

# XMC Digital Power Explorer Kit

Getting Started



# Agenda (1/2)

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– Example – XMC4200 Buck Converter in Voltage Control Mode

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6b – How to load Example Project in DAVE™?

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4a

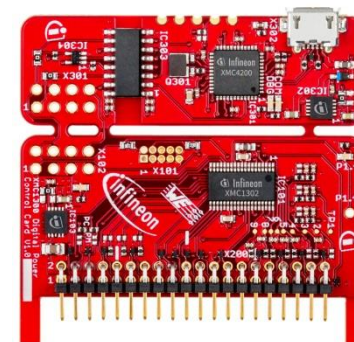
– Example – XMC4200 Buck Converter in Voltage Control Mode

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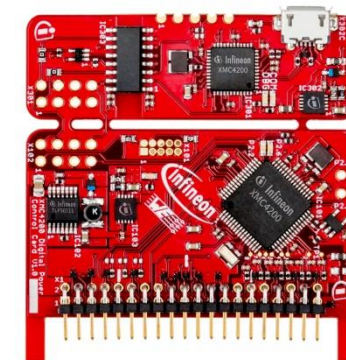
– Example – XMC1300 Buck Converter in Voltage Control Mode

# Kit Overview (1/2)

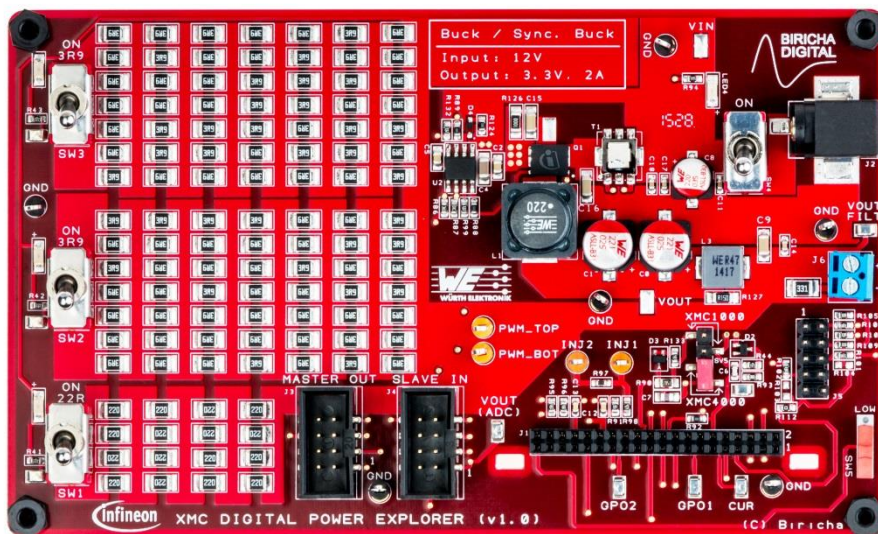
- › XMC Digital Power Explorer Kit
  - › XMC1300 Digital Power Control Card
  - › XMC4200 Digital Power Control Card
  - › XMC Digital Power Explorer Board



XMC1300 Digital Power Control Card



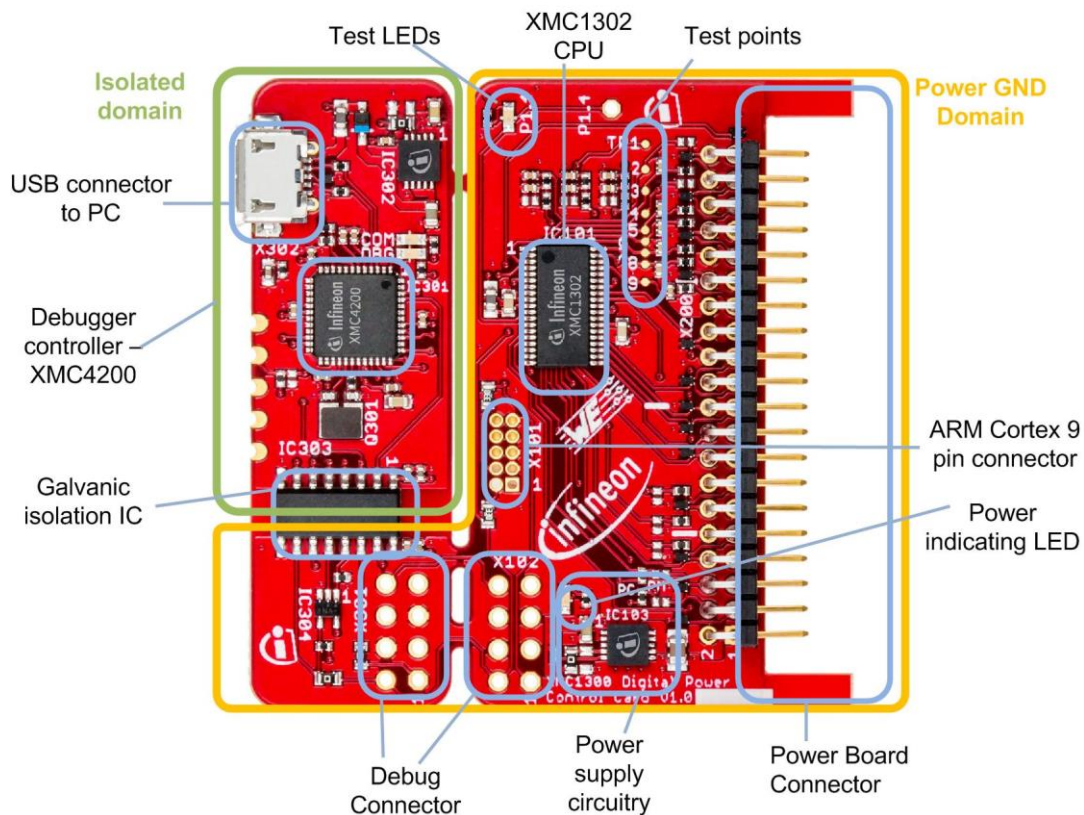
XMC4200 Digital Power Control Card



XMC Digital Power Explorer

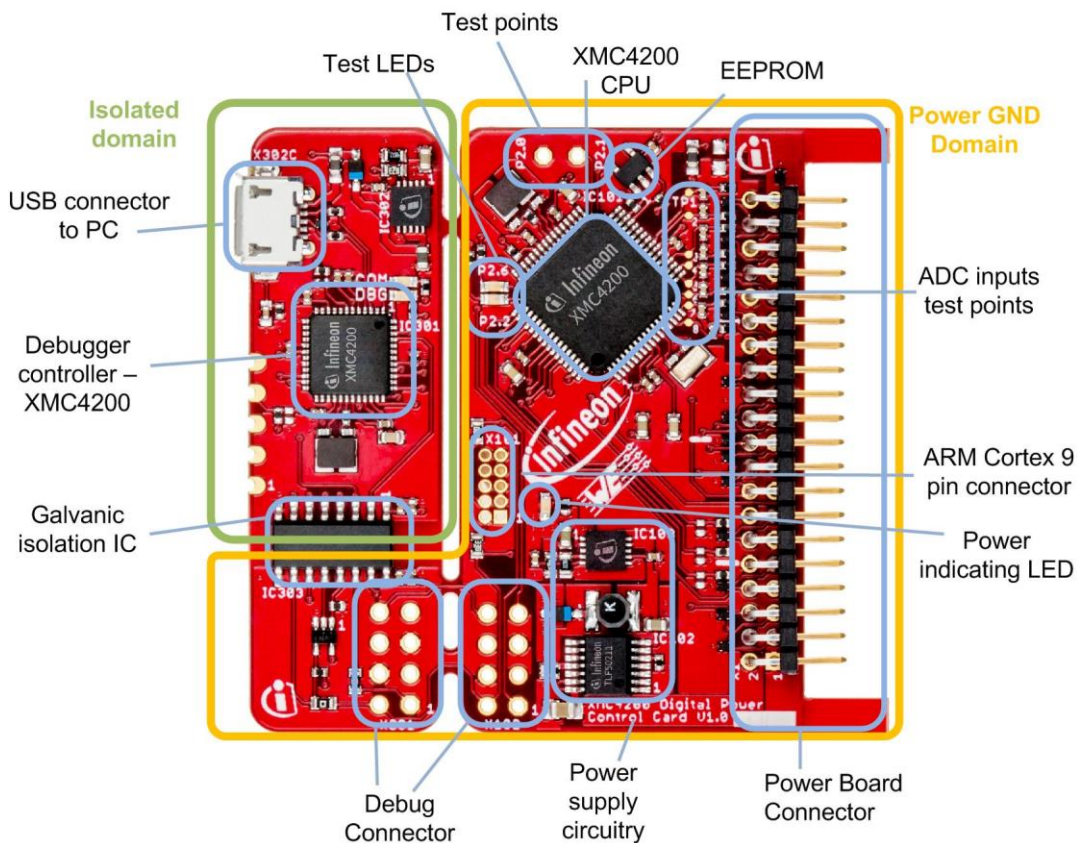
# Kit Overview (2/2)

## > XMC1300 Digital Power Control Card



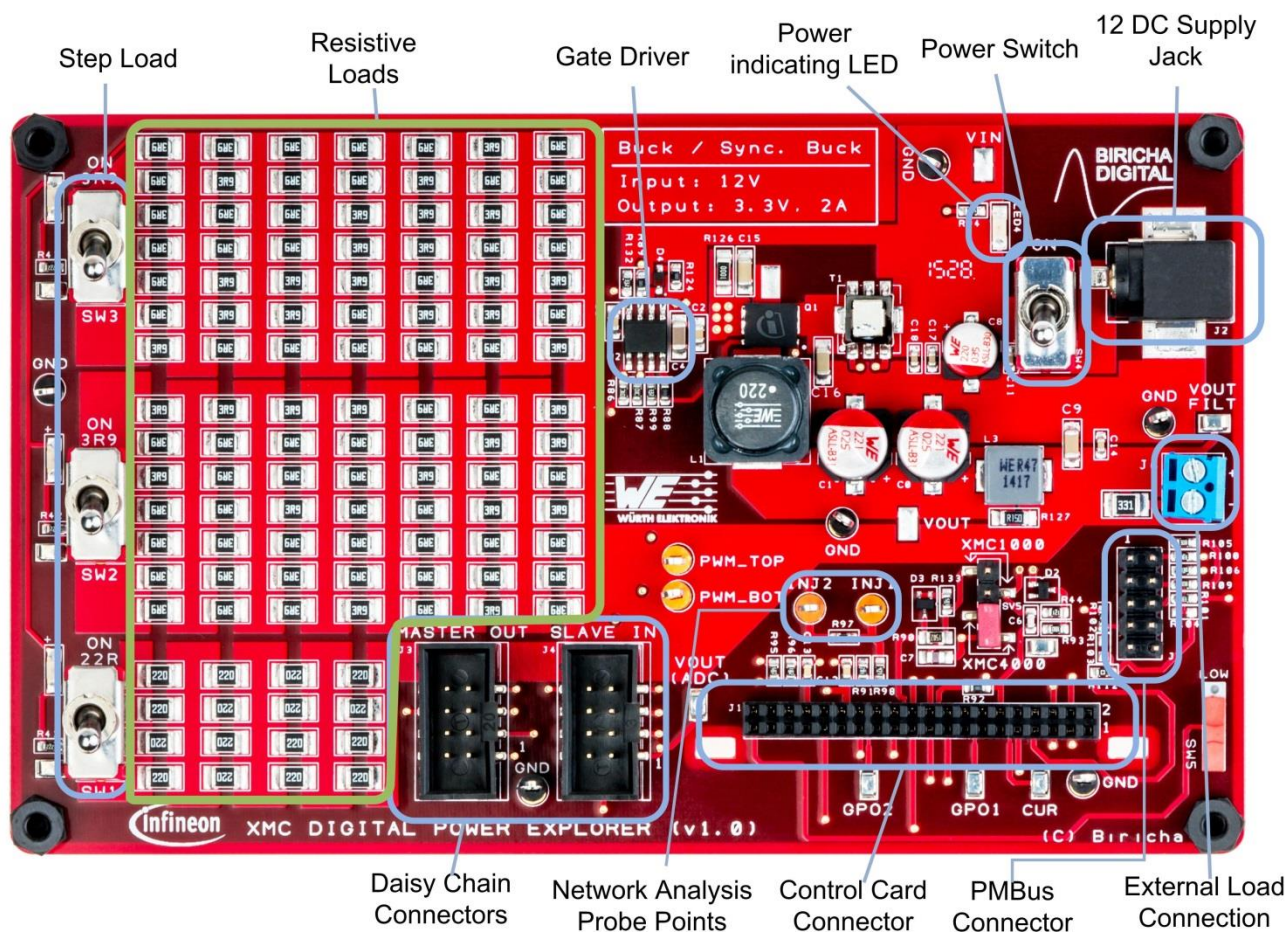
# Kit Overview (2/2)

## > XMC4200 Digital Power Control Card



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## > XMC Digital Power Explorer





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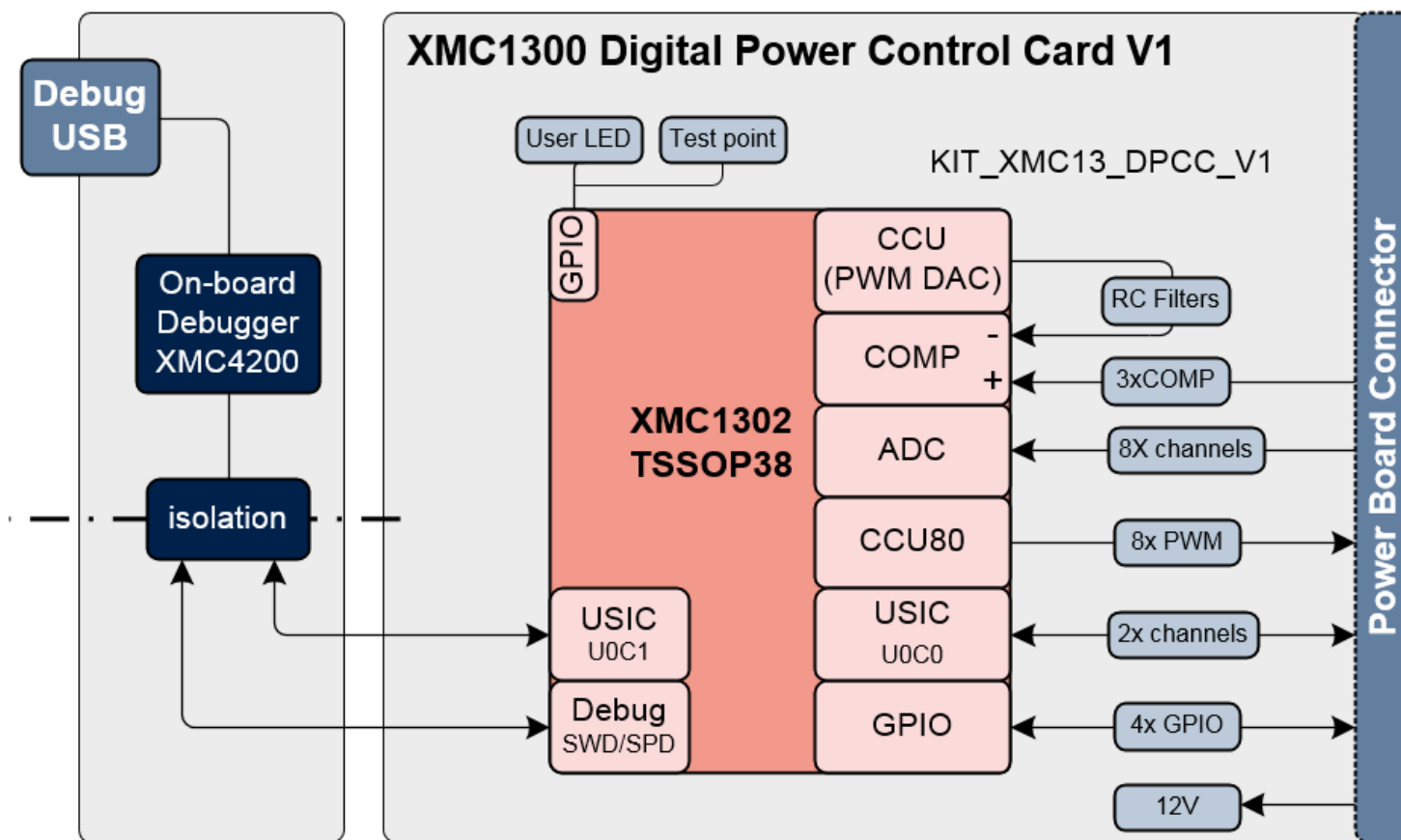
– Example – XMC4200 Buck Converter in Voltage Control Mode

4b

– Example – XMC1300 Buck Converter in Voltage Control Mode

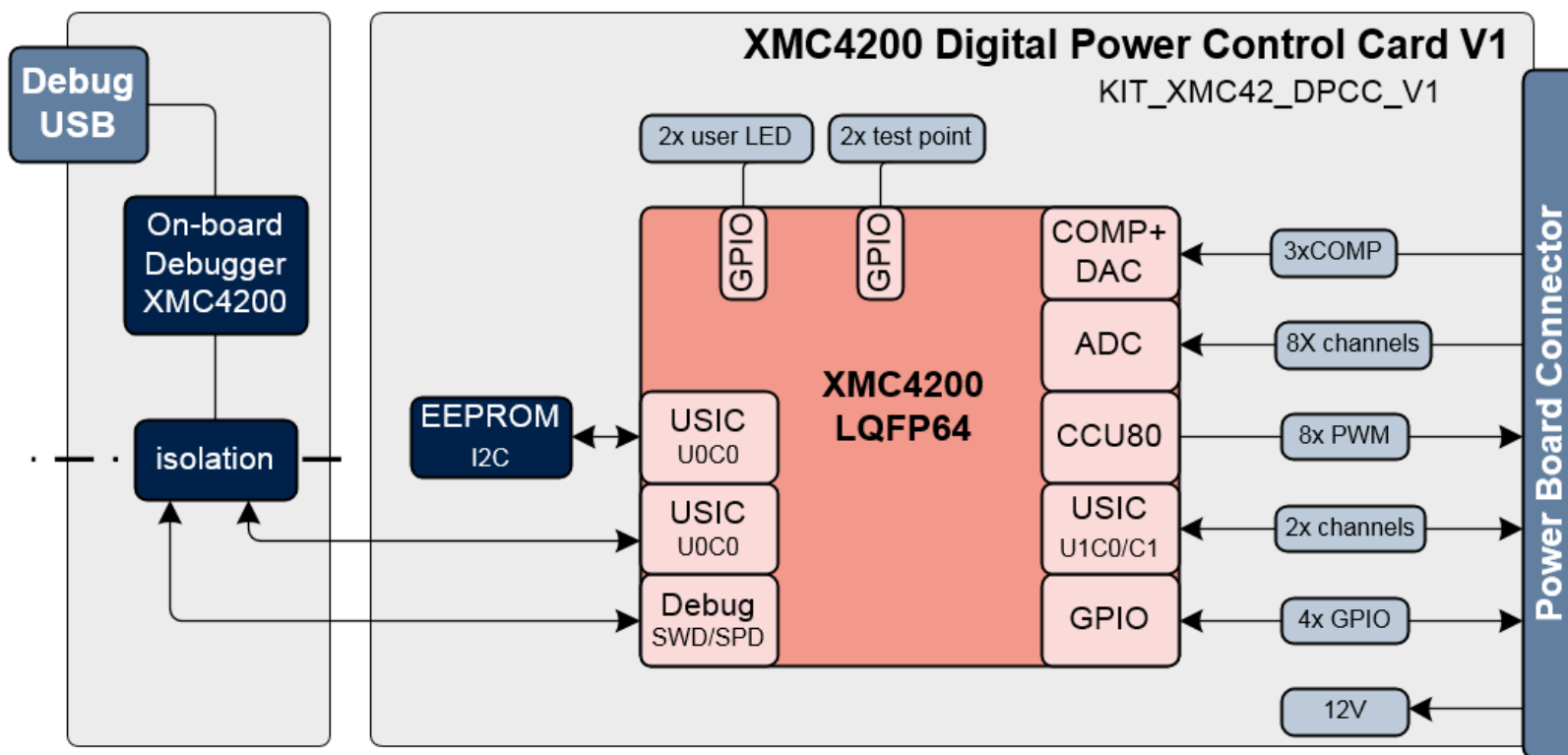
# Hardware Overview

## › Hardware Block Diagram of XMC1300 Control Card:



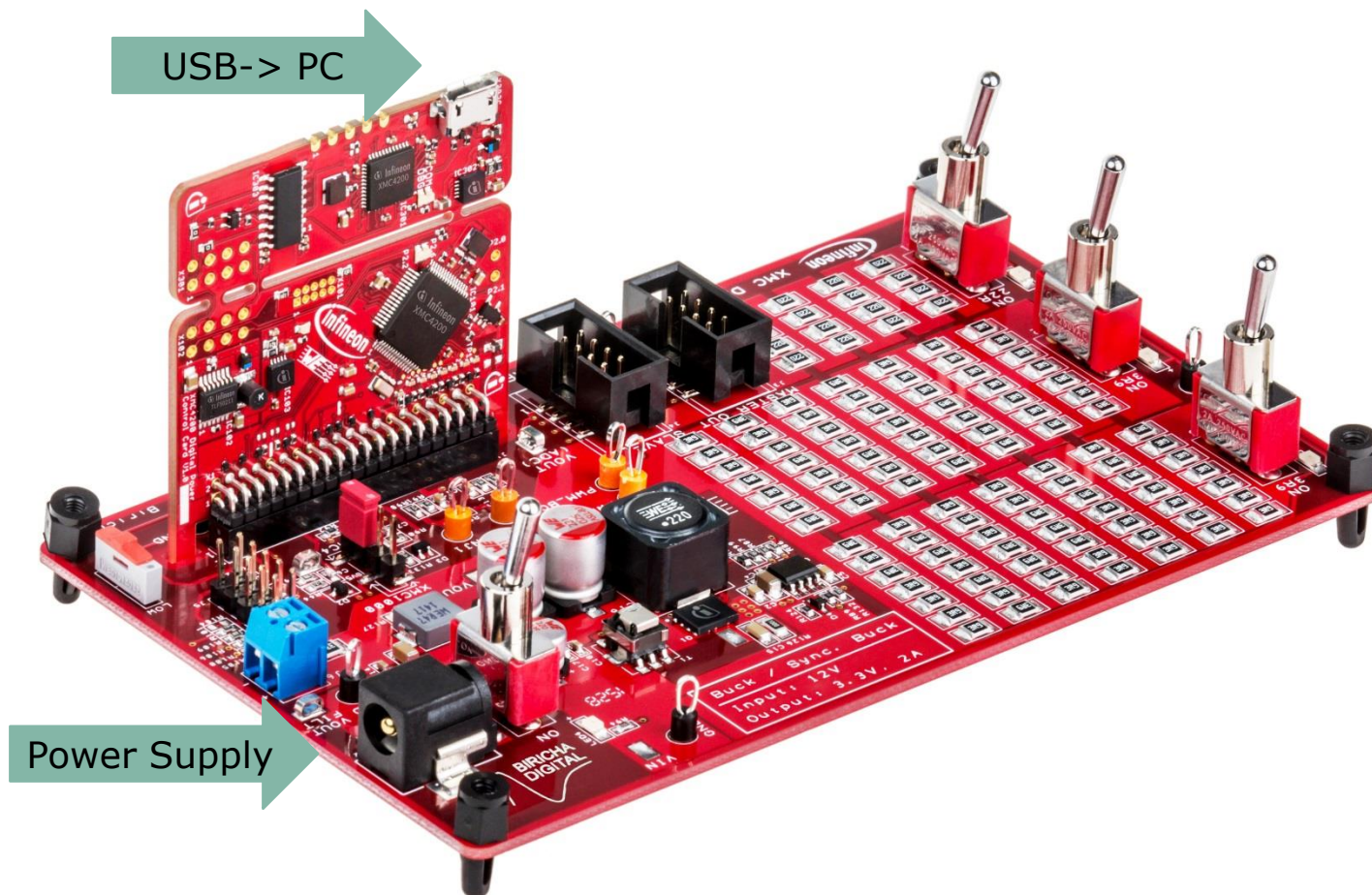
# Hardware Overview

## > Hardware Block Diagram of XMC4200 Control Card:



# Hardware Overview

› Hardware connection is shown below:



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– Example – XMC1300 Buck Converter in Voltage Control Mode

# Tooling Overview – DAVE™ (1/5)



- › Download DAVE™ installer package from:  
<http://www.infineon.com/dave>
- › Download and unzip the installer package

DAVE™

Free Eclipse based integrated development environment (IDE) including GNU C-compiler, debugger, comprehensive code repository, hardware resource management, and code generation plug-in.  
*A complete download package is provided, including IDE, XMC™ Lib, DAVE™ APPs, EXAMPLES, and DAVE™ SDK.*  
[DAVE™ Release Note](#)

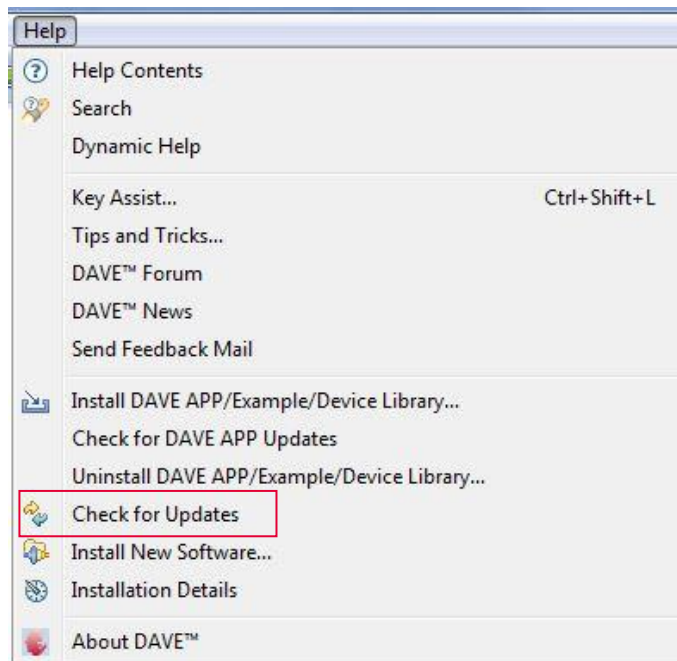


- › Run \*\_Setup.exe file to install DAVE and Segger J-Link drivers
- › After Installation, DAVE™ v4 can be started from desktop.

# Tooling Overview – DAVE™ (2/5)

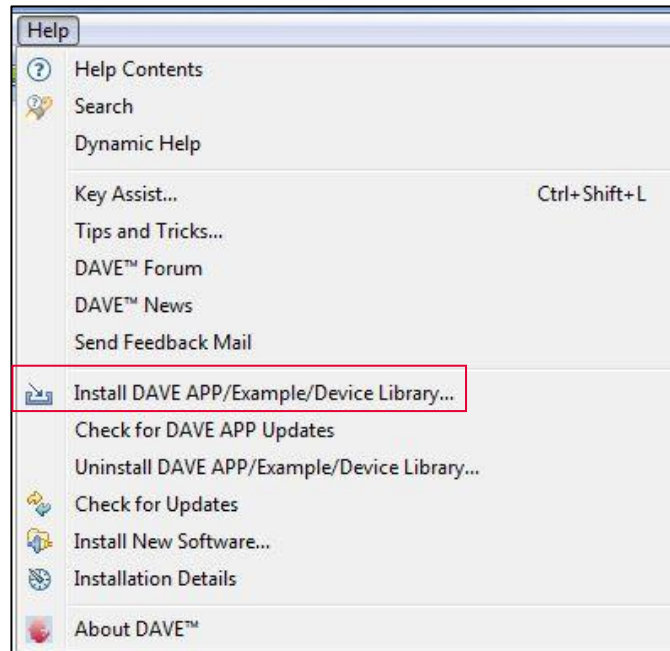
- › Check for DAVE updates

Help → Check for Updates



- › Install DAVE APPs and Device Descriptions

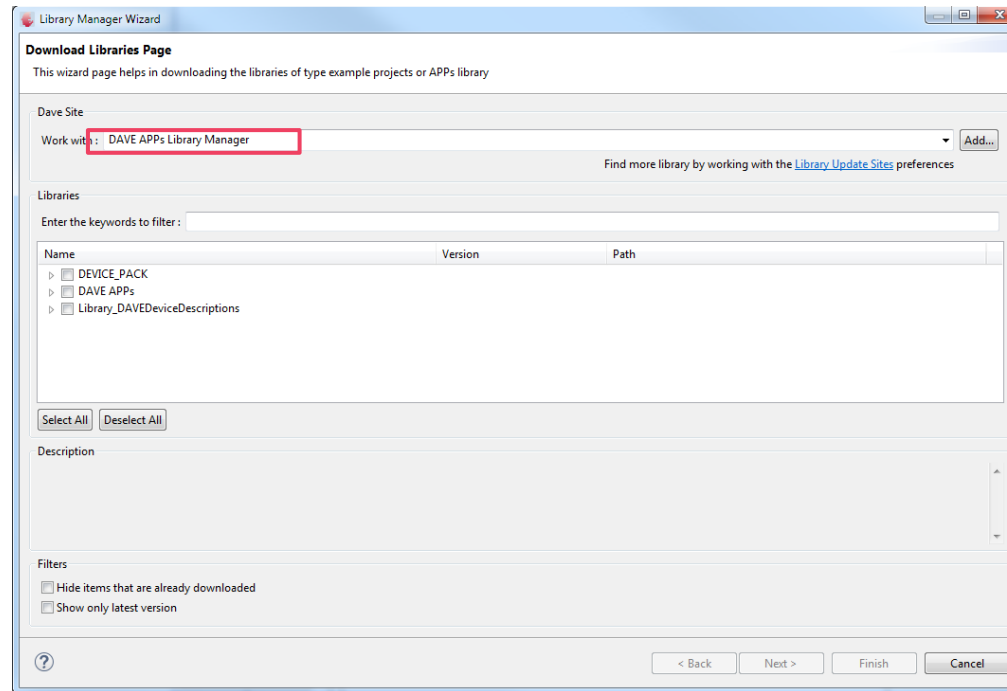
Help → Install DAVE APP/Example/Device Library



- › Note: You may skip the above step if you are not using DAVE APPs



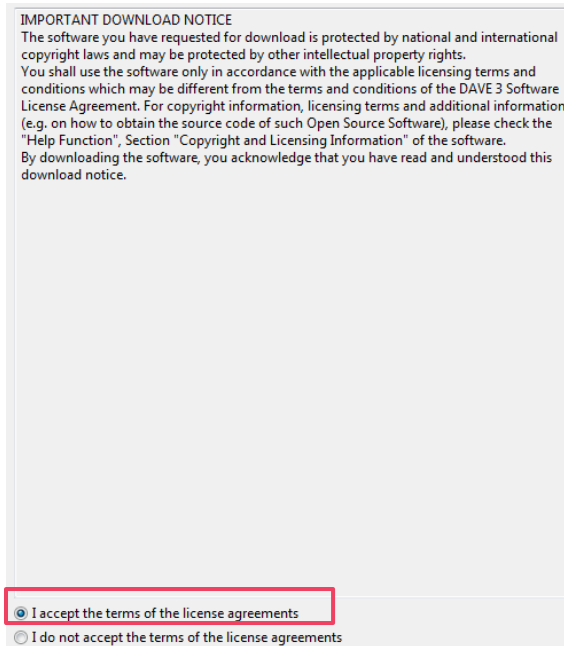
- › Select DAVE Apps Library Manager in the drop-down menu



- › Select all and click Next

- ›  DEVICE\_PACK
- ›  DAVE APPs
- ›  Library\_DAVEDeviceDescriptions

- › Accept terms of the license agreements and click Finish



- › DEVICE\_PACK, DAVE APPs and DAVE device descriptions are installed

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– Example – XMC1300 Buck Converter in Voltage Control Mode

# Getting Started – Example – XMC4200 Buck Converter in Voltage Control Mode (1/16)




- › For this project, we will use
  - Hardware: XMC Digital Power Explorer Power Board + XMC4200 Digital Power Control Card
  - Tools: DAVE™ version 4
  
- › Next, we will show you
  1. How to create project in DAVE™.
  2. Select and configure the required DAVE APPs to control the switching of the buck converter.

# Getting Started – Example – XMC4200 Buck Converter in Voltage Control Mode (2/16)


1. Open DAVE™



2. In DAVE™ workspace, create DAVE Code Engine (CE) project


- Go to File -> New -> DAVE Project 
- Select DAVE CE Project
- Click Next
- Select the device accordingly
  - For XMC4200 Digital Power Control Card, select 'XMC4200-F64x256'

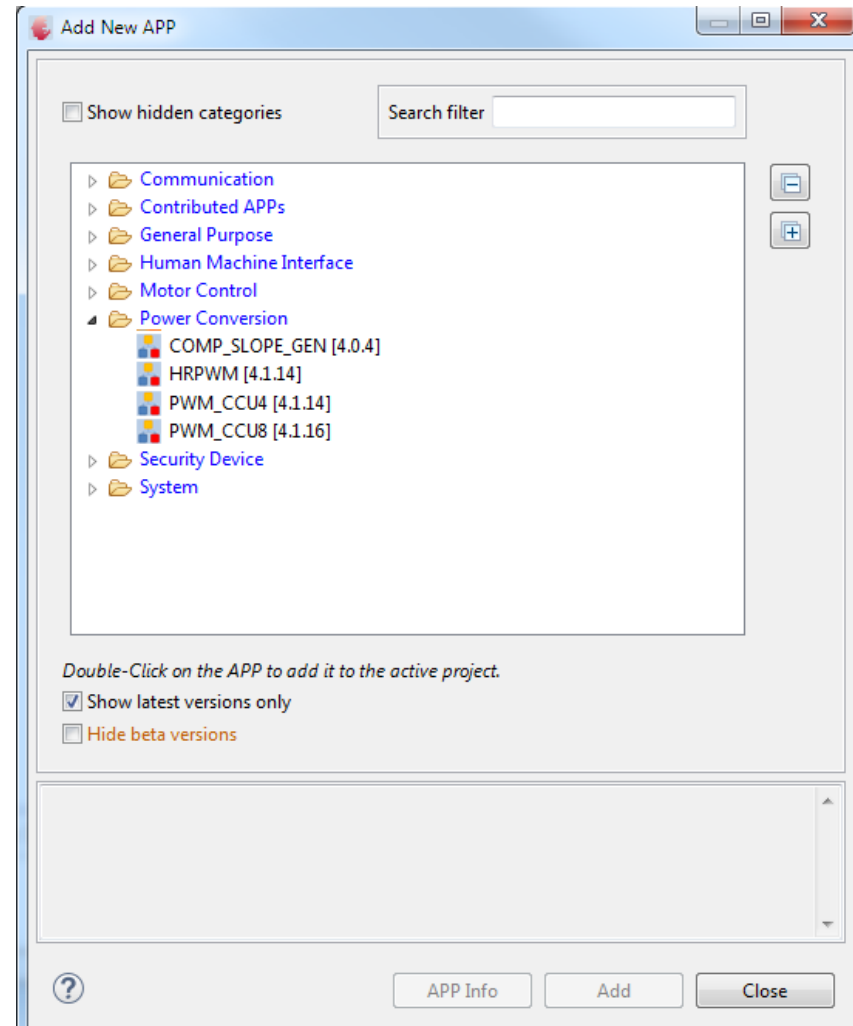
3. To change Compiler optimization level

- Click  to change active project setting.
- Select C/C++ Build -> Settings.
- Under Tool Settings, select ARM-GCC C Compiler -> Optimization.
- Set Optimization level to 'Optimize most (-O3)'

# Getting Started – Example – XMC4200 Buck Converter in Voltage Control Mode (3/16)

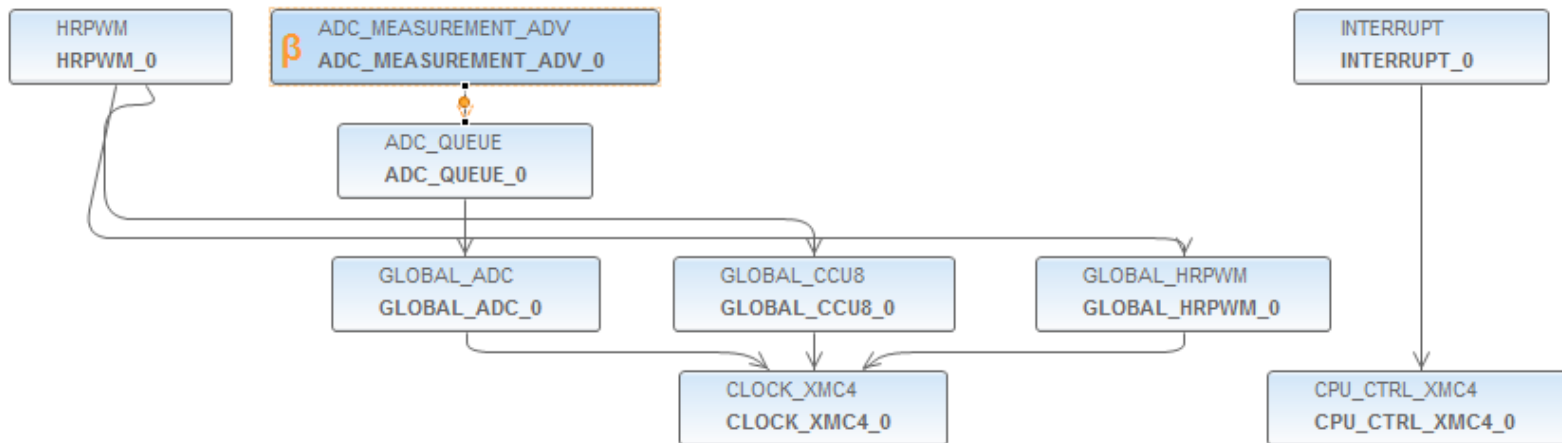
## 4. Add the required APPs to Project:

- Click  in Tool Panel
- Double-click for including the following APPs:
  - HRPWM
  - ADC\_MEASUREMENT\_ADV
  - COMP\_SLOPE\_GEN
  - INTERRUPT



# Getting Started – Example – XMC4200 Buck Converter in Voltage Control Mode (4/16)

- › After including the APPs, the APP Dependency View of your project should look like this:



# Getting Started – Example – XMC4200 Buck Converter in Voltage Control Mode (5/16)

## 5. Configure HRPWM APP – PWM and VADC trigger signal configuration

The screenshot shows the configuration interface for the HRPWM APP. The tabs at the top are: General Settings, HRPWM Settings, External Event Settings, Timer Event Settings, and Pin Settings. The HRPWM Settings tab is active. The fields are organized into sections: Clock Settings (Clock Frequency [MHz]: 80), PWM Settings (Counting Mode: Edge Aligned, Compare Mode: Symmetric), Timer Settings (Frequency [Hz]: 200000, Actual Frequency [Hz]: 200000, PWM Resolution [psec]: 150, Period Register: 0x18F), and Symmetric (CCU8 Compare 1: 0xA0, CCU8 Compare 2: 0x18F, Actual Duty Cycle [%]: 60). There are also fields for HRPWM Compare 1 (0x0) and HRPWM Compare 2 (0x0). A waveform diagram at the bottom shows the CCU8 Timer Period and the resulting HRPWM Compare 1 and HRPWM Compare 2 signals.

Counting and compare mode

PWM Frequency

CCU8 Compare 1, Duty cycle

CCU8 Compare 2, VADC trigger signal



# Getting Started – Example – XMC4200 Buck Converter in Voltage Control Mode (6/16)

## 6. Configure HRPWM APP – PWM and VADC trigger signal configuration

Enabling HR path  
Configuring set and clear signals

Enable Dead Time:  
Rising and Falling time 50ns

The screenshot shows the configuration interface for the HRPWM APP. The 'HRPWM Settings' tab is active. The 'High Resolution Path' section is highlighted with a red dashed box, showing that 'Enable High Resolution Path' is checked. The 'Signal Selector' is set to 'Set0 <-> CCU8; Clear0 <-> Manually'. The 'Set0' signal is configured as 'Falling' and 'Clear0' as 'Rising'. The 'Low Resolution Path' section is also visible, with 'Enable Low Resolution Path' unchecked. The 'HRC Output Control' section is also highlighted with a red dashed box, showing that 'Enable Dead Time' is checked. The 'Rising Time [nsec]' and 'Falling Time [nsec]' are both set to 50. The 'Direct Output HROUT0' and 'Inverted Output HROUT1' sections are also visible, with 'Trap Enable' unchecked and 'Passive Level' set to 'Low'.

# Getting Started – Example – XMC4200 Buck Converter in Voltage Control Mode (7/16)



## 7. Configure HRPWM APP – Enable Compare Match 2 while counting up (for VADC conversions triggering)

The screenshot shows the configuration interface for the HRPWM APP. The 'Timer Event Settings' tab is selected. Under the 'Enable Events' section, the following options are listed:

- Period match
- One match while counting down
- Compare 1 match while counting up
- Compare 1 match while counting down
- Compare 2 match while counting up
- Compare 2 match while counting down
- Event 0
- Event 1
- Event 2

# Getting Started – Example – XMC4200 Buck Converter in Voltage Control Mode (8/16)



8. Configure INTERRUPT APP – Interrupt Settings, Enable the interrupt at initialization and choose the name for the voltage control loop callback.

Interrupt Settings

Enable interrupt at initialization

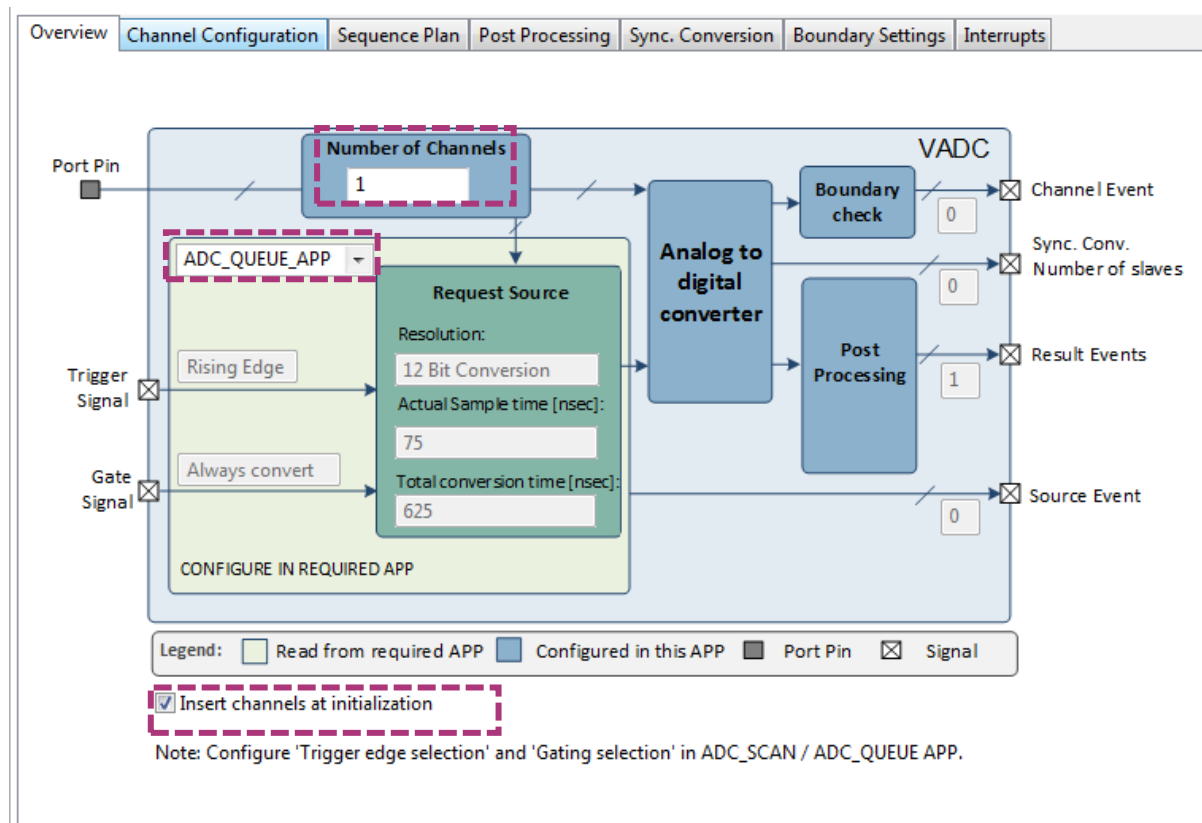
Interrupt Priority

Preemption priority  Subpriority

Interrupt handler:

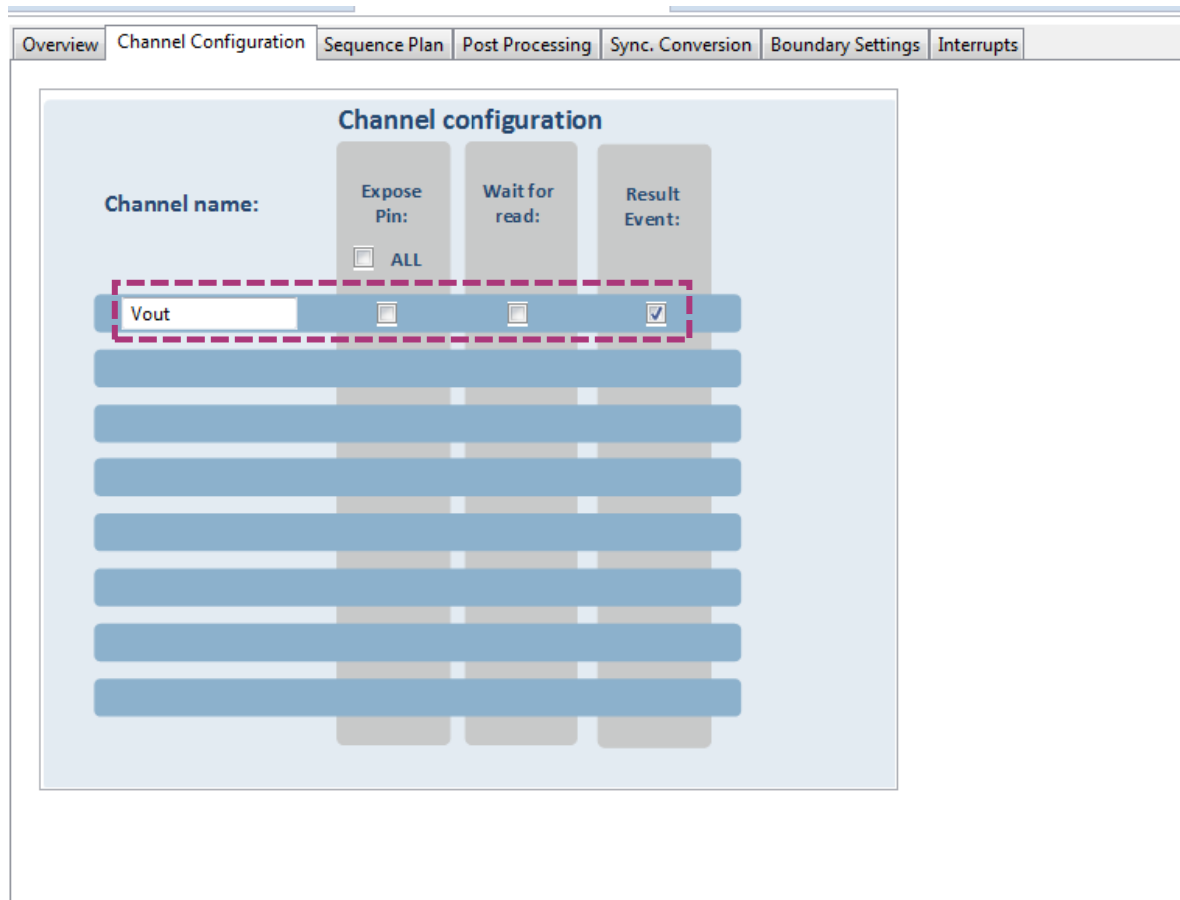
# Getting Started – Example – XMC4200 Buck Converter in Voltage Control Mode (9/16)

9. Configure ADC\_MEASUREMENT\_ADV APP – Choose 1 channel, select the queue request source and insert the channel at initialization



# Getting Started – Example – XMC4200 Buck Converter in Voltage Control Mode (10/16)

10. Configure ADC\_MEASUREMENT\_ADV APP – Give a name to the measured channel (Vout) and enable the “Result Event”



# Getting Started – Example – XMC4200 Buck Converter in Voltage Control Mode (11/16)

11. Configure ADC\_MEASUREMENT\_ADV APP – Configure the sequence for the conversion and select “Wait For Trigger” and “Refill”.

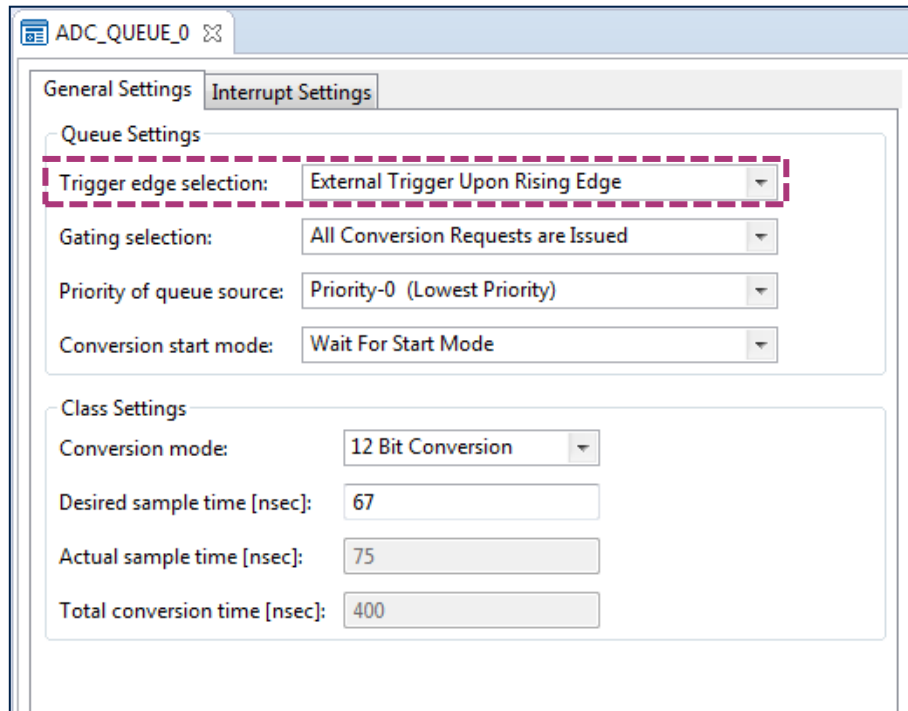
Overview Channel Configuration Sequence Plan Post Processing Sync. Conversion Boundary Settings Interrupts

### Sequence Plan

		Wait For Trigger:	Refill:	Source Event:
Position 0:	Vout	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Position 1:	None	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Position 2:	None	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Position 3:	None	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Position 4:	None	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Position 5:	None	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Position 6:	None	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Position 7:	None	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

# Getting Started – Example – XMC4200 Buck Converter in Voltage Control Mode (12/16)


## 12. Configure Trigger edge selection in the ADC\_QUEUE APP



# Getting Started – Example – XMC4200 Buck Converter in Voltage Control Mode (13/16)

13. Click  to open Manual Pin Allocator view

- Allocate:
  - Vout pin to P14.6
  - HRPWM OUT0 to P0.5
  - HRPWM OUT1 to P0.2

14. Connect hardware signal by doing right-click in the APP and then select  HW Signal Connections

- In HRPWM connect:
  - event\_ch2\_cmp\_match → ADC\_QUEUE → trigger\_input
- In ADC\_MEASUREMENT\_ADV connect:
  - Event\_res\_Vout → INTERRUPT → sr\_irq



# Getting Started – Example – XMC4200 Buck Converter in Voltage Control Mode (14/16)



15. Make sure you have the source code for the voltage control loop implementation. The following files can be copied from the provide example project( go to section [6. References](#) for more information):
  - xmc\_3p3z\_filter\_float.h
  - main.c
  
16. Prepare board set up:
  - Connect XMC4200 Digital Power Control Card into XMC Digital Power Explorer and supply power with included power adapter to it.
  - Place the jumper is in the "XMC4000" position.
  - Make sure power on switch is in the "on" position.

# Getting Started – XMC4200 Example Buck Converter in Voltage Control Mode (15/16)

17. Click  to generate code

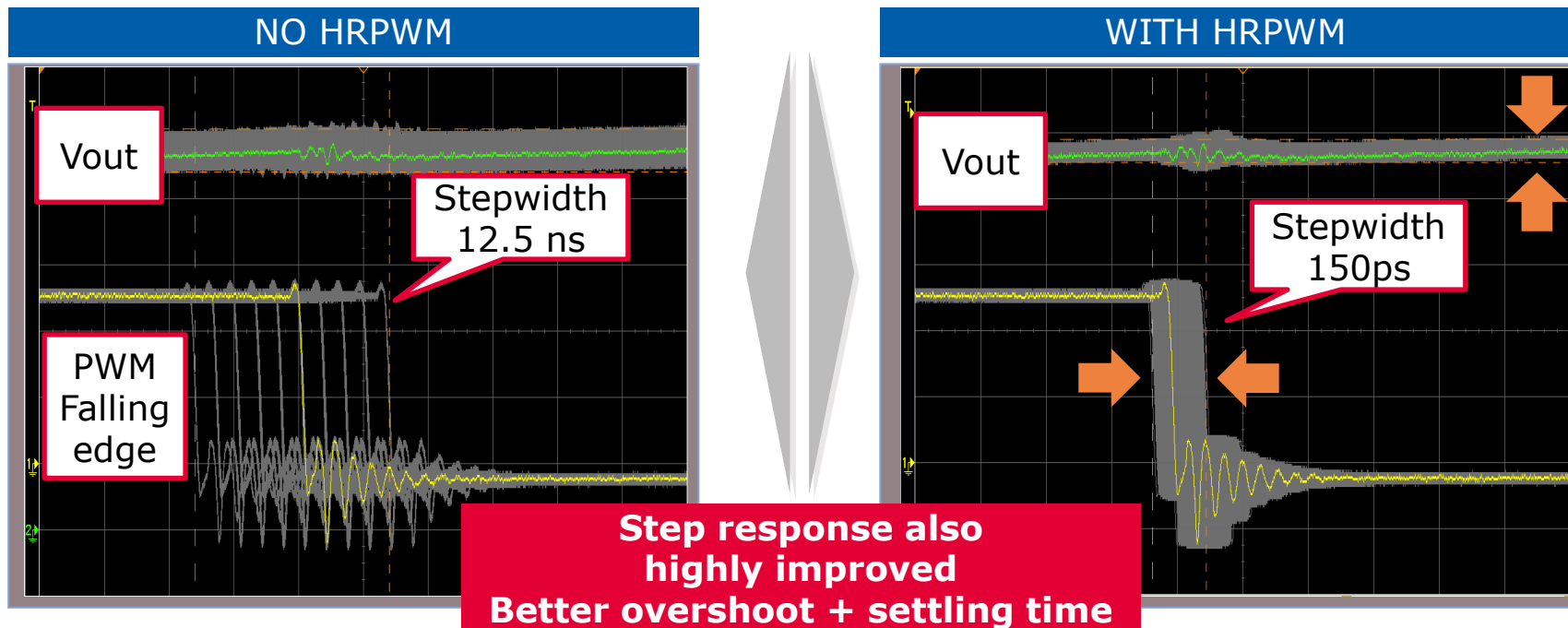
18. Click  to build project

19. Download code and debug

– Click 

– Click  to run code

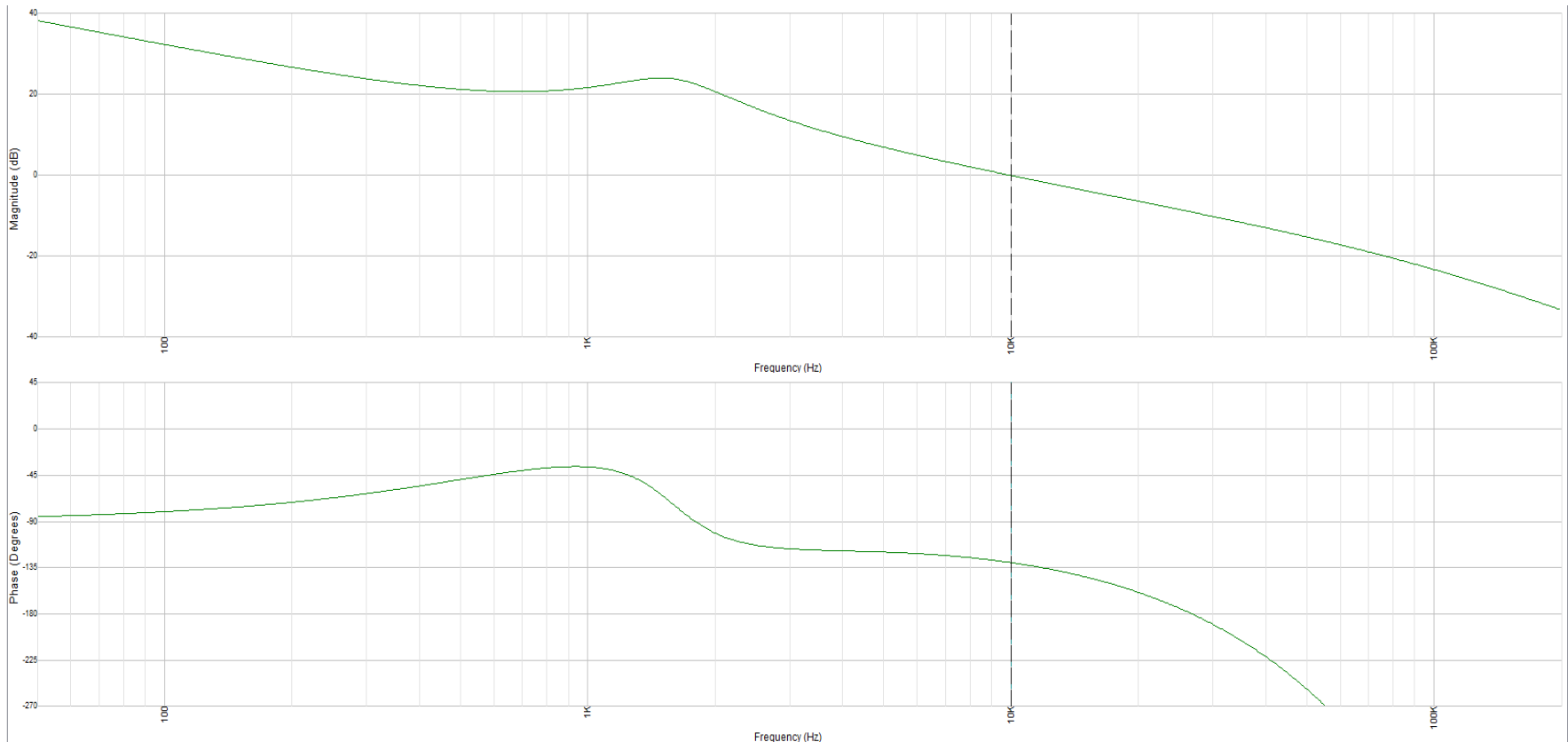
- › With finer adjustment of the duty cycle, the output voltage is regulated more accurately and this reduce the ripple significantly



# Getting Started – XMC4200 Example Buck Converter in Voltage Control Mode (16/16)



- Expected Frequency Response of the control loop: crossover frequency 10kHz, phase margin 50°, gain margin 10dB



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4a – Example – XMC4200 Buck Converter in Voltage Control Mode




4b – Example – XMC1300 Buck Converter in Voltage Control Mode

# Getting Started – Example – XMC1300 Buck Converter in Voltage Control Mode (1/16)




- › For this project, we will use
  - Hardware: XMC Digital Power Explorer Power Board + XMC1300 Digital Power Control Card
  - Tools: DAVE™ version 4
  
- › Next, we will show you
  1. How to create project in DAVE™.
  2. Configure the required DAVE APPs to control the switching of the buck converter.

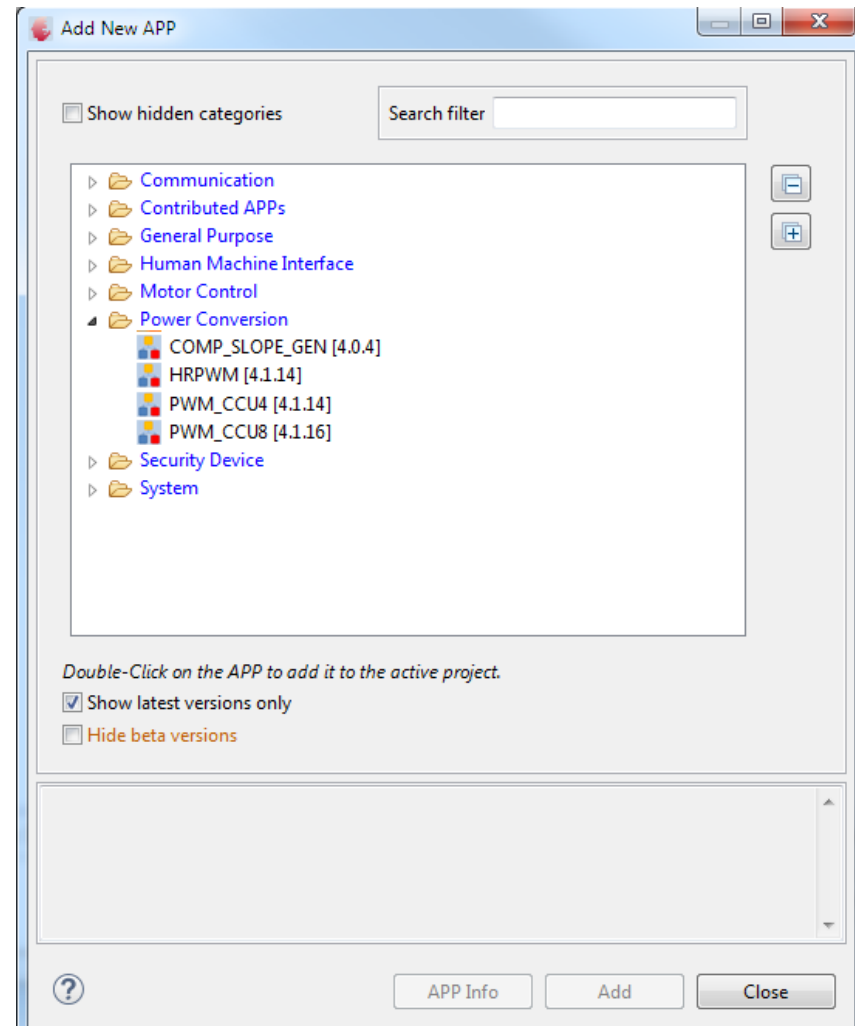
# Getting Started – Example – XMC1300 Buck Converter in Voltage Control Mode (2/16)

1. Open DAVE™ 
2. In DAVE™ workspace, create DAVE Code Engine (CE) project
  - Go to File -> New -> DAVE Project 
  - Select DAVE CE Project
  - Click Next
  - Select the device accordingly
    - For XMC1300 Digital Power Control Card, select 'XMC1302-T038x200'
3. To change Compiler optimization level
  - Click  to change active project setting.
  - Select C/C++ Build -> Settings.
  - Under Tool Settings, select ARM-GCC C Compiler -> Optimization.
  - Set Optimization level to 'Optimize most (-O3)'

# Getting Started – Example – XMC1300 Buck Converter in Voltage Control Mode (3/16)

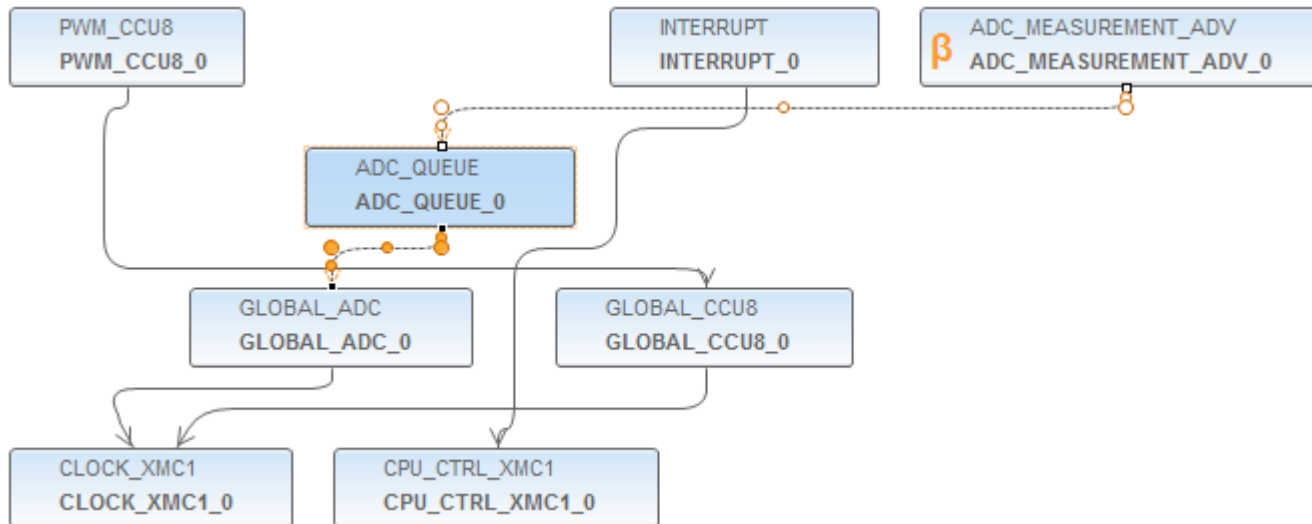
## 4. Add the required APPs to Project:

- Click  in Tool Panel
- Double-click for including the following APPs:
  - PWM\_CCU8
  - ADC\_MEASUREMENT\_ADV
  - INTERRUPT



# Getting Started – Example – XMC1300 Buck Converter in Voltage Control Mode (4/16)

- › After including the APPs, the APP Dependency View of your project should look like this:





# Getting Started – Example – XMC1300 Buck Converter in Voltage Control Mode (5/16)

## 5. Configure PWM\_CCU8 APP – PWM and VADC trigger signal configuration

The screenshot displays the configuration interface for the PWM\_CCU8 APP. The 'Signal Settings' tab is active, showing the following parameters:

- General Settings:** External Event Settings, Signal Settings, Shadow Transfer Settings, Timer Event Settings, Pi
- Clock Settings:** Clock frequency [MHz]: 64
- PWM Settings:** Counting mode: Edge Aligned, Compare mode: Symmetric. Includes checkboxes for 'Start during initialization' and 'Single-shot mode'.
- Timer Settings:** PWM resolution [nsec]: 16, Prescaler: 0, Frequency [Hz]: 100000. Actual values: Actual PWM resolution [nsec]: 15.625, Period register: 0x27F, Actual frequency [Hz]: 100000.
- Symmetric Mode:** Channel 1 duty cycle [%]: 90, Channel 2 duty cycle [%]: 50.05. Actual values: Channel 1 actual duty cycle [%]: 90, Channel 2 actual duty cycle [%]: 50.16.
- Asymmetric Mode:** Compare 1: 0x30, Compare 2: 0x1A9, Actual duty cycle [%]: 0.0.

Annotations in the image:

- Counting and compare mode:** Points to the 'Edge Aligned' and 'Symmetric' dropdown menus.
- PWM Frequency:** Points to the 'Frequency [Hz]' input field.
- CCU8 Channel 1, Duty cycle:** Points to the 'Channel 1 duty cycle [%]' input field.
- CCU8 Channel 2, VADC trigger signal:** Points to the 'Channel 2 duty cycle [%]' input field.

# Getting Started – Example – XMC1300 Buck Converter in Voltage Control Mode (6/16)

## 6. Configure PWM\_CCU8 APP – PWM and VADC trigger signal configuration

Status bit selection



Channel 1 and Channel 2 Outputs configuration

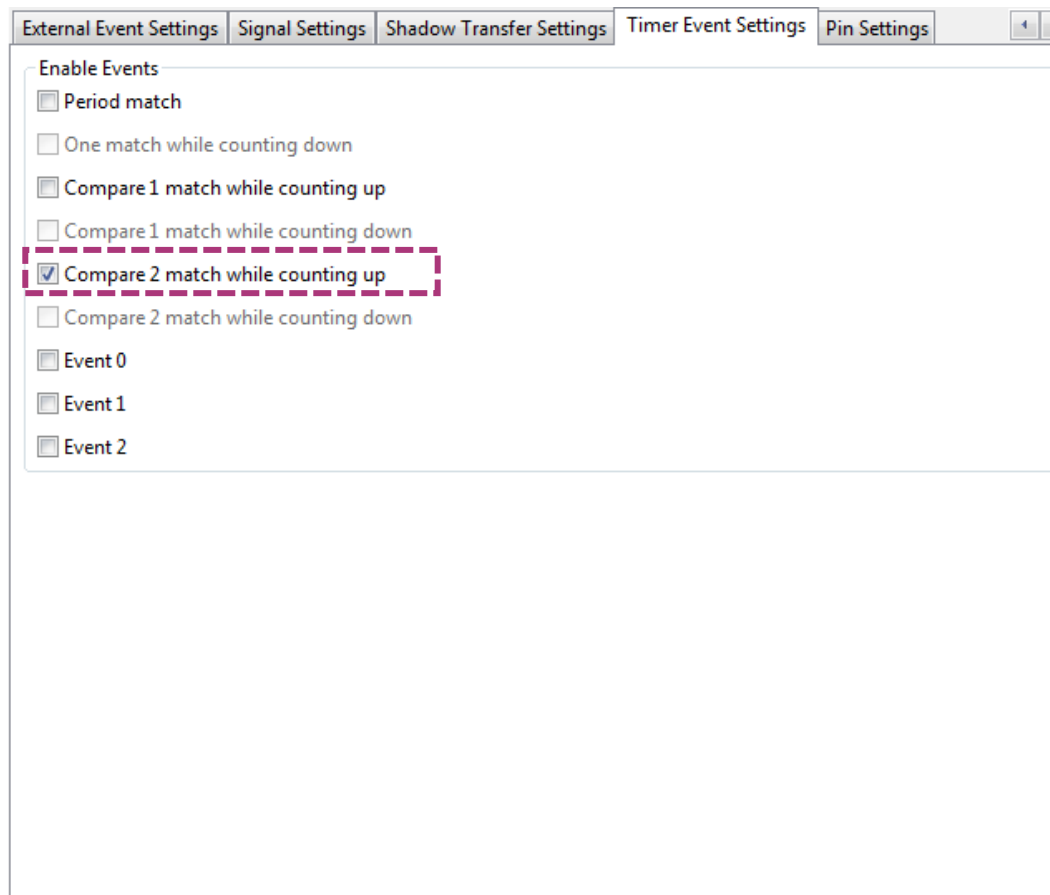


Dead time selection



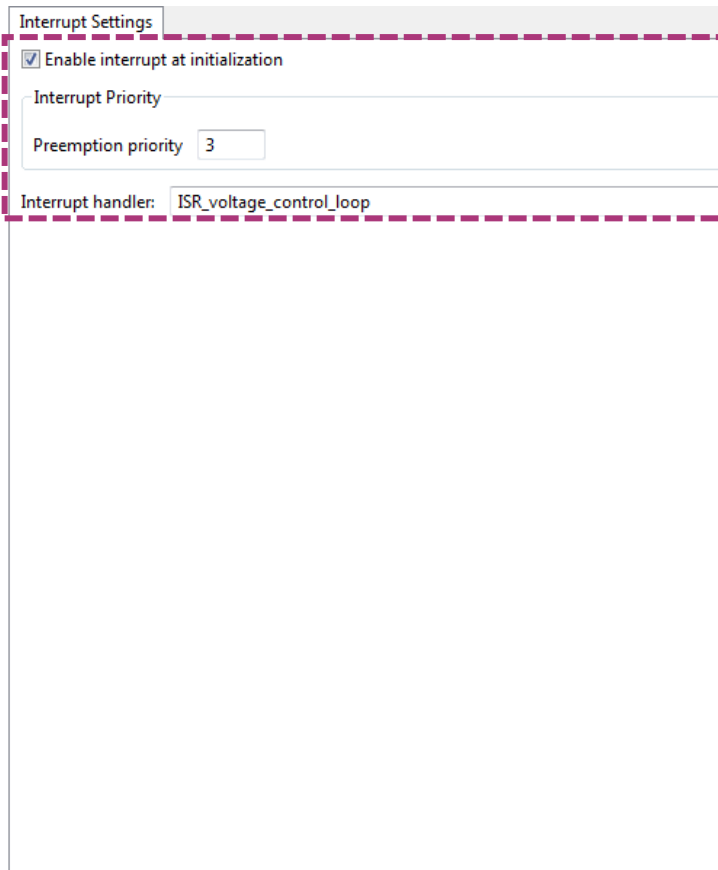
# Getting Started – Example – XMC1300 Buck Converter in Voltage Control Mode (7/16)

## 7. Configure PWM\_CCU8 APP – Enable Compare Match 2 while counting up (for VADC conversions triggering)



# Getting Started – Example – XMC1300 Buck Converter in Voltage Control Mode (8/16)

8. Configure INTERRUPT APP – Interrupt Settings, Enable the interrupt at initialization and choose the name for the voltage control loop callback.



Interrupt Settings

Enable interrupt at initialization

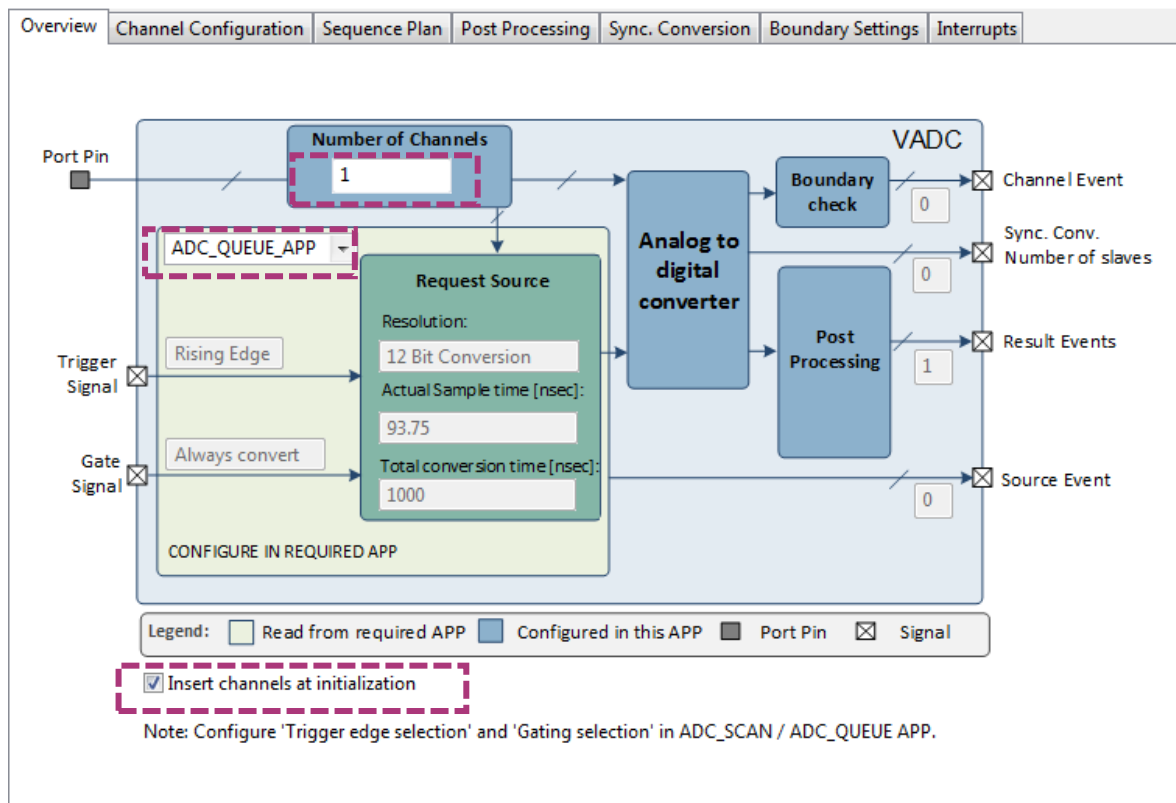
Interrupt Priority

Preemption priority 3

Interrupt handler: ISR\_voltage\_control\_loop

# Getting Started – Example – XMC1300 Buck Converter in Voltage Control Mode (9/16)

9. Configure ADC\_MEASUREMENT\_ADV APP – Choose 1 channel, select the queue request source and insert the channel at initialization



# Getting Started – Example – XMC1300 Buck Converter in Voltage Control Mode (10/16)

10. Configure ADC\_MEASUREMENT\_ADV APP – Give a name to the measured channel (Vout) and enable the “Result Event”

Overview Channel Configuration Sequence Plan Post Processing Sync. Conversion Boundary Settings Interrupts

### Channel configuration

Channel name:	Expose Pin:	Wait for read:	Result Event:	Gain:
Vout	<input type="checkbox"/> ALL	<input type="checkbox"/>	<input checked="" type="checkbox"/>	1:1

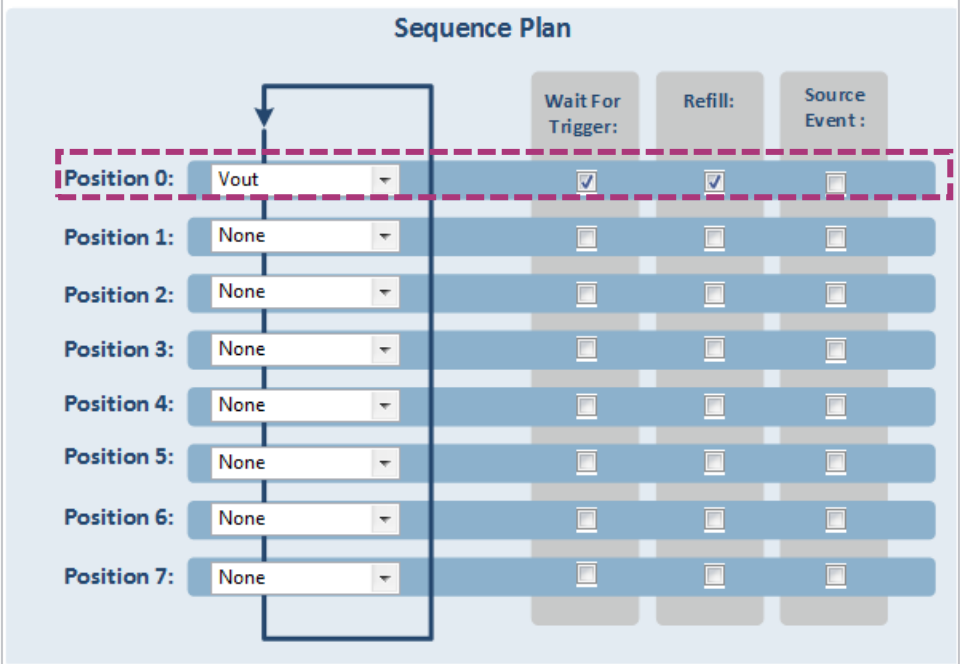
# Getting Started – Example – XMC1300 Buck Converter in Voltage Control Mode (11/16)

11. Configure ADC\_MEASUREMENT\_ADV APP – Configure the sequence for the conversion and select “Wait For Trigger” and “Refill”.

Overview Channel Configuration Sequence Plan Post Processing Sync. Conversion Boundary Settings Interrupts

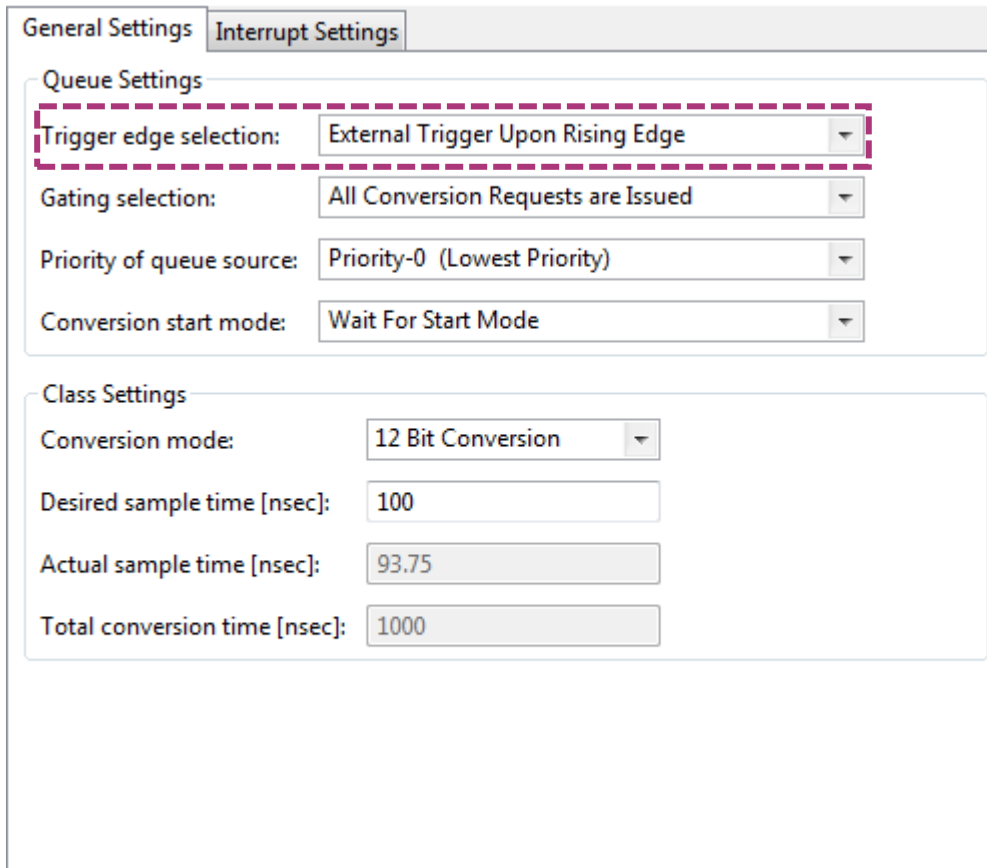
### Sequence Plan

		Wait For Trigger:	Refill:	Source Event:
Position 0:	Vout	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Position 1:	None	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Position 2:	None	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Position 3:	None	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Position 4:	None	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Position 5:	None	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Position 6:	None	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Position 7:	None	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



# Getting Started – Example – XMC1300 Buck Converter in Voltage Control Mode (12/16)

## 12. Configure Trigger edge selection in the ADC\_QUEUE APP



The screenshot displays the configuration interface for the ADC\_QUEUE APP, divided into two tabs: "General Settings" and "Interrupt Settings". The "Interrupt Settings" tab is active. It contains two main sections: "Queue Settings" and "Class Settings".

**Queue Settings:**

- Trigger edge selection: External Trigger Upon Rising Edge (highlighted with a dashed red box)
- Gating selection: All Conversion Requests are Issued
- Priority of queue source: Priority-0 (Lowest Priority)
- Conversion start mode: Wait For Start Mode

**Class Settings:**


- Conversion mode: 12 Bit Conversion
- Desired sample time [nsec]: 100
- Actual sample time [nsec]: 93.75
- Total conversion time [nsec]: 1000



# Getting Started – Example – XMC1300 Buck Converter in Voltage Control Mode (13/16)

13. Click  to open Manual Pin Allocator view

- Allocate:
  - Vout pin to P2.3
  - PWM\_CCU8 CH1 Direct Out to P0.0
  - PWM\_CCU8 CH1 Invert Out to P0.5

14. Connect hardware signal by doing right-click in the APP and then select  HW Signal Connections

- In HRPWM connect:
  - event\_ch2\_cmp\_match → ADC\_QUEUE → trigger\_input
- In ADC\_MEASUREMENT\_ADV connect:
  - Event\_res\_Vout → INTERRUPT → sr\_irq

# Getting Started – Example – XMC1300 Buck Converter in Voltage Control Mode (14/16)



15. Make sure you have the source code for the voltage control loop implementation. The following files can be copied from the provide example project( go to section [6. References](#) for more information):
  - xmc\_3p3z\_filter\_fixed.h
  - main.c
  
16. Prepare board set up:
  - Connect XMC1300 Digital Power Control Card into XMC Digital Power Explorer and supply power with included power adapter to it.
  - Place the jumper is in the "XMC4000" position(Voltage Control Mode position).
  - Make sure power on switch is in the "on" position.

# Getting Started – Example – XMC1300 Buck Converter in Voltage Control Mode (15/16)

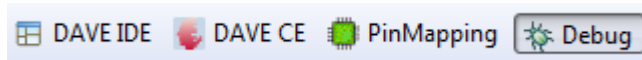
17. Click  to generate code

18. Click  to build project

19. Download code and debug

– Click 

– Switch to Debug view

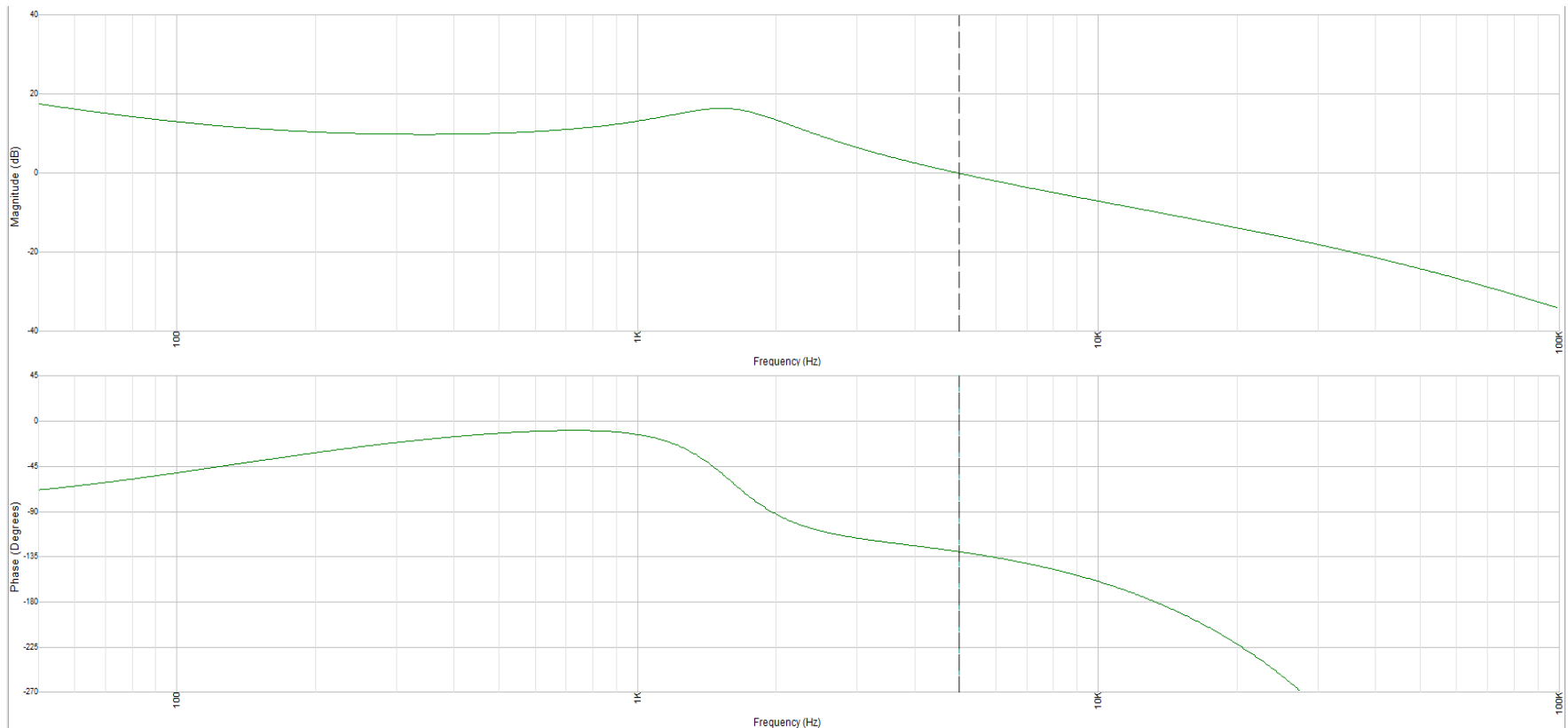


– Click  to run code

# Getting Started – Example – XMC1300 Buck Converter in Voltage Control Mode (16/16)



- Expected Frequency Response of the control loop: crossover frequency 5kHz, phase margin 50°, gain margin 10dB



# Agenda (2/2)

5 General Information

6 References

6a – How to load Example Project in DAVE™?

6b – Where to download Example Projects?

## General Information (1/2)

- › Where to buy XMC Digital Power Explorer kit:
  - ISAR Order Name: KIT\_XMC\_DP\_EXP\_01
  
- › Documentation:
  - [XMC Digital Power Explorer Kit](#)
  - [XMC4100 / 4200 Reference Manual](#)
  - [XMC4100 / 4200 Datasheet](#)
  - [XMC1300 Reference Manual](#)
  - [XMC1300 Datasheet](#)
  
- › Video Series: XMC Digital Power Explorer Kit
  - [XMC Digital Power Explorer Kit - Live Demo](#)

## General Information (2/2)

- › Infineon parts utilized on kit:

Infineon Parts	Order Number
XMC1300 Microcontroller	XMC1302-T038X0200
XMC4200 Microcontroller	XMC4200-F64K256
XMC4200 Microcontroller	XMC4200-Q48K256
DC/DC Converter	IFX90121ELV50
Regulator	IFX54441LDV
Diode	BAS 16
Schottky Diode	BAT 54-05
Schottky Diode	BAS 3010B-03W
Dual N-Channel OptiMOS™ MOSFET	BSC0924NDI
High Side & low side gate driver	IRS2011SPBF

# Agenda (2/2)

5 General Information

6 References

6a – How to load Example Project in DAVE™?

6b – Where to download Example Projects?



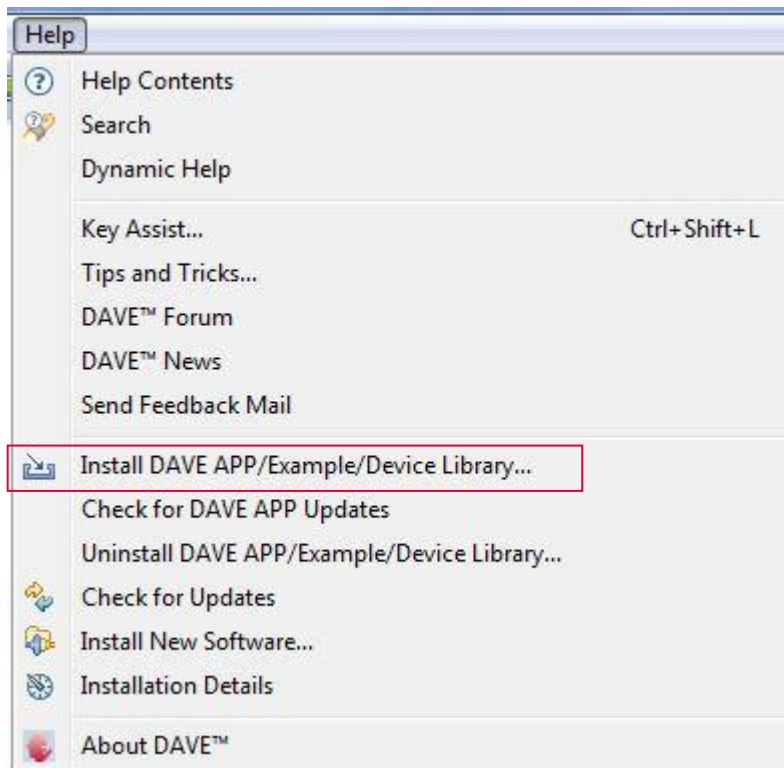
# References – Where to download Example Projects?



- DAVE™ Project Library Examples
  - Can be downloaded from library in DAVE™

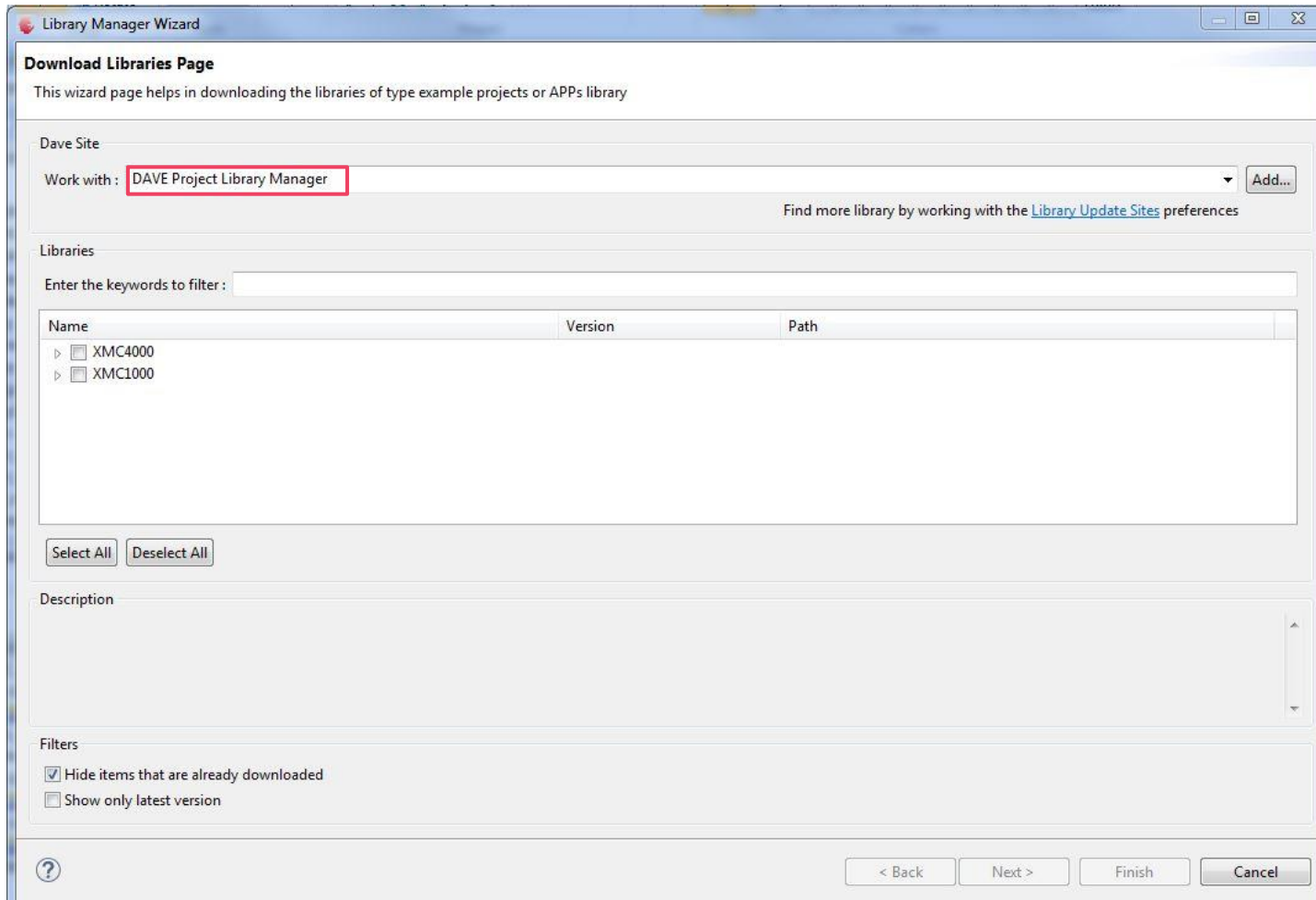
# References – How to load Example Project in DAVE™? (1/3)

- › Download Example Projects via DAVE™ library store
  - Help → Install DAVE APP/Example/Device Library



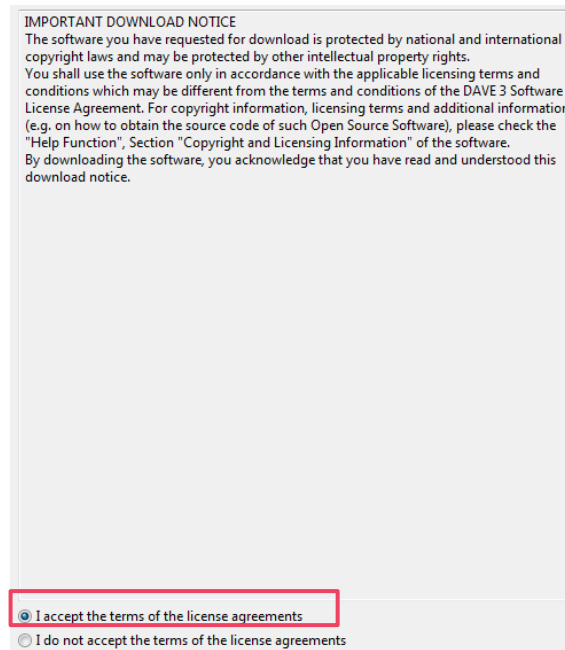
# References – How to load Example Project in DAVE™? (2/3)

- Select DAVE Project Library Manager in the drop-down menu



# References – How to load Example Project in DAVE™? (3/3)

- Select Examples in the Libraries window and click Next
- Accept terms of the license agreements and click Finish



- DAVE Example Projects are installed



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