0/Dave/Model/APPS/ACIM_FREC

File Edit Navigate Search Project Run DAVE Window Help



Step 8: Debug – start program

- > Switch to debug perspective. Confirm with "YES"
- > To start the program click "Resume (F^I)"



File	Edit	Source	Refactor	Navigate	Search	Window
8	b 🔒			. ∿ .r i≯	₹.₹	8 i 🗠 i



Behavior

> The Motor slowly ramps up to 1500rpm





Induction Motor V/F Control App





Getting started limitations

- > The following example shows the default usage of the App.
- This Getting Started shows how to create an example with the default settings.
 Only the used App configurations are described. More information about the spectrum of the App can be found in the Help or an Application Note.
- The creation is described in steps. If a step is specific to XMC1300 or XMC4400 it is mentioned in the title and a sub-step e.g. 2.a, 2.b. Variation of the example (e.g. with adjustable speed) based on the main example.
- The following examples based on ACIM_FREQ_CTRL/ACIM_FREQ_CTRL APP v.
 4.0.5 beta
- > Example 2 with adjustable speed based on example 1. Only the delta is discribed in this cheptar. The target speed is selected by adjusting the potentiometer.

Step 1: APP configuration



- > open "ACIM_FREQ_CTRL" by double click or right click → "Configure App instance"
- Open the "Measurements" tab
- Click "Enable speed set via analog input"
- This will add the ADC APP. This can take a few seconds.

Control Algorithm	Basic	Control Sche	me	Control Paramete	rs Task Sch	eduler	Power Board	Measurements	Err
Measurement									
Current measurer	ment:	None					Ψ.		
Enable over current detection									
Enable voltag	e comp	pensation							
V Enable speed	set via	analog inpu	t						
ADC Carfin metia									
Enable measurem	n nent	Request sou	rce	Queue position	Refill	Exter	nal trigger		
I_Average		Queue A	Ŧ	0	Enable	E	nable		
V_DCLink		Queue A	Ŧ	1	Enable	E	nable		
Analog_Inp	ut	Queue A	Ŧ	2	✓ Enable	E	nable		
User_Define	ed 🛛	Queue A	Ŧ	3	Enable	E	nable		





Step 1: APP configuration – XMC4400

The V/f control is less efficient than FOC control. To reduce the maximum power consumption the default values is be changed. This only applies to **XMC4400** kits.

- Open the "Control Parameters" tab
- Reduce "No load speed [rpm]" to 2000
- > Enable "User defined"
- > Set "V/f constant" to 70
- > Set "V/f offset" to 300

Control Algorithm	Basic Control S	cheme	Control Parame	ters	Task Scheduler	Power Board	Measurem	ents	Error Handler	Interrupt Settings	
Control Panel Para	ameters					Motor Paramet	ers				
Motor direction:	[Clockw	ise		-	Nominal voltag	e [V]:	24			
User speed set [rp	om]:	1500				No load speed [[rpm]:	200)		
Over current limi	t [mA]:	500				Pole pair:		4			
Maximum voltag	e limit [%]:	100									
V/f Configuratio	on	Defau	lt 🗸	User o	lefined						
V/f constant [m	nV/Hz]:	180	70								
V/f offset [mV]:	: [1200	300								

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Step 2: Pin assignment

- > Assign the ADC pin in table or graphical view:
 - 1) table view 💷

ritter PWW_SVM_0 +			
APP Instance Name	APP Pin Name	Pin Number (Port)	
# PWM_SVM_0			
	PhaseU_High Pin	Not Selected	*
	PhaseV_High Pin	Not Selected	
	PhaseW High Pin	Not Selected	*
	PhaseU Low Pin	Not Selected	-
	PhaseV Low Pin	Not Selected	
	PhaseW Low Pin	Not Selected	
	Tran Pin	Not Selected	-
	Inverter Enable Pin	Not Selected	
		Not Selected	~
		#17 (P0.0)	
		#18 (P0.1)	
		#19 (PO.2)	
		#20 (P0.3)	
		#21 (P0.4)	-
		#22 (P0.5)	
		#23 (P0.6)	
		#24(P0.7)	
		#28 (P0.8)	
		#29 (P0.10)	
		#30 (P0.11)	
		#31 (P0.12)	
		#32 (P0.13)	
		#33 (P0.14)	
		#34 (P0.15)	
		#16 (P1.0)	+





Note: Pin assignment is explained in example1 step 4





Step 2a: Pin assignment - XMC1300

> Allocate the "Analog_Input pin" to the potentiometer input pin

Filter ALL]		
APP Instance Name	APP Pin Name	Pin Number (Port)	
ACIM_FREQ_CTRL_0			
	Analog_Input pin	#2 (P2.5)	Ŧ
PWM_SVM_0			
	PhaseU_High Pin	#17 (P0.0)	.
	PhaseV_High Pin	#24 (P0.7)	.
	PhaseW_High Pin	#27 (P0.8)	.
	PhaseU_Low Pin	#18 (P0.1)	.
	PhaseV_Low Pin	#23 (P0.6)	v
	PhaseW_Low Pin	#28 (P0.9)	Ŧ
	Trap Pin	#31 (P0.12)	T
	Inverter Enable Pin	#30 (P0.11)	.
?	S	ave Reset	Close
U		incort incort	ciose





Step 2b: Pin assignment- XMC4400

> Allocate the "Analog_Input pin" to the potentiometer input pin

ilter ALL 🗸	Second Constitution			
				1
APP Instance Name	APP Pin Name	Pin Number (Port)		
▲ PWM_SVM_0				
	PhaseU_High Pin	#97 (P0.5)	Ŧ	
	PhaseV_High Pin	#98 (P0.4)	Ŧ	
	PhaseW_High Pin	#99 (P0.3)	Ŧ	
	PhaseU_Low Pin	#100 (P0.2)	Ŧ	
	PhaseV_Low Pin	#1 (PO.1)	Ŧ	
	PhaseW_Low Pin	#2 (P0.0)	Ŧ	
	Trap Pin	#89 (P0.7)	Ŧ	
	Inverter Enable Pin	#68 (P1.15)	T	
?	Sa	ve Reset	Close	P00 2 P10 4 P10 4 P2 5 P2 5 P3 6 P3 6 P3 7 P3 6 P3 7 P3 P3 P

P15.2 0 P14.15 0 P14.14 0 P14.13 0 P14.12 0 P14.12 0 P14.7 0 P14.6 0

Step 3: Generate, build, debug

- > Repeat following steps from example 1:
 - Step 5: Generate code
 - Step 7: Build code
 - Step 8: Debug



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Behavior

- > The target speed is selected by potentiometer
- > The target speed can vary from 0rpm to "No load speed"
- Motor slowly ramps up or down to the target speed





Induction Motor V/F Control App





App help

This will show helpful information regarding to the APP:

- Right click on ACIM_FREQ_CTRL_0
- > Select "App Help"
- > This will show the help contents this App

ACIM_FREQ_CTRL	
Hide Locate Back Forward Stop	「2」(A) AL 毎7 節- Refresh Home Font Pint Options
Contents Index Search Favorites	ACIM_FREQ_CTRL
Opys Opys Opys Opys Opysight Infom	Home
License Terms and Copyright Ir	Overview
	Overview ACIM_FREQ_CTRL APP implements open loop V/f control algorithm to drive three phase AC Induction Motor. This is scalar control technique which involves controlling the amagnitude of voltage or frequency of the induction motor. Constant V/f method maintains the constant flux density by changing the voltage in proportion with frequency. This APP provides the configurations required for the V/f control lass facilitates the use of the AUTOMATION APP for runtime parameter checking, error logging and connecting to the Ram Generator Function Block. It uses MOTOR_LB which is math library used for common algorithms.
(d) 😵 Files	The ACIM_FREQ_CTRL APP provides the following features: 1. Basic Control Scheme: This includes mandatory V/f control algorithm parameters. 2. Advanced Castrol Externel:
	 Advanced Control Scheinte: This gives option for adding offset values, inserting user code via call back function and Position control algorithm. Task Scheduler: Tasks can be scheduled from various time sources. And task execution time can be adjusted. State Hachine: Notor state machine controls the execution of the motor control algorithm. This APP also supports Drive State Machine (optional) which interacts with the external Motor state machine the execution of the motor control algorithm. This APP also supports Drive State Machine (optional) which interacts with the external Motor state machine the average interact massivement (overcurrent protection). DC link voltance measurement (Voltane compensation) and analog speed control measurement to support the average interact measurement (overcurrent protection). DC link voltance measurement (Voltane compensation) and analog speed control measurement
	 Compared the Workforing: Runtime set/get of the motor parameters. Forror Handler: Logging the errors, warnings reported by the APP which can be communicated to the central system. Ramp Function Block Connection: Speed of the motor can be ramped in linear or s-curve by connecting the user end speed to the ramp function block.
	Hardware and software connectivity of APP Figure 1, shows how the APP is structured in DAVE. The LLD layer provides abstraction for these hardware modules. Control algorithm is built on top of the basic building blocks like PVM (PVM_SVM) and ADC (ADC_QUEUE). It makes use of low level drivers for CCU8, ADC, SCU and GPIO.
	user application (main.c) USER CODE





Where to buy - XMC1300

Development Boards	5	Order Number
XMC1300 Boot Kit		KIT XMC13 BOOT 001
XMC1000 Motor Control Application Kit		KIT XMC1x AK Motor 001



Where to buy – XMC4400

Development Boards	Order Number
XMC4400 Enterprise Kit	<u>KIT XMC44 EE1 001</u>
General Purpose Motor Drive Kit	KIT XMC4x MOT GPDLV 001
XMC4400 Motor Control Application Kit	<u>KIT XMC44 AE3 001</u>



General information

- Information about all available XMC Motor Control Application Kits:
 <u>LINK</u>
- For latest updates, please refer to: <u>http://www.infineon.com/xmc1000</u> <u>http://www.infineon.com/xmc4000</u>
- > DAVE[™] development platform: <u>http://www.infineon.com/DAVE</u>
- > For support:

http://www.infineonforums.com/forums/8-XMC-Forum



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