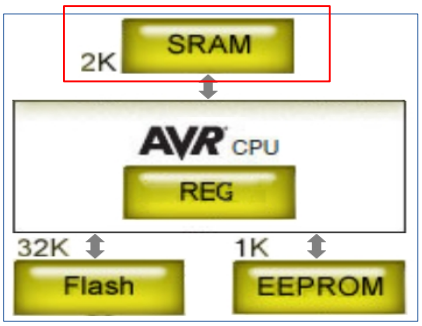
ATMEGA328/Arduino Uno – MEMORY – VARIABLE – PART 1
https://github.com/teaksoon/lmaewapm

WORKING MEMORY

The "WORKING MEMORY" is for us to use in our PROGRAM as temporary working storage

This MEMORY can be visualized as a long sequence of individual BITs



To use the **WORKING MEMORY (SRAM)** in our PROGRAM, we will need "Reserve in BLOCKS of multiple BITS". Each "BLOCK" of "Reserved MEMORY" is commonly known as **"VARIABLE"**

The C-Language Keywords and Symbols

Keywords

MEMORY	CONTROL
01.void	21.return
02.char	22.if
03.int	23.else
04.short	24.switch
05.long	25.case
06.float	26.default
07.double	27.while
08.signed	28.do
09.unsigned	29.for
10.struct	30.break
11.union	31.continue
12.enum	32.goto
13.const	
14.volatile	
15.auto	
16.extern	
17.static	
18.register	
19.typedef	
20.sizeof	

Symbols

CONTROL	LOGIC	MATH	BIT OP
#	==	*	|
< >	!=	%	&
//	<	/	^
/* */	>	+	~
( )	<=	–	<<
{ }	>=		>>
;			
,	&&		
"	||		
'			
=	!		
[ ]			
:			
?			
.			
\			
MEMORY			
&			
*			

Out of the Total 32 C-Language Keywords
20 Keywords are used to just handle the WORKING MEMORY

– The **first 18 Keywords,** are used exclusively for creating/declaring VARIABLES with its various properties and features

19.typedef – utility for us to create a new DATATYPE from the existing datatype
20.sizeof – utility for us to find out the number of BYTE used in any VARIABLE

That leaves us just **12 Keywords for all the other things.** This is how important the WORKING MEMORY is to C-Language

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Lets look at the **20 C-Language Keywords** that we use to manipulate the WORKING MEMORY

(PART 1)

BASIC DATATYPE

these are the BASIC DATATYPE used in C-Language

02.char (8-BIT)
03.int (16-BIT for ATMEGA328P) - can be different for others
04.short (16-BIT)
05.long (32-BIT)
06.float (32-BIT)
07.double (32-BIT for ATMEGA328P) - can be different for others

08.signed (Stored number can have **Positive** and **Negative Numbers**)
09.unsigned (Stored number can have **Positive Numbers Only**)

SPECIAL DATATYPE

these are extensions to the BASIC DATATYPE

10.struct (Multiple members of various DATATYPE)
11.union (Multiple members of various DATATYPE sharing the same the MEMORY)
12.enum (Multiple members of 16-BIT auto-increment number)

PROPERTIES

also known as type qualifiers

13.const (Variable with Initial Data assigned that cannot be changed)
14.volatile (Prevent the Compiler from automatic Optimizing of MEMORY)

FEATURES

these are Storage Classes of a Variable

15.auto (DATATYPE from the Initial Data assigned)
16.extern (Variable declaration is stored in a different file)
17.static (Variable with Initial Data assigned just once, retains value)
18.register (Use CPU MEMORY instead of WORKING MEMORY) *compiler decides

DATATYPE UTILITIES

19.typedef (Create a new DATATYPE from the existing DATATYPE)
20.sizeof (Find out the number of BYTE in any Variable) : 1 BYTE = 8 BITS

VOID

01.void (Empty DATATYPE)
- Most commonly used as function return DATTYPE when a function returns nothing
- Less commonly used as parameter(optional) when functions that does not have any parameters
- Also used as memory pointers Variable to unknown DATATYPE

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Although we are going through all the 20 C-Language Keywords for WORKING MEMORY manipulation. We will probably just need to use a few of them, some maybe only in some rare situation

We will start with the most commonly used ones in **PART 1**
(this may be all that we need)

BASIC DATATYPE: Create/Declare Basic Variable
Part1:datatype
Part2:name

Part1:datatype, followed by space
Part2:name, followed by a semi-colon ;

```
datatype name;
```

BASIC DATATYPE: Create/Declare Basic Variable with initial value
Part1:datatype
Part2:name
Part3:value

Part1:datatype, followed by space
Part2:name, followed by an equal sign =
Part3:value, followed by a semi colon ;

```
datatype name = value;
```

Example PROGRAM:

Arduino IDE|Save PROGRAM as: **c_variable_basic**
Enter codes below and upload. Use the Serial Monitor to see results

```
int counter = 0;
int temp;
float frac_num = 1.5;

void setup(){
  Serial.begin(9600);
  Serial.print("\nSerial Monitor at 9600 baud...\n");

  Serial.print("\nData stored in variable counter = ");
  Serial.print(counter);
  temp = counter+1;
  Serial.print("\nData stored in variable temp = ");
  Serial.print(temp);
  Serial.print("\nData stored in variable frac_num = ");
  Serial.print(frac_num,2);
}
void loop(){}
```

NOTE: Variables with BASIC DATATYPE are used to store a single number,
- char,int,long,short stores whole numbers
- float,double stores numbers with fractions

C-Language Keywords
02.char (8-BIT)
03.int (16-BIT for ATMEGA328P) - can be different for others
04.short (16-BIT)
05.long (32-BIT)
06.float (32-BIT)
07.double (32-BIT for ATMEGA328P) - can be different for others

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BASIC DATATYPE: Create/Declare Variable with "unsigned" Keyword
Part1:"unsigned" Keyword
Part2:datatype
Part3:name

Part1:"unsigned" Keyword followed by space
Part2:datatype, followed by space
Part3:name, followed by a semi-colon ;

```
unsigned datatype name;
```

Or with an initial value

```
unsigned datatype name = value;
```

Example PROGRAM:

Arduino IDE|Save PROGRAM as: **c_variable_unsigned**
Enter codes below and upload. Use the Serial Monitor to see results

```
unsigned int counter;

void setup(){
  Serial.begin(9600);
  Serial.print("\nSerial Monitor at 9600 baud...\n");

  counter =  1; // Positive Number
  Serial.print("\n1 stored in unsigned variable counter = ");
  Serial.print(counter);

  counter = -1; // Negative Number ( this is not allowed )
  // -1 will be converted into positive number
  // "int" datatype use twos complement for negative numbers
  // therefore, -1 will be converted to 65535
  Serial.print("\n-1 stored in unsigned variable counter = ");
  Serial.print(counter);
}
void loop(){}
```

NOTE: This is like the normal BASIC DATATYPE where the Variable stores a single number.

- When the **"unsigned" Keyword IS NOT specified**, it is considered as "signed" (we can put the "signed" Keyword infront of our DATATYPE if we wish, however it is optional), The Variable can store both Positive and Negative number

- When the **"unsigned" Keyword IS specified**, the Variable can store Positive number only. If a negative number is assigned to a "unsigned" Variable, the number will be automatically converted into a positive number using the following two formats,
- "twos complement" format for char,int,long,short (whole numbers)
- "IEEE 754" format for float,double (numbers with fractions)

C-Language Keywords
08.signed (Stored number can have **Positive** and **Negative Numbers**)
09.unsigned (Stored number can have **Positive Numbers Only**)

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BASIC DATATYPE: Create/Declare Variable with "const" Keyword
Part1:"const" Keyword
Part2:datatype
Part3:name
Part4:value

Part1:"const" Keyword followed by space
Part2:datatype, followed by space
Part3:name, followed by an equal sign =
Part4:value, followed by a semi-colon ;

```
const datatype name = value;
```

Example PROGRAM:

Arduino IDE|Save PROGRAM as: **c_variable_const**
Enter codes below and upload. Use the Serial Monitor to see results

```
const int led_pin = 9;

void setup(){
  Serial.begin(9600);
  Serial.print("\nSerial Monitor at 9600 baud...\n");

  Serial.print("\nData stored in const variable led_pin = ");
  Serial.print(led_pin);

  // the following code will compile with error, un-comment to test
  // led_pin = 10;
}

void loop(){}
```

NOTE: A "const" Variable must be assigned an initial value. After that, the assigned initial value is "read-only" – CANNOT BE CHANGED

C-Language Keywords
13.const (Variable with Initial Data assigned that cannot be changed)

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BASIC DATATYPE: Create/Declare Variable with "static" Keyword
Part1:"static" Keyword
Part2:datatype
Part3:name
Part4:value

Part1:"static" Keyword followed by space
Part2:datatype, followed by space
Part3:name, followed by an equal sign =
Part4:value, followed by a semi-colon ;

```
static datatype name = value;
```

Example PROGRAM:

Arduino IDE|Save PROGRAM as: **c_variable_static**
Enter codes below and upload. Use the Serial Monitor to see results

```
void setup(){
  Serial.begin(9600);
  Serial.print("\nSerial Monitor at 9600 baud...\n");
}

void loop(){
int temp;
  temp = static_var();
  Serial.print("\n\nData from static_var() function = ");
  Serial.print(temp);
  temp = non_static_var();
  Serial.print("\nData from non_static_var() function = ");
  Serial.print(temp);
  delay(2000);
}

int static_var(){
static int counter = 0; // this is run just once
  counter = counter+1;
  return counter;
}

int non_static_var(){
int counter = 0;
  counter = counter+1;
  return counter;
}
```

NOTE: We need to specify an initial Value for "static" Variable. When used in a function, the initial value will only be set once. Subsequence call to this function will not set initial value for the Variable again, the function will continue with whatever value that is already in the Variable

C-Language Keywords
17.static (Variable with Initial Data assigned just once, retain value)

BASIC DATATYPE:Using "void" Keyword for function Declaration and Variable

Part1:"**void**" Keyword
Part2:name

Part1:"**void**" Keyword followed by space
Part2:name – Function name declaration

```
void name(){}
```
Function with no return value

```
void name(void){}
```
Function with no parameters (instead of "void" can also leave blank)

```
void *name;
```
Memory Pointer Variable for unknown DATATYPE

Part2:name – Variable name declaration

Example PROGRAM:

Arduino IDE|Save PROGRAM as: **c_variable_void**
Enter codes below and upload. Use the Serial Monitor to see results

```
void setup(){
int    a=5;
float  b=5.67;
void  *ptr; // memory pointer Variable for unknown datatype

  Serial.begin(9600);
  Serial.print("\nSerial Monitor at 9600 baud...\n");

  // calling return_void() function, returns nothing
  return_void();
  // calling no_parameter() function, with no parameters
  no_parameter();

  ptr=&a; // Assigning address of integer to void pointer
  Serial.print("\nData stored in memory ptr = ");
  Serial.print( *((int*)ptr) );

  ptr=&b; // Assigning address of float to void pointer
  Serial.print("\nData stored in memory ptr = ");
  Serial.print( *((float*)ptr) );
}
void loop(){}

void return_void() {
  // do something here
  // this function does not return anything
}
void no_parameter(void) {
  // function oes not have any parameters
  // we can specify void or just leave the bracket ( ) pair blank
}
```

NOTE: void is an empty DATATYPE. There are many ways to use it, following are three ways of use it,
1. Use when function does not return anything
2. Use when function does not need any parameters (this is optional)
3. Use as Memory Pointer Varaible to unknown DATATYPE

C-Language Keywords
01.void (Empty DATATYPE)