

64000

**HP64000
Logic Development
System**

**Model 64000
Assembler Supplement
6805/6809**



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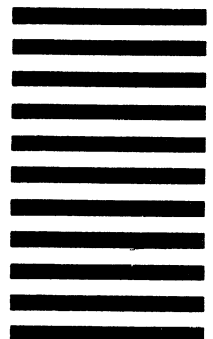
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6805/6809**

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Chapter 1

General Information (6805/6809)

Introduction

This chapter contains general information about the 6805 microcomputer and 6809 microprocessor. It briefly discusses their architecture, addressing modes, and condition codes. For a detailed description of a specific device, refer to the manufacturer's Programming Reference Manual.

NOTE

Use the processor number for the assembler directive; i.e. "6805" or "6809"

NOTE

The following paragraphs apply to both the MC6805 and MC6809. Paragraphs and subparagraphs that apply to only one device will so indicate in their title.

MC6805 Architecture

General

There are five registers available in the MC6805 microcomputer. These registers are discussed briefly in the following paragraphs.

Accumulator Register (A)

The microcomputer has one 8-bit register that functions as an accumulator for arithmetic calculations and data manipulations.

Program Counter Register (PC)

The 11-bit program counter register contains the address of the next instruction to be executed.

Index Register (X)

The index register is a special-purpose 8-bit register used for the indexed addressing mode. It may also be used for limited calculations and data manipulations when using read/modify/write instructions. When not required for indexing, it may be used as a temporary storage area.

Stack Pointer Register (SP)

The stack pointer is a special-purpose 11-bit register that contains the address of the next usable location on the stack. The six most significant bits of the stack pointer are permanently set to 000011B. During a microcomputer reset or the reset stack pointer (RSP) instruction, the stack pointer will be set to location 07FH. Subroutines and interrupts may be nested down to location 061H.

Condition Code Register (CC)

The condition code register contains the five flags which indicate the results of the instruction just executed. These flags may be individually tested for conditional branching purposes. A description of each condition code is given later in this chapter.

MC6809 Architecture

General

There are nine registers available in the MC6809 microprocessor. These registers are discussed briefly in the following paragraphs.

Accumulating Registers

The microprocessor has two registers that function as accumulators for arithmetic calculations and data manipulation. They are referred to as register A and register B. Each register has its own group of instructions and the mnemonic of the source statement specifies which register is to be used. For example:

ROLA - Rotate content of register A to the left.

ROLB - Rotate content of register B to the left.

CLRA - Clear register A.

CLRB - Clear register B.

In addition, certain instructions join the two registers to form a 16-bit register. When used in this configuration, the combined registers are referred to as the D register and the most significant byte of the 16-bit word is maintained in register A.

Program Counter Register (PC)

The 16-bit program counter of the microprocessor may specify up to 65,536 addresses. When using the relative addressing mode of operation, the program counter register may also be used as an index register (in specific operations).

Index Registers (X and Y)

The index registers are special-purpose 16-bit registers used in the indexed addressing mode of operation. The address in each register allows the microprocessor to point to memory locations directly or they may be altered to produce a register offset. During certain operations, the registers may be incremented or decremented to point to the next location in memory.

Stack Pointer Registers (U and S)

The stack pointer registers are another set of special-purpose 16-bit registers and have the same indexed addressing capabilities as the index registers (X and Y).

The S (hardware) stack pointer register is used by the microprocessor during interrupt and subroutine calls.

The U (user) stack pointer register is controlled exclusively by the programmer.

NOTE

Both stack pointers point to the top of the stack as opposed to some microprocessors where the stack pointer points to the next vacant location on the stack.

Condition Code Register (CC)

The microprocessor has eight condition codes that make up bits 0 through 7 of an 8-bit register. The eight condition codes and their use are discussed later in this chapter.

Direct Page Register (DP)

The direct page register permits addressing directly any location in memory. The content of this register appears on the address bus (A8-A15) during the execution of instructions using the direct mode of addressing.

Modes of Addressing

Instructions for microprocessors may be separated into a number of categories, but their most common attribute is their modes of addressing. An addressing mode refers to the method by which an instruction addresses its operand. The addressing modes for each MC6805 instruction are listed in table 1-1. The addressing modes for each MC6809 instruction are listed in table 1-2.

Inherent Addressing

The inherent mode of addressing requires no operand and extended addressing is not permitted. All instructions that use this form of addressing are one-byte operations.

Immediate Addressing

In this mode of addressing, the instruction contains the value of the operand to be used in the operation or computation. The only instructions permitted for this mode of addressing are indicated in table 1-1 and table 1-2 under the column labelled "Immediate."

To select this mode of addressing, the corresponding operand must be preceded by the pound (#) character. The operand data may be in the form of an ASCII character, a number, a label, or an expression. The microprocessor uses both 8- and 16-bit immediate values depending on the size specified by the opcode.

Direct and Extended Addressing

In direct addressing, an instruction requires two bytes of memory. The first byte will be the opcode of the instruction and the second byte will be the absolute numerical address where the operand is located.

In extended addressing, the instruction uses three bytes of memory with the first byte containing the opcode of the instruction, the second byte containing the highest 8 bits of the absolute numerical address, and the third byte containing the lowest 8 bits of the absolute numerical address.

For those instructions that can use both direct and extended modes, the assembler defaults to extended for externals, relocatables, and forward references. The direct mode is used when addresses are in the 0 to FFH range. The default function can be overridden by using the DIRECT pseudo instruction. Once the direct pseudo is inserted in a source program, the direct mode of addressing will be in effect until cancelled by an EXTEND pseudo instruction.

Relative Addressing

Branch instructions are somewhat different from other instructions in that their associated addresses do not indicate the location of data. Instead, the address indicates the location of the next instruction that is to be executed. This location is relative to the current setting of the program counter. There are two forms of branch instructions.

For the short branch relative addressing mode to be valid, the distance of the branch must fall in the value range of -126 to $+129$ bytes. This relationship between the relative address and the absolute address of the destination of the branch may be expressed by the following:

$$DA = (PC+2)+R$$

where:

DA = address of the destination of the branch instruction.

PC = content of the program counter.

R = the 8-bit, two's complement, binary number listed in the second byte of the instruction.

The long branch relative addressing mode may operate in the full range of addressing ($0000H$ - $FFFFH$). In this mode of operation, a two-byte offset is calculated and placed in the operand field of the branch instruction. The offset is the two's complement value of the difference between the location of the byte immediately following the opcode and the location of the destination of the branch.

Indexed Addressing (MC6805 only)

No Offset. This mode of operation addresses the lowest 256 bytes of memory. The instructions are one-byte operations and the index register points to the destination address.

8-bit Offset. The destination address will be calculated by adding the content of the byte following the opcode to the content of the index register. This mode of operation addresses the lowest 511 bytes of memory. The instructions using this mode of operation are two-byte operations.

16-bit Offset. This mode of operation calculates the destination address by adding the content of the two bytes following the opcode to the index register. Thus, the entire memory space may be addressed. Instructions that use this mode of operation are three-byte operations.

Indexed Addressing (MC6809 only)

Indexed addressing relates to one of the index registers (X, Y, U, S, and sometimes PC). The address will be determined at the time of execution by adding the value specified in the operand field to the current content of the designated register. There are five modes of indexed addressing (both indirect and non-indirect) and they are given in table 1-3.

NOTE

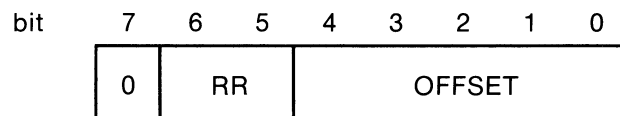
The indexed indirect mode of addressing is selected by enclosing the operand field in brackets.

The value of the opcode postbyte (first byte following the opcode) listed in table 1-3 is determined by the format of the operand. The two indexing formats are as follows:

- a. Simple format indexing: this type of formatting takes the form:

expr,R

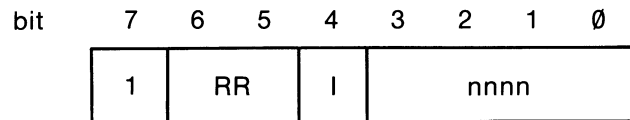
where: expr is an absolute expression in the range -16 to +15 but not zero, and R designates one of the index registers X, Y, U, or S. The postbyte code for simple format indexing is as follows:



where: RR = 00 if X register
 = 01 if Y register
 = 10 if U register
 = 11 if S register

OFFSET = 5-bit two's complement

- b. Complex format indexing: all indexed addressing modes that do not fall under the simple format indexing category use the complex format for indexing. The postbyte code form for complex format indexing is as follows:



where: RR = 00 if X or PC register
 = 01 if Y register
 = 10 if U register
 = 11 if S register

and: I = 0 if non-indirect
 = 1 if indirect

and: nnnn = 0000 Single auto increment (R+)
 = 0001 Double auto increment (R++)
 = 0010 Single auto decrement (-R)
 = 0011 Double auto decrement (- -R)
 = 0100 Zero offset value or no offset
 = 0101 Register B is offset (B,R)
 = 0110 Register A is offset (A,R)
 = 1000 8-bit offset
 = 1001 16-bit offset
 = 1011 Register D is offset (D,R)
 = 1100 8-bit offset with PC register
 = 1101 16-bit offset with PC register
 = 1111 Extended indirect

Zero Offset Indexed Addressing. In this mode, the selected index register contains the address of the data to be used by the instruction.

Examples:

LDA ,U

LDA 0,S

Constant Offset Indexed Addressing. In this mode, a two's complement offset and the content of the selected index register are added to form the address of the operand. The content of the index register is unchanged by the addition. There are three ranges of offset:

- a. 5-bit Offset (-16 to +15) - the two's complement 5-bit offset is included in the postbyte code. Bit 4 of the postbyte code is used as the sign bit. Bits 0 through 3 are used to designate the constant offset.
- b. 8-bit Offset (-128 to +127) - the two's complement 8-bit offset is contained in a single byte following the postbyte code.
- c. 16-bit Offset (-32768 to +32767) - the two's complement 16-bit offset is contained in the two bytes following the postbyte code.

Examples:

```
LDA    10,U  
  
LDU    SAM,X
```

Accumulator Offset Indexed Addressing. This mode of addressing is similar to the constant offset mode of indexed addressing except that the two's complement value in one of the accumulators (A, B, or D) and the content of the specified index register are added to form the address of the operand. The contents of both registers are unchanged by this addition.

Examples:

```
LDA    B,X  
  
LDX    D,X
```

Auto Increment/Decrement Indexed Addressing. In the auto increment addressing mode, the specified index register contains the address of the operand. Then, after the register is used, it will be incremented by one or two. In the auto decrement mode, the specified index register will be decremented before being used for the address of the data. No offset is permitted in this mode of addressing.

Examples:

```
LDA    ,Y+
```

```
LDB    ,-X
```

Extended Indirect Addressing. In extended indirect addressing, two bytes following the postbyte code of an indexed addressing instruction are used as a pointer to consecutive locations in memory that contains the new address.

Examples:

```
LDA    [SAM]
```

```
LDX    [0F10H]
```

Indexed Indirect Addressing (MC6809 only)

All of the indexed addressing modes with the exception of auto increment/decrement by one or a 5-bit offset may specify an additional level of indirection (refer to table 1-3). In indexed indirect addressing, the address will be contained in the location specified by the content of the index register plus any offset.

Examples:

```
LDA    [,Y]
```

```
LDA    [B,X]
```

Bit Set/Clear Addressing (MC6805 only)

This mode of addressing applies to instructions which can set or clear any bit on page zero. Page zero consists of all RAM space, I/O registers, and 128 bytes of ROM. The lower three bits in the opcode specify the bit to be set or cleared while the byte following the opcode specifies the address in page zero.

Bit Test and Branch (MC6805 only)

This mode of addressing applies to instructions which can test any bit in the first 256 locations (00H through 0FFH) and branch to any location relative to the PC. The byte to be tested will be addressed by the byte following the opcode. The individual bit within that byte is addressed by the lower three bits of the opcode. The third byte is the relative address to be added to the program counter if the branch condition is met. These instructions are three-byte operations. The value of the bit tested will be written to the carry bit in the condition code register.

Condition Codes

The condition code register contains codes that are relevant to the execution of instructions. The register is actually a group of one-bit registers that contain the following information:

Condition Code	Definition	MC6805 Bit No.	MC6809 Bit No.
C	carry-borrow	0	0
V	overflow		1
Z	zero	1	2
N	negative	2	3
I	IRQ interrupt mask	3	4
H	half-carry	4	5
F	FIRQ interrupt mask		6
E	Entire flag		7

The effect of each instruction on the condition codes is indicated in tables 5-1 and 5-2, Chapter 5. A brief description of each condition code is given in the following paragraphs.

Carry/Borrow (C) Register

The carry-borrow register operates like an extension to the accumulator. In an arithmetic addition operation, the final sum may be 9 bits. If this occurs, the carry-borrow code is set ($C=1$) to indicate a carry. If there was no carry, the C register will be reset ($C=0$). For the arithmetic subtraction operation, the carry-borrow code represents a borrow condition. The condition code, when set ($C=1$), indicates that a borrow condition occurred; when reset ($C=0$), it indicates that there was no borrow.

Overflow (V) Register (MC6809 only)

The overflow condition code register will be set ($V=1$) when a two's complement overflow occurs from an arithmetic operation. If no overflow occurs, the register will be reset ($V=0$).

Zero (Z) Register

Immediately after an operation, the zero-detect circuit will look at the result. If all zeros are detected, the zero register will be set ($Z=1$); otherwise, the zero register will be reset ($Z=0$).

Negative (N) Register

Negative numbers are expressed in the two's complement form with bit 7 indicating the negative quality. Bit 7 will be a 1 if the two's complement was negative. Immediately after an operation, the negative register will look at bit 7 to determine if the result was negative. If so, the condition code (N) will be set ($N=1$). The condition code will be reset ($N=0$) if bit 7 was zero, indicating that the two's complement number represented by the result was zero or positive.

IRQ Interrupt Mask (I) Register

The interrupt mask code is set ($I=1$) to prevent the microprocessor from servicing interrupts on the IRQ line. Interrupt requests from any peripheral device will be ignored by the microprocessor until the interrupt mask code is reset ($I=0$).

Half Carry (H) Register

The half carry code will be set ($H=1$) during execution of an ADC or ADD instruction if there was a carry from bit position 3 to bit position 4. The half carry code will be reset ($H=0$) during these instructions if there was no carry.

The half carry code will be undefined after all subtract operations and should not be used in following operations.

FIRQ Interrupt Mask (F) Register (MC6809 only)

The microprocessor will not recognize interrupts from the FIRQ line if this bit is set (F=1).

Entire Flag (E) Register (MC6809 only)

The entire flag, when set (E=1), indicates that all the registers were moved to the stack (as opposed to only the program counter and condition code registers). The E code bit is used on a return from an interrupt to indicate the extent of unstacking that is required.

Table 1-1. Instruction Addressing Modes - MC6805

I N S T R U C T I O N	I N H E R E N T	I M M E D I A T E	D I R E C T	E X T E N D E D	I N D E X E D	R E L A T I V E	I N S T R U C T I O N	I N H E R E N T	I M M E D I A T E	D I R E C T	E X T E N D E D	I N D E X E D	R E L A T I V E
ADC		X	X	X	X		CLR	X		X		X	
ADD		X	X	X	X		CMP		X	X	X	X	
AND		X	X	X	X		COM	X		X		X	
ASL	X		X		X		CPX		X	X	X	X	
ASR	X		X		X		DEC	X		X		X	
BCC						X	EOR		X	X	X	X	
*BCLR							INC	X		X		X	
BCS						X	JMP			X	X	X	
BEQ						X	JSR			X	X	X	
BHCC						X	LDA		X	X	X	X	
BHCS						X	LDX		X	X	X	X	
BHI						X	LSL	X		X		X	
BHS						X	LSR	X		X		X	
BIH						X	NEG	X		X		X	
BIL						X	NOP	X					
BIT		X	X	X	X		ORA		X	X	X	X	
BLO						X	ROL	X		X		X	
BLS						X	ROR	X		X		X	
BMC						X	RSP	X					
BMI						X	RTI	X					
BMS						X	RTS	X					
BNE						X	SBC		X	X	X	X	
BPL						X	SEC	X					
BRA						X	SEI	X					
BRN						X	STA			X	X	X	
**BRCLR							STX			X	X	X	
**BRSET							SUB		X	X	X	X	
*BSET							SWI	X					
BSR						X	TAX	X					
CLC						X	TST	X		X		X	
CLI						X	TXA	X					

NOTE: (*) - Bit Set/Clear mode of addressing.
(**) - Bit Test and Branch mode of addressing.

Table 1-2. Instruction Addressing Modes - MC6809

I N S T R U C T I O N	I M M E D I A T E							E X T E N D E D		E X T I N D R		I N D X I N D R		R E L A T I V E		R E L I N D R		
	I N H E R E N T	D I R E C T																
ABX	X																	
ADC		X	X	X	X	X	X	X	X	X								
ADD		X	X	X	X	X	X	X	X	X								
AND		X	X	X	X	X	X	X	X	X								
ASL			X	X	X	X	X	X	X	X								
ASR			X	X	X	X	X	X	X	X								
BCC															X			
BCS															X			
BEQ															X			
BGE															X			
BGT															X			
BHI															X			
BHS															X			
BIT		X	X	X	X	X	X	X	X	X								X
BLE															X			
BLO															X			
BLS															X			
BLT															X			
BMI															X			
BNE															X			
BPL															X			
BRA															X			
BRN															X			
BSR															X			
BVC															X			
BVS															X			
CLR			X	X	X	X	X	X	X	X								
CMP		X	X	X	X	X	X	X	X	X								
COM			X	X	X	X	X	X	X	X								
CWAI		X																
DAA	X																	
DEC										X	X	X	X	X	X	X	X	X
EOR			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
EXG	X																	
INC			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
JMP				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
JSR				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
LD_			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
LEA										X	X	X	X	X	X	X	X	X
LSL				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
LSR				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
MUL	X																	
NEG				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
NOP	X																	
ORA			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
ORCC			X															
PSHS	X																	
PSHU	X																	
PULS	X																	
PULU	X																	
ROL				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
ROR				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
RTI	X																	
RTS	X																	
SBC			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SEX	X																	
ST_				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SUB			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SWI	X																	
SYNC	X																	
TRF	X																	
TST				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Table 1-3. Indexed Addressing Modes (MC6809 only)

Mode	Type	Non-Indirect		Indirect	
		Format	Postbyte Op Code	Format	Postbyte Op Code
Constant Offset From R (Signed)	No Offset	,R	1RR00100	[,R]	1RR10100
	5-Bit Offset	n,R	0RRnnnnn	defaults to 8-bit	
	8-Bit Offset	n,R	1RR01000	[n,R]	1RR11000
	16-Bit Offset	n,R	1RR01001	[n,R]	1RR11000
Accm Offset From R (Signed)	A - Reg Offset	A,R	1RR00110	[A,R]	1RR10110
	B - Reg Offset	B,R	1RR00101	[B,R]	1RR10101
	D - Reg Offset	D,R	1RR01011	[D,R]	1RR11011
Auto Incr/ Decr R	Incr by 1	,R+	1RR00000	not allowed	
	Incr by 2	,R++	1RR00001	[,R++]	1RR10001
	Decr by 1	,-R	1RR00010	not allowed	
	Decr by 2	,--R	1RR00011	[,--R]	1RR10011
Constant Offset From R	8-Bit Offset	n,PCR	1dd01100	[n,PCR]	1dd11100
	16-Bit Offset	n,PCR	1dd01101	[n,PCR]	1dd11101
Extended Indirect	16-Bit Addr			[n]	10011111

where: R = X, Y, U, or S

and where: X bit code = 00
 Y bit code = 01
 U bit code = 10
 S bit code = 11
 d = don't care
 n = offset

Operand Rules and Conventions

Types of Information

There are four types of data that may be needed as items in the operand field:

- a. Register Information - operands may reference directly data contained in the processor registers such as the stack, register A, or the index register.

Example:

```
STA          SAM          ;MOVE CONTENTS OF  
                ;REGISTER A TO SAM
```

- b. Index Register Information - operands may reference directly data contained in the index register.

Example:

```
LDX          0100H        ;LOAD INDEX REGISTER  
                ;FROM MEMORY
```

- c. Immediate Data - operands may contain immediate data. The required value is inserted directly into the operand field. The value may be in the form of numbers, an expression to be evaluated at assembly time, a symbol, or an ASCII constant enclosed in quotation marks.

Examples:

```
LDA          #0FFH      ;LOAD "FF" HEX INTO  
                ;REGISTER A  
  
LDA          #"A"       ;LOAD VALUE OF ASCII  
                ;CONSTANT A (01000001B)  
                ;INTO REGISTER A
```

- d. 16-bit Memory Address - operands may reference a 16-bit absolute memory address within the range of 0 to 65,535 that contains the operand data.

Example:

5FFFH

Additional Operand Information

Immediate Addressing Indicator

To select the immediate addressing mode, the corresponding operand must be preceded by the pound (#) character. The data following the (#) sign will be assigned one or two bytes of memory, depending on the instruction.

For MC6809 instructions PSHS, PULS, PSHU, and PULU, any register list (A, B, CC, D, DP, PC, S, U, X, or Y) may be used with the following exceptions:

- a. Register S cannot be specified with a PSHS or PULS instruction.
- b. Register U cannot be specified with a PSHU or PULU instruction.

For MC6809 instructions EXG and TFR exactly two registers must be specified in the register list. The following restrictions hold for the two instructions:

- a. EXG instruction - the two designated registers must be of the same size.
- b. TFR instruction - the two designated registers must be of the same size, or the first register listed must be a 16-bit register and the second register listed must be an 8-bit register.

Indexed Addressing Indicator

With this mode of addressing, the numerical address is variable and dependent on the content of one of the MC6809 index registers (S, U, X, or Y) or the MC6805 index register (X). The address is obtained during instruction execution by adding the value of the operand expression to the current content of the index register.

Example:

```
ADC          10,X
```

Direct - Extended Addressing Mode Default

For those instructions that can use both direct and extended modes, the assembler defaults to extended for externals, relocatables, and forward references. The direct mode is used when addresses are in the 0 to FFH range. The default function can be overridden by using the DIRECT pseudo instruction. Once the direct pseudo is inserted in a source program, the direct mode of addressing will be in effect until cancelled by an EXTEND pseudo instruction.

While in the direct mode of addressing (MC6809), individual source statements may be assigned the extended mode of addressing by prefixing the operand with a greater-than (>) character.

Example:

```
CLR          >0F10H
```

While in the extended mode of addressing (EXTEND pseudo in effect), individual source statements (MC6809) may be assigned the direct mode of addressing by prefixing the operand with a less-than (<) character.

Example:

```
ADDA        <0FH
```

Location Counter Indicator

The dollar symbol (\$) refers to the current location of the program counter. The program counter contains the address where the current instruction or data statement is being assembled.

Example:

```
JUMP          JMP          $+3          ;JUMP TO ADDRESS  
                                           ;3 BYTES BEYOND  
                                           ;FIRST BYTE OF THIS  
                                           ;INSTRUCTION
```

Operand Expressions

The operand field may contain an expression consisting of one or more terms acted on by the expression operators listed in Chapter 2 of the Assembler/Linker Reference Manual. A term may be either a symbol, a string constant, a numeric constant, or an expression. The assembler reduces the entire expression to a single value.

Chapter **3**

Special Pseudo Instructions

Introduction

This chapter supplements Chapter 3 in the HP Model 64000 Assembler/Linker Reference Manual. It lists and defines in detail those assembler instructions that are applicable to the 6805 microcomputer and 6809 microprocessor.

Declare Symbols Relocatable and on Base Page

SYNTAX:

Label	Operation	Operand	Comment
	BASE_SEG		
	BASE_END		

The BASE_SEG and BASE_END pseudo instructions alert the assembler for symbols that will be on base page although they are relocatable.

BASE_SEG only affects labels defined by pseudo instructions FCB, FDB, and RMB.

Example:

Label	Operation	Operand	Comment
	DATA		
	BASE_SEG		
JULY	FCB	0	;JULY is DATA ;relocatable and flagged ;as base page.
JUNE	RMB	12	
	BASE_END		;Turns off base page ;flag.
	PROG		
	LDA	JULY	;Generates base page
	LDA	JUNE	;reference. Linker
			;checks for errors.
			;Labels must be defined
			;before using or they
			;will not be flagged as
			;base page.
	LDA	AUGUST	;This will not be on
			;base page, since it
			;is defined out of the
			;BASE_SEG range.
AUGUST	FCB	0	

Declare Symbols External and on Base Page

SYNTAX:

Label	Operation	Operand	Comment
[Name]	BEXT	operand[, operand, . . .]	

The BEXT pseudo instruction declares expression as external and on base page. The linker checks for range errors.

Example:

BEXT	SAM	;SAM is external and on ;base page.
EXT	CHARLIE	;CHARLIE is external.
LDAA	SAM	;Generates base page ;reference.
LDAA	CHARLIE	;Assembler generates ;extended addressing ;unless told to put ;on base page.

Block Storage of Zeros

SYNTAX:

Label	Operation	Operand	Comment
[Name]	BSZ	expression	

The BSZ pseudo instruction allocates a block of bytes. Each byte has an initial value of zero. Expression determines the number of bytes allocated.

An error will be generated if Expression has a value of zero, or contains symbols that are undefined, external references, or forward references.

Example:

Label	Operation	Operand	Comment
	BSZ	10	;Generates 10 bytes of ;zeros.

Direct Addressing Mode

SYNTAX:

Label	Operation	Operand	Comment
	DIRECT		

Some microprocessor instructions can use either the direct or the extended mode of addressing. Unless otherwise instructed, the assembler defaults to extended addressing. To cancel this default condition, insert the DIRECT pseudo instruction into the source program.

Extended Addressing Mode

SYNTAX:

Label	Operation	Operand	Comment
	EXTEND		

The EXTEND pseudo instruction selects the extended mode of addressing. To cancel the EXTEND instruction, insert the DIRECT pseudo instruction into the source program.

Form Constant Byte

SYNTAX:

Label	Operation	Operand	Comment
[Name]	FCB	expression	

The FCB pseudo instruction will store data in consecutive memory locations starting with the current setting of the program counter. The operand field may contain symbols or expressions that evaluate to one byte (8 bits) numbers in the range 0 through 255.

The label name is optional. If the label name is present, it is assigned the starting value of the program counter, and will reference the first byte stored by the FCB instruction.

Example:

Label	Operation	Operand	Comment
SAM	FCB	CHARLIE+05H	

Form Constant Character String

SYNTAX:

Label	Operation	Operand	Comment
[Name]	FCC	number, string expression	
[Name]	FCC	or string expression	

The FCC pseudo instruction stores ASCII strings into consecutive bytes of memory. Any printable ASCII character can be included in the string. This pseudo has two formats. In the first format, *Number* is a decimal constant, which specifies the number of characters contained in *String Expression*. If *Number* exceeds the characters in *String Expression*, spaces will be inserted to fill the remainder of the string.

In the second format, FCC specifies the string, which can be any printable ASCII character within quotation marks (" . "), apostrophe marks (' . '), or carets (^ . ^).

Examples:

Label	Operation	Operand	Comment
	FCC	10, "TEXT"	;Generates TEXT in ASCII ;followed by 6 blanks.
	FCC	"TEXT"	;Only generates TEXT.

Form Double Byte

SYNTAX:

Label	Operation	Operand	Comment
[Name]	FDB	expression list	

The FDB pseudo instruction will store each 16-bit value from the expression list as an address. The values are stored in memory starting at the current setting of the program counter.

Expressions evaluate to one-word (16 bits) numbers, typically addresses. If an expression evaluates to a single byte, it is assumed to be the low order byte of a 16-bit word where the high order byte is all zeros.

If the label name is present, it is assigned the starting address of the program counter, and thus will reference the first byte stored by the FDB instruction.

Example:

Label	Operation	Operand	Comment
SAM	FDB	0B123H	

Define Register List

SYNTAX:

Label	Operation	Operand	Comment
Name	REG	register list	

The REG pseudo instruction assigns the value of Register List to Name. Name cannot be redefined elsewhere in the program. Register List must be in the following form:

R1,[R2,...,R_n] where R1 to R_n are symbols A,B,CC,D,DP,PC,S, U,X, or Y. Both S and U cannot be used at the same time. Register D is the same as registers A and B. A register can only be specified once with REG.

After REG is defined, Name should only be used with PSHU, PULU, PSHS, and PULS. A "U" in Register List should not be used with PSHU or PULU. An "S" in Register List should not be used with PSHS or PULS.

Example:

Label	Operation	Operand	Comment
ABREG	REG	A,B	
	PSHS	# ABREG	

Reserve Memory Byte

SYNTAX:

Label	Operation	Operand	Comment
[Name]	RMB	expression	

The RMB pseudo instruction may be used to define a block of memory space. The value of the expression in the operand field specifies the number of bytes to be reserved.

Any symbol appearing in the operand field must be predefined. If the value of the operand expression is zero, no memory is reserved; however, if the optional label name is present, it will be assigned the current value of the program counter.

The RMB instruction reserves space in memory by incrementing the program counter by the value in the operand expression.

Example:

Label	Operation	Operand	Comment
SAM	RMB	15	;RESERVE 15 ;BYTES FOR SAM ;ROUTINE

Set Symbol to a Value

SYNTAX:

Label	Operation	Operand	Comment
Name	SET	expression	

The SET pseudo instruction assigns the value of Expression to Name. The value of Name can be changed later in the program with another SET instruction.

Example:

Label	Operation	Operand	Comment
SAM	SET	15	;SAM has a value of 15.

(6809 only)

Set Direct Page Pseudo Register

SYNTAX:

Label	Operation	Operand	Comment
[Name]	SETDP	expression	

The SETDP pseudo instruction assigns the value of the least significant byte in Expression to the direct page pseudo register at assembly time. SETDP can be used as often as required in an assembly; the value of the direct page pseudo register will change each time. No external references, forward references, or undefined symbols are allowed in Expression and it must be an absolute expression.

Example:

Label	Operation	Operand	Comment
	SETDP	30H	;The direct page pseudo ;register is set to 30H ;and absolute addresses ;in range 3000H-3000FFH ;are assembled with the ;direct addressing mode.

Assembler Output Listing

General

The assembler processes source program modules and produces an output that consists of a source program listing, a relocatable object file, and a symbol cross-reference list. Errors detected by the assembler will be noted in the output listing as error messages.

Input/Output Files

Source Input File

The input to the assembler is a source file that is created through the editor. It consists of the following:

Example	Description
"6809"	- Assembler directive.
Source Code	- Source statements consisting of:
.	Assembler Pseudos - refer to Chapter 3 (Assembler/Linker Reference Manual)
.	Assembler Instructions - refer to Chapter 5, this Supplement
.	
.	

Assembler Output Files

The assembler produces relocatable object modules that are stored under the same name as the source file but in a format that can be processed by the linker. If an object file does not exist at assembly time, the assembler will create one. If an object file does exist, the assembler will replace it.

List File. The list file is a formatted file that is output to a line printer. It can also be stored in a file or applied to the system CRT display. The listing may include the following:

- a. Source statements with object code.
- b. Error messages.
- c. Summary of errors with a description list.
- d. Symbol cross-reference list.

Symbol Cross-reference List. All symbols are cross-referenced except local macro labels and parameters. A cross-reference listing contains the following:

- a. Alphabetical list of program symbols.
- b. Line numbers where symbols are defined.
- c. All references (by line numbers) to symbols in the program.

Output Listing

An example of an assembler output listing is given in table 4-2, using the source program example listed in table 4-1. To illustrate an assembler output listing that contains error messages refer to table 4-3.

NOTE

The source program example was not written as a specific program. It merely lists a group of mnemonics to present a formatted example.

Table 4-1. Source Program Format Example

"6809" LIST XREF		
	GLB	KYBD9
	EXT	DSPL9
KYBD9	DEC	[10,X]
	DECA	
	DECB	
	EXG	X,Y
	INC	[10,X]
	JMP	DSPL9
	CWAI	#0FH
	JSR	MIKE
	INCA	
	INCB	
	LBCC	1FFDH
	LBGE	1FEEH
	LDA	#0FFH
	LDB	#00H
	LDS	#0500H
	LDU	#0010H
	LEAS	10,U
	LEAX	10,Y
	LSLA	
	LSLB	
	MUL	
	NEG	10,U
MIKE	NOP	
	ORA	15H
	ORB	20H
	ORCC	#0FH
	PSHS	X,Y
	PSHU	S,X
	ROLA	
	ROLB	
	JSR	DSPL9
	END	

Table 4-2. Assembler Output Listing

FILE: PGM09E:		HEWLETT-PACKARD: MOTOROLA 6809 ASSEMBLER			
LINE	LOC	CODE	ADDR	SOURCE STATEMENT	
1				"6809" LIST XREF	
2				GLB	KYBD9
3				EXT	DSPL9
4	0000	6A	98	KYBD9	DEC [10,X]
5	0003	4A		DECA	
6	0004	5A		DECB	
7	0005	1E	12	EXG	X,Y
8	0007	6C	98	INC	[10,X]
9	000A	0E	00	JMP	DSPL9
10	000C	3C	0F	CWAI	#0FH
11	000E	9D	2E	JSR	MIKE
12	0010	4C		INCA	
13	0011	5C		INCB	
14	0012	1024	1FFD	LBCC	1FFDH
15	0016	102C	1FEE	LBGE	1FEEH
16	001A	86	FF	LDA	#0FFH
17	001C	C6	00	LDB	#00H
18	001E	10CE	0500	LDS	#0500H
19	0022	CE	0010	LDU	#0010H
20	0025	32	4A	LEAS	10,U
21	0027	30	2A	LEAX	10,Y
22	0029	48		LSLA	
23	002A	58		LSLB	
24	002B	3D		MUL	
25	002C	60	4A	NEG	10,U
26	002E	12		NOPI	MIKE
27	002F	9A	15	ORA	15H
28	0031	DA	20	ORB	20H
29	0033	1A	0F	ORCC	#0FH
30	0035	34	30	PSHS	X,Y
31	0037	36	50	PSHU	S,X
32	0039	49		ROLA	
33	003A	59		ROLB	
34	003B	9D	00	JSR	DSPL9
35				END	

Errors= 0

Table 4-2. Assembler Output Listing (Cont'd)

FILE: PGM09E:		CROSS REFERENCE TABLE		PAGE 2
LINE#	SYMBOL	TYPE	REFERENCES	
3	DSPL9	E	9	
4	KYBD9	P	2	
26	MIKE	P		
	S	R	31	
	U	R	20,25	
	X	R	4,7,8,30,31	
	Y	R	7,21,30	

NOTE: In the cross-reference table, the letter listed under the TYPE column has the following definition:

- A = Absolute
- C = Common (COMN)
- D = Data (DATA)
- E = External
- M = Multiple Defined
- P = Program (PROG)
- R = Predefined Register
- U = Undefined

Table 4-3. Assembler Output with Errors

FILE: PGM09E:		HEWLETT-PACKARD: MOTOROLA 6809 ASSEMBLER			
LINE	LOC	CODE	ADDR	SOURCE STATEMENT	
1				"6809" LIST XREF	
2				GLB	KYBD9
3				EXT	DSPL9
4	0000	6A	98	KYBD9	DEC [10,X]
5	0003	4A		DECA	
6	0004	5A		DECB	
7				EXGF	X,Y
				^	
ERROR-UO					
8	0007	6C		INC	[10,X]
9	000A	0E	00	JMP	DSPL9
10				CWAI	\$+1
				^	
ERROR-IO,see line 7					
11	000E	9D	2E	JSR	MIKE
12	0010	4C		INCA	
13	0011	5C		INCB	
14	0012	1024	1FFD	LBCC	1FFDH
15	0016	102C	1FEE	LBGE	1FEEH
16	001A	86	00	LDA	#FFH
				^	
ERROR-US,see line 10					
17	001C	C6	00	LDB	#00H
18	001E	10CE	0500	LDS	#0500H
19	0022	CE	0010	LDU	#0010H
20	0025	32	4A	LEAS	10,U
				^	
ERROR-IO, see line 16					
21	0027	30	2A	LEAX	10,Y
22	0029	48		LSLA	
23	002A	58		LSLB	
24	002B	3D		MUL	
25	002C	60	4A	NEG	10,U
26	002E	12		NOP	
27	002F	9A	15	ORA	15H
28	0031	DA	20	ORB	20H
29				ORCC	FFH
ERROR-US,see line 16					
30	0035	34	30	PSHS	X,Y

Instruction Set Summary

General

All MC6805/6809 instructions are summarized in tables 5-1 and 5-2. The tables are arranged in alphabetical order.

Each instruction consists of a mnemonic symbol, object code for each addressing mode, the boolean operation performed, and condition codes affected. The descriptive symbols used in tables 5-1 and 5-2 to represent items in mnemonic definitions are as follows:

Symbol	Description
A	Register A
B	Register B
C or CC	Carry/borrow condition code
CCR	Condition Code Register
D	Register D (Reg A and Reg B)
Dir	Direct addressing mode
E	Entire condition code
EA	Effective address
Ext	Extended addressing mode
F	FIRQ interrupt code
H	Half-carry condition code
I	IRQ interrupt code
Imm	Immediate addressing mode
Ind	Indexed addressing mode
Inh	Inherent addressing mode
M	A memory location (1 byte)

Symbol	Description
n	Condition code not affected
N	Negative condition code
off.	Offset
OP	Operation Code (Hexadecimal)
PC	Program counter
PCH	Program counter (High Byte)
PCL	Program counter (Low Byte)
PCR	Program counter (Relative)
Rel	Relative Address
S	Register S
SP	Stack Pointer
SPH	Stack Pointer (High Byte)
SPL	Stack Pointer (Low Byte)
U	Register U
u	Condition code unknown
V	Overflow condition code
X	Register X
x	Condition code affected
Y	Register Y
Z	Zero condition code
∅	Bit = ∅
1	Bit = 1
•	Boolean AND
<—	Transfer into
<—>	Exchange
+	Arithmetic plus
—	Arithmetic minus
*	Multiplication indicator
=	Equality indicator
()	Refers to contents of address or register
⊕	Exclusive OR
⊙	Inclusive OR

Predefined Symbols

The following symbols are reserved. They have special meaning to the assembler and cannot appear as user-defined symbols.

Symbol	Definition
A	Register A
B	Register B
D	Register D
DP	Direct Page Register
S	Register S
U	Register U
X	Register X
Y	Register Y
SP	Stack Pointer
\$	Program Counter
#	Immediate addressing byte follows
[]	Addressing indirection

Table 5-1. MC6805 Instruction Set Summary

Mnemonic	Object Code	Addr Mode	Operation	Flag	H	I	N	Z	C
				Bits	4	3	2	1	0
ADC	A9	Imm	$A \leftarrow (A) + (M) + (C)$		x	n	x	x	x
	B9	Dir							
	C9	Ext							
	F9	Ind (no off.)							
	E9	Ind (8-bit off.)							
	D9	Ind (16-bit off.)							
ADD	AB	Imm	$A \leftarrow (A) + (M)$		x	n	x	x	x
	BB	Dir							
	CB	Ext							
	FB	Ind (no off.)							
	EB	Ind (8-bit off.)							
	DB	Ind (16-bit off.)							
AND	A4	Imm	$A \leftarrow (A) \bullet (M)$		n	n	x	x	n
	B4	Dir							
	C4	Ext							
	F4	Ind (no off.)							
	E4	Ind (8-bit off.)							
	D4	Ind (16-bit off.)							
ASL	38	Dir	$CC \leftarrow 7 \leftarrow \dots \leftarrow 0 \leftarrow \emptyset$		n	n	x	x	x
	78	Ind (no off.)							
	68	Ind (8-bit off.)							
ASLA	48	Inh	$CC \leftarrow 7 \leftarrow \dots \leftarrow 0 \leftarrow \emptyset$		n	n	x	x	x
ASLX	58	Inh	$CC \leftarrow 7 \leftarrow \dots \leftarrow 0 \leftarrow \emptyset$		n	n	x	x	x
ASR	37	Dir			n	n	x	x	x
	77	Ind (no off.)							
	67	Ind (8-bit off.)							

Table 5-1. MC6805 Instruction Set Summary (Cont'd)

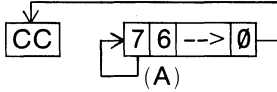
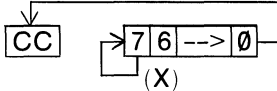
Mnemonic	Object Code	Addr Mode	Operation	Flag	H	I	N	Z	C
				Bits	4	3	2	1	0
ASRA	47	Inh		n	n	x	x	x	x
ASRX	57	Inh		n	n	x	x	x	x
BCC	24	Rel	Test for C=0	n	n	n	n	n	n
BCLR	(11+ 2 x n)	Bit Set/Clear	Clear bit	n	n	n	n	n	n
BCS	25	Rel	Test for C=1	n	n	n	n	n	n
BEQ	27	Rel	Test for Z=1	n	n	n	n	n	n
BHCC	28	Rel	Test for H=0	n	n	n	n	n	n
BHCS	29	Rel	Test for H=1	n	n	n	n	n	n
BHI	22	Rel	Test for C ⊙ Z=0	n	n	n	n	n	n
BHS	24	Rel	Test for C=0	n	n	n	n	n	n
BIH	2F	Rel	Test for I=1	n	n	n	n	n	n
BIL	2E	Rel	Test for I=0	n	n	n	n	n	n
BIT	A5	Imm	(A) • (M)	n	n	x	x	n	n
	B5	Dir							
	C5	Ext							
	F5	Ind (no off.)							
	E5	Ind (8-bit off.)							
	D5	Ind (16-bit off.)							

Table 5-1. MC6805 Instruction Set Summary (Cont'd)

Mnemonic	Object Code	Addr Mode	Operation	Flag	H	I	N	Z	C
				Bits	4	3	2	1	0
BLO	25	Rel	Test for C=1		n	n	n	n	n
BLS	23	Rel	Test for C ⊙ Z=1		n	n	n	n	n
BMC	2C	Rel	Test for I=0		n	n	n	n	n
BMI	2B	Rel	Test for N=1		n	n	n	n	n
BMS	2D	Rel	Test for I=1		n	n	n	n	n
BNE	26	Rel	Test for Z=0		n	n	n	n	n
BPL	2A	Rel	Test for N=0		n	n	n	n	n
BRA	20	Rel	Branch always		n	n	n	n	n
BRN	21	Rel	Branch never		n	n	n	n	n
BRCLR	(01+ 2 x n)	Bit Test	Test for bit n=0		n	n	n	n	x
BRSET	(2 x n)	Bit Test	Test for bit n=1		n	n	n	n	x
BSET	(10+ 2 x n)	Bit Set/Clear	Set bit n		n	n	n	n	n
BSR	AD	Rel	Branch to subroutine		n	n	n	n	n
CLC	98	Inh	CC ← 0		n	n	n	n	0
CLI	9A	Inh	I ← 0		n	0	n	n	n
CLR	3F 7F 6F	Dir Ind (no off.) Ind (8-bit off.)	(M) ← 0		n	n	0	1	n

Table 5-1. MC6805 Instruction Set Summary (Cont'd)

Mnemonic	Object Code	Addr Mode	Operation	Flag	H	I	N	Z	C
				Bits	4	3	2	1	0
CLRA	4F	Inh	$(A) \leftarrow \emptyset$		n	n	0	1	n
CLR X	5F	Inh	$(X) \leftarrow \emptyset$		n	n	0	1	n
CMP	A1	Imm	Compare (A), (M)		n	n	x	x	x
	B1	Dir							
	C1	Ext							
	F1	Ind (no off.)							
	E1	Ind (8-bit off.)							
	D1	Ind (16-bit off.)							
COM	33	Dir	$(M) \leftarrow (\overline{M})$		n	n	x	x	1
	73	Ind (no off.)							
	63	Ind (8-bit off.)							
COMA	43	Inh	$(A) \leftarrow (\overline{A})$		n	n	x	x	1
COMX	53	Inh	$(X) \leftarrow (\overline{X})$		n	n	x	x	1
CPX	A3	Imm	Compare (X), (M)		n	n	x	x	x
	B3	Dir							
	C3	Ext							
	F3	Ind (no off.)							
	E3	Ind (8-bit off.)							
	D3	Ind (16-bit off.)							
DEC	3A	Dir	$(M) \leftarrow (M)-1$		n	n	x	x	n
	7A	Ind (no off.)							
	6A	Ind (8-bit off.)							
DECA	4A	Inh	$(A) \leftarrow (A)-1$		n	n	x	x	n
DECX	5A	Inh	$(X) \leftarrow (X)-1$		n	n	x	x	n

Table 5-1. MC6805 Instruction Set Summary (Cont'd)

Mnemonic	Object Code	Addr Mode	Operation	Flag	H	I	N	Z	C
				Bits	4	3	2	1	0
EOR	A8	Imm	$(A) \leftarrow (A) \oplus (M)$		n	n	x	x	n
	B8	Dir							
	C8	Ext							
	F8	Ind (no off.)							
	E8	Ind (8-bit off.)							
	D8	Ind (16-bit off.)							
INC	3C	Dir	$(M) \leftarrow (M)+1$		n	n	x	x	n
	7C	Ind (no off.)							
	6C	Ind (8-bit off.)							
INCA	4C	Inh	$(A) \leftarrow (A)+1$		n	n	x	x	n
INCX	5C	Inh	$(X) \leftarrow (X)+1$		n	n	x	x	n
JMP	BC	Dir	$PC \leftarrow EA$		n	n	n	n	n
	CC	Ext							
	FC	Ind (no off.)							
	EC	Ind (8-bit off.)							
	DC	Ind (16-bit off.)							
JSR	BD	Dir	$PC \leftarrow EA$		n	n	n	n	n
	CD	Ext							
	FD	Ind (no off.)							
	ED	Ind (8-bit off.)							
	DD	Ind (16-bit off.)							
LDA	A6	Imm	$(A) \leftarrow (M)$		n	n	x	x	n
	B6	Dir							
	C6	Ext							
	F6	Ind (no off.)							
	E6	Ind (8-bit off.)							
	D6	Ind (16-bit off.)							

Table 5-1. MC6805 Instruction Set Summary (Cont'd)

Mnemonic	Object Code	Addr Mode	Operation	Flag	H	I	N	Z	C
				Bits	4	3	2	1	0
LDX	AE	Imm	$(X) \leftarrow (M)$		n	n	x	x	n
	BE	Dir							
	CE	Ext							
	FE	Ind (no off.)							
	EE	Ind (8-bit off.)							
	DE	Ind (16-bit off.)							
LSL	38	Dir	$\boxed{CC} \leftarrow \boxed{7} \leftarrow \boxed{0} \leftarrow \emptyset$ (M)		n	n	x	x	x
	78	Ind (no off.)							
	68	Ind (8-bit off.)							
LSLA	48	Inh	$\boxed{CC} \leftarrow \boxed{7} \leftarrow \boxed{0} \leftarrow \emptyset$ (A)		n	n	x	x	x
LSLX	58	Inh	$\boxed{CC} \leftarrow \boxed{7} \leftarrow \boxed{0} \leftarrow \emptyset$ (X)		n	n	x	x	x
LSR	34	Dir	$\emptyset \rightarrow \boxed{7} \rightarrow \boxed{0} \rightarrow \boxed{CC}$ (M)		n	n	0	x	x
	74	Ind (no off.)							
	64	Ind (8-bit off.)							
LSRA	44	Inh	$\emptyset \rightarrow \boxed{7} \rightarrow \boxed{0} \rightarrow \boxed{CC}$ (A)		n	n	0	x	x
LSRX	54	Inh	$\emptyset \rightarrow \boxed{7} \rightarrow \boxed{0} \rightarrow \boxed{CC}$ (X)		n	n	0	x	x
NEG	30	Dir	$(M) \leftarrow \overline{(M)} + 1$		n	n	x	x	x
	70	Ind (no off.)							
	60	Ind (8-bit off.)							

Table 5-1. MC6805 Instruction Set Summary (Cont'd)

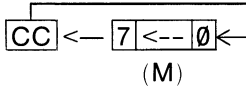
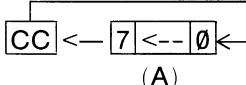
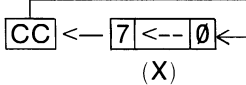
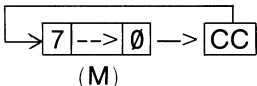
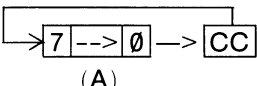
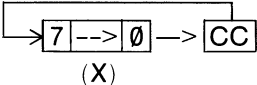
Mnemonic	Object Code	Addr Mode	Operation	Flag	H	I	N	Z	C
				Bits	4	3	2	1	0
NEGA	40	Inh	$(A) \leftarrow (\overline{A})+1$		n	n	x	x	x
NEGX	50	Inh	$(X) \leftarrow (\overline{X})+1$		n	n	x	x	x
NOP	9D	Inh	No operation		n	n	n	n	n
ORA	AA BA CA FA EA DA	Imm Dir Ext Ind (no off.) Ind (8-bit off.) Ind (16-bit off.)	$(A) \leftarrow (A) \odot (M)$		n	n	x	x	n
ROL	39 79 69	Dir Ind (no off.) Ind (8-bit off.)	 (M)		n	n	x	x	x
ROLA	49	Inh	 (A)		n	n	x	x	x
ROLX	59	Inh	 (X)		n	n	x	x	x
ROR	36 76 66	Dir Ind (no off.) Ind (8-bit off.)	 (M)		n	n	x	x	x
RORA	46	Inh	 (A)		n	n	x	x	x
RORX	56	Inh	 (X)		n	n	x	x	x

Table 5-1. MC6805 Instruction Set Summary (Cont'd)

Mnemonic	Object Code	Addr Mode	Operation	Flag	H	I	N	Z	C
				Bits	4	3	2	1	0
RSP	9C	Inh	(SP) ← 07FH		n	n	n	n	n
RTI	80	Inh	Return from interrupt		u	u	u	u	u
RTS	81	Inh	Return from subroutine		n	n	n	n	n
SBC	A2	Imm	(A) ← (A)-(M)-(CC)		n	n	x	x	x
	B2	Dir							
	C2	Ext							
	F2	Ind (no off.)							
	E2	Ind (8-bit off.)							
	D2	Ind (16-bit off.)							
SEC	99	Inh	(CC) ← 1		n	n	n	n	1
SEI	9B	Inh	(I) ← 1		n	1	n	n	n
STA	B7	Dir	(M) ← (A)		n	n	x	x	n
	C7	Ext							
	F7	Ind (no off.)							
	E7	Ind (8-bit off.)							
	D7	Ind (16-bit off.)							
STX	BF	Dir	(M) ← (X)		n	n	x	x	n
	CF	Ext							
	FF	Ind (no off.)							
	EF	Ind (8-bit off.)							
	DF	Ind (16-bit off.)							
SUB	A0	Imm	(A) ← (A)-(M)		n	n	x	x	x
	B0	Dir							
	C0	Ext							
	F0	Ind (no off.)							
	E0	Ind (8-bit off.)							
	D0	Ind (16-bit off.)							

Table 5-1. MC6805 Instruction Set Summary (Cont'd)

Mnemonic	Object Code	Addr Mode	Operation	Flag	H	I	N	Z	C
				Bits	4	3	2	1	0
SWI	83	Inh	Software Interrupt		n	1	n	n	n
TAX	97	Inh	(X) ← (A)		n	n	n	n	n
TST	3D	Dir	Test (M)		n	n	x	x	n
	7D	Ind (no off.)							
	6D	Ind (8-bit off.)							
TSTA	4D	Inh	Test (A)		n	n	x	x	n
TSTX	5D	Inh	Test (X)		n	n	x	x	n
TXA	9F	Inh	(A) ← (X)		n	n	n	n	n

Table 5-2. MC6809 Instruction Set Summary

Mnemonic	Object Code	Addr Mode	Operation	FLAG	E	F	H	I	N	Z	V	C
				BITS	7	6	5	4	3	2	1	0
ABX	3A	Inh	$X \leftarrow (X)+(B)$		n	n	n	n	n	n	n	n
ADCA	89	Imm	$A \leftarrow (A)+(M)+(C)$		n	n	x	n	x	x	x	x
	99	Dir										
	B9	Ext										
	A9	Ind										
ADCB	C9	Imm	$B \leftarrow (B)+(M)+(C)$		n	n	x	n	x	x	x	x
	D9	Dir										
	F9	Ext										
	E9	Ind										
ADDA	8B	Imm	$A \leftarrow (A)+(M)$		n	n	x	n	x	x	x	x
	9B	Dir										
	BB	Ext										
	AB	Ind										
ADDB	CB	Imm	$B \leftarrow (B)+(M)$		n	n	x	n	x	x	x	x
	DB	Dir										
	FB	Ext										
	EB	Ind										
ADDD	C3	Imm	$D \leftarrow (D)+(M:M+1)$		n	n	x	n	x	x	x	x
	D3	Dir										
	F3	Ext										
	E3	Ind										
ANDA	84	Imm	$A \leftarrow (A) \bullet (M)$		n	n	n	n	x	x	0	n
	94	Dir										
	B4	Ext										
	A4	Ind										

Table 5-2. MC6809 Instruction Set Summary (Cont'd)

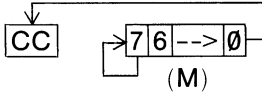
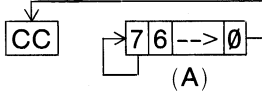
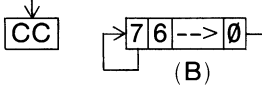
Mnemonic	Object Code	Addr Mode	Operation	FLAG BITS	E	F	H	I	N	Z	V	C
					7	6	5	4	3	2	1	0
ANDB	C4 D4 F4 E4	Imm Dir Ext Ind	$B \leftarrow (B) \bullet (M)$		n	n	n	n	x	x	0	n
ANDCC	1C	Imm	$CCR \leftarrow (CCR) \bullet \text{data}$		u	u	u	u	u	u	u	1
ASL	08 78 68	Dir Ext Ind	$CC \leftarrow 7 \leftarrow \emptyset \leftarrow \emptyset$ (M)		n	n	n	n	x	x	x	x
ASLA	48	Inh	$CC \leftarrow 7 \leftarrow \emptyset \leftarrow \emptyset$ (A)		n	n	n	n	x	x	x	x
ASLB	58	Inh	$CC \leftarrow 7 \leftarrow \emptyset \leftarrow \emptyset$ (B)		n	n	n	n	x	x	x	x
ASR	07 77 67	Dir Ext Ind	 (M)		n	n	n	n	x	x	n	x
ASRA	47	Inh	 (A)		n	n	n	n	x	x	n	x
ASRB	57	Inh	 (B)		n	n	n	n	x	x	n	x
BCC	24	Rel	Test for $C = 0$		n	n	n	n	n	n	n	n
BCS	25	Rel	Test for $C = 1$		n	n	n	n	n	n	n	n
BEQ	27	Rel	Test for $Z = 1$		n	n	n	n	n	n	n	n

Table 5-2. MC6809 Instruction Set Summary (Cont'd)

Mnemonic	Object Code	Addr Mode	Operation	FLAG	E	F	H	I	N	Z	V	C	
				BITS	7	6	5	4	3	2	1	0	
BGE	2C	Rel	Test for $N \oplus V = 0$		n	n	n	n	n	n	n	n	
BGT	2E	Rel	Test for $Z \odot [N \oplus V] = 0$		n	n	n	n	n	n	n	n	
BHI	22	Rel	Test for $C \odot Z = 0$		n	n	n	n	n	n	n	n	
BHS	24	Rel	Test for $C = 0$		n	n	n	n	n	n	n	n	
BITA	85	Imm	$(A) \bullet (M)$		n	n	n	n	x	x	0	n	
	95	Dir											
	B5	Ext											
	A5	Ind											
BITB	C5	Imm	$(B) \bullet (M)$		n	n	n	n	x	x	0	n	
	D5	Dir											
	F5	Ext											
	E5	Ind											
BLE	2F	Rel	Test for $Z \odot [N \oplus V] = 1$		n	n	n	n	n	n	n		
BLO	25	Rel	Test for $C = 1$		n	n	n	n	n	n	n		
BLS	23	Rel	Test for $C \odot Z = 1$		n	n	n	n	n	n	n		
BLT	2D	Rel	Test for $N \oplus V = 1$		n	n	n	n	n	n	n		
BMI	2B	Rel	Test for $N = 1$		n	n	n	n	n	n	n		
BNE	26	Rel	Test for $Z = 0$		n	n	n	n	n	n	n		
BPL	2A	Rel	Test for $N = 0$		n	n	n	n	n	n	n		
BRA	20	Rel	Branch always		n	n	n	n	n	n	n		

Table 5-2. MC6809 Instruction Set Summary (Cont'd)

Mnemonic	Object Code	Addr Mode	Operation	FLAG	E	F	H	I	N	Z	V	C
				BITS	7	6	5	4	3	2	1	0
BRN	21	Rel	Branch Never		n	n	n	n	n	n	n	n
BSR	8D	Rel	Branch Subroutine		n	n	n	n	n	n	n	n
BVC	28	Rel	Test for V = 0		n	n	n	n	n	n	n	n
BVS	29	Rel	Test for V = 1		n	n	n	n	n	n	n	n
CLR	0F 7F 6F	Dir Ext Ind	(M) ← 0		n	n	n	n	0	1	0	0
CLRA	4F	Inh	(A) ← 0		n	n	n	n	0	1	0	0
CLRB	5F	Inh	(B) ← 0		n	n	n	n	0	1	0	0
CMPA	81 91 B1 A1	Imm Dir Ext Ind	Compare (A), (M)		n	n	n	n	x	x	x	x
CMPB	C1 D1 F1 E1	Imm Dir Ext Ind	Compare (B), (M)		n	n	n	n	x	x	x	x
CMPD	1083 1093 10B3 10A3	Imm Dir Ext Ind	Compare (D), (M:M+1)		n	n	n	n	x	x	x	x
CMPS	118C 119C 11BC 11AC	Imm Dir Ext Ind	Compare (S), (M:M+1)		n	n	n	n	x	x	x	x

Table 5-2. MC6809 Instruction Set Summary (Cont'd)

Mnemonic	Object Code	Addr Mode	Operation	FLAG	E	F	H	I	N	Z	V	C
				BITS	7	6	5	4	3	2	1	0
CMPU	1183	Imm	Compare (U), (M:M+1)		n	n	n	n	x	x	x	x
	1193	Dir										
	11B3	Ext										
	11A3	Ind										
CMPX	8C	Imm	Compare (X), (M:M+1)		n	n	n	n	x	x	x	x
	9C	Dir										
	BC	Ext										
	AC	Ind										
CMPY	108C	Imm	Compare (Y), (M:M+1)		n	n	n	n	x	x	x	x
	109C	Dir										
	10BC	Ext										
	10AC	Ind										
COM	03	Dir	$(M) \leftarrow \overline{(M)}$		n	n	n	n	x	x	0	1
	73	Ext										
	63	Ind										
COMA	43	Inh	$(A) \leftarrow \overline{(A)}$		n	n	n	n	x	x	0	1
COMB	53	Inh	$(B) \leftarrow \overline{(B)}$		n	n	n	n	x	x	0	1
CWAI	3C	Inh	CCR ← CCR ⊙ data; wait for interrupt		u	u	u	u	u	u	u	1
DAA	19	Inh	Decimal Adj Reg (A)		n	n	n	n	x	x	0	x
DEC	0A	Dir	$(M) \leftarrow (M) - 1$		n	n	n	n	x	x	x	n
	7A	Ext										
	6A	Ind										
DECA	4A	Inh	$(A) \leftarrow (A) - 1$		n	n	n	n	x	x	x	n
DECB	5A	Inh	$(B) \leftarrow (B) - 1$		n	n	n	n	x	x	x	n

Table 5-2. MC6809 Instruction Set Summary (Cont'd)

Mnemonic	Object Code	Addr Mode	Operation	FLAG	E	F	H	I	N	Z	V	C	
				BITS	7	6	5	4	3	2	1	0	
EORA	88	Imm	$(A) \leftarrow (A) \oplus (M)$		n	n	n	n	x	x	0	n	
	98	Dir											
	B8	Ext											
	A8	Ind											
EORB	C8	Imm	$(B) \leftarrow (B) \oplus (M)$		n	n	n	n	x	x	0	n	
	D8	Dir											
	F8	Ext											
	E8	Ind											
EXG	1E	Inh	$R1 \leftrightarrow R2$		n	n	n	n	n	n	n	n	
INC	0C	Dir	$(M) \leftarrow (M)+1$		n	n	n	n	x	x	x	n	
	7C	Ext											
	6C	Ind											
INCA	4C	Inh	$(A) \leftarrow (A)+1$		n	n	n	n	x	x	x	n	
INCB	5C	Inh	$(B) \leftarrow (B)+1$		n	n	n	n	x	x	x	n	
JMP	0E	Dir	$PC \leftarrow EA$		n	n	n	n	n	n	n	n	
	7E	Ext											
	6E	Ind											
JSR	9D	Dir	$(SP) = (SP)-1,$ $(SP) \text{ PCL};$ $(SP) = (SP)-1,$ $(SP) \leftarrow \text{PCH};$ $PC \leftarrow EA$		n	n	n	n	n	n	n	n	
	BD	Ext											
	AD	Ind											
LBCC	1024	Rel	Test for $C = 0$		n	n	n	n	n	n	n	n	
LBCS	1025	Rel	Test for $C = 1$		n	n	n	n	n	n	n	n	

Table 5-2. MC6809 Instruction Set Summary (Cont'd)

Mnemonic	Object Code	Addr Mode	Operation	FLAG	E	F	H	I	N	Z	V	C
				BITS	7	6	5	4	3	2	1	0
LBEQ	1027	Rel	Test for $Z = 1$		n	n	n	n	n	n	n	n
LBGE	102C	Rel	Test for $N \oplus V = 0$		n	n	n	n	n	n	n	n
LBGT	102E	Rel	Test for $Z \odot [N \oplus V] = 0$		n	n	n	n	n	n	n	n
LBHI	1022	Rel	Test for $C \odot Z = 0$		n	n	n	n	n	n	n	n
LBHS	1024	Rel	Test for $C = 0$		n	n	n	n	n	n	n	n
LBLE	102F	Rel	Test for $Z \odot [N \oplus V] = 1$		n	n	n	n	n	n	n	n
LBLO	1025	Rel	Test for $C = 1$		n	n	n	n	n	n	n	n
LBLS	1023	Rel	Test for $C \odot Z = 1$		n	n	n	n	n	n	n	n
LBLT	102D	Rel	Test for $N \oplus V = 1$		n	n	n	n	n	n	n	n
LBMI	102B	Rel	Test for $N = 1$		n	n	n	n	n	n	n	n
LBNE	1026	Rel	Test for $Z = 0$		n	n	n	n	n	n	n	n
LBPL	102A	Rel	Test for $N = 0$		n	n	n	n	n	n	n	n
LBRA	16	Rel	Branch always		n	n	n	n	n	n	n	n
LBRN	1021	Rel	Branch never		n	n	n	n	n	n	n	n
LBSR	17	Rel	Branch Subroutine		n	n	n	n	n	n	n	n
LBVC	1028	Rel	Test for $V = 0$		n	n	n	n	n	n	n	n
LBVS	1029	Rel	Test for $V = 1$		n	n	n	n	n	n	n	n

Table 5-2. MC6809 Instruction Set Summary (Cont'd)

Mnemonic	Object Code	Addr Mode	Operation	FLAG	E	F	H	I	N	Z	V	C	
				BITS	7	6	5	4	3	2	1	0	
LDA	86	Imm	(A) ← (M)		n	n	n	n	x	x	0	n	
	96	Dir											
	B6	Ext											
	A6	Ind											
LDB	C6	Imm	(B) ← (M)		n	n	n	n	x	x	0	n	
	D6	Dir											
	F6	Ext											
	E6	Ind											
LDD	CC	Imm	(D) ← (M:M+1)		n	n	n	n	x	x	0	n	
	DC	Dir											
	FC	Ext											
	EC	Ind											
LDS	10CE	Imm	(S) ← (M:M+1)		n	n	n	n	x	x	0	n	
	10DE	Dir											
	10FE	Ext											
	10EE	Ind											
LDU	CE	Imm	(U) ← (M:M+1)		n	n	n	n	x	x	0	n	
	DE	Dir											
	FE	Ext											
	EE	Ind											
LDX	8E	Imm	(X) ← (M:M+1)		n	n	n	n	x	x	0	n	
	9E	Dir											
	BE	Ext											
	AE	Ind											
LDY	108E	Imm	(Y) ← (M:M+1)		n	n	n	n	x	x	0	n	
	109E	Dir											
	10BE	Ext											
	10AE	Ind											

Table 5-2. MC6809 Instruction Set Summary (Cont'd)

Mnemonic	Object Code	Addr Mode	Operation	FLAG	E	F	H	I	N	Z	V	C
				BITS	7	6	5	4	3	2	1	0
LEAS	32	Ind	(S) ← EA		n	n	n	n	n	n	n	n
LEAU	33	Ind	(U) ← EA		n	n	n	n	n	n	n	n
LEAX	30	Ind	(X) ← EA		n	n	n	n	n	n	n	n
LEAY	31	Ind	(Y) ← EA		n	n	n	n	n	n	n	n
LSL	08	Dir	$\boxed{CC} \leftarrow \boxed{7} \leftarrow \boxed{0} \leftarrow \emptyset$ (M)		n	n	n	n	x	x	x	x
	78	Ext										
	68	Ind										
LSLA	48	Inh	$\boxed{CC} \leftarrow \boxed{7} \leftarrow \boxed{0} \leftarrow \emptyset$ (A)		n	n	n	n	x	x	x	x
LSLB	58	Inh	$\boxed{CC} \leftarrow \boxed{7} \leftarrow \boxed{0} \leftarrow \emptyset$ (B)		n	n	n	n	x	x	x	x
LSR	04	Dir	$\emptyset \rightarrow \boxed{7} \rightarrow \boxed{0} \rightarrow \boxed{CC}$ (M)		n	n	n	n	0	x	n	x
	74	Ext										
	64	Ind										
LSRA	44	Inh	$\emptyset \rightarrow \boxed{7} \rightarrow \boxed{0} \rightarrow \boxed{CC}$ (A)		n	n	n	n	0	x	n	x
LSRB	54	Inh	$\emptyset \rightarrow \boxed{7} \rightarrow \boxed{0} \rightarrow \boxed{CC}$ (B)		n	n	n	n	0	x	n	x
MUL	3D	Inh	(D) ← (A)*(B)		n	n	n	n	n	x	n	x
NEG	00	Dir	(M) ← $\overline{(M)} + 1$		n	n	u	n	x	x	x	x
	70	Ext										
	60	Ind										

Table 5-2. MC6809 Instruction Set Summary (Cont'd)

Mnemonic	Object Code	Addr Mode	Operation	FLAG	E	F	H	I	N	Z	V	C	
				BITS	7	6	5	4	3	2	1	0	
NEGA	40	Inh	$(A) \leftarrow \overline{(A)}+1$		n	n	u	n	x	x	x	x	
NEGB	50	Inh	$(B) \leftarrow \overline{(B)}+1$		n	n	u	n	x	x	x	x	
NOP	12	Inh	No operation (PC) = (PC)+1		n	n	n	n	n	n	n	n	
ORA	8A	Imm	$(A) \leftarrow (A) \odot (M)$		n	n	n	n	x	x	0	n	
	9A	Dir											
	BA	Ext											
	AA	Ind											
ORB	CA	Imm	$(B) \leftarrow (B) \odot (M)$		n	n	n	n	x	x	0	n	
	DA	Dir											
	FA	Ext											
	EA	Ind											
ORCC	1A	Imm	$(CCR) \leftarrow (CCR) \odot \text{data}$		u	u	u	u	u	u	u	u	
PSHS	34	Inh	Push Reg(s) on hardware stack (S)		n	n	n	n	n	n	n	n	
PSHU	36	Inh	Push Reg(s) on user stack (U)		n	n	n	n	n	n	n	n	
PULS	35	Inh	Pull Reg(s) from hardware stack (S)		u	u	u	u	u	u	u	u	
PULU	37	Inh	Pull Reg(s) from user stack (U)		u	u	u	u	u	u	u	u	
ROL	09	Dir			n	n	n	n	x	x	x	x	
	79	Ext											
	69	Ind											

Table 5-2. MC6809 Instruction Set Summary (Cont'd)

Mnemonic	Object Code	Addr Mode	Operation	FLAG	E	F	H	I	N	Z	V	C
				BITS	7	6	5	4	3	2	1	0
ROLA	49	Inh	<p>(A)</p>	n	n	n	n	x	x	x	x	x
ROLB	59	Inh	<p>(B)</p>	n	n	n	n	x	x	x	x	x
ROR	06	Dir	<p>(M)</p>	n	n	n	n	x	x	n	x	
	76	Ext										
	66	Ind										
RORA	46	Inh	<p>(A)</p>	n	n	n	n	x	x	n	x	
RORB	56	Inh	<p>(B)</p>	n	n	n	n	x	x	n	x	
RTI	3B	Inh	Return from Interrupt	u	u	u	u	u	u	u	u	u
RTS	39	Inh	Return from Subroutine	n	n	n	n	n	n	n	n	n
SBCA	82	Imm	(A) ← (A)-(M)-(CC)	n	n	n	n	x	x	x	x	
	92	Dir										
	B2	Ext										
	A2	Ind										
SBCB	C2	Imm	(B) ← (B)-(M)-(CC)	n	n	n	n	x	x	x	x	
	D2	Dir										
	F2	Ext										
	E2	Ind										
SEX	1D	Inh	Sign Extended	n	n	n	n	x	x	0	n	

Table 5-2. MC6809 Instruction Set Summary (Cont'd)

Mnemonic	Object Code	Addr Mode	Operation	FLAG	E	F	H	I	N	Z	V	C
				BITS	7	6	5	4	3	2	1	0
STA	97	Dir	$(M) \leftarrow (A)$		n	n	n	n	x	x	0	n
	B7	Ext										
	A7	Ind										
STB	D7	Dir	$(M) \leftarrow (B)$		n	n	n	n	x	x	0	n
	F7	Ext										
	E7	Ind										
STD	DD	Dir	$(M:M+1) \leftarrow (D)$		n	n	n	n	x	x	0	n
	FD	Ext										
	ED	Ind										
STS	10DF	Dir	$(M:M+1) \leftarrow (S)$		n	n	n	n	x	x	0	n
	10FF	Ext										
	10EF	Ind										
STU	DF	Dir	$(M:M+1) \leftarrow (U)$		n	n	n	n	x	x	0	n
	FF	Ext										
	EF	Ind										
STX	9F	Dir	$(M:M+1) \leftarrow (X)$		n	n	n	n	x	x	0	n
	BF	Ext										
	AF	Ind										
STY	109F	Dir	$(M:M+1) \leftarrow (Y)$		n	n	n	n	x	x	0	n
	10BF	Ext										
	10AF	Ind										
SUBA	80	Imm	$(A) \leftarrow (A)-(M)$		n	n	n	n	x	x	x	x
	90	Dir										
	B0	Ext										
	A0	Ind										

Table 5-2. MC6809 Instruction Set Summary (Cont'd)

Mnemonic	Object Code	Addr Mode	Operation	FLAG	E	F	H	I	N	Z	V	C	
				BITS	7	6	5	4	3	2	1	0	
SUBB	C0	Imm	(B) ← (B) - (M)		n	n	n	n	x	x	x	x	
	D0	Dir											
	F0	Ext											
	E0	Ind											
SUBD	83	Imm	(D) ← (D) - (M:M+1)		n	n	n	n	x	x	x	x	
	93	Dir											
	B3	Ext											
	A3	Ind											
SWI	3F	Inh	Software Interrupt 1		n	n	n	n	n	n	n		
SWI2	103F	Inh	Software Interrupt 2		n	n	n	n	n	n	n		
SWI3	113F	Inh	Software Interrupt 3		n	n	n	n	n	n	n		
SYNC	13	Inh	Sync to interrupt		n	n	n	n	n	n	n		
TFR	1F	Inh	(R2) ← (R1)		n	n	n	n	n	n	n		
TST	0D	Dir	Test (M)		n	n	n	n	x	x	0	n	
	7D	Ext											
	6D	Ind											
TSTA	4D	Inh	Test (A)		n	n	n	n	x	x	0	n	
TSTB	5D	Inh	Test (B)		n	n	n	n	x	x	0	n	

