

T.O.M.A.S Team







- Now it is time for some activities with STM32CubeMX again ③
- Our current goal is to port provided ready project done for
 - NUCLEO-L053R8 board (STM32L053R8T6 microcontroller)

to

• NUCLEO-L476RG board (STM32L476RGT6 microcontroller)





Our goals for this session:

Original concept description (for STM32L053R8T6 MCU)

Project migration in STM32CubeMX step-by-step:

- □Import STM32CubeMX project
- □Run migration to new platform (STM32L476RGT6 MCU)

□Tune project in STM32CubeMX:

- Update clocks
- Re-configure peripherals
- Generate project for new MCU

□Tune project in SW4STM32:

- □ Import modified project to the same workspace
- Apply necessary modifications to generated sources
- Compile and run project on the new platform





Project migration in STM32CubeMX





Concept of the system original project for NUCLEO-L053

Concept description Hardware

• **DAC1 Channel1** and **ADC1 Channel1** were selected as **PA4 and PA1** are neighboring pins on the connector; no rework, just need a jumper.

Software

- Timer2 is configured to work with 5Hz (200msec period) and to trigger:
 - **DAC** (on TRGO Update event)
 - **ADC** (on Channel4 Output Compare event)
- **DAC1 Channel1** is configured to generate on **PA4** signal based on the data sent by **DMA** from internal **dacbuf[]** buffer (sine wave in this example).
- ADC1 Channel1 is configured to measure signal on PA1. Measured data are copied by DMA to internal adcbuf[] buffer.



Hardware overview





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Concept of the system triggering of ADC and DAC by TIM2





configuration for selected timer output compare set to toggle on match



Concept of the system migration to NUCLEO-L476RG



Hardware overview



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Project migration from L0 to L4 platform

When creating new project in STM32CubeMX, after selection of the MCU it is possible to import project settings from other project that could be based on different MCU.

Task:

Import the L0_DAC_ADC project (generated for STM32L053R8T6 based Nucleo-L053R8 board) into a new STM32CubeMX project for STM32L476RGT6 MCU and run it on Nucleo-L476RG board. New project can be named L4_DAC_ADC

ICU Selector Bo	oard S	electo	r								
ACU Filters											
eries :			L	ines :	F	Package :					
STM32L4		-	-	STM32L4x6	•	LQFP64		•	More Filte	ers 🕶	
						-					
Peripheral Selec	tion			MCUs List: 4 Items							
Peripherals	Nb	Max		мси	Lines	Package	Flash	Ram	Eeprom	IO	t
ADC 12-bit	0	16		STM32L476RCTx	STM32L4>	6 LOFP64	256	128	0	51	
ADC 16-bit	0	0		STM32L476RETx	STM32L4)	6 LOFP64	512	128	0	51	
CAN	0	1		STM32L476RGTx	STM32L4	6 LOEP64	1024	128	0	51	
COMP	0	2		STM32L486RCTV	STM32L4		1024	128	0	51	
DAC 12-bit	0	2		STHOLLTOURGEX	31032147	LQIIOT	1024	120	U U	51	
DCMI											
DFSDM											
DSTHOST											
BOTHOOL	and the second sec										
Ethernet											
Ethernet FMC											
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Ethernet FMC FMPI2C FSMC											
Ethernet FMC FMPI2C FSMC HDMI CEC											
Ethernet FMC FMPI2C FSMC HDMI CEC HRTIM											
Ethernet FMC FMPI2C FSMC HDMI CEC HRTIM		3									
Ethernet FMC FMC FSMC FSMC HDMI CEC HRTIM I2C I2S		30									
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Ethernet FMC FMC FSMC FSMC HDMI CEC HRTIM I2C I2S IRTIM LPTIM		3 0 2									
Ethernet FMC FMC FSMC FSMC HDMI CEC HRTIM I2C I2S IRTIM LPTIM LPTIM		302									
Ethernet FMC FMC FMPI2C FSMC HDMI CEC HRTIM I2C I2S IRTIM LPTIM LPUART OPAMP		3 0 2 2									
Ethernet FMC FMPI2C FSMC HDMI CEC HRTIM I2C I2S IRTIM LPTIM LPUART OPAMP QUADSPI		3 0 2 2									
Ethernet FMC FMPI2C FSMC HDMI CEC HRTIM I2C I2S IRTIM LPTIM LPUART OPAMP QUADSPI RTC		3 0 2 2									
Ethernet Ethernet FMC FMC FSMC HDMI CEC HRTIM I2C I2S IRTIM LPTIM LPUART OPAMP QUADSPI RTC SAI		3 0 2 2 2									
Ethernet Ethernet FMC FMC FSMC HDMI CEC HRTIM I2C I2S IRTIM LPTIM LPUART OPAMP QUADSPI RTC SAI SDIO		3 0 2 2 2									
Ethernet FMC FMPI2C FSMC HDMI CEC HRTIM I2C I2S IRTIM LPUART OPAMP QUADSPI RTC SAI SDIO SDMMC		3 0 2 2 2 2									
 Ethernet Ethernet FMC FMC FSMC HDMI CEC HRTIM I2C I2S IRTIM LPUART OPAMP QUADSPI RTC SAI SDIO SDIMMC SPDIFRX 		3 0 2 2 2 1									
 Ethernet Ethernet FMC FMPI2C FSMC HDMI CEC HRTIM I2C I2S IRTIM LPUART OPAMP QUADSPI RTC SAI SDIO SDMMC SPI 		3 0 2 2 2 1 3									



Importing the project within STM32CubeMX

- Run STM32CubeMX and start New Project
- Complete MCU selection, then select **File→Import Project**
- Select reference STM32CubeMX project file to be imported (L0_DAC_ADC.ioc in our example)
- Select Automatic Import and then click Try Import button to analyze possible issues and incompatibilities
 - If Automatic Import fails, this is possible to adjust import process flow selecting Manual Import option (see next slide for reference) – we will not follow this step during workshop
- Click OK



automatic import

Import Project	X
Imported Project	
C:_Work_Seminar\L0_DAC_ADC.ioc	
Import MX Settings	
Import PCC Settings	
Import Project Settings	
Import Pinout/Clock Configuration/Configuration Settings	
Automatic Import	
O Manual Import	
✓ Import Pinning Status	
✓ Import Peripherals Configuration	
Peripheral List	
From ST To STM321476RGTy	
	- -
Try Import Show View Pinout -]
Import Status	
Import Analysis: C:_Work_Seminar\L0_DAC_AD	
The Mcu (STM32L053R8Tx) found in the Project	-
۰ III ک	
OK Cancel	

Importing the project within STM32CubeMX

- Complete MCU selection then select File→Import Project
- Select reference STM32CubeMX project file to be imported (L0_DAC_ADC.ioc in our example)
- In order to adapt import settings select Manual Import
- In Manual Import mode it is possible to:
 - Select peripherals which would be imported into new project
 - Change destination peripheral after import (like different timer or ADC) if possible
 - Enable/disable import of peripherals configuration
 - Enable/disable import of pinning status
- When completed click **Try Import** button to verify new configuration.
- Click **OK** if import is possible, otherwise try to review setup again

ſ	Import Project
	Imported Project
	C:_Work_Seminar\L0_DAC_ADC.ioc
	Import MX Settings
	Import PCC Settings
	Import Project Settings
	Import Pinout/Clock Configuration/Configuration Settings
	O Automatic Import
	Manual Import
	🔽 Import Pinning Status
	Import Peripherals Configuration
	Peripheral List
	From ST To STM32L476RGTx
	ADC import to ADC1
	DAC import to DAC1
	RCC RCC
	SYS SYS
	NVIC V NVIC
	Try Import Show View Pinout
	Import Status
	Loading: C:\ Work\ Seminar\L0 DAC ADC.ioc projec
	Import Analysis: C:_Work_Seminar\L0_DAC_ADC.ic
	The Mcu (STM32L053R8Tx) found in the Project bei

Cancel

manual import



Importing the project within STM32CubeMX

- After completion of import process
 - · An information window will be displayed
 - Import Status window will show all issues found (like in an example below)

```
Import Status
Import Analysis: C:\ Work\ L0 DAC ADC\L0 DAC ADC.ioc project
The Mcu (STM32L053R8Tx) found in the Project being imported is not the same as the Mcu (STM32L476RGTx) currently edited
Import Try :
Importing Pinout ...
Importing IP configurations ...
Some parameters can't be imported for DMA
   ADMA request DAC CH1 mapped on DMA1 Channel2 is remapped on DMA1 Channel3
   ▲DMA request ADC mapped on DMA1 Channel1 is imported to ADC1 mapped on DMA1 Channel1
ASome parameters can't be imported for NVIC
   AInterrupt SVC IRQn is replaced by interrupt SVCall IRQn
ASome parameters can't be imported from ADC to ADC1
   ACan't import parameter:Scan Conversion Mode = ADC SCAN DIRECTION FORWARD, it isn't a possible value in STM32L476RGTx, it's set to default value.
   ACan't import parameter:Low Frequency Mode, it doesn't exist in STM32L476RGTx
   ACan't import parameter: Auto Off, it doesn't exist in STM32L476RGTx
   ACan't import parameter:Sampling Time = ADC SAMPLETIME 7CYCLES 5, it isn't a possible value in STM32L476RGTx, it's set to default value.
   ACan't import parameter:External Trigger Conversion Source = ADC EXTERNALTRIGCONV T2 CC4, it isn't a possible value in STM32L476RGTx, it's set to default value.
   Can't import parameter:Enable Analog WatchDog Mode, it doesn't exist in STM32L476RGTx
Importing project completed
```

• After clicking Close and OK buttons, new MCU pinout for imported project will be displayed.







Importing the project within STM32CubeMX warnings overview

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▲Some parameters can't be imported for DMA ▲DMA request DAC_CH1 mapped on DMA1_Channel2 is remapped on DMA1_Channel3 ▲DMA request ADC mapped on DMA1 Channel1 is imported to ADC1 mapped on DMA1 Channel1

Proper DMA channels will be assigned automatically – no action on programmer side

Some parameters can't be imported for NVIC
Interrupt SVC_IRQn is replaced by interrupt SVCall_IRQn

There is no SVC usage in our application (it is mainly used in RTOS based systems)





We should focus on 2 warnings only:

- Sampling time -> we should select different value as a default one 2.5 ADC clk is too small for 40MHz ADC clock
- External Trigger Conversion Source -> as in STM32L4 there is no trigger of ADC on TIM2_CC2 signal. -> What we should select ?

Both parameters can be checked and tuned within **configuration tab**, under **ADC1 button**





STM32L476 is more complex MCU, therefore it might be necessary to adjust the settings for new platform, i.e.

- Pinout
- Clock configuration
- Peripherals configuration





Concept of the system after migration to NUCLEO-L476RG





Hardware overview



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Project tuning after migration pinout - task

- After project migration there might be necessity to re-route some pins.
- During migration selected ADC channels were left unchanged. But
 - ADC Channel1 in both MCUs is assigned to different pins (PA1 and PC0 respectively).
- In case of our application we have to keep ADC-DAC connection to the same pins (PA1-PA4) to avoid HW changes. Thus
 - We have to select different ADC channel to meet the condition of PA1-PA4 connection.





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Project tuning after migration pinout - solution

- To keep PA1-PA4 connection in place, it is necessary to change ADC channel to ADC1 Channel6
- The procedure should be the following:
 - 1. Add ADC1 Channel6 in single ended mode
 - 2. Disable ADC1 Channel1

Warning: removing the last ADC channel means removing ADC from the application and set its configuration to default values.





Concept of the system after migration to NUCLEO-L476RG – ADC input fixed 19



Hardware overview



Hardware overview





Project tuning after migration clock configuration - task

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- After project migration it is necessary to adapt clock scheme of new MCU.
- It is possible to insert all values manually or let the application calculate them based on given conditions.
- Application (HCLK, PCLK1, PCLK2) will use 80MHz clock coming from High Speed Internal (HSI) RC oscillator (16MHz).







Project tuning after migration clock configuration - task

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 In case it is not possible to reach set target using selected input clocks, information window is generated:

Clock Wizard No solution found using the current selected source Do you want to use other sources?	
?	No solution found using the current selected sources. Do you want to use other sources?

• All errors/issues will be automatically detected and can be solved either automatically or manually





Project tuning after migration clock configuration - solution 22

Correct clock configuration of new L4_DAC_ADC project on STM32L476RGT6 MCU can be done by the following procedure:

- 1. Select HSI as PLL Source Mux
- 2. Select PLLCLK in System Clock Mux
- 3. Set 80 in HCLK field and press Enter
- 4. All PLL settings will be re-calculated automatically





Concept of the system after migration to NUCLEO-L476RG – clock fixed 23





Hardware overview



Project tuning after migration configuration - task 24

Check and adapt if necessary configuration of used peripherals:

- ADC
- DAC
- DMA
- TIM2







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Concept of the system triggering of ADC and DAC by TIM2²⁵





configuration for selected timer output compare set to toggle on match



ADC1 Configuration 🗸 Parameter Settings 🗹 User Constants 🗹 NVIC Settings 🗹 DMA Settings 🗹 GPIO Settings Configure the below parameters : Search : Search (Crtl+F) ا ج ADCs Common Settings Independent mode Mode ADC Settings Synchronous clock mode divided by 2 Clock Prescaler ADC 12-bit resolution Resolution Data Alignment Right alignment Scan Conversion Mode Disabled Continuous Conversion Mode Disabled Discontinuous Conversion Mode Disabled DMA Continuous Requests Enabled End of single conversion End Of Conversion Selection Overrun behaviour Overrun data preserved Low Power Auto Wait Disabled ADC_Regular_ConversionMode Enable Regular Conversions Enable Enable Regular Oversampling Disable Number Of Conversion Trigger detection on the rising and falling edges External Trigger Conversion Edge External Trigger Conversion Source Timer 1 Capture Compare 1 event Rank

Default trigger setting is Timer1 Capture Compare 1 event

Concept of the system

Tuning of ADC1 trigger source

Steps 1 and 2 only for verification. Should contain correct value if ADC configuration was not reset to default (slide 18).

External Trigger Conversion Edge	Trigger detection on the rising and falling edges	
External Trigger Conversion Source	Timer 1 Capture Compare 1 event	•
🗄 Rank	Timer 1 Capture Compare 1 event	
ADC_Injected_ConversionMode	Timer 1 Capture Compare 2 event	
Enable Injected Conversions	Timer 1 Capture Compare 3 event	Ξ
Analog Watchdog 1	Timer 2 Capture Compare 2 event	
······································	Timer 3 Trigger Out event	
External Trigger Conversion Source	Timer 4 Capture Compare 4 event	
ExternalTrigConv	Timer 8 Trigger Out event	
Parameter Description:	Timer 8 Trigger Out 2 event	Ŧ

To use single timer we should select trigger from Timer2. Timer2 Capture Compare 2 event would be the best choice



Concept of the system triggering of ADC and DAC by TIM2²⁷







Project tuning after migration ADC re-configuration

Some of ADC parameters need to be modified according to STM32L4 capabilities.

In particular:

- ADC1 Channel1 (PC0) should be changed to Channel6 (PA1) in order to use the same jumper connection on Nucleo board (PA1-PA4) – already done
- Different DMA channel is available for ADC in STM32L4 (DMA1, Channel1)
- There are different sampling time values available (suggested 12.5 cycles)
- Different external triggers are available for ADC conversions (as we are using Timer2 - capture compare on channel 2 event will be used)

ADC1 Configuration				X
🖋 Parameter Settings ┥	User Constants	🖋 NVIC Settings √ DMA	Settings 🎻 GP	IO Settings
DMA Request	Channel	Direction	Priority	
ADC1	DMA1 Channel 1	Peripheral To Me	mory Low	
			Add	Delete
DMA Request Settings				
			Peripheral	Memory
Mode Circular	•	Increment Address		
		Data Width	Half Word 🔻	Half Word 🔻
		Ā	Apply Ok	Cancel

ADC1 Configuration	
🖉 Parameter Settings 🎻 User Constants 🗹 N	VIC Settings 🔣 DMA Settings 🚀 GPIO Settings
configure the below parameters :	
and a Count (Orthin)	
Search (Crti+F)	· ·
ADCs_Common_Settings	
* Mode	Independent mode
ADC_Settings	
Clock Prescaler	Synchronous clock mode divided by 2
Resolution	ADC 12-bit resolution
Data Alignment	Right alignment
* Scan Conversion Mode	Disabled
Continuous Conversion Mode	Disabled
Discontinuous Conversion Mode	Disabled
DMA Continuous Requests	Enabled
End Of Conversion Selection	End of single conversion
Overrun behaviour	Overrun data preserved
Low Power Auto Wait	Disabled
ADC_Regular_ConversionMode	
Enable Regular Conversions	Enable
Enable Regular Oversampling	Disable
Number Of Conversion	1
External Trigger Conversion Edge	Trigger detection on the rising and falling edges
External Trigger Conversion Source	Timer 2 Capture Compare 2 event
Rank Rank	1
Channel	Channel 6
Sampling Time	12.5 Cycles
Offset Number	No offset

Concept of the system after migration to NUCLEO-L476RG – ADC config fixed 29





Hardware overview





Project tuning after migration DAC re-configuration 30

There is **no need** to do any manual reconfiguration of the DAC

DAC1 Configuration				X
Parameter Settings 🎻	User Constants 🔣 N	IVIC Settings 🗹 DMA Settin	gs 🎻 GPIO	Settings
DMA Request	Channel	Direction	Priority	
DAC_CH1	DMA1 Channel 3	Memory To Peripheral	Low	
			Ade	d Delete
DMA Request Settings				
		Pe	ripheral	Memory
Mode Circular	•	Increment Address		
		Data Width Half	Word 🔻	Half Word 🔻
		Apply	/ Oł	Cancel

DAC1 Configuration	
🖋 Parameter Settings 🗹 User Constants 🚽	NVIC Settings 🗹 DMA Settings
Configure the below parameters :	
Search : Search (Crtl+F)	▼ ▲
DAC Out1 Settings	
Output Buffer	Enable
Trigger	Timer 2 Trigger Out event
Wave generation mode	Disabled
User Trimming	Factory trimming
Sample And Hold	Sampleandhold Disable



Some of Timer2 parameters need to be modified according to STM32L4 and clock capabilities.

In particular:

- Change Channel 4 to Channel 2 (output 1. compare, no output mode) to have trigger signal for ADC – **pinout tab**
- Prescaler, period and pulse values to get 5Hz 2. output signal with 50% duty cycle @80MHz clock on the bus - configuration tab
 - Prescaler: 39999 (/40000) •
 - Period: 399 (/400) •
 - Mode for channel 2: Toggle on match
 - Pulse: 200 •

(Period/2)

Pinout

Project t	uning after	migration
Clock Configuration Configuration Power Co		
	Timor ² ro-(configuration -
		Johngulation
EPUART1		
🖶 🧘 ОРАМР1		
🖶 💿 ОРАМР2		
🖶 💿 QUADSPI		
RCC		
E • • RNG		
■ ● RTC		
	2	
	• TIM2 Configuration	
	Parameter Settings of User Constants of NVIC Setting	s 🔊 DMA Settings
	Configure the below parameters :	
	Search : Search (Ortl+E)	
Ⅲ Ⅲ 1		
	Counter Settings	
-Slave Mode Disable 🔹	Prescaler (PSC - 16 bits value)	39999
Trigger Source Disable	Counter Mode	Up
Clock Source Internal Clock	Counter Period (AutoReload Register - 32 bits value	e) 399
Channel1 Disable	Internal Clock Division (CKD)	No Division
	Trigger Output (TRGO) Parameters	
	Master/Slave Mode	Disable (no sync between this TIM (Master) and its Slaves
Channeld Disable	Trigger Event Selection TRGO	Update Event
	🗄 Clear Input	
	Output Compare No Output Channel 2	
Use ETR as Clearing Source Disable	Mode	Toggle on match
	Pulse (32 bits value)	200
One Pulse Mode	CH Polarity	High
	Prescaler (PSC - 16 bits value) Prescaler must be between 0 and 65 535.	

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Apply

Ok

Cancel



Concept of the system after migration to NUCLEO-L476RG – DAC & Timer2 fixed









Project tuning after migration Code generation for STM32L4xx device

After all necessary configuration modifications, final project for NUCLEO-L476RG board can be saved as L4_DAC_ADC and code for SW4STM32 can be generated.

Project Settings				
roject Code Generator Adv	anced Settings			
Project Settings				
Project Name				
L4_DAC_ADC				
Project Location				
C:_Work_Seminar\			Browse	
Toolchain Folder Location C:_Work_Seminar\L4_DA	C_ADC\			
Toolchain / IDE				
SW4STM32	•	Generate Under Root		
Linker Settings Minimum Heap Size Minimum Stack Size	0x200 0x400			
Mcu and Firmware Package				
Mcu Reference				
STM32L476RGTx				
Firmware Package Name ar	d Version			
STM32Cube FW_L4 V1.5.1				
			Cance	al



Concept of the system migration to NUCLEO-L476RG completed





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What have we learnt?

✓ How to migrate the project between two different microcontrollers:

- ✓ Importing STM32CubeMX project
- ✓ Running automatic migration to new platform (STM32L476RGT6 MCU)
- ✓ Tuning project in STM32CubeMX:
 - ✓ Updating clocks
 - ✓ Re-configuring peripherals
 - ✓ Generating project for new MCU

□Tuning project in SW4STM32:

Importing modified project to the same workspace
 Apply necessary modifications to generated sources
 Compile and run project on the new platform



Further reading 36

More information can be found in the following documents:

• **UM1718** - STM32CubeMX for STM32 configuration, available on the web:

http://www.st.com/resource/en/user_manual/dm00104712.pdf







www.st.com/mcu

