Decimal arithmetic

- Binary-coded decimal (BCD) notation
- Decimal digits encoded in nibbles
- Byte can represent
  - 0d00 -> 0x00 = 0b00000000 to
  - 0d99 -> 0x99 = 0b10011001
- Adding 0x26 and 0x35 gives 0x5B, but we want 0x61

1

How to do it?

- DAA – decimal adjust accumulator
- Only works on A
- normal sequence is:
  - ADDA #0x03
  - DAA
- If you want to increment (or decrement) use ADDA or SUBA not INCA or DECA.

2

How to do it? – 2

- H flag – "half-carry"
  - Used by DAA
  - INCA and DECA do not set it
  - But ADDA/SUBA do
- BCD "Increment"
  - ADDA #0x01
  - DAA

3

Misc. algorithm

- An accumulator holds a number from 0 to 9. This is to be displayed (in ASCII)
  - Notice, the numbers are in order in the ASCII table
  - Just add #0x30 (or #'0) to the accumulator

4

Misc. algorithm – 2

- An accumulator holds a number from 0x0 to 0xF. This is to be displayed (in ASCII)
  - Notice, the numbers and letters are in order in the ASCII table
  - If number < 0xA, add #0x30 (or #'0)
  - If number >= 0xA, add 0x37 (or #'A-0xA)

5

Misc. algorithm – 3

- An accumulator holds a BCD number from 0x00 to 0x99. This is to be displayed (in ASCII)
  - Save number, mask off upper nibble (ANDA #0b00001111)
  - Add #'0
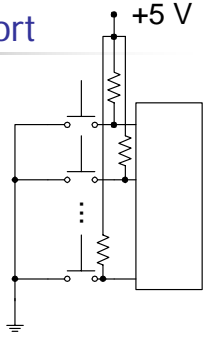 - Restore number, LSRA four times
  - Add #'0

6

Fox11 Expanded Mode – I/O Ports

- Standard HC11 ports
  - PORTA – 0x1000 – 3 O, 3 I, 2 I/O
  - *PORTB – 0x1004 – reserved O (high address)*
  - *PORTC – 0x1003 – reserved I/O (data / low addr.)*
  - PORTD – 0x1008 – 4 I/O (+2 for COM)
  - PORTE – 0x100A – 8 I
- Special Fox11 ports
  - PORTB – 0x1404 – output to LEDs
  - PORTC – 0x1403 – input from DIPs
  - PORTF – 0x1401 – output for LCD
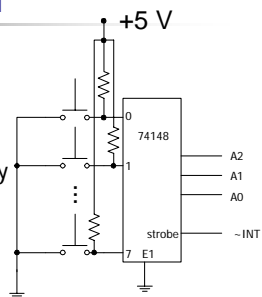
7

One switch per port

+5 V

- Push buttons
- One button per port input
- An unpushed button is +5 V (logic 1)
- A pushed button is 0 V (logic 0)
- Not efficient

8

Priority encoder

+5 V

- 74148 is an 8-to-3 priority encoder
- Only need 3 input port lines for 8 switches
- switch 7 highest priority (output = 000)
- switch 0 lowest priority (output = 111)
- strobe low on switch push

74148

0
1
7   E1
strobe

A2
A1
A0
~INT

9

Keypad Matrix – Fox11

- Switches across the rows and columns
- Columns connected as outputs (from processor)
- Pull rows high, connect to input (to processor)
- "Scan" by pulling each column low sequentially – look for low in row

10

Matrix Keypad – Fox11

Port D	2	3	4	5
Header Pin	2	3	4	5

Left of header towards top of board, pins 1 and 10 not connected.

Outputs from processor

11

Scanning sequence – Fox11

- Set ddrd to 0xXX111110 (final 10 is for COM)
- Set portd[2:5] to one
- Set portd[2] to zero
- Check porte[0:3], if any zeroes, found the row/column
- If no zeros, set portd[3] to zero and portc[2] back to one
- Check porte[0:3], if any zeroes, found row/column
- Repeat until checked all 4 rows

12

Wookie simulator

- Briefcase keypad
  - Approximation of hardware, okay for 1 key at a time and only 1 row pulled low at a time
- Fox11 keypad
  - Not yet implemented

13

LED output

- Top LED, turns on when port is low (logic 0)
  - Port "sinks" LED current
  - Active low
- Bottom LED, turns on when port is high (logic 1)
  - Port "sources" LED current
  - Active high

+5 V

14