68000 ADDRESSING MODES

ADDRESSING MODES

An addressing mode tells the computer where to get/place a number.

Basic form of a MC68000 instruction:

Instruction Source, Destination

The source and destination can use DIFFERENT addressing modes.

Addressing modes on the MC68000 are usually specified in the first 12 bits of the 68000 instruction word:

15 1 1 1 1 1 9 8 7 6 5 4 3 2 1 0

Opcode	Size	Destination		Source	
		Register	Addressing Mode	Addressing Mode	Register

A few specialized instructions make assumptions about the addressing modes and use different formats. For example, MOVEQ assumes that the source is an 8-bit immediate constant and the destination is a data register.

MOVEQ

15	1	1	1	1	1	9	8	7	6	5	4	3	2	1	0
0	1	1	1		Destination Register Dn		0				8-bit constant (-128 to +127)				

For the following examples we will consider the different source addressing modes for a word length ADD instruction which will put the resulting word into data register D3.

The general form of the ADD instruction:

15	1	1	1	1	1	9	8	7	6	5	4	3	2	1	0
Opcode				Register			Op-mode			Effective Address					
										Mode			Register		

The general form of the ADD instruction which adds the contents of D3 to something and puts the results into D3 is:

15	1	1	1	1	1	9	8	7	6	5	4	3	2	1	0
1	1	0	1	0	1	1	0	0	1						

where

- bits 15-12 indicate the op code 1101 for an ADD
- bits 11-9 indicate that data register D3 (i.e. 3) is the destination for the result of the ADD $(3_{10}=011_2)$
- bits 8-6 indicate the op-mode of the ADD. In this case the calculation will be a word length ADD of the form (<Dn>)+(<ea>)→<Dn>. This is indicated by 001; see the Programmer's Reference Manual for information about the other modes. [NOTE: This translates into add the contents of D3 to the contents of the effective address <ea> and put the result into D3.]
- bits 5-3 indicate the addressing mode of the source

- bits 2-0 indicate the register (if applicable) of the source

We will examine bits 5-0 in detail in the following examples.

Source is data register direct
(mode=000, register=register#)

general form ADD D1,D3 ← Both source and destination are data register direct

Assembled instruction:

15	1	1	1	1	1	9	8	7	6	5	4	3	2	1	0
1	1	0	1	0	1	1	0	0	1	0	0	0	0	0	1

where mode=000_2 to indicate a data register and register=1_{10}=001_2 to indicate register D1.

Address register direct
(mode=001, register=register#)

general form ADD A1,D3 ← Source is address register direct; destination is data register direct

Assembled instruction:

15	1	1	1	1	1	9	8	7	6	5	4	3	2	1	0
1	1	0	1	0	1	1	0	0	0	0	0	0	0	0	1

where mode=001_2 to indicate an address register and register=1_{10}=001_2 to indicate register A1.

Immediate

(mode=000, register=100)

Although this looks like an ordinary ADD instruction

general form ADD #7,D3 ← Source is immediate; destination is data register direct

this instruction is always re-coded by the assembler into the more specific ADDI (ADD immediate) instruction format

general form ADDI #7,D3 ← Source is immediate; destination is data register direct

which has the instruction format:

<table>
<tr><td>15</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">0</td><td rowspan="2">0</td><td rowspan="2">0</td><td rowspan="2">0</td><td rowspan="2">0</td><td rowspan="2">1</td><td rowspan="2">1</td><td rowspan="2">0</td><td colspan="2" rowspan="2">Size</td><td colspan="6">Effective Address</td></tr>
<tr><td colspan="3">Mode</td><td colspan="3">Register</td></tr>
<tr><td colspan="8">Word Data (16 bits)</td><td colspan="8">Byte Data (8 bits)</td></tr>
<tr><td colspan="16">Long Data (32 bits, including previous word)</td></tr>
</table>

where the immediate constant is stored in one or two extension words according to the above conventions.

In this particular case the assembled instruction will become:

15	1	1	1	1	1	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	1
0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1

where the constant is stored in one extension word. Note that it is the instruction (default is .W) which determines the mode, NOT the size of the constant.

NOTE: As shown the instruction ADDI #7,D3 takes two words of computer memory. This instruction could be shortened to one word using the ADDQ (ADD quick) instruction. A quick instruction uses a special instruction word format which can include constants represented as 3-bit binary numbers (the constants are limited to the range 1 to 8 decimal)

general format:

15	1	1	1	1	1	9	8	7	6	5	4	3	2	1	0
Opcode				Data			0	Size		Effective Address Mode			Register		

Assembled instruction:

15	1	1	1	1	1	9	8	7	6	5	4	3	2	1	0
0	1	0	1	1	1	1	0	0	1	0	0	0	0	0	1

where the size = 01_2 to indicate a word length operation and the effective address is that of the source. In this case it is mode=000_2 to indicate a data register and register=011_2 to indicate D3.

Note that if the immediate constant was 1234567810 that the ADDQ instruction could NOT be used. The ADDI with two (2) extension words would be used because the binary constant is so large.

Different methods of specifying immediate constants:

```
ADD.W  #$452,D3     ;specifies a hexadecimal
                    constant
```

```
ADD.L    #I,D3          ;specifies the address of I
                        as a constant

ADDI.W #%1011,D3        ;specifies a binary
                        constant
```

IMMEDIATE ADDRESSING

#xxx indicates immediate addressing in the Programmer's Reference Manual

Immediate mode addressing can only be used for source addressing; it is NOT allowed for destination addressing.

examples of immediate mode addressing:

```
MOVE.W    #$452,D0     ;moves the number
                       $452 to D0
MOVE.L    #I,D0        ;moves the value of I
                       (the address in the
                       symbol table) into D0
                       as a number
ADDI.W    #%1011,D0    ;add the binary
                       constant 1011 (13₁₀)
                       to the contents of D0
MOVE.L    I,D0         ;move the contents of
                       the memory location I
                       into D0.  NOT
                       IMMEDIATE MODE
                       ADDRESSING.
;Yes, you can do calculations with labels
```

ABSOLUTE MODES OF ADDRESSING

absolute

xxx	indicates absolute short addressing in the Programmer's Reference Manual
xxxxxx	indicates absolute long addressing in the Programmer's Reference Manual

Whether an absolute addressing mode is long or short is usually assigned by the assembler.

examples of absolute long addressing:

```
MOVE.W    I,D0          ;moves the contents
                        of address (longword)
                        I to D0
ADD.W     $500,D0       ;add the contents of
                        $0000 0500 to D0
MOVE.W    D0,I-4        ;move the contents of
                        D0 to (long word)
                        address I-4
;Yes, you can do calculations with labels
```

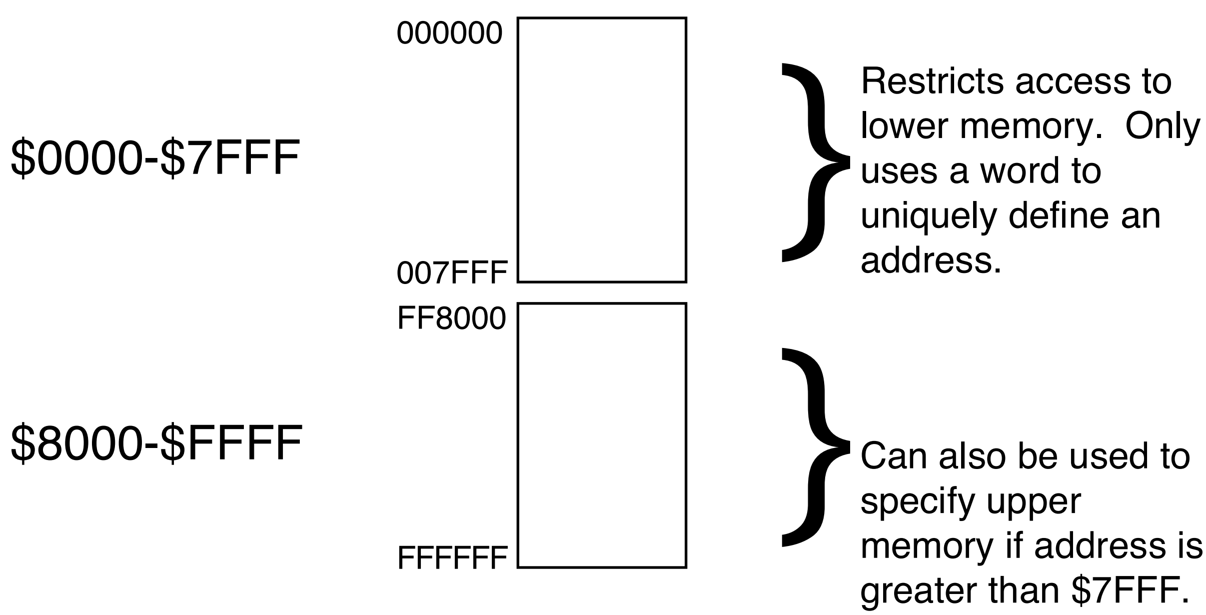
examples of absolute short addressing:
(usually only the assembler does this)

```
MOVE.W    $1000.W,D0  ;address is sign
                      extended to 24 bits
                      and stored in a single
                      extension word
```

```
ADD.L    I.W,D0    ;takes only the lower
                   16 bits of I to form the
                   extension word
```

Absolute long addressing is generated by default.
Absolute short addressing is usually generated by the assembler rather than directly by the programmer. The assembler does this to generate shorter code but it restricts the memory range you can access.

As absolute short uses a 16-bit extension word it can only be used to access memory at the bottom of memory or at the top of memory as shown below. Absolute short cannot be used to access the memory in between.



	ADD.L	I,D3	;not immediate, specifies moving the contents of I (I is a label)
I	DC.L	75	;I specifies a memory address, the DC.L instruction instructs the assembler to reserve 75 longwords in memory beginning at this address

absolute long
(mode=111, register=001)

The primary difference between Absolute Short and Absolute Long is that the address is bigger than 16-bits and must be represented as a full 32-bit address.

general form	ADD	LABEL,D3	←	Source is absolute (an address specified by a symbol);

The assembled form of an absolute long ADD instruction is:

15	1	1	1	1	1	9	8	7	6	5	4	3	2	1	0
1	1	0	1	0	1	1	0	0	1	1	1	1	0	0	0
x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

where xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx is a 32-bit binary address indicating the value of LABEL and is used as the address of the data to be used in the

ADD. Compared to immediate mode, this is the address of the data.