Course Overview

Course URL: http://www.ee.nmt.edu/~rison/ee308

Texts:

- Class Notes (http://www.ee.nmt.edu/~rison/ee308)
- Freescale Databooks on the MC9S12

Grading:

- 20%: Homework due every Monday.
- 10%: Quiz every Friday
- 50%: Three midterms exams
- 20%: Final exam
Outline:

- Introduction to the MC9S12 Microcontroller
- Binary and Hexadecimal Numbers
- Assembly Language Programming
- C Language Programming
- Introduction to MC9S12 Internal Peripherals
  - The MC9S12 Timer Subsystem
  - Interrupts using the Timer Subsystem
  - The MC9S12 Pulse Width Modulator Subsystem
- The MC9S12 Expanded Mode
  - Address and Data Buses and Timing
  - Adding Memory and External Peripherals
  - Interfacing to the MC9S12
- More MC9S12 Internal Peripherals
  - The A/D Converter Subsystem
  - The Serial Peripheral Interface
  - The Serial Communications Interface
- Using the MC9S12 in a Control Application
Lab Overview

- The lab meets Wednesday afternoons. **No labs this week.**
- Lab handouts will be posted on the EE 308 website:
  http://www.ee.nmt.edu/~rison/ee308
- The MC9S12 evaluation kits will be passed out in lab next week.
- **You need to bring a bound lab notebook to the first lab.**
- There will be a prelab for each lab. This must be done and turned in at the start of your lab section. The lab TA will verify that you have completed the prelab.
- Be prepared to answer questions about the pre-lab when you come to lab.
- If you do not complete the prelab before coming to lab, you will lose 50% of the points for that lab.
AUTOMOBILE CRUISE CONTROL

MEASURE SPEED

SET DESIRED SPEED

CONTROL

THROTTLE
\[ \Delta T = \text{time for one revolution of wheel.} \]

\[ \text{Speed} = \frac{C}{\Delta T}, \text{where } C \text{ is the circumference of the wheel} \]
START

CC ON? NO

READ MANUAL THROTTLE

G = MT

YES

READ ΔT

S_A = C/ΔT

READ S_D

Calculate new G

READ S

S = C/T
MICROCONTROLLER

A/D
D/A
Parallel
Serial
Time

COMPUTER

MEMORY
SIMPLE MICROPROCESSOR

INSTRUCTION

REG A

REG B

MEMORY

INSTRUCTION ACTION

(A) + (B) => A
0 => A
(A) => Address 5

18 06  (A) + (B) => A
87 0 => A
5A 05 (A) => Address 5
HARVARD ARCHITECTURE

MICROPROCESSOR

DATA MEMORY

INSTRUCTION MEMORY

DATA & ADDR

CONTROL

INSTRUCTION

ALU

CONTROL

STATUS

CLOCK

IN

OUT
PRINCETON (VON NEUMAN) ARCHITECTURE

MICROPROCESSOR

MEMORY

ALU

CONTROL

DATA

INSTRUCTION & ADDR

IN

OUT

CONTROL & ADDR

STATUS

CLOCK
**MEMORY MAP**

*(Princeton Architecture)*

<table>
<thead>
<tr>
<th>PROGRAM</th>
<th>DATA</th>
</tr>
</thead>
</table>

*Function of memory determined by programmer*
<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>0</th>
<th>7</th>
<th>B</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>D</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>IX</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>IY</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>SP</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>PC</td>
<td>0</td>
<td></td>
<td></td>
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</tbody>
</table>

8-BIT ACCUMULATORS A AND B  
OR  
16-BIT DOUBLE ACCUMULATOR D  

INDEX REGISTER X  
INDEX REGISTER Y  
STACK POINTER  
PROGRAM COUNTER  

CONDITION CODE REGISTER  

**Figure 2-1. Programming Model**
<table>
<thead>
<tr>
<th>Binary</th>
<th>Hex</th>
<th>Decimal</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000</td>
<td>0</td>
<td>0</td>
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<tr>
<td>0001</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>0010</td>
<td>2</td>
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<td>0100</td>
<td>4</td>
<td>4</td>
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<tr>
<td>0101</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>0110</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>0111</td>
<td>7</td>
<td>7</td>
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<tr>
<td>1000</td>
<td>8</td>
<td>8</td>
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<tr>
<td>1001</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>1010</td>
<td>A</td>
<td>10</td>
</tr>
<tr>
<td>1011</td>
<td>B</td>
<td>11</td>
</tr>
<tr>
<td>1100</td>
<td>C</td>
<td>12</td>
</tr>
<tr>
<td>1101</td>
<td>D</td>
<td>13</td>
</tr>
<tr>
<td>1110</td>
<td>E</td>
<td>14</td>
</tr>
<tr>
<td>1111</td>
<td>F</td>
<td>15</td>
</tr>
</tbody>
</table>
Convert Binary to Decimal

\[ 1111011_2 \]

\[ 1 \times 2^6 + 1 \times 2^5 + 1 \times 2^4 + 1 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 1 \times 2^0 \]

\[ 1 \times 64 + 1 \times 32 + 1 \times 16 + 1 \times 8 + 0 \times 4 + 1 \times 2 + 1 \times 1 \]

\[ 123_{10} \]
Convert Hex to Decimal

$82D6_{16}$

$8 \times 16^3 + 2 \times 16^2 + 13 \times 16^1 + 6 \times 16^0$

$8 \times 4096 + 2 \times 256 + 13 \times 16 + 6 \times 1$

$33494_{10}$