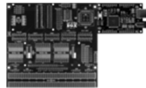


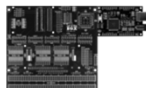
EEL 4744

Menu

• Introduction to C for Atmel XMega

See Examples or Classes on web-site:
`Usage of simple …, usart_serial.c, ebi.c, ebi_driver.h`
See Software/Docs:
`Getting Started Writing C …,`
`Info on C for the Atmel XMEGA, Tips to Optimize C Code`

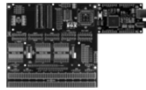
`For mixed C/Assembly:`
- `"Mixed C and Assembly (for Atmel XMEGA)",`
- `VectorAdd_Mixed_ASM.s, VectorAdd_Mixed.c,`
- `VectorADD_Casm.c, Input_Port_C.c`



EEL 4744

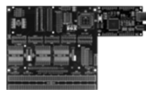
Menu

- Motivation
- Overview of C Basics
- Variables, Types, and Definitions
- Conditionals
- Ports and Registers
- Interrupts
- Pointers
- C Example
- **<u>NOT</u>** covered, but possibly useful info after 4744
  >Using C with Assembly: slides 42-…



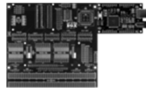
EEL 4744 Introduction to C & other High-level Languages

- Source Languages (e.g., C, C++, Java)
  - > Most modern programs are written in high-level languages (such as C), because it is generally easier than Assembly.
  - > A compiler is used to convert a source language into a target language (e.g., Assembly), resulting in object code (just as an assembler converts Assembly to object/machine code).
  - > A compiler is given limited time to “optimize” the object code in terms of speed, memory usage, etc.
  - > The resulting object code is not guaranteed to be as fast or efficient as can be done with Assembly code.



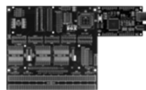
EEL 4744 Mixed C/Assembly

- Why Mixed Coding?
  - > Occasionally a programmer may want to take advantage of the increased specificity in Assembly to improve the resulting object code (usually for increased speed).
  - > When programming in high-level language, there may be limitations due to processor specific features.
    - – Memory Mapping
    - – External Bus Control



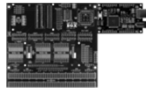
EEL 4744 Costs/Benefits of Mixed C/Assembly versus C or Assembly

- Benefits of either C or Assembly (but not both)
  - > … of C
    - – Power of a high-level source language such as C
      - Libraries (Graphical, Math, etc.), String-processing functions, etc.
    - – Use of C structures and layout
  - > … of Assembly
    - – Speed and control of assembler (optimization)
    - – Direct control of code placement
    - – Access to processor specific functions
- Drawbacks of mixed C/Assembly
  - > Assembly coding in mixed coding is slightly different from standard Assembly
    - – Naming conventions, function usages
  - > Code is less portable (i.e., is often specific to the processor)



EEL 4744 What is Mixed C/Assembly Coding?

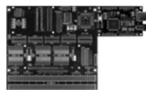
- Use Assembly code to improve C code or take advantage of a specific processor's capabilities
- For our board, mixed coding is handled by the AVR-GCC toolchain for compiling with the GNU Assembler (GAS); previously used Eclipse toolchair.
- W/ XMEGA, 2 ways to mix C and Assembly code
  - > Use separate files for C code and Assembly code, the **.c** extension and **.s** extension respectively
  - > Inline Assembly code directly inserted into the C code
  - > You will **NOT** be expected to write mixed code
    - – See the end of this lecture for more mixed C/Assembly info



EEL 4744

Basic C Structures

- Overview
  - (The primary C structures are also used in Mixed C/Assembly)
  - Preprocessor Directives
  - Functions (prototypes)
  - Main Function
  - Function Calls



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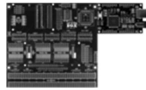
Basic C Structures

- C (or Mixed C/Assembly) start with a standard structure
  > Example:

```
#define F_CPU 2000000
#include <avr/io.h>

// function prototype below
int add(int x, int y);
```

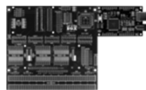
```
// main routine below
int main(void)
{
   int x=3, y=7, z;
   while(1)
   {
      z=add(x,y);
   }
}
// function is below
int add(int x, int y)
{
   return (x+y);
}
```



EEL 4744 Basic C Structures Preprocessor Directives

- Preprocessor Directives (**#** sign)
  - > The **#define** is an "object-like" macro definition (similar to **.equ** or **.def**)
    - – Allows us to define a value for a symbolic name that may be used in our code or the systems code
  - > The **#include** is a method used to include other files that include code (similar to **.include**)
    - – If using brackets (< >), the file is expected in **standard compiler include paths**
    - – If using quotation marks (**" "**), the path for the file will include the **current source directory**
  - > Example:

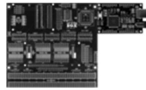
```
#define F_CPU 2000000
#include <avr/io.h>
```

EEL 4744 Basic C Structures Preprocessor Directives

- There are various other types of preprocessor directives that may be used
  - >The given example shows
    - – A defined rate to be used for the clock frequency of the XMEGA
    - – A definitions file to be used for an AVR processor
  - > Example:

```
#define F_CPU 2000000
#include <avr/io.h>
```

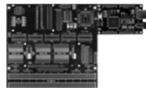


EEL 4744

Basic C Structures Function Prototypes

- Function Prototypes
  - >Functions may not be called unless they have been defined with a **prototype**
    - – Some compiles do not require this (including ours), **but 4744 does!**
  - >Function **prototypes** allow a function to be partially defined
    - – Prototypes are typically found near the top of the file, below preprocessor directives (or in header files, i.e., .h)
    - – Defines the function, but does not supply a body of code
    - – Functions are defined later in the program with its body of code
    - – Allows the function to be called before its complete definition
    - – Example:

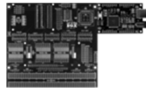
```
int add(int x, int y);
```

EEL 4744

Overview of C Basics

- Main Functions
  - > One in every program, starting point for all code
- Functions
  - > Similar to subroutines in Assembly
  - > Organized scheme for holding code
  - > Allows passing of parameters and returning results
  - > Use of prototypes for organizing code
    - – Prototypes should **ALWAYS** be used; they are **NOT** optional, even if Microchip/Atmel Studio does not require them in the present version
- Preprocessor Directives
  - > Defining names (or variables) as values
  - > Including extra files detailing code
  - > Creating Macros to detail functions or values



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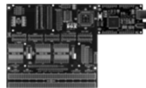
Basic C Structures Main Function

- Main Function
  - >A few properties of the **main** function
    - – Resembles a standard function
    - – A single **main** function is required for **each** project
    - – Starting point for the project
  - > Example:

```
int main(void)
{
   while(1)
   {
      z = add(x,y);
   }
}
```

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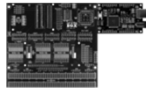
Basic C Structures Main Function

- >When the **main** function ends, the program ends
  - – A **while** loop may be used to run a block of code “forever”
    - Like the “dog chasing its tail” loop used at the end of Assembly programs
- >The example also shows how a function may be called
  - – The name of the function to be called is used
  - – If the function requires arguments, they may be passed within parenthesis (x and y in the below example)
- > Example:

```
int main(void)
{  …..
   while(1)
   {
      add(x,y);
   }
}
```



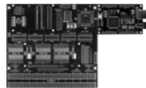
EEL 4744

Basic C Structures Function Prototypes

- Function Prototype
  - > Example:

```
int add(int x, int y);    // this is the prototype

int main(void)
{
   while(1)
   {
      add(x,y);           // this is the function call
   }
}
int add(int x, int y)     // this is the function
{
   return (x+y);
}
```

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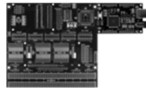
Overview of C Basics

- We can (and will) write programs entirely in C
- Values are defined using variables (not registers)
  - >No registers are directly referenced (although they will be used "underneath the hood," i.e., after compilation)
- High-level conditional structures are available for flow control
  - >Easier use of comparisons
  - >No branch functions (used in Assembly) available (or necessary)
- Cleaner way of looking at port usage and interrupts



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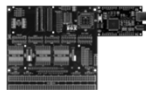
Variables

- Variables
  - >Type
    - – Standard: int, char, float, double, etc.
    - – Special: uint8_t, uint16_t, int8_t, int16_t, etc.
  - >Scope of Variables
    - – Local: Declare at the beginning of a function in which it is to be used
    - – Global: Declare outside of any function, typically at the top of the c file
  - >Modifiers: causes variable to use more or less memory The following are typical examples
    - – short (works on int)
    - – long: 4 to 8 bytes (depending on the compiler/processor)
    - – signed, unsigned, long, long long (twice as long as long)



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How to use Variables

- When defining variables, there are many types available

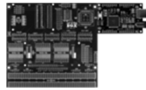
Type	Expression
char	
standard	'j'
ascii	106, 0x6A
string	"microp"
int	
decimal	37
hex	0x37
binary	0b110111
float	0.00037
double	37.000001

Example:

```
char char1 = 'j';
char char2 = 0x6A
char str[7] = "microp"
char str[] = "4744 #1"
char *str = "Hi!"
int x = 37;
int y = 0x37;
float = 0.00037;
double = 37.000001;
```

'j' = 0x6A

- When quotes (") are used, the **string** terminates with a null (0) character
- When arrays uses brackets ([ ]), then the size depends on the number of elements in the brackets; if empty, then "unlimited"



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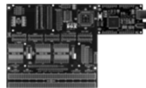
Pointers and Addresses

- When there is an * in a declaration, then it means that it is a pointer variable
  - > `*x` means that x is a pointer variable
  - > `char *x = "Hi!"` // x is a pointer variable
  - > `*x = "Bye"` // value, starting at address x is now "Bye"
- `&x` means "address of x"
  - > `&x[0]` means address of x or the address of x[0]
  - > `&x[2]` means address of x, plus 2; which is the address of x[2]



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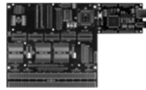
Arrays

- An Array is a method of grouping a series of same type elements in a single variable located in contiguous memory locations
  - > Syntax: *type name [elements] = {initialized value list};*
    - – Type may be any variable type
    - – Elements states the size or number of variables in the array
    - – The initialized value list represents the initial values populating the array
      - If defining an initial list, the value of elements may be omitted
  - > Examples:

```
uint8_t buffer[20]; // unsigned character (8 bits)
char message[] = {'m', 'i', 'c', 'r', 'o', 'p'}
                    // no 0x0 appended
char string[] = "microp"; // an 0x0 is appended
```



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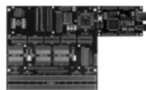
Conditionals

- Conditionals controls flow of code given programmer defined conditions
- Handles the concept of comparisons and branches (that were used in Assembly)



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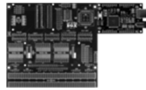
If, Else If, Else

- Check conditional statements for truth values
  - >**`if`** conditional
    - – If expression is true, execute expressions within conditional block
    - – If expression is false, check any following conditionals tied to *if* conditional
  - >**`else if`** conditional (may be omitted)
    - – Follows same concept as *if* conditional, giving more conditional checks
  - >**`else`** conditional (may be omitted)
    - – If all other conditionals fail, this block is executed



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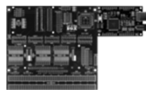
If, Else If, Else

> Syntax:

```
if (expression) {
    <statements>
} else if (expression) {
    <statements>
} else {
    <statements>
}
```

simple_if_statements.c



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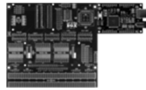
Relational Operators

- To create a conditional expression, utilize one of relational operators

Relational Operator	Definition	Example (True results)
>	Greater than	47 > 37
>=	Greater than or equal to	47 >= 47
<	Less than	37 < 47
<=	Less than or equal to	37 <= 47
==	Equal to	47 == 47
! =	Not equal to	37 != 47



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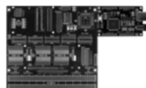
Boolean Operators

- To create more complex conditional expressions, Boolean operators may be used

Boolean Operator	Definition	Example (True results)
&&	AND two expressions	((47 >= 47) && (47 > 37))
||	OR two expressions	((37 != 47) || (37 > 47))
!	Complement expression	!(37 > 47)



EEL 4744

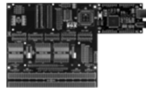
While and Do While

- **While** loops allow for repetition
  - >If expression is true, execute expressions within conditional block and continue to execute until false
  - >If expression is false, exit conditional block and continue with code following the while block
- **Do While** loops allow for repetition
  - >Follows same concept as While loop, except condition expression happens at the end of the code
  - >Will execute code block at least once
- Syntax:

simple_whiles_loops.c
multiple_whiles_loops.c

```
while (expression) {
   <statements>
}
```

```
do {
   <statements>
} while (expression)
```



EEL 4744

For Loop

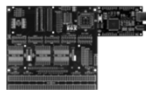
- **For** loops allow for repetition while also iterating
  - >Has a start value, e.g., **`int i = 0`**
  - >Loops until an end condition has been met, e.g., **`i < 10`**
  - >Every loop, the start value will either be increase or decrease, e.g., **`i++`** or **`i--`**
  - >Syntax:

```
for (start value; end condition; inc/dec value) {
  <statements>
}
```

  - >Example:

```
for (int i = 0; i < 10; i++) {
   <statements>
}
```

if_and_for_loops.c



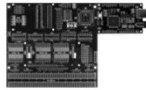
EEL 4744

Switch Statements

- **Switch** statements acts as selection control, changing the code flow through a multi-way branch
  - >Multi conditional system such as a large **if** conditional structure
  - >May also be used to create a state machine
  - >Has a single variable that compared to multiple values, executing different code for potentially each value.
  - >Syntax:

```
switch ( variable )
{
case value1:
   <statements>
   break;
case value2:
   <statements>
   break;
default:
   <statements>
   break;
}
```

switch_statements.c

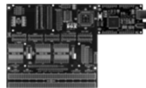


EEL 4744

Break

- While running loops, it is possible to break out of the code at anytime using the break expression
  - >If using nested loops, the break expression will break out of all loops
  - >Can use labels to jump to the outer loop
- Example:

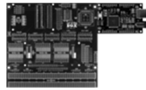
```
outer_loop:
for (int i = 0; i < 10; i++) {
    for (int j = 0; j < 10; j++) {
        if ( (i * j) == 37 ) // Won't happen!
              break outer_loop;
    }
}
```

EEL 4744

Volatile

```
asm volatile ("nop");
--------------
void RoughDelay1sec(void)
{
    volatile uint32_t ticks;
//Volatile prevents compiler optimization
    for(ticks=0;ticks<=F_CPU;ticks++);
//increment 2e6 times -> ~ 1 sec
}
```



EEL 4744

PORT / Modules

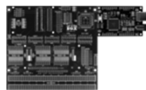
- May access Ports similarly to Assembly, use the **header** file

```
#include <avr/io.h>
```

  - HINT: Right mouse click on variable name and choose goto implementation
- When programming, make use of intelli-sense
- Naming follows the AVR Manuals
- Access PORTS (or modules) by name directly
  - Examples:

```
PORTA_DIRCLR = 0xFF
USARTC0_CTRLA = 0xFF
```

simple_whiles_loops.c
multiple_whiles_loops.c



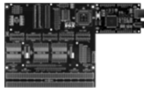
EEL 4744

Registers

- It is possible to use C syntax and **structures** to access registers of various modules in a cleaner manner
- Instead of typing the entire name, you can
  - Enter the module name
  - Enter a period
  - Enter the register name (with autocomplete)
  - Example:

```
PORTA.DIRCLR = 0xFF
USARTC0.CTRLA = 0xFF
```

simple_whiles_loops.c
multiple_whiles_loops.c



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Bitwise and Compound Operators

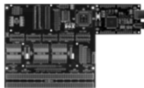
- When modifying ports and registers, bitwise operators are often used.
- `&`, `|`, and `^` may be tied to equal sign to simply AND or OR the variable with another variable
- Examples:

```
PORTB_DIRCLR |= 0xF0;
X <<= 2;// X=X<<2
```

Symbol	Bitwise Operation
&	AND
|	OR
^	Exclusive OR
<<	Left Shift
>>	Right Shift
~	One's Complement

- Can also do this with +, -, *, /, etc.
  - Example:

```
Var1 += 37; // Var1 = Var1 + 37
```

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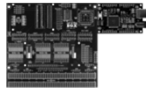
Bitmasks

- Programming in C allows a user to use various defined enumerations or structures when working with PORTs and control registers
- Standard bitmasks allow a user to change only specific bits in a register when desired (noted by bm)
  - Example:

```
PORTB_DIRCLR = PIN2_bm | PIN4_bm;
PORTB.DIRCLR = PIN2_bm | PIN4_bm;
```

usart_serial.c



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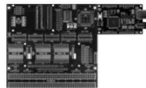
Bitmasks

- Group **Configuration Bitmasks** allow a user to change only multiple bits representing aspects of a control register
  - >Example

```
USARTC0.CTRLC = USART_CMODE_ASYNCHRONOUS_gc |
                USART_PMODE_DISABLED_gc |
                USART_CHSIZE_8BIT_gc;
```

usart_serial.c



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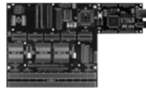
Interrupts

- First must include the interrupt header file
  - >`#include <avr/interrupt.h>`
- After defining interrupts use module registers, enable or clear the global interrupts as needed
  - >`sei();`
  - >`cli();`
- Finally, write the interrupt service routine for the required interrupt vector

usart_serial.c

```
ISR(USARTC0_RXC_vect)
{
  USARTC0.DATA = USARTC0.DATA;
}
```



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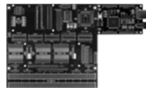
Interrupts

- Occasionally clearing the interrupts is necessary, but preserving the status register is **ALMOST ALWAYS** required (and always, in Assembly, but **NOT** in C)
- In the XMEGA (and likely most processors) the below is automatically done (so **UNNECESSARY**) in C; but if it isn't, this could be done
  - Example:

```
uint8_t sreg = SREG;  // save status reg
cli();
<statements>
SREG = sreg;          // restore status reg
```

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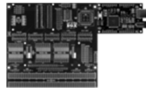
Using C with Assembly

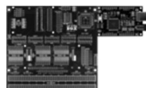
- It is possible to use C and Assembly more seamlessly by creating variables and functions in C and using them in various ways with Assembly
  - This puts less emphasis on the Assembly code, using it only as needed to improve code
  - When using more of C's capabilities, some extra considerations must be placed on the choice of Registers in Assembly (as described in the lecture *Intro to Mixed C and Assembly*)



EEL 4744 Using C with Assembly Passing Arguments

- Arguments are passed to Assembly functions in register pairs or via the stack if more than 9 arguments
  - > **Word Data** takes both registers
  - > **Byte Data** takes the lower register

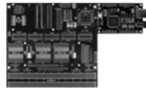
Argument	Registers
1	r25:r24
2	r23:r22
3	r21:r20
….	
9	r9:r8



EEL 4744 Using C with Assembly Returning Values

- Return values always use the following convention

Type	Registers
8 bit data (sign or zero extended)	r25:r24
32 bit data	r25:r22
64 bit data	r25:r18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Pointers

- Pointers may be used to contain the address of a variable. You create pointers using the * symbol

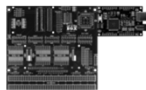
```
>int value = 5;       // A variable holding a value of type int
>int *valuePtr;       // A pointer to a value of type int
```

- To reference the address of the pointer you use the & symbol

```
>valuePtr = &value;   // Place address of value in pointer
```

- To get the data that the pointer points to, you can "dereference it" by using the * symbol on the pointer

```
>int data = *valuePtr;    // Get data pointed to by pointer
```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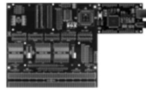
Examples

- External Bus Interface (EBI) example:

`ebi.c`
`ebi_driver.h`

- Asynchronous Serial example:

`usart_serial.c`



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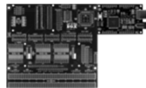
Mixed C/Assembly

You are not responsible for the following pages



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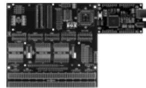
C Projects and **I**nline Assembly

- If it is only desired to add a few lines of assembly code to a C Project, it is possible to add assembly "inline"
- Inline assembly uses the asm function with the following template
  asm volatile(*asm-template* : *output-operand-list* :
  list-input-operand : *clobber list*)
- When using the **asm** function, the compiler will have a harder time optimizing code
- The **volatile** keyword may be used to prevent the compiler from attempting to optimize the line
  - The keyword volatile may be omitted, but then the compiler might optimize away your intended structure



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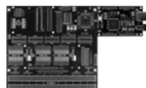
Inline Assembly

asm volatile (asm-template : output-operand-list :
list-input-operand : clobber list)

- The ***asm-template*** component of the asm function follows standard Assembly with small changes
  - > The *Mixed C and Assembly (for Atmel XMEGA)* document detail any required changes
    - – Example:

      asm volatile (“STS %0, r18” : “=m” (EBI_CTRL));

      STS command above is used to define EBI_CTRL
      The %0 is a place holder showing that the defined operand will come later in the template
      The output operand section, EBI_CTRL, is defined as an output only memory (“=m”) location address



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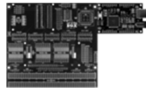
Inline Assembly

asm volatile (asm-template : output-operand-list :
list-input-operand : clobber list)

- The *asm-template* may use “%” expressions to define placeholders replaced by operands in the *output-operand-list* and *list-input-operand*

Placeholder	Replaced by
% n	By argument in operands where n = 0 to 9 for argument
A% n	The first register of the argument n (bits 0 to 7)
% B n	The second register of the argument n (bits 8 to 15)
% C n	The third register of the argument n (bits 16 to 23)
% D n	The fourth register of the argument n (bits 24 to 31)
% A n	The Address register X, Y, or Z
% %	The % symbol when needed
\ \	The \ symbol when needed
\ N	A newline to separate multiple asm commands
\ T	A tab used in generated asm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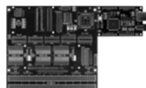
Inline Assembly

asm volatile (asm-template : output-operand-list :
list-input-operand : clobber list)

- The *output-operand-list* and *list-input-operand uses various modifiers as needed for the operands given*

Modifier	Meaning
=	Output operand
&	Not used as input but only an output
+	Input and Output Operand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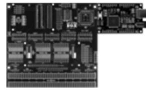
Examples

- Vector Add Mixed
  > **.s** File Compilation Example
  > Requires both .c and .s file
- Later
  > Vector Add
  – Inline Assembly version
  > Input Port
  – Inline Assembly version

VectorAdd_Mixed.c
VectorAdd_Mixed.s

VectorAdd_Casm.c

Input_Port_C.c



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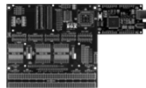
Mixed C/Assembly

- The slides that follow are **<u>NOT</u>** covered this semester, i.e., you will not write mixed C/Assembly code, nor will you be responsible to know this for labs or exams



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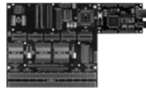
C Projects and .s Assembly Files

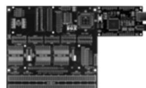
- When creating a C project in Microchip/Atmel Studio, a simple **.c** file is created with a template structure
  - > C code should be restricted to **.c** files
- When adding Assembly to a C project, a **.s** file is used to hold all Assembly code (**<u>not</u>** a **.asm** file)
- A **.s** file will resemble a standard assembly file, however, there are some considerations that must be made when in C projects
  - > Registers are used differently since C also uses them
  - > Assembly preprocessor directives have different formats



EEL 4744 “.s” File Compilation Registers

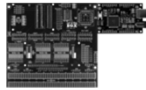
- When writing assembly in a C project, registers have different rules

Register	Description	Assembly code called from C	Assembly code that calls C code
r0	Temporary	Save and restore	Save and restore
r1	Always Zero	Must clear before returning	Must clear before returning
r2-r17 r28 r29	“call-saved”	Save and restore	Can freely use
r18-r27 r30 r31	“call-used”	Can freely use	Save and restore



EEL 4744 “.s” File Compilation Registers

- ***r0***: defined as a temporary register which may be used by compiler generated code
- ***r1***: assumed to always be zero by the compiler, so any assembly code that uses this should clear the register before calling compiler generated code
- ***r2 – r31***: defined as “call-saved” or “call-used”
  - ***call-saved***: registers that a called C function may leave unaltered, however, assembly functions called from C should save and restore the contents of the register (using stack)
  - ***call-used***: registers available for any code to use, but if calling a C function, these registers should be saved since compiler generated code will not attempt to save them

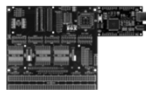


EEL 4744 ".s" File Compilation Syntax

- When writing assembly in a C project, some syntax is different

Path for the equivalent file to the ATxmega128A1Udef.inc is: C:\Program Files (x86)\Atmel\Atmel Toolchain\AVR8 GCC\Native\3.4.2.1002\avr8-gnu-toolchain\avr\include\avr\iox128a1u.h

Atmel AVR	AVR-GCC
.include "ATxmega128A1Udef.inc"	#include <avr/io.h>
.dseg	.section .data
.cseg	.section .text
.db 1,2,3,4	.byte 1,2,3,4
.db "message"	.ascii "message"
.db "message", 0x00	.asciz "message"
.byte 37 ;save space for bytes	.ds.b 37
.dw	.word
HIGH(), LOW()	hi8(), lo8()

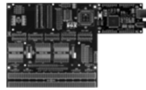


EEL 4744 ".s" File Compilation .dseg and Data Memory

- Data memory defaults to start at 0x2000
- **.section .data** replaces the use of **.dseg** to access the Data Memory space
  - Example:

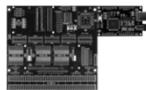
```
.section  .data           // old way .dseg
Var1:     .ds.b   7       // save 7 bytes
Var2:     .ds.w   3       // save 3 words
Var3:     .byte   0x37    // Var3 = 0x37
// Previously, .byte saved space; now value
Text:     .asciz  "hello world"

.global __do_copy_data   // needed for Var3
                         // and Text
```



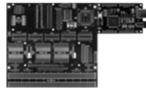
EEL 4744 “.s” File Compilation .dseg and Data Memory

- **.section .data** is necessary to begin the Data Memory (i.e., volatile memory = RAM) segment
- The **.asciz** command is used to define a **specific** null terminated string, a constant
  - > **.ascii** is like .asciz, but with no null termination
- The **ds.b** and **ds.w** commands are used to define **storage** of varying sizes (like .byte in .asm files)
- The **.byte** command is used to define a **specific** byte, i.e., a constant (like .db in .asm files)



EEL 4744 “.s” File Compilation .dseg and Data Memory

- Data memory is typically used to create storage of variables like **Var1** and **Var2**
- It is occasionally desired to create memory **<u>and</u> store an initial value** in that memory space, as we did for **Var3** and **Text**
  - >The initial value is stored in program memory
  - >The **.global __do_copy_data** special command handles copying the data from program memory to data memory



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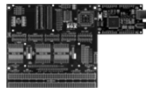
“.s” File Compilation
.cseg and Program Memory

- Like Assembly, program memory is used to hold program constants and assembly code
- **.section .text** replaces the use of **.cseg** to access the Program Memory space
  - > Example:

```
.section      .text
VA:     .byte  1, 2, 3, 4, 5, 6
VB:     .byte  0xA0,0xB0,0xC0,0xD0,0xE0,0xF0
.global MAIN_ASM  //Required for mixed

MAIN_ASM:
        ldi    R18, 6
        ...
```

VectorAdd_Mixed.s



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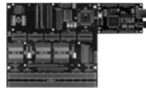
“.s” File Compilation
.cseg and Program Memory

- **.section .text** is shown to begin the Program Memory segment
- The **.byte** command is used just as it was under the Data Memory section
  - > May be used to defined multiple bytes in a section
  - > Saved in Program Memory, not desired to transfer to Data Memory (no need of **.global __do_copy_data)**
- The rest of the example follows standard Assembly

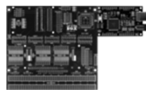


EEL 4744 .s File Program Memory & Watch Window

- In a .s file, we do **NOT** have to do the shifting that we did in .asm files for reading Program Memory Section (.dseg in .asm and .section .text in .s)
  > Example for a .s file

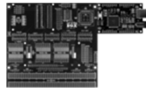
```
ldi ZL, lo8(VA)    // Load the address of program
ldi ZH, hi8(VA)    //   memory for VA
```

- The watch window can **NOT** display XL, XH, YL, YH, ZL, or ZH in .s files, nor most other things (other than registers, Rx)



EEL 4744 ".s" File Compilation Functions Example

- One of the main aspects of using Assembly in a C project is to benefit from using Assembly functions
- Functions must be declared in both C files and Assembly files
  > Function prototypes should be defined in C code for any function called from Assembly
    – extern int funct();
  > Functions defined in Assembly code that will be called from C code should be declared global
    – .global funct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".s" File Compilation
Functions in C/Assembly

> .c file syntax:

```
extern int funct();

int main(void)
{
   funct();
}
```

> .s file syntax:

```
.global funct

funct:
   ldi   R18, 0x47
   ...
   ret
```

> .c file example:

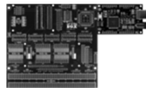
```
extern void MAIN_ASM();
int main(void)
{
   MAIN_ASM();
}
```

VectorAdd_Mixed.c

> .s file example:

```
.global MAIN_ASM
MAIN_ASM:
   ldi   R18, N
   ...
   ret
```

VectorAdd_Mixed.s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The End!