

- **The 9S12 in Expanded Mode - How to get into expanded mode**
- **Huang Chapter 14**

### Getting into expanded mode

- The HCS12 can operate in several modes:
  - Normal Single-Chip Mode (the way we have been using the HCS12)
  - Normal Expanded Wide (16-bit address bus, 16-bit data bus)
  - Normal Expanded Narrow (16-bit address bus, 8-bit data bus)
  - Special Single Chip Mode, Special Test Mode, Emulation Expanded Wide Mode, Emulation Expanded Narrow Mode, Special Peripheral Mode
- How does the HCS12 know what mode to run in?
- There are two ways:
  - When you reset the HCS12 it looks at the state of three external pins: MODA, MODB and MODC (BKGD)

Based on the logic levels on these three pins the HCS12 goes into one of the eight possible modes:

<b>MODC</b>	<b>MODB</b>	<b>MODA</b>	<b>Mode</b>
0	0	0	Special Single Chip
0	0	1	Emulation Expanded Wide
0	1	0	Special Test
0	1	1	Emulation Expanded Wide
1	0	0	Normal Single Chip
1	0	1	Normal Expanded Narrow
1	1	0	Peripheral
1	1	1	Normal Expanded Wide

- You can write to the **MODE** register to change the mode

In Normal modes you can switch operating modes once by writing to the MODE register

In Normal modes the MODE register is a write-once register

Coming out of reset the HC12 checks the state of the following three pins, and starts in one of several modes:


BKGD	MODB	MODA	
0	0	0	Special Single Chip
0	0	1	Emulation Expanded Wide
0	1	0	Special Peripheral
0	1	1	Emulation Expanded Wide
<b>1</b>	<b>0</b>	<b>0</b>	<b>Normal Single Chip (Flash EEPROM on)</b>
1	0	1	Normal Expanded Narrow
1	1	0	Peripheral
<b>1</b>	<b>1</b>	<b>1</b>	<b>Normal Expanded Wide (Flash EEPROM off)</b>

On the EVBU, the HC12 starts in **Normal Single Chip**

After reset, can change modes by writing to **MODE** register

Address: Base + \$\_0B

	BIT 7	6	5	4	3	2	1	BIT 0	
Read:	MODC	MODB	MODA	0	IVIS	0	EMK	EME	
Write:									
Reset:	0	0	0	0	0	0	0	0	Special Single Chip
Reset:	0	0	1	0	1	0	1	1	Emulation Expanded Narrow
Reset:	0	1	0	0	1	0	0	0	Special Test
Reset:	0	1	1	0	1	0	1	1	Emulation Expanded Wide
Reset:	1	0	0	0	0	0	0	0	Normal Single Chip
Reset:	1	0	1	0	0	0	0	0	Normal Expanded Narrow
Reset:	1	1	0	0	0	0	0	0	Peripheral
Reset:	1	1	1	0	0	0	0	0	Normal Expanded Wide

 = Unimplemented



**Figure 3-10 MODE Register (MODE)**

In normal modes can change **MODE** once.

To switch from **Normal Single Chip** to **Normal Expanded Wide**, write 111 to MODC:MODB:MODA.

Also turn on internal visibility by setting **IVIS** bit to 1

IVIS = 1 tells the HC12 to display internal bus cycles on the external bus

```
BSET $000B, #E8
```

### Setting Up the HCS12 for expanded mode

- We will start the HCS12 in Normal Single Chip Mode, and write to the MODE register to switch it into Normal Expanded Wide Mode
- In Normal Expanded Mode the HCS12 uses the E-clock, the R/W and LSTRB lines for control of the external bus
- In Normal Single Chip Mode, the HCS12 does not use these control lines, so it sets up their pins for general purpose I/O
- You need to tell the HCS12 to drive these signals onto external pins
- When enabled these signals, they are driven onto Port E in order to use the HCS12 in expanded mode
- You do this by writing to **PEAR** (Port E Assignment Register)
- PEAR is a write-once register

In **Normal Single Chip** mode, the E-Clock, LSTRB, and R\_W lines are set up as general purpose I/O lines. When switched to **Normal Expanded Wide** need to use these control lines for expanded mode. Write to PEAR register:

Address: Base + \$\_0A

	BIT 7	6	5	4	3	2	1	BIT 0	
Read:	NOACCE	0	PIPOE	NECLK	LSTRE	RDWE	0	0	
Write:									
Reset:	0	0	0	0	0	0	0	0	Special Single Chip
Reset:	0	0	1	0	1	1	0	0	Special Test
Reset:	0	0	0	0	0	0	0	0	Peripheral
Reset:	1	0	1	0	1	1	0	0	Emulation Expanded Narrow
Reset:	1	0	1	0	1	1	0	0	Emulation Expanded Wide
Reset:	0	0	0	1	0	0	0	0	Normal Single Chip
Reset:	0	0	0	0	0	0	0	0	Normal Expanded Narrow
Reset:	0	0	0	0	0	0	0	0	Normal Expanded Wide

= Unimplemented

**Figure 3-9 Port E Assignment Register (PEAR)**

Write 0 to NECLK (no external E clock) to enable E-Clock on external pin

Write 1 to LSTRE (Low strobe Enable) to enable LSTRB on external pin

Write 1 to RDWE (Read/Write Enable) to enable R\_W on external pin

```
MOVB #0C, , $000A
```

- The **MISC** (Miscellaneous) register needs to be set up to allow the HCS12 to operate properly in Expanded Mode
- The MISC register allows you to change the number of clock stretches used by the HCS12
- The MISC register allows you to disable the Flash EEPROM
- The MISC register allows you to move the Flash EEPROM to address block 0x0000 to 0x7fff
- When reset the HCS12 forces three E-clock stretches to external data accesses
- This is useful when using slow memory and peripheral devices
- We will use a fast peripheral device, so we will speed up external data accesses by forcing the HCS12 to not to use E-clock stretches
- We will leave the Flash EEPROM enabled at its normal address block of 0x8000 to 0xffff

Address Offset: \$0013

Bit 7	6	5	4	3	2	1	Bit 0	Mode
0	0	0	0	EXSTR1	EXSTR0	ROMHM	ROMON	
Reset: 0	0	0	0	1	1	0	(1)	Exp mode
Reset: 0	0	0	0	1	1	0	1	peripheral or SC mode

1. In expanded modes the reset value of ROMON is determined by the value present on the PK7 pin during reset.

Change EXSTR1:EXSTR0 (external access stretch) from 11 to 00 to change from three E-clock stretches to no E-clock stretch.

Change ROMHM (ROM in second half of memory map) to 1 to turn off Flash EEPROM from 0x4000 to 0x7FFF

Leave ROMON (enable ROM) at 1 to have DDebug12 at 0x8000–0xFFFF

```
MOVB #$03,$0013
```

### Putting the HCS12 into normal expanded wide mode

- To put the HCS12 into Normal Expanded Wide you must write to the MODE, PEAR and MISC registers
- When D-Debug12 runs, it writes to these registers as part of its start-up code
- Because these three registers are write-once, you must write to them before DDebug-12 does
- In order to switch to Normal Expanded Wide mode, we will put code to write to these registers in EEPROM and set the jumpers on the EVBU to run out of EEPROM
- In addition, it is necessary to do some setup which DDebug-12 normally does – disable the COP (Computer Operating Properly) monitor, and set the bus clock to 24 MHz.

```

SYNR:    equ $0034
REFDV:   equ $0035
CRGFLG:  equ $0037
CLKSEL:  equ $0039
COPCTL:  equ $003C
ARMCOP:  equ $003F

        org $0400
        ldaa #$55                ;Reset COP
        staa ARMCOP
        coma
        staa ARMCOP
        clr COPCTL              ; Turn off COP
        ldab #$11              ; Map RAM into proper location
        nop
        stab INITRM
        clr REFVDV              ; Set clock reference divider to 0
        movb #$03,SYNR         ; Set PLL to multiply oscillator clock by 4
        nop                    ; wait
        nop
        nop
        nop
11:      brclr CRGFLG,$08,11     ; Wait for PLL to lock
        bset CLKSEL,$80         ; Switch to PLL clock
        movb #$e8,MODE          ; Expanded wide mode, intern vis. on
        movb #$0c,PEAR         ; Turn on R/W, LSTRB
        movb #$01,EBICTL       ; Use E-clock to control external bus
        movb #$03,MISC         ; No E-clock stretch, disable ROM from
                                ; 4000 to 7FFF

```

### **One-Byte and Two-Byte data accesses in normal expanded wide mode**

- In Normal Expanded Wide Mode the HCS12 can access one byte or two bytes in a single memory cycle
- A single byte can be located at an even address or an odd address
- The data lines for bytes at even addresses are connected to AD15-8 lines
  - Because the data for even bytes are accessed through the upper 8 bits of the data bus, these are called Upper Bytes (or High Bytes)
- The data lines for bytes at odd addresses are connected to AD7-0 lines
  - Because the data for odd bytes are accessed through the lower 8 bits of the data bus, these are called Low Bytes
- The HCS12 can access a High Byte and the following Low Byte in one memory access
  - For such a 16-bit access the 15 upper address lines are the same; only the lower line is different.

- The HCS12 cannot access a Low Byte and the following High Byte
  - The 15 upper address bits are different for these bytes, and it would be difficult to build a decoder which could deal with this
  - For example, the address of the bytes at 0x7fff and 0x8000 are:

```
011111111111111 0x7fff
100000000000000 0x8000
```

- To determine whether the HCS12 is trying to access a single High Byte, a single Low Byte, or two bytes (High Byte and following Low Byte) the HCS12 uses the A0 address line and the LSTRB control line

- LSTRB = 0 means access low (odd) byte
- A0 = 0 means access high (even) byte

<u>LSTRB</u>	A0	Access Type
1	0	8-bit access of even address (high byte)
0	1	8-bit access of odd address (low byte)
0	0	16-bit access of even address (high and low byte)
1	1	Cannot occur

- Note: LSTRB = 1 and A0 = 1 would imply access of low (odd) byte and following high (even) byte. This will not occur for external data accesses on the HCS12

- If the HCS12 needs to access a 16-bit number from an odd address, it will do this in two memory cycles — it will access the 8-bit number at the odd address, followed by the 8-bit number at the even address

- For example the instruction

```
movw #$55aa,$08ff
```

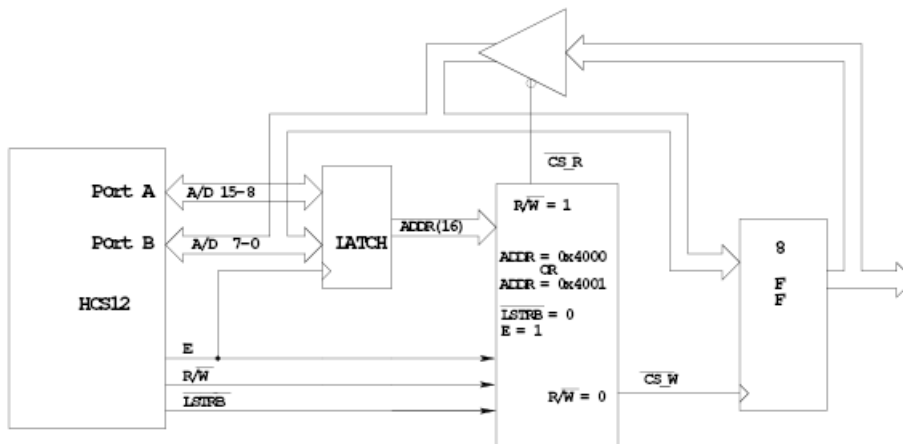
will write the 0x55 to memory location 0x08ff on one memory cycle, and the 0xaa to memory location 0x0900 on the next memory cycle.

### **The HCS12 in expanded wide mode**

- In expanded mode the HCS12 can communicate with external memory and devices over the multiplexed address/data bus
- To connect an external device to the HCS12 bus you need to identify an unused region of memory

- By turning off some of the flash EEPROM, the region from address 0x4000 to address 0x7FFF is available.
- We will map an output port to address 0x4001
- Need decoder to demultiplex address from data, and to generate control lines needed by output port

### Output Ports for Lab 5



Writing to address 0x4001 will bring CS\_W low.  
 On the high-to-low transition of E, CS\_W will go high, latching the data into the flip-flops

Reading from address 0x4001 will bring CS\_R low  
 This will drive the data from the flip-flops onto the data bus  
 The HCS12 will read the data on the flip-flops on the high-to-low transition of the E-clock