# Vhodno izhodne naprave

## Laboratorijska vaja 12

## Tipala in signali – praktični izzivi

# Laboratorijska vaja 12
# LV5: Tipala in signali – praktični izzivi

- 12a: LV5a : Tipala in signali – meritve
  a) Meritev karakteristične upornosti linije z multimetrom ($R_0$)
  b) Preizkusi različnih tipal (IR,UZ razdalja, PIR, Hall, …)
  c) Meritve deformacij UTP kabla
  d) *LV2-4 - Presluh – meritve na ploščatem kablu

- 12b: LV5b : STM32H7 – Generator signalov
  a) UART PB14
  b) PWM PA3
  c) SPI PD3(SCK), PI3 (MOSI)
  d) I2C PD12(SCL), PD13(SDA)
  e) CANBUS CN1 (FDCAN1: CAN-L, CAN-H

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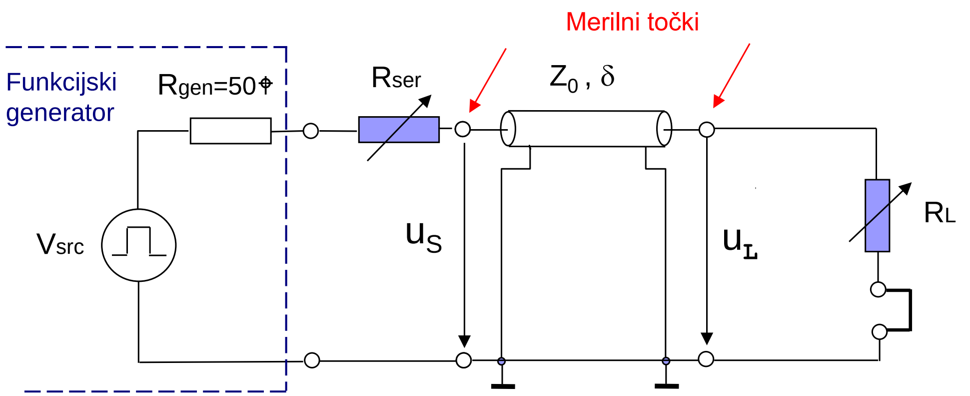
- 12b: LV5b : STM32H7 – Generator signalov

| | | |
|---|---|---|
| a) | UART | PB14 |
| b) | PWM | PA3 |
| c) | SPI | PD3(SCK), PI3 (MOSI) |
| d) | I2C | PD12(SCL), PD13(SDA) |
| e) | CANBUS | CN1 (FDCAN1: CAN-L, CAN-H |

# LV1*: Meritev karakteristične upornosti prenosne linije

***Izziv:*** ali bi lahko z multimetrom in dano opremo lahko določili karakteristično upornost linije ?




Podan je komplet kablov in opreme z multimetrom. Razmislite ali je mogoče s tem kompletom določiti karakteristično upornost linije in če je mogoče, opišite vse podrobnosti. Sicer utemeljite nasprotni odgovor.


# Laboratorijska vaja 12
# Tipala in signali – praktični izzivi

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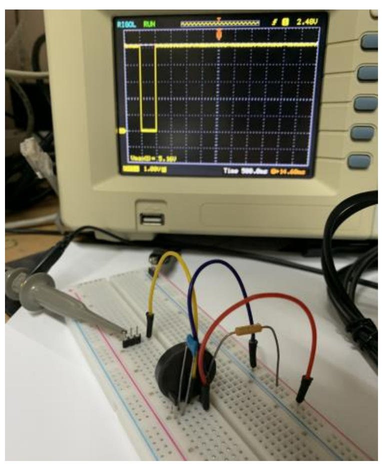
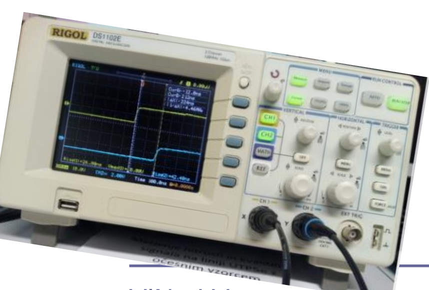
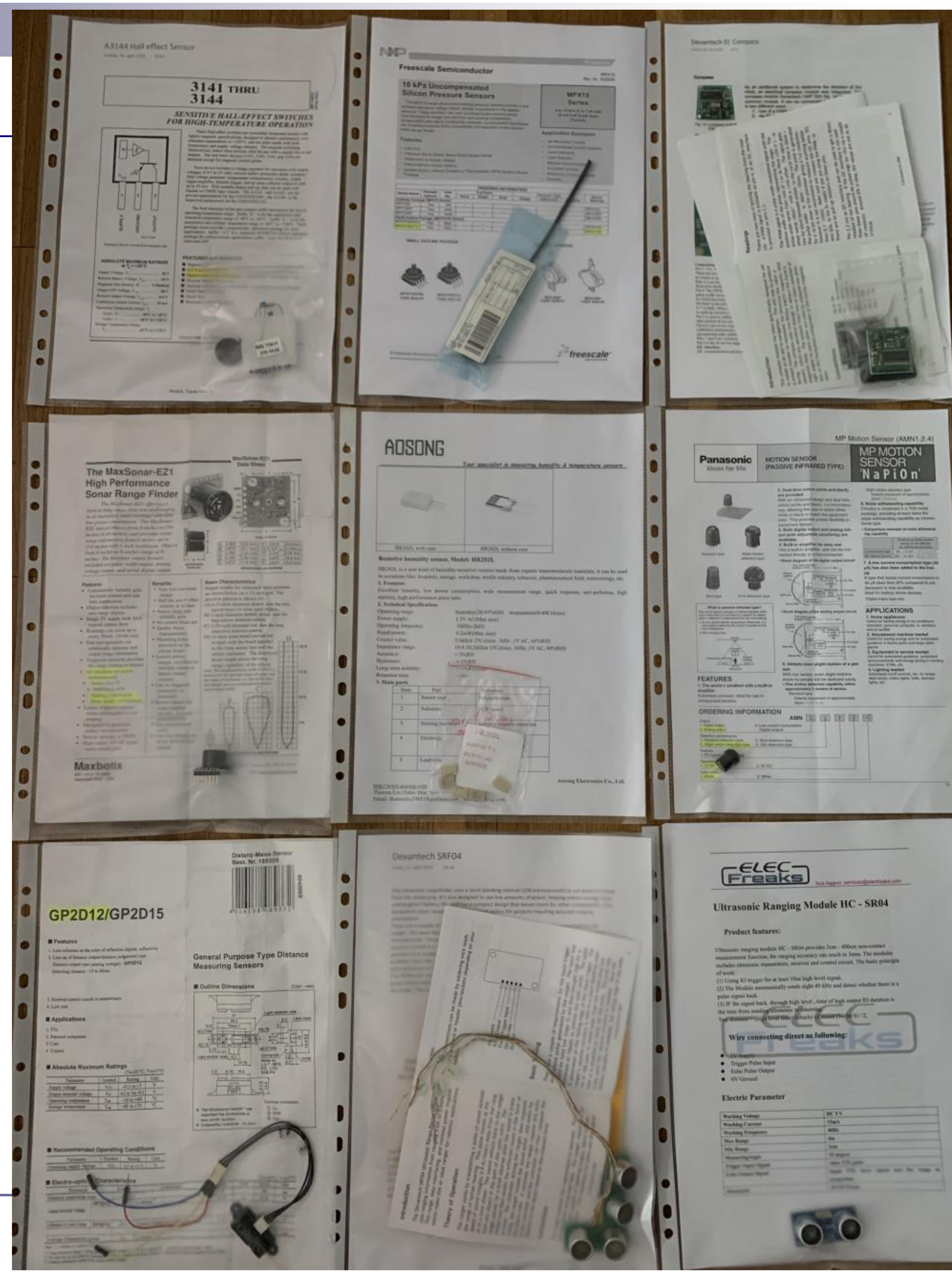
## Preizkusi različnih tipal

# Tipala: IR,UZ razdalja, PIR, Hall, …)

***Izziv:*** z ustreznimi orodji (osciloskop, generator, …) preizkusite in opišite delovanje različnih vrst tipal po lastni izbiri.

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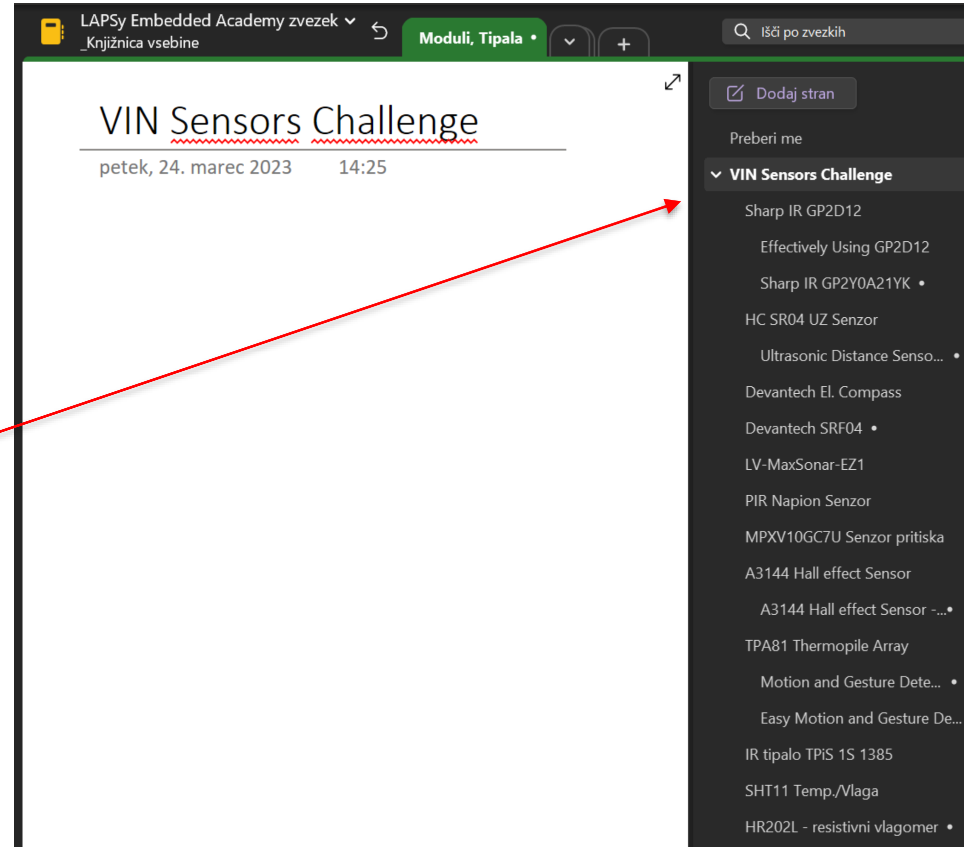
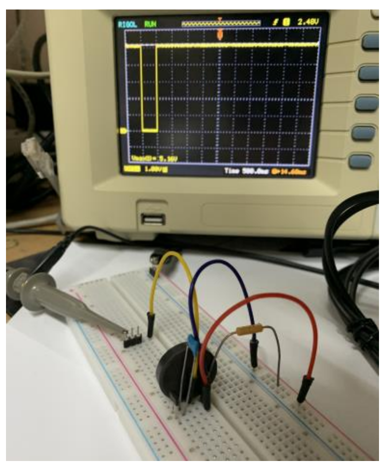
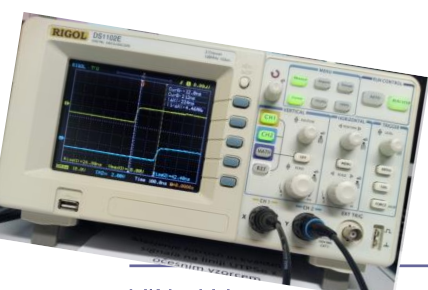








## MB1010 LV-MaxSonar-EZ1

MB1010 Datasheet

Ranges from 6 inches to 254 inches with a 20Hz read rate. Wide detection field. Excellent for people detection.

*Z naslova <https://maxbotix.com/products/mb1010>*

LV-MaxSonar® - EZ™ Series

# LV-MaxSonar®-EZ™ Series

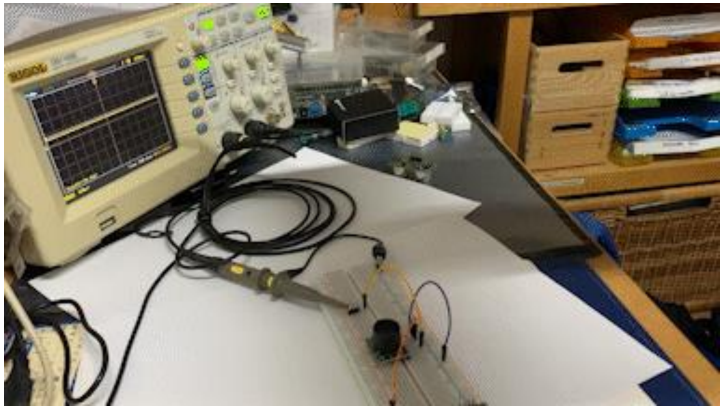
### High Performance Sonar Range Finder

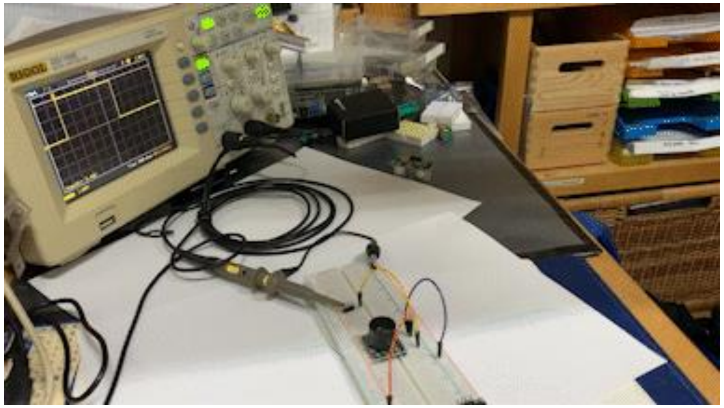
**MB1000, MB1010, MB1020, MB1030, MB1040**[2]

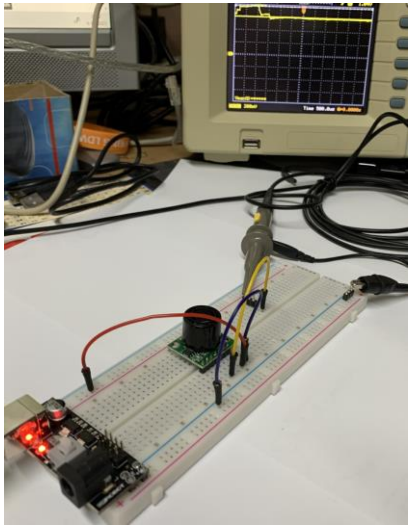
*With 2.5V - 5.5V power the LV-MaxSonar-EZ provides very short to long-range detection and ranging in a very small package. The LV-MaxSonar-EZ detects objects from 0-inches to 254-inches (6.45-meters) and provides sonar range information from 6-inches out to 254-inches with 1-inch resolution. Objects from 0-inches to 6-inches typically range as 6-inches*[1]*. The interface output formats included are pulse width output, analog voltage output, and RS232 serial output. Factory calibration and testing is completed with a flat object.* [1]***See Close Range Operation***

### Features

- Continuously variable gain for control and side lobe suppression
- Object detection to zero range objects
- 2.5V to 5.5V supply with 2mA typical current draw
- Readings can occur up to every 50mS, (20-Hz rate)
- Free run operation can continually measure and output range information
- Triggered operation provides the range reading as desired
- Interfaces are active simultaneously
- Serial, 0 to Vcc, 9600 Baud, 81N
- Analog, (Vcc/512) / inch
- Pulse width, (147uS/inch)

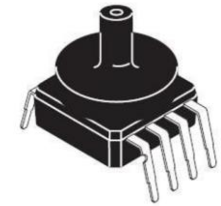






Priklop :
- Napajanje
  - 2.5-5.5V
  - GND
- Izhoda:
  - Analogni
  - PWM

## Preizkusi različnih tipal (IR,UZ razdalja, PIR, Hall, …)



**MPXV10GC7U**

*Z naslova <https://eu.mouser.com/ProductDetail/NXP-Semiconductors/MPXV10GC7U?qs=N2XN0KY4UWWYdp78g4P8QQ%3D%3D>*

### 6 Pin Information

#### 6.1 MPXV10GC6U

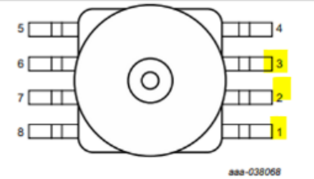
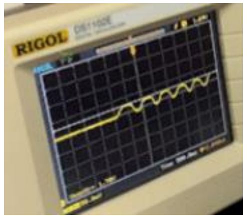



Figure 2. Case 482A-01

Table 2. Pin definitions - MPXV10GC6U

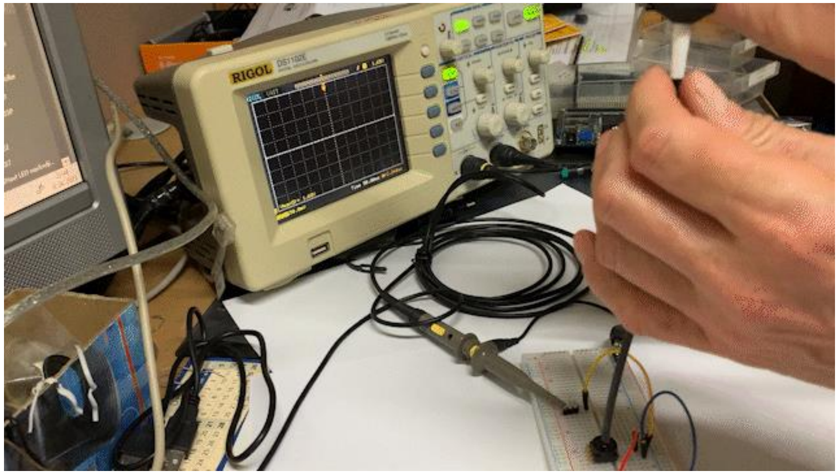
| Symbol | Pin | Description |
|---|---|---|
| GND | 1 | Ground |
| $+V_{OUT}$ | 2 | +Voltage output |
| $V_S$ | 3 | Power supply |

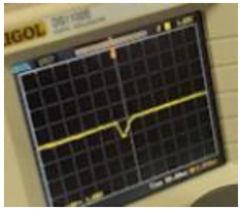




### 8 Operating Characteristics

Table 7. Operating Characteristics ($V_S$ = 3.0 Vdc, $T_A$ = 25 °C unless otherwise noted, P1 > P2)

| Characteristic | | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Operating Pressure Range | [1] | $P_{OP}$ | 0 | — | 10 | kPa |
| Supply Voltage | [2] | $V_S$ | — | 3.0 | 6.0 | $V_{DC}$ |
| Supply Current | | $I_o$ | — | 6.0 | — | mAdc |
| Full Scale Span | [3] | $V_{FSS}$ | 20 | 35 | 50 | mV |
| Offset | [4] | $V_{off}$ | 0 | 20 | 35 | mV |
| Sensitivity | | ΔV/ΔP | — | 3.5 | — | mV/kPa |



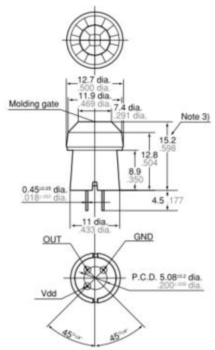



Priklop :

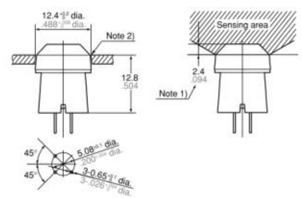
- Napajanje
  - Do 6V
  - GND
- Izhod:
  - Analogni

# Preizkusi različnih tipal (IR,UZ razdalja, PIR, Hall, …)

2. Slight motion detection type




Recommended PC board pattern (BOTTOM VIEW)




Notes: 1. In order to ensure proper detection, install it with the lens exposed at least 2.4mm .094inch.
2. As for panel mounting hole, tapering or making a large size hole should be done.
3. The height dimension does not include the remaining molding gate.

**Priklop :**

- Napajanje
  - 3-6V
  - GND
- Izhod:
  - Digitalni (H/L)

**3. Electrical characteristics** (Measuring condition: ambient temp. = 25°C 77°F; operating voltage = 5V) (Common to All types)

1) Digital output

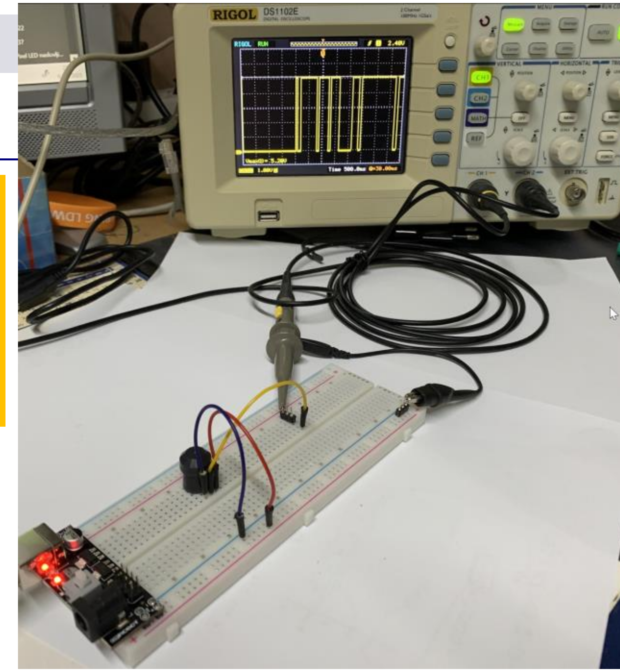
| Items | | | Symbol | Specified value: Standard type | Specified value: Low current consumption type | Measured conditions |
|---|---|---|---|---|---|---|
| Reted operating voltage | | Minimum<br>Typical<br>Maximum | Vdd | 3.0 V DC<br>—<br>6.0 V DC | 2.2 V DC<br>—<br>3.0 V DC | |
| Reted consumption current (Standby) *Remark | | Typical<br>Maximum | Iw | 170 µA<br>300 µA | 46 µA<br>60 µA | Iout = 0 |
| Output (when detecting) | Current | Maximum | Iout | 100 µA | 100 µA | Vout ≧ Vdd–0.5 |
| | Voltage | Minimum<br>Maximum | Vout | Vdd –0.5<br>— | Vdd –0.5<br>— | Open when not detecting |
| Circuit stability time | | Typical<br>Maximum | Twu | 7 s<br>30 s | 7 s<br>30 s | |

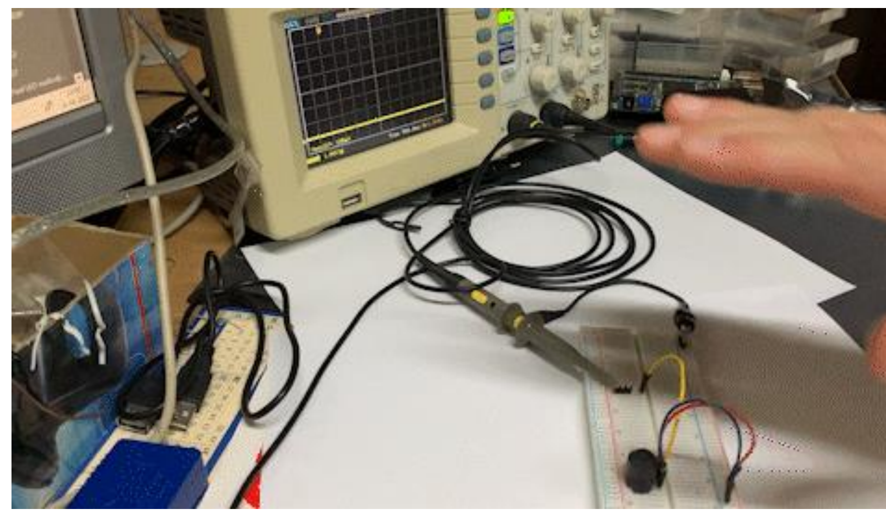
Remark: The current which is consumed during detection consists of the standby consumed current plus the output current.

2) Analog output

| Items | | Symbol | Specified value | Measured conditions |
|---|---|---|---|---|
| Reted operating voltage | Minimum<br>Maximum | Vdd | 4.5 V DC<br>5.5 V DC | |
| Reted consumption current | Typical<br>Maximum | Iw | 0.17 mA<br>0.3 mA | Iout = 0 |
| Output current | Maximum | Iout | 50 µA | |
| Output voltage | Minimum<br>Typical<br>Maximum | Vout | 0 V<br>2.5 V<br>Vdd | |
| Output offset average voltage | Minimum<br>Typical<br>Maximum | Voff | 2.3 V<br>2.5 V<br>2.7 V | Steady-state output voltage when not detecting |
| Steady-state noise | Typical<br>Maximum | Vn | 130 m Vp-p<br>300 m Vp-p | |
| Circuit stability time | Maximum | Twu | 45 s | |

Note: To set to the same detection performance as the digital type, set the output voltage to the offset voltage (2.5V) ±0.45V (i.e. 2.95V or more and 2.05V or less).



*Z naslova <https://eu.mouser.com/ProductDetail/Panasonic-Industrial-Devices/AMN22111?qs=mTeSeKeuVA4zSZ1O6%2F0inQ%3D%3D>*

https://eu.mouser.com/datasheet/2/315/panasonic_amn1_2_4-1196943.pdf

Priklop :
- Napajanje
  - 5V Pin1
  - GND Pin9
- Izhod - PWM: Pin4
  - 0-360˚ (1-37ms)

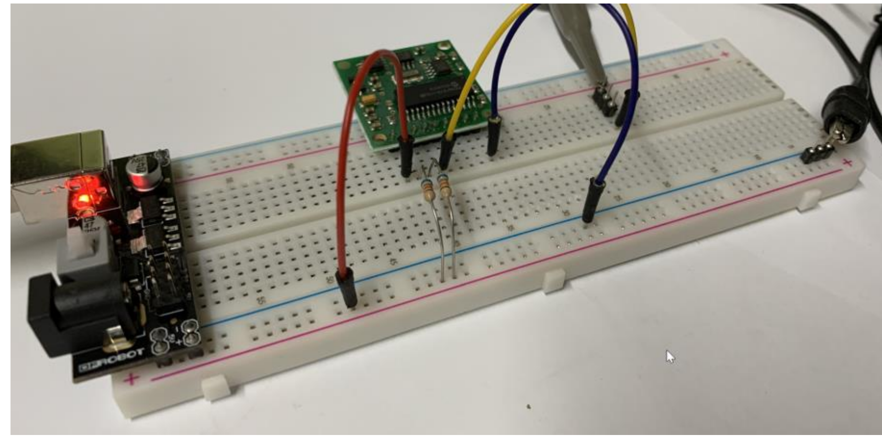
# CMPS03 - Compass Module

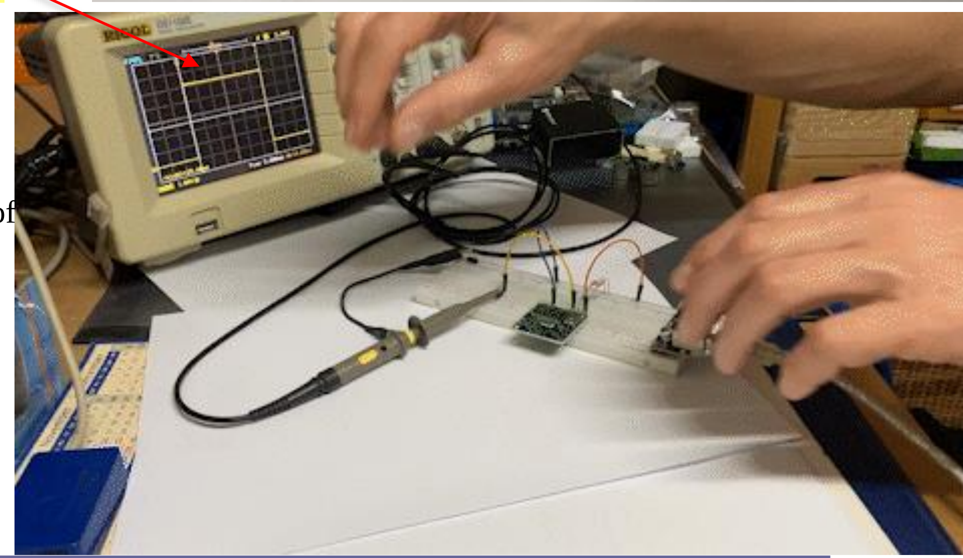
**For documentation on CMPS03 revisions prior to Rev14, click here**

Earlier versions can be identified by the presence of the silver 8MHz ceramic resonator in the middle of the PCB, this has been removed on new modules.

Rev14 was released March 2007

*Z naslova <http://www.robot-electronics.co.uk/htm/cmps3tech.htm>*



**Connections**

Pins 2,3 are the I2C interface and can be used to get a direct readout of the bearing. If the I2C interface is not used then these pins should be pulled high (to +5v) via a couple of resistors. Around 47k is ok, the values are not at all critical.

Pin 4. The PWM signal is a pulse width modulated signal with the positive width of the pulse representing the angle. The pulse width varies from 1mS (0˚ ) to 36.99mS (359.9˚ ) – in other words 100uS/˚ with a +1mS offset.

# Preizkusi različnih tipal (IR,UZ razdalja, PIR, Hall, …)

| PARAMETER | SYMBOL | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| Measuring Distance Range | ΔL | | 10 | - | 80 | cm |
| Output Voltage | $V_O$ | L = 80 cm | 0.25 | 0.4 | 0.55 | V |
| Output Voltage Difference | $\Delta V_O$ | Output change at L change (80 cm - 10 cm) | 1.75 | 2.0 | 2.25 | V |

SHARP

**GP2D12**

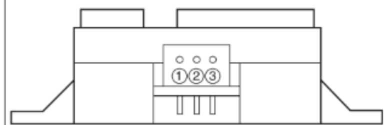
**Optoelectronic Device**

### FEATURES

- Analog output
- Effective Range: 10 to 80 cm
- LED pulse cycle duration: 32 ms
- Typical response time: 39 ms
- Typical start up delay: 44 ms
- Average current consumption: 33 mA
- Detection area diameter @ 80 cm: 6 cm

### DESCRIPTION

The GP2D12 is a distance measuring sensor with integrated signal processing and analog voltage output.




| PIN | SIGNAL NAME |
|---|---|
| ① | $V_O$ |
| ② | GND |
| ③ | $V_{CC}$ |

GP2D12-8

**Figure 1. Pinout**

SHARP GP2

### ELECTRICAL SPECIFICATIONS

#### Absolute Maximum Ratings

Ta = 25°C, $V_{CC}$ = 5 VDC

| PARAMETER | SYMBOL | RATING | UNIT |
|---|---|---|---|
| Supply Voltage | $V_{CC}$ | -0.3 to +7.0 | V |
| Output Terminal Voltage | $V_O$ | -0.3 to ($V_{CC}$ + 0.3) | V |
| Operating Temperature | Topr | -10 to +60 | °C |
| Storage Temperature | Tstg | -40 to +70 | °C |

Priklop :

- Napajanje
  - Do 7V
  - GND
- Izhod:
  - Analogni

#### Operating Supply Voltage

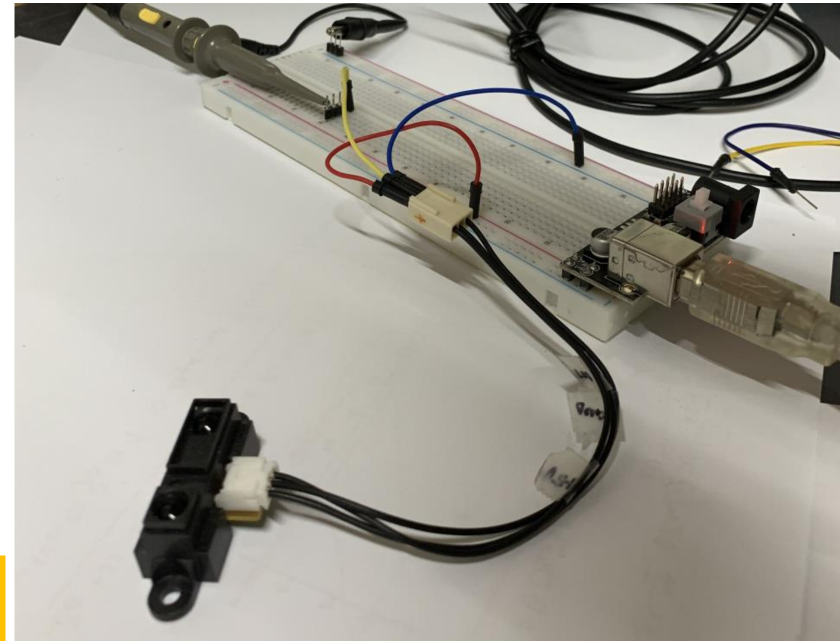
| PARAMETER | SYMBOL | RATING | UNIT |
|---|---|---|---|
| Operating Supply Voltage | $V_{CC}$ | 4.5 to 5.5 | V |

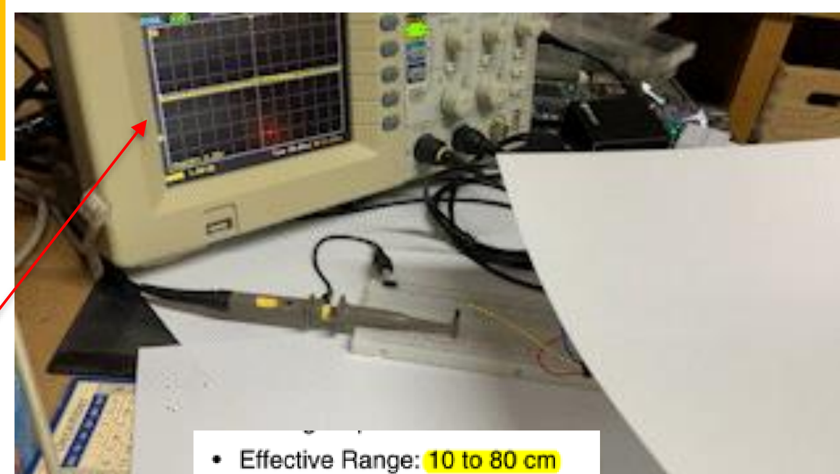
#### Electro-optical Characteristics

Ta = 25°C, $V_{CC}$ = 5 VDC

| PARAMETER | SYMBOL | CONDITIONS | MIN. | TYP. | MAX. | UNIT | NOTES |
|---|---|---|---|---|---|---|---|
| Measuring Distance Range | ΔL | | 10 | - | 80 | cm | 1, 2 |
| Output Voltage | $V_O$ | L = 80 cm | 0.25 | 0.4 | 0.55 | V | 1, 2 |
| Output Voltage Difference | $\Delta V_O$ | Output change at L change (80 cm - 10 cm) | 1.75 | 2.0 | 2.25 | V | 1, 2 |
| Average Supply Current | $I_{CC}$ | L = 80 cm | - | 33 | 50 | mA | 1, 2 |

NOTES:
1. Measurements made with Kodak R-27 Gray Card, using the white side, (90% reflectivity).
2. L = Distance to reflective object.





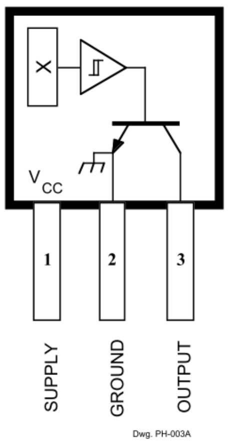
## Preizkusi različnih tipal (IR,UZ razdalja, PIR, Hall, …)

Priklop :
- Napajanje
  - 4.5-24V
  - GND
- Izhod OC – „Open Collector“:
  - Digitalni (OC) (10k Pull-up upor)

# 3141 THRU 3144

Data Sheet 27621.6B*

## *SENSITIVE HALL-EFFECT SWITCHES FOR HIGH-TEMPERATURE OPERATION*




Pinning is shown viewed from branded side.

These Hall-effect switches are monolithic integrated circuits with tighter magnetic specifications, designed to operate continuously over extended temperatures to +150°C, and are more stable with both temperature and supply voltage changes. The unipolar switching characteristic makes these devices ideal for use with a simple bar or rod magnet. The four basic devices (3141, 3142, 3143, and 3144) are identical except for magnetic switch points.

Each device includes a voltage regulator for operation with supply voltages of 4.5 to 24 volts, reverse battery protection diode, quadratic Hall-voltage generator, temperature compensation circuitry, small-signal amplifier, Schmitt trigger, and an open-collector output to sink up to 25 mA. With suitable output pull up, they can be used with bipolar or CMOS logic circuits. The A3141– and A3142– are improved replacements for the UGN/UGS3140–; the A3144– is the improved replacement for the UGN/UGS3120–.

The first character of the part number suffix determines the device operating temperature range. Suffix ‘E–’ is for the automotive and industrial temperature range of -40°C to +85°C. Suffix ‘L–’ is for the automotive and military temperature range of -40°C to +150°C. Three package styles provide a magnetically optimized package for most applications. Suffix ‘–LT’ is a miniature SOT89/TO-243AA transistor package for surface-mount applications; suffix ‘–UA’ is a three-lead ultra-mini-SIP.

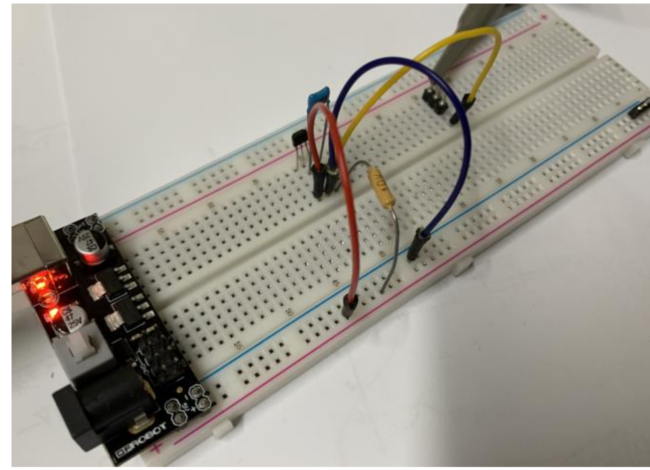
### ABSOLUTE MAXIMUM RATINGS at $T_A$ = +25°C

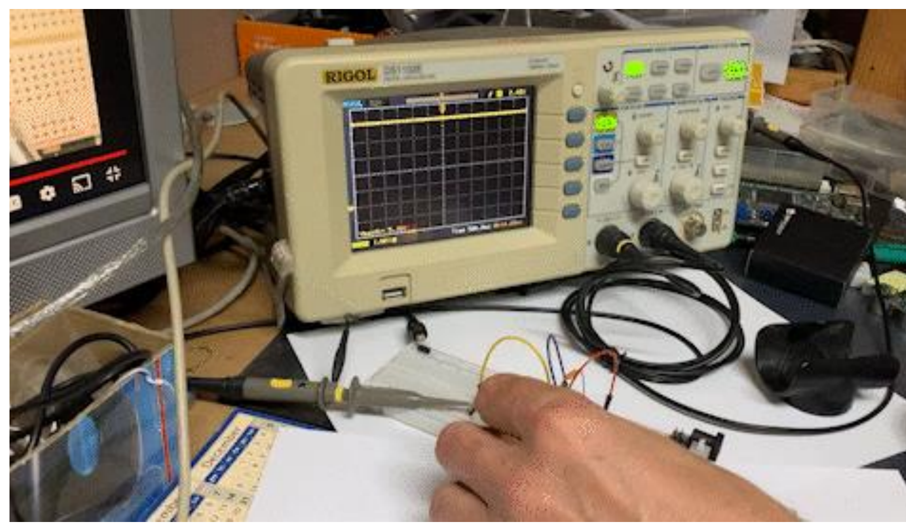
| | |
|---|---|
| Supply Voltage, $V_{CC}$ | **28 V** |
| Reverse Battery Voltage, $V_{RCC}$ | **-35 V** |
| Magnetic Flux Density, B | **Unlimited** |
| Output OFF Voltage, $V_{OUT}$ | **28 V** |
| Reverse Output Voltage, $V_{OUT}$ | **-0.5 V** |
| Continuous Output Current, $I_{OUT}$ | **25 mA** |
| Operating Temperature Range, $T_A$ | |
| Suffix ‘E–’ | **-40°C to +85°C** |
| Suffix ‘L–’ | **-40°C to +150°C** |
| Storage Temperature Range, $T_S$ | **-65°C to +170°C** |

### FEATURES and BENEFITS

- Superior Temp. Stability for Automotive or Industrial Applications
- 4.5 V to 24 V Operation … Needs Only An Unregulated Supply
- Open-Collector 25 mA Output … Compatible with Digital Logic
- Reverse Battery Protection
- Activate with Small, Commercially Available Permanent Magnets
- Solid-State Reliability
- Small Size
- Resistant to Physical Stress

Always order by complete part number, e.g., A3141ELT .



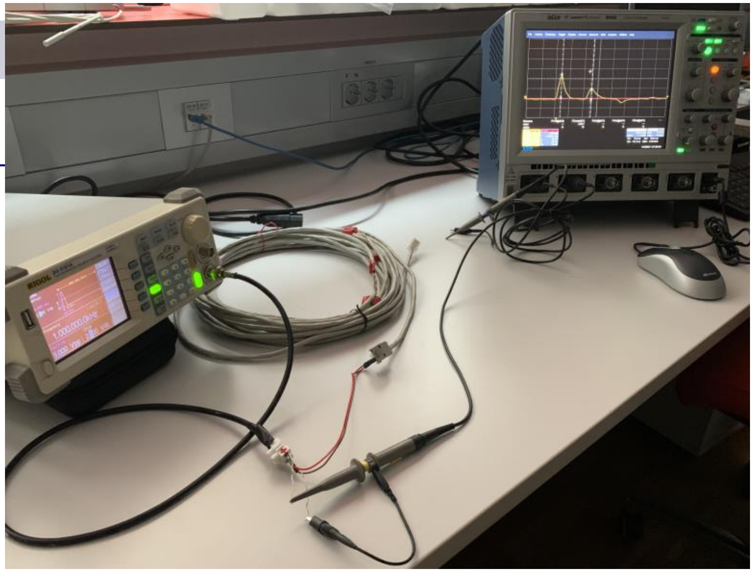


# Laboratorijska vaja 12
# Tipala in signali – praktični izzivi

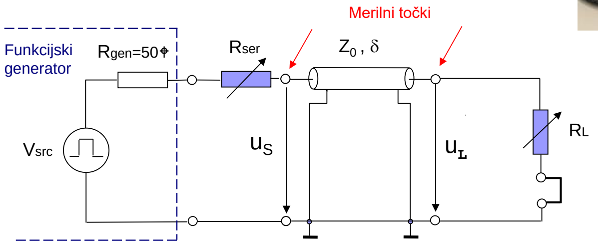
- 12a: LV5a : Tipala in signali – meritve
  a) Meritev karakteristične upornosti linije z multimetrom ($R_0$)
  b) Preizkusi različnih tipal (IR,UZ razdalja, PIR, Hall, …)
  c) Meritve deformacij UTP kabla
  d) *LV2-4 - Presluh – meritve na ploščatem kablu

- 12b: LV5b : STM32H7 – Generator signalov
  a) UART PB14
  b) PWM PA3
  c) SPI PD3(SCK), PI3 (MOSI)
  d) I2C PD12(SCL), PD13(SDA)
  e) CANBUS CN1 (FDCAN1: CAN-L, CAN-H

# LV 2*: Meritve deformacij UTP kabla



***Izziv:*** z ustreznimi orodji (osciloskop, generator, …) določite deformacije (vrsta, razdalja od točke A) na vseh paricah v UTP kablu.

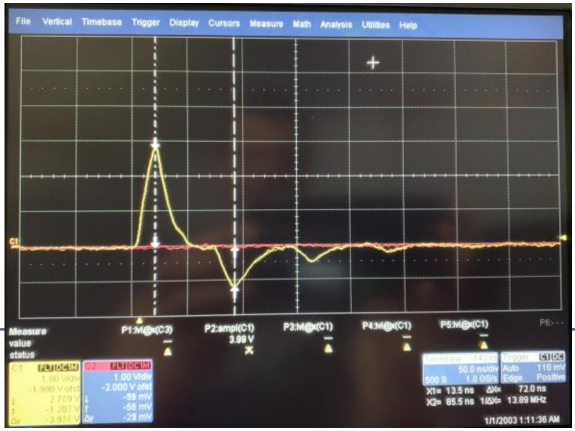


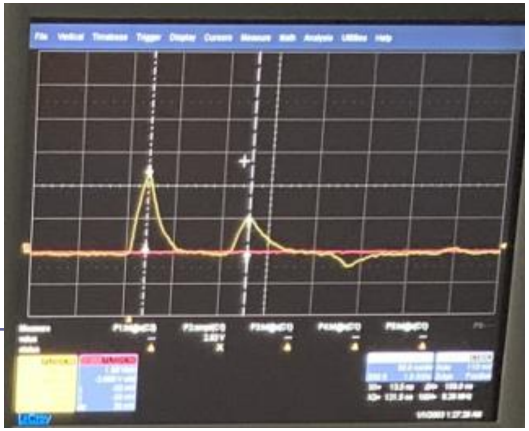

Meritev s pravokotnim signalom, kot pri $R_0$: trajanje stopničk = 2 τ

Meritev s kratkim impulzom: zakasnitev odboja impulza = 2 τ

odboj v - … kratki stik

odboj v + … prekinitev





# Laboratorijska vaja 12
# Tipala in signali – praktični izzivi

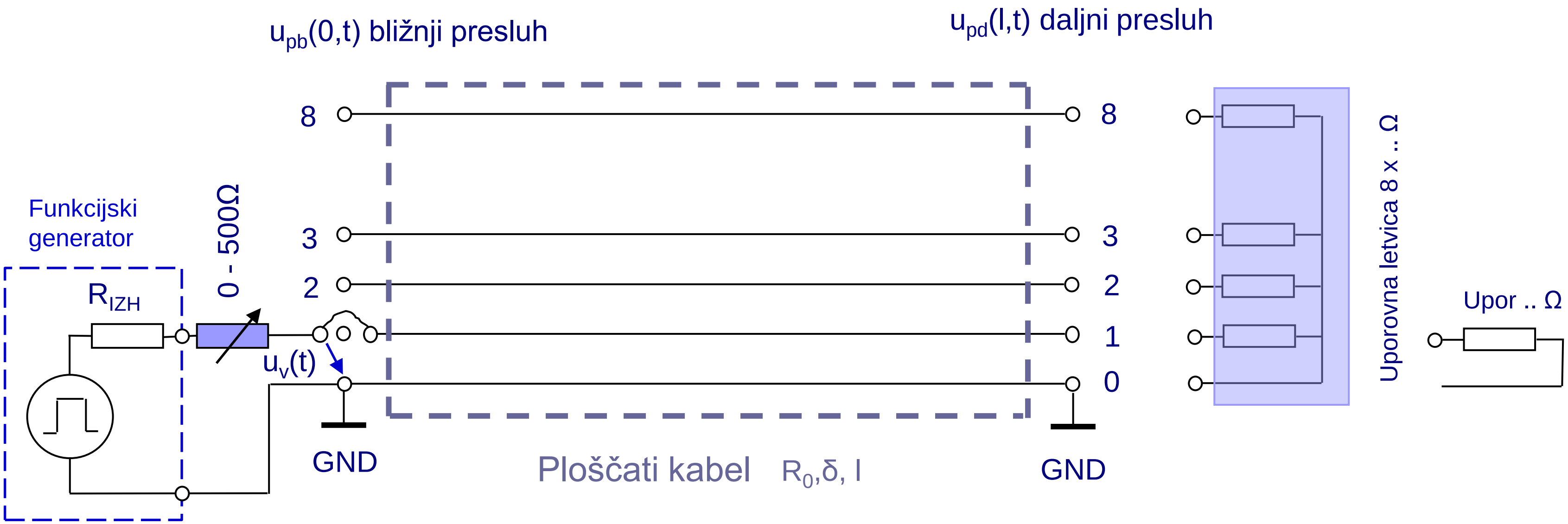
- 12a: LV5a : Tipala in signali – meritve
  a) Meritev karakteristične upornosti linije z multimetrom ($R_0$)
  b) Preizkusi različnih tipal (IR,UZ razdalja, PIR, Hall, …)
  c) Meritve deformacij UTP kabla
  d) *LV2-4 - Presluh – meritve na ploščatem kablu

- 12b: LV5b : STM32H7 – Generator signalov

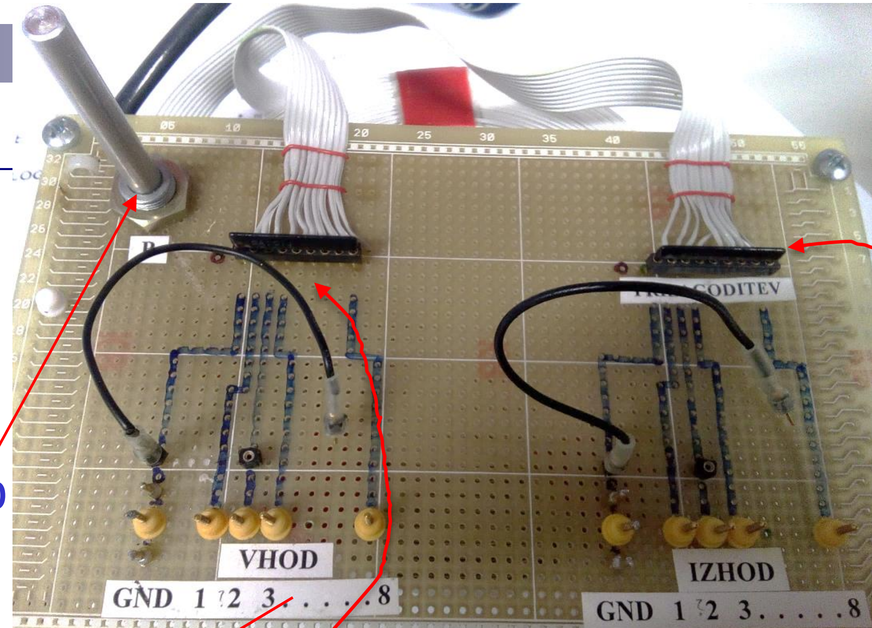
| | | |
|---|---|---|
| a) | UART | PB14 |
| b) | PWM | PA3 |
| c) | SPI | PD3(SCK), PI3 (MOSI) |
| d) | I2C | PD12(SCL), PD13(SDA) |
| e) | CANBUS | CN1 (FDCAN1: CAN-L, CAN-H |

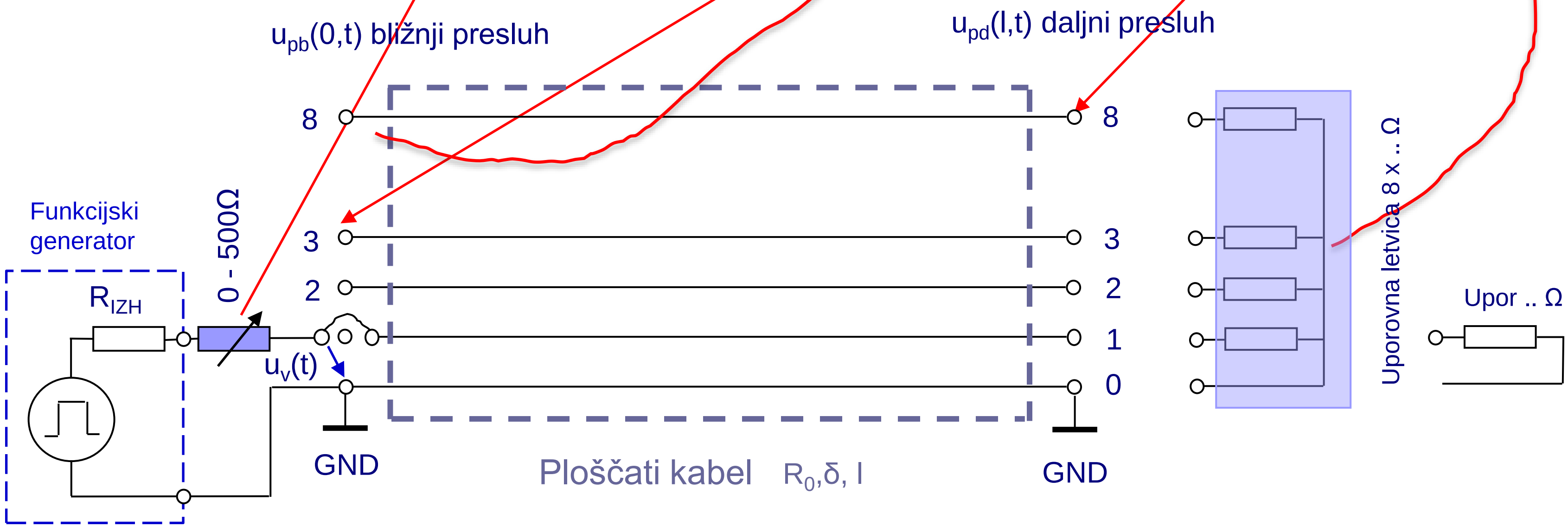
# LV2-4*: Merjenje presluha na ploščatem kablu

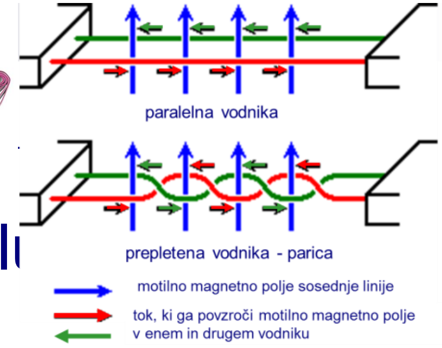
- Funkcijski generator priključite na vodnik 1, vodnik 0 pa uporabite kot skupni povratni vodnik GND in nastavite primerno obliko signala $u_v(t)$.



- Funkcijski generator priključite na vodnik 1, vodnik 0 pa uporabite kot skupni povratni vodnik GND in nastavite primerno obliko signala $u_v(t)$.



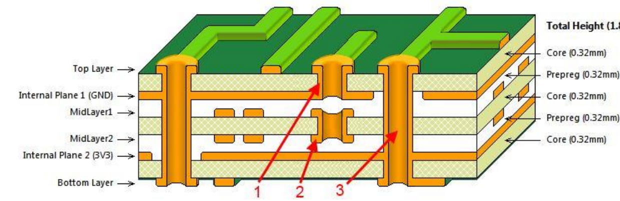


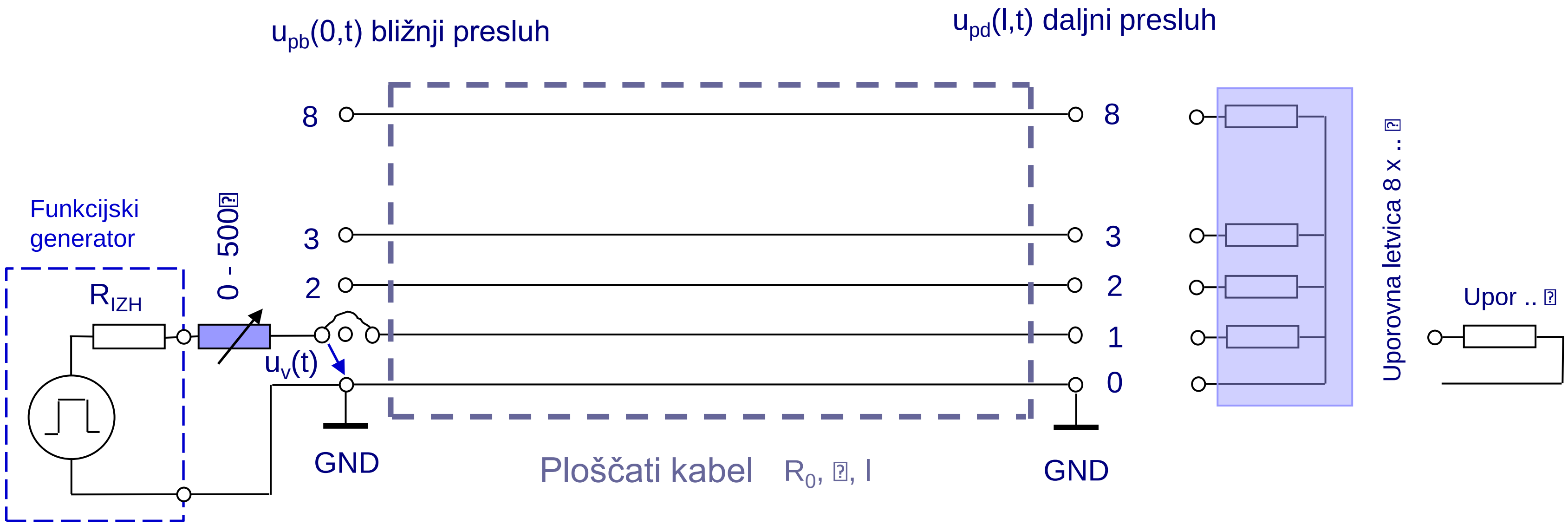

# LV2-4: Merjenje presluha na ploščatem kablu

Pozor: ploščati kabel je precej slabši od UTP glede presluhov :

- ni parica (večji presluh)
- zvitek: presluh se bolj širi

Pri $R_0$ meritvi ozemljiti linijo 2 (GND) !!!



# TABLA: Lab.vaja LV2-4 Presluh – ploščati kabel

## PLOŠČATI KABEL

### LINIJA 0-1:

- (a) · ČAS POTOVANJA – $\tau$
- (b) · KARAKT. UPORNOST – $R_0$

} – LIN. 0-2 ← GND

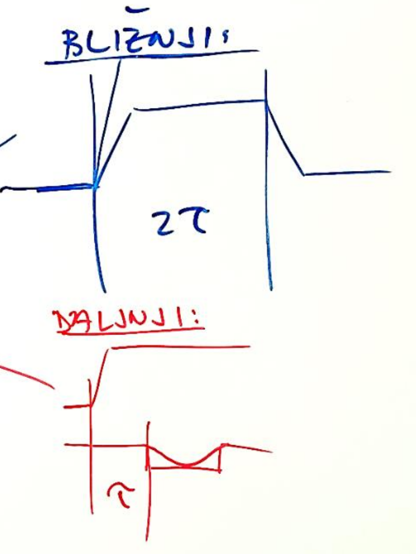
### LINIJE 0-2, 0-3, 0-8:

(e) $K_B = ?$ ← · BLIŽNJI PRESLUH

· DALJNJI PRESLUH

MERITVE:

- · ČASOVNI POTEK
- · VPLIV ODBOSEV: (c)
  - · BREZ
- (d)
  - · ODBOJ NA ISTI STRANI
  - · ODBOJ NA OBEH STRANEH
  - → ZAKLJUČITEV 0-1 Z UPOROM! (DESNA STRAN)




· OMEJEVANJE PRESLUHOV:

- (f) · OZEMLJITEV LINIJE 0-2
- (g) · DALJŠANJE $t_r, t_f$

POROČILO:

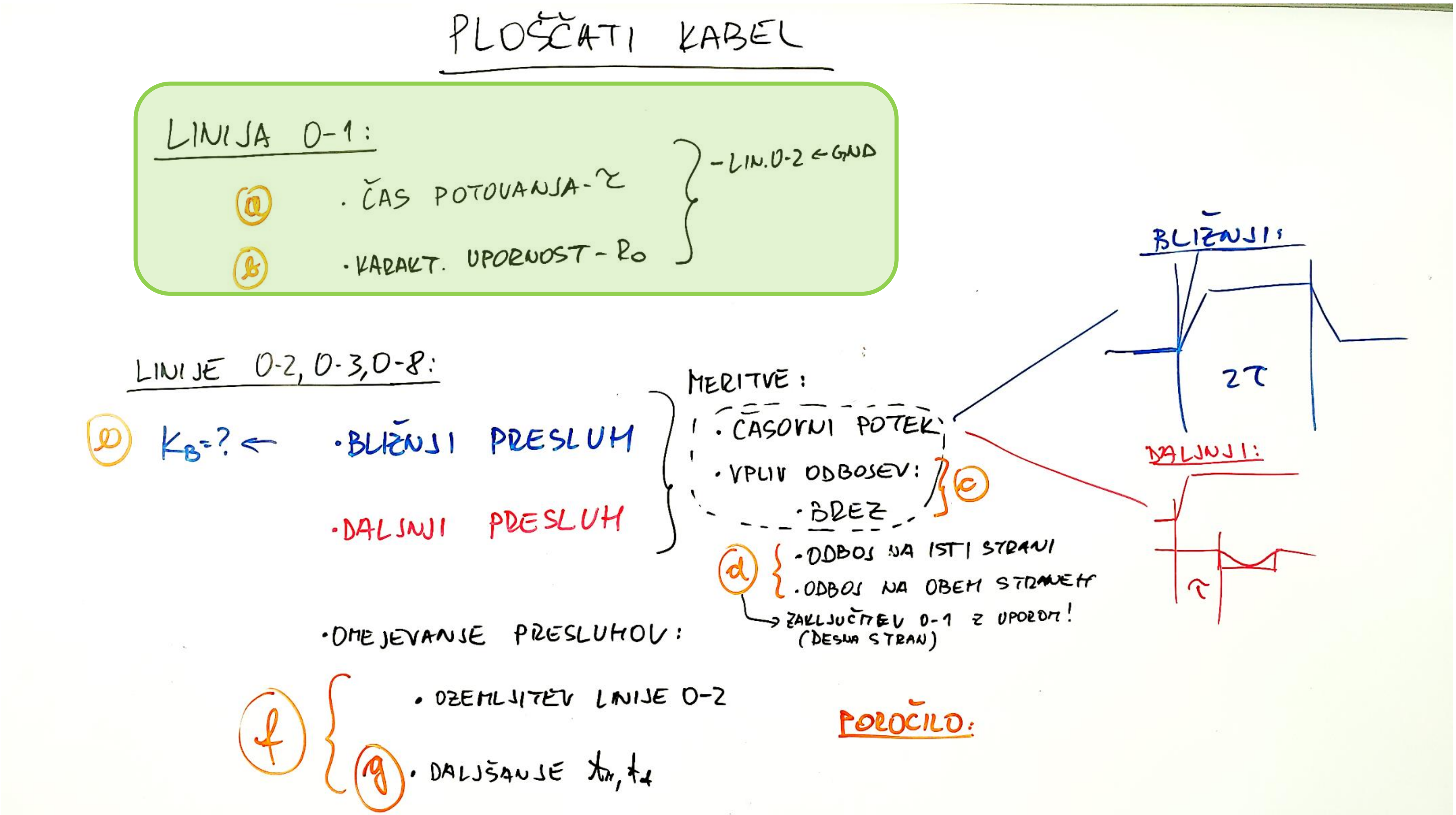
Izhodna upornost funkcijskega generatorja je $R_{IZH}=50\Omega$, zakasnitev ploščatega kabla $\delta=4{,}53ns/m$

- Izmerite čas potovanja po ploščatem kablu.
- Izmerite in izračunajte karakteristično upornost ploščatega kabla in izberite primerno zaključitev za linije 2 do 8, da ne bo odbojev (podobno kot v LV 2-2, linijo 2 ozemljite).
  - *Kaj se zgodi, če linije 2 ne ozemljite?*
- Izmerite napetostne nivoje bližnjega presluha $u_{pb}(0,t)$ na vhodih v linije 2,3 in 8 in daljnega presluha $u_{pd}(l,t)$ na izhodih linij 2,3 in 8.
- Opazujte vpliv zaključitev na linijah 2 do 8 na amplitudo in potek bližnjega in daljnega presluha (brez odboja, odboj na isti in še na obeh straneh).
- Podajte postopek in izračun bližnje preslušne konstante $K_B$ .

**Bližnji presluh (NEXT)**

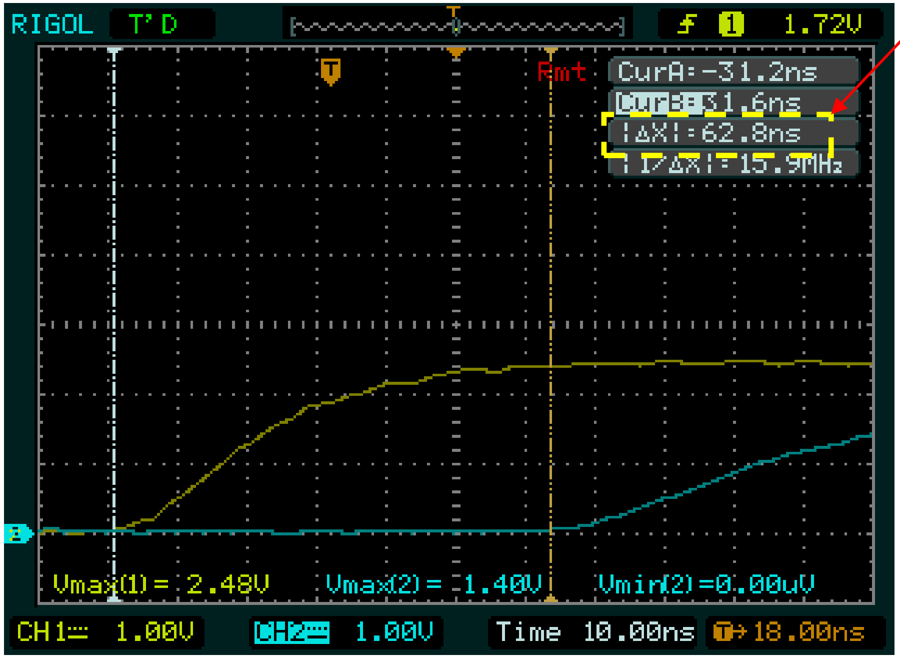
$$u_p(0,t) = K_B \cdot [u_v(t) - u_v(t - 2 \cdot \tau)]$$

# TABLA: Lab.vaja LV2-4 Presluh – ploščati kabel



- Izmerite čas potovanja po ploščatem kablu ≈ 62ns



# TABLA: Lab.vaja LV2-4 Presluh – ploščati kabel

## PLOŠČATI KABEL

### LINIJA 0-1:

(a) · ČAS POTOVANJA - $\tau$

(b) · KARAKT. UPORNOST - $R_0$

} - LIN. 0-2 ← GND

### LINIJE 0-2, 0-3, 0-8:

(e) $K_B = ?$ ← · BLIŽNJI PRESLUH

· DALJNI PRESLUH

MERITVE:

· ČASOVNI POTEK:

· VPLIV ODBOJEV:

· BREZ (c)

(d) · ODBOJ NA ISTI STRANI

· ODBOJ NA OBEH STRANEH

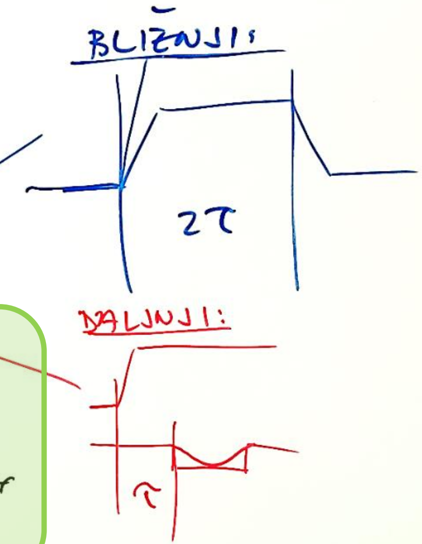
→ ZAKLJUČITEV 0-1 Z UPOROM! (DESNA STRAN)

· OMEJEVANJE PRESLUHOV:

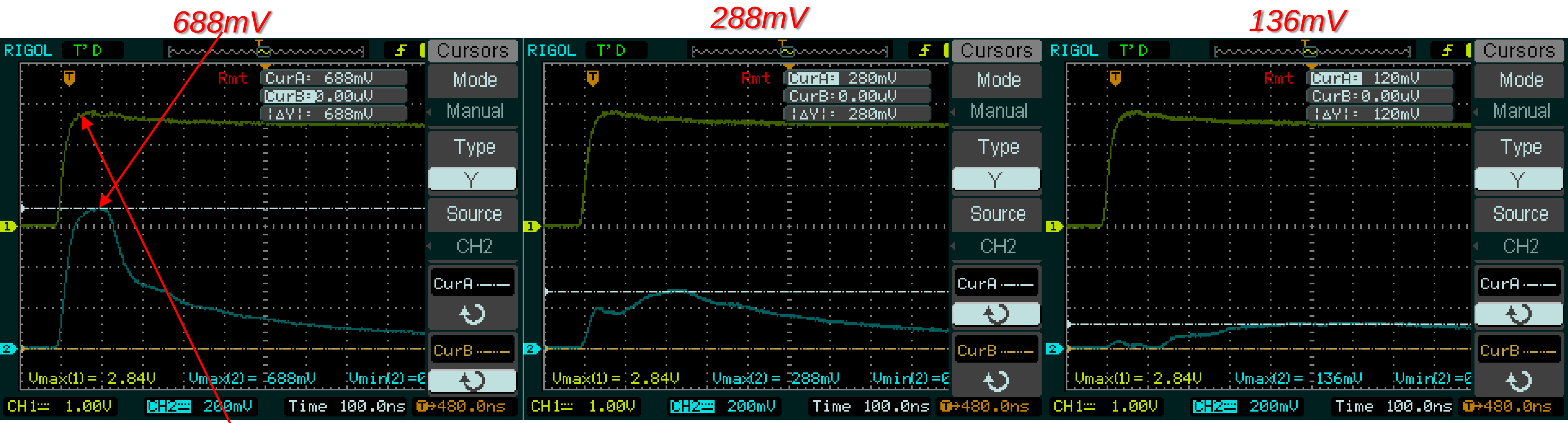
(f) · OZEMLJITEV LINIJE 0-2

(g) · DALJŠANJE $t_r, t_f$

POROČILO:



- Izmerite napetostne nivoje bližnjega presluha $u_{pb}(0,t)$ na vhodih v linije 2, 3 in 8




Bližnji presluh (NEXT)

$$u_p(0,t) = K_B \cdot [u_v(t) - u_v(t - 2 \cdot \tau)]$$

- *Primer izračuna Kb (vstavljene zaključitve)*

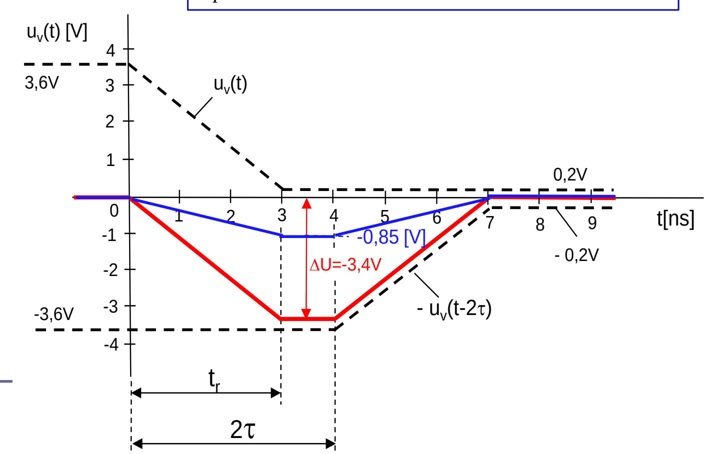
KABEL #*N*

-->Kb=0.688/2.86

Kb =

0.240559

*Komentar: 1.slika – vzamem max (2.86V) namesto Vstac (2.54V) za izračun*

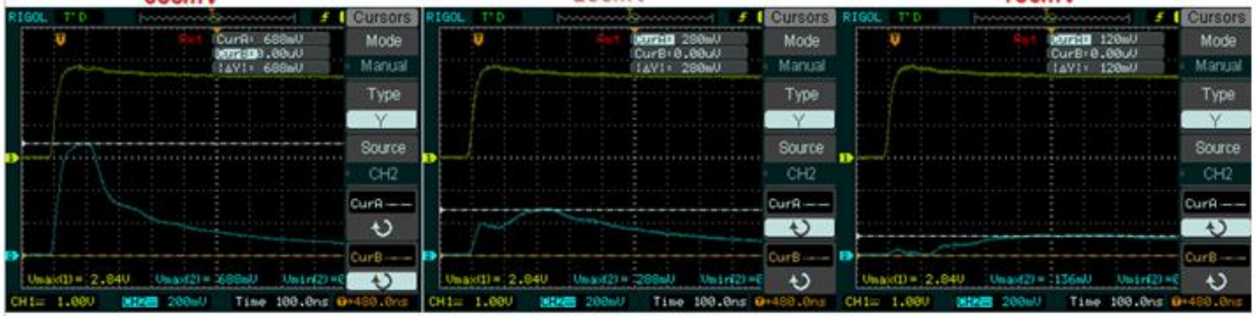


# Vpliv zaključitev na linijah 2, 3 in 8 (stolpci) na amplitudo in potek bližnjega presluha

Bližnji presluh

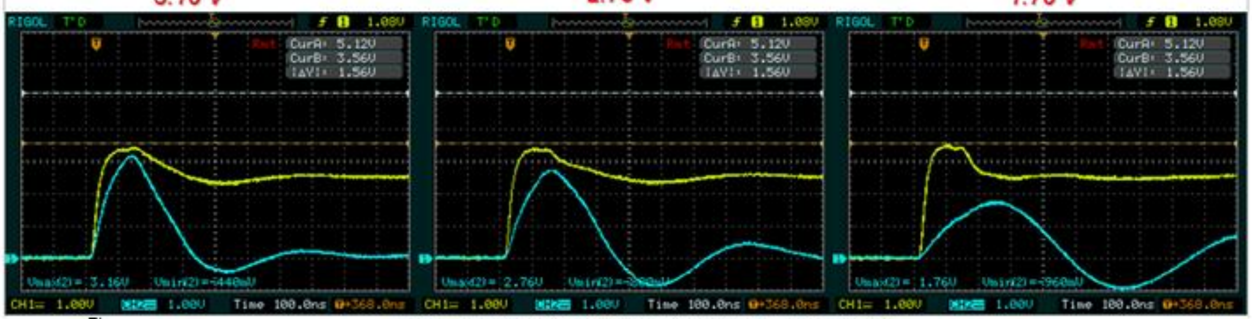
A) Vstavljene zaključitve

688mV | 288mV | 136mV



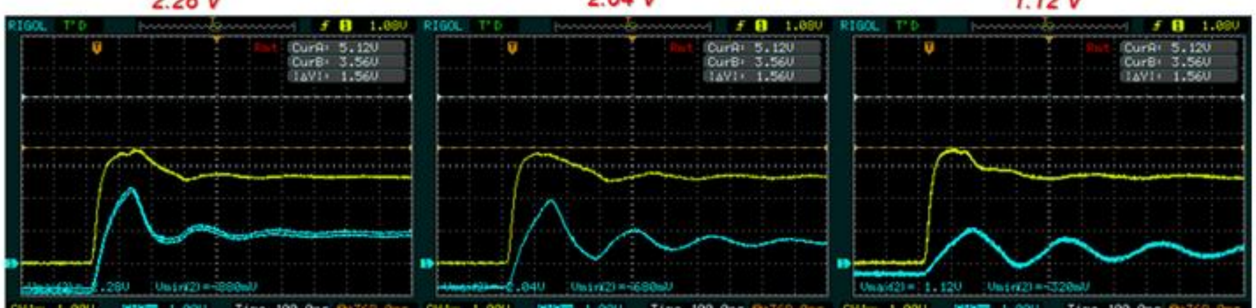
B) Brez zaključitev na isti strani

3.16 V | 2.76 V | 1.76 V



C) Brez zaključitev na obeh straneh

2.28 V | 2.04 V | 1.12 V



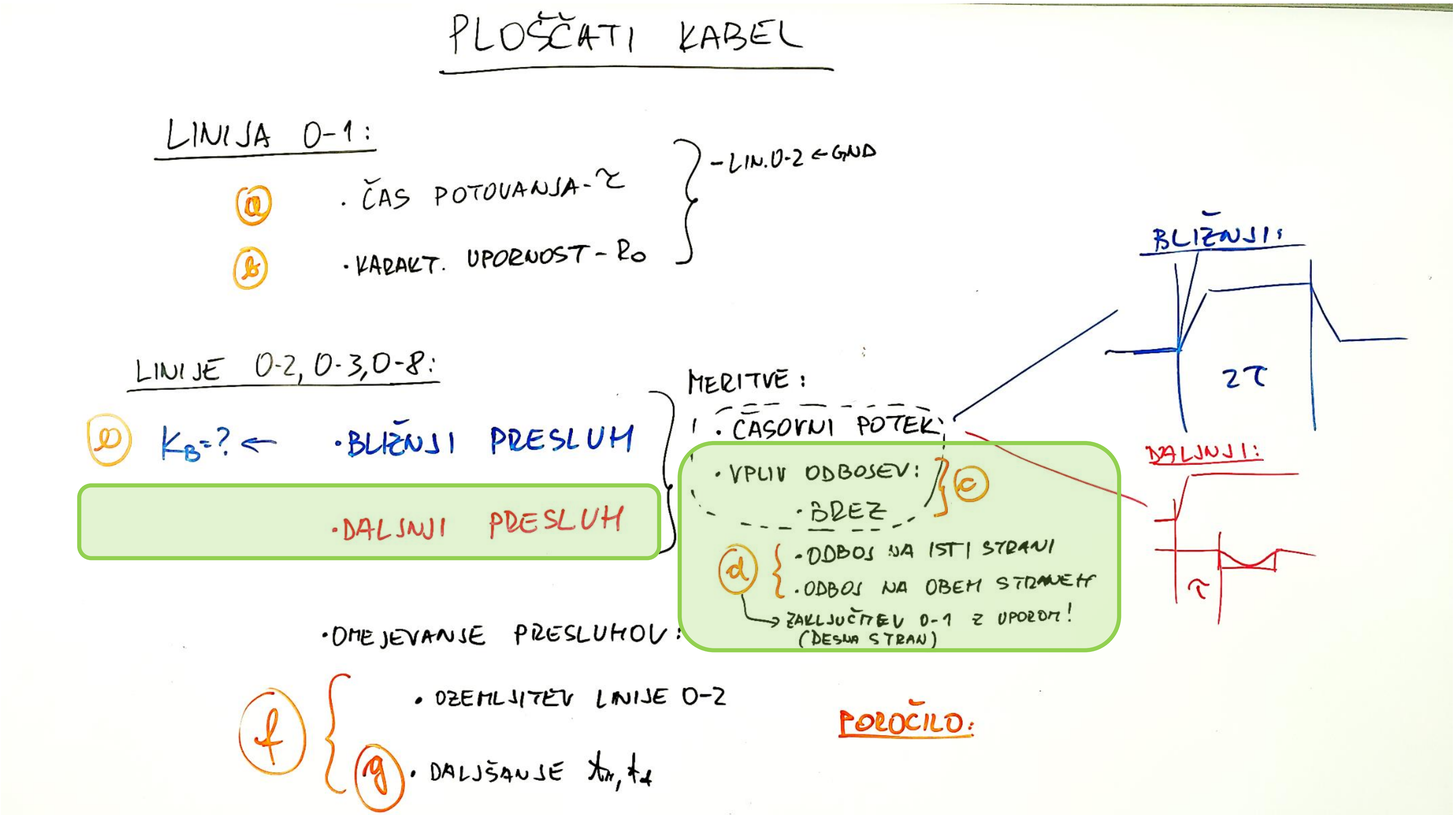




Stolpci prikazujejo povezave

0-2 | 0-3 | 0-8

# TABLA: Lab.vaja LV2-4 Presluh – ploščati kabel



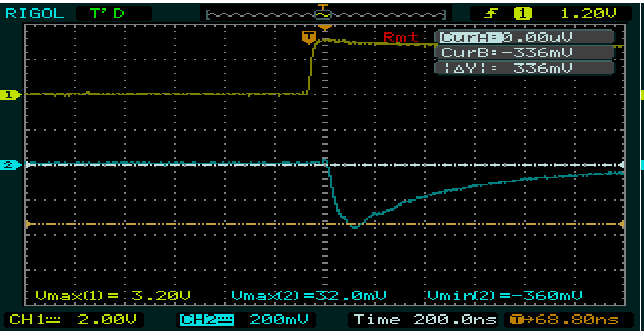
Stolpci prikazujejo povezave

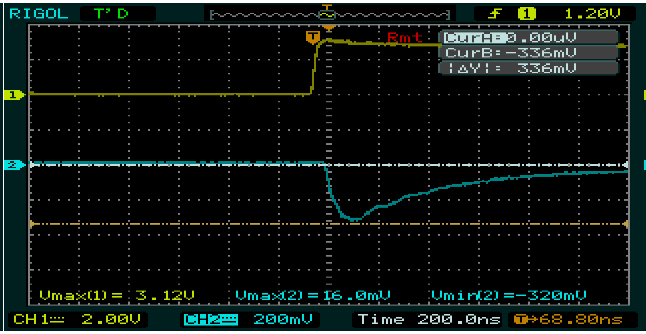
0-2 0-3 0-8

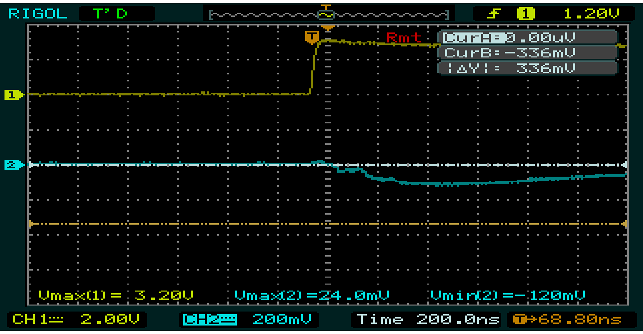
REŠ: Merjenje presluha na ploščatem kablu : Daljni presluh

# Izmerite napetostne nivoje daljnega presluha $u_{pd}(l,t)$ na izhodih linij 2,3 in 8.

*-360mV* *-320mV* *-120mV*

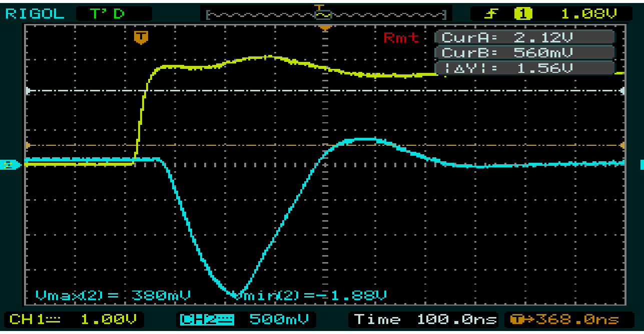


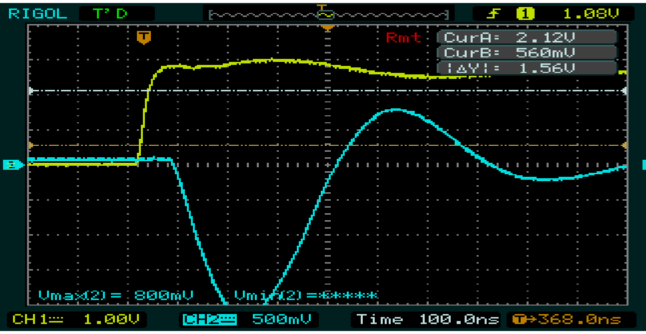



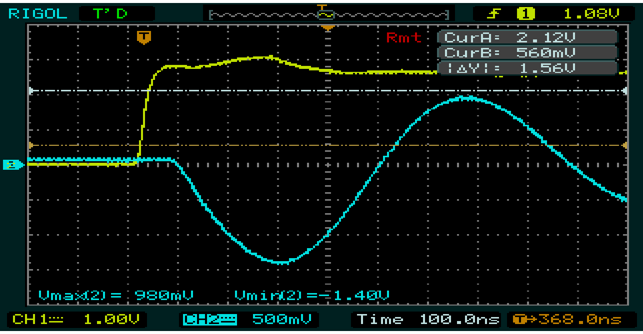




- Brez zaključitve na daljni strani (spodaj) in obeh straneh (čisto spodaj)

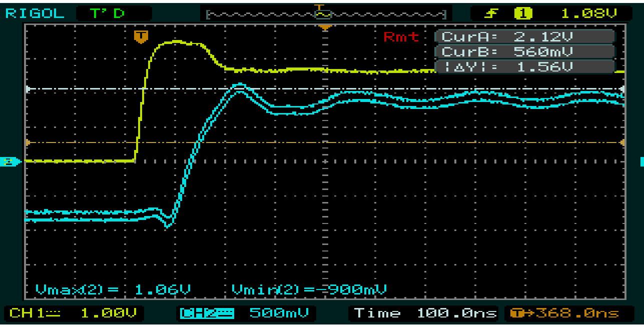
*-1.88 V* *< -2V* *-1.4 V*

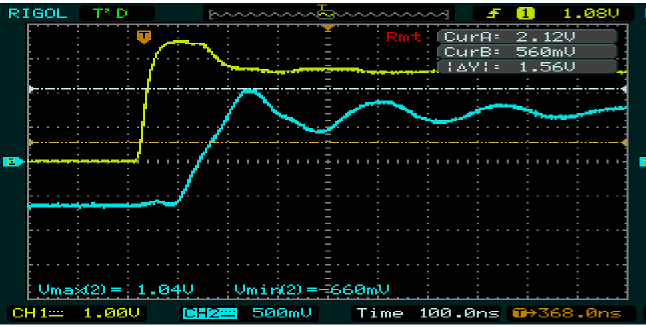


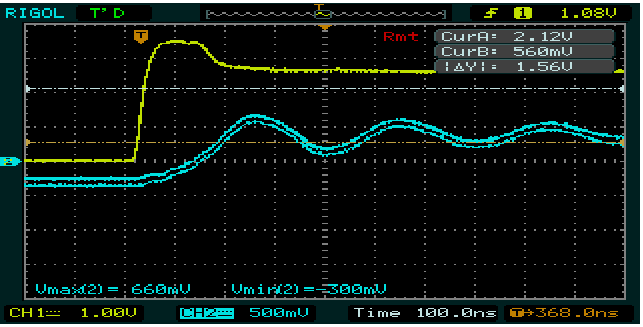




*1.06 V* *1.04 V* *0.66 V*



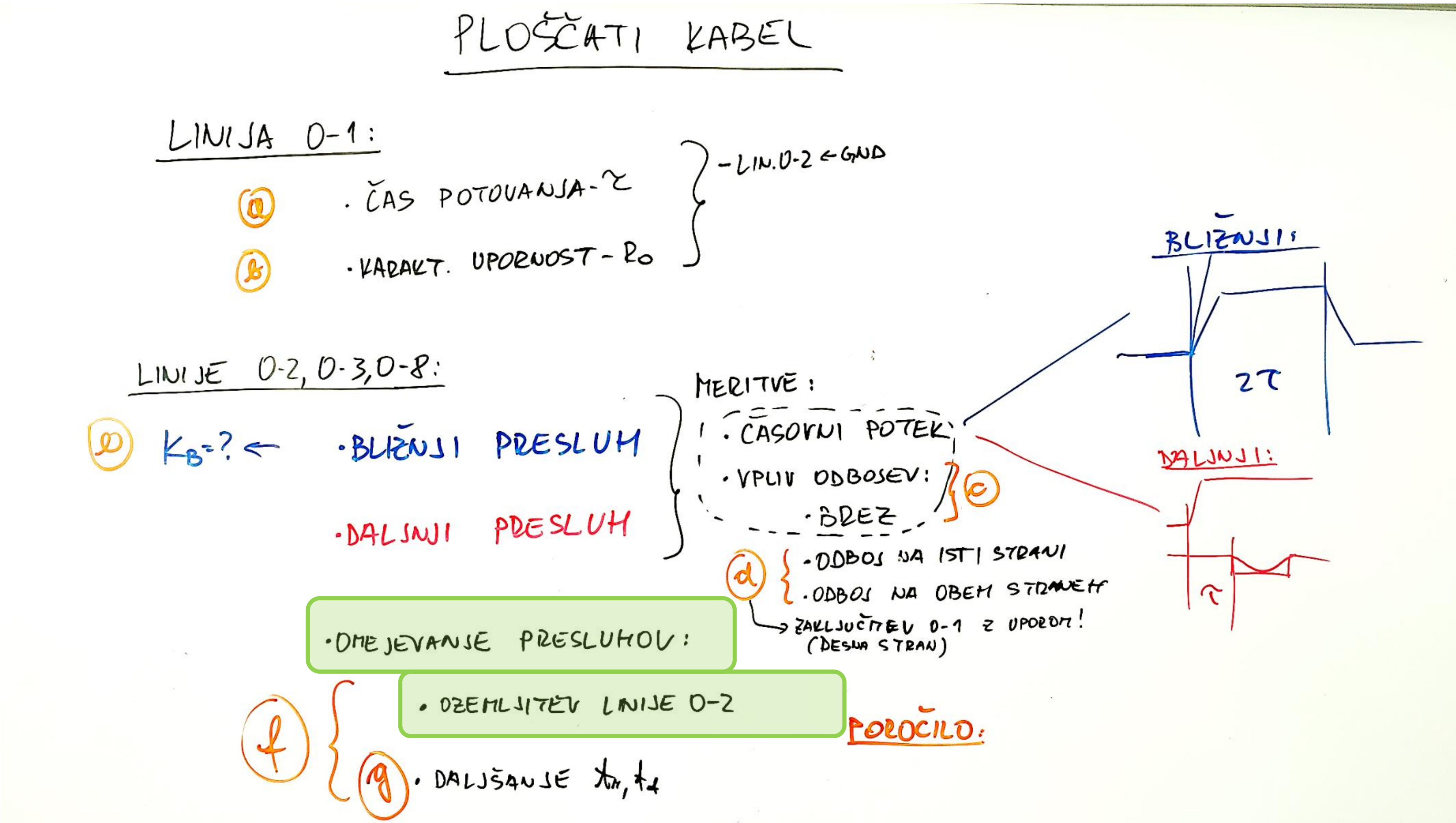



Ponovitev – predavanja

# Omejevanje presluha

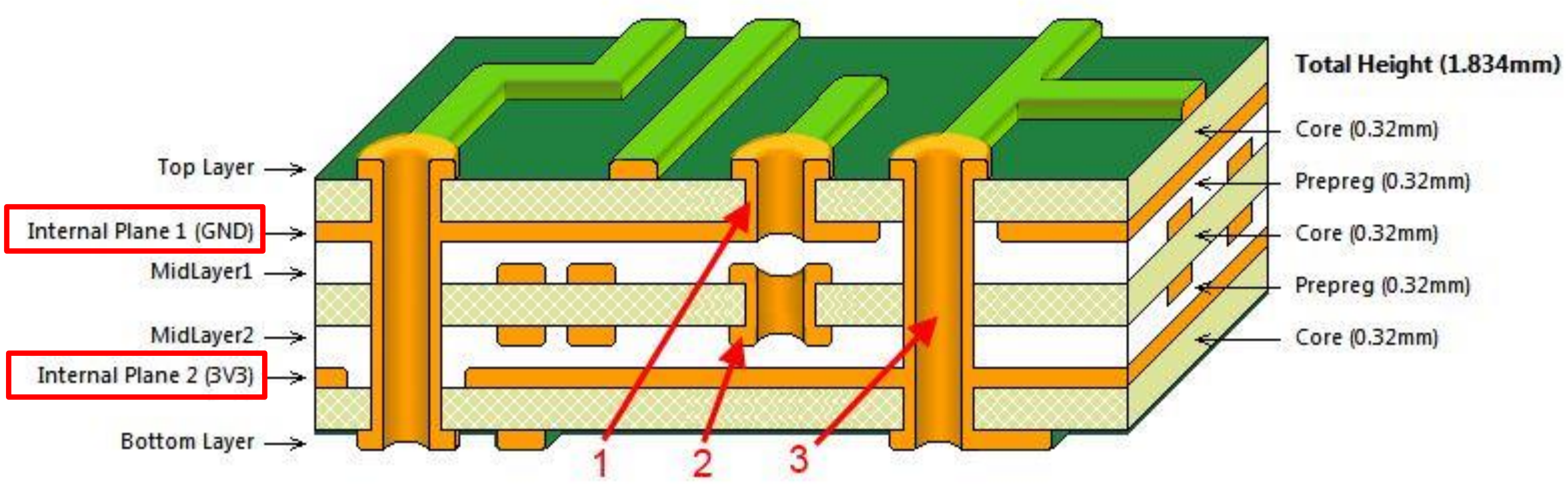
- Presluh lahko zmanjšamo z več različnimi ukrepi:
  - Z večanjem razmerja $t_r / \tau$ (čas vzpona signala / čas potovanja signala po liniji)
  - Z manjšanjem spremembe napetosti $\Delta U$ pri spremembi stanja ($0 \rightarrow 1$, $1 \rightarrow 0$)
  - Z manjšanjem preslušnih konstant $K_B$ in $K_F$ :
    - Večplastna tiskana vezja
    - Večje število povratnih (ozemljitvenih) vodnikov
    - Prepleteni vodniki (parica)
    - Oklopljena parica
    - Koaksialni kabel
    - Simetrični (diferencialni) prenos
    - Optični vodniki
  - Upoštevanje občutljivosti na presluh pri različnih vrstah signalov

# TABLA: Lab.vaja LV2-4 Presluh – ploščati kabel



# Manjšanje preslušnih konstant $K_B$ in $K_F$

## Večplastna tiskana vezja




Vmesna plast z ozemljitvenimi in napajalnimi povezavami zmanjšuje medsebojni vpliv povezav v plasti 1 in zgornji plasti ter povezav v plasti 2 in spodnji plasti.

# Omejevanje presluha na ploščatem kablu

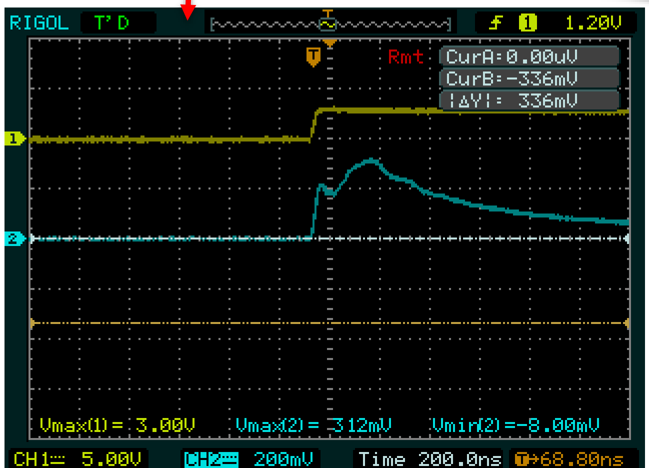
- Opazujte vpliv ozemljitve na liniji 2 (na enem ali obeh koncih) na amplitudo bližnjega in daljnega presluha na liniji 3.
- Na funkcijskem generatorju spreminjajte čas vzpona $t_r$ in čas padca signala $t_f$ in opazujte vpliv na presluh (bližnji in daljnji).
  - Pri kateri vrednosti $t_r$ oziroma $t_f$ se presluh začne manjšati ?
  - Kako se to vidi na osciloskopu ?

# Omejevanje presluha na ploščatem kablu - ozemljitev

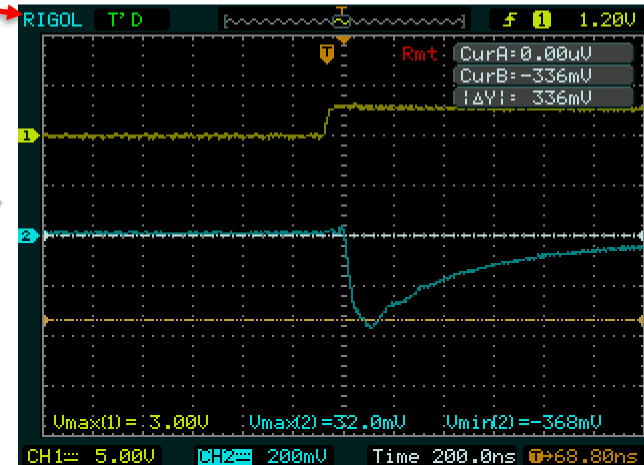
- Opazujte vpliv ozemljitve na liniji 2 (na enem ali obeh koncih) na amplitudo bližnjega in daljnega presluha na liniji 0-3.

brez ozemljitve

*312 mV*

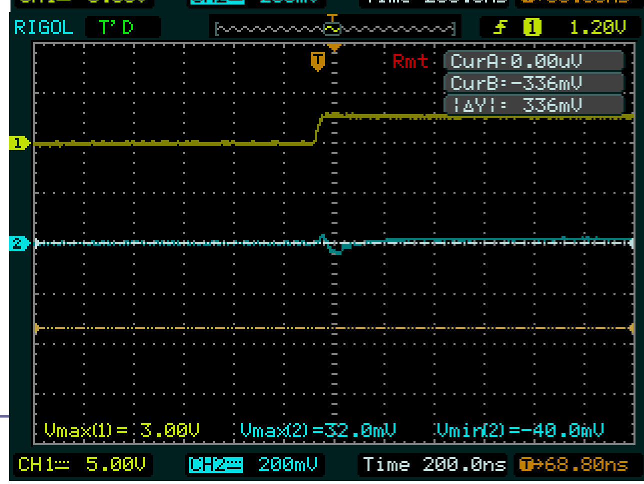



*-368mV*

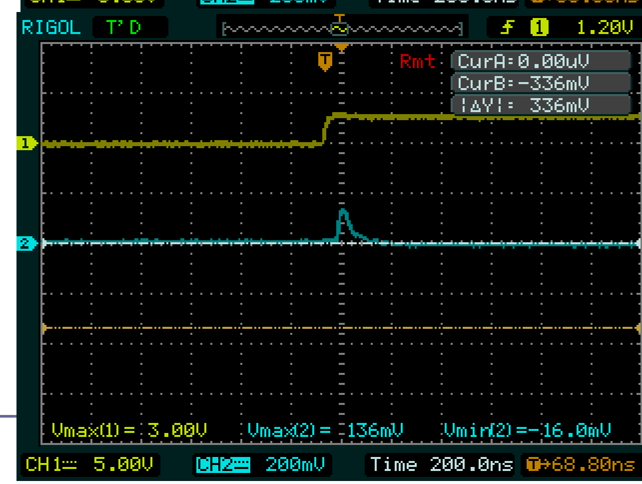



ozemljitev 2 - GND

*32 mV*




*136mV*




*Bližnji presluh* *Daljnji presluh*

# TABLA: Lab.vaja LV2-4 Presluh – ploščati kabel

## PLOŠČATI KABEL

### LINIJA 0-1:

- (a) ČAS POTOVANJA - $\tau$
- (b) KARAKT. UPORNOST - $R_0$

} - LIN. 0-2 ← GND

### LINIJE 0-2, 0-3, 0-8:

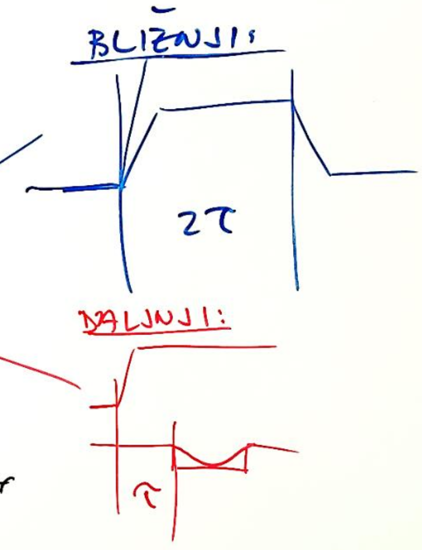
(e) $K_B$ = ? ←

- BLIŽNJI PRESLUH
- DALJNJI PRESLUH

MERITVE:

- ČASOVNI POTEK
- VPLIV ODBOJEV:
  - BREZ (c)
  - (d) ODBOJ NA ISTI STRANI
  - ODBOJ NA OBEH STRANEH

→ ZAKLJUČITEV 0-1 Z UPOROM! (DESNA STRAN)

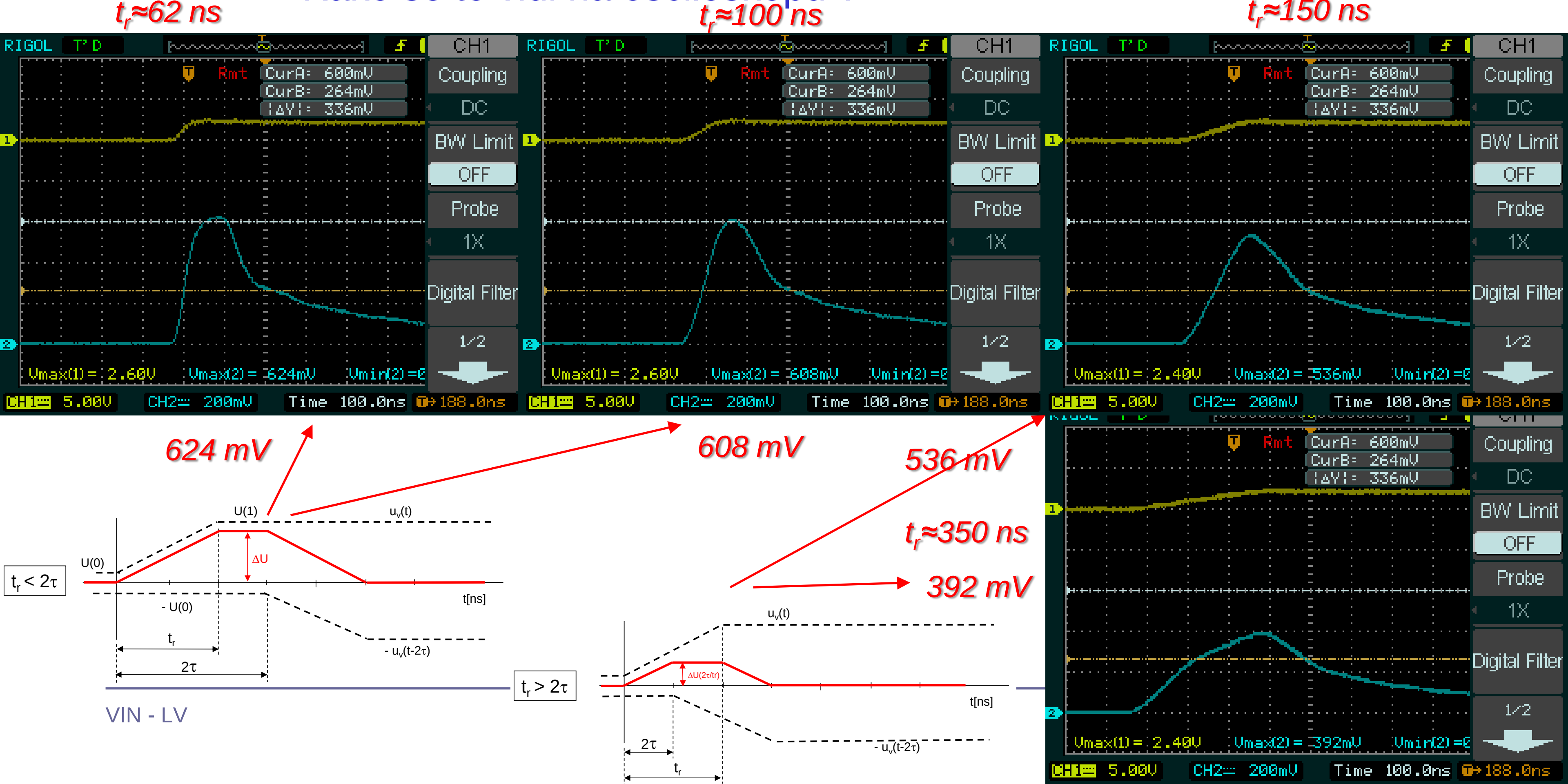



- OMEJEVANJE PRESLUHOV:
  - (f) OZEMLJITEV LINIJE 0-2
  - (g) DALJŠANJE $t_m, t_d$

POROČILO:

# Omejevanje presluha na ploščatem kablu – čas vzpona

- Na funkcijskem generatorju spreminjajte čas vzpona $t_r$ in čas padca signala $t_f$ in opazujte vpliv na presluh.
  - Pri kateri vrednosti $t_r$ oziroma $t_f$ se presluh začne manjšati?
  - Kako se to vidi na osciloskopu ?



# Laboratorijska vaja 12
# Tipala in signali – praktični izzivi

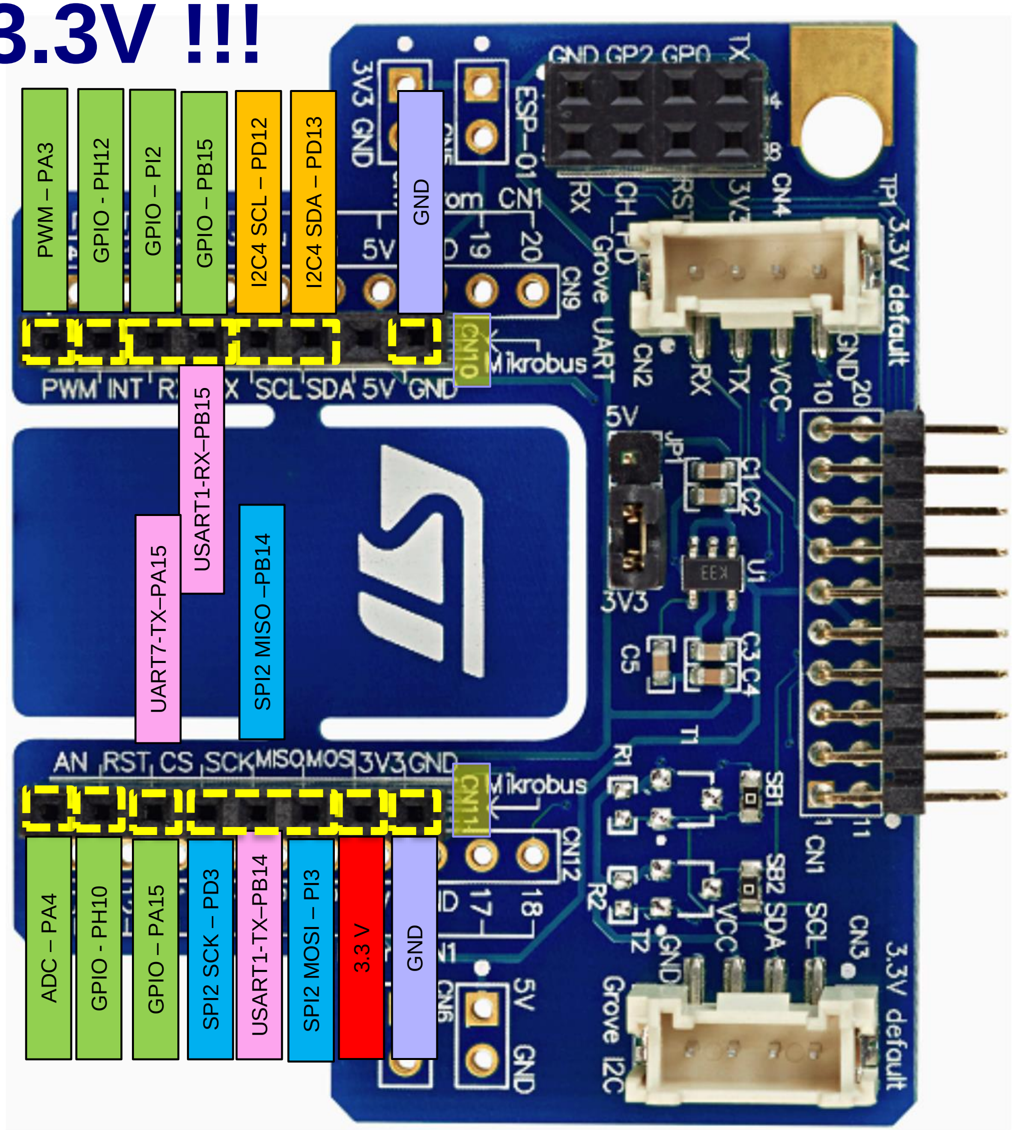
- 12a: LV5a : Tipala in signali – meritve
  a) Meritev karakteristične upornosti linije z multimetrom ($R_0$)
  b) Preizkusi različnih tipal (IR,UZ razdalja, PIR, Hall, …)
  c) Meritve deformacij UTP kabla
  d) *LV2-4 - Presluh – meritve na ploščatem kablu

- 12b: LV5b : STM32H7 – Generator signalov

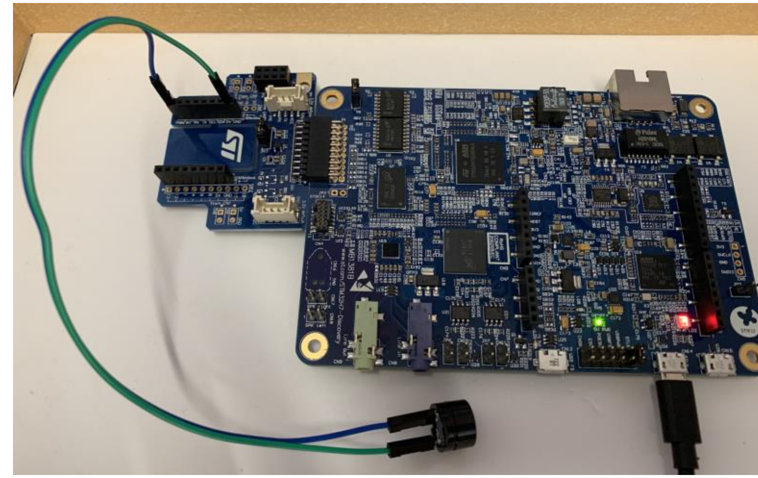
| | | | |
|---|---|---|---|
| a) | UART | PB14 | |
| b) | PWM | PA3 | |
| c) | SPI | PD3(SCK), | PI3 (MOSI) |
| d) | I2C | PD12(SCL), | PD13(SDA) |
| e) | CANBUS | CN1 (FDCAN1: CAN-L, CAN-H | |

# STM32H750B – DISCOVERY StMod+ konektor

**3.3V !!!**




**Pravilna priključitev**

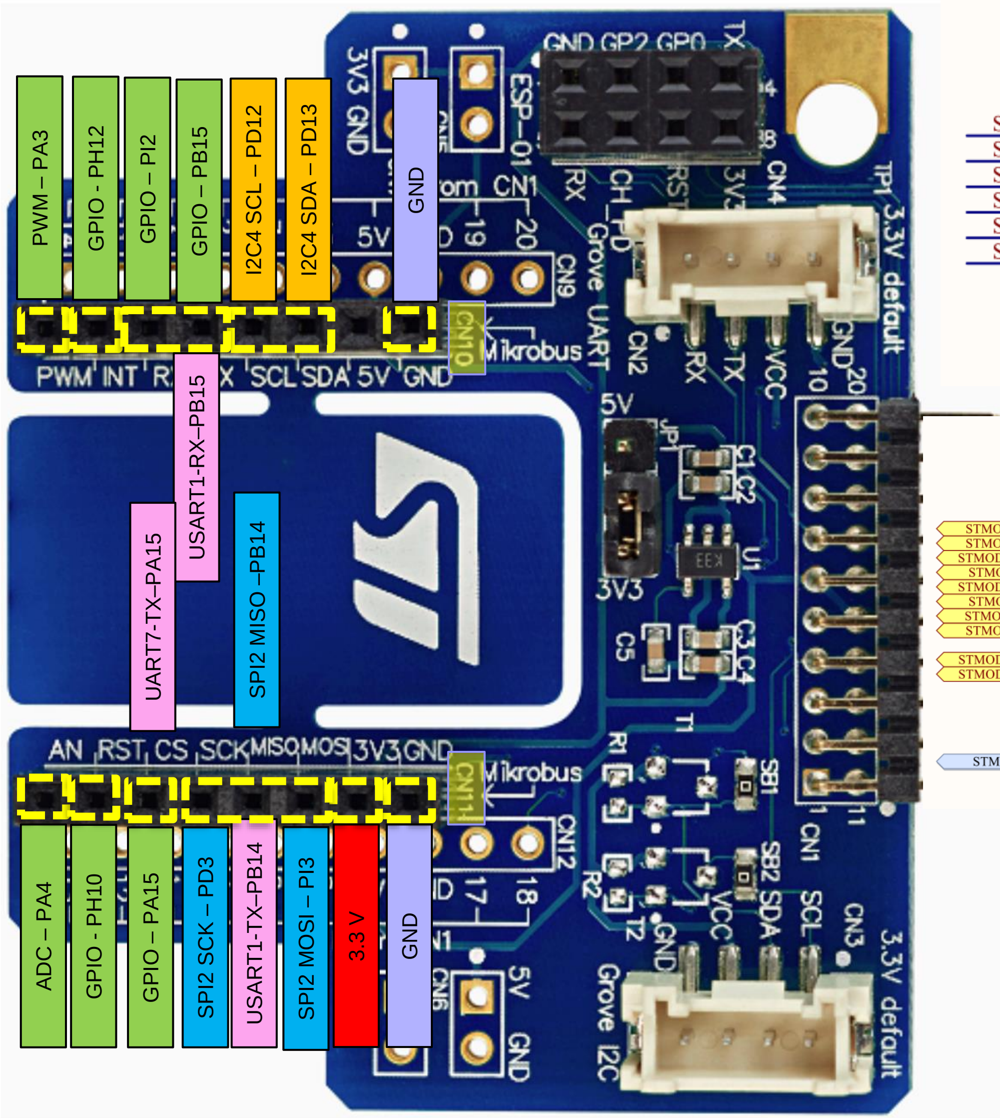


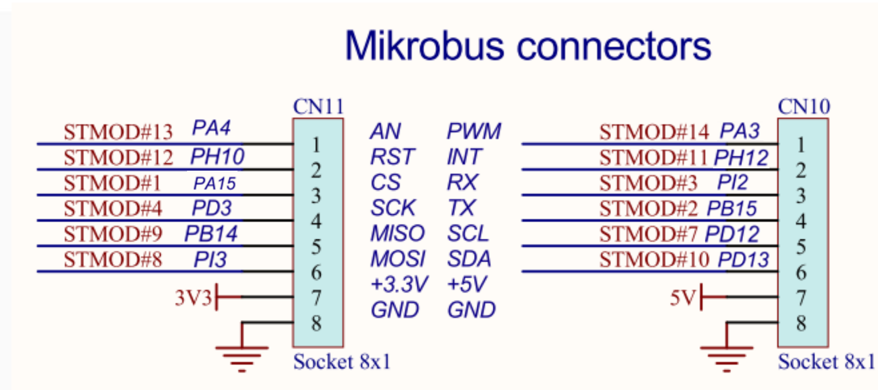
**Nepravilna priključitev**

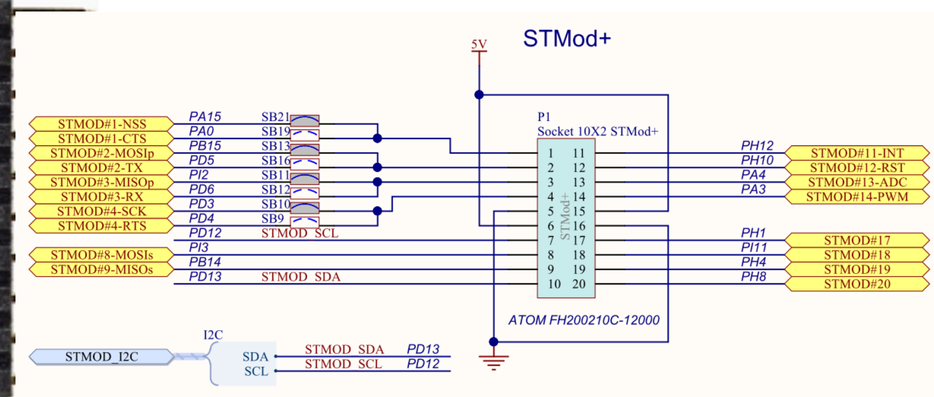
https://www.st.com/en/evaluation-tools/stm32h750b-dk.html

3.3V !!!

# STM32H750B – DISCOVERY StMod+ konektor



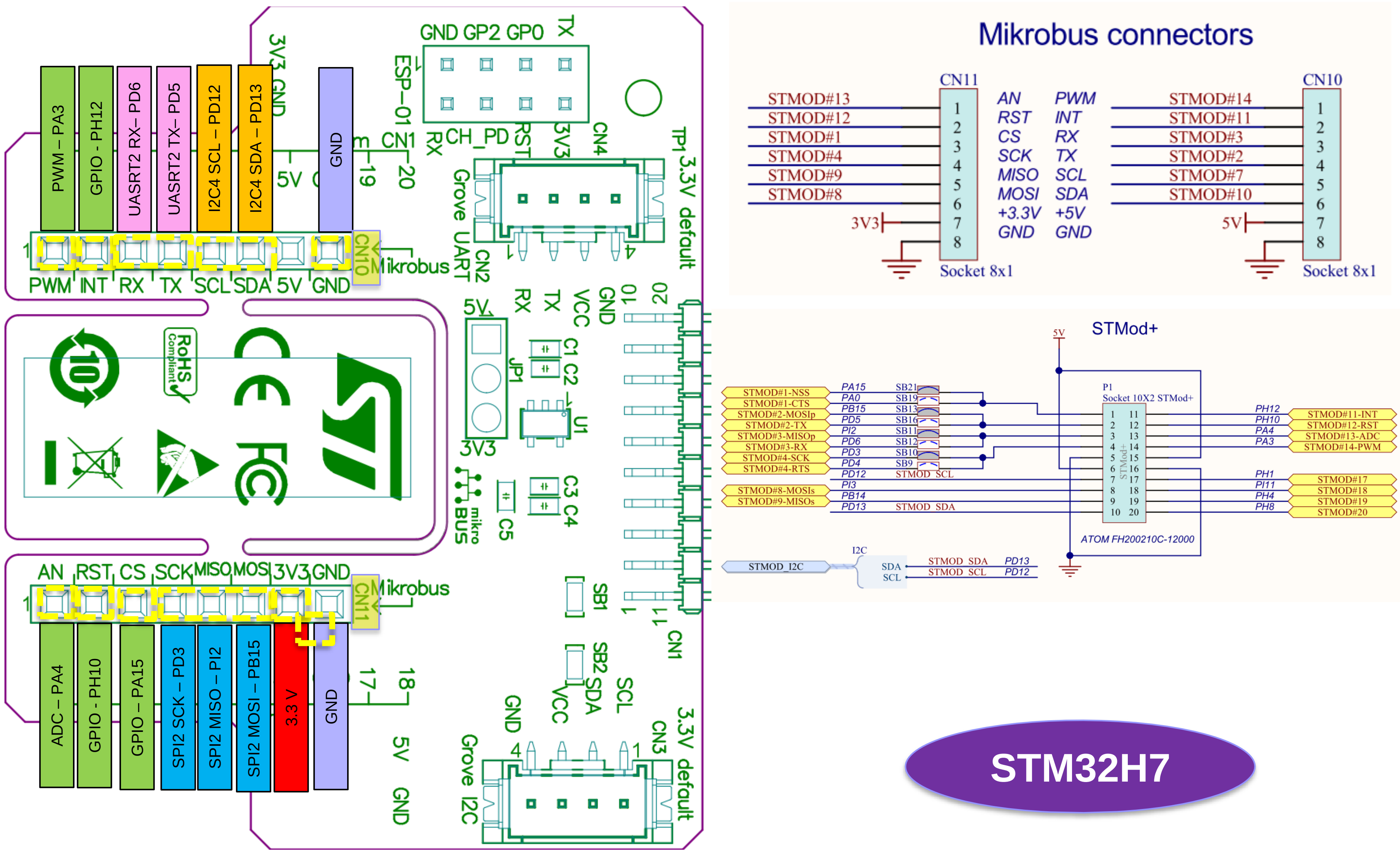




**STM32H7**

# STM32H750B – DISCOVERY StMod+ konektor

**3.3V !!!**



# 3.3V !!!

# STM32H750B – DISCOVERY CANBUS konektorja

**STM32H7**

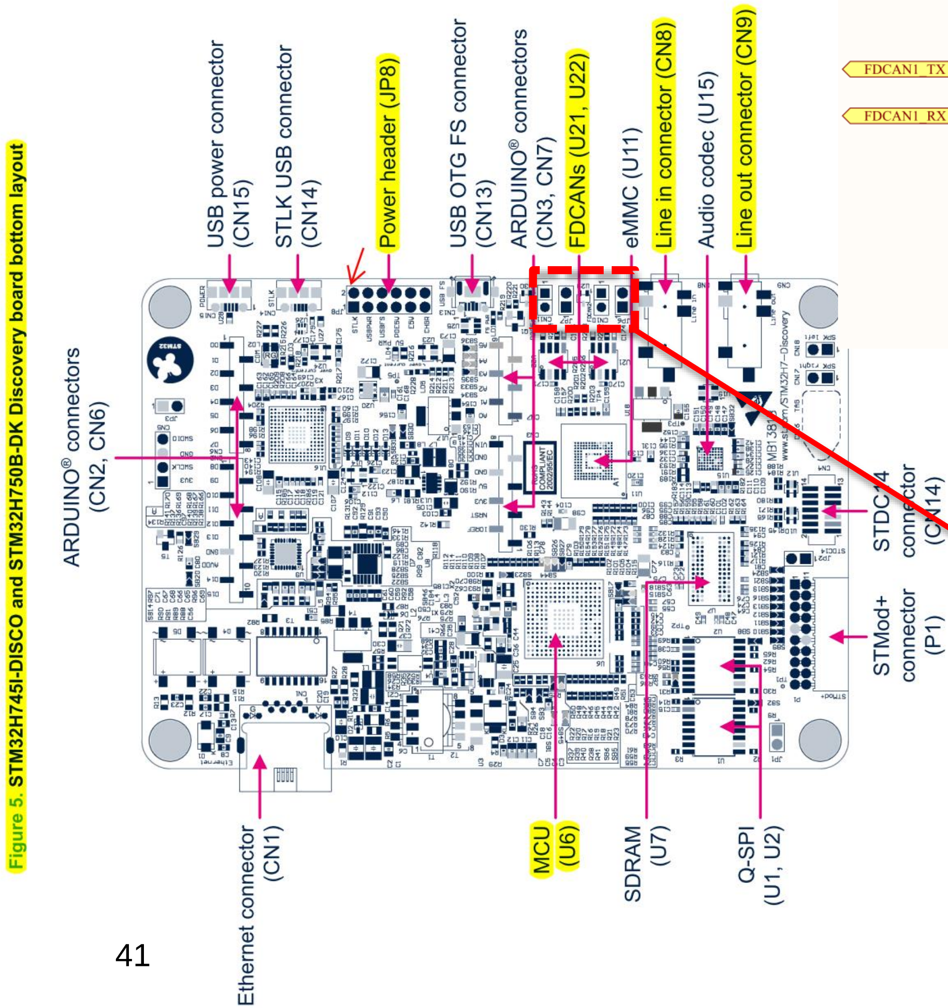
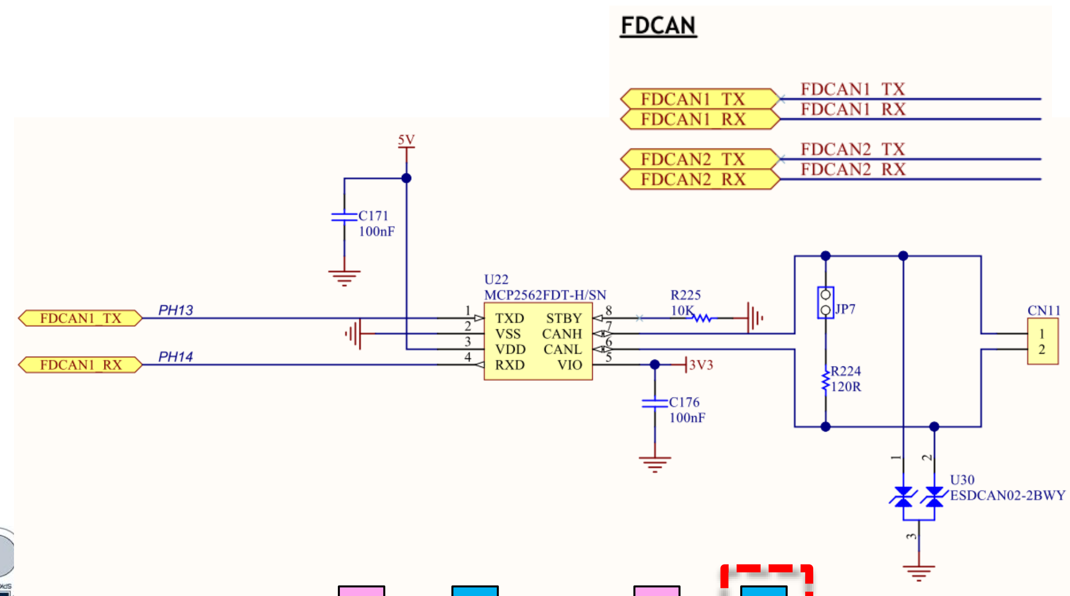
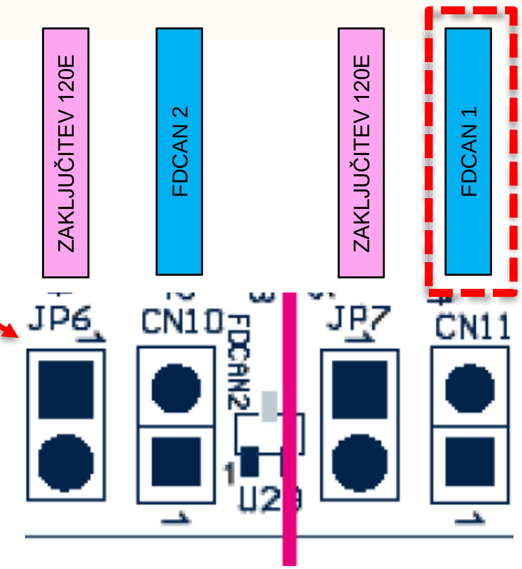


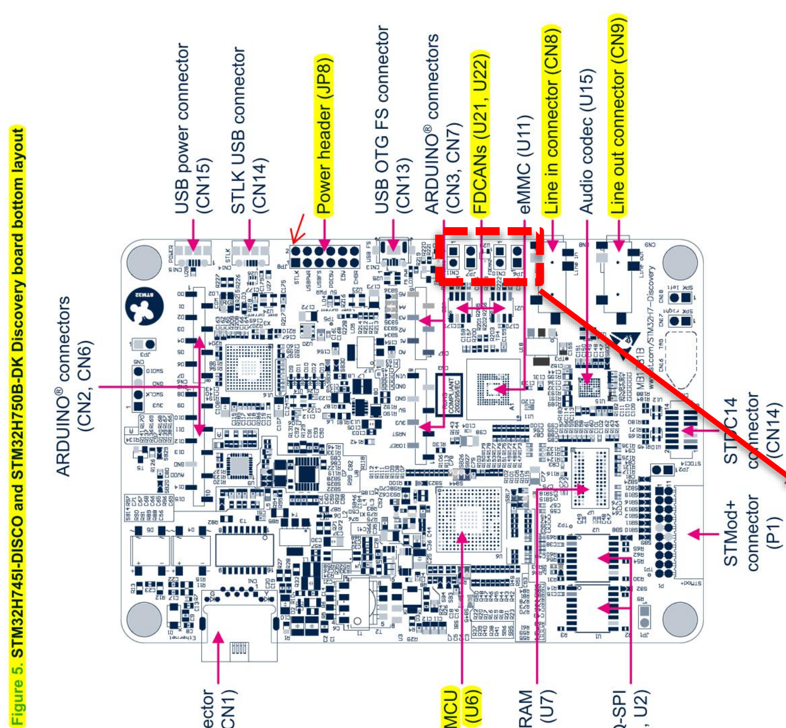

Figure 5. STM32H745I-DISCO and STM32H750B-DK Discovery board bottom layout

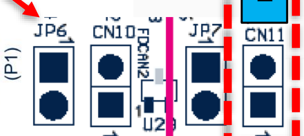


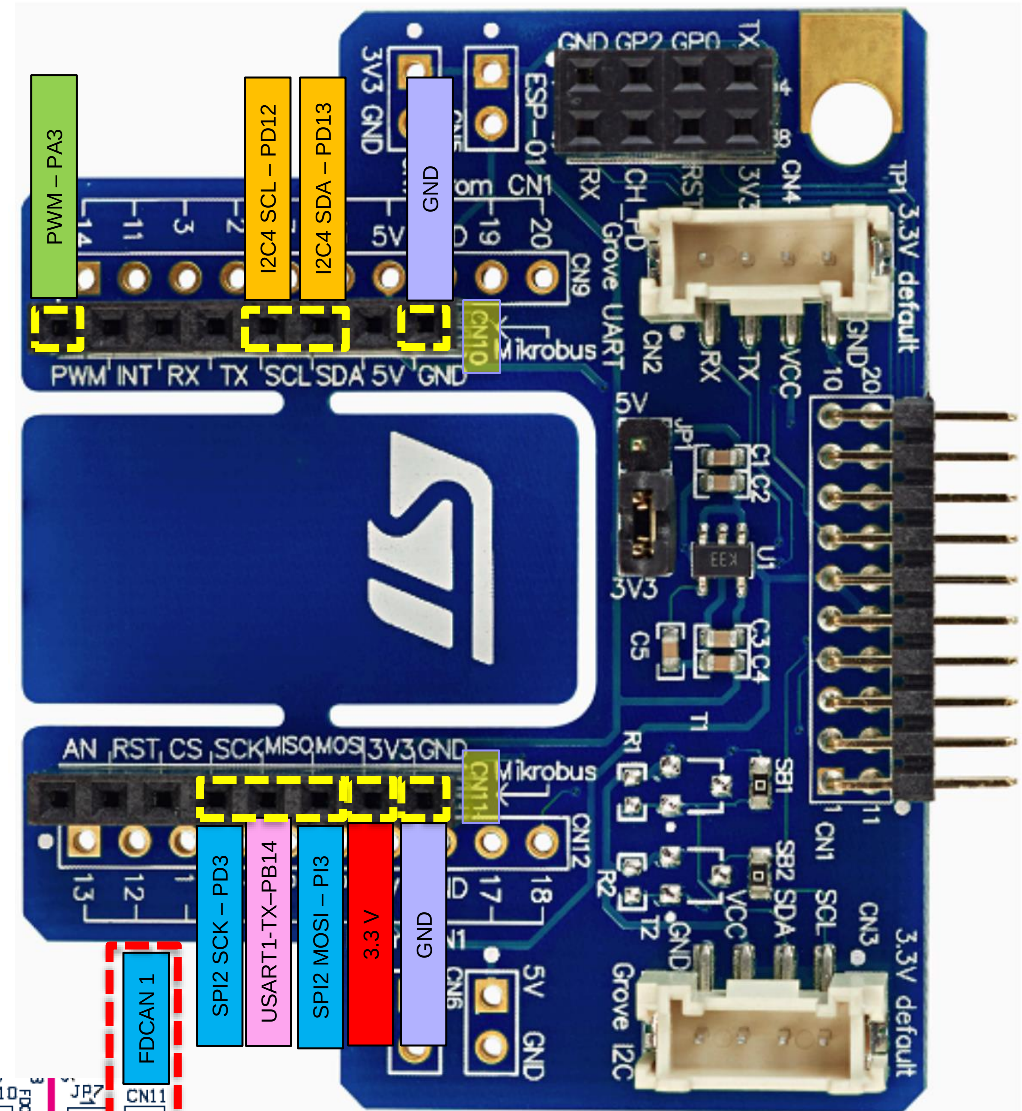



# Izzivi - povezave

- PWM PA3
- UART PB14
- SPI PD3(SCK), PI3 (MOSI)
- I2C PD12(SCL), PD13(SDA)
- CANBUS CN1 (FDCAN1)
  - CAN-L, CAN-H



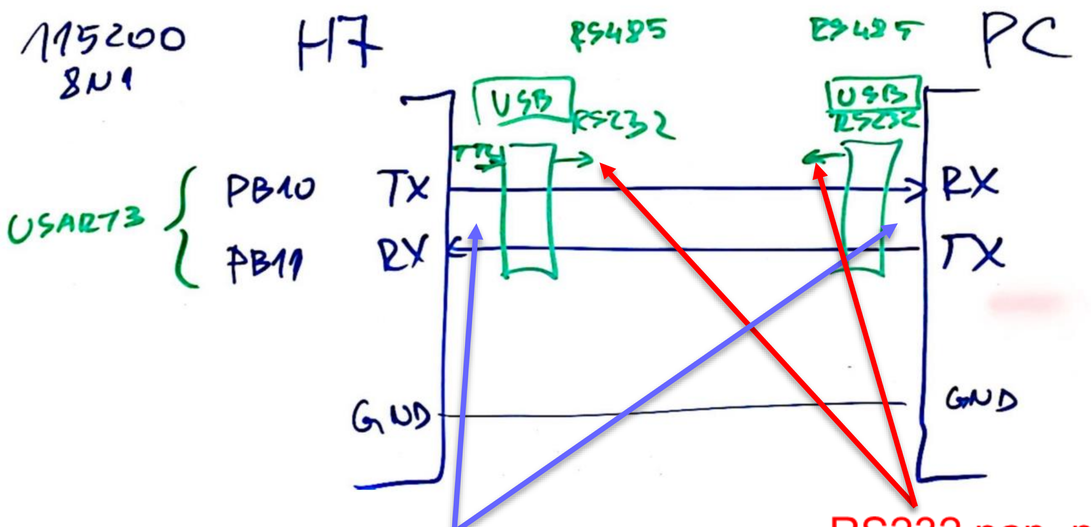



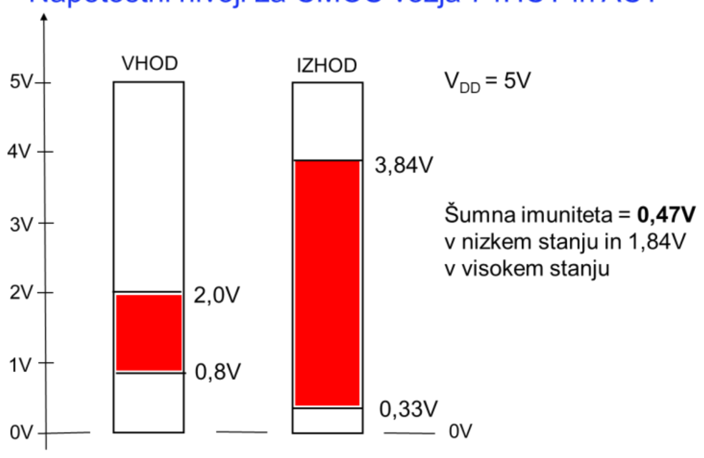
# Laboratorijska vaja 12
# Tipala in signali – praktični izzivi

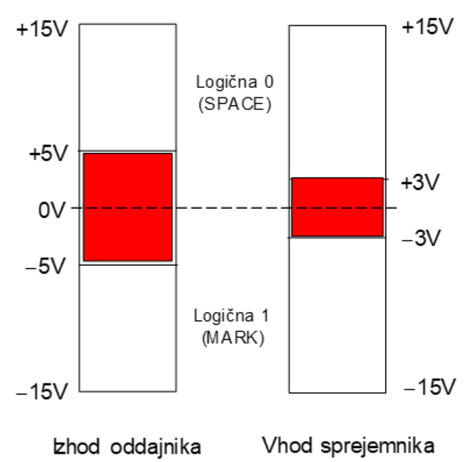
- 12a: LV5a : Tipala in signali – meritve
  a) Meritev karakteristične upornosti linije z multimetrom ($R_0$)
  b) Preizkusi različnih tipal (IR,UZ razdalja, PIR, Hall, …)
  c) Meritve deformacij UTP kabla
  d) *LV2-4 - Presluh – meritve na ploščatem kablu

- 12b: LV5b : STM32H7 – Generator signalov
  a) UART PB14
  b) PWM PA3
  c) SPI PD3(SCK), PI3 (MOSI)
  d) I2C PD12(SCL), PD13(SDA)
  e) CANBUS CN1 (FDCAN1: CAN-L, CAN-H

# UART komunikacija (TTL ali RS232 napetostni nivoji)

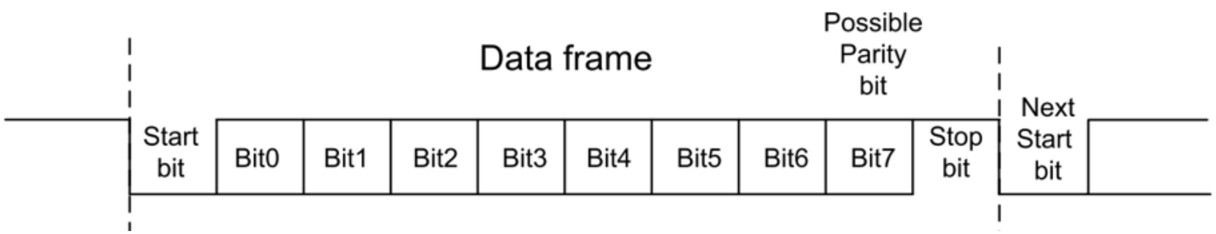


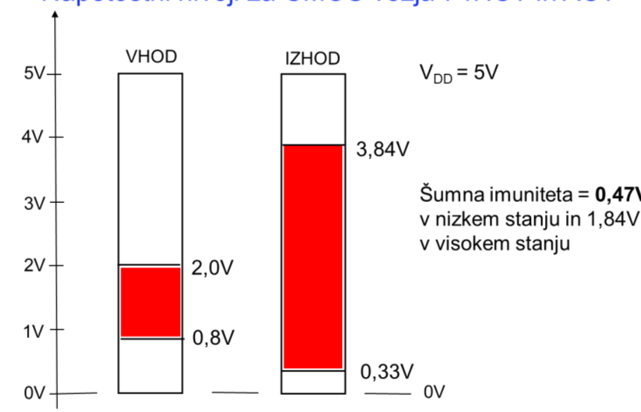



Določite bitno hitrost prenosa in ugotovite ASCII kodo znakov, ki se prenašajo ob nastavitvi 8N1 (8 podatkovnih bitov, brez paritetnega bita, 2 stop bita).

- Primer poteka signala TTL – nastavitve „8N1“:
  - Napetostna in logična nivoja



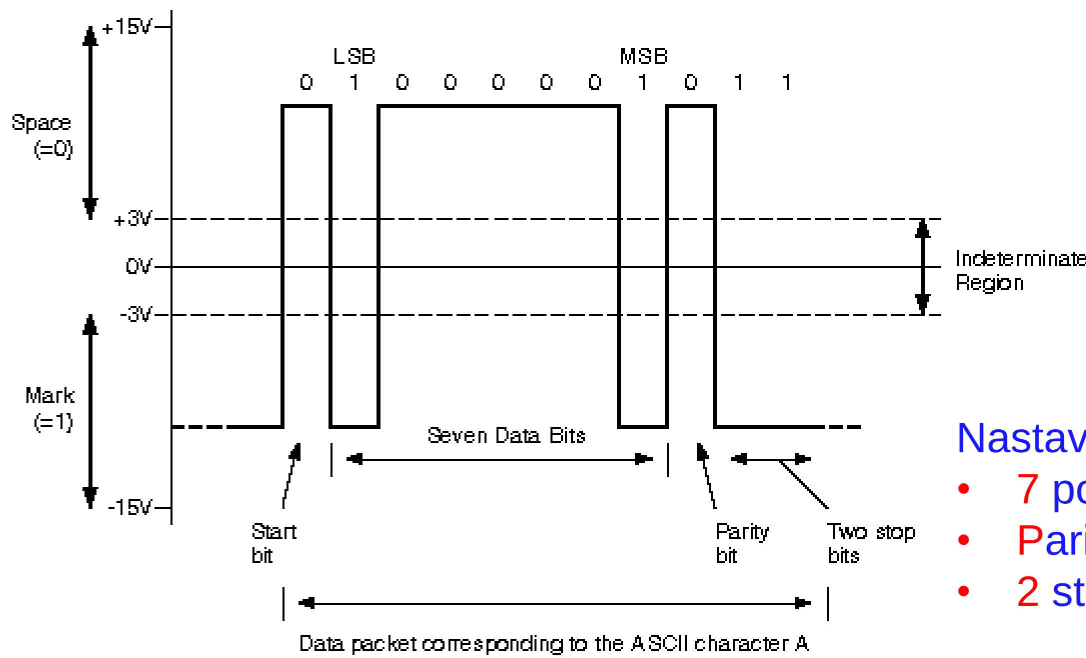

Napetostni nivoji za CMOS vezja 74HCT in ACT



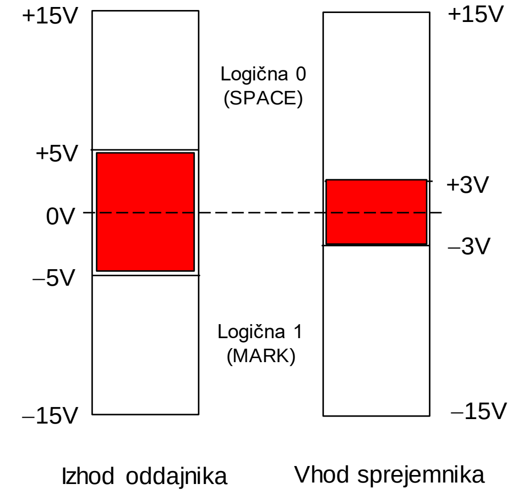

Nastavitve TTL na prikazani sliki – „8N1“:
- 8 podatkovnih bitov
- Ni paritetnega bita
- 1 stop bit

Določite bitno hitrost prenosa in ugotovite ASCII kodo znakov, ki se prenašajo ob nastavitvi 8N1 (8 podatkovnih bitov, brez paritetnega bita, 2 stop bita).

- Primer poteka signala RS232 – nastavitve „7P2“:
  - Napetostna in logična nivoja




RS232 nap. nivoji




Nastavitve RS232 na prikazani sliki – „7P2“:

- 7 podatkovnih bitov
- Paritetni bit
- 2 stop bita

# Laboratorijska vaja 12
# Tipala in signali – praktični izzivi

- 12a: LV5a : Tipala in signali – meritve
  a) Meritev karakteristične upornosti linije z multimetrom ($R_0$)
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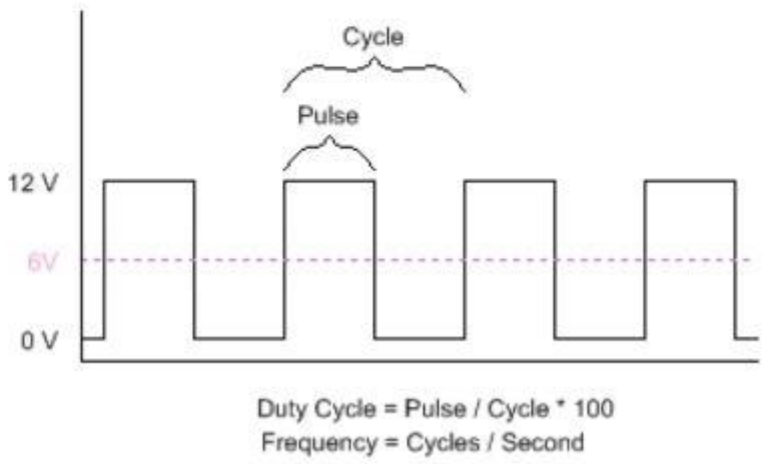
- 12b: LV5b : STM32H7 – Generator signalov
  a) UART PB14
  b) PWM PA3
  c) SPI PD3(SCK), PI3 (MOSI)
  d) I2C PD12(SCL), PD13(SDA)
  e) CANBUS CN1 (FDCAN1: CAN-L, CAN-H

# Določite frekvenco PWM signala in ustrezno noto.




*Example of a PWM signal at 50% duty cycle*

```
#define NOTE_A3 220
#define NOTE_AS3 233
#define NOTE_B3 247
#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
#define NOTE_AS4 466
#define NOTE_B4 494
#define NOTE_C5 523
#define NOTE_CS5 554
#define NOTE_D5 587
#define NOTE_DS5 622
#define NOTE_E5 659
#define NOTE_F5 698
#define NOTE_FS5 740
#define NOTE_G5 784
#define NOTE_GS5 831
#define NOTE_A5 880
#define NOTE_AS5 932
#define NOTE_B5 988
```

# Laboratorijska vaja 12
# Tipala in signali – praktični izzivi

- 12a: LV5a : Tipala in signali – meritve
  a) Meritev karakteristične upornosti linije z multimetrom ($R_0$)
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  a) UART PB14
  b) PWM PA3
  c) SPI PD3(SCK), PI3 (MOSI)
  d) I2C PD12(SCL), PD13(SDA)
  e) CANBUS CN1 (FDCAN1: CAN-L, CAN-H

# 5 Digital main blocks

## 5.1 State machine

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

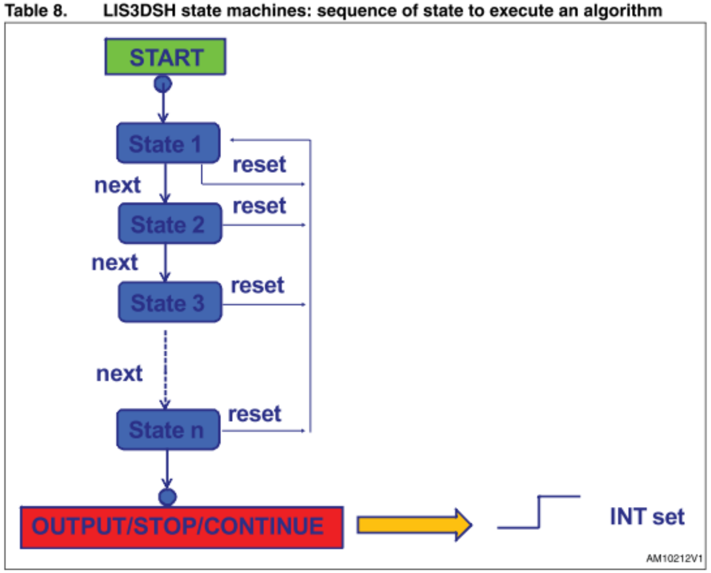
The program is made up of a set of instructions that define the transition to successive states. Conditional branches are possible.

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**

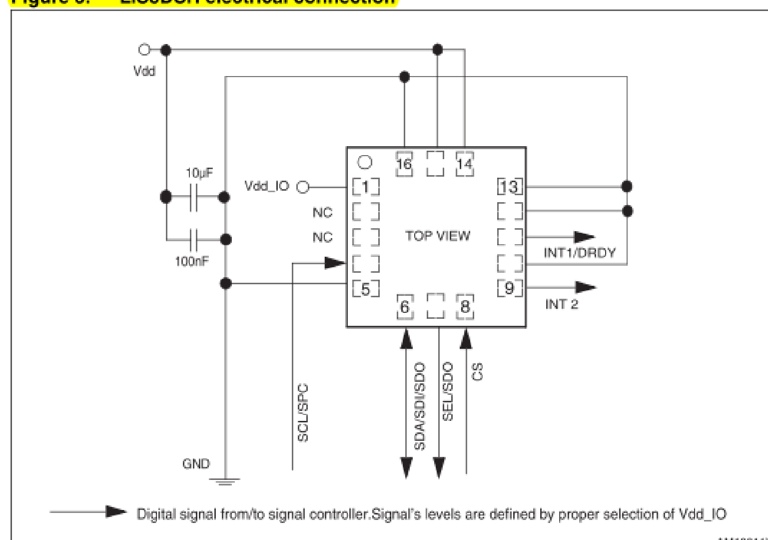
| Parameter | I²C standard mode (1) | | I²C fast mode (1) | | Unit |
|---|---|---|---|---|---|
| | Min. | Max. | Min. | Max. | |
| SCL clock frequency | 0 | 100 | 0 | 400 | kHz |

**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**

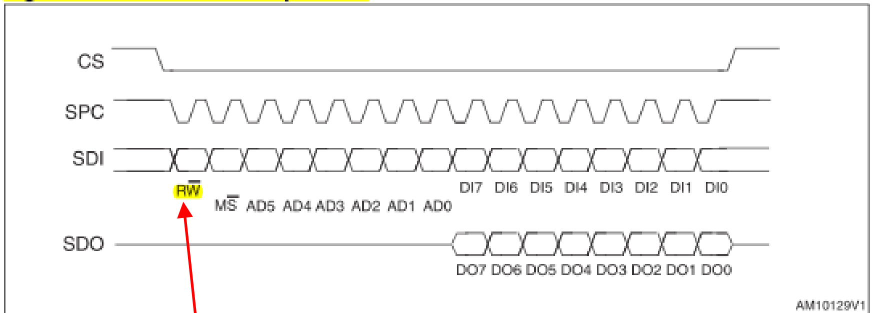



https://github.com/LAPSyLAB/STM32F4_Docs_and_Examples/blob/main/STM32F407_Discovery_kit/LIS3DSH.pdf

# VP 6 - STM32 CubeIDE, SPI in LIS3DSH

Gradiva

**Figure 6. Read and write protocol**




***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)

Who_AM_I register.

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

**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 |

## 8.5 CTRL_REG4 (20h)

Control register 4.

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

**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<br>0:continuos update 1:output registers not updated until MSB and LSB reading) |
| Zen | Z axis enable. Default value:1<br>(0:Z axis disabled; 1:Z axis enabled) |
| Yen | Y axis enable. Default value:1<br>(0:Y axis disabled; 1:Y axis enabled) |
| Xen | X axis enable. Default value:1<br>0=X axis disabled; 1=X axis enabled |

**Table 24. CTRL4 ODR configuration**

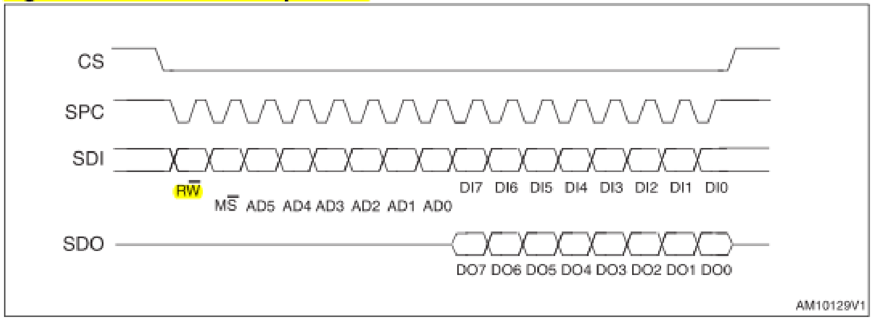
| ODR3 | ODR2 | ODR1 | ODR0 | ODR selection |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | Power down |
| 0 | 0 | 0 | 1 | 3.125 Hz |
| 0 | 0 | 1 | 0 | 6.25 Hz |
| 0 | 0 | 1 | 1 | 12.5 Hz |
| 0 | 1 | 0 | 0 | 25 Hz |

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**




***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 */
```

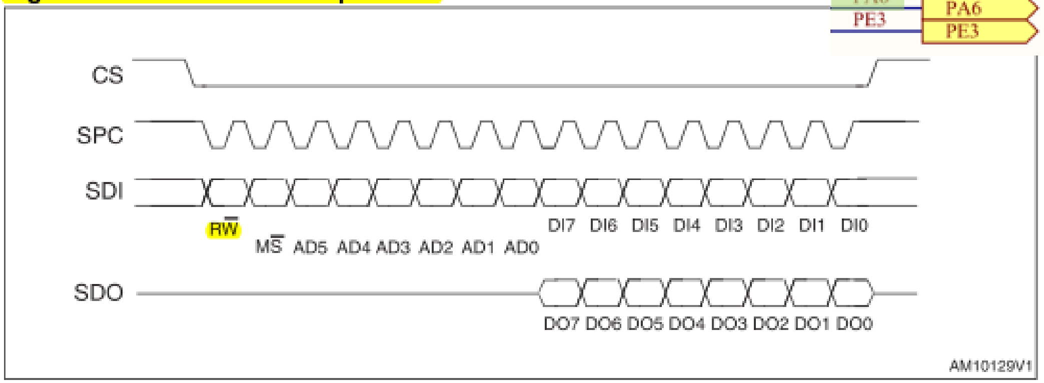
Inicializacija

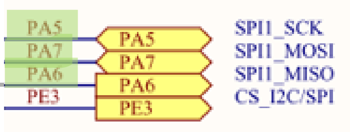
```
  /* USER CODE BEGIN 2 */

  // 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**

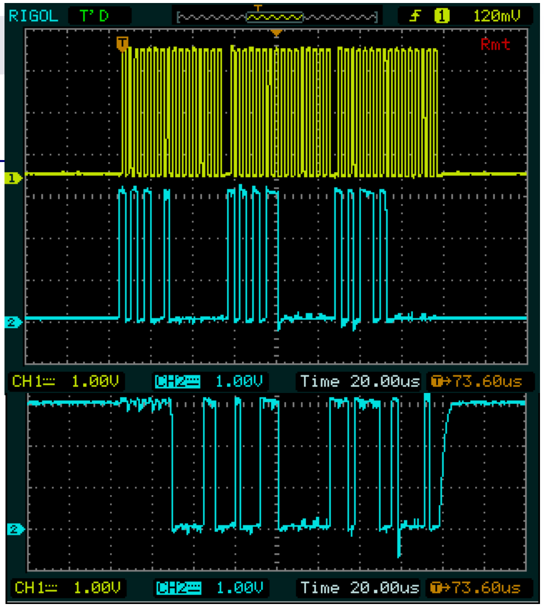


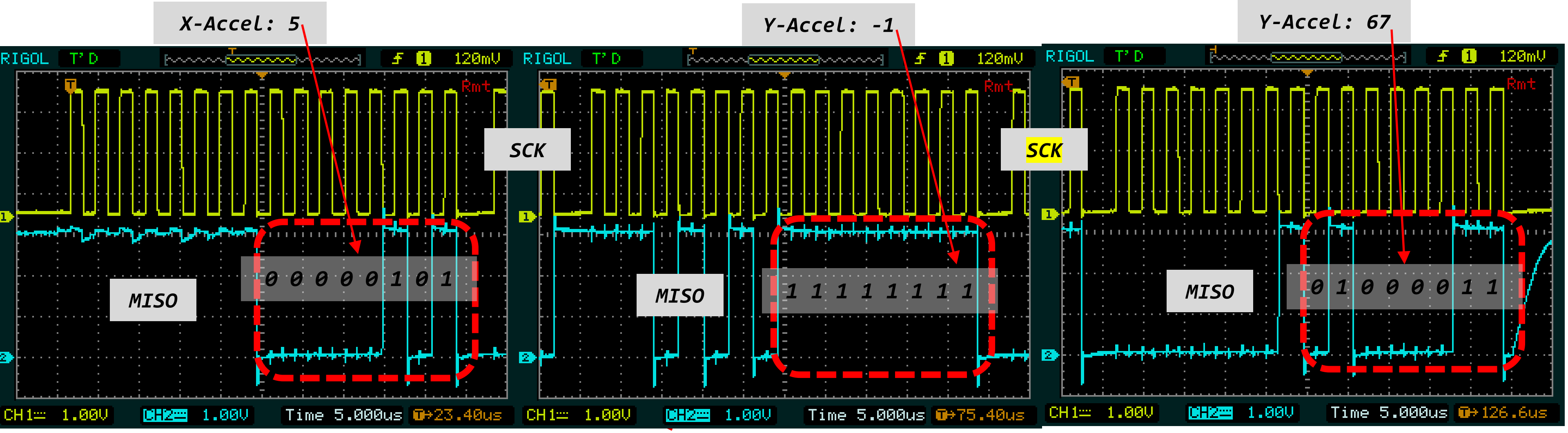

SCK

MOSI

MISO

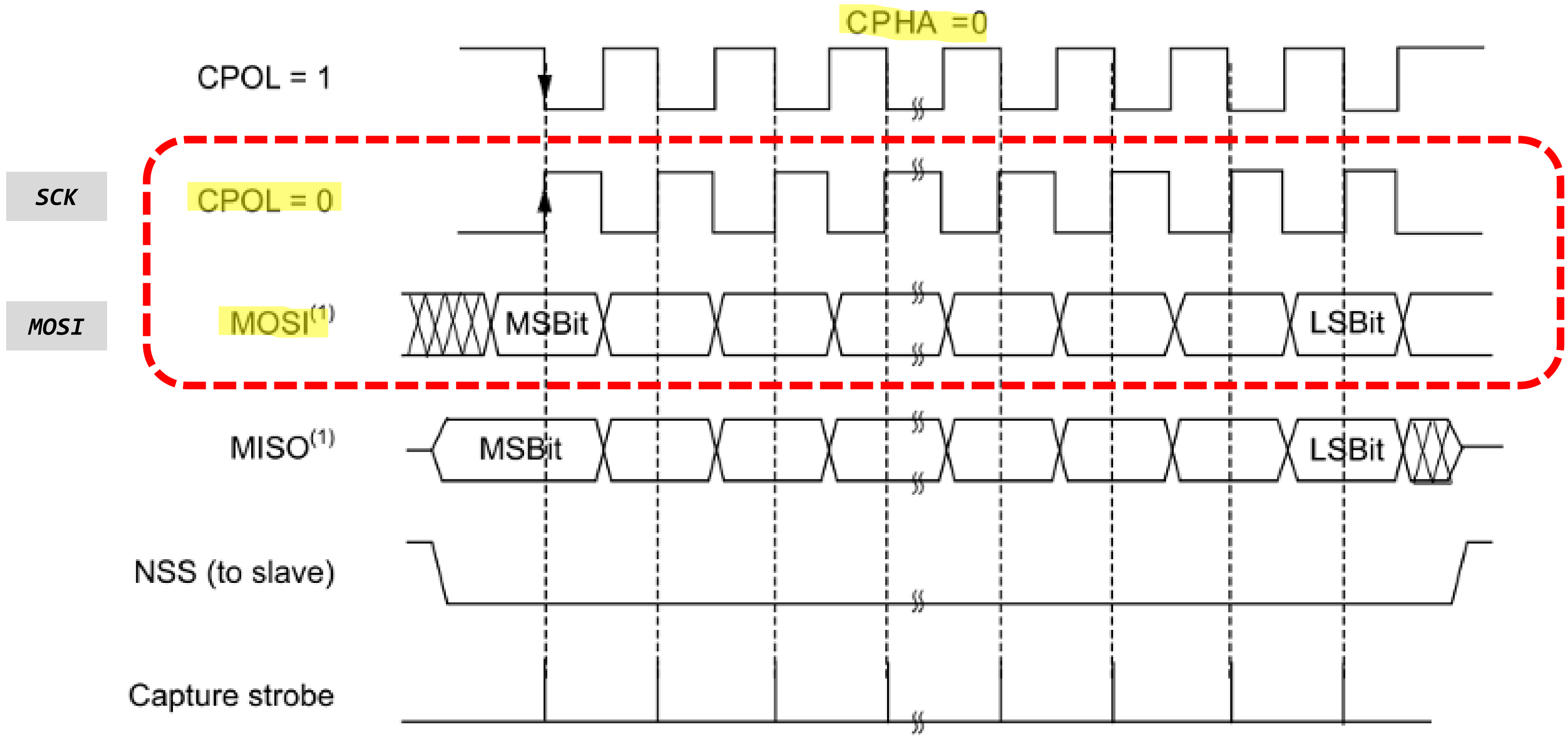



```
Hello World [3530]: Key:0000 Accel[ID:00] X:0005 Y:-1 Z:0066
Hello World [3531]: Key:0000 Accel[ID:00] X:0005 Y:-1 Z:0067
```



# Določite bitno hitrost prenosa in ugotovite vsebino signala SPI2 z nastavitvami: CPOL=0, CPHA=0, komunikacija z napravo LIS3DSH, …



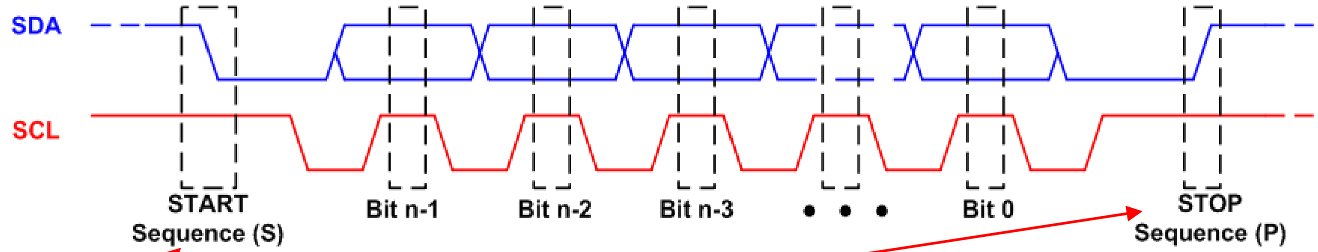
# Laboratorijska vaja 12
# Tipala in signali – praktični izzivi

- 12a: LV5a : Tipala in signali – meritve
  a) Meritev karakteristične upornosti linije z multimetrom ($R_0$)
  b) Preizkusi različnih tipal (IR,UZ razdalja, PIR, Hall, …)
  c) Meritve deformacij UTP kabla
  d) *LV2-4 - Presluh – meritve na ploščatem kablu

- 12b: LV5b : STM32H7 – Generator signalov
  a) UART PB14
  b) PWM PA3
  c) SPI PD3(SCK), PI3 (MOSI)
  d) I2C PD12(SCL), PD13(SDA)
  e) CANBUS CN1 (FDCAN1: CAN-L, CAN-H

# Izhodišča

- Signali na linijah

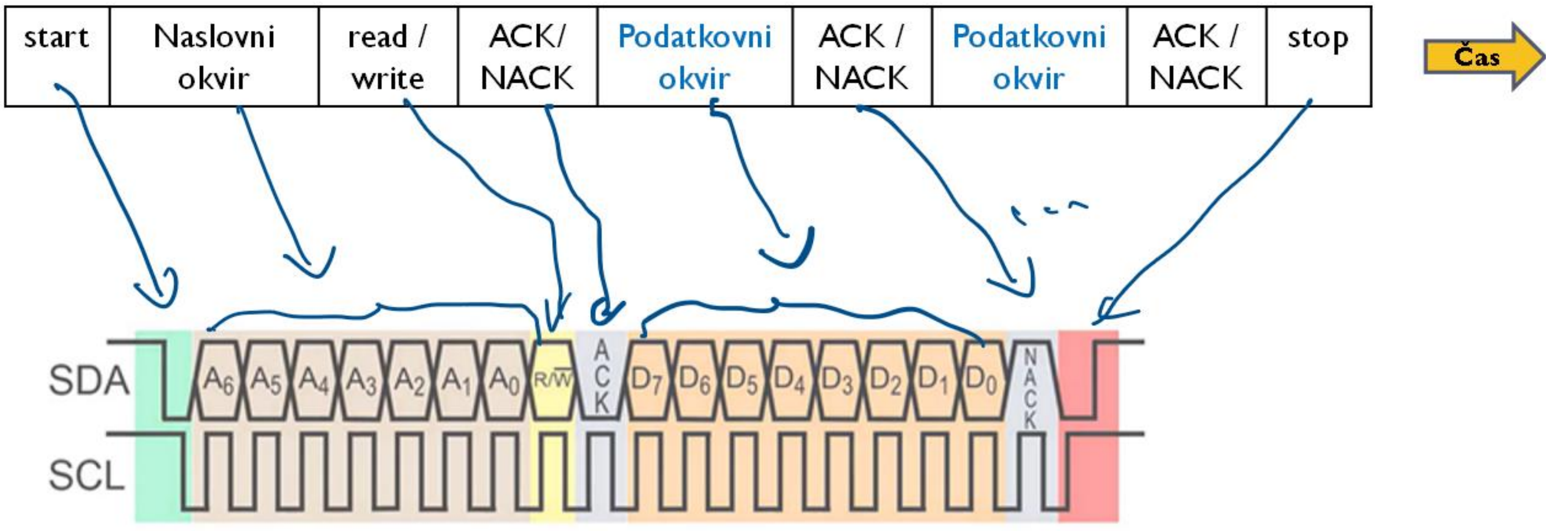



- Dodatna bita (vedno generira master) :
  - pogoj **start** – linija SDA preklopi iz 1 v 0 preden linija SCL preklopi iz 1 v 0
  - pogoj **stop** - linija SDA preklopi iz 0 v 1 potem ko linija SCL preklopi iz 0 v 1

- Primer komunikacije

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| start | Naslovni okvir | read / write | ACK/ NACK | Podatkovni okvir | ACK / NACK | Podatkovni okvir | ACK / NACK | stop |

- Dodatni biti:
  - **read/write** – en bit določa prenos iz ‘master‘ v ‘slave‘ napravo (0) ali ‘master‘ zahteva podatek iz ‘slave‘ naprave (1).
  - **ACK/NACK** – vsak okvir sporočila ima bit ‘acknowledge/noacknovledge‘. Če je bil naslovni ali podatkovni okvir uspešno prejet je pošiljatelju vrnjen bit ACK, sicer NACK.




Dodatni biti med okvirji:

- **read/write** – en bit določa prenos iz 'master' v 'slave' napravo (0) ali 'master' zahteva podatek iz 'slave' naprave (1).
- **ACK/NACK** – vsak okvir sporočila ima bit 'acknowledge/noacknovledge'. Če je bil naslovni ali podatkovni okvir uspešno prejet je pošiljatelju vrnjen bit ACK, sicer NACK.
- **start** – linija SDA preklopi iz 1 v 0 preden linija SCL preklopi iz 1 v 0
- **stop** - linija SDA preklopi iz 0 v 1 potem ko linija SCL preklopi iz 0 v 1

# Primer I2C komunikacije STM32H7 - Touch

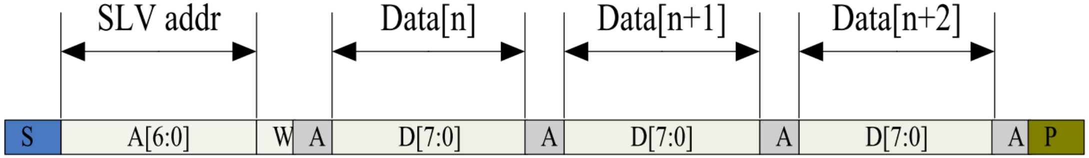



*Figure 2-5 I2C master write, slave read*

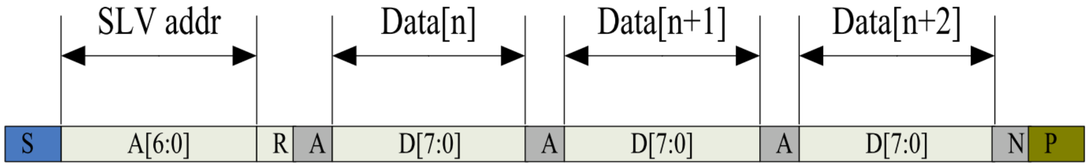
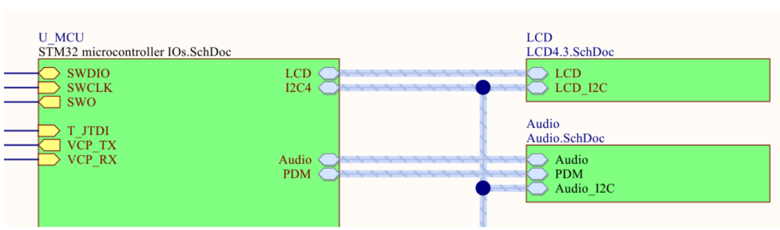



*Figure 2-6 I2C master read, slave write*




**FocalTech** **FT5336GQQ**

**True Multi-Touch Capacitive Touch Panel Controller**

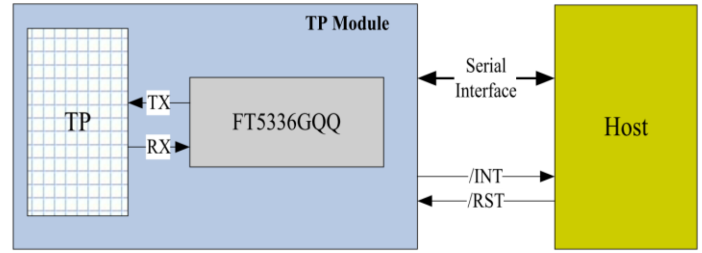



*Figure 2-3 Host Interface Diagram*

https://github.com/LAPSyLAB/STM32H7_Discovery_VIN_Projects/tree/main/STM32H750B-DK_I2C_Touch_Demo

*8-bitni naslovi in registri*

Work Mode Register Map

| Address | Name | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 | Host Access |
|---|---|---|---|---|---|---|---|---|---|---|
| 00h | DEVIDE_MODE | | Device Mode[2:0] | | | | | | | RW |
| 01h | GEST_ID | Gesture ID[7:0] | | | | | | | | R |
| 02h | TD_STATUS | | | | | Number of touch points[3:0] | | | | R |
| 03h | TOUCH1_XH | 1stEvent Flag | | | | 1st Touch X Position[11:8] | | | | R |
| 04h | TOUCH1_XL | 1st Touch X Position[7:0] | | | | | | | | R |
| 05h | TOUCH1_YH | 1st Touch ID[3:0] | | | | 1st Touch Y Position[11:8] | | | | R |
| 06h | TOUCH1_YL | 1st Touch Y Position[7:0] | | | | | | | | R |
| A8h | ID_G_FT5201ID | CTPM Vendor ID | | | | | | | | R |

# Primer I2C komunikacije STM32H7 - Touch

```
// 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,&VendorID, 1, HAL_MAX_DELAY);

retval = HAL_I2C_Mem_Read(&hi2c4, (0x38 << 1), 0x00, I2C_MEMADD_SIZE_8BIT,&DeviceMode, 1, HAL_MAX_DELAY);
retval = HAL_I2C_Mem_Read(&hi2c4, (0x38 << 1), 0x01, I2C_MEMADD_SIZE_8BIT,&Gesture, 1, HAL_MAX_DELAY);
retval = HAL_I2C_Mem_Read(&hi2c4, (0x38 << 1), 0x02, I2C_MEMADD_SIZE_8BIT,&Status, 1, HAL_MAX_DELAY);

retval = HAL_I2C_Mem_Read(&hi2c4, (0x38 << 1), 0x03, I2C_MEMADD_SIZE_8BIT,&dataBuffer, 5, HAL_MAX_DELAY);
if (Status != 0) {
      TouchX = ( (dataBuffer[0] & 0b1111) << 8) + dataBuffer[1];
      TouchY = ( (dataBuffer[2] & 0b1111) << 8) + dataBuffer[3];
} else {
      TouchX = 0;
      TouchY = 0;
}
```

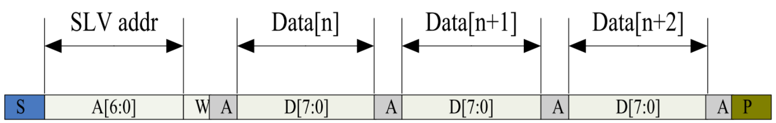



*Figure 2-5 I2C master write, slave read*

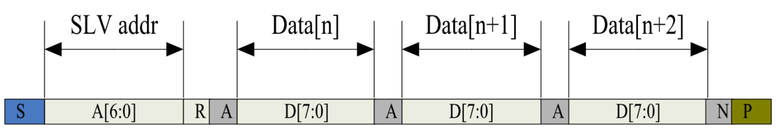



*Figure 2-6 I2C master read, slave write*

*8-bitni naslovi in registri*

Work Mode Register Map

| Address | Name | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 | Host Access |
|---|---|---|---|---|---|---|---|---|---|---|
| 00h | DEVIDE_MODE | | Device Mode[2:0] | | | | | | | RW |
| 01h | GEST_ID | Gesture ID[7:0] | | | | | | | | R |
| 02h | TD_STATUS | | | | | Number of touch points[3:0] | | | | R |
| 03h | TOUCH1_XH | 1st Event Flag | | | | 1st Touch X Position[11:8] | | | | R |
| 04h | TOUCH1_XL | 1st Touch X Position[7:0] | | | | | | | | R |
| 05h | TOUCH1_YH | 1st Touch ID[3:0] | | | | 1st Touch Y Position[11:8] | | | | R |
| 06h | TOUCH1_YL | 1st Touch Y Position[7:0] | | | | | | | | R |
| A8h | ID_G_FT5201ID | CTPM Vendor ID | | | | | | | | R |

https://github.com/LAPSyLAB/STM32H7_Discovery_VIN_Projects/tree/main/STM32H750B-DK_I2C_Touch_Demo

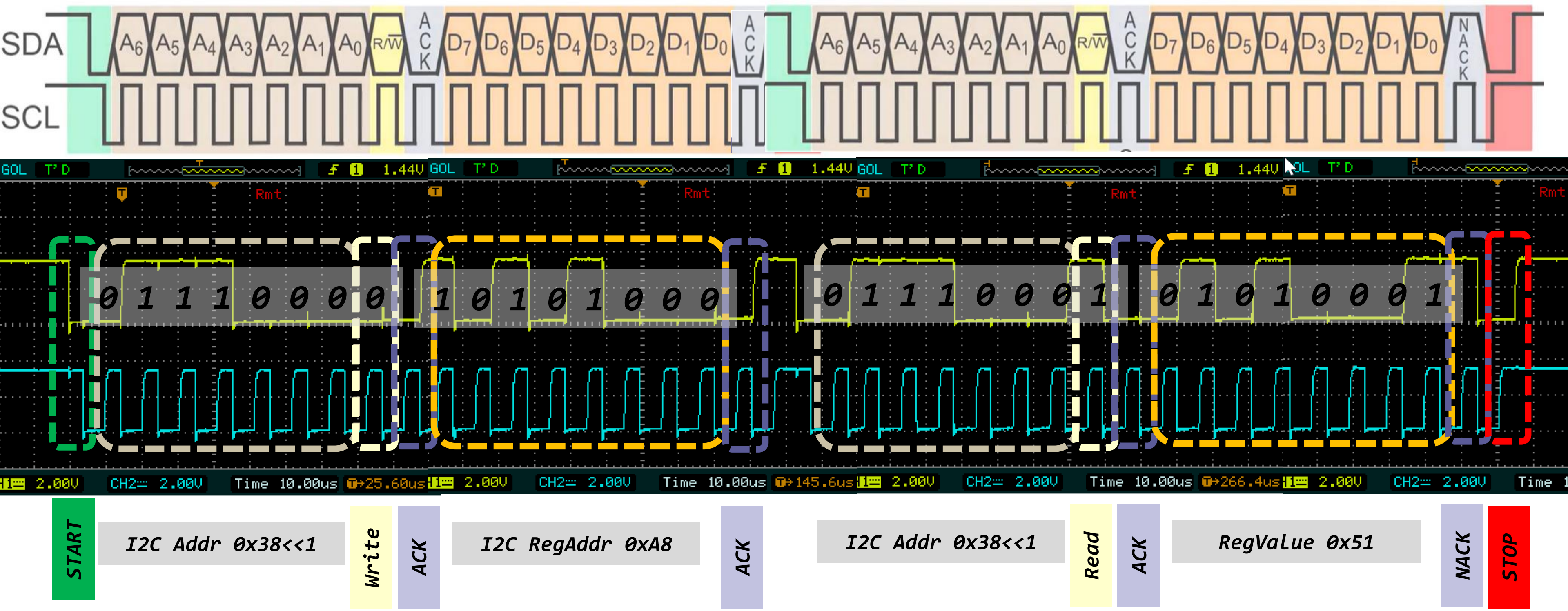
STM32H7

# Primer I2C komunikacije

## STM32H7 - Touch

I2C branje

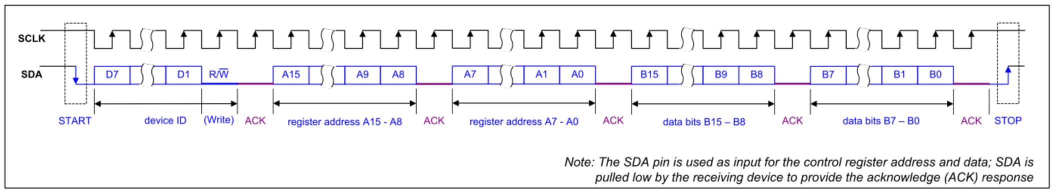
```
// Reading from address 0x38 register Vendor's Chip ID (addr. 0xA8) default value should be 0x51=81

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




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

# Primer I2C komunikacije STM32H7 - Audio

The sequence of signals associated with a single register write operation is illustrated in Figure 72.




[Brez naslova]

**Figure 72 Control Interface 2-wire (I2C) Register Write**

The sequence of signals associated with a single register read operation is illustrated in Figure 73.

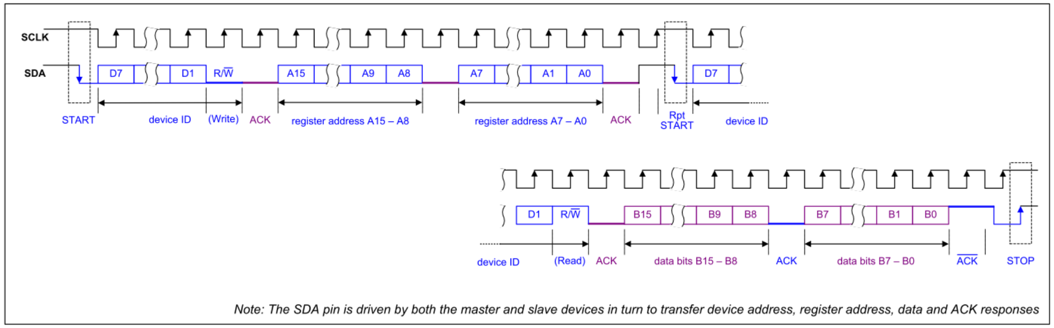
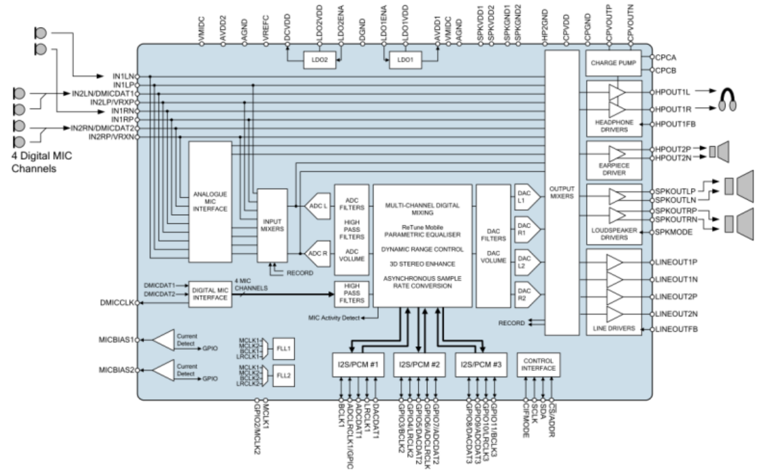



**Figure 73 Control Interface 2-wire (I2C) Register Read**

CIRRUS LOGIC®

**WM8994**

***Multi-channel Audio Hub CODEC for Smartphones***




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

*16-bitni naslovi in registri*

## REGISTER MAP

The WM8994 control registers are listed below. Note that only the register addresses described here should be accessed; writing to other addresses may result in undefined behaviour. Register bits that are not documented should not be changed from the default values.

| REG | NAME | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | DEFAULT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R0 (0h) | Software Reset | SW_RESET [15:0] | | | | | | | | | | | | | | | | 0000h |
| R1 (1h) | Power Management (1) | 0 | 0 | SPKOUTR_ENA | SPKOUTL_ENA | HPOUT2_ENA | 0 | HPOUT1L_ENA | HPOUT1R_ENA | 0 | 0 | MICB2_ENA | MICB1_ENA | 0 | VMID_SEL [1:0] | | BIAS_ENA | 0000h |
| R2 (2h) | Power Management (2) | 0 | TSHUT_ENA | TSHUT_OPDIS | 0 | OPCLK_ENA | 0 | MIXINL_ENA | MIXINR_ENA | IN2L_ENA | IN1L_ENA | IN2R_ENA | IN1R_ENA | 0 | 0 | 0 | 0 | 6000h |

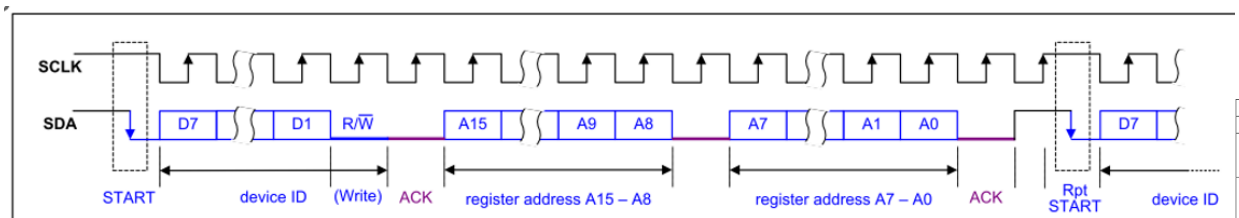
# Primer I2C komunikacije STM32H7 - Audio

**CIRRUS LOGIC** **WM8994**

***Multi-channel Audio Hub CODEC for Smartphones***

*16-bitni naslovi in registri*

```
// Reading from device address 0x1a register R0 (addr. 0x00) default value should be 0x8994
    dataBuffer[0] = 0; dataBuffer[1] = 0x00;
    retval = HAL_I2C_Master_Transmit(&hi2c4, (0x1a << 1), dataBuffer, 2, HAL_MAX_DELAY);

    retval = HAL_I2C_Master_Receive(&hi2c4, (0x1a << 1), dataBuffer, 2, HAL_MAX_DELAY);

    snprintf(SendBuffer,BUFSIZE,"Hello World [%d]: Key:%d Reg.value1:0x%\n\r",Counter++,KeyState,
  dataBuffer[0]*256+dataBuffer[1]);

    HAL_UART_Transmit(&huart3,SendBuffer,strlen(SendBuffer),100);
```




**REGISTER MAP**

The WM8994 control registers are listed below. Note that only the register addresses described here should be accessed; writing to other addresses may result in undefined behaviour. Register bits that are not documented should not be changed from the default values.

| REG | NAME | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | DEFAULT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R0 (0h) | Software Reset | SW_RESET [15:0] | | | | | | | | | | | | | | | | 0000h |
| R1 (1h) | Power Management (1) | 0 | 0 | SPKOUTR_ENA | SPKOUTL_ENA | HPOUT2_ENA | 0 | HPOUT1L_ENA | HPOUT1R_ENA | 0 | 0 | MICB2_ENA | MICB1_ENA | 0 | VMID_SEL [1:0] | | BIAS_ENA | 0000h |
| R2 (2h) | Power Management (2) | 0 | TSHUT_ENA | TSHUT_OPDIS | 0 | OPCLK_ENA | 0 | MIXINL_ENA | MIXINR_ENA | IN2L_ENA | IN1L_ENA | IN2R_ENA | IN1R_ENA | 0 | 0 | 0 | 0 | 6000h |

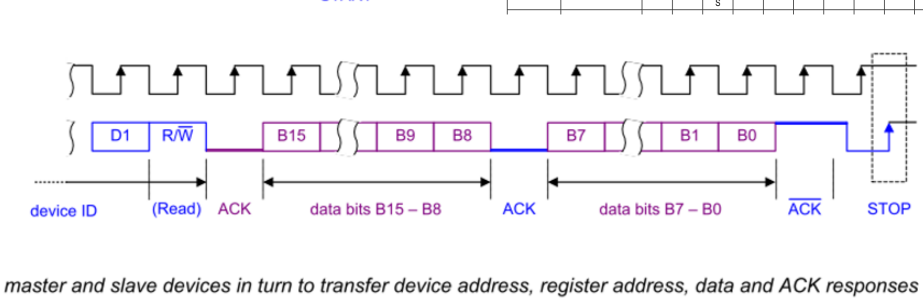
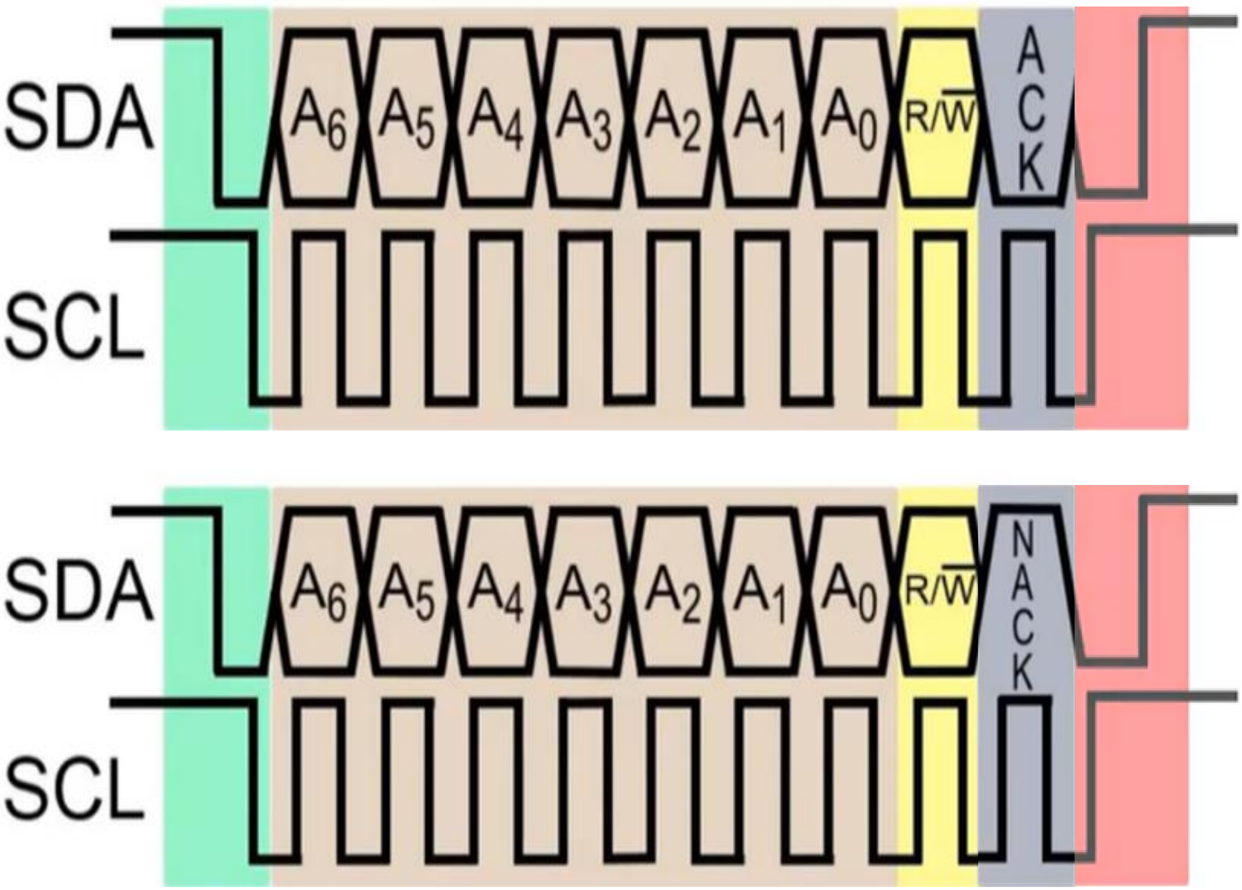



**Figure 73 Control Interface 2-wire (I2C) Register Read**

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

## Določite bitno hitrost prenosa in ugotovite vsebino signala I2C4:



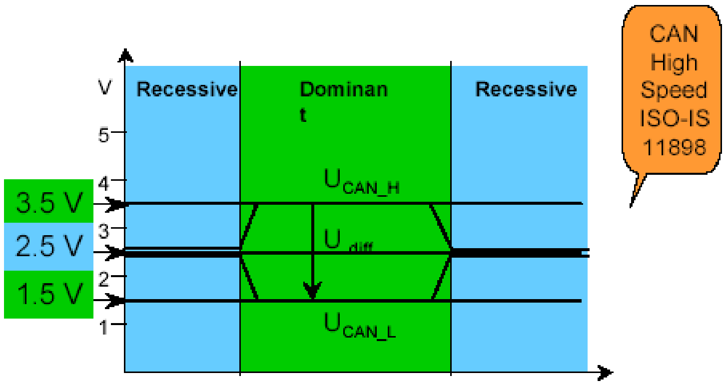

 

# Laboratorijska vaja 12
# Tipala in signali – praktični izzivi

- 12a: LV5a : Tipala in signali – meritve
  a) Meritev karakteristične upornosti linije z multimetrom ($R_0$)
  b) Preizkusi različnih tipal (IR,UZ razdalja, PIR, Hall, …)
  c) Meritve deformacij UTP kabla
  d) *LV2-4 - Presluh – meritve na ploščatem kablu

- 12b: LV5b : STM32H7 – Generator signalov
  a) UART PB14
  b) PWM PA3
  c) SPI PD3(SCK), PI3 (MOSI)
  d) I2C PD12(SCL), PD13(SDA)
  e) CANBUS CN1 (FDCAN1: CAN-L, CAN-H

# CANbus napetostni nivoji ISO-IS 11898

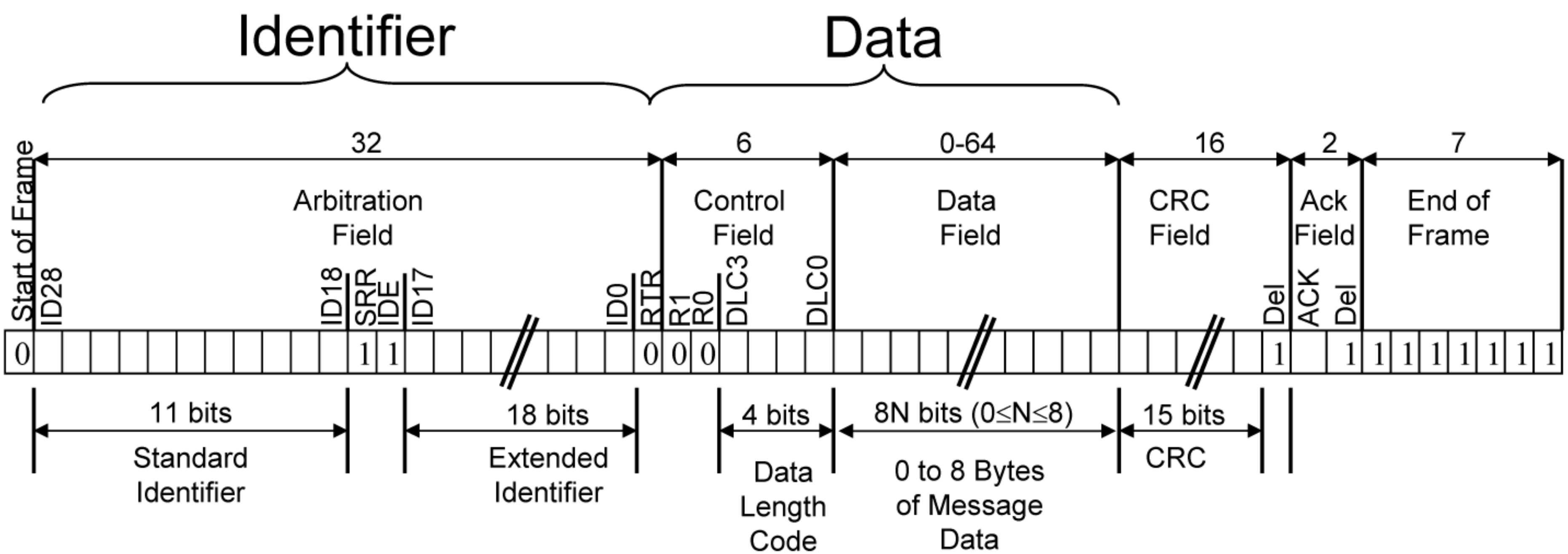



- Recesivni bit „1“:
  - obe liniji na približno 2.5V
  - diferencialna napetost CAN_H in CAN_L ≈ 0 V

- Dominantni bit „0“:
  - CAN_H na pribl. 3.5 V in CAN_L pribl. 1.5 V
  - diferencialna napetost CAN_H in CAN_L ≈ 2 V

# Format sporočila

- Vsako sporočilo ima ID, podatke in dodatke
- ID - 11 ali 29 bitov
- Data - do 8 bajtov
- Dodatki - start (SOF), CRC, ACK, end (EOF)



Izhodišča

# Format sporočila

## *CAN vs. RS-485: Why CAN Is on the Move*

By Robert Gee, Executive Business Manager, Core Products Group, Maxim Integrated

- Recesivni bit „1“:
  - obe liniji na približno 2.5V
- Dominantni bit „0“:
  - CAN_H na pribl. 3.5 V in CAN_L pribl. 1.5 V

| Field Name | Bit Length | Description |
|---|---|---|
| SOF | 1 | Start of frame |
| Identifier (green) | 11/29; 12/32 | Represents the message priority (11 or 29 bits for standard CAN and extended CAN; 12 or 32 bits for CAN-FD) |
| RTR (blue) | 1 | Remote transmission request |
| IDE | 1 | Identifier extension bit |
| r0 | 1 | Reserved bit for future protocol expansion |
| DLC (yellow) | 4/8/9 | Code for number of data bytes (4-bit for standard CAN; 8 or 9 bits for CAN-FD) |
| Data Field (red) | 0–64 (0–8 bytes); 0–512 (0–64 bytes) | Data to be transmitted (0–8 bytes for standard CAN; 0–64 bytes for CAN-FD) |
| CRC | 15 | Cyclic redundancy check |
| CRC Delimiter | 1 | Assigned recessive (1) |
| ACK slot | 1 | Dominant bit if error-free message; recessive to discard errant message |
| ACK Delimiter | 1 | Acknowledgement delimiter |
| EOF | 7 | End of frame |

*Table 1. CAN Message Data-Frame Format*

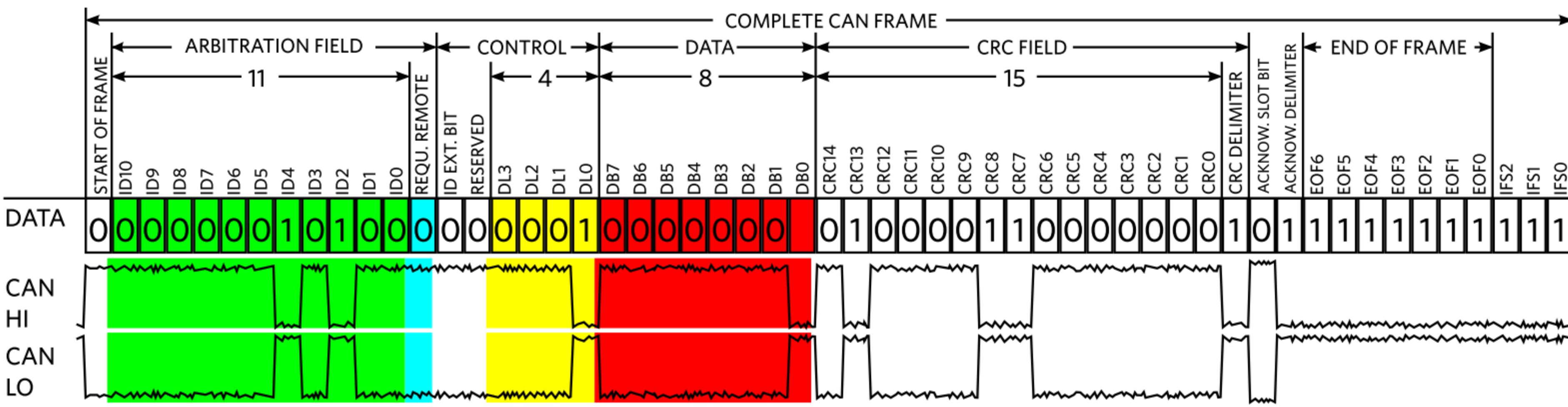
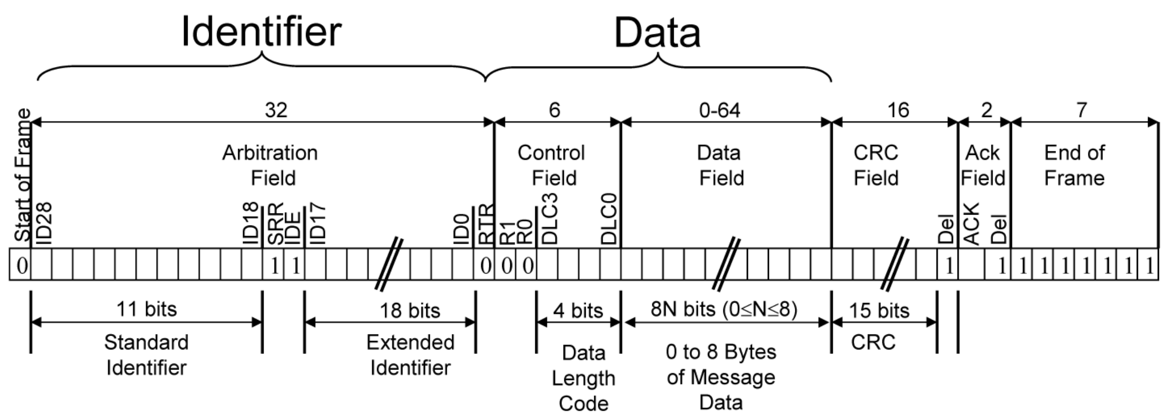



*Figure 4. CAN Message Data-Frame Format*

# Določite bitno hitrost prenosa in določite vsebino signala CANBUS, ki se prenaša ob nastavitvah: 11b ID = 0x555, 2 bajta 0xCC, bit-stuff (po 5 enakih bitih), …

Recesivni bit „1“:
- obe liniji na približno 2.5V

•Dominantni bit „0“:
- CAN_H na pribl. 3.5 V in CAN_L pribl. 1.5 V



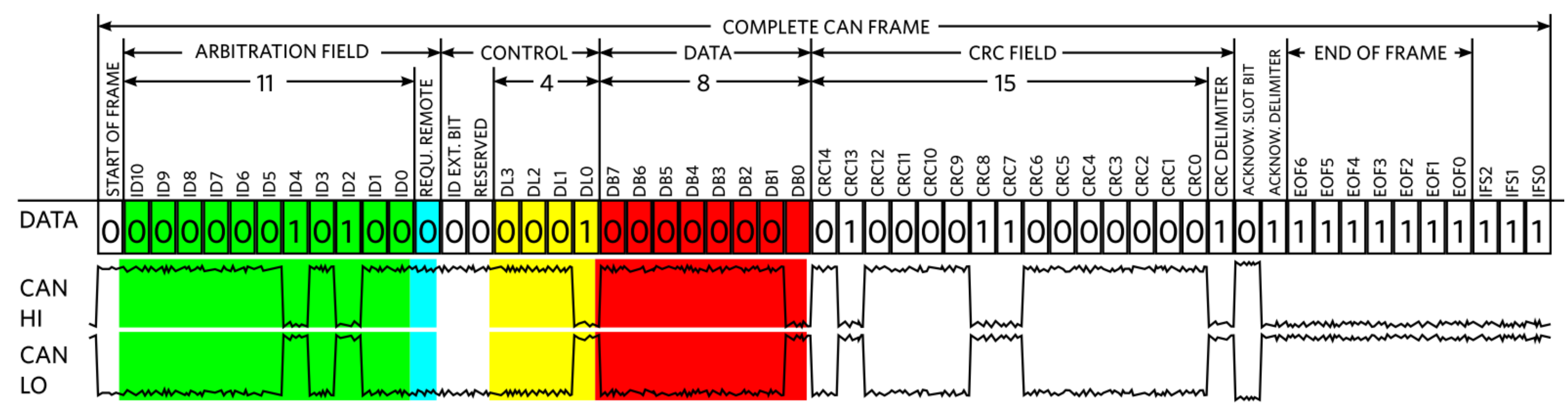
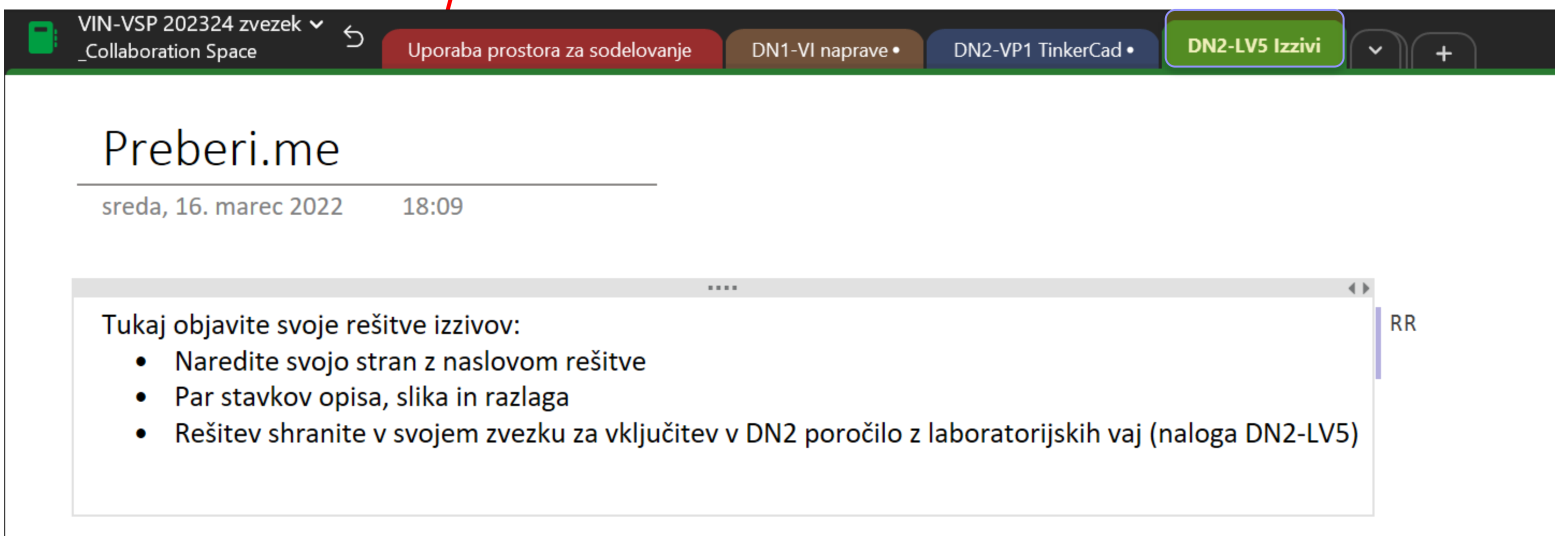




Figure 4. CAN Message Data-Frame Format

# Tipala in signali – praktični izzivi – DN2-LV5*

- **Spada v sklop poročila z LAB vaj**
- **Opišite reševanje izzivov po lastni izbiri**
- **Objavite v OneNote delovnem zvezku**
  - **_Prostor za sodelovanje, razdelek DN2-LV5 Izzivi**



# Tipala in signali – praktični izzivi – DN2-LV5*

## LV5 Meritve tipal in signalov (PWM,I2C,SPI,UART)

*Izberite in rešite čimveč izzivov in ustrezno dokumentirajte postopke.*

**LV5a: Izzivi LV1-LV4**

**Neobvezni izzivi**

a) Meritev karakteristične upornosti linije z multimetrom (R0)

b) Preizkusi različnih tipal (IR,UZ razdalja, PIR, Hall, …)

c) Meritve deformacij UTP kabla

d) *LV2-4 - Presluh – meritve na ploščatem kablu

***LV4-3 IEX Modul na STM32H7**

*Dopolnite osnovni program za IEX modul na STM32H7 vsaj s sprejemom QX sporočil in oddajo IX sporočil, da se bo na modulu lahko uporabilo tudi tipke in LED diode. Program lahko razširite še na PWM izhoda in ADC vhoda.*

**LV5b Meritve signalov – STM32H7 Signal generator - izziv**

**Neobvezni izzivi**

| | | |
|---|---|---|
| a) | UART | PB14 |
| b) | PWM | PA3 |
| c) | SPI | PD3(SCK), PI3 (MOSI) |
| d) | I2C | PD12(SCL), PD13(SDA) |
| e) | CANBUS | CN1 (FDCAN1:CAN-L, CAN-H |

**Meritve UART signala**

Določite bitno hitrost in znak(e), ki se prenašajo po UART TTL povezavi.

**Meritve PWM signala**

Določite periodo, frekvenco PWM signala in ustrezno glasbeno noto.

**Meritve SPI signala**

Določite bitno hitrost prenosa in ugotovite vsebino signala SPI2 z nastavitvami: CPOL=0, CPHA=0, naprava LIS3DSH, …

**Meritve I2C signala**

Določite bitno hitrost prenosa in ugotovite vsebino signala I2C4.

**Meritve CANBUS signala**

Določite bitno hitrost prenosa in določite vsebino signala CANBUS, ki se prenaša ob nastavitvah: 11b ID = 0x555, 2 bajta 0xCC, bit-stuff (po 5 enakih bitih), …