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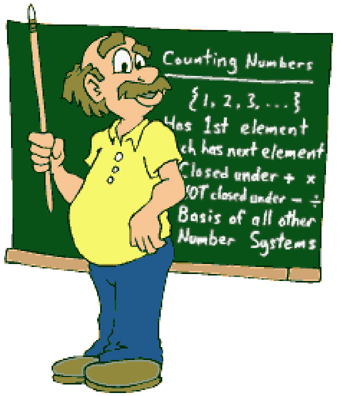
MSYS

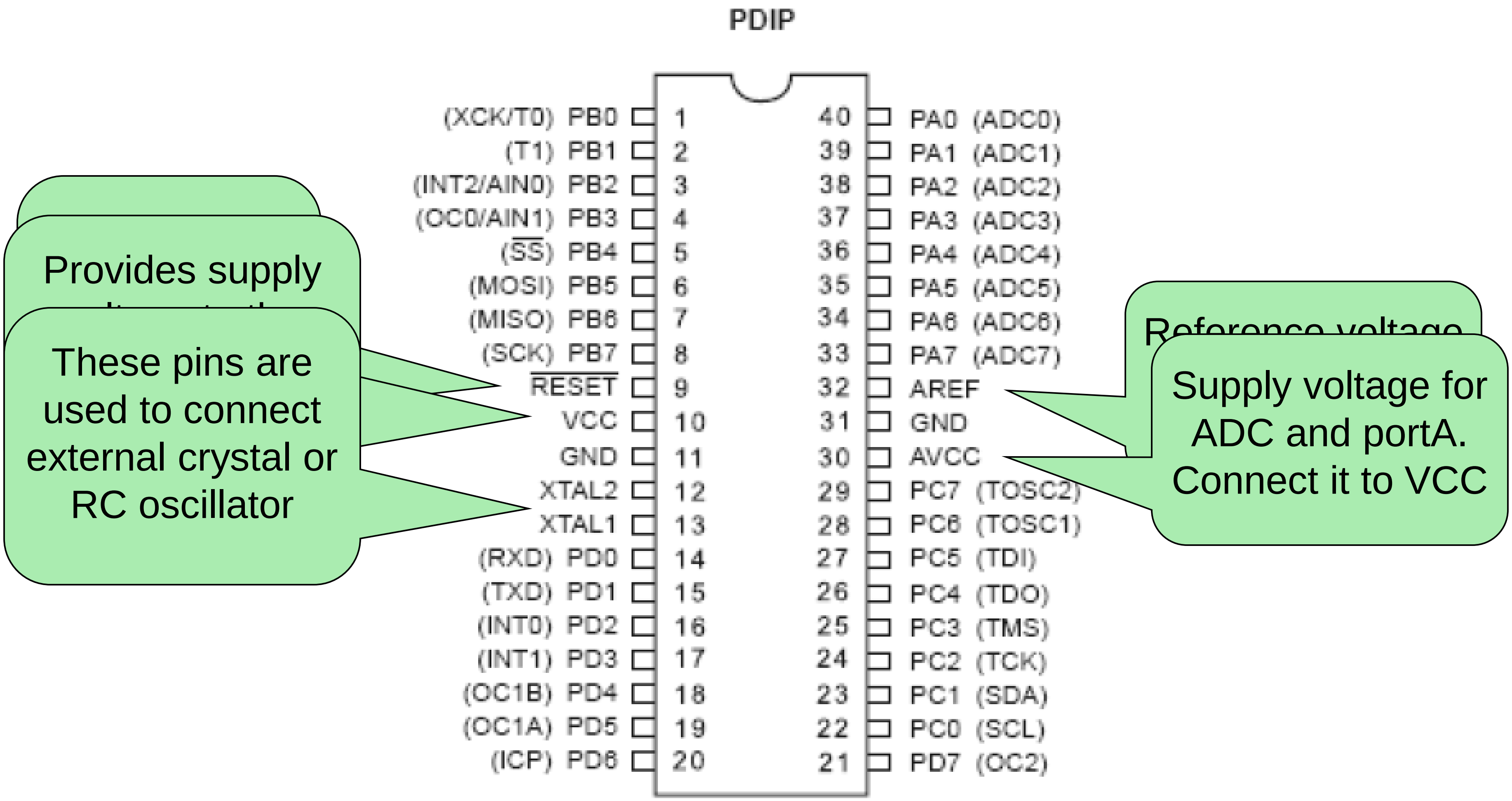
Microcontroller Systems

Lektion 11
AVR hardware konfiguration



Version: 2-10-2017, Henning Hargaard

Mega32 pins



PDIP

(XCK/T0) PB0	1	40	PA0 (ADC0)
(T1) PB1	2	39	PA1 (ADC1)
(INT2/AIN0) PB2	3	38	PA2 (ADC2)
(OC0/AIN1) PB3	4	37	PA3 (ADC3)
(SS) PB4	5	36	PA4 (ADC4)
(MOSI) PB5	6	35	PA5 (ADC5)
(MISO) PB6	7	34	PA6 (ADC6)
(SCK) PB7	8	33	PA7 (ADC7)
RESET	9	32	AREF
VCC	10	31	GND
GND	11	30	AVCC
XTAL2	12	29	PC7 (TOSC2)
XTAL1	13	28	PC6 (TOSC1)
(RXD) PD0	14	27	PC5 (TDI)
(TXD) PD1	15	26	PC4 (TDO)
(INT0) PD2	16	25	PC3 (TMS)
(INT1) PD3	17	24	PC2 (TCK)
(OC1B) PD4	18	23	PC1 (SDA)
(OC1A) PD5	19	22	PC0 (SCL)
(ICP) PD6	20	21	PD7 (OC2)

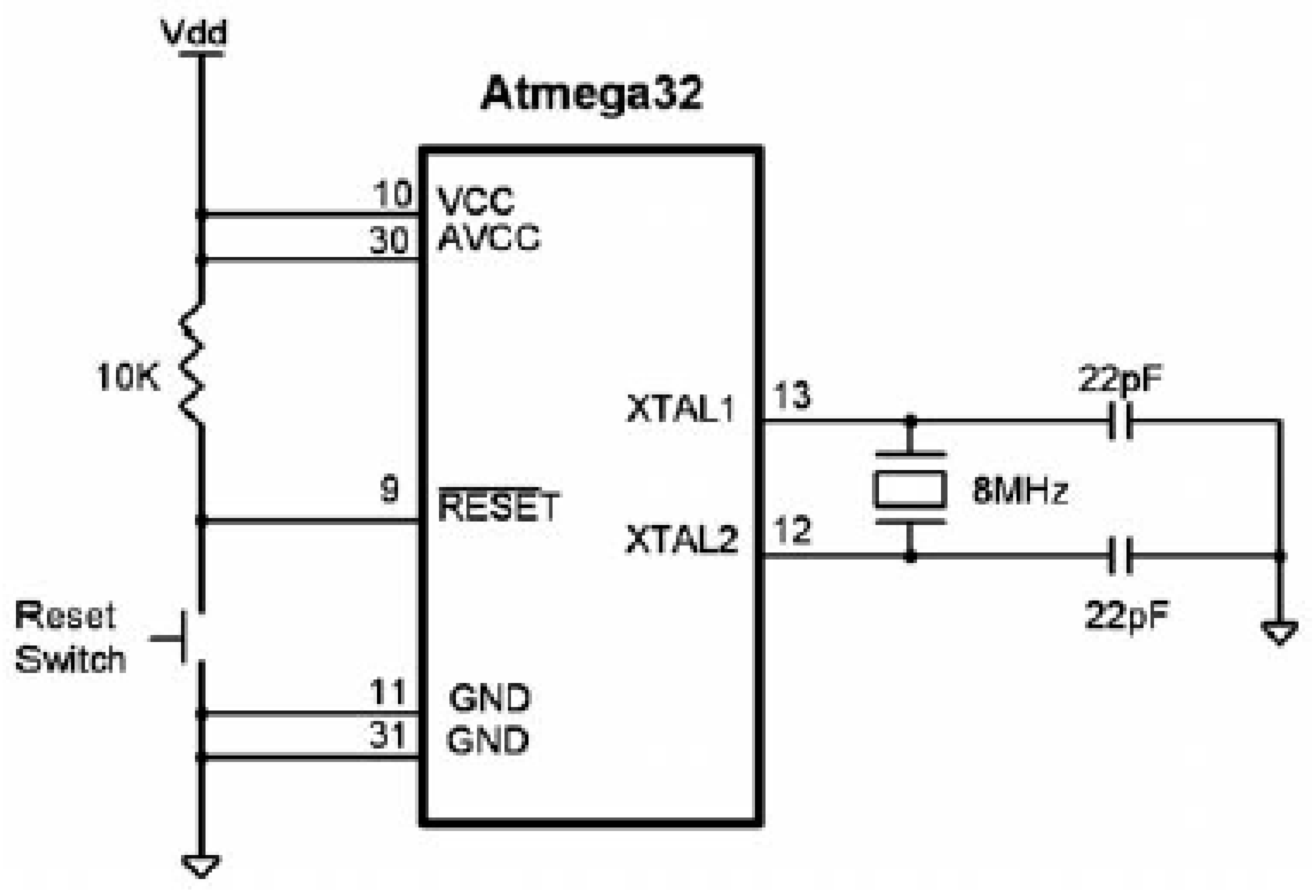
Provides supply

These pins are used to connect external crystal or RC oscillator

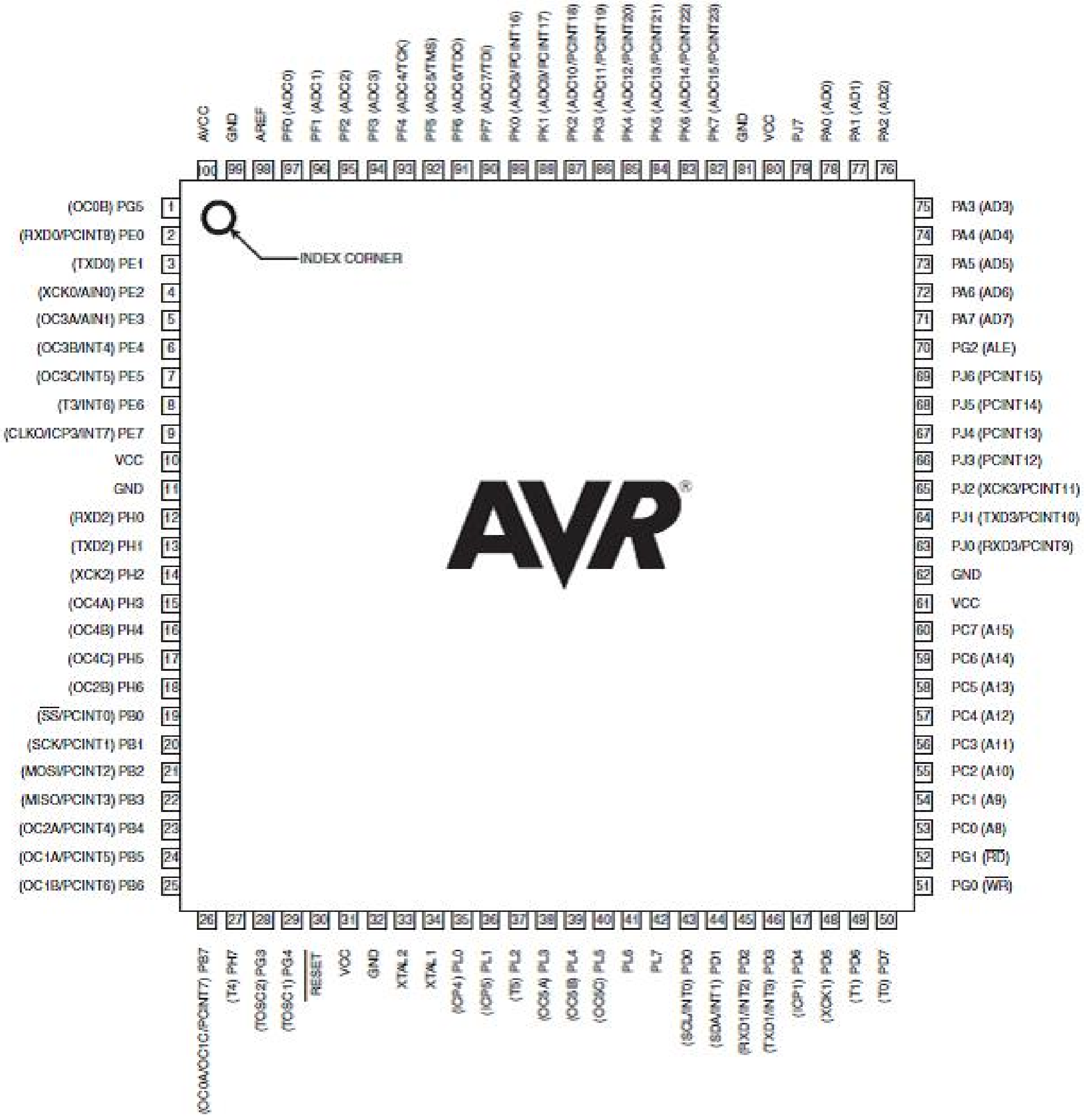
Reference voltage

Supply voltage for ADC and portA. Connect it to VCC

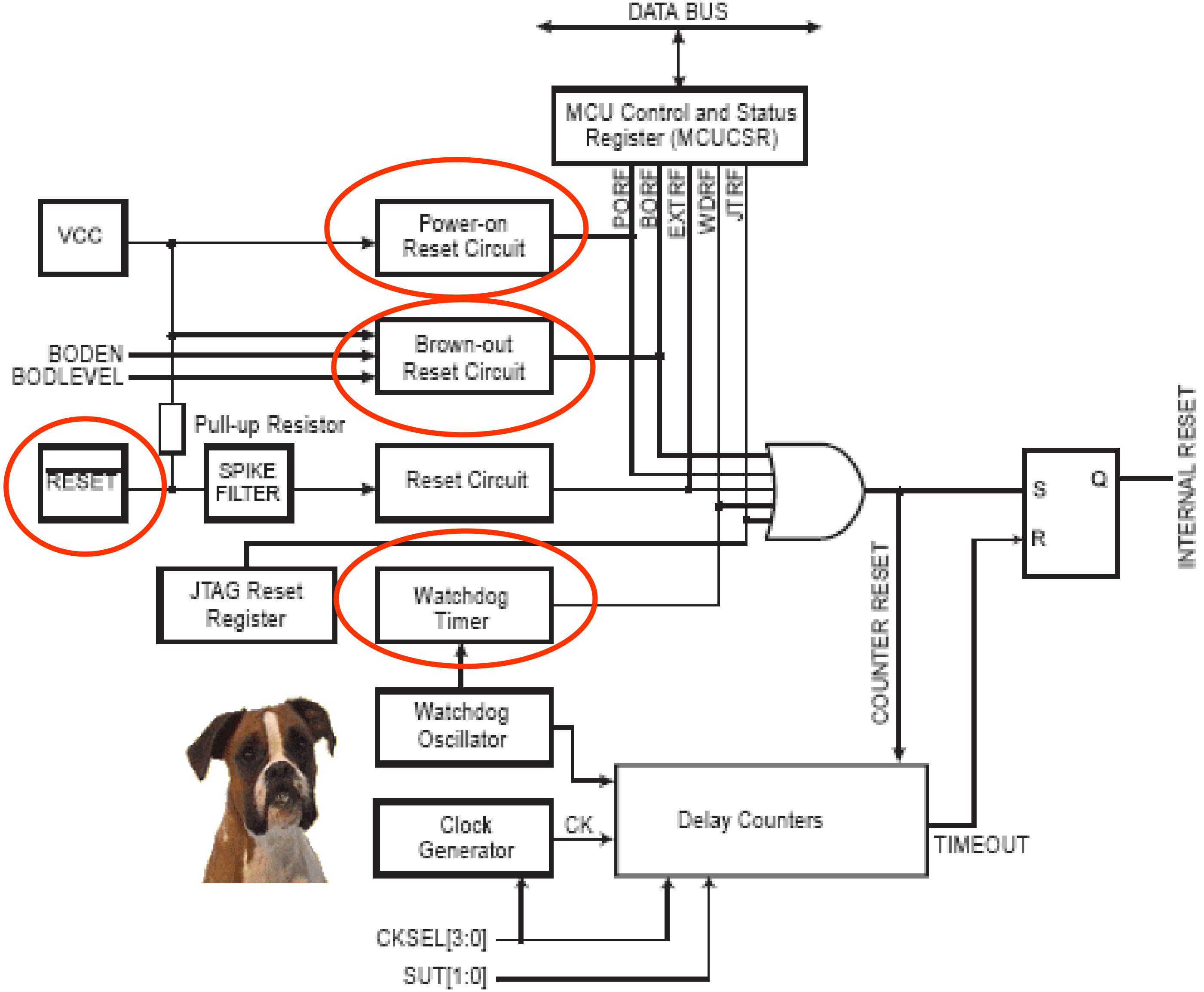
Simpel HW konfiguration



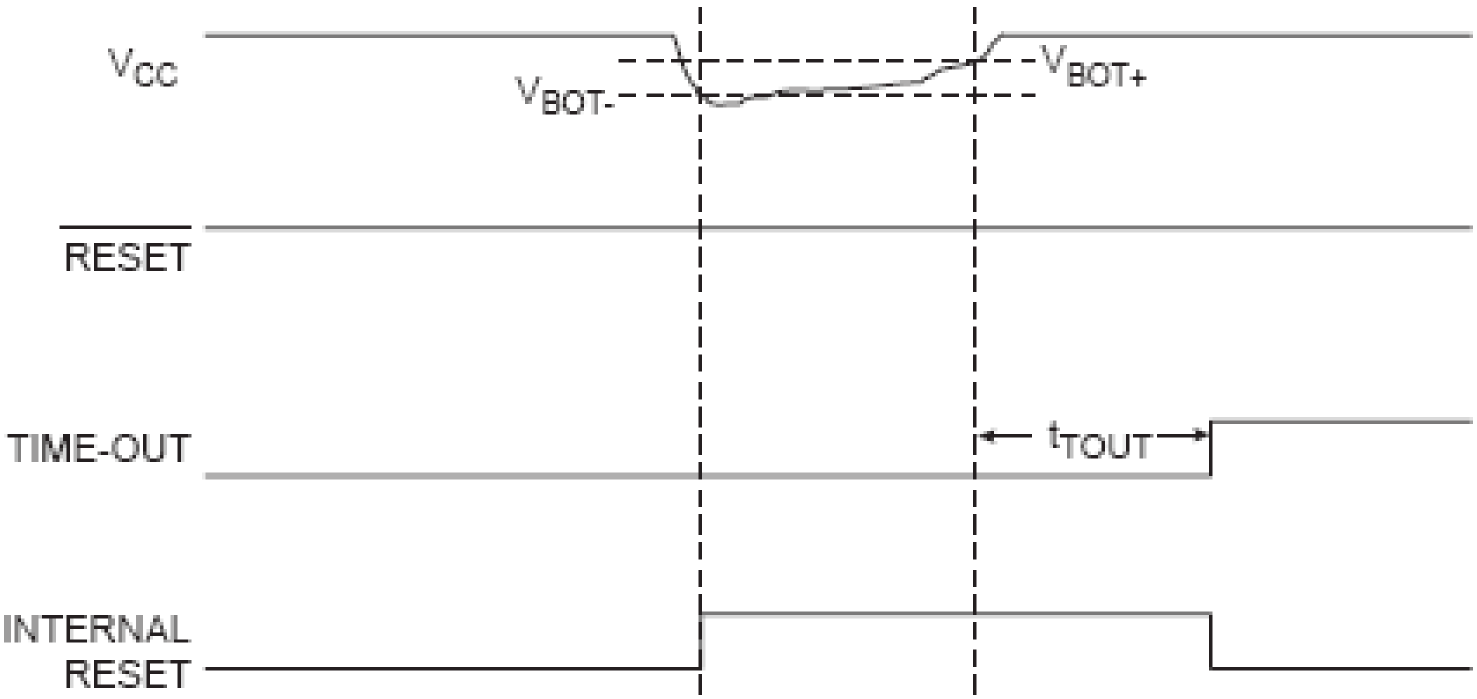
Mega2560 pins



RESET logik

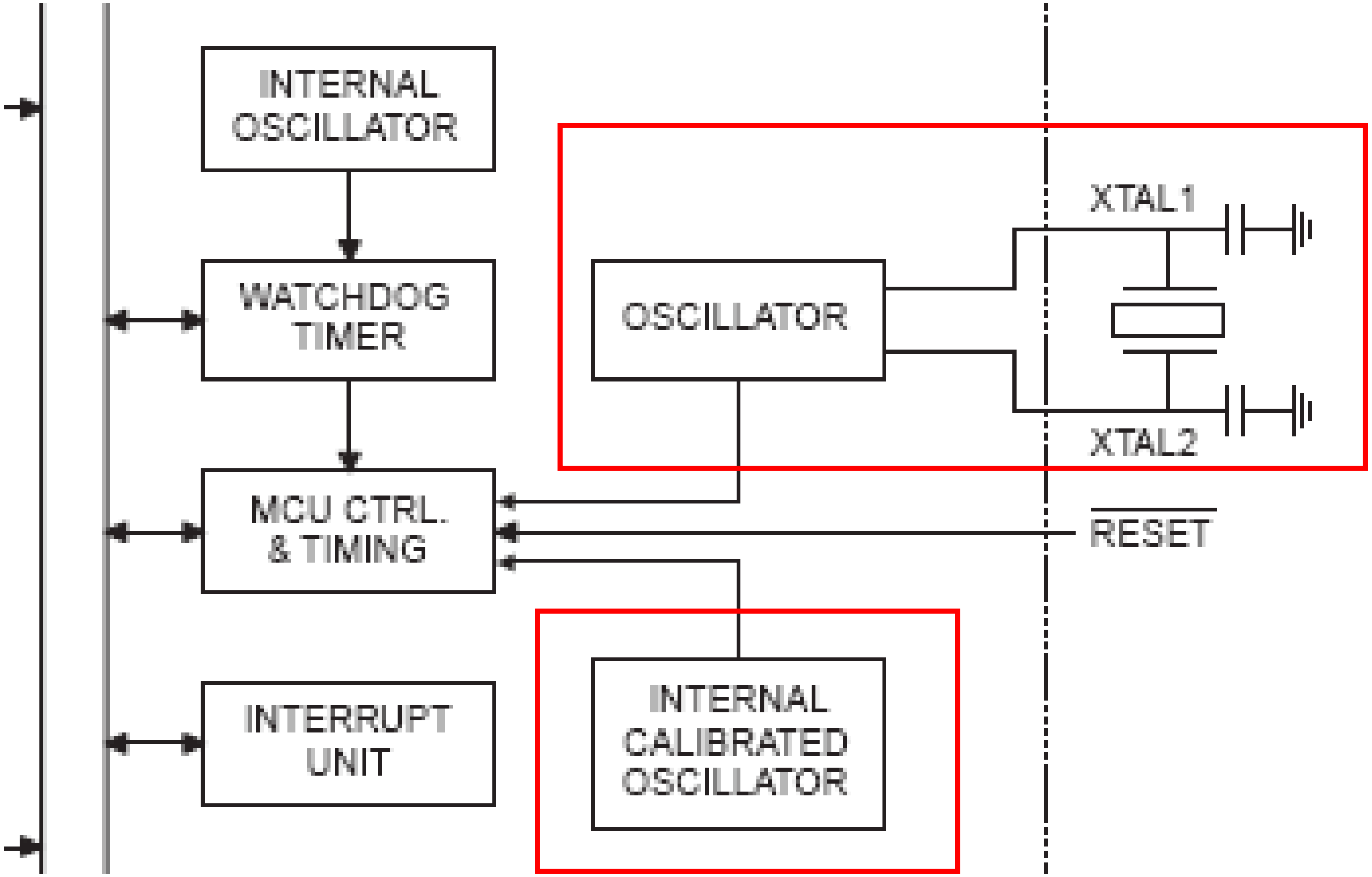

DATA BUS
MCU Control and Status Register (MCUCSR)
PORF
BORF
EXTRF
WDRF
JTRF
VCC
Power-on Reset Circuit
BODEN
BODLEVEL
Brown-out Reset Circuit
Pull-up Resistor
RESET
SPIKE FILTER
Reset Circuit
JTAG Reset Register
Watchdog Timer
Watchdog Oscillator
Clock Generator
CK
Delay Counters
TIMEOUT
COUNTER RESET
S
R
Q
INTERNAL RESET
CKSEL[3:0]
SUT[1:0]

Brown Out RESET

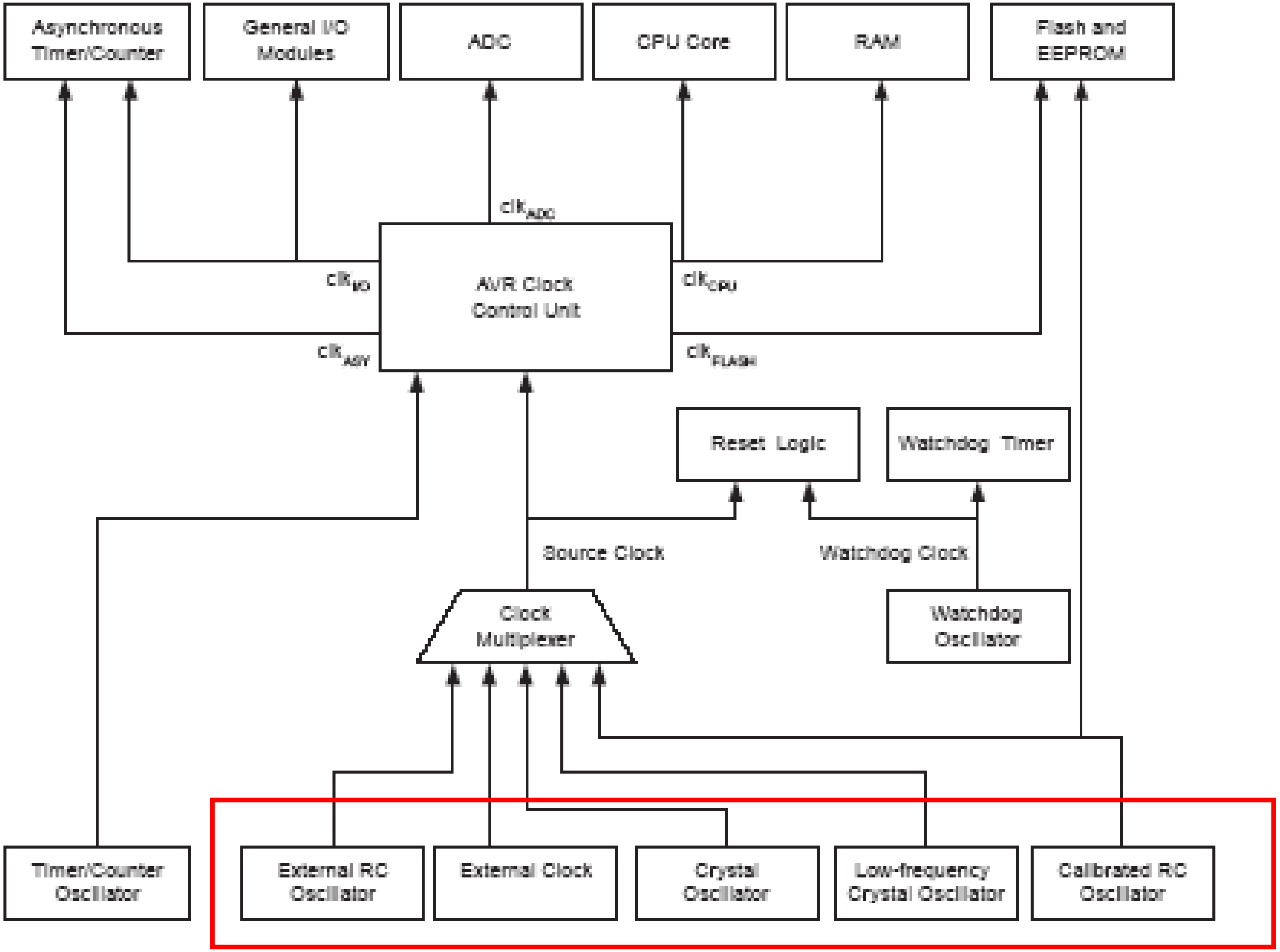


OBS:
Brown out RESET kun aktiv, hvis enabled af programmøren

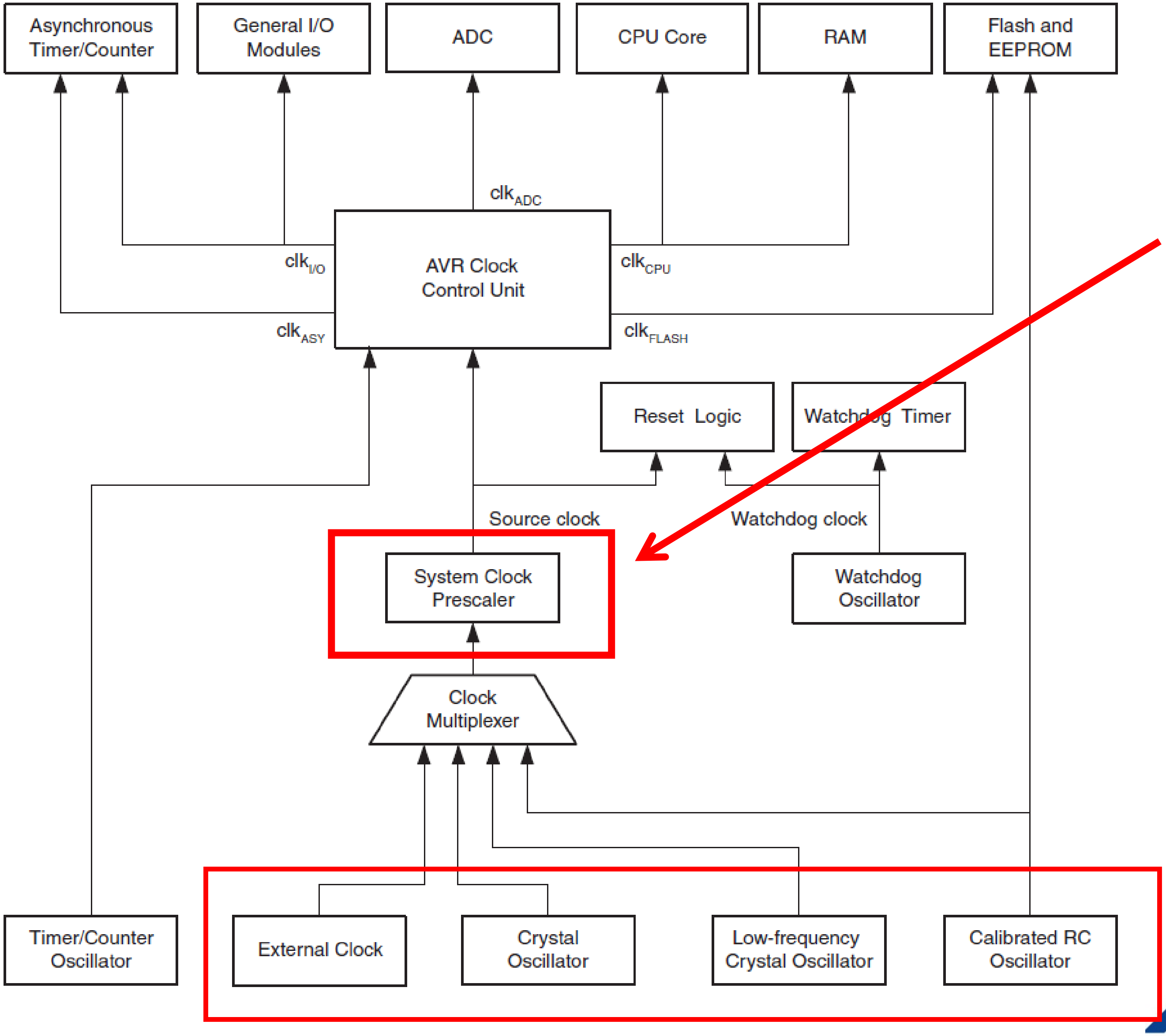
Clock options



Mega32: Intern clock distribution



Mega2560: Intern clock distribution



”System clock prescaler”

Findes ikke i Mega32

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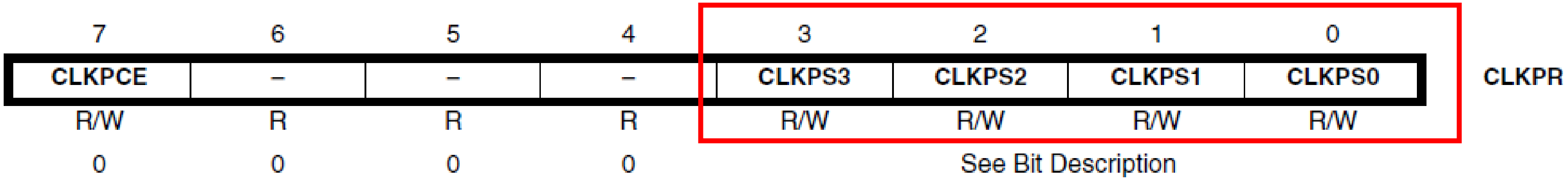
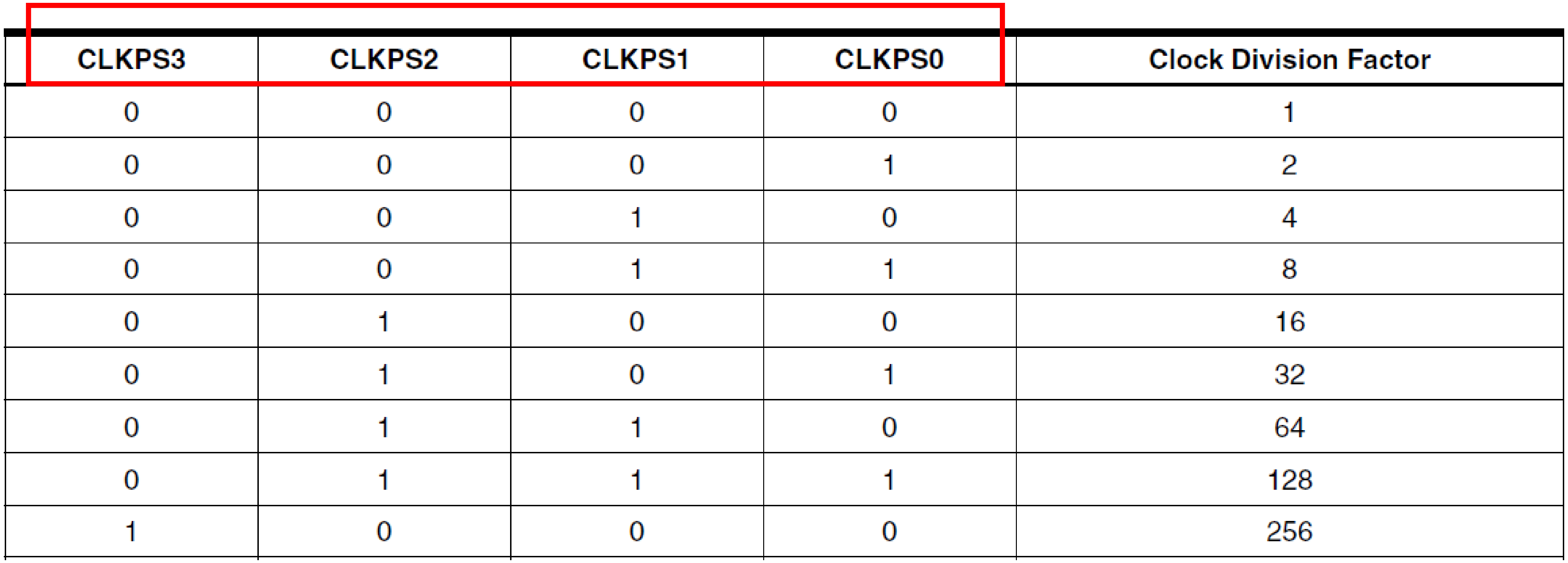
CLKPR = System Clock Prescale Register



	7	6	5	4	3	2	1	0
CLKPR	CLKPCE	–	–	–	CLKPS3	CLKPS2	CLKPS1	CLKPS0
	R/W	R	R	R	R/W	R/W	R/W	R/W
	0	0	0	0	See Bit Description			



CLKPS3	CLKPS2	CLKPS1	CLKPS0	Clock Division Factor
0	0	0	0	1
0	0	0	1	2
0	0	1	0	4
0	0	1	1	8
0	1	0	0	16
0	1	0	1	32
0	1	1	0	64
0	1	1	1	128
1	0	0	0	256

Metode (sæt prescaler til 32):
CLKPR = 0b10000000; //Skal være først
CLKPR = 0b00000101; //Straks derefter

Clock ”fuses”

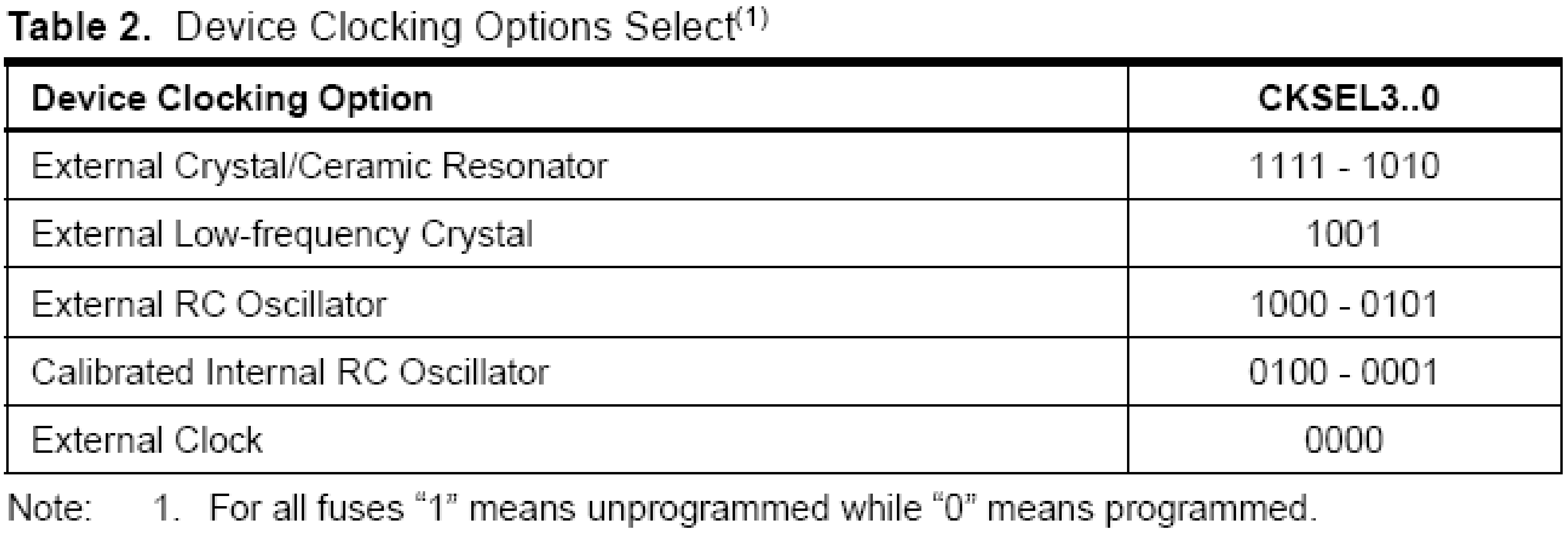


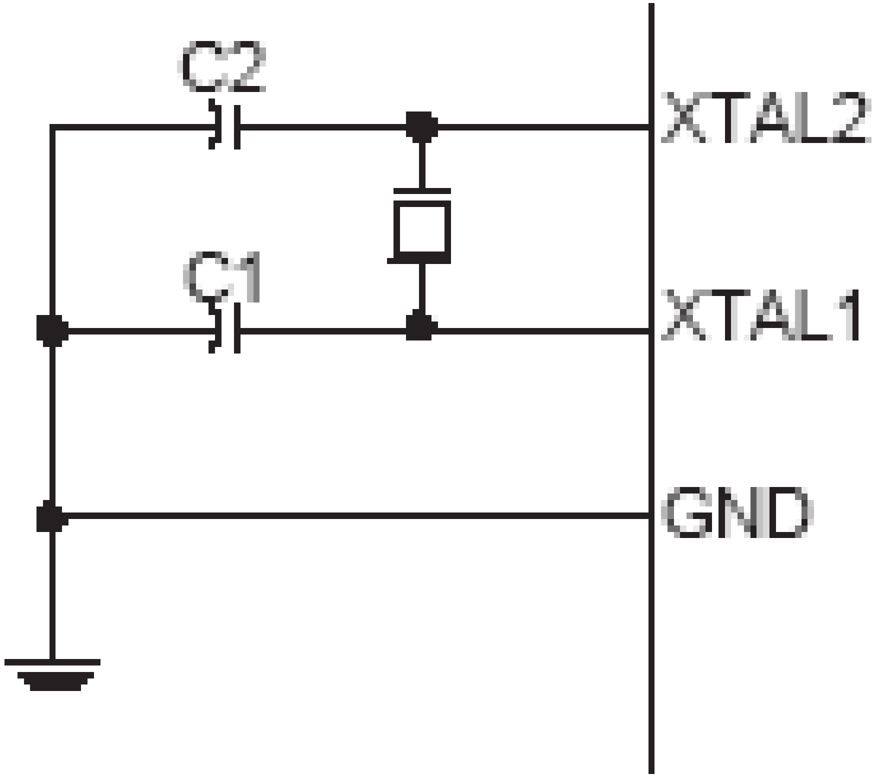
Table 2. Device Clocking Options Select[1]

Device Clocking Option	**CKSEL3..0**
External Crystal/Ceramic Resonator	1111 - 1010
External Low-frequency Crystal	1001
External RC Oscillator	1000 - 0101
Calibrated Internal RC Oscillator	0100 - 0001
External Clock	0000

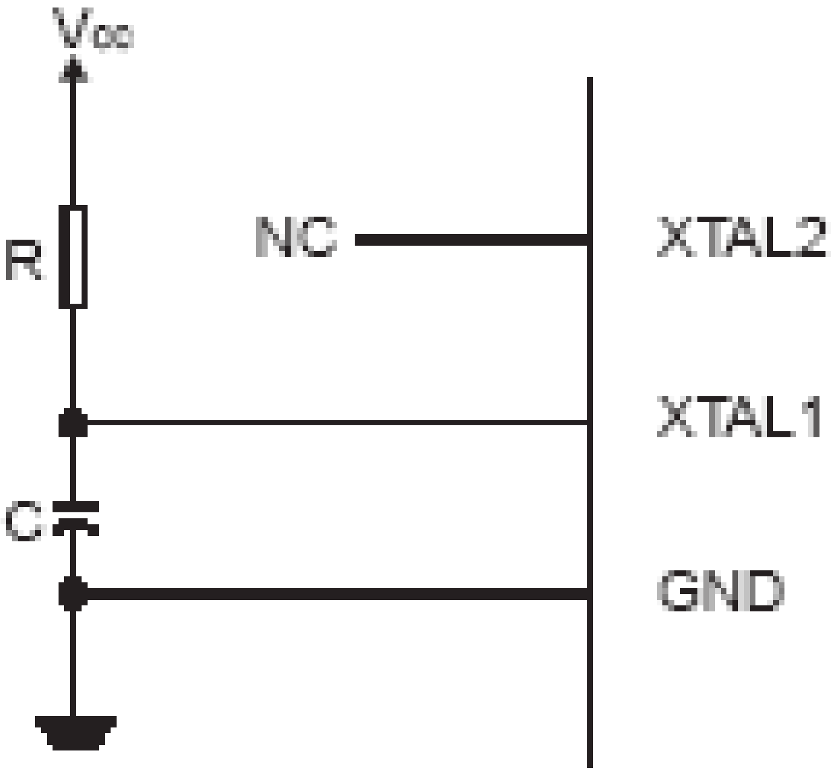
Note: 1. For all fuses “1” means unprogrammed while “0” means programmed.

- Valg af clock source sker med et programmeringsværktøj (f.eks. ”AVRdude”).
- Vores ”Arduino Mega2560” board er sat op til at anvende et eksternt krystal - men det kan vi ændre (anbefales ikke).

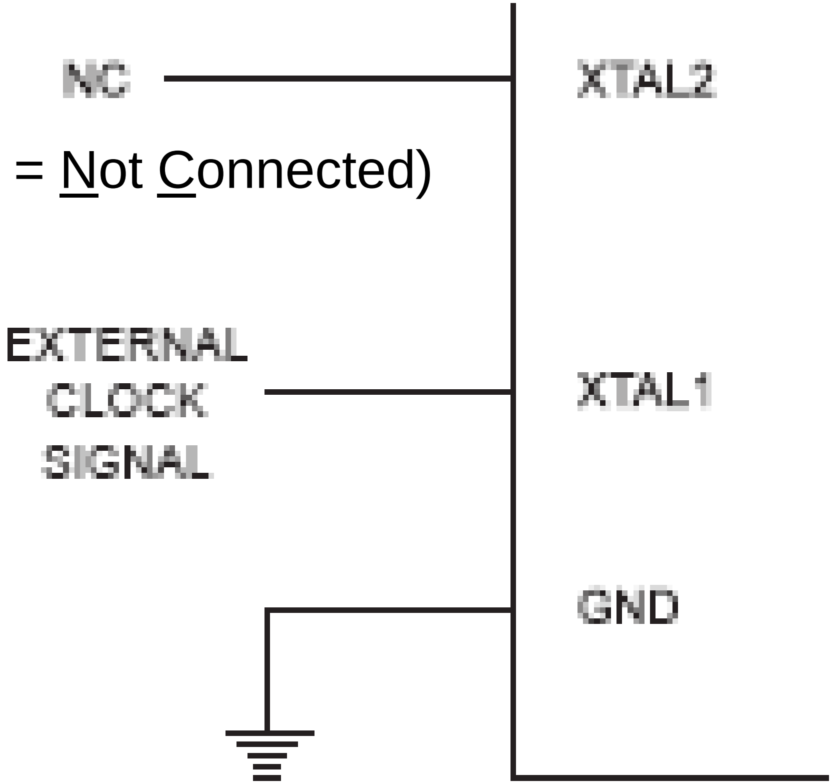
Hvis krystal oscillator vælges:



Hvis ekstern RC-oscillator vælges:



Hvis ekstern clocksignal vælges:



("NC" = Not Connected)

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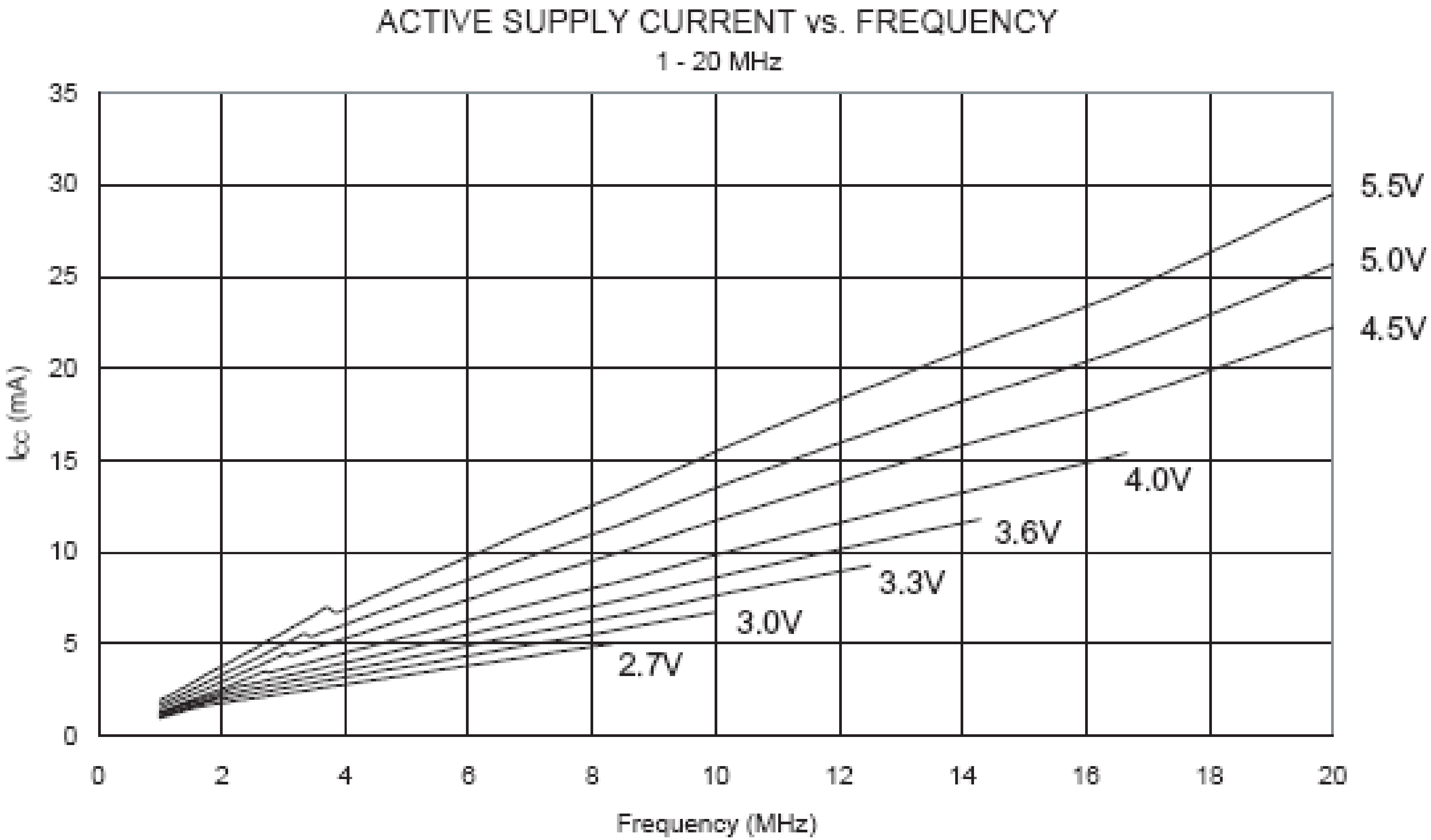
Strømforbrug vs. frekvens



Test (”socrative.com”: Room = MSYS)

- Vi har valgt clock fuses til ”external crystal” og anvender et krystal på 1 MHz.
  Hvad bliver CPU clockfrekvensen efter :
  CLKPR = 0b10000000;
  CLKPR = 0b00001000;

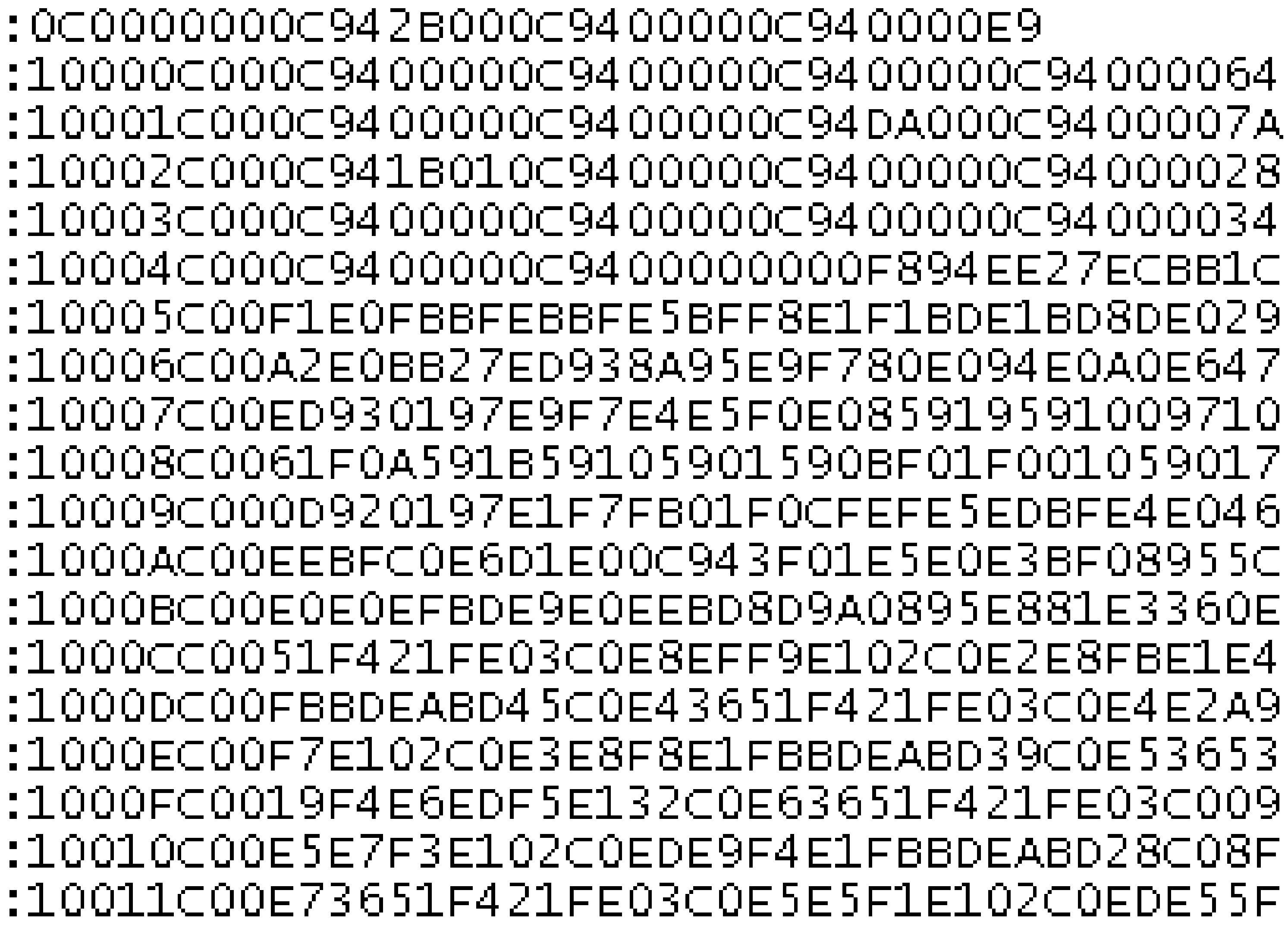
A: 1 MHz

B: 3,9 kHz

C: 62,5 kHz

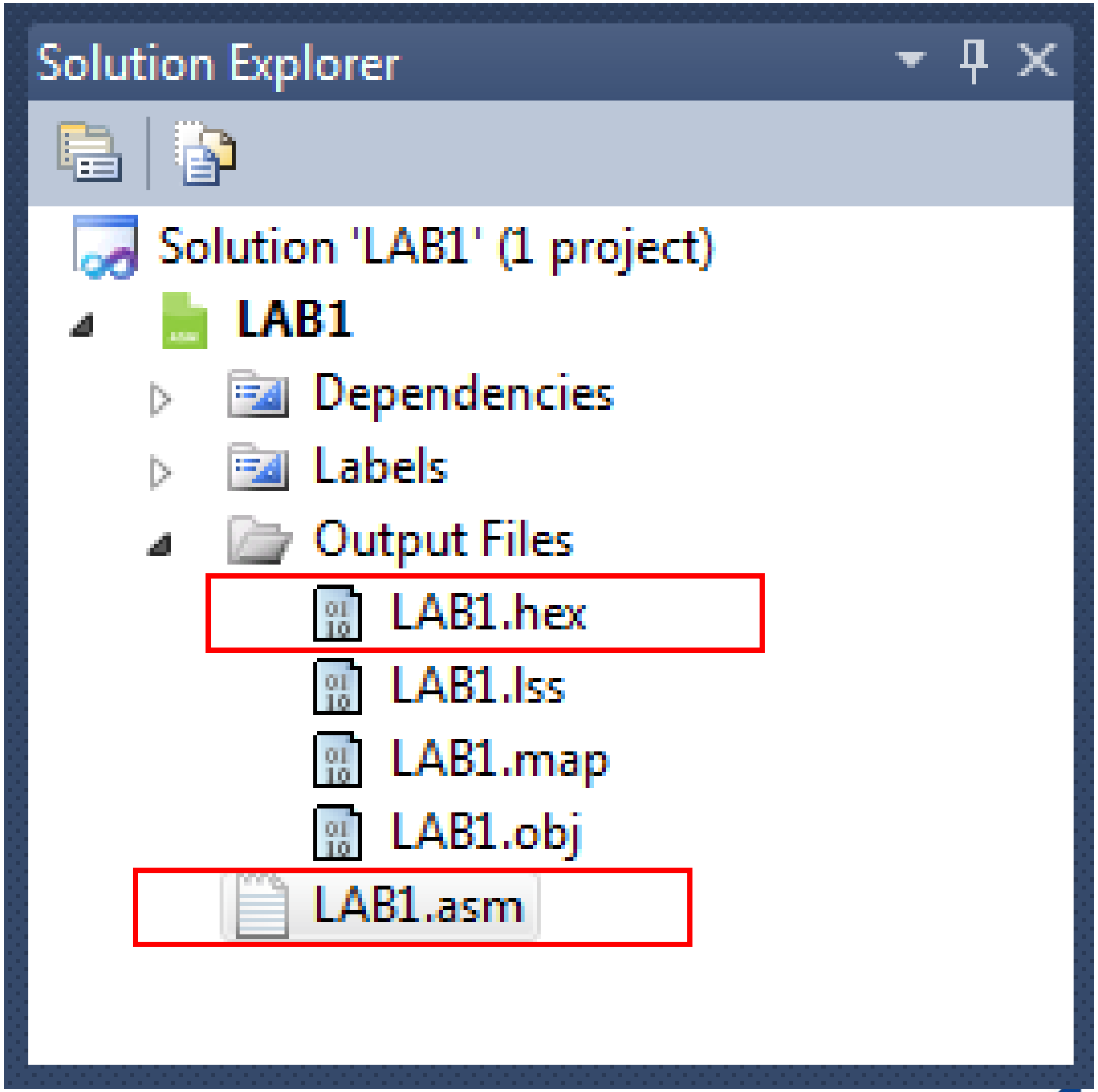
D: 256 kHz

Uddrag af en .hex - fil

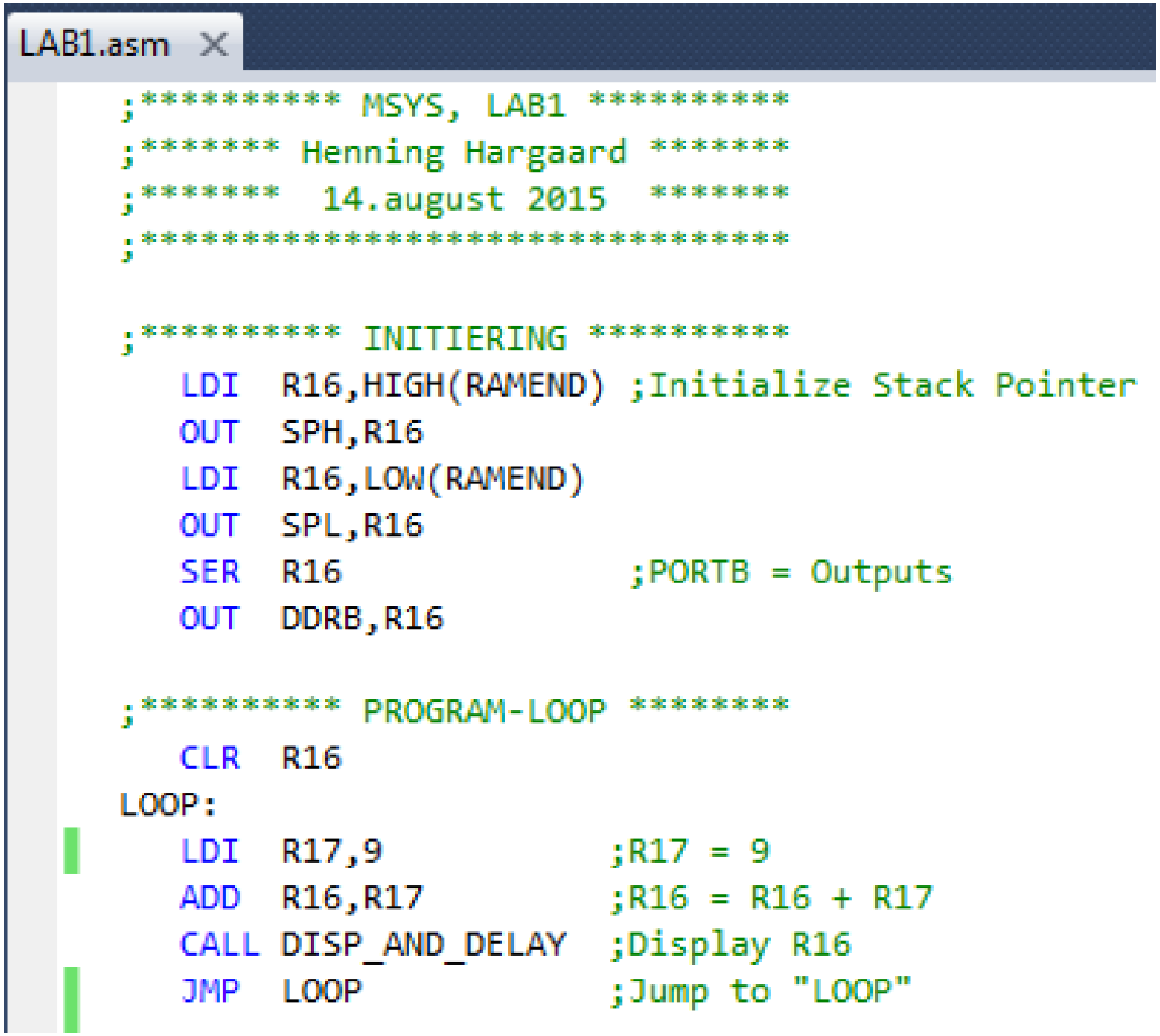


```
:0C0000000C942B000C9400000C940000E9
:10000C000C9400000C9400000C9400000C94000064
:10001C000C9400000C9400000C94DA000C9400007A
:10002C000C941B010C9400000C9400000C94000028
:10003C000C9400000C9400000C9400000C94000034
:10004C000C9400000C9400000000F894EE27ECBB1C
:10005C00F1E0FBBFEBBFE5BFF8E1F1BDE1BD8DE029
:10006C00A2E0BB27ED938A95E9F780E094E0A0E647
:10007C00ED930197E9F7E4E5F0E0859195910097 10
:10008C0061F0A591B5910590159 0BF01F00105901 7
:10009C000D920197E1F7FB01F0CFEFE5EDBFE4E046
:1000AC00EEBFC0E6D1E00C943F01E5E0E3BF08955C
:1000BC00E0E0EFBDE9E0EEBD8D9A0895E881E3360E
:1000CC0051F421FE03C0E8EFF9E102C0E2E8FBE1E4
:1000DC00FBBDEABD45C0E43651F421FE03C0E4E2A9
:1000EC00F7E102C0E3E8F8E1FBBDEABD39C0E53653
:1000FC0019F4E6EDF5E132C0E63651F421FE03C009
:10010C00E5E7F3E102C0EDE9F4E1FBBDEABD28C08F
:10011C00E73651F421FE03C0E5E5F1E102C0EDE55F
```

LAB1 (assembly projekt)

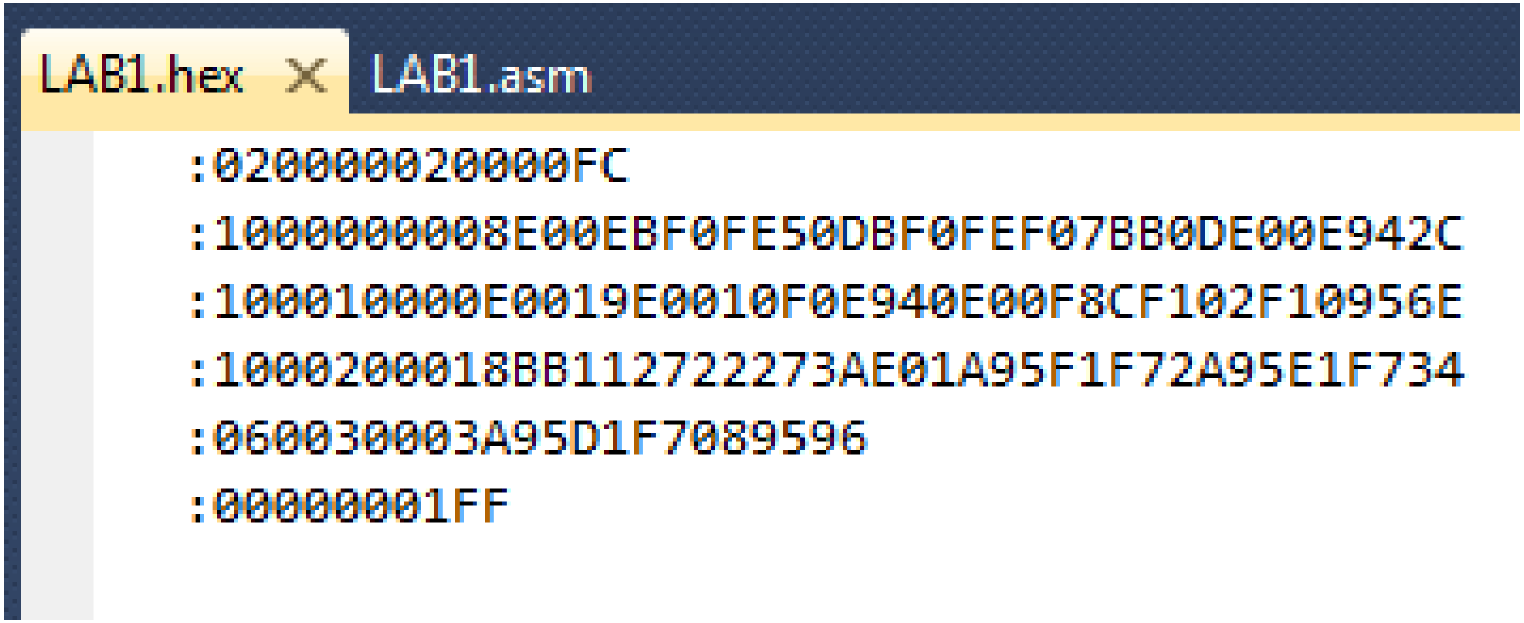


LAB1.asm



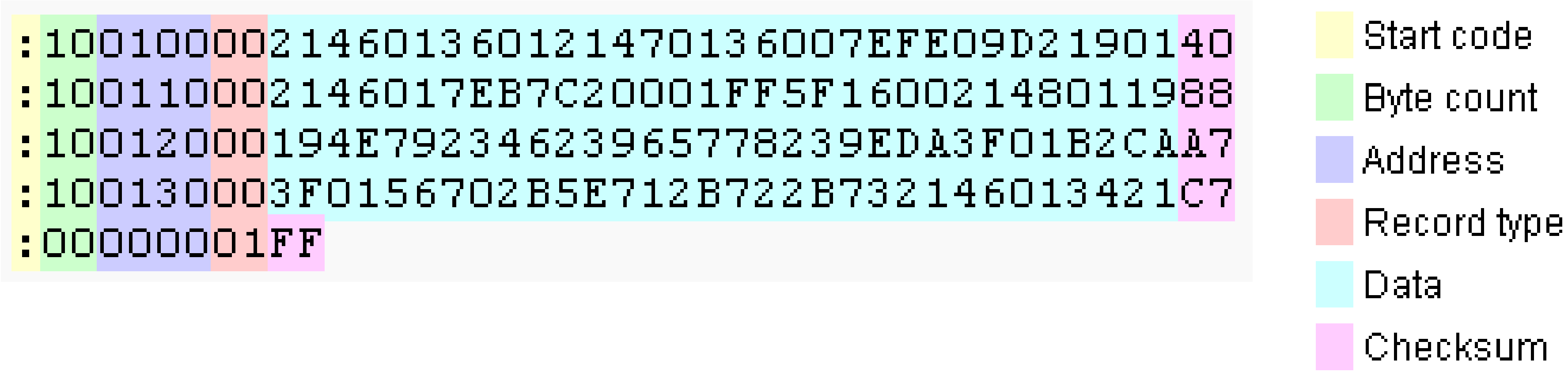
```
;********** MSYS, LAB1 **********
;******* Henning Hargaard *******
;*******  14.august 2015  *******
;********************************

;********** INITIERING **********
  LDI  R16,HIGH(RAMEND) ;Initialize Stack Pointer
  OUT  SPH,R16
  LDI  R16,LOW(RAMEND)
  OUT  SPL,R16
  SER  R16              ;PORTB = Outputs
  OUT  DDRB,R16

;********** PROGRAM-LOOP ********
  CLR  R16
LOOP:
  LDI  R17,9           ;R17 = 9
  ADD  R16,R17         ;R16 = R16 + R17
  CALL DISP_AND_DELAY  ;Display R16
  JMP  LOOP            ;Jump to "LOOP"
```

LAB1.hex



```
:020000020000FC
:1000000008E00EBF0FE50DBF0FEF07BB0DE00E942C
:100010000E0019E0010F0E940E00F8CF102F10956E
:1000200018BB112722273AE01A95F1F72A95E1F734
:060030003A95D1F7089596
:00000001FF
```

Intel 8 Hex format



```
:10010000214601360121470136007EFE09D2190140
:100110002146017EB7C20001FF5F16002148011988
:10012000194E79234623965778239EDA3F01B2CAA7
:100130003F0156702B5E712B722B732146013421C7
:00000001FF
```

🟨 Start code

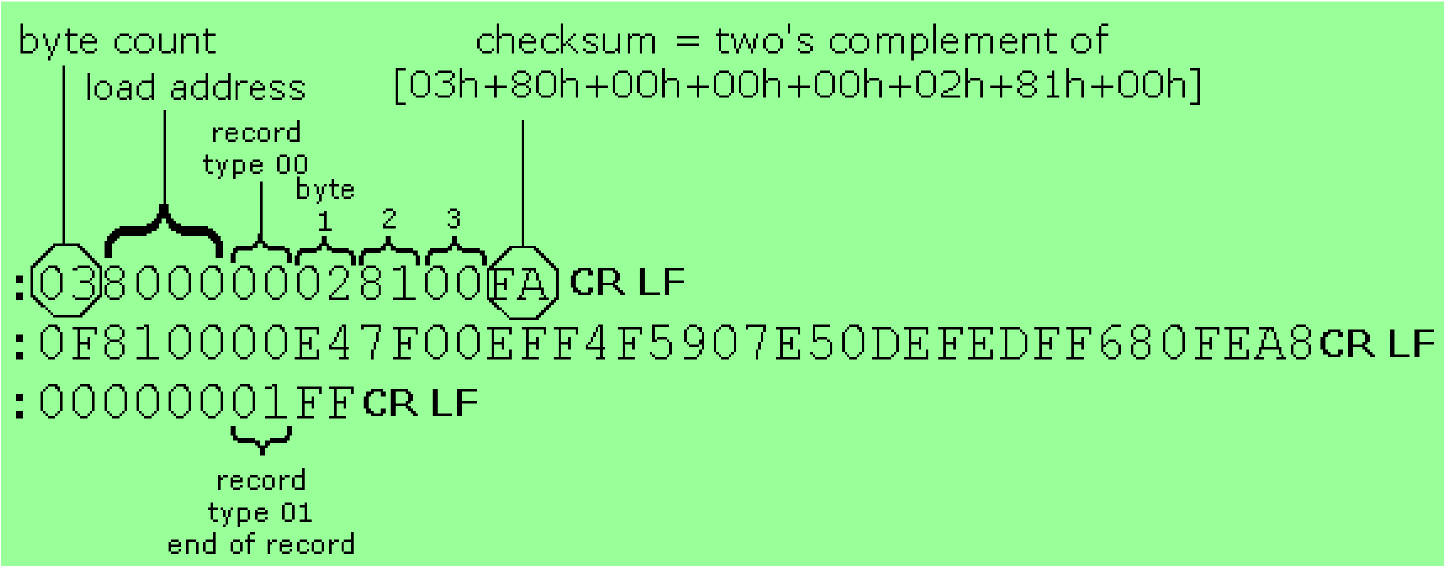
🟩 Byte count

🟪 Address

🟥 Record type

🟦 Data

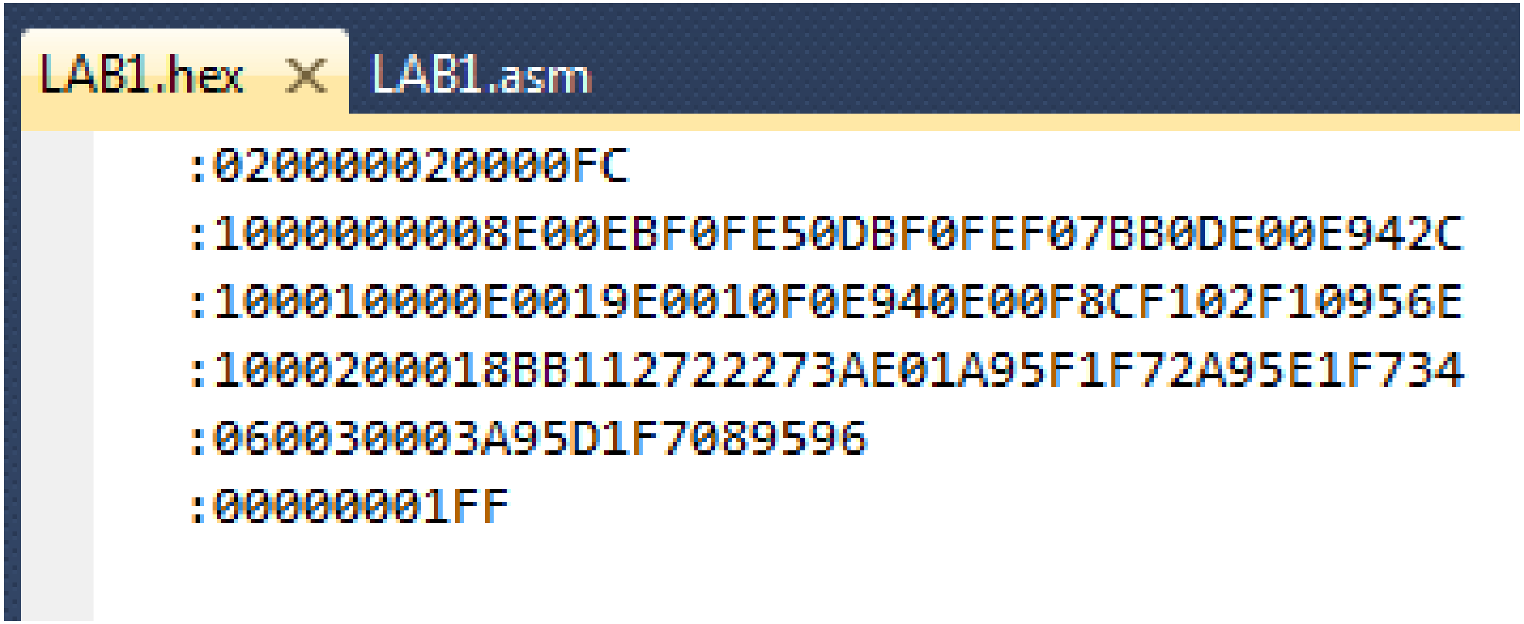
🟪 Checksum



```
:03800000028100FA CR LF
:0F810000E47F00EFF4F5907E50DEFEDFF680FEA8 CR LF
:00000001FF CR LF
```

byte count
load address
record type 00
byte
1
2
3
checksum = two's complement of [03h+80h+00h+00h+00h+02h+81h+00h]
record type 01 end of record

LAB1.hex

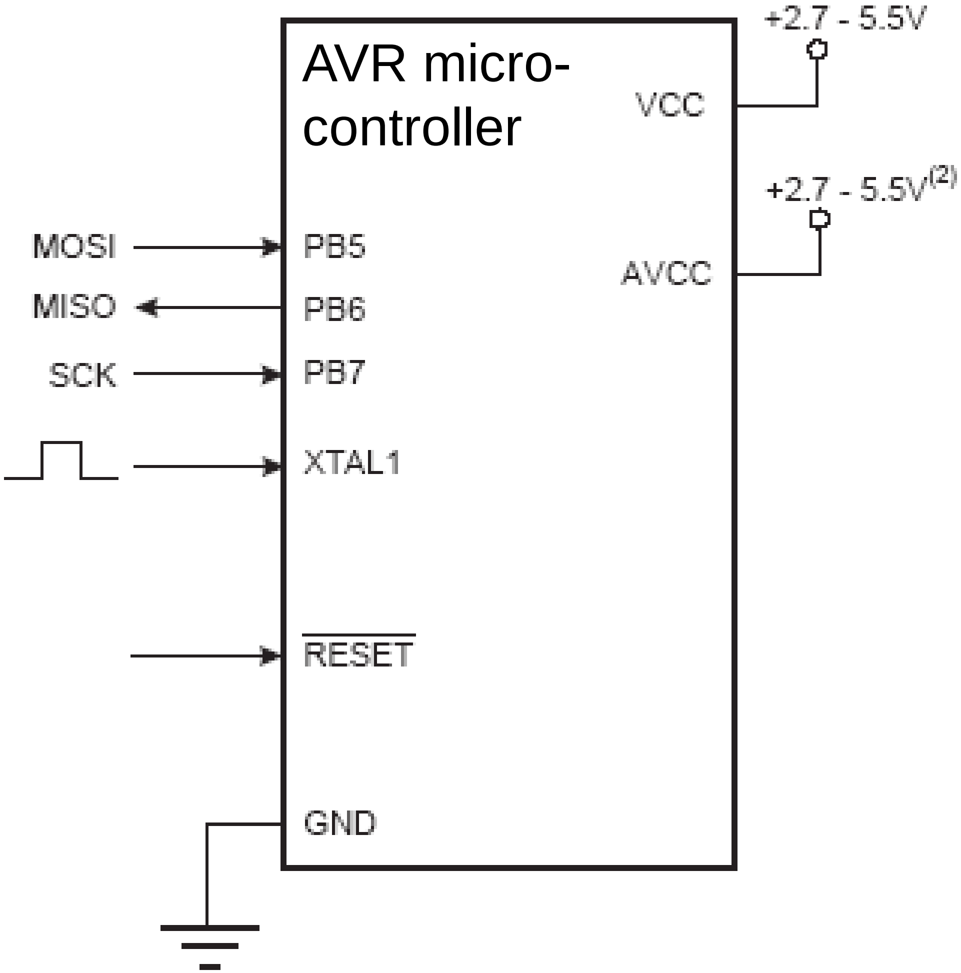


```
:020000020000FC
:1000000008E00EBF0FE50DBF0FEF07BB0DE00E942C
:100010000E0019E0010F0E940E00F8CF102F10956E
:1000200018BB112722273AE01A95F1F72A95E1F734
:060030003A95D1F7089596
:00000001FF
```

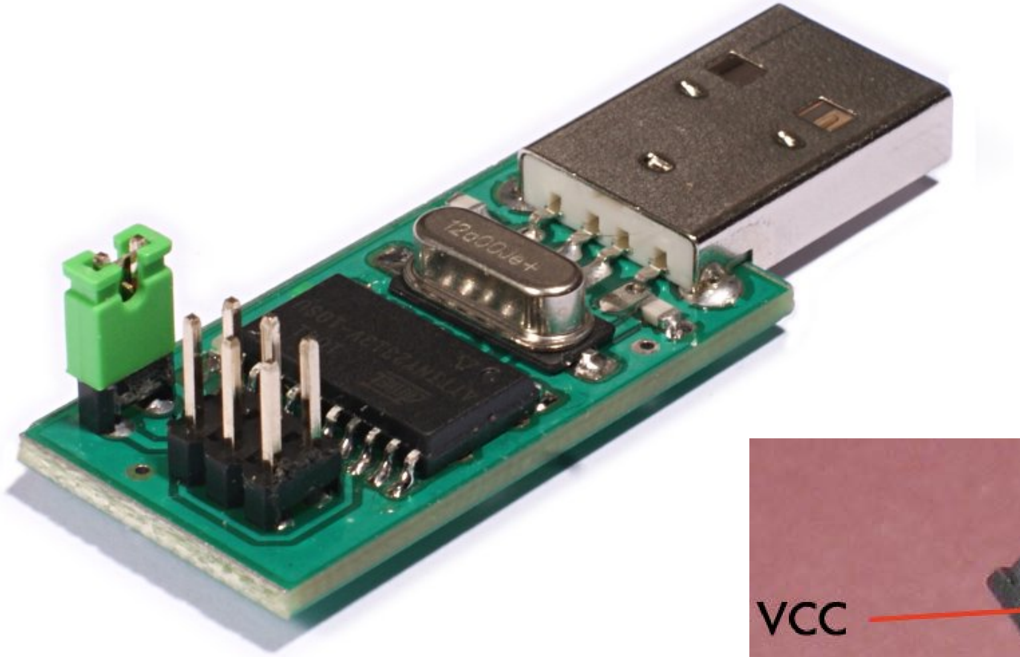
AVR programmerings-metoder

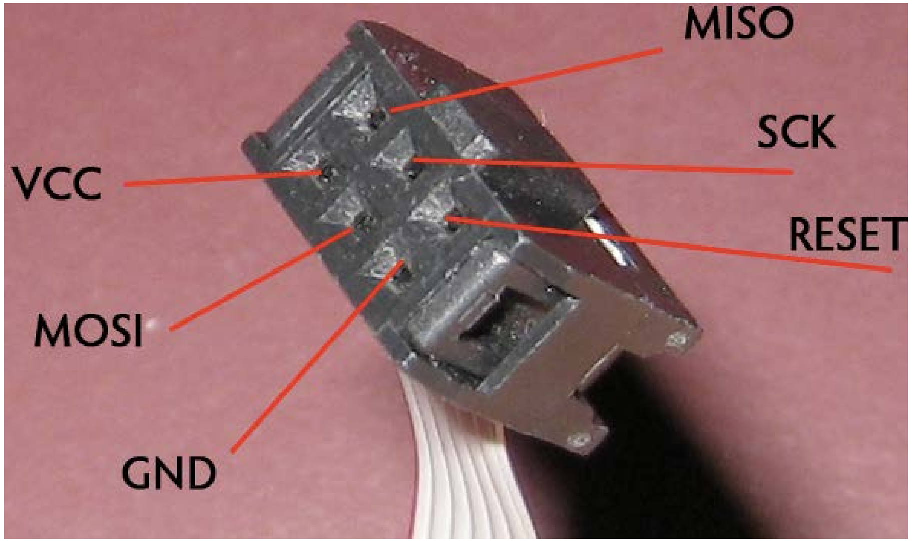
- Parallel programming (anvendes sjældent).
- ISP = In System Programming (anvendes meget ofte).
  - SPI
  - JTAG (kræver ekstra – ret dyrt – udstyr).
- Bootloading (speciel teknik, der kræver specialprogram på microcontrolleren).
  “Arduino Mega2560” boardet har en bootloader, der er programmeret fra fabrikken.

ISP seriel programmering



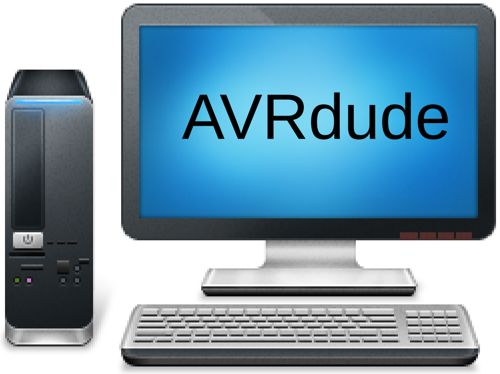
ISP programmer





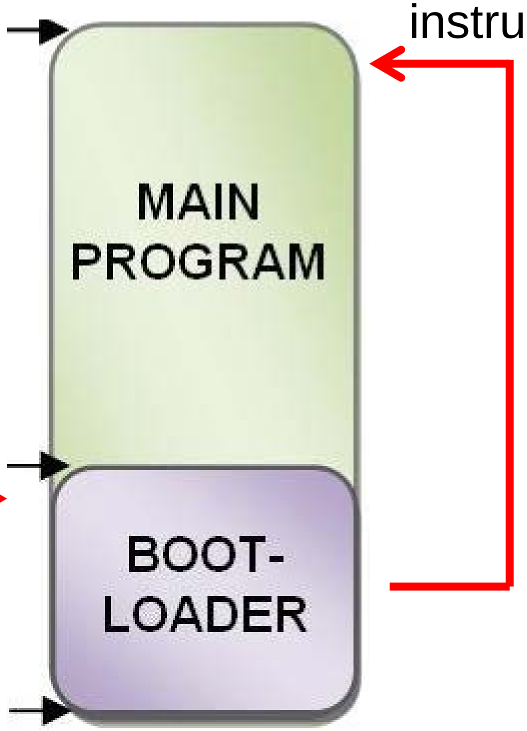
Boot loading

Arduino boards leveres alle med en boot-loader fra fabrikken.



”hex file”

(maskinkoder for vores program)



Program (flash) memory

STM instruction

MAIN PROGRAM

BOOT-LOADER

Slut på lektion 11

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