Vhodno izhodne naprave

Laboratorijska vaja 6 - VP 6

STM32F4 – ADC, PWM, SPI-Accel, I2C, Tracing, Osciloskop

VIN projekt - VP6: STM32F4 VIN Demo

- Osvežitev: STM32F4

- CubeIDE projekt STM32F4 in V/I naprave :
  - CubeIDE projekt, GPIO in VCOM port
  - PWM - LED dimmer, brenčač
  - SPI - LIS3DSH pospeškomer
  - I2C - CS43L22 zvočni čip
  - ADC

- Sledenje („tracing“) - CubeMonitor, osciloskop

VIN Projekt – Osnovna platforma

STM32F407 ST Discovery

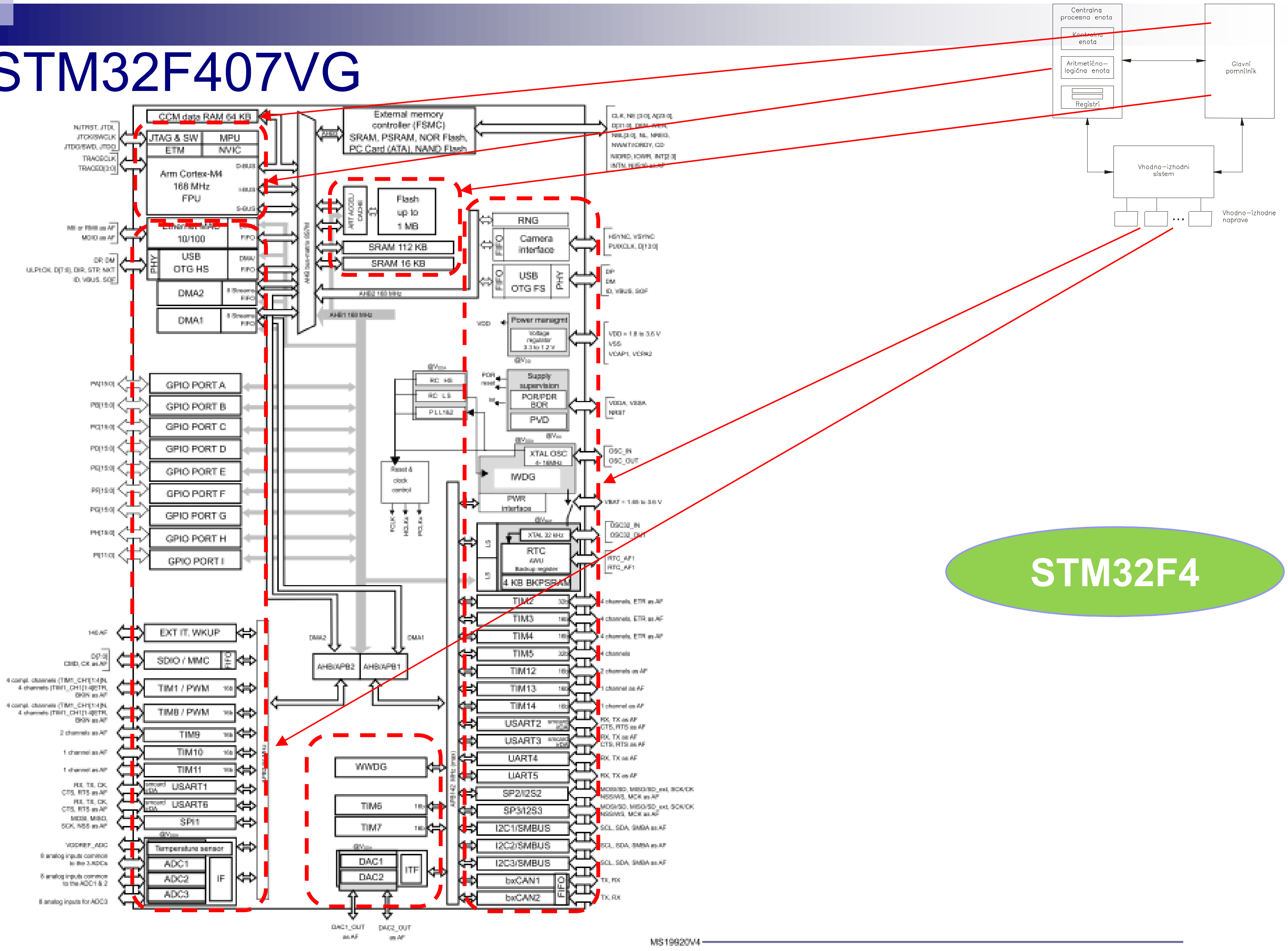
STM Discovery F4 (Cortex M4)

- STM32F407VGT6 microcontroller featuring 32-bit Arm® Cortex®-M4 with FPU core, 1-Mbyte Flash memory and 192-Kbyte RAM in an LQFP100 package
- USB OTG FS
- ST MEMS 3-axis accelerometer
- ST-MEMS audio sensor omni-directional digital microphone
- Audio DAC with integrated class D speaker driver
- User and reset push-buttons
- Eight LEDs:
  - LD1 (red/green) for USB communication
  - LD2 (red) for 3.3 V power on
  - Four user LEDs, LD3 (orange), LD4 (green), LD5 (red) and LD6 (blue)
- Board connectors:
  - USB with Micro-AB
  - Stereo headphone output jack
  - 2.54 mm pitch extension header for all LQFP100 I/Os for quick connection to prototyping board and easy probing
- External application power supply: 3 V and 5 V

STM32

STM32F4

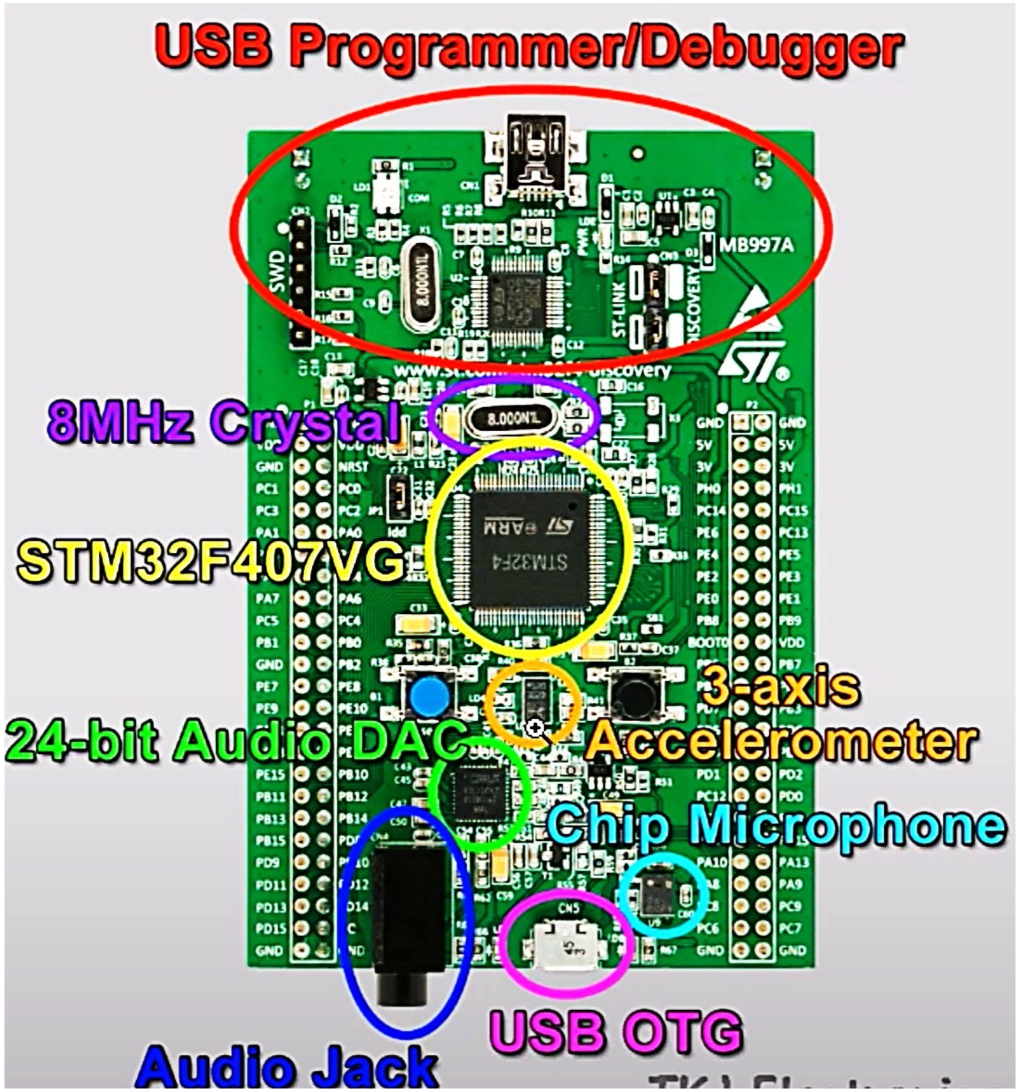
STM32F407VG



STM32F4

STM32F4DISCOVERY

3.3V !!!



STM32F4DISCOVERY

STM32F4

3.3V !!!

P1

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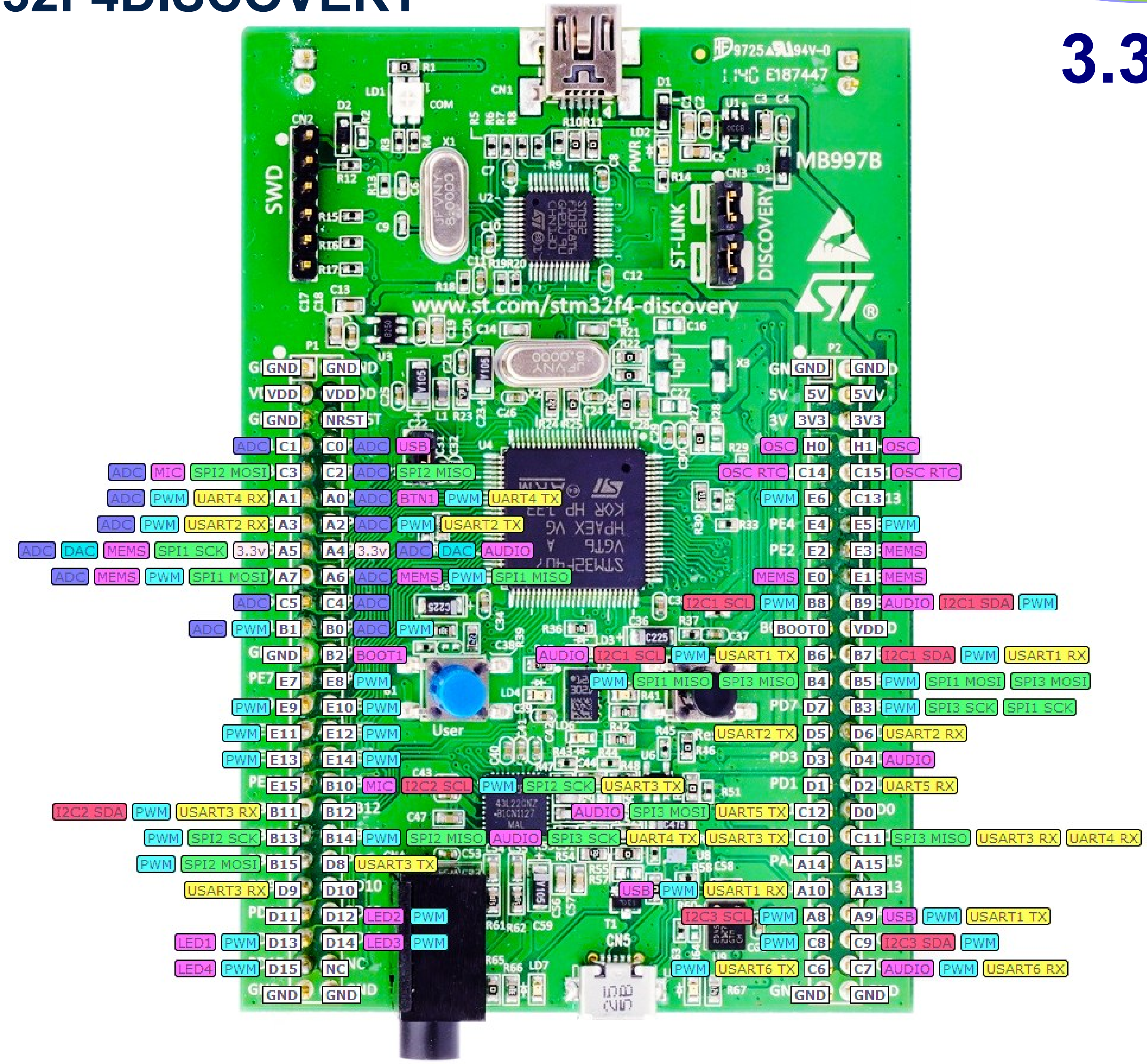

GND | GND
VDD | VDD
GND | NRST
ADC C1 | C0 ADC USB
ADC MIC SPI2 MOSI C3 | C2 ADC SPI2 MISO
ADC PWM UART4 RX A1 | A0 ADC BTN1 PWM UART4 TX
ADC PWM USART2 RX A3 | A2 ADC PWM USART2 TX
ADC DAC MEMS SPI1 SCK 3.3v A5 | A4 3.3v ADC DAC AUDIO
ADC MEMS PWM SPI1 MOSI A7 | A6 ADC MEMS PWM SPI1 MISO
ADC C5 | C4 ADC
ADC PWM B1 | B0 ADC PWM
GND | B2 BOOT1
E7 | E8 PWM
PWM E9 | E10 PWM
PWM E11 | E12 PWM
PWM E13 | E14 PWM
E15 | B10 MIC I2C2 SCL PWM SPI2 SCK USART3 TX
I2C2 SDA PWM USART3 RX B11 | B12
PWM SPI2 SCK B13 | B14 PWM SPI2 MISO
PWM SPI2 MOSI B15 | D8 USART3 TX
USART3 RX D9 | D10
D11 | D12 LED2 PWM
LED1 PWM D13 | D14 LED3 PWM
LED4 PWM D15 | NC
GND | GND
GND | GND
5V | 5V
3V3 | 3V3
OSC H0 | H1 OSC
OSC RTC C14 | C15 OSC RTC
PWM E6 | C13
E4 | E5 PWM
E2 | E3 MEMS
MEMS E0 | E1 MEMS
I2C1 SCL PWM B8 | B9 AUDIO I2C1 SDA PWM
BOOT0 | VDD
AUDIO I2C1 SCL PWM USART1 TX B6 | B7 I2C1 SDA PWM USART1 RX
PWM SPI1 MISO SPI3 MISO B4 | B5 PWM SPI1 MOSI SPI3 MOSI
D7 | B3 PWM SPI3 SCK SPI1 SCK
USART2 TX D5 | D6 USART2 RX
D3 | D4 AUDIO
D1 | D2 UART5 RX
AUDIO SPI3 MOSI UART5 TX C12 | D0
AUDIO SPI3 SCK UART4 TX USART3 TX C10 | C11 SPI3 MISO USART3 RX UART4 RX
A14 | A15
USB PWM USART1 RX A10 | A13
I2C3 SCL PWM A8 | A9 USB PWM USART1 TX
PWM C8 | C9 I2C3 SDA PWM
PWM USART6 TX C6 | C7 AUDIO PWM USART6 RX
GND | GND
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ST-LINK
DISCOVERY
MB997B
User
www.st.com/stm32f4-discovery

P2

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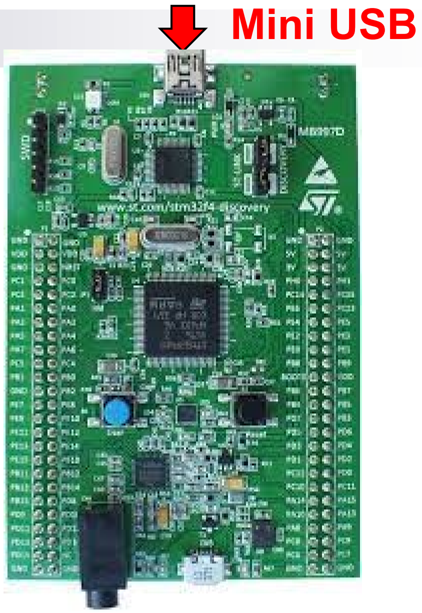
Delo na STM32F4 razvojnem sistemu

Priključitev :

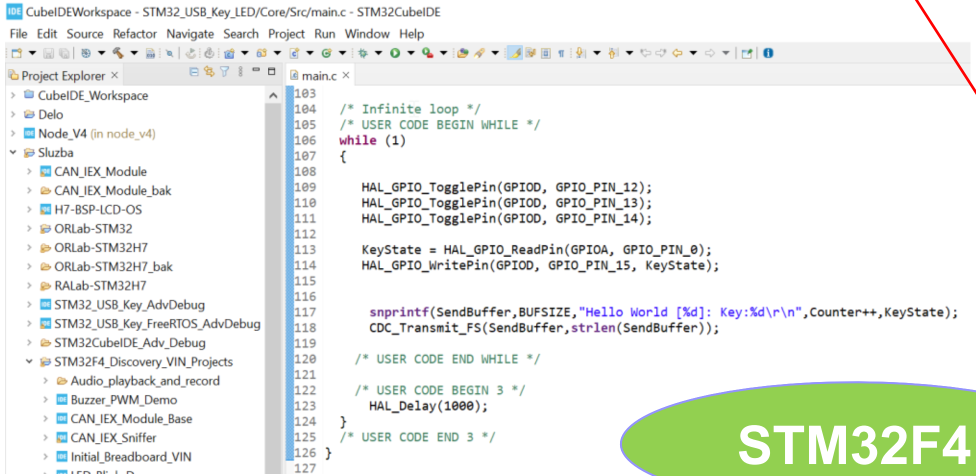
- **Mini USB** priklop na **krajši stranici**, svetita rdeči **LED** diodi
- **Micro USB** priklop (VCom port)

Poseben začetni projekt za *STM32F4* (e-učilnica) :

- ***dodajanje vsebine (main.c):***



Mikro USB VCom-port



```
  /* Infinite loop */
  /* USER CODE BEGIN WHILE */
  while (1)
  {

     HAL_GPIO_TogglePin(GPIOD, GPIO_PIN_12);
     HAL_GPIO_TogglePin(GPIOD, GPIO_PIN_13);
     HAL_GPIO_TogglePin(GPIOD, GPIO_PIN_14);

     KeyState = HAL_GPIO_ReadPin(GPIOA, GPIO_PIN_0);
     HAL_GPIO_WritePin(GPIOD, GPIO_PIN_15, KeyState);


      snprintf(SendBuffer,BUFSIZE,"Hello World [%d]: Key:%d\r\n",Counter++,KeyState);
      CDC_Transmit_FS(SendBuffer,strlen(SendBuffer));

    /* USER CODE END WHILE */

    /* USER CODE BEGIN 3 */
      HAL_Delay(1000);
  }
  /* USER CODE END 3 */
}
```

STM32F4

--------- Razvojni sistem STM32F407 Discovery -----------

STM32F4DISCOVERY Discovery kit with STM32F407VG MCU

VINLab-STM32 - GitHub repozitorij

ORLab-STM32 - GitHub repozitorij

STM32F4 - Dokumentacija

Lastni viri :

https://github.com/LAPSyLAB/STM32F4_Discovery_VIN_Projects

https://github.com/LAPSyLAB/STM32F4_Docs_and_Examples

https://github.com/LAPSyLAB/ORLab-STM32

STM32F4

Osnovni projekt CubeIDE – GPIO – različni nivoji programiranja

Baremetal - zbirnik

```
INIT_IO:
  push {r5, r6, lr}
    // Enable GPIOD Peripheral Clock (bit 3 in AHB1ENR register)
    ldr r6, = RCC_AHB1ENR        // Load peripheral clock reg address to r6
    ldr r5, [r6]                 // Read its content to r5
    orr r5, 0x00000008           // Set bit 3 to enable GPIOD clock
    str r5, [r6]                 // Store result in peripheral clock register

    // Make GPIOD Pin12 as output pin (bits 25:24 in MODER register)
    ldr r6, =GPIOD_BASE        // Load GPIOD BASE address to r6
    ldr r5, [r6,#GPIOD_MODER]  // Read GPIOD_MODER content to r5
    and r5, 0x00FFFFFF           // Clear bits 31-24 for P12-15
    orr r5, 0x55000000           // Write 01 to bits 31-24 for P12-15
    str r5, [r6]                 // Store result in GPIOD MODER register
  pop {r5, r6, pc}


LED_ON:
    push {r5, r6, lr}
    // Set GPIOD Pins to 1 (through BSSR register)
    ldr    r6, =GPIOD_BASE       // Load GPIOD BASE address to r6
    mov    r5, #LEDs_ON
    str    r5, [r6,#GPIOD_BSSR] // Write to BSRR register
    pop {r5, r6, pc}

LED_OFF:
    push {r5, r6, lr}
    // Set GPIOD Pins to 0 (through BSSR register)
    ldr    r6, =GPIOD_BASE       // Load GPIOD BASE address to r6
    mov    r5, #LEDs_OFF
    str    r5, [r6,#GPIOD_BSSR] // Write to BSRR register
    pop {r5, r6, pc}
```

https://github.com/LAPSyLAB/ORLab-STM32/tree/main/GPIO_LEDs

RA, OR

Baremetal - C

```
   /* USER CODE BEGIN 2 */


  RCC->AHB1ENR |= 0x08;
// Enable clock for GPIOD
  GPIOD->MODER |= 0x01000000;        //
MODE Register: bit 12 == out

  /* USER CODE END 2 */

  /* Infinite loop */
  /* USER CODE BEGIN WHILE */
  while (1)
  {
    GPIOD->ODR ^= 0x1000;            //
Toggle PD12

/* USER CODE END WHILE */

    /* USER CODE BEGIN 3 */
    for (int i=0; i<0x1000000; i++) {};
// waste some time
  }
  /* USER CODE END 3 */
```

https://github.com/LAPSyLAB/STM32F4_Discovery_VIN_Projects/tree/main/LED_GPIO_C_Baremetal_C

HAL - C

```
/* Infinite loop */
 /* USER CODE BEGIN WHILE */
 while (1)
 {

HAL_GPIO_TogglePin(GPIOD, GPIO_PIN_12);

  /* USER CODE END WHILE */

   /* USER CODE BEGIN 3 */
 HAL_Delay(1000);
 }
 /* USER CODE END 3 */



void HAL_GPIO_TogglePin(GPIO_TypeDef* GPIOx,
uint16_t GPIO_Pin)
{
  uint32_t odr;

  /* Check the parameters */
  assert_param(IS_GPIO_PIN(GPIO_Pin));

  /* get current Ouput Data Register value
*/
  odr = GPIOx->ODR;

  /* Set selected pins that were at low
level, and reset ones that were high */
  GPIOx->BSRR = ((odr & GPIO_Pin) <<
GPIO_NUMBER) | (~odr & GPIO_Pin);
}
```

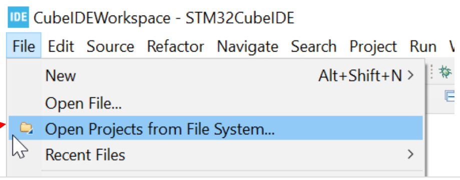
VIN

https://github.com/LAPSyLAB/STM32F4_Discovery_VIN_Projects/tree/main/LED_Blink_Demo

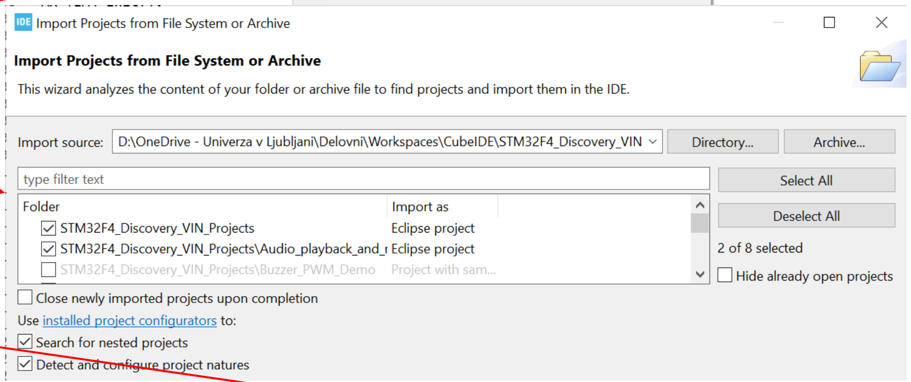
Delo v CubeIDE

Vzpostavitev začetnega projekta :

- **Uvoz obstoječega**
  - Open projects from File System
  - Select project(s)
- **Nov projekt Cube MX**
- **Kopiranje obstoječega**



CubeIDEWorkspace - STM32CubeIDE
File Edit Source Refactor Navigate Search Project Run
New Alt+Shift+N >
Open File...
Open Projects from File System...
Recent Files >


Import Projects from File System or Archive

Import Projects from File System or Archive

This wizard analyzes the content of your folder or archive file to find projects and import them in the IDE.

Import source: D:\OneDrive - Univerza v Ljubljani\Delovni\Workspaces\CubeIDE\STM32F4_Discovery_VIN [Directory...] [Archive...]

type filter text [Select All] [Deselect All]

Folder	Import as
☑ STM32F4_Discovery_VIN_Projects	Eclipse project
☑ STM32F4_Discovery_VIN_Projects\Audio_playback_and_r	Eclipse project
☐ STM32F4_Discovery_VIN_Projects\Buzzer_PWM_Demo	Project with sam...

2 of 8 selected

☐ Hide already open projects

☐ Close newly imported projects upon completion

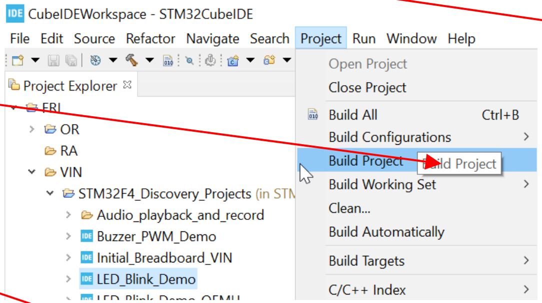
Use installed project configurators to:

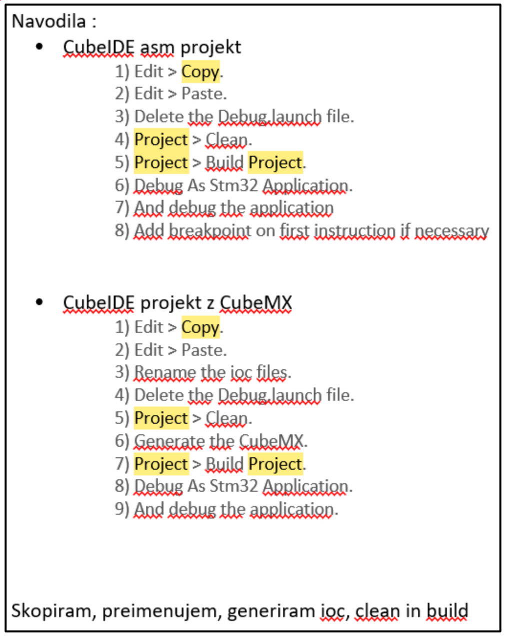
☑ Search for nested projects

☑ Detect and configure project natures

Prevajanje, zagon :

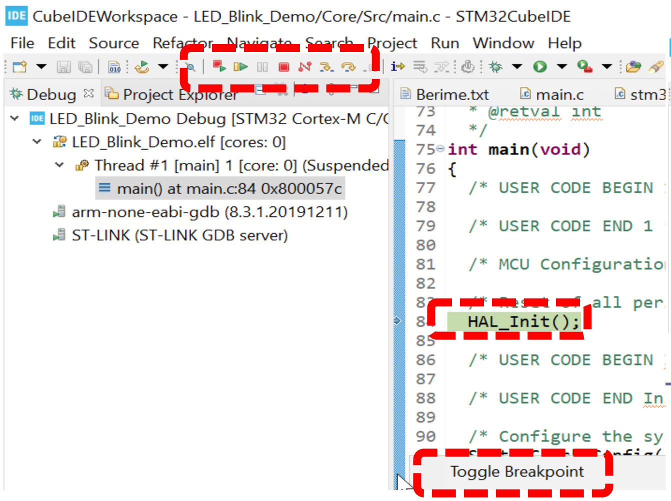
- Project -> Build Project
- Run -> Debug
- Step (Into,Over), Breakpoints




Navodila :

- CubeIDE asm projekt
  1) Edit > Copy.
  2) Edit > Paste.
  3) Delete the Debug.launch file.
  4) Project > Clean.
  5) Project > Build Project.
  6) Debug As Stm32 Application.
  7) And debug the application.
  8) Add breakpoint on first instruction if necessary
- CubeIDE projekt z CubeMX
  1) Edit > Copy.
  2) Edit > Paste.
  3) Rename the ioc files.
  4) Delete the Debug.launch file.
  5) Project > Clean.
  6) Generate the CubeMX.
  7) Project > Build Project.
  8) Debug As Stm32 Application.
  9) And debug the application.

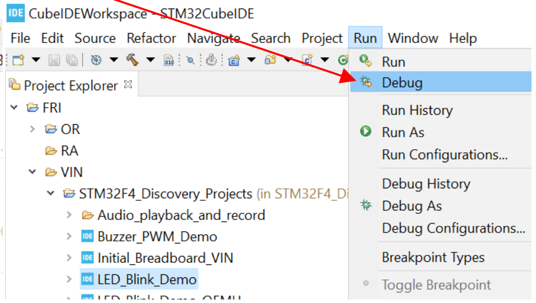
Skopiram, preimenujem, generiram ioc, clean in build



CubeIDEWorkspace - LED_Blink_Demo/Core/Src/main.c - STM32CubeIDE
File Edit Source Refactor Navigate Search Project Run Window Help
Debug
Project Explorer
Berime.txt
main.c
stm3
Toggle Breakpoint

```
LED_Blink_Demo Debug [STM32 Cortex-M C/C
  LED_Blink_Demo.elf [cores: 0]
    Thread #1 [main] 1 [core: 0] (Suspended
      main() at main.c:84 0x800057c
  arm-none-eabi-gdb (8.3.1.20191211)
  ST-LINK (ST-LINK GDB server)
```

```
  * @retval int
  */
int main(void)
{
  /* USER CODE BEGIN

  /* USER CODE END 1

  /* MCU Configuratio

  /* Reset of all per
  HAL_Init();

  /* USER CODE BEGIN

  /* USER CODE END In

  /* Configure the sy
```



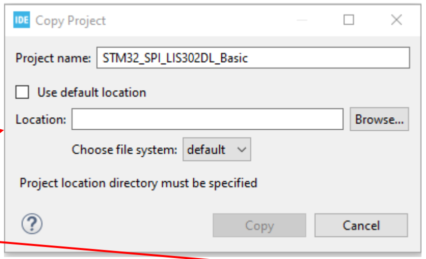
CubeIDE – delo s projekti

Kopiranje/preimenovanje projekta :

- **Kopiranje projekta Cube MX I:**
  - Znotraj CubeIDE

Kopiranje CubeIDE projekta z CubeMX .ioc datoteko

1) Edit > Copy.
2) Edit > Paste.
3) Preimenuj .ioc datoteko.
4) Zbriši Debug.launch datoteko.
5) Project > Clean.
6) Generiraj kodo s CubeMX.
7) Project > Build Project.
8) Debug As Stm32 Application.
9) Debug aplikacije.


Copy Project

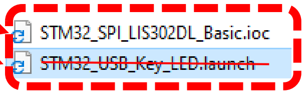
Project name: STM32_SPI_LIS302DL_Basic

☐ Use default location

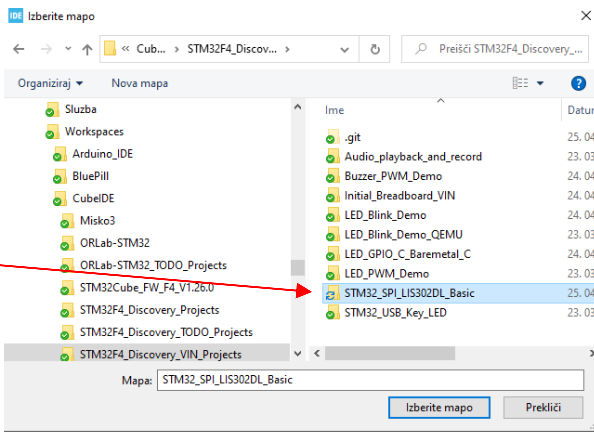
Location:

Choose file system: default

Project location directory must be specified


STM32_SPI_LIS302DL_Basic.ioc

~~STM32_USB_Key_LED.launch~~


Izberite mapo

« Cub... › STM32F4_Discov... ›

Preišči STM32F4_Discovery_...

Sluzba
Workspaces
Arduino_IDE
BluePill
CubeIDE
Misko3
ORLab-STM32
ORLab-STM32_TODO_Projects
STM32Cube_FW_F4_V1.26.0
STM32F4_Discovery_Projects
STM32F4_Discovery_TODO_Projects
STM32F4_Discovery_VIN_Projects

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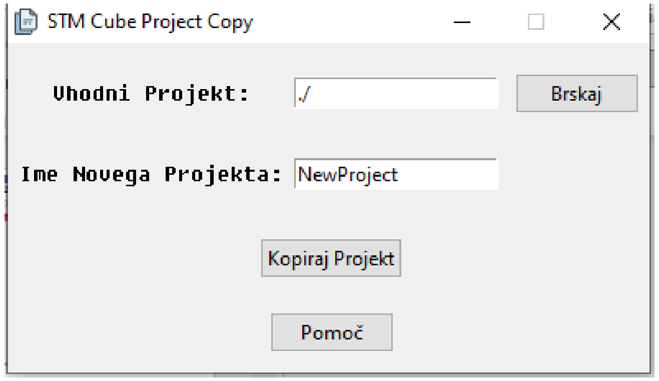
.git	25. 04
Audio_playback_and_record	23. 03
Buzzer_PWM_Demo	24. 04
Initial_Breadboard_VIN	24. 04
LED_Blink_Demo	24. 04
LED_Blink_Demo_QEMU	23. 03
LED_GPIO_C_Baremetal_C	24. 04
LED_PWM_Demo	23. 03
STM32_SPI_LIS302DL_Basic	25. 04
STM32_USB_Key_LED	23. 03

Mapa: STM32_SPI_LIS302DL_Basic

Skopiram, preimenujem ioc, generiram kodo, brišem Debug.launch, clean in build

- **Kopiranje projekta Cube MX II:**
  - Uporaba orodja


STM Cube Project Copy

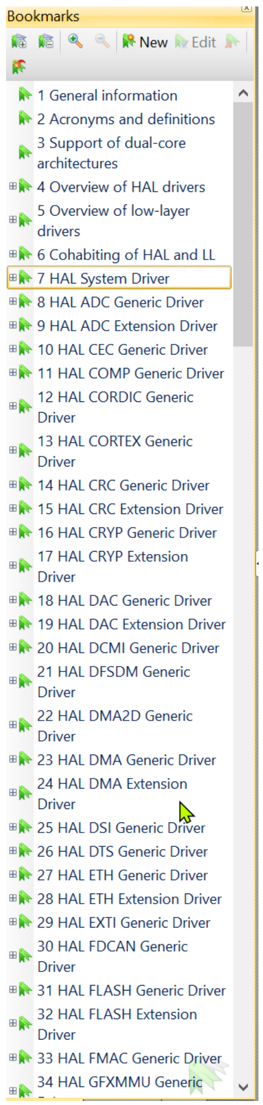
Vhodni Projekt: ./

Ime Novega Projekta: NewProject

https://github.com/LAPSyLAB/STM32F4_Docs_and_Examples/tree/main/Documentation/CubeIDE

Vir: UM2217 - HAL and Low-layer drivers

STM32F4

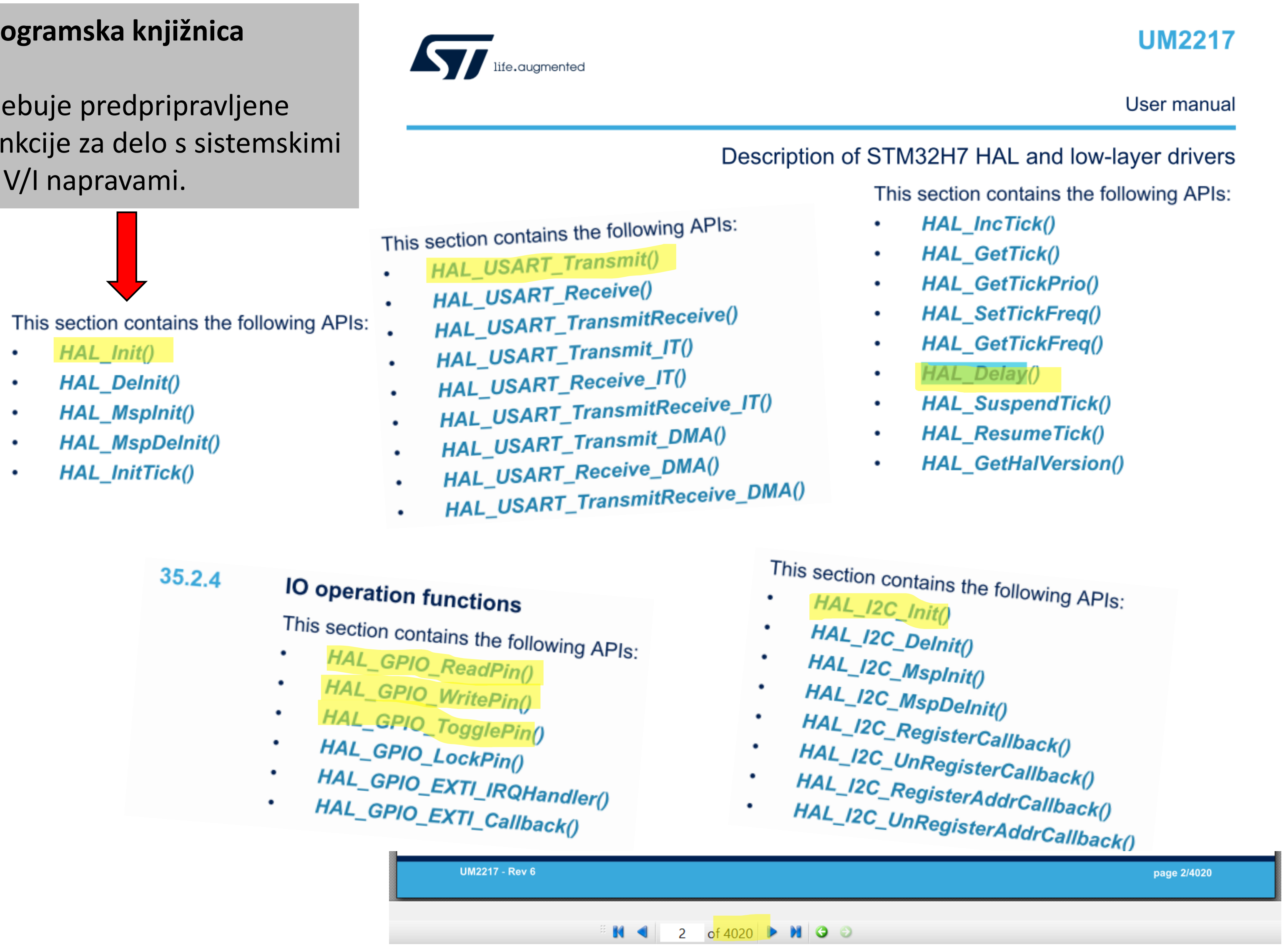

Bookmarks

New Edit

1 General information
2 Acronyms and definitions
3 Support of dual-core architectures
4 Overview of HAL drivers
5 Overview of low-layer drivers
6 Cohabiting of HAL and LL
7 HAL System Driver
8 HAL ADC Generic Driver
9 HAL ADC Extension Driver
10 HAL CEC Generic Driver
11 HAL COMP Generic Driver
12 HAL CORDIC Generic Driver
13 HAL CORTEX Generic Driver
14 HAL CRC Generic Driver
15 HAL CRC Extension Driver
16 HAL CRYP Generic Driver
17 HAL CRYP Extension Driver
18 HAL DAC Generic Driver
19 HAL DAC Extension Driver
20 HAL DCMI Generic Driver
21 HAL DFSDM Generic Driver
22 HAL DMA2D Generic Driver
23 HAL DMA Generic Driver
24 HAL DMA Extension Driver
25 HAL DSI Generic Driver
26 HAL DTS Generic Driver
27 HAL ETH Generic Driver
28 HAL ETH Extension Driver
29 HAL EXTI Generic Driver
30 HAL FDCAN Generic Driver
31 HAL FLASH Generic Driver
32 HAL FLASH Extension Driver
33 HAL FMAC Generic Driver
34 HAL GFXMMU Generic

Programska knjižnica

Vsebuje predpripravljene funkcije za delo s sistemskimi in V/I napravami.


life.augmented

UM2217

User manual

Description of STM32H7 HAL and low-layer drivers

This section contains the following APIs:
- *HAL_Init()*
- *HAL_DeInit()*
- *HAL_MspInit()*
- *HAL_MspDeInit()*
- *HAL_InitTick()*

This section contains the following APIs:
- *HAL_USART_Transmit()*
- *HAL_USART_Receive()*
- *HAL_USART_TransmitReceive()*
- *HAL_USART_Transmit_IT()*
- *HAL_USART_Receive_IT()*
- *HAL_USART_TransmitReceive_IT()*
- *HAL_USART_Transmit_DMA()*
- *HAL_USART_Receive_DMA()*
- *HAL_USART_TransmitReceive_DMA()*

This section contains the following APIs:
- *HAL_IncTick()*
- *HAL_GetTick()*
- *HAL_GetTickPrio()*
- *HAL_SetTickFreq()*
- *HAL_GetTickFreq()*
- *HAL_Delay()*
- *HAL_SuspendTick()*
- *HAL_ResumeTick()*
- *HAL_GetHalVersion()*

35.2.4 **IO operation functions**

This section contains the following APIs:
- *HAL_GPIO_ReadPin()*
- *HAL_GPIO_WritePin()*
- *HAL_GPIO_TogglePin()*
- *HAL_GPIO_LockPin()*
- *HAL_GPIO_EXTI_IRQHandler()*
- *HAL_GPIO_EXTI_Callback()*

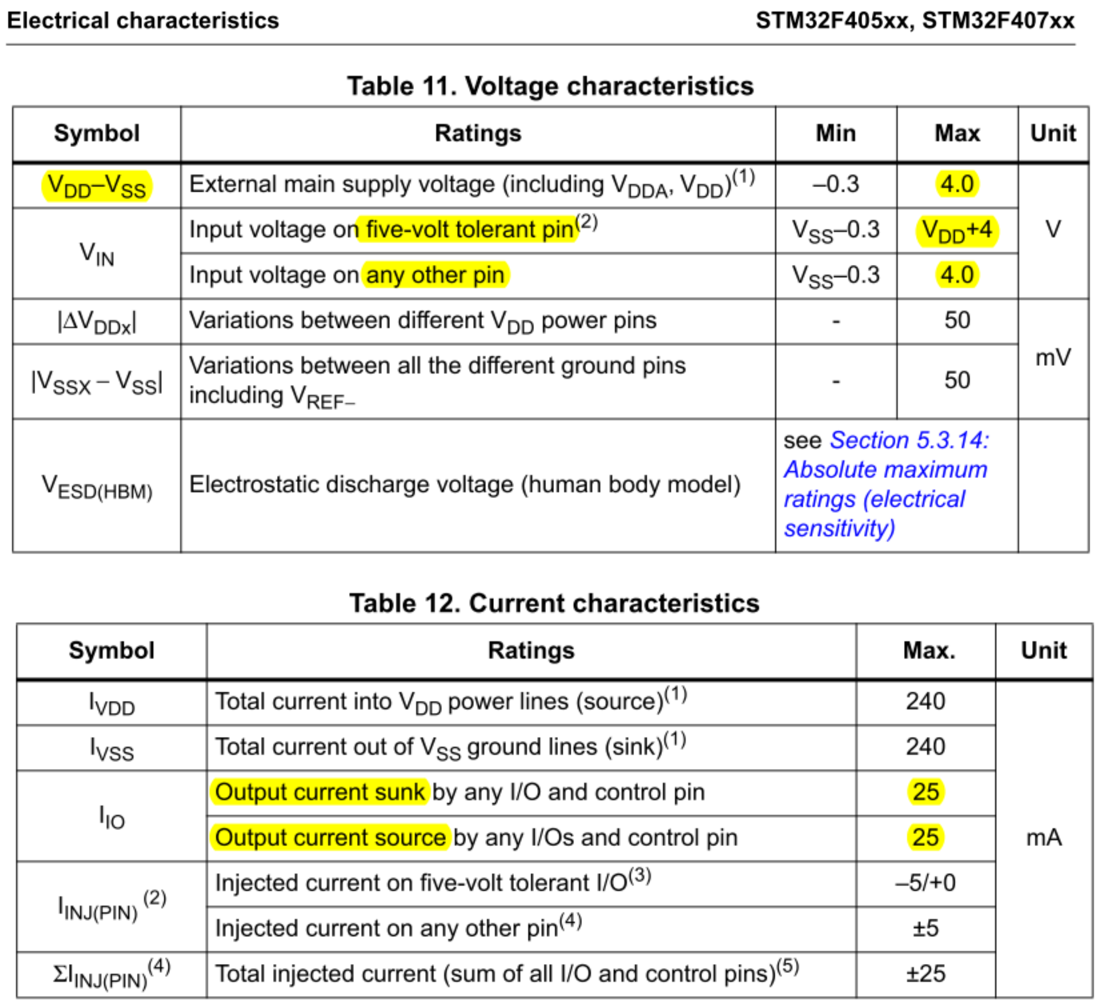
This section contains the following APIs:
- *HAL_I2C_Init()*
- *HAL_I2C_DeInit()*
- *HAL_I2C_MspInit()*
- *HAL_I2C_MspDeInit()*
- *HAL_I2C_RegisterCallback()*
- *HAL_I2C_UnRegisterCallback()*
- *HAL_I2C_RegisterAddrCallback()*
- *HAL_I2C_UnRegisterAddrCallback()*

UM2217 - Rev 6 page 2/4020

2 of 4020

STM32F4DISCOVERY

3.3V !!!



Electrical characteristics — **STM32F405xx, STM32F407xx**

Table 11. Voltage characteristics

Symbol	Ratings	Min	Max	Unit
$V_{DD}–V_{SS}$	External main supply voltage (including V_{DDA}, V_{DD})(1)	–0.3	4.0	V
V_{IN}	Input voltage on five-volt tolerant pin(2)	V_{SS}–0.3	V_{DD}+4	V
	Input voltage on any other pin	V_{SS}–0.3	4.0	V
$\|\Delta V_{DDx}\|$	Variations between different V_{DD} power pins	-	50	mV
$\|V_{SSX} - V_{SS}\|$	Variations between all the different ground pins including V_{REF-}	-	50	mV
$V_{ESD(HBM)}$	Electrostatic discharge voltage (human body model)	see *Section 5.3.14: Absolute maximum ratings (electrical sensitivity)*		

Table 12. Current characteristics

Symbol	Ratings	Max.	Unit
I_{VDD}	Total current into V_{DD} power lines (source)(1)	240	mA
I_{VSS}	Total current out of V_{SS} ground lines (sink)(1)	240	mA
I_{IO}	Output current sunk by any I/O and control pin	25	mA
	Output current source by any I/Os and control pin	25	mA
$I_{INJ(PIN)}$ (2)	Injected current on five-volt tolerant I/O(3)	–5/+0	mA
	Injected current on any other pin(4)	±5	mA
$\Sigma I_{INJ(PIN)}$(4)	Total injected current (sum of all I/O and control pins)(5)	±25	mA

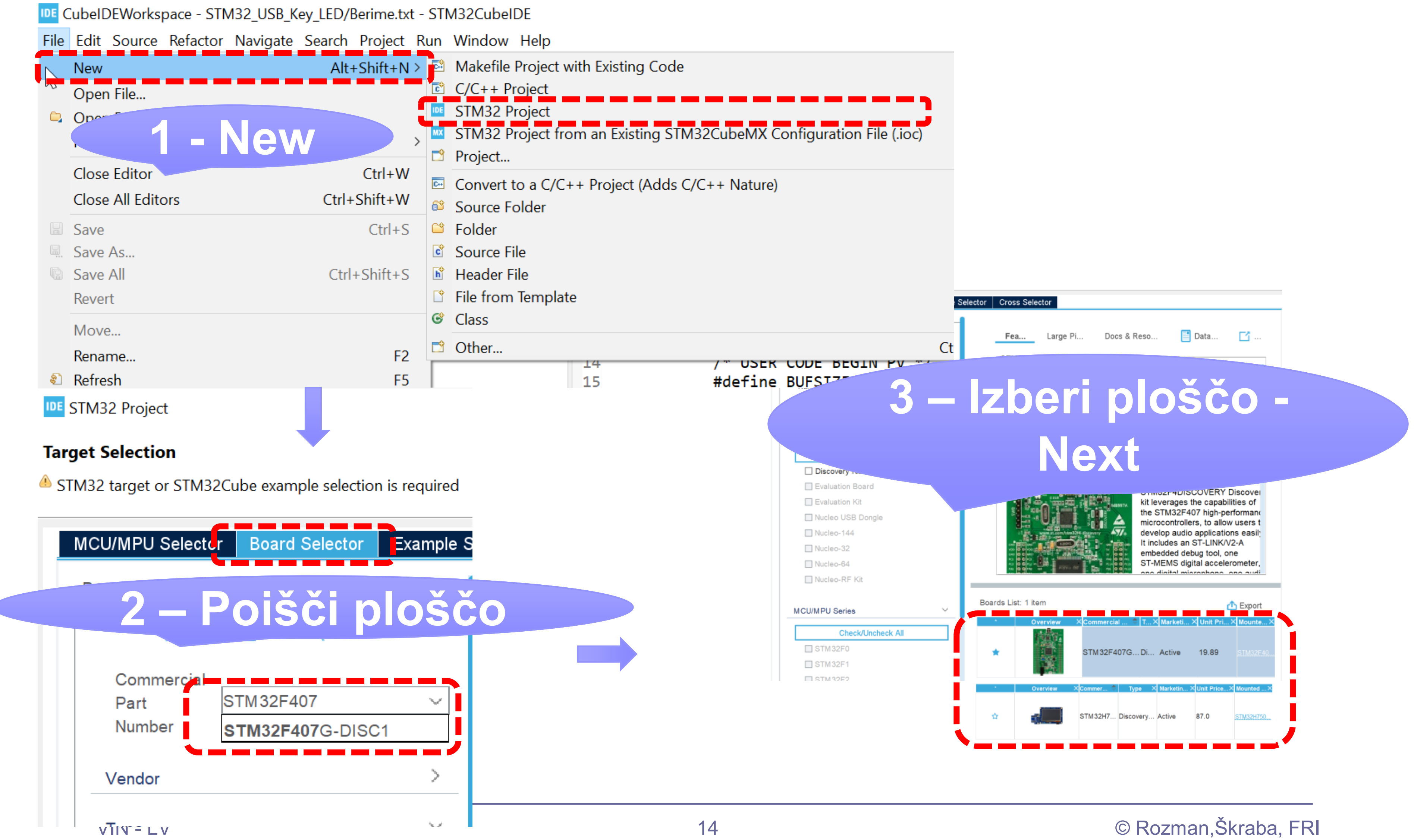
VIN projekt - VP6: STM32F4 VIN Demo

- Osvežitev: STM32F4
- CubeIDE projekt STM32F4 in V/I naprave :
  - CubeIDE projekt, GPIO in VCOM port
  - PWM - LED dimmer, brenčač
  - SPI - LIS3DSH pospeškomer
  - I2C - CS43L22 zvočni čip
  - ADC
- Sledenje („tracing“) - CubeMonitor, osciloskop

CubeIDE – Vzpostavitev novega projekta

STM32F4

Nov projekt :



CubeIDEWorkspace - STM32_USB_Key_LED/Berime.txt - STM32CubeIDE

File Edit Source Refactor Navigate Search Project Run Window Help
New Alt+Shift+N
Open File...
Close Editor Ctrl+W
Close All Editors Ctrl+Shift+W
Save Ctrl+S
Save As...
Save All Ctrl+Shift+S
Revert
Move...
Rename... F2
Refresh F5
Makefile Project with Existing Code
C/C++ Project
STM32 Project
STM32 Project from an Existing STM32CubeMX Configuration File (.ioc)
Project...
Convert to a C/C++ Project (Adds C/C++ Nature)
Source Folder
Folder
Source File
Header File
File from Template
Class
Other...

```
/* USER CODE BEGIN PV */
#define BUFSIZE
```

STM32 Project

Target Selection

⚠ STM32 target or STM32Cube example selection is required

Commercial Part Number: STM32F407 — STM32F407G-DISC1

STM32F4DISCOVERY Discovery kit leverages the capabilities of the STM32F407 high-performance microcontrollers, to allow users to develop audio applications easily. It includes an ST-LINK/V2-A embedded debug tool, one ST-MEMS digital accelerometer, one digital microphone, one audio

Boards List: 1 item

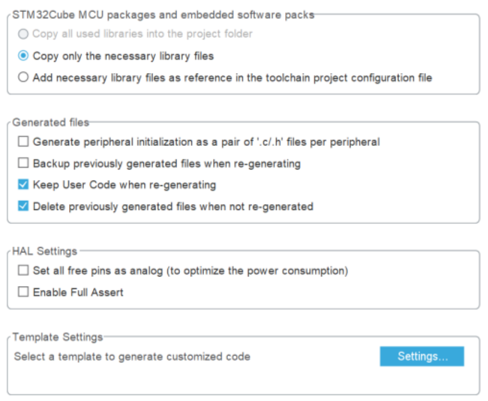
*	Overview	Commercial ...	T...	Marketi...	Unit Pri...	Mounte...
★		STM32F407G...	Di...	Active	19.89	STM32F40...

*	Overview	Commer...	Type	Marketin...	Unit Price...	Mounted ...
☆		STM32H7...	Discovery...	Active	87.0	STM32H750...

STM32F4

Osnovni projekt CubeIDE – CubeMX

Konfiguracija : priključki, knjižnice STM32F4

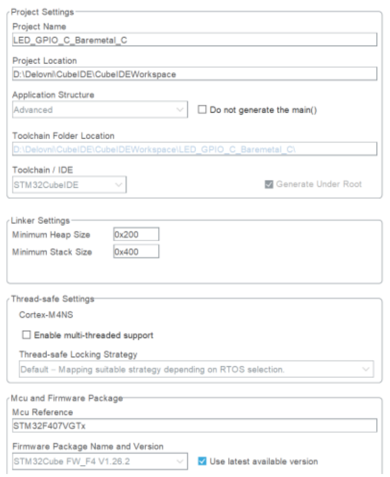


STM32Cube MCU packages and embedded software packs
- ○ Copy all used libraries into the project folder
- ● Copy only the necessary library files
- ○ Add necessary library files as reference in the toolchain project configuration file

Generated files
- ☐ Generate peripheral initialization as a pair of '.c/.h' files per peripheral
- ☐ Backup previously generated files when re-generating
- ☑ Keep User Code when re-generating
- ☑ Delete previously generated files when not re-generated

HAL Settings
- ☐ Set all free pins as analog (to optimize the power consumption)
- ☐ Enable Full Assert

Template Settings
Select a template to generate customized code — Settings...

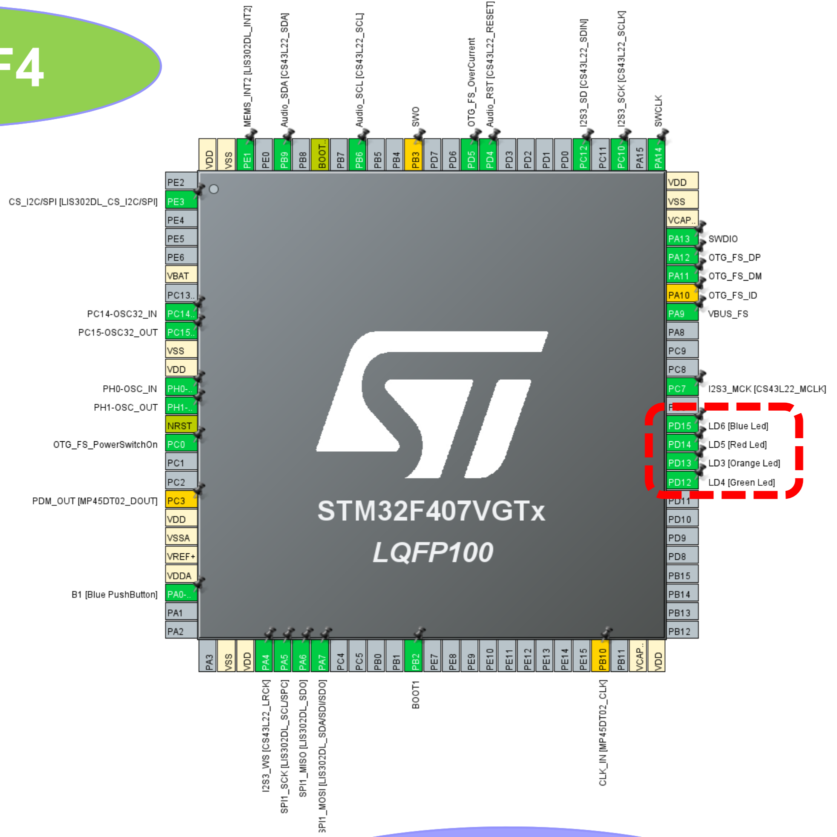


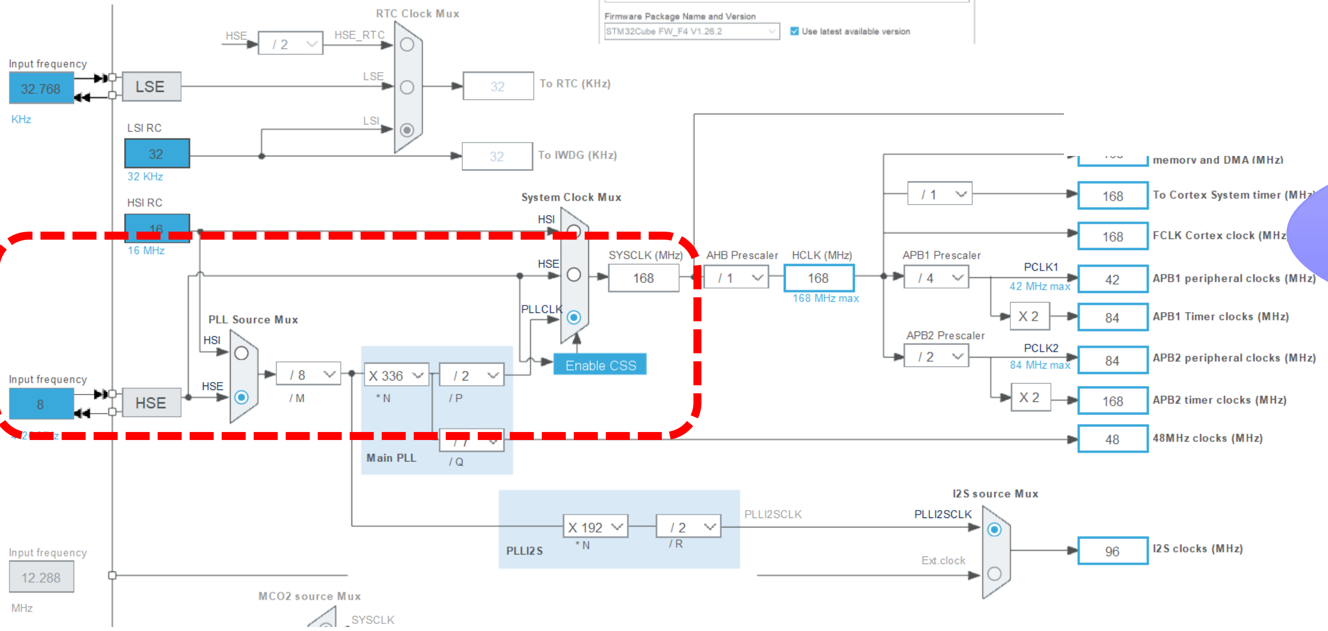
Project Settings
- Project Name: LED_GPIO_C_Baremetal_C
- Project Location: D:\Delovni\CubeIDE\CubeIDEWorkspace
- Application Structure: Advanced — ☐ Do not generate the main()
- Toolchain Folder Location: D:\Delovni\CubeIDE\CubeIDEWorkspace\LED_GPIO_C_Baremetal_C\
- Toolchain / IDE: STM32CubeIDE — ☑ Generate Under Root

Linker Settings
- Minimum Heap Size: 0x200
- Minimum Stack Size: 0x400

Thread-safe Settings
- Cortex-M4NS
- ☐ Enable multi-threaded support
- Thread-safe Locking Strategy: Default – Mapping suitable strategy depending on RTOS selection.

Mcu and Firmware Package
- Mcu Reference: STM32F407VGTx
- Firmware Package Name and Version: STM32Cube FW_F4 V1.26.2 — ☑ Use latest available version



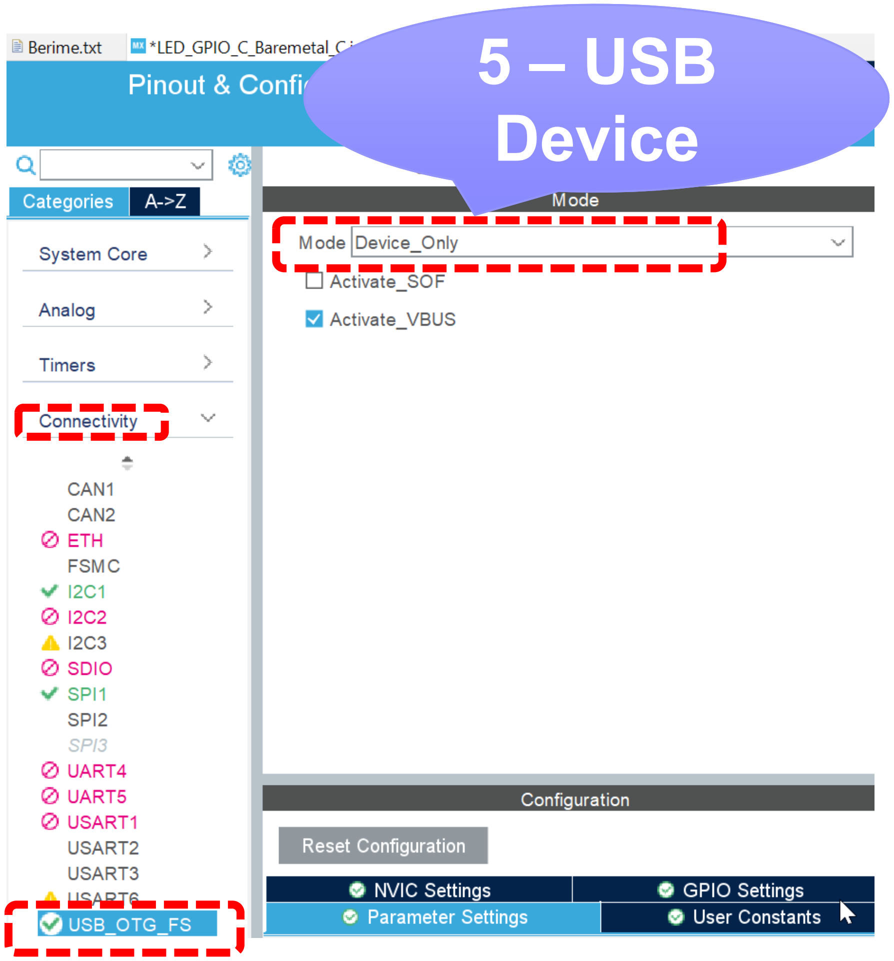


4 – Preveri nastavitve

STM32F4

Osnovni projekt CubeIDE – USB Virtual COM Port

Konfiguracija : USB Device,CDC Class = Virtual COM Port

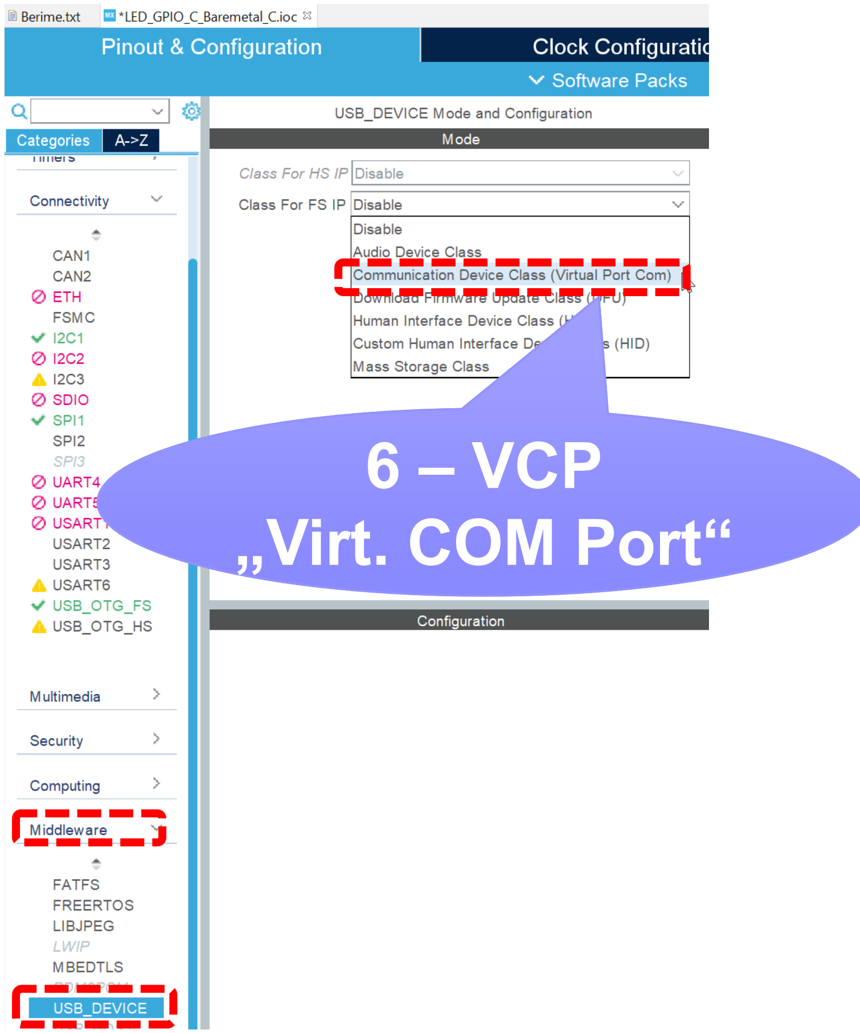


Mode

Mode Device_Only

☐ Activate_SOF

☑ Activate_VBUS



USB_DEVICE Mode and Configuration

Mode

Class For HS IP Disable

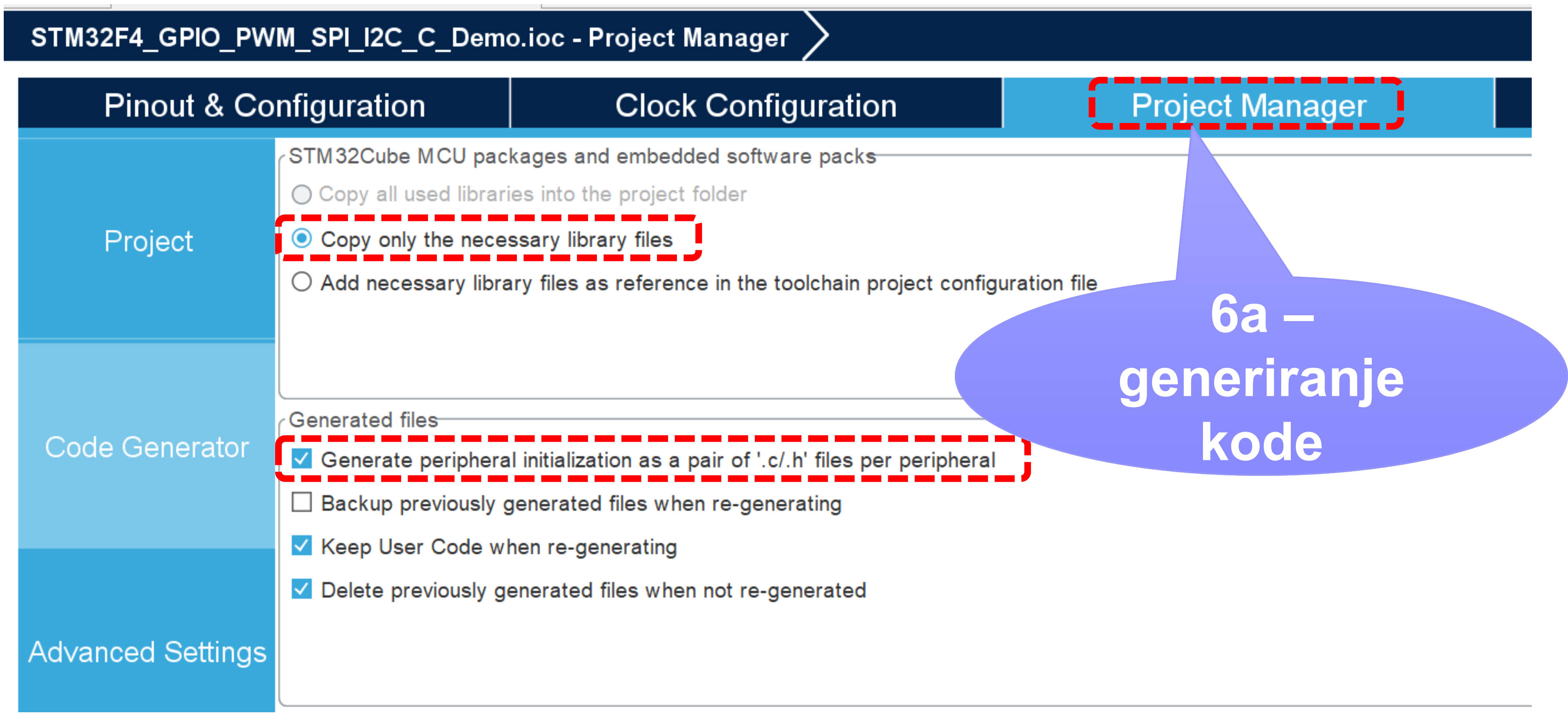
Class For FS IP Disable

- Disable
- Audio Device Class
- Communication Device Class (Virtual Port Com)
- Download Firmware Update Class (DFU)
- Human Interface Device Class (H
- Custom Human Interface De s (HID)
- Mass Storage Class

STM32F4

Osnovni projekt CubeIDE – USB Virtual COM Port

Konfiguracija : USB Device,CDC Class = Virtual COM Port



STM32F4_GPIO_PWM_SPI_I2C_C_Demo.ioc - Project Manager

STM32Cube MCU packages and embedded software packs

- Copy all used libraries into the project folder
- [✓ Copy only the necessary library files]
- Add necessary library files as reference in the toolchain project configuration file

Generated files

- ✓ Generate peripheral initialization as a pair of '.c/.h' files per peripheral
- ☐ Backup previously generated files when re-generating
- ✓ Keep User Code when re-generating
- ✓ Delete previously generated files when not re-generated

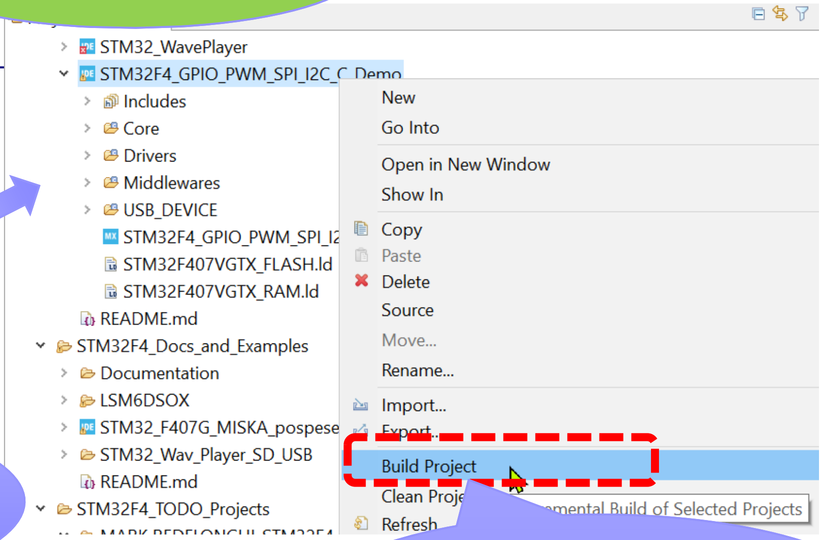
Osnovni projekt CubeIDE – USB Virtual COM Port

STM32F4

Program : za pošiljanje po USB Virtual COM Port

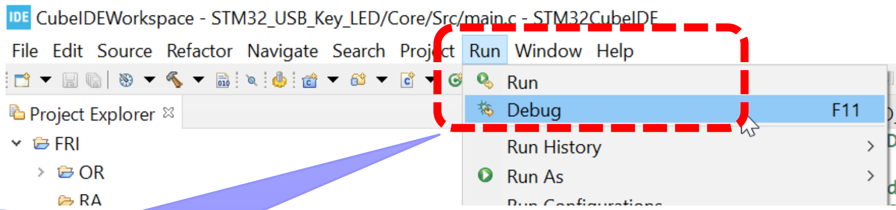
```
/* Private variables ------------*/

/* USER CODE BEGIN PV */
#define    BUFSIZE 256
char       SendBuffer[BUFSIZE];
int        Counter;
/* USER CODE END PV */
```

7 – USB VCP koda



8 – Build project

```
/* Infinite loop */
/* USER CODE BEGIN WHILE */
while (1)
{
        snprintf(SendBuffer,BUFSIZE,"Hello World [%d]\r\n",Counter++);
        CDC_Transmit_FS(SendBuffer,strlen(SendBuffer));
/* USER CODE END WHILE */

/* USER CODE BEGIN 3 */
        HAL_Delay(1000);
}
/* USER CODE END 3 */
```



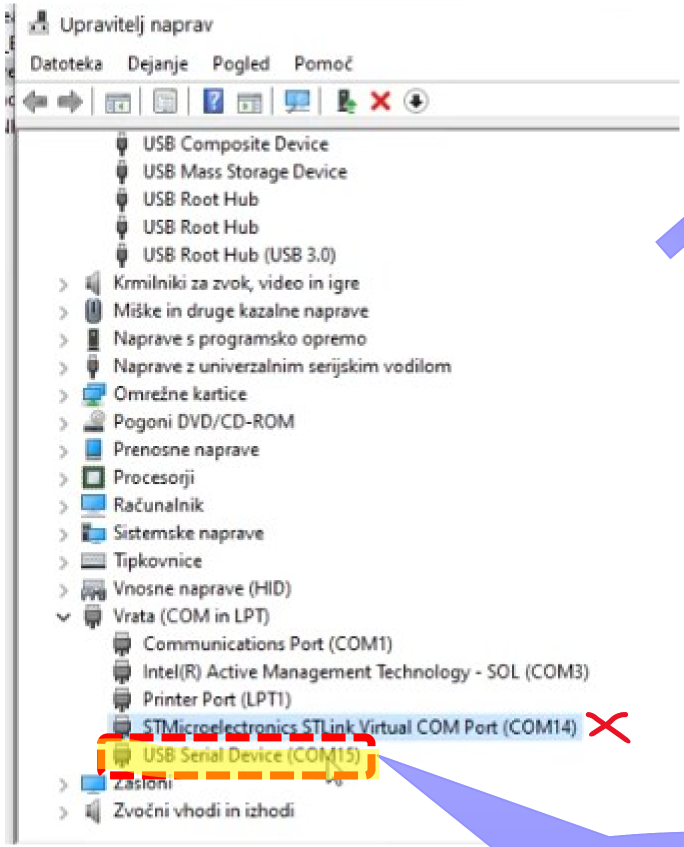
CubeIDEWorkspace - STM32_USB_Key_LED/Core/Src/main.c - STM32CubeIDE
File Edit Source Refactor Navigate Search Project Run Window Help
Project Explorer
FRI
OR
RA
Run
Debug F11
Run History
Run As

9 – Debug project

STM32F4

Osnovni projekt CubeIDE – USB Virtual COM Port

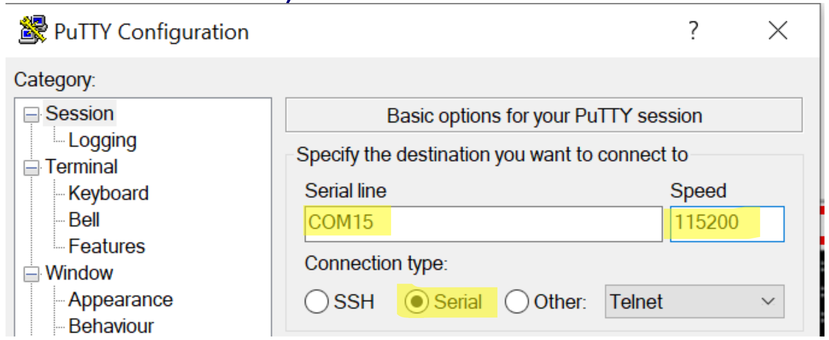
Program : sprejem na PC strani (povezava z Micro-USB kablom)



Upravitelj naprav

Datoteka Dejanje Pogled Pomoč

- USB Composite Device
- USB Mass Storage Device
- USB Root Hub
- USB Root Hub
- USB Root Hub (USB 3.0)
- Krmilniki za zvok, video in igre
- Miške in druge kazalne naprave
- Naprave s programsko opremo
- Naprave z univerzalnim serijskim vodilom
- Omrežne kartice
- Pogoni DVD/CD-ROM
- Prenosne naprave
- Procesorji
- Računalnik
- Sistemske naprave
- Tipkovnice
- Vnosne naprave (HID)
- Vrata (COM in LPT)
  - Communications Port (COM1)
  - Intel(R) Active Management Technology - SOL (COM3)
  - Printer Port (LPT1)
  - ~~STMicroelectronics STLink Virtual COM Port (COM14)~~
  - USB Serial Device (COM15)
- Zasloni
- Zvočni vhodi in izhodi



PuTTY Configuration

Category:

- Session
  - Logging
- Terminal
  - Keyboard
  - Bell
  - Features
- Window
  - Appearance
  - Behaviour

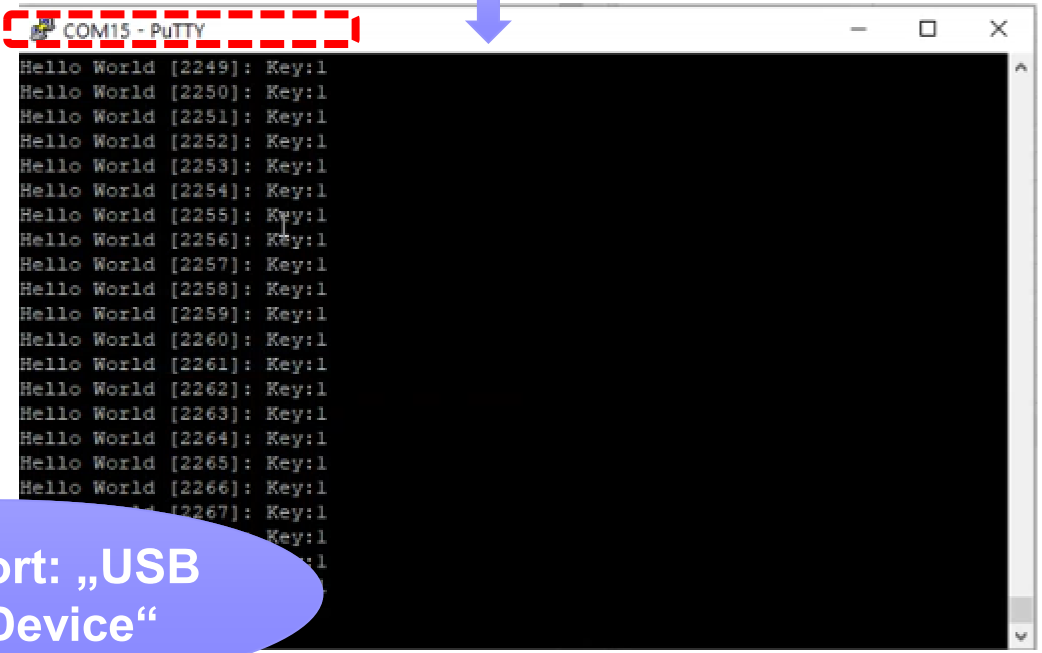
Basic options for your PuTTY session

Specify the destination you want to connect to

Serial line: COM15

Speed: 115200

Connection type: SSH [✓ Serial] Other: Telnet



COM15 - PuTTY

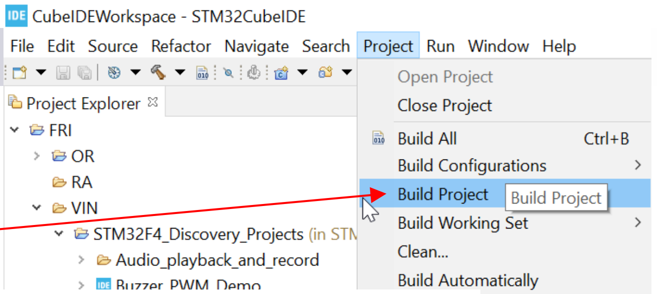
```
Hello World [2249]: Key:1
Hello World [2250]: Key:1
Hello World [2251]: Key:1
Hello World [2252]: Key:1
Hello World [2253]: Key:1
Hello World [2254]: Key:1
Hello World [2255]: Key:1
Hello World [2256]: Key:1
Hello World [2257]: Key:1
Hello World [2258]: Key:1
Hello World [2259]: Key:1
Hello World [2260]: Key:1
Hello World [2261]: Key:1
Hello World [2262]: Key:1
Hello World [2263]: Key:1
Hello World [2264]: Key:1
Hello World [2265]: Key:1
Hello World [2266]: Key:1
            [2267]: Key:1
                    Key:1
                      :1
```

VCOM port: „USB Serial Device“

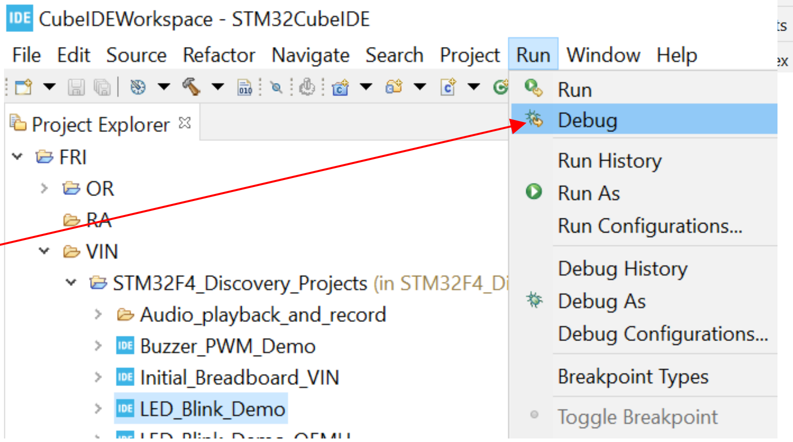
CubeIDE – Zagon, debug

Prevajanje, zagon :

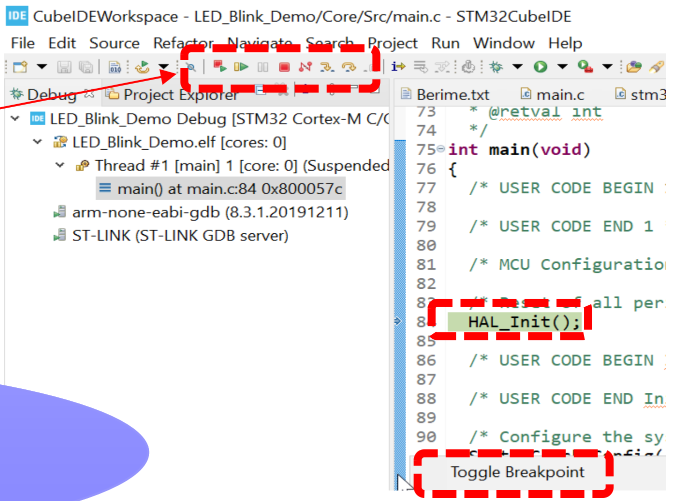
- Project -> Build Project



- Run -> Debug



- Step (Into,Over), Breakpoints

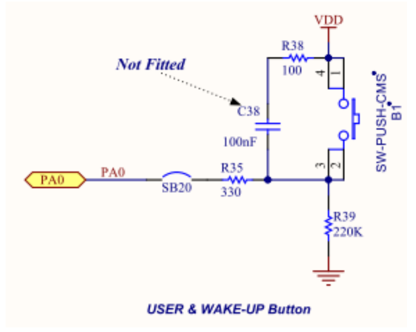

CubeIDEWorkspace - LED_Blink_Demo/Core/Src/main.c - STM32CubeIDE
File Edit Source Refactor Navigate Search Project Run Window Help
Debug
Project Explorer
Berime.txt
main.c
stm3
Toggle Breakpoint

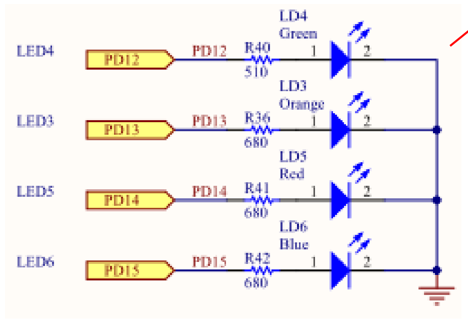
```
LED_Blink_Demo Debug [STM32 Cortex-M C/C
  LED_Blink_Demo.elf [cores: 0]
    Thread #1 [main] 1 [core: 0] (Suspended
      main() at main.c:84 0x800057c
  arm-none-eabi-gdb (8.3.1.20191211)
  ST-LINK (ST-LINK GDB server)
```

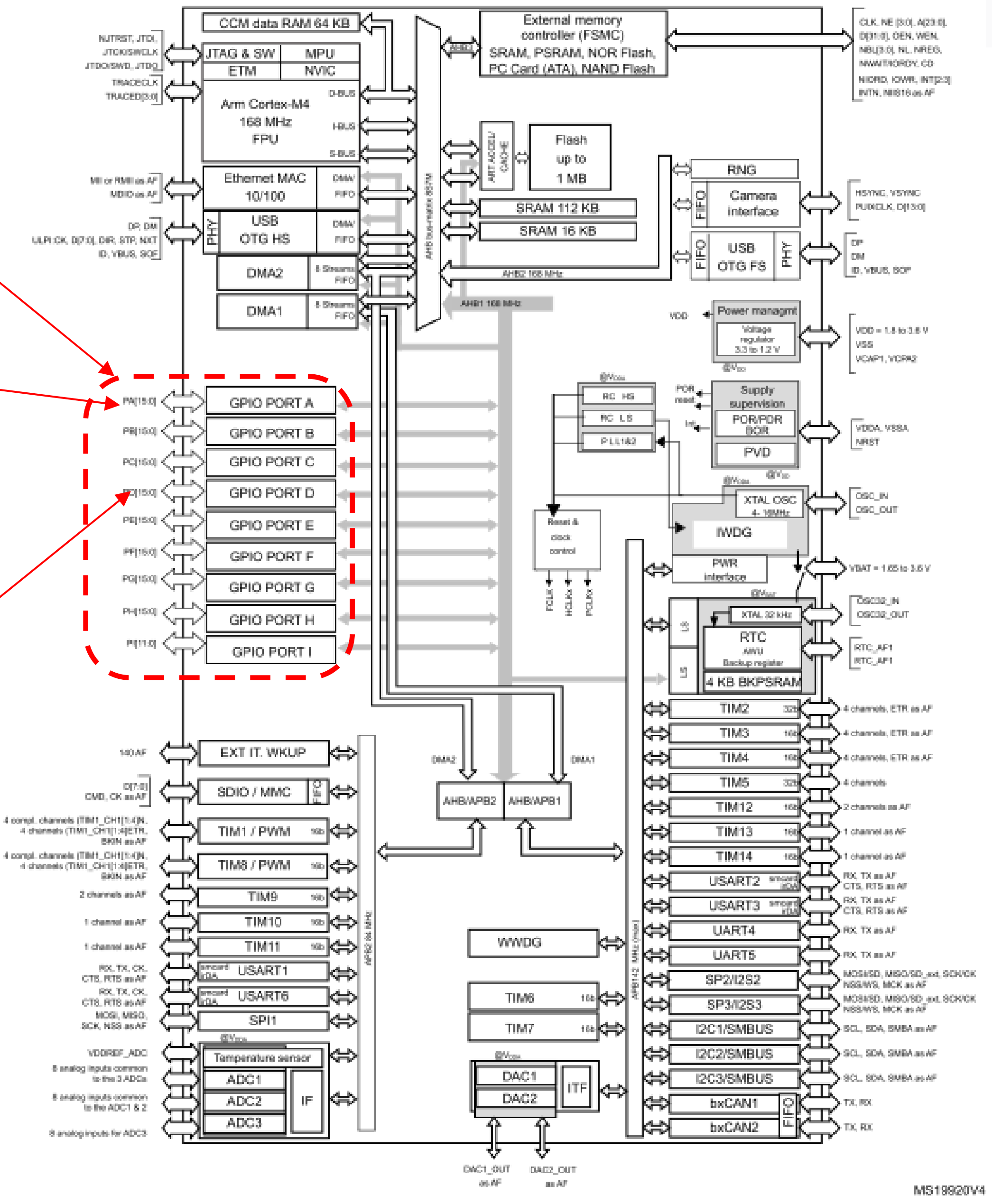
```c
  * @retval int
  */
int main(void)
{
  /* USER CODE BEGIN

  /* USER CODE END 1

  /* MCU Configuratio

  /* Reset of all per
  HAL_Init();

  /* USER CODE BEGIN

  /* USER CODE END In

  /* Configure the sy
```

Build <->Debug project, …

GPIO Krmilnik

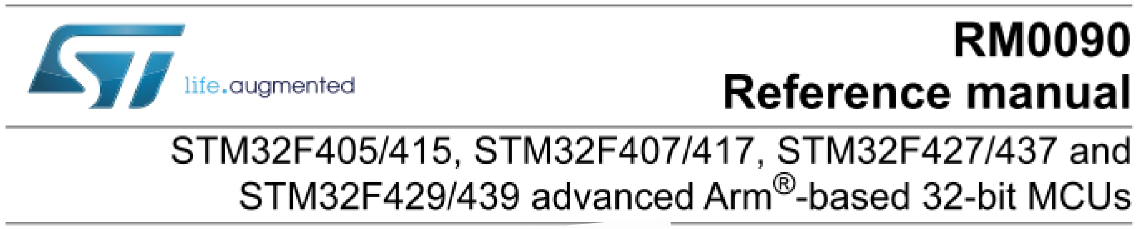






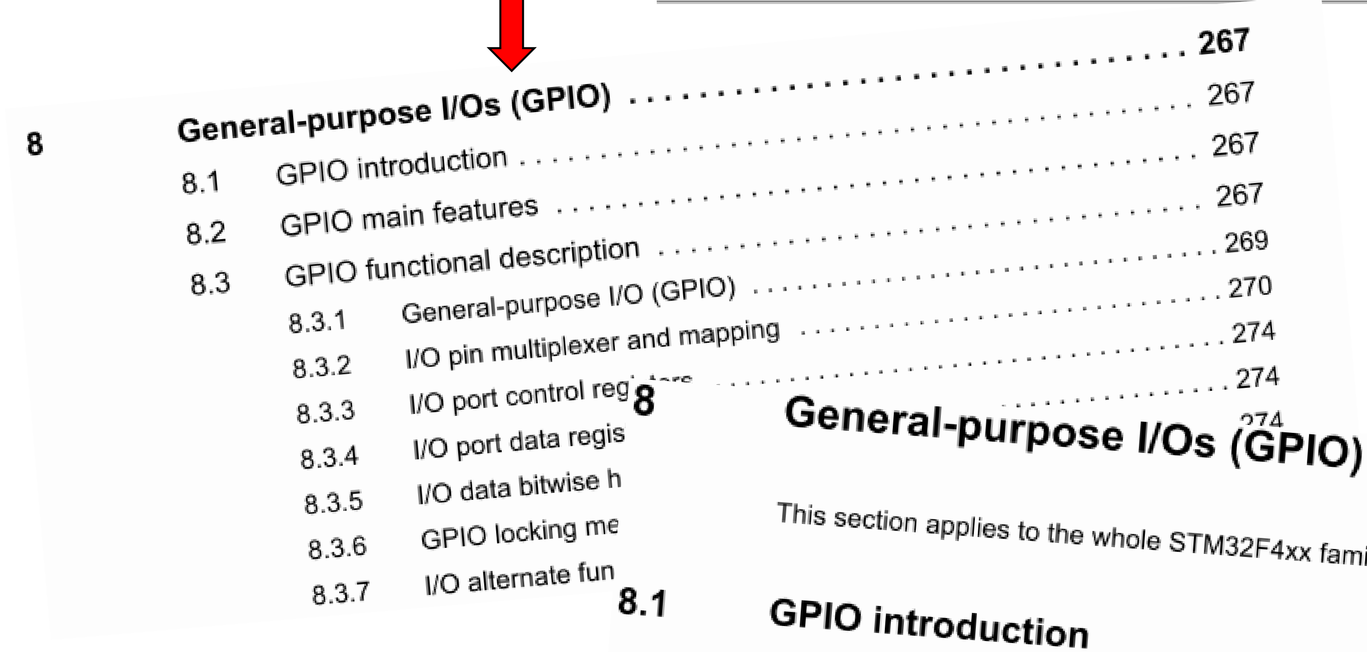
STM32F4

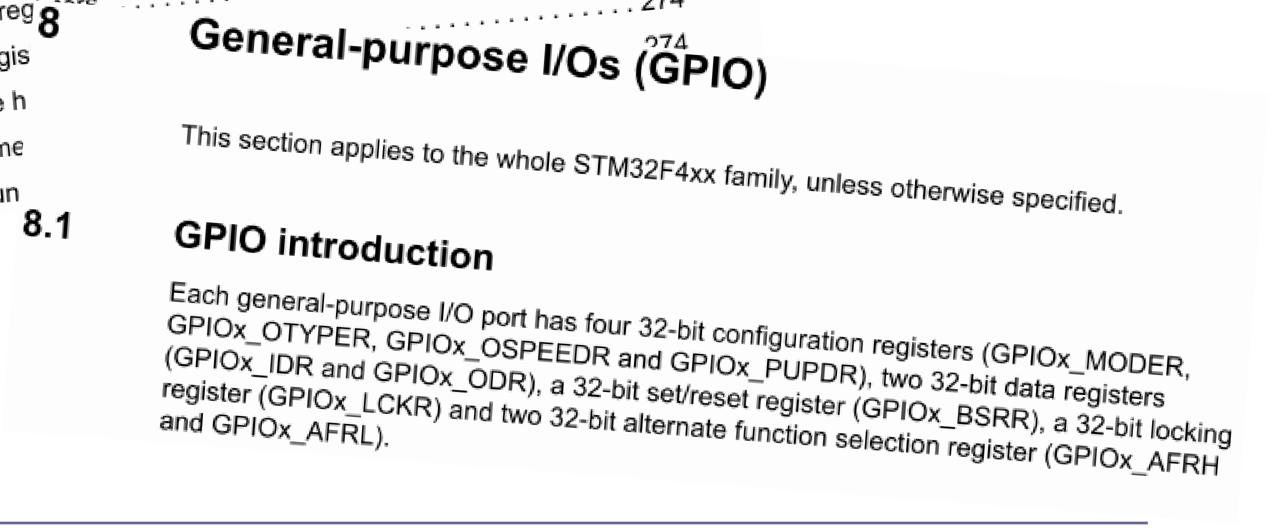
Vir: RM0090 Reference manual



RM0090
Reference manual

STM32F405/415, STM32F407/417, STM32F427/437 and STM32F429/439 advanced Arm®-based 32-bit MCUs





8 General-purpose I/Os (GPIO)

This section applies to the whole STM32F4xx family, unless otherwise specified.

8.1 GPIO introduction

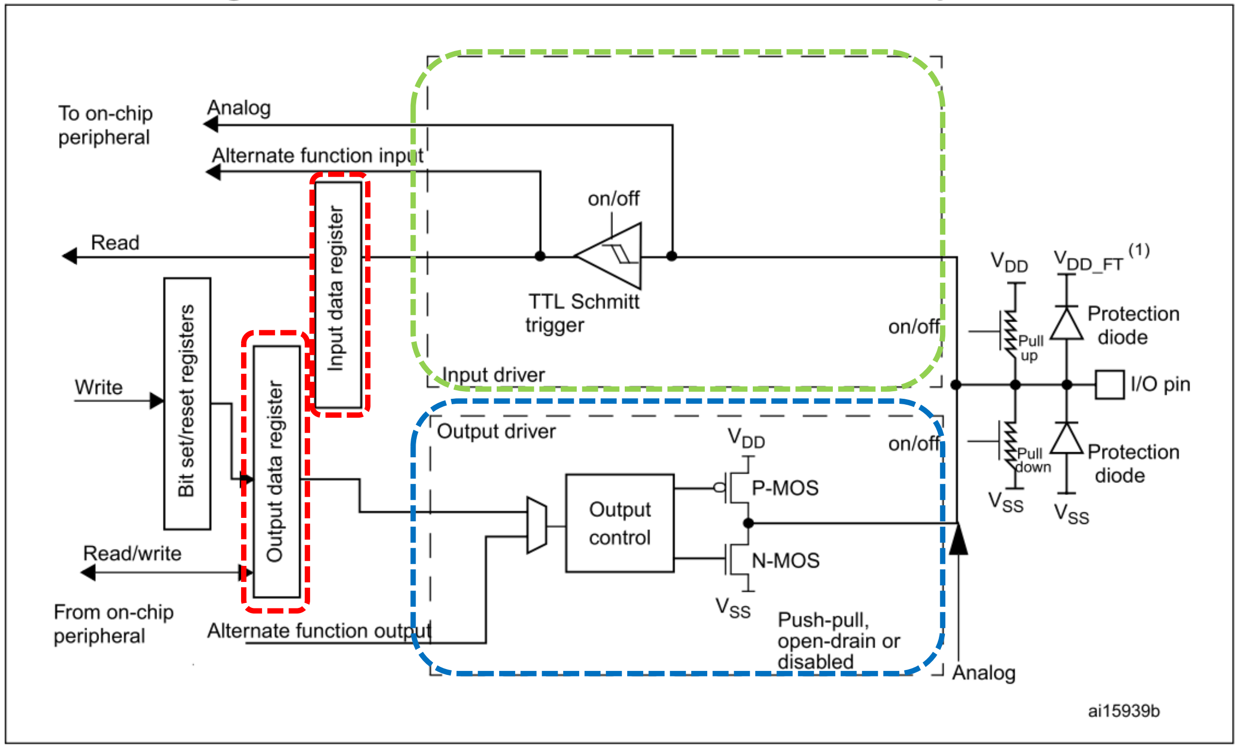
Each general-purpose I/O port has four 32-bit configuration registers (GPIOx_MODER, GPIOx_OTYPER, GPIOx_OSPEEDR and GPIOx_PUPDR), two 32-bit data registers (GPIOx_IDR and GPIOx_ODR), a 32-bit set/reset register (GPIOx_BSRR), a 32-bit locking register (GPIOx_LCKR) and two 32-bit alternate function selection register (GPIOx_AFRH and GPIOx_AFRL).

STM32F4

STM32F4

GPIO krmilnik – vhod/izhod

Figure 25. Basic structure of a five-volt tolerant I/O port bit



Potrebni koraki za krmiljenje izhoda:

1. RCC_AHB1ENR(Peripheral Clock Register): b_3=1 .. Port D Enable
2. **MODER (Mode Register): 01: General purpose output mode**
3. Default vrednosti že ustrezne v registrih :
   OTYPER (Output TYPE Register): 0: Output push-pull (reset state)
   OSPEEDR (Output SPEED Register): 00 – Low speed (reset state)
   PUPDR (Pull Up/Down Register): 00 – No pull (reset state)
4. določi stanje izhoda s pisanjem v ODR ali BSRR (nastavljamo na 1/0)

STM32F4

Osnovni projekt CubeIDE – GPIO – različni mogoči nivoji programiranja

Baremetal - zbirnik

```
INIT_IO:
  push {r5, r6, lr}
    // Enable GPIOD Peripheral Clock (bit 3 in AHB1ENR register)
    ldr r6, = RCC_AHB1ENR       // Load peripheral clock reg address to r6
    ldr r5, [r6]                // Read its content to r5
    orr r5, 0x00000008          // Set bit 3 to enable GPIOD clock
    str r5, [r6]                // Store result in peripheral clock register

    // Make GPIOD Pin12 as output pin (bits 25:24 in MODER register)
    ldr r6, =GPIOD_BASE       // Load GPIOD BASE address to r6
    ldr r5, [r6,#GPIOD_MODER]  // Read GPIOD_MODER content to r5
    and r5, 0x00FFFFFF          // Clear bits 31-24 for P12-15
    orr r5, 0x55000000          // Write 01 to bits 31-24 for P12-15
    str r5, [r6]                // Store result in GPIOD MODER register
  pop {r5, r6, pc}


LED_ON:
    push {r5, r6, lr}
    // Set GPIOD Pins to 1 (through BSSR register)
    ldr    r6, =GPIOD_BASE       // Load GPIOD BASE address to r6
    mov    r5, #LEDs_ON
    str    r5, [r6,#GPIOD_BSSR] // Write to BSRR register
    pop {r5, r6, pc}

LED_OFF:
    push {r5, r6, lr}
    // Set GPIOD Pins to 0 (through BSSR register)
    ldr    r6, =GPIOD_BASE       // Load GPIOD BASE address to r6
    mov    r5, #LEDs_OFF
    str    r5, [r6,#GPIOD_BSSR] // Write to BSRR register
    pop {r5, r6, pc}
```

https://github.com/LAPSyLAB/ORLab-STM32/tree/main/GPIO_LEDs

Baremetal - C

```
  /* USER CODE BEGIN 2 */


  RCC->AHB1ENR |= 0x08;
// Enable clock for GPIOD
  GPIOD->MODER |= 0x01000000;        //
MODE Register: bit 12 == out

  /* USER CODE END 2 */

  /* Infinite loop */
  /* USER CODE BEGIN WHILE */
  while (1)
  {
    GPIOD->ODR ^= 0x1000;            //
Toggle PD12

/* USER CODE END WHILE */

    /* USER CODE BEGIN 3 */
    for (int i=0; i<0x1000000; i++) {};
// waste some time
  }
  /* USER CODE END 3 */
```

https://github.com/LAPSyLAB/STM32F4_Discovery_VIN_Projects/tree/main/LED_GPIO_C_Baremetal_C

HAL - C

```
/* Infinite loop */
 /* USER CODE BEGIN WHILE */
 while (1)
 {

HAL_GPIO_TogglePin(GPIOD, GPIO_PIN_12);

   /* USER CODE END WHILE */

    /* USER CODE BEGIN 3 */
 HAL_Delay(1000);
 }
 /* USER CODE END 3 */


void HAL_GPIO_TogglePin(GPIO_TypeDef* GPIOx,
uint16_t GPIO_Pin)
{
  uint32_t odr;

  /* Check the parameters */
  assert_param(IS_GPIO_PIN(GPIO_Pin));

  /* get current Ouput Data Register value
*/
  odr = GPIOx->ODR;

  /* Set selected pins that were at low
level, and reset ones that were high */
  GPIOx->BSRR = ((odr & GPIO_Pin) <<
GPIO_NUMBER) | (~odr & GPIO_Pin);
}
```

https://github.com/LAPSyLAB/STM32F4_Discovery_VIN_Projects/tree/main/LED_Blink_Demo

Potrebni koraki za krmiljenje izhoda:

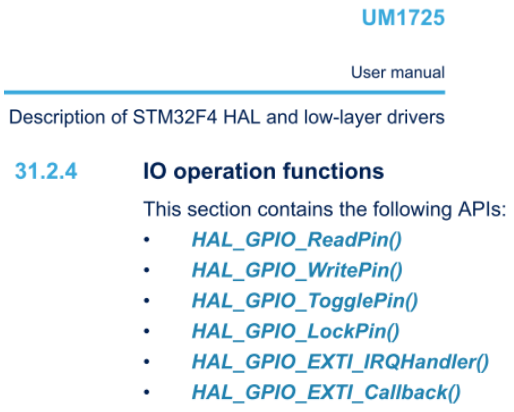
1. RCC_AHB1ENR(Peripheral Clock Register): b_3=1 .. Port D Enable
2. **MODER (Mode Register): 01: General purpose output mode**
3. Default vrednosti že ustrezne v registrih :
   OTYPER (Output TYPE Register): 0: Output push-pull (reset state)
   OSPEEDR (Output SPEED Register): 00 – Low speed (reset state)
   PUPDR (Pull Up/Down Register): 00 – No pull (reset state)
4. določi stanje izhoda s pisanjem v ODR ali BSRR (nastavljamo na 1/0)

STM32F4

Osnovni projekt CubeIDE – GPIO – tipka, LED diode

HAL - C

```c
/* USER CODE BEGIN PV */
#define BUFSIZE 256
char SendBuffer[BUFSIZE];
int Counter;
int KeyState=0;

/* USER CODE END PV */




/* Infinite loop */
 /* USER CODE BEGIN WHILE */
 while (1)
 {

        HAL_GPIO_TogglePin(GPIOD, GPIO_PIN_12);
        HAL_GPIO_TogglePin(GPIOD, GPIO_PIN_13);
        HAL_GPIO_TogglePin(GPIOD, GPIO_PIN_14);

        KeyState = HAL_GPIO_ReadPin(GPIOA, GPIO_PIN_0);
        HAL_GPIO_WritePin(GPIOD, GPIO_PIN_15, KeyState);


         snprintf(SendBuffer,BUFSIZE,"Hello World [%d]: Key:%d\r\n",Counter++,KeyState);
         CDC_Transmit_FS(SendBuffer,strlen(SendBuffer));

   /* USER CODE END WHILE */

   /* USER CODE BEGIN 3 */
 HAL_Delay(1000);
 }
 /* USER CODE END 3 */
```


UM1725

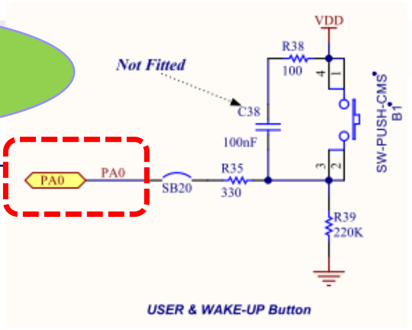
User manual

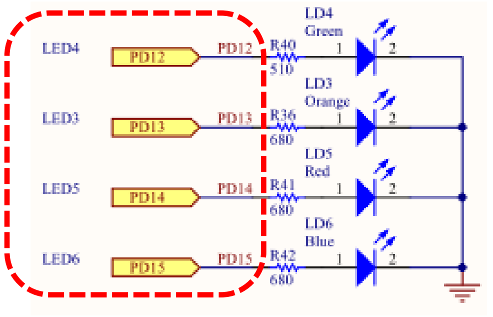
Description of STM32F4 HAL and low-layer drivers

31.2.4 **IO operation functions**

This section contains the following APIs:

- *HAL_GPIO_ReadPin()*
- *HAL_GPIO_WritePin()*
- *HAL_GPIO_TogglePin()*
- *HAL_GPIO_LockPin()*
- *HAL_GPIO_EXTI_IRQHandler()*
- *HAL_GPIO_EXTI_Callback()*





https://github.com/LAPSyLAB/STM32F4_Discovery_VIN_Projects/tree/main/STM32_USB_Key_LED

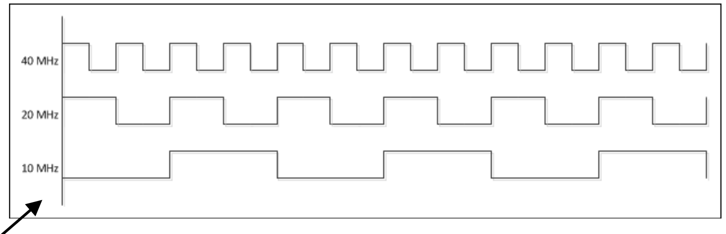
VIN projekt - VP6: STM32F4 VIN Demo

- Osvežitev: STM32F4

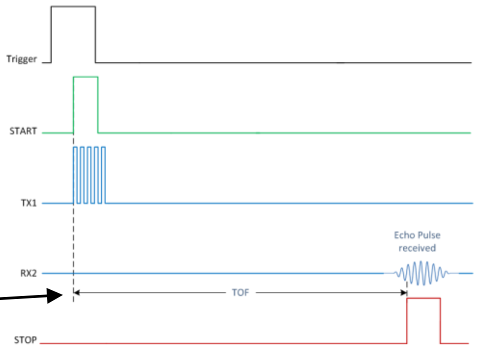
- CubeIDE projekt STM32F4 in V/I naprave :
  - CubeIDE projekt, GPIO in VCOM port
  - PWM - LED dimmer, brenčač
  - SPI - LIS3DSH pospeškomer
  - I2C - CS43L22 zvočni čip
  - ADC

- Sledenje („tracing“) - CubeMonitor, osciloskop

Timer - Counter (časovnik - števec)

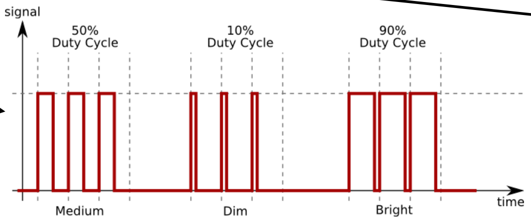


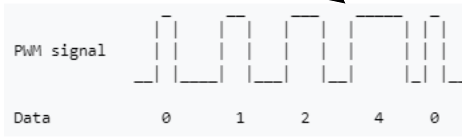
- Običajno več enakovrednih kanalov
- Uporabni za
  - štetje dogodkov (Capture)
  - tvorjenje časovnih signalov (Waveform)
  - zakasnitve (DELAY s časovnikom !)
  - merjenje intervalov
  - periodične prekinitve
  - tvorba signalov s pulzno širinsko modulacijo (PWM)

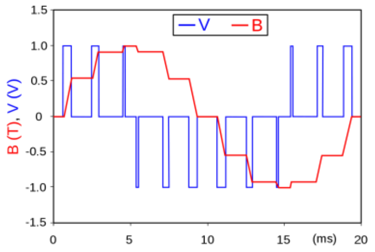


Variacije „Duty Cycle“:

- LED „dimmer“
- krmiljenje hitrosti motorjev
- „enostavni“ DAC – povprečje
- kodiranje podatkov

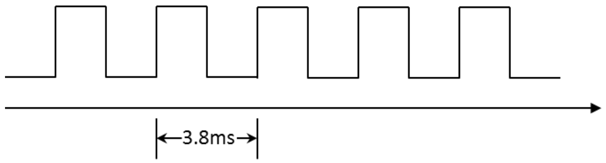






Variacije periode:

- krmiljenje servo motorjev
- približek sinusnih tonov (50% duty)
  - primer: nota C2 = 262Hz, perioda T=1/262=3.8ms
  - izhod: brenčač



STM32F4 – PWM signali za LED diode (LED dimmer)

HAL - C

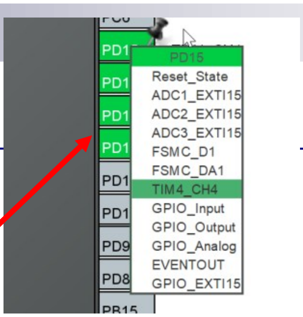
STM32F4

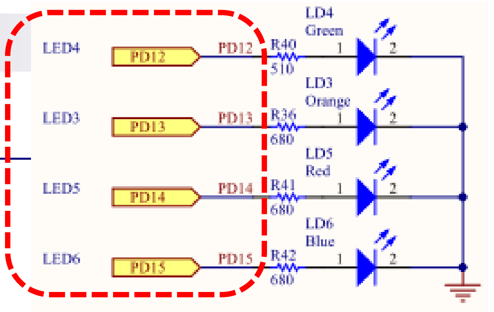
CubeMX :

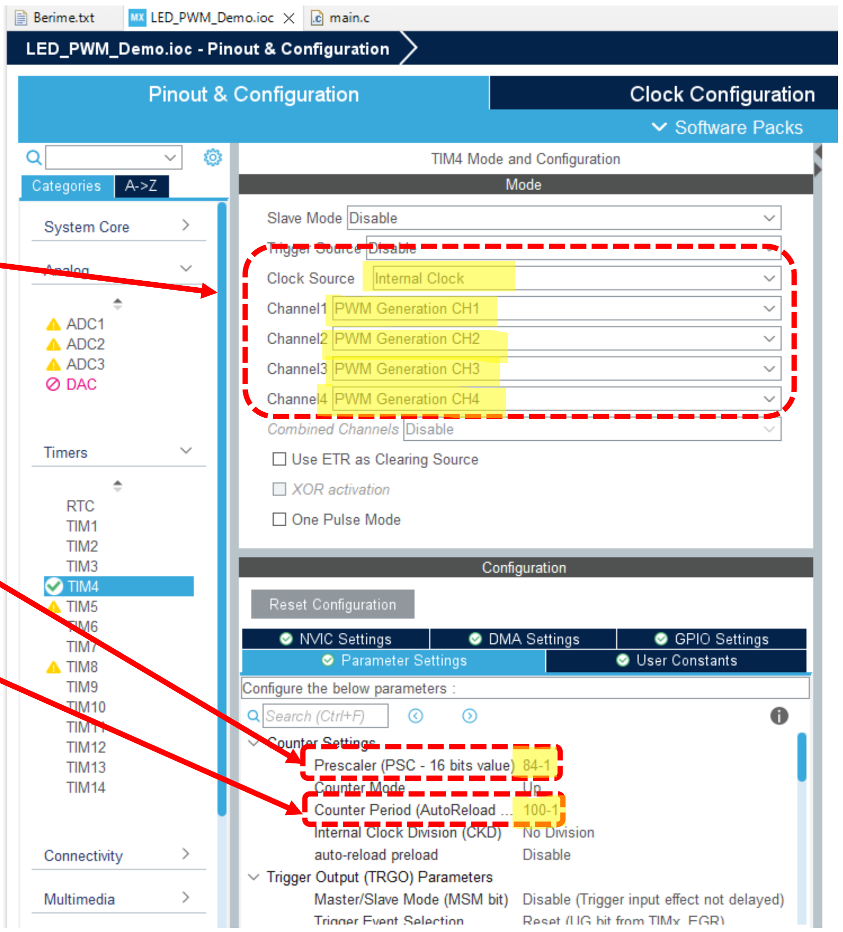
1. New project -> STM32 Project -> Board -> 407DISC1
2. CubeMX: Spremeniti USB Host v USB Device :
   Connectivity -> USB_OTG_FS -> Mode v Device Only
   Middleware -> DEVICE_USB in Class Virtual Com Port

3. Spremeniti pine PD12-PD15 (LED diode) v TIM4_CH1-4
   tim4 Vse kanale spremeniti na PWM Generation CH1-4

4. Clock :
   Ura števca = 1 MHz
      Prescaler (PSC - 16 bits value) = 84-1 = 83 (clock 1Mhz)
      (PSC - 16 bits value) must be between 0 and 65 535
   Perioda štetja je 100 (duty cycle pa lahko 0-100)
      Counter Period = 100-1 = 99
      (AutoReload Register - 16 bits value)






Berime.txt | LED_PWM_Demo.ioc | main.c

LED_PWM_Demo.ioc - Pinout & Configuration

Pinout & Configuration | Clock Configuration | Software Packs

Categories | A->Z

System Core, Analog (ADC1, ADC2, ADC3, DAC), Timers (RTC, TIM1, TIM2, TIM3, TIM4, TIM5, TIM6, TIM7, TIM8, TIM9, TIM10, TIM11, TIM12, TIM13, TIM14), Connectivity, Multimedia

TIM4 Mode and Configuration

Mode

Slave Mode: Disable
Trigger Source: Disable
Clock Source: Internal Clock
Channel1: PWM Generation CH1
Channel2: PWM Generation CH2
Channel3: PWM Generation CH3
Channel4: PWM Generation CH4
Combined Channels: Disable
☐ Use ETR as Clearing Source
☐ XOR activation
☐ One Pulse Mode

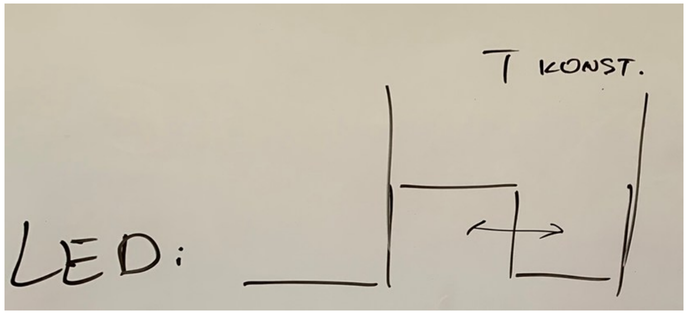
Configuration

Reset Configuration

NVIC Settings | DMA Settings | GPIO Settings | Parameter Settings | User Constants

Configure the below parameters :

Counter Settings
Prescaler (PSC - 16 bits value): 84-1
Counter Mode: Up
Counter Period (AutoReload ...: 100-1
Internal Clock Division (CKD): No Division
auto-reload preload: Disable
Trigger Output (TRGO) Parameters
Master/Slave Mode (MSM bit): Disable (Trigger input effect not delayed)
Trigger Event Selection: Reset (UG bit from TIMx_EGR)



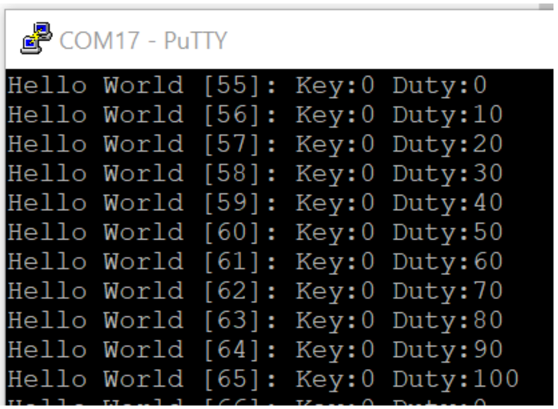
STM32F4

Osnovni projekt CubeIDE – GPIO – PWM, LED diode HAL - C

```
/* USER CODE BEGIN PV */
#define BUFSIZE 256
char SendBuffer[BUFSIZE];
int Counter;
int KeyState=0;
int Duty=0;
/* USER CODE END PV */

/* USER CODE BEGIN 2 */

  HAL_TIM_PWM_Start(&htim4, TIM_CHANNEL_1);
  HAL_TIM_PWM_Start(&htim4, TIM_CHANNEL_2);
  HAL_TIM_PWM_Start(&htim4, TIM_CHANNEL_3);
  HAL_TIM_PWM_Start(&htim4, TIM_CHANNEL_4);

/* USER CODE END 2 */
/* Infinite loop */
 /* USER CODE BEGIN WHILE */
 while (1)
 {
       htim4.Instance->CCR1 = Duty;
       htim4.Instance->CCR2 = 100-Duty;
       htim4.Instance->CCR3 = Duty;
       htim4.Instance->CCR4 = 100-Duty;


       KeyState = HAL_GPIO_ReadPin(GPIOA, GPIO_PIN_0);


       snprintf(SendBuffer,BUFSIZE,"Hello World [%d]: Key:%d Duty:%d\r\n",Counter++,KeyState,Duty);
       CDC_Transmit_FS(SendBuffer,strlen(SendBuffer));
       /* USER CODE END WHILE */

   /* USER CODE BEGIN 3 */
       Duty = (Duty + 10) ;
       if (Duty > 100 )
       Duty = 0;

       HAL_Delay(1000);
 }
 /* USER CODE END 3 */
```

CubeMX :

1. New project -> STM32 Project -> Board -> 407DISC1
2. CubeMX: Spremeniti USB Host v USB Device :
   - Connectivity -> USB_OTG_FS -> Mode v Device Only
   - Middleware -> DEVICE_USB in Class Virtual Com Port
3. Spremeniti pine PD12-PD15 (LED diode) v TIM4_CH1-4
   - tim4 Vse kanale spremeniti na PWM Generation CH1-4
4. Clock :
   - Ura števca = 1 MHz
     - Prescaler (PSC - 16 bits value) = 84-1 = 83 (clock 1Mhz)
     - (PSC - 16 bits value) must be between 0 and 65 535
   - Perioda štetja je 100 (duty cycle pa lahko 0-100)
     - Counter Period = 100-1 = 99
     - (AutoReload Register - 16 bits value)


COM17 - PuTTY

```
Hello World [55]: Key:0 Duty:0
Hello World [56]: Key:0 Duty:10
Hello World [57]: Key:0 Duty:20
Hello World [58]: Key:0 Duty:30
Hello World [59]: Key:0 Duty:40
Hello World [60]: Key:0 Duty:50
Hello World [61]: Key:0 Duty:60
Hello World [62]: Key:0 Duty:70
Hello World [63]: Key:0 Duty:80
Hello World [64]: Key:0 Duty:90
Hello World [65]: Key:0 Duty:100
```

https://github.com/LAPSyLAB/STM32F4_Discovery_VIN_Projects/tree/main/LED_PWM_Demo

STM32F4

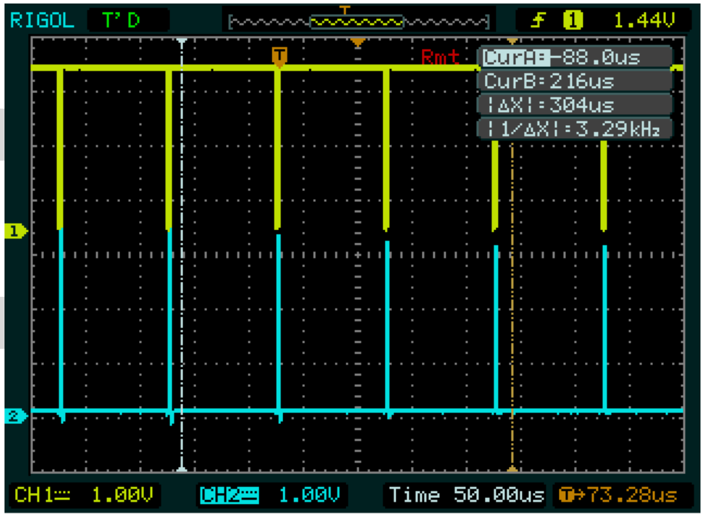
Osnovni projekt CubeIDE – GPIO – PWM, LED diode

HAL - C

```
 /* USER CODE BEGIN PV */
 #define BUFSIZE 256
 char SendBuffer[BUFSIZE];
 int Counter;
 int KeyState=0;
 int Duty=0;
 /* USER CODE END PV */
  /* USER CODE BEGIN 2 */

  HAL_TIM_PWM_Start(&htim4, TIM_CHANNEL_1);
  HAL_TIM_PWM_Start(&htim4, TIM_CHANNEL_2);
  HAL_TIM_PWM_Start(&htim4, TIM_CHANNEL_3);
  HAL_TIM_PWM_Start(&htim4, TIM_CHANNEL_4);

  /* USER CODE END 2 */
/* Infinite loop */
 /* USER CODE BEGIN WHILE */
 while (1)
 {
        htim4.Instance->CCR1 = Duty;
        htim4.Instance->CCR2 = 100-Duty;
        htim4.Instance->CCR3 = Duty;
        htim4.Instance->CCR4 = 100-Duty;


        KeyState = HAL_GPIO_ReadPin(GPIOA, GPIO_PIN_0);


        snprintf(SendBuffer,BUFSIZE,"Hello World [%d]: Key:%d Duty:%d\r\n",Counter++,KeyState,Duty);
        CDC_Transmit_FS(SendBuffer,strlen(SendBuffer));
        /* USER CODE END WHILE */

   /* USER CODE BEGIN 3 */
        Duty = (Duty + 10) ;
        if (Duty > 100 )
        Duty = 0;

        HAL_Delay(1000);
 }
 /* USER CODE END 3 */
```

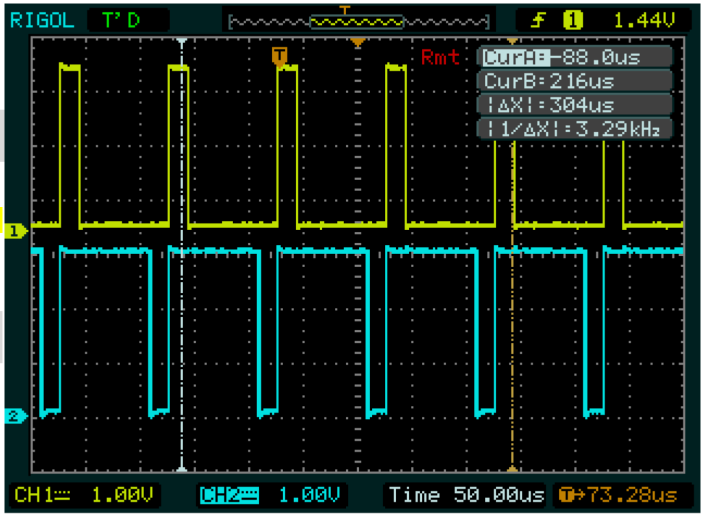
Max Duty

Min Duty



Min Duty

Max Duty



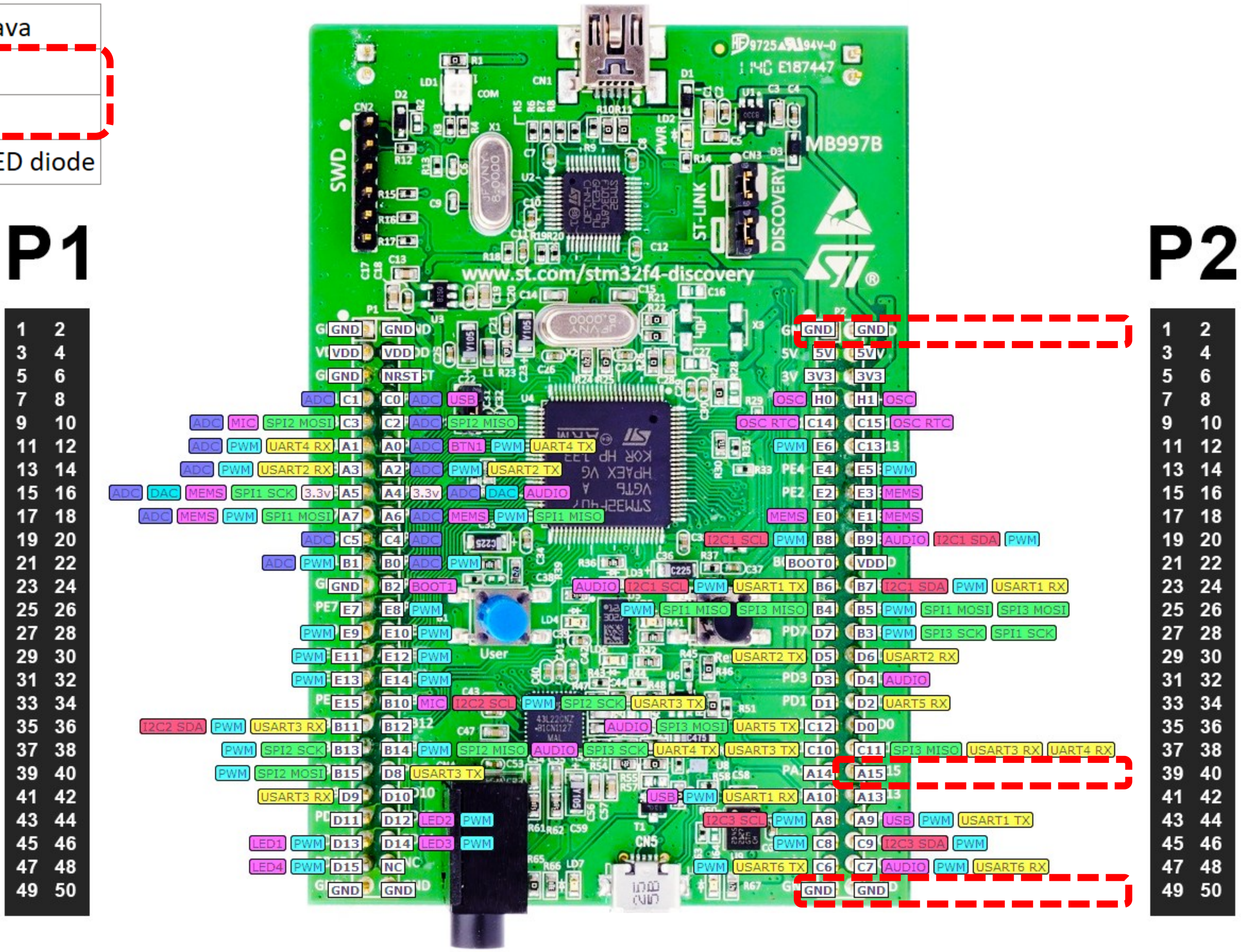
https://github.com/LAPSyLAB/STM32F4_Discovery_VIN_Projects/tree/main/LED_PWM_Demo

Vezava brenčača

Priključitev na STM32 : 1 x PWM izhod za brenčač (PA15), 1 x GND

Testno vezje (primer) :

GPIO	Vrsta	Povezava
PA15	Brencac	+
GND	Brencac	-
PD12-PD15	Dig. Izhodi	vgr. LED diode



STM32F4 – PWM signali/melodija za brenčača (Buzzer)

HAL - C

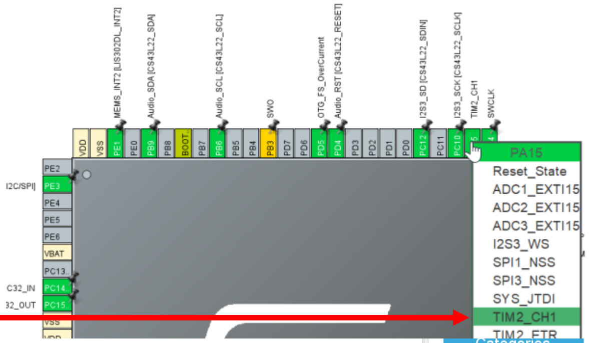
Brencac se prikljuci na **PA15 (TIM2->CH1) in GND**

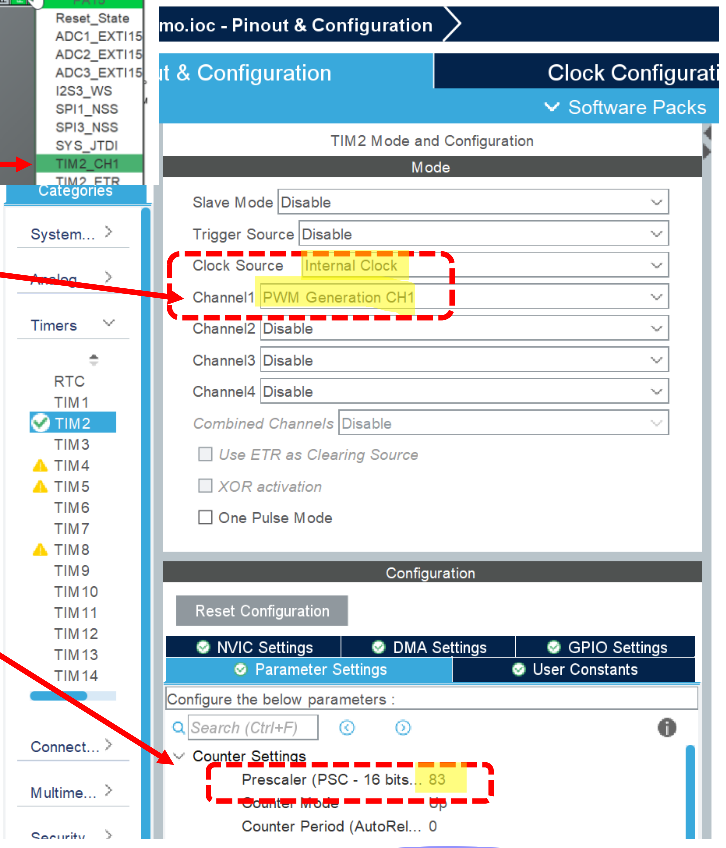
CubeMX :
1. New project -> STM32 Project -> Board -> 407DISC1
2. CubeMX: Spremeniti USB Host v USB Device :
Connectivity -> USB_OTG_FS -> Mode v Device Only
Middleware -> DEVICE_USB in Class Virtual Com Port

3. Spremeniti pin PA15 v TIM2->CH1
tim2 kanal 1 spremeniti na PWM Generation CH1

4. Clock :
Ura števca = 1 MHz
Prescaler (PSC - 16 bits value) = **84-1 = 83 (clock 1Mhz)**
Perioda štetja se bo določala glede na noto (duty cycle je vedno 50%)
Counter Period (AutoReload Register - 16 bits value)
ARR = 1000000 (ura števca) / Frekv.note[Hz]
CCR1 bo vedno ARR/2 (50% duty cycle)

Več informacij : BeriMe.txt





TIM2 Mode and Configuration

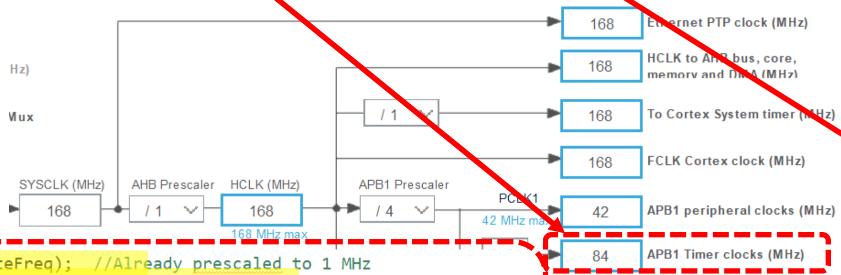
Mode

Slave Mode Disable
Trigger Source Disable
Clock Source Internal Clock
Channel1 PWM Generation CH1
Channel2 Disable
Channel3 Disable
Channel4 Disable
Combined Channels Disable
☐ Use ETR as Clearing Source
☐ XOR activation
☐ One Pulse Mode

Configuration

Configure the below parameters :

Counter Settings
Prescaler (PSC - 16 bits... 83
Counter Mode Up
Counter Period (AutoRel... 0



Nota:

```
ARR_period = (int)(1000000/NoteFreq);  //Already prescaled to 1 MHz
setPWM(htim2, TIM_CHANNEL_1, ARR_period, ARR_period/2);

Delaymsecs = noteDurations[melodyIndex][noteIndex] * melodySlowfactor[melodyIndex];

snprintf (SendBuffer,BUFSIZE,"Melody[%d],Note #%d F=%d Hz Duration:%d ms| ARR=%d CCR
CDC_Transmit_FS(SendBuffer,strlen(SendBuffer));

HAL_Delay(Delaymsecs);
```

STM32F4

https://github.com/LAPSyLAB/STM32F4_Discovery_VIN_Projects/tree/main/Buzzer_PWM_Demo

STM32F4

STM32F4 – PWM signal/ton za brenčača (Buzzer)

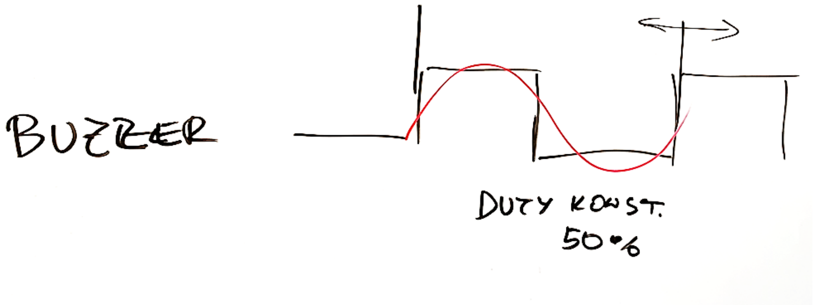
HAL - C

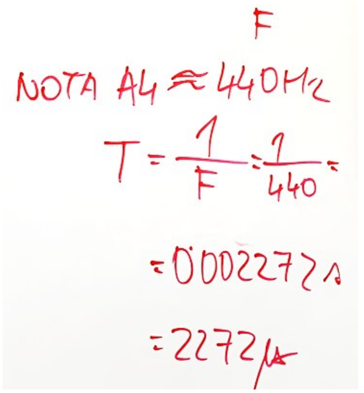
```
/* USER CODE BEGIN PV */
…
int NoteFreq = 440 ; // Note A4 = 440 Hz
int NotePeriod; //Already prescaled to 1 MHz

/* USER CODE END PV */
```

```
/* USER CODE BEGIN 0 */
void setPWM(TIM_HandleTypeDef timer, uint32_t channel, uint16_t period, uint16_t pulse)
{
HAL_TIM_PWM_Stop(&timer, channel); // stop generation of pwm
TIM_OC_InitTypeDef sConfigOC;
timer.Init.Period = period; // set the period duration
HAL_TIM_PWM_Init(&timer); // reinititialise with new period value
sConfigOC.OCMode = TIM_OCMODE_PWM1;
sConfigOC.Pulse = pulse; // set the pulse duration
sConfigOC.OCPolarity = TIM_OCPOLARITY_HIGH;
sConfigOC.OCFastMode = TIM_OCFAST_DISABLE;
HAL_TIM_PWM_ConfigChannel(&timer, &sConfigOC, channel);
HAL_TIM_PWM_Start(&timer, channel); // start pwm generation
}
/* USER CODE END 0 */
```

```
/* USER CODE BEGIN 2 */
…
HAL_TIM_PWM_Start(&htim2, TIM_CHANNEL_1);
/* USER CODE END 2 */
```

```
/* USER CODE BEGIN WHILE */
while (1)
{
htim4.Instance->CCR1 = Duty;
htim4.Instance->CCR2 = 100-Duty;
htim4.Instance->CCR3 = Duty;
htim4.Instance->CCR4 = 100-Duty;

KeyState = HAL_GPIO_ReadPin(GPIOA, GPIO_PIN_0);

NotePeriod = (int)(1000000/NoteFreq); //Already prescaled to 1 MHz
setPWM(htim2, TIM_CHANNEL_1, NotePeriod, NotePeriod/2);

snprintf(SendBuffer,BUFSIZE,"Hello World [%d]: Key:%d Duty:%d PWM-Freq:%d PWM-Period:%d\r\n",Counter++,KeyState,Duty,NoteFreq,NotePeriod);
```





STM32F4

STM32F4 – PWM signali/melodija za brenčača (Buzzer)

HAL - C

```
/* Infinite loop */
/* USER CODE BEGIN WHILE */
while (1)
{

melodyCount = sizeof(melodySizes)/ sizeof(uint32_t);

for(melodyIndex = 0; melodyIndex < melodyCount; melodyIndex++)
{
        for(noteIndex = 0; noteIndex < melodySizes[melodyIndex]; noteIndex++)
          {
            //    buzzerSetNewFrequency(melody[melodyIndex][noteIndex]);
              NoteFreq = melody[melodyIndex][noteIndex];
              if (NoteFreq == 0) NoteFreq = 1;

              ARR_period = (int)(1000000/NoteFreq);  //Already prescaled to 1 MHz
              setPWM(htim2, TIM_CHANNEL_1, ARR_period, ARR_period/2);

              Delaymsecs = noteDurations[melodyIndex][noteIndex] * melodySlowfactor[melodyIndex];

              HAL_Delay(Delaymsecs);
          }
        snprintf (SendBuffer,BUFSIZE,"\r\n\r\nEnd of Melody[%d]\r\n\r\n",melodyIndex);
            CDC_Transmit_FS(SendBuffer,strlen(SendBuffer));

}
…
```

Melody.h:

```
//##############**"Crazy Frog" song of Crazy frog album**##############//
const uint32_t   CrazyFrog_notes[] = {
  NOTE_D4, 0, NOTE_F4, NOTE_D4, 0, NOTE_D4, NOTE_G4, NOTE_D4, NOTE_C4,
  NOTE_D4, 0, NOTE_A4, NOTE_D4, 0, NOTE_D4, NOTE_AS4, NOTE_A4, NOTE_F4,
  NOTE_D4, NOTE_A4, NOTE_D5, NOTE_D4, NOTE_C4, 0, NOTE_C4, NOTE_A3, NOTE_E4,
NOTE_D4,
  0,NOTE_D4,NOTE_D4
};

const uint32_t   CrazyFrog_durations[] = {
  8, 8, 6, 16, 16, 16, 8, 8, 8,
  8, 8, 6, 16, 16, 16, 8, 8, 8,
  8, 8, 8, 16, 16, 16, 16, 8, 8, 2,
  8,4,4
};
//###########End of Crazy Frog############//
```

Melody.h:

```
const uint32_t* melody[] ={marioMelody, secondMelody,
Titanic_Melody,Pirates_notes,CrazyFrog_notes};
const uint32_t* noteDurations[] = {marioDuration, secondDuration,
Titanic_duration,Pirates_durations,CrazyFrog_durations};
const uint16_t melodySlowfactor[] ={15, 30, 20, 20, 20};

const uint32_t melodySizes[] ={sizeof(marioMelody)/sizeof(uint32_t),
sizeof(secondDuration)/sizeof(uint32_t),
sizeof(Titanic_duration)/sizeof(uint32_t),
sizeof(Pirates_durations)/sizeof(uint32_t),
sizeof(CrazyFrog_durations)/sizeof(uint32_t)};
```

https://github.com/LAPSyLAB/STM32F4_Discovery_VIN_Projects/tree/main/Buzzer_PWM_Demo

STM32F4

STM32F4, H7 – PWM signali/melodija za brenčača (Buzzer)

HAL - C

```
/* Infinite loop */
/* USER CODE BEGIN WHILE */
while (1)
{

melodyCount = sizeof(melodySizes)/ sizeof(uint32_t);

for(melodyIndex = 0; melodyIndex < melodyCount; melodyIndex++)
{
        for(noteIndex = 0; noteIndex < melodySizes[melodyIndex]; noteIndex++)
          {
            //    buzzerSetNewFrequency(melody[melodyIndex][noteIndex]);
              NoteFreq = melody[melodyIndex][noteIndex];
              if (NoteFreq == 0) NoteFreq = 1;

              ARR_period = (int)(1000000/NoteFreq);  //Already prescaled to 1 MHz
              setPWM(htim2, TIM_CHANNEL_1, ARR_period, ARR_period/2);

              Delaymsecs = noteDurations[melodyIndex][noteIndex] * melodySlowfactor[melodyIndex];

              HAL_Delay(Delaymsecs);
          }
        snprintf (SendBuffer,BUFSIZE,"\r\n\r\nEnd of Melody[%d]\r\n\r\n",melodyIndex);
            CDC_Transmit_FS(SendBuffer,strlen(SendBuffer));

}
…
```

```
Melody.h:
const uint32_t* melody[] ={marioMelody, secondMelody,
Titanic_Melody,Pirates_notes,CrazyFrog_notes};
const uint32_t* noteDurations[] = {marioDuration, secondDuration,
Titanic_duration,Pirates_durations,CrazyFrog_durations};
const uint16_t melodySlowfactor[] ={15, 30, 20, 20, 20};

const uint32_t melodySizes[] ={sizeof(marioMelody)/sizeof(uint32_t),
sizeof(secondDuration)/sizeof(uint32_t),
sizeof(Titanic_duration)/sizeof(uint32_t),
sizeof(Pirates_durations)/sizeof(uint32_t),
sizeof(CrazyFrog_durations)/sizeof(uint32_t)};
```

```
Melody.h:
// Zapisi not v [Hz]
#define NOTE_C4   262
#define NOTE_CS4 277
#define NOTE_D4   294
#define NOTE_DS4 311
#define NOTE_E4   330
#define NOTE_F4   349
#define NOTE_FS4 370
#define NOTE_G4   392
#define NOTE_GS4 415
#define NOTE_A4   440


// Zapisi melodij v notah [Hz] in trajanju
//##############**"Crazy Frog" song of Crazy frog
album**##############//
const uint32_t   CrazyFrog_notes[] = {
  NOTE_D4, 0, NOTE_F4, NOTE_D4, 0, NOTE_D4, NOTE_G4,
NOTE_D4, NOTE_C4,
  NOTE_D4, 0, NOTE_A4, NOTE_D4, 0, NOTE_D4, NOTE_AS4,
NOTE_A4, NOTE_F4,
  NOTE_D4, NOTE_A4, NOTE_D5, NOTE_D4, NOTE_C4, 0,
NOTE_C4, NOTE_A3, NOTE_E4, NOTE_D4,
  0,NOTE_D4,NOTE_D4
};

const uint32_t   CrazyFrog_durations[] = {
  8, 8, 6, 16, 16, 16, 8, 8, 8,
  8, 8, 6, 16, 16, 16, 8, 8, 8,
  8, 8, 8, 16, 16, 16, 16, 8, 8, 2,
  8,4,4
};
//###########End of Crazy Frog############//
```

https://github.com/LAPSyLAB/STM32F4_Discovery_VIN_Projects/tree/main/Buzzer_PWM_Demo

VIN projekt - VP6: STM32F4 VIN Demo

- Osvežitev: STM32F4
- CubeIDE projekt STM32F4 in V/I naprave :
  - CubeIDE projekt, GPIO in VCOM port
  - PWM - LED dimmer, brenčač
  - SPI - LIS3DSH pospeškomer
  - I2C - CS43L22 zvočni čip
  - ADC
- Sledenje („tracing“) - CubeMonitor, osciloskop

VP 6 - STM32 CubeIDE, SPI in LIS3DSH Gradiva

5 Digital main blocks

5.1 State machine

The LIS3DSH embeds two state machines able to run a user defined program.

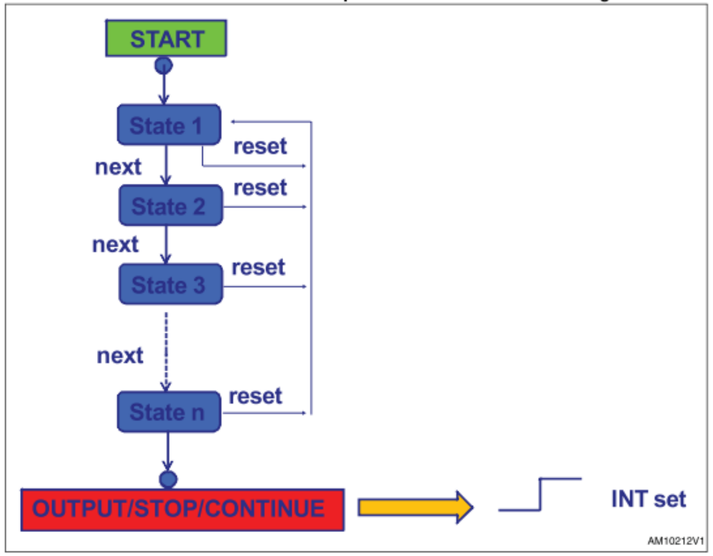
The program is made up of a set of instructions that define the transition to successive states. Conditional branches are possible.

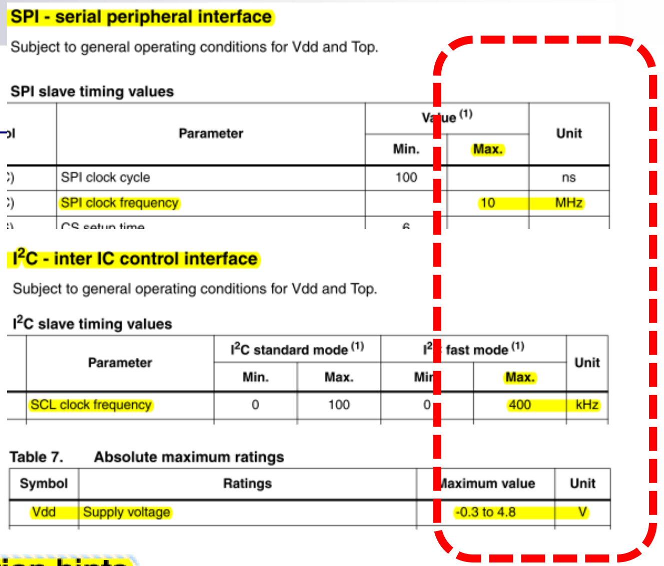
From each state (n) it is possible to have transition to the next state (n+1) or to reset state. Transition to reset point happens when "RESET condition" is true; Transition to the next step happens when "NEXT condition" is true.

Interrupt is triggered when output/stop/continue state is reached.

Each state machine allows to implement gesture recognition in a flexible way, free-fall, wake-up, 4D/6D orientation, pulse counter and step recognition, click/double click, shake/double shake, face-up/face-down, turn/double turn:

Table 8. LIS3DSH state machines: sequence of state to execute an algorithm





SPI - serial peripheral interface

Subject to general operating conditions for Vdd and Top.

SPI slave timing values

ol	Parameter	Value (1)		Unit
		Min.	Max.	
:)	SPI clock cycle	100		ns
:)	SPI clock frequency		10	MHz
:)	CS setup time	6		

I²C - inter IC control interface

Subject to general operating conditions for Vdd and Top.

I²C slave timing values

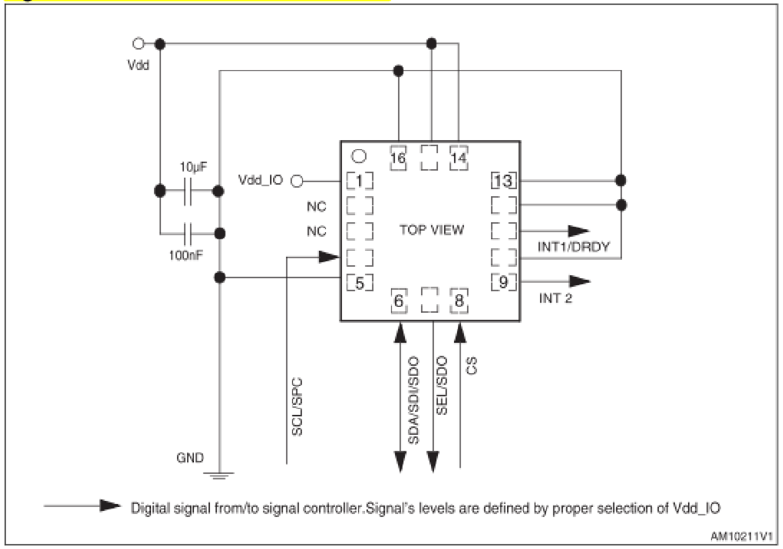
	Parameter	I²C standard mode (1)		I² fast mode (1)		Unit
		Min.	Max.	Min	Max.	
	SCL clock frequency	0	100	0	400	kHz

Table 7. Absolute maximum ratings

Symbol	Ratings	Maximum value	Unit
Vdd	Supply voltage	-0.3 to 4.8	V

Application hints

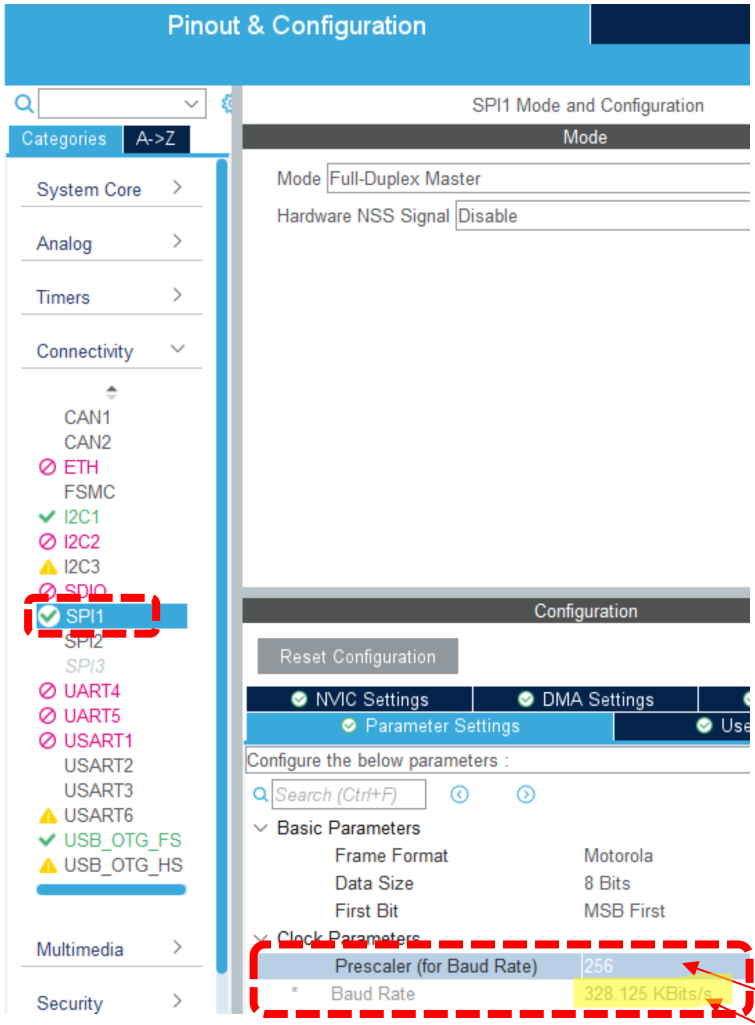
Figure 5. LIS3DSH electrical connection


Vdd
10µF
100nF
Vdd_IO
NC
NC
TOP VIEW
16
14
1
13
5
9
6
8
INT1/DRDY
INT 2
GND
SCL/SPC
SDA/SDI/SDO
SEL/SDO
CS
Digital signal from/to signal controller.Signal's levels are defined by proper selection of Vdd_IO
AM10211V1

https://github.com/LAPSyLAB/STM32F4_Docs_and_Examples/blob/main/STM32F407_Discovery_kit/LIS3DSH.pdf

VP 6 - STM32 CubeIDE, SPI in LIS3DSH

CubeMX nastavitve :



Pinout & Configuration

Categories | A->Z

System Core >
Analog >
Timers >
Connectivity ⌄

CAN1
CAN2
ETH
FSMC
I2C1
I2C2
I2C3
SDIO
SPI1
SPI2
SPI3
UART4
UART5
USART1
USART2
USART3
USART6
USB_OTG_FS
USB_OTG_HS

Multimedia >
Security >

SPI1 Mode and Configuration

Mode

Mode: Full-Duplex Master
Hardware NSS Signal: Disable

Configuration

Reset Configuration

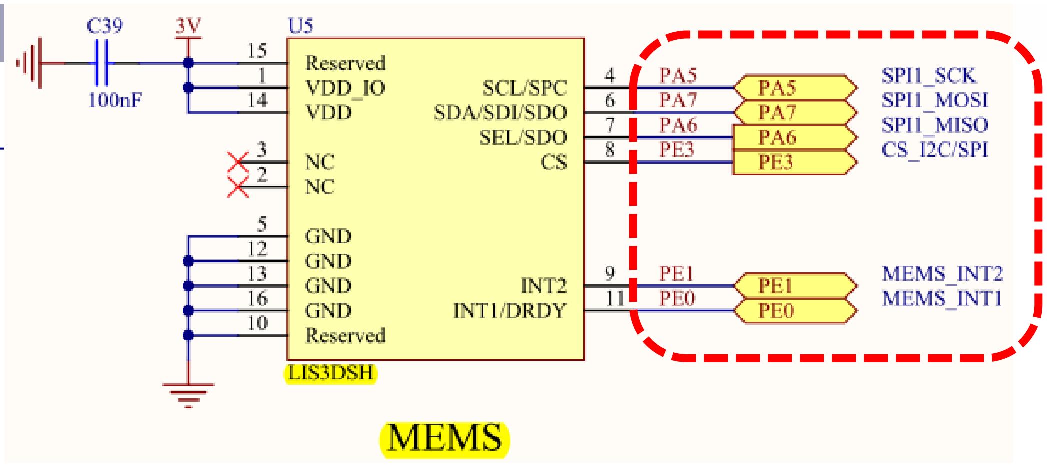
NVIC Settings | DMA Settings | Parameter Settings | Use

Configure the below parameters :

Search (Ctrl+F)

Basic Parameters
- Frame Format: Motorola
- Data Size: 8 Bits
- First Bit: MSB First

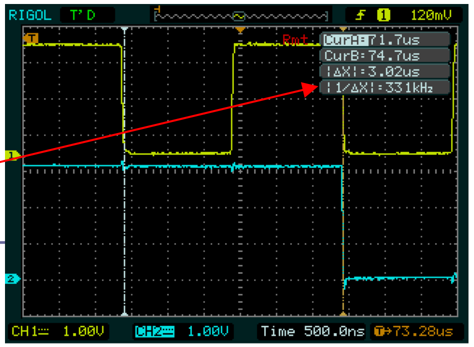
Clock Parameters
- Prescaler (for Baud Rate): 256
- * Baud Rate: 328.125 KBits/s



spi.c:

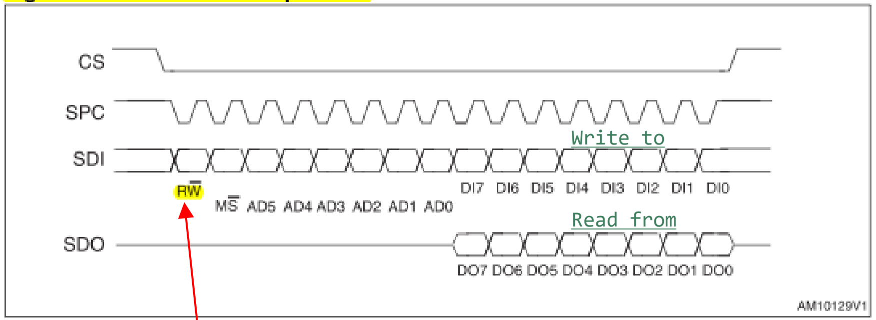
```
/* USER CODE END SPI1_Init 1 */
  hspi1.Instance = SPI1;
  hspi1.Init.Mode = SPI_MODE_MASTER;
  hspi1.Init.Direction = SPI_DIRECTION_2LINES;
  hspi1.Init.DataSize = SPI_DATASIZE_8BIT;
  hspi1.Init.CLKPolarity = SPI_POLARITY_LOW;
  hspi1.Init.CLKPhase = SPI_PHASE_1EDGE;
  hspi1.Init.NSS = SPI_NSS_SOFT;
  hspi1.Init.BaudRatePrescaler = SPI_BAUDRATEPRESCALER_256;
  hspi1.Init.FirstBit = SPI_FIRSTBIT_MSB;
  hspi1.Init.TIMode = SPI_TIMODE_DISABLE;
  hspi1.Init.CRCCalculation = SPI_CRCCALCULATION_DISABLE;
  hspi1.Init.CRCPolynomial = 10;
  if (HAL_SPI_Init(&hspi1) != HAL_OK)
  {
    Error_Handler();
  }
  /* USER CODE BEGIN SPI1_Init 2 */
```

Spremenimo iz 2 v 256
(počasnejša komunikacija)



VP 6 - STM32 SPI1 in LIS3DSH - program

Figure 6. Read and write protocol


CS
SPC
SDI
Write to
RW
MS AD5 AD4 AD3 AD2 AD1 AD0
DI7 DI6 DI5 DI4 DI3 DI2 DI1 DI0
Read from
SDO
DO7 DO6 DO5 DO4 DO3 DO2 DO1 DO0
AM10129V1

***bit 0*: RW bit**. When 0, the data DI(7:0) is written into the device. When 1, the data DO(7:0) from the device is read. In the latter case, the chip drives **SDO** at the start of bit 8.

***bit 1-7*: address AD(6:0)**. This is the address field of the indexed register.

***bit 8-15*: data DI(7:0) (write mode)**. This is the data that is written into the device (MSb first).

***bit 8-15*: data DO(7:0) (read mode)**. This is the data that is read from the device (MSb first).

8.3 WHO_AM_I (0Fh)

rozman 26. 04. 2022, 0..
0x3F

Who_AM_I register.

Table 19. WHO_AM_I register default value

0	0	1	1	1	1	1	1

```
// Config accelerometer
// Read WHOAMI register
HAL_GPIO_WritePin(GPIOE, GPIO_PIN_3, GPIO_PIN_RESET);
outdata[0] = 0x0f | 0x80 ;  // read whoami
HAL_SPI_TransmitReceive(&hspi1, &outdata, &indata, 2, HAL_MAX_DELAY);
lis_id = indata[1];
HAL_GPIO_WritePin(GPIOE, GPIO_PIN_3, GPIO_PIN_SET);

// Write to CTRL register (enable 3 axes meaurements on 25Hz)
HAL_GPIO_WritePin(GPIOE, GPIO_PIN_3, GPIO_PIN_RESET);
outdata[0] = 0x20 ;  // switch on axes
outdata[1] = 0x47 ;
HAL_SPI_TransmitReceive(&hspi1, &outdata, &indata, 2, HAL_MAX_DELAY);
HAL_GPIO_WritePin(GPIOE, GPIO_PIN_3, GPIO_PIN_SET);
```

SPI - serial peripheral interface

Subject to general operating conditions for Vdd and Top.

SPI slave timing values

l	Parameter	Value (1) Min.	Max.	Unit
)	SPI clock cycle	100		ns
)	SPI clock frequency		10	MHz
)	CS setup time	6		

Table 7. Absolute maximum ratings

Symbol	Ratings	Maximum value	Unit
Vdd	Supply voltage	-0.3 to 4.8	V

Gradiva

8.5 CTRL_REG4 (20h)

rozman 26. 04. 2022, 0..
0x47 (25Hz, all axes on)

Control register 4.

Table 22. Control register 4

ODR3	ODR2	ODR1	ODR0	BDU	ZEN	YEN	XEN

Table 23. CTRL_REG4 register description

ODR 3:0	Output data rate and power mode selection. Default value:0000 (see *Table 24*)
BDU	Block data update. Default value:0 0:continuos update 1:output registers not updated until MSB and LSB reading)
Zen	Z axis enable. Default value:1 (0:Z axis disabled; 1:Z axis enabled)
Yen	Y axis enable. Default value:1 (0:Y axis disabled; 1:Y axis enabled)
Xen	X axis enable. Default value:1 0=X axis disabled; 1=X axis enabled

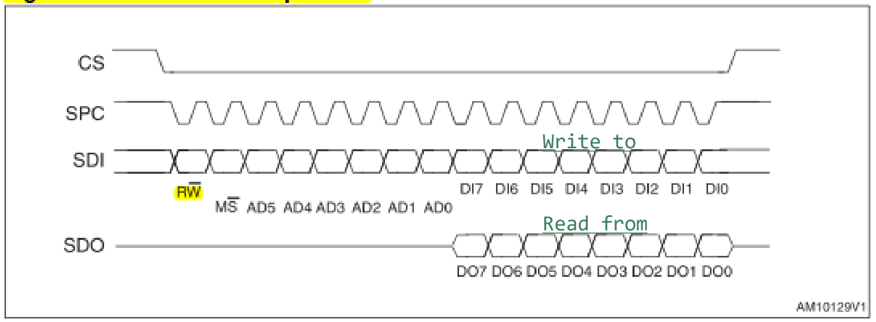
Table 24. CTRL4 ODR configuration

ODR3	ODR2	ODR1	ODR0	ODR selection
0	0	0	0	Power down
0	0	0	1	3.125 Hz
0	0	1	0	6.25 Hz
0	0	1	1	12.5 Hz
0	1	0	0	25 Hz

https://github.com/LAPSyLAB/STM32F4_Docs_and_Examples/blob/main/Documentation/STM32F407_Discovery_kit/LIS3DSH.pdf

VP 6 - STM32 CubeIDE, SPI in LIS3DSH Gradiva

Figure 6. Read and write protocol


CS
SPC
SDI
Write to
RW
MS AD5 AD4 AD3 AD2 AD1 AD0
DI7 DI6 DI5 DI4 DI3 DI2 DI1 DI0
Read from
SDO
DO7 DO6 DO5 DO4 DO3 DO2 DO1 DO0
AM10129V1

bit 0: RW bit. When 0, the data DI(7:0) is written into the device. When 1, the data DO(7:0) from the device is read. In the latter case, the chip drives **SDO** at the start of bit 8.

bit 1-7: address AD(6:0). This is the address field of the indexed register.

bit 8-15: data DI(7:0) (write mode). This is the data that is written into the device (MSb first).

bit 8-15: data DO(7:0) (read mode). This is the data that is read from the device (MSb first).

7 Register mapping

Table 16 provides a list of the 8/16-bit registers embedded in the device and the related address:

Table 16. Register address map

Name	Type	Register address		Default	Comment
		Hex	Binary		
INFO1	r	0D	00001101	0010 0001	Information register 1
INFO2	r	0E	00001110	0000 0000	Information register 2
WHO_AM_I	r	OF	00001111	0011 1111	Who I am ID
OUT_X_L	r	28	00101000	0000 0000	Output registers
OUT_X_H	r	29	00101001		
OUT_Y_L	r	2A	00101010		
OUT_Y_H	r	2B	00101011		
OUT_Z_L	r	2C	00101100		
OUT_Z_H	r	2D	00101101		

```
// Read x,y,z axes
  outdata[0] = 0x29 | 0x80  ;  // read x
  HAL_GPIO_WritePin(GPIOE, GPIO_PIN_3, GPIO_PIN_RESET);
  HAL_SPI_TransmitReceive(&hspi1, &outdata, &indata, 2, HAL_MAX_DELAY);
  AccelX = indata[1];

  outdata[0] = 0x2B | 0x80  ;  // read y
  HAL_SPI_TransmitReceive(&hspi1, &outdata, &indata, 2, HAL_MAX_DELAY);
  AccelY = indata[1];

  outdata[0] = 0x2D | 0x80  ;  // read z
  HAL_SPI_TransmitReceive(&hspi1, &outdata, &indata, 2, HAL_MAX_DELAY);
  HAL_GPIO_WritePin(GPIOE, GPIO_PIN_3, GPIO_PIN_SET);
  AccelZ = indata[1];
```

8.23 OUT_X (28h - 29h)

X-axis output register.

Table 49. OUT_X_L register default value

0	0	0	0	0	0	0	0

Table 50. OUT_X_H register default value

0	0	0	0	0	0	0	0

https://github.com/LAPSyLAB/STM32F4_Docs_and_Examples/blob/main/Documentation/STM32F407_Discovery_kit/LIS3DSH.pdf

VP 6 - STM32 CubeIDE, SPI in LIS3DSH

main.c : dodana koda

Spremenljivke

```
/* USER CODE BEGIN PV */
#define BUFSIZE 256
charSendBuffer[BUFSIZE];
intCounter;
int KeyState=0;

// Global variables
uint8_t indata[2];
uint8_t outdata[2] = {0,0};
uint8_t lis_id;
int8_t AccelX;
int8_t AccelY;
int8_t AccelZ;

HAL_StatusTypeDef SPIStatus;

/* USER CODE END PV */
```

Glavna zanka

```
 /* Infinite loop */
  /* USER CODE BEGIN WHILE */
  while (1)
  {

// Read x,y,z axes
  outdata[0] = 0x29 | 0x80  ;  // read x
  HAL_GPIO_WritePin(GPIOE, GPIO_PIN_3, GPIO_PIN_RESET);
  HAL_SPI_TransmitReceive(&hspi1, &outdata, &indata, 2, HAL_MAX_DELAY);
  AccelX = indata[1];

  outdata[0] = 0x2B | 0x80  ;  // read y
  HAL_SPI_TransmitReceive(&hspi1, &outdata, &indata, 2, HAL_MAX_DELAY);
  AccelY = indata[1];

  outdata[0] = 0x2D | 0x80  ;  // read z
  HAL_SPI_TransmitReceive(&hspi1, &outdata, &indata, 2, HAL_MAX_DELAY);
  HAL_GPIO_WritePin(GPIOE, GPIO_PIN_3, GPIO_PIN_SET);
  AccelZ = indata[1];

…

snprintf(SendBuffer,BUFSIZE,"Hello World [%d]: Key:%d Duty:%d PWM-Freq:%d PWM-Period:%d
Accel[ID:%02x] X:%04d Y:%d
Z:%04d\r\n",Counter++,KeyState,Duty,NoteFreq,NotePeriod,lis_id,AccelX,AccelY,AccelZ);
  CDC_Transmit_FS(SendBuffer,strlen(SendBuffer));

    /* USER CODE END WHILE */
```

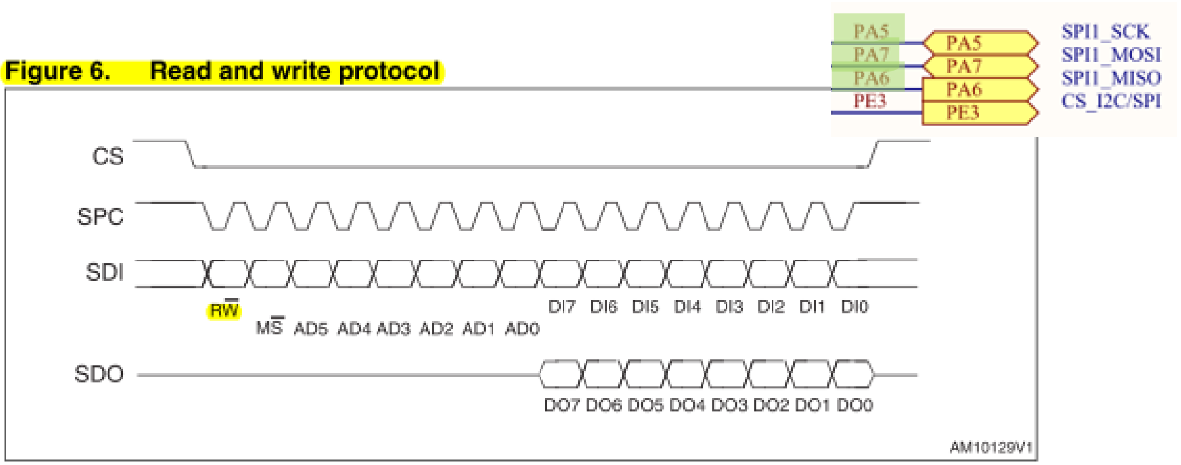
Inicializacija

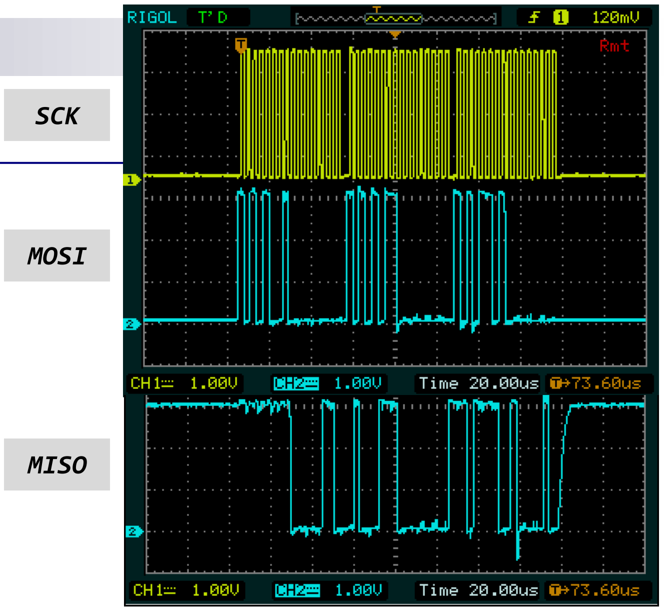
```
  /* USER CODE BEGIN 2 */

  // Config accelerometer
  // Read WHOAMI register
  HAL_GPIO_WritePin(GPIOE, GPIO_PIN_3, GPIO_PIN_RESET);
  outdata[0] = 0x0f | 0x80 ;  // read whoami
  HAL_SPI_TransmitReceive(&hspi1, &outdata, &indata, 2,
HAL_MAX_DELAY);
  lis_id = indata[1];
  HAL_GPIO_WritePin(GPIOE, GPIO_PIN_3, GPIO_PIN_SET);

  HAL_Delay(500);

  // Set CTRL register 0x47 -> [0x20]
  HAL_GPIO_WritePin(GPIOE, GPIO_PIN_3, GPIO_PIN_RESET);
  outdata[0] = 0x20 ;  // switch on axes
  outdata[1] = 0x47 ;
  HAL_SPI_TransmitReceive(&hspi1, &outdata, &indata, 2,
HAL_MAX_DELAY);
  HAL_GPIO_WritePin(GPIOE, GPIO_PIN_3, GPIO_PIN_SET);

  HAL_Delay(500);
  outdata[1] = 0x00 ;

  /* USER CODE END 2 */
```

https://github.com/LAPSyLAB/STM32F4_Discovery_VIN_Projects/tree/main/STM32_SPI_LIS302DL_Basic

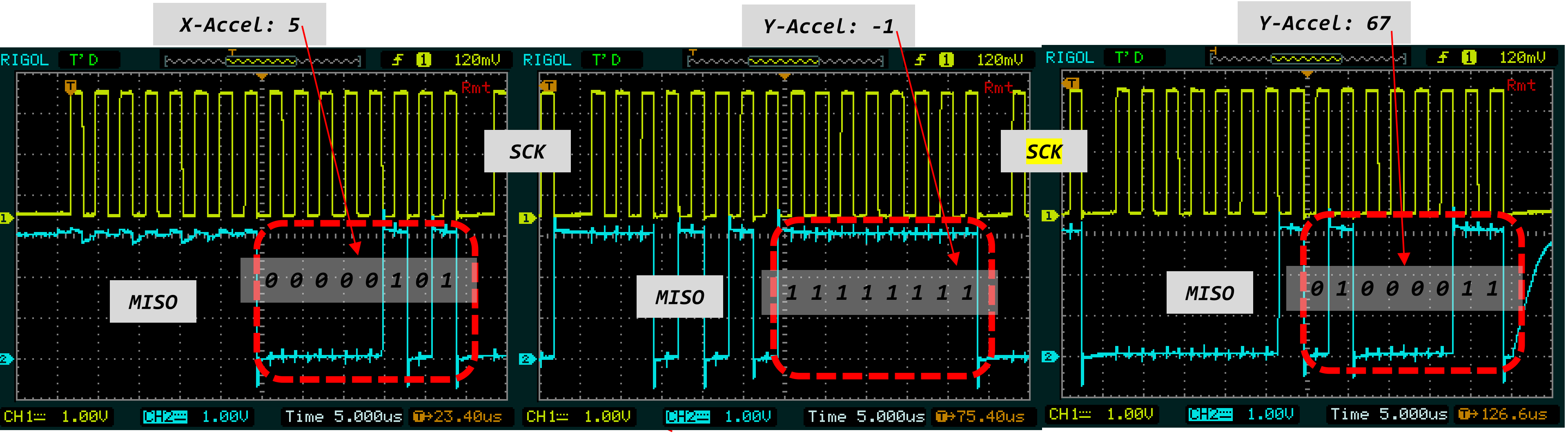
VP 6 - STM32 CubeIDE, SPI in LIS3DSH - Osciloskop

Figure 6. Read and write protocol


PA5
PA7
PA6
PE3
PA5
PA7
PA6
PE3
SPI1_SCK
SPI1_MOSI
SPI1_MISO
CS_I2C/SPI
CS
SPC
SDI
RW
MS AD5 AD4 AD3 AD2 AD1 AD0
DI7 DI6 DI5 DI4 DI3 DI2 DI1 DI0
SDO
DO7 DO6 DO5 DO4 DO3 DO2 DO1 DO0
AM10129V1



```
Hello World [3530]: Key:0000 Accel[ID:00] X:0005 Y:-1 Z:0066
Hello World [3531]: Key:0000 Accel[ID:00] X:0005 Y:-1 Z:0067
```


X-Accel: 5
Y-Accel: -1
Y-Accel: 67
SCK
SCK
MISO
MISO
MISO
0 0 0 0 0 1 0 1
1 1 1 1 1 1 1 1
0 1 0 0 0 0 1 1
CH1 1.00V CH2 1.00V Time 5.000us 23.40us
CH1 1.00V CH2 1.00V Time 5.000us 75.40us
CH1 1.00V CH2 1.00V Time 5.000us 126.6us

VIN projekt - VP6: STM32F4 VIN Demo

- Osvežitev: STM32F4

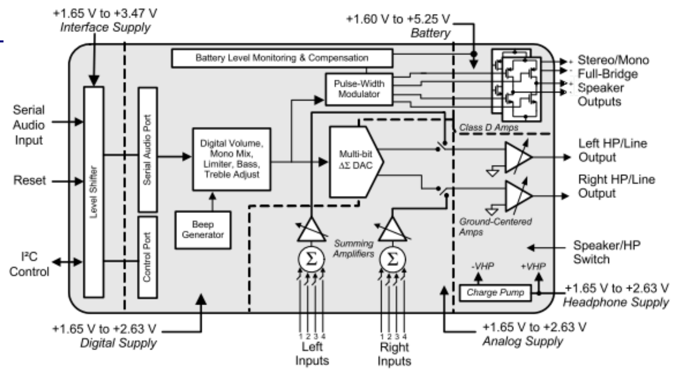
- CubeIDE projekt STM32F4 in V/I naprave :
  - CubeIDE projekt, GPIO in VCOM port
  - PWM - LED dimmer, brenčač
  - SPI - LIS3DSH pospeškomer
  - I2C - CS43L22 zvočni čip
  - ADC

- Sledenje („tracing“) - CubeMonitor, osciloskop

VP 6 - STM32 CubeIDE, I2C in CS43L22 Gradiva

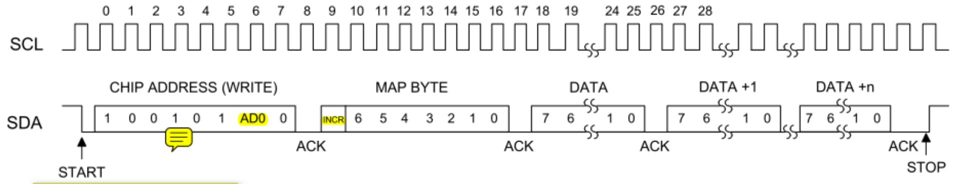
CIRRUS LOGIC® **CS43L22**

Low Power, Stereo DAC w/Headphone & Speaker Amps



5.1 I²C Control

The upper 6 bits of the address field are fixed at 100101. To communicate with the CS43L22, the chip address field, which is the first byte sent to the CS43L22, should match 100101 followed by the setting of the AD0 pin. The eighth bit of the address is the R/W bit. If the operation is a write, the next byte is the Memory Address Pointer (MAP), which selects the register to be read or written. If the operation is a read, the contents of the register pointed to by the MAP will be output. Setting the auto-increment bit in MAP allows successive reads or writes of consecutive registers. Each byte is separated by an acknowledge bit. The ACK bit is output from the CS43L22 after each input byte is read and is input to the CS43L22 from the microcontroller after each transmitted byte.



rozman 26. 04. 2022, 1...

AD0 -> GND Addr=0x94

Figure 16. Control Port Timing, I²C Write

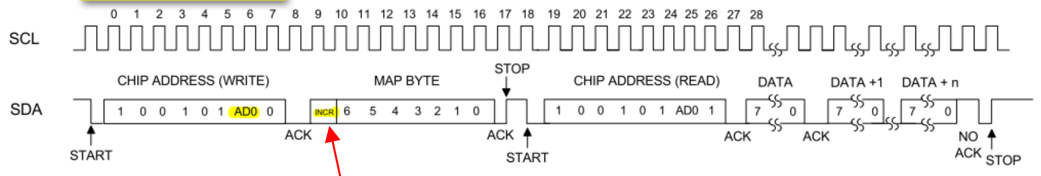


Figure 17. Control Port Timing, I²C Read

5.1.1 Memory Address Pointer (MAP)

The MAP byte comes after the address byte and selects the register to be read or written. Refer to the pseudo code above for implementation details.

5.1.1.1 Map Increment (INCR)

The device has MAP auto-increment capability enabled by the INCR bit (the MSB) of the MAP. If INCR is set to 0, MAP will stay constant for successive I²C writes or reads. If INCR is set to 1, MAP will auto-increment after each byte is read or written, allowing block reads or writes of successive registers.

7. REGISTER DESCRIPTION

All registers are read/write except for the chip I.D. and Revision Register and Interrupt Status Register which are read only. See the following bit definition tables for bit assignment information. The default state of each bit after a power-up sequence or reset is shown as shaded in the table. Unless otherwise specified, all "Reserved" bits must maintain their default value.

7.1 Chip I.D. and Revision Register (Address 01h) *(Read Only)*

7	6	5	4	3	2	1	0
CHIPID4	CHIPID3	CHIPID2	CHIPID1	CHIPID0	REVID2	REVID1	REVID0

7.1.1 ***Chip I.D.*** *(Read Only)*

I.D. code for the CS43L22.

CHIPID[4:0]	Device
11100	CS43L22

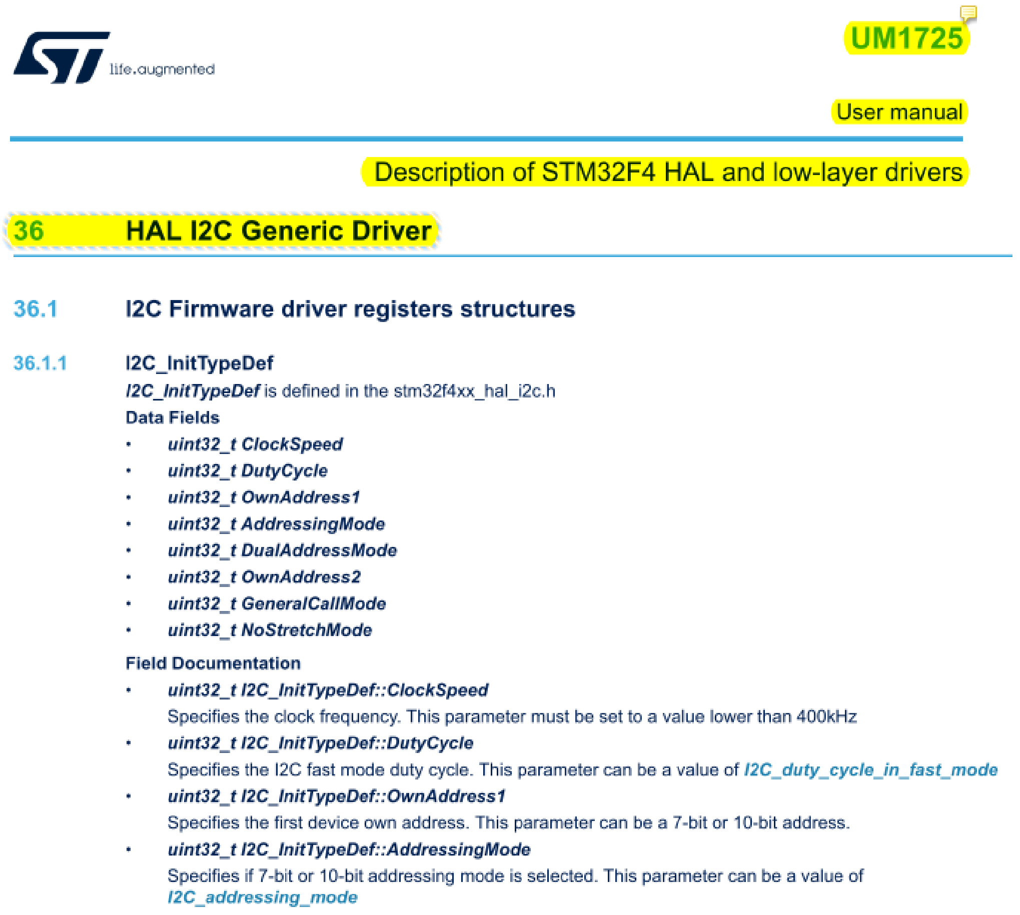
7.1.2 ***Chip Revision*** *(Read Only)*

CS43L22 revision level.

REVID[2:0]	Revision Level
000	A0
001	A1
010	B0
011	B1

https://github.com/LAPSyLAB/STM32F4_Docs_and_Examples/blob/main/Documentation/STM32F407_Discovery_kit/CS43L22_F2.pdf

Delo na STM32F4 razvojnem sistemu


life.augmented

UM1725

User manual

Description of STM32F4 HAL and low-layer drivers

36 HAL I2C Generic Driver

36.1 I2C Firmware driver registers structures

36.1.1 I2C_InitTypeDef

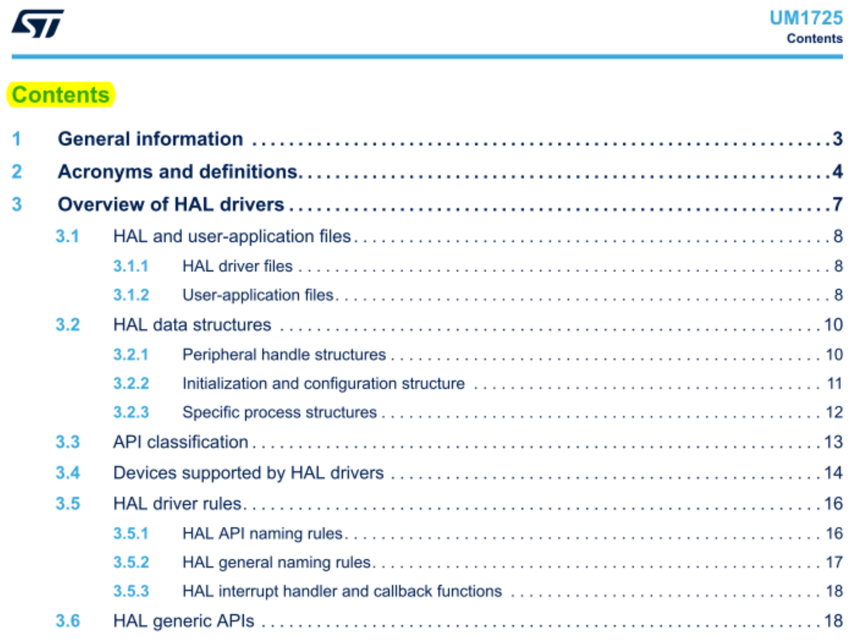
I2C_InitTypeDef is defined in the stm32f4xx_hal_i2c.h

Data Fields

- ***uint32_t ClockSpeed***
- ***uint32_t DutyCycle***
- ***uint32_t OwnAddress1***
- ***uint32_t AddressingMode***
- ***uint32_t DualAddressMode***
- ***uint32_t OwnAddress2***
- ***uint32_t GeneralCallMode***
- ***uint32_t NoStretchMode***

Field Documentation

- ***uint32_t I2C_InitTypeDef::ClockSpeed***
  Specifies the clock frequency. This parameter must be set to a value lower than 400kHz
- ***uint32_t I2C_InitTypeDef::DutyCycle***
  Specifies the I2C fast mode duty cycle. This parameter can be a value of ***I2C_duty_cycle_in_fast_mode***
- ***uint32_t I2C_InitTypeDef::OwnAddress1***
  Specifies the first device own address. This parameter can be a 7-bit or 10-bit address.
- ***uint32_t I2C_InitTypeDef::AddressingMode***
  Specifies if 7-bit or 10-bit addressing mode is selected. This parameter can be a value of ***I2C_addressing_mode***


UM1725
Contents

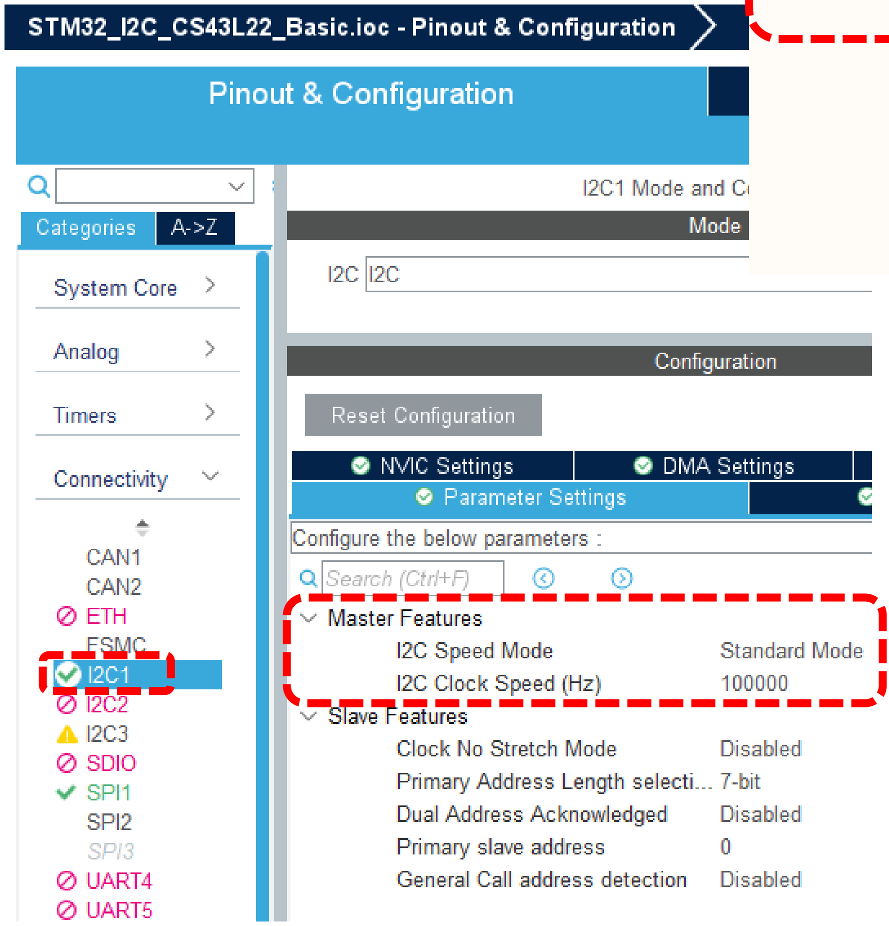
Contents

Lastni viri :

https://github.com/LAPSyLAB/STM32F4_Docs_and_Examples

VP 6 - STM32 CubeIDE, I2C in CS43L22

CubeMX nastavitve (I2C1 že nastavljen)



STM32_I2C_CS43L22_Basic.ioc - Pinout & Configuration

Pinout & Configuration

Categories | A->Z

System Core
Analog
Timers
Connectivity

CAN1
CAN2
ETH
FSMC
I2C1
I2C2
I2C3
SDIO
SPI1
SPI2
SPI3
UART4
UART5

I2C1 Mode and C

Mode

I2C I2C

Configuration

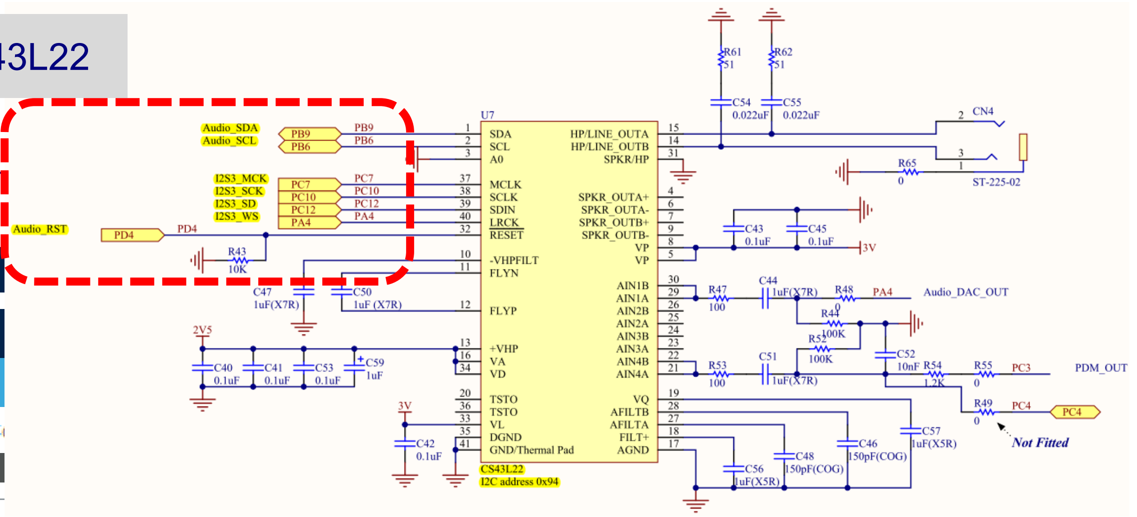
Reset Configuration

NVIC Settings | DMA Settings

Parameter Settings

Configure the below parameters :

Master Features
I2C Speed Mode   Standard Mode
I2C Clock Speed (Hz)   100000
Slave Features
Clock No Stretch Mode   Disabled
Primary Address Length selecti...   7-bit
Dual Address Acknowledged   Disabled
Primary slave address   0
General Call address detection   Disabled



i2c.c:

```
/* I2C1 init function */
void MX_I2C1_Init(void)
{
  /* USER CODE BEGIN I2C1_Init 0 */
  /* USER CODE END I2C1_Init 0 */

  /* USER CODE BEGIN I2C1_Init 1 */
  /* USER CODE END I2C1_Init 1 */

  hi2c1.Instance = I2C1;
  hi2c1.Init.ClockSpeed = 100000;
  hi2c1.Init.DutyCycle = I2C_DUTYCYCLE_2;
  hi2c1.Init.OwnAddress1 = 0;
  hi2c1.Init.AddressingMode = I2C_ADDRESSINGMODE_7BIT;
  hi2c1.Init.DualAddressMode = I2C_DUALADDRESS_DISABLE;
  hi2c1.Init.OwnAddress2 = 0;
  hi2c1.Init.GeneralCallMode = I2C_GENERALCALL_DISABLE;
  hi2c1.Init.NoStretchMode = I2C_NOSTRETCH_DISABLE;
  if (HAL_I2C_Init(&hi2c1) != HAL_OK)
  {
    Error_Handler();
  }
  /* USER CODE BEGIN I2C1_Init 2 */

  /* USER CODE END I2C1_Init 2 */

}
```

VP 6 - STM32 CubeIDE, I2C in CS43L22

Spremenljivke

main.c : dodana koda

```
/* USER CODE BEGIN PV */
…
uint8_t ChipID;

HAL_StatusTypeDef retval;
/* USER CODE END PV */
```

Inicializacija

```
/* USER CODE BEGIN 2 */

HAL_GPIO_WritePin(GPIOD, GPIO_PIN_4,GPIO_PIN_SET);   // Set Reset line to 1 (switch device on)

HAL_Delay(1000);   // recomended by datasheet

// From Device with address=0x94, Read register with address 0x01 and put value in ChipID
// DevAddress_0x94, tMemAddress=0x01, MemAddSize=8b, *pData,Size, Timeout);
retval = HAL_I2C_Mem_Read(&hi2c1, 0x94, 0x01, I2C_MEMADD_SIZE_8BIT, &ChipID, 1, 1000);

/* USER CODE END 2 */
```

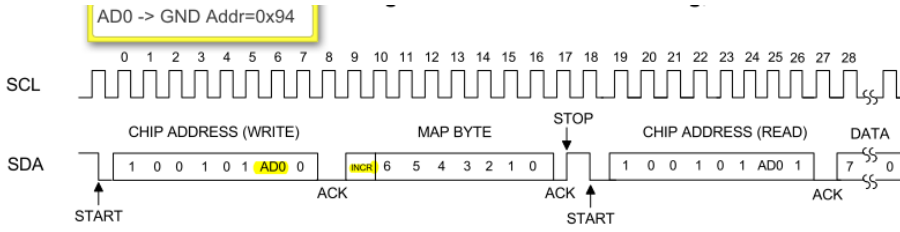


Figure 17. Control Port Timing, I²C Read

```
  /* Infinite loop */
  /* USER CODE BEGIN WHILE */
  while (1)
  {

 HAL_GPIO_TogglePin(GPIOD, GPIO_PIN_12);
 HAL_GPIO_TogglePin(GPIOD, GPIO_PIN_13);
 HAL_GPIO_TogglePin(GPIOD, GPIO_PIN_14);

 KeyState = HAL_GPIO_ReadPin(GPIOA, GPIO_PIN_0);
 HAL_GPIO_WritePin(GPIOD, GPIO_PIN_15, KeyState);


snprintf(SendBuffer,BUFSIZE,"Hello World [%d]: Key:%d Duty:%d PWM-Freq:%d PWM-Period:%d Accel[ID:%02x]
X:%04d Y:%d Z:%04d
ChipID:%02x\r\n",Counter++,KeyState,Duty,NoteFreq,NotePeriod,lis_id,AccelX,AccelY,AccelZ,ChipID);
  CDC_Transmit_FS(SendBuffer,strlen(SendBuffer));

    /* USER CODE END WHILE */

    /* USER CODE BEGIN 3 */
  HAL_Delay(1000);
  }
  /* USER CODE END 3 */
}
```

Glavna zanka

VIN projekt - VP6: STM32F4 VIN Demo

- Osvežitev: STM32F4

- CubeIDE projekt STM32F4 in V/I naprave :
  - CubeIDE projekt, GPIO in VCOM port
  - PWM - LED dimmer, brenčač
  - SPI - LIS3DSH pospeškomer
  - I2C - CS43L22 zvočni čip
  - ADC

- Sledenje („tracing“) - CubeMonitor, osciloskop

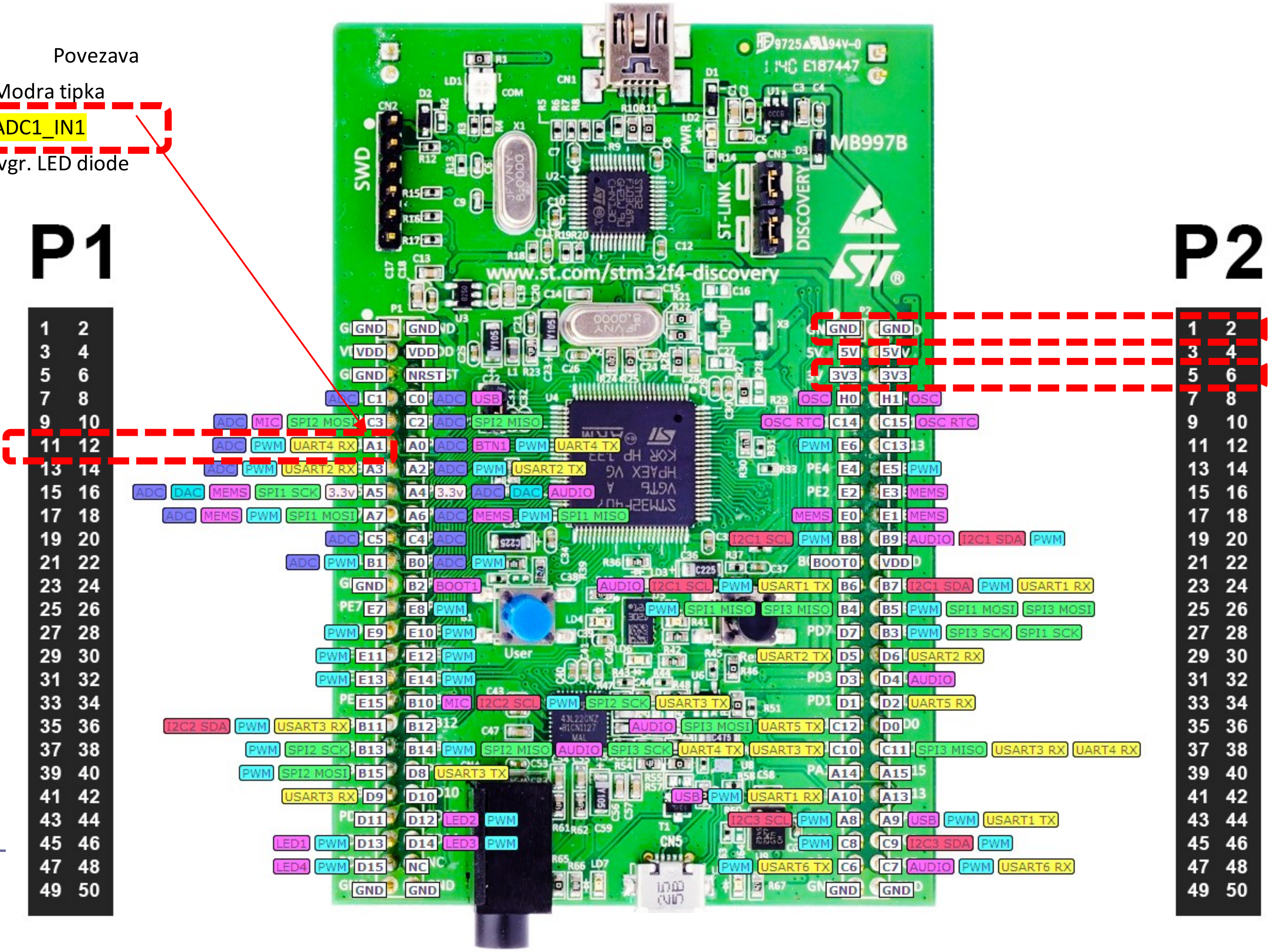
Breadboard vezava – STM32F4

STM32F4

Priključitev na STM32 : 3 x analogni, 1x digitalni vhod, 4x vgrajene LED diode

Testno vezje (primer) - STM32F4 :

GPIO	Vrsta	Povezava
PA0	User tipka	Modra tipka
PA1	Analogni vhod	ADC1_IN1
PD12-PD15	Dig. Izhodi	vgr. LED diode

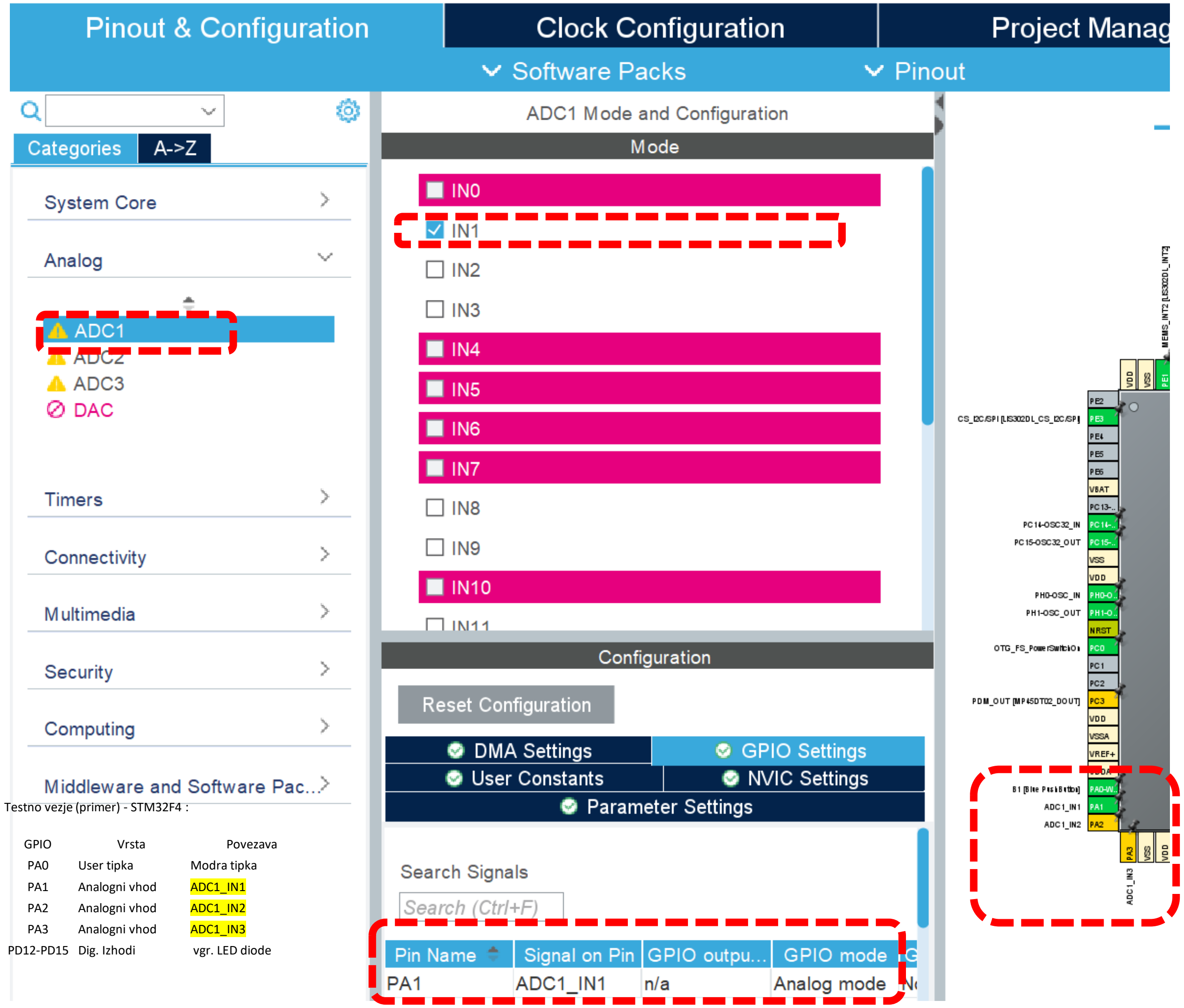


VIN - LV

STM32F4

VIN projekt - VP 6 ADC

Konfiguracija 2: (PA1 ADC1_IN1)



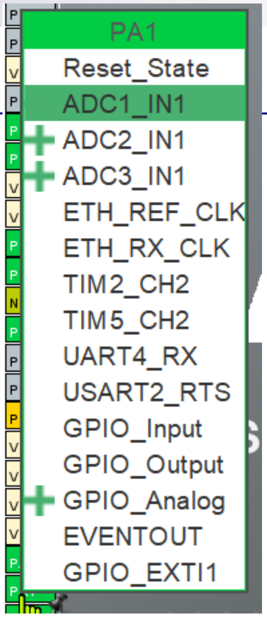
ADC1 Mode and Configuration

Mode

- [ ] IN0
- [✓] IN1
- [ ] IN2
- [ ] IN3
- [ ] IN4
- [ ] IN5
- [ ] IN6
- [ ] IN7
- [ ] IN8
- [ ] IN9
- [ ] IN10
- [ ] IN11

Configuration

Pin Name	Signal on Pin	GPIO outpu...	GPIO mode
PA1	ADC1_IN1	n/a	Analog mode



PA1
- Reset_State
- ADC1_IN1
- ADC2_IN1
- ADC3_IN1
- ETH_REF_CLK
- ETH_RX_CLK
- TIM2_CH2
- TIM5_CH2
- UART4_RX
- USART2_RTS
- GPIO_Input
- GPIO_Output
- GPIO_Analog
- EVENTOUT
- GPIO_EXTI1

Testno vezje (primer) - STM32F4 :

GPIO	Vrsta	Povezava
PA0	User tipka	Modra tipka
PA1	Analogni vhod	ADC1_IN1
PA2	Analogni vhod	ADC1_IN2
PA3	Analogni vhod	ADC1_IN3
PD12-PD15	Dig. Izhodi	vgr. LED diode

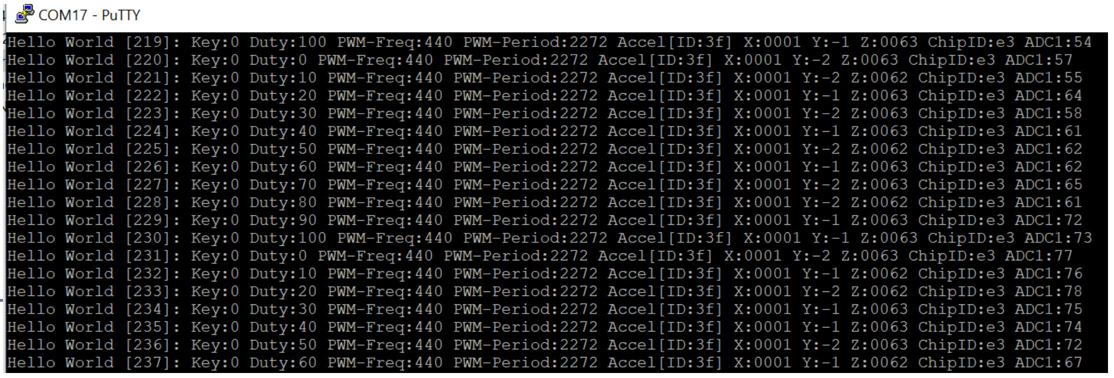
STM32F4

VIN projekt - VP 6 STM32-CubeIDE projekt, ADC

Program : za branje tipal in pošiljanje po USB Virtual COM Port

```
/* USER CODE BEGIN PV */
…

int AnalogValue1,AnalogValue2,AnalogValue3;
/* USER CODE END PV */
```

```
/* Infinite loop */
 /* USER CODE BEGIN WHILE */
 while (1)
 {

    HAL_ADC_Start(&hadc1);
    HAL_ADC_PollForConversion(&hadc1, HAL_MAX_DELAY);
    AnalogValue1 = HAL_ADC_GetValue(&hadc1);

    HAL_GPIO_TogglePin(GPIOD, GPIO_PIN_12);    // On-board LED

    HAL_GPIO_TogglePin(GPIOB, GPIO_PIN_5);    //External LED on PB5
    KeyState = HAL_GPIO_ReadPin(GPIOB, GPIO_PIN_4); //External Key on PB4

      snprintf(SendBuffer,BUFSIZE,"Hello World [%d]: Key:%d Duty:%d PWM-Freq:%d PWM-Period:%d
      Accel[ID:%02x] X:%04d Y:%d Z:%04d ChipID:%02x
      ADC1:%d\r\n",Counter++,KeyState,Duty,NoteFreq,NotePeriod,lis_id,AccelX,AccelY,AccelZ,ChipID,AnalogVal
      ue1);
      CDC_Transmit_FS(SendBuffer,strlen(SendBuffer));
    /* USER CODE END WHILE */

    /* USER CODE BEGIN 3 */
        HAL_Delay(1000);
 }
 /* USER CODE END 3 */
```

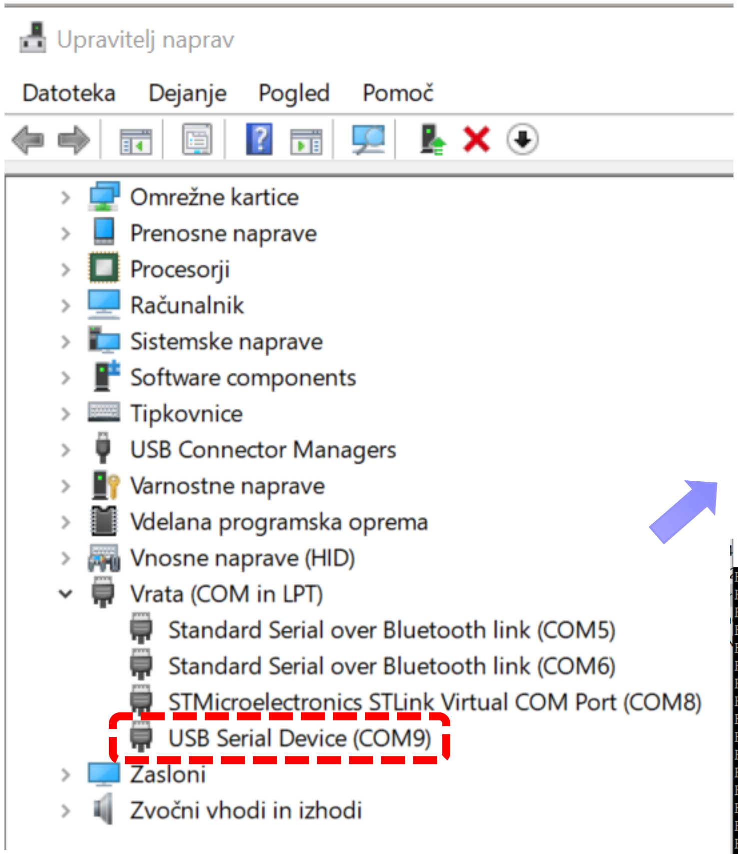

COM17 - PuTTY

```
Hello World [219]: Key:0 Duty:100 PWM-Freq:440 PWM-Period:2272 Accel[ID:3f] X:0001 Y:-1 Z:0063 ChipID:e3 ADC1:54
Hello World [220]: Key:0 Duty:0 PWM-Freq:440 PWM-Period:2272 Accel[ID:3f] X:0001 Y:-2 Z:0063 ChipID:e3 ADC1:57
Hello World [221]: Key:0 Duty:10 PWM-Freq:440 PWM-Period:2272 Accel[ID:3f] X:0001 Y:-2 Z:0062 ChipID:e3 ADC1:55
Hello World [222]: Key:0 Duty:20 PWM-Freq:440 PWM-Period:2272 Accel[ID:3f] X:0001 Y:-1 Z:0063 ChipID:e3 ADC1:64
Hello World [223]: Key:0 Duty:30 PWM-Freq:440 PWM-Period:2272 Accel[ID:3f] X:0001 Y:-2 Z:0063 ChipID:e3 ADC1:58
Hello World [224]: Key:0 Duty:40 PWM-Freq:440 PWM-Period:2272 Accel[ID:3f] X:0001 Y:-1 Z:0063 ChipID:e3 ADC1:61
Hello World [225]: Key:0 Duty:50 PWM-Freq:440 PWM-Period:2272 Accel[ID:3f] X:0001 Y:-2 Z:0062 ChipID:e3 ADC1:62
Hello World [226]: Key:0 Duty:60 PWM-Freq:440 PWM-Period:2272 Accel[ID:3f] X:0001 Y:-1 Z:0063 ChipID:e3 ADC1:62
Hello World [227]: Key:0 Duty:70 PWM-Freq:440 PWM-Period:2272 Accel[ID:3f] X:0001 Y:-2 Z:0063 ChipID:e3 ADC1:65
Hello World [228]: Key:0 Duty:80 PWM-Freq:440 PWM-Period:2272 Accel[ID:3f] X:0001 Y:-2 Z:0062 ChipID:e3 ADC1:61
Hello World [229]: Key:0 Duty:90 PWM-Freq:440 PWM-Period:2272 Accel[ID:3f] X:0001 Y:-1 Z:0063 ChipID:e3 ADC1:72
Hello World [230]: Key:0 Duty:100 PWM-Freq:440 PWM-Period:2272 Accel[ID:3f] X:0001 Y:-1 Z:0063 ChipID:e3 ADC1:73
Hello World [231]: Key:0 Duty:0 PWM-Freq:440 PWM-Period:2272 Accel[ID:3f] X:0001 Y:-2 Z:0063 ChipID:e3 ADC1:77
Hello World [232]: Key:0 Duty:10 PWM-Freq:440 PWM-Period:2272 Accel[ID:3f] X:0001 Y:-1 Z:0062 ChipID:e3 ADC1:76
Hello World [233]: Key:0 Duty:20 PWM-Freq:440 PWM-Period:2272 Accel[ID:3f] X:0001 Y:-2 Z:0062 ChipID:e3 ADC1:78
Hello World [234]: Key:0 Duty:30 PWM-Freq:440 PWM-Period:2272 Accel[ID:3f] X:0001 Y:-1 Z:0063 ChipID:e3 ADC1:75
Hello World [235]: Key:0 Duty:40 PWM-Freq:440 PWM-Period:2272 Accel[ID:3f] X:0001 Y:-1 Z:0063 ChipID:e3 ADC1:74
Hello World [236]: Key:0 Duty:50 PWM-Freq:440 PWM-Period:2272 Accel[ID:3f] X:0001 Y:-2 Z:0063 ChipID:e3 ADC1:72
Hello World [237]: Key:0 Duty:60 PWM-Freq:440 PWM-Period:2272 Accel[ID:3f] X:0001 Y:-1 Z:0062 ChipID:e3 ADC1:67
```

STM32F4

Osnovni projekt CubeIDE – USB Virtual COM Port

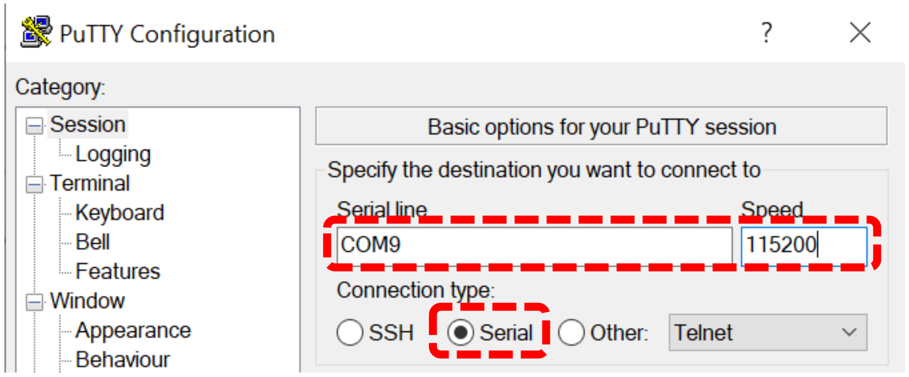
Program : sprejem na PC strani (povezava z dodatnim Micro-USB kablom)



Upravitelj naprav

Datoteka Dejanje Pogled Pomoč

- Omrežne kartice
- Prenosne naprave
- Procesorji
- Računalnik
- Sistemske naprave
- Software components
- Tipkovnice
- USB Connector Managers
- Varnostne naprave
- Vdelana programska oprema
- Vnosne naprave (HID)
- Vrata (COM in LPT)
  - Standard Serial over Bluetooth link (COM5)
  - Standard Serial over Bluetooth link (COM6)
  - STMicroelectronics STLink Virtual COM Port (COM8)
  - USB Serial Device (COM9)
- Zasloni
- Zvočni vhodi in izhodi



PuTTY Configuration

Category:

- Session
  - Logging
- Terminal
  - Keyboard
  - Bell
  - Features
- Window
  - Appearance
  - Behaviour

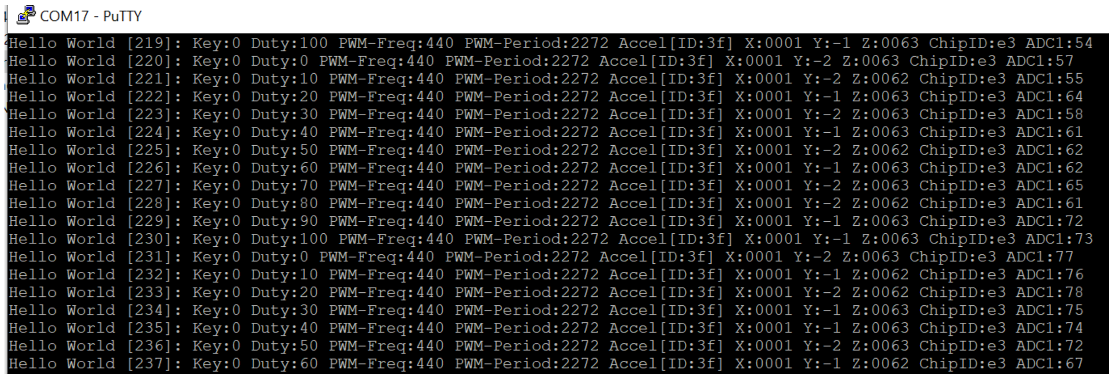
Basic options for your PuTTY session

Specify the destination you want to connect to

Serial line: COM9

Speed: 115200

Connection type: SSH [✓ Serial] Other: Telnet



COM17 - PuTTY

```
Hello World [219]: Key:0 Duty:100 PWM-Freq:440 PWM-Period:2272 Accel[ID:3f] X:0001 Y:-1 Z:0063 ChipID:e3 ADC1:54
Hello World [220]: Key:0 Duty:0 PWM-Freq:440 PWM-Period:2272 Accel[ID:3f] X:0001 Y:-2 Z:0063 ChipID:e3 ADC1:57
Hello World [221]: Key:0 Duty:10 PWM-Freq:440 PWM-Period:2272 Accel[ID:3f] X:0001 Y:-2 Z:0062 ChipID:e3 ADC1:55
Hello World [222]: Key:0 Duty:20 PWM-Freq:440 PWM-Period:2272 Accel[ID:3f] X:0001 Y:-1 Z:0063 ChipID:e3 ADC1:64
Hello World [223]: Key:0 Duty:30 PWM-Freq:440 PWM-Period:2272 Accel[ID:3f] X:0001 Y:-2 Z:0063 ChipID:e3 ADC1:58
Hello World [224]: Key:0 Duty:40 PWM-Freq:440 PWM-Period:2272 Accel[ID:3f] X:0001 Y:-1 Z:0063 ChipID:e3 ADC1:61
Hello World [225]: Key:0 Duty:50 PWM-Freq:440 PWM-Period:2272 Accel[ID:3f] X:0001 Y:-2 Z:0062 ChipID:e3 ADC1:62
Hello World [226]: Key:0 Duty:60 PWM-Freq:440 PWM-Period:2272 Accel[ID:3f] X:0001 Y:-1 Z:0063 ChipID:e3 ADC1:62
Hello World [227]: Key:0 Duty:70 PWM-Freq:440 PWM-Period:2272 Accel[ID:3f] X:0001 Y:-2 Z:0063 ChipID:e3 ADC1:65
Hello World [228]: Key:0 Duty:80 PWM-Freq:440 PWM-Period:2272 Accel[ID:3f] X:0001 Y:-2 Z:0062 ChipID:e3 ADC1:61
Hello World [229]: Key:0 Duty:90 PWM-Freq:440 PWM-Period:2272 Accel[ID:3f] X:0001 Y:-1 Z:0063 ChipID:e3 ADC1:72
Hello World [230]: Key:0 Duty:100 PWM-Freq:440 PWM-Period:2272 Accel[ID:3f] X:0001 Y:-1 Z:0063 ChipID:e3 ADC1:73
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Hello World [232]: Key:0 Duty:10 PWM-Freq:440 PWM-Period:2272 Accel[ID:3f] X:0001 Y:-1 Z:0062 ChipID:e3 ADC1:76
Hello World [233]: Key:0 Duty:20 PWM-Freq:440 PWM-Period:2272 Accel[ID:3f] X:0001 Y:-2 Z:0062 ChipID:e3 ADC1:78
Hello World [234]: Key:0 Duty:30 PWM-Freq:440 PWM-Period:2272 Accel[ID:3f] X:0001 Y:-1 Z:0063 ChipID:e3 ADC1:75
Hello World [235]: Key:0 Duty:40 PWM-Freq:440 PWM-Period:2272 Accel[ID:3f] X:0001 Y:-1 Z:0063 ChipID:e3 ADC1:74
Hello World [236]: Key:0 Duty:50 PWM-Freq:440 PWM-Period:2272 Accel[ID:3f] X:0001 Y:-2 Z:0063 ChipID:e3 ADC1:72
Hello World [237]: Key:0 Duty:60 PWM-Freq:440 PWM-Period:2272 Accel[ID:3f] X:0001 Y:-1 Z:0062 ChipID:e3 ADC1:67
```

VIN projekt - VP6: STM32F4 VIN Demo

- Osvežitev: STM32F4

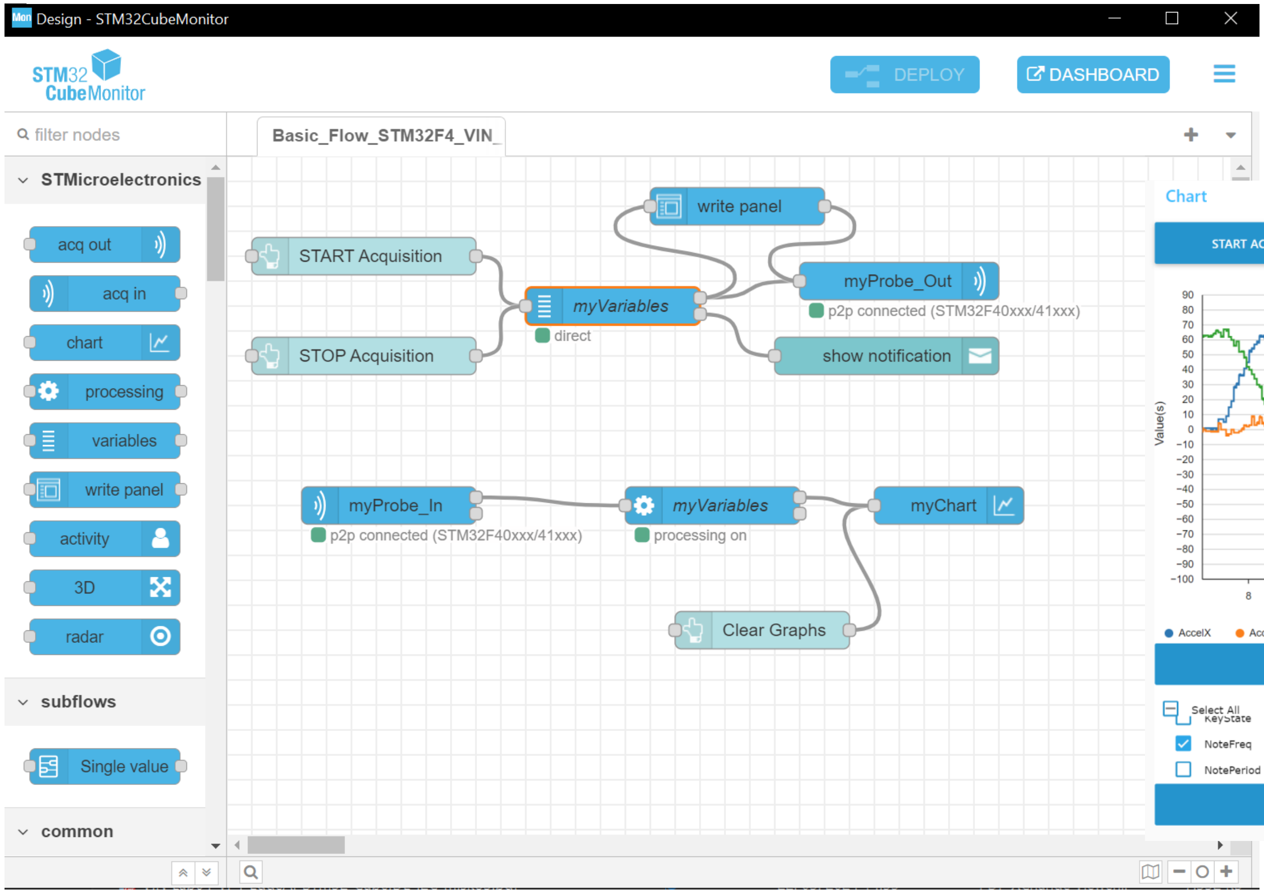
- CubeIDE projekt STM32F4 in V/I naprave :
  - CubeIDE projekt, GPIO in VCOM port
  - PWM - LED dimmer, brenčač
  - SPI - LIS3DSH pospeškomer
  - I2C - CS43L22 zvočni čip
  - ADC

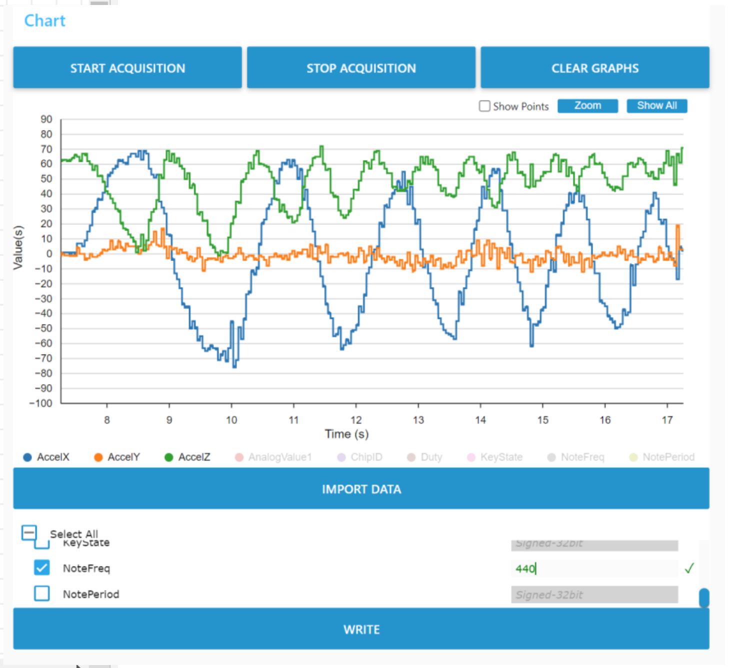
- Sledenje („tracing“) - CubeMonitor, osciloskop

STM32CubeMonitor

STM32CubeMonitor is a tool that allows real-time sampling and visualization of user variables while the application is running. It runs on Windows, Linux or macOS, and provides a browser-based interface.

The user can define their own flow to monitor variables for their STM32 microcontroller-based application. Example design and dashboard views are shown below.





https://wiki.stmicroelectronics.cn/stm32mcu/wiki/Category:STM32CubeMonitor

STM32F4

VIN projekt - VP 6 STM32-CubeIDE projekt

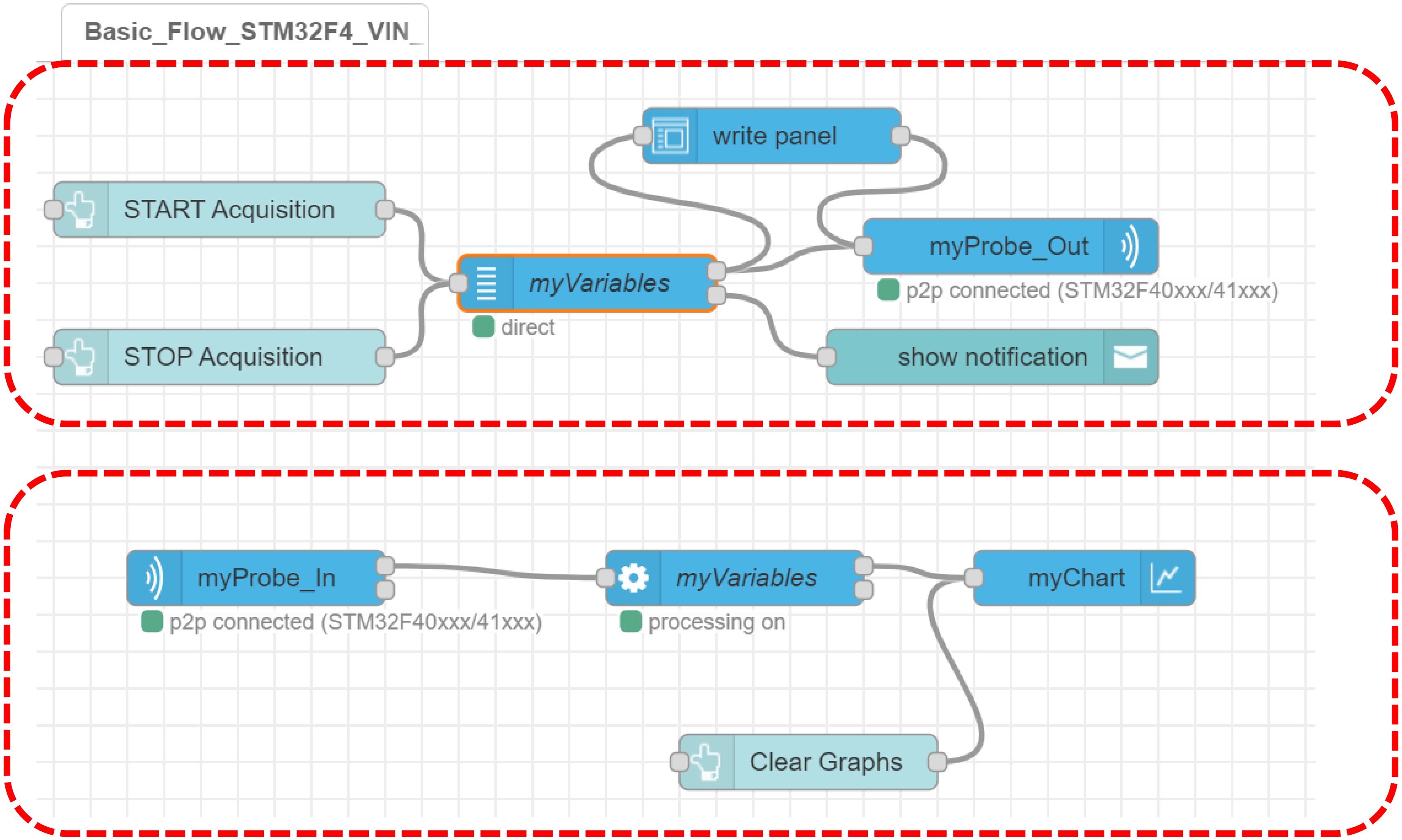
Program : za demonstracijo različnih funkcionalnosti – ADC, PWM – LED, Buzzer, SPI - Accel, I2C - audio

```
/* Infinite loop */
/* USER CODE BEGIN WHILE */
        while (1)
        {
        htim4.Instance->CCR1 = Duty;
        htim4.Instance->CCR2 = 100-Duty;
        htim4.Instance->CCR3 = Duty;
        htim4.Instance->CCR4 = 100-Duty;

        KeyState = HAL_GPIO_ReadPin(GPIOA, GPIO_PIN_0);

        // Read x,y,z axes
        outdata[0] = 0x29 | 0x80 ; // read x
        HAL_GPIO_WritePin(GPIOE, GPIO_PIN_3, GPIO_PIN_RESET);
        HAL_SPI_TransmitReceive(&hspi1, &outdata, &indata, 2, HAL_MAX_DELAY);
        AccelX = indata[1];

        outdata[0] = 0x2B | 0x80 ; // read y
        HAL_SPI_TransmitReceive(&hspi1, &outdata, &indata, 2, HAL_MAX_DELAY);
        AccelY = indata[1];

        outdata[0] = 0x2D | 0x80 ; // read z
        HAL_SPI_TransmitReceive(&hspi1, &outdata, &indata, 2, HAL_MAX_DELAY);
        HAL_GPIO_WritePin(GPIOE, GPIO_PIN_3, GPIO_PIN_SET);
        AccelZ = indata[1];

        HAL_ADC_PollForConversion(&hadc1, HAL_MAX_DELAY);
        AnalogValue1 = HAL_ADC_GetValue(&hadc1);
        HAL_ADC_Start(&hadc1);
/* USER CODE END WHILE */
```

```
/* USER CODE BEGIN 3 */
if ( (HAL_GetTick() - TickLast) > 1000) { // Do this each second !
Duty = (Duty + 10) ; // Add 10 if delay 1 sec, add 1 on shorter delay...
if (Duty > 100 )
Duty = 1;


// From Device with address=0x94, Read register with address 0x01 and put value
in ChipID
// DevAddress_0x94, tMemAddress=0x01, MemAddSize=8b, *pData,Size, Timeout);
retval = HAL_I2C_Mem_Read(&hi2c1, 0x94, 0x01, I2C_MEMADD_SIZE_8BIT, &ChipID, 1,
1000);


// Change Period and set 50% duty for buzzer PWM output
NotePeriod = (int)(1000000/NoteFreq); //Already prescaled to 1 MHz
setPWM(htim2, TIM_CHANNEL_1, NotePeriod, NotePeriod/2);


// Print values on USB VComPort
snprintf(SendBuffer,BUFSIZE,"Hello World [%d]: Key:%d Duty:%d PWM-Freq:%d PWM-
Period:%d Accel[ID:%02x] X:%04d Y:%d Z:%04d ChipID:%02x
ADC1:%d\r\n",Counter++,KeyState,Duty,NoteFreq,NotePeriod,lis_id,AccelX,AccelY,A
ccelZ,ChipID,AnalogValue1);
CDC_Transmit_FS(SendBuffer,strlen(SendBuffer));


TickLast = HAL_GetTick(); // Reset counter
};


// HAL_Delay(1000);
}
/* USER CODE END 3 */
}
```

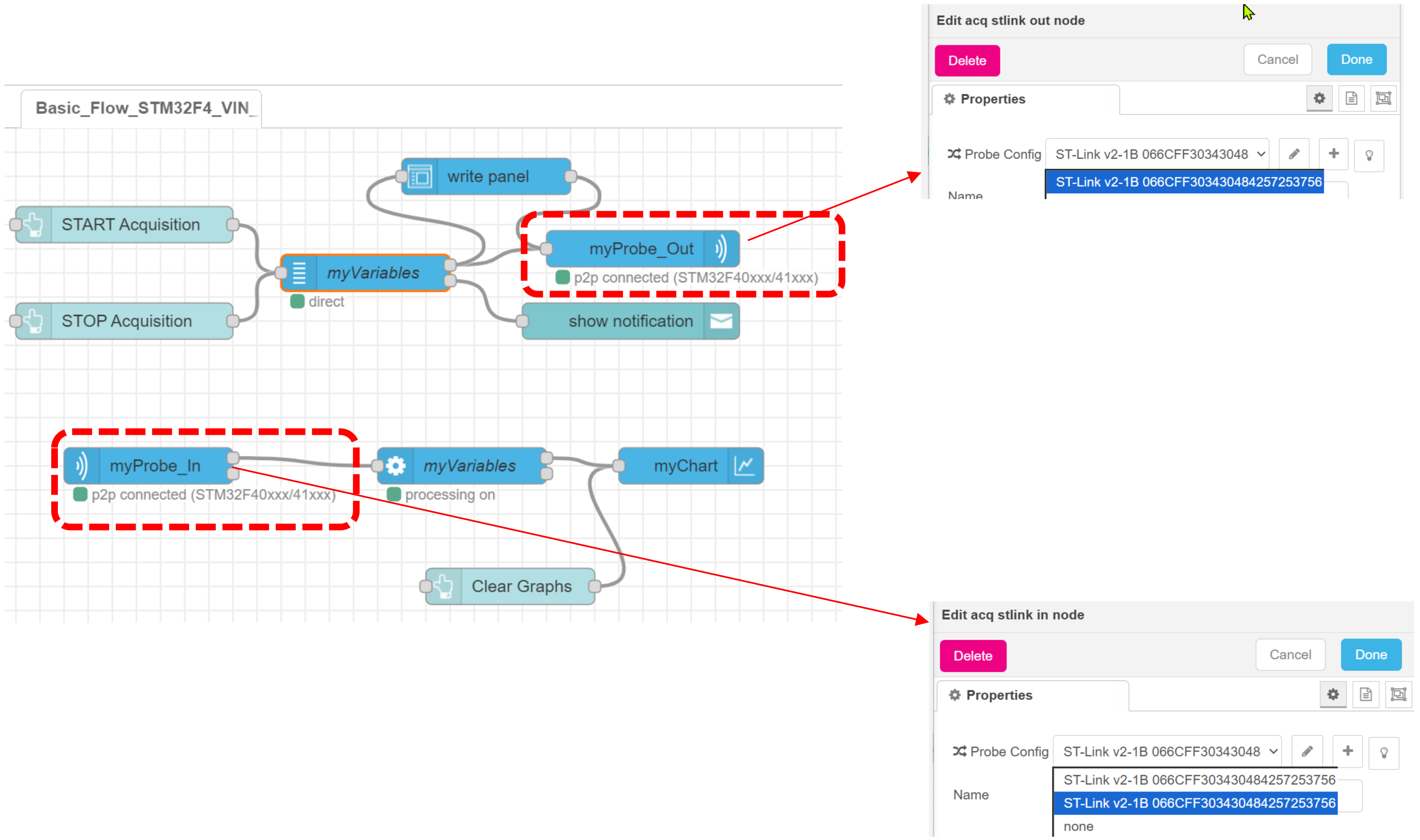
https://github.com/LAPSyLAB/STM32F4_Discovery_VIN_Projects/tree/main/STM32F4_GPIO_PWM_SPI_I2C_C_Demo

STM32CubeMonitor



https://wiki.stmicroelectronics.cn/stm32mcu/wiki/Category:STM32CubeMonitor

STM32CubeMonitor



Edit acq stlink out node

Delete Cancel Done

Properties

Probe Config: ST-Link v2-1B 066CFF30343048

ST-Link v2-1B 066CFF303430484257253756

Name

Edit acq stlink in node

Delete Cancel Done

Properties

Probe Config: ST-Link v2-1B 066CFF30343048

ST-Link v2-1B 066CFF303430484257253756

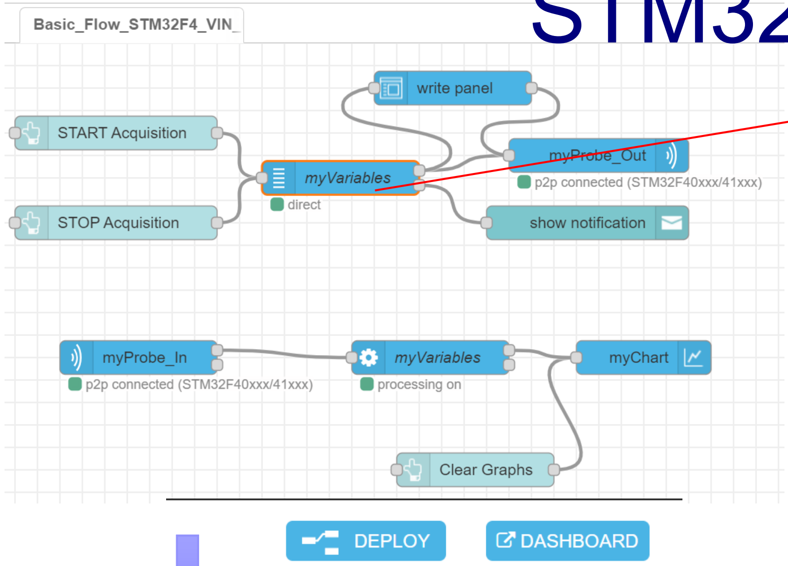
ST-Link v2-1B 066CFF303430484257253756

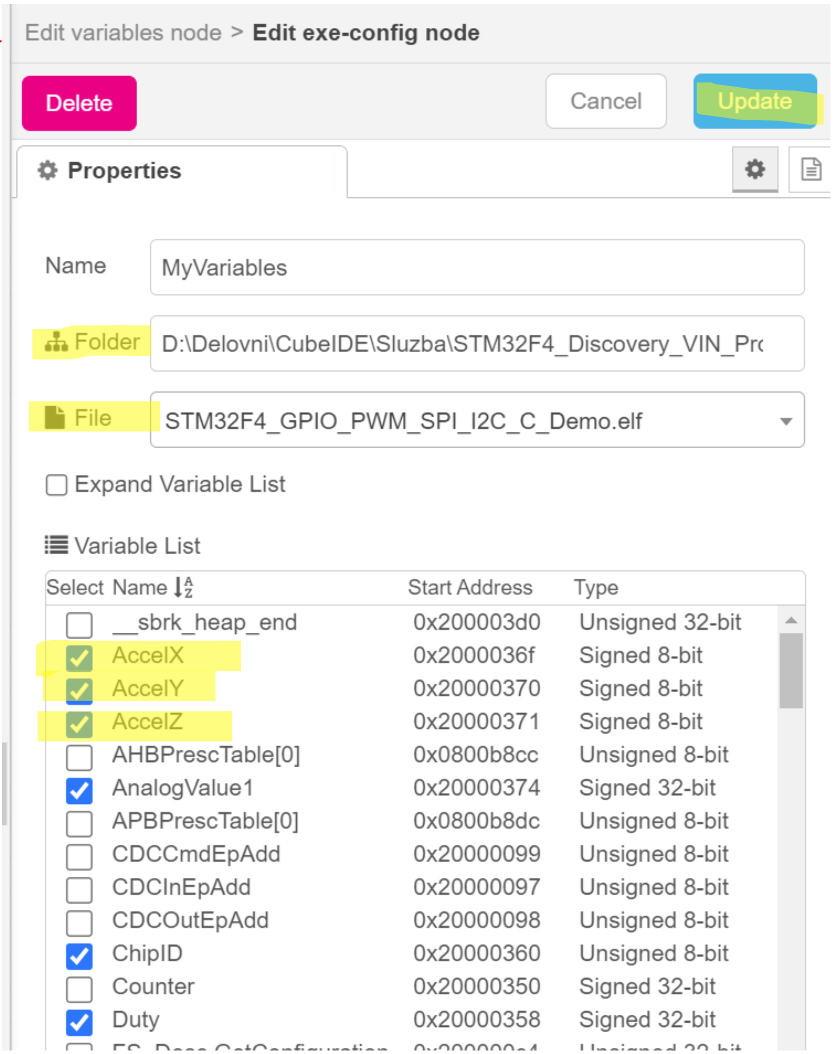
none

Name

https://wiki.stmicroelectronics.cn/stm32mcu/wiki/Category:STM32CubeMonitor

STM32CubeMonitor




Edit variables node > **Edit exe-config node**

Name: MyVariables

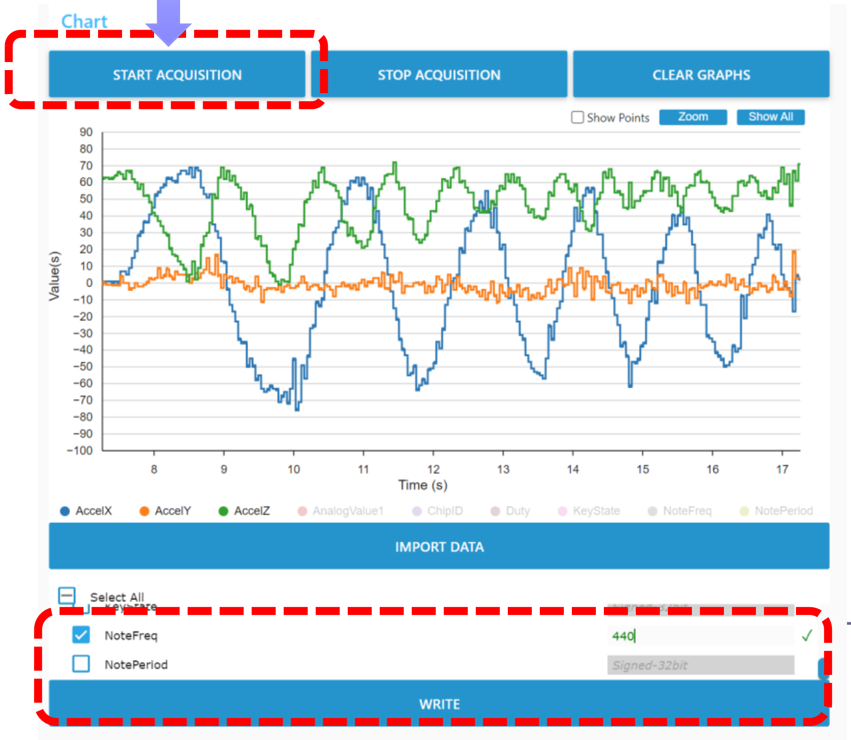
Folder: D:\Delovni\CubeIDE\Sluzba\STM32F4_Discovery_VIN_Prc

File: STM32F4_GPIO_PWM_SPI_I2C_C_Demo.elf

☐ Expand Variable List

Variable List

Select	Name	Start Address	Type
☐	__sbrk_heap_end	0x200003d0	Unsigned 32-bit
✓	AccelX	0x2000036f	Signed 8-bit
✓	AccelY	0x20000370	Signed 8-bit
✓	AccelZ	0x20000371	Signed 8-bit
☐	AHBPrescTable[0]	0x0800b8cc	Unsigned 8-bit
✓	AnalogValue1	0x20000374	Signed 32-bit
☐	APBPrescTable[0]	0x0800b8dc	Unsigned 8-bit
☐	CDCCmdEpAdd	0x20000099	Unsigned 8-bit
☐	CDCInEpAdd	0x20000097	Unsigned 8-bit
☐	CDCOutEpAdd	0x20000098	Unsigned 8-bit
✓	ChipID	0x20000360	Unsigned 8-bit
☐	Counter	0x20000350	Signed 32-bit
✓	Duty	0x20000358	Signed 32-bit



VIN projekt - VP6: STM32F4 VIN Demo

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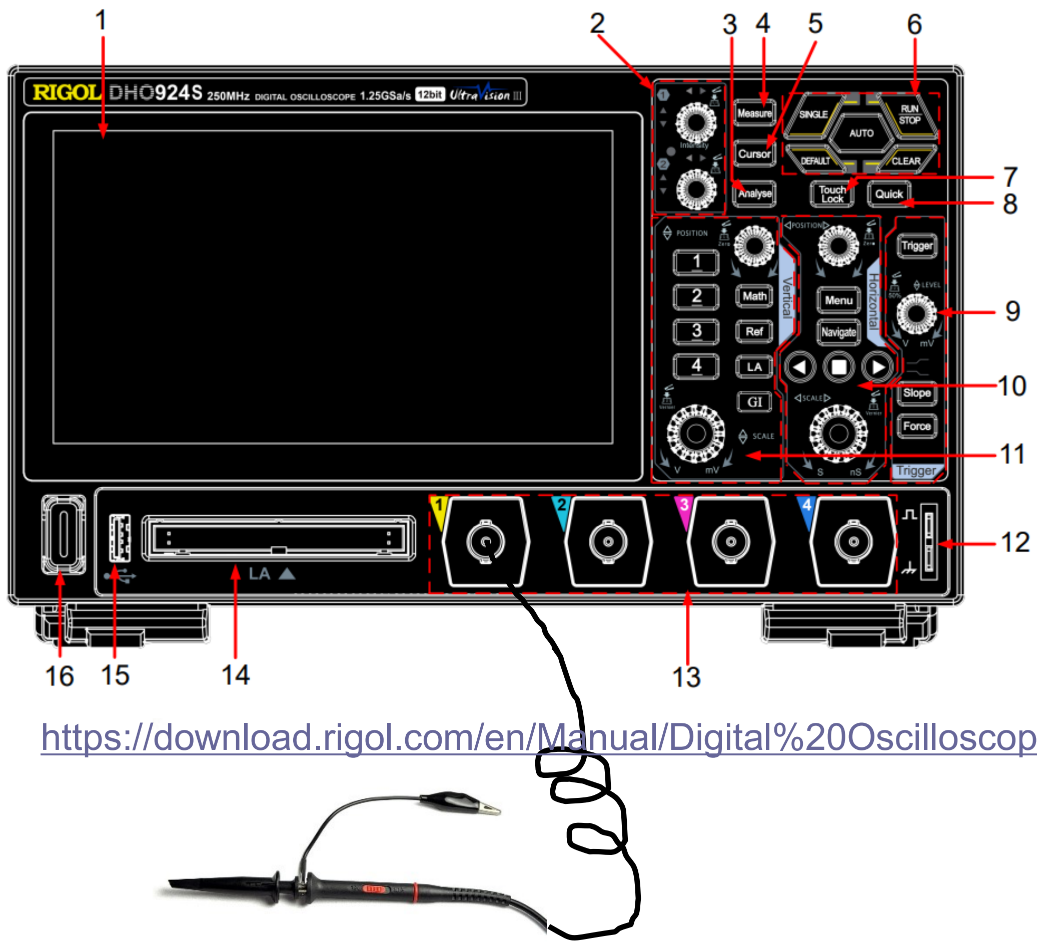
- CubeIDE projekt STM32F4 in V/I naprave :
  - CubeIDE projekt, GPIO in VCOM port
  - PWM - LED dimmer, brenčač
  - SPI - LIS3DSH pospeškomer
  - I2C - CS43L22 zvočni čip
  - ADC

- Sledenje („tracing“) - CubeMonitor, osciloskop

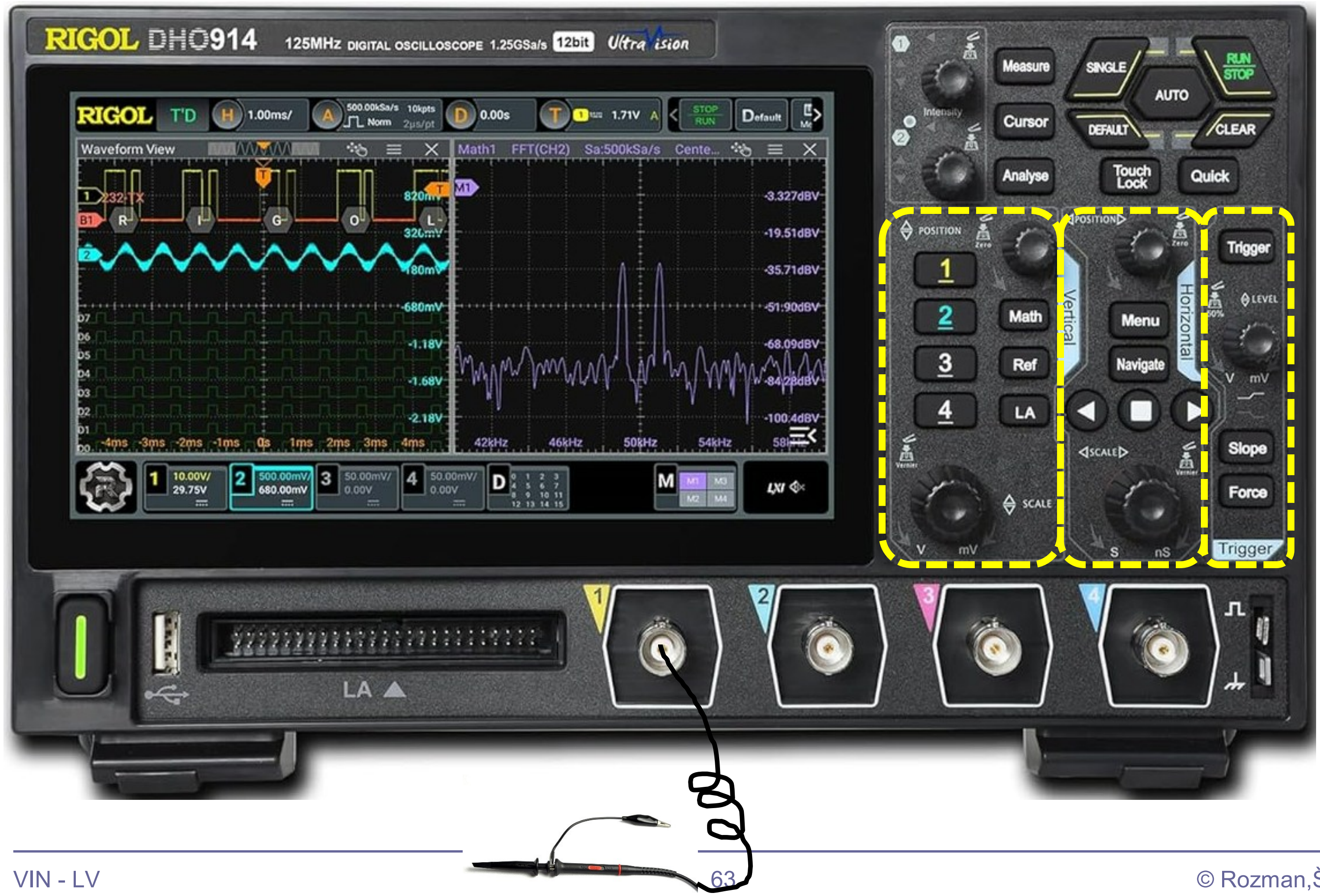
Prednja stran osciloskopa - shema



1	7'' Capacitive Touch Screen	9	Trigger Controls
2	Multipurpose Knobs	10	Horizontal Controls
3	Analyse Key	11	Vertical Controls
4	Measure Key	12	Probe Compensation Signal Output Terminal/Ground Terminal
5	Cursor Key	13	Analog Channel Input Terminals
6	Common Tools Keys	14	Digital Channel Input Terminal
7	Touch Lock Key	15	USB HOST Port
8	Quick Action Key (Self-defined function)	16	Power Key

https://download.rigol.com/en/Manual/Digital%20Oscilloscope/DHO900/DHO900_QuickGuide_EN.pdf

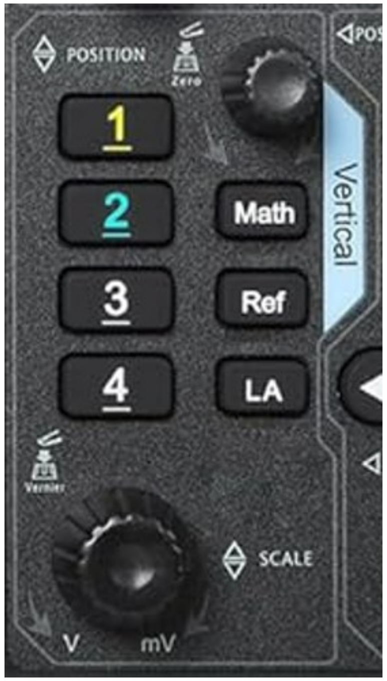
Prednja stran osciloskopa - realna



Prednja stran osciloskopa - kontrole

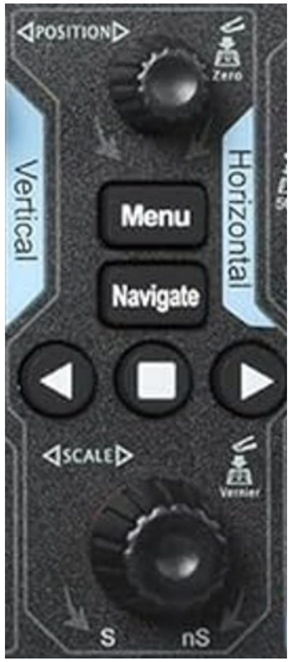
Y-os (el. napetost)

- **nastavitev merila [V/razdelek]**
- **pozicioniranje y-os**
- **prikaz kanalov da/ne**



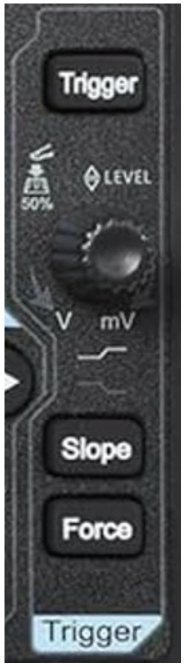
X-os (čas)

- **nastavitev merila [s/razdelek]**
- **pozicioniranje**



Prožilnik

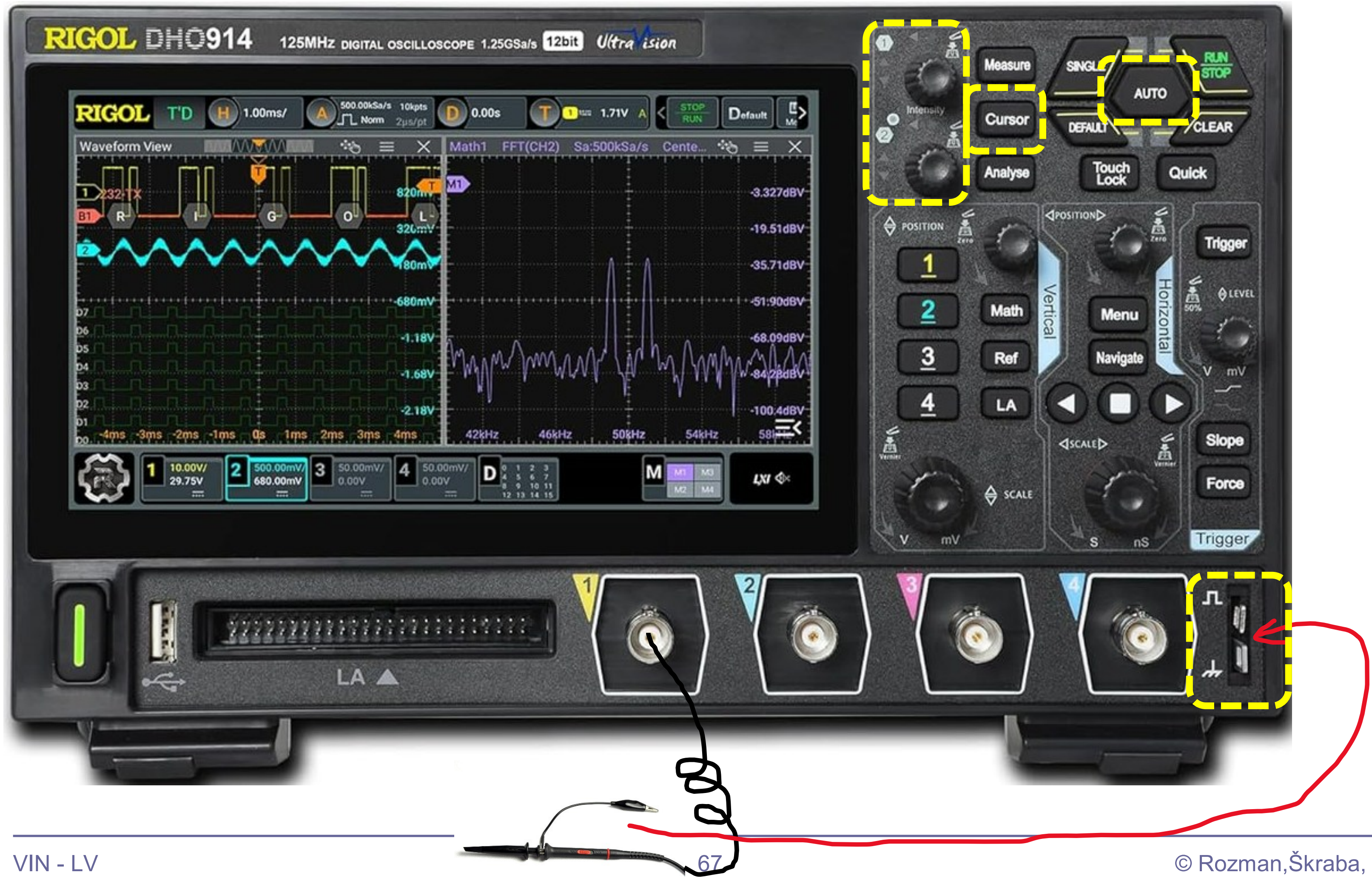
- **začetek prikaza**
- **tipično: poz. fronta in 50%**



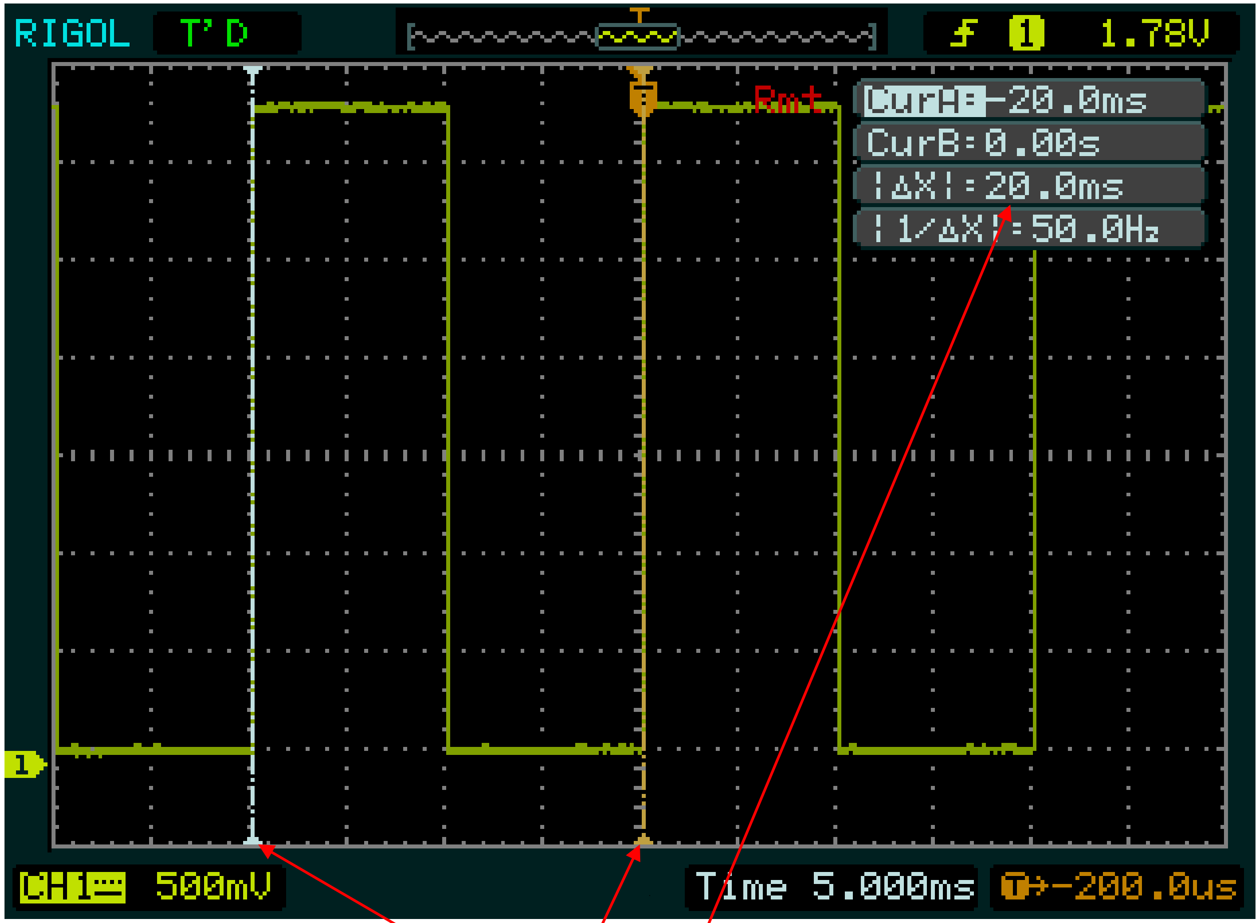
https://rigolshop.eu/dho914.html

Spoznavanje merilne opreme…

Meritev testnega signala



Testni signal – meritev periode, frekvence

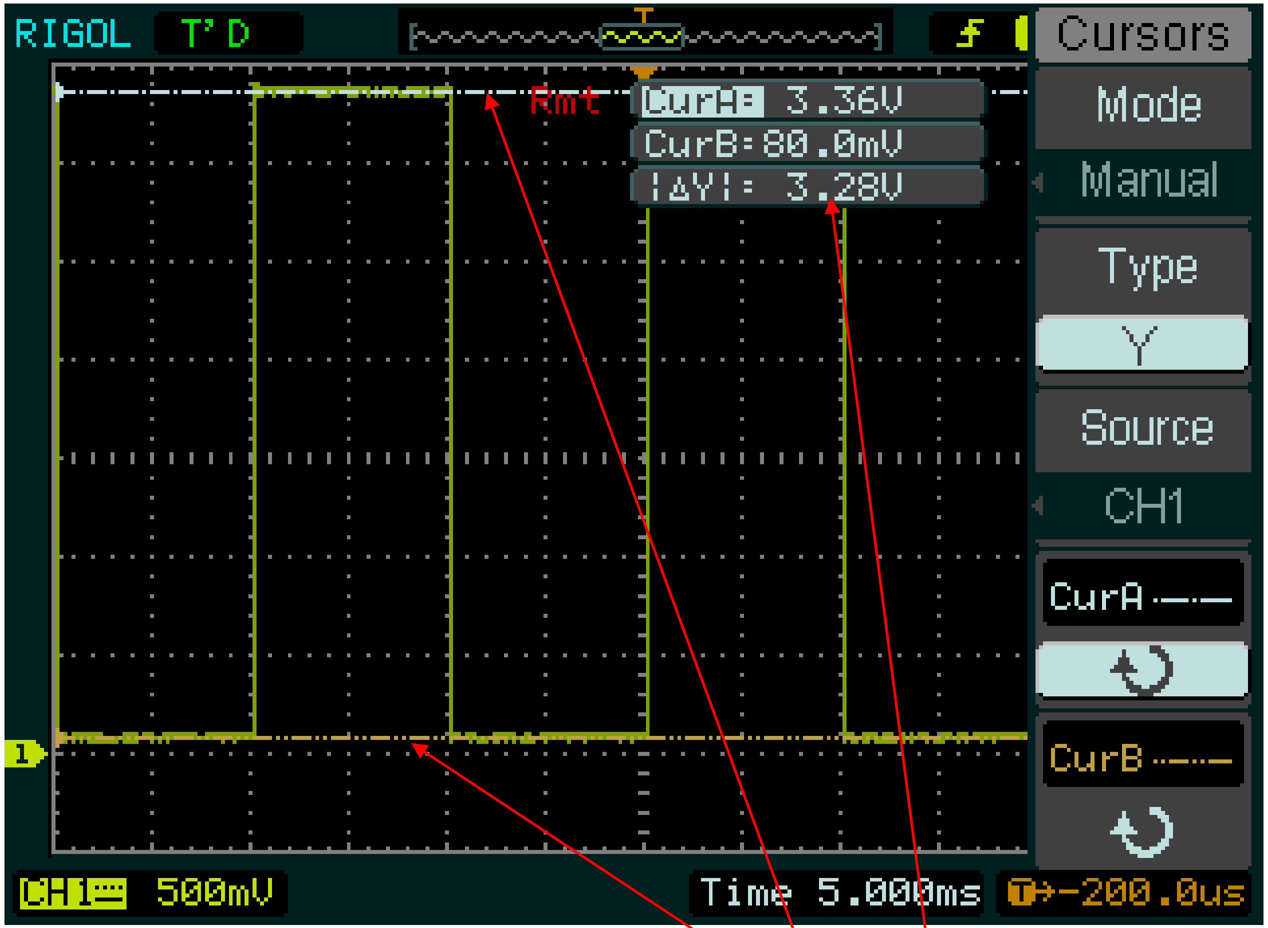


```
CurA:-20.0ms
CurB:0.00s
|ΔX|:20.0ms
|1/ΔX|:50.0Hz
```

Meritev periode/frekvence signala:

- **? ms, ? Hz**

Testni signal – meritev amplitude



CurA: 3.36V
CurB: 80.0mV
|ΔY|: 3.28V

Meritev amplitude signala:

- **? V**

STM32F4

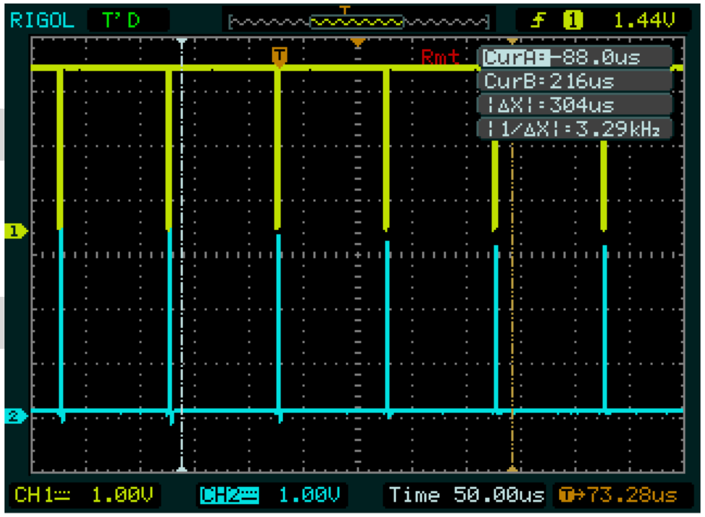
Osnovni projekt CubeIDE – GPIO – PWM, LED diode

HAL - C

```
  /* USER CODE BEGIN PV */
  #define BUFSIZE 256
  char SendBuffer[BUFSIZE];

  /* USER CODE END PV */
  /* USER CODE BEGIN 2 */

  HAL_TIM_PWM_Start(&htim4, TIM_CHANNEL_1);
  HAL_TIM_PWM_Start(&htim4, TIM_CHANNEL_2);
  HAL_TIM_PWM_Start(&htim4, TIM_CHANNEL_3);
  HAL_TIM_PWM_Start(&htim4, TIM_CHANNEL_4);

  /* USER CODE END 2 */

 /* Infinite loop */
  /* USER CODE BEGIN WHILE */
  while (1)
  {
    htim4.Instance->CCR1 = duty;
    htim4.Instance->CCR2 = 100-duty;
    htim4.Instance->CCR3 = duty;
    htim4.Instance->CCR4 = 100-duty;

    /* USER CODE END WHILE */

    /* USER CODE BEGIN 3 */
    snprintf (SendBuffer,BUFSIZE,"USB:0.1 secs. Duty=%d%%\r\n",duty);
    CDC_Transmit_FS(SendBuffer,strlen(SendBuffer));

      duty = (duty + 1) ;
      if (duty > 100 )
        duty = 0;


    HAL_Delay(100);

  }
  /* USER CODE END 3 */
```

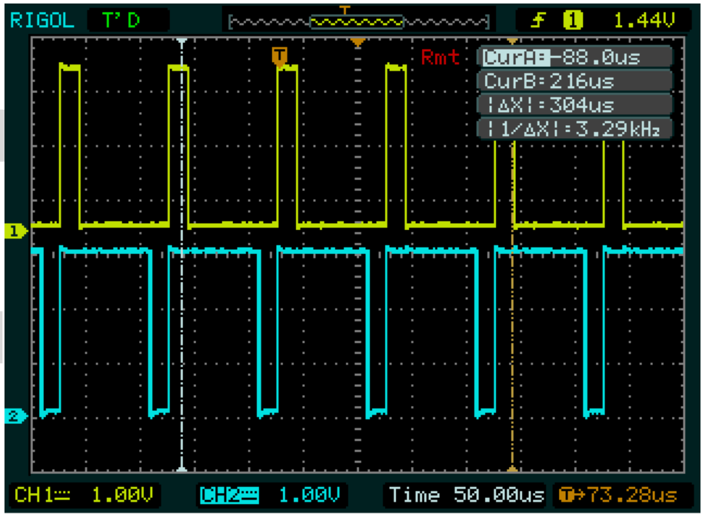
Max Duty

Min Duty



Min Duty

Max Duty



GPIO priključki :
PD12-PD15: 4 LED diode

https://github.com/LAPSyLAB/STM32F4_Discovery_VIN_Projects/tree/main/LED_PWM_Demo

VP 6 - STM32 CubeIDE, SPI in LIS3DSH - Osciloskop

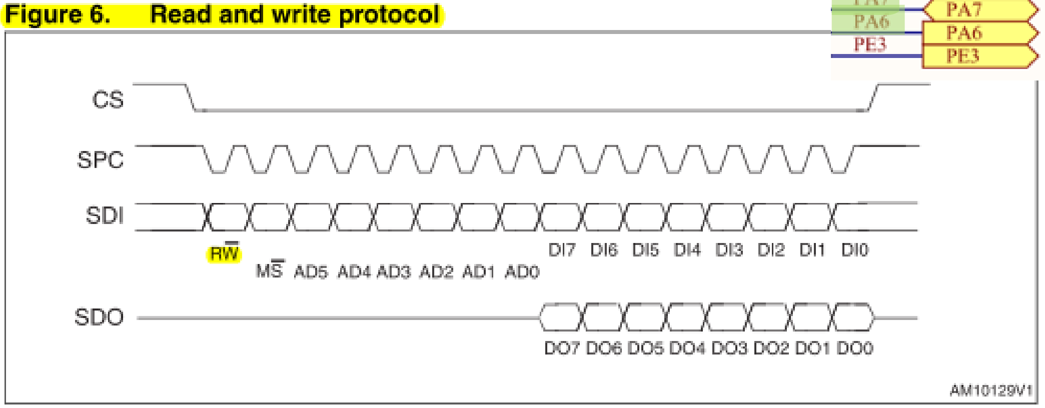
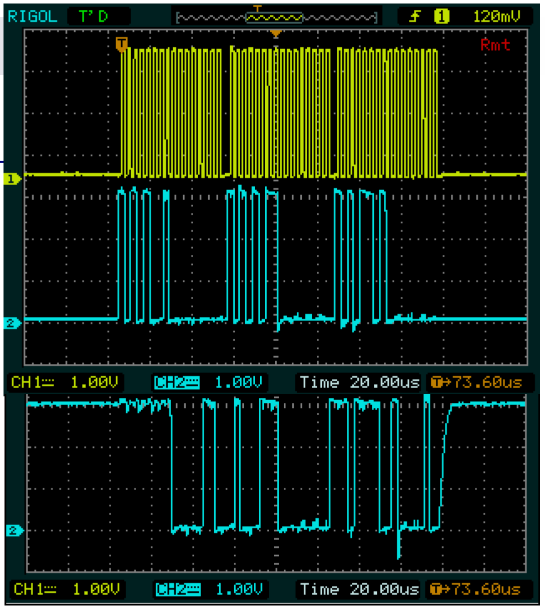


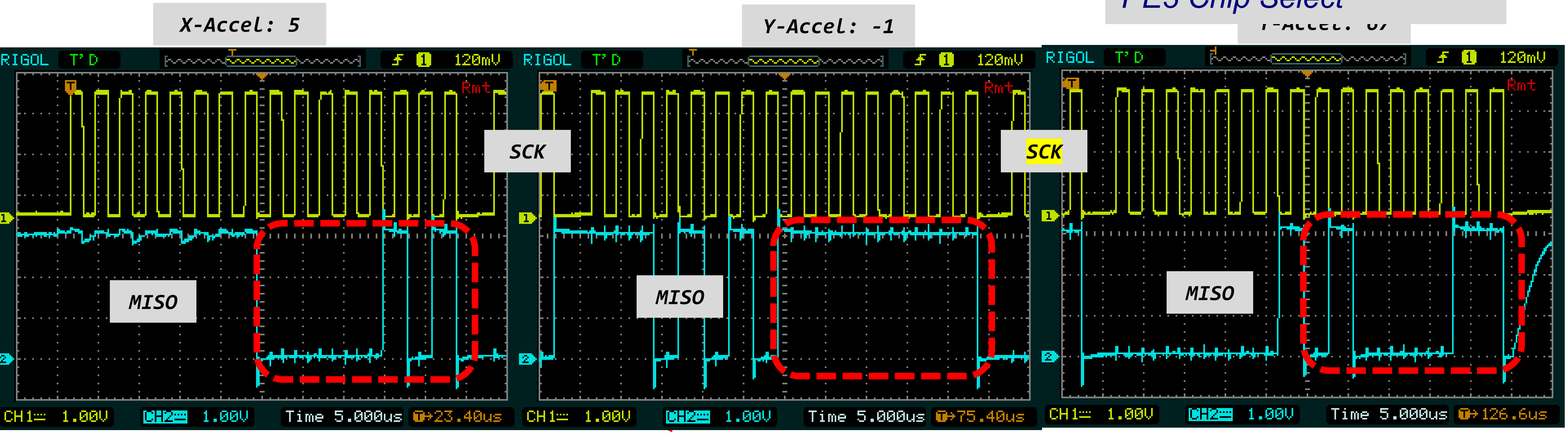
Figure 6. Read and write protocol
CS
SPC
SDI
SDO
RW
MS AD5 AD4 AD3 AD2 AD1 AD0
DI7 DI6 DI5 DI4 DI3 DI2 DI1 DI0
DO7 DO6 DO5 DO4 DO3 DO2 DO1 DO0
AM10129V1
PA5
PA7
PA6
PE3
SPI1_SCK
SPI1_MOSI
SPI1_MISO
CS_I2C/SPI



STM32F4

```
Hello World [3530]: Key:0000 Accel[ID:00] X:0005 Y:-1 Z:0066
Hello World [3531]: Key:0000 Accel[ID:00] X:0005 Y:-1 Z:0067
```

GPIO priključki :
PA5-PA7: SPI,
PE3 Chip Select



VP 4 - STM32H7 CubeIDE, I2C4 branje

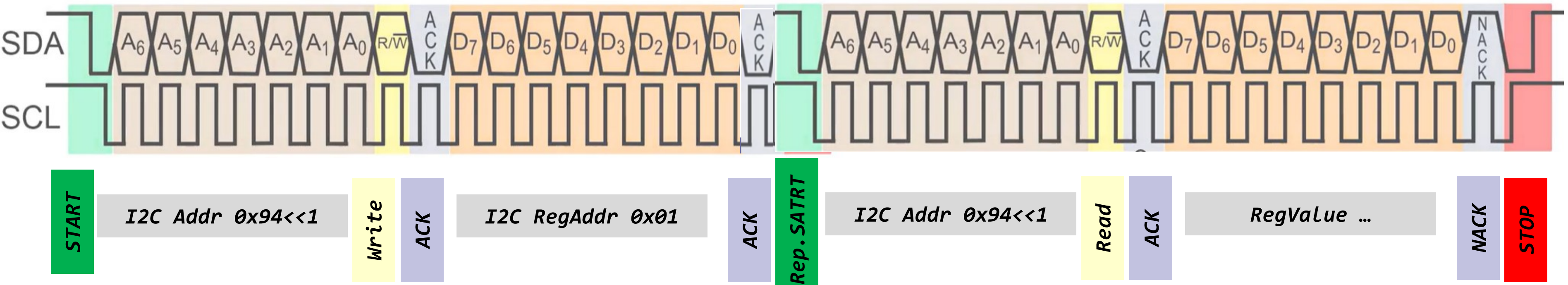
STM32F4

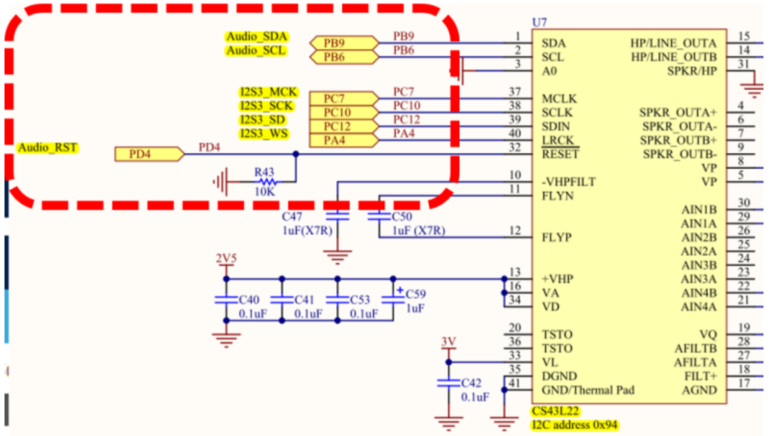
I2C branje

GPIO priključki :
PB6,9: I2C1,
PD4: Reset (1=Dev-ON)

main.c : dodana koda

```
  /* USER CODE BEGIN 2 */
  HAL_GPIO_WritePin(GPIOD, GPIO_PIN_4,GPIO_PIN_SET);   // Set Reset line to 1 (switch device on)
  HAL_Delay(1000);   // recomended by datasheet
 // From Device with address=0x94, Read register with address 0x01 and put value in ChipID
 // DevAddress_0x94, tMemAddress=0x01, MemAddSize=8b, *pData,Size, Timeout);
  retval = HAL_I2C_Mem_Read(&hi2c1, 0x94, 0x01, I2C_MEMADD_SIZE_8BIT, &ChipID, 1, 1000);
  /* USER CODE END 2 */
```


SDA
SCL
A6 A5 A4 A3 A2 A1 A0 R/W ACK D7 D6 D5 D4 D3 D2 D1 D0 ACK
A6 A5 A4 A3 A2 A1 A0 R/W ACK D7 D6 D5 D4 D3 D2 D1 D0 NACK
START
I2C Addr 0x94<<1
Write
ACK
I2C RegAddr 0x01
ACK
Rep.SATRT
I2C Addr 0x94<<1
Read
ACK
RegValue …
NACK
STOP



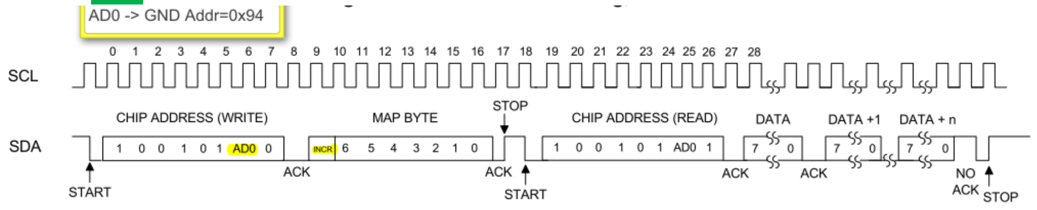
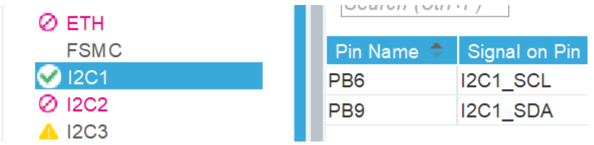


Figure 17. Control Port Timing, I²C Read



Pin Name	Signal on Pin
PB6	I2C1_SCL
PB9	I2C1_SDA

https://github.com/LAPSyLAB/STM32F4_Discovery_VIN_Projects/tree/main/STM32_I2C_CS43L22_Basic

STM32H7

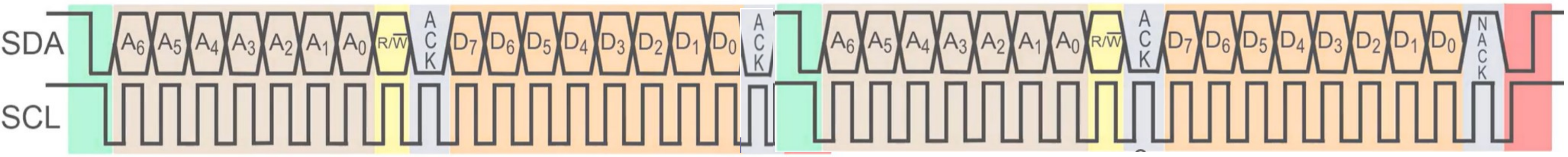
VP 4 - STM32H7 CubeIDE, I2C4 branje

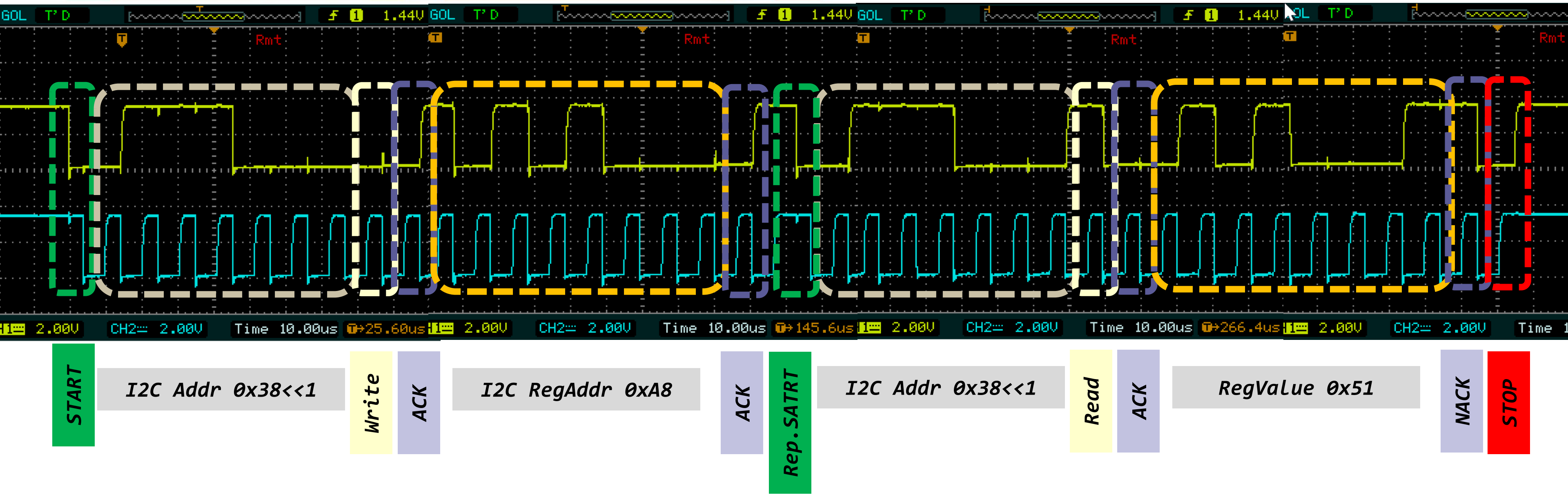
I2C branje

GPIO priključki :
PD12,13: I2C4

main.c : dodana koda

```
// Reading from address 0x38 register Vendor's Chip ID (addr. 0xA8) default value should be 0x51=81

retval = HAL_I2C_Mem_Read(&hi2c4, (0x38 << 1), 0xA8, I2C_MEMADD_SIZE_8BIT,&dataBuffer[5], 1, HAL_MAX_DELAY);
```


SDA
SCL
A6 A5 A4 A3 A2 A1 A0 R/W ACK
D7 D6 D5 D4 D3 D2 D1 D0 ACK
A6 A5 A4 A3 A2 A1 A0 R/W ACK
D7 D6 D5 D4 D3 D2 D1 D0 NACK



https://github.com/LAPSyLAB/STM32H7_Discovery_VIN_Projects/tree/main/STM32H750B-DK_I2C_Basic_Demo

VIN projekt - VP6: STM32-breadboard vezave

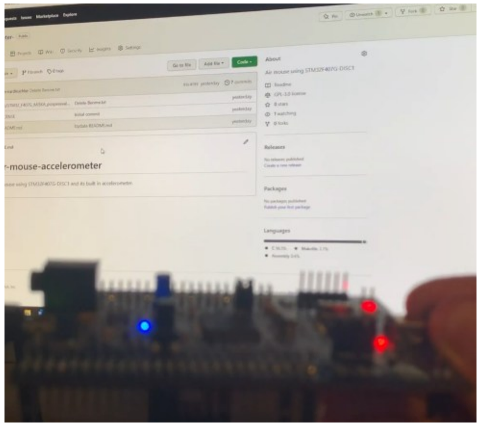
- Osvežitev: STM32 breadboard vezave
- Osciloskop
- Uporaba osciloskopa – VP4 :
  - SPI
  - PWM
  - I2C

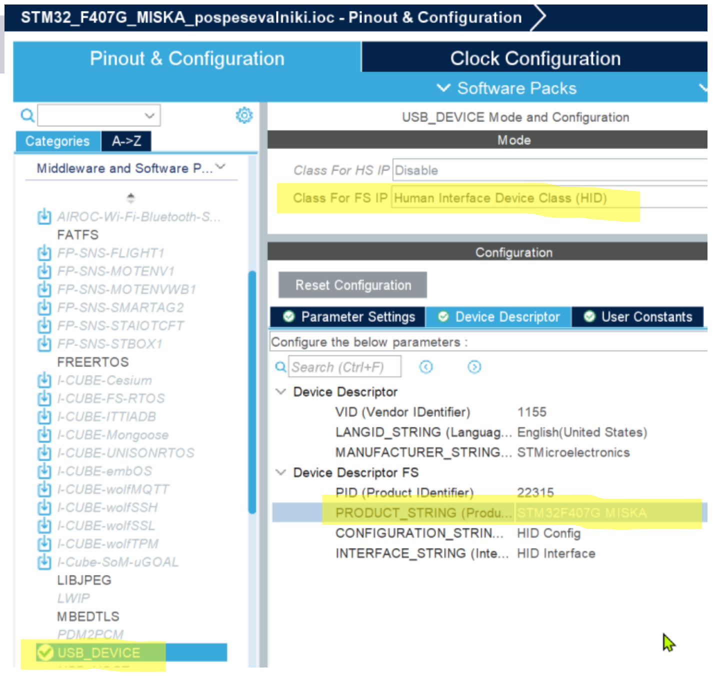
- VIN Projekt – STM32F4 (AirMouse, Wav-audio), Smarteh

AirMouse STM32F4

Beremo pospeškomer in sporočamo premike kazalca na zaslonu preko ustreznega USB HID profila
Avtor: Bernard Kuchler

```c
while (1)
{

// Read accel values into AccelX,Y,Z

if (AccelX < min_xval){
newxval = AccelX - min_xval;
} else if (AccelX > max_xval) {
newxval = AccelX - max_xval;
}

if (AccelY < min_yval){
newyval = AccelY - min_yval;
} else if (AccelY > max_yval){
newyval = AccelY - max_yval;
}

if ((newxval > 10) || (newxval <-10)) //Determines the necessary
amount of change in value from the sensor to start moving the mouse
cursor
{
mousehid.mouse_y = (newxval/10); //Divides the value from the
sensor by 10 in order to make a slower acceleration of the mouse
cursor and thereby making it more accurate to use
}
else mousehid.mouse_y = 0;


if ((newyval > 10) || (newyval <-10)) {
mousehid.mouse_x= (newyval)/10;
} else mousehid.mouse_x = 0;
…
USBD_HID_SendReport(&hUsbDeviceFS,&mousehid, sizeof (mousehid));
//Send data to USB
```





STM32_F407G_MISKA_pospesevalniki.ioc - Pinout & Configuration

Pinout & Configuration | Clock Configuration | Software Packs

Categories | A->Z

Middleware and Software P...

AIROC-Wi-Fi-Bluetooth-S...
FATFS
FP-SNS-FLIGHT1
FP-SNS-MOTENV1
FP-SNS-MOTENVWB1
FP-SNS-SMARTAG2
FP-SNS-STAIOTCFT
FP-SNS-STBOX1
FREERTOS
I-CUBE-Cesium
I-CUBE-FS-RTOS
I-CUBE-ITTIADB
I-CUBE-Mongoose
I-CUBE-UNISONRTOS
I-CUBE-embOS
I-CUBE-wolfMQTT
I-CUBE-wolfSSH
I-CUBE-wolfSSL
I-CUBE-wolfTPM
I-Cube-SoM-uGOAL
LIBJPEG
LWIP
MBEDTLS
PDM2PCM
USB_DEVICE

USB_DEVICE Mode and Configuration

Mode

Class For HS IP: Disable
Class For FS IP: Human Interface Device Class (HID)

Configuration

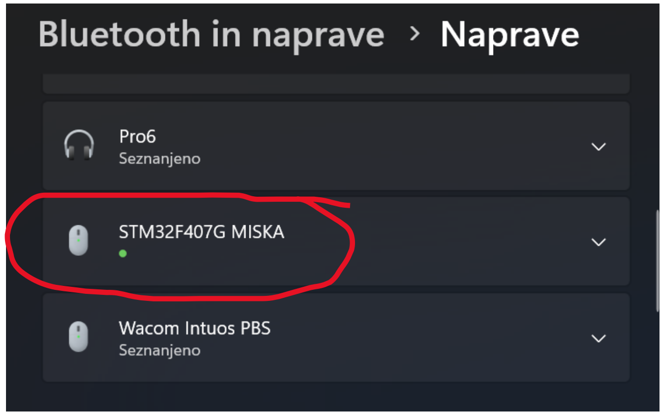
Reset Configuration

Parameter Settings | Device Descriptor | User Constants

Configure the below parameters :

Search (Ctrl+F)

Device Descriptor	
VID (Vendor IDentifier)	1155
LANGID_STRING (Languag...	English(United States)
MANUFACTURER_STRING...	STMicroelectronics
Device Descriptor FS	
PID (Product IDentifier)	22315
PRODUCT_STRING (Produ...	STM32F407G MISKA
CONFIGURATION_STRIN...	HID Config
INTERFACE_STRING (Inte...	HID Interface



Bluetooth in naprave > Naprave

Pro6
Seznanjeno

STM32F407G MISKA

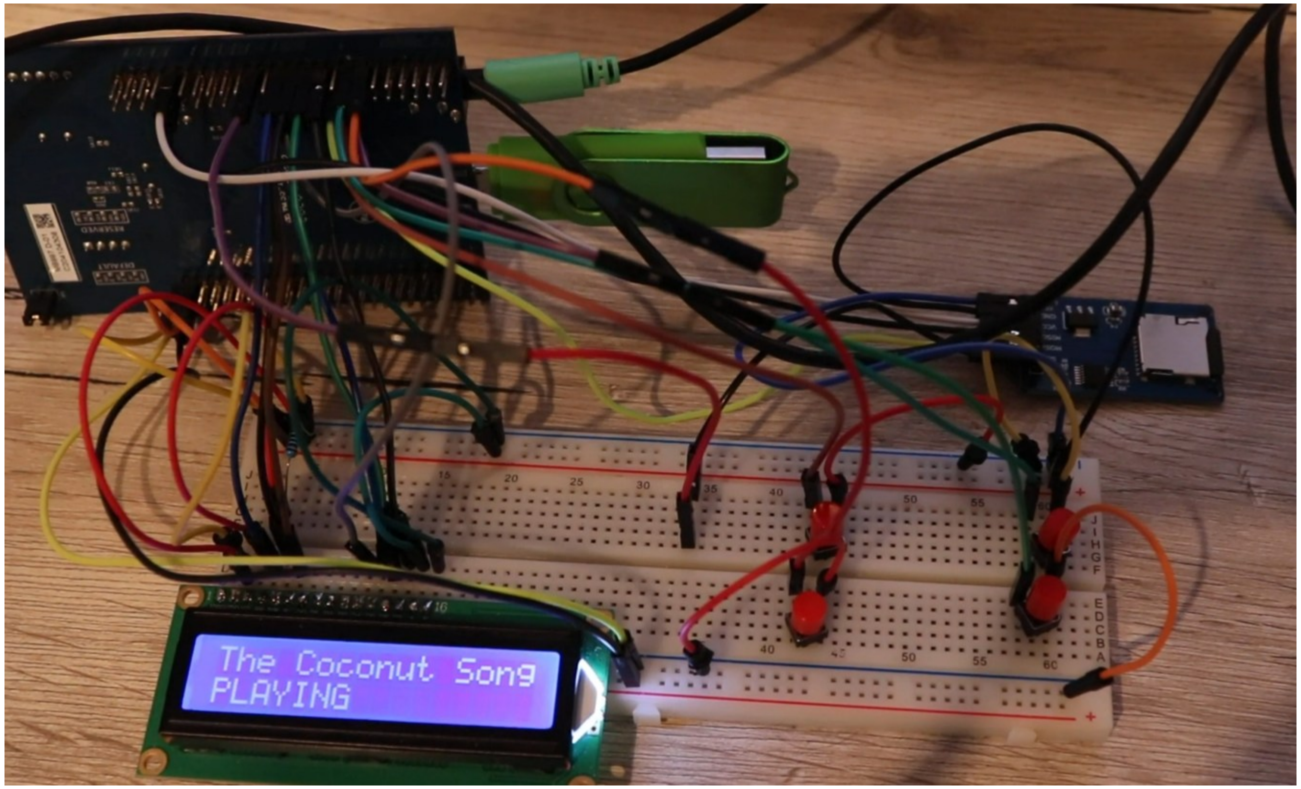
Wacom Intuos PBS
Seznanjeno

https://github.com/LAPSyLAB/STM32F4_Docs_and_Examples/tree/main/STM32_F407G_MISKA_pospesevalniki

Primer kompleksnejše demo USB-Audio aplikacije :

"Wave player - Predvajalnik .wav datotek iz USB ključka na izhod za slušalke„

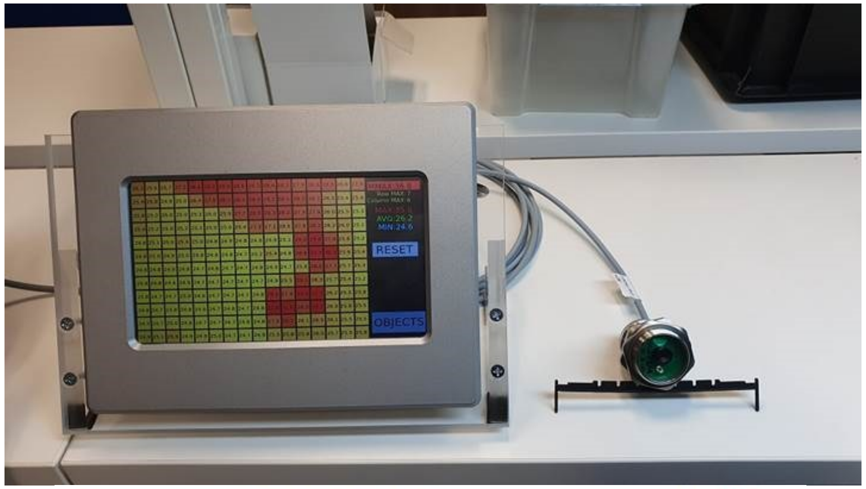
Avtor: Matic Pristavnik Vrešnjak

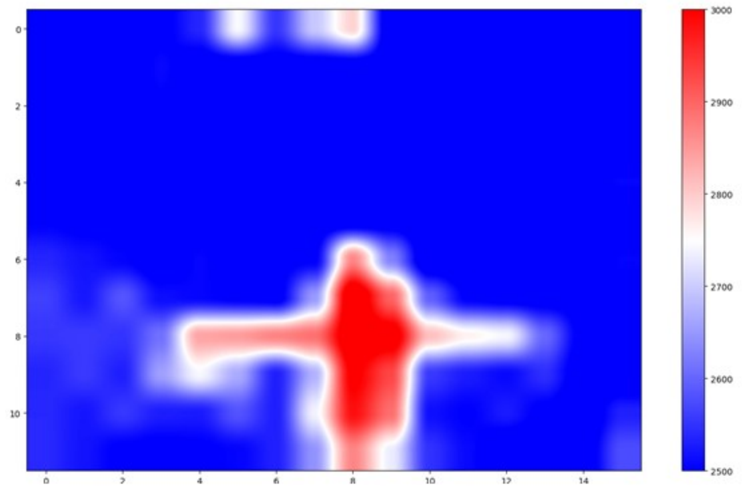


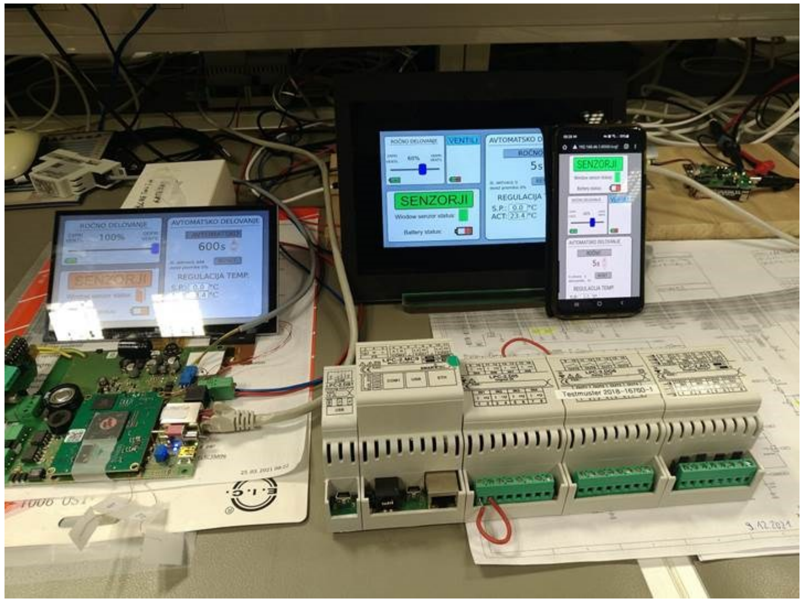
https://github.com/LAPSyLAB/STM32F4_Docs_and_Examples/tree/main/STM32_Wav_Player_SD_USB

Smarteh

Matrični senzorji (LIR, LIDAR)







Osnovni PLC komplet za uporabo :
- Model pametne hiše
- VIN LAB vaje
  - RS485, Modbus, osciloskopi, …

VIN projekt - VP5: STM32-Edge computing, CubeIDE projekti, Miško3

- Diskusija, vprašanja ?