

# Teeme ise 2014

AVR mikrokontroller

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# Sisujuht

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- Programmi elutsükkel
- Pisi-Xbee 4.1
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  - Digitaalse sisend/väljund pordi seadistamise registrid
- Programmeerimise erivõtted
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# Mõisted

- **Arvutiprogramm** - kindlate reeglite järgi kirja pandud instruksioonide kogum, mis on mõeldud arvuti protsessorile täitmiseks.
- **Programmeerimiskeel** – tehiskeel arvutile instruksioonide kirja panemiseks. Keelel on kindel süntaks (lauseehitus) ja semantika (tähendus). Keele abil kirja pandud lauseid kutsutakse lähtekoodiks.
- **Kompilaator** – programm, mis muudab inimesele arusaadava lähtekoodi arvutile arusaadavaks masinkoodiks. Meie kasutame **AVR-GCC** kompilaatorit.



# Programmi elutsükkel

Lähtekoodi kirjutamine  
(Eclipse, Atmel Studio)



AVR GCC kompilaator



- objektifailid
- linkimine
- masinkood

Hex-fail

```
00000000 12 00 00 EA 14 F0 9F E5 14 F0 9F E5 14 F0 9F E5 14 F0 9F E5
00000010 14 F0 9F E5 9F 4F C0 84 FF FF E5 10 10 9F E5
00000020 38 00 00 00 3C 00 00 00 40 00 00 05 44 00 00 00
00000030 40 00 00 CA 4C FF FF EA FE FF FF EA FE FF FF EA
00000040 07 F0 9F E5 00 00 40 E1 00 00 40 E2 01 F0 9F E5
00000050 00 00 E1 04 00 40 E3 00 00 40 E4 00 00 40 E5
00000060 00 00 E1 04 00 40 E3 00 00 40 E4 00 00 40 E5
00000070 7C 20 9F E5 00 00 00 00 00 00 00 00 00 00 00 00
00000080 0F F0 9F E5 00 00 40 E1 00 00 40 E2 01 F0 9F E5
00000090 00 00 E1 04 00 40 E3 00 00 40 E4 00 00 40 E5
000000A0 02 00 00 00 00 00 00 00 00 00 00 00 00 00 00
000000B0 0F F0 9F E5 00 00 40 E1 00 00 40 E2 01 F0 9F E5
000000C0 00 00 E1 04 00 40 E3 00 00 40 E4 00 00 40 E5
000000D0 00 00 E1 04 00 40 E3 00 00 40 E4 00 00 40 E5
000000E0 00 00 E1 04 00 40 E3 00 00 40 E4 00 00 40 E5
000000F0 00 00 E1 04 00 40 E3 00 00 40 E4 00 00 40 E5
00000100 00 00 E1 04 00 40 E3 00 00 40 E4 00 00 40 E5
00000110 00 00 E1 04 00 40 E3 00 00 40 E4 00 00 40 E5
00000120 00 00 E1 04 00 40 E3 00 00 40 E4 00 00 40 E5
00000130 00 00 E1 04 00 40 E3 00 00 40 E4 00 00 40 E5
00000140 00 00 E1 04 00 40 E3 00 00 40 E4 00 00 40 E5
00000150 00 00 E1 04 00 40 E3 00 00 40 E4 00 00 40 E5
00000160 00 00 E1 04 00 40 E3 00 00 40 E4 00 00 40 E5
00000170 00 00 E1 04 00 40 E3 00 00 40 E4 00 00 40 E5
00000180 00 00 E1 04 00 40 E3 00 00 40 E4 00 00 40 E5
00000190 00 00 E1 04 00 40 E3 00 00 40 E4 00 00 40 E5
000001A0 00 00 E1 04 00 40 E3 00 00 40 E4 00 00 40 E5
000001B0 00 00 E1 04 00 40 E3 00 00 40 E4 00 00 40 E5
000001C0 00 00 E1 04 00 40 E3 00 00 40 E4 00 00 40 E5
000001D0 00 00 E1 04 00 40 E3 00 00 40 E4 00 00 40 E5
000001E0 00 00 E1 04 00 40 E3 00 00 40 E4 00 00 40 E5
000001F0 00 00 E1 04 00 40 E3 00 00 40 E4 00 00 40 E5
```

•kogu kood Hex arvudena

MCU



Programmi  
püsimälu  
(flash)

Programmaator



•Programmeerib mikrokontrollerit Hex-failiga

# Programmi elutsükkel (2)

Lähtekoodi kirjutamine  
(Eclipse, Atmel Studio)



AVR GCC kompilaator



- objektifailid
- linkimine
- masinkood

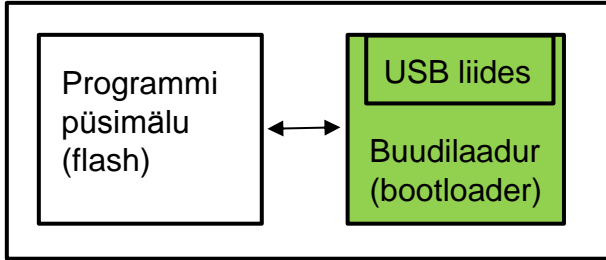
Hex-fail

```
00000000 12 00 00 EA 14 F0 9F E5 14 F0 9F E5 14 F0 9F E5 14 F0 9F E5
00000010 14 F0 9F E5 14 F0 9F E5 14 F0 9F E5 14 F0 9F E5 14 F0 9F E5 14 F0 9F E5 14 F0 9F E5
00000020 38 00 00 00 3C 00 00 00 3C 00 00 00 3C 00 00 00 3C 00 00 00
00000030 40 00 00 00 4C 00 00 00 4C 00 00 00 4C 00 00 00 4C 00 00 00
00000040 48 00 00 00 54 00 00 00 54 00 00 00 54 00 00 00 54 00 00 00
00000050 50 00 00 00 5C 00 00 00 5C 00 00 00 5C 00 00 00 5C 00 00 00
00000060 58 00 00 00 64 00 00 00 64 00 00 00 64 00 00 00 64 00 00 00
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00000080 60 00 00 00 70 00 00 00 70 00 00 00 70 00 00 00 70 00 00 00
00000090 64 00 00 00 74 00 00 00 74 00 00 00 74 00 00 00 74 00 00 00
000000A0 68 00 00 00 78 00 00 00 78 00 00 00 78 00 00 00 78 00 00 00
000000B0 6C 00 00 00 7C 00 00 00 7C 00 00 00 7C 00 00 00 7C 00 00 00
000000C0 70 00 00 00 80 00 00 00 80 00 00 00 80 00 00 00 80 00 00 00
000000D0 74 00 00 00 84 00 00 00 84 00 00 00 84 00 00 00 84 00 00 00
000000E0 78 00 00 00 8C 00 00 00 8C 00 00 00 8C 00 00 00 8C 00 00 00
000000F0 7C 00 00 00 90 00 00 00 90 00 00 00 90 00 00 00 90 00 00 00
00000100 80 00 00 00 94 00 00 00 94 00 00 00 94 00 00 00 94 00 00 00
00000110 84 00 00 00 98 00 00 00 98 00 00 00 98 00 00 00 98 00 00 00
00000120 88 00 00 00 9C 00 00 00 9C 00 00 00 9C 00 00 00 9C 00 00 00
00000130 8C 00 00 00 A0 00 00 00 A0 00 00 00 A0 00 00 00 A0 00 00 00
00000140 90 00 00 00 A4 00 00 00 A4 00 00 00 A4 00 00 00 A4 00 00 00
00000150 94 00 00 00 A8 00 00 00 A8 00 00 00 A8 00 00 00 A8 00 00 00
00000160 98 00 00 00 AC 00 00 00 AC 00 00 00 AC 00 00 00 AC 00 00 00
00000170 9C 00 00 00 B0 00 00 00 B0 00 00 00 B0 00 00 00 B0 00 00 00
00000180 98 00 00 00 B4 00 00 00 B4 00 00 00 B4 00 00 00 B4 00 00 00
00000190 9C 00 00 00 B8 00 00 00 B8 00 00 00 B8 00 00 00 B8 00 00 00
000001A0 98 00 00 00 BC 00 00 00 BC 00 00 00 BC 00 00 00 BC 00 00 00
000001B0 9C 00 00 00 C0 00 00 00 C0 00 00 00 C0 00 00 00 C0 00 00 00
000001C0 98 00 00 00 C4 00 00 00 C4 00 00 00 C4 00 00 00 C4 00 00 00
000001D0 9C 00 00 00 C8 00 00 00 C8 00 00 00 C8 00 00 00 C8 00 00 00
000001E0 98 00 00 00 CC 00 00 00 CC 00 00 00 CC 00 00 00 CC 00 00 00
000001F0 9C 00 00 00 D0 00 00 00 D0 00 00 00 D0 00 00 00 D0 00 00 00
```

•kogu kood Hex arvudena



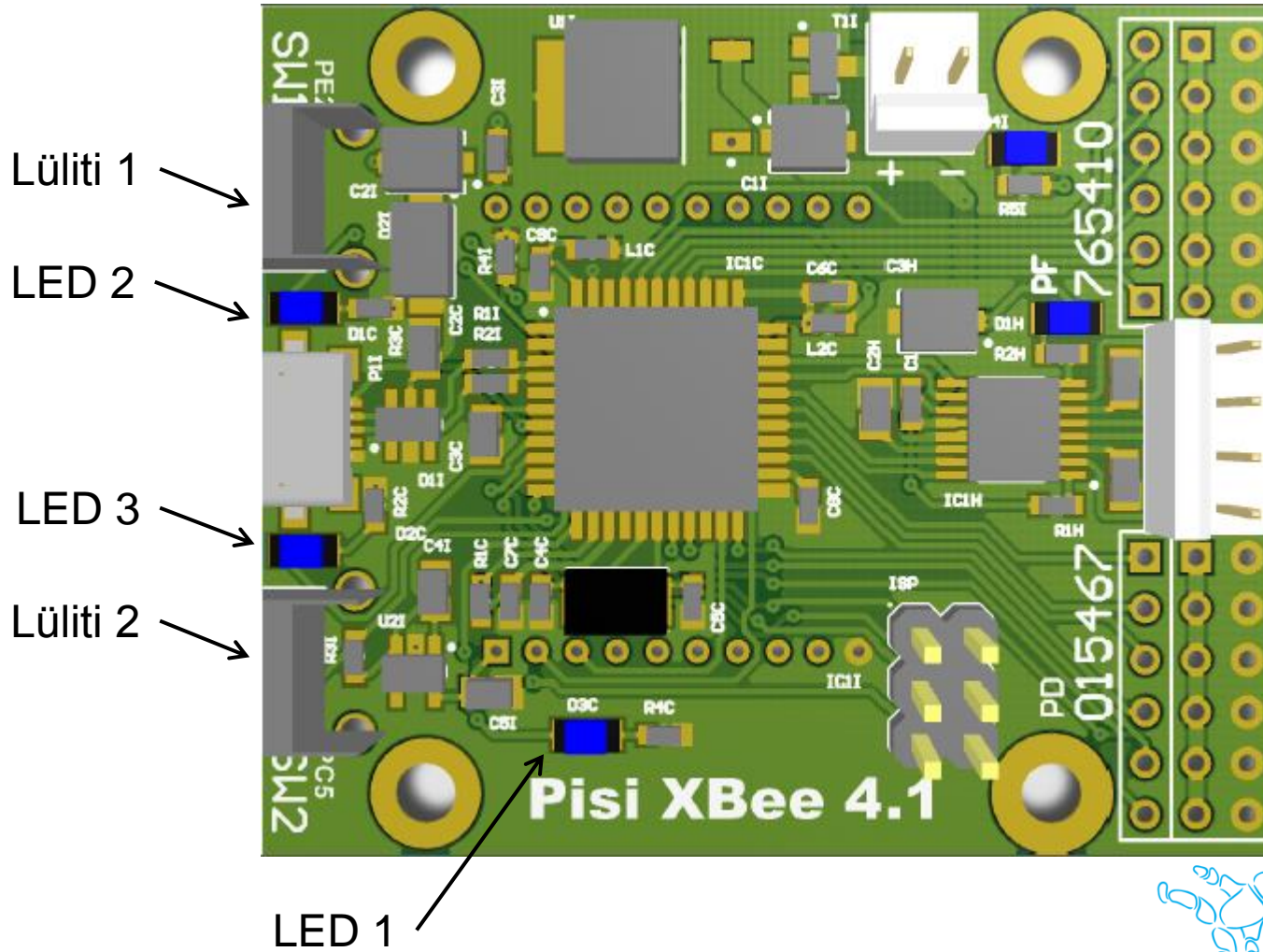
USB



MCU

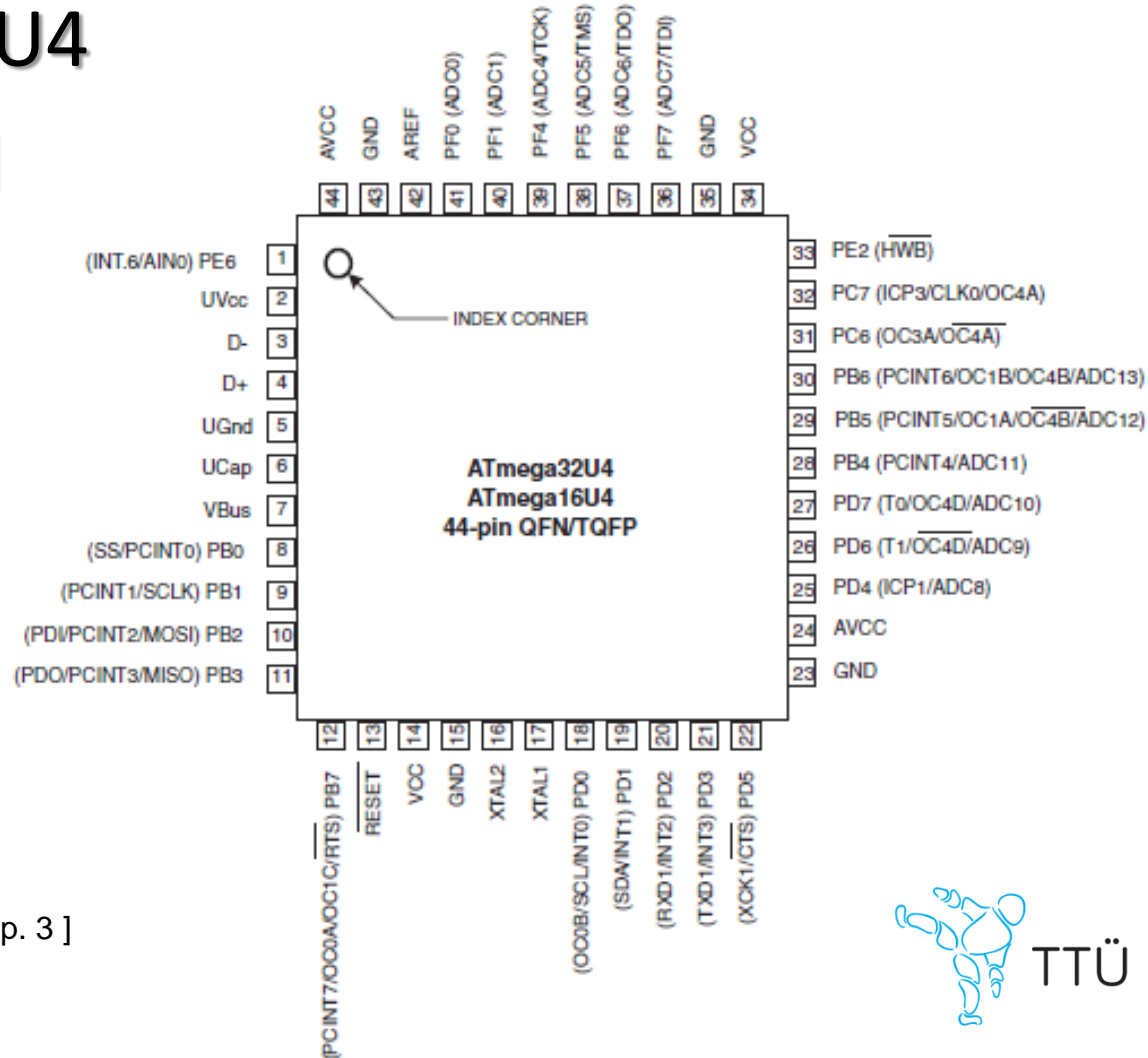
•Programmeerib mikrokontrollerit Hex-failiga

# Pisi-Xbee 4.1



# AVR mikrokontroller

## ATmega32U4 väljaviigud



[ATmega16/32U4 data sheet, p. 3]



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# AVR mikrokontroller

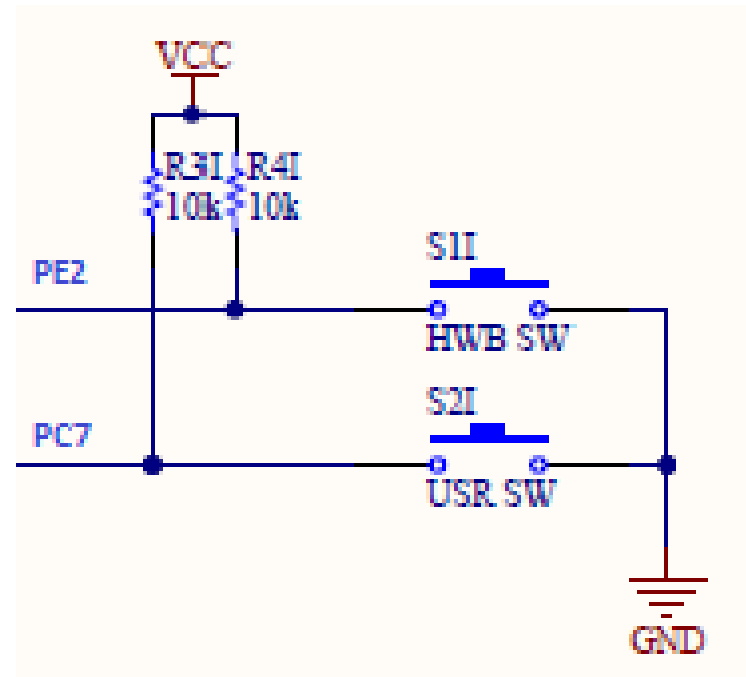
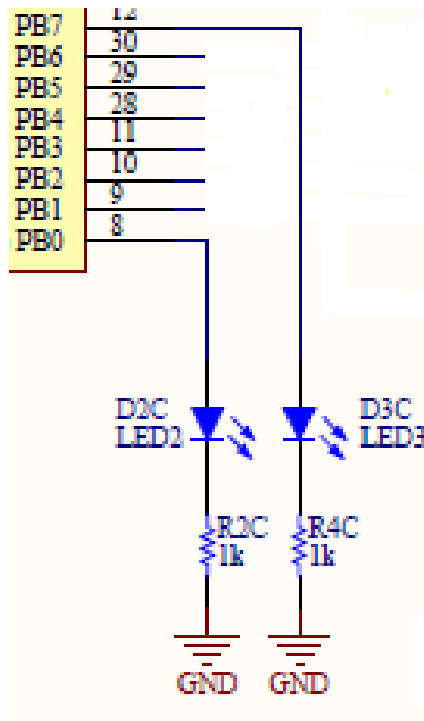
- Digitaalne sisend/väljund
  - Viigud on mikrokontrolleri metallist kontaktid, kõnekeeles jalad, mille kaudu saab edastada ja vastu võtta digitaalseid pingeväärtusi. Kui viik seadistada programmis sisendiks, saab selle kaudu mikrokontroller lugeda lülitite või muude lihtsamate andurite olekut. Kui viik seadistada väljundiks, saab selle kaudu süüdata valgusdioode või juhtida elektriseadmeid.





# AVR mikrokontroller

- LEDide ja lülitite elektriskeemid Pisi-Xbee plaadil



# AVR mikrokontroller

- Digitaalse sisend/väljund pordi seadistamise registrid

## Port B Data Register – PORTB

Bit	7	6	5	4	3	2	1	0	
	<b>PORTB7</b>	<b>PORTB6</b>	<b>PORTB5</b>	<b>PORTB4</b>	<b>PORTB3</b>	<b>PORTB2</b>	<b>PORTB1</b>	<b>PORTB0</b>	<b>PORTB</b>
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

## Port B Data Direction Register – DDRB

Bit	7	6	5	4	3	2	1	0	
	<b>DDB7</b>	<b>DDB6</b>	<b>DDB5</b>	<b>DDB4</b>	<b>DDB3</b>	<b>DDB2</b>	<b>DDB1</b>	<b>DDB0</b>	<b>DDRB</b>
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

## Port B Input Pins Address – PINB

Bit	7	6	5	4	3	2	1	0	
	<b>PINB7</b>	<b>PINB6</b>	<b>PINB5</b>	<b>PINB4</b>	<b>PINB3</b>	<b>PINB2</b>	<b>PINB1</b>	<b>PINB0</b>	<b>PINB</b>
Read/Write	R	R	R	R	R	R	R	R	
Initial Value	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	



# Programmeerimise erivõtted

- Üheks seadma (*set*)

```
register = register | 0b00010000
```

- Nullima (*clear*)

```
register = register & ~0b00010000
```

- Muutma (*toggle*)

```
register = register ^ 0b00010000
```



# Projekti loomine

- **File->New->Project...** Vali **GCC C Executable project Project** ja sisesta projekti nimi. Muuda vajadusel projekti asukohta.
- Vali mikrokontrolleriks **ATmega32U4**



# Flip programmi seadistamine

- Vali **Tools->External Tools ...** ja **Add**
- **Title:** Flip
- **Command:** ...\`Flip 3.4.7\bin\batchisp.exe`  
*(määra installeeritud Flipi kaust)*
- **Arguments:** `-device atmega32u4 -hardware usb -operation ERASE F LOADBUFFER MyProgram.hex PROGRAM VERIFY START RESET 0`  
*(hex faili nimi tuleb muuta)*
- **Initial directory:** `$(ProjectDir)\Debug`



# Praktiline programmeerimine



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# Täna!



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