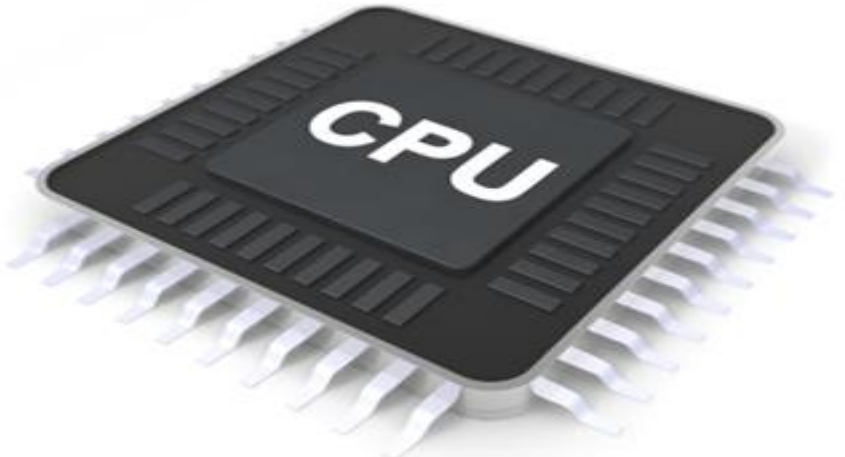

Flags

ENEE 3582

Microp

Status Register (SREG)

I	T	H	S	V	N	Z	C

- 8 bit register
  - C: Carry Flag
  - Z: Zero Flag
  - N: Negative Flag
  - V: Overflow indicator
  - S: Sign Test
  - H: Half Carry Flag
  - T: Transfer bit
  - I: Global Interrupt Enable/Disable Flag

Zero Flag, Negative Flag

- Zero:
  - Z = 1 is used to indicate the arithmetic/logic answer is 0
  - Z = 0 the arithmetic/logic answer is not 0
- Negative:
  - N = msb of arithmetic/logic answer
  - If N = 1 and answer is signed => answer is negative
    - Useful of signed operations only

Carry Flag

- Addition: C=1 if there is a carry-out from the addition
  - `INC` doesn't affect C
  - Useful for indicating when unsigned calculations are out of range
    - Example byte addition: 255 + 1 = 0xFF + 1 = 0
- Subtraction: C=1 if there is a borrow-in during subtraction
  - Example subtraction: 1 - 6 = -5
  - `NEG`ate is a subtraction: 0 - Rd
  - `COM`parison is a form of subtraction
  - `DEC` doesn't affect C
- Complement: C=1 always
- Multiplication: C= MSB of the answer
- Shift/Rotate: C= bit shifted/rotated out

Overflow Indicator

- V = 1: if Carry into MSB ≠ Carry out of MSB
  - V = Cin ⊕ Cout
- Useful for indicating when signed values are out of range
- Examples of byte operations:
  - -100 - 100 = -200 < -128 signed min
  - 100 + 100 = 200 > 127 signed max
  - -1 + 1 = 0 within range
  - 0 - 1 = -1 within range

```
  1 1 1          1 1            1 1 1 1 1 1 1
  1 0 0 1 1 1 0 0    0 1 1 0 0 1 0 0    1 1 1 1 1 1 1 1    0 0 0 0 0 0 0 0
+ 1 0 0 1 1 1 0 0  + 0 1 1 0 0 1 0 0  + 0 0 0 0 0 0 0 1  + 1 1 1 1 1 1 1 1
-----------------  -----------------  -----------------  -----------------
1 0 0 1 1 1 0 0 0    1 1 0 0 0 1 0 0    1 0 0 0 0 0 0 0 0    1 1 1 1 1 1 1 1
```

Sign Test

- $S = V \oplus N$
  - S = 1 when V and N are not identical

Examples of byte Operations

- 100 - 10
  - SVNZC =00000

```
  1 1   1
  0 1 1 0 0 1 0 0
+ 1 1 1 1 0 1 1 0
-----------------
1 0 1 0 0 1 0 1 0
```

- 100 - 100 N=0, V=0
  - SVNZC =00010

```
  1 1 1 1
  0 1 1 0 0 1 0 0
+ 1 0 0 1 1 1 0 0
-----------------
1 0 0 0 0 0 0 0 0
```

- 100 - 120 N=1, V=0
  - SVNZC =10101

```
  0 1 1 0 0 1 0 0
+ 1 0 0 0 1 0 0 0
-----------------
  1 1 0 1 1 0 0 0
```

- 100 - 200 N=1, V=1
  - SVNZC =01101

```
  1     1
  0 1 1 0 0 1 0 0
+ 0 1 0 0 0 1 1 1
-----------------
  1 0 1 0 1 0 1 1
```

Examples of byte Operations

- -100 - 10 N=1, V=0
  - SVNZC =10010 0

```
  1 1 1 1
  1 0 0 1 1 1 0 0
+ 1 1 1 1 0 1 1 0
-----------------
1 1 0 0 1 0 0 1 0
```

- -100 - 100 N=0, V=1
  - SVNZC =11000

```
    1 1 1
  1 0 0 1 1 1 0 0
+ 1 0 0 1 1 1 0 0
-----------------
1 0 0 1 1 1 0 0 0
```

- -100 - 120 N=0, V=1
  - SVNZC =11000

```
    1 1
  1 0 0 1 1 1 0 0
+ 1 0 0 0 1 0 0 0
-----------------
1 0 0 1 0 0 1 0 0
```

- -100 - 200 N=1, V=0
  - SVNZC =10100

```
    1 1 1
  1 0 0 1 1 1 0 0
+ 0 1 0 0 0 1 1 1
-----------------
  1 1 1 0 0 0 0 0
```

Clear/Set Flags

- BCLR/BSET
  - Format: `BCLR s ;SREG • (s)’`
  - Format: `BSET s ;SREG v s`
  - Clear/set for bits in s that are 1
- CLC/SEC: Clear/Set carry flag. No arguments
- CLN/SEN: Clear/Set negative flag. No arguments
- CLZ/SEZ: Clear/Set zero flag. No arguments
- CLS/SES: Clear/Set sign indicator. No arguments
- CLV/SEV: Clear/Set overflow flag. No arguments
- CLH/SEH: Clear/Set half carry flag. No arguments