MF855-03a

EPSON

CMOS 4-BIT SINGLE CHIP MICROCOMPUTER

S1C63000

Core CPU Manual

SEIKO EPSON CORPORATION

Configuration of product number

Devices

S1 C 63158 F 0A01 00

- **Packing specifications**
  [00 : Besides tape & reel
  0A : TCP BL 2 directions
  0B : Tape & reel BACK
  0C : TCP BR 2 directions
  0D : TCP BT 2 directions
  0E : TCP BD 2 directions
  0F : Tape & reel FRONT
  0G : TCP BT 4 directions
  0H : TCP BD 4 directions
  0J : TCP SL 2 directions
  0K : TCP SR 2 directions
  0L : Tape & reel LEFT
  0M : TCP ST 2 directions
  0N : TCP SD 2 directions
  0P : TCP ST 4 directions
  0Q : TCP SD 4 directions
  0R : Tape & reel RIGHT
  99 : Specs not fixed]
- **Specification**
- **Package**
  [D: die form; F: QFP]
- **Model number**
- **Model name**
  [C: microcomputer, digital products]
- **Product classification**
  [S1: semiconductor]

Development tools

S5U1 C 63000 A1 1 00

- **Packing specifications**
  [00: standard packing]
- **Version**
  [1: Version 1]
- **Tool type**
  [Hx : ICE
  Ex : EVA board
  Px : Peripheral board
  Wx: Flash ROM writer for the microcomputer
  Xx : ROM writer peripheral board
  Cx : C compiler package
  Ax : Assembler package
  Dx : Utility tool by the model
  Qx : Soft simulator]
- **Corresponding model number**
  [63000: common to S1C63 Family]
- **Tool classification**
  [C: microcomputer use]
- **Product classification**
  [S5U1: development tool for semiconductor products]

S1C63000 CORE CPU MANUAL

PREFACE

This manual explains the architecture, operation and instruction of the core CPU S1C63 of the CMOS 4-bit single chip microcomputer S1C63 Family.
Also, since the memory configuration and the peripheral circuit configuration is different for each device of the S1C63 Family, you should refer to the respective manuals for specific details other than the basic functions.

CONTENTS

CHAPTER 1 OUTLINE

The S1C63000 is the core CPU of the 4-bit single chip microcomputer S1C63 Family that utilizes original EPSON architecture. It has a large and linear addressable space, maximum 64K words (13 bits / word) program memory (code ROM area) and maximum 64K words (4 bits / word) data memory (RAM, data ROM and I / O area), and high speed, abundant instruction sets. It operates in a wide range of supply voltage and features low power consumption. Furthermore, modularization of programs can be done easily because the program memory does not need bank and page management and relocatable programming is possible.
In addition, it has adopted a unified architecture and a peripheral circuit interface in memory mapped I / O method to flexibly meet future expansion of the S1C63 Family.

1.1 Features

The S1C63000 boasts the below features.

Program memory	Maximum 64K × 13 bits (linear address, non-page method)	
Data memory	Maximum 64K × 4 bits	
Basic instruction set	47 types with 5 types of basic addressing modes and 3 types of extended addressing modes	
Instruction cycle	1 cycle (2 clocks), 2 cycles (4 clocks) and 3 cycles (6 clocks)	
Register configuration	Data register	2 × 4 bits
	Index register	2 × 16 bits
	Address extension register	8 bits
	Program counter	16 bits
	Stack pointer	2 × 8 bits
	Condition flag	4 bits
	Queue register	16 bits
Interrupt function	NMI (Non Maskable Interrupt) vector	1
	Hardware interrupt vector	Maximum 15 vectors
	Software interrupt vector	Maximum 63 vectors
Standby function	HALT / SLEEP	
Peripheral circuit interface	Memory mapped I / O method	
Pipeline processing	2 stages (fetch and execution) pipeline processing	

1.2 Instruction Set Features

(1) It adopts high efficiency machine cycles, high speed and abundant instruction set.
Almost all standard instructions operate in 1 cycle (2 clock).

(2) Both the program space and the data space are designed as a 64K-word linear space without page concept and can be addressed with 1 instruction.

(3) The instruction system includes relocatable jump instructions and allows a relocatable programming. Thus modular programming and software library development can be realized easily, and it increases an efficiency for developing applications.

(4) Memory management can be done easily by 5 types of basic addressing modes, 3 types of extended addressing modes with the address extension register and 16-bit operation function that is useful in address calculations.

(5) 8-bit data processing is possible using the table look-up instruction and other instructions.

(6) Some instructions support a numbering system, thus binary to hexadecimal software counters can be made easily.

1.3 Block Diagram

Figure 1.3.1 shows the S1C63000 block diagram.

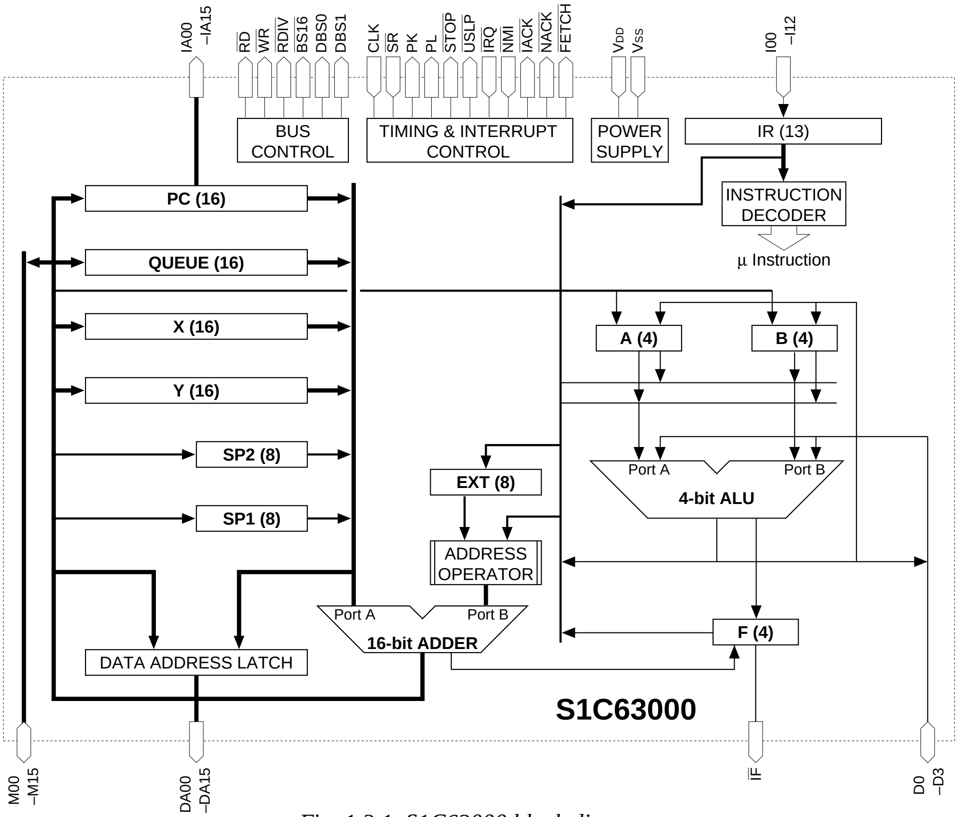


Fig. 1.3.1 S1C63000 block diagram

1.4 Input-Output Signals

Tables 1.4.1 (a) and 1.4.1 (b) show the input/output signals between the S1C63000 and peripheral circuits.

Table 1.4.1(a) Input/output signal list (1)

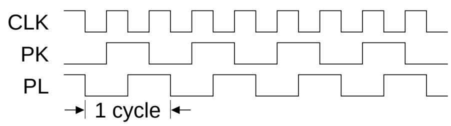
Type	Terminal name	I/O	Function
Power supply	VDD (VD1)	I	Power supply (+) Inputs a plus supply voltage.
	VSS (VS1)	I	Power supply (-) Inputs a minus supply voltage.
Clock	CLK	I	Clock input Inputs the system clock from the peripheral circuit.
	PK PL	O	2-phase divided clock output Outputs the 2-phase divided signals to be generated from the system clock input to the CLK terminal as following phase. 
Address bus	IA00–IA15	O	Instruction address output Outputs an instruction (code ROM) address.
	DA00–DA15	O	Data address output Outputs a data (RAM, I/O) address.

Table 1.4.1(b) Input/output signal list (2)

Type	Terminal name	I/O	Function
Data bus	I00–I12	I	Instruction bus Inputs an instruction code.
	M00–M15	I/O	16-bit data bus A bidirectional data bus to connect to the RAM (stack RAM) for 16-bit accessing.
	D0–D3	I/O	4-bit data bus A bidirectional data bus to connect to the RAM and I/O.
Bus control signal	$\overline{\text{RD}}$	O	Data read Goes to a low level when the CPU reads data (from RAM, I/O).
	$\overline{\text{WR}}$	O	Data write Goes to a low level when the CPU writes data (to RAM, I/O).
	$\overline{\text{RDIV}}$	O	Read interrupt vector Goes to a low level when the CPU reads an interrupt vector.
System control signal	$\overline{\text{SR}}$	I	Reset input A low level input resets the CPU.
	$\overline{\text{USLP}}$	O	Micro sleep Goes to a low level when the CPU executes the SLP instruction. The peripheral circuit stops oscillation on the basis of this signal.
Interrupt signal	$\overline{\text{NMI}}$	I	Non-maskable interrupt request An interrupt request terminal for an interrupt that cannot be masked by software. It is accepted at the falling edge of an input signal to this terminal.
	$\overline{\text{IRQ}}$	I	Interrupt request An interrupt request terminal for interrupts that can be masked by software. It is accepted by a low level signal input to this terminal.
	$\overline{\text{IACK}}$	O	Interrupt acknowledge Goes to a low level while executing an $\overline{\text{NMI}}$ or $\overline{\text{IRQ}}$ interrupt response cycle.
	$\overline{\text{NACK}}$	O	Non-maskable interrupt acknowledge Goes to a low level while executing a non-maskable interrupt response cycle.
Status signal	$\overline{\text{FETCH}}$	O	Fetch cycle Goes to a low level when the CPU fetches an instruction.
	$\overline{\text{STOP}}$	O	Stop signal Goes to a low level when the CPU is in stop status after executing the HALT or SLP instruction, or in reset status ($\overline{\text{SR}}$ is low).
	IF	O	Interrupt flag Outputs a status (inverted value) of the interrupt flag in the flag (F) register.
	BS16	O	16-bit access Goes to a low level when the CPU accesses to a 16-bit RAM.
	DBS0 DBS1	O	Data bus status Outputs data bus status (for both the 4-bit and 16-bit data bus). DBS1 DBS0 State 0 0 High impedance 0 1 Interrupt vector read 1 0 Memory write 1 1 Memory read

See Chapter 3, "CPU OPERATION", for the timing of the signals.

CHAPTER 2 ARCHITECTURE

This chapter explains the S1C63000 ALU, registers, configuration of the program memory area and data memory area, and addressing.

2.1 ALU and Registers

2.1.1 ALU

The ALU (Arithmetic and Logic Unit) loads 4-bit data from a memory or a register and operates the data according to the instruction. Table 2.1.1.1 shows the ALU operation functions.

Table 2.1.1.1 ALU operation functions

Function classification	Mnemonic	Operation
Arithmetic	ADD	Addition
	ADC	Addition with carry
	SUB	Subtraction
	SBC	Subtraction with carry
	CMP	Comparison
	INC	Increment (adds 1)
	DEC	Decrement (subtracts 1)
Logic	AND	Logical product
	OR	Logical sum
	XOR	Exclusive OR
	BIT	Bit test
	CLR	Bit clear
	SET	Bit set
	TST	Bit test
Rotate / shift	RL	Rotate to left with carry
	RR	Rotate to right with carry
	SLL	Logical shift to left
	SRL	Logical shift to right

The operation result is stored to a register or memory according to the instruction.
In addition, the Z (zero) flag and C (carry) flag are set / reset according to the operation result.

2.1.2 Register configuration

Figure 2.1.2.1 shows the register configuration of the S1C63000.

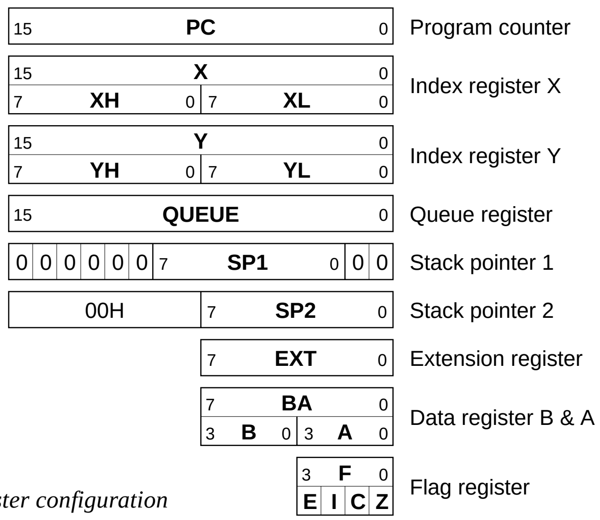


Fig. 2.1.2.1 Register configuration

- **A and B registers**

  The A and B registers are respective 4-bit data registers that are used for data transfer and operation with other registers, data memories or immediate data. They are used independently for 4-bit transfer / operations and used in a BA pair that makes the B register the high-order 4 bits for 8-bit transfer / operations.

- **X and Y registers**

  The X and Y registers are respective 16-bit index registers that are used for indirect addressing of the data memory. These registers are configured as an 8-bit register pair (high-order 8 bits: XH / YH, low-order 8 bits: XL / YL) and data transfer / operations can be done in an 8-bit unit or a 16-bit unit.

- **PC (program counter)**

  The PC is a 16-bit counter to address a program memory and indicates the following address to be executed.

- **SP1 and SP2 (stack pointers)**

  The SP1 and SP2 are respective 8-bit registers that indicate a stack address in the data memory. 8 bits of the SP1 correspond to the DA02 to DA09 bits of the address bus for 16-bit data accessing (address stacking) and it is used to operate the stack in a 4-word (16-bit) unit. 8 bits of the SP2 correspond to the low-order 8 bits (DA01 to DA07) of the address bus for 4-bit data accessing and it is used to operate stack in 1-word (4-bit) unit.
  See Section 2.3.3, "Stack and stack pointer" for details of the stack operation.

- **EXT register**

  The EXT register is an 8-bit data register that is used when an address or data is extended into 16 bits. See Section 2.1.5, "EXT register and data extension", for details.

- **F register**

  The F register includes 4 bits of flags; Z and C flags that are changed by operation results, I flag that is used to enable / disable interrupts, and E flag that indicates extended addressing mode.

- **Queue register**

  The queue register is used as a queue buffer for data when the SP1 processes 16-bit stack operations. This register is provided in order to process 16-bit data pop operations from the SP1 stack at high-speed. The queue register is accessed by the hardware, so it is not necessary to be aware of the register operation when programming.

2.1.3 Flags

The S1C63000 contains a 4-bit flag register (F register) that indicates such things as the operation result status within the CPU.

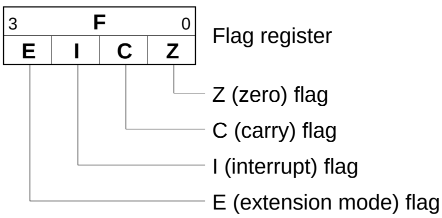


Fig. 2.1.3.1 F (flag) register

- **Z (zero) flag**

  The Z flag is set to "1" when the execution result of an arithmetic instruction or a shift / rotate instruction has become "0" and is reset to "0'" when the result is other than "0".

  Arithmetic instructions that change the Z flag:

  `ADD, ADC, SUB, SBC, CMP, INC, DEC, AND, OR, XOR, BIT, CLR, SET, TST`

Shift/Rotate instructions that change the Z flag:

`SLL, SRL, RL, RR`

The Z flag is used for condition judgments when executing the conditional jump ("JRZ sign8" and "JRNZ sign8") instructions, thus it is possible to branch processing to a routine according to the operation result.

• C (carry) flag

The C flag is set to "1" when a carry (carry from the most significant bit) or a borrow (the most significant bit borrows) has been generated by the execution of an arithmetic instruction and a shift / rotate instruction, otherwise the flag is set to "0".

Arithmetic instructions that change the C flag:

`ADD, ADC, SUB, SBC, CMP, INC, DEC`

(It is different from the Z flag, the logic operation instructions except for the instruction that operates the F register does not change the C flag. In addition, the ADD instructions for the X and Y register operations and the INC and DEC instructions for the stack pointer operation does not change the C flag.)

Shift/Rotate instructions that change the C flag:

`SLL, SRL, RL, RR`

The C flag is used for condition judgments when executing the conditional jump ("JRC sign8" and "JRNC sign8") instructions, thus it is possible to branch processing to a routine according to the operation result.

• I flag

The I flag permits and forbids the hardware interrupts except for the NMI. By setting the I flag to "1", the CPU enters in the EI (enable interrupts) status and the hardware interrupts are enabled. When the I flag is set to "0", the CPU is in the DI (disable interrupts) and the interrupts except for NMI are disabled. Furthermore, when a hardware interrupt (including the NMI) is generated, the I flag is reset to "0" and interrupts after that point are disabled. The multiple interrupts can be accepted by setting the I flag to "1" in the interrupt processing routine.
The NMI (non-maskable interrupt) is accepted regardless of the I flag setting.
The software interrupts are accepted regardless of the I flag and do not reset the I flag.
The I flag is set to "0" (DI status) at an initial reset, therefore it is necessary to set "1" before using interrupts by software.
See Section 3.5, "Interrupts" for details.

• E (extension mode) flag

The E flag indicates whether an extended addressing that uses the EXT (extension) register is valid or invalid. When data is loaded into the EXT register, this flag is set to "1" and the data of the instruction immediately after that (extended addressable instructions only) is extended with the EXT register. Then the instruction is executed and the E flag is reset to "0".
See Section 2.1.5, "EXT register and data extension" for details.

• Flag operations

As described above, the flags are automatically set / reset by the hardware. However, it is necessary to set by software, especially the I flag. The following instructions are provided in order to operate the F flag.

LD	%A,%F	Reads all the flag data	XOR	%F,imm4	Inverts flag(s)
LD	%F,%A	Writes all the flag data	PUSH	%F	Evacuates the F register
LD	%F,imm4	Writes all the flag data	POP	%F	Returns the F register
AND	%F,imm4	Resets flag(s)	RETI		Returns the F register*
OR	%F,imm4	Sets flag(s)			

* The RETI instruction is used to return from interrupt processing routines (including software interrupts), and returns the F register data that was evacuated when the interrupt was generated.

2.1.4 Arithmetic operations with numbering system

In the S1C63000, some instructions support a numbering system. These instructions are indicated with the following notations in the instruction list.

```
ADC  operand,n4
SBC  operand,n4
INC  operand,n4
DEC  operand,n4
```

(See "Instruction List" or "Detailed Explanation of Instructions" for the contents of the operand.)

"n4" is a radix, and can be specified from 1 to 16. The additions / subtractions are done in the numbering system with n4 as the radix. Various counters (such as binary, octal, decimal and hexadecimal) can be realized easily by software.

The Z flag indicates that an operation result is "0" or not in arithmetics with any numbering system. The C flag indicates a carry / borrow according to the radix.

The following shows examples of these operation.

Example 1) Octal addition `ADC %B,%A,8` (C flag is "0" before operation)

Setting value		Result	F register			
B register	A register	B register	E	I	C	Z
0010B(2)	0111B(7)	0001B(1)	0	–	1	0
0101B(5)	0011B(3)	0000B(0)	0	–	1	1

Example 2) Decimal subtractio `SBC %B,%A,10` (C flag is "0" before operation)

Setting value		Result	F register			
B register	A register	B register	E	I	C	Z
1001B(9)	0111B(7)	0010B(2)	0	–	0	0
0001B(1)	0010B(2)	1001B(9)	0	–	1	0

Example 3) 3-digit BCD down counter

```
     LDB  %EXT,0          ; Counter base address [0010H]
     LD   %XL,0x10
     LDB  [%X]+,0         ; Initial value setting [100]
     LDB  [%X]+,0
     LDB  [%X]+,1

     :
     :
CTDOWN:                   ; Count down subroutine----------
     LDB  %EXT,0          ; Counter base address [0010H]
     LD   %XL,0x10

     DEC  [%X]+,10        ; Decrements digit 1
     SBC  [%X]+,0,10      ; Decrements carry from digit 2
     SBC  [%X],0,10       ; Decrements carry from digit 3
     CALR CTDISP          ; Count number display routine
     LD   %A,0            ; Zero check
     ADD  %A,[%X]
     ADD  %X,-1
     ADD  %A,[%X]
     ADD  %X,-1
     JRNZ CTEXIT          ; Return if counter is not zero
     CALR CTOVER          ; Count over processing routine
CTEXIT:
     RET
```

This routine constructs a 3-digit BCD counter using the decimal operation instructions underlined. Calling the CTDOWN subroutine decrements the counter, and then returns to the main routine. If the counter has to be zero, the CTOVER subroutine is called before returning to the main routine to process the end of counting.

- **Notes in numbering operations**

When performing a numbering operation, set operands in correct notation according to the radix before operation.
For example, if a decimal operation is done for hexadecimal values (AH to FH), the correct operation result is not obtained as shown in the following example.

Example: `ADC %B,%A,10`

	Setting value		Result	F register				
	B register	A register	B register	E	I	C	Z	
1	1001B(9)	1001B(9)	1000B(8)	0	–	1	0	○
2	0101B(AH)	1001B(9)	1001B(9)	0	–	1	0	△
3	1010B(AH)	1010B(AH)	1010B(AH)	0	–	1	0	×
4	1010B(AH)	1111B(FH)	1111B(FH)	0	–	1	0	×

Example 1 operates correctly because a decimal value is loaded in the B and A registers.
Examples 3 and 4 do not operate correctly.
Example 2 operates correctly even though it is a wrong setting.

2.1.5 EXT register and data extension

The S1C63000 has a linear 64K-word addressable space, therefore it is required to handle 16-bit address data. The EXT register and the F flag that extend 8-bit data into 16-bit data permit 16-bit data processing. The EXT register is an 8-bit register for storing extension data. The E flag indicates that the EXT register data is valid (extended addressing mode), and is set to "1" by writing data to the EXT register. The E flag is reset at 1 cycle after setting (during executing the next instruction), therefore an EXT register data is valid only for the executable instruction immediately after writing. However, that executable instruction must be a specific instruction which permits the extended addressing to extend the data using the EXT register. These instructions are specified in "Instruction List" and "Detailed Explanation of Instructions". Make sure of the instructions when programming.

Note: Do not use instructions (see Instruction List) which are invalid for the extended addressing when the E flag is set to "1". (Do not use them following instructions that write data to the EXT register or that set the E flag.) Normal operations cannot be guaranteed if such instructions are used.

(1) Operation for EXT register and E flag (flag register)

The following explains the operation for the EXT register and the E flag (flag register).

- ***Data setting to the EXT register***

The following two instructions are provided to set data in the EXT register.

```
LDB   %EXT,imm8      Loads an 8-bit immediate data to the EXT register
LDB   %EXT,%BA       Loads the content of the BA register to the EXT register
```

By executing the instruction, the EXT flag is set to "1" and it indicates that the content of the EXT register is valid (the content of the EXT register will be used for data extension in the following instructions).
Furthermore, the content of the EXT register can be read using the instruction below.

```
LDB   %BA,%EXT       Loads the content of the EXT register to the BA register
```

- ***Setting/resetting the E flag***

As mentioned above, the E flag is set to "1" by data setting to the EXT register and reset to "0" while executing the next instruction.
In addition, the E flag can be set / reset using the following instructions that operate the flags.

```
LD    %F,%A          Writes all the flag data
LD    %F,imm4        Writes all the flag data
AND   %F,imm4        Resets flag(s)
OR    %F,imm4        Sets flag(s)
XOR   %F,imm4        Inverts flag(s)
```

The EXT register maintains the data set previously until new data is written or an initial reset. In other words, the content of the EXT register becomes valid by only setting the E flag using an above instruction without the register writing and is used for an extended addressing. However, the EXT register is undefined at an initial reset, therefore, do not directly set the E flag except when the content of the EXT register has been set for certain.

The following shows the other instructions related to flag data transfer.

`LD %A,%F`	Reads all the flag data
`PUSH %F`	Evacuates the F register
`POP %F`	Returns the F register
`RETI`	Returns the F register *

* The RETI instruction is used to return from interrupt processing routines (including software interrupts), and returns the F register data that was evacuated when the interrupt was generated.
If an interrupt (including NMI) is generated while fetching an instruction, such as a "LDB %EXT, • •" instruction or an instruction which writes data to the flag register (the E flag may be set), the interrupt is accepted after fetching (and executing) the next instruction. In normal processing, data extension processing is not performed after returning from the interrupt service routine because the interrupt processing including the F register evacuation is performed after the data extension has finished (E flag is reset). However, if the stack data in the memory is directly changed in the interrupt service routine, the F register in which the E flag is set may return. In this case, the instruction immediately after returning by the RETI instruction is executed in the extended addressing mode by the E flag set to "1". Pay attention to the F register setting except when consciously describing such a processing. It is necessary to pay the same attention when returning the F register using the "POP %F" instruction.

(2) Extension with E flag

The following explains the instructions that can be executed when the E flag is set to "1" and its operation.

- ***Modifying the indirect addressing with the X and Y registers (for 4-bit data access)***

The indirect addressing instructions, which contain [%X] or [%Y] as an operand and accesses 4-bit data using the X or Y register, functions as an absolute addressing that uses the EXT register data together with the E flag (= "1").
When an 8-bit immediate data (imm8) is written to the EXT register and the E flag is set immediately before these instructions, the instruction is modified executing as [%X] = [0000H + imm8] or [%Y] = [FF00H + imm8]. Therefore, the addressable space with this function is data memory address from 0000H to 00FFH when [%X] is used, and from FF00H to FFFFH when [%Y] is used. Generally, data that are often used are allocated to the data memory from 0000H to 00FFH and the area from FF00H to FFFFH is assigned to the I/O memory area (for peripheral circuit control), so these areas are frequently accessed. To access these areas by a normal indirect addressing (if the E flag has not been set) using the X or Y register, two or three steps of instructions are necessary for setting an address data. In other words, using this function promotes efficiency of the entire program. See Section 2.3, "Data Memory" for details of the data memory.

Examples:

```
LDB  %EXT,0x37
LD   %A,[%X]       ...Works as "LD  %A, [0x0037]"

LDB  %EXT,0x9C
ADD  [%Y],5        ...Works as "ADD  [0xFF9C], 5"
```

Note: This function can be used by only the specific instructions which permits the extended addressing (see "Instruction List"). Be aware that the operation cannot be guaranteed if the instructions indicated below are used.

1. *Instructions which have a source and /or a destination operand with the post-increment function, [%X]+ and [%Y]+.*
2. *Instructions which have [%X] and/or [%Y] in both the source and destination operands.*
3. *The RETD instruction and the LDB instructions which transfers 8-bit data.*

- ***16-bit data transfer/arithmetic for the index registers X and Y***

  The following six instructions, which handle the X or Y register and have an 8-bit immediate data as the operand, permit the extended addressing.

```
LDB  %XL,imm8      LDB  %YL,imm8
ADD  %X,sign8      ADD  %Y,sign8
CMP  %X,imm8       CMP  %Y,imm8
```

  When data is written to the EXT register and the E flag is set immediately before these instructions, the data is processed after extending into 16-bit; imm8 (sign8) is used as the low-order 8 bits and the content of the EXT register is used as the high-order 8 bits.

  Examples:

```
LDB  %EXT,0x15
LDB  %XL,0x7D      ...Works as "LD  %X,0x157D"

LDB  %EXT,0xB8
ADD  %X,0x4F       ...Works as "ADD  %X, 0xB84F"

LDB  %EXT,0xE6
CMP  %X,0xA2       ...Works as "CMP  %X, 0x19A2"
                     * 19H = FFH - [EXT] (E6H)
```

  Above examples use the X register, but work the same even when the Y register is used.

Note: The CMP instruction performs a subtraction with a complement, therefore it is necessary to set the complement (1's complement) of the high-order 8-bit data in the EXT register.
EXT register ← [FFH - High-order 8-bit data]

- ***Extending branch addresses***

  The following PC relative branch instructions, which have a signed 8-bit relative address as the operand, permit extended addressing.

```
JR   sign8      JRC  sign8      JRNC sign8      JRZ  sign8      JRNZ sign8
CALR sign8
```

  When data is written to the EXT register and the E flag is set immediately before these instructions, the relative address is processed after extending into signed 16-bit; sign8 is used as the low-order 8 bits and the content of the EXT register is as the high-order 8 bits.

  Examples:

```
LDB  %EXT,0x64
JR   0x29          ...Works as "JR  0x6429"

LDB  %EXT,0x00
JR   127           ...Works as "JR  127"

LDB  %EXT,0xFF
JR   -128          ...Works as "JR  -128"

LDB  %EXT,0x3A
JR*  0x88          ...Works as "JR*  0x3A88" (* = C, NC, Z, or NZ)

LDB  %EXT,0xF8
CALR 0x62          ...Works as "CALR  0xF862"
```

  See Section 2.2.3, "Branch instructions" for the branch instructions.

2.2 Program Memory

2.2.1 Configuration of program memory

The S1C63000 can access a maximum 64K-word (× 13 bits) program memory space. In the individual model of the S1C63 Family, the ROM of which size is decided depending on the model is connected to this space to write a program and static data.
Figure 2.2.1.1 shows the program memory map of the S1C63000.

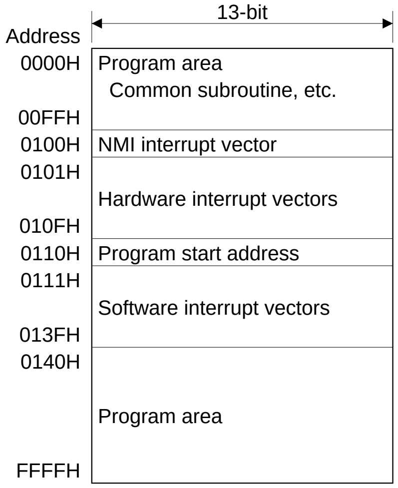


Fig. 2.2.1.1 S1C63000 program memory map

The S1C63000 can access 64K-word space linearly without any page management used in current 4-bit microcomputers.

As shown in Figure 2.2.1.1, the program start address after an initial reset is fixed at 0110H independent of the S1C63 Family models. Programming should be done so that the execution program starts from that address.

The address 0100H to 010FH is the hardware interrupt vector's area in which up to 16 interrupt vectors can be assigned. Address 0100H is for the exclusive use of NMI (non-maskable interrupt). The number of interrupt vectors is dependent on the interrupt function of the S1C63 Family models. Branch instructions to the interrupt service routines should be written in this area. See Section 3.5, "Interrupts" for details of the interrupts.

The address 0111H to 013FH is the software interrupt vector's area. Up to 63 software interrupts can be set up together with the hardware interrupt vector area. Set branch instructions to the interrupt service routines in this area similarly to the hardware interrupts.

Addresses from 0000H to 00FFH and from 0140H to FFFFH are program area. A call instruction (CALZ) that is for the exclusive use of the area from 0000H to 00FFH is provided so that the area is useful to store common subroutines that are called from relocatable modules.

2.2.2 PC (program counter)

The PC (program counter) is a 16-bit counter that keeps the program address to be executed next. The PC is incremented by executing every instruction step to execute a program sequentially. When a branch instruction is executed or an interrupt is generated, the content of the PC is modified to branch the process flow.
The PC covers the entire program memory space alone, therefore processing such as page management are unnecessary.
At initial reset, the PC is initialized to 0110H and the program starts executing from that address.

2.2.3 Branch instructions

Various branch instructions are provided for program repeat and subroutine calls that change a sequential program flow controlled with the PC. The branch instruction modifies the PC to branch the program to an optional address. The types of the branch instructions are classified as follows, according to their operation differences.

Table 2.2.3.1 Types of branch instructions

Type	Condition	Instruction
PC relative jump	Unconditional	JR
PC relative jump	Conditional	JRC, JRNC, JRZ, JRNZ
Indirect jump	Unconditional	JP
Absolute call	Unconditional	CALZ
PC relative call	Unconditional	CALR
Return	Unconditional	RET, RETS, RETD, RETI
Software interrupt	Unconditional	INT

• PC relative jump instructions (JR)

The PC relative jump instruction adds the relative address specified in the operand to the PC that has indicated the next address, and branches to that address. It permits relocatable programming.
The relative address to be specified in the operand is a displacement from the PC value (address of the next instruction) when the branch instruction is executed to the branch destination address. When programming using the S1C63 Family assembler, it is not necessary to calculate displacements because a branch destination address can be defined as a label and it can be used as an operand.
However, the range of branch destination addresses is different depending on the number of data bits that are handled as relative addresses.
The following explains the PC relative jump instructions and the relative addresses.

(1) Instructions with a signed 8-bit immediate data sign8 that specifies a relative address

Unconditional jump `JR sign8`
Conditional jump `JRC sign8` `JRNC sign8` `JRZ sign8` `JRNZ sign8`

These instructions branch the program sequence with the sign8 specified in the operand as a signed 8-bit relative address. The range that can be branched is from the next instruction address -128 to +127. A value within the range from -128 to +127 should be used if specifying a value for jumping in the assembler. Generally branch destination labels such as "JR LABEL" are used, and they are expanded into the actual address by the assembler.
These instructions permit the extended addressing with the E flag, and the 8-bit relative address can be extended into 16 bits (the contents of the EXT register become the high-order 8 bits). In this case, the range that can be branched is from the next instruction address -32768 to +32767. Consequently, in the extended addressing mode these instructions can branch the entire 64K program memory.

Examples:

`JR`	`-100`	...Jumps to the instruction 99 steps before
`LDB`	`%EXT,100`	...(100 × 256) = 25600
`JR`	`100`	...Jumps to the instruction 25701 steps after

The unconditional jump instruction "JR sign8" jumps to the branch destination unconditionally when it is executed.
The conditional jump instructions jump according to the status of C flag or the Z flag.

`JRC`	`sign8`	...Jumps if the C flag is "1", or executes the next instruction if the C flag is "0"
`JRNC`	`sign8`	...Jumps if the C flag is "0", or executes the next instruction if the C flag is "1"
`JRZ`	`sign8`	...Jumps if the Z flag is "1", or executes the next instruction if the Z flag is "0"
`JRNZ`	`sign8`	...Jumps if the Z flag is "0", or executes the next instruction if the Z flag is "1"

(2) Instruction with a 4-bit A register data that specifies a relative address

```
JR    %A
```

This instruction branches the program sequence with the content of the A register as an unsigned 4-bit relative address. The range that can be branched is from the next instruction address +0 to +15 (absolute value in the A register). This instruction is useful when operation results are used as the 4-bit relative addresses.

Example:

```
LD    %A,4
JR    %A                ...Jumps to the instruction 5 steps after
```

(3) Instruction with an 8-bit BA register data that specifies a relative address

```
JR    %BA
```

This instruction branches the program sequence with the content of the BA register as an unsigned 8-bit relative address (the B register data becomes the high-order 4 bits). The range that can be branched is from the next instruction address +0 to +255 (absolute value in the BA register). This instruction is useful when operation results are used as the 8-bit relative addresses.

Example:

```
LDB   %BA,29
JR    %BA               ...Jumps to the instruction 30 steps after
```

(4) Instruction with a data memory address within 0000H to 003FH in which the content specifies a 4-bit relative address

```
JR    [addr6]
```

This instruction branches the program sequence with the content of the data memory specified by the [addr6] as an unsigned 4-bit relative address. The operand [addr6] can specify a data memory address within 0000H to 003FH. The range that can be branched is from the next instruction address +0 to +15 (absolute value in the specified data memory). For the data memory area that is specified with [addr6], bit operation instructions (CLR, SET, TST) are provided so that various flags can be set simply. This jump instruction can be used as a conditional jump according to these flags.

Example: When the content of the address 0010H is 4 (0100B).

```
SET   [0x0010],0        ...Sets the bit 0 in the address 0010H to "1" ([0010H] = 5)
JR    [0x0010]          ...Jumps to the instruction 6 steps after
```

• Indirect jump instruction (JP)

The indirect jump instruction "JP %Y" loads the content of the Y register into the PC to branch to that address unconditionally. This instruction can branch entire 64K program memory because the 16-bit data in the Y register becomes a branch destination address as it is.

Example:

```
LDB   %EXT,0x24
LDB   %YL,0x00          ...Y = 2400H
JP    %Y                ...Jumps to the address 2400H
```

Figure 2.2.3.1 shows the operation of the jump instructions and the branch range.

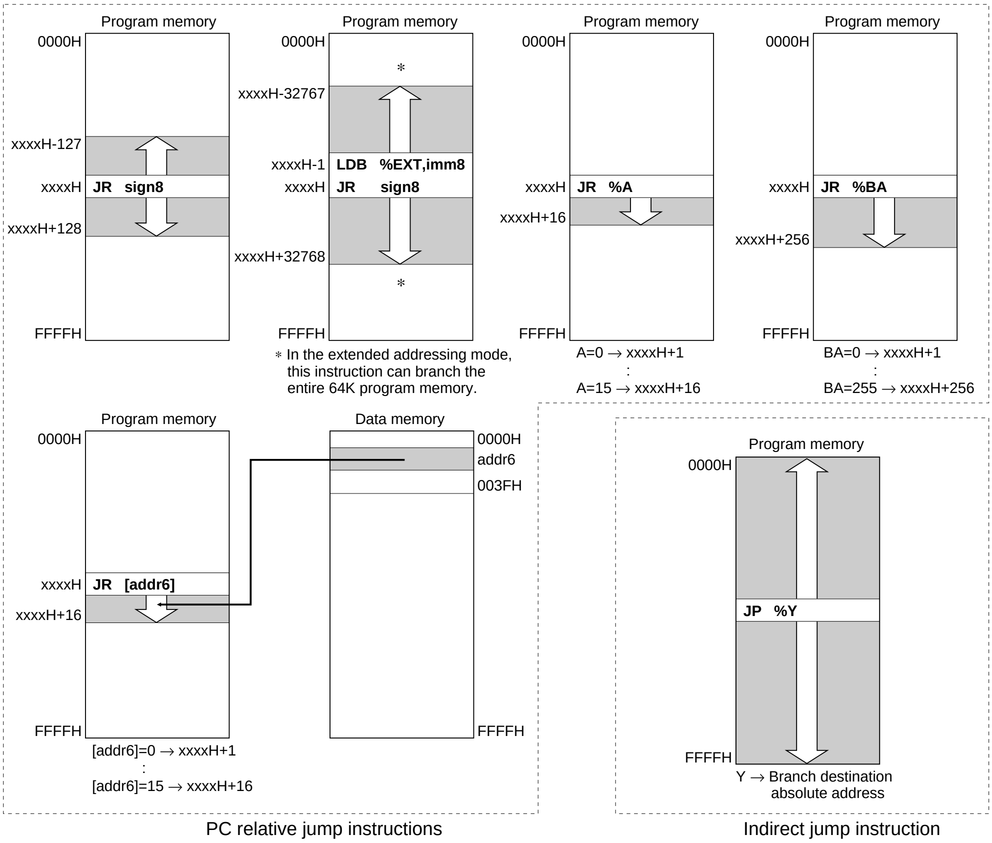


Fig. 2.2.3.1 Operation of jump instructions

• Absolute call instruction (CALZ)

The absolute call instruction "CALZ imm8" calls a subroutine within addresses 0000H to 00FFH. A subroutine start address (absolute address) should be specified to imm8. When the call instruction is executed, the PC value (address of the next instruction) is saved into the stack for return, then it branches to the specified address.
Generally common subroutines that are called from two or more modules are placed in this area when the program is developed as multiple modules.

Example:

`CALZ 0x50` ...Calls the subroutine located at the address 0050H

See Section 2.3.3, "Stack and stack pointer" for stack.

• PC relative call instructions (CALR)

The PC relative call instruction adds the relative address specified in the operand to the PC that has indicated the next address, and calls a subroutine started from that address. It permits relocatable programming.
The relative address to be specified in the operand is same as the PC related jump instruction.
The PC value (address of the next instruction) is saved into the stack before branching.

(1) Instructions with a signed 8-bit immediate data sign8 that specifies a relative address

`CALR sign8`

This instruction branches the program sequence with the sign8 specified in the operand as a signed 8-bit relative address. The range that can be branched is from the next instruction address -128 to +127. A value within the range from -128 to +127 should be used if specifying a value for calling in the assembler. Generally branch destination labels such as "CALR LABEL" are used, and they are expanded into the actual address by the assembler.

This instruction permits the extended addressing with the E flag, and the 8-bit relative address can be extended into 16 bits (the contents of the EXT register becomes the high-order 8 bits). In this case, the range that can be branched is from the next instruction address -32768 to +32767. Consequently, in the extended addressing mode this instruction can call subroutines over a 64K program memory.

Examples:

`CALR -50` ...Calls the subroutine 49 steps before

`LDB %EXT,50` ...(50 × 256) = 17800
`CALR 50` ...Calls the subroutine 17851 steps after

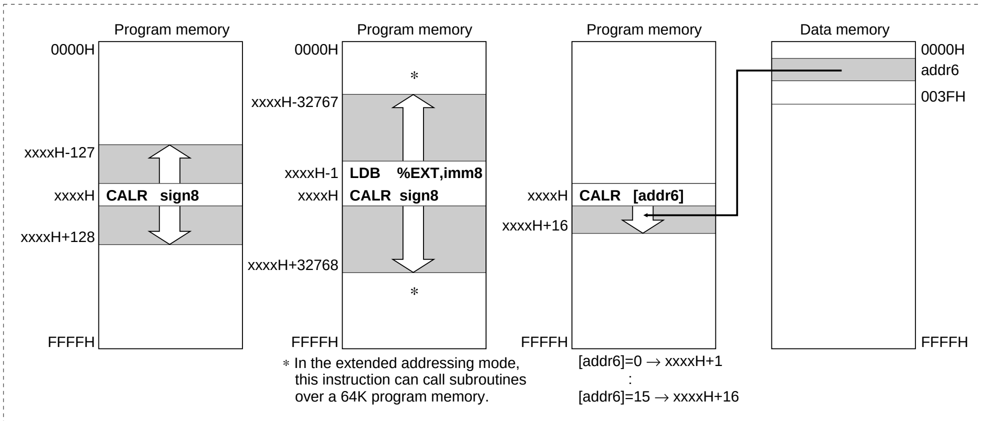
(2) Instruction with a data memory address within 0000H to 003FH in which the content specifies a 4-bit relative address

CALR [addr6]

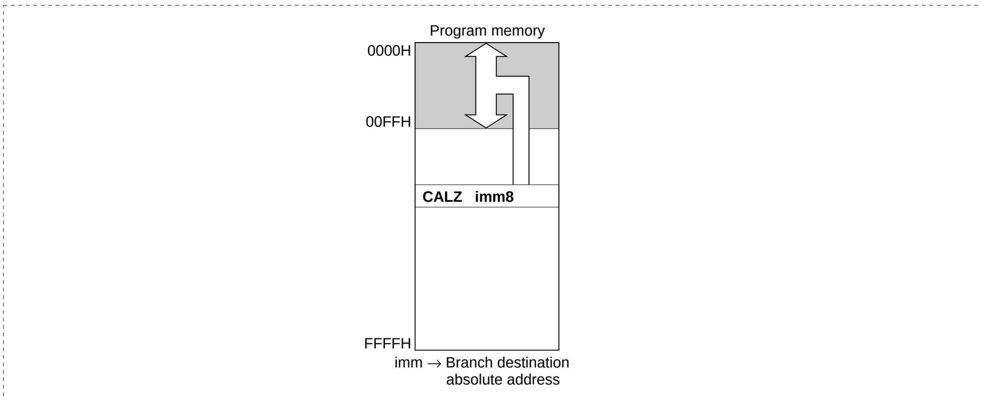
This instruction branches the program sequence with the content of the data memory specified by the [addr6] as an unsigned 4-bit relative address. The operand [addr6] can specify a data memory address within 0000H to 003FH. The range that can be branched is from the next instruction address +0 to +15. Same with the "JR [addr6]", this call instruction can be used as a conditional call according to the flags that are set in the memory specified with [addr6].

Example: When the content of the address 0010H is 4 (0100B).
`SET [0x0010],0` ...Sets the bit 0 in the address 0010H to "1" ([0010H] = 5)
`CALR [0x0010]` ...Calls the subroutine 6 steps after

Figure 2.2.3.2 shows the operation of the call instructions and the branch range.



PC relative call instructions



Absolute call instruction

Fig. 2.2.3.2 Operation of call instructions

- **Return instructions (RET, RETS, RETD, RETI)**

A return instruction is used to return from a subroutine called by the call instruction to the routine that called the subroutine. Return operation is done by loading the PC value (address next to the call instruction) that was stored in the stack when the subroutine was called into the PC.

The RET instruction operates only to return the PC value in the stack, and the processing is continued from the address next to the call instruction.

The RETS instruction returns the PC value then adds "1" to the PC. It skips executing an instruction next to the call instruction.

Figure 2.2.3.3 shows return operations from a subroutine.

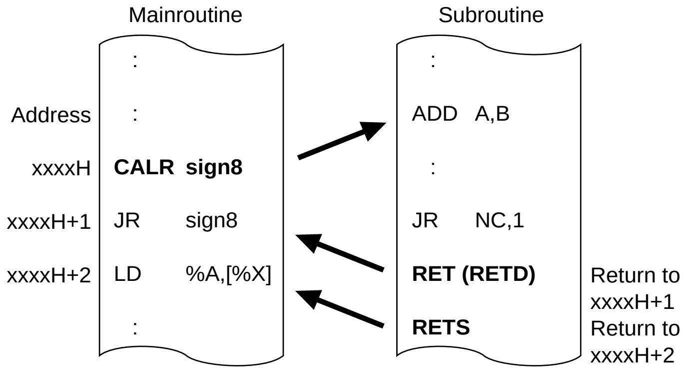


Fig. 2.2.3.3 Return from subroutine

The RETD instruction performs the same operation as the RET instruction, then stores the 8-bit data specified in the operand into the memory specified with the X register. This function is useful to create data tables that will be explained in the next section.

The RETI instruction is for the exclusive use of hardware and software interrupt service routines. When an interrupt is generated, the content of the F register is saved into the stack with the current PC value. The RETI instruction returns them.

- **Software interrupt instruction (INT)**

The software interrupt instruction "INT imm6" specifies a vector address within the addresses from 0111H to 013FH to execute its interrupt service routine. It can also call a hardware interrupt service routine because it can specify an address from 0100H. It performs the same operation with the call instruction, but the F register is also saved into the stack before branching. Consequently, the RETI instruction must be used for returning from interrupt service routines. See Section 3.5, "Interrupts" for details of the interrupt.

2.2.4 Table look-up instruction

The RETD instruction, one of the return instructions, has an 8-bit data in the operand, and stores the data in the memory specified with the X register (the low-order 8 bits are stored in [X] and the high-order 8 bits are stored in [X+1]) immediately after returning.
By using the RETD instruction combined with the "JR %BA" or "JR %A" instructions, an 8-bit data table for an LCD segment data conversion or similar can simply be constructed in the code ROM.

Example: The following is an example of a table for converting a BCD data (0 to 9) in the A register into an ASCII code (30H to 39H). The conversion result is stored in the addresses 0040H (low-order 4 bits) and 0041H (high-order 4 bits).

```
LD   %A,3       ;Sets data to be converted
CALR TOASCII    ;Calls converting routine
LDB  %BA,[%X]+  ;Loads result from memory to BA register
    :
    :
```

```
TOASCII:              ;BCD to ASCII conversion
     LDB  %EXT,0x00  ;Sets address 0040H
     LDB  %XL,0x40
     JR   %A
     RETD 0x30        ;"0"
     RETD 0x31        ;"1"
     RETD 0x32        ;"2"
     RETD 0x33        ;"3"
     RETD 0x34        ;"4"
     RETD 0x35        ;"5"
     RETD 0x36        ;"6"
     RETD 0x37        ;"7"
     RETD 0x38        ;"8"
     RETD 0x39        ;"9"
```

As shown in the example, operation results in the A or BA register can simply be converted into other formats.

2.3 Data Memory

2.3.1 Configuration of data memory

In addition to the program memory space, the S1C63000 can also access 64K-word (× 4 bits) data memory. In the individual model of the S1C63 Family, RAM of which size is decided depending on the model and I/O memory are connected to this space.
Figure 2.3.1.1 shows the data memory map of the S1C63000.

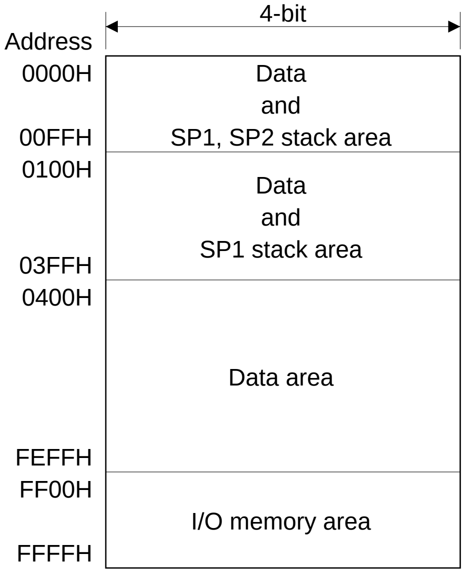


Fig. 2.3.1.1 S1C63000 data memory map

The S1C63000 can access 64K-word space linearly without any of the page management commonly used in current 4-bit microcomputers.

The S1C63000 has a built-in 16-bit data bus for the address stack (SP1), and a RAM that permits 16-bit data accessing can be connected to the addresses 0000H to 03FFH. The 16-bit accessible area is different depending on the individual models. That area permits normal 4-bit accessing. Switching between 4-bit accessing and 16-bit accessing is done according to the instruction by the hardware. A normal 4-bit data stack (SP2) is assigned within the addresses 0000H to 00FFH.

The addresses FF00H to FFFFH are used for an I/O memory area to control the peripheral circuits.

2.3.2 Addressing for data memory

For addressing to access the data memory, the index registers X and Y, and stack pointers SP1 and SP2 are used. (The next section will explain the stack pointers.)

Index registers X and Y are both 16-bit registers and cover the entire 64K data memory space. The data memory is accessed by setting an address in the register.

Example:

```
LDB  %EXT,0x00
LDB  %XL,0x10      ...Sets 0010H in the X register
LD   A,[%X]        ...Loads the content of the memory address 0010H into the A register
```

The indirect addressing with the X or Y register permits use of the post-increment function and processing for continuous addresses can be done efficiently. This function can be used in the instruction with [%X]+ or [%Y]+ as an operand. [%X]+ indicates that the content of the X register is incremented after end of transfer or operation, therefore the next address can be accessed without the X register re-setting. It is the same in case of the Y register.

Example: To copy the 3-word data from the address specified with the X register to the area specified with the Y register

```
LD [%Y]+,[%X]+
LD [%Y]+,[%X]+
LD [%Y],[%X]
```

In addition, the S1C63000 has also provided instructions in order to efficiently access only the area which is accessed frequently such as the I/O memory and lower addresses.
One of that is the addressing using the EXT register explained in Section 2.1.5.

- **Accessing for addresses 0000H to 00FFH**

  For absolute addressing in this area, the EXT register and an indirect instruction with the X register ([%X]) are used. To access this area, first write an 8-bit low-order address (00H to FFH) in the EXT register, then execute an indirect addressing instruction with an operand [%X] (only the instruction that permits the extended addressing). In this case, the content of the X register does not affect the address to be accessed. Also the content of the X register is not changed.

  Example:

  ```
  LDB  %EXT,0x37
  LD   %A,[%X]       ...Works as "LD  %A, [0x0037]"
  ```

- **Accessing for addresses FF00H to FFFFH (I/O memory area)**

  For absolute addressing in this area, the EXT register and an indirect instruction with the Y register ([%Y]) are used. To access this area, first write an 8-bit low-order address (00H to FFH) in the EXT register, then execute an indirect addressing instruction with an operand [%Y] (only the instruction that permits the extended addressing). In this case, the content of the Y register does not affect the address to be accessed. Also the content of the Y register is not changed.

  Example:

  ```
  LDB  %EXT,0x9C
  ADD  [%Y],5        ...Works as "ADD  [0xFF9C], 5"
  ```

Note: The extended addressing function using the EXT register is effective only for the instruction following immediately after writing data to the EXT register or setting the E flag to "1". For that instruction, do not use instructions other than the instructions that permit the extended addressing. Operation cannot be guaranteed if used.

In addition to the above functions, some 6-bit addressing instructions are provided to directly access that area. These instructions have a [addr6] as the operand and can alone directly access the area 0000H to 003FH or FFC0H to FFFFH.

- **Accessing for addresses 0000H to 003FH**

  Data in this area is used for a relative address by the "JR [addr6]" and "CALR [addr6]" explained in Section 2.2.3. This area is suitable for setting up various flags and counters since the bit operation instructions (CLR, SET, TST) and increment/decrement instructions (INC, DEC) are provided for accessing this area.

- **Accessing for addresses FFC0H to FFFFH (I/O memory area)**

  The bit operation instructions (CLR, SET, TST) are provided for accessing this area. Therefore, control bits in the I/O memory can be operated simply.

  Examples:

  `CLR [0xFFC0],0` ...Clears the D0 bit in the I/O memory address FFC0H to "0"

  `SET [0xFFD2],3` ...Sets the D3 bit in the I/O memory address FFD2H to "1"

2.3.3 Stack and stack pointer

The stack is a memory that is accessed in the LIFO (Last In, First Out) format and is allocated to the RAM area of the address 0000H to 03FFH. The stack area can be set from an optional address (toward the lower address) using the stack pointer.

The S1C63000 contains two stack pointers SP1 and SP2.

(1) Stack pointer SP1

The SP1 is used for the address data stack, and permits 16-bit data accessing.

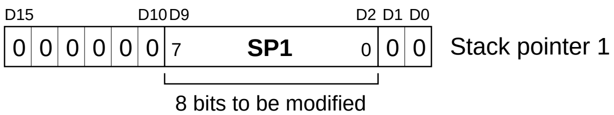


Fig. 2.3.3.1 SP1 configuration

As shown in the figure, the D0, D1 and D10–D15 within the 16 bits are fixed at "0". 8 bits of the D2–D9 can be set by software. Furthermore, the hardware also operates for this 8-bit field. Therefore, addressing by the SP1 is done in 4-word units, and a 16-bit address data can be transferred in one accessing. Since the SP1 performs 16-bit data accessing, this stack area is limited to the 16-bit accessible RAM area even though it is within the addresses 0000H to 03FFH.

This stack is used to evacuate return addresses when the call instructions are executed or the interrupts are generated. It is also used when the 16-bit data in the X or Y register is evacuated using the PUSH instruction. The return address data is written into the stack as shown in Figure 2.3.3.2.
The SP1 is decremented after the data is evacuated and is incremented when a return instruction is executed or after returning data by executing the POP instruction.

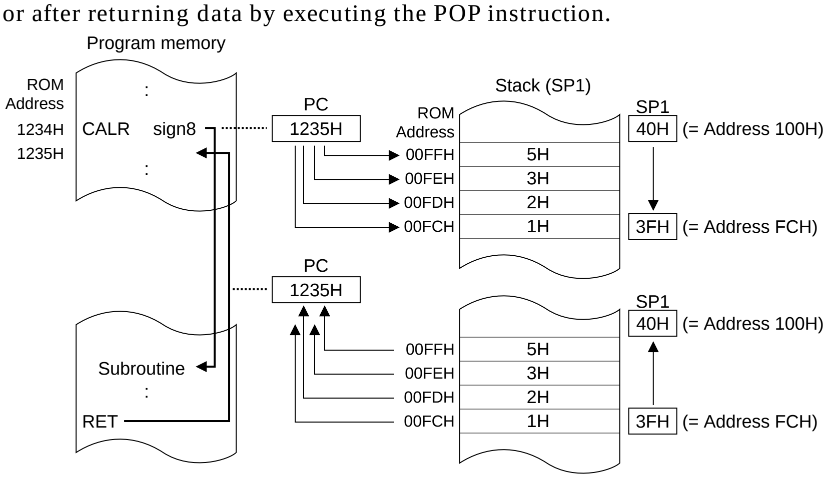


Fig. 2.3.3.2 Address stack operation

The SP1 increment / decrement affects only the 8-bit field shown in Figure 2.3.3.1, and its operation is performed cyclically. In other words, if the SP1 is decremented by the PUSH instruction or other conditions when the SP1 is 00H (indicating the memory address 0000H), the SP1 becomes FFH (indicating the memory address 03FCH). Similarly, if the SP1 is incremented by the POP instruction or other conditions when the SP1 is FFH (indicating the memory address 03FCH), the SP1 becomes 00H (indicating the memory address 0000H).

- ***Queue register***

  The queue register is provided in order to reduce the process time of the 16-bit data transfer by the SP1. The queue register retains 16-bit data in the RAM indicated with the SP1. It is accessed when the following instructions are executed, not by programs directly.

  1. When the call instruction or the PUSH instruction is executed, and when an interrupt is generated

     When the CALR or CALZ instruction is executed, a software interrupt by the INT instruction is generated, and a hardware interrupt is generated, the PC value for returning is written in the memory [SP1-1]. When the "PUSH %X" or "PUSH %Y" instruction is executed, the content of the X register or Y register is written in the memory [SP1-1]. At this time, the same data which is written in the memory [SP1-1] is also written to the queue register.

  2. When the return instruction or the POP instruction is executed

     When the RET, RETS, RETD, RETI, "POP %X" or "POP %Y" instructions are executed, the data retained in the queue register is returned to the PC, X register or Y register. Since the SP1 is incremented, the content of the queue register is renewed (it generates a bus cycle to load the content of the memory [SP1+1] to the queue register).

  3. When the "LDB %SP1, %BA", "INC SP1" or "DEC SP1" instructions are executed

     When these instructions are executed, the content of the queue register is also renewed (it generates a bus cycle to load the content of the memory [SP1] to the queue register).

Note: *As shown above, the memory content that is indicated by the SP1 is written to the queue register according to the SP1 changes. Therefore, the queue register is not renewed even if the memory [SP1] is directly modified when the SP1 is not changed. Be aware that intended return and POP operations cannot be performed if such an operation is done.*

(2) Stack pointer SP2

The SP2 is used for the normal 4-bit data stack.

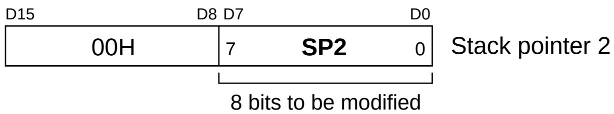


Fig. 2.3.3.3 SP2 configuration

In the case of the SP1, the D8–D15 within the 16 bits are fixed at "0". 8 bits of the D0–D7 can be set by software. Furthermore, the hardware also operates for this 8-bit field. The address range that can be used for the data stack is limited to within 0000H to 00FFH. Data evacuation / return is done in 1-word units.

This stack is used to evacuate the F register data when an interrupt is generated. It is also used when the 4-bit register data (A, B, F) is evacuated using the PUSH instruction. The register data is written into the stack as shown in Figure 2.3.3.4.
The SP2 is decremented after the data is evacuated and is incremented when the data is returned.

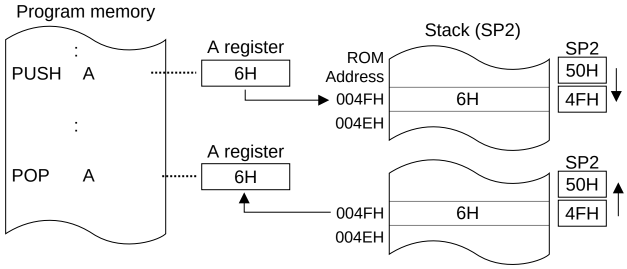


Fig. 2.3.3.4 4-bit stack operation

The SP2 increment/decrement affects only the 8-bit field shown in Figure 2.3.3.3, and its operation is performed cyclically. In other words, if the SP2 is decremented by the PUSH instruction or other conditions when the SP2 is 00H (indicating the memory address 0000H), the SP2 becomes FFH (indicating the memory address 00FFH). Similarly, if the SP2 is incremented by the POP instruction or other conditions when the SP2 is FFH (indicating the memory address 00FFH), the SP2 becomes 00H (indicating the memory address 0000H).

(3) Notes for using the stack pointer

- The SP1 and SP2 are undefined at an initial reset. Therefore, both the stack pointers must be initialized by software.
  For safety, all the interrupts including NMI are masked until both the SP1 and SP2 are set by software. Furthermore, if either the SP1 or SP2 is re-set, all the interrupts are masked again until the other is re-set. Therefore be sure to set the SP1 and SP2 as a pair.
- The increment/decrement for the SP1 and SP2 is operated cyclically from 0000H to 03FFH (SP1) and from 0000H to 00FFH (SP2) regardless of the memory capacity/allocation set up in each model. Control with the program so that the stacks do not cross over the upper/lower limits of the mounted memory.
- The SP1 must be set in the RAM area that permits 16-bit accessing depending on the model. The SP1 address stack cannot be allocated to other than the 16-bit accessible area even if the address is less than 03FFH.
- The area management for the SP1 stack, SP2 stack and data RAM should be done by the user. Pay attention to these areas so that they do not overlap in the same addresses.

2.3.4 Memory mapped I/O

The S1C63 Family contains the S1C63000 as the core CPU and various types of peripheral circuits, such as input/output ports. The S1C63000 has adopted a memory mapped I/O system for controlling the peripheral circuits, and the control bits and the registers for exchanging data are arranged in the data memory area.

The I/O memory for controlling the peripheral circuits is assigned to the area from FF00H to FFFFH, and is distinguished from RAM and others. However, the accessing method is the same as RAM, so indirect addressing can be done using the X or Y register. In addition, since the I/O memory is accessed frequently, the exclusive instructions for this area are also provided. (See Section 2.3.2.)

Refer to the manual for the individual model of the S1C63 Family for the I/O memory and the peripheral circuits.

CHAPTER 3 CPU OPERATION

This section explains the CPU operations and the operation timings.

3.1 Timing Generator and Bus Cycle

The S1C63000 has a built-in timing generator. The timing generator of the S1C63000 generates the two-phase divided signals PK and PL based on the clock (CLK) input externally (*) to make states. One state is a 1/2 cycle of the CLK and the one bus cycle that becomes the instruction execution unit is composed of four states.

* The clock that is input to the S1C63000 is generated by an oscillation circuit provided outside of the CPU. The S1C63 Family models have a built-in oscillation circuit.

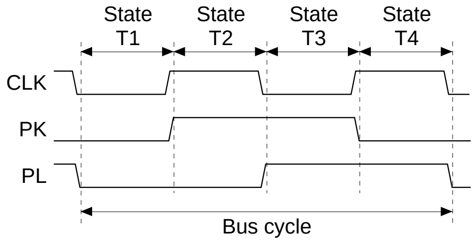


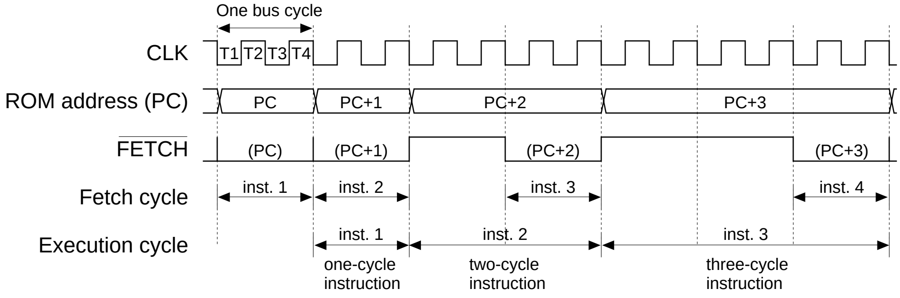
Fig. 3.1.1 State and bus cycle

The number of cycles which is stated in the instruction list indicates the number of bus cycles.

3.2 Instruction Fetch and Execution

The S1C63000 executes the instructions indicated with the PC (program counter) one by one. That operation for an instruction is divided into two stages; one is a fetch cycle to read an instruction, and another is an execution cycle to execute the instruction that has been read.

All the S1C63000 instructions are composed of one step (word), and are fetched in one bus cycle. An instruction code that is written in the ROM is read out during the fetch cycle and is analyzed by the instruction decoder. The $\overline{\text{FETCH}}$ signal goes to a low level during that time. In addition, the PC is incremented at the end of each fetch.
The analyzed instruction is executed from the next bus cycle. The number of execution cycles is shown in the instruction list and it is one, two or three bus cycles depending on the instruction.
The S1C63000 contains two different buses for the program memory and the data memory. Consequently, a fetch cycle for the next instruction can be executed to overlap with the last execution cycle, and it increases the processing speed. In the one-cycle instructions, the next instruction is fetched at the same time an instruction is executed.



ROM address	Instruction
:	:
PC	inst. 1 (one-cycle instruction)
PC+1	inst. 2 (two-cycle instruction)
PC+2	inst. 3 (three-cycle instruction)
PC+3	inst. 4 (one-cycle instruction)
:	:

Fig. 3.2.1 Fetch cycle and execution cycle

3.3 Data Bus (Data Memory) Control

3.3.1 Data bus status

The S1C63000 output the data bus status in each bus cycle externally on the DBS0 and DBS1 signals as a 2-bit status. The peripheral circuits perform the direction control of the bus driver and other controls with these signals. The data bus statuses indicated by the DBS0 and DBS1 are as shown in Table 3.3.1.1.

Table 3.3.1.1 Data bus status

DBS1	DBS0	State
0	0	High impedance
0	1	Interrupt vector read
1	0	Memory write
1	1	Memory read

3.3.2 High-impedance control

The data bus goes to a high-impedance during an execution cycle (∗) that accesses only the internal registers in the CPU. During the bus cycle period, both the read signal $\overline{RD}$ and write signal $\overline{WR}$ are fixed at a high level and a dummy address is output on the address bus.

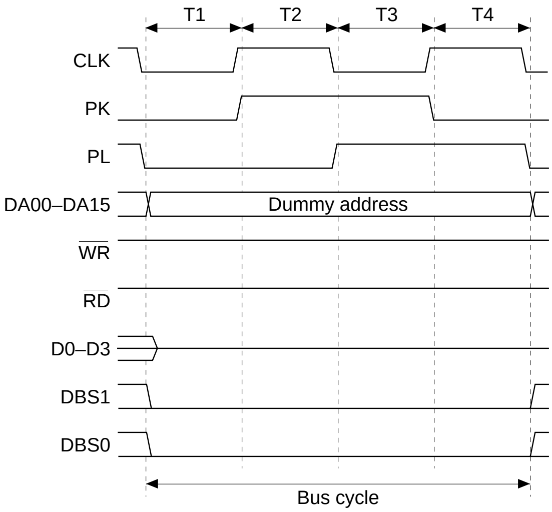


Fig. 3.3.2.1 Bus cycle during accessing internal register

∗ Data is output on the data bus only when the stack pointer SP1 is accessed because a data transfer is performed between the queue register and the data memory. In this case, the data bus status becomes a memory write or a memory read depending on the instruction that accesses the SP1.

3.3.3 Interrupt vector read

When an interrupt is generated, the CPU reads the interrupt vector output to the data bus by the peripheral circuit that has generated the interrupt. The interrupt vector read status indicates this bus cycle. The peripheral circuit outputs the interrupt vector to the data bus during this status, and the CPU reads the data between the T2 and T3 states. At this time, the CPU outputs the $\overline{\text{RDIV}}$ signal (for exclusive use of the interrupt vector read) as a read signal, not the $\overline{\text{RD}}$ signal that is used for normal data memory read. The address bus outputs a dummy address during this bus cycle. See Section 3.5 for the operation when an interrupt is generated.

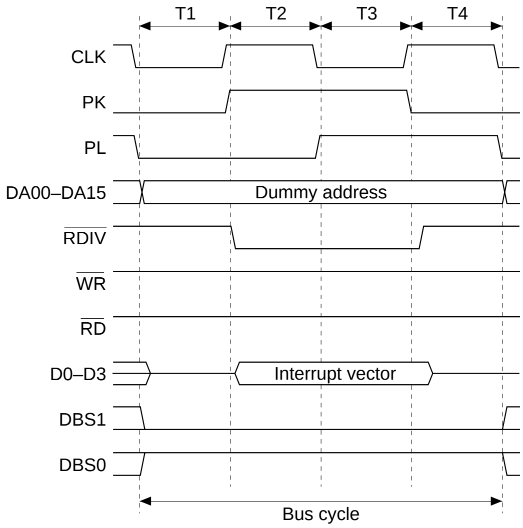
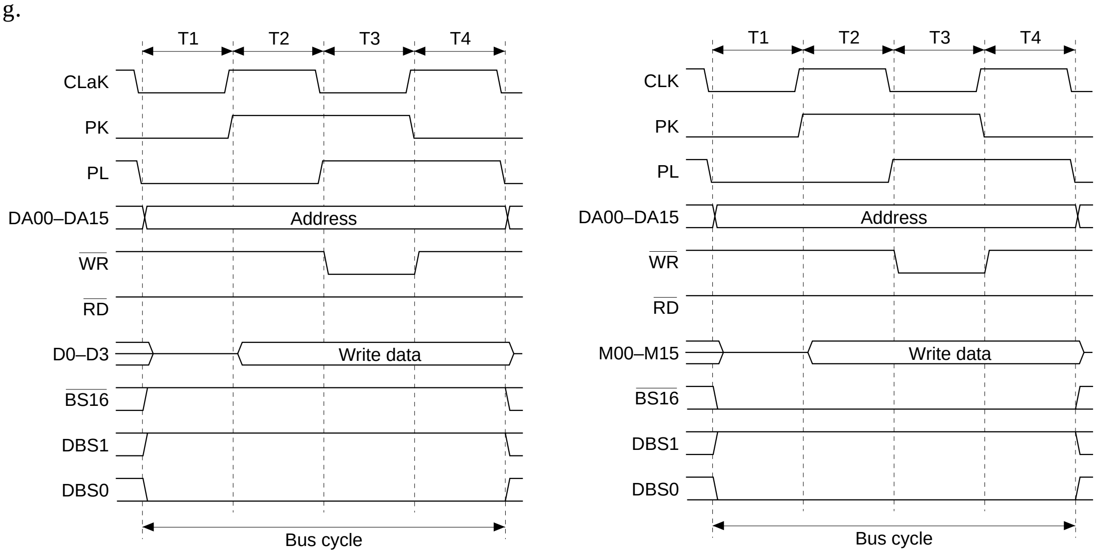


Fig. 3.3.3.1 Bus cycle during reading interrupt vector

3.3.4 Memory write

In an execution cycle that writes data to the data memory, the writing data is output to the data bus between the T2 and T4 states and the write signal $\overline{\text{WR}}$ is output in the T3 state. The address bus outputs the target address during this bus cycle.

The S1C63000 contains a 4-bit data bus (D0–D3) and a 16-bit data bus (M00–M15) for an address stacking. The CPU switches the data bus according to the instruction. The $\overline{\text{BS16}}$ signal is provided for this switching.

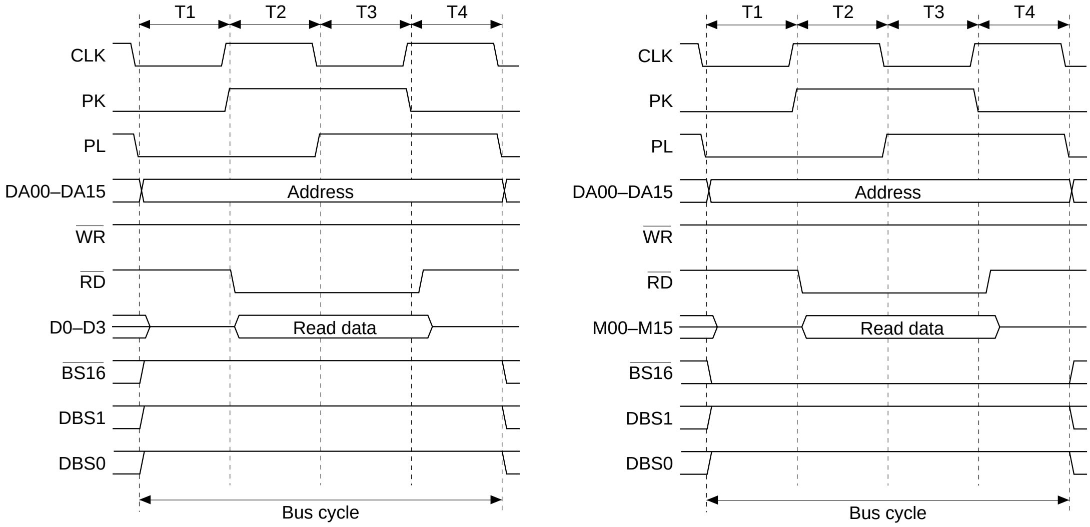


(a) During 4-bit data access (b) During 16-bit data access

Fig. 3.3.4.1 Bus cycle during memory write

3.3.5 Memory read

In an execution cycle that reads data from the data memory, the read signal $\overline{\text{RD}}$ is output between the T2 and T3 states and data is read from the data bus. The address bus outputs the target address during this bus cycle.
The 4-bit / 16-bit access is the same as the memory write.



(a) During 4-bit data access (b) During 16-bit data access

Fig. 3.3.5.1 Bus cycle during memory read

3.4 Initial Reset

The S1C63000 has a reset ($\overline{\text{SR}}$) terminal in order to start the program after initializing the circuit when the power is turned on or other situations. The following explains the operation at an initial reset and the initial setting of the internal registers.

3.4.1 Initial reset sequence

The S1C63000 enters into an initial reset status immediately after setting the $\overline{\text{SR}}$ terminal to a low level, and the internal circuits are initialized. During an initial reset, the data bus goes to a high-impedance and the $\overline{\text{RD}}$ and $\overline{\text{WR}}$ signals go to a high level.
When the $\overline{\text{SR}}$ terminal goes to a high level, the initial reset is released and the program starts executing from address 0110H. The release of an initial reset (the $\overline{\text{SR}}$ terminal goes a high level) is accepted at the rising edge of the CPU operation clock (CLK), and the first bus cycle (fetching the instruction of the address 0110H) starts from 1 clock after.

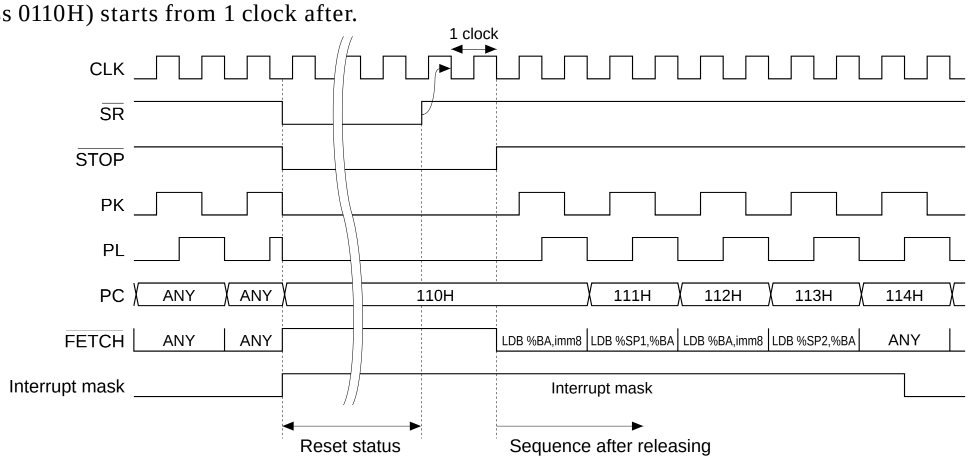


Fig. 3.4.1.1 Initial reset status and sequence after releasing

After an initial reset, all the interrupts including NMI are masked until both the stack pointers SP1 and SP2 are set by software.

3.4.2 Initial setting of internal registers

An initial reset initializes the internal registers in the CPU as shown in Table 3.4.2.1.

Table 3.4.2.1 Initial setting of internal registers

Name	Symbol	Number of bits	Setting value
Data register A	A	4	Undefined
Data register B	B	4	Undefined
Extension register EXT	EXT	8	Undefined
Index register X	X	16	Undefined
Index register Y	Y	16	Undefined
Program counter	PC	16	0110H
Stack pointer SP1	SP1	8	Undefined
Stack pointer SP2	SP2	8	Undefined
Zero flag	Z	1	Undefined
Carry flag	C	1	Undefined
Interrupt flag	I	1	0
Extension flag	E	1	0
Queue register	Q	16	Undefined

The registers and flags which are not initialized at an initial reset should be initialized in the program if necessary.
Be sure to set both the stack pointers SP1 and SP2. All the interrupts cannot be accepted if they are not set as a pair.

3.5 Interrupts

Interrupt is a function to process factors, that generate asynchronously with program execution, such as a key entry and an end of a peripheral circuit operation. When the CPU accepts an interrupt request that is sent by the hardware, the CPU stops executing the current sequence of the program and shifts into the interrupt processing. When all the interrupt processing has finished, the interrupted program is resumed.

The S1C63000 has the hardware interrupt function for the peripheral circuits including an NMI (non-maskable interrupt) and the hardware interrupt function. The hardware interrupts excluding the NMI can be set to the DI (disable interrupts) status by setting the I (interrupt) flag.

I flag = "1": EI (enable interrupts) status ...The CPU accepts interrupt requests from the peripheral circuits.
I flag = "0": DI (disable interrupts) status ...The CPU does not accept interrupt requests from the peripheral circuits. (excluding NMI and software interrupts)

The I flag is set to "0" at an initial reset. Furthermore, all the interrupts including NMI are masked and cannot be accepted regardless of the I flag setting until both the stack pointers SP1 and SP2 are set in the program after an initial reset.

3.5.1 Interrupt vectors

Interrupt vectors are provided to execute a interrupt service routine corresponding to the interrupt generated.
The interrupt vectors are assigned to the following addresses in the ROM.

NMI interrupt vector: 0100H
Hardware interrupt vectors: 0101H to 010FH
Software interrupt vectors: 0111H to 013FH

Each of the addresses listed above corresponds to an interrupt factor individually. A branch (jump) instruction to the interrupt service routine should be written to these addresses.

Up to 15 hardware interrupt vectors are available, however, the number of vectors is different depending on the S1C63 Family models. The addresses, that are not assigned to the hardware interrupt vector within the addresses 0101H to 010FH, can be used as software interrupt vectors. In addition, since the hardware interrupt service routines can be executed using the software interrupt, up to 63 software interrupts can be used (excluding the address 0110H because it is the program start address).

3.5.2 Interrupt sequence

• Hardware interrupts

Hardware interrupts including NMI are generated by the peripheral circuits. The peripheral circuit that contains the interrupt function outputs an interrupt request to the CPU when the interrupt factor is generated. The $\overline{\text{NMI}}$ terminal for NMI or $\overline{\text{IRQ}}$ terminal for other interrupts goes low. Sampling the $\overline{\text{NMI}}$ signal is done at the falling edge by the CPU. Sampling the $\overline{\text{IRQ}}$ signal is done at the rising edge of the T3 state in the bus cycle. The CPU executes the following process after accepting an interrupt request.

Bus cycle 0 Sampling the interrupt request.

Bus cycle 1 The last execution cycle of the instruction under execution becomes a dummy fetch cycle. This cycle turns the interrupt acknowledge signal low (both $\overline{\text{NACK}}$ and $\overline{\text{IACK}}$ for NMI, $\overline{\text{IACK}}$ only for a normal interrupt), which indicates that the interrupt has been accepted.

Bus cycle 2 Saves the F register into the stack indicated by the SP2, then resets the I flag to "0" to prohibit following interrupts (excluding NMI).

Bus cycle 3 Sets the data bus status DBS1 / DBS0 to "01B". Then, turns the vector read signal $\overline{\text{RDIV}}$ low and reads the interrupt vector (4 bits) output from the peripheral circuit to the data bus.
When NMI is generated, this cycle becomes a dummy cycle because the interrupt vector is fixed at 0100H.
The $\overline{\text{NACK}}$ and / or $\overline{\text{IACK}}$ are returned to high at the end of this cycle.

Bus cycle 4 Fetches the instruction in the interrupt vector (data that is read in Bus cycle 3 becomes the low-order 4 bits of the vector) and saves the content of the PC (address immediately after the instruction that is executed in Bus cycle 0 or branch destination address when it is a branch instruction) to the stack indicated by the SP1.

Bus cycle 5 Executes the instruction fetched in Bus cycle 4. (If it is 1-cycle instruction, the next instruction is fetched at the same time.)

• ***Exceptional acceptance of interrupt***

For all the interrupts including NMI that are generated during fetching the following instructions are accepted after the next instruction is fetched (it is executed) even in the EI (enable interrupts) status.

1. Instructions that set the E flag
```
LDB %EXT,imm8     LDB %EXT,%BA
```
2. Instructions that write data in the F (flag) register
```
LD  %F,%A     LD  %F,imm4     AND %F,imm4     OR  %F,imm4
XOR %F,imm4   POP %F          RETI
```

These instructions set the E flag or may set it. Therefore, if an extended addressing instruction follows them, it is executed previous to the interrupt processing.
Further, these instructions may modify the content of the I flag. If these instructions set the I flag (EI status), the interrupt processing is done after executing the next instruction. If these instructions reset the I flag (DI status), interrupts generated after the instruction fetch cycle are masked.

3. Instructions that set the stack pointer
   `LDB %SP1,%BA`   `LDB %SP2,%BA`

These two instructions are also accepted after fetching the next instruction. However, these instructions must be executed as a pair. When one of them is fetched at first, all the interrupts including NMI are masked (interrupts cannot be accepted). Then, when the other instruction is fetched, that mask is released and interrupts can be accepted after the next instruction is fetched.

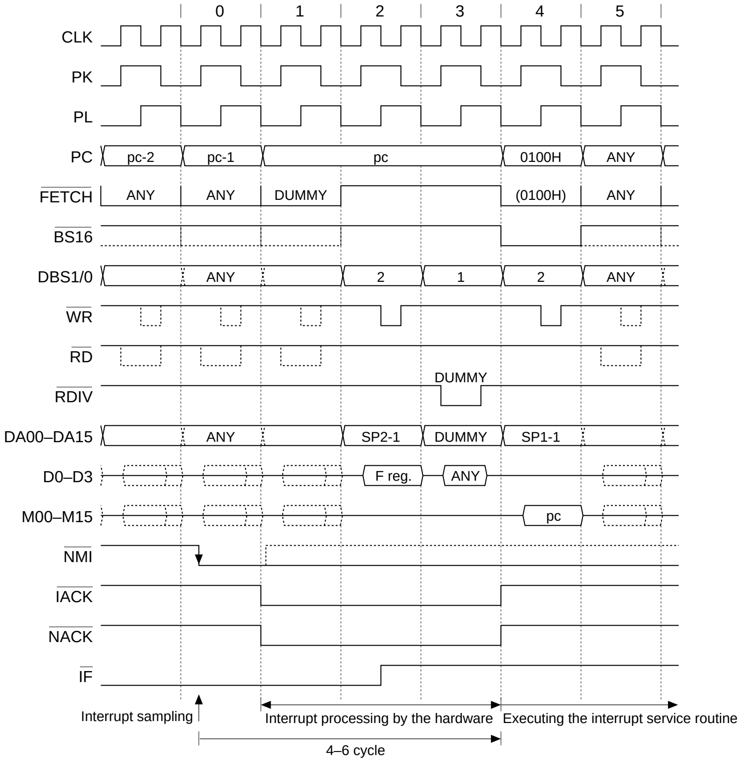
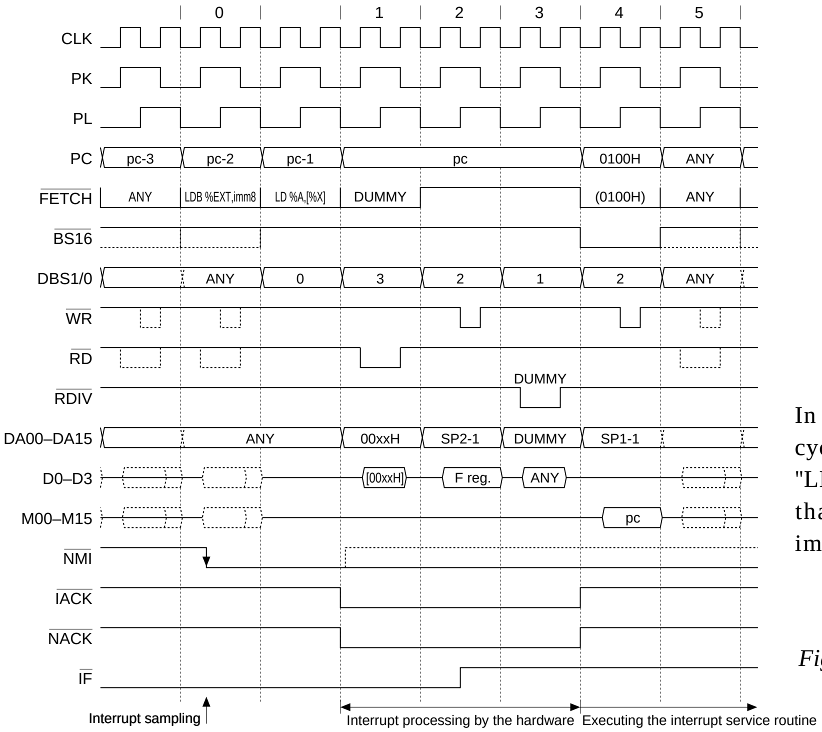


Fig. 3.5.2.1 NMI sequence (normal acceptance)



In this chart, the dummy fetch cycle starts after fetching the "LD %A, [%X]" instruction that follows the "LDB %EXT, imm8" instruction.

Fig. 3.5.2.2 NMI sequence (interrupt acceptance after 1 instruction)

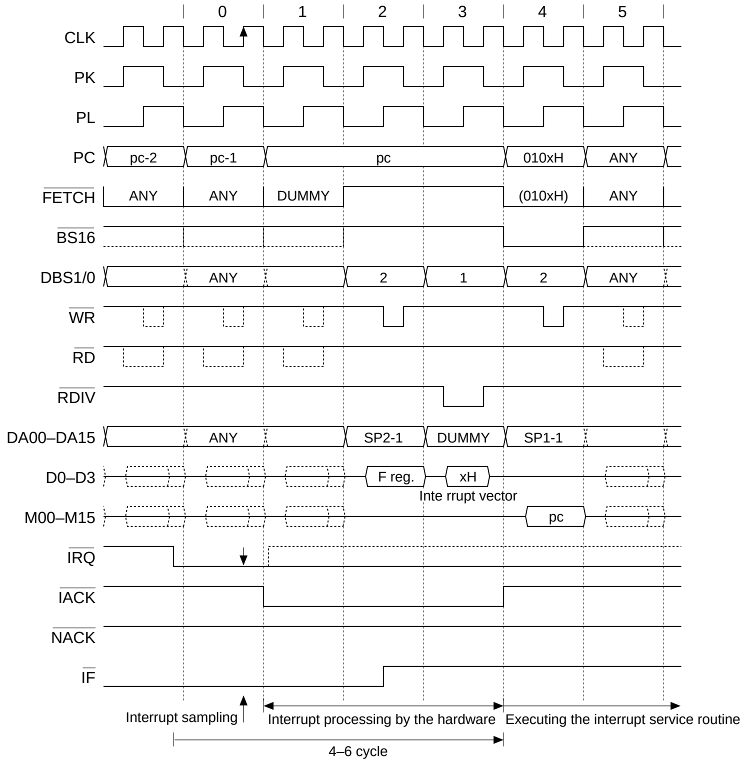
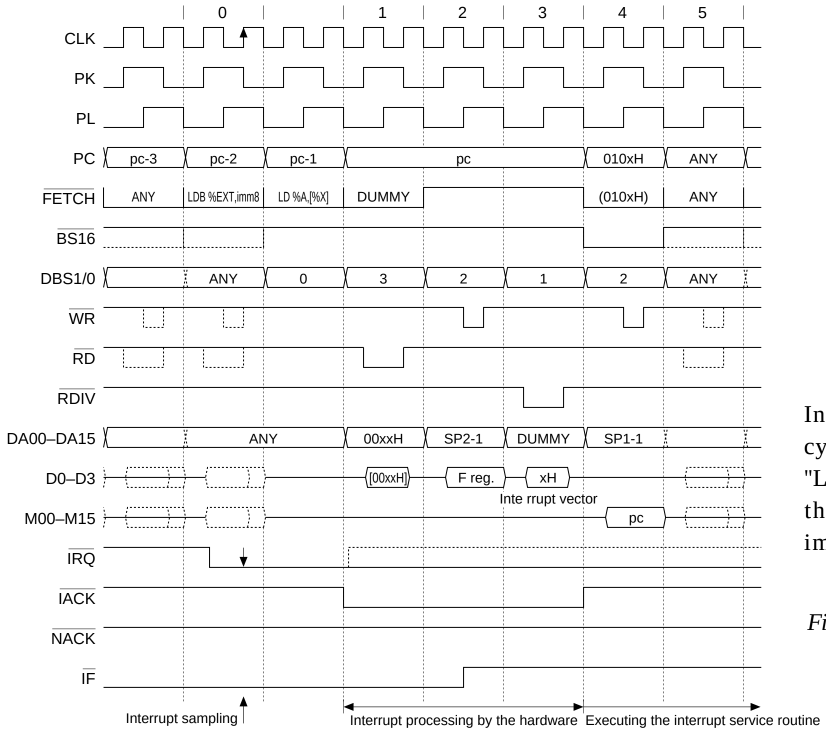


Fig. 3.5.2.3 Hardware interrupt (IRQ) sequence (normal acceptance)



In this chart, the dummy fetch cycle starts after fetching the "LD %A, [%X]" instruction that follows the "LDB %EXT, imm8" instruction.

Fig. 3.5.2.4 Hardware interrupt (IRQ) sequence (interrupt acceptance after 1 instruction)

- **Software interrupts**

The software interrupts are generated by the INT instruction. Time of the interrupt generation is determined by the software, so the I flag setting does not affect the interrupt. That processing is the same as the subroutine that evacuates the F register into the stack.
This interrupt does not change the interrupt control signals between the CPU and the peripheral circuits, or the I flag either. An address that is specified with the operand of the INT instruction is used as it is as the interrupt vector.

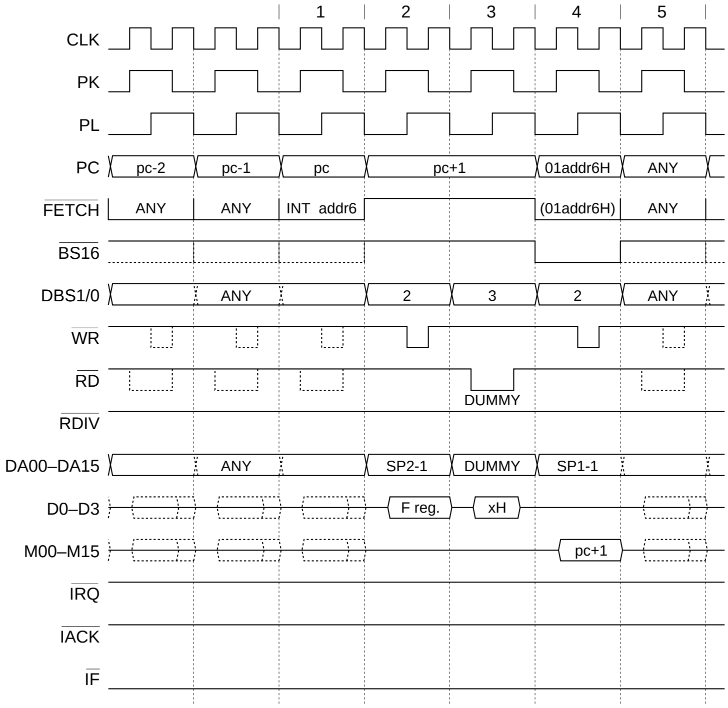


Fig. 3.5.2.5 Software interrupt sequence

3.5.3 Notes for interrupt processing

(1) After an initial reset, all the interrupts including NMI are masked and cannot be accepted regardless of the I flag setting until both the stack pointers SP1 and SP2 are set in the program. Be sure to set the SP1 and SP2 in the initialize routine.
Further, when re-setting the stack pointer, the SP1 and SP2 must be set as a pair. When one of them is set, all the interrupts including NMI are masked and interrupts cannot be accepted until the other one is set.

(2) The interrupt processing is the same as a subroutine call that branches to the interrupt vector address. At that time, the F register is evacuated into the stack. Therefore, the interrupt service routine should be made as a subroutine and the RETI instruction that returns the F register must be used for return.

(3) If an interrupt (including NMI) is generated while fetching an instruction, that sets the E flag or writes data to the F (flag) register, the interrupt is accepted after fetching (and executing) the next instruction. Therefore, the extended addressing with the EXT register is processed before executing the interrupt processing. However, if the stack data in the memory is directly changed in the interrupt service routine, the F register in which the E flag is set may return. In this case, the instruction immediately after returning by the RETI instruction is executed in the extended addressing mode by the E flag that is set to "1". Pay attention to the F register setting except when describing such a processing consciously.

3.6 Standby Status

The S1C63000 has a function that stops the CPU operation and it can greatly reduce power consumption. This function should be used to stop the CPU when there is no processing to be executed in the CPU, example while the application program waits an interrupt. This is a standby status where the CPU has been stopped to shift it to low power consumption.
This status is available in two types, a HALT status and a SLEEP status.

3.6.1 HALT status

The HALT status is the status in which only the CPU stops and shifting to it can be done using the HALT instruction. The HALT status is released by a hardware interrupt including NMI, and the program sequence returns to the step immediately after the HALT instruction by the RETI instruction in the interrupt service routine. The peripheral circuits including the oscillation circuit and timer operate all through the HALT status. Moreover during HALT status, the contents of the registers in the CPU that have been set before shifting are maintained.
Figure 3.6.1.1 shows the sequence of shifting to the HALT status and restarting.
In the HALT status the Th1 and Th2 states are continuously inserted. During this period, interrupt sampling is done at the falling edge of the Th2 state and the generation of an interrupt factor causes it to shift to the interrupt processing.

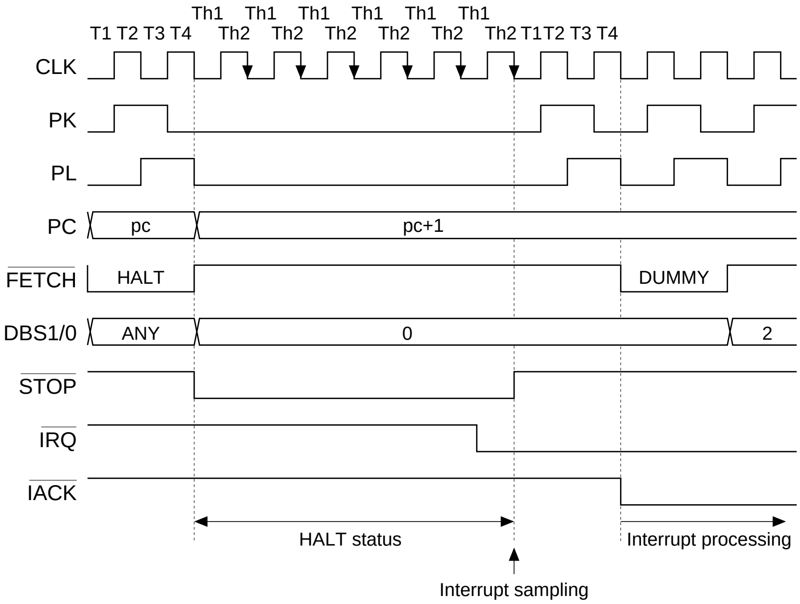


Fig. 3.6.1.1 Sequence of shifting to HALT status and restarting

3.6.2 SLEEP status

The SLEEP status is the status in which the CPU and the peripheral circuits within the MCU stop operating and shifting it can be done using the SLP instruction.
The SLEEP status is released by a reset or a specific interrupt (it differs depending on the model). When the SLEEP status is released by a reset, the program restarts from the program start address (0110H). When it is released by an interrupt, the program sequence returns to the step immediately after the SLP instruction by the RETI instruction in the interrupt service routine.
Power consumption in the SLEEP status can be greatly reduced in comparison with the the HALT status, because such peripheral circuits as the oscillation circuit are also stopped. However, since stabilization time is needed for the oscillation circuit when restarting, it is effective when used for extended standby where instantaneous restarting is not necessary.

During SLEEP status, as in the HALT status, the contents of the registers in the CPU that have been set before shifting are maintained if rated voltage is supplied.
Figure 3.6.2.1 shows the sequence of shifting to the SLEEP status and restarting.
When an interrupt that releases the SLEEP status is generated, the oscillation circuit begins to oscillate. When the oscillation starts, the CLK input to the CPU is masked by the peripheral circuit and the input to the CPU begins after stabilization waiting time (several 10 msec–several msec) has elapsed. The CPU samples the interrupt at the falling edge of the initially input CLK and starts the interrupt processing.

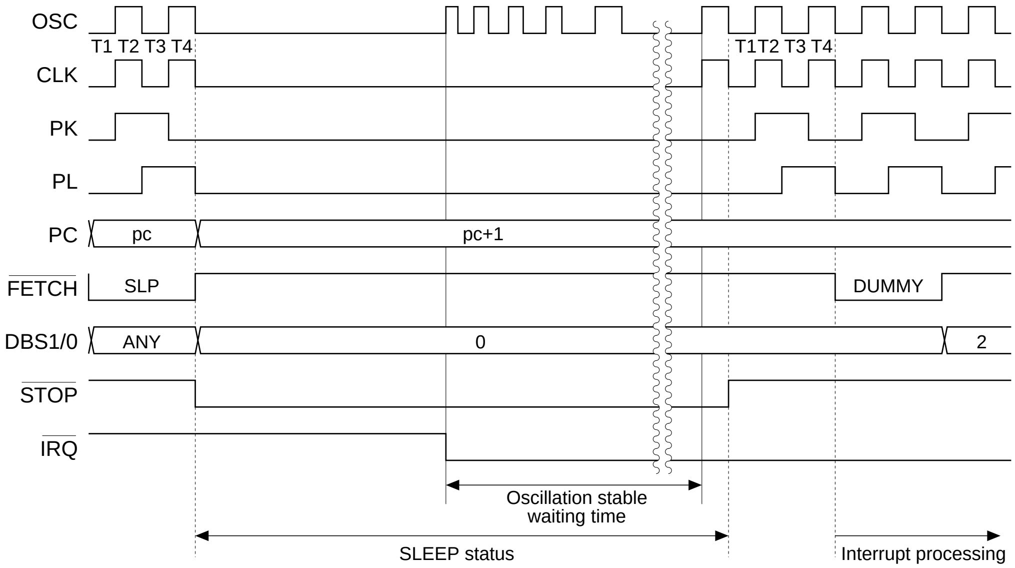


Fig. 3.6.2.1 Sequence of the shift to SLEEP status and restarting

CHAPTER 4 INSTRUCTION SET

The S1C63000 offers high machine cycle efficiency and a high speed instruction set. It has 47 basic instructions (412 instructions in all) that are designed as an instruction system permitting relocatable programming.
This chapter explains about the addressing modes for memory management and about the details of each instruction.

4.1 Addressing Mode

The S1C63000 has the following 8 types of addressing modes and the address specifications corresponding to the various statuses are done concisely and accurately.

- **Types of addressing modes**

Basic addressing modes (5 types)
1) Immediate data addressing
2) Register direct addressing
3) Register indirect addressing
4) 6-bit absolute addressing
5) Signed 8-bit PC relative addressing

Extended addressing modes (3 types)
1) 16-bit immediate data addressing
2) 8-bit absolute addressing
3) Signed 16-bit PC relative addressing

4.1.1 Basic addressing modes

The basic addressing mode is an addressing function independent of the instruction.

- **Immediate data addressing**

The immediate data addressing is the addressing mode in which the immediate data is used for operations and is used as transfer data. Values that are specified in the operand are directly used as data or addresses. In the instruction list, the following symbols are used to write immediate data.

Table 4.1.1.1 Symbol and size of immediate data

Symbol	Use	Size	Specifiable range
imm2	Specifying a bit No. in 4-bit data	2 bits	0–3
imm4	4-bit general-purpose data	4 bits	0–15
imm6	Specifying a software interrupt vector	6 bits	0–63
imm8	8-bit general-purpose data	8 bits	0–255
sign8	Signed 8-bit general-purpose data	8 bits	-128–127
n4	Specifying a radix	4 bits	1–16

Examples:

```
CLR  [addr6],imm2
LD   %A,imm4
INT  imm6
LDB  %BA,imm8
CALZ imm8

ADD  %X,sign8
ADC  %B,%A,n4
```

`CLR [addr6],imm2`	...Clears a bit specified with imm2 within a 4-bit data in an address [addr6]
`LD %A,imm4`	...Loads a 4-bit data imm4 into the A register
`INT imm6`	...A software interrupt of which the vector address is specified with imm6
`LDB %BA,imm8`	...Loads an 8-bit data imm8 into the BA register
`CALZ imm8`	...Calls a subroutine that starts from an address imm8 (Address specifiable range is 0000H to 00FFH.)
`ADD %X,sign8`	...Adds a signed 8-bit data sign8 to the X register
`ADC %B,%A,n4`	...Adds data in the A register to the B register with a radix n4 specification

- **Register direct addressing**

The register direct addressing is the addressing mode when specifying a register for the source and / or destination. Register names should be written with % in front.
Instructions in which the operand has the following register name operate in this addressing mode.

4-bit registers: `%A,%B,%F`
8-bit registers: `%BA,%XH,%XL,%EXT,%SP1,%SP2`
16-bit registers: `%X,%Y`

Examples:

```
ADD  %A,%B        ...Adds the data in the B register to the A register
LDB  %BA,%XL      ...Loads the data in the XL register into the BA register
DEC  %SP1         ...Decrements the stack pointer SP1
JR   %A           ...Jumps using the content of the A register as a relative address
JP   %Y           ...Jumps to the address indicated with the Y register
```

- **Register indirect addressing**

The register indirect addressing is the addressing mode for accessing the data memory and it indirectly specifies the data memory address with the index register X or Y. To write the instructions, place % in front of the index register name and enclose them with [ ].

Indirect addressing with the X register: Instructions which have [%X] or [%X]+ as the operand
Indirect addressing with the Y register: Instructions which have [%Y] or [%Y]+ as the operand

The content of the X register or Y register regarded as an address, and operations and transfers are performed for the data stored in the address or the address.
"+" in the [%X]+ and [%Y]+ indicates a post-increment function. Instructions that have these operands increment the content of the X register or Y register after executing the transfer or operation. This function is useful to access a continuous addresses in the data memory.

Examples:

```
SUB  %A,[%X]       ...Subtracts the content of a memory specified with the X register from the A
                      register
LD   [%X]+,[%Y]+   ...Transfers the content of a memory specified with the Y register to a memory
                      specified with the X register. Then increments the contents of the X register
                      and Y register
```

- **6-bit absolute addressing**

The 6-bit absolute addressing is the addressing mode for accessing within the 6-bit address range from 0000H or FFC0H. Instructions that have [addr6] as the operand operate in this addressing mode. The address range that can be specified with the addr6 is 0000H to 003FH or FFC0H to FFFFH.

(1) Instructions that access from 0000H to 003FH

For this area, the following instructions, which are used in this area as counters and flags, are provided. An address within 0000H to 003FH is specified with the addr6.

```
INC  [addr6]        ...Increments the content of a memory specified with the addr6
DEC  [addr6]        ...Decrements the content of a memory specified with the addr6
CLR  [addr6],imm2   ...Clears a bit specified with the imm2 in a memory specified with the addr6
SET  [addr6],imm2   ...Sets a bit specified with the imm2 in a memory specified with the addr6
TST  [addr6],imm2   ...Tests a bit specified with the imm2 in a memory specified with the addr6
```

In addition, the following branch instructions, which permit a conditional branch according to the contents of this area, are provided.

```
JR   [addr6]     ...PC relative jump instruction that uses the content of a memory specified
                    with addr6 as a relative address
CALR [addr6]     ...PC relative call instruction that uses the content of a memory specified with
                    addr6 as a relative address
```

These instructions perform a PC relative branch using the content (4 bits) of a memory specified with the [addr6] as a relative address. The branch destination address is [the address next to the branch instruction] + [the contents (0 to 15) of the memory specified with the addr6].

(2) Instructions that access from FFC0H to FFFFH

This area is reserved for the I/O memory in the S1C63 Family and the following instructions are provided to operate the control bits of the peripheral circuits.
An address within FFC0H to FFFFH is specified with the addr6. However the addr6 is handled as 0 to 3FH in the machine codes.

`CLR [addr6],imm2` ...Clears a bit specified with the imm2 in a memory specified with the addr6
`SET [addr6],imm2` ...Sets a bit specified with the imm2 in a memory specified with the addr6
`TST [addr6],imm2` ...Tests a bit specified with the imm2 in a memory specified with the addr6

Write only or read only control bits may have been assigned depending on the peripheral circuit. Pay attention when using the above-mentioned instructions for such bits or addresses containing such bits.

- **Signed 8-bit PC relative addressing**

The signed 8-bit PC relative addressing is the addressing mode used for the branch instructions. The signed 8-bit relative address (-128 to 127) that is specified in the operand is added to the address next to the branch instruction to branch to that address.
The following instructions operate in this addressing mode.

Jump instructions:	`JR sign8`
	`JRC sign8`
	`JRNC sign8`
	`JRZ sign8`
	`JRNZ sign8`
Call instruction:	`CALR sign8`

4.1.2 Extended addressing mode

In the S1C63000, when data is written to the EXT register (the E flag is set) and a specific instruction follows, the data specified by that instruction is extended with the EXT register data (see Section 2.1.5). When the E flag is set, instructions are extended in an addressing mode different from the mode that is specified in each instruction. This is the extended addressing mode that will be explained below. However, instructions that can operate in the extended addressing mode are limited to those indicated in the instruction list, so check it when programming.
Further the extended addressing mode is effective only for the instruction following immediately after writing data to the EXT register and setting the E flag to "1" (the E flag is reset to "0" by executing that instruction). When using an instruction in the extended addressing mode, write data to be extended to the EXT register or set the E flag (when the E register has already been set).

- **16-bit immediate data addressing**

The addressing mode of the following instructions, which have an 8-bit immediate data as the operand, change to the 16-bit immediate data addressing when the E flag is set to "1". Consequently, it is possible to transfer and operate a 16-bit immediate data to the X or Y register.

Instructions that operate in the 16-bit immediate data addressing mode with the E flag

```
LDB  %XL,imm8     LDB  %Y,imm8
ADD  %X,sign8     ADD  %Y,sign8
CMP  %X,imm8      CMP  %X,imm8
```

The data is extended into 16 bits in which the E register data is the high-order 8 bits and the immediate data specified with the above instruction is the low-order 8 bit.

Examples:

```
LDB  %EXT,0x15
LDB  %XL,0x7D          ...Works as "LD  %X, 0157D"
LDB  %EXT,0xB8
ADD  %X,0x4F           ...Works as "ADD  %X, 0xB84F"

LDB  %EXT,0xE6
CMP  %X,0xA2           ...Works as "CMP  %X, 0x19A2"
                          * 19H = FFH - [EXT] (E6H)
```

Above examples use the X register, but they work the same even when the Y register is used.

Note: The CMP instruction performs a subtraction with a complement, therefore it is necessary to set the complement (1's complement) of the high-order 8-bit data in the EXT register.
EXT register ← [FFH - High-order 8-bit data]

• 8-bit absolute addressing

The 8-bit absolute addressing is the addressing mode for accessing within the 8-bit address range from 0000H or FF00H. To enter this mode, write the low-order 8 bits (00H to FFH) of the address to the EXT register, then execute an indirect addressing instruction which has [%X] or [%Y] as the source operand or the destination operand. When [%X] is used, the memory from 0000H to 00FFH can be accessed, and when [%Y] is used, FF00H to FFFFH can be accessed.

Instructions that operate in the 8-bit absolute addressing mode with the E flag

Instruction	Operand
LD	%r,[%X] %r,[%Y] [%X],%r [%Y],%r [%X],imm4 [%Y],imm4
EX	%r,[%X] %r,[%Y]
ADD	%r,[%X] %r,[%Y] [%X],%r [%Y],%r [%X],imm4 [%Y],imm4
ADC	%r,[%X] %r,[%Y] [%X],%r [%Y],%r [%X],imm4 [%Y],imm4 %B,[%X],n4 %B,[%Y],n4 [%X],%B,n4 [%Y],%B,n4 [%X],0,n4 [%Y],0,n4
SUB	%r,[%X] %r,[%Y] [%X],%r [%Y],%r [%X],imm4 [%Y],imm4
SBC	%r,[%X] %r,[%Y] [%X],%r [%Y],%r [%X],imm4 [%Y],imm4 %B,[%X],n4 %B,[%Y],n4 [%X],%B,n4 [%Y],%B,n4 [%X],0,n4 [%Y],0,n4
INC	[%X],n4 [%Y],n4
DEC	[%X],n4 [%Y],n4
CMP	%r,[%X] %r,[%Y] [%X],%r [%Y],%r [%X],imm4 [%Y],imm4
AND	%r,[%X] %r,[%Y] [%X],%r [%Y],%r [%X],imm4 [%Y],imm4
OR	%r,[%X] %r,[%Y] [%X],%r [%Y],%r [%X],imm4 [%Y],imm4
XOR	%r,[%X] %r,[%Y] [%X],%r [%Y],%r [%X],imm4 [%Y],imm4
BIT	%r,[%X] %r,[%Y] [%X],%r [%Y],%r [%X],imm4 [%Y],imm4
SLL	[%X] [%Y]
SRL	[%X] [%Y]
RL	[%X] [%Y]
RR	[%X] [%Y]

* "r" indicates the A or B register. Instructions with an operand other than above or the post-increment function do not have the extended addressing function.

Examples:

```
LDB  %EXT,0x37
LD   %A,[%X]           ...Works as "LD  %A, [0x0037]"

LDB  %EXT,0x9C
ADD  [%Y],5            ...Works as "ADD  [0xFF9C]"
```

- **Signed 16-bit PC relative addressing**

The addressing mode of the following branch instructions, which have an 8-bit relative address as the operand, change to the signed 16-bit PC relative addressing with the E flag set to "1". Consequently, it is possible to extend the branch range to the next address -32768 to +32767. (In this mode these instructions can branch the entire 64K program memory.)

Instructions that operate in the signed 16-bit PC relative addressing mode with the E flag

```
JR   sign8     JRC  sign8     JRNC sign8     JRZ  sign8     JRNZ sign8
CALR sign8
```

Examples:

```
LDB  %EXT,0x64
JR   0x29                  ...Works as "JR  0x6429"

LDB  %EXT,0x3A
JR*  0x88                  ...Works as "JR*  0x3A88" (* = C, NC, Z, or NZ)

LDB  %EXT,0xF8
CALR 0x62                  ...Works as "CALR  0xF862"
```

4.2 Instruction List

4.2.1 Function classification

Table 4.2.1.1 lists the function classifications of the instructions.

Table 4.2.1.1 Instruction function classifications

Function classification	Mnemonic	Operation	Function classification	Mnemonic	Operation
Arithmetic	ADD	Addition	Rotate / shift	RL	Rotate to left with carry
	ADC	Addition with carry		RR	Rotate to right with carry
	SUB	Subtraction		SLL	Logical shift to left
	SBC	Subtraction with carry		SRL	Logical shift to right
	CMP	Comparison	Stack control	PUSH	Push
	INC	Increment (adds 1)		POP	Pop
	DEC	Decrement (subtracts 1)	Branch	JR	Relative jump
Logic	AND	Logical product		JP	Indirect jump
	OR	Logical sum		CALZ	Absolute call
	XOR	Exclusive OR		CALR	Rrelative call
	BIT	Bit test		RET	Return
	CLR	Bit clear		RETS	Return and skip
	SET	Bit set		RETD	Return and data set
	TST	Bit test		RETI	Interrupt return
Transfer	LD	Load (4-bit data)		INT	Software interrupt
	LDB	Load (8-bit data)	System control	NOP	No operation
	EX	Exchange (4-bit data)		HALT	Shift to HALT status
				SLP	Shift to SLEEP status

4.2.2 Symbol meanings

The following indicates the meanings of the symbols used in the instruction list.

Register names

A .... Data register A (4 bits)
B .... Data register B (4 bits)
BA .... BA register pair (8 bits, the B register is the high-order 4 bits)
X .... Index register X (16 bits)
XH .... XH register (high-order 8 bits of the X register)
XL .... XL register (low-order 8 bits of the X register)
Y .... Index register Y (16 bits)
YH .... YH register (high-order 8 bits of the Y register)
YL .... YL register (low-order 8 bits of the Y register)
F........................... Flag register F (4 bits)
EXT .... Extension register EXT (8 bits)
SP1 .... Stack pointer SP1 (16 bits, however the setting data is 8 bits of D2 to D9)
SP2 .... Stack pointer SP2 (16 bits, however the setting data is 8 bits of D0 to D7)
PC .... Program counter PC (16 bits)

In the notation with mnemonics, the register names should be written with a % placed in front of them, according to the S1C63 Family assembler source format.

%A .... A register
%B .... B register
%BA .... BA register
%X .... X register
%XH .... XH register
%XL .... XL register
%Y .... Y register
%YH .... YH register
%YL .... YL register
%F .... F register
%EXT .... EXT register
%SP1 .... Stack pointer SP1
%SP2 .... Stack pointer SP2

Immediate data

imm2 .... 2-bit immediate data (0 to 3)
imm4 .... 4-bit immediate data (0 to 15)
imm6 .... Software interrupt vector (0100H to 013FH)
imm8 .... 8-bit immediate data (0 to 255)
i7–i0 .... Each bit in immX
n4 .... 4-bit radix specification data (1 to 16)
n3–n0 .... Each bit in n4
sign8 .... Signed 8-bit immediate data (-128 to 127)
s7–s0 .... Each bit in sign8
addr6 .... 6-bit address (00H to 3FH)
a5–a0 .... Each bit in addr6
00addr6 .... addr6 which specifies an address within 0000H to 003FH
FFaddr6 .... addr6 which specifies an address within FFC0H to FFFFH

Memory

[%X], [X] .... Memory where the X register specifies
[%Y], [Y] .... Memory where the Y register specifies
[00addr6] .... Memory within 0000H to 003FH where the addr6 specifies
[FFaddr6] .... Memory within FFC0H to FFFFH where the addr6 specifies
[%SP1], [SP1] ...... 16-bit address stack where the SP1 specifies
[%SP2], [SP2] ...... 4-bit data stack where the SP2 specifies

Flags

Z .... Zero flag
C .... Carry flag
I .... Interrupt flag
E .... Extension flag
↑ .... Flag is set
↓ .... Flag is reset
↕ .... Flag is set or reset
– .... Flag is not changed

Operations and others

\+ .... Addition
\- .... Subtraction
∧ .... Logical product
∨ .... Logical sum
∀ .... Exclusive OR
← .... Data load
↔ .... Data exchange

Extended addressing mode (EXT.mode)

○ .... Can be used
× .... Cannot be used (prohibit use)

4.2.3 Instruction list by function

4-bit data transfer

Mnemonic		Machine code													Operation	Cycle	Flag				EXT. mode	Page
		12	11	10	9	8	7	6	5	4	3	2	1	0			E	I	C	Z		
LD	%A,%A	1	1	1	1	0	1	1	1	1	0	0	0	0	A ← A	1	↓	–	–	–	×	99
	%A,%B	1	1	1	1	0	1	1	1	1	0	0	1	0	A ← B	1	↓	–	–	–	×	99
	%A,%F	1	1	1	1	1	1	1	1	1	0	1	1	0	A ← F	1	↓	–	–	–	×	99
	%A,imm4	1	1	1	1	0	1	1	0	0	i3	i2	i1	i0	A ← imm4	1	↓	–	–	–	×	100
	%A,[%X]	1	1	1	1	0	1	1	1	0	0	0	0	0	A ← [X]	1	↓	–	–	–	○	100
	%A,[%X]+	1	1	1	1	0	1	1	1	0	0	0	0	1	A ← [X], X ← X+1	1	↓	–	–	–	×	101
	%A,[%Y]	1	1	1	1	0	1	1	1	0	0	0	1	0	A ← [Y]	1	↓	–	–	–	○	100
	%A,[%Y]+	1	1	1	1	0	1	1	1	0	0	0	1	1	A ← [Y], Y ← Y+1	1	↓	–	–	–	×	101
LD	%B,%A	1	1	1	1	0	1	1	1	1	0	1	0	0	B ← A	1	↓	–	–	–	×	99
	%B,%B	1	1	1	1	0	1	1	1	1	0	1	1	0	B ← B	1	↓	–	–	–	×	99
	%B,imm4	1	1	1	1	0	1	1	0	1	i3	i2	i1	i0	B ← imm4	1	↓	–	–	–	×	100
	%B,[%X]	1	1	1	1	0	1	1	1	0	0	1	0	0	B ← [X]	1	↓	–	–	–	○	100
	%B,[%X]+	1	1	1	1	0	1	1	1	0	0	1	0	1	B ← [X], X ← X+1	1	↓	–	–	–	×	101
	%B,[%Y]	1	1	1	1	0	1	1	1	0	0	1	1	0	B ← [Y]	1	↓	–	–	–	○	100
	%B,[%Y]+	1	1	1	1	0	1	1	1	0	0	1	1	1	B ← [Y], Y ← Y+1	1	↓	–	–	–	×	101
LD	%F,%A	1	1	1	1	1	1	1	1	1	0	1	0	1	F ← A	1	↕	↕	↕	↕	×	99
	%F,imm4	1	0	0	0	0	1	0	1	1	i3	i2	i1	i0	F ← imm4	1	↕	↕	↕	↕	×	100
LD	[%X],%A	1	1	1	1	0	1	1	1	0	1	0	0	0	[X] ← A	1	↓	–	–	–	○	101
	[%X],%B	1	1	1	1	0	1	1	1	0	1	1	0	0	[X] ← B	1	↓	–	–	–	○	101
	[%X],imm4	1	1	1	1	0	1	0	0	0	i3	i2	i1	i0	[X] ← imm4	1	↓	–	–	–	○	102
	[%X],[%Y]	1	1	1	1	0	1	1	1	1	1	0	1	0	[X] ← [Y]	2	↓	–	–	–	×	103
	[%X],[%Y]+	1	1	1	1	0	1	1	1	1	1	0	1	1	[X] ← [Y], Y ← Y+1	2	↓	–	–	–	×	104
	[%X]+,%A	1	1	1	1	0	1	1	1	0	1	0	0	1	[X] ← A, X ← X+1	1	↓	–	–	–	×	102
	[%X]+,%B	1	1	1	1	0	1	1	1	0	1	1	0	1	[X] ← B, X ← X+1	1	↓	–	–	–	×	102
	[%X]+,imm4	1	1	1	1	0	1	0	0	1	i3	i2	i1	i0	[X] ← imm4, X ← X+1	1	↓	–	–	–	×	103
	[%X]+,[%Y]	1	1	1	1	0	1	1	1	1	1	1	1	0	[X] ← [Y], X ← X+1	2	↓	–	–	–	×	104
	[%X]+,[%Y]+	1	1	1	1	0	1	1	1	1	1	1	1	1	[X] ← [Y], X ← X+1, Y ← Y+1	2	↓	–	–	–	×	105
LD	[%Y],%A	1	1	1	1	0	1	1	1	0	1	0	1	0	[Y] ← A	1	↓	–	–	–	○	101
	[%Y],%B	1	1	1	1	0	1	1	1	0	1	1	1	0	[Y] ← B	1	↓	–	–	–	○	101
	[%Y],imm4	1	1	1	1	0	1	0	1	0	i3	i2	i1	i0	[Y] ← imm4	1	↓	–	–	–	○	102
	[%Y],[%X]	1	1	1	1	0	1	1	1	1	1	0	0	0	[Y] ← [X]	2	↓	–	–	–	×	103
	[%Y],[%X]+	1	1	1	1	0	1	1	1	1	1	0	0	1	[Y] ← [X], X ← X+1	2	↓	–	–	–	×	104
	[%Y]+,%A	1	1	1	1	0	1	1	1	0	1	0	1	1	[Y] ← A, Y ← Y+1	1	↓	–	–	–	×	102
	[%Y]+,%B	1	1	1	1	0	1	1	1	0	1	1	1	1	[Y] ← B, Y ← Y+1	1	↓	–	–	–	×	102
	[%Y]+,imm4	1	1	1	1	0	1	0	1	1	i3	i2	i1	i0	[Y] ← imm4, Y ← Y+1	1	↓	–	–	–	×	103
	[%Y]+,[%X]	1	1	1	1	0	1	1	1	1	1	1	0	0	[Y] ← [X], Y ← Y+1	2	↓	–	–	–	×	104
	[%Y]+,[%X]+	1	1	1	1	0	1	1	1	1	1	1	0	1	[Y] ← [X], Y ← Y+1, X ← X+1	2	↓	–	–	–	×	105
EX	%A,%B	1	1	1	1	1	1	1	1	1	0	1	1	1	A ↔ B	1	↓	–	–	–	×	90
EX	%A,[%X]	1	0	0	0	0	1	1	1	1	1	0	0	0	A ↔ [X]	2	↓	–	–	–	○	91
	%A,[%X]+	1	0	0	0	0	1	1	1	1	1	0	0	1	A ↔ [X], X ← X+1	2	↓	–	–	–	×	91
	%A,[%Y]	1	0	0	0	0	1	1	1	1	1	0	1	0	A ↔ [Y]	2	↓	–	–	–	○	91
	%A,[%Y]+	1	0	0	0	0	1	1	1	1	1	0	1	1	A ↔ [Y], Y ← Y+1	2	↓	–	–	–	×	91
EX	%B,[%X]	1	0	0	0	0	1	1	1	1	1	1	0	0	B ↔ [X]	2	↓	–	–	–	○	91
	%B,[%X]+	1	0	0	0	0	1	1	1	1	1	1	0	1	B ↔ [X], X ← X+1	2	↓	–	–	–	×	91
	%B,[%Y]	1	0	0	0	0	1	1	1	1	1	1	1	0	B ↔ [Y]	2	↓	–	–	–	○	91
	%B,[%Y]+	1	0	0	0	0	1	1	1	1	1	1	1	1	B ↔ [Y], Y ← Y+1	2	↓	–	–	–	×	91

ALU alithmetic operation (1/3)

Mnemonic		Machine code 12	11	10	9	8	7	6	5	4	3	2	1	0	Operation	Cycle	Flag E	I	C	Z	EXT. mode	Page
ADD	%A,%A	1	1	0	0	1	0	1	1	1	0	0	0	X	A ← A+A	1	↓	–	↕	↕	×	68
	%A,%B	1	1	0	0	1	0	1	1	1	0	0	1	X	A ← A+B	1	↓	–	↕	↕	×	68
	%A,imm4	1	1	0	0	1	0	1	0	0	i3	i2	i1	i0	A ← A+imm4	1	↓	–	↕	↕	×	69
	%A,[%X]	1	1	0	0	1	0	1	1	0	0	0	0	0	A ← A+[X]	1	↓	–	↕	↕	○	69
	%A,[%X]+	1	1	0	0	1	0	1	1	0	0	0	0	1	A ← A+[X], X ← X+1	1	↓	–	↕	↕	×	70
	%A,[%Y]	1	1	0	0	1	0	1	1	0	0	0	1	0	A ← A+[Y]	1	↓	–	↕	↕	○	69
	%A,[%Y]+	1	1	0	0	1	0	1	1	0	0	0	1	1	A ← A+[Y], Y ← Y+1	1	↓	–	↕	↕	×	70
ADD	%B,%A	1	1	0	0	1	0	1	1	1	0	1	0	X	B ← B+A	1	↓	–	↕	↕	×	68
	%B,%B	1	1	0	0	1	0	1	1	1	0	1	1	X	B ← B+B	1	↓	–	↕	↕	×	68
	%B,imm4	1	1	0	0	1	0	1	0	1	i3	i2	i1	i0	B ← B+imm4	1	↓	–	↕	↕	×	69
	%B,[%X]	1	1	0	0	1	0	1	1	0	0	1	0	0	B ← B+[X]	1	↓	–	↕	↕	○	69
	%B,[%X]+	1	1	0	0	1	0	1	1	0	0	1	0	1	B ← B+[X], X ← X+1	1	↓	–	↕	↕	×	70
	%B,[%Y]	1	1	0	0	1	0	1	1	0	0	1	1	0	B ← B+[Y]	1	↓	–	↕	↕	○	69
	%B,[%Y]+	1	1	0	0	1	0	1	1	0	0	1	1	1	B ← B+[Y], Y ← Y+1	1	↓	–	↕	↕	×	70
ADD	[%X],%A	1	1	0	0	1	0	1	1	0	1	0	0	0	[X] ← [X]+A	2	↓	–	↕	↕	○	70
	[%X],%B	1	1	0	0	1	0	1	1	0	1	1	0	0	[X] ← [X]+B	2	↓	–	↕	↕	○	70
	[%X],imm4	1	1	0	0	1	0	0	0	0	i3	i2	i1	i0	[X] ← [X]+imm4	2	↓	–	↕	↕	○	71
	[%X]+,%A	1	1	0	0	1	0	1	1	0	1	0	0	1	[X] ← [X]+A, X ← X+1	2	↓	–	↕	↕	×	71
	[%X]+,%B	1	1	0	0	1	0	1	1	0	1	1	0	1	[X] ← [X]+B, X ← X+1	2	↓	–	↕	↕	×	71
	[%X]+,imm4	1	1	0	0	1	0	0	0	1	i3	i2	i1	i0	[X] ← [X]+imm4, X ← X+1	2	↓	–	↕	↕	×	72
ADD	[%Y],%A	1	1	0	0	1	0	1	1	0	1	0	1	0	[Y] ← [Y]+A	2	↓	–	↕	↕	○	70
	[%Y],%B	1	1	0	0	1	0	1	1	0	1	1	1	0	[Y] ← [Y]+B	2	↓	–	↕	↕	○	70
	[%Y],imm4	1	1	0	0	1	0	0	1	0	i3	i2	i1	i0	[Y] ← [Y]+imm4	2	↓	–	↕	↕	○	71
	[%Y]+,%A	1	1	0	0	1	0	1	1	0	1	0	1	1	[Y] ← [Y]+A, Y ← Y+1	2	↓	–	↕	↕	×	71
	[%Y]+,%B	1	1	0	0	1	0	1	1	0	1	1	1	1	[Y] ← [Y]+B, Y ← Y+1	2	↓	–	↕	↕	×	71
	[%Y]+,imm4	1	1	0	0	1	0	0	1	1	i3	i2	i1	i0	[Y] ← [Y]+imm4, Y ← Y+1	2	↓	–	↕	↕	×	72
ADC	%A,%A	1	1	0	0	1	1	1	1	1	0	0	0	X	A ← A+A+C	1	↓	–	↕	↕	×	61
	%A,%B	1	1	0	0	1	1	1	1	1	0	0	1	X	A ← A+B+C	1	↓	–	↕	↕	×	61
	%A,imm4	1	1	0	0	1	1	1	0	0	i3	i2	i1	i0	A ← A+imm4+C	1	↓	–	↕	↕	×	61
	%A,[%X]	1	1	0	0	1	1	1	1	0	0	0	0	0	A ← A+[X]+C	1	↓	–	↕	↕	○	62
	%A,[%X]+	1	1	0	0	1	1	1	1	0	0	0	0	1	A ← A+[X]+C, X ← X+1	1	↓	–	↕	↕	×	62
	%A,[%Y]	1	1	0	0	1	1	1	1	0	0	0	1	0	A ← A+[Y]+C	1	↓	–	↕	↕	○	62
	%A,[%Y]+	1	1	0	0	1	1	1	1	0	0	0	1	1	A ← A+[Y]+C, Y ← Y+1	1	↓	–	↕	↕	×	62
ADC	%B,%A	1	1	0	0	1	1	1	1	1	0	1	0	X	B ← B+A+C	1	↓	–	↕	↕	×	61
	%B,%B	1	1	0	0	1	1	1	1	1	0	1	1	X	B ← B+B+C	1	↓	–	↕	↕	×	61
	%B,imm4	1	1	0	0	1	1	1	0	1	i3	i2	i1	i0	B ← B+imm4+C	1	↓	–	↕	↕	×	61
	%B,[%X]	1	1	0	0	1	1	1	1	0	0	1	0	0	B ← B+[X]+C	1	↓	–	↕	↕	○	62
	%B,[%X]+	1	1	0	0	1	1	1	1	0	0	1	0	1	B ← B+[X]+C, X ← X+1	1	↓	–	↕	↕	×	62
	%B,[%Y]	1	1	0	0	1	1	1	1	0	0	1	1	0	B ← B+[Y]+C	1	↓	–	↕	↕	○	62
	%B,[%Y]+	1	1	0	0	1	1	1	1	0	0	1	1	1	B ← B+[Y]+C, Y ← Y+1	1	↓	–	↕	↕	×	62
ADC	[%X],%A	1	1	0	0	1	1	1	1	0	1	0	0	0	[X] ← [X]+A+C	2	↓	–	↕	↕	○	63
	[%X],%B	1	1	0	0	1	1	1	1	0	1	1	0	0	[X] ← [X]+B+C	2	↓	–	↕	↕	○	63
	[%X],imm4	1	1	0	0	1	1	0	0	0	i3	i2	i1	i0	[X] ← [X]+imm4+C	2	↓	–	↕	↕	○	64
	[%X]+,%A	1	1	0	0	1	1	1	1	0	1	0	0	1	[X] ← [X]+A+C, X ← X+1	2	↓	–	↕	↕	×	63
	[%X]+,%B	1	1	0	0	1	1	1	1	0	1	1	0	1	[X] ← [X]+B+C, X ← X+1	2	↓	–	↕	↕	×	63
	[%X]+,imm4	1	1	0	0	1	1	0	0	1	i3	i2	i1	i0	[X] ← [X]+imm4+C, X ← X+1	2	↓	–	↕	↕	×	64
ADC	[%Y],%A	1	1	0	0	1	1	1	1	0	1	0	1	0	[Y] ← [Y]+A+C	2	↓	–	↕	↕	○	63
	[%Y],%B	1	1	0	0	1	1	1	1	0	1	1	1	0	[Y] ← [Y]+B+C	2	↓	–	↕	↕	○	63
	[%Y],imm4	1	1	0	0	1	1	0	1	0	i3	i2	i1	i0	[Y] ← [Y]+imm4+C	2	↓	–	↕	↕	○	64
	[%Y]+,%A	1	1	0	0	1	1	1	1	0	1	0	1	1	[Y] ← [Y]+A+C, Y ← Y+1	2	↓	–	↕	↕	×	63
	[%Y]+,%B	1	1	0	0	1	1	1	1	0	1	1	1	1	[Y] ← [Y]+B+C, Y ← Y+1	2	↓	–	↕	↕	×	63
	[%Y]+,imm4	1	1	0	0	1	1	0	1	1	i3	i2	i1	i0	[Y] ← [Y]+imm4+C, Y ← Y+1	2	↓	–	↕	↕	×	64
SUB	%A,%A	1	1	0	0	0	0	1	1	1	0	0	0	X	A ← A-A	1	↓	–	↓	↑	×	135
	%A,%B	1	1	0	0	0	0	1	1	1	0	0	1	X	A ← A-B	1	↓	–	↕	↕	×	135
	%A,imm4	1	1	0	0	0	0	1	0	0	i3	i2	i1	i0	A ← A-imm4	1	↓	–	↕	↕	×	135
	%A,[%X]	1	1	0	0	0	0	1	1	0	0	0	0	0	A ← A-[X]	1	↓	–	↕	↕	○	136
	%A,[%X]+	1	1	0	0	0	0	1	1	0	0	0	0	1	A ← A-[X], X ← X+1	1	↓	–	↕	↕	×	136
	%A,[%Y]	1	1	0	0	0	0	1	1	0	0	0	1	0	A ← A-[Y]	1	↓	–	↕	↕	○	136
	%A,[%Y]+	1	1	0	0	0	0	1	1	0	0	0	1	1	A ← A-[Y], Y ← Y+1	1	↓	–	↕	↕	×	136

ALU alithmetic operation (2/3)

Mnemonic		Machine code													Operation	Cycle	Flag				EXT.	Page
		12	11	10	9	8	7	6	5	4	3	2	1	0			E	I	C	Z	mode	
SUB	%B,%A	1	1	0	0	0	0	1	1	1	0	1	0	X	B ← B-A	1	↓	–	↕	↕	×	135
	%B,%B	1	1	0	0	0	0	1	1	1	0	1	1	X	B ← B-B	1	↓	–	↓	↑	×	135
	%B,imm4	1	1	0	0	0	0	1	0	1	i3	i2	i1	i0	B ← B-imm4	1	↓	–	↕	↕	×	135
	%B,[%X]	1	1	0	0	0	0	1	1	0	0	1	0	0	B ← B-[X]	1	↓	–	↕	↕	○	136
	%B,[%X]+	1	1	0	0	0	0	1	1	0	0	1	0	1	B ← B-[X], X ← X+1	1	↓	–	↕	↕	×	136
	%B,[%Y]	1	1	0	0	0	0	1	1	0	0	1	1	0	B ← B-[Y]	1	↓	–	↕	↕	○	136
	%B,[%Y]+	1	1	0	0	0	0	1	1	0	0	1	1	1	B ← B-[Y], Y ← Y+1	1	↓	–	↕	↕	×	136
SUB	[%X],%A	1	1	0	0	0	0	1	1	0	1	0	0	0	[X] ← [X]-A	2	↓	–	↕	↕	○	137
	[%X],%B	1	1	0	0	0	0	1	1	0	1	1	0	0	[X] ← [X]-B	2	↓	–	↕	↕	○	137
	[%X],imm4	1	1	0	0	0	0	0	0	0	i3	i2	i1	i0	[X] ← [X]-imm4	2	↓	–	↕	↕	○	138
	[%X]+,%A	1	1	0	0	0	0	1	1	0	1	0	0	1	[X] ← [X]-A, X ← X+1	2	↓	–	↕	↕	×	137
	[%X]+,%B	1	1	0	0	0	0	1	1	0	1	1	0	1	[X] ← [X]-B, X ← X+1	2	↓	–	↕	↕	×	137
	[%X]+,imm4	1	1	0	0	0	0	0	0	1	i3	i2	i1	i0	[X] ← [X]-imm4, X ← X+1	2	↓	–	↕	↕	×	138
SUB	[%Y],%A	1	1	0	0	0	0	1	1	0	1	0	1	0	[Y] ← [Y]-A	2	↓	–	↕	↕	○	137
	[%Y],%B	1	1	0	0	0	0	1	1	0	1	1	1	0	[Y] ← [Y]-B	2	↓	–	↕	↕	○	137
	[%Y],imm4	1	1	0	0	0	0	0	1	0	i3	i2	i1	i0	[Y] ← [Y]-imm4	2	↓	–	↕	↕	○	138
	[%Y]+,%A	1	1	0	0	0	0	1	1	0	1	0	1	1	[Y] ← [Y]-A, Y ← Y+1	2	↓	–	↕	↕	×	137
	[%Y]+,%B	1	1	0	0	0	0	1	1	0	1	1	1	1	[Y] ← [Y]-B, Y ← Y+1	2	↓	–	↕	↕	×	137
	[%Y]+,imm4	1	1	0	0	0	0	0	1	1	i3	i2	i1	i0	[Y] ← [Y]-imm4, Y ← Y+1	2	↓	–	↕	↕	×	138
SBC	%A,%A	1	1	0	0	0	1	1	1	1	0	0	0	X	A ← A-A-C	1	↓	–	↕	↕	×	123
	%A,%B	1	1	0	0	0	1	1	1	1	0	0	1	X	A ← A-B-C	1	↓	–	↕	↕	×	123
	%A,imm4	1	1	0	0	0	1	1	0	0	i3	i2	i1	i0	A ← A-imm4-C	1	↓	–	↕	↕	×	124
	%A,[%X]	1	1	0	0	0	1	1	1	0	0	0	0	0	A ← A-[X]-C	1	↓	–	↕	↕	○	124
	%A,[%X]+	1	1	0	0	0	1	1	1	0	0	0	0	1	A ← A-[X]-C, X ← X+1	1	↓	–	↕	↕	×	125
	%A,[%Y]	1	1	0	0	0	1	1	1	0	0	0	1	0	A ← A-[Y]-C	1	↓	–	↕	↕	○	124
	%A,[%Y]+	1	1	0	0	0	1	1	1	0	0	0	1	1	A ← A-[Y]-C, Y ← Y+1	1	↓	–	↕	↕	×	125
SBC	%B,%A	1	1	0	0	0	1	1	1	1	0	1	0	X	B ← B-A-C	1	↓	–	↕	↕	×	123
	%B,%B	1	1	0	0	0	1	1	1	1	0	1	1	X	B ← B-B-C	1	↓	–	↕	↕	×	123
	%B,imm4	1	1	0	0	0	1	1	0	1	i3	i2	i1	i0	B ← B-imm4-C	1	↓	–	↕	↕	×	124
	%B,[%X]	1	1	0	0	0	1	1	1	0	0	1	0	0	B ← B-[X]-C	1	↓	–	↕	↕	○	124
	%B,[%X]+	1	1	0	0	0	1	1	1	0	0	1	0	1	B ← B-[X]-C, X ← X+1	1	↓	–	↕	↕	×	125
	%B,[%Y]	1	1	0	0	0	1	1	1	0	0	1	1	0	B ← B-[Y]-C	1	↓	–	↕	↕	○	124
	%B,[%Y]+	1	1	0	0	0	1	1	1	0	0	1	1	1	B ← B-[Y]-C, Y ← Y+1	1	↓	–	↕	↕	×	125
SBC	[%X],%A	1	1	0	0	0	1	1	1	0	1	0	0	0	[X] ← [X]-A-C	2	↓	–	↕	↕	○	125
	[%X],%B	1	1	0	0	0	1	1	1	0	1	1	0	0	[X] ← [X]-B-C	2	↓	–	↕	↕	○	125
	[%X],imm4	1	1	0	0	0	1	0	0	0	i3	i2	i1	i0	[X] ← [X]-imm4-C	2	↓	–	↕	↕	○	126
	[%X]+,%A	1	1	0	0	0	1	1	1	0	1	0	0	1	[X] ← [X]-A-C, X ← X+1	2	↓	–	↕	↕	×	126
	[%X]+,%B	1	1	0	0	0	1	1	1	0	1	1	0	1	[X] ← [X]-B-C, X ← X+1	2	↓	–	↕	↕	×	126
	[%X]+,imm4	1	1	0	0	0	1	0	0	1	i3	i2	i1	i0	[X] ← [X]-imm4-C, X ← X+1	2	↓	–	↕	↕	×	127
SBC	[%Y],%A	1	1	0	0	0	1	1	1	0	1	0	1	0	[Y] ← [Y]-A-C	2	↓	–	↕	↕	○	125
	[%Y],%B	1	1	0	0	0	1	1	1	0	1	1	1	0	[Y] ← [Y]-B-C	2	↓	–	↕	↕	○	125
	[%Y],imm4	1	1	0	0	0	1	0	1	0	i3	i2	i1	i0	[Y] ← [Y]-imm4-C	2	↓	–	↕	↕	○	126
	[%Y]+,%A	1	1	0	0	0	1	1	1	0	1	0	1	1	[Y] ← [Y]-A-C, Y ← Y+1	2	↓	–	↕	↕	×	126
	[%Y]+,%B	1	1	0	0	0	1	1	1	0	1	1	1	1	[Y] ← [Y]-B-C, Y ← Y+1	2	↓	–	↕	↕	×	126
	[%Y]+,imm4	1	1	0	0	0	1	0	1	1	i3	i2	i1	i0	[Y] ← [Y]-imm4-C, Y ← Y+1	2	↓	–	↕	↕	×	127
CMP	%A,%A	1	1	1	1	0	0	1	1	1	X	0	0	0	A-A	1	↓	–	↓	↑	×	84
	%A,%B	1	1	1	1	0	0	1	1	1	X	0	1	0	A-B	1	↓	–	↕	↕	×	84
	%A,imm4	1	1	1	1	0	0	1	0	0	i3	i2	i1	i0	A-imm4	1	↓	–	↕	↕	×	84
	%A,[%X]	1	1	1	1	0	0	1	1	0	0	0	0	0	A-[X]	1	↓	–	↕	↕	○	85
	%A,[%X]+	1	1	1	1	0	0	1	1	0	0	0	0	1	A-[X], X ← X+1	1	↓	–	↕	↕	×	85
	%A,[%Y]	1	1	1	1	0	0	1	1	0	0	0	1	0	A-[Y]	1	↓	–	↕	↕	○	85
	%A,[%Y]+	1	1	1	1	0	0	1	1	0	0	0	1	1	A-[Y], Y ← Y+1	1	↓	–	↕	↕	×	85
CMP	%B,%A	1	1	1	1	0	0	1	1	1	X	1	0	0	B-A	1	↓	–	↕	↕	×	84
	%B,%B	1	1	1	1	0	0	1	1	1	X	1	1	0	B-B	1	↓	–	↓	↑	×	84
	%B,imm4	1	1	1	1	0	0	1	0	1	i3	i2	i1	i0	B-imm4	1	↓	–	↕	↕	×	84
	%B,[%X]	1	1	1	1	0	0	1	1	0	0	1	0	0	B-[X]	1	↓	–	↕	↕	○	85
	%B,[%X]+	1	1	1	1	0	0	1	1	0	0	1	0	1	B-[X], X ← X+1	1	↓	–	↕	↕	×	85
	%B,[%Y]	1	1	1	1	0	0	1	1	0	0	1	1	0	B-[Y]	1	↓	–	↕	↕	○	85
	%B,[%Y]+	1	1	1	1	0	0	1	1	0	0	1	1	1	B-[Y], Y ← Y+1	1	↓	–	↕	↕	×	85

ALU alithmetic operation (3/3)

Mnemonic		Machine code													Operation	Cycle	Flag				EXT. mode	Page
		12	11	10	9	8	7	6	5	4	3	2	1	0			E	I	C	Z		
CMP	[%X],%A	1	1	1	1	0	0	1	1	0	1	0	0	0	[X]-A	1	↓	–	↕	↕	○	86
	[%X],%B	1	1	1	1	0	0	1	1	0	1	1	0	0	[X]-B	1	↓	–	↕	↕	○	86
	[%X],imm4	1	1	1	1	0	0	0	0	0	i3	i2	i1	i0	[X]-imm4	1	↓	–	↕	↕	○	87
	[%X]+,%A	1	1	1	1	0	0	1	1	0	1	0	0	1	[X]-A, X ← X+1	1	↓	–	↕	↕	×	86
	[%X]+,%B	1	1	1	1	0	0	1	1	0	1	1	0	1	[X]-B, X ← X+1	1	↓	–	↕	↕	×	86
	[%X]+,imm4	1	1	1	1	0	0	0	0	1	i3	i2	i1	i0	[X]-imm4, X ← X+1	1	↓	–	↕	↕	×	87
CMP	[%Y],%A	1	1	1	1	0	0	1	1	0	1	0	1	0	[Y]-A	1	↓	–	↕	↕	○	86
	[%Y],%B	1	1	1	1	0	0	1	1	0	1	1	1	0	[Y]-B	1	↓	–	↕	↕	○	86
	[%Y],imm4	1	1	1	1	0	0	0	1	0	i3	i2	i1	i0	[Y]-imm4	1	↓	–	↕	↕	○	87
	[%Y]+,%A	1	1	1	1	0	0	1	1	0	1	0	1	1	[Y]-A, Y ← Y+1	1	↓	–	↕	↕	×	86
	[%Y]+,%B	1	1	1	1	0	0	1	1	0	1	1	1	1	[Y]-B, Y ← Y+1	1	↓	–	↕	↕	×	86
	[%Y]+,imm4	1	1	1	1	0	0	0	1	1	i3	i2	i1	i0	[Y]-imm4, Y ← Y+1	1	↓	–	↕	↕	×	87
INC	[00addr6]	1	0	0	0	0	0	1	a5	a4	a3	a2	a1	a0	[00addr6] ← [00addr6]+1	2	↓	–	↕	↕	×	92
DEC	[00addr6]	1	0	0	0	0	0	0	a5	a4	a3	a2	a1	a0	[00addr6] ← [00addr6]-1	2	↓	–	↕	↕	×	88
ADC	%B,%A,n4	1	0	0	0	0	1	1	0	1	[10H-n4]				B ← N's adjust (B+A+C)	2	↓	–	↕	↕	×	65
∗1	%B,[%X],n4	1	1	1	0	1	1	1	0	0	[10H-n4]				B ← N's adjust (B+[X]+C)	2	↓	–	↕	↕	○	65
	%B,[%X]+,n4	1	1	1	0	1	1	1	0	1	[10H-n4]				B ← N's adjust (B+[X]+C), X ← X+1	2	↓	–	↕	↕	×	66
	%B,[%Y],n4	1	1	1	0	1	1	1	1	0	[10H-n4]				B ← N's adjust (B+[Y]+C)	2	↓	–	↕	↕	○	65
	%B,[%Y]+,n4	1	1	1	0	1	1	1	1	1	[10H-n4]				B ← N's adjust (B+[Y]+C), Y ← Y+1	2	↓	–	↕	↕	×	66
ADC	[%X],%B,n4	1	1	1	0	1	0	1	0	0	[10H-n4]				[X] ← N's adjust ([X]+B+C)	2	↓	–	↕	↕	○	66
∗1	[%X],0,n4	1	1	1	0	1	0	0	0	0	[10H-n4]				[X] ← N's adjust ([X]+0+C)	2	↓	–	↕	↕	○	67
	[%X]+,%B,n4	1	1	1	0	1	0	1	0	1	[10H-n4]				[X] ← N's adjust ([X]+B+C), X ← X+1	2	↓	–	↕	↕	×	67
	[%X]+,0,n4	1	1	1	0	1	0	0	0	1	[10H-n4]				[X] ← N's adjust ([X]+0+C), X ← X+1	2	↓	–	↕	↕	×	68
ADC	[%Y],%B,n4	1	1	1	0	1	0	1	1	0	[10H-n4]				[Y] ← N's adjust ([Y]+B+C)	2	↓	–	↕	↕	○	66
∗1	[%Y],0,n4	1	1	1	0	1	0	0	1	0	[10H-n4]				[Y] ← N's adjust ([Y]+0+C)	2	↓	–	↕	↕	○	67
	[%Y]+,%B,n4	1	1	1	0	1	0	1	1	1	[10H-n4]				[Y] ← N's adjust ([Y]+B+C), Y ← Y+1	2	↓	–	↕	↕	×	67
	[%Y]+,0,n4	1	1	1	0	1	0	0	1	1	[10H-n4]				[Y] ← N's adjust ([Y]+0+C), Y ← Y+1	2	↓	–	↕	↕	×	68
SBC	%B,%A,n4	1	0	0	0	0	1	1	0	0	n3	n2	n1	n0	B ← N's adjust (B-A-C)	2	↓	–	↕	↕	×	127
∗1	%B,[%X],n4	1	1	1	0	0	1	1	0	0	n3	n2	n1	n0	B ← N's adjust (B-[X]-C)	2	↓	–	↕	↕	○	128
	%B,[%X]+,n4	1	1	1	0	0	1	1	0	1	n3	n2	n1	n0	B ← N's adjust (B-[X]-C), X ← X+1	2	↓	–	↕	↕	×	128
	%B,[%Y],n4	1	1	1	0	0	1	1	1	0	n3	n2	n1	n0	B ← N's adjust (B-[Y]-C)	2	↓	–	↕	↕	○	128
	%B,[%Y]+,n4	1	1	1	0	0	1	1	1	1	n3	n2	n1	n0	B ← N's adjust (B-[Y]-C), Y ← Y+1	2	↓	–	↕	↕	×	128
SBC	[%X],%B,n4	1	1	1	0	0	0	1	0	0	n3	n2	n1	n0	[X] ← N's adjust ([X]-B-C)	2	↓	–	↕	↕	○	129
∗1	[%X],0,n4	1	1	1	0	0	0	0	0	0	n3	n2	n1	n0	[X] ← N's adjust ([X]-0-C)	2	↓	–	↕	↕	○	130
	[%X]+,%B,n4	1	1	1	0	0	0	1	0	1	n3	n2	n1	n0	[X] ← N's adjust ([X]-B-C), X ← X+1	2	↓	–	↕	↕	×	129
	[%X]+,0,n4	1	1	1	0	0	0	0	0	1	n3	n2	n1	n0	[X] ← N's adjust ([X]-0-C), X ← X+1	2	↓	–	↕	↕	×	130
SBC	[%Y],%B,n4	1	1	1	0	0	0	1	1	0	n3	n2	n1	n0	[Y] ← N's adjust ([Y]-B-C)	2	↓	–	↕	↕	○	129
∗1	[%Y],0,n4	1	1	1	0	0	0	0	1	0	n3	n2	n1	n0	[Y] ← N's adjust ([Y]-0-C)	2	↓	–	↕	↕	○	130
	[%Y]+,%B,n4	1	1	1	0	0	0	1	1	1	n3	n2	n1	n0	[Y] ← N's adjust ([Y]-B-C), Y ← Y+1	2	↓	–	↕	↕	×	129
	[%Y]+,0,n4	1	1	1	0	0	0	0	1	1	n3	n2	n1	n0	[Y] ← N's adjust ([Y]-0-C), Y ← Y+1	2	↓	–	↕	↕	×	130
INC	[%X],n4	1	1	1	0	1	1	0	0	0	[10H-n4]				[X] ← N's adjust ([X]+1)	2	↓	–	↕	↕	○	93
∗1	[%X]+,n4	1	1	1	0	1	1	0	0	1	[10H-n4]				[X] ← N's adjust ([X]+1), X ← X+1	2	↓	–	↕	↕	×	93
INC	[%Y],n4	1	1	1	0	1	1	0	1	0	[10H-n4]				[Y] ← N's adjust ([Y]+1)	2	↓	–	↕	↕	○	93
∗1	[%Y]+,n4	1	1	1	0	1	1	0	1	1	[10H-n4]				[Y] ← N's adjust ([Y]+1), Y ← Y+1	2	↓	–	↕	↕	×	93
DEC	[%X],n4	1	1	1	0	0	1	0	0	0	n3	n2	n1	n0	[X] ← N's adjust ([X]-1)	2	↓	–	↕	↕	○	89
∗1	[%X]+,n4	1	1	1	0	0	1	0	0	1	n3	n2	n1	n0	[X] ← N's adjust ([X]-1), X ← X+1	2	↓	–	↕	↕	×	89
DEC	[%Y],n4	1	1	1	0	0	1	0	1	0	n3	n2	n1	n0	[Y] ← N's adjust ([Y]-1)	2	↓	–	↕	↕	○	89
∗1	[%Y]+,n4	1	1	1	0	0	1	0	1	1	n3	n2	n1	n0	[Y] ← N's adjust ([Y]-1), Y ← Y+1	2	↓	–	↕	↕	×	89

∗1 "n4" should be specified with a value between 1 and 16 that indicates a radix.
In the ADC and INC instructions, the assembler converts the "n4" into a complement, and places it at the low-order 4 bits in the machine code.
In the SBC and DEC instructions, the "n4" is placed as it is at the low-order 4 bits in the machine code.
(However, when 16 is specified to n4, the machine code is generated with 0000H as the low-order 4 bits.)

ALU logic operation (1/2)

Mnemonic		Machine code													Operation	Cycle	Flag				EXT. mode	Page
		12	11	10	9	8	7	6	5	4	3	2	1	0			E	I	C	Z		
AND	%A,%A	1	1	0	1	0	0	1	1	1	0	0	0	X	A ← A∧A	1	↓	–	–	↕	×	73
	%A,%B	1	1	0	1	0	0	1	1	1	0	0	1	X	A ← A∧B	1	↓	–	–	↕	×	73
	%A,imm4	1	1	0	1	0	0	1	0	0	i3	i2	i1	i0	A ← A∧imm4	1	↓	–	–	↕	×	74
	%A,[%X]	1	1	0	1	0	0	1	1	0	0	0	0	0	A ← A∧[X]	1	↓	–	–	↕	○	75
	%A,[%X]+	1	1	0	1	0	0	1	1	0	0	0	0	1	A ← A∧[X], X ← X+1	1	↓	–	–	↕	×	75
	%A,[%Y]	1	1	0	1	0	0	1	1	0	0	0	1	0	A ← A∧[Y]	1	↓	–	–	↕	○	75
	%A,[%Y]+	1	1	0	1	0	0	1	1	0	0	0	1	1	A ← A∧[Y], Y ← Y+1	1	↓	–	–	↕	×	75
AND	%B,%A	1	1	0	1	0	0	1	1	1	0	1	0	X	B ← B∧A	1	↓	–	–	↕	×	73
	%B,%B	1	1	0	1	0	0	1	1	1	0	1	1	X	B ← B∧B	1	↓	–	–	↕	×	73
	%B,imm4	1	1	0	1	0	0	1	0	1	i3	i2	i1	i0	B ← B∧imm4	1	↓	–	–	↕	×	74
	%B,[%X]	1	1	0	1	0	0	1	1	0	0	1	0	0	B ← B∧[X]	1	↓	–	–	↕	○	75
	%B,[%X]+	1	1	0	1	0	0	1	1	0	0	1	0	1	B ← B∧[X], X ← X+1	1	↓	–	–	↕	×	75
	%B,[%Y]	1	1	0	1	0	0	1	1	0	0	1	1	0	B ← B∧[Y]	1	↓	–	–	↕	○	75
	%B,[%Y]+	1	1	0	1	0	0	1	1	0	0	1	1	1	B ← B∧[Y], Y ← Y+1	1	↓	–	–	↕	×	75
AND	%F,imm4	1	0	0	0	0	1	0	0	0	i3	i2	i1	i0	F ← F∧imm4	1	↓	↓	↓	↓	×	74
AND	[%X],%A	1	1	0	1	0	0	1	1	0	1	0	0	0	[X] ← [X]∧A	2	↓	–	–	↕	○	76
	[%X],%B	1	1	0	1	0	0	1	1	0	1	1	0	0	[X] ← [X]∧B	2	↓	–	–	↕	○	76
	[%X],imm4	1	1	0	1	0	0	0	0	0	i3	i2	i1	i0	[X] ← [X]∧imm4	2	↓	–	–	↕	○	77
	[%X]+,%A	1	1	0	1	0	0	1	1	0	1	0	0	1	[X] ← [X]∧A, X ← X+1	2	↓	–	–	↕	×	76
	[%X]+,%B	1	1	0	1	0	0	1	1	0	1	1	0	1	[X] ← [X]∧B, X ← X+1	2	↓	–	–	↕	×	76
	[%X]+,imm4	1	1	0	1	0	0	0	0	1	i3	i2	i1	i0	[X] ← [X]∧imm4, X ← X+1	2	↓	–	–	↕	×	77
AND	[%Y],%A	1	1	0	1	0	0	1	1	0	1	0	1	0	[Y] ← [Y]∧A	2	↓	–	–	↕	○	76
	[%Y],%B	1	1	0	1	0	0	1	1	0	1	1	1	0	[Y] ← [Y]∧B	2	↓	–	–	↕	○	76
	[%Y],imm4	1	1	0	1	0	0	0	1	0	i3	i2	i1	i0	[Y] ← [Y]∧imm4	2	↓	–	–	↕	○	77
	[%Y]+,%A	1	1	0	1	0	0	1	1	0	1	0	1	1	[Y] ← [Y]∧A, Y ← Y+1	2	↓	–	–	↕	×	76
	[%Y]+,%B	1	1	0	1	0	0	1	1	0	1	1	1	1	[Y] ← [Y]∧B, Y ← Y+1	2	↓	–	–	↕	×	76
	[%Y]+,imm4	1	1	0	1	0	0	0	1	1	i3	i2	i1	i0	[Y] ← [Y]∧imm4, Y ← Y+1	2	↓	–	–	↕	×	77
OR	%A,%A	1	1	0	1	1	0	1	1	1	0	0	0	X	A ← A∨A	1	↓	–	–	↕	×	112
	%A,%B	1	1	0	1	1	0	1	1	1	0	0	1	X	A ← A∨B	1	↓	–	–	↕	×	112
	%A,imm4	1	1	0	1	1	0	1	0	0	i3	i2	i1	i0	A ← A∨imm4	1	↓	–	–	↕	×	112
	%A,[%X]	1	1	0	1	1	0	1	1	0	0	0	0	0	A ← A∨[X]	1	↓	–	–	↕	○	113
	%A,[%X]+	1	1	0	1	1	0	1	1	0	0	0	0	1	A ← A∨[X], X ← X+1	1	↓	–	–	↕	×	114
	%A,[%Y]	1	1	0	1	1	0	1	1	0	0	0	1	0	A ← A∨[Y]	1	↓	–	–	↕	○	113
	%A,[%Y]+	1	1	0	1	1	0	1	1	0	0	0	1	1	A ← A∨[Y], Y ← Y+1	1	↓	–	–	↕	×	114
OR	%B,%A	1	1	0	1	1	0	1	1	1	0	1	0	X	B ← B∨A	1	↓	–	–	↕	×	112
	%B,%B	1	1	0	1	1	0	1	1	1	0	1	1	X	B ← B∨B	1	↓	–	–	↕	×	112
	%B,imm4	1	1	0	1	1	0	1	0	1	i3	i2	i1	i0	B ← B∨imm4	1	↓	–	–	↕	×	112
	%B,[%X]	1	1	0	1	1	0	1	1	0	0	1	0	0	B ← B∨[X]	1	↓	–	–	↕	○	113
	%B,[%X]+	1	1	0	1	1	0	1	1	0	0	1	0	1	B ← B∨[X], X ← X+1	1	↓	–	–	↕	×	114
	%B,[%Y]	1	1	0	1	1	0	1	1	0	0	1	1	0	B ← B∨[Y]	1	↓	–	–	↕	○	113
	%B,[%Y]+	1	1	0	1	1	0	1	1	0	0	1	1	1	B ← B∨[Y], Y ← Y+1	1	↓	–	–	↕	×	114
OR	%F,imm4	1	0	0	0	0	1	0	0	1	i3	i2	i1	i0	F ← F∨imm4	1	↑	↑	↑	↑	×	113
OR	[%X],%A	1	1	0	1	1	0	1	1	0	1	0	0	0	[X] ← [X]∨A	2	↓	–	–	↕	○	114
	[%X],%B	1	1	0	1	1	0	1	1	0	1	1	0	0	[X] ← [X]∨B	2	↓	–	–	↕	○	114
	[%X],imm4	1	1	0	1	1	0	0	0	0	i3	i2	i1	i0	[X] ← [X]∨imm4	2	↓	–	–	↕	○	115
	[%X]+,%A	1	1	0	1	1	0	1	1	0	1	0	0	1	[X] ← [X]∨A, X ← X+1	2	↓	–	–	↕	×	115
	[%X]+,%B	1	1	0	1	1	0	1	1	0	1	1	0	1	[X] ← [X]∨B, X ← X+1	2	↓	–	–	↕	×	115
	[%X]+,imm4	1	1	0	1	1	0	0	0	1	i3	i2	i1	i0	[X] ← [X]∨imm4, X ← X+1	2	↓	–	–	↕	×	116
OR	[%Y],%A	1	1	0	1	1	0	1	1	0	1	0	1	0	[Y] ← [Y]∨A	2	↓	–	–	↕	○	114
	[%Y],%B	1	1	0	1	1	0	1	1	0	1	1	1	0	[Y] ← [Y]∨B	2	↓	–	–	↕	○	114
	[%Y],imm4	1	1	0	1	1	0	0	1	0	i3	i2	i1	i0	[Y] ← [Y]∨imm4	2	↓	–	–	↕	○	115
	[%Y]+,%A	1	1	0	1	1	0	1	1	0	1	0	1	1	[Y] ← [Y]∨A, Y ← Y+1	2	↓	–	–	↕	×	115
	[%Y]+,%B	1	1	0	1	1	0	1	1	0	1	1	1	1	[Y] ← [Y]∨B, Y ← Y+1	2	↓	–	–	↕	×	115
	[%Y]+,imm4	1	1	0	1	1	0	0	1	1	i3	i2	i1	i0	[Y] ← [Y]∨imm4, Y ← Y+1	2	↓	–	–	↕	×	116

ALU logic operation (2/2)

Mnemonic		Machine code													Operation	Cycle	Flag				EXT. mode	Page
		12	11	10	9	8	7	6	5	4	3	2	1	0			E	I	C	Z		
XOR	%A,%A	1	1	0	1	1	1	1	1	1	0	0	0	X	A ← A∀A	1	↓	–	–	↑	×	139
	%A,%B	1	1	0	1	1	1	1	1	1	0	0	1	X	A ← A∀B	1	↓	–	–	↕	×	139
	%A,imm4	1	1	0	1	1	1	1	0	0	i3	i2	i1	i0	A ← A∀imm4	1	↓	–	–	↕	×	140
	%A,[%X]	1	1	0	1	1	1	1	1	0	0	0	0	0	A ← A∀[X]	1	↓	–	–	↕	○	141
	%A,[%X]+	1	1	0	1	1	1	1	1	0	0	0	0	1	A ← A∀[X], X ← X+1	1	↓	–	–	↕	×	141
	%A,[%Y]	1	1	0	1	1	1	1	1	0	0	0	1	0	A ← A∀[Y]	1	↓	–	–	↕	○	141
	%A,[%Y]+	1	1	0	1	1	1	1	1	0	0	0	1	1	A ← A∀[Y], Y ← Y+1	1	↓	–	–	↕	×	141
XOR	%B,%A	1	1	0	1	1	1	1	1	1	0	1	0	X	B ← B∀A	1	↓	–	–	↕	×	139
	%B,%B	1	1	0	1	1	1	1	1	1	0	1	1	X	B ← B∀B	1	↓	–	–	↑	×	139
	%B,imm4	1	1	0	1	1	1	1	0	1	i3	i2	i1	i0	B ← B∀imm4	1	↓	–	–	↕	×	140
	%B,[%X]	1	1	0	1	1	1	1	1	0	0	1	0	0	B ← B∀[X]	1	↓	–	–	↕	○	141
	%B,[%X]+	1	1	0	1	1	1	1	1	0	0	1	0	1	B ← B∀[X], X ← X+1	1	↓	–	–	↕	×	141
	%B,[%Y]	1	1	0	1	1	1	1	1	0	0	1	1	0	B ← B∀[Y]	1	↓	–	–	↕	○	141
	%B,[%Y]+	1	1	0	1	1	1	1	1	0	0	1	1	1	B ← B∀[Y], Y ← Y+1	1	↓	–	–	↕	×	141
XOR	%F,imm4	1	0	0	0	0	1	0	1	0	i3	i2	i1	i0	F ← F∀imm4	1	↕	↕	↕	↕	×	140
XOR	[%X],%A	1	1	0	1	1	1	1	1	0	1	0	0	0	[X] ← [X]∀A	2	↓	–	–	↕	○	142
	[%X],%B	1	1	0	1	1	1	1	1	0	1	1	0	0	[X] ← [X]∀B	2	↓	–	–	↕	○	142
	[%X],imm4	1	1	0	1	1	1	0	0	0	i3	i2	i1	i0	[X] ← [X]∀imm4	2	↓	–	–	↕	○	143
	[%X]+,%A	1	1	0	1	1	1	1	1	0	1	0	0	1	[X] ← [X]∀A, X ← X+1	2	↓	–	–	↕	×	142
	[%X]+,%B	1	1	0	1	1	1	1	1	0	1	1	0	1	[X] ← [X]∀B, X ← X+1	2	↓	–	–	↕	×	142
	[%X]+,imm4	1	1	0	1	1	1	0	0	1	i3	i2	i1	i0	[X] ← [X]∀imm4, X ← X+1	2	↓	–	–	↕	×	143
XOR	[%Y],%A	1	1	0	1	1	1	1	1	0	1	0	1	0	[Y] ← [Y]∀A	2	↓	–	–	↕	○	142
	[%Y],%B	1	1	0	1	1	1	1	1	0	1	1	1	0	[Y] ← [Y]∀B	2	↓	–	–	↕	○	142
	[%Y],imm4	1	1	0	1	1	1	0	1	0	i3	i2	i1	i0	[Y] ← [Y]∀imm4	2	↓	–	–	↕	○	143
	[%Y]+,%A	1	1	0	1	1	1	1	1	0	1	0	1	1	[Y] ← [Y]∀A, Y ← Y+1	2	↓	–	–	↕	×	142
	[%Y]+,%B	1	1	0	1	1	1	1	1	0	1	1	1	1	[Y] ← [Y]∀B, Y ← Y+1	2	↓	–	–	↕	×	142
	[%Y]+,imm4	1	1	0	1	1	1	0	1	1	i3	i2	i1	i0	[Y] ← [Y]∀imm4, Y ← Y+1	2	↓	–	–	↕	×	143
BIT	%A,%A	1	1	0	1	0	1	1	1	1	0	0	0	X	A∧A	1	↓	–	–	↕	×	78
	%A,%B	1	1	0	1	0	1	1	1	1	0	0	1	X	A∧B	1	↓	–	–	↕	×	78
	%A,imm4	1	1	0	1	0	1	1	0	0	i3	i2	i1	i0	A∧imm4	1	↓	–	–	↕	×	78
	%A,[%X]	1	1	0	1	0	1	1	1	0	0	0	0	0	A∧[X]	1	↓	–	–	↕	○	79
	%A,[%X]+	1	1	0	1	0	1	1	1	0	0	0	0	1	A∧[X], X ← X+1	1	↓	–	–	↕	×	79
	%A,[%Y]	1	1	0	1	0	1	1	1	0	0	0	1	0	A∧[Y]	1	↓	–	–	↕	○	79
	%A,[%Y]+	1	1	0	1	0	1	1	1	0	0	0	1	1	A∧[Y], Y ← Y+1	1	↓	–	–	↕	×	79
BIT	%B,%A	1	1	0	1	0	1	1	1	1	0	1	0	X	B∧A	1	↓	–	–	↕	×	78
	%B,%B	1	1	0	1	0	1	1	1	1	0	1	1	X	B∧B	1	↓	–	–	↕	×	78
	%B,imm4	1	1	0	1	0	1	1	0	1	i3	i2	i1	i0	B∧imm4	1	↓	–	–	↕	×	78
	%B,[%X]	1	1	0	1	0	1	1	1	0	0	1	0	0	B∧[X]	1	↓	–	–	↕	○	79
	%B,[%X]+	1	1	0	1	0	1	1	1	0	0	1	0	1	B∧[X], X ← X+1	1	↓	–	–	↕	×	79
	%B,[%Y]	1	1	0	1	0	1	1	1	0	0	1	1	0	B∧[Y]	1	↓	–	–	↕	○	79
	%B,[%Y]+	1	1	0	1	0	1	1	1	0	0	1	1	1	B∧[Y], Y ← Y+1	1	↓	–	–	↕	×	79
BIT	[%X],%A	1	1	0	1	0	1	1	1	0	1	0	0	0	[X]∧A	1	↓	–	–	↕	○	80
	[%X],%B	1	1	0	1	0	1	1	1	0	1	1	0	0	[X]∧B	1	↓	–	–	↕	○	80
	[%X],imm4	1	1	0	1	0	1	0	0	0	i3	i2	i1	i0	[X]∧imm4	1	↓	–	–	↕	○	81
	[%X]+,%A	1	1	0	1	0	1	1	1	0	1	0	0	1	[X]∧A, X ← X+1	1	↓	–	–	↕	×	80
	[%X]+,%B	1	1	0	1	0	1	1	1	0	1	1	0	1	[X]∧B, X ← X+1	1	↓	–	–	↕	×	80
	[%X]+,imm4	1	1	0	1	0	1	0	0	1	i3	i2	i1	i0	[X]∧imm4, X ← X+1	1	↓	–	–	↕	×	81
BIT	[%Y],%A	1	1	0	1	0	1	1	1	0	1	0	1	0	[Y]∧A	1	↓	–	–	↕	○	80
	[%Y],%B	1	1	0	1	0	1	1	1	0	1	1	1	0	[Y]∧B	1	↓	–	–	↕	○	80
	[%Y],imm4	1	1	0	1	0	1	0	1	0	i3	i2	i1	i0	[Y]∧imm4	1	↓	–	–	↕	○	81
	[%Y]+,%A	1	1	0	1	0	1	1	1	0	1	0	1	1	[Y]∧A, Y ← Y+1	1	↓	–	–	↕	×	80
	[%Y]+,%B	1	1	0	1	0	1	1	1	0	1	1	1	1	[Y]∧B, Y ← Y+1	1	↓	–	–	↕	×	80
	[%Y]+,imm4	1	1	0	1	0	1	0	1	1	i3	i2	i1	i0	[Y]∧imm4, Y ← Y+1	1	↓	–	–	↕	×	81
CLR	[00addr6],imm2	1	0	1	0	0	i1	i0	a5	a4	a3	a2	a1	a0	[00addr6] ← [00addr6]∧not (2^{imm2})	2	↓	–	–	↕	×	83
	[FFaddr6],imm2	1	0	1	0	1	i1	i0	a5	a4	a3	a2	a1	a0	[FFaddr6] ← [FFaddr6]∧not (2^{imm2})	2	↓	–	–	↕	×	83
SET	[00addr6],imm2	1	0	1	1	0	i1	i0	a5	a4	a3	a2	a1	a0	[00addr6] ← [00addr6]∧(2^{imm2})	2	↓	–	–	↕	×	131
	[FFaddr6],imm2	1	0	1	1	1	i1	i0	a5	a4	a3	a2	a1	a0	[FFaddr6] ← [FFaddr6]∧(2^{imm2})	2	↓	–	–	↕	×	131
TST	[00addr6],imm2	1	0	0	1	0	i1	i0	a5	a4	a3	a2	a1	a0	[00addr6]∧(2^{imm2})	1	↓	–	–	↕	×	139
	[FFaddr6],imm2	1	0	0	1	1	i1	i0	a5	a4	a3	a2	a1	a0	[FFaddr6]∧(2^{imm2})	1	↓	–	–	↕	×	139

ALU shift and rotate operation

Mnemonic		Machine code													Operation	Cycle	Flag				EXT. mode	Page
		12	11	10	9	8	7	6	5	4	3	2	1	0			E	I	C	Z		
SLL	%A	1	0	0	0	0	1	1	1	1	0	0	0	0	A (C←D3←D2←D1←D0←0)	1	↓	–	↕	↕	×	131
	%B	1	0	0	0	0	1	1	1	1	0	1	0	0	B (C←D3←D2←D1←D0←0)	1	↓	–	↕	↕	×	131
	[%X]	1	0	0	0	0	1	1	1	0	0	0	0	0	[X] (C←D3←D2←D1←D0←0)	2	↓	–	↕	↕	○	132
	[%X]+	1	0	0	0	0	1	1	1	0	0	0	0	1	[X] (C←D3←D2←D1←D0←0), X ← X+1	2	↓	–	↕	↕	×	132
	[%Y]	1	0	0	0	0	1	1	1	0	0	0	1	0	[Y] (C←D3←D2←D1←D0←0)	2	↓	–	↕	↕	○	132
	[%Y]+	1	0	0	0	0	1	1	1	0	0	0	1	1	[Y] (C←D3←D2←D1←D0←0), Y ← Y+1	2	↓	–	↕	↕	×	132
SRL	%A	1	0	0	0	0	1	1	1	1	0	0	0	1	A (0→D3→D2→D1→D0→C)	1	↓	–	↕	↕	×	133
	%B	1	0	0	0	0	1	1	1	1	0	1	0	1	B (0→D3→D2→D1→D0→C)	1	↓	–	↕	↕	×	133
	[%X]	1	0	0	0	0	1	1	1	0	0	1	0	0	[X] (0→D3→D2→D1→D0→C)	2	↓	–	↕	↕	○	134
	[%X]+	1	0	0	0	0	1	1	1	0	0	1	0	1	[X] (0→D3→D2→D1→D0→C), X ← X+1	2	↓	–	↕	↕	×	134
	[%Y]	1	0	0	0	0	1	1	1	0	0	1	1	0	[Y] (0→D3→D2→D1→D0→C)	2	↓	–	↕	↕	○	134
	[%Y]+	1	0	0	0	0	1	1	1	0	0	1	1	1	[Y] (0→D3→D2→D1→D0→C), Y ← Y+1	2	↓	–	↕	↕	×	134
RL	%A	1	0	0	0	0	1	1	1	1	0	0	1	0	A (C←D3←D2←D1←D0←C)	1	↓	–	↕	↕	×	120
	%B	1	0	0	0	0	1	1	1	1	0	1	1	0	B (C←D3←D2←D1←D0←C)	1	↓	–	↕	↕	×	120
	[%X]	1	0	0	0	0	1	1	1	0	1	0	0	0	[X] (C←D3←D2←D1←D0←C)	2	↓	–	↕	↕	○	121
	[%X]+	1	0	0	0	0	1	1	1	0	1	0	0	1	[X] (C←D3←D2←D1←D0←C), X ← X+1	2	↓	–	↕	↕	×	121
	[%Y]	1	0	0	0	0	1	1	1	0	1	0	1	0	[Y] (C←D3←D2←D1←D0←C)	2	↓	–	↕	↕	○	121
	[%Y]+	1	0	0	0	0	1	1	1	0	1	0	1	1	[Y] (C←D3←D2←D1←D0←C), Y ← Y+1	2	↓	–	↕	↕	×	121
RR	%A	1	0	0	0	0	1	1	1	1	0	0	1	1	A (C→D3→D2→D1→D0→C)	1	↓	–	↕	↕	×	122
	%B	1	0	0	0	0	1	1	1	1	0	1	1	1	B (C→D3→D2→D1→D0→C)	1	↓	–	↕	↕	×	122
	[%X]	1	0	0	0	0	1	1	1	0	1	1	0	0	[X] (C→D3→D2→D1→D0→C)	2	↓	–	↕	↕	○	122
	[%X]+	1	0	0	0	0	1	1	1	0	1	1	0	1	[X] (C→D3→D2→D1→D0→C), X ← X+1	2	↓	–	↕	↕	×	123
	[%Y]	1	0	0	0	0	1	1	1	0	1	1	1	0	[Y] (C→D3→D2→D1→D0→C)	2	↓	–	↕	↕	○	122
	[%Y]+	1	0	0	0	0	1	1	1	0	1	1	1	1	[Y] (C→D3→D2→D1→D0→C), Y ← Y+1	2	↓	–	↕	↕	×	123

8/16-bit operation

Mnemonic		Machine code													Operation	Cycle	Flag				EXT. mode	Page
		12	11	10	9	8	7	6	5	4	3	2	1	0			E	I	C	Z		
LDB	%BA,%XL	1	1	1	1	1	1	1	0	0	1	0	0	0	BA ← XL	1	↓	–	–	–	×	107
	%BA,%XH	1	1	1	1	1	1	1	0	0	1	0	0	1	BA ← XH	1	↓	–	–	–	×	107
	%BA,%YL	1	1	1	1	1	1	1	0	0	1	0	1	0	BA ← YL	1	↓	–	–	–	×	107
	%BA,%YH	1	1	1	1	1	1	1	0	0	1	0	1	1	BA ← YH	1	↓	–	–	–	×	107
	%BA,%EXT	1	1	1	1	1	1	1	0	1	0	1	1	X	BA ← EXT	1	↓	–	–	–	×	106
	%BA,%SP1	1	1	1	1	1	1	1	0	0	1	1	0	X	BA ← SP1	1	↓	–	–	–	×	107
	%BA,%SP2	1	1	1	1	1	1	1	0	0	1	1	1	X	BA ← SP2	1	↓	–	–	–	×	107
	%BA,imm8	0	1	0	0	1	i7	i6	i5	i4	i3	i2	i1	i0	BA ← imm8	1	↓	–	–	–	×	105
	%BA,[%X]+	1	1	1	1	1	1	1	0	1	1	0	0	0	A ← [X], B ← [X+1], X ← X+2	2	↓	–	–	–	×	106
	%BA,[%Y]+	1	1	1	1	1	1	1	0	1	1	0	1	0	A ← [Y], B ← [Y+1], Y ← Y+2	2	↓	–	–	–	×	106
LDB	%XL,%BA	1	1	1	1	1	1	1	0	0	0	0	0	0	XL ← BA	1	↓	–	–	–	×	110
	%XL,imm8	0	1	0	1	0	i7	i6	i5	i4	i3	i2	i1	i0	XL ← imm8	1	↓	–	–	–	○	110
	%XH,%BA	1	1	1	1	1	1	1	0	0	0	0	0	1	XH ← BA	1	↓	–	–	–	×	110
LDB	%YL,%BA	1	1	1	1	1	1	1	0	0	0	0	1	0	YL ← BA	1	↓	–	–	–	×	110
	%YL,imm8	0	1	0	1	1	i7	i6	i5	i4	i3	i2	i1	i0	YL ← imm8	1	↓	–	–	–	○	110
	%YH,%BA	1	1	1	1	1	1	1	0	0	0	0	1	1	YH ← BA	1	↓	–	–	–	×	110
LDB	%EXT,%BA	1	1	1	1	1	1	1	0	1	0	1	0	X	EXT ← BA	1	↑	–	–	–	×	109
	%EXT,imm8	0	1	0	0	0	i7	i6	i5	i4	i3	i2	i1	i0	EXT ← imm8	1	↑	–	–	–	×	109
LDB	%SP1,%BA	1	1	1	1	1	1	1	0	0	0	1	0	X	SP1 ← BA	1	↓	–	–	–	×	111
	%SP2,%BA	1	1	1	1	1	1	1	0	0	0	1	1	X	SP2 ← BA	1	↓	–	–	–	×	111
LDB	[%X]+,%BA	1	1	1	1	1	1	1	0	1	1	0	0	1	[X] ← A, [X+1] ← B, X ← X+2	2	↓	–	–	–	×	108
	[%X]+,imm8	0	0	0	0	1	i7	i6	i5	i4	i3	i2	i1	i0	[X] ← i3~0, [X+1] ← i7~4, X ← X+2	2	↓	–	–	–	×	108
LDB	[%Y]+,%BA	1	1	1	1	1	1	1	0	1	1	0	1	1	[Y] ← A, [Y+1] ← B, Y ← Y+2	2	↓	–	–	–	×	108
ADD	%X,%BA	1	1	1	1	1	1	1	0	1	0	0	0	X	X ← X+BA	1	↓	–	–	↕	×	72
	%X,sign8	0	1	1	0	0	s7	s6	s5	s4	s3	s2	s1	s0	X ← X+sign8 (sign8=-128~127)	1	↓	–	–	↕	○	72
	%Y,%BA	1	1	1	1	1	1	1	0	1	0	0	1	X	Y ← Y+BA	1	↓	–	–	↕	×	72
	%Y,sign8	0	1	1	0	1	s7	s6	s5	s4	s3	s2	s1	s0	Y ← Y+sign8 (sign8=-128~127)	1	↓	–	–	↕	○	72
CMP	%X,imm8	0	1	1	1	0	[FFH - imm8]								X-imm8 (imm8=0~255)	1	↓	–	↕	↕	○	88
	%Y,imm8	0	1	1	1	1	[FFH - imm8]								Y-imm8 (imm8=0~255)	1	↓	–	↕	↕	○	88
INC	%SP1	1	1	1	1	1	1	1	1	0	1	0	0	0	SP1 ← SP1+1	1	↓	–	–	↕	×	94
	%SP2	1	1	1	1	1	1	1	1	0	1	1	0	0	SP2 ← SP2+1	1	↓	–	–	↕	×	94
DEC	%SP1	1	1	1	1	1	1	1	1	0	0	0	0	0	SP1 ← SP1-1	1	↓	–	–	↕	×	90
	%SP2	1	1	1	1	1	1	1	1	0	0	1	0	0	SP2 ← SP2-1	1	↓	–	–	↕	×	90

Stack operation

Mnemonic		Machine code													Operation	Cycle	Flag				EXT. mode	Page
		12	11	10	9	8	7	6	5	4	3	2	1	0			E	I	C	Z		
PUSH	%A	1	1	1	1	1	1	1	1	0	0	1	1	1	[SP2-1] ← A, SP2 ← SP2-1	1	↓	–	–	–	×	117
	%B	1	1	1	1	1	1	1	1	0	0	1	1	0	[SP2-1] ← B, SP2 ← SP2-1	1	↓	–	–	–	×	117
	%F	1	1	1	1	1	1	1	1	0	0	1	0	1	[SP2-1] ← F, SP2 ← SP2-1	1	↓	–	–	–	×	117
	%X	1	1	1	1	1	1	1	1	0	0	0	0	1	([(SP1-1)*4+3]~[(SP1-1)*4]) ← X, SP1 ← SP1-1	1	↓	–	–	–	×	118
	%Y	1	1	1	1	1	1	1	1	0	0	0	1	X	([(SP1-1)*4+3]~[(SP1-1)*4]) ← Y, SP1 ← SP1-1	1	↓	–	–	–	×	118
POP	%A	1	1	1	1	1	1	1	1	0	1	1	1	1	A ← [SP2], SP2 ← SP2+1	1	↓	–	–	–	×	116
	%B	1	1	1	1	1	1	1	1	0	1	1	1	0	B ← [SP2], SP2 ← SP2+1	1	↓	–	–	–	×	116
	%F	1	1	1	1	1	1	1	1	0	1	1	0	1	F ← [SP2], SP2 ← SP2+1	1	↕	↕	↕	↕	×	116
	%X	1	1	1	1	1	1	1	1	0	1	0	0	1	X ← ([SP1*4+3]~[SP1*4]), SP1 ← SP1+1	1	↓	–	–	–	×	117
	%Y	1	1	1	1	1	1	1	1	0	1	0	1	X	Y ← ([SP1*4+3]~[SP1*4]), SP1 ← SP1+1	1	↓	–	–	–	×	117

Branch control

Mnemonic		Machine code													Operation	Cycle	Flag				EXT. mode	Page
		12	11	10	9	8	7	6	5	4	3	2	1	0			E	I	C	Z		
JR	sign8	0	0	0	0	0	s7	s6	s5	s4	s3	s2	s1	s0	PC ← PC+sign8+1 (sign8=-128~127)	1	↓	–	–	–	○	97
JR	%A	1	1	1	1	1	1	1	1	1	0	0	0	1	PC ← PC+A+1	1	↓	–	–	–	×	95
	%BA	1	1	1	1	1	1	1	1	1	0	0	0	0	PC ← PC+BA+1	1	↓	–	–	–	×	96
JR	[00addr6]	1	1	1	1	1	0	1	a5	a4	a3	a2	a1	a0	PC ← PC+[00addr6]+1	2	↓	–	–	–	×	96
JRC	sign8	0	0	1	0	0	s7	s6	s5	s4	s3	s2	s1	s0	If C=1 then PC ← PC+sign8+1 (sign8=-128~127)	1	↓	–	–	–	○	97
JRNC	sign8	0	0	1	0	1	s7	s6	s5	s4	s3	s2	s1	s0	If C=0 then PC ← PC+sign8+1 (sign8=-128~127)	1	↓	–	–	–	○	98
JRZ	sign8	0	0	1	1	0	s7	s6	s5	s4	s3	s2	s1	s0	If Z=1 then PC ← PC+sign8+1 (sign8=-128~127)	1	↓	–	–	–	○	99
JRNZ	sign8	0	0	1	1	1	s7	s6	s5	s4	s3	s2	s1	s0	If Z=0 then PC ← PC+sign8+1 (sign8=-128~127)	1	↓	–	–	–	○	98
JP	%Y	1	1	1	1	1	1	1	1	1	0	0	1	X	PC ← Y	1	↓	–	–	–	×	95
CALZ	imm8	0	0	0	1	1	i7	i6	i5	i4	i3	i2	i1	i0	([(SP1-1)*4+3]~[(SP1-1)*4]) ← PC+1, SP1 ← SP1-1, PC ← imm8	1	↓	–	–	–	×	83
CALR	sign8	0	0	0	1	0	s7	s6	s5	s4	s3	s2	s1	s0	([(SP1-1)*4+3]~[(SP1-1)*4]) ← PC+1, SP1 ← SP1-1, PC ← PC+sign8+1 (sign8=-128~127)	1	↓	–	–	–	○	82
CALR	[00addr6]	1	1	1	1	1	0	0	a5	a4	a3	a2	a1	a0	([(SP1-1)*4+3]~[(SP1-1)*4]) ← PC+1, SP1 ← SP1-1, PC ← PC+[00addr6]+1	2	↓	–	–	–	×	82
INT	imm6	1	1	1	1	1	1	0	i5	i4	i3	i2	i1	i0	[SP2-1] ← F, SP2 ← SP2-1 ([(SP1-1)*4+3]~[(SP1-1)*4]) ← PC+1, SP1 ← SP1-1, PC ← imm6 (imm6=0100H~013FH)	3	↓	–	–	–	×	94
RET		1	1	1	1	1	1	1	1	1	1	0	X	0	PC ← ([SP1*4+3]~[SP1*4]), SP1 ← SP1+1	1	↓	–	–	–	×	118
RETS		1	1	1	1	1	1	1	1	1	1	0	1	1	PC ← ([SP1*4+3]~[SP1*4]), SP1 ← SP1+1 PC ← PC+1	2	↓	–	–	–	×	120
RETD	imm8	1	0	0	0	1	i7	i6	i5	i4	i3	i2	i1	i0	PC ← ([SP1*4+3]~[SP1*4]), SP1 ← SP1+1 [X] ← i3~0, [X+1] ← i7~4, X ← X+2	3	↓	–	–	–	×	119
RETI		1	1	1	1	1	1	1	1	1	1	0	0	1	PC ← ([SP1*4+3]~[SP1*4]), SP1 ← SP1+1 F ← [SP2], SP2 ← SP2+1	2	↕	↕	↕	↕	×	119

System control

Mnemonic		Machine code													Operation	Cycle	Flag				EXT. mode	Page
		12	11	10	9	8	7	6	5	4	3	2	1	0			E	I	C	Z		
HALT		1	1	1	1	1	1	1	1	1	1	1	0	0	Halt	2	↓	–	–	–	×	92
SLP		1	1	1	1	1	1	1	1	1	1	1	0	1	Sleep	2	↓	–	–	–	×	133
NOP		1	1	1	1	1	1	1	1	1	1	1	1	X	No operation (PC ← PC+1)	1	↓	–	–	–	×	111

Note: • *The extended addressing (combined with the E flag) is available only for the instructions indicated with ○ in the EXT. mode row. Operation of other instructions (indicated with ×) cannot be guaranteed, therefore do not write data to the EXT register or do not set the E flag immediately before those instructions.*

• *X in the machine code row indicates that the bit is valid even though it is "0" or "1", but the assembler generates it as "0". When entering the code directly, such as for debugging, "0" should be entered.*

4.2.4 List in alphabetical order

Mnemonic		Machine code (12 11 10 9 8 7 6 5 4 3 2 1 0)	Operation	Cycle	Flag E	Flag I	Flag C	Flag Z	EXT. mode	Page
ADC	%A,%A	1 1 0 0 1 1 1 1 1 0 0 0 X	A ← A+A+C	1	↓	–	↕	↕	×	61
	%A,%B	1 1 0 0 1 1 1 1 1 0 0 1 X	A ← A+B+C	1	↓	–	↕	↕	×	61
	%A,imm4	1 1 0 0 1 1 1 0 0 i3 i2 i1 i0	A ← A+imm4+C	1	↓	–	↕	↕	×	61
	%A,[%X]	1 1 0 0 1 1 1 1 0 0 0 0 0	A ← A+[X]+C	1	↓	–	↕	↕	○	62
	%A,[%X]+	1 1 0 0 1 1 1 1 0 0 0 0 1	A ← A+[X]+C, X ← X+1	1	↓	–	↕	↕	×	62
	%A,[%Y]	1 1 0 0 1 1 1 1 0 0 0 1 0	A ← A+[Y]+C	1	↓	–	↕	↕	○	62
	%A,[%Y]+	1 1 0 0 1 1 1 1 0 0 0 1 1	A ← A+[Y]+C, Y ← Y+1	1	↓	–	↕	↕	×	62
	%B,%A	1 1 0 0 1 1 1 1 1 0 1 0 X	B ← B+A+C	1	↓	–	↕	↕	×	61
	%B,%A,n4	1 0 0 0 0 1 1 0 1 [10H-n4]	B ← N's adjust (B+A+C)	2	↓	–	↕	↕	×	65
	%B,%B	1 1 0 0 1 1 1 1 1 0 1 1 X	B ← B+B+C	1	↓	–	↕	↕	×	61
	%B,imm4	1 1 0 0 1 1 1 0 1 i3 i2 i1 i0	B ← B+imm4+C	1	↓	–	↕	↕	×	61
	%B,[%X]	1 1 0 0 1 1 1 1 0 0 1 0 0	B ← B+[X]+C	1	↓	–	↕	↕	○	62
	%B,[%X],n4	1 1 1 0 1 1 1 0 0 [10H-n4]	B ← N's adjust (B+[X]+C)	2	↓	–	↕	↕	○	65
	%B,[%X]+	1 1 0 0 1 1 1 1 0 0 1 0 1	B ← B+[X]+C, X ← X+1	1	↓	–	↕	↕	×	62
	%B,[%X]+,n4	1 1 1 0 1 1 1 0 1 [10H-n4]	B ← N's adjust (B+[X]+C), X ← X+1	2	↓	–	↕	↕	×	66
	%B,[%Y]	1 1 0 0 1 1 1 1 0 0 1 1 0	B ← B+[Y]+C	1	↓	–	↕	↕	○	62
	%B,[%Y],n4	1 1 1 0 1 1 1 1 0 [10H-n4]	B ← N's adjust (B+[Y]+C)	2	↓	–	↕	↕	○	65
	%B,[%Y]+	1 1 0 0 1 1 1 1 0 0 1 1 1	B ← B+[Y]+C, Y ← Y+1	1	↓	–	↕	↕	×	62
	%B,[%Y]+,n4	1 1 1 0 1 1 1 1 1 [10H-n4]	B ← N's adjust (B+[Y]+C), Y ← Y+1	2	↓	–	↕	↕	×	66
	[%X],%A	1 1 0 0 1 1 1 1 0 1 0 0 0	[X] ← [X]+A+C	2	↓	–	↕	↕	○	63
	[%X],%B	1 1 0 0 1 1 1 1 0 1 1 0 0	[X] ← [X]+B+C	2	↓	–	↕	↕	○	63
	[%X],%B,n4	1 1 1 0 1 0 1 0 0 [10H-n4]	[X] ← N's adjust ([X]+B+C)	2	↓	–	↕	↕	○	66
	[%X],imm4	1 1 0 0 1 1 0 0 0 i3 i2 i1 i0	[X] ← [X]+imm4+C	2	↓	–	↕	↕	○	64
	[%X],0,n4	1 1 1 0 1 0 0 0 0 [10H-n4]	[X] ← N's adjust ([X]+0+C)	2	↓	–	↕	↕	○	67
	[%X]+,%A	1 1 0 0 1 1 1 1 0 1 0 0 1	[X] ← [X]+A+C, X ← X+1	2	↓	–	↕	↕	×	63
	[%X]+,%B	1 1 0 0 1 1 1 1 0 1 1 0 1	[X] ← [X]+B+C, X ← X+1	2	↓	–	↕	↕	×	63
	[%X]+,%B,n4	1 1 1 0 1 0 1 0 1 [10H-n4]	[X] ← N's adjust ([X]+B+C), X ← X+1	2	↓	–	↕	↕	×	67
	[%X]+,imm4	1 1 0 0 1 1 0 0 1 i3 i2 i1 i0	[X] ← [X]+imm4+C, X ← X+1	2	↓	–	↕	↕	×	64
	[%X]+,0,n4	1 1 1 0 1 0 0 0 1 [10H-n4]	[X] ← N's adjust ([X]+0+C), X ← X+1	2	↓	–	↕	↕	×	68
	[%Y],%A	1 1 0 0 1 1 1 1 0 1 0 1 0	[Y] ← [Y]+A+C	2	↓	–	↕	↕	○	63
	[%Y],%B	1 1 0 0 1 1 1 1 0 1 1 1 0	[Y] ← [Y]+B+C	2	↓	–	↕	↕	○	63
	[%Y],%B,n4	1 1 1 0 1 0 1 1 0 [10H-n4]	[Y] ← N's adjust ([Y]+B+C)	2	↓	–	↕	↕	○	66
	[%Y],imm4	1 1 0 0 1 1 0 1 0 i3 i2 i1 i0	[Y] ← [Y]+imm4+C	2	↓	–	↕	↕	○	64
	[%Y],0,n4	1 1 1 0 1 0 0 1 0 [10H-n4]	[Y] ← N's adjust ([Y]+0+C)	2	↓	–	↕	↕	○	67
	[%Y]+,%A	1 1 0 0 1 1 1 1 0 1 0 1 1	[Y] ← [Y]+A+C, Y ← Y+1	2	↓	–	↕	↕	×	63
	[%Y]+,%B	1 1 0 0 1 1 1 1 0 1 1 1 1	[Y] ← [Y]+B+C, Y ← Y+1	2	↓	–	↕	↕	×	63
	[%Y]+,%B,n4	1 1 1 0 1 0 1 1 1 [10H-n4]	[Y] ← N's adjust ([Y]+B+C), Y ← Y+1	2	↓	–	↕	↕	×	67
	[%Y]+,imm4	1 1 0 0 1 1 0 1 1 i3 i2 i1 i0	[Y] ← [Y]+imm4+C, Y ← Y+1	2	↓	–	↕	↕	×	64
	[%Y]+,0,n4	1 1 1 0 1 0 0 1 1 [10H-n4]	[Y] ← N's adjust ([Y]+0+C), Y ← Y+1	2	↓	–	↕	↕	×	67
ADD	%A,%A	1 1 0 0 1 0 1 1 1 0 0 0 X	A ← A+A	1	↓	–	↕	↕	×	68
	%A,%B	1 1 0 0 1 0 1 1 1 0 0 1 X	A ← A+B	1	↓	–	↕	↕	×	68
	%A,imm4	1 1 0 0 1 0 1 0 0 i3 i2 i1 i0	A ← A+imm4	1	↓	–	↕	↕	×	69
	%A,[%X]	1 1 0 0 1 0 1 1 0 0 0 0 0	A ← A+[X]	1	↓	–	↕	↕	○	69
	%A,[%X]+	1 1 0 0 1 0 1 1 0 0 0 0 1	A ← A+[X], X ← X+1	1	↓	–	↕	↕	×	70
	%A,[%Y]	1 1 0 0 1 0 1 1 0 0 0 1 0	A ← A+[Y]	1	↓	–	↕	↕	○	69
	%A,[%Y]+	1 1 0 0 1 0 1 1 0 0 0 1 1	A ← A+[Y], Y ← Y+1	1	↓	–	↕	↕	×	70
	%B,%A	1 1 0 0 1 0 1 1 1 0 1 0 X	B ← B+A	1	↓	–	↕	↕	×	68
	%B,%B	1 1 0 0 1 0 1 1 1 0 1 1 X	B ← B+B	1	↓	–	↕	↕	×	68
	%B,imm4	1 1 0 0 1 0 1 0 1 i3 i2 i1 i0	B ← B+imm4	1	↓	–	↕	↕	×	69
	%B,[%X]	1 1 0 0 1 0 1 1 0 0 1 0 0	B ← B+[X]	1	↓	–	↕	↕	○	69
	%B,[%X]+	1 1 0 0 1 0 1 1 0 0 1 0 1	B ← B+[X], X ← X+1	1	↓	–	↕	↕	×	70
	%B,[%Y]	1 1 0 0 1 0 1 1 0 0 1 1 0	B ← B+[Y]	1	↓	–	↕	↕	○	69
	%B,[%Y]+	1 1 0 0 1 0 1 1 0 0 1 1 1	B ← B+[Y], Y ← Y+1	1	↓	–	↕	↕	×	70
	%X,%BA	1 1 1 1 1 1 1 0 1 0 0 0 X	X ← X+BA	1	↓	–	–	↕	×	72
	%X,sign8	0 1 1 0 0 s7 s6 s5 s4 s3 s2 s1 s0	X ← X+sign8 (sign8=-128~127)	1	↓	–	–	↕	○	73
	%Y,%BA	1 1 1 1 1 1 1 0 1 0 0 1 X	Y ← Y+BA	1	↓	–	–	↕	×	72
	%Y,sign8	0 1 1 0 1 s7 s6 s5 s4 s3 s2 s1 s0	Y ← Y+sign8 (sign8=-128~127)	1	↓	–	–	↕	○	73
	[%X],%A	1 1 0 0 1 0 1 1 0 1 0 0 0	[X] ← [X]+A	2	↓	–	↕	↕	○	70
	[%X],%B	1 1 0 0 1 0 1 1 0 1 1 0 0	[X] ← [X]+B	2	↓	–	↕	↕	○	70

Mnemonic		Machine code 12	11	10	9	8	7	6	5	4	3	2	1	0	Operation	Cycle	Flag E	I	C	Z	EXT. mode	Page
ADD	[%X],imm4	1	1	0	0	1	0	0	0	0	i3	i2	i1	i0	[X] ← [X]+imm4	2	↓	–	↕	↕	○	71
	[%X]+,%A	1	1	0	0	1	0	1	1	0	1	0	0	1	[X] ← [X]+A, X ← X+1	2	↓	–	↕	↕	×	71
	[%X]+,%B	1	1	0	0	1	0	1	1	0	1	1	0	1	[X] ← [X]+B, X ← X+1	2	↓	–	↕	↕	×	71
	[%X]+,imm4	1	1	0	0	1	0	0	0	1	i3	i2	i1	i0	[X] ← [X]+imm4, X ← X+1	2	↓	–	↕	↕	×	72
	[%Y],%A	1	1	0	0	1	0	1	1	0	1	0	1	0	[Y] ← [Y]+A	2	↓	–	↕	↕	○	70
	[%Y],%B	1	1	0	0	1	0	1	1	0	1	1	1	0	[Y] ← [Y]+B	2	↓	–	↕	↕	○	70
	[%Y],imm4	1	1	0	0	1	0	0	1	0	i3	i2	i1	i0	[Y] ← [Y]+imm4	2	↓	–	↕	↕	○	71
	[%Y]+,%A	1	1	0	0	1	0	1	1	0	1	0	1	1	[Y] ← [Y]+A, Y ← Y+1	2	↓	–	↕	↕	×	71
	[%Y]+,%B	1	1	0	0	1	0	1	1	0	1	1	1	1	[Y] ← [Y]+B, Y ← Y+1	2	↓	–	↕	↕	×	71
	[%Y]+,imm4	1	1	0	0	1	0	0	1	1	i3	i2	i1	i0	[Y] ← [Y]+imm4, Y ← Y+1	2	↓	–	↕	↕	×	72
AND	%A,%A	1	1	0	1	0	0	1	1	1	0	0	0	X	A ← A∧A	1	↓	–	–	↕	×	73
	%A,%B	1	1	0	1	0	0	1	1	1	0	0	1	X	A ← A∧B	1	↓	–	–	↕	×	73
	%A,imm4	1	1	0	1	0	0	1	0	0	i3	i2	i1	i0	A ← A∧imm4	1	↓	–	–	↕	×	74
	%A,[%X]	1	1	0	1	0	0	1	1	0	0	0	0	0	A ← A∧[X]	1	↓	–	–	↕	○	75
	%A,[%X]+	1	1	0	1	0	0	1	1	0	0	0	0	1	A ← A∧[X], X ← X+1	1	↓	–	–	↕	×	75
	%A,[%Y]	1	1	0	1	0	0	1	1	0	0	0	1	0	A ← A∧[Y]	1	↓	–	–	↕	○	75
	%A,[%Y]+	1	1	0	1	0	0	1	1	0	0	0	1	1	A ← A∧[Y], Y ← Y+1	1	↓	–	–	↕	×	75
	%B,%A	1	1	0	1	0	0	1	1	1	0	1	0	X	B ← B∧A	1	↓	–	–	↕	×	73
	%B,%B	1	1	0	1	0	0	1	1	1	0	1	1	X	B ← B∧B	1	↓	–	–	↕	×	73
	%B,imm4	1	1	0	1	0	0	1	0	1	i3	i2	i1	i0	B ← B∧imm4	1	↓	–	–	↕	×	74
	%B,[%X]	1	1	0	1	0	0	1	1	0	0	1	0	0	B ← B∧[X]	1	↓	–	–	↕	○	75
	%B,[%X]+	1	1	0	1	0	0	1	1	0	0	1	0	1	B ← B∧[X], X ← X+1	1	↓	–	–	↕	×	75
	%B,[%Y]	1	1	0	1	0	0	1	1	0	0	1	1	0	B ← B∧[Y]	1	↓	–	–	↕	○	75
	%B,[%Y]+	1	1	0	1	0	0	1	1	0	0	1	1	1	B ← B∧[Y], Y ← Y+1	1	↓	–	–	↕	×	75
	%F,imm4	1	0	0	0	0	1	0	0	0	i3	i2	i1	i0	F ← F∧imm4	1	↓	↓	↓	↓	×	74
	[%X],%A	1	1	0	1	0	0	1	1	0	1	0	0	0	[X] ← [X]∧A	2	↓	–	–	↕	○	76
	[%X],%B	1	1	0	1	0	0	1	1	0	1	1	0	0	[X] ← [X]∧B	2	↓	–	–	↕	○	76
	[%X],imm4	1	1	0	1	0	0	0	0	0	i3	i2	i1	i0	[X] ← [X]∧imm4	2	↓	–	–	↕	○	77
	[%X]+,%A	1	1	0	1	0	0	1	1	0	1	0	0	1	[X] ← [X]∧A, X ← X+1	2	↓	–	–	↕	×	76
	[%X]+,%B	1	1	0	1	0	0	1	1	0	1	1	0	1	[X] ← [X]∧B, X ← X+1	2	↓	–	–	↕	×	76
	[%X]+,imm4	1	1	0	1	0	0	0	0	1	i3	i2	i1	i0	[X] ← [X]∧imm4, X ← X+1	2	↓	–	–	↕	×	77
	[%Y],%A	1	1	0	1	0	0	1	1	0	1	0	1	0	[Y] ← [Y]∧A	2	↓	–	–	↕	○	76
	[%Y],%B	1	1	0	1	0	0	1	1	0	1	1	1	0	[Y] ← [Y]∧B	2	↓	–	–	↕	○	76
	[%Y],imm4	1	1	0	1	0	0	0	1	0	i3	i2	i1	i0	[Y] ← [Y]∧imm4	2	↓	–	–	↕	○	77
	[%Y]+,%A	1	1	0	1	0	0	1	1	0	1	0	1	1	[Y] ← [Y]∧A, Y ← Y+1	2	↓	–	–	↕	×	76
	[%Y]+,%B	1	1	0	1	0	0	1	1	0	1	1	1	1	[Y] ← [Y]∧B, Y ← Y+1	2	↓	–	–	↕	×	76
	[%Y]+,imm4	1	1	0	1	0	0	0	1	1	i3	i2	i1	i0	[Y] ← [Y]∧imm4, Y ← Y+1	2	↓	–	–	↕	×	77
BIT	%A,%A	1	1	0	1	0	1	1	1	1	0	0	0	X	A∧A	1	↓	–	–	↕	×	78
	%A,%B	1	1	0	1	0	1	1	1	1	0	0	1	X	A∧B	1	↓	–	–	↕	×	78
	%A,imm4	1	1	0	1	0	1	1	0	0	i3	i2	i1	i0	A∧imm4	1	↓	–	–	↕	×	78
	%A,[%X]	1	1	0	1	0	1	1	1	0	0	0	0	0	A∧[X]	1	↓	–	–	↕	○	79
	%A,[%X]+	1	1	0	1	0	1	1	1	0	0	0	0	1	A∧[X], X ← X+1	1	↓	–	–	↕	×	79
	%A,[%Y]	1	1	0	1	0	1	1	1	0	0	0	1	0	A∧[Y]	1	↓	–	–	↕	○	79
	%A,[%Y]+	1	1	0	1	0	1	1	1	0	0	0	1	1	A∧[Y], Y ← Y+1	1	↓	–	–	↕	×	79
	%B,%A	1	1	0	1	0	1	1	1	1	0	1	0	X	B∧A	1	↓	–	–	↕	×	78
	%B,%B	1	1	0	1	0	1	1	1	1	0	1	1	X	B∧B	1	↓	–	–	↕	×	78
	%B,imm4	1	1	0	1	0	1	1	0	1	i3	i2	i1	i0	B∧imm4	1	↓	–	–	↕	×	78
	%B,[%X]	1	1	0	1	0	1	1	1	0	0	1	0	0	B∧[X]	1	↓	–	–	↕	○	79
	%B,[%X]+	1	1	0	1	0	1	1	1	0	0	1	0	1	B∧[X], X ← X+1	1	↓	–	–	↕	×	79
	%B,[%Y]	1	1	0	1	0	1	1	1	0	0	1	1	0	B∧[Y]	1	↓	–	–	↕	○	79
	%B,[%Y]+	1	1	0	1	0	1	1	1	0	0	1	1	1	B∧[Y], Y ← Y+1	1	↓	–	–	↕	×	79
	[%X],%A	1	1	0	1	0	1	1	1	0	1	0	0	0	[X]∧A	1	↓	–	–	↕	○	80
	[%X],%B	1	1	0	1	0	1	1	1	0	1	1	0	0	[X]∧B	1	↓	–	–	↕	○	80
	[%X],imm4	1	1	0	1	0	1	0	0	0	i3	i2	i1	i0	[X]∧imm4	1	↓	–	–	↕	○	81
	[%X]+,%A	1	1	0	1	0	1	1	1	0	1	0	0	1	[X]∧A, X ← X+1	1	↓	–	–	↕	×	80
	[%X]+,%B	1	1	0	1	0	1	1	1	0	1	1	0	1	[X]∧B, X ← X+1	1	↓	–	–	↕	×	80
	[%X]+,imm4	1	1	0	1	0	1	0	0	1	i3	i2	i1	i0	[X]∧imm4, X ← X+1	1	↓	–	–	↕	×	81
	[%Y],%A	1	1	0	1	0	1	1	1	0	1	0	1	0	[Y]∧A	1	↓	–	–	↕	○	80
	[%Y],%B	1	1	0	1	0	1	1	1	0	1	1	1	0	[Y]∧B	1	↓	–	–	↕	○	80

Mnemonic		Machine code 12	11	10	9	8	7	6	5	4	3	2	1	0	Operation	Cycle	Flag E	I	C	Z	EXT. mode	Page
BIT	[%Y],imm4	1	1	0	1	0	1	0	1	0	i3	i2	i1	i0	[Y]∧imm4	1	↓	–	–	↕	○	81
	[%Y]+,%A	1	1	0	1	0	1	1	1	0	1	0	1	1	[Y]∧A, Y ← Y+1	1	↓	–	–	↕	×	80
	[%Y]+,%B	1	1	0	1	0	1	1	1	0	1	1	1	1	[Y]∧B, Y ← Y+1	1	↓	–	–	↕	×	80
	[%Y]+,imm4	1	1	0	1	0	1	0	1	1	i3	i2	i1	i0	[Y]∧imm4, Y ← Y+1	1	↓	–	–	↕	×	81
CALR	[00addr6]	1	1	1	1	1	0	0	a5	a4	a3	a2	a1	a0	([(SP1-1)∗4+3]~[(SP1-1)∗4]) ← PC+1, SP1 ← SP1-1, PC ← PC+[00addr6]+1	2	↓	–	–	–	×	82
CALR	sign8	0	0	0	1	0	s7	s6	s5	s4	s3	s2	s1	s0	([(SP1-1)∗4+3]~[(SP1-1)∗4]) ← PC+1, SP1 ← SP1-1, PC ← PC+sign8+1 (sign8=-128~127)	1	↓	–	–	–	○	82
CALZ	imm8	0	0	0	1	1	i7	i6	i5	i4	i3	i2	i1	i0	([(SP1-1)∗4+3]~[(SP1-1)∗4]) ← PC+1, SP1 ← SP1-1, PC ← imm8	1	↓	–	–	–	×	83
CLR	[00addr6],imm2	1	0	1	0	0	i1	i0	a5	a4	a3	a2	a1	a0	[00addr6] ← [00addr6]∧not (2^{imm2})	2	↓	–	–	↕	×	83
	[FFaddr6],imm2	1	0	1	0	1	i1	i0	a5	a4	a3	a2	a1	a0	[FFaddr6] ← [FFaddr6]∧not (2^{imm2})	2	↓	–	–	↕	×	83
CMP	%A,%A	1	1	1	1	0	0	1	1	1	X	0	0	0	A-A	1	↓	–	↓	↑	×	84
	%A,%B	1	1	1	1	0	0	1	1	1	X	0	1	0	A-B	1	↓	–	↕	↕	×	84
	%A,imm4	1	1	1	1	0	0	1	0	0	i3	i2	i1	i0	A-imm4	1	↓	–	↕	↕	×	84
	%A,[%X]	1	1	1	1	0	0	1	1	0	0	0	0	0	A-[X]	1	↓	–	↕	↕	○	85
	%A,[%X]+	1	1	1	1	0	0	1	1	0	0	0	0	1	A-[X], X ← X+1	1	↓	–	↕	↕	×	85
	%A,[%Y]	1	1	1	1	0	0	1	1	0	0	0	1	0	A-[Y]	1	↓	–	↕	↕	○	85
	%A,[%Y]+	1	1	1	1	0	0	1	1	0	0	0	1	1	A-[Y], Y ← Y+1	1	↓	–	↕	↕	×	85
	%B,%A	1	1	1	1	0	0	1	1	1	X	1	0	0	B-A	1	↓	–	↕	↕	×	84
	%B,%B	1	1	1	1	0	0	1	1	1	X	1	1	0	B-B	1	↓	–	↓	↑	×	84
	%B,imm4	1	1	1	1	0	0	1	0	1	i3	i2	i1	i0	B-imm4	1	↓	–	↕	↕	×	84
	%B,[%X]	1	1	1	1	0	0	1	1	0	0	1	0	0	B-[X]	1	↓	–	↕	↕	○	85
	%B,[%X]+	1	1	1	1	0	0	1	1	0	0	1	0	1	B-[X], X ← X+1	1	↓	–	↕	↕	×	85
	%B,[%Y]	1	1	1	1	0	0	1	1	0	0	1	1	0	B-[Y]	1	↓	–	↕	↕	○	85
	%B,[%Y]+	1	1	1	1	0	0	1	1	0	0	1	1	1	B-[Y], Y ← Y+1	1	↓	–	↕	↕	×	85
	%X,imm8	0	1	1	1	0	[FFH - imm8]								X-imm8 (imm8=0~255)	1	↓	–	↕	↕	○	88
	%Y,imm8	0	1	1	1	1	[FFH - imm8]								Y-imm8 (imm8=0~255)	1	↓	–	↕	↕	○	88
	[%X],%A	1	1	1	1	0	0	1	1	0	1	0	0	0	[X]-A	1	↓	–	↕	↕	○	86
	[%X],%B	1	1	1	1	0	0	1	1	0	1	1	0	0	[X]-B	1	↓	–	↕	↕	○	86
	[%X],imm4	1	1	1	1	0	0	0	0	0	i3	i2	i1	i0	[X]-imm4	1	↓	–	↕	↕	○	87
	[%X]+,%A	1	1	1	1	0	0	1	1	0	1	0	0	1	[X]-A, X ← X+1	1	↓	–	↕	↕	×	86
	[%X]+,%B	1	1	1	1	0	0	1	1	0	1	1	0	1	[X]-B, X ← X+1	1	↓	–	↕	↕	×	86
	[%X]+,imm4	1	1	1	1	0	0	0	0	1	i3	i2	i1	i0	[X]-imm4, X ← X+1	1	↓	–	↕	↕	×	87
	[%Y],%A	1	1	1	1	0	0	1	1	0	1	0	1	0	[Y]-A	1	↓	–	↕	↕	○	86
	[%Y],%B	1	1	1	1	0	0	1	1	0	1	1	1	0	[Y]-B	1	↓	–	↕	↕	○	86
	[%Y],imm4	1	1	1	1	0	0	0	1	0	i3	i2	i1	i0	[Y]-imm4	1	↓	–	↕	↕	○	87
	[%Y]+,%A	1	1	1	1	0	0	1	1	0	1	0	1	1	[Y]-A, Y ← Y+1	1	↓	–	↕	↕	×	86
	[%Y]+,%B	1	1	1	1	0	0	1	1	0	1	1	1	1	[Y]-B, Y ← Y+1	1	↓	–	↕	↕	×	86
	[%Y]+,imm4	1	1	1	1	0	0	0	1	1	i3	i2	i1	i0	[Y]-imm4, Y ← Y+1	1	↓	–	↕	↕	×	87
DEC	%SP1	1	1	1	1	1	1	1	1	0	0	0	0	0	SP1 ← SP1-1	1	↓	–	–	↕	×	90
	%SP2	1	1	1	1	1	1	1	1	0	0	1	0	0	SP2 ← SP2-1	1	↓	–	–	↕	×	90
	[%X],n4	1	1	1	0	0	1	0	0	0	n3	n2	n1	n0	[X] ← N's adjust ([X]-1)	2	↓	–	↕	↕	○	89
	[%X]+,n4	1	1	1	0	0	1	0	0	1	n3	n2	n1	n0	[X] ← N's adjust ([X]-1), X ← X+1	2	↓	–	↕	↕	×	89
	[%Y],n4	1	1	1	0	0	1	0	1	0	n3	n2	n1	n0	[Y] ← N's adjust ([Y]-1)	2	↓	–	↕	↕	○	89
	[%Y]+,n4	1	1	1	0	0	1	0	1	1	n3	n2	n1	n0	[Y] ← N's adjust ([Y]-1), Y ← Y+1	2	↓	–	↕	↕	×	89
	[00addr6]	1	0	0	0	0	0	0	a5	a4	a3	a2	a1	a0	[00addr6] ← [00addr6]-1	2	↓	–	↕	↕	×	88
EX	%A,%B	1	1	1	1	1	1	1	1	1	0	1	1	1	A ↔ B	1	↓	–	–	–	×	90
	%A,[%X]	1	0	0	0	0	1	1	1	1	1	0	0	0	A ↔ [X]	2	↓	–	–	–	○	91
	%A,[%X]+	1	0	0	0	0	1	1	1	1	1	0	0	1	A ↔ [X], X ← X+1	2	↓	–	–	–	×	91
	%A,[%Y]	1	0	0	0	0	1	1	1	1	1	0	1	0	A ↔ [Y]	2	↓	–	–	–	○	91
	%A,[%Y]+	1	0	0	0	0	1	1	1	1	1	0	1	1	A ↔ [Y], Y ← Y+1	2	↓	–	–	–	×	91
	%B,[%X]	1	0	0	0	0	1	1	1	1	1	1	0	0	B ↔ [X]	2	↓	–	–	–	○	91
	%B,[%X]+	1	0	0	0	0	1	1	1	1	1	1	0	1	B ↔ [X], X ← X+1	2	↓	–	–	–	×	91
	%B,[%Y]	1	0	0	0	0	1	1	1	1	1	1	1	0	B ↔ [Y]	2	↓	–	–	–	○	91
	%B,[%Y]+	1	0	0	0	0	1	1	1	1	1	1	1	1	B ↔ [Y], Y ← Y+1	2	↓	–	–	–	×	91
HALT		1	1	1	1	1	1	1	1	1	1	1	0	0	Halt	2	↓	–	–	–	×	92
INC	%SP1	1	1	1	1	1	1	1	1	0	1	0	0	0	SP1 ← SP1+1	1	↓	–	–	↕	×	94
	%SP2	1	1	1	1	1	1	1	1	0	1	1	0	0	SP2 ← SP2+1	1	↓	–	–	↕	×	94

Mnemonic		Machine code													Operation	Cycle	Flag				EXT. mode	Page
		12	11	10	9	8	7	6	5	4	3	2	1	0			E	I	C	Z		
INC	[%X],n4	1	1	1	0	1	1	0	0	0	[10H-n4]				[X] ← N's adjust ([X]+1)	2	↓	–	↕	↕	○	93
	[%X]+,n4	1	1	1	0	1	1	0	0	1	[10H-n4]				[X] ← N's adjust ([X]+1), X ← X+1	2	↓	–	↕	↕	×	93
	[%Y],n4	1	1	1	0	1	1	0	1	0	[10H-n4]				[Y] ← N's adjust ([Y]+1)	2	↓	–	↕	↕	○	93
	[%Y]+,n4	1	1	1	0	1	1	0	1	1	[10H-n4]				[Y] ← N's adjust ([Y]+1), Y ← Y+1	2	↓	–	↕	↕	×	93
	[00addr6]	1	0	0	0	0	0	1	a5	a4	a3	a2	a1	a0	[00addr6] ← [00addr6]+1	2	↓	–	↕	↕	×	92
INT	imm6	1	1	1	1	1	1	0	i5	i4	i3	i2	i1	i0	[SP2-1] ← F, SP2 ← SP2-1 ([(SP1-1)∗4+3]~[(SP1-1)∗4]) ← PC+1, SP1 ← SP1-1, PC ← imm6 (imm6=0100H~013FH)	3	↓	–	–	–	×	94
JP	%Y	1	1	1	1	1	1	1	1	1	0	0	1	X	PC ← Y	1	↓	–	–	–	×	95
JR	%A	1	1	1	1	1	1	1	1	1	0	0	0	1	PC ← PC+A+1	1	↓	–	–	–	×	95
	%BA	1	1	1	1	1	1	1	1	1	0	0	0	0	PC ← PC+BA+1	1	↓	–	–	–	×	96
	sign8	0	0	0	0	0	s7	s6	s5	s4	s3	s2	s1	s0	PC ← PC+sign8+1 (sign8=-128~127)	1	↓	–	–	–	○	97
	[00addr6]	1	1	1	1	1	0	1	a5	a4	a3	a2	a1	a0	PC ← PC+[00addr6]+1	2	↓	–	–	–	×	96
JRC	sign8	0	0	1	0	0	s7	s6	s5	s4	s3	s2	s1	s0	If C=1 then PC ← PC+sign8+1 (sign8=-128~127)	1	↓	–	–	–	○	97
JRNC	sign8	0	0	1	0	1	s7	s6	s5	s4	s3	s2	s1	s0	If C=0 then PC ← PC+sign8+1 (sign8=-128~127)	1	↓	–	–	–	○	98
JRNZ	sign8	0	0	1	1	1	s7	s6	s5	s4	s3	s2	s1	s0	If Z=0 then PC ← PC+sign8+1 (sign8=-128~127)	1	↓	–	–	–	○	98
JRZ	sign8	0	0	1	1	0	s7	s6	s5	s4	s3	s2	s1	s0	If Z=1 then PC ← PC+sign8+1 (sign8=-128~127)	1	↓	–	–	–	○	99
LD	%A,%A	1	1	1	1	0	1	1	1	1	0	0	0	0	A ← A	1	↓	–	–	–	×	99
	%A,%B	1	1	1	1	0	1	1	1	1	0	0	1	0	A ← B	1	↓	–	–	–	×	99
	%A,%F	1	1	1	1	1	1	1	1	1	0	1	1	0	A ← F	1	↓	–	–	–	×	99
	%A,imm4	1	1	1	1	0	1	1	0	0	i3	i2	i1	i0	A ← imm4	1	↓	–	–	–	×	100
	%A,[%X]	1	1	1	1	0	1	1	1	0	0	0	0	0	A ← [X]	1	↓	–	–	–	○	100
	%A,[%X]+	1	1	1	1	0	1	1	1	0	0	0	0	1	A ← [X], X ← X+1	1	↓	–	–	–	×	101
	%A,[%Y]	1	1	1	1	0	1	1	1	0	0	0	1	0	A ← [Y]	1	↓	–	–	–	○	100
	%A,[%Y]+	1	1	1	1	0	1	1	1	0	0	0	1	1	A ← [Y], Y ← Y+1	1	↓	–	–	–	×	101
	%B,%A	1	1	1	1	0	1	1	1	1	0	1	0	0	B ← A	1	↓	–	–	–	×	99
	%B,%B	1	1	1	1	0	1	1	1	1	0	1	1	0	B ← B	1	↓	–	–	–	×	99
	%B,imm4	1	1	1	1	0	1	1	0	1	i3	i2	i1	i0	B ← imm4	1	↓	–	–	–	×	100
	%B,[%X]	1	1	1	1	0	1	1	1	0	0	1	0	0	B ← [X]	1	↓	–	–	–	○	100
	%B,[%X]+	1	1	1	1	0	1	1	1	0	0	1	0	1	B ← [X], X ← X+1	1	↓	–	–	–	×	101
	%B,[%Y]	1	1	1	1	0	1	1	1	0	0	1	1	0	B ← [Y]	1	↓	–	–	–	○	100
	%B,[%Y]+	1	1	1	1	0	1	1	1	0	0	1	1	1	B ← [Y], Y ← Y+1	1	↓	–	–	–	×	101
	%F,%A	1	1	1	1	1	1	1	1	1	0	1	0	1	F ← A	1	↕	↕	↕	↕	×	99
	%F,imm4	1	0	0	0	0	1	0	1	1	i3	i2	i1	i0	F ← imm4	1	↕	↕	↕	↕	×	100
	[%X],%A	1	1	1	1	0	1	1	1	0	1	0	0	0	[X] ← A	1	↓	–	–	–	○	101
	[%X],%B	1	1	1	1	0	1	1	1	0	1	1	0	0	[X] ← B	1	↓	–	–	–	○	101
	[%X],imm4	1	1	1	1	0	1	0	0	0	i3	i2	i1	i0	[X] ← imm4	1	↓	–	–	–	○	102
	[%X],[%Y]	1	1	1	1	0	1	1	1	1	1	0	1	0	[X] ← [Y]	2	↓	–	–	–	×	103
	[%X],[%Y]+	1	1	1	1	0	1	1	1	1	1	0	1	1	[X] ← [Y], Y ← Y+1	2	↓	–	–	–	×	104
	[%X]+,%A	1	1	1	1	0	1	1	1	0	1	0	0	1	[X] ← A, X ← X+1	1	↓	–	–	–	×	102
	[%X]+,%B	1	1	1	1	0	1	1	1	0	1	1	0	1	[X] ← B, X ← X+1	1	↓	–	–	–	×	102
	[%X]+,imm4	1	1	1	1	0	1	0	0	1	i3	i2	i1	i0	[X] ← imm4, X ← X+1	1	↓	–	–	–	×	103
	[%X]+,[%Y]	1	1	1	1	0	1	1	1	1	1	1	1	0	[X] ← [Y], X ← X+1	2	↓	–	–	–	×	104
	[%X]+,[%Y]+	1	1	1	1	0	1	1	1	1	1	1	1	1	[X] ← [Y], X ← X+1, Y ← Y+1	2	↓	–	–	–	×	105
	[%Y],%A	1	1	1	1	0	1	1	1	0	1	0	1	0	[Y] ← A	1	↓	–	–	–	○	101
	[%Y],%B	1	1	1	1	0	1	1	1	0	1	1	1	0	[Y] ← B	1	↓	–	–	–	○	101
	[%Y],imm4	1	1	1	1	0	1	0	1	0	i3	i2	i1	i0	[Y] ← imm4	1	↓	–	–	–	○	102
	[%Y],[%X]	1	1	1	1	0	1	1	1	1	1	0	0	0	[Y] ← [X]	2	↓	–	–	–	×	103
	[%Y],[%X]+	1	1	1	1	0	1	1	1	1	1	0	0	1	[Y] ← [X], X ← X+1	2	↓	–	–	–	×	104
	[%Y]+,%A	1	1	1	1	0	1	1	1	0	1	0	1	1	[Y] ← A, Y ← Y+1	1	↓	–	–	–	×	102
	[%Y]+,%B	1	1	1	1	0	1	1	1	0	1	1	1	1	[Y] ← B, Y ← Y+1	1	↓	–	–	–	×	102
	[%Y]+,imm4	1	1	1	1	0	1	0	1	1	i3	i2	i1	i0	[Y] ← imm4, Y ← Y+1	1	↓	–	–	–	×	103
	[%Y]+,[%X]	1	1	1	1	0	1	1	1	1	1	1	0	0	[Y] ← [X], Y ← Y+1	2	↓	–	–	–	×	104
	[%Y]+,[%X]+	1	1	1	1	0	1	1	1	1	1	1	0	1	[Y] ← [X], Y ← Y+1, X ← X+1	2	↓	–	–	–	×	105
LDB	%BA,%EXT	1	1	1	1	1	1	1	0	1	0	1	1	X	BA ← EXT	1	↓	–	–	–	×	106
	%BA,%SP1	1	1	1	1	1	1	1	0	0	1	1	0	X	BA ← SP1	1	↓	–	–	–	×	107
	%BA,%SP2	1	1	1	1	1	1	1	0	0	1	1	1	X	BA ← SP2	1	↓	–	–	–	×	107
	%BA,%XH	1	1	1	1	1	1	1	0	0	1	0	0	1	BA ← XH	1	↓	–	–	–	×	107
	%BA,%XL	1	1	1	1	1	1	1	0	0	1	0	0	0	BA ← XL	1	↓	–	–	–	×	107

Mnemonic		Machine code													Operation	Cycle	Flag				EXT. mode	Page
		12	11	10	9	8	7	6	5	4	3	2	1	0			E	I	C	Z		
LDB	%BA,%YH	1	1	1	1	1	1	1	0	0	1	0	1	1	BA ← YH	1	↓	–	–	–	×	107
	%BA,%YL	1	1	1	1	1	1	1	0	0	1	0	1	0	BA ← YL	1	↓	–	–	–	×	107
	%BA,imm8	0	1	0	0	1	i7	i6	i5	i4	i3	i2	i1	i0	BA ← imm8	1	↓	–	–	–	×	105
	%BA,[%X]+	1	1	1	1	1	1	1	0	1	1	0	0	0	A ← [X], B ← [X+1], X ← X+2	2	↓	–	–	–	×	106
	%BA,[%Y]+	1	1	1	1	1	1	1	0	1	1	0	1	0	A ← [Y], B ← [Y+1], Y ← Y+2	2	↓	–	–	–	×	106
	%EXT,%BA	1	1	1	1	1	1	1	0	1	0	1	0	X	EXT ← BA	1	↑	–	–	–	×	109
	%EXT,imm8	0	1	0	0	0	i7	i6	i5	i4	i3	i2	i1	i0	EXT ← imm8	1	↑	–	–	–	×	109
	%SP1,%BA	1	1	1	1	1	1	1	0	0	0	1	0	X	SP1 ← BA	1	↓	–	–	–	×	111
	%SP2,%BA	1	1	1	1	1	1	1	0	0	0	1	1	X	SP2 ← BA	1	↓	–	–	–	×	111
	%XH,%BA	1	1	1	1	1	1	1	0	0	0	0	0	1	XH ← BA	1	↓	–	–	–	×	110
	%XL,%BA	1	1	1	1	1	1	1	0	0	0	0	0	0	XL ← BA	1	↓	–	–	–	×	110
	%XL,imm8	0	1	0	1	0	i7	i6	i5	i4	i3	i2	i1	i0	XL ← imm8	1	↓	–	–	–	○	110
	%YH,%BA	1	1	1	1	1	1	1	0	0	0	0	1	1	YH ← BA	1	↓	–	–	–	×	110
	%YL,%BA	1	1	1	1	1	1	1	0	0	0	0	1	0	YL ← BA	1	↓	–	–	–	×	110
	%YL,imm8	0	1	0	1	1	i7	i6	i5	i4	i3	i2	i1	i0	YL ← imm8	1	↓	–	–	–	○	110
	[%X]+,%BA	1	1	1	1	1	1	1	0	1	1	0	0	1	[X] ← A, [X+1] ← B, X ← X+2	2	↓	–	–	–	×	108
	[%X]+,imm8	0	0	0	0	1	i7	i6	i5	i4	i3	i2	i1	i0	[X] ← i3~0, [X+1] ← i7~4, X ← X+2	2	↓	–	–	–	×	108
	[%Y]+,%BA	1	1	1	1	1	1	1	0	1	1	0	1	1	[Y] ← A, [Y+1] ← B, Y ← Y+2	2	↓	–	–	–	×	108
NOP		1	1	1	1	1	1	1	1	1	1	1	1	X	No operation (PC ← PC+1)	1	↓	–	–	–	×	111
OR	%A,%A	1	1	0	1	1	0	1	1	1	0	0	0	X	A ← A∨A	1	↓	–	–	↕	×	112
	%A,%B	1	1	0	1	1	0	1	1	1	0	0	1	X	A ← A∨B	1	↓	–	–	↕	×	112
	%A,imm4	1	1	0	1	1	0	1	0	0	i3	i2	i1	i0	A ← A∨imm4	1	↓	–	–	↕	×	112
	%A,[%X]	1	1	0	1	1	0	1	1	0	0	0	0	0	A ← A∨[X]	1	↓	–	–	↕	○	113
	%A,[%X]+	1	1	0	1	1	0	1	1	0	0	0	0	1	A ← A∨[X], X ← X+1	1	↓	–	–	↕	×	114
	%A,[%Y]	1	1	0	1	1	0	1	1	0	0	0	1	0	A ← A∨[Y]	1	↓	–	–	↕	○	113
	%A,[%Y]+	1	1	0	1	1	0	1	1	0	0	0	1	1	A ← A∨[Y], Y ← Y+1	1	↓	–	–	↕	×	114
	%B,%A	1	1	0	1	1	0	1	1	1	0	1	0	X	B ← B∨A	1	↓	–	–	↕	×	112
	%B,%B	1	1	0	1	1	0	1	1	1	0	1	1	X	B ← B∨B	1	↓	–	–	↕	×	112
	%B,imm4	1	1	0	1	1	0	1	0	1	i3	i2	i1	i0	B ← B∨imm4	1	↓	–	–	↕	×	112
	%B,[%X]	1	1	0	1	1	0	1	1	0	0	1	0	0	B ← B∨[X]	1	↓	–	–	↕	○	113
	%B,[%X]+	1	1	0	1	1	0	1	1	0	0	1	0	1	B ← B∨[X], X ← X+1	1	↓	–	–	↕	×	114
	%B,[%Y]	1	1	0	1	1	0	1	1	0	0	1	1	0	B ← B∨[Y]	1	↓	–	–	↕	○	113
	%B,[%Y]+	1	1	0	1	1	0	1	1	0	0	1	1	1	B ← B∨[Y], Y ← Y+1	1	↓	–	–	↕	×	114
	%F,imm4	1	0	0	0	0	1	0	0	1	i3	i2	i1	i0	F ← F∨imm4	1	↑	↑	↑	↑	×	113
	[%X],%A	1	1	0	1	1	0	1	1	0	1	0	0	0	[X] ← [X]∨A	2	↓	–	–	↕	○	114
	[%X],%B	1	1	0	1	1	0	1	1	0	1	1	0	0	[X] ← [X]∨B	2	↓	–	–	↕	○	114
	[%X],imm4	1	1	0	1	1	0	0	0	0	i3	i2	i1	i0	[X] ← [X]∨imm4	2	↓	–	–	↕	○	115
	[%X]+,%A	1	1	0	1	1	0	1	1	0	1	0	0	1	[X] ← [X]∨A, X ← X+1	2	↓	–	–	↕	×	115
	[%X]+,%B	1	1	0	1	1	0	1	1	0	1	1	0	1	[X] ← [X]∨B, X ← X+1	2	↓	–	–	↕	×	115
	[%X]+,imm4	1	1	0	1	1	0	0	0	1	i3	i2	i1	i0	[X] ← [X]∨imm4, X ← X+1	2	↓	–	–	↕	×	116
	[%Y],%A	1	1	0	1	1	0	1	1	0	1	0	1	0	[Y] ← [Y]∨A	2	↓	–	–	↕	○	114
	[%Y],%B	1	1	0	1	1	0	1	1	0	1	1	1	0	[Y] ← [Y]∨B	2	↓	–	–	↕	○	114
	[%Y],imm4	1	1	0	1	1	0	0	1	0	i3	i2	i1	i0	[Y] ← [Y]∨imm4	2	↓	–	–	↕	○	115
	[%Y]+,%A	1	1	0	1	1	0	1	1	0	1	0	1	1	[Y] ← [Y]∨A, Y ← Y+1	2	↓	–	–	↕	×	115
	[%Y]+,%B	1	1	0	1	1	0	1	1	0	1	1	1	1	[Y] ← [Y]∨B, Y ← Y+1	2	↓	–	–	↕	×	115
	[%Y]+,imm4	1	1	0	1	1	0	0	1	1	i3	i2	i1	i0	[Y] ← [Y]∨imm4, Y ← Y+1	2	↓	–	–	↕	×	116
POP	%A	1	1	1	1	1	1	1	1	0	1	1	1	1	A ← [SP2], SP2 ← SP2+1	1	↓	–	–	–	×	116
	%B	1	1	1	1	1	1	1	1	0	1	1	1	0	B ← [SP2], SP2 ← SP2+1	1	↓	–	–	–	×	116
	%F	1	1	1	1	1	1	1	1	0	1	1	0	1	F ← [SP2], SP2 ← SP2+1	1	↕	↕	↕	↕	×	116
	%X	1	1	1	1	1	1	1	1	0	1	0	0	1	X ← ([SP1∗4+3]~[SP1∗4]), SP1 ← SP1+1	1	↓	–	–	–	×	117
	%Y	1	1	1	1	1	1	1	1	0	1	0	1	X	Y ← ([SP1∗4+3]~[SP1∗4]), SP1 ← SP1+1	1	↓	–	–	–	×	117
PUSH	%A	1	1	1	1	1	1	1	1	0	0	1	1	1	[SP2-1] ← A, SP2 ← SP2-1	1	↓	–	–	–	×	117
	%B	1	1	1	1	1	1	1	1	0	0	1	1	0	[SP2-1] ← B, SP2 ← SP2-1	1	↓	–	–	–	×	117
	%F	1	1	1	1	1	1	1	1	0	0	1	0	1	[SP2-1] ← F, SP2 ← SP2-1	1	↓	–	–	–	×	117
	%X	1	1	1	1	1	1	1	1	0	0	0	0	1	([(SP1-1)∗4+3]~[(SP1-1)∗4]) ← X, SP1 ← SP1-1	1	↓	–	–	–	×	118
	%Y	1	1	1	1	1	1	1	1	0	0	0	1	X	([(SP1-1)∗4+3]~[(SP1-1)∗4]) ← Y, SP1 ← SP1-1	1	↓	–	–	–	×	118
RET		1	1	1	1	1	1	1	1	1	1	0	X	0	PC ← ([SP1∗4+3]~[SP1∗4]), SP1 ← SP1+1	1	↓	–	–	–	×	118
RETD	imm8	1	0	0	0	1	i7	i6	i5	i4	i3	i2	i1	i0	PC ← ([SP1∗4+3]~[SP1∗4]), SP1 ← SP1+1 [X] ← i3~0, [X+1] ← i7~4, X ← X+2	3	↓	–	–	–	×	119

Mnemonic		Machine code 12	11	10	9	8	7	6	5	4	3	2	1	0	Operation	Cycle	Flag E	I	C	Z	EXT. mode	Page
RETI		1	1	1	1	1	1	1	1	1	1	0	0	1	PC ← ([SP1∗4+3]~[SP1∗4]), SP1 ← SP1+1 F ← [SP2], SP2 ← SP2+1	2	↕	↕	↕	↕	×	119
RETS		1	1	1	1	1	1	1	1	1	1	0	1	1	PC ← ([SP1∗4+3]~[SP1∗4]), SP1 ← SP1+1 PC ← PC+1	2	↓	–	–	–	×	120
RL	%A	1	0	0	0	0	1	1	1	1	0	0	1	0	A (C←D3←D2←D1←D0←C)	1	↓	–	↕	↕	×	120
	%B	1	0	0	0	0	1	1	1	1	0	1	1	0	B (C←D3←D2←D1←D0←C)	1	↓	–	↕	↕	×	120
	[%X]	1	0	0	0	0	1	1	1	0	1	0	0	0	[X] (C←D3←D2←D1←D0←C)	2	↓	–	↕	↕	○	121
	[%X]+	1	0	0	0	0	1	1	1	0	1	0	0	1	[X] (C←D3←D2←D1←D0←C), X ← X+1	2	↓	–	↕	↕	×	121
	[%Y]	1	0	0	0	0	1	1	1	0	1	0	1	0	[Y] (C←D3←D2←D1←D0←C)	2	↓	–	↕	↕	○	121
	[%Y]+	1	0	0	0	0	1	1	1	0	1	0	1	1	[Y] (C←D3←D2←D1←D0←C), Y ← Y+1	2	↓	–	↕	↕	×	121
RR	%A	1	0	0	0	0	1	1	1	1	0	0	1	1	A (C→D3→D2→D1→D0→C)	1	↓	–	↕	↕	×	122
	%B	1	0	0	0	0	1	1	1	1	0	1	1	1	B (C→D3→D2→D1→D0→C)	1	↓	–	↕	↕	×	122
	[%X]	1	0	0	0	0	1	1	1	0	1	1	0	0	[X] (C→D3→D2→D1→D0→C)	2	↓	–	↕	↕	○	122
	[%X]+	1	0	0	0	0	1	1	1	0	1	1	0	1	[X] (C→D3→D2→D1→D0→C), X ← X+1	2	↓	–	↕	↕	×	123
	[%Y]	1	0	0	0	0	1	1	1	0	1	1	1	0	[Y] (C→D3→D2→D1→D0→C)	2	↓	–	↕	↕	○	122
	[%Y]+	1	0	0	0	0	1	1	1	0	1	1	1	1	[Y] (C→D3→D2→D1→D0→C), Y ← Y+1	2	↓	–	↕	↕	×	123
SBC	%A,%A	1	1	0	0	0	1	1	1	1	0	0	0	X	A ← A-A-C	1	↓	–	↕	↕	×	123
	%A,%B	1	1	0	0	0	1	1	1	1	0	0	1	X	A ← A-B-C	1	↓	–	↕	↕	×	123
	%A,imm4	1	1	0	0	0	1	1	0	0	i3	i2	i1	i0	A ← A-imm4-C	1	↓	–	↕	↕	×	124
	%A,[%X]	1	1	0	0	0	1	1	1	0	0	0	0	0	A ← A-[X]-C	1	↓	–	↕	↕	○	124
	%A,[%X]+	1	1	0	0	0	1	1	1	0	0	0	0	1	A ← A-[X]-C, X ← X+1	1	↓	–	↕	↕	×	125
	%A,[%Y]	1	1	0	0	0	1	1	1	0	0	0	1	0	A ← A-[Y]-C	1	↓	–	↕	↕	○	124
	%A,[%Y]+	1	1	0	0	0	1	1	1	0	0	0	1	1	A ← A-[Y]-C, Y ← Y+1	1	↓	–	↕	↕	×	125
%B,%A		1	1	0	0	0	1	1	1	1	0	1	0	X	B ← B-A-C	1	↓	–	↕	↕	×	123
	%B,%A,n4	1	0	0	0	0	1	1	0	0	n3	n2	n1	n0	B ← N's adjust (B-A-C)	2	↓	–	↕	↕	×	127
	%B,%B	1	1	0	0	0	1	1	1	1	0	1	1	X	B ← B-B-C	1	↓	–	↕	↕	×	123
	%B,imm4	1	1	0	0	0	1	1	0	1	i3	i2	i1	i0	B ← B-imm4-C	1	↓	–	↕	↕	×	124
	%B,[%X]	1	1	0	0	0	1	1	1	0	0	1	0	0	B ← B-[X]-C	1	↓	–	↕	↕	○	124
	%B,[%X],n4	1	1	1	0	0	1	1	0	0	n3	n2	n1	n0	B ← N's adjust (B-[X]-C)	2	↓	–	↕	↕	○	128
	%B,[%X]+	1	1	0	0	0	1	1	1	0	0	1	0	1	B ← B-[X]-C, X ← X+1	1	↓	–	↕	↕	×	125
	%B,[%X]+,n4	1	1	1	0	0	1	1	0	1	n3	n2	n1	n0	B ← N's adjust (B-[X]-C), X ← X+1	2	↓	–	↕	↕	×	128
	%B,[%Y]	1	1	0	0	0	1	1	1	0	0	1	1	0	B ← B-[Y]-C	1	↓	–	↕	↕	○	124
	%B,[%Y],n4	1	1	1	0	0	1	1	1	0	n3	n2	n1	n0	B ← N's adjust (B-[Y]-C)	2	↓	–	↕	↕	○	128
	%B,[%Y]+	1	1	0	0	0	1	1	1	0	0	1	1	1	B ← B-[Y]-C, Y ← Y+1	1	↓	–	↕	↕	×	125
	%B,[%Y]+,n4	1	1	1	0	0	1	1	1	1	n3	n2	n1	n0	B ← N's adjust (B-[Y]-C), Y ← Y+1	2	↓	–	↕	↕	×	128
	[%X],%A	1	1	0	0	0	1	1	1	0	1	0	0	0	[X] ← [X]-A-C	2	↓	–	↕	↕	○	125
	[%X],%B	1	1	0	0	0	1	1	1	0	1	1	0	0	[X] ← [X]-B-C	2	↓	–	↕	↕	○	125
	[%X],%B,n4	1	1	1	0	0	0	1	0	0	n3	n2	n1	n0	[X] ← N's adjust ([X]-B-C)	2	↓	–	↕	↕	○	129
	[%X],imm4	1	1	0	0	0	1	0	0	0	i3	i2	i1	i0	[X] ← [X]-imm4-C	2	↓	–	↕	↕	○	126
	[%X],0,n4	1	1	1	0	0	0	0	0	0	n3	n2	n1	n0	[X] ← N's adjust ([X]-0-C)	2	↓	–	↕	↕	○	130
	[%X]+,%A	1	1	0	0	0	1	1	1	0	1	0	0	1	[X] ← [X]-A-C, X ← X+1	2	↓	–	↕	↕	×	126
	[%X]+,%B	1	1	0	0	0	1	1	1	0	1	1	0	1	[X] ← [X]-B-C, X ← X+1	2	↓	–	↕	↕	×	126
	[%X]+,%B,n4	1	1	1	0	0	0	1	0	1	n3	n2	n1	n0	[X] ← N's adjust ([X]-B-C), X ← X+1	2	↓	–	↕	↕	×	129
	[%X]+,imm4	1	1	0	0	0	1	0	0	1	i3	i2	i1	i0	[X] ← [X]-imm4-C, X ← X+1	2	↓	–	↕	↕	×	127
	[%X]+,0,n4	1	1	1	0	0	0	0	0	1	n3	n2	n1	n0	[X] ← N's adjust ([X]-0-C), X ← X+1	2	↓	–	↕	↕	×	130
	[%Y],%A	1	1	0	0	0	1	1	1	0	1	0	1	0	[Y] ← [Y]-A-C	2	↓	–	↕	↕	○	125
	[%Y],%B	1	1	0	0	0	1	1	1	0	1	1	1	0	[Y] ← [Y]-B-C	2	↓	–	↕	↕	○	125
	[%Y],%B,n4	1	1	1	0	0	0	1	1	0	n3	n2	n1	n0	[Y] ← N's adjust ([Y]-B-C)	2	↓	–	↕	↕	○	129
	[%Y],imm4	1	1	0	0	0	1	0	1	0	i3	i2	i1	i0	[Y] ← [Y]-imm4-C	2	↓	–	↕	↕	○	126
	[%Y],0,n4	1	1	1	0	0	0	0	1	0	n3	n2	n1	n0	[Y] ← N's adjust ([Y]-0-C)	2	↓	–	↕	↕	○	130
	[%Y]+,%A	1	1	0	0	0	1	1	1	0	1	0	1	1	[Y] ← [Y]-A-C, Y ← Y+1	2	↓	–	↕	↕	×	126
	[%Y]+,%B	1	1	0	0	0	1	1	1	0	1	1	1	1	[Y] ← [Y]-B-C, Y ← Y+1	2	↓	–	↕	↕	×	126
	[%Y]+,%B,n4	1	1	1	0	0	0	1	1	1	n3	n2	n1	n0	[Y] ← N's adjust ([Y]-B-C), Y ← Y+1	2	↓	–	↕	↕	×	130
	[%Y]+,imm4	1	1	0	0	0	1	0	1	1	i3	i2	i1	i0	[Y] ← [Y]-imm4-C, Y ← Y+1	2	↓	–	↕	↕	×	127
	[%Y]+,0,n4	1	1	1	0	0	0	0	1	1	n3	n2	n1	n0	[Y] ← N's adjust ([Y]-0-C), Y ← Y+1	2	↓	–	↕	↕	×	130
SET	[00addr6],imm2	1	0	1	1	0	i1	i0	a5	a4	a3	a2	a1	a0	[00addr6] ← [00addr6]∨(2^{imm2})	2	↓	–	–	↕	×	131
	[FFaddr6],imm2	1	0	1	1	1	i1	i0	a5	a4	a3	a2	a1	a0	[FFaddr6] ← [FFaddr6]∨(2^{imm2})	2	↓	–	–	↕	×	131
SLL	%A	1	0	0	0	0	1	1	1	1	0	0	0	0	A (C←D3←D2←D1←D0←0)	1	↓	–	↕	↕	×	131
	%B	1	0	0	0	0	1	1	1	1	0	1	0	0	B (C←D3←D2←D1←D0←0)	1	↓	–	↕	↕	×	131

Mnemonic		Machine code													Operation	Cycle	Flag				EXT. mode	Page
		12	11	10	9	8	7	6	5	4	3	2	1	0			E	I	C	Z		
SLL	[%X]	1	0	0	0	0	1	1	1	0	0	0	0	0	[X] (C←D3←D2←D1←D0←0)	2	↓	–	↕	↕	○	132
	[%X]+	1	0	0	0	0	1	1	1	0	0	0	0	1	[X] (C←D3←D2←D1←D0←0), X ← X+1	2	↓	–	↕	↕	×	132
	[%Y]	1	0	0	0	0	1	1	1	0	0	0	1	0	[Y] (C←D3←D2←D1←D0←0)	2	↓	–	↕	↕	○	132
	[%Y]+	1	0	0	0	0	1	1	1	0	0	0	1	1	[Y] (C←D3←D2←D1←D0←0), Y ← Y+1	2	↓	–	↕	↕	×	132
SLP		1	1	1	1	1	1	1	1	1	1	1	0	1	Sleep	2	↓	–	–	–	×	133
SRL	%A	1	0	0	0	0	1	1	1	1	0	0	0	1	A (0→D3→D2→D1→D0→C)	1	↓	–	↕	↕	×	133
	%B	1	0	0	0	0	1	1	1	1	0	1	0	1	B (0→D3→D2→D1→D0→C)	1	↓	–	↕	↕	×	133
	[%X]	1	0	0	0	0	1	1	1	0	0	1	0	0	[X] (0→D3→D2→D1→D0→C)	2	↓	–	↕	↕	○	134
	[%X]+	1	0	0	0	0	1	1	1	0	0	1	0	1	[X] (0→D3→D2→D1→D0→C), X ← X+1	2	↓	–	↕	↕	×	134
	[%Y]	1	0	0	0	0	1	1	1	0	0	1	1	0	[Y] (0→D3→D2→D1→D0→C)	2	↓	–	↕	↕	○	134
	[%Y]+	1	0	0	0	0	1	1	1	0	0	1	1	1	[Y] (0→D3→D2→D1→D0→C), Y ← Y+1	2	↓	–	↕	↕	×	134
SUB	%A,%A	1	1	0	0	0	0	1	1	1	0	0	0	X	A ← A-A	1	↓	–	↓	↑	×	135
	%A,%B	1	1	0	0	0	0	1	1	1	0	0	1	X	A ← A-B	1	↓	–	↕	↕	×	135
	%A,imm4	1	1	0	0	0	0	1	0	0	i3	i2	i1	i0	A ← A-imm4	1	↓	–	↕	↕	×	135
	%A,[%X]	1	1	0	0	0	0	1	1	0	0	0	0	0	A ← A-[X]	1	↓	–	↕	↕	○	136
	%A,[%X]+	1	1	0	0	0	0	1	1	0	0	0	0	1	A ← A-[X], X ← X+1	1	↓	–	↕	↕	×	136
	%A,[%Y]	1	1	0	0	0	0	1	1	0	0	0	1	0	A ← A-[Y]	1	↓	–	↕	↕	○	136
	%A,[%Y]+	1	1	0	0	0	0	1	1	0	0	0	1	1	A ← A-[Y], Y ← Y+1	1	↓	–	↕	↕	×	136
	%B,%A	1	1	0	0	0	0	1	1	1	0	1	0	X	B ← B-A	1	↓	–	↕	↕	×	135
	%B,%B	1	1	0	0	0	0	1	1	1	0	1	1	X	B ← B-B	1	↓	–	↓	↑	×	135
	%B,imm4	1	1	0	0	0	0	1	0	1	i3	i2	i1	i0	B ← B-imm4	1	↓	–	↕	↕	×	135
	%B,[%X]	1	1	0	0	0	0	1	1	0	0	1	0	0	B ← B-[X]	1	↓	–	↕	↕	○	136
	%B,[%X]+	1	1	0	0	0	0	1	1	0	0	1	0	1	B ← B-[X], X ← X+1	1	↓	–	↕	↕	×	136
	%B,[%Y]	1	1	0	0	0	0	1	1	0	0	1	1	0	B ← B-[Y]	1	↓	–	↕	↕	○	136
	%B,[%Y]+	1	1	0	0	0	0	1	1	0	0	1	1	1	B ← B-[Y], Y ← Y+1	1	↓	–	↕	↕	×	136
	[%X],%A	1	1	0	0	0	0	1	1	0	1	0	0	0	[X] ← [X]-A	2	↓	–	↕	↕	○	137
	[%X],%B	1	1	0	0	0	0	1	1	0	1	1	0	0	[X] ← [X]-B	2	↓	–	↕	↕	○	137
	[%X],imm4	1	1	0	0	0	0	0	0	0	i3	i2	i1	i0	[X] ← [X]-imm4	2	↓	–	↕	↕	○	138
	[%X]+,%A	1	1	0	0	0	0	1	1	0	1	0	0	1	[X] ← [X]-A, X ← X+1	2	↓	–	↕	↕	×	137
	[%X]+,%B	1	1	0	0	0	0	1	1	0	1	1	0	1	[X] ← [X]-B, X ← X+1	2	↓	–	↕	↕	×	137
	[%X]+,imm4	1	1	0	0	0	0	0	0	1	i3	i2	i1	i0	[X] ← [X]-imm4, X ← X+1	2	↓	–	↕	↕	×	138
	[%Y],%A	1	1	0	0	0	0	1	1	0	1	0	1	0	[Y] ← [Y]-A	2	↓	–	↕	↕	○	137
	[%Y],%B	1	1	0	0	0	0	1	1	0	1	1	1	0	[Y] ← [Y]-B	2	↓	–	↕	↕	○	137
	[%Y],imm4	1	1	0	0	0	0	0	1	0	i3	i2	i1	i0	[Y] ← [Y]-imm4	2	↓	–	↕	↕	○	138
	[%Y]+,%A	1	1	0	0	0	0	1	1	0	1	0	1	1	[Y] ← [Y]-A, Y ← Y+1	2	↓	–	↕	↕	×	137
	[%Y]+,%B	1	1	0	0	0	0	1	1	0	1	1	1	1	[Y] ← [Y]-B, Y ← Y+1	2	↓	–	↕	↕	×	137
	[%Y]+,imm4	1	1	0	0	0	0	0	1	1	i3	i2	i1	i0	[Y] ← [Y]-imm4, Y ← Y+1	2	↓	–	↕	↕	×	138
TST	[00addr6],imm2	1	0	0	1	0	i1	i0	a5	a4	a3	a2	a1	a0	[00addr6]∧(2^{imm2})	1	↓	–	–	↕	×	139
	[FFaddr6],imm2	1	0	0	1	1	i1	i0	a5	a4	a3	a2	a1	a0	[FFaddr6]∧(2^{imm2})	1	↓	–	–	↕	×	139
XOR	%A,%A	1	1	0	1	1	1	1	1	1	0	0	0	X	A ← A∀A	1	↓	–	–	↑	×	139
	%A,%B	1	1	0	1	1	1	1	1	1	0	0	1	X	A ← A∀B	1	↓	–	–	↕	×	139
	%A,imm4	1	1	0	1	1	1	1	0	0	i3	i2	i1	i0	A ← A∀imm4	1	↓	–	–	↕	×	140
	%A,[%X]	1	1	0	1	1	1	1	1	0	0	0	0	0	A ← A∀[X]	1	↓	–	–	↕	○	141
	%A,[%X]+	1	1	0	1	1	1	1	1	0	0	0	0	1	A ← A∀[X], X ← X+1	1	↓	–	–	↕	×	141
	%A,[%Y]	1	1	0	1	1	1	1	1	0	0	0	1	0	A ← A∀[Y]	1	↓	–	–	↕	○	141
	%A,[%Y]+	1	1	0	1	1	1	1	1	0	0	0	1	1	A ← A∀[Y], Y ← Y+1	1	↓	–	–	↕	×	141
	%B,%A	1	1	0	1	1	1	1	1	1	0	1	0	X	B ← B∀A	1	↓	–	–	↕	×	139
	%B,%B	1	1	0	1	1	1	1	1	1	0	1	1	X	B ← B∀B	1	↓	–	–	↑	×	139
	%B,imm4	1	1	0	1	1	1	1	0	1	i3	i2	i1	i0	B ← B∀imm4	1	↓	–	–	↕	×	140
	%B,[%X]	1	1	0	1	1	1	1	1	0	0	1	0	0	B ← B∀[X]	1	↓	–	–	↕	○	141
	%B,[%X]+	1	1	0	1	1	1	1	1	0	0	1	0	1	B ← B∀[X], X ← X+1	1	↓	–	–	↕	×	141
	%B,[%Y]	1	1	0	1	1	1	1	1	0	0	1	1	0	B ← B∀[Y]	1	↓	–	–	↕	○	141
	%B,[%Y]+	1	1	0	1	1	1	1	1	0	0	1	1	1	B ← B∀[Y], Y ← Y+1	1	↓	–	–	↕	×	141
	%F,imm4	1	0	0	0	0	1	0	1	0	i3	i2	i1	i0	F ← F∀imm4	1	↕	↕	↕	↕	×	140
	[%X],%A	1	1	0	1	1	1	1	1	0	1	0	0	0	[X] ← [X]∀A	2	↓	–	–	↕	○	142
	[%X],%B	1	1	0	1	1	1	1	1	0	1	1	0	0	[X] ← [X]∀B	2	↓	–	–	↕	○	142
	[%X],imm4	1	1	0	1	1	1	0	0	0	i3	i2	i1	i0	[X] ← [X]∀imm4	2	↓	–	–	↕	○	143
	[%X]+,%A	1	1	0	1	1	1	1	1	0	1	0	0	1	[X] ← [X]∀A, X ← X+1	2	↓	–	–	↕	×	142
	[%X]+,%B	1	1	0	1	1	1	1	1	0	1	1	0	1	[X] ← [X]∀B, X ← X+1	2	↓	–	–	↕	×	142
	[%X]+,imm4	1	1	0	1	1	1	0	0	1	i3	i2	i1	i0	[X] ← [X]∀imm4, X ← X+1	2	↓	–	–	↕	×	143
	[%Y],%A	1	1	0	1	1	1	1	1	0	1	0	1	0	[Y] ← [Y]∀A	2	↓	–	–	↕	○	142
	[%Y],%B	1	1	0	1	1	1	1	1	0	1	1	1	0	[Y] ← [Y]∀B	2	↓	–	–	↕	○	142
	[%Y],imm4	1	1	0	1	1	1	0	1	0	i3	i2	i1	i0	[Y] ← [Y]∀imm4	2	↓	–	–	↕	○	143
	[%Y]+,%A	1	1	0	1	1	1	1	1	0	1	0	1	1	[Y] ← [Y]∀A, Y ← Y+1	2	↓	–	–	↕	×	142
	[%Y]+,%B	1	1	0	1	1	1	1	1	0	1	1	1	1	[Y] ← [Y]∀B, Y ← Y+1	2	↓	–	–	↕	×	142
	[%Y]+,imm4	1	1	0	1	1	1	0	1	1	i3	i2	i1	i0	[Y] ← [Y]∀imm4, Y ← Y+1	2	↓	–	–	↕	×	143

4.2.5 List of extended addressing instructions

8-bit absolute addressing (1/4)

Mnemonic		Operation	Flag E	I	C	Z
LDB LD	%EXT,imm8 %A,[%X]	A ← [00imm8] (00imm8 = 0000H ~ 00FFH)	↓	–	–	–
LDB LD	%EXT,imm8 %A,[%Y]	A ← [FFimm8] (FFimm8 = FF00H + 00H ~ FFH)	↓	–	–	–
LDB LD	%EXT,imm8 %B,[%X]	B ← [00imm8]	↓	–	–	–
LDB LD	%EXT,imm8 %B,[%Y]	B ← [FFimm8]	↓	–	–	–
LDB LD	%EXT,imm8 [%X],%A	[00imm8] ← A	↓	–	–	–
LDB LD	%EXT,imm8 [%X],%B	[00imm8] ← B	↓	–	–	–
LDB LD	%EXT,imm8 [%X],imm4	[00imm8] ← imm4	↓	–	–	–
LDB LD	%EXT,imm8 [%Y],%A	[FFimm8] ← A	↓	–	–	–
LDB LD	%EXT,imm8 [%Y],%B	[FFimm8] ← B	↓	–	–	–
LDB LD	%EXT,imm8 [%Y],imm4	[FFimm8] ← imm4	↓	–	–	–
LDB EX	%EXT,imm8 %A,[%X]	A ↔ [00imm8]	↓	–	–	–
LDB EX	%EXT,imm8 %A,[%Y]	A ↔ [FFimm8]	↓	–	–	–
LDB EX	%EXT,imm8 %B,[%X]	B ↔ [00imm8]	↓	–	–	–
LDB EX	%EXT,imm8 %B,[%Y]	B ↔ [FFimm8]	↓	–	–	–
LDB ADD	%EXT,imm8 %A,[%X]	A ← A + [00imm8]	↓	–	↕	↕
LDB ADD	%EXT,imm8 %A,[%Y]	A ← A + [FFimm8]	↓	–	↕	↕
LDB ADD	%EXT,imm8 %B,[%X]	B ← B + [00imm8]	↓	–	↕	↕
LDB ADD	%EXT,imm8 %B,[%Y]	B ← B + [FFimm8]	↓	–	↕	↕
LDB ADD	%EXT,imm8 [%X],%A	[00imm8] ← [00imm8] + A	↓	–	↕	↕
LDB ADD	%EXT,imm8 [%X],%B	[00imm8] ← [00imm8] + B	↓	–	↕	↕
LDB ADD	%EXT,imm8 [%X],imm4	[00imm8] ← [00imm8] + imm4	↓	–	↕	↕
LDB ADD	%EXT,imm8 [%Y],%A	[FFimm8] ← [FFimm8] + A	↓	–	↕	↕
LDB ADD	%EXT,imm8 [%Y],%B	[FFimm8] ← [FFimm8] + B	↓	–	↕	↕
LDB ADD	%EXT,imm8 [%Y],imm4	[FFimm8] ← [FFimm8] + imm4	↓	–	↕	↕
LDB ADC	%EXT,imm8 %A,[%X]	A ← A + [00imm8] + C	↓	–	↕	↕
LDB ADC	%EXT,imm8 %A,[%Y]	A ← A + [FFimm8] + C	↓	–	↕	↕
LDB ADC	%EXT,imm8 %B,[%X]	B ← B + [00imm8] + C	↓	–	↕	↕
LDB ADC	%EXT,imm8 %B,[%Y]	B ← B + [FFimm8] + C	↓	–	↕	↕
LDB ADC	%EXT,imm8 [%X],%A	[00imm8] ← [00imm8] + A + C	↓	–	↕	↕
LDB ADC	%EXT,imm8 [%X],%B	[00imm8] ← [00imm8] + B + C	↓	–	↕	↕
LDB ADC	%EXT,imm8 [%X],imm4	[00imm8] ← [00imm8] + imm4 + C	↓	–	↕	↕

8-bit absolute addressing (2/4)

Mnemonic		Operation	Flag E	I	C	Z
LDB ADC	%EXT,imm8 [%Y],%A	[FFimm8] ← [FFimm8] + A + C	↓	–	↕	↕
LDB ADC	%EXT,imm8 [%Y],%B	[FFimm8] ← [FFimm8] + B + C	↓	–	↕	↕
LDB ADC	%EXT,imm8 [%Y],imm4	[FFimm8] ← [FFimm8] + imm4 + C	↓	–	↕	↕
LDB SUB	%EXT,imm8 %A,[%X]	A ← A - [00imm8] (00imm8 = 0000H ~ 00FFH)	↓	–	↕	↕
LDB SUB	%EXT,imm8 %A,[%Y]	A ← A - [FFimm8] (FFimm8 = FF00H + 00H ~ FFH)	↓	–	↕	↕
LDB SUB	%EXT,imm8 %B,[%X]	B ← B - [00imm8]	↓	–	↕	↕
LDB SUB	%EXT,imm8 %B,[%Y]	B ← B - [FFimm8]	↓	–	↕	↕
LDB SUB	%EXT,imm8 [%X],%A	[00imm8] ← [00imm8] - A	↓	–	↕	↕
LDB SUB	%EXT,imm8 [%X],%B	[00imm8] ← [00imm8] - B	↓	–	↕	↕
LDB SUB	%EXT,imm8 [%X],imm4	[00imm8] ← [00imm8] - imm4	↓	–	↕	↕
LDB SUB	%EXT,imm8 [%Y],%A	[FFimm8] ← [FFimm8] - A	↓	–	↕	↕
LDB SUB	%EXT,imm8 [%Y],%B	[FFimm8] ← [FFimm8] - B	↓	–	↕	↕
LDB SUB	%EXT,imm8 [%Y],imm4	[FFimm8] ← [FFimm8] - imm4	↓	–	↕	↕
LDB SBC	%EXT,imm8 %A,[%X]	A ← A - [00imm8] - C	↓	–	↕	↕
LDB SBC	%EXT,imm8 %A,[%Y]	A ← A - [FFimm8] - C	↓	–	↕	↕
LDB SBC	%EXT,imm8 %B,[%X]	B ← B - [00imm8] - C	↓	–	↕	↕
LDB SBC	%EXT,imm8 %B,[%Y]	B ← B - [FFimm8] - C	↓	–	↕	↕
LDB SBC	%EXT,imm8 [%X],%A	[00imm8] ← [00imm8] - A - C	↓	–	↕	↕
LDB SBC	%EXT,imm8 [%X],%B	[00imm8] ← [00imm8] - B - C	↓	–	↕	↕
LDB SBC	%EXT,imm8 [%X],imm4	[00imm8] ← [00imm8] - imm4 - C	↓	–	↕	↕
LDB SBC	%EXT,imm8 [%Y],%A	[FFimm8] ← [FFimm8] - A - C	↓	–	↕	↕
LDB SBC	%EXT,imm8 [%Y],%B	[FFimm8] ← [FFimm8] - B - C	↓	–	↕	↕
LDB SBC	%EXT,imm8 [%Y],imm4	[FFimm8] ← [FFimm8] - imm4 - C	↓	–	↕	↕
LDB CMP	%EXT,imm8 %A,[%X]	A - [00imm8]	↓	–	↕	↕
LDB CMP	%EXT,imm8 %A,[%Y]	A - [FFimm8]	↓	–	↕	↕
LDB CMP	%EXT,imm8 %B,[%X]	B - [00imm8]	↓	–	↕	↕
LDB CMP	%EXT,imm8 %B,[%Y]	B - [FFimm8]	↓	–	↕	↕
LDB CMP	%EXT,imm8 [%X],%A	[00imm8] - A	↓	–	↕	↕
LDB CMP	%EXT,imm8 [%X],%B	[00imm8] - B	↓	–	↕	↕
LDB CMP	%EXT,imm8 [%X],imm4	[00imm8] - imm4	↓	–	↕	↕
LDB CMP	%EXT,imm8 [%Y],%A	[FFimm8] - A	↓	–	↕	↕
LDB CMP	%EXT,imm8 [%Y],%B	[FFimm8] - B	↓	–	↕	↕
LDB CMP	%EXT,imm8 [%Y],imm4	[FFimm8] - imm4	↓	–	↕	↕

8-bit absolute addressing (3/4)

Mnemonic		Operation	Flag			
			E	I	C	Z
LDB ADC	%EXT,imm8 %B,[%X],n4	B ← N's adjust (B + [00imm8] + C) (00imm8 = 0000H ~ 00FFH)	↓	–	↕	↕
LDB ADC	%EXT,imm8 %B,[%Y],n4	B ← N's adjust (B + [FFimm8] + C) (FFimm8 = FF00H + 00H ~ FFH)	↓	–	↕	↕
LDB ADC	%EXT,imm8 [%X],%B,n4	[00imm8] ← N's adjust ([00imm8] + B + C)	↓	–	↕	↕
LDB ADC	%EXT,imm8 [%X],0,n4	[00imm8] ← N's adjust ([00imm8] + 0 + C)	↓	–	↕	↕
LDB ADC	%EXT,imm8 [%Y],%B,n4	[FFimm8] ← N's adjust ([FFimm8] + B + C)	↓	–	↕	↕
LDB ADC	%EXT,imm8 [%Y],0,n4	[FFimm8] ← N's adjust ([FFimm8] + 0 + C)	↓	–	↕	↕
LDB SBC	%EXT,imm8 %B,[%X],n4	B ← N's adjust (B - [00imm8] - C)	↓	–	↕	↕
LDB SBC	%EXT,imm8 %B,[%Y],n4	B ← N's adjust (B - [FFimm8] - C)	↓	–	↕	↕
LDB SBC	%EXT,imm8 [%X],%B,n4	[00imm8] ← N's adjust ([00imm8] - B - C)	↓	–	↕	↕
LDB SBC	%EXT,imm8 [%X],0,n4	[00imm8] ← N's adjust ([00imm8] - 0 - C)	↓	–	↕	↕
LDB SBC	%EXT,imm8 [%Y],%B,n4	[FFimm8] ← N's adjust ([FFimm8] - B - C)	↓	–	↕	↕
LDB SBC	%EXT,imm8 [%Y],0,n4	[FFimm8] ← N's adjust ([FFimm8] - 0 - C)	↓	–	↕	↕
LDB INC	%EXT,imm8 [%X],n4	[00imm8] ← N's adjust ([00imm8] + 1)	↓	–	↕	↕
LDB INC	%EXT,imm8 [%Y],n4	[FFimm8] ← N's adjust ([FFimm8] + 1)	↓	–	↕	↕
LDB DEC	%EXT,imm8 [%X],n4	[00imm8] ← N's adjust ([00imm8] - 1)	↓	–	↕	↕
LDB DEC	%EXT,imm8 [%Y],n4	[FFimm8] ← N's adjust ([FFimm8] -1)	↓	–	↕	↕
LDB AND	%EXT,imm8 %A,[%X]	A ← A ∧ [00imm8]	↓	–	–	↕
LDB AND	%EXT,imm8 %A,[%Y]	A ← A ∧ [FFimm8]	↓	–	–	↕
LDB AND	%EXT,imm8 %B,[%X]	B ← B ∧ [00imm8]	↓	–	–	↕
LDB AND	%EXT,imm8 %B,[%Y]	B ← B ∧ [FFimm8]	↓	–	–	↕
LDB AND	%EXT,imm8 [%X],%A	[00imm8] ← [00imm8] ∧ A	↓	–	–	↕
LDB AND	%EXT,imm8 [%X],%B	[00imm8] ← [00imm8] ∧ B	↓	–	–	↕
LDB AND	%EXT,imm8 [%X],imm4	[00imm8] ← [00imm8] ∧ imm4	↓	–	–	↕
LDB AND	%EXT,imm8 [%Y],%A	[FFimm8] ← [FFimm8] ∧ A	↓	–	–	↕
LDB AND	%EXT,imm8 [%Y],%B	[FFimm8] ← [FFimm8] ∧ B	↓	–	–	↕
LDB AND	%EXT,imm8 [%Y],imm4	[FFimm8] ← [FFimm8] ∧ imm4	↓	–	–	↕
LDB OR	%EXT,imm8 %A,[%X]	A ← A ∨ [00imm8]	↓	–	–	↕
LDB OR	%EXT,imm8 %A,[%Y]	A ← A ∨ [FFimm8]	↓	–	–	↕
LDB OR	%EXT,imm8 %B,[%X]	B ← B ∨ [00imm8]	↓	–	–	↕
LDB OR	%EXT,imm8 %B,[%Y]	B ← B ∨ [FFimm8]	↓	–	–	↕
LDB OR	%EXT,imm8 [%X],%A	[00imm8] ← [00imm8] ∨ A	↓	–	–	↕
LDB OR	%EXT,imm8 [%X],%B	[00imm8] ← [00imm8] ∨ B	↓	–	–	↕
LDB OR	%EXT,imm8 [%X],imm4	[00imm8] ← [00imm8] ∨ imm4	↓	–	–	↕

8-bit absolute addressing (4/4)

Mnemonic		Operation	Flag			
			E	I	C	Z
LDB OR	%EXT,imm8 [%Y],%A	[FFimm8] ← [FFimm8] ∨ A (FFimm8 = FF00H + 00H ~ FFH)	↓	–	–	↕
LDB OR	%EXT,imm8 [%Y],%B	[FFimm8] ← [FFimm8] ∨ B	↓	–	–	↕
LDB OR	%EXT,imm8 [%Y],imm4	[FFimm8] ← [FFimm8] ∨ imm4	↓	–	–	↕
LDB XOR	%EXT,imm8 %A,[%X]	A ← A ∀ [00imm8] (00imm8 = 0000H ~ 00FFH)	↓	–	–	↕
LDB XOR	%EXT,imm8 %A,[%Y]	A ← A ∀ [FFimm8]	↓	–	–	↕
LDB XOR	%EXT,imm8 %B,[%X]	B ← B ∀ [00imm8]	↓	–	–	↕
LDB XOR	%EXT,imm8 %B,[%Y]	B ← B ∀ [FFimm8]	↓	–	–	↕
LDB XOR	%EXT,imm8 [%X],%A	[00imm8] ← [00imm8] ∀ A	↓	–	–	↕
LDB XOR	%EXT,imm8 [%X],%B	[00imm8] ← [00imm8] ∀ B	↓	–	–	↕
LDB XOR	%EXT,imm8 [%X],imm4	[00imm8] ← [00imm8] ∀ imm4	↓	–	–	↕
LDB XOR	%EXT,imm8 [%Y],%A	[FFimm8] ← [FFimm8] ∀ A	↓	–	–	↕
LDB XOR	%EXT,imm8 [%Y],%B	[FFimm8] ← [FFimm8] ∀ B	↓	–	–	↕
LDB XOR	%EXT,imm8 [%Y],imm4	[FFimm8] ← [FFimm8] ∀ imm4	↓	–	–	↕
LDB BIT	%EXT,imm8 %A,[%X]	A ∧ [00imm8]	↓	–	–	↕
LDB BIT	%EXT,imm8 %A,[%Y]	A ∧ [FFimm8]	↓	–	–	↕
LDB BIT	%EXT,imm8 %B,[%X]	B ∧ [00imm8]	↓	–	–	↕
LDB BIT	%EXT,imm8 %B,[%Y]	B ∧ [FFimm8]	↓	–	–	↕
LDB BIT	%EXT,imm8 [%X],%A	[00imm8] ∧ A	↓	–	–	↕
LDB BIT	%EXT,imm8 [%X],%B	[00imm8] ∧ B	↓	–	–	↕
LDB BIT	%EXT,imm8 [%X],imm4	[00imm8] ∧ imm4	↓	–	–	↕
LDB BIT	%EXT,imm8 [%Y],%A	[FFimm8] ∧ A	↓	–	–	↕
LDB BIT	%EXT,imm8 [%Y],%B	[FFimm8] ∧ B	↓	–	–	↕
LDB BIT	%EXT,imm8 [%Y],imm4	[FFimm8] ∧ imm4	↓	–	–	↕
LDB SLL	%EXT,imm8 [%X]	[00imm8] (C ← D3 ← D2 ← D1 ← D0 ← 0)	↓	–	↕	↕
LDB SLL	%EXT,imm8 [%Y]	[FFimm8] (C ← D3 ← D2 ← D1 ← D0 ← 0)	↓	–	↕	↕
LDB SRL	%EXT,imm8 [%X]	[00imm8] (0 → D3 → D2 → D1 → D0 → C)	↓	–	↕	↕
LDB SRL	%EXT,imm8 [%Y]	[FFimm8] (0 → D3 → D2 → D1 → D0 → C)	↓	–	↕	↕
LDB RL	%EXT,imm8 [%X]	[00imm8] (C ← D3 ← D2 ← D1 ← D0 ← C)	↓	–	↕	↕
LDB RL	%EXT,imm8 [%Y]	[FFimm8] (C ← D3 ← D2 ← D1 ← D0 ← C)	↓	–	↕	↕
LDB RR	%EXT,imm8 [%X]	[00imm8] (C → D3 → D2 → D1 → D0 → C)	↓	–	↕	↕
LDB RR	%EXT,imm8 [%Y]	[FFimm8] (C → D3 → D2 → D1 → D0 → C)	↓	–	↕	↕

16-bit immediate data addressing

Mnemonic	Operation	Flag E	I	C	Z
LDB %EXT,imm8 *1 LDB %XL,imm8 *2	X ← imm16 (*1 is upper 8-bit, *2 is lower 8-bit)	↓	–	–	–
LDB %EXT,imm8 *1 LDB %YL,imm8 *2	Y ← imm16 (*1 is upper 8-bit, *2 is lower 8-bit)	↓	–	–	–
LDB %EXT,imm8 *1 ADD %X,sign8 *2	X ← X + imm16 (*1 is upper 8-bit, *2 is lower 8-bit)	↓	–	–	↕
LDB %EXT,imm8 *1 ADD %Y,sign8 *2	Y ← Y + imm16 (*1 is upper 8-bit, *2 is lower 8-bit)	↓	–	–	↕
LDB %EXT,imm8 *1 CMP %X,imm8 *2	X - imm16 (FFH - *1 is upper 8-bit, *2 is lower 8-bit)	↓	–	↕	↕
LDB %EXT,imm8 *1 CMP %X,imm8 *2	Y - imm16 (FFH - *1 is upper 8-bit, *2 is lower 8-bit)	↓	–	↕	↕

signed 16-bit PC relative addressing

Mnemonic	Operation	Flag E	I	C	Z
LDB %EXT,imm8 JR sign8	(sign16 : imm8 is upper 8-bit, sign8 is lower 8-bit) PC ← PC + sign16 + 1 (sign16 = 32767~-32768)	↓	–	–	–
LDB %EXT,imm8 JRC sign8	If C = 1 then PC ← PC + sign16 + 1 (sign16 = 32767 ~ -32768)	↓	–	–	–
LDB %EXT,imm8 JRNC sign8	If C = 0 then PC ← PC + sign16 + 1 (sign16 = 32767 ~ -32768)	↓	–	–	–
LDB %EXT,imm8 JRZ sign8	If Z = 1 then PC ← PC + sign16 + 1 (sign16 = 32767 ~ -32768)	↓	–	–	–
LDB %EXT,imm8 JRNZ sign8	If Z = 0 then PC ← PC + sign16 + 1 (sign16 = 32767 ~ -32768)	↓	–	–	–
LDB %EXT,imm8 CALR sign8	([SP1 - 1 *4 + 3] ~ [(SP1 - 1) *4]) ← PC + 1, SP1 ← SP1 - 1 PC ← PC + sign16 + 1 (sign16 = 32767 ~ -32768)	↓	–	–	–

4.3 Instruction Formats

All the instructions of the S1C63000 are configured with 1 word (13 bits) as follows:

I 13-bit operation code

OP Code

Examples:
LD %A,%B
ADD %A,[%X]
PUSH %F

II 9-bit operation code + 4-bit immediate data

OP Code	Operand

Examples:
LD %A,imm4
ADC [%Y],%B,n4
BIT %B,imm4

III 7-bit operation code + 6-bit immediate data

OP Code	Operand

Examples:
INC [addr6]
CALR [addr6]
INT imm6

IV 5-bit operation code + 8-bit immediate data

OP Code	Operand

Examples:
LDB %BA,imm8
CALZ imm8
JR sign8

V 5-bit operation code + 2-bit immediate data + 6-bit immediate data

OP Code	Operand	Operand

Examples:
CLR [addr6],imm2
SET [addr6],imm2
TST [addr6],imm2

4.4 Detailed Explanation of Instructions

This section explains the individual instructions in alphabetic order according to the following format.

View of the explanation

Mnemonic | Mnemonic meaning | Number of bus cycles

ADC %r,%r' ***Add with carry r' reg. to r reg.*** ***1 cycle***

Function explanation

Function: r ← r + r' + C
Adds the content of the r' register (A or B) and carry (C) to the r register (A or B).

Mnemonic and object codes

Code:

Mnemonic	MSB											LSB		
ADC %A,%A	1	1	0	0	1	1	1	1	1	0	0	0	X	19F0H, (19F1H)
ADC %A,%B	1	1	0	0	1	1	1	1	1	0	0	1	X	19F2H, (19F3H)
ADC %B,%A	1	1	0	0	1	1	1	1	1	0	1	0	X	19F4H, (19F5H)
ADC %B,%B	1	1	0	0	1	1	1	1	1	0	1	1	X	19F6H, (19F7H)

Flags:

E	I	C	Z
↓	–	↕	↕

Status of the flag
– Does not change
↓ Reset
↑ Set
↕ Set/reset

Addressing mode
Src indicates the source and Dst indicates the destination

Mode: Src: Register direct
Dst: Register direct
Extended addressing: Invalid

The meaning of the symbols are the same as for the instruction list.
The following symbols are used to explain two or more registers as aggregations.

r .... Data registers A, B, or flag register F
ir .... Index registers X or Y
rr .... Index registers XL, XH, YL or YH
sp .... Stack pointers SP1 or SP2

ADC %r,%r' — *Add with carry r' reg. to r reg.* — *1 cycle*

Function: r ← r + r' + C
Adds the content of the r' register (A or B) and carry (C) to the r register (A or B).

Code:

Mnemonic	MSB											LSB	
ADC %A,%A	1	1	0	0	1	1	1	1	1	0	0	0	X	19F0H, (19F1H)
ADC %A,%B	1	1	0	0	1	1	1	1	1	0	0	1	X	19F2H, (19F3H)
ADC %B,%A	1	1	0	0	1	1	1	1	1	0	1	0	X	19F4H, (19F5H)
ADC %B,%B	1	1	0	0	1	1	1	1	1	0	1	1	X	19F6H, (19F7H)

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Register direct
Dst: Register direct
Extended addressing: Invalid

ADC %r,imm4 — *Add with carry immediate data imm4 to r reg.* — *1 cycle*

Function: r ← r + imm4 + C
Adds the 4-bit immediate data imm4 and carry (C) to the r register (A or B).

Code:

Mnemonic	MSB											LSB	
ADC %A,imm4	1	1	0	0	1	1	1	0	0	i3	i2	i1	i0	19C0H–19CFH
ADC %B,imm4	1	1	0	0	1	1	1	0	1	i3	i2	i1	i0	19D0H–19DFH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Immediate data
Dst: Register direct
Extended addressing: Invalid

ADC %r,[%ir] — *Add with carry location [ir reg.] to r reg.* — *1 cycle*

Function: r ← r + [ir] + C
Adds the content of the data memory addressed by the ir register (X or Y) and carry (C) to the r register (A or B).

Code:

Mnemonic	MSB												LSB	
ADC %A,[%X]	1	1	0	0	1	1	1	1	0	0	0	0	0	19E0H
ADC %A,[%Y]	1	1	0	0	1	1	1	1	0	0	0	1	0	19E2H
ADC %B,[%X]	1	1	0	0	1	1	1	1	0	0	1	0	0	19E4H
ADC %B,[%Y]	1	1	0	0	1	1	1	1	0	0	1	1	0	19E6H

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Register indirect
Dst: Register direct
Extended addressing: Valid

Extended operation:

LDB %EXT,imm8
ADC %r,[%X] r ← r + [00imm8] + C (00imm8 = 0000H + 00H to FFH)

LDB %EXT,imm8
ADC %r,[%Y] r ← r + [FFimm8] + C (FFimm8 = FF00H + 00H to FFH)

ADC %r,[%ir]+ — *Add with carry location [ir reg.] to r reg. and increment ir reg.* — *1 cycle*

Function: r ← r + [ir] + C, ir ← ir + 1
Adds the content of the data memory addressed by the ir register (X or Y) and carry (C) to the r register (A or B). Then increments the ir register (X or Y). The flags change due to the operation result of the r register and the increment result of the ir register does not affect the flags.

Code:

Mnemonic	MSB												LSB	
ADC %A,[%X]+	1	1	0	0	1	1	1	1	0	0	0	0	1	19E1H
ADC %A,[%Y]+	1	1	0	0	1	1	1	1	0	0	0	1	1	19E3H
ADC %B,[%X]+	1	1	0	0	1	1	1	1	0	0	1	0	1	19E5H
ADC %B,[%Y]+	1	1	0	0	1	1	1	1	0	0	1	1	1	19E7H

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Register indirect
Dst: Register direct
Extended addressing: Invalid

ADC [%ir],%r *Add with carry r reg. to location [ir reg.]* *2 cycles*

Function: [ir] ← [ir] + r + C
Adds the content of the r register (A or B) and carry (C) to the data memory addressed by the ir register (X or Y).

Code:

Mnemonic	MSB												LSB	
ADC [%X],%A	1	1	0	0	1	1	1	1	0	1	0	0	0	19E8H
ADC [%X],%B	1	1	0	0	1	1	1	1	0	1	1	0	0	19ECH
ADC [%Y],%A	1	1	0	0	1	1	1	1	0	1	0	1	0	19EAH
ADC [%Y],%B	1	1	0	0	1	1	1	1	0	1	1	1	0	19EEH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Register direct
Dst: Register indirect
Extended addressing: Valid

Extended operation:

LDB %EXT,imm8
ADC [%X],%r [00imm8] ← [00imm8] + r + C (00imm8 = 0000H + 00H to FFH)

LDB %EXT,imm8
ADC [%Y],%r [FFimm8] ← [FFimm8] + r + C (FFimm8 = FF00H + 00H to FFH)

ADC [%ir]+,%r *Add with carry r reg. to location [ir reg.] and increment ir reg.* *2 cycles*

Function: [ir] ← [ir] + r + C, ir ← ir + 1
Adds the content of the r register (A or B) and carry (C) to the data memory addressed by the ir register (X or Y). Then increments the ir register (X or Y). The flags change due to the operation result of the data memory and the increment result of the ir register does not affect the flags.

Code:

Mnemonic	MSB												LSB	
ADC [%X]+,%A	1	1	0	0	1	1	1	1	0	1	0	0	1	19E9H
ADC [%X]+,%B	1	1	0	0	1	1	1	1	0	1	1	0	1	19EDH
ADC [%Y]+,%A	1	1	0	0	1	1	1	1	0	1	0	1	1	19EBH
ADC [%Y]+,%B	1	1	0	0	1	1	1	1	0	1	1	1	1	19EFH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Register direct
Dst: Register indirect
Extended addressing: Invalid

ADC [%ir],imm4 *Add with carry immediate data imm4 to location [ir reg.]* *2 cycles*

Function: [ir] ← [ir] + imm4 + C
Adds the 4-bit immediate data imm4 and carry (C) to the data memory addressed by the ir register (X or Y).

Code:

Mnemonic	MSB												LSB	
ADC [%X],imm4	1	1	0	0	1	1	0	0	0	i3	i2	i1	i0	1980H–198FH
ADC [%Y],imm4	1	1	0	0	1	1	0	1	0	i3	i2	i1	i0	19A0H–19AFH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Immediate data
Dst: Register indirect
Extended addressing: Valid

Extended operation:

LDB	%EXT,imm8	
ADC	[%X],imm4	[00imm8] ← [00imm8] + imm4 + C (00imm8 = 0000H + 00H to FFH)
LDB	%EXT,imm8	
ADC	[%Y],imm4	[FFimm8] ← [FFimm8] + imm4 + C (FFimm8 = FF00H + 00H to FFH)

ADC [%ir]+,imm4 *Add with carry immediate data imm4 to location [ir reg.] and increment ir reg.* *2 cycles*

Function: [ir] ← [ir] + imm4 + C, ir ← ir + 1
Adds the immediate data imm4 and carry (C) to the data memory addressed by the ir register (X or Y). Then increments the ir register (X or Y). The flags change due to the operation result of the data memory and the increment result of the ir register does not affect the flags.

Code:

Mnemonic	MSB												LSB	
ADC [%X]+,imm4	1	1	0	0	1	1	0	0	1	i3	i2	i1	i0	1990H–199FH
ADC [%Y]+,imm4	1	1	0	0	1	1	0	1	1	i3	i2	i1	i0	19B0H–19BFH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Immediate data
Dst: Register indirect
Extended addressing: Invalid

ADC %B,%A,n4 *Add with carry A reg. to B reg. in specified radix* *2 cycles*

Function: B ← N's adjust (B + A + C)
Adds the content of the A register and carry (C) to the B register. The operation result is adjusted with n4 as the radix. The C flag is set by a carry according to the radix.

Code:

Mnemonic	MSB									LSB	
ADC %B,%A,n4	1	0	0	0	0	1	1	0	1	[10H-n4]	10D0H–10DFH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Register direct
Dst: Register direct
Extended addressing: Invalid

Note: n4 should be specified with a value from 1 to 16.

ADC %B,[%ir],n4 *Add with carry location [ir reg.] to B reg. in specified radix* *2 cycles*

Function: B ← N's adjust (B + [ir] + C)
Adds the content of the data memory addressed by the ir register (X or Y) and carry (C) to the B register. The operation result is adjusted with n4 as the radix. The C flag is set by a carry according to the radix.

Code:

Mnemonic	MSB									LSB	
ADC %B,[%X],n4	1	1	1	0	1	1	1	0	0	[10H-n4]	1DC0H–1DCFH
ADC %B,[%Y],n4	1	1	1	0	1	1	1	1	0	[10H-n4]	1DE0H–1DEFH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Register indirect
Dst: Register direct
Extended addressing: Valid

Extended operation:

LDB %EXT,imm8
ADC %B,[%X],n4 B ← N’s adjust (B + [00imm8] + C) (00imm8 = 0000H + 00H to FFH)

LDB %EXT,imm8
ADC %B,[%Y],n4 B ← N’s adjust (B + [FFimm8] + C) (FFimm8 = FF00H + 00H to FFH)

Note: n4 should be specified with a value from 1 to 16.

ADC %B,[%ir]+,n4 *Add with carry location [ir reg.] to B reg. in specified radix and increment ir reg. 2 cycles*

Function: B ← N's adjust (B + [ir] + C), ir ← ir + 1
Adds the content of the data memory addressed by the ir register (X or Y) and carry (C) to the B register. The operation result is adjusted with n4 as the radix. Then increments the ir register (X or Y). The flags change due to the operation result of the B register and the increment result of the ir register does not affect the flags. The C flag is set by a carry according to the radix.

Code:

Mnemonic	MSB										LSB
ADC %B,[%X]+,n4	1	1	1	0	1	1	1	0	1	[10H-n4]	1DD0H–1DDFH
ADC %B,[%Y]+,n4	1	1	1	0	1	1	1	1	1	[10H-n4]	1DF0H–1DFFH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Register indirect
Dst: Register direct
Extended addressing: Invalid

Note: n4 should be specified with a value from 1 to 16.

ADC [%ir],%B,n4 *Add with carry B reg. to location [ir reg.] in specified radix 2 cycles*

Function: [ir] ← N's adjust ([ir] + B + C)
Adds the content of the B register and carry (C) to the data memory addressed by the ir register (X or Y). The operation result is adjusted with n4 as the radix. The C flag is set by a carry according to the radix.

Code:

Mnemonic	MSB										LSB
ADC [%X],%B,n4	1	1	1	0	1	0	1	0	0	[10H-n4]	1D40H–1D4FH
ADC [%Y],%B,n4	1	1	1	0	1	0	1	1	0	[10H-n4]	1D60H–1D6FH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Register direct
Dst: Register indirect
Extended addressing: Valid

Extended operation:

```
LDB  %EXT,imm8
ADC  [%X],%B,n4     [00imm8] ← N's adjust ([00imm8] + B + C)
                              (00imm8 = 0000H + 00H to FFH)

LDB  %EXT,imm8
ADC  [%Y],%B,n4     [FFimm8] ← N's adjust ([FFimm8] + B + C)
                              (FFimm8 = FF00H + 00H to FFH)
```

Note: n4 should be specified with a value from 1 to 16.

ADC [%ir]+,%B,n4 *Add with carry B reg. to location [ir reg.] in specified radix and increment ir reg. 2 cycles*

Function: [ir] ← N's adjust ([ir] + B + C), ir ← ir + 1
Adds the content of the B register and carry (C) to the data memory addressed by the ir register (X or Y). The operation result is adjusted with n4 as the radix. Then increments the ir register (X or Y). The flags change due to the operation result of the data memory and the increment result of the ir register does not affect the flags. The C flag is set by a carry according to the radix.

Code:

Mnemonic	MSB									LSB	
ADC [%X]+,%B,n4	1	1	1	0	1	0	1	0	1	[10H-n4]	1D50H–1D5FH
ADC [%Y]+,%B,n4	1	1	1	0	1	0	1	1	1	[10H-n4]	1D70H–1D7FH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Register direct
Dst: Register indirect
Extended addressing: Invalid

Note: n4 should be specified with a value from 1 to 16.

ADC [%ir],0,n4 *Add carry to location [ir reg.] in specified radix* *2 cycles*

Function: [ir] ← N's adjust ([ir] + 0 + C)
Adds the carry (C) to the data memory addressed by the ir register (X or Y). The operation result is adjusted with n4 as the radix. The C flag is set by a carry according to the radix. This instruction is useful for a carry processing to the highest digit of n based counters.

Code:

Mnemonic	MSB									LSB	
ADC [%X],0,n4	1	1	1	0	1	0	0	0	0	[10H-n4]	1D00H–1D0FH
ADC [%Y],0,n4	1	1	1	0	1	0	0	1	0	[10H-n4]	1D20H–1D2FH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Register direct
Dst: Register indirect
Extended addressing: Valid

Extended operation:

```
LDB  %EXT,imm8
ADC  [%X],0,n4     [00imm8] ← N's adjust ([00imm8] + 0 + C)
                            (00imm8 = 0000H + 00H to FFH)

LDB  %EXT,imm8
ADC  [%Y],0,n4     [FFimm8] ← N's adjust ([FFimm8] + 0 + C)
                            (FFimm8 = FF00H + 00H to FFH)
```

Note: n4 should be specified with a value from 1 to 16.

ADC [%ir]+,0,n4 *Add carry to location [ir reg.] in specified radix and increment ir reg. 2 cycles*

Function: [ir] ← N's adjust ([ir] + 0 + C), ir ← ir + 1
Adds the carry (C) to the data memory addressed by the ir register (X or Y). The operation result is adjusted with n4 as the radix. Then increments the ir register (X or Y). The flags change due to the operation result of the data memory and the increment result of the ir register does not affect the flags. The C flag is set by a carry according to the radix. This instruction is useful for a carry processing of n based counters.

Code:

Mnemonic	MSB									LSB	
ADC [%X]+,0,n4	1	1	1	0	1	0	0	0	1	[10H-n4]	1D10H–1D1FH
ADC [%Y]+,0,n4	1	1	1	0	1	0	0	1	1	[10H-n4]	1D30H–1D3FH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Register direct
Dst: Register indirect
Extended addressing: Invalid

Note: n4 should be specified with a value from 1 to 16.

ADD %r,%r' *Add r' reg. to r reg.* *1 cycle*

Function: r ← r + r'
Adds the content of the r' register (A or B) to the r register (A or B).

Code:

Mnemonic	MSB												LSB	
ADD %A,%A	1	1	0	0	1	0	1	1	1	0	0	0	X	1970H, (1971H)
ADD %A,%B	1	1	0	0	1	0	1	1	1	0	0	1	X	1972H, (1973H)
ADD %B,%A	1	1	0	0	1	0	1	1	1	0	1	0	X	1974H, (1975H)
ADD %B,%B	1	1	0	0	1	0	1	1	1	0	1	1	X	1976H, (1977H)

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Register direct
Dst: Register direct
Extended addressing: Invalid

ADD %r,imm4 — *Add immediate data imm4 to r reg.* — *1 cycle*

Function: r ← r + imm4
Adds the 4-bit immediate data imm4 to the r register (A or B).

Code:

Mnemonic	MSB												LSB	
ADD %A,imm4	1	1	0	0	1	0	1	0	0	i3	i2	i1	i0	1940H–194FH
ADD %B,imm4	1	1	0	0	1	0	1	0	1	i3	i2	i1	i0	1950H–195FH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Immediate data
Dst: Register direct
Extended addressing: Invalid

ADD %r,[%ir] — *Add location [ir reg.] to r reg.* — *1 cycle*

Function: r ← r + [ir]
Adds the content of the data memory addressed by the ir register (X or Y) to the r register (A or B).

Code:

Mnemonic	MSB												LSB	
ADD %A,[%X]	1	1	0	0	1	0	1	1	0	0	0	0	0	1960H
ADD %A,[%Y]	1	1	0	0	1	0	1	1	0	0	0	1	0	1962H
ADD %B,[%X]	1	1	0	0	1	0	1	1	0	0	1	0	0	1964H
ADD %B,[%Y]	1	1	0	0	1	0	1	1	0	0	1	1	0	1966H

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Register indirect
Dst: Register direct
Extended addressing: Valid

Extended operation:

```
LDB   %EXT,imm8
ADD   %r,[%X]        r ← r + [00imm8]  (00imm8 = 0000H + 00H to FFH)

LDB   %EXT,imm8
ADD   %r,[%Y]        r ← r + [FFimm8]  (FFimm8 = FF00H + 00H to FFH)
```

ADD %r,[%ir]+ *Add location [ir reg.] to r reg. and increment ir reg.* *1 cycle*

Function: r ← r + [ir], ir ← ir + 1

Adds the content of the data memory addressed by the ir register (X or Y) to the r register (A or B). Then increments the ir register (X or Y). The flags change due to the operation result of the r register and the increment result of the ir register does not affect the flags.

Code:

Mnemonic	MSB												LSB	
ADD %A,[%X]+	1	1	0	0	1	0	1	1	0	0	0	0	1	1961H
ADD %A,[%Y]+	1	1	0	0	1	0	1	1	0	0	0	1	1	1963H
ADD %B,[%X]+	1	1	0	0	1	0	1	1	0	0	1	0	1	1965H
ADD %B,[%Y]+	1	1	0	0	1	0	1	1	0	0	1	1	1	1967H

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Register indirect
Dst: Register direct
Extended addressing: Invalid

ADD [%ir],%r *Add r reg. to location [ir reg.]* *2 cycles*

Function: [ir] ← [ir] + r

Adds the content of the r register (A or B) to the data memory addressed by the ir register (X or Y).

Code:

Mnemonic	MSB												LSB	
ADD [%X],%A	1	1	0	0	1	0	1	1	0	1	0	0	0	1968H
ADD [%X],%B	1	1	0	0	1	0	1	1	0	1	1	0	0	196CH
ADD [%Y],%A	1	1	0	0	1	0	1	1	0	1	0	1	0	196AH
ADD [%Y],%B	1	1	0	0	1	0	1	1	0	1	1	1	0	196EH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Register direct
Dst: Register indirect
Extended addressing: Valid

Extended operation:

LDB	%EXT,imm8	
ADD	[%X],%r	[00imm8] ← [00imm8] + r (00imm8 = 0000H + 00H to FFH)
LDB	%EXT,imm8	
ADD	[%Y],%r	[FFimm8] ← [FFimm8] + r (FFimm8 = FF00H + 00H to FFH)

ADD [%ir]+,%r *Add r reg. to location [ir reg.] and increment ir reg.* *2 cycles*

Function: [ir] ← [ir] + r, ir ← ir + 1

Adds the content of the r register (A or B) to the data memory addressed by the ir register (X or Y). Then increments the ir register (X or Y). The flags change due to the operation result of the data memory and the increment result of the ir register does not affect the flags.

Code:

Mnemonic	MSB												LSB	
ADD [%X]+,%A	1	1	0	0	1	0	1	1	0	1	0	0	1	1969H
ADD [%X]+,%B	1	1	0	0	1	0	1	1	0	1	1	0	1	196DH
ADD [%Y]+,%A	1	1	0	0	1	0	1	1	0	1	0	1	1	196BH
ADD [%Y]+,%B	1	1	0	0	1	0	1	1	0	1	1	1	1	196FH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Register direct
Dst: Register indirect
Extended addressing: Invalid

ADD [%ir],imm4 *Add immediate data imm4 to location [ir reg.]* *2 cycles*

Function: [ir] ← [ir] + imm4

Adds the 4-bit immediate data imm4 to the data memory addressed by the ir register (X or Y).

Code:

Mnemonic	MSB												LSB	
ADD [%X],imm4	1	1	0	0	1	0	0	0	0	i3	i2	i1	i0	1900H–190FH
ADD [%Y],imm4	1	1	0	0	1	0	0	1	0	i3	i2	i1	i0	1920H–192FH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Immediate data
Dst: Register indirect
Extended addressing: Valid

Extended operation:

LDB %EXT,imm8
ADD [%X],imm4 [00imm8] ← [00imm8] + imm4 (00imm8 = 0000H + 00H to FFH)

LDB %EXT,imm8
ADD [%Y],imm4 [FFimm8] ← [FFimm8] + imm4 (FFimm8 = FF00H + 00H to FFH)

ADD [%ir]+,imm4 *Add immediate data imm4 to location [ir reg.] and increment ir reg. 2 cycles*

Function: [ir] ← [ir] + imm4, ir ← ir + 1
Adds the 4-bit immediate data imm4 to the data memory addressed by the ir register (X or Y). Then increments the ir register (X or Y). The flags change due to the operation result of the data memory and the increment result of the ir register does not affect the flags.

Code:

Mnemonic	MSB												LSB	
ADD [%X]+,imm4	1	1	0	0	1	0	0	0	1	i3	i2	i1	i0	1910H–191FH
ADD [%Y]+,imm4	1	1	0	0	1	0	0	1	1	i3	i2	i1	i0	1930H–193FH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Immediate data
Dst: Register indirect
Extended addressing: Invalid

ADD %ir,%BA *Add BA reg. to ir reg.* *1 cycle*

Function: ir ← ir + BA
Adds the content of the BA register to the ir register (X or Y). This instruction does not affect the C flag regardless of the operation result.

Code:

Mnemonic	MSB												LSB	
ADD %X,%BA	1	1	1	1	1	1	1	0	1	0	0	0	X	1FD0H, (1FD1H)
ADD %Y,%BA	1	1	1	1	1	1	1	0	1	0	0	1	X	1FD2H, (1FD3H)

Flags:

E	I	C	Z
↓	–	–	↕

Mode: Src: Register direct
Dst: Register direct
Extended addressing: Invalid

ADD %ir,sign8 — *Add immediate data sign8 to ir reg.* — *1 cycle*

Function: ir ← ir + sign8

Adds the signed 8-bit immediate data sign8 (-128 to 127) to the ir register (X or Y). This instruction does not affect the C flag regardless of the operation result.

Code:

Mnemonic	MSB												LSB	
ADD %X,sign8	0	1	1	0	0	s7	s6	s5	s4	s3	s2	s1	s0	0C00H–0CFFH
ADD %Y,sign8	0	1	1	0	1	s7	s6	s5	s4	s3	s2	s1	s0	0D00H–0DFFH

Flags:

E	I	C	Z
↓	–	–	↕

Mode: Src: Immediate data

Dst: Register direct

Extended addressing: Valid

Extended operation:

LDB %EXT,imm8

ADD %ir,sign8 ir ← ir + sign16 (upper 8-bit: imm8, lower 8-bit: sign8)

AND %r,%r' — *Logical AND of r' reg. and r reg.* — *1 cycle*

Function: r ← r ∧ r'

Performs a logical AND operation of the content of the r' register (A or B) and the content of the r register (A or B), and stores the result in the r register.

Code:

Mnemonic	MSB												LSB	
AND %A,%A	1	1	0	1	0	0	1	1	1	0	0	0	X	1A70H, (1A71H)
AND %A,%B	1	1	0	1	0	0	1	1	1	0	0	1	X	1A72H, (1A73H)
AND %B,%A	1	1	0	1	0	0	1	1	1	0	1	0	X	1A74H, (1A75H)
AND %B,%B	1	1	0	1	0	0	1	1	1	0	1	1	X	1A76H, (1A77H)

Flags:

E	I	C	Z
↓	–	–	↕

Mode: Src: Register direct

Dst: Register direct

Extended addressing: Invalid

AND %r,imm4 — *Logical AND of immediate data imm4 and r reg.* — *1 cycle*

Function: r ← r ∧ imm4

Performs a logical AND operation of the 4-bit immediate data imm4 and the content of the r register (A or B), and stores the result in the r register.

Code:

Mnemonic	MSB												LSB	
AND %A,imm4	1	1	0	1	0	0	1	0	0	i3	i2	i1	i0	1A40H–1A4FH
AND %B,imm4	1	1	0	1	0	0	1	0	1	i3	i2	i1	i0	1A50H–1A5FH

Flags:

E	I	C	Z
↓	–	–	↕

Mode: Src: Immediate data

Dst: Register direct

Extended addressing: Invalid

AND %F,imm4 — *Logical AND of immediate data imm4 and F reg.* — *1 cycle*

Function: F ← F ∧ imm4

Performs a logical AND operation of the 4-bit immediate data imm4 and the content of the F (flag) register, and stores the result in the r register. It is possible to reset any flag.

Code:

Mnemonic	MSB												LSB	
AND %F,imm4	1	0	0	0	0	1	0	0	0	i3	i2	i1	i0	1080H–108FH

Flags:

E	I	C	Z
↓	↓	↓	↓

Mode: Src: Immediate data

Dst: Register direct

Extended addressing: Invalid

AND %r,[%ir] *Logical AND of location [ir reg.] and r reg.* *1 cycle*

Function: r ← r ∧ [ir]

Performs a logical AND operation of the content of the data memory addressed by the ir register (X or Y) and the content of the r register (A or B), and stores the result in the r register.

Code:

Mnemonic	MSB												LSB	
AND %A,[%X]	1	1	0	1	0	0	1	1	0	0	0	0	0	1A60H
AND %A,[%Y]	1	1	0	1	0	0	1	1	0	0	0	1	0	1A62H
AND %B,[%X]	1	1	0	1	0	0	1	1	0	0	1	0	0	1A64H
AND %B,[%Y]	1	1	0	1	0	0	1	1	0	0	1	1	0	1A66H

Flags:

E	I	C	Z
↓	–	–	↕

Mode: Src: Register indirect
Dst: Register direct
Extended addressing: Valid

Extended operation:

LDB	%EXT,imm8	
AND	%r,[%X]	r ← r ∧ [00imm8] (00imm8 = 0000H + 00H to FFH)
LDB	%EXT,imm8	
AND	%r,[%Y]	r ← r ∧ [FFimm8] (FFimm8 = FF00H + 00H to FFH)

AND %r,[%ir]+ *Logical AND of location [ir reg.] and r reg. and increment ir reg.* *1 cycle*

Function: r ← r ∧ [ir], ir ← ir + 1

Performs a logical AND operation of the content of the data memory addressed by the ir register (X or Y) and the content of the r register (A or B), and stores the result in the r register. Then increments the ir register (X or Y). The flags change due to the operation result of the r register and the increment result of the ir register does not affect the flags.

Code:

Mnemonic	MSB												LSB	
AND %A,[%X]+	1	1	0	1	0	0	1	1	0	0	0	0	1	1A61H
AND %A,[%Y]+	1	1	0	1	0	0	1	1	0	0	0	1	1	1A63H
AND %B,[%X]+	1	1	0	1	0	0	1	1	0	0	1	0	1	1A65H
AND %B,[%Y]+	1	1	0	1	0	0	1	1	0	0	1	1	1	1A67H

Flags:

E	I	C	Z
↓	–	–	↕

Mode: Src: Register indirect
Dst: Register direct
Extended addressing: Invalid

AND [%ir],%r *Logical AND of r reg. and location [ir reg.]* *2 cycles*

Function: [ir] ← [ir] ∧ r

Performs a logical AND operation of the content of the r register (A or B) and the content of the data memory addressed by the ir register (X or Y), and stores the result in that address.

Code:

Mnemonic	MSB												LSB	
AND [%X],%A	1	1	0	1	0	0	1	1	0	1	0	0	0	1A68H
AND [%X],%B	1	1	0	1	0	0	1	1	0	1	1	0	0	1A6CH
AND [%Y],%A	1	1	0	1	0	0	1	1	0	1	0	1	0	1A6AH
AND [%Y],%B	1	1	0	1	0	0	1	1	0	1	1	1	0	1A6EH

Flags:

E	I	C	Z
↓	–	–	↕

Mode: Src: Register direct
Dst: Register indirect
Extended addressing: Valid

Extended operation:

LDB %EXT,imm8		
AND [%X],%r	[00imm8] ← [00imm8] ∧ r	(00imm8 = 0000H + 00H to FFH)
LDB %EXT,imm8		
AND [%Y],%r	[FFimm8] ← [FFimm8] ∧ r	(FFimm8 = FF00H + 00H to FFH)

AND [%ir]+,%r *Logical AND of r reg. and location [ir reg.] and increment ir reg.* *2 cycles*

Function: [ir] ← [ir] ∧ r, ir ← ir + 1

Performs a logical AND operation of the content of the r register (A or B) and the content of the data memory addressed by the ir register (X or Y), and stores the result in that address. Then increments the ir register (X or Y). The flags change due to the operation result of the data memory and the increment result of the ir register does not affect the flags.

Code:

Mnemonic	MSB												LSB	
AND [%X]+,%A	1	1	0	1	0	0	1	1	0	1	0	0	1	1A69H
AND [%X]+,%B	1	1	0	1	0	0	1	1	0	1	1	0	1	1A6DH
AND [%Y]+,%A	1	1	0	1	0	0	1	1	0	1	0	1	1	1A6BH
AND [%Y]+,%B	1	1	0	1	0	0	1	1	0	1	1	1	1	1A6FH

Flags:

E	I	C	Z
↓	–	–	↕

Mode: Src: Register direct
Dst: Register indirect
Extended addressing: Invalid

AND [%ir],imm4 *Logical AND of immediate data imm4 and location [ir reg.]* *2 cycles*

Function: [ir] ← [ir] ∧ imm4

Performs a logical AND operation of the 4-bit immediate data imm4 and the content of the data memory addressed by the ir register (X or Y), and stores the result in that address.

Code:

Mnemonic	MSB												LSB	
AND [%X],imm4	1	1	0	1	0	0	0	0	0	i3	i2	i1	i0	1A00H–1A0FH
AND [%Y],imm4	1	1	0	1	0	0	0	1	0	i3	i2	i1	i0	1A20H–1A2FH

Flags:

E	I	C	Z
↓	–	–	↕

Mode: Src: Immediate data
Dst: Register indirect
Extended addressing: Valid

Extended operation:

LDB %EXT,imm8
AND [%X],imm4 [00imm8] ← [00imm8] ∧ imm4 (00imm8 = 0000H + 00H to FFH)

LDB %EXT,imm8
AND [%Y],imm4 [FFimm8] ← [FFimm8] ∧ imm4 (FFimm8 = FF00H + 00H to FFH)

AND [%ir]+,imm4 *Logical AND of immediate data imm4 and location [ir reg.] and increment ir reg.* *2 cycles*

Function: [ir] ← [ir] ∧ imm4, ir ← ir + 1

Performs a logical AND operation of the 4-bit immediate data imm4 and the content of the data memory addressed by the ir register (X or Y), and stores the result in that address. Then increments the ir register (X or Y). The flags change due to the operation result of the data memory and the increment result of the ir register does not affect the flags.

Code:

Mnemonic	MSB												LSB	
AND [%X]+,imm4	1	1	0	1	0	0	0	0	1	i3	i2	i1	i0	1A10H–1A1FH
AND [%Y]+,imm4	1	1	0	1	0	0	0	1	1	i3	i2	i1	i0	1A30H–1A3FH

Flags:

E	I	C	Z
↓	–	–	↕

Mode: Src: Immediate data
Dst: Register indirect
Extended addressing: Invalid

BIT %r,%r'   *Test bit of r reg. with r' reg.*   *1 cycle*

Function: r ∧ r'

Performs a logical AND of the content of the r' register (A or B) and the content of the r register (A or B) to check the bits of the r register. The Z flag is changed due to the operation result, but the content of the register is not changed.

Code:

Mnemonic	MSB											LSB	
BIT %A,%A	1	1	0	1	0	1	1	1	1	0	0	0	X	1AF0H, (1AF1H)
BIT %A,%B	1	1	0	1	0	1	1	1	1	0	0	1	X	1AF2H, (1AF3H)
BIT %B,%A	1	1	0	1	0	1	1	1	1	0	1	0	X	1AF4H, (1AF5H)
BIT %B,%B	1	1	0	1	0	1	1	1	1	0	1	1	X	1AF6H, (1AF7H)

Flags:

E	I	C	Z
↓	–	–	↕

Mode: Src: Register direct
Dst: Register direct
Extended addressing: Invalid

BIT %r,imm4   *Test bit of r reg. with immediate data imm4*   *1 cycle*

Function: r ∧ imm4

Performs a logical AND of the 4-bit immediate data imm4 and the content of the r register (A or B) to check the bits of the r register. The Z flag is changed due to the operation result, but the content of the register is not changed.

Code:

Mnemonic	MSB											LSB	
BIT %A,imm4	1	1	0	1	0	1	1	0	0	i3	i2	i1	i0	1AC0H–1ACFH
BIT %B,imm4	1	1	0	1	0	1	1	0	1	i3	i2	i1	i0	1AD0H–1ADFH

Flags:

E	I	C	Z
↓	–	–	↕

Mode: Src: Immediate data
Dst: Register direct
Extended addressing: Invalid

BIT %r,[%ir] *Test bit of r reg. with location [ir reg.]* *1 cycle*

Function: r ∧ [ir]

Performs a logical AND of the content of the data memory addressed by the ir register (X or Y) and the content of the r register (A or B) to check the bits of the r register. The Z flag is changed due to the operation result, but the content of the register is not changed.

Code:

Mnemonic	MSB												LSB	
BIT %A,[%X]	1	1	0	1	0	1	1	1	0	0	0	0	0	1AE0H
BIT %A,[%Y]	1	1	0	1	0	1	1	1	0	0	0	1	0	1AE2H
BIT %B,[%X]	1	1	0	1	0	1	1	1	0	0	1	0	0	1AE4H
BIT %B,[%Y]	1	1	0	1	0	1	1	1	0	0	1	1	0	1AE6H

Flags:

E	I	C	Z
↓	–	–	↕

Mode: Src: Register indirect
Dst: Register direct
Extended addressing: Valid

Extended operation:

LDB	%EXT,imm8		
BIT	%r,[%X]	r ∧ [00imm8]	(00imm8 = 0000H + 00H to FFH)
LDB	%EXT,imm8		
BIT	%r,[%Y]	r ∧ [FFimm8]	(FFimm8 = FF00H + 00H to FFH)

BIT %r,[%ir]+ *Test bit of r reg. with location [ir reg.] and increment ir reg.* *1 cycle*

Function: r ∧ [ir], ir ← ir + 1

Performs a logical AND of the content of the data memory addressed by the ir register (X or Y) and the content of the r register (A or B) to check the bits of the r register. The Z flag is changed due to the operation result, but the content of the register is not changed. Then increments the ir register (X or Y). The increment result of the ir register does not affect the flags.

Code:

Mnemonic	MSB												LSB	
BIT %A,[%X]+	1	1	0	1	0	1	1	1	0	0	0	0	1	1AE1H
BIT %A,[%Y]+	1	1	0	1	0	1	1	1	0	0	0	1	1	1AE3H
BIT %B,[%X]+	1	1	0	1	0	1	1	1	0	0	1	0	1	1AE5H
BIT %B,[%Y]+	1	1	0	1	0	1	1	1	0	0	1	1	1	1AE7H

Flags:

E	I	C	Z
↓	–	–	↕

Mode: Src: Register indirect
Dst: Register direct
Extended addressing: Invalid

BIT [%ir],%r — *Test bit of location [ir reg.] with r reg.* — *1 cycle*

Function: [ir] ∧ r

Performs a logical AND of the content of the r register (A or B) and the content of the data memory addressed by the ir register (X or Y) to check the bits of the memory. The Z flag is changed due to the operation result, but the content of the memory is not changed.

Code:

Mnemonic	MSB												LSB	
BIT [%X],%A	1	1	0	1	0	1	1	1	0	1	0	0	0	1AE8H
BIT [%X],%B	1	1	0	1	0	1	1	1	0	1	1	0	0	1AECH
BIT [%Y],%A	1	1	0	1	0	1	1	1	0	1	0	1	0	1AEAH
BIT [%Y],%B	1	1	0	1	0	1	1	1	0	1	1	1	0	1AEEH

Flags:

E	I	C	Z
↓	–	–	↕

Mode: Src: Register direct
Dst: Register indirect
Extended addressing: Valid

Extended operation:

LDB %EXT,imm8
BIT [%X],%r [00imm8] ∧ r (00imm8 = 0000H + 00H to FFH)

LDB %EXT,imm8
BIT [%Y],%r [FFimm8] ∧ r (FFimm8 = FF00H + 00H to FFH)

BIT [%ir]+,%r — *Test bit of location [ir reg.] with r reg. and increment ir reg.* — *1 cycle*

Function: [ir] ∧ r, ir ← ir + 1

Performs a logical AND of the content of the r register (A or B) and the content of the data memory addressed by the ir register (X or Y) to check the bits of the memory. The Z flag is changed due to the operation result, but the content of the memory is not changed. Then increments the ir register (X or Y). The increment result of the ir register does not affect the flags.

Code:

Mnemonic	MSB												LSB	
BIT [%X]+,%A	1	1	0	1	0	1	1	1	0	1	0	0	1	1AE9H
BIT [%X]+,%B	1	1	0	1	0	1	1	1	0	1	1	0	1	1AEDH
BIT [%Y]+,%A	1	1	0	1	0	1	1	1	0	1	0	1	1	1AEBH
BIT [%Y]+,%B	1	1	0	1	0	1	1	1	0	1	1	1	1	1AEFH

Flags:

E	I	C	Z
↓	–	–	↕

Mode: Src: Register direct
Dst: Register indirect
Extended addressing: Invalid

BIT [%ir],imm4 — *Test bit of location [ir reg.] with immediate data imm4* — *1 cycle*

Function: [ir] $\wedge$ imm4

Performs a logical AND of the 4-bit immediate data imm4 and the content of the data memory addressed by the ir register (X or Y) to check the bits of the memory. The Z flag is changed due to the operation result, but the content of the memory is not changed.

Code:

Mnemonic	MSB												LSB	
BIT [%X],imm4	1	1	0	1	0	1	0	0	0	i3	i2	i1	i0	1A80H–1A8FH
BIT [%Y],imm4	1	1	0	1	0	1	0	1	0	i3	i2	i1	i0	1AA0H–1AAFH

Flags:

E	I	C	Z
↓	–	–	↕

Mode: Src: Immediate data
Dst: Register indirect
Extended addressing: Valid

Extended operation:

LDB %EXT,imm8
BIT [%X],imm4 [00imm8] $\wedge$ imm4 (00imm8 = 0000H + 00H to FFH)

LDB %EXT,imm8
BIT [%Y],imm4 [FFimm8] $\wedge$ imm4 (FFimm8 = FF00H + 00H to FFH)

BIT [%ir]+,imm4 — *Test bit of location [ir reg.] with immediate data imm4 and increment ir reg.* — *1 cycle*

Function: [ir] $\wedge$ imm4, ir ← ir + 1

Performs a logical AND of the 4-bit immediate data imm4 and the content of the data memory addressed by the ir register (X or Y) to check the bits of the memory. The Z flag is changed due to the operation result, but the content of the memory is not changed. Then increments the ir register (X or Y). The increment result of the ir register does not affect the flags.

Code:

Mnemonic	MSB												LSB	
BIT [%X]+,imm4	1	1	0	1	0	1	0	0	1	i3	i2	i1	i0	1A90H–1A9FH
BIT [%Y]+,imm4	1	1	0	1	0	1	0	1	1	i3	i2	i1	i0	1AB0H–1ABFH

Flags:

E	I	C	Z
↓	–	–	↕

Mode: Src: Immediate data
Dst: Register indirect
Extended addressing: Invalid

CALR [addr6] — *Call subroutine at relative location [addr6]* — *2 cycles*

Function: ([(SP1-1)*4+3]~[(SP1-1)*4]) ← PC + 1, SP1 ← SP1 - 1, PC ← PC + [addr6] + 1
(addr6 = 0000H–003FH)
Saves the address next to this instruction to the stack as a return address, then adds the content of the data memory (0000H–003FH) specified with the addr6 to that address to unconditionally call the subroutine started from the address. Branch destination range is the next address of this instruction +0 to 15.

Code:

Mnemonic	MSB												LSB	
CALR [addr6]	1	1	1	1	1	0	0	a5	a4	a3	a2	a1	a0	1F00H–1F3FH

Flags:

E	I	C	Z
↓	–	–	–

Mode: 6-bit absolute
Extended addressing: Invalid

CALR sign8 — *Call subroutine at relative location sign8* — *1 cycle*

Function: ([(SP1-1)*4+3]~[(SP1-1)*4]) ← PC + 1, SP1 ← SP1 - 1, PC ← PC + sign8 + 1 (sign8 = -128~127)
Saves the address next to this instruction to the stack as a return address, then adds the related address specified with the sign8 to that address to unconditionally call the subroutine started from the address. Branch destination range is the next address of this instruction -128 to +127.

Code:

Mnemonic	MSB												LSB	
CALR sign8	0	0	0	1	0	s7	s6	s5	s4	s3	s2	s1	s0	0200H–02FFH

Flags:

E	I	C	Z
↓	–	–	–

Mode: Signed 8-bit PC relative
Extended addressing: Valid

Extended operation:
LDB %EXT,imm8
CALR sign8 ([(SP1-1)∗4+3]~[(SP1-1)∗4]) ← PC + 1, SP1 ← SP1 - 1,
PC ← PC + sign16 + 1
(sign16 = -32768 to 32767, upper 8-bit: imm8, lower 8-bit: sign8)

CALZ imm8 — *Call subroutine at location imm8* — *1 cycle*

Function: ([(SP1-1)*4+3]~[(SP1-1)*4]) ← PC + 1, SP1 ← SP1 - 1, PC ← imm8
Saves the address next to this instruction to the stack as a return address, then unconditionally calls the subroutine started from the address (0000H–00FFH) specified with the imm8.

Code:

Mnemonic	MSB												LSB	
CALZ imm8	0	0	0	1	1	i7	i6	i5	i4	i3	i2	i1	i0	0300H–03FFH

Flags:

E	I	C	Z
↓	–	–	–

Mode: Immediate data
Extended addressing: Invalid

CLR [addr6],imm2 — *Clear bit imm2 in location [addr6]* — *2 cycles*

Function: [addr6] ← [addr6] ∧ not (2^{imm2})
(addr6 = 0000H–003FH or FFC0H–FFFFH)
Clears the bit specified with the imm2 in the data memory specified with the addr6 to "0".

Code:

Mnemonic	MSB												LSB	
CLR [00addr6],imm2	1	0	1	0	0	i1	i0	a5	a4	a3	a2	a1	a0	1400H–14FFH
CLR [FFaddr6],imm2	1	0	1	0	1	i1	i0	a5	a4	a3	a2	a1	a0	1500H–15FFH

Flags:

E	I	C	Z
↓	–	–	↕

Mode: Src: Immediate data
Dst: 6-bit absolute
Extended addressing: Invalid

CMP %r,%r' — *Compare r reg. with r' reg.* — *1 cycle*

Function: r - r'

Subtracts the content of the r' register (A or B) from the content of the r register (A or B). It changes the flags (Z and C), but does not change the content of the register.

Code:

Mnemonic	MSB												LSB	
CMP %A,%A	1	1	1	1	0	0	1	1	1	X	0	0	0	1E70H, (1E78H)
CMP %A,%B	1	1	1	1	0	0	1	1	1	X	0	1	0	1E72H, (1E7AH)
CMP %B,%A	1	1	1	1	0	0	1	1	1	X	1	0	0	1E74H, (1E7CH)
CMP %B,%B	1	1	1	1	0	0	1	1	1	X	1	1	0	1E76H, (1E7EH)

Flags:

E	I	C	Z	
↓	–	↕	↕	(r ≠ r')
↓	–	↓	↑	(r = r')

Mode: Src: Register direct
Dst: Register direct
Extended addressing: Invalid

CMP %r,imm4 — *Compare r reg. with immediate data imm4* — *1 cycle*

Function: r - imm4

Subtracts the 4-bit immediate data imm4 from the content of the r register (A or B). It changes the flags (Z and C), but does not change the content of the register.

Code:

Mnemonic	MSB												LSB	
CMP %A,imm4	1	1	1	1	0	0	1	0	0	i3	i2	i1	i0	1E40H–1E4FH
CMP %B,imm4	1	1	1	1	0	0	1	0	1	i3	i2	i1	i0	1E50H–1E5FH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Immediate data
Dst: Register direct
Extended addressing: Invalid

CMP %r,[%ir] *Compare r reg. with location [ir reg.]* *1 cycle*

Function: r - [ir]

Subtracts the content of the data memory addressed by the ir register (X or Y) from the content of the r register (A or B). It changes the flags (Z and C), but does not change the content of the register.

Code:

Mnemonic	MSB												LSB	
CMP %A,[%X]	1	1	1	1	0	0	1	1	0	0	0	0	0	1E60H
CMP %A,[%Y]	1	1	1	1	0	0	1	1	0	0	0	1	0	1E62H
CMP %B,[%X]	1	1	1	1	0	0	1	1	0	0	1	0	0	1E64H
CMP %B,[%Y]	1	1	1	1	0	0	1	1	0	0	1	1	0	1E66H

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Register indirect
Dst: Register direct
Extended addressing: Valid

Extended operation:

```
LDB   %EXT,imm8
CMP   %r,[%X]        r - [00imm8]  (00imm8 = 0000H + 00H to FFH)

LDB   %EXT,imm8
CMP   %r,[%Y]        r - [FFimm8]  (FFimm8 = FF00H + 00H to FFH)
```

CMP %r,[%ir]+ *Compare r reg. with location [ir reg.] and increment ir reg.* *1 cycle*

Function: r - [ir], ir ← ir + 1

Subtracts the content of the data memory addressed by the ir register (X or Y) from the content of the r register (A or B). It changes the flags (Z and C), but does not change the content of the register. Then increments the ir register (X or Y). The increment result of the ir register does not affect the flags.

Code:

Mnemonic	MSB												LSB	
CMP %A,[%X]+	1	1	1	1	0	0	1	1	0	0	0	0	1	1E61H
CMP %A,[%Y]+	1	1	1	1	0	0	1	1	0	0	0	1	1	1E63H
CMP %B,[%X]+	1	1	1	1	0	0	1	1	0	0	1	0	1	1E65H
CMP %B,[%Y]+	1	1	1	1	0	0	1	1	0	0	1	1	1	1E67H

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Register indirect
Dst: Register direct
Extended addressing: Invalid

CMP [%ir],%r — *Compare location [ir reg.] with r reg.* — *1 cycle*

Function: [ir] - r
Subtracts the content of the r register (A or B) from the content of the data memory addressed by the ir register (X or Y). It changes the flags (Z and C), but does not change the content of the memory.

Code:

Mnemonic	MSB												LSB	
CMP [%X],%A	1	1	1	1	0	0	1	1	0	1	0	0	0	1E68H
CMP [%X],%B	1	1	1	1	0	0	1	1	0	1	1	0	0	1E6CH
CMP [%Y],%A	1	1	1	1	0	0	1	1	0	1	0	1	0	1E6AH
CMP [%Y],%B	1	1	1	1	0	0	1	1	0	1	1	1	0	1E6EH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Register direct
Dst: Register indirect
Extended addressing: Valid

Extended operation:

```
LDB   %EXT,imm8
CMP   [%X],%r       [00imm8] - r  (00imm8 = 0000H + 00H to FFH)

LDB   %EXT,imm8
CMP   [%Y],%r       [FFimm8] - r  (FFimm8 = FF00H + 00H to FFH)
```

CMP [%ir]+,%r — *Compare location [ir reg.] with r reg. and increment ir reg.* — *1 cycle*

Function: [ir] - r, ir ← ir + 1
Subtracts the content of the r register (A or B) from the content of the data memory addressed by the ir register (X or Y). It changes the flags (Z and C), but does not change the content of the memory. Then increments the ir register (X or Y). The increment result of the ir register does not affect the flags.

Code:

Mnemonic	MSB												LSB	
CMP [%X]+,%A	1	1	1	1	0	0	1	1	0	1	0	0	1	1E69H
CMP [%X]+,%B	1	1	1	1	0	0	1	1	0	1	1	0	1	1E6DH
CMP [%Y]+,%A	1	1	1	1	0	0	1	1	0	1	0	1	1	1E6BH
CMP [%Y]+,%B	1	1	1	1	0	0	1	1	0	1	1	1	1	1E6FH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Register direct
Dst: Register indirect
Extended addressing: Invalid

CMP [%ir],imm4 *Compare location [ir reg.] with immediate data imm4* *1 cycle*

Function: [ir] - imm4

Subtracts the 4-bit immediate data imm4 from the content of the data memory addressed by the ir register (X or Y). It changes the flags (Z and C), but does not change the content of the memory.

Code:

Mnemonic	MSB												LSB	
CMP [%X],imm4	1	1	1	1	0	0	0	0	0	i3	i2	i1	i0	1E00H–1E0FH
CMP [%Y],imm4	1	1	1	1	0	0	0	1	0	i3	i2	i1	i0	1E20H–1E2FH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Immediate data

Dst: Register indirect

Extended addressing: Valid

Extended operation:

LDB %EXT,imm8
CMP [%X],imm4 [00imm8] - imm4 (00imm8 = 0000H + 00H to FFH)

LDB %EXT,imm8
CMP [%Y],imm4 [FFimm8] - imm4 (FFimm8 = FF00H + 00H to FFH)

CMP [%ir]+,imm4 *Compare location [ir reg.] with immediate data imm4 and increment ir reg.* *1 cycle*

Function: [ir] - imm4, ir ← ir + 1

Subtracts the 4-bit immediate data imm4 from the content of the data memory addressed by the ir register (X or Y). It changes the flags (Z and C), but does not change the content of the memory. Then increments the ir register (X or Y). The increment result of the ir register does not affect the flags.

Code:

Mnemonic	MSB												LSB	
CMP [%X]+,imm4	1	1	1	1	0	0	0	0	1	i3	i2	i1	i0	1E10H–1E1FH
CMP [%Y]+,imm4	1	1	1	1	0	0	0	1	1	i3	i2	i1	i0	1E30H–1E3FH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Immediate data

Dst: Register indirect

Extended addressing: Invalid

CMP %ir,imm8 — *Compare ir reg. with immediate data imm8* — *1 cycle*

Function: ir - imm8

Subtracts the 8-bit immediate data imm8 from the content of the ir register (X or Y). It changes the flags (Z and C), but does not change the register.

Code:

Mnemonic	MSB							LSB	
CMP %X,imm8	0	1	1	1	0	[	FFH-imm8	]	0E00H–0EFFH
CMP %Y,imm8	0	1	1	1	1	[	FFH-imm8	]	0F00H–0FFFH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Immediate data
Dst: Register direct
Extended addressing: Valid

Extended operation:
LDB %EXT,imm8
CMP %ir,imm8' ir - imm16 (upper 8-bit: FFH - imm8, lower 8-bit: imm8')

DEC [addr6] — *Decrement location [addr6]* — *2 cycles*

Function: [addr6] ← [addr6] - 1
(addr6 = 0000H–003FH)
Decrements (-1) the content of the data memory addressed by the addr6.

Code:

Mnemonic	MSB												LSB	
DEC [addr6]	1	0	0	0	0	0	0	a5	a4	a3	a2	a1	a0	1000H–103FH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: 6-bit absolute addressing
Extended addressing: Invalid

DEC [ir],n4 — *Decrement location [ir] in specified radix* — *2 cycles*

Function: [ir] ← N's adjust ([ir] - 1)
Decrements (-1) the content of the data memory addressed by the ir register (X or Y). The operation result is adjusted with n4 as the radix.

Code:

Mnemonic	MSB												LSB	
DEC [%X],n4	1	1	1	0	0	1	0	0	0	n3	n2	n1	n0	1C80H–1C8FH
DEC [%Y],n4	1	1	1	0	0	1	0	1	0	n3	n2	n1	n0	1CA0H–1CAFH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Immediate data
Dst: Register indirect
Extended addressing: Valid

Extended operation:

LDB	%EXT,imm8	
DEC	[%X],n4	[00imm8] ← N's adjust ([00imm8] - 1) (00imm8 = 0000H + 00H to FFH)
LDB	%EXT,imm8	
DEC	[%Y],n4	[FFimm8] ← N's adjust ([FFimm8] - 1) (FFimm8 = FF00H + 00H to FFH)

Note: n4 should be specified with a value from 1 to 16. When 16 is specified for n4, the low-order 4 bits of the machine code (n3–n0) become 0000B.

DEC [ir]+,n4 — *Decrement location [ir] in specified radix and increment ir reg.* — *2 cycles*

Function: [ir] ← N's adjust ([ir] - 1), ir ← ir + 1
Decrements (-1) the content of the data memory addressed by the ir register (X or Y). The operation result is adjusted with n4 as the radix. Then increments the ir register (X or Y). The increment result of the ir register does not affect the flags.

Code:

Mnemonic	MSB												LSB	
DEC [%X]+,n4	1	1	1	0	0	1	0	0	1	n3	n2	n1	n0	1C90H–1C9FH
DEC [%Y]+,n4	1	1	1	0	0	1	0	1	1	n3	n2	n1	n0	1CB0H–1CBFH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Immediate data
Dst: Register indirect
Extended addressing: Invalid

Note: n4 should be specified with a value from 1 to 16. When 16 is specified for n4, the low-order 4 bits of the machine code (n3–n0) become 0000B.

DEC %sp *Decrement stack pointer* *1 cycle*

Function: sp ← sp - 1
Decrements (-1) the content of the stack pointer sp (SP1 or SP2). This instruction does not change the C flag regardless of the operation result.

Code:

Mnemonic	MSB												LSB	
DEC %SP1	1	1	1	1	1	1	1	1	0	0	0	0	0	1FE0H
DEC %SP2	1	1	1	1	1	1	1	1	0	0	1	0	0	1FE4H

Flags:

E	I	C	Z
↓	–	–	↕

Mode: Register direct
Extended addressing: Invalid

EX %A,%B *Exchange A reg. and B reg.* *1 cycle*

Function: A ↔ B
Exchanges the contents of the A register and B register.

Code:

Mnemonic	MSB												LSB	
EX %A,%B	1	1	1	1	1	1	1	1	1	0	1	1	1	1FF7H

Flags:

E	I	C	Z
↓	–	–	–

Mode: Src: Register direct
Dst: Register direct
Extended addressing: Invalid

EX %r,[%ir] *Exchange r reg. and location [ir reg.]* *2 cycles*

Function: r ↔ [ir]
Exchanges the contents of the r register (A or B) and data memory addressed by the ir register (X or Y).

Code:

Mnemonic	MSB												LSB	
EX %A,[%X]	1	0	0	0	0	1	1	1	1	1	0	0	0	10F8H
EX %A,[%Y]	1	0	0	0	0	1	1	1	1	1	0	1	0	10FAH
EX %B,[%X]	1	0	0	0	0	1	1	1	1	1	1	0	0	10FCH
EX %B,[%Y]	1	0	0	0	0	1	1	1	1	1	1	1	0	10FEH

Flags:

E	I	C	Z
↓	–	–	–

Mode: Src: Register indirect
Dst: Register direct
Extended addressing: Valid

Extended operation:

LDB %EXT,imm8
EX %r,[%X] r ↔ [00imm8] (00imm8 = 0000H + 00H to FFH)

LDB %EXT,imm8
EX %r,[%Y] r ↔ [FFimm8] (FFimm8 = FF00H + 00H to FFH)

EX %r,[%ir]+ *Exchange r reg. and location [ir reg.] and increment ir reg.* *2 cycles*

Function: r ↔ [ir], ir ← ir + 1
Exchanges the contents of the r register (A or B) and data memory addressed by the ir register (X or Y). Then increments the ir register (X or Y). The increment result of the ir register does not affect the flags.

Code:

Mnemonic	MSB												LSB	
EX %A,[%X]+	1	0	0	0	0	1	1	1	1	1	0	0	1	10F9H
EX %A,[%Y]+	1	0	0	0	0	1	1	1	1	1	0	1	1	10FBH
EX %B,[%X]+	1	0	0	0	0	1	1	1	1	1	1	0	1	10FDH
EX %B,[%Y]+	1	0	0	0	0	1	1	1	1	1	1	1	1	10FFH

Flags:

E	I	C	Z
↓	–	–	–

Mode: Src: Register indirect
Dst: Register direct
Extended addressing: Invalid

HALT — *Set CPU to HALT mode* — *2 cycles*

Function: Halt
Sets the CPU to HALT status.
The CPU stops operating, thus the power consumption is reduced. Peripheral circuits such as the oscillation circuit still operate.
An interrupt causes it to return from HALT status to the normal program execution status.

Code:

Mnemonic	MSB												LSB	
HALT	1	1	1	1	1	1	1	1	1	1	1	0	0	1FFCH

Flags:

E	I	C	Z
↓	–	–	–

INC [addr6] — *Increment location [addr6]* — *2 cycles*

Function: [addr6] ← [addr6] + 1
(addr6 = 0000H–003FH)
Increments (+1) the content of the data memory addressed by the addr6.

Code:

Mnemonic	MSB												LSB	
INC [addr6]	1	0	0	0	0	0	1	a5	a4	a3	a2	a1	a0	1040H–107FH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: 6-bit absolute
Extended addressing: Invalid

INC [ir],n4 — *Increment location [ir] in specified radix* — *2 cycles*

Function: [ir] ← N's adjust ([ir] + 1)

Increments (+1) the content of the data memory addressed by the ir register (X or Y). The operation result is adjusted with n4 as the radix.

Code:

Mnemonic	MSB									LSB	
INC [%X],n4	1	1	1	0	1	1	0	0	0	[10H-n4]	1D80H–1D8FH
INC [%Y],n4	1	1	1	0	1	1	0	1	0	[10H-n4]	1DA0H–1DAFH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Immediate data

Dst: Register indirect

Extended addressing: Valid

Extended operation:

LDB %EXT,imm8
INC [%X],n4 [00imm8] ← N's adjust ([00imm8] + 1) (00imm8 = 0000H + 00H to FFH)

LDB %EXT,imm8
INC [%Y],n4 [FFimm8] ← N's adjust ([FFimm8] + 1) (FFimm8 = FF00H + 00H to FFH)

Note: n4 should be specified with a value from 1 to 16.

INC [ir]+,n4 — *Increment location [ir] in specified radix and increment ir reg.* — *2 cycles*

Function: [ir] ← N's adjust ([ir] + 1), ir ← ir + 1

Increments (+1) the content of the data memory addressed by the ir register (X or Y). The operation result is adjusted with n4 as the radix. Then increments the ir register (X or Y). The increment result of the ir register does not affect the flags.

Code:

Mnemonic	MSB									LSB	
INC [%X]+,n4	1	1	1	0	1	1	0	0	1	[10H-n4]	1D90H–1D9FH
INC [%Y]+,n4	1	1	1	0	1	1	0	1	1	[10H-n4]	1DB0H–1DBFH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Immediate data

Dst: Register indirect

Extended addressing: Invalid

Note: n4 should be specified with a value from 1 to 16.

INC %sp — *Increment stack pointer* — *1 cycle*

Function: sp ← sp + 1

Increments (+1) the content of the stack pointer sp (SP1 or SP2). This instruction does not change the C flag regardless of the operation result.

Code:

Mnemonic	MSB												LSB	
INC %SP1	1	1	1	1	1	1	1	1	0	1	0	0	0	1FE8H
INC %SP2	1	1	1	1	1	1	1	1	0	1	1	0	0	1FECH

Flags:

E	I	C	Z
↓	–	–	↕

Mode: Register direct

Extended addressing: Invalid

INT imm6 — *Software interrupt* — *3 cycles*

Function: [SP2-1] ← F, SP2 ← SP2 - 1, ([(SP1-1)*4+3]~[(SP1-1)*4]) ← PC + 1, SP1 ← SP1 - 1, PC ← imm6 (imm6 = 0100H–013FH)

Saves the content of the F register and the return address (this instruction address + 1) to the stack, then executes the software interrupt routine that starts from the vector address (0100H–013FH) specified by the imm6.

Code:

Mnemonic	MSB												LSB	
INT imm6	1	1	1	1	1	1	0	i5	i4	i3	i2	i1	i0	1F80H–1FBFH

Flags:

E	I	C	Z
↓	–	–	–

Mode: Immediate data

Extended addressing: Invalid

Note: The RETI instruction, which returns the content of the F register, should be used for returning from the interrupt routine that is executed by this instruction.

JP %Y — *Indirect jump using Y reg.* — *1 cycle*

Function: PC ← Y
Loads the content of the Y register into the PC to branch unconditionally.

Code:

Mnemonic	MSB											LSB	
JP %Y	1	1	1	1	1	1	1	1	1	0	0	1	X	1FF2H, (1FF3H)

Flags:

E	I	C	Z
↓	–	–	–

Mode: Register direct
Extended addressing: Invalid

JR %A — *Jump to relative location A reg.* — *1 cycle*

Function: PC ← PC + A + 1
Adds the content of the A register to the address next to this instruction, to unconditionally branch to that address. Branch destination range is the next address of this instruction +0 to 15.

Code:

Mnemonic	MSB											LSB	
JR %A	1	1	1	1	1	1	1	1	1	0	0	0	1	1FF1H

Flags:

E	I	C	Z
↓	–	–	–

Mode: Register direct
Extended addressing: Invalid

JR %BA — *Jump to relative location BA reg.* — *1 cycle*

Function: PC ← PC + BA + 1

Adds the content of the BA register to the address next to this instruction, to unconditionally branch to that address. Branch destination range is the next address of this instruction +0 to 255.

Code:

Mnemonic	MSB												LSB	
JR %BA	1	1	1	1	1	1	1	1	1	0	0	0	0	1FF0H

Flags:

E	I	C	Z
↓	–	–	–

Mode: Register direct

Extended addressing: Invalid

JR [addr6] — *Jump to relative location [addr6]* — *2 cycles*

Function: PC ← PC + [addr6] + 1 (addr6 = 0000H–003FH)

Adds the content of the data memory (0000H–003FH) specified with the addr6 to the address next to this instruction , to unconditionally branch to that address. Branch destination range is the next address of this instruction +0 to 15.

Code:

Mnemonic	MSB												LSB	
JR [addr6]	1	1	1	1	1	0	1	a5	a4	a3	a2	a1	a0	1F40H–1F7FH

Flags:

E	I	C	Z
↓	–	–	–

Mode: 6-bit absolute

Extended addressing: Invalid

JR sign8

Jump to relative location sign8 ***1 cycle***

Function: PC ← PC + sign8 + 1 (sign8 = -128~127)
Adds the relative address specified with the sign8 to the address next to this instruction, to unconditionally branch to that address. Branch destination range is the next address of this instruction -128 to +127.

Code:

Mnemonic	MSB											LSB	
JR sign8	0	0	0	0	0	s7	s6	s5	s4	s3	s2	s1	s0	0000H–00FFH

Flags:

E	I	C	Z
↓	–	–	–

Mode: Signed 8-bit PC relative
Extended addressing: Valid

Extended operation:

LDB	%EXT,imm8	
JR	sign8	PC ← PC + sign16 + 1 (sign16 = -32768 to 32767, upper 8-bit: imm8, lower 8-bit: sign8)

JRC sign8

Jump to relative location sign8 if C flag is set ***1 cycle***

Function: If C = 1 then PC ← PC + sign8 + 1 (sign8 = -128~127)
Executes the "JR sign8" instruction if the C (carry) flag has been set to "1", otherwise executes the next instruction.

Code:

Mnemonic	MSB											LSB	
JRC sign8	0	0	1	0	0	s7	s6	s5	s4	s3	s2	s1	s0	0400H–04FFH

Flags:

E	I	C	Z
↓	–	–	–

Mode: Signed 8-bit PC relative
Extended addressing: Valid

Extended operation:

LDB	%EXT,imm8	
JRC	sign8	If C = 1 then PC ← PC + sign16 + 1 (sign16 = -32768 to 32767, upper 8-bit: imm8, lower 8-bit: sign8)

JRNC sign8 — *Jump to relative location sign8 if C flag is reset* — *1 cycle*

Function: If C = 0 then PC ← PC + sign8 + 1 (sign8 = -128~127)
Executes the "JR sign8" instruction if the C (carry) flag has been reset to "0", otherwise executes the next instruction.

Code:

Mnemonic	MSB												LSB	
JRNC sign8	0	0	1	0	1	s7	s6	s5	s4	s3	s2	s1	s0	0500H–05FFH

Flags:

E	I	C	Z
↓	–	–	–

Mode: Signed 8-bit PC relative
Extended addressing: Valid

Extended operation:

LDB	%EXT,imm8	
JRNC	sign8	If C = 0 then PC ← PC + sign16 + 1
		(sign16 = -32768 to 32767, upper 8-bit: imm8, lower 8-bit: sign8)

JRNZ sign8 — *Jump to relative location sign8 if Z flag is reset* — *1 cycle*

Function: If Z = 0 then PC ← PC + sign8 + 1 (sign8 = -128~127)
Executes the "JR sign8" instruction if the Z (zero) flag has been set to "1", otherwise executes the next instruction.

Code:

Mnemonic	MSB												LSB	
JRNZ sign8	0	0	1	1	1	s7	s6	s5	s4	s3	s2	s1	s0	0700H–07FFH

Flags:

E	I	C	Z
↓	–	–	–

Mode: Signed 8-bit PC relative
Extended addressing: Valid

Extended operation:

LDB	%EXT,imm8	
JRNZ	sign8	If Z = 0 then PC ← PC + sign16 + 1
		(sign16 = -32768 to 32767, upper 8-bit: imm8, lower 8-bit: sign8)

JRZ sign8 — *Jump to relative location sign8 if Z flag is set* — *1 cycle*

Function: If Z = 1 then PC ← PC + sign8 + 1 (sign8 = -128~127)
Executes the "JR sign8" instruction if the Z (zero) flag has been reset to "0", otherwise executes the next instruction.

Code:

Mnemonic	MSB												LSB	
JRZ sign8	0	0	1	1	0	s7	s6	s5	s4	s3	s2	s1	s0	0600H–06FFH

Flags:

E	I	C	Z
↓	–	–	–

Mode: Signed 8-bit PC relative
Extended addressing: Valid

Extended operation:
LDB %EXT,imm8
JRZ sign8 — If Z = 1 then PC ← PC + sign16 + 1
(sign16 = -32768 to 32767, upper 8-bit: imm8, lower 8-bit: sign8)

LD %r,%r’ — *Load r’ reg. into r reg.* — *1 cycle*

Function: r ← r’
Loads the content of the r’ register (A, B or F) into the r register (A, B or F).

Code:

Mnemonic	MSB												LSB	
LD %A,%A	1	1	1	1	0	1	1	1	1	0	0	0	0	1EF0H
LD %A,%B	1	1	1	1	0	1	1	1	1	0	0	1	0	1EF2H
LD %A,%F	1	1	1	1	1	1	1	1	1	0	1	1	0	1FF6H
LD %B,%A	1	1	1	1	0	1	1	1	1	0	1	0	0	1EF4H
LD %B,%B	1	1	1	1	0	1	1	1	1	0	1	1	0	1EF6H
LD %F,%A	1	1	1	1	1	1	1	1	1	0	1	0	1	1FF5H

Flags:

E	I	C	Z	
↓	–	–	–	
↕	↕	↕	↕	(r = F)

Mode: Src: Register direct
Dst: Register direct
Extended addressing: Invalid

LD %r,imm4 — *Load immediate data imm4 into r reg.* — *1 cycle*

Function: r ← imm4

Loads the 4-bit immediate data imm4 into the r register (A, B or F).

Code:

Mnemonic	MSB												LSB	
LD %A,imm4	1	1	1	1	0	1	1	0	0	i3	i2	i1	i0	1EC0H–1ECFH
LD %B,imm4	1	1	1	1	0	1	1	0	1	i3	i2	i1	i0	1ED0H–1EDFH
LD %F,imm4	1	0	0	0	0	1	0	1	1	i3	i2	i1	i0	10B0H–10BFH

Flags:

E	I	C	Z	
↓	–	–	–	
↕	↕	↕	↕	(r = F)

Mode: Src: Immediate data
Dst: Register direct
Extended addressing: Invalid

LD %r,[%ir] — *Load location [ir reg.] into r reg.* — *1 cycle*

Function: r ← [ir]

Loads the content of the data memory addressed by the ir register (X or Y) into the r register (A or B).

Code:

Mnemonic	MSB												LSB	
LD %A,[%X]	1	1	1	1	0	1	1	1	0	0	0	0	0	1EE0H
LD %A,[%Y]	1	1	1	1	0	1	1	1	0	0	0	1	0	1EE2H
LD %B,[%X]	1	1	1	1	0	1	1	1	0	0	1	0	0	1EE4H
LD %B,[%Y]	1	1	1	1	0	1	1	1	0	0	1	1	0	1EE6H

Flags:

E	I	C	Z
↓	–	–	–

Mode: Src: Register indirect
Dst: Register direct
Extended addressing: Valid

Extended operation:

LDB	%EXT,imm8	
LD	%r,[%X]	r ← [00imm8] (00imm8 = 0000H + 00H to FFH)
LDB	%EXT,imm8	
LD	%r,[%Y]	r ← [FFimm8] (FFimm8 = FF00H + 00H to FFH)

LD %r,[%ir]+ *Load location [ir reg.] into r reg. and increment ir reg.* *1 cycle*

Function: r ← [ir], ir ← ir + 1

Loads the content of the data memory addressed by the ir register (X or Y) into the r register (A or B). Then increments the ir register (X or Y).

Code:

Mnemonic	MSB												LSB	
LD %A,[%X]+	1	1	1	1	0	1	1	1	0	0	0	0	1	1EE1H
LD %A,[%Y]+	1	1	1	1	0	1	1	1	0	0	0	1	1	1EE3H
LD %B,[%X]+	1	1	1	1	0	1	1	1	0	0	1	0	1	1EE5H
LD %B,[%Y]+	1	1	1	1	0	1	1	1	0	0	1	1	1	1EE7H

Flags:

E	I	C	Z
↓	–	–	–

Mode: Src: Register indirect
Dst: Register direct
Extended addressing: Invalid

LD [%ir],%r *Load r reg. into location [ir reg.]* *1 cycle*

Function: [ir] ← r

Loads the content of the r register (A or B) into the data memory addressed by the ir register (X or Y).

Code:

Mnemonic	MSB												LSB	
LD [%X],%A	1	1	1	1	0	1	1	1	0	1	0	0	0	1EE8H
LD [%X],%B	1	1	1	1	0	1	1	1	0	1	1	0	0	1EECH
LD [%Y],%A	1	1	1	1	0	1	1	1	0	1	0	1	0	1EEAH
LD [%Y],%B	1	1	1	1	0	1	1	1	0	1	1	1	0	1EEEH

Flags:

E	I	C	Z
↓	–	–	–

Mode: Src: Register direct
Dst: Register indirect
Extended addressing: Valid

Extended operation:

```
LDB  %EXT,imm8
LD   [%X],%r     [00imm8] ← r  (00imm8 = 0000H + 00H to FFH)

LDB  %EXT,imm8
LD   [%Y],%r     [FFimm8] ← r  (FFimm8 = FF00H + 00H to FFH)
```

LD [%ir]+,%r

Load r reg. into location [ir reg.] and increment ir reg. ***1 cycle***

Function: [ir] ← r, ir ← ir + 1

Loads the content of the r register (A or B) into the data memory addressed by the ir register (X or Y). Then increments the ir register (X or Y).

Code:

Mnemonic	MSB												LSB	
LD [%X]+,%A	1	1	1	1	0	1	1	1	0	1	0	0	1	1EE9H
LD [%X]+,%B	1	1	1	1	0	1	1	1	0	1	1	0	1	1EEDH
LD [%Y]+,%A	1	1	1	1	0	1	1	1	0	1	0	1	1	1EEBH
LD [%Y]+,%B	1	1	1	1	0	1	1	1	0	1	1	1	1	1EEFH

Flags:

E	I	C	Z
↓	–	–	–

Mode: Src: Register direct
Dst: Register indirect
Extended addressing: Invalid

LD [%ir],imm4

Load immediate data imm4 into location [ir reg.] ***1 cycle***

Function: [ir] ← imm4

Loads the 4-bit immediate data imm4 into the data memory addressed by the ir register (X or Y).

Code:

Mnemonic	MSB												LSB	
LD [%X],imm4	1	1	1	1	0	1	0	0	0	i3	i2	i1	i0	1E80H–1E8FH
LD [%Y],imm4	1	1	1	1	0	1	0	1	0	i3	i2	i1	i0	1EA0H–1EAFH

Flags:

E	I	C	Z
↓	–	–	–

Mode: Src: Immediate data
Dst: Register indirect
Extended addressing: Valid

Extended operation:

```
LDB   %EXT,imm8
LD    [%X],imm4     [00imm8] ← imm4  (00imm8 = 0000H + 00H to FFH)

LDB   %EXT,imm8
LD    [%Y],imm4     [FFimm8] ← imm4  (FFimm8 = FF00H + 00H to FFH)
```

LD [%ir]+,imm4

Load immediate data imm4 into location [ir reg.] and increment ir reg. 1 cycle

Function: [ir] ← imm4, ir ← ir + 1

Loads the 4-bit immediate data imm4 into the data memory addressed by the ir register (X or Y). Then increments the ir register (X or Y).

Code:

Mnemonic	MSB												LSB	
LD [%X]+,imm4	1	1	1	1	0	1	0	0	1	i3	i2	i1	i0	1E90H–1E9FH
LD [%Y]+,imm4	1	1	1	1	0	1	0	1	1	i3	i2	i1	i0	1EB0H–1EBFH

Flags:

E	I	C	Z
↓	–	–	–

Mode: Src: Immediate data
Dst: Register indirect
Extended addressing: Invalid

LD [%ir],[%ir']

Load location [ir' reg.] into location [ir reg.] 2 cycles

Function: [ir] ← [ir']

Loads the content of the data memory addressed by the ir' register (X or Y) into the data memory addressed by the ir register (Y or X).

Code:

Mnemonic	MSB												LSB	
LD [%X],[%Y]	1	1	1	1	0	1	1	1	1	1	0	1	0	1EFAH
LD [%Y],[%X]	1	1	1	1	0	1	1	1	1	1	0	0	0	1EF8H

Flags:

E	I	C	Z
↓	–	–	–

Mode: Src: Register indirect
Dst: Register indirect
Extended addressing: Invalid

LD [%ir],[%ir']+ *Load location [ir' reg.] into location [ir reg.] and increment ir' reg. 2 cycles*

Function: [ir] ← [ir'], ir' ← ir' + 1
Loads the content of the data memory addressed by the ir' register (X or Y) into the data memory addressed by the ir register (Y or X). Then increments the ir' register (Y or X).

Code:

Mnemonic	MSB												LSB	
LD [%X],[%Y]+	1	1	1	1	0	1	1	1	1	1	0	1	1	1EFBH
LD [%Y],[%X]+	1	1	1	1	0	1	1	1	1	1	0	0	1	1EF9H

Flags:

E	I	C	Z
↓	–	–	–

Mode: Src: Register indirect
Dst: Register indirect
Extended addressing: Invalid

LD [%ir]+,[%ir'] *Load location [ir' reg.] into location [ir reg.] and increment ir reg. 2 cycles*

Function: [ir] ← [ir'], ir ← ir + 1
Loads the content of the data memory addressed by the ir' register (X or Y) into the data memory addressed by the ir register (Y or X). Then increments the ir register (X or Y).

Code:

Mnemonic	MSB												LSB	
LD [%X]+,[%Y]	1	1	1	1	0	1	1	1	1	1	1	1	0	1EFEH
LD [%Y]+,[%X]	1	1	1	1	0	1	1	1	1	1	1	0	0	1EFCH

Flags:

E	I	C	Z
↓	–	–	–

Mode: Src: Register indirect
Dst: Register indirect
Extended addressing: Invalid

LD [%ir]+,[%ir']+ *Load location [ir' reg.] into location [ir reg.] and increment ir and ir' reg. 2 cycles*

Function: [ir] ← [ir'], ir ← ir + 1, ir' ← ir' + 1
Loads the content of the data memory addressed by the ir' register (X or Y) into the data memory addressed by the ir register (Y or X). Then increments both the ir and ir' registers.

Code:

Mnemonic	MSB												LSB	
LD [%X]+,[%Y]+	1	1	1	1	0	1	1	1	1	1	1	1	1	1EFFH
LD [%Y]+,[%X]+	1	1	1	1	0	1	1	1	1	1	1	0	1	1EFDH

Flags:

E	I	C	Z
↓	–	–	–

Mode: Src: Register indirect
Dst: Register indirect
Extended addressing: Invalid

LDB %BA,imm8 *Load immediate data imm8 into BA reg. 1 cycle*

Function: BA ← imm8
Loads the 8-bit immediate data imm8 into the BA register.

Code:

Mnemonic	MSB												LSB	
LDB %BA,imm8	0	1	0	0	1	i7	i6	i5	i4	i3	i2	i1	i0	0900H–09FFH

Flags:

E	I	C	Z
↓	–	–	–

Mode: Src: Immediate data
Dst: Register direct
Extended addressing: Invalid

LDB %BA,[%ir]+ *Load location [ir reg.] into BA reg. and increment ir reg.* *2 cycles*

Function: A ← [ir], B ← [ir + 1], ir ← ir + 2

Loads the 2-word data in the data memory into the BA register. The content of the data memory addressed by the ir register (X or Y) is loaded into the A register as the low-order 4 bits, and the content of the next address is loaded into the B register as the high-order 4 bits. The ir register (X or Y) is incremented by 2 words.

Code:

Mnemonic	MSB												LSB	
LDB %BA,[%X]+	1	1	1	1	1	1	1	0	1	1	0	0	0	1FD8H
LDB %BA,[%Y]+	1	1	1	1	1	1	1	0	1	1	0	1	0	1FDAH

Flags:

E	I	C	Z
↓	–	–	–

Mode: Src: Register indirect
Dst: Register direct
Extended addressing: Invalid

LDB %BA,%EXT *Load EXT reg. into BA reg.* *1 cycle*

Function: BA ← EXT

Loads the content of the EXT register into the BA register.

Code:

Mnemonic	MSB												LSB	
LDB %BA,%EXT	1	1	1	1	1	1	1	0	1	0	1	1	X	1FD6H, (1FD7H)

Flags:

E	I	C	Z
↓	–	–	–

Mode: Src: Register direct
Dst: Register direct
Extended addressing: Invalid

LDB %BA,%rr — *Load rr reg. into BA reg.* — *1 cycle*

Function: BA ← rr
Loads the content of the rr register (XL, XH, YL or YH) into the BA register.

Code:

Mnemonic	MSB												LSB	
LDB %BA,%XL	1	1	1	1	1	1	1	0	0	1	0	0	0	1FC8H
LDB %BA,%XH	1	1	1	1	1	1	1	0	0	1	0	0	1	1FC9H
LDB %BA,%YL	1	1	1	1	1	1	1	0	0	1	0	1	0	1FCAH
LDB %BA,%YH	1	1	1	1	1	1	1	0	0	1	0	1	1	1FCBH

Flags:

E	I	C	Z
↓	–	–	–

Mode: Src: Register direct
Dst: Register direct
Extended addressing: Invalid

LDB %BA,%sp — *Load stack pointer into BA reg.* — *1 cycle*

Function: BA ← sp
Loads the content of the stack pointer sp (SP1 or SP2) into the BA register.

Code:

Mnemonic	MSB												LSB	
LDB %BA,%SP1	1	1	1	1	1	1	1	0	0	1	1	0	X	1FCCH, (1FCDH)
LDB %BA,%SP2	1	1	1	1	1	1	1	0	0	1	1	1	X	1FCEH, (1FCFH)

Flags:

E	I	C	Z
↓	–	–	–

Mode: Src: Register direct
Dst: Register direct
Extended addressing: Invalid

LDB [%ir]+,%BA *Load BA reg. into location [ir reg.] and increment ir reg.* *2 cycles*

Function: [ir] ← A, [ir + 1] ← B, ir ← ir + 2
Loads the content of the BA register into the data memory. The content of the A register is loaded into the data memory addressed by the ir register (X or Y) as the low-order 4 bits, and the content of the B register is loaded into the next address as the high-order 4 bits. The ir register (X or Y) is incremented by 2 words.

Code:

Mnemonic	MSB												LSB	
LDB [%X]+,%BA	1	1	1	1	1	1	1	0	1	1	0	0	1	1FD9H
LDB [%Y]+,%BA	1	1	1	1	1	1	1	0	1	1	0	1	1	1FDBH

Flags:

E	I	C	Z
↓	–	–	–

Mode: Src: Register direct
Dst: Register indirect
Extended addressing: Invalid

LDB [%X]+,imm8 *Load immediate data imm8 into location [X reg.] and increment X reg.* *2 cycles*

Function: [X] ← i3-0, [X+1] ← i7-4, X ← X + 2
Loads the 8-bit immediate data imm8 into the data memory. The low-order 4 bit-data is loaded into the data memory addressed by the ir register (X or Y), and the high-order 4-bit data is loaded into the next address. The ir register (X or Y) is incremented by 2 words.

Code:

Mnemonic	MSB												LSB	
LDB [%X]+,imm8	0	0	0	0	1	i7	i6	i5	i4	i3	i2	i1	i0	0100H–01FFH

Flags:

E	I	C	Z
↓	–	–	–

Mode: Src: Immediate data
Dst: Register indirect
Extended addressing: Invalid

LDB %EXT,imm8 *Load immediate data imm8 into EXT reg.* *1 cycle*

Function: EXT ← imm8

Loads the 8-bit immediate data into the EXT register. The E flag is set to "1".

Code:

Mnemonic	MSB											LSB	
LDB %EXT,imm8	0	1	0	0	0	i7	i6	i5	i4	i3	i2	i1	i0	0800H–08FFH

Flags:

E	I	C	Z
↑	–	–	–

Mode: Src: Immediate data

Dst: Register direct

Extended addressing: Invalid

LDB %EXT,%BA *Load BA reg. into EXT reg.* *1 cycle*

Function: EXT ← BA

Loads the content of the BA register into the EXT register. The E flag is set to "1".

Code:

Mnemonic	MSB											LSB	
LDB %EXT,%BA	1	1	1	1	1	1	1	0	1	0	1	0	X	1FD4H, (1FD5H)

Flags:

E	I	C	Z
↑	–	–	–

Mode: Src: Register direct

Dst: Register direct

Extended addressing: Invalid

LDB %rr,imm8 — *Load immediate data imm8 into rr reg.* — *1 cycle*

Function: rr ← imm8
Loads the 8-bit immediate data imm8 into the rr (XL or YL) register.

Code:

Mnemonic	MSB												LSB	
LDB %XL,imm8	0	1	0	1	0	i7	i6	i5	i4	i3	i2	i1	i0	0A00H–0AFFH
LDB %YL,imm8	0	1	0	1	1	i7	i6	i5	i4	i3	i2	i1	i0	0B00H–0BFFH

Flags:

E	I	C	Z
↓	–	–	–

Mode: Src: Immediate data
Dst: Register direct
Extended addressing: Valid

Extended operation:
LDB %EXT,imm8
LDB %XL,imm8' X ← imm16 (upper 8-bit: imm8, lower 8-bit: imm8')

LDB %EXT,imm8
LDB %YL,imm8' Y ← imm16 (upper 8-bit: imm8, lower 8-bit: imm8')

LDB %rr,%BA — *Load BA reg. into rr reg.* — *1 cycle*

Function: rr ← BA
Loads the content of the BA register into the rr register (XL, XH, YL or YH).

Code:

Mnemonic	MSB												LSB	
LDB %XL,%BA	1	1	1	1	1	1	1	0	0	0	0	0	0	1FC0H
LDB %XH,%BA	1	1	1	1	1	1	1	0	0	0	0	0	1	1FC1H
LDB %YL,%BA	1	1	1	1	1	1	1	0	0	0	0	1	0	1FC2H
LDB %YH,%BA	1	1	1	1	1	1	1	0	0	0	0	1	1	1FC3H

Flags:

E	I	C	Z
↓	–	–	–

Mode: Src: Register direct
Dst: Register direct
Extended addressing: Invalid

LDB %sp,%BA *Load BA reg. into stack pointer* *1 cycle*

Function: sp ← BA
Loads the content of the BA register into the stack pointer sp (SP1 or SP2).

Code:

Mnemonic	MSB											LSB	
LDB %SP1,%BA	1	1	1	1	1	1	1	0	0	0	1	0	X	1FC4H, (1FC5H)
LDB %SP2,%BA	1	1	1	1	1	1	1	0	0	0	1	1	X	1FC6H, (1FC7H)

Flags:

E	I	C	Z
↓	–	–	–

Mode: Src: Register direct
Dst: Register direct
Extended addressing: Invalid

NOP *No operation* *1 cycle*

Function: No operation (PC ← PC+1)
Expends 1 cycle without doing an operation that otherwise exerts an affect. The PC (program counter) is incremented.

Code:

Mnemonic	MSB											LSB	
NOP	1	1	1	1	1	1	1	1	1	1	1	1	X	1FFEH, (1FFFH)

Flags:

E	I	C	Z
↓	–	–	–

OR %r,%r' *Logical OR of r' reg. and r reg.* *1 cycle*

Function: r ← r ∨ r'

Performs a logical OR operation of the content of the r' register (A or B) and the content of the r register (A or B), and stores the result in the r register.

Code:

Mnemonic	MSB											LSB	
OR %A,%A	1	1	0	1	1	0	1	1	1	0	0	0	X	1B70H, (1B71H)
OR %A,%B	1	1	0	1	1	0	1	1	1	0	0	1	X	1B72H, (1B73H)
OR %B,%A	1	1	0	1	1	0	1	1	1	0	1	0	X	1B74H, (1B75H)
OR %B,%B	1	1	0	1	1	0	1	1	1	0	1	1	X	1B76H, (1B77H)

Flags:

E	I	C	Z
↓	–	–	↕

Mode: Src: Register direct
Dst: Register direct
Extended addressing: Invalid

OR %r,imm4 *Logical OR of immediate data imm4 and r reg.* *1 cycle*

Function: r ← r ∨ imm4

Performs a logical OR operation of the 4-bit immediate data imm4 and the content of the r register (A or B), and stores the result in the r register.

Code:

Mnemonic	MSB											LSB	
OR %A,imm4	1	1	0	1	1	0	1	0	0	i3	i2	i1	i0	1B40H–1B4FH
OR %B,imm4	1	1	0	1	1	0	1	0	1	i3	i2	i1	i0	1B50H–1B5FH

Flags:

E	I	C	Z
↓	–	–	↕

Mode: Src: Immediate data
Dst: Register direct
Extended addressing: Invalid

OR %F,imm4 — *Logical OR of immediate data imm4 and F reg.* — *1 cycle*

Function: F ← F ∨ imm4

Performs a logical OR operation of the 4-bit immediate data imm4 and the content of the F (flag) register, and stores the result in the r register. It is possible to set any flag.

Code:

Mnemonic	MSB												LSB	
OR %F,imm4	1	0	0	0	0	1	0	0	1	i3	i2	i1	i0	1090H–109FH

Flags:

E	I	C	Z
↑	↑	↑	↑

Mode: Src: Immediate data
Dst: Register direct
Extended addressing: Invalid

OR %r,[%ir] — *Logical OR of location [ir reg.] and r reg.* — *1 cycle*

Function: r ← r ∨ [ir]

Performs a logical OR operation of the content of the data memory addressed by the ir register (X or Y) and the content of the r register (A or B), and stores the result in the r register.

Code:

Mnemonic	MSB												LSB	
OR %A,[%X]	1	1	0	1	1	0	1	1	0	0	0	0	0	1B60H
OR %A,[%Y]	1	1	0	1	1	0	1	1	0	0	0	1	0	1B62H
OR %B,[%X]	1	1	0	1	1	0	1	1	0	0	1	0	0	1B64H
OR %B,[%Y]	1	1	0	1	1	0	1	1	0	0	1	1	0	1B66H

Flags:

E	I	C	Z
↓	–	–	↕

Mode: Src: Register indirect
Dst: Register direct
Extended addressing: Valid

Extended operation:

```
LDB   %EXT,imm8
OR    %r,[%X]      r ← r ∨ [00imm8]  (00imm8 = 0000H + 00H to FFH)

LDB   %EXT,imm8
OR    %r,[%Y]      r ← r ∨ [FFimm8]  (FFimm8 = FF00H + 00H to FFH)
```

OR %r,[%ir]+ *Logical OR of location [ir reg.] and r reg. and increment ir reg.* *1 cycle*

Function: r ← r ∨ [ir], ir ← ir +1

Performs a logical OR operation of the content of the data memory addressed by the ir register (X or Y) and the content of the r register (A or B), and stores the result in the r register. Then increments the ir register (X or Y). The flags change due to the operation result of the r register and the increment result of the ir register does not affect the flags.

Code:

Mnemonic	MSB												LSB	
OR %A,[%X]+	1	1	0	1	1	0	1	1	0	0	0	0	1	1B61H
OR %A,[%Y]+	1	1	0	1	1	0	1	1	0	0	0	1	1	1B63H
OR %B,[%X]+	1	1	0	1	1	0	1	1	0	0	1	0	1	1B65H
OR %B,[%Y]+	1	1	0	1	1	0	1	1	0	0	1	1	1	1B67H

Flags:

E	I	C	Z
↓	–	–	↕

Mode: Src: Register indirect
Dst: Register direct
Extended addressing: Invalid

OR [%ir],%r *Logical OR of r reg. and location [ir reg.]* *2 cycles*

Function: [ir] ← [ir] ∨ r

Performs a logical OR operation of the content of the r register (A or B) and the content of the data memory addressed by the ir register (X or Y), and stores the result in that address.

Code:

Mnemonic	MSB												LSB	
OR [%X],%A	1	1	0	1	1	0	1	1	0	1	0	0	0	1B68H
OR [%X],%B	1	1	0	1	1	0	1	1	0	1	1	0	0	1B6CH
OR [%Y],%A	1	1	0	1	1	0	1	1	0	1	0	1	0	1B6AH
OR [%Y],%B	1	1	0	1	1	0	1	1	0	1	1	1	0	1B6EH

Flags:

E	I	C	Z
↓	–	–	↕

Mode: Src: Register direct
Dst: Register indirect
Extended addressing: Valid

Extended operation:

LDB	%EXT,imm8	
OR	[%X],%r	[00imm8] ← [00imm8] ∨ r (00imm8 = 0000H + 00H to FFH)
LDB	%EXT,imm8	
OR	[%Y],%r	[FFimm8] ← [FFimm8] ∨ r (FFimm8 = FF00H + 00H to FFH)

OR [%ir]+,%r

Logical OR of r reg. and location [ir reg.] and increment ir reg. ***2 cycles***

Function: [ir] ← [ir] ∨ r, ir ← ir +1

Performs a logical OR operation of the content of the r register (A or B) and the content of the data memory addressed by the ir register (X or Y), and stores the result in that address. Then increments the ir register (X or Y). The flags change due to the operation result of the data memory and the increment result of the ir register does not affect the flags.

Code:

Mnemonic	MSB												LSB	
OR [%X]+,%A	1	1	0	1	1	0	1	1	0	1	0	0	1	1B69H
OR [%X]+,%B	1	1	0	1	1	0	1	1	0	1	1	0	1	1B6DH
OR [%Y]+,%A	1	1	0	1	1	0	1	1	0	1	0	1	1	1B6BH
OR [%Y]+,%B	1	1	0	1	1	0	1	1	0	1	1	1	1	1B6FH

Flags:

E	I	C	Z
↓	–	–	↕

Mode: Src: Register direct
Dst: Register indirect
Extended addressing: Invalid

OR [%ir],imm4

Logical OR of immediate data imm4 and location [ir reg.] ***2 cycles***

Function: [ir] ← [ir] ∨ imm4

Performs a logical OR operation of the 4-bit immediate data imm4 and the content of the data memory addressed by the ir register (X or Y), and stores the result in that address.

Code:

Mnemonic	MSB												LSB	
OR [%X],imm4	1	1	0	1	1	0	0	0	0	i3	i2	i1	i0	1B00H–1B0FH
OR [%Y],imm4	1	1	0	1	1	0	0	1	0	i3	i2	i1	i0	1B20H–1B2FH

Flags:

E	I	C	Z
↓	–	–	↕

Mode: Src: Immediate data
Dst: Register indirect
Extended addressing: Valid

Extended operation:

LDB %EXT,imm8
OR [%X],imm4 [00imm8] ← [00imm8] ∨ imm4 (00imm8 = 0000H + 00H to FFH)

LDB %EXT,imm8
OR [%Y],imm4 [FFimm8] ← [FFimm8] ∨ imm4 (FFimm8 = FF00H + 00H to FFH)

OR [%ir]+,imm4

Logical OR of immediate data imm4 and location [ir reg.] and increment ir reg. 2 cycles

Function: [ir] ← [ir] ∨ imm4, ir ← ir +1

Performs a logical OR operation of the 4-bit immediate data imm4 and the content of the data memory addressed by the ir register (X or Y), and stores the result in that address. Then increments the ir register (X or Y). The flags change due to the operation result of the data memory and the increment result of the ir register does not affect the flags.

Code:

Mnemonic	MSB												LSB	
OR [%X]+,imm4	1	1	0	1	1	0	0	0	1	i3	i2	i1	i0	1B10H–1B1FH
OR [%Y]+,imm4	1	1	0	1	1	0	0	1	1	i3	i2	i1	i0	1B30H–1B3FH

Flags:

E	I	C	Z
↓	–	–	↕

Mode: Src: Immediate data

Dst: Register indirect

Extended addressing: Invalid

POP %r

Pop top of stack into r reg. ***1 cycle***

Function: r ← [SP2], SP2 ← SP2 +1

Loads the 4-bit data that has been stored in the address indicated by the stack pointer SP2 into the r register (A, B or F), then increments the SP2.

Code:

Mnemonic	MSB												LSB	
POP %A	1	1	1	1	1	1	1	1	0	1	1	1	1	1FEFH
POP %B	1	1	1	1	1	1	1	1	0	1	1	1	0	1FEEH
POP %F	1	1	1	1	1	1	1	1	0	1	1	0	1	1FEDH

Flags:

E	I	C	Z	
↓	–	–	–	(r = A, B)
↕	↕	↕	↕	(r = F)

Mode: Register direct

Extended addressing: Invalid

POP %ir — *Pop top of stack into ir reg.* — *1 cycle*

Function: ir ← ([SP1*4+3]~[SP1*4]), SP1 ← SP1 +1
Loads the 16-bit data that has been stored in the addresses (4 words) indicated by the stack pointer SP1 (SP1 indicates the lowest address) into the ir register (X or Y), then increments the SP1.

Code:

Mnemonic	MSB												LSB	
POP %X	1	1	1	1	1	1	1	1	0	1	0	0	1	1FE9H
POP %Y	1	1	1	1	1	1	1	1	0	1	0	1	X	1FEAH, (1FEBH)

Flags:

E	I	C	Z
↓	–	–	–

Mode: Register direct
Extended addressing: Invalid

PUSH %r — *Push r reg. onto stack* — *1 cycle*

Function: [SP2-1] ← r, SP2 ← SP2 -1
Decrements the stack pointer SP2, then stores the content of the r register (A, B or F) into the address indicated by the SP2.

Code:

Mnemonic	MSB												LSB	
PUSH %A	1	1	1	1	1	1	1	1	0	0	1	1	1	1FE7H
PUSH %B	1	1	1	1	1	1	1	1	0	0	1	1	0	1FE6H
PUSH %F	1	1	1	1	1	1	1	1	0	0	1	0	1	1FE5H

Flags:

E	I	C	Z
↓	–	–	–

Mode: Register direct
Extended addressing: Invalid

PUSH %ir — *Push ir reg. onto stack* — *1 cycle*

Function: ([(SP1-1)*4+3]~[(SP1-1)*4]) ← ir, SP1 ← SP1 -1
Decrements the stack pointer SP1, then stores the content of the ir register (X or Y) into the addresses (4 words) indicated by the SP1 (SP1 indicates the lowest address).

Code:

Mnemonic	MSB												LSB	
PUSH %X	1	1	1	1	1	1	1	1	0	0	0	0	1	1FE1H
PUSH %Y	1	1	1	1	1	1	1	1	0	0	0	1	X	1FE2H, (1FE3H)

Flags:

E	I	C	Z
↓	–	–	–

Mode: Register direct
Extended addressing: Invalid

RET — *Return from subroutine* — *1 cycle*

Function: PC ← ([SP1*4+3]~[SP1*4]), SP1 ← SP1 +1
Loads the 16-bit data (return address) that has been stored in the addresses (4 words) indicated by the stack pointer SP1 (SP1 indicates the lowest address) into the PC to return from the subroutine. The SP1 is incremented.

Code:

Mnemonic	MSB												LSB	
RET	1	1	1	1	1	1	1	1	1	1	0	X	0	1FF8H, (1FFAH)

Flags:

E	I	C	Z
↓	–	–	–

RETD imm8

Return from subroutine and load imm8 into location [X] ***3 cycles***

Function: PC ← ([SP1*4+3]~[SP1*4]), SP1 ← SP1 +1, [X] ← i3-0, [X+1] ← i7-4, X ← X + 2
After executing the RET instruction, stores the 8-bit immediate data imm8 into the data memory (2 words) indicated by the X register (X register specifies the low-order address of the 2 words). The X register is incremented by 2 words.

Code:

Mnemonic	MSB												LSB	
RETD imm8	1	0	0	0	1	i7	i6	i5	i4	i3	i2	i1	i0	1100H–11FFH

Flags:

E	I	C	Z
↓	–	–	–

Mode: Immediate data
Extended addressing: Invalid

RETI

Return from interrupt routine ***2 cycles***

Function: PC ← ([SP1*4+3]~[SP1*4]), SP1 ← SP1 +1, F ← [SP2], SP2 ← SP2 +1
After executing the RET instruction, loads the 4-bit data that has been stored in the address indicated by the stack pointer SP2 into the F register, then increments the SP2. This instruction is used for returning from interrupt routines.

Code:

Mnemonic	MSB												LSB	
RETI	1	1	1	1	1	1	1	1	1	1	0	0	1	1FF9H

Flags:

E	I	C	Z
↕	↕	↕	↕

RETS — *Return and skip* — *2 cycles*

Function: PC ← ([SP1*4+3]~[SP1*4]), SP1 ← SP1 +1, PC ← PC + 1
After executing the RET instruction, increments the PC to skip 1 instruction immediately after the return.

Code:

Mnemonic	MSB												LSB	
RETS	1	1	1	1	1	1	1	1	1	1	0	1	1	1FFBH

Flags:

E	I	C	Z
↓	–	–	–

RL %r — *Rotate left r reg. with carry* — *1 cycle*

Function: C ← 3 2 1 0 ← r

Rotates the content of the r register (A or B) including the carry (C) to the left for 1 bit. The content of the C flag moves to bit 0 of the r register and bit 3 moves to the C flag.

Code:

Mnemonic	MSB												LSB	
RL %A	1	0	0	0	0	1	1	1	1	0	0	1	0	10F2H
RL %B	1	0	0	0	0	1	1	1	1	0	1	1	0	10F6H

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Register direct
Extended addressing: Invalid

RL [%ir] *Rotate left location [ir reg.] with carry* *2 cycles*

Function: C ◄ 3 2 1 0 ◄ [ir]

Rotates the content of the data memory addressed by the ir register (X or Y) including the carry (C) to the left for 1 bit. The content of the C flag moves to bit 0 of the data memory and bit 3 moves to the C flag.

Code:

Mnemonic	MSB												LSB	
RL [%X]	1	0	0	0	0	1	1	1	0	1	0	0	0	10E8H
RL [%Y]	1	0	0	0	0	1	1	1	0	1	0	1	0	10EAH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Register indirect
Extended addressing: Valid

Extended operation:

LDB %EXT,imm8
RL [%X] Rotates the content of [00imm8] (00imm8 = 0000H + 00H to FFH)

LDB %EXT,imm8
RL [%Y] Rotates the content of [FFimm8] (FFimm8 = FF00H + 00H to FFH)

RL [%ir]+ *Rotate left location [ir reg.] with carry and increment ir reg.* *2 cycles*

Function: C ◄ 3 2 1 0 ◄ [ir] , ir ← ir +1

Rotates the content of the data memory addressed by the ir register (X or Y) including the carry (C) to the left for 1 bit. The content of the C flag moves to bit 0 of the data memory and bit 3 moves to the C flag. Then increments the ir register (X or Y). The increment result of the ir register does not affect the flags.

Code:

Mnemonic	MSB												LSB	
RL [%X]+	1	0	0	0	0	1	1	1	0	1	0	0	1	10E9H
RL [%Y]+	1	0	0	0	0	1	1	1	0	1	0	1	1	10EBH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Register indirect
Extended addressing: Invalid

RR %r — *Rotate right r reg. with carry* — *1 cycle*

Function: 3 2 1 0 → C r

Rotates the content of the r register (A or B) including the carry (C) to the right for 1 bit. The content of the C flag moves to bit 3 of the r register and bit 0 moves to the C flag.

Code:

Mnemonic	MSB												LSB	
RR %A	1	0	0	0	0	1	1	1	1	0	0	1	1	10F3H
RR %B	1	0	0	0	0	1	1	1	1	0	1	1	1	10F7H

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Register direct
Extended addressing: Invalid

RR [%ir] — *Rotate right location [ir reg.] with carry* — *2 cycles*

Function: 3 2 1 0 → C [ir]

Rotates the content of the data memory addressed by the ir register (X or Y) including the carry (C) to the right for 1 bit. The content of the C flag moves to bit 3 of the data memory and bit 0 moves to the C flag.

Code:

Mnemonic	MSB												LSB	
RR [%X]	1	0	0	0	0	1	1	1	0	1	1	0	0	10ECH
RR [%Y]	1	0	0	0	0	1	1	1	0	1	1	1	0	10EEH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Register indirect
Extended addressing: Valid

Extended operation:

LDB	%EXT,imm8	
RR	[%X]	Rotates the content of [00imm8] (00imm8 = 0000H + 00H to FFH)
LDB	%EXT,imm8	
RR	[%Y]	Rotates the content of [FFimm8] (FFimm8 = FF00H + 00H to FFH)

RR [%ir]+ *Rotate right location [ir reg.] with carry and increment ir reg.* *2 cycles*

Function: → 3 2 1 0 → C [ir] , ir ← ir +1

Rotates the content of the data memory addressed by the ir register (X or Y) including the carry (C) to the right for 1 bit. The content of the C flag moves to bit 3 of the data memory and bit 0 moves to the C flag. Then increments the ir register (X or Y). The increment result of the ir register does not affect the flags.

Code:

Mnemonic	MSB												LSB	
RR [%X]+	1	0	0	0	0	1	1	1	0	1	1	0	1	10EDH
RR [%Y]+	1	0	0	0	0	1	1	1	0	1	1	1	1	10EFH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Register indirect
Extended addressing: Invalid

SBC %r,%r' *Subtract with carry r' reg. from r reg.* *1 cycle*

Function: r ← r - r' - C

Subtracts the content of the r' register (A or B) and carry (C) from the r register (A or B).

Code:

Mnemonic	MSB												LSB	
SBC %A,%A	1	1	0	0	0	1	1	1	1	0	0	0	X	18F0H, (18F1H)
SBC %A,%B	1	1	0	0	0	1	1	1	1	0	0	1	X	18F2H, (18F3H)
SBC %B,%A	1	1	0	0	0	1	1	1	1	0	1	0	X	18F4H, (18F5H)
SBC %B,%B	1	1	0	0	0	1	1	1	1	0	1	1	X	18F6H, (18F7H)

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Register direct
Dst: Register direct
Extended addressing: Invalid

SBC %r,imm4 — *Subtract with carry immediate data imm4 from r reg.* — *1 cycle*

Function: r ← r - imm4 - C
Subtracts the 4-bit immediate data imm4 and carry (C) from the r register (A or B).

Code:

Mnemonic	MSB												LSB	
SBC %A,imm4	1	1	0	0	0	1	1	0	0	i3	i2	i1	i0	18C0H–18CFH
SBC %B,imm4	1	1	0	0	0	1	1	0	1	i3	i2	i1	i0	18D0H–18DFH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Immediate data
Dst: Register direct
Extended addressing: Invalid

SBC %r,[%ir] — *Subtract with carry location [ir reg.] from r reg.* — *1 cycle*

Function: r ← r - [ir] - C
Subtracts the content of the data memory addressed by the ir register (X or Y) and carry (C) from the r register (A or B).

Code:

Mnemonic	MSB												LSB	
SBC %A,[%X]	1	1	0	0	0	1	1	1	0	0	0	0	0	18E0H
SBC %A,[%Y]	1	1	0	0	0	1	1	1	0	0	0	1	0	18E2H
SBC %B,[%X]	1	1	0	0	0	1	1	1	0	0	1	0	0	18E4H
SBC %B,[%Y]	1	1	0	0	0	1	1	1	0	0	1	1	0	18E6H

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Register indirect
Dst: Register direct
Extended addressing: Valid

Extended operation:

LDB %EXT,imm8
SBC %r,[%X] r ← r - [00imm8] - C (00imm8 = 0000H + 00H to FFH)

LDB %EXT,imm8
SBC %r,[%Y] r ← r - [FFimm8] - C (FFimm8 = FF00H + 00H to FFH)

SBC %r,[%ir]+

Subtract with carry location [ir reg.] from r reg. and increment ir reg. 1 cycle

Function: r ← r - [ir] - C, ir ← ir + 1

Subtracts the content of the data memory addressed by the ir register (X or Y) and carry (C) from the r register (A or B). Then increments the ir register (X or Y). The flags change due to the operation result of the r register and the increment result of the ir register does not affect the flags.

Code:

Mnemonic	MSB												LSB	
SBC %A,[%X]+	1	1	0	0	0	1	1	1	0	0	0	0	1	18E1H
SBC %A,[%Y]+	1	1	0	0	0	1	1	1	0	0	0	1	1	18E3H
SBC %B,[%X]+	1	1	0	0	0	1	1	1	0	0	1	0	1	18E5H
SBC %B,[%Y]+	1	1	0	0	0	1	1	1	0	0	1	1	1	18E7H

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Register indirect
Dst: Register direct
Extended addressing: Invalid

SBC [%ir],%r

Subtract with carry r reg. from location [ir reg.] 2 cycles

Function: [ir] ← [ir] - r - C

Subtracts the content of the r register (A or B) and carry (C) from the data memory addressed by the ir register (X or Y).

Code:

Mnemonic	MSB												LSB	
SBC [%X],%A	1	1	0	0	0	1	1	1	0	1	0	0	0	18E8H
SBC [%X],%B	1	1	0	0	0	1	1	1	0	1	1	0	0	18ECH
SBC [%Y],%A	1	1	0	0	0	1	1	1	0	1	0	1	0	18EAH
SBC [%Y],%B	1	1	0	0	0	1	1	1	0	1	1	1	0	18EEH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Register direct
Dst: Register indirect
Extended addressing: Valid

Extended operation:

LDB %EXT,imm8
SBC [%X],%r [00imm8] ← [00imm8] - r - C (00imm8 = 0000H + 00H to FFH)

LDB %EXT,imm8
SBC [%Y],%r [FFimm8] ← [FFimm8] - r - C (FFimm8 = FF00H + 00H to FFH)

SBC [%ir]+,%r

Subtract with carry r reg. from location [ir reg.] and increment ir reg.   2 cycles

Function: [ir] ← [ir] - r - C, ir ← ir + 1

Subtracts the content of the r register (A or B) and carry (C) from the data memory addressed by the ir register (X or Y). Then increments the ir register (X or Y). The flags change due to the operation result of the data memory and the increment result of the ir register does not affect the flags.

Code:

Mnemonic	MSB												LSB	
SBC [%X]+,%A	1	1	0	0	0	1	1	1	0	1	0	0	1	18E9H
SBC [%X]+,%B	1	1	0	0	0	1	1	1	0	1	1	0	1	18EDH
SBC [%Y]+,%A	1	1	0	0	0	1	1	1	0	1	0	1	1	18EBH
SBC [%Y]+,%B	1	1	0	0	0	1	1	1	0	1	1	1	1	18EFH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Register direct
Dst: Register indirect
Extended addressing: Invalid

SBC [%ir],imm4

Subtract with carry immediate data imm4 from location [ir reg.]   2 cycles

Function: [ir] ← [ir] - imm4 - C

Subtracts the 4-bit immediate data imm4 and carry (C) from the data memory addressed by the ir register (X or Y).

Code:

Mnemonic	MSB												LSB	
SBC [%X],imm4	1	1	0	0	0	1	0	0	0	i3	i2	i1	i0	1880H–188FH
SBC [%Y],imm4	1	1	0	0	0	1	0	1	0	i3	i2	i1	i0	18A0H–18AFH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Immediate data
Dst: Register indirect
Extended addressing: Valid

Extended operation:

LDB %EXT,imm8
SBC [%X],imm4   [00imm8] ← [00imm8] - imm4 - C (00imm8 = 0000H + 00H to FFH)

LDB %EXT,imm8
SBC [%Y],imm4   [FFimm8] ← [FFimm8] - imm4 - C (FFimm8 = FF00H + 00H to FFH)

SBC [%ir]+,imm4 *Subtract with carry immediate data imm4 from location [ir reg.] and increment ir reg. 2 cycles*

Function: [ir] ← [ir] - imm4 - C, ir ← ir + 1
Subtracts the immediate data imm4 and carry (C) from the data memory addressed by the ir register (X or Y). Then increments the ir register (X or Y). The flags change due to the operation result of the data memory and the increment result of the ir register does not affect the flags.

Code:

Mnemonic	MSB												LSB	
SBC [%X]+,imm4	1	1	0	0	0	1	0	0	1	i3	i2	i1	i0	1890H–189FH
SBC [%Y]+,imm4	1	1	0	0	0	1	0	1	1	i3	i2	i1	i0	18B0H–18BFH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Immediate data
Dst: Register indirect
Extended addressing: Invalid

SBC %B,%A,n4 *Subtract with carry A reg. from B reg. in specified radix* *2 cycles*

Function: B ← N's adjust (B - A - C)
Subtracts the content of the A register and carry (C) from the B register. The operation result is adjusted with n4 as the radix. The C flag is set according to the radix.

Code:

Mnemonic	MSB												LSB	
SBC %B,%A,n4	1	0	0	0	0	1	1	0	0	n3	n2	n1	n0	10C0H–10CFH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Register direct
Dst: Register direct
Extended addressing: Invalid

Note: n4 should be specified with a value from 1 to 16. When 16 is specified for n4, the low-order 4 bits of the machine code (n3–n0) become 0000B.

SBC %B,[%ir],n4 *Subtract with carry location [ir reg.] from B reg. in specified radix 2 cycles*

Function: B ← N's adjust (B - [ir] - C)

Subtracts the content of the data memory addressed by the ir register (X or Y) and carry (C) from the B register. The operation result is adjusted with n4 as the radix. The C flag is set according to the radix.

Code:

Mnemonic	MSB												LSB	
SBC %B,[%X],n4	1	1	1	0	0	1	1	0	0	n3	n2	n1	n0	1CC0H–1CCFH
SBC %B,[%Y],n4	1	1	1	0	0	1	1	1	0	n3	n2	n1	n0	1CE0H–1CEFH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Register indirect
Dst: Register direct
Extended addressing: Valid

Extended operation:

LDB %EXT,imm8
SBC %B,[%X],n4 B ← N's adjust (B - [00imm8] - C) (00imm8 = 0000H + 00H to FFH)

LDB %EXT,imm8
SBC %B,[%Y],n4 B ← N's adjust (B - [FFimm8] - C) (FFimm8 = FF00H + 00H to FFH)

Note: n4 should be specified with a value from 1 to 16. When 16 is specified for n4, the low-order 4 bits of the machine code (n3–n0) become 0000B.

SBC %B,[%ir]+,n4 *Subtract with carry location [ir reg.] from B reg. in specified radix and increment ir reg. 2 cycles*

Function: B ← N's adjust (B - [ir] - C), ir ← ir + 1

Subtracts the content of the data memory addressed by the ir register (X or Y) and carry (C) from the B register. The operation result is adjusted with n4 as the radix. Then increments the ir register (X or Y). The flags change due to the operation result of the B register and the increment result of the ir register does not affect the flags. The C flag is set according to the radix.

Code:

Mnemonic	MSB												LSB	
SBC %B,[%X]+,n4	1	1	1	0	0	1	1	0	1	n3	n2	n1	n0	1CD0H–1CDFH
SBC %B,[%Y]+,n4	1	1	1	0	0	1	1	1	1	n3	n2	n1	n0	1CF0H–1CFFH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Register indirect
Dst: Register direct
Extended addressing: Invalid

Note: n4 should be specified with a value from 1 to 16. When 16 is specified for n4, the low-order 4 bits of the machine code (n3–n0) become 0000B.

SBC [%ir],%B,n4 *Subtract with carry B reg. from location [ir reg.] in specified radix 2 cycles*

Function: [ir] ← N's adjust ([ir] - B - C)
Subtracts the content of the B register and carry (C) from the data memory addressed by the ir register (X or Y). The operation result is adjusted with n4 as the radix. The C flag is set according to the radix.

Code:

Mnemonic	MSB												LSB	
SBC [%X],%B,n4	1	1	1	0	0	0	1	0	0	n3	n2	n1	n0	1C40H–1C4FH
SBC [%Y],%B,n4	1	1	1	0	0	0	1	1	0	n3	n2	n1	n0	1C60H–1C6FH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Register direct
Dst: Register indirect
Extended addressing: Valid

Extended operation:
LDB %EXT,imm8
SBC [%X],%B,n4 [00imm8] ← N's adjust ([00imm8] - B - C) (00imm8 = 0000H + 00H to FFH)

LDB %EXT,imm8
SBC [%Y],%B,n4 [FFimm8] ← N's adjust ([FFimm8] - B - C) (FFimm8 = FF00H + 00H to FFH)

Note: n4 should be specified with a value from 1 to 16. When 16 is specified for n4, the low-order 4 bits of the machine code (n3–n0) become 0000B.

SBC [%ir]+,%B,n4 *Subtract with carry B reg. from location [ir reg.] in specified radix and increment ir reg. 2 cycles*

Function: [ir] ← N's adjust ([ir] - B - C), ir ← ir + 1
Subtracts the content of the B register and carry (C) from the data memory addressed by the ir register (X or Y). The operation result is adjusted with n4 as the radix. Then increments the ir register (X or Y). The flags change due to the operation result of the data memory and the increment result of the ir register does not affect the flags. The C flag is set according to the radix.

Code:

Mnemonic	MSB												LSB	
SBC [%X]+,%B,n4	1	1	1	0	0	0	1	0	1	n3	n2	n1	n0	1C50H–1C5FH
SBC [%Y]+,%B,n4	1	1	1	0	0	0	1	1	1	n3	n2	n1	n0	1C70H–1C7FH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Register direct
Dst: Register indirect
Extended addressing: Invalid

Note: n4 should be specified with a value from 1 to 16. When 16 is specified for n4, the low-order 4 bits of the machine code (n3–n0) become 0000B.

SBC [%ir],0,n4 — *Subtract carry from location [ir reg.] in specified radix* — *2 cycles*

Function: [ir] ← N's adjust ([ir] - 0 - C)

Subtracts the carry (C) from the data memory addressed by the ir register (X or Y). The operation result is adjusted with n4 as the radix. The C flag is set according to the radix. This instruction is useful for borrow processing of n based counters.

Code:

Mnemonic	MSB												LSB	
SBC [%X],0,n4	1	1	1	0	0	0	0	0	0	n3	n2	n1	n0	1C00H–1C0FH
SBC [%Y],0,n4	1	1	1	0	0	0	0	1	0	n3	n2	n1	n0	1C20H–1C2FH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Register direct
Dst: Register indirect
Extended addressing: Valid

Extended operation:

LDB %EXT,imm8
SBC [%X],0,n4 [00imm8] ← N's adjust ([00imm8] - 0 - C) (00imm8 = 0000H + 00H to FFH)

LDB %EXT,imm8
SBC [%Y],0,n4 [FFimm8] ← N's adjust ([FFimm8] - 0 - C) (FFimm8 = FF00H + 00H to FFH)

Note: n4 should be specified with a value from 1 to 16. When 16 is specified for n4, the low-order 4 bits of the machine code (n3–n0) become 0000B.

SBC [%ir]+,0,n4 — *Subtract carry from location [ir reg.] in specified radix and increment ir reg.* — *2 cycles*

Function: [ir] ← N's adjust ([ir] - 0 - C), ir ← ir + 1

Subtracts the carry (C) from the data memory addressed by the ir register (X or Y). The operation result is adjusted with n4 as the radix. Then increments the ir register (X or Y). The flags change due to the operation result of the data memory and the increment result of the ir register does not affect the flags. The C flag is set according to the radix. This instruction is useful for borrow processing of n based counters.

Code:

Mnemonic	MSB												LSB	
SBC [%X]+,0,n4	1	1	1	0	0	0	0	0	1	n3	n2	n1	n0	1C10H–1C1FH
SBC [%Y]+,0,n4	1	1	1	0	0	0	0	1	1	n3	n2	n1	n0	1C30H–1C3FH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Register direct
Dst: Register indirect
Extended addressing: Invalid

Note: n4 should be specified with a value from 1 to 16. When 16 is specified for n4, the low-order 4 bits of the machine code (n3–n0) become 0000B.

SET [addr6],imm2 *Set bit imm2 in location [addr6]* *2 cycles*

Function: [addr6] ← [addr6] ∨ (2^{imm2})
(addr6 = 0000H–003FH or FFC0H–FFFFH)
Sets the bit specified with the imm2 in the data memory specified with the addr6 to "1".

Code:

Mnemonic	MSB												LSB	
SET [00addr6],imm2	1	0	1	1	0	i1	i0	a5	a4	a3	a2	a1	a0	1600H–16FFH
SET [FFaddr6],imm2	1	0	1	1	1	i1	i0	a5	a4	a3	a2	a1	a0	1700H–17FFH

Flags:

E	I	C	Z
↓	–	–	↕

Mode: Src: Immediate data
Dst: 6-bit absolute
Extended addressing: Invalid

SLL %r *Shift left r reg. logical* *1 cycle*

Function: C ← 3 2 1 0 ← 0 r
Shifts the content of the r register (A or B) to the left for 1 bit. Bit 3 of the r register moves to the C flag and bit 0 goes "0".

Code:

Mnemonic	MSB												LSB	
SLL %A	1	0	0	0	0	1	1	1	1	0	0	0	0	10F0H
SLL %B	1	0	0	0	0	1	1	1	1	0	1	0	0	10F4H

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Register direct
Extended addressing: Invalid

SLL [%ir] *Shift left location [ir reg.] logical* *2 cycles*

Function: $\boxed{C} \leftarrow \boxed{3|2|1|0} \leftarrow 0$ [ir]

Shifts the content of the data memory addressed by the ir register (X or Y) to the left for 1 bit. Bit 3 of the r register moves to the C flag and bit 0 goes "0".

Code:

Mnemonic	MSB												LSB	
SLL [%X]	1	0	0	0	0	1	1	1	0	0	0	0	0	10E0H
SLL [%Y]	1	0	0	0	0	1	1	1	0	0	0	1	0	10E2H

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Register indirect
Extended addressing: Valid

Extended operation:

LDB %EXT,imm8
SLL [%X] Shifts the content of [00imm8] (00imm8 = 0000H + 00H to FFH)

LDB %EXT,imm8
SLL [%Y] Shifts the content of [FFimm8] (FFimm8 = FF00H + 00H to FFH)

SLL [%ir]+ *Shift left location [ir reg.] logical and increment ir reg.* *2 cycles*

Function: $\boxed{C} \leftarrow \boxed{3|2|1|0} \leftarrow 0$ [ir], ir ← ir + 1

Shifts the content of the data memory addressed by the ir register (X or Y) to the left for 1 bit. Bit 3 of the r register moves to the C flag and bit 0 goes "0". Then increments the ir register (X or Y). The increment result of the ir register does not affect the flags.

Code:

Mnemonic	MSB												LSB	
SLL [%X]+	1	0	0	0	0	1	1	1	0	0	0	0	1	10E1H
SLL [%Y]+	1	0	0	0	0	1	1	1	0	0	0	1	1	10E3H

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Register indirect
Extended addressing: Invalid

SLP *Set CPU to SLEEP mode* *2 cycles*

Function: Sleep

Sets the CPU to SLEEP status.

The CPU and the peripheral circuits including the oscillation circuit stops operating, thus the power consumption is substantially reduced.

An interrupt from outside the MCU causes it to return from SLEEP status to the normal program execution status.

Code:

Mnemonic	MSB												LSB	
SLP	1	1	1	1	1	1	1	1	1	1	1	0	1	1FFDH

Flags:

E	I	C	Z
↓	–	–	–

SRL %r *Shift right r reg. logical* *1 cycle*

Function: 0 → [3|2|1|0] → [C] r

Shifts the content of the r register (A or B) to the right for 1 bit. Bit 0 of the r register moves to the C flag and bit 3 goes "0".

Code:

Mnemonic	MSB												LSB	
SRL %A	1	0	0	0	0	1	1	1	1	0	0	0	1	10F1H
SRL %B	1	0	0	0	0	1	1	1	1	0	1	0	1	10F5H

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Register direct

Extended addressing: Invalid

SRL [%ir] *Shift right location [ir reg.] logical* *2 cycles*

Function: 0 → [3|2|1|0] → [C] [ir]

Shifts the content of the data memory addressed by the ir register (X or Y) to the right for 1 bit. Bit 0 of the r register moves to the C flag and bit 3 goes "0".

Code:

Mnemonic	MSB												LSB	
SRL [%X]	1	0	0	0	0	1	1	1	0	0	1	0	0	10E4H
SRL [%Y]	1	0	0	0	0	1	1	1	0	0	1	1	0	10E6H

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Register indirect
Extended addressing: Valid

Extended operation:

LDB %EXT,imm8
SRL [%X] Shifts the content of [00imm8] (00imm8 = 0000H + 00H to FFH)

LDB %EXT,imm8
SRL [%Y] Shifts the content of [FFimm8] (FFimm8 = FF00H + 00H to FFH)

SRL [%ir]+ *Shift right location [ir reg.] logical and increment ir reg.* *2 cycles*

Function: 0 → [3|2|1|0] → [C] [ir] , ir ← ir + 1

Shifts the content of the data memory addressed by the ir register (X or Y) to the right for 1 bit. Bit 0 of the r register moves to the C flag and bit 3 goes "0". Then increments the ir register (X or Y). The increment result of the ir register does not affect the flags.

Code:

Mnemonic	MSB												LSB	
SRL [%X]+	1	0	0	0	0	1	1	1	0	0	1	0	1	10E5H
SRL [%Y]+	1	0	0	0	0	1	1	1	0	0	1	1	1	10E7H

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Register indirect
Extended addressing: Invalid

SUB %r,%r' *Subtract r' reg. from r reg.* *1 cycle*

Function: r ← r - r'
Subtracts the content of the r' register (A or B) from the r register (A or B).

Code:

Mnemonic	MSB												LSB	
SUB %A,%A	1	1	0	0	0	0	1	1	1	0	0	0	X	1870H, (1871H)
SUB %A,%B	1	1	0	0	0	0	1	1	1	0	0	1	X	1872H, (1873H)
SUB %B,%A	1	1	0	0	0	0	1	1	1	0	1	0	X	1874H, (1875H)
SUB %B,%B	1	1	0	0	0	0	1	1	1	0	1	1	X	1876H, (1877H)

Flags:

E	I	C	Z	
↓	–	↕	↕	(r ≠ r')
↓	–	↓	↑	(r = r')

Mode: Src: Register direct
Dst: Register direct
Extended addressing: Invalid

SUB %r,imm4 *Subtract immediate data imm4 from r reg.* *1 cycle*

Function: r ← r - imm4
Subtracts the 4-bit immediate data imm4 from the r register (A or B).

Code:

Mnemonic	MSB												LSB	
SUB %A,imm4	1	1	0	0	0	0	1	0	0	i3	i2	i1	i0	1840H–184FH
SUB %B,imm4	1	1	0	0	0	0	1	0	1	i3	i2	i1	i0	1850H–185FH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Immediate data
Dst: Register direct
Extended addressing: Invalid

SUB %r,[%ir]

Subtract location [ir reg.] from r reg. ***1 cycle***

Function: r ← r - [ir]
Subtracts the content of the data memory addressed by the ir register (X or Y) from the r register (A or B).

Code:

Mnemonic	MSB												LSB	
SUB %A,[%X]	1	1	0	0	0	0	1	1	0	0	0	0	0	1860H
SUB %A,[%Y]	1	1	0	0	0	0	1	1	0	0	0	1	0	1862H
SUB %B,[%X]	1	1	0	0	0	0	1	1	0	0	1	0	0	1864H
SUB %B,[%Y]	1	1	0	0	0	0	1	1	0	0	1	1	0	1866H

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Register indirect
Dst: Register direct
Extended addressing: Valid

Extended operation:

LDB %EXT,imm8
SUB %r,[%X] r ← r - [00imm8] (00imm8 = 0000H + 00H to FFH)

LDB %EXT,imm8
SUB %r,[%Y] r ← r - [FFimm8] (FFimm8 = FF00H + 00H to FFH)

SUB %r,[%ir]+

Subtract location [ir reg.] from r reg. and increment ir reg. ***1 cycle***

Function: r ← r - [ir], ir ← ir + 1
Subtracts the content of the data memory addressed by the ir register (X or Y) from the r register (A or B). Then increments the ir register (X or Y). The flags change due to the operation result of the r register and the increment result of the ir register does not affect the flags.

Code:

Mnemonic	MSB												LSB	
SUB %A,[%X]+	1	1	0	0	0	0	1	1	0	0	0	0	1	1861H
SUB %A,[%Y]+	1	1	0	0	0	0	1	1	0	0	0	1	1	1863H
SUB %B,[%X]+	1	1	0	0	0	0	1	1	0	0	1	0	1	1865H
SUB %B,[%Y]+	1	1	0	0	0	0	1	1	0	0	1	1	1	1867H

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Register indirect
Dst: Register direct
Extended addressing: Invalid

SUB [%ir],%r — *Subtract r reg. from location [ir reg.]* — *2 cycles*

Function: [ir] ← [ir] - r

Subtracts the content of the r register (A or B) from the data memory addressed by the ir register (X or Y).

Code:

Mnemonic	MSB												LSB	
SUB [%X],%A	1	1	0	0	0	0	1	1	0	1	0	0	0	1868H
SUB [%X],%B	1	1	0	0	0	0	1	1	0	1	1	0	0	186CH
SUB [%Y],%A	1	1	0	0	0	0	1	1	0	1	0	1	0	186AH
SUB [%Y],%B	1	1	0	0	0	0	1	1	0	1	1	1	0	186EH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Register direct
Dst: Register indirect
Extended addressing: Valid

Extended operation:

LDB %EXT,imm8
SUB [%X],%r — [00imm8] ← [00imm8] - r (00imm8 = 0000H + 00H to FFH)

LDB %EXT,imm8
SUB [%Y],%r — [FFimm8] ← [FFimm8] - r (FFimm8 = FF00H + 00H to FFH)

SUB [%ir]+,%r — *Subtract r reg. from location [ir reg.] and increment ir reg.* — *2 cycles*

Function: [ir] ← [ir] - r, ir ← ir + 1

Subtracts the content of the r register (A or B) from the data memory addressed by the ir register (X or Y). Then increments the ir register (X or Y). The flags change due to the operation result of the data memory and the increment result of the ir register does not affect the flags.

Code:

Mnemonic	MSB												LSB	
SUB [%X]+,%A	1	1	0	0	0	0	1	1	0	1	0	0	1	1869H
SUB [%X]+,%B	1	1	0	0	0	0	1	1	0	1	1	0	1	186DH
SUB [%Y]+,%A	1	1	0	0	0	0	1	1	0	1	0	1	1	186BH
SUB [%Y]+,%B	1	1	0	0	0	0	1	1	0	1	1	1	1	186FH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Register direct
Dst: Register indirect
Extended addressing: Invalid

SUB [%ir],imm4 *Subtract immediate data imm4 from location [ir reg.]* *2 cycles*

Function: [ir] ← [ir] - imm4

Subtracts the 4-bit immediate data imm4 from the data memory addressed by the ir register (X or Y).

Code:

Mnemonic	MSB												LSB	
SUB [%X],imm4	1	1	0	0	0	0	0	0	0	i3	i2	i1	i0	1800H–180FH
SUB [%Y],imm4	1	1	0	0	0	0	0	1	0	i3	i2	i1	i0	1820H–182FH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Immediate data

Dst: Register indirect

Extended addressing: Valid

Extended operation:

LDB %EXT,imm8
SUB [%X],imm4 [00imm8] ← [00imm8] - imm4 (00imm8 = 0000H + 00H to FFH)

LDB %EXT,imm8
SUB [%Y],imm4 [FFimm8] ← [FFimm8] - imm4 (FFimm8 = FF00H + 00H to FFH)

SUB [%ir]+,imm4 *Subtract immediate data imm4 from location [ir reg.] and increment ir reg.* *2 cycles*

Function: [ir] ← [ir] - imm4, ir ← ir + 1

Subtracts the 4-bit immediate data imm4 from the data memory addressed by the ir register (X or Y). Then increments the ir register (X or Y). The flags change due to the operation result of the data memory and the increment result of the ir register does not affect the flags.

Code:

Mnemonic	MSB												LSB	
SUB [%X]+,imm4	1	1	0	0	0	0	0	0	1	i3	i2	i1	i0	1810H–181FH
SUB [%Y]+,imm4	1	1	0	0	0	0	0	1	1	i3	i2	i1	i0	1830H–183FH

Flags:

E	I	C	Z
↓	–	↕	↕

Mode: Src: Immediate data

Dst: Register indirect

Extended addressing: Invalid

TST [addr6],imm2 *Test bit imm2 in location [addr6]* *1 cycle*

Function: [addr6] $\vee$ (2^{imm2})

(addr6 = 0000H–003FH or FFC0H–FFFFH)

Tests the bit specified with the imm2 in the data memory specified with the addr6, and sets/resets the Z flag. It does not change the content of the data memory.

Code:

Mnemonic	MSB												LSB	
TST [00addr6],imm2	1	0	0	1	0	i1	i0	a5	a4	a3	a2	a1	a0	1200H–12FFH
TST [FFaddr6],imm2	1	0	0	1	1	i1	i0	a5	a4	a3	a2	a1	a0	1300H–13FFH

Flags:

E	I	C	Z
↓	–	–	↕

Mode: Src: Immediate data

Dst: 6-bit absolute

Extended addressing: Invalid

XOR %r,%r' *Exclusive OR r' reg. and r reg.* *1 cycle*

Function: r ← r ∀ r'

Performs an exclusive OR operation of the content of the r' register (A or B) and the content of the r register (A or B), and stores the result in the r register.

Code:

Mnemonic	MSB												LSB	
XOR %A,%A	1	1	0	1	1	1	1	1	1	0	0	0	X	1BF0H, (1BF1H)
XOR %A,%B	1	1	0	1	1	1	1	1	1	0	0	1	X	1BF2H, (1BF3H)
XOR %B,%A	1	1	0	1	1	1	1	1	1	0	1	0	X	1BF4H, (1BF5H)
XOR %B,%B	1	1	0	1	1	1	1	1	1	0	1	1	X	1BF6H, (1BF7H)

Flags:

E	I	C	Z	
↓	–	–	↕	(r ≠ r')
↓	–	–	↑	(r = r')

Mode: Src: Register direct

Dst: Register direct

Extended addressing: Invalid

XOR %r,imm4 — *Exclusive OR immediate data imm4 and r reg.* — *1 cycle*

Function: r ← r ∀ imm4

Performs an exclusive OR operation of the 4-bit immediate data imm4 and the content of the r register (A or B), and stores the result in the r register.

Code:

Mnemonic	MSB												LSB	
XOR %A,imm4	1	1	0	1	1	1	1	0	0	i3	i2	i1	i0	1BC0H–1BCFH
XOR %B,imm4	1	1	0	1	1	1	1	0	1	i3	i2	i1	i0	1BD0H–1BDFH

Flags:

E	I	C	Z
↓	–	–	↕

Mode: Src: Immediate data
Dst: Register direct
Extended addressing: Invalid

XOR %F,imm4 — *Exclusive OR immediate data imm4 and F reg.* — *1 cycle*

Function: F ← F ∀ imm4

Performs an exclusive OR operation of the 4-bit immediate data imm4 and the content of the F (flag) register, and stores the result in the r register. It is possible to set / reset any flag.

Code:

Mnemonic	MSB												LSB	
XOR %F,imm4	1	0	0	0	0	1	0	1	0	i3	i2	i1	i0	10A0H–10AFH

Flags:

E	I	C	Z
↕	↕	↕	↕

Mode: Src: Immediate data
Dst: Register direct
Extended addressing: Invalid

XOR %r,[%ir] *Exclusive OR location [ir reg.] and r reg.* *1 cycle*

Function: r ← r ∀ [ir]

Performs an exclusive OR operation of the content of the data memory addressed by the ir register (X or Y) and the content of the r register (A or B), and stores the result in the r register.

Code:

Mnemonic	MSB												LSB	
XOR %A,[%X]	1	1	0	1	1	1	1	1	0	0	0	0	0	1BE0H
XOR %A,[%Y]	1	1	0	1	1	1	1	1	0	0	0	1	0	1BE2H
XOR %B,[%X]	1	1	0	1	1	1	1	1	0	0	1	0	0	1BE4H
XOR %B,[%Y]	1	1	0	1	1	1	1	1	0	0	1	1	0	1BE6H

Flags:

E	I	C	Z
↓	–	–	↕

Mode: Src: Register indirect
Dst: Register direct
Extended addressing: Valid

Extended operation:

LDB %EXT,imm8
XOR %r,[%X] r ← r ∀ [00imm8] (00imm8 = 0000H + 00H to FFH)

LDB %EXT,imm8
XOR %r,[%Y] r ← r ∀ [FFimm8] (FFimm8 = FF00H + 00H to FFH)

XOR %r,[%ir]+ *Exclusive OR location [ir reg.] and r reg. and increment ir reg.* *1 cycle*

Function: r ← r ∀ [ir], ir ← ir + 1

Performs an exclusive OR operation of the content of the data memory addressed by the ir register (X or Y) and the content of the r register (A or B), and stores the result in the r register. Then increments the ir register (X or Y). The flags change due to the operation result of the r register and the increment result of the ir register does not affect the flags.

Code:

Mnemonic	MSB												LSB	
XOR %A,[%X]+	1	1	0	1	1	1	1	1	0	0	0	0	1	1BE1H
XOR %A,[%Y]+	1	1	0	1	1	1	1	1	0	0	0	1	1	1BE3H
XOR %B,[%X]+	1	1	0	1	1	1	1	1	0	0	1	0	1	1BE5H
XOR %B,[%Y]+	1	1	0	1	1	1	1	1	0	0	1	1	1	1BE7H

Flags:

E	I	C	Z
↓	–	–	↕

Mode: Src: Register indirect
Dst: Register direct
Extended addressing: Invalid

XOR [%ir],%r — *Exclusive OR r reg. and location [ir reg.]* — *2 cycles*

Function: [ir] ← [ir] ∀ r
Performs an exclusive OR operation of the content of the r register (A or B) and the content of the data memory addressed by the ir register (X or Y), and stores the result in that address.

Code:

Mnemonic	MSB												LSB	
XOR [%X],%A	1	1	0	1	1	1	1	1	0	1	0	0	0	1BE8H
XOR [%X],%B	1	1	0	1	1	1	1	1	0	1	1	0	0	1BECH
XOR [%Y],%A	1	1	0	1	1	1	1	1	0	1	0	1	0	1BEAH
XOR [%Y],%B	1	1	0	1	1	1	1	1	0	1	1	1	0	1BEEH

Flags:

E	I	C	Z
↓	–	–	↕

Mode: Src: Register direct
Dst: Register indirect
Extended addressing: Valid

Extended operation:

LDB %EXT,imm8
XOR [%X],%r   [00imm8] ← [00imm8] ∀ r (00imm8 = 0000H + 00H to FFH)

LDB %EXT,imm8
XOR [%Y],%r   [FFimm8] ← [FFimm8] ∀ r (FFimm8 = FF00H + 00H to FFH)

XOR [%ir]+,%r — *Exclusive OR r reg. and location [ir reg.] and increment ir reg.* — *2 cycles*

Function: [ir] ← [ir] ∀ r, ir ← ir + 1
Performs an exclusive OR operation of the content of the r register (A or B) and the content of the data memory addressed by the ir register (X or Y), and stores the result in that address. Then increments the ir register (X or Y). The flags change due to the operation result of the data memory and the increment result of the ir register does not affect the flags.

Code:

Mnemonic	MSB												LSB	
XOR [%X]+,%A	1	1	0	1	1	1	1	1	0	1	0	0	1	1BE9H
XOR [%X]+,%B	1	1	0	1	1	1	1	1	0	1	1	0	1	1BEDH
XOR [%Y]+,%A	1	1	0	1	1	1	1	1	0	1	0	1	1	1BEBH
XOR [%Y]+,%B	1	1	0	1	1	1	1	1	0	1	1	1	1	1BEFH

Flags:

E	I	C	Z
↓	–	–	↕

Mode: Src: Register direct
Dst: Register indirect
Extended addressing: Invalid

XOR [%ir],imm4 *Exclusive OR immediate data imm4 and location [ir reg.]* *2 cycles*

Function: [ir] ← [ir] ∀ imm4

Performs an exclusive OR operation of the 4-bit immediate data imm4 and the content of the data memory addressed by the ir register (X or Y), and stores the result in that address.

Code:

Mnemonic	MSB												LSB	
XOR [%X],imm4	1	1	0	1	1	1	0	0	0	i3	i2	i1	i0	1B80H–1B8FH
XOR [%Y],imm4	1	1	0	1	1	1	0	1	0	i3	i2	i1	i0	1BA0H–1BAFH

Flags:

E	I	C	Z
↓	–	–	↕

Mode: Src: Immediate data
Dst: Register indirect
Extended addressing: Valid

Extended operation:

LDB	%EXT,imm8	
XOR	[%X],imm4	[00imm8] ← [00imm8] ∀ imm4 (00imm8 = 0000H + 00H to FFH)
LDB	%EXT,imm8	
XOR	[%Y],imm4	[FFimm8] ← [FFimm8] ∀ imm4 (FFimm8 = FF00H + 00H to FFH)

XOR [%ir]+,imm4 *Exclusive OR immediate data imm4 and location [ir reg.] and increment ir reg.* *2 cycles*

Function: [ir] ← [ir] ∀ imm4, ir ← ir + 1

Performs an exclusive OR operation of the 4-bit immediate data imm4 and the content of the data memory addressed by the ir register (X or Y), and stores the result in that address. Then increments the ir register (X or Y). The flags change due to the operation result of the data memory and the increment result of the ir register does not affect the flags.

Code:

Mnemonic	MSB												LSB	
XOR [%X]+,imm4	1	1	0	1	1	1	0	0	1	i3	i2	i1	i0	1B90H–1B9FH
XOR [%Y]+,imm4	1	1	0	1	1	1	0	1	1	i3	i2	i1	i0	1BB0H–1BBFH

Flags:

E	I	C	Z
↓	–	–	↕

Mode: Src: Immediate data
Dst: Register indirect
Extended addressing: Invalid

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