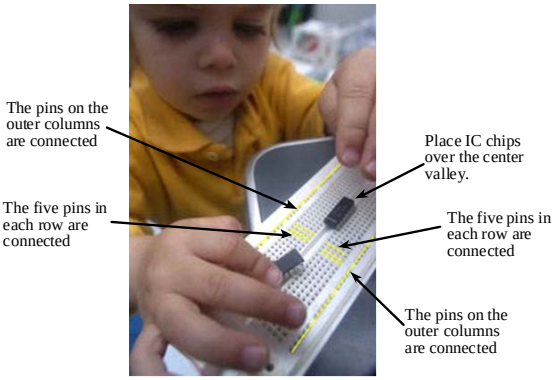
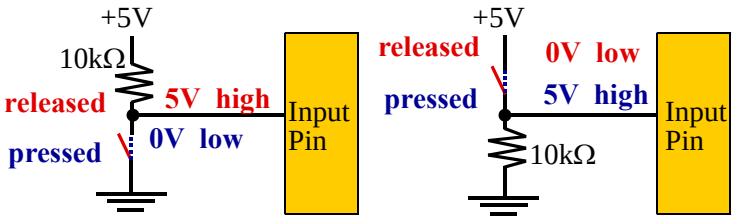
Recap

Addition and subtraction set CCR bits
Subtraction used for conditional branching

Overview

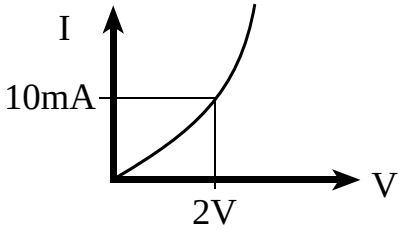
Switch interfacing
LED interfacing
Introduction to Lab 3
Running on the real 9S12 board
if-then statements reviewed



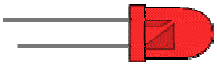


Show actual switch interface and voltages with the DVM

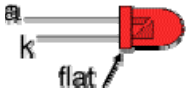
LED interfacing



LED brightness = power = V*I

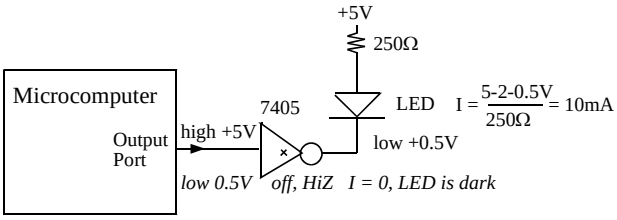
Photo: 

Circuit symbol: 



LEDs emit light when an electric current passes through them. LEDs have polarity, meaning current must pass from anode to cathode to activate. The anode is labeled **a** or **+** , and cathode is labeled **k** or **-**. The cathode is the short lead and there may be a slight flat spot on the body of round LEDs. Thus, the anode is the longer lead

LED interfacing



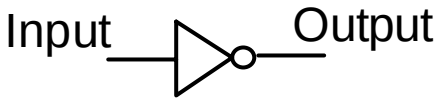
Ohm's Law through the resistor V = I*R

$$R = \frac{5\text{ V} - (\text{LED V}) - (\text{output low voltage of the 7406})}{\text{desired LED current}}$$

$$= \frac{(5 - 2 - 0.5\text{V})}{0.01\text{ A}} = 250\Omega$$

solid state relay
optical sensors
fiberoptic cable
Show actual LED interface and voltages with the DVM
`Show S12C32.htm`
http://users.ece.utexas.edu/~valvano/S12C32.htm

Hardware Setup
Cut paper with pin names
Gently place 9S12DG128 system into protoboard
Move switch on 9S12DG128 in LOAD mode
Cable from PC to docking module
In **TExaS**
Need **microcomputer** and **program** files
Need an **IO** file to first simulate system
Redesign, implement and test the NOT gate



PH6 PT1
1) Design- data flow graph, flowchart, pseudocode
2) Implement in TExaS, debug it
3) Build the hardware as needed, check it, then check it again
4) Power applied to embedded system, reset button
5) Switch to Real 9S12 mode and debug it again
In Real 9S12 mode, show
Reset
Assemble (also downloads)
Look at registers
Look at global variables
Single step
Change memory address

Run
Halt
Reset
Breakpoint

6) place 9S12DG128 in RUN mode
Power applied to embedded system, reset button
It's running at 8 MHz

Redesign making it a friendly NOT gate

Branch operations (review)

```
bcc  place      ;go if C=0
bcs  place      ;go if C=1
beq  place      ;go if Z=1
bne  place      ;go if Z=0
bmi  place      ;go if N=1
bpl  place      ;go if N=0
bvc  place      ;go if V=0
bvs  place      ;go if V=1
bra  place      ;go always
brn  place      ;go never
jmp  place      ;go always, ext addr
```

> < ≥ ≤ conditional branch instructions must follow a subtract compare or test instruction, such as

```
suba subb sbca sbcb subd
cba cmpa cmpb cpd cpx cpy
tsta tstb tst
```

signed branches, branch if

`bge` *`place`* greater than or equal to
if (N^V)=0
i.e., (~N•V+N•~V)=0

`bgt` *`place`* greater than
if (Z+N^V)=0
i.e., (Z+~N•V+N•~V)=0

`ble` *`place`* less than or equal to
if (Z+N^V)=1
i.e., (Z+~N•V+N•~V)=1

`blt` *`place`* less than
if (N^V)=1
i.e., (~N•V+N•~V)=1

unsigned branches, branch if

`bhs` *`place`* greater than or equal to
if C=0, same as `bcc`

`bhi` *`place`* greater than
if C+Z=0

`blo` *`place`* less than
if C=1, same as `bcs`

`bls` *`place`* less than or equal to
if C+Z=1

it is important to know

- precision (e.g., 8-bit, 16-bit)
- format (e.g., unsigned, signed)

It takes three steps

1. read the first value into a register
2. compare the first value with the second value
3. conditional branch

When testing for equal or not equal

- doesn't matter whether signed or unsigned
- still matters if 8-bit or 16-bit
- doesn't matter about load and compare order

The bottom line

Think of current and voltage when interfacing
Switches bounce when touched and when released
LEDs are fast, but our eyes are slow
Double-check wiring before turning on power
Is it 8-bit or 16-bit data?
Are they signed or unsigned numbers?