STEMKRAF - ATMEGA328 fuse bits
https://github.com/teaksoon/stemkraf

The “fuse” bits contains settings (0 or 1) that are used by the chip to determine how it should function.

There are total of 19 fuse bits in the Atmega328 micro-controller chip. They can be accessed via three(3) seperated bytes, they are commonly known as

1. low fuse bits (1 byte - 8 bits)
2. high fuse bits (1 byte - 8 bits)
3. extended fuse bits (1 byte - 8 bits, only 3 bits are used here)

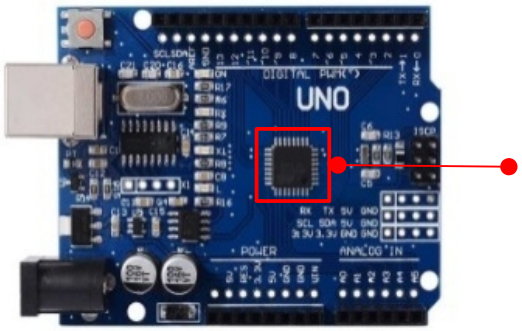
Depending on are needs, the fuse can be set by the factory or us.

However, be very careful when you change the fuse settings because you may render the chip “unusable”. Most of us does not have the tools to set back the fuse to a “usabale” settings again

Here, we are just reading and displaying the content of the fuse with our program. No harm will be done.

Atmega328 micro-controller stand alone chip (QFP Package)

Normally fuse are set with **Factory specification** (unless specified otherwise)



Atmega328 micro-controller chip (QFP Package) mounted on the Arduino Uno board

fuse are set with **Arduino specification**

To know the exact setting values and their usage, please refer to the Atmega328 chip datasheet.

STEMKRAF - ATMEGA328 fuse bits
https://github.com/teaksoon/stemkraf

ATMEGA328 chip fuse settings with the FACTORY specification (bit-7 ... bit-0)

```
low fuse bits       = 0 1 1 0 0 0 1 0
high fuse bits      = 1 1 0 1 1 0 0 1
extended fuse bits = 1 1 1 1 1 1 1 1
```

Low Byte Fuse

Bit	Name	Description	Value		
7	CKDIV8	Divide clock by 8	0	Set	Divide clock by 8
6	CKOUT	Output clock on PB0	1	Not set	
5	SUT1	Sets start up delay time	1	Not set	14CK + 65m
4	SUT0		0	Set	
3	CKSEL3	Clock Source	0	Set	Internal clock @ 8MHz
2	CKSEL2		0	Set	
1	CKSEL1		1	Not set	
0	CKSEL0		0	Set	

High Byte Fuse

Bit	Name	Description	Value		
7	RSTDISBL	External reset disable	1	Not set	
6	DWEN	debugWIRE enable	1	Not set	
5	SPIEN	Enable Serial programming	0	Set	Allow serial programming
4	WDTON	Watchdog Timer Always On	1	Not set	
3	EESAVE	Preserve eeprom	1	Not set	Erase eeprom memory when the chip is programmed
2	BOOTSZ1	boot loader memory size	0	Set	Boot loader size
1	BOOTSZ0		0	Set	
0	BOOTRST	Boot loader reset vector	1	Not set	

Extended Fuse

Bit	Name	Description	Value		
7		Not used	1	Not set	
6		Not used	1	Not set	
5		Not used	1	Not set	
4		Not used	1	Not set	
3		Not used	1	Not set	
2	BODLEVEL2	Brown-out detector level	1	Not set	BOD level disabled
1	BODLEVEL1		1	Not set	
0	BODLEVEL0		1	Not set	

One very notable setting on Factory fuse specification is the setting to use the 8Mhz internal clock(CKSEL bits) and enable the divide_by_8(CKDIV8 bit) to operate at 1/8 clock speed.

That is why a Blank factory fuse setting ATMEGA328 chip runs at 1Mhz (8Mhz divided by 8).

Unlike the Arduino Uno, Mini and the Nano, the factory fuse setting ATMEGA328 chip can run without any external clock crystal. IF we wish to use External Crystal, then we will need to set some fuse (refer to the chip datasheet on what to set).

STEMKRAF - ATMEGA328 fuse bits
https://github.com/teaksoon/stemkraf

ATMEGA328 chip fuse settings with the ARDUINO specification (bit-7 ... bit-0)

```
low fuse bits       = 1 1 1 1 1 1 1 1
high fuse bits      = 1 1 0 1 1 1 1 0
extended fuse bits = 1 1 1 1 1 1 0 1
```

Low Byte Fuse

Bit	Name	Description	Value		
7	CKDIV8	Divide clock by 8	0	Set	Divide clock by 8
6	CKOUT	Output clock on PB0	1	Not set	
5	SUT1	Sets start up delay time	1	Not set	14CK + 65m
4	SUT0		0	Set	
3	CKSEL3	Clock Source	0	Set	Internal clock @ 8MHz
2	CKSEL2		0	Set	
1	CKSEL1		1	Not set	
0	CKSEL0		0	Set	

High Byte Fuse

Bit	Name	Description	Value		
7	RSTDISBL	External reset disable	1	Not set	
6	DWEN	debugWIRE enable	1	Not set	
5	SPIEN	Enable Serial programming	0	Set	Allow serial programming
4	WDTON	Watchdog Timer Always On	1	Not set	
3	EESAVE	Preserve eeprom	1	Not set	Erase eeprom memory when the chip is programmed
2	BOOTSZ1	boot loader memory size	0	Set	Boot loader size
1	BOOTSZ0		0	Set	
0	BOOTRST	Boot loader reset vector	1	Not set	

Extended Fuse

Bit	Name	Description	Value		
7		Not used	1	Not set	
6		Not used	1	Not set	
5		Not used	1	Not set	
4		Not used	1	Not set	
3		Not used	1	Not set	
2	BODLEVEL2	Brown-out detector level	1	Not set	BOD level disabled
1	BODLEVEL1		1	Not set	
0	BODLEVEL0		1	Not set	

One very notable setting on Arduino fuse specification, is the setting to use the External Clock(CKSEL bits) 16Mhz Crystal and with the divide_by_8(CKDIV8 bit) disabled.

That is why an Arduino fuse setting ATMEGA328 chip runs at full 16Mhz External Clock Speed (the division by 8 has been disable).

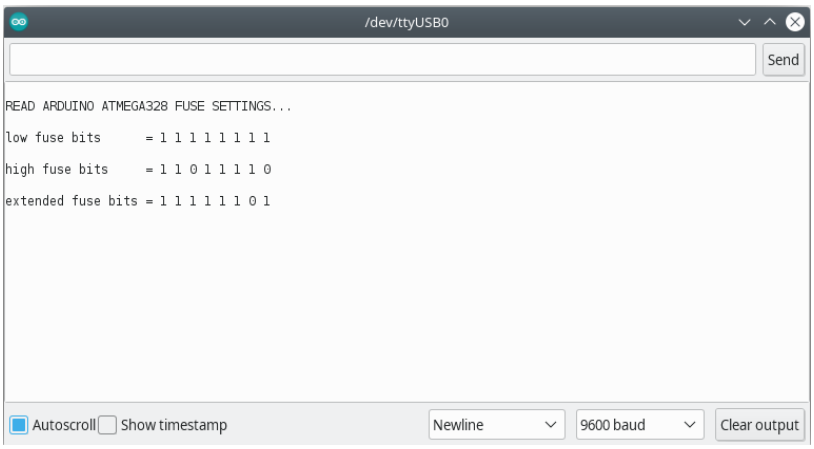
The development board like Arduino Uno, Mini and Nano are using this fuse settings specification. An external 16Mhz Clock Crystal must be connected to the ATMEGA328 chip with this fuse setting, otherwise the chip will not function.

STEMKRAF - ATMEGA328P fuse bits
https://github.com/teaksoon/stemkraf

```
Program: stemkraf_read_atmega328_fuse
  (1/1): program to read fuse bit in ATMEGA328P
       :
       : by TeakSoon Ding for STEMKRAF (NOV-2021)
```

- Upload this program with the Arduino IDE Software
- Open up the Serial Monitor from the Arduino IDE Software
- Watch the Serial Monitor Screen

```
// Program: stemkraf_read_atmega328_fuse
//        : program to read atmega328 fuse
//        : WARNING!!! DO NOT ATTEMPT TO CHANGE the fuse setting if not sure
//        : by TeakSoon Ding for STEMKRAF ( NOV-2021 )
// ------------------------------------------------
#include <avr/boot.h>

void setup() {
uint8_t low_fuse_bits, high_fuse_bits, extended_fuse_bits;

  low_fuse_bits       = boot_lock_fuse_bits_get(GET_LOW_FUSE_BITS);
  high_fuse_bits      = boot_lock_fuse_bits_get(GET_HIGH_FUSE_BITS);
  extended_fuse_bits  = boot_lock_fuse_bits_get(GET_EXTENDED_FUSE_BITS);

  Serial.begin(9600);
  Serial.print("\nREAD ARDUINO ATMEGA328 FUSE SETTINGS...");

  Serial.print("\n\nlow fuse bits      = ");
  Serial_monitor_show_bits(low_fuse_bits);

  Serial.print("\n\nhigh fuse bits     = ");
  Serial_monitor_show_bits(high_fuse_bits);

  Serial.print("\n\nextended fuse bits = ");
  Serial_monitor_show_bits(extended_fuse_bits);
}

void loop() {}

void serial_monitor_show_bits(uint8_t by) {
   for (int i=7; i>=0; i--) {
    Serial.print((by >> i) & 0x1);Serial.print(" ");
  }
}
```



This program only read the fuse bits from the ATMEGA328 chip and show it on the Serial Monitor Screen.

WARNING!!! Do not attempt to change the the default fuse settings if you are not sure. You may render the chip "unusable"