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April 1st, 2010
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User's Manual

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R8C/Tiny Series

Software Manual

RENESAS 16-BIT SINGLE-CHIP
MICROCOMPUTER

Renesas Electronics
www.renesas.com

Rev.2.00 2005.10

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Using This Manual

This software manual is written for the R8C/Tiny Series. It applies to all microcomputers integrating the R8C/Tiny Series CPU core.
The reader of this manual is assumed to have a basic knowledge of electrical circuits, logic circuits, and microcomputers.
This manual consists of six chapters. The chapters and the subjects they cover are listed below.

This manual also contains quick reference sections immediately following the table of contents. These quick reference sections can be used to rapidly find the pages referring to specific functions, instruction codes, and cycle counts.

A Q&A table, symbols, a glossary, and an index are appended at the end of this manual.

M16C Family Documents

The following documents were prepared for the M16C family. (1)

Document	Contents
Short Sheet	Hardware overview
Data Sheet	Hardware overview and electrical characteristics
Hardware Manual	Hardware specifications (pin assignments, memory maps, peripheral specifications, electrical characteristics, timing charts). *Refer to the application note for how to use peripheral functions.
Software Manual	Detailed description of assembly instructions and microcomputer performance of each instruction
Application Note	• Usage and application examples of peripheral functions • Sample programs • Introduction to the basic functions in the M16C family • Programming method with Assembly and C languages
RENESAS TECHNICAL UPDATE	Preliminary report about the specification of a product, a document, etc.

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Quick Reference in Alphabetic Order

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Quick Reference by Function

Function	Mnemonic	Description	Page No. for Function	Page No. for Instruction Code /No. of Cycles
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Quick Reference by Function

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	EXTS	Extend sign	74	178
	INC	Increment	77	180
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	MULU	Unsigned multiply	95	205
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	SBB	Subtract with borrow	114	222
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	LDC	Transfer to control register	85	189
	LDCTX	Restore context	86	189
	LDINTB	Transfer to INTB register	88	192

Quick Reference by Function

Function	Mnemonic	Description	Page No. for Function	Page No. for Instruction Code /No. of Cycles
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	NOP	No operation	97	207
	POPC	Restore control register	102	213
	PUSHC	Save control register	106	216
	REIT	Return from interrupt	108	216
	STC	Transfer from control register	121	232
	STCTX	Save context	122	233
	UND	Interrupt for undefined instruction	130	241
	WAIT	Wait	131	241

Quick Reference by Addressing Mode (General Instruction Addressing)

Mnemonic	Addressing Mode															Page No. for Function	Page No. for Instruction Code /No. of Cycles
	R0L/R0	R0H/R1	R1L/R2	R1H/R3	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16	#IMM8	#IMM16	#IMM20	#IMM		
ABS	○	○	○	○	○	○	○	○	○	○	○					39	138
ADC	○	○	○	○	○	○	○	○	○	○	○	○	○			40	138
ADCF	○	○	○	○	○	○	○	○	○	○	○					41	140
ADD*1	○	○	○	○	○	○	○	○	○	○	○	○	○			42	140
ADJNZ*1	○	○	○	○	○	○	○	○	○	○	○				○	44	146
AND	○	○	○	○	○	○	○	○	○	○	○	○	○			45	147
CMP	○	○	○	○	○	○	○	○	○	○	○	○	○			62	161
DADC	○	○										○	○			64	165
DADD	○	○										○	○			65	167
DEC	○	○			○			○			○					66	169
DIV	○	○	○	○	○	○	○	○	○	○	○	○	○			67	170
DIVU	○	○	○	○	○	○	○	○	○	○	○	○	○			68	171
DIVX	○	○	○	○	○	○	○	○	○	○	○	○	○			69	172
DSBB	○	○										○	○			70	173
DSUB	○	○										○	○			71	175
ENTER												○				72	177
EXTS	○		○*2			○	○	○	○	○	○					74	178
INC	○*3	○*4			○			○			○					77	180
INT															○	78	181
JMPI*1	○	○	○	○	○	○	○	○		○	○					82	185
JSRI*1	○	○	○	○	○	○	○	○		○	○					83	187
LDC*1	○	○	○	○	○	○	○	○	○	○	○		○			85	189
LDE*1	○	○	○	○	○	○	○	○	○	○	○					87	191
LDINTB														○		88	192
LDIPL															○	89	193

*1 Has special instruction addressing.

*2 Only R1L can be selected.

*3 Only R0L can be selected.

*4 Only R0H can be selected.

Quick Reference by Addressing Mode (General Instruction Addressing)

Mnemonic	Addressing Mode															Page No. for Function	Page No. for Instruction Code /No. of Cycles
	R0L/R0	R0H/R1	R1L/R2	R1H/R3	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16	#IMM8	#IMM16	#IMM20	#IMM		
MOV*1	○	○	○	○	○	○	○	○	○	○	○	○	○			90	193
MOVA	○	○	○	○	○		○	○	○	○	○					92	200
MOV*Dir*	○	○	○	○		○	○	○	○	○	○					93	201
MUL	○	○	○	○	○	○	○	○	○	○	○	○	○			94	203
MULU	○	○	○	○	○	○	○	○	○	○	○	○	○			95	205
NEG	○	○	○	○	○	○	○	○	○	○	○					96	207
NOT	○	○	○	○	○	○	○	○	○	○	○					98	208
OR	○	○	○	○	○	○	○	○	○	○	○	○	○			99	209
POP	○	○	○	○	○	○	○	○	○	○	○					101	211
POPM*1	○	○	○	○	○											103	213
PUSH	○	○	○	○	○	○	○	○	○	○	○					104	214
PUSHA							○	○	○	○	○					105	216
PUSHM*1	○	○	○	○	○											107	217
ROLC	○	○	○	○	○	○	○	○	○	○	○					110	218
RORC	○	○	○	○	○	○	○	○	○	○	○					111	219
ROT	○	○	○	○	○	○	○	○	○	○	○				○	112	220
SBB	○	○	○	○	○	○	○	○	○	○	○	○	○			114	222
SBJNZ*1	○	○	○	○	○	○	○	○	○	○	○				○	115	224
SHA*1	○	○	○	○	○	○	○	○	○	○	○				○	116	225
SHL*1	○	○	○	○	○	○	○	○	○	○	○				○	117	228
STC*1	○	○	○	○	○	○	○	○	○	○	○					121	232
STCTX*1											○					122	233
STE*1	○	○	○	○	○	○	○	○	○	○	○					123	233
STNZ	○	○						○			○	○				124	235
STZ	○	○						○			○	○				125	235

*1 Has special instruction addressing.

Quick Reference by Addressing Mode (General Instruction Addressing)

Mnemonic	Addressing Mode															Page No. for Function	Page No. for Instruction Code /No. of Cycles
	R0L/R0	R0H/R1	R1L/R2	R1H/R3	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16	#IMM8	#IMM16	#IMM20	#IMM		
STZX	○	○						○			○	○				126	236
SUB	○	○	○	○	○	○	○	○	○	○	○	○	○			127	236
TST	○	○	○	○	○	○	○	○	○	○	○	○	○			129	239
XCHG	○	○	○	○	○	○	○	○	○	○	○					132	242
XOR	○	○	○	○	○	○	○	○	○	○	○	○	○			133	243

Quick Reference by Addressing Mode (Special Instruction Addressing)

Mnemonic	Addressing Mode													Page No. for Function	Page No. for Instruction Code /No. of Cycles
	dsp:20[A0]	dsp:20[A1]	abs20	R2R0/R3R1	A1A0	[A1A0]	dsp:8[SP]	label	SB/FB	ISP/USP	FLG	INTBL/INTBH	PC		
ADD*1										○				42	140
ADJNZ*1								○						44	146
JCnd								○						80	182
JMP			○					○						81	184
JMPI*1	○	○		○	○									82	185
JSR			○					○						83	187
JSRI*1	○	○		○	○									84	188
LDC*1									○	○	○	○		85	189
LDCTX			○											86	189
LDE*1	○		○			○								87	191
LDINTB												○*2		88	192
MOV*1							○							90	193
POPC									○	○	○	○		102	213
POPM*1									○					103	213
PUSHC									○	○	○	○		106	216
PUSHM*1									○					107	217
SBJNZ*1								○						115	224
SHA*1				○										116	225
SHL*1				○										117	228
STC*1				○	○				○	○	○	○	○	121	232
STCTX*1			○											122	233
STE*1	○		○			○								123	233

*1 Has general instruction addressing.

*2 INTBL and INTBH can be set simultaneously when using the LDINTB instruction.

Quick Reference by Addressing Mode (Bit Instruction Addressing)

Mnemonic	Addressing Mode										Page No. for Function	Page No. for Instruction Code /No. of Cycles
	bit,Rn	bit,An	[An]	base:8[An]	bit,base:8[SB/FB]	base:16[An]	bit,base:16[SB]	bit,base:16	bit,base:11	U/I/O/B/S/Z/D/C		
BAND	○	○	○	○	○	○	○	○			47	150
BCLR	○	○	○	○	○	○	○	○	○		48	150
BM*Cnd*	○	○	○	○	○	○	○	○		○	49	152
BNAND	○	○	○	○	○	○	○	○			50	153
BNOR	○	○	○	○	○	○	○	○			21	154
BNOT	○	○	○	○	○	○	○	○	○		52	154
BNTST	○	○	○	○	○	○	○	○			53	155
BNXOR	○	○	○	○	○	○	○	○			54	156
BOR	○	○	○	○	○	○	○	○			55	156
BSET	○	○	○	○	○	○	○	○	○		57	157
BTST	○	○	○	○	○	○	○	○	○		58	158
BTSTC	○	○	○	○	○	○	○	○			59	159
BTSTS	○	○	○	○	○	○	○	○			60	160
BXOR	○	○	○	○	○	○	○	○			61	160
FCLR										○	75	179
FSET										○	76	180

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Chapter 1

Overview

1.1 Features of R8C/Tiny Series

The R8C/Tiny Series of single-chip microcomputers was developed for embedded applications.
The R8C/Tiny Series supports instructions tailored for the C language, with frequently used instructions implemented in one-byte op-code. It thus allows development of efficient programs with reduced memory requirements when using either assembly language or C. Furthermore, some instructions can be executed in a single clock cycle, enabling fast arithmetic processing.

The instruction set comprises 89 discrete instructions matched to the R8C's many addressing modes. This powerful instruction set provides support for register-register, register-memory, and memory-memory operations, as well as arithmetic/logic operations using single-bit and 4-bit data.
Some R8C/Tiny Series models incorporate an on-chip multiplier, allowing for high-speed computation.

1.1.1 Features of R8C/Tiny Series

●Register configuration

Data registers: Four 16-bit registers (of which two can be used as 8-bit registers)
Address registers: Two 16-bit registers
Base registers: Two 16-bit registers

●Versatile instruction set

Instructions suited to C language (stack frame manipulation): ENTER, EXITD, etc.
Instructions that do not discriminate by register or memory area MOV, ADD, SUB, etc.
Powerful bit manipulation instructions: BNOT, BTST, BSET, etc.
4-bit transfer instructions: MOVLL, MOVHL, etc.
Frequently used 1-byte instructions: MOV, ADD, SUB, JMP, etc.
High-speed 1-cycle instructions: MOV, ADD, SUB, etc.

●Fast instruction execution time

Minimum 1-cycle instructions: Of 89 instructions, 20 are 1-cycle instructions. (Approximately 75% of instructions execute in five cycles or fewer.)

1.1.2 Speed Performance

Register-register transfer 2 cycles
Register-memory transfer 2 cycles
Register-register addition/subtraction 2 cycles
8 bits x 8 bits register-register operation 4 cycles
16 bits x 16 bits register-register operation 5 cycles
16 bits / 8 bits register-register operation 18 cycles
32 bits / 16 bits register-register operation 25 cycles

1.2 Address Space

Figure 1.2.1 shows the address space.

Addresses 00000_{16} through $002FF_{16}$ make up an SFR (special function register) area. In some models in the R8C/Tiny Series, the SFR area extends from $002FF_{16}$ to lower addresses.

Addresses from 00400_{16} and below make up the memory area. In some models in the R8C/Tiny Series, the RAM area extends from address 00400_{16} to higher addresses, and the ROM area extends from $0FFFF_{16}$ to lower addresses. Addresses $0FFDC_{16}$ through $0FFFF_{16}$ make up a fixed vector area.

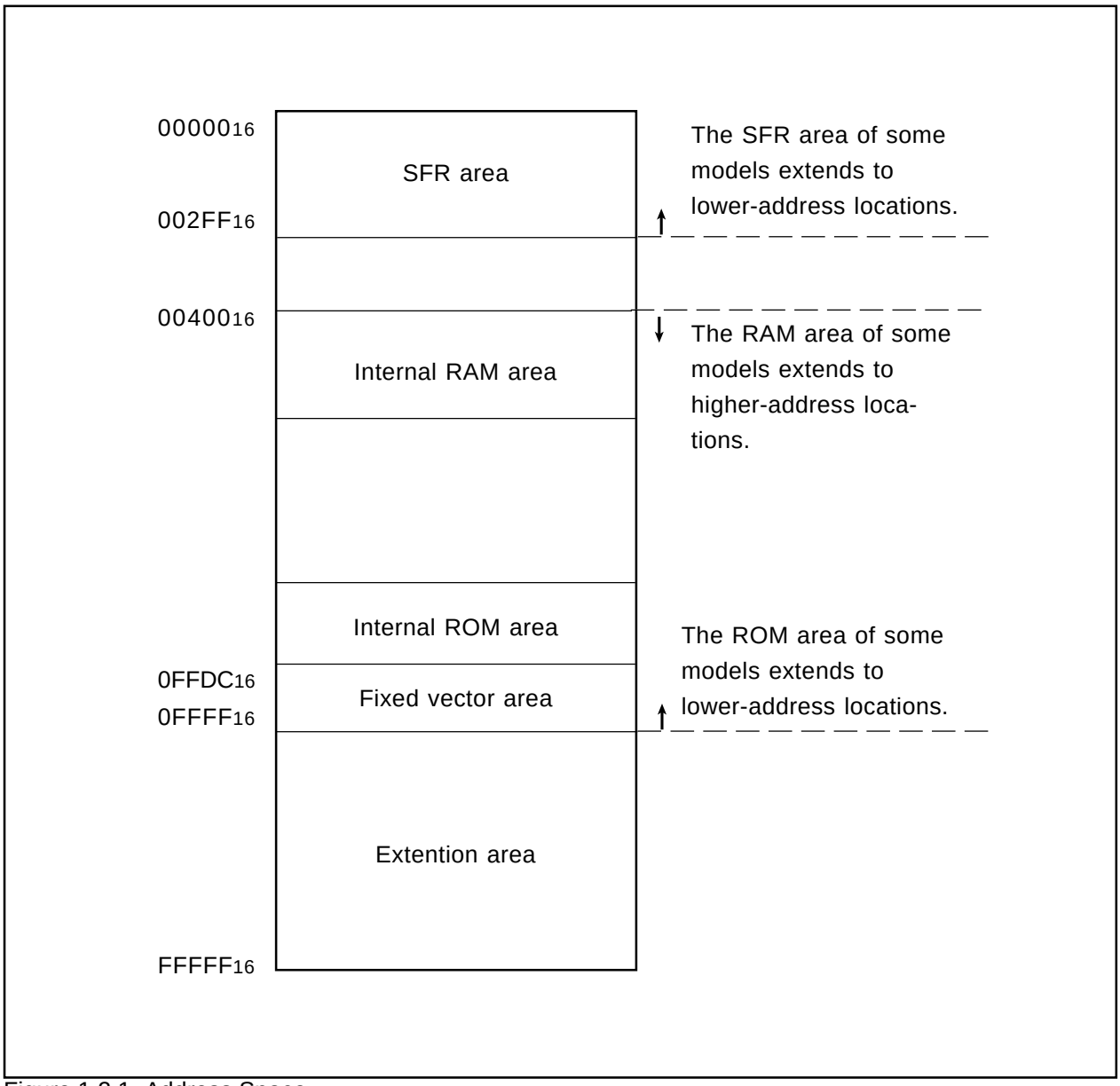


Figure 1.2.1 Address Space

1.3 Register Configuration

The central processing unit (CPU) contains the 13 registers shown in figure 1.3.1. Of these registers, R0, R1, R2, R3, A0, A1, and FB each consist of two sets of registers configured as two register banks.

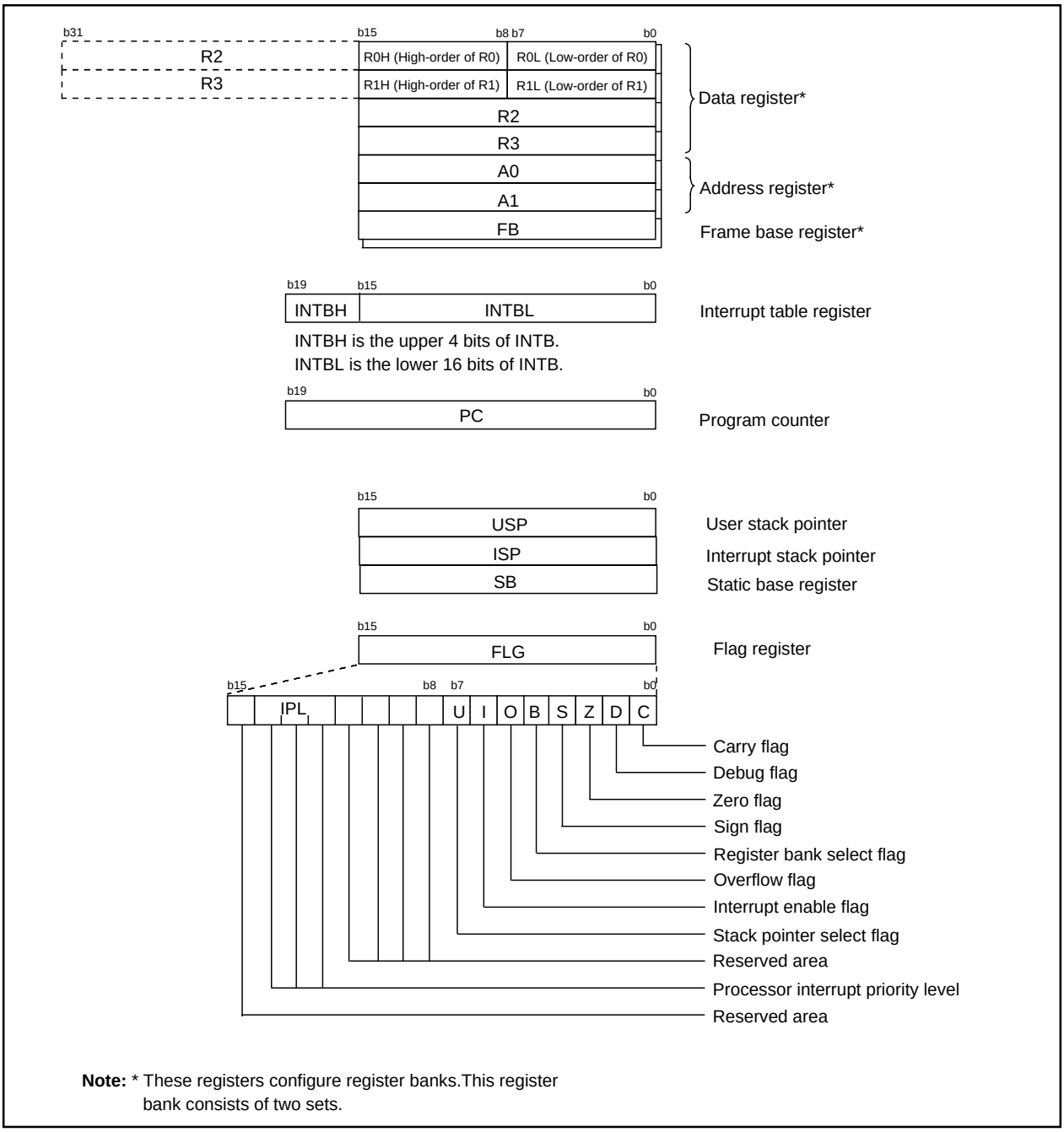


Figure 1.3.1 CPU Register Configuration

1.3.1 Data Registers (R0, R0H, R0L, R1, R1H, R1L, R2, and R3)

The data registers (R0, R1, R2, and R3) each consist of 16 bits and are used primarily for transfers and arithmetic/logic operations.

Registers R0 and R1 can be divided into separate high-order (R0H, R1H) and low-order (R0L, R1L) parts for use as 8-bit data registers. For some instructions, moreover, R2 and R0 or R3 and R1 can be combined to configure a 32-bit data register (R2R0 or R3R1).

1.3.2 Address Registers (A0 and A1)

The address registers (A0 and A1) are 16-bit registers with functions similar to those of the data registers. These registers are used for address register-based indirect addressing and address register-based relative addressing.

For some instructions, registers A1 and A0 can be combined to configure a 32-bit address register (A1A0).

1.3.3 Frame Base Register (FB)

The frame base register (FB) is a 16-bit register used for FB-based relative addressing.

1.3.4 Program Counter (PC)

The program counter (PC) is a 20-bit register that indicates the address of the instruction to be executed next.

1.3.5 Interrupt Table Register (INTB)

The interrupt table register (INTB) is a 20-bit register that indicates the initial address of the interrupt vector table.

1.3.6 User Stack Pointer (USP) and Interrupt Stack Pointer (ISP)

There are two types of stack pointers: a user stack pointer (USP) and an interrupt stack pointer (ISP). Each consists of 16 bits.

The stack pointer (USP/ISP) to be used can be switched with the stack pointer select flag (U flag).

The stack pointer select flag (U flag) is bit 7 of the flag register (FLG).

1.3.7 Static Base Register (SB)

The static base register (SB) is a 16-bit register used for SB-based relative addressing.

1.3.8 Flag Register (FLG)

The flag register (FLG) is an 11-bit register used as flags in one-bit units. For details on the functions of the flags, see Section 1.4, **“Flag Register (FLG).”**

1.4 Flag Register (FLG)

Figure 1.4.1 shows the configuration of the flag register (FLG). The function of each flag is described below.

1.4.1 Bit 0: Carry Flag (C Flag)

This flag holds bits carried, borrowed, or shifted-out by the arithmetic/logic unit.

1.4.2 Bit 1: Debug Flag (D Flag)

This flag enables a single-step interrupt.

When this flag is set to 1, a single-step interrupt is generated after an instruction is executed. When the interrupt is acknowledged, the flag is cleared to 0.

1.4.3 Bit 2: Zero Flag (Z Flag)

This flag is set to 1 when an arithmetic operation results in 0; otherwise, its value is 0.

1.4.4 Bit 3: Sign Flag (S Flag)

This flag is set to 1 when an arithmetic operation results in a negative value; otherwise, its value is 0.

1.4.5 Bit 4: Register Bank Select Flag (B Flag)

This flag selects a register bank. If it is set to 0, register bank 0 is selected; if it is set to 1, register bank 1 is selected.

1.4.6 Bit 5: Overflow Flag (O Flag)

This flag is set to 1 when an arithmetic operation results in an overflow.

1.4.7 Bit 6: Interrupt Enable Flag (I Flag)

This flag enables a maskable interrupt.

When this flag is set to 0, the interrupt is disabled; when it is set to 1, the interrupt is enabled. When the interrupt is acknowledged, the flag is cleared to 0.

1.4.8 Bit 7: Stack Pointer Select Flag (U Flag)

When this flag is set to 0, the interrupt stack pointer (ISP) is selected; when it is set to 1, the user stack pointer (USP) is selected.

This flag is cleared to 0 when a hardware interrupt is acknowledged or an INT instruction is executed for software interrupt numbers 0 to 31.

1.4.9 Bits 8 to 11: Reserved

1.4.10 Bits 12 to 14: Processor Interrupt Priority Level (IPL)

The processor interrupt priority level (IPL) consists of three bits, enabling specification of eight processor interrupt priority levels from level 0 to level 7. If a requested interrupt's priority level is higher than the processor interrupt priority level (IPL), the interrupt is enabled.

1.4.11 Bit 15: Reserved

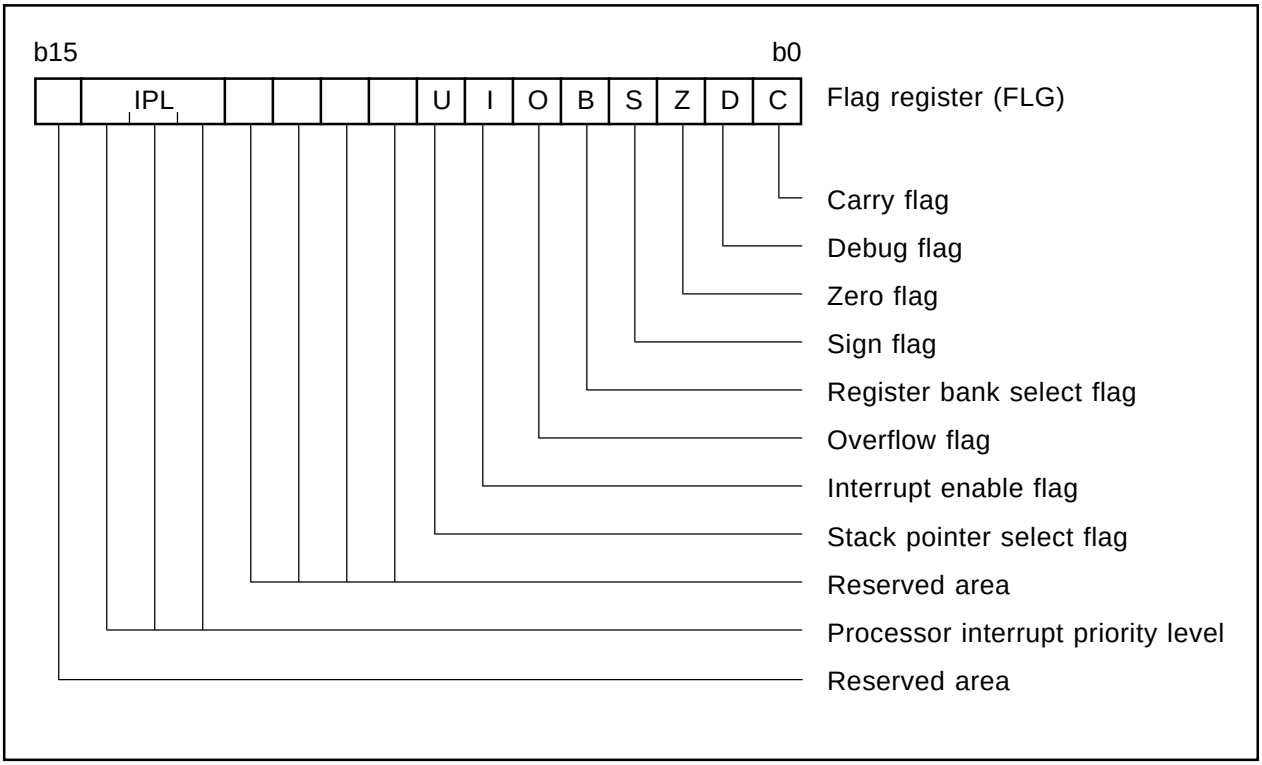


Figure 1.4.1 Configuration of Flag Register (FLG)

1.5 Register Banks

The R8C/Tiny has two register banks, each comprising data registers (R0, R1, R2, and R3), address registers (A0 and A1), and a frame base register (FB). These two register banks are switched by the register bank select flag (B flag) in the flag register (FLG).
Figure 1.5.1 shows the configuration of the register banks.

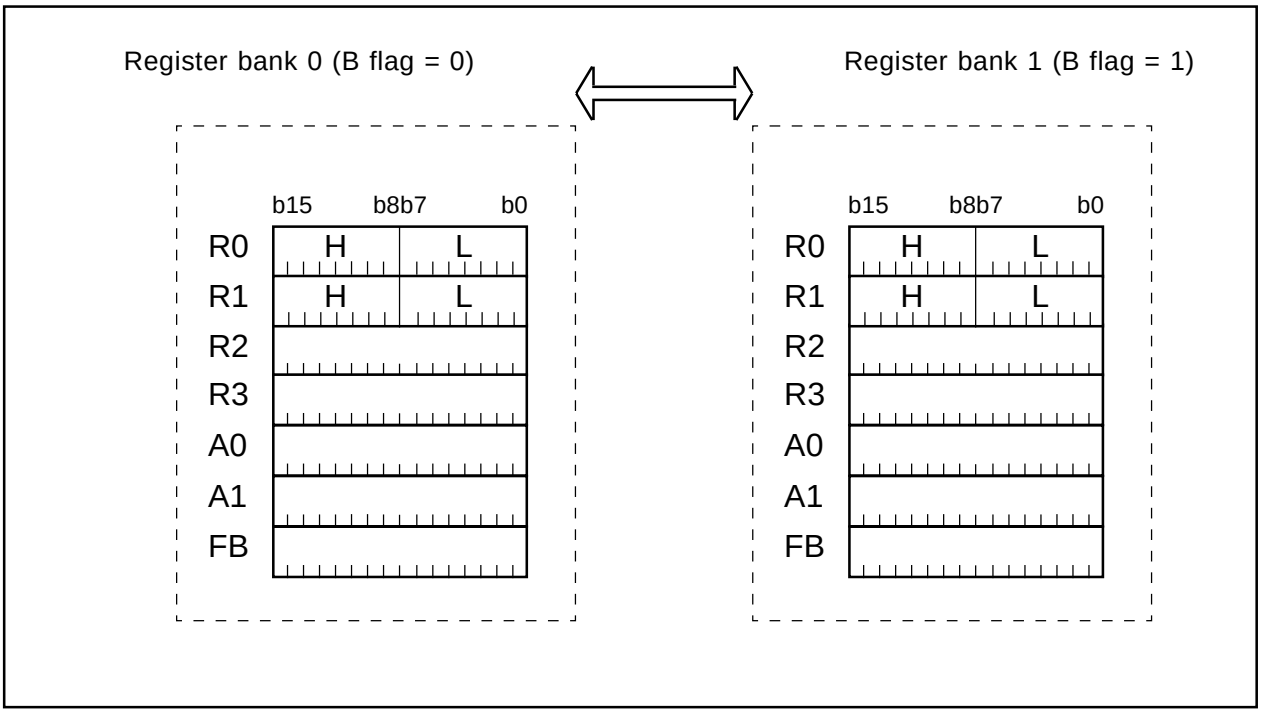


Figure 1.5.1 Configuration of Register Banks

1.6 Internal State after Reset is Cleared

The contents of each register after a reset is cleared are as follows.

- Data registers (R0, R1, R2, and R3): 0000_{16}
- Address registers (A0 and A1): 0000_{16}
- Frame base register (FB): 0000_{16}
- Interrupt table register (INTB): 00000_{16}
- User stack pointer (USP): 0000_{16}
- Interrupt stack pointer (ISP): 0000_{16}
- Static base register (SB): 0000_{16}
- Flag register (FLG): 0000_{16}

1.7 Data Types

There are four data types: integer, decimal, bit, and string.

1.7.1 Integer

An integer can be signed or unsigned. A negative value of a signed integer is represented by two's complement.

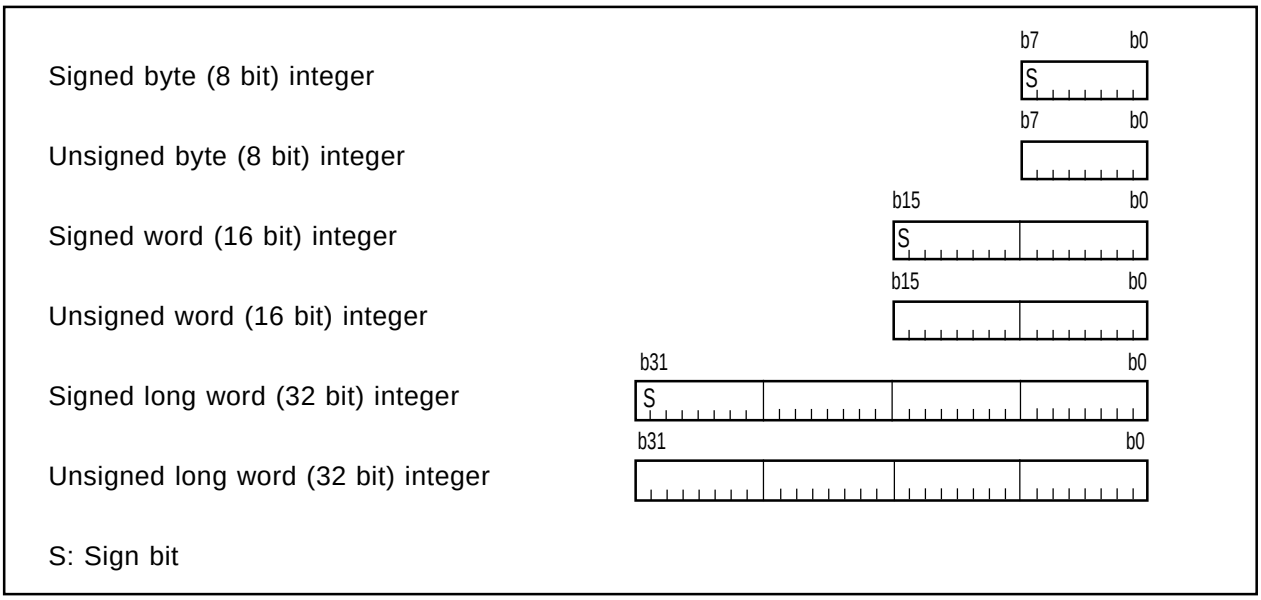


Figure 1.7.1 Integer Data

1.7.2 Decimal

The decimal data type is used by the DADC, DADD, DSBB, and DSUB instructions.

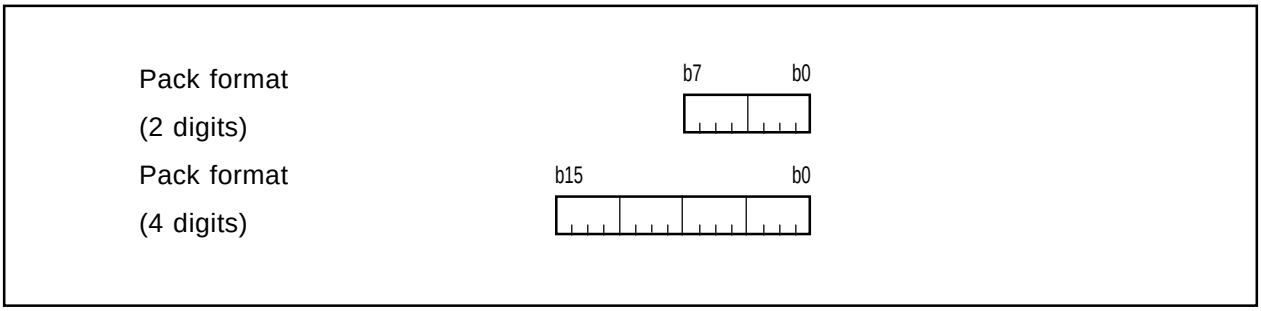


Figure 1.7.2 Decimal Data

1.7.3 Bits

●Register bits

Figure 1.7.3 shows register bit specification.

Register bits can be specified by register directly (**bit, Rn** or **bit, An**). Use **bit, Rn** to specify a bit in a data register (**Rn**); use **bit, An** to specify a bit in an address register (**An**).

The bits in each register are assigned bit numbers from 0 to 15, from LSB to MSB. Therefore, **bit, Rn** and **bit, An** can be used to specify a bit number from 0 to 15.

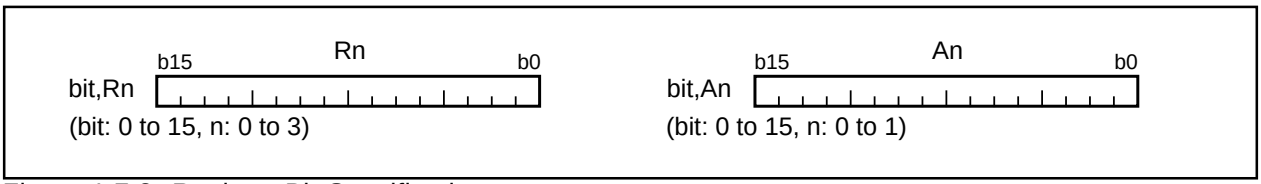


Figure 1.7.3 Register Bit Specification

●Memory bits

Figure 1.7.4 shows the addressing modes used for memory bit specification. Table 1.7.1 lists the address range in which bits can be specified in each addressing mode. Be sure to observe the address range in Table 1.7.1 when specifying memory bits.

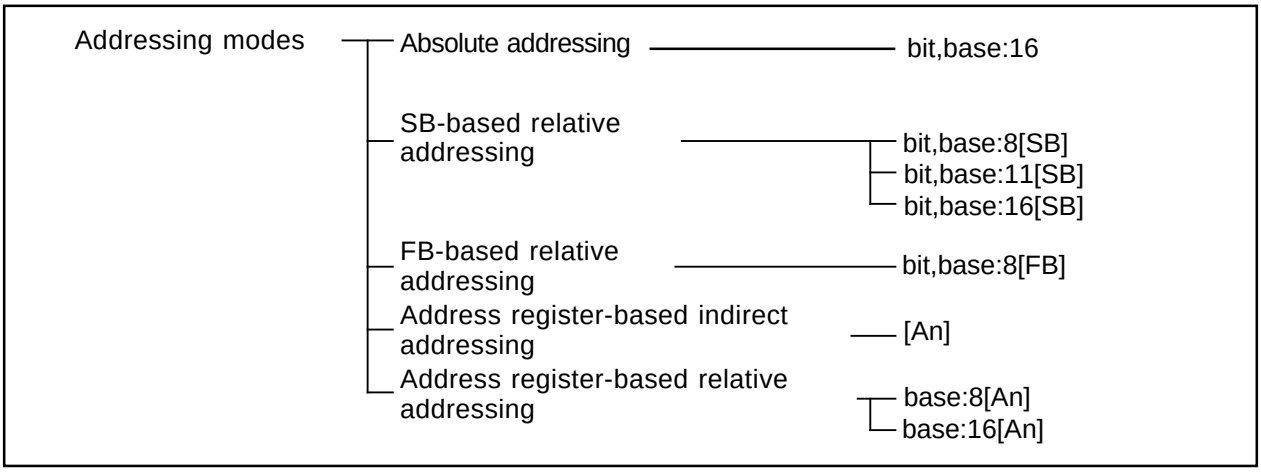


Figure 1.7.4 Addressing Modes Used for Memory Bit Specification

Table 1.7.1 Bit Specification Address Range

Addressing	Specification range		Remarks
	Lower Limit (Address)	Upper Limit (Address)	
bit,base:16	00000_{16}	$01FFF_{16}$	
bit,base:8[SB]	[SB]	[SB]+$0001F_{16}$	The access range is 00000_{16} to $0FFFF_{16}$.
bit,base:11[SB]	[SB]	[SB]+$000FF_{16}$	The access range is 00000_{16} to $0FFFF_{16}$.
bit,base:16[SB]	[SB]	[SB]+$01FFF_{16}$	The access range is 00000_{16} to $0FFFF_{16}$.
bit,base:8[FB]	[FB]–00010_{16}	[FB]+$0000F_{16}$	The access range is 00000_{16} to $0FFFF_{16}$.
[An]	00000_{16}	$01FFF_{16}$	
base:8[An]	base:8	base:8+$01FFF_{16}$	The access range is 00000_{16} to $020FE_{16}$.
base:16[An]	base:16	base:16+$01FFF_{16}$	The access range is 00000_{16} to $0FFFF_{16}$.

(1) Bit Specification by Bit, Base

Figure 1.7.5 shows the relationship between the memory map and the bit map.

Memory bits can be handled as an array of consecutive bits. Bits can be specified by a combination of **bit** and **base**. Using bit 0 of the address that is set in **base** as the reference (= 0), set the desired bit position in **bit**. Figure 1.7.6 shows examples of how to specify bit 2 of address 0000A16.

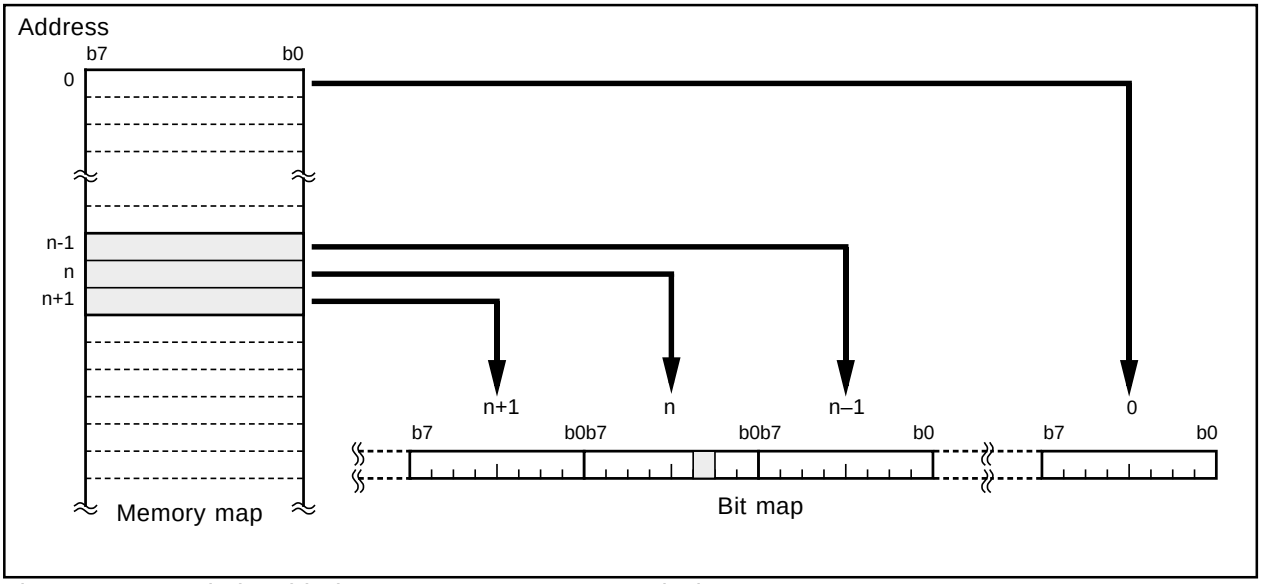


Figure 1.7.5 Relationship between Memory Map and Bit Map

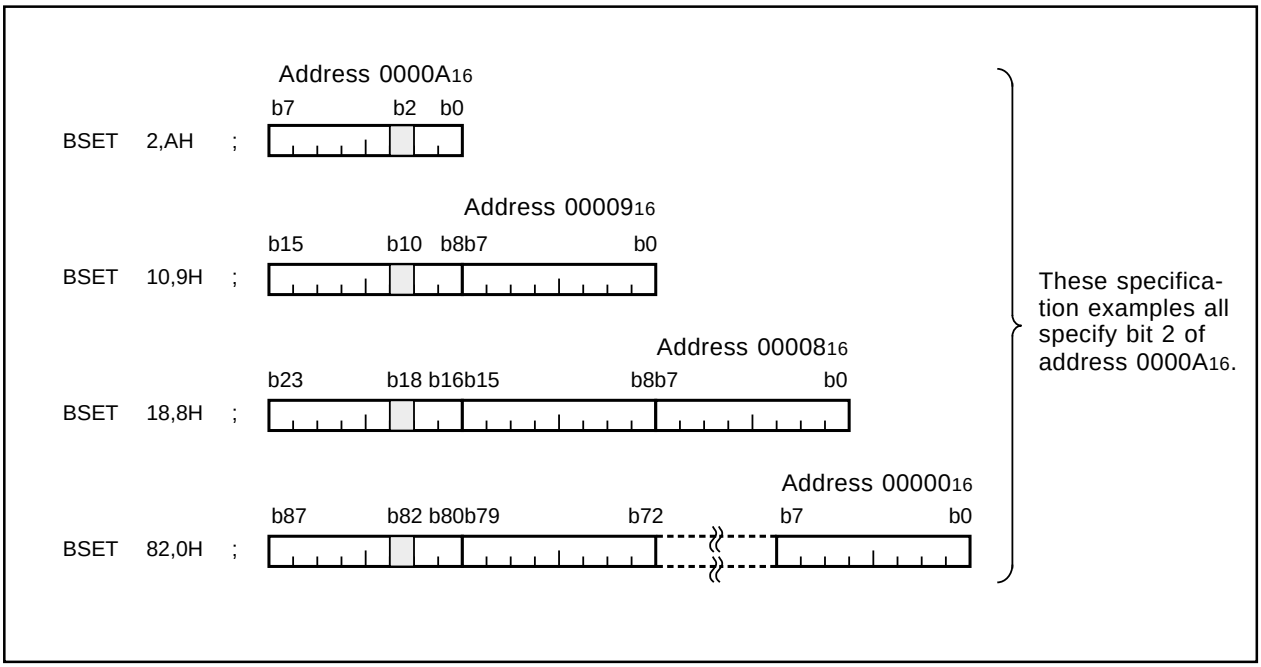


Figure 1.7.6 Examples of How to Specify Bit 2 of Address 0000A16

(2) SB/FB Relative Bit Specification

For SB/FB-based relative addressing, use bit 0 of the address that is the sum of the address set in static base register (**SB**) or frame base register (**FB**) plus the address set in **base** as the reference (= 0), and set the desired bit position in **bit**.

(3) Address Register Indirect/Relative Bit Specification

For address register-based indirect addressing, use bit 0 of address 00000_{16} as the reference (= 0) and set the desired bit position in the address register (**An**).

For address register-based relative addressing, use bit 0 of the address set in **base** as the reference (= 0) and set the desired bit position in the address register (**An**).

1.7.4 String

String data consists of a given length of consecutive byte (8-bit) or word (16-bit) data.

This data type can be used in three string instructions: character string backward transfer (SMOVB instruction), character string forward transfer (SMOVF instruction), and specified area initialize (SSTR instruction).

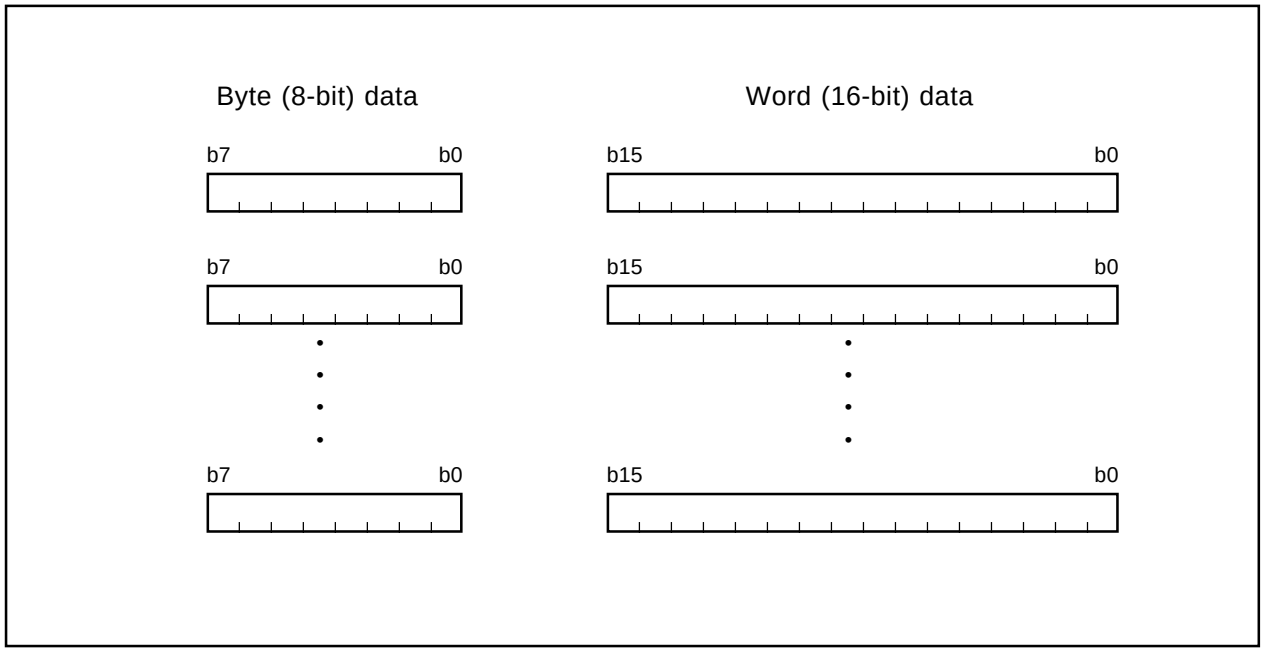


Figure 1.7.7 String Data

1.8 Data Arrangement

1.8.1 Data Arrangement in Register

Figure 1.8.1 shows the relationship between a register's data size and bit numbers.

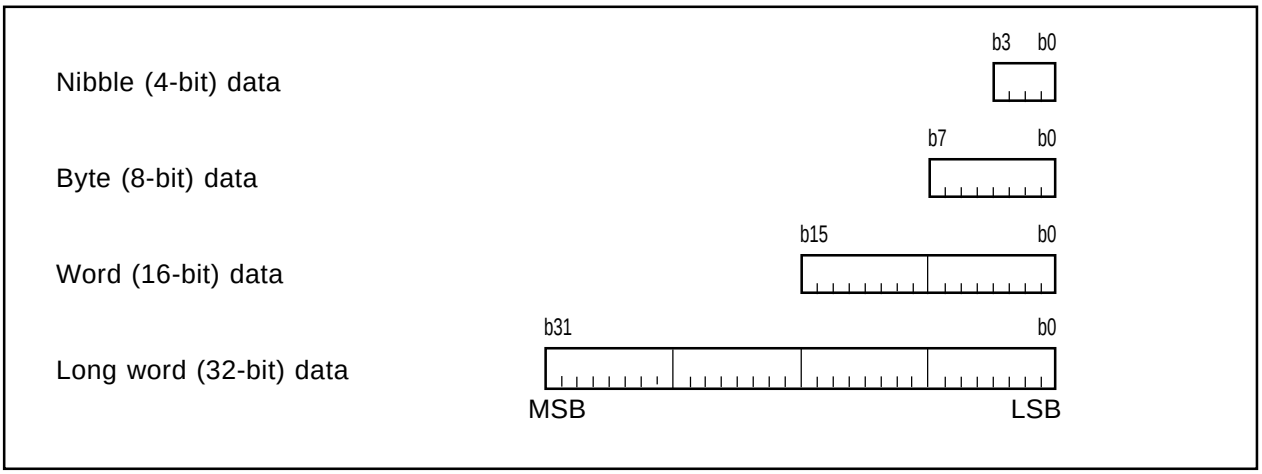


Figure 1.8.1 Data Arrangement in Register

1.8.2 Data Arrangement in Memory

Figure 1.8.2 shows the data arrangement in memory. Figure 1.8.3 shows some operation examples.

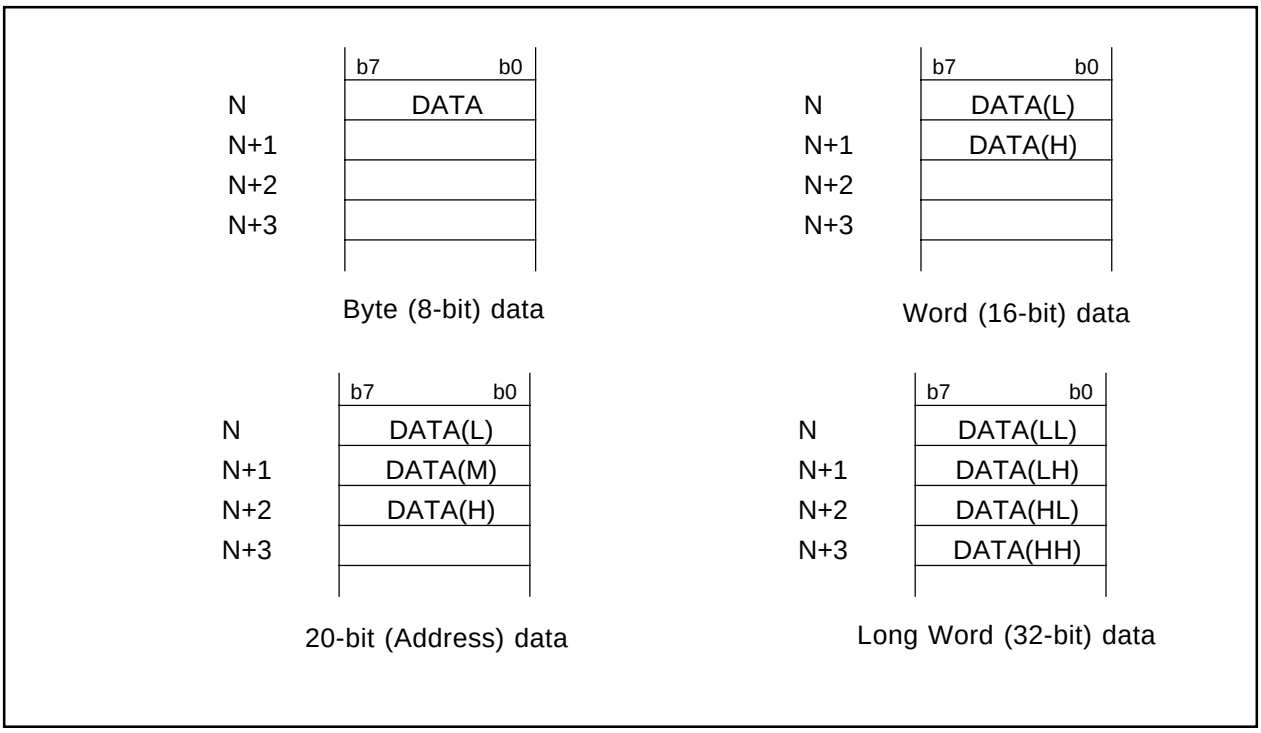


Figure 1.8.2 Data Arrangement in Memory

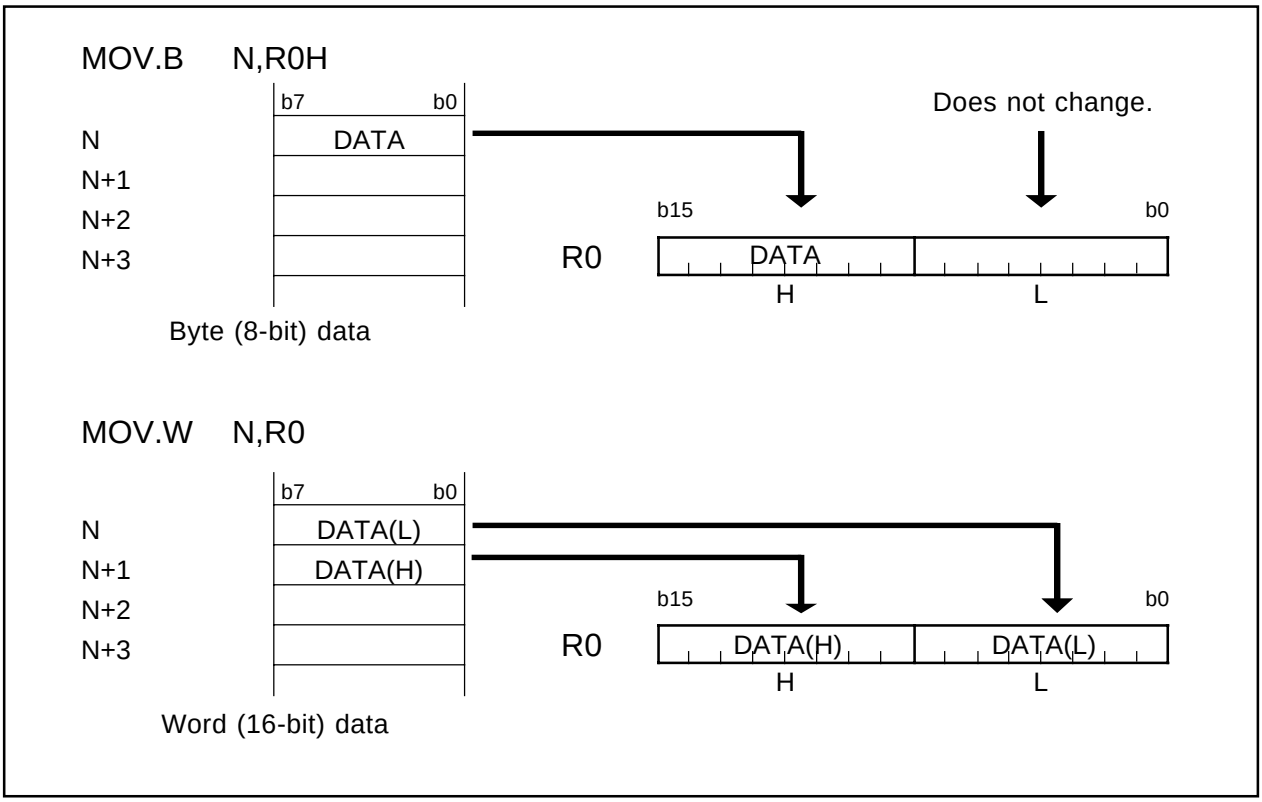


Figure 1.8.3 Operation Examples

1.9 Instruction Formats

The instruction formats can be classified into four types: generic, quick, short, and zero. The number of instruction bytes that can be chosen by a given format is least for the zero format, and increases successively for the short, quick, and generic formats, in that order.
The features of each format are described below.

1.9.1 Generic Format (:G)

The op-code in this format comprises two bytes. This op-code contains information on the operation and the src[*1] and dest[*2] addressing modes.
The instruction code is composed of op-code (2 bytes), src code (0 to 3 bytes), and dest code (0 to 3 bytes).

1.9.2 Quick Format (:Q)

The op-code in this format comprises two bytes. This op-code contains information on the operation and the immediate data and dest addressing modes. Note, however, that the immediate data in the op-code is a numeric value that can be expressed as -7 to +8 or -8 to +7 (depending on the instruction).
The instruction code is composed of op-code (2 bytes) containing immediate data and dest code (0 to 2 bytes).

1.9.3 Short Format (:S)

The op-code in this format comprises one byte. This op-code contains information on the operation and the src and dest addressing modes. Note, however, that the usable addressing modes are limited.
The instruction code is composed of op-code (1 byte), src code (0 to 2 bytes), and dest code (0 to 2 bytes).

1.9.4 Zero Format (:Z)

The op-code in this format comprises one byte. This op-code contains information on the operation (plus immediate data) and dest addressing modes. Note, however, that the immediate data is fixed at 0, and that the usable addressing modes are limited.
The instruction code is composed of op-code (1 byte) and dest code (0 to 2 bytes).

*1 src is an abbreviation of “source.”
*2 dest is an abbreviation of “destination.”

1.10 Vector Tables

Interrupt vector tables are the only vector tables. There are two types of interrupt vector tables: fixed and variable.

1.10.1 Fixed Vector Tables

A fixed vector table is an address-fixed vector table. Part of the interrupt vector table is allocated to addresses 0FFDC16 through 0FFFF16. Figure 1.10.1 shows a fixed vector table.

Interrupt vector tables are composed of four bytes per table. Each vector table must contain the interrupt handler routine's entry address.

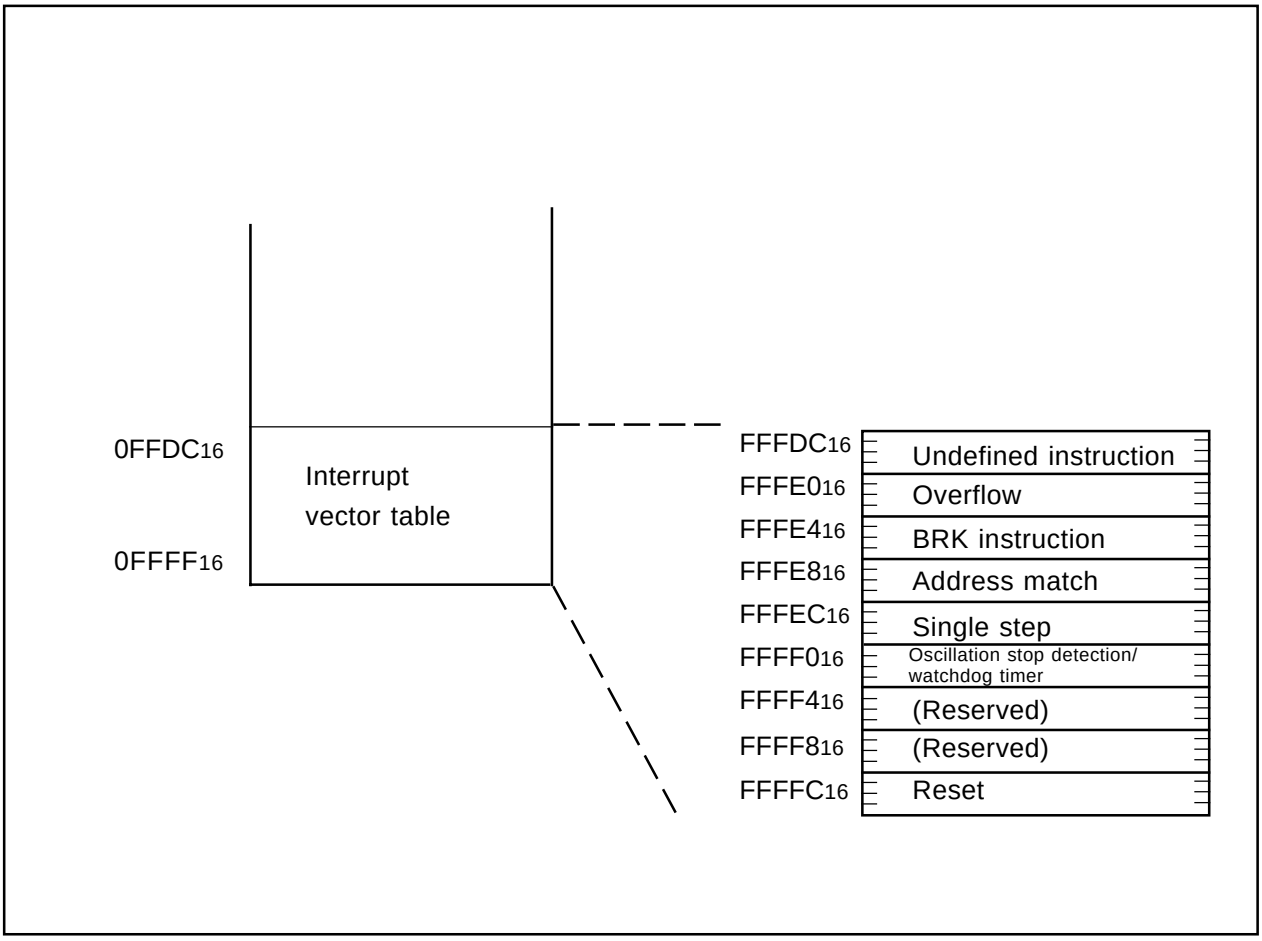


Figure 1.10.1 Fixed Vector Table

1.10.2 Variable Vector Tables

A variable vector table is an address-variable vector table. Specifically, this type of vector table is a 256-byte interrupt vector table that uses the value indicated by the interrupt table register (INTB) as the entry address (IntBase). Figure 1.10.2 shows a variable vector table.

Variable vector tables are composed of four bytes per table. Each vector table must contain the interrupt handler routine's entry address.

Each vector table has software interrupt numbers (0 to 63), which are used by the INT instruction. Interrupts for the on-chip peripheral functions of each M16C model are allocated to software interrupt numbers 0 through 31.

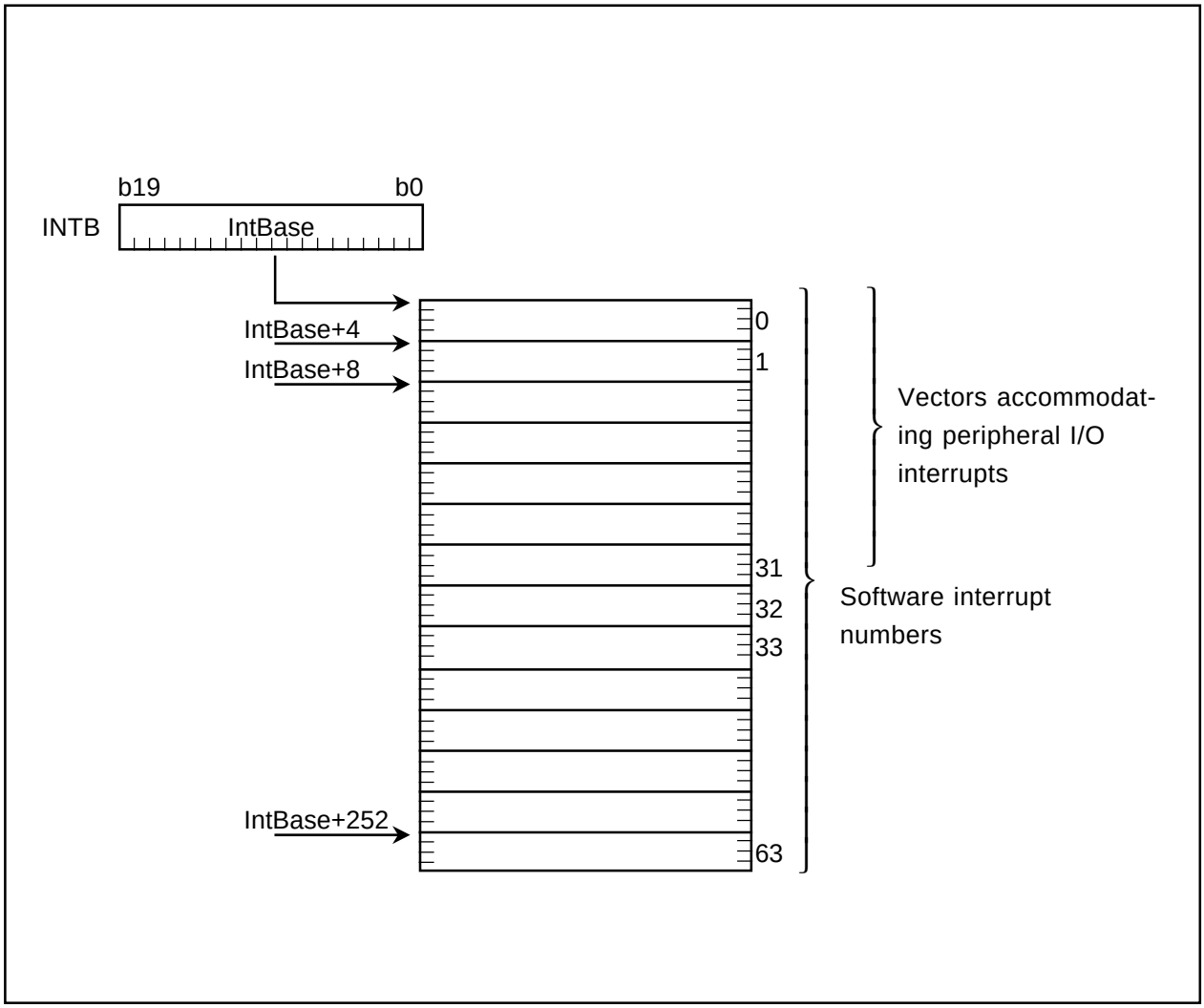


Figure 1.10.2 Variable Vector Table

Chapter 2

Addressing Modes

2.1 Addressing Modes

This section describes the symbols used to represent addressing modes and operations of each addressing mode. The R8C/Tiny Series has three types of addressing modes as outlined below.

2.1.1 General Instruction Addressing

This addressing mode type accesses the area from address 00000_{16} through address $0FFFF_{16}$.
The names of the general instruction addressing modes are as follows:

- Immediate
- Register direct
- Absolute
- Address register indirect
- Address register relative
- SB relative
- FB relative
- Stack pointer relative

2.1.2 Special Instruction Addressing

This addressing mode type accesses the area from address 00000_{16} through address $FFFFF_{16}$ and the control registers.
The names of the specific instruction addressing modes are as follows:

- 20-bit absolute
- Address register relative with 20-bit displacement
- 32-bit address register indirect
- 32-bit register direct
- Control register direct
- Program counter relative

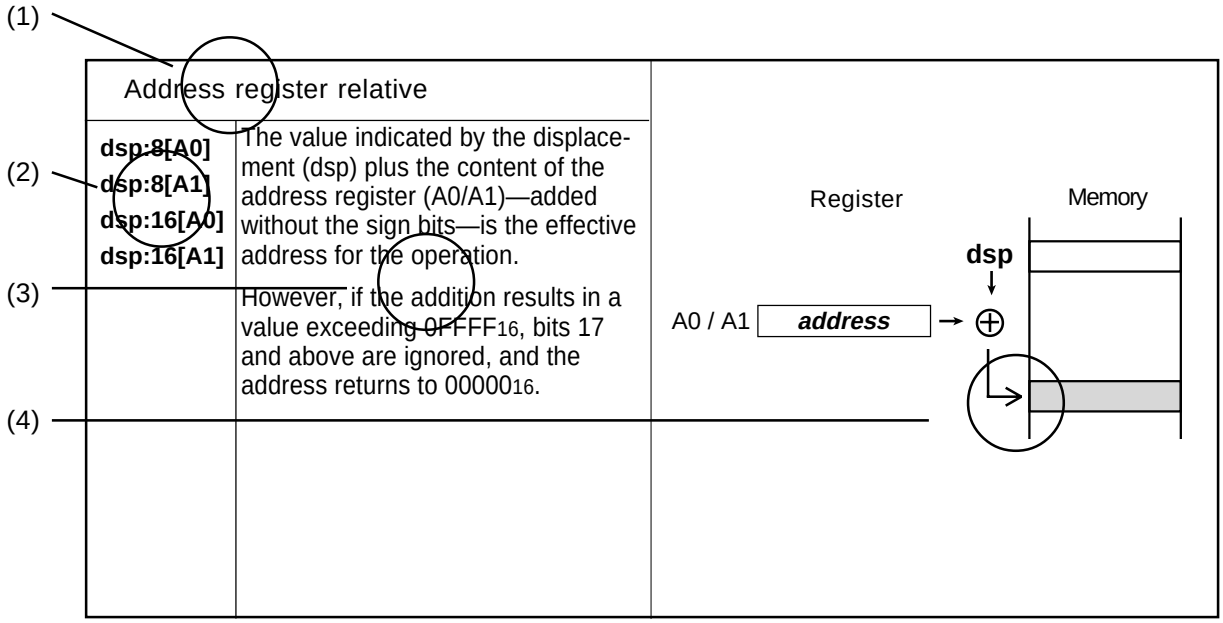
2.1.3 Bit Instruction Addressing

This addressing mode type accesses the area from address 00000_{16} through address $0FFFF_{16}$.
The names of the bit instruction addressing modes are as follows:

- Register direct
- Absolute
- Address register indirect
- Address register relative
- SB relative
- FB relative
- FLG direct

2.2 Guide to This Chapter

An example illustrating how to read this chapter is shown below.



(1) Name

The name of the addressing mode.

(2) Symbol

The symbol representing the addressing mode.

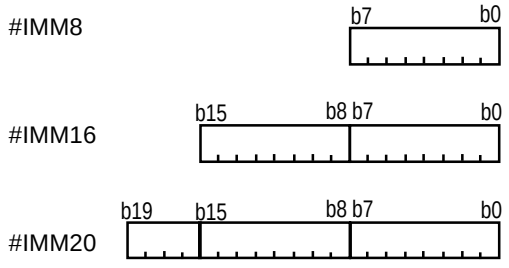
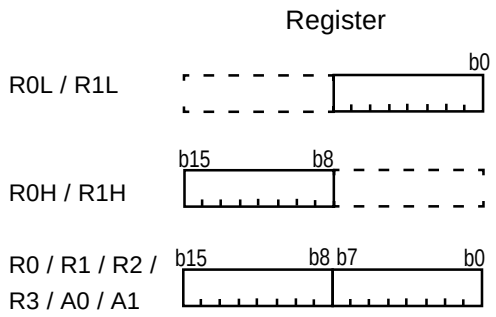
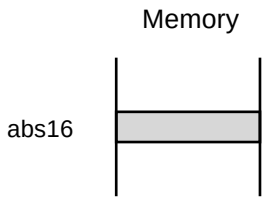
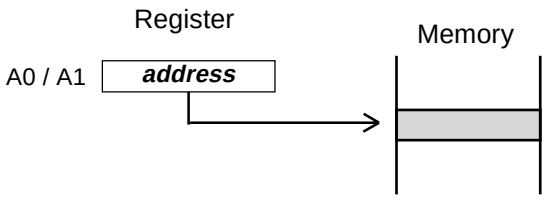
(3) Description

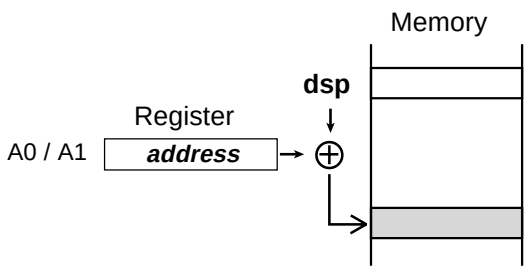
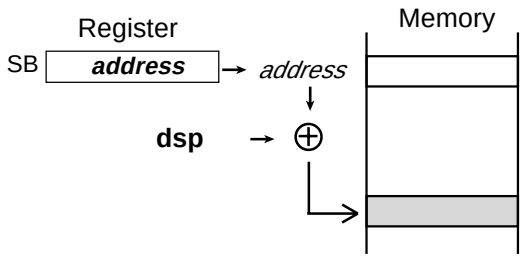
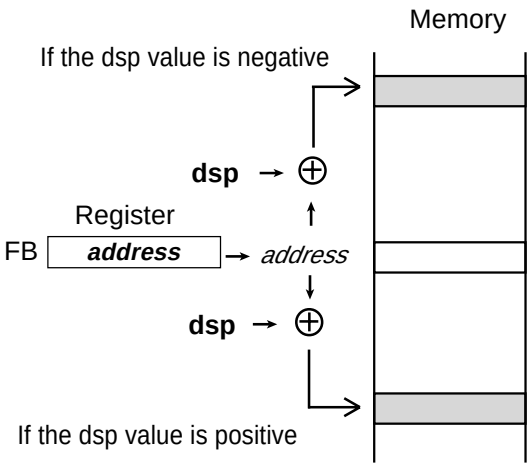
A description of the addressing operation and the effective address range.

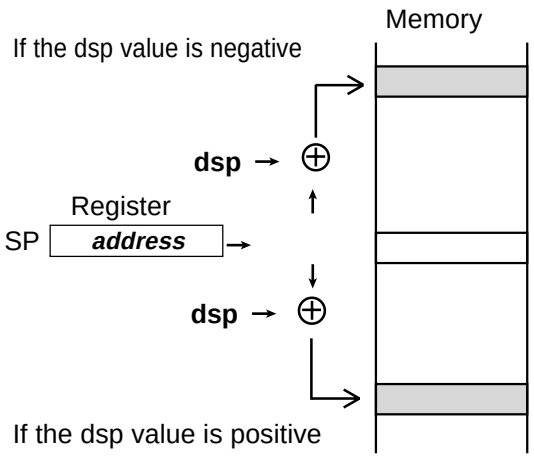
(4) Operation diagram

A diagram illustrating the addressing operation.

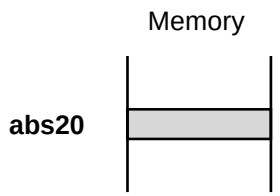
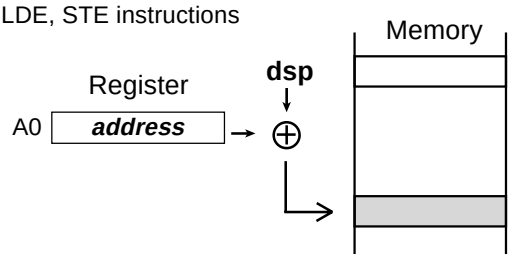
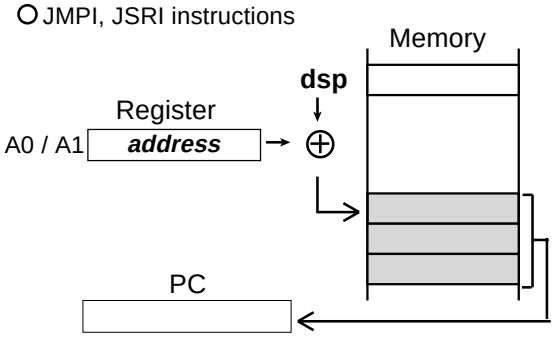
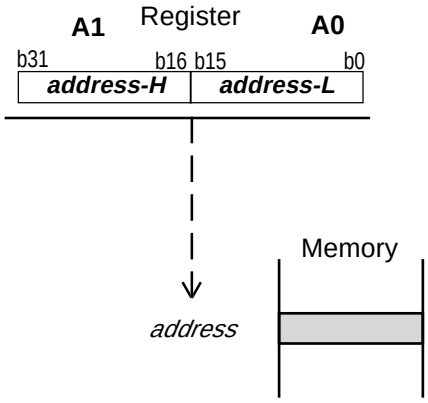
2.3 General Instruction Addressing

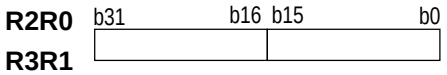
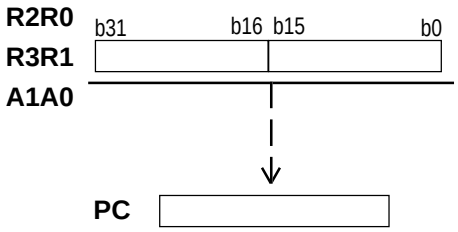
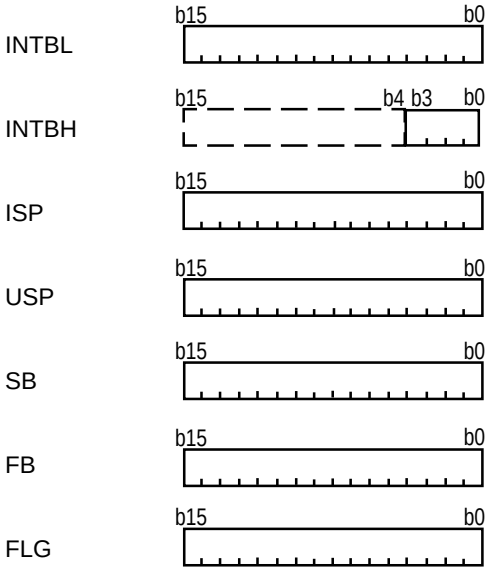
Immediate		
#IMM **#IMM8** **#IMM16** **#IMM20**	The immediate data indicated by #IMM is the object of the operation.	
Register direct		
R0L **R0H** **R1L** **R1H** **R0** **R1** **R2** **R3** **A0** **A1**	The specified register is the object of the operation.	
Absolute		
abs16	The value indicated by abs16 is the effective address for the operation. The effective address range is 00000_{16} to $0FFFF_{16}$.	
Address register indirect		
[A0] **[A1]**	The value indicated by the content of the address register (A0/A1) is the effective address for the operation. The effective address range is 00000_{16} to $0FFFF_{16}$.	

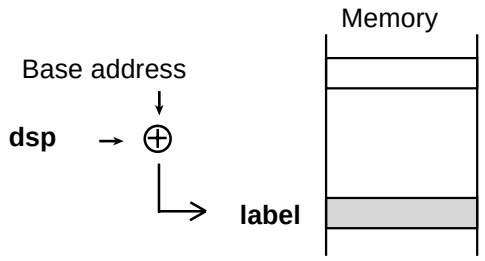
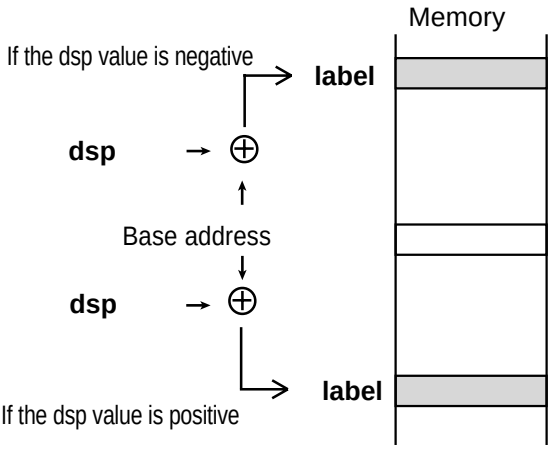
Address register relative		
dsp:8[A0] **dsp:8[A1]** **dsp:16[A0]** **dsp:16[A1]**	The value indicated by the displacement (dsp) plus the content of the address register (A0/A1)—added without the sign bits—is the effective address for the operation. However, if the addition results in a value exceeding 0FFFF16, bits 17 and above are ignored, and the address returns to 00000016.	
SB relative		
dsp:8[SB] **dsp:16[SB]**	The address indicated by the content of the static base register (SB) plus the value indicated by the displacement (dsp)—added without the sign bits—is the effective address for the operation. However, if the addition results in a value exceeding 0FFFF16, bits 17 and above are ignored, and the address returns to 00000016.	
FB relative		
dsp:8[FB]	The address indicated by the content of the frame base register (FB) plus the value indicated by the displacement (dsp)—added including the sign bits—is the effective address for the operation. However, if the addition results in a value outside the range 00000016 to 0FFFF16, bits 17 and above are ignored, and the address returns to 00000016 or 0FFFF16.	

Stack pointer relative		
dsp:8[SP]	The address indicated by the content of the stack pointer (SP) plus the value indicated by the displacement (dsp)—added including the sign bits—is the effective address for the operation. The stack pointer (SP) here is the one indicated by the U flag. However, if the addition results in a value outside the range 00000_{16} to $0FFFF_{16}$, bits 17 and above are ignored, and the address returns to 00000_{16} or $0FFFF_{16}$. This addressing mode can be used with the MOV instruction.	

2.4 Special Instruction Addressing

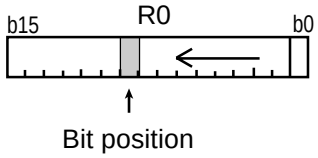
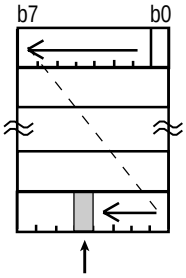
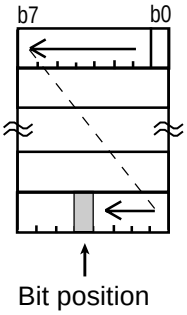
20-bit absolute		
abs20	The value indicated by abs20 is the effective address for the operation. The effective address range is 00000_{16} to $FFFFF_{16}$. This addressing mode can be used with the LDE, STE, JSR, and JMP instructions.	
Address register relative with 20-bit displacement		○ LDE, STE instructions  ○ JMPI, JSRI instructions 
dsp:20[A0] **dsp:20[A1]**	The address indicated by the displacement (dsp) plus the content of the address register (A0/A1)—added without the sign bits—is the effective address for the operation. However, if the addition results in a value exceeding $FFFFF_{16}$, bits 21 and above are ignored, and the address returns to 00000_{16}. This addressing mode can be used with the LDE, STE, JMPI, and JSRI instructions. Valid addressing mode and instruction combinations are as follows. dsp: 20[A0] → LDE, STE, JMPI, and JSRI instructions dsp: 20[A1] → JMPI and JSRI instructions	
32-bit address register indirect		
[A1A0]	The address indicated by the 32 concatenated bits of the address registers (A0 and A1) is the effective address for the operation. However, if the concatenated register value exceeds $FFFFF_{16}$, bits 21 and above are ignored. This addressing mode can be used with the LDE and STE instructions.	

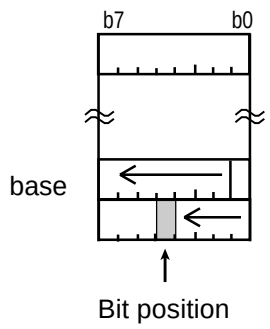
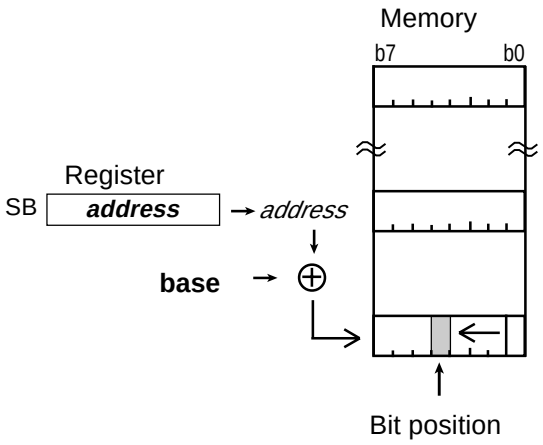
32-bit register direct		
R2R0 **R3R1** **A1A0**	The 32-bit concatenated register content of two specified registers is the object of the operation. This addressing mode can be used with the SHL, SHA, JMPI, and JSRI instructions. Valid register and instruction combinations are as follows. R2R0, R3R1 → SHL, SHA, JMPI, and JSRI instructions A1A0 → JMPI and JSRI instructions	○ SHL, SHA instructions  ○ JMPI, JSRI instructions 
Control register direct		
INTBL **INTBH** **ISP** **SP** **SB** **FB** **FLG**	The specified control register is the object of the operation. This addressing mode can be used with the LDC, STC, PUSHC, and POPC instructions. If SP is specified, the stack pointer indicated by the U flag is the object of the operation.	Register 

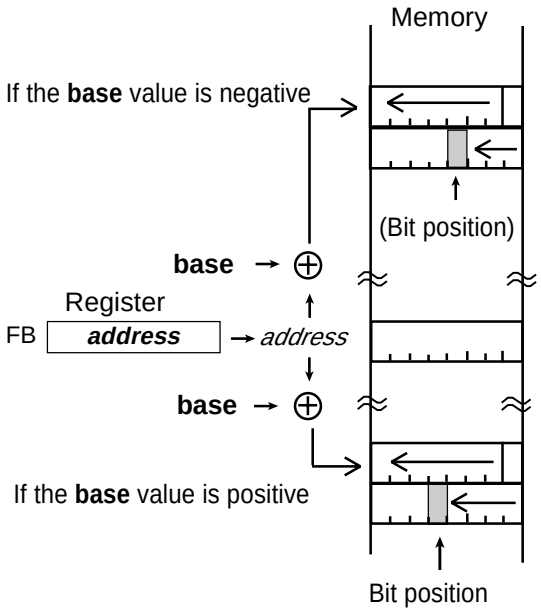
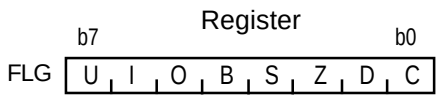
Program counter relative		
label	• If the jump length specifier (.length) is (.S), the base address plus the value indicated by the displacement (dsp)—added without the sign bits—is the effective address. This addressing mode can be used with the JMP instruction.	 +0 ≦ dsp ≦ +7 *1 The base address is (start address of instruction + 2).
	• If the jump length specifier (.length) is (.B) or (.W), the base address plus the value indicated by the displacement (dsp)—added including the sign bits—is the effective address. However, if the addition results in a value outside the range 00000_{16} to $FFFFF_{16}$, bits 21 and above are ignored, and the address returns to 00000_{16} or $FFFFF_{16}$. This addressing mode can be used with the JMP and JSR instructions.	 If the specifier is (.B), -128 dsp +127 If the specifier is (.W), -32768 dsp +32767 *2 The base address varies depending on the instruction.

2.5. Bit Instruction Addressing

This addressing mode type can be used with the following instructions: BCLR, BSET, BNOT, BTST, BNTST, BAND, BNAND, BOR, BNOR, BXOR, BNXOR, BM*Cnd*, BTSTS, BTSTC

Register direct		bit,R0 
bit,R0 **bit,R1** **bit,R2** **bit,R3** **bit,A0** **bit,A1**	The specified register bit is the object of the operation. A value of 0 to 15 may be specified as the bit position (**bit**).	
Absolute		base 
bit,base:16	The bit that is the number of bits indicated by **bit** away from bit 0 at the address indicated by **base** is the object of the operation. Bits at addresses 00000_{16} through $01FFF_{16}$ can be the object of the operation.	
Address register indirect		00000_{16} 
[A0] **[A1]**	The bit that is the number of bits indicated by the address register (A0/A1) away from bit 0 at address 00000_{16} is the object of the operation. Bits at addresses 00000_{16} through $01FFF_{16}$ can be the object of the operation.	

Address register relative		
base:8[A0] **base:8[A1]** **base:16[A0]** **base:16[A1]**	The bit that is the number of bits indicated by the address register (A0/A1) away from bit 0 at the address indicated by **base** is the object of the operation. However, if the address of the bit that is the object of the operation exceeds 0FFFF16, bits 17 and above are ignored and the address returns to 00000$_{16}$. The address range that can be specified by the address register (A0/A1) extends 8,192 bytes from **base**.	
SB relative		
bit,base:8[SB] **bit,base:11[SB]** **bit,base:16[SB]**	The bit that is the number of bits indicated by **bit** away from bit 0 at the address indicated by the static base register (SB) plus the value indicated by **base** (added without the sign bits) is the object of the operation. However, if the address of the bit that is the object of the operation exceeds 0FFFF16, bits 17 and above are ignored and the address returns to 00000$_{16}$. The address ranges that can be specified by bit,base:8, bit,base:11, and bit,base:16, respectively, extend 32 bytes, 256 bytes, and 8,192 bytes from the static base register (SB) value.	

FB relative		
bit,base:8[FB]	The bit that is the number of bits indicated by **bit** away from bit 0 at the address indicated by the frame base register (FB) plus the value indicated by **base** (added including the sign bit) is the object of the operation. However, if the address of the bit that is the object of the operation is outside the range 00000_{16} to $0FFFF_{16}$, bits 17 and above are ignored and the address returns to 00000_{16} or $0FFFF_{16}$. The address range that can be specified by bit, base:8 extends 16 bytes toward lower addresses or 15 bytes toward higher addresses from the frame base register (FB) value.	
FLG direct		
U **I** **O** **B** **S** **Z** **D** **C**	The specified flag is the object of the operation. This addressing mode can be used with the FCLR and FSET instructions.	

Chapter 3

Functions

3.1 Guide to This Chapter

In this chapter each instruction's syntax, operation, function, selectable src/dest, and flag changes are listed, and description examples and related instructions are shown.
An example illustrating how to read this chapter is shown below.

(1) **MOV** *Transfer* **MOVe** **MOV**

(2) **[Instruction Code/Number of Cycles]**

[Syntax] Page: 193

(3) **MOV.size (:format) src,dest**

G , Q , Z , S (Can be specified)

B , W

(4) **[Operation]**

dest ← src

(5) **[Function]**

- This instruction transfers *src* to *dest*.
- If *dest* is A0 or A1 and the selected size specifier (.size) is (.B), *src* is zero-expanded to transfer data in 16 bits. If *src* is A0 or A1, the 8 low-order bits of A0 or A1 are transferred.

(6) **[Selectable *src/dest*]** (See next page for src/dest classified by format.)

src				dest			
R0L/R0	R0H/R1	R1L/R2	R1H/R3	R0L/R0	R0H/R1	R1L/R2	R1H/R3
A0/A0	A1/A1	[A0]	[A1]	A0/A0	A1/A1	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]	dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16	dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	#IMM	~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	
~~R2R0~~	~~R3R1~~	~~A1A0~~	dsp:8[SP]	~~R2R0~~	~~R3R1~~	~~A1A0~~	dsp:8[SP]

(7) **[Flag Change]**

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	○	○	—	—

Conditions

S : The flag is set when the transfer results in MSB of dest = 1; otherwise cleared.

Z : The flag is set when the transfer results in 0; otherwise cleared.

(8) **[Description Example]**

```
MOV.B:S     #0ABH,R0L
MOV.W       #-1,R2
```

(9) **[Related Instruction]** LDE, STE, XCHG

(1) Mnemonic

The mnemonic explained in the page.

(2) Instruction Code/Number of Cycles

The page on which the instruction code and number of cycles is listed.
Refer to this page for information on the instruction code and number of cycles.

(3) Syntax

The syntax of the instruction using symbols. If (:format) is omitted, the assembler chooses the optimum specifier.

MOV.size (: format) src , dest

G , Q , S , Z → (f)
B , W → (e)

(a) (b) (c) (d)

(a) Mnemonic **MOV**
Shows the mnemonic.

(b) Size specifier **.size**
Shows the data sizes in which data is handled. The following data sizes may be specified:

.B Byte (8 bits)
.W Word (16 bits)
.L Long word (32 bits)

Some instructions do not have a size specifier.

(c) Instruction format specifier **(: format)**
Shows the instruction format. If (: format) is omitted, the assembler chooses the optimum specifier.
If (: format) is entered, its content is given priority. The following instruction formats may be specified:

:G Generic format
:Q Quick format
:S Short format
:Z Zero format

Some instructions do not have an instruction format specifier.

(d) Operands **src, dest**
Shows the operands.

(e) Shows the data sizes that can be specified in (b).

(f) Shows the instruction formats that can be specified in (c).

(1) **MOV** *Transfer* **MOV**

(2) **MOVe** **[Instruction Code/Number of Cycles]**

Page: 193

[Syntax]

(3) **MOV.size (:format) src,dest**

G , Q , Z , S (Can be specified)

B , W

(4) **[Operation]**

dest ← src

(5) **[Function]**

- This instruction transfers *src* to *dest*.
- If *dest* is A0 or A1 and the selected size specifier (.size) is (.B), *src* is zero-expanded to transfer data in 16 bits. If *src* is A0 or A1, the 8 low-order bits of A0 or A1 are transferred.

(6) **[Selectable *src/dest*]** (See next page for src/dest classified by format.)

src				dest			
R0L/R0	R0H/R1	R1L/R2	R1H/R3	R0L/R0	R0H/R1	R1L/R2	R1H/R3
A0/A0	A1/A1	[A0]	[A1]	A0/A0	A1/A1	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]	dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16	dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	#IMM	~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	
~~R2R0~~	~~R3R1~~	~~A1A0~~	dsp:8[SP]	~~R2R0~~	~~R3R1~~	~~A1A0~~	dsp:8[SP]

(7) **[Flag Change]**

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	○	○	—	—

Conditions

S : The flag is set when the transfer results in MSB of dest = 1; otherwise cleared.

Z : The flag is set when the transfer results in 0; otherwise cleared.

(8) **[Description Example]**

```
MOV.B:S    #0ABH,R0L
MOV.W      #-1,R2
```

(9) **[Related Instruction]** LDE, STE, XCHG

(4) Operation

Explains the operation of the instruction using symbols.

(5) Function

Explains the function of the instruction and precautions to be taken when using the instruction.

(6) Selectable *src* / *dest* (label)

If the instruction has operands, the valid formats are listed here.

src				dest			
R0L/R0	R0H/R1	R1L/R2	R1H/R3	R0L/R0	R0H/R1	R1L/R2	R1H/R3
A0/A0	A1/A1	[A0]	[A1]	A0/A0	A1/A1	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]	dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16	dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	#IMM	~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	
~~R2R0~~	~~R3R1~~	~~A1A0~~	dsp:8[SP]	~~R2R0~~	~~R3R1~~	~~A1A0~~	dsp:8[SP]

(a) (b) (c) (d) (e)

(a) **Items that can be selected as *src* (source)**

(b) **Items that can be selected as *dest* (destination)**

(c) **Addressing modes that can be selected**

(d) **Addressing modes that cannot be selected**

(e) **Shown on the left side of the slash (R0H) is the addressing mode when data is handled in bytes (8 bits). Shown on the right side of the slash (R1) is the addressing mode when data is handled in words (16 bits).**

(7) Flag change

Shows a flag change that occurs after the instruction is executed. The symbols in the table mean the following.

"_" The flag does not change.
"O" The flag changes depending on a condition.

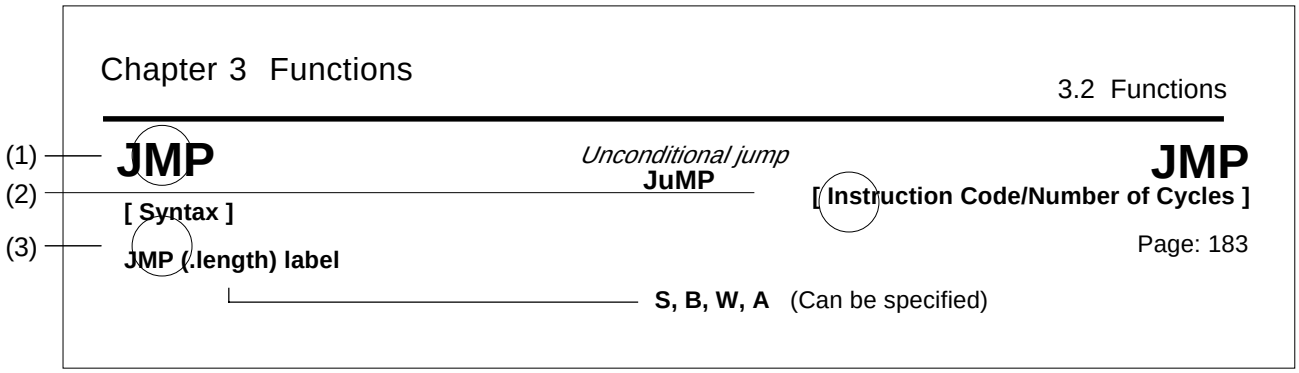
(8) Description example

Description examples for the instruction.

(9) Related instructions

Related instructions that cause an operation similar or opposite to that of the instruction.

The syntax of the jump instructions JMP, JPMI, JSR, and JSRI are illustrated below by example .



(3) Syntax

Indicates the instruction syntax using symbols.

(a) Mnemonic **JMP**

Shows the mnemonic.

(b) Jump distance specifier **.length**

Shows the distance of the jump. If (.length) is omitted from the JMP or JSR instruction, the assembler chooses the optimum specifier. If (.length) is entered, its content is given priority.

The following jump distances may be specified:

- .S 3-bit PC forward relative (+2 to +9)
- .B 8-bit PC relative
- .W 16-bit PC relative
- .A 20-bit absolute

(c) Operand **label**

Shows the operand.

(d) Shows the jump distances that can be specified in (b).

ABS

Absolute value
ABSolute

ABS

[Syntax]

ABS.size dest

B , W

[Instruction Code/Number of Cycles]

Page: 138

[Operation]

dest ← | dest |

[Function]

- This instruction takes the absolute value of *dest* and stores it in *dest*.

[Selectable dest]

dest			
R0L/R0	R0H/R1	R1L/R2	R1H/R3
~~A0/~~A0	~~A1/~~A1	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	
~~R2R0~~	~~R3R1~~	~~A1A0~~	

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	○	—	○	○	—	○

Conditions

O : The flag is set (= 1) when dest before the operation is –128 (.B) or –32768 (.W); otherwise cleared (= 0).
S : The flag is set when the operation results in MSB = 1; otherwise cleared.
Z : The flag is set when the operation results in 0; otherwise cleared.
C : The flag value is undefined.

[Description Example]

```
ABS.B    R0L
ABS.W    A0
```

ADC

Add with carry
ADdition with Carry

ADC

[Syntax]

ADC.size src,dest

B , W

[Instruction Code/Number of Cycles]

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[Operation]

dest ← src + dest + C

[Function]

- This instruction adds *dest*, *src*, and the C flag and stores the result in *dest*.
- If *dest* is A0 or A1 and the selected size specifier (.size) is (.B), *src* is zero-expanded to perform calculation in 16 bits. If *src* is A0 or A1, the operation is performed on the eight low-order bits of A0 or A1.

[Selectable src/dest]

src				dest			
R0L/R0	R0H/R1	R1L/R2	R1H/R3	R0L/R0	R0H/R1	R1L/R2	R1H/R3
A0/A0*1	A1/A1*1	[A0]	[A1]	A0/A0*1	A1/A1*1	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]	dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16	dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	#IMM	~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	
~~R2R0~~	~~R3R1~~	~~A1A0~~		~~R2R0~~	~~R3R1~~	~~A1A0~~	

*1 If (.B) is selected as the size specifier (.size), A0 or A1 cannot be chosen for *src* and *dest* simultaneously.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	○	—	○	○	—	○

Conditions

O : The flag is set when a signed operation results in a value exceeding +32767 (.W) or –32768 (.W) or +127 (.B) or –128 (.B); otherwise cleared.

S : The flag is set when the operation results in MSB = 1; otherwise cleared.

Z : The flag is set when the operation results in 0; otherwise cleared.

C : The flag is set when an unsigned operation results in a value exceeding +65535 (.W) or +255 (.B); otherwise cleared.

[Description Example]

```
ADC.B   #2,R0L
ADC.W   A0,R0
ADC.B   A0,R0L      ; 8 low-order bits of A0 and R0L are added.
ADC.B   R0L,A0      ; R0L is zero-expanded and added to A0.
```

[Related Instructions] ADCF, ADD, SBB, SUB

ADCF

Add carry flag
ADdition Carry Flag

ADCF

[Syntax]

ADCF.size dest

B , W

[Instruction Code/Number of Cycles]

Page: 140

[Operation]

dest ← dest + C

[Function]

This instruction adds *dest* and the C flag and stores the result in *dest*.

[Selectable dest]

dest			
R0L/R0	R0H/R1	R1L/R2	R1H/R3
~~A0/~~A0	~~A1/~~A1	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	
~~R2R0~~	~~R3R1~~	~~A1A0~~	

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	○	—	○	○	—	○

Conditions

O : The flag is set when a signed operation results in a value exceeding +32767 (.W) or –32768 (.W) or +127 (.B) or –128 (.B); otherwise cleared.

S : The flag is set when the operation results in MSB = 1; otherwise cleared.

Z : The flag is set when the operation results in 0; otherwise cleared.

C : The flag is set when an unsigned operation results in a value exceeding +65535 (.W) or +255 (.B); otherwise cleared.

[Description Example]

```
ADCF.B    R0L
ADCF.W    Ram:16[A0]
```

[Related Instructions] ADC, ADD, SBB, SUB

ADD

Add without carry
ADDition

ADD

[Syntax]

ADD.size (:format) src,dest

G , Q , S (Can be specified)
B , W

[Instruction Code/Number of Cycles]

Page: 140

[Operation]

dest ← dest + src

[Function]

- This instruction adds *dest* and *src* and stores the result in *dest*.
- If *dest* is A0 or A1 and the selected size specifier (.size) is (.B), *src* is zero-expanded to perform calculation in 16 bits. If *src* is A0 or A1, the operation is performed on the eight low-order bits of A0 or A1.
- If *dest* is a stack pointer and the selected size specifier (.size) is (.B), *src* is sign extended to perform calculation in 16 bits.

[Selectable src/dest] (See next page for *src*/*dest* classified by format.)

src				dest			
R0L/R0	R0H/R1	R1L/R2	R1H/R3	R0L/R0	R0H/R1	R1L/R2	R1H/R3
A0/A0*1	A1/A1*1	[A0]	[A1]	A0/A0*1	A1/A1*1	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]	dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16	dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	#IMM	~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	SP/SP*2
~~R2R0~~	~~R3R1~~	~~A1A0~~		~~R2R0~~	~~R3R1~~	~~A1A0~~	

*1 If (.B) is selected as the size specifier (.size), A0 or A1 cannot be chosen for *src* and *dest* simultaneously.

*2 The operation is performed on the stack pointer indicated by the U flag. Only #IMM can be selected for *src*.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	○	—	○	○	—	○

Conditions

O : The flag is set when a signed operation results in a value exceeding +32767 (.W) or –32768 (.W) or +127 (.B) or –128 (.B); otherwise cleared.

S : The flag is set when the operation results in MSB = 1; otherwise cleared.

Z : The flag is set when the operation results in 0; otherwise cleared.

C : The flag is set when an unsigned operation results in a value exceeding +65535 (.W) or +255 (.B); otherwise cleared.

[Description Example]

```
ADD.B   A0,R0L          ; 8 low-order bits of A0 and R0L are added.
ADD.B   R0L,A0          ; R0L is zero-expanded and added to A0.
ADD.B   Ram:8[SB],R0L
ADD.W   #2,[A0]
```

[Related Instructions] ADC, ADCF, SBB, SUB

[src/dest Classified by Format]

G format

src				dest			
R0L/R0	R0H/R1	R1L/R2	R1H/R3	R0L/R0	R0H/R1	R1L/R2	R1H/R3
A0/A0*1	A1/A1*1	[A0]	[A1]	A0/A0*1	A1/A1*1	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]	dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16	dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	#IMM	~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	SP/SP*2
~~R2R0~~	~~R3R1~~	~~A1A0~~		~~R2R0~~	~~R3R1~~	~~A1A0~~	

*1 If (.B) is selected as the size specifier (.size), A0 or A1 cannot be chosen for *src* and *dest* simultaneously.

*2 The operation is performed on the stack pointer indicated by the U flag. Only #IMM can be selected for *src*.

Q format

src				dest			
~~R0L/R0~~	~~R0H/R1~~	~~R1L/R2~~	~~R1H/R3~~	R0L/R0	R0H/R1	R1L/R2	R1H/R3
~~A0/A0~~	~~A1/A1~~	~~[A0]~~	~~[A1]~~	A0/A0	A1/A1	[A0]	[A1]
~~dsp:8[A0]~~	~~dsp:8[A1]~~	~~dsp:8[SB]~~	~~dsp:8[FB]~~	dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
~~dsp:16[A0]~~	~~dsp:16[A1]~~	~~dsp:16[SB]~~	~~abs16~~	dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	#IMM*3	~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	SP/SP*2
~~R2R0~~	~~R3R1~~	~~A1A0~~		~~R2R0~~	~~R3R1~~	~~A1A0~~	

*2 The operation is performed on the stack pointer indicated by the U flag. Only #IMM can be selected for *src*.

*3 The acceptable range of values is $-8 \leq$ #IMM $\leq +7$.

S format*4

src				dest			
~~R0L~~	~~R0H~~	~~dsp:8[SB]~~	~~dsp:8[FB]~~	R0L	R0H	dsp:8[SB]	dsp:8[FB]
~~abs16~~	#IMM			abs16	~~A0~~	~~A1~~	
R0L*5	R0H*5	dsp:8[SB]	dsp:8[FB]	R0L*5	R0H*5	~~dsp:8[SB]~~	~~dsp:8[FB]~~
abs16	~~#IMM~~			~~abs16~~	~~A0~~	~~A1~~	

*4 Only (.B) can be selected as the size specifier (.size).

*5 The same register cannot be used for *src* and *dest* simultaneously.

ADJNZ

Add and conditional jump
ADdition then Jump on Not Zero

ADJNZ

[Syntax]

ADJNZ.size src,dest,label

B , W

[Instruction Code/Number of Cycles]

Page: 146

[Operation]

dest ← dest + src

if dest ≠ 0 **then** jump label

[Function]

- This instruction adds *dest* and *src* and stores the result in *dest*.
- If the addition results in any value other than 0, control jumps to **label**. If the addition results in 0, the next instruction is executed.
- The op-code of this instruction is the same as that of SBJNZ.

[Selectable src/dest/label]

src	dest			label
#IMM*1	R0L/R0 R1H/R3 [A0] dsp:8[A1] dsp:16[A0] abs16	R0H/R1 A0/A0 [A1] dsp:8[SB] dsp:16[A1]	R1L/R2 A1/A1 dsp:8[A0] dsp:8[FB] dsp:16[SB]	PC*2–126 ≦ label ≦ PC*2+129

*1 The acceptable range of values is –8 ≤ #IMM ≤ +7.

*2 PC indicates the start address of the instruction.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	—	—	—	—

[Description Example]

```
ADJNZ.W    #–1,R0,label
```

[Related Instructions] SBJNZ

AND

Logically AND
AND

AND

[Syntax]

AND.size (:format) src,dest

G , S (Can be specified)
B , W

[Instruction Code/Number of Cycles]

Page: 147

[Operation]

dest ← src ∧ dest

[Function]

- This instruction logically ANDs *dest* and *src* and stores the result in *dest*.
- If *dest* is A0 or A1 and the selected size specifier (.size) is (.B), *src* is zero-expanded to perform calculation in 16 bits. If *src* is A0 or A1, operation is performed on the eight low-order bits of A0 or A1.

[Selectable src/dest] (See next page for *src/dest* classified by format.)

src				dest			
R0L/R0	R0H/R1	R1L/R2	R1H/R3	R0L/R0	R0H/R1	R1L/R2	R1H/R3
A0/A0*1	A1/A1*1	[A0]	[A1]	A0/A0*1	A1/A1*1	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]	dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16	dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	#IMM	~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	~~SP/SP~~
~~R2R0~~	~~R3R1~~	~~A1A0~~		~~R2R0~~	~~R3R1~~	~~A1A0~~	

*1 If (.B) is selected as the size specifier (.size), A0 or A1 cannot be chosen for *src* and *dest* simultaneously.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	○	○	—	—

Conditions

S : The flag is set when the operation results in MSB = 1; otherwise cleared.
Z : The flag is set when the operation results in 0; otherwise cleared.

[Description Example]

```
AND.B      Ram:8[SB],R0L
AND.B:G    A0,R0L          ; 8 low-order bits of A0 and R0L are ANDed.
AND.B:G    R0L,A0          ; R0L is zero-expanded and ANDed with A0.
AND.B:S    #3,R0L
```

[Related Instructions] OR, XOR, TST

[src/dest Classified by Format]

G format

src				dest			
R0L/R0	R0H/R1	R1L/R2	R1H/R3	R0L/R0	R0H/R1	R1L/R2	R1H/R3
A0/A0*1	A1/A1*1	[A0]	[A1]	A0/A0*1	A1/A1*1	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]	dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16	dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	#IMM	~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	~~SP/SP~~
~~R2R0~~	~~R3R1~~	~~A1A0~~		~~R2R0~~	~~R3R1~~	~~A1A0~~	

*1 If (.B) is selected as the size specifier (.size), A0 or A1 cannot be chosen for *src* and *dest* simultaneously.

S format*2

src				dest			
~~R0L~~	~~R0H~~	~~dsp:8[SB]~~	~~dsp:8[FB]~~	R0L	R0H	dsp:8[SB]	dsp:8[FB]
~~abs16~~	#IMM			abs16	~~A0~~	~~A1~~	
R0L*3	R0H*3	dsp:8[SB]	dsp:8[FB]	R0L*3	R0H*3	~~dsp:8[SB]~~	~~dsp:8[FB]~~
abs16	~~#IMM~~			~~abs16~~	~~A0~~	~~A1~~	

*2 Only (.B) can be selected as the size specifier (.size).

*3 The same register cannot be used for *src* and *dest*.

BAND

Logically AND bits
Bit AND carry flag

BAND

[Syntax]

BAND src

[Instruction Code/Number of Cycles]

Page: 150

[Operation]

C ← src ∧ C

[Function]

- This instruction logically ANDs the C flag and *src* and stores the result in the C flag.

[Selectable src]

src			
bit,R0	bit,R1	bit,R2	bit,R3
bit,A0	bit,A1	[A0]	[A1]
base:8[A0]	base:8[A1]	bit,base:8[SB]	bit,base:8[FB]
base:16[A0]	base:16[A1]	bit,base:16[SB]	bit,base:16
~~bit,base:11[SB]~~			

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	—	—	—	○

Conditions

C : The flag is set when the operation results in 1; otherwise cleared.

[Description Example]

```
BAND    flag
BAND    4,Ram
BAND    16,Ram:16[SB]
BAND    [A0]
```

[Related Instructions] BOR, BXOR, BNAND, BNOR, BNXOR

BCLR

Clear bit
Bit CLeaR

BCLR

[Syntax]

BCLR (:format) dest

G , S (Can be specified)

[Instruction Code/Number of Cycles]

Page: 150

[Operation]

dest ← 0

[Function]

- This instruction stores 0 in *dest*.

[Selectable dest]

dest			
bit,R0	bit,R1	bit,R2	bit,R3
bit,A0	bit,A1	[A0]	[A1]
base:8[A0]	base:8[A1]	bit,base:8[SB]	bit,base:8[FB]
base:16[A0]	base:16[A1]	bit,base:16[SB]	bit,base:16
	bit,base:11[SB]*1		

*1 This *dest* can only be selected when in S format.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	–	–	–	–	–	–	–	–

[Description Example]

```
BCLR    flag
BCLR    4,Ram:8[SB]
BCLR    16,Ram:16[SB]
BCLR    [A0]
```

[Related Instructions] BSET, BNOT, BNTST, BTST, BTSTC, BTSTS

BM*Cnd*

Conditional bit transfer
Bit Move Condition

BM*Cnd*

[Syntax]

BM*Cnd* **dest**

[Instruction Code/Number of Cycles]

Page: 152

[Operation]

if true then dest ← 1
else dest ← 0

[Function]

- This instruction transfers the true or false value of the condition indicated by *Cnd* to *dest*. If the condition is true, 1 is transferred; if false, 0 is transferred.
- The supported types of *Cnd* are as follows.

Cnd	Condition		Expression	*Cnd*	Condition		Expression
GEU/C	C=1	Equal to or greater than C flag is 1.	≦	LTU/NC	C=0	Less than C flag is 0.	>
EQ/Z	Z=1	Equal to Z flag is 1.	=	NE/NZ	Z=0	Not equal Z flag is 0.	≠
GTU	C∧$\overline{Z}$=1	Greater than	<	LEU	C∧$\overline{Z}$=0	Equal to or less than	≧
PZ	S=0	Positive or zero	0≦	N	S=1	Negative	0>
GE	S∀O=0	Equal to or greater than (signed value)	≦	LE	(S∀O)∨Z=1	Equal to or less than (signed value)	≧
GT	(S∀O)∨Z=0	Greater than (signed value)	<	LT	S∀O=1	Less than (signed value)	>
O	O=1	O flag is 1.		NO	O=0	O flag is 0.	

[Selectable dest]

dest			
bit,R0	bit,R1	bit,R2	bit,R3
bit,A0	bit,A1	[A0]	[A1]
base:8[A0]	base:8[A1]	bit,base:8[SB]	bit,base:8[FB]
base:16[A0]	base:16[A1]	bit,base:16[SB]	bit,base:16
C	bit,base:11[SB]		

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	—	—	—	*1

*1 The flag changes if the C flag was specified for *dest*.

[Description Example]

```
BMN     3,Ram:8[SB]
BMZ     C
```

[Related Instructions] J*Cnd*

BNAND

Logically AND inverted bits
Bit Not AND carry flag

BNAND

[Syntax]

BNAND src

[Instruction Code/Number of Cycles]

Page: 153

[Operation]

$C \leftarrow \overline{src} \wedge C$

[Function]

- This instruction logically ANDs the C flag and the inverted value of *src* and stores the result in the C flag.

[Selectable src]

src			
bit,R0	bit,R1	bit,R2	bit,R3
bit,A0	bit,A1	[A0]	[A1]
base:8[A0]	base:8[A1]	bit,base:8[SB]	bit,base:8[FB]
base:16[A0]	base:16[A1]	bit,base:16[SB]	bit,base:16
∈	bit,base:11[SB]		

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	—	—	—	○

Condition

C : The flag is set when the operation results in 1; otherwise cleared.

[Description Example]

```
BNAND    flag
BNAND    4,Ram
BNAND    16,Ram:16[SB]
BNAND    [A0]
```

[Related Instructions] BAND, BOR, BXOR, BNOR, BNXOR

BNOR

Logically OR inverted bits
Bit Not OR carry flag

BNOR

[Syntax]

BNOR src

[Instruction Code/Number of Cycles]

Page: 154

[Operation]

$C \leftarrow \overline{src} \vee C$

[Function]

- This instruction logically ORs the C flag and the inverted value of *src* and stores the result in the C flag.

[Selectable src]

src			
bit,R0	bit,R1	bit,R2	bit,R3
bit,A0	bit,A1	[A0]	[A1]
base:8[A0]	base:8[A1]	bit,base:8[SB]	bit,base:8[FB]
base:16[A0]	base:16[A1]	bit,base:16[SB]	bit,base:16
~~C~~	~~bit,base:11[SB]~~		

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	—	—	—	○

Condition

C : The flag is set when the operation results in 1; otherwise cleared.

[Description Example]

```
BNOR    flag
BNOR    4,Ram
BNOR    16,Ram:16[SB]
BNOR    [A0]
```

[Related Instructions] BAND, BOR, BXOR, BNAND, BNXOR

BNOT

Invert bit
Bit NOT

BNOT

[Syntax]

BNOT(:format) dest

G , S (Can be specified)

[Instruction Code/Number of Cycles]

Page: 154

[Operation]

dest ← $\overline{\text{dest}}$

[Function]

- This instruction inverts *dest* and stores the result in *dest*.

[Selectable dest]

dest			
bit,R0	bit,R1	bit,R2	bit,R3
bit,A0	bit,A1	[A0]	[A1]
base:8[A0]	base:8[A1]	bit,base:8[SB]	bit,base:8[FB]
base:16[A0]	base:16[A1]	bit,base:16[SB]	bit,base:16
	bit,base:11[SB]*1		

*1 This *dest* can only be selected when in S format.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	–	–	–	–	–	–	–	–

[Description Example]

```
BNOT    flag
BNOT    4,Ram:8[SB]
BNOT    16,Ram:16[SB]
BNOT    [A0]
```

[Related Instructions] BCLR, BSET, BNTST, BTST, BTSTC, BTSTS

BNTST

Test inverted bit
Bit Not TeST

BNTST

[Syntax]

BNTST src

[Instruction Code/Number of Cycles]

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[Operation]

Z ← $\overline{src}$
C ← $\overline{src}$

[Function]

- This instruction transfers the inverted value of *src* to the Z flag and the inverted value of *src* to the C flag.

[Selectable src]

src			
bit,R0	bit,R1	bit,R2	bit,R3
bit,A0	bit,A1	[A0]	[A1]
base:8[A0]	base:8[A1]	bit,base:8[SB]	bit,base:8[FB]
base:16[A0]	base:16[A1]	bit,base:16[SB]	bit,base:16
~~bit,base:11[SB]~~			

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	—	○	—	○

Conditions

Z : The flag is set when *src* is 0; otherwise cleared.
C : The flag is set when *src* is 0; otherwise cleared.

[Description Example]

```
BNTST   flag
BNTST   4,Ram:8[SB]
BNTST   16,Ram:16[SB]
BNTST   [A0]
```

[Related Instructions] BCLR, BSET, BNOT, BTST, BTSTC, BTSTS

BNXOR

Exclusive OR inverted bits
Bit Not eXclusive OR carry flag

BNXOR

[Syntax]

BNXOR src

[Instruction Code/Number of Cycles]

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[Operation]

$C \leftarrow \overline{src} \ \forall \ C$

[Function]

- This instruction exclusive ORs the C flag and the inverted value of *src* and stores the result in the C flag.

[Selectable src]

src			
bit,R0	bit,R1	bit,R2	bit,R3
bit,A0	bit,A1	[A0]	[A1]
base:8[A0]	base:8[A1]	bit,base:8[SB]	bit,base:8[FB]
base:16[A0]	base:16[A1]	bit,base:16[SB]	bit,base:16
∈	bit,base:11[SB]		

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	—	—	—	○

Conditions

C : The flag is set when the operation results in 1; otherwise cleared.

[Description Example]

```
BNXOR   flag
BNXOR   4,Ram
BNXOR   16,Ram:16[SB]
BNXOR   [A0]
```

[Related Instructions] BAND, BOR, BXOR, BNAND, BNOR

BOR

Logically OR bits
Bit OR carry flag

BOR

[Syntax]

BOR src

[Instruction Code/Number of Cycles]

Page: 156

[Operation]

C ← src ∨ C

[Function]

- This instruction logically ORs the C flag and *src* and stores the result in the C flag.

[Selectable src]

src			
bit,R0	bit,R1	bit,R2	bit,R3
bit,A0	bit,A1	[A0]	[A1]
base:8[A0]	base:8[A1]	bit,base:8[SB]	bit,base:8[FB]
base:16[A0]	base:16[A1]	bit,base:16[SB]	bit,base:16
~~bit,base:11[SB]~~			

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	—	—	—	○

Conditions

C : The flag is set when the operation results in 1; otherwise cleared.

[Description Example]

```
BOR     flag
BOR     4,Ram
BOR     16,Ram:16[SB]
BOR     [A0]
```

[Related Instructions] BAND, BXOR, BNAND, BNOR, BNXOR

BRK

Debug interrupt
BReaK

BRK

[Syntax]

BRK

[Instruction Code/Number of Cycles]

Page: 157

[Operation]

SP ← SP – 2
M(SP) ← (PC + 1)H, FLG
SP ← SP – 2
M(SP) ← (PC + 1)ML
PC ← M(FFFE4$_{16}$)

[Function]

- This instruction generates a BRK interrupt.
- The BRK interrupt is a nonmaskable interrupt.

[Flag Change][*1]

Flag	U	I	O	B	S	Z	D	C
Change	○	○	—	—	—	—	○	—

Conditions

U : The flag is cleared.
I : The flag is cleared.
D : The flag is cleared.

*1 The flags are saved to the stack area before the BRK instruction is executed. After the interrupt, the flags change state as shown at left.

[Description Example]

BRK

[Related Instructions] INT, INTO

BSET

Set bit
Bit SET

BSET

[Syntax]

BSET (:format) dest

G , S (Can be specified)

[Instruction Code/Number of Cycles]

Page: 157

[Operation]

dest ← 1

[Function]

- This instruction stores 1 in *dest*.

[Selectable dest]

dest			
bit,R0	bit,R1	bit,R2	bit,R3
bit,A0	bit,A1	[A0]	[A1]
base:8[A0]	base:8[A1]	bit,base:8[SB]	bit,base:8[FB]
base:16[A0]	base:16[A1]	bit,base:16[SB]	bit,base:16
	bit,base:11[SB]*1		

*1 This *dest* can only be selected when in S format.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	—	—	—	—

[Description Example]

```
BSET    flag
BSET    4,Ram:8[SB]
BSET    16,Ram:16[SB]
BSET    [A0]
```

[Related Instructions] BCLR, BNOT, BNTST, BTST, BTSTC, BTSTS

BTST

Test bit
Bit TeST

BTST

[Syntax]

BTST (:format) src

G , S (Can be specified)

[Instruction Code/Number of Cycles]

Page: 158

[Operation]

Z ← $\overline{\text{src}}$

C ← src

[Function]

- This instruction transfers the inverted value of *src* to the Z flag and the non-inverted value of *src* to the C flag.

[Selectable src]

src			
bit,R0	bit,R1	bit,R2	bit,R3
bit,A0	bit,A1	[A0]	[A1]
base:8[A0]	base:8[A1]	bit,base:8[SB]	bit,base:8[FB]
base:16[A0]	base:16[A1]	bit,base:16[SB]	bit,base:16
	bit,base:11[SB]*1		

*1 This *src* can only be selected when in S format.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	—	○	—	○

Conditions

Z : The flag is set when *src* is 0; otherwise cleared.

C : The flag is set when *src* is 1; otherwise cleared.

[Description Example]

```
BTST    flag
BTST    4,Ram:8[SB]
BTST    16,Ram:16[SB]
BTST    [A0]
```

[Related Instructions] BCLR, BSET, BNOT, BNTST, BTSTC, BTSTS

BTSTC

Test bit and clear
Bit TeST and Clear

BTSTC

[Syntax]

BTSTC **dest**

[Instruction Code/Number of Cycles]

Page: 159

[Operation]

Z ← $\overline{\text{dest}}$
C ← dest
dest ← 0

[Function]

- This instruction transfers the inverted value of *dest* to the Z flag and the non-inverted value of *dest* to the C flag. Then it stores 0 in *dest*.

[Selectable dest]

dest			
bit,R0	bit,R1	bit,R2	bit,R3
bit,A0	bit,A1	[A0]	[A1]
base:8[A0]	base:8[A1]	bit,base:8[SB]	bit,base:8[FB]
base:16[A0]	base:16[A1]	bit,base:16[SB]	bit,base:16
~~C~~	~~bit,base:11[SB]~~		

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	—	○	—	○

Conditions

Z : The flag is set when *dest* is 0; otherwise cleared.
C : The flag is set when *dest* is 1; otherwise cleared.

[Description Example]

```
BTSTC   flag
BTSTC   4,Ram
BTSTC   16,Ram:16[SB]
BTSTC   [A0]
```

[Related Instructions] BCLR, BSET, BNOT, BNTST, BTST, BTSTS

BTSTS

Test bit and set
Bit TeST and Set

BTSTS

[Syntax]

BTSTS **dest**

[Instruction Code/Number of Cycles]

Page: 160

[Operation]

Z ← $\overline{\text{dest}}$
C ← dest
dest ← 1

[Function]

- This instruction transfers the inverted value of *dest* to the Z flag and the non-inverted value of *dest* to the C flag. Then it stores 1 in *dest*.

[Selectable dest]

dest			
bit,R0	bit,R1	bit,R2	bit,R3
bit,A0	bit,A1	[A0]	[A1]
base:8[A0]	base:8[A1]	bit,base:8[SB]	bit,base:8[FB]
base:16[A0]	base:16[A1]	bit,base:16[SB]	bit,base:16
~~C~~	~~bit,base:11[SB]~~		

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	—	○	—	○

Conditions

Z : The flag is set when *dest* is 0; otherwise cleared.
C : The flag is set when *dest* is 1; otherwise cleared.

[Description Example]

```
BTSTS   flag
BTSTS   4,Ram
BTSTS   16,Ram:16[SB]
BTSTS   [A0]
```

[Related Instructions] BCLR, BSET, BNOT, BNTST, BTST, BTSTC

BXOR

Exclusive OR bits
Bit eXclusive OR carry flag

BXOR

[Syntax]

BXOR src

[Instruction Code/Number of Cycles]

Page: 160

[Operation]

C ← src ∀ C

[Function]

- This instruction exclusive ORs the C flag and *src* and stores the result in the C flag.

[Selectable src]

src			
bit,R0	bit,R1	bit,R2	bit,R3
bit,A0	bit,A1	[A0]	[A1]
base:8[A0]	base:8[A1]	bit,base:8[SB]	bit,base:8[FB]
base:16[A0]	base:16[A1]	bit,base:16[SB]	bit,base:16
~~C~~	~~bit,base:11[SB]~~		

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	—	—	—	○

Conditions

C : The flag is set when the operation results in 1; otherwise cleared.

[Description Example]

```
BXOR    flag
BXOR    4,Ram
BXOR    16,Ram:16[SB]
BXOR    [A0]
```

[Related Instructions] BAND, BOR, BNAND, BNOR, BNXOR

CMP

Compare
CoMPare

CMP

[Syntax]

CMP.size (:format) src,dest

G , Q , S (Can be specified)
B , W

[Instruction Code/Number of Cycles]

Page: 161

[Operation]

dest – src

[Function]

- Flag bits in the flag register change depending on the result of subtraction of *src* from *dest*.
- If *dest* is A0 or A1 and the selected size specifier (.size) is (.B), *src* is zero-expanded to perform operation in 16 bits. If *src* is A0 or A1, operation is performed on the 8 low-order bits of A0 or A1.

[Selectable src/dest]

(See next page for *src/dest* classified by format.)

src				dest			
R0L/R0	R0H/R1	R1L/R2	R1H/R3	R0L/R0	R0H/R1	R1L/R2	R1H/R3
A0/A0*1	A1/A1*1	[A0]	[A1]	A0/A0*1	A1/A1*1	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]	dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16	dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	#IMM	~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	~~SP/SP~~
~~R2R0~~	~~R3R1~~	~~A1A0~~		~~R2R0~~	~~R3R1~~	~~A1A0~~	

*1 If (.B) is selected as the size specifier (.size), A0 or A1 cannot be chosen for *src* and *dest* simultaneously.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	○	—	○	○	—	○

Conditions

O : The flag is set when a signed operation results in a value exceeding +32767 (.W) or –32768 (.W), or +127 (.B) or –128 (.B); otherwise cleared.

S : The flag is set when the operation results in MSB = 1; otherwise cleared.

Z : The flag is set when the operation results in 0; otherwise cleared.

C : The flag is set when an unsigned operation results in any value equal to or greater than 0; otherwise cleared.

[Description Example]

```
CMP.B:S    #10,R0L
CMP.W:G    R0,A0
CMP.W      #–3,R0
CMP.B      #5,Ram:8[FB]
CMP.B      A0,R0L          ; 8 low-order bits of A0 and R0L are compared.
```

[src/dest Classified by Format]

G format

src				dest			
R0L/R0	R0H/R1	R1L/R2	R1H/R3	R0L/R0	R0H/R1	R1L/R2	R1H/R3
A0/A0*1	A1/A1*1	[A0]	[A1]	A0/A0*1	A1/A1*1	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]	dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16	dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
dsp:20[A0]	dsp:20[A1]	abs20	#IMM	dsp:20[A0]	dsp:20[A1]	abs20	SP/SP
R2R0	R3R1	A1A0		R2R0	R3R1	A1A0	

*1 If (.B) is selected as the size specifier (.size), A0 or A1 cannot be chosen for *src* and *dest* simultaneously.

Q format

src				dest			
R0L/R0	R0H/R1	R1L/R2	R1H/R3	R0L/R0	R0H/R1	R1L/R2	R1H/R3
A0/A0	A1/A1	[A0]	[A1]	A0/A0	A1/A1	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]	dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16	dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
dsp:20[A0]	dsp:20[A1]	abs20	#IMM*2	dsp:20[A0]	dsp:20[A1]	abs20	SP/SP
R2R0	R3R1	A1A0		R2R0	R3R1	A1A0	

*2 The acceptable range of values is $-8 \leq$ #IMM $\leq +7$.

S format*3

src				dest			
R0L	R0H	dsp:8[SB]	dsp:8[FB]	R0L	R0H	dsp:8[SB]	dsp:8[FB]
abs16	#IMM			abs16	A0	A1	
R0L*4	R0H*4	dsp:8[SB]	dsp:8[FB]	R0L*4	R0H*4	dsp:8[SB]	dsp:8[FB]
abs16	#IMM			abs16	A0	A1	

*3 Only (.B) can be selected as the size specifier (.size).

*4 The same register cannot be used for *src* and *dest*.

DADC

Decimal add with carry
Decimal ADdition with Carry

DADC

[Syntax]

DADC.size src,dest

B , W

[Instruction Code/Number of Cycles]

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[Operation]

dest ← src + dest + C

[Function]

- This instruction adds *dest*, *src*, and the C flag as decimal data and stores the result in *dest*.

[Selectable src/dest]

src				dest			
R0L/R0	R0H/R1	R1L/R2	R1H/R3	R0L/R0	R0H/R1	R1L/R2	R1H/R3
A0/A0	A1/A1	[A0]	[A1]	A0/A0	A1/A1	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]	dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16	dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
dsp:20[A0]	dsp:20[A1]	abs20	#IMM	dsp:20[A0]	dsp:20[A1]	abs20	
R2R0	R3R1	A1A0		R2R0	R3R1	A1A0	

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	○	○	—	○

Conditions

S : The flag is set when the operation results in MSB = 1; otherwise cleared.

Z : The flag is set when the operation results in 0; otherwise cleared.

C : The flag is set when the operation results in a value exceeding +9999 (.W) or +99 (.B); otherwise cleared.

[Description Example]

```
DADC.B    #3,R0L
DADC.W    R1,R0
```

[Related Instructions] DADD, DSUB, DSBB

DADD

Decimal add without carry
Decimal ADDition

DADD

[Syntax]

DADD.size src,dest

B , W

[Instruction Code/Number of Cycles]

Page: 167

[Operation]

dest ← src + dest

[Function]

- This instruction adds *dest* and *src* as decimal data and stores the result in *dest*.

[Selectable src/dest]

src				dest			
R0L/R0	R0H/R1	R1L/R2	R1H/R3	R0L/R0	R0H/R1	R1L/R2	R1H/R3
A0/A0	A1/A1	[A0]	[A1]	A0/A0	A1/A1	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]	dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16	dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
dsp:20[A0]	dsp:20[A1]	abs20	#IMM	dsp:20[A0]	dsp:20[A1]	abs20	
R2R0	R3R1	A1A0		R2R0	R3R1	A1A0	

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	○	○	—	○

Conditions

S : The flag is set when the operation results in MSB = 1; otherwise cleared.

Z : The flag is set when the operation results in 0; otherwise cleared.

C : The flag is set when the operation results in a value exceeding +9999 (.W) or +99 (.B); otherwise cleared.

[Description Example]

```
DADD.B    #3,R0L
DADD.W    R1,R0
```

[Related Instructions] DADC, DSUB, DSBB

DEC

Decrement
DECrement

DEC

[Syntax]

DEC.size dest

B , W

[Instruction Code/Number of Cycles]

Page: 169

[Operation]

dest ← dest – 1

[Function]

- This instruction decrements *dest* by 1 and stores the result in *dest*.

[Selectable dest]

dest			
R0L*1	R0H*1	dsp:8[SB]*1	dsp:8[FB]*1
abs16*1	A0*2	A1*2	

*1 Only (.B) can be specified as the size specifier (.size).

*2 Only (.W) can be specified as the size specifier (.size).

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	○	○	—	—

Conditions

S : The flag is set when the operation results in MSB = 1; otherwise cleared.

Z : The flag is set when the operation results in 0; otherwise cleared.

[Description Example]

```
DEC.W    A0
DEC.B    R0L
```

[Related Instructions] INC

DIV

Signed divide
DIVide

DIV

[Syntax]

DIV.size src

B , W

[Instruction Code/Number of Cycles]

Page: 170

[Operation]

If the size specifier (.size) is (.B)

R0L (quotient), R0H (remainder) ← R0 ÷ src

If the size specifier (.size) is (.W)

R0 (quotient), R2 (remainder) ← R2R0 ÷ src

[Function]

- This instruction divides R2R0 (R0)*1 by the signed value of *src* and stores the quotient in R0 (R0L)*1 and the remainder in R2 (R0H)*1. The remainder has the same sign as the dividend. Items in parentheses and followed by"*1" ( )*1 indicate registers that are the object of the operation when (.B) is selected as the size specifier (.size).
- If *src* is A0 or A1 and the selected size specifier (.size) is (.B), the operation is performed on the 8 low-order bits of A0 or A1.
- If (.B) is selected as the size specifier (.size), the O flag is set when the operation results in a quotient exceeding 8 bits or the divisor is 0. In this case, R0L and R0H are undefined.
- If (.W) is selected as the size specifier (.size), the O flag is set when the operation results in a quotient exceeding 16 bits or the divisor is 0. In this case, R0 and R2 are undefined.

[Selectable src]

src			
R0L/R0	R0H/R1	R1L/R2	R1H/R3
A0/A0	A1/A1	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	#IMM
~~R2R0~~	~~R3R1~~	~~A1A0~~	

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	○	—	—	—	—	—

Conditions

O : The flag is set when the operation results in a quotient exceeding 16 bits (.W) or 8 bits (.B) or the divisor is 0; otherwise cleared.

[Description Example]

```
DIV.B   A0      ;Value of 8 low-order bits of A0 is the divisor.
DIV.B   #4
DIV.W   R0
```

[Related Instructions] DIVU, DIVX, MUL, MULU

DIVU

Unsigned divide
DIVide Unsigned

DIVU

[Syntax]

DIVU.size src

└ **B , W**

[Instruction Code/Number of Cycles]

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[Operation]

If the size specifier (.size) is (.B)

R0L (quotient), R0H (remainder) ←R0 ÷ src

If the size specifier (.size) is (.W)

R0 (quotient), R2 (remainder) ←R2R0 ÷ src

[Function]

- This instruction divides R2R0 (R0)*1 by the unsigned value of *src* and stores the quotient in R0 (R0L)*1 and the remainder in R2 (R0H)*1. Items in parentheses and followed by"*1" ( )*1 indicate registers that are the object of the operation when (.B) is selected as the size specifier (.size).
- If *src* is A0 or A1 and the selected size specifier (.size) is (.B), the operation is performed on the 8 low-order bits of A0 or A1.
- If (.B) is selected as the size specifier (.size), the O flag is set when the operation results in a quotient exceeding 8 bits or the divisor is 0. In this case, R0L and R0H are undefined.
- If (.W) is selected as the size specifier (.size), the O flag is set when the operation results in a quotient exceeding 16 bits or the divisor is 0. In this case, R0 and R2 are undefined.

[Selectable src]

src			
R0L/R0	R0H/R1	R1L/R2	R1H/R3
A0/A0	A1/A1	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	#IMM
~~R2R0~~	~~R3R1~~	~~A1A0~~	

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	○	—	—	—	—	—

Conditions

O : The flag is set when the operation results in a quotient exceeding 16 bits (.W) or 8 bits (.B) or the divisor is 0; otherwise cleared.

[Description Example]

```
DIVU.B    A0        ;Value of 8 low-order bits of A0 is the divisor.
DIVU.B    #4
DIVU.W    R0
```

[Related Instructions] DIV, DIVX, MUL, MULU

DIVX

Signed divide
DIVide eXtension

DIVX

[Syntax]

DIVX.size src

B , W

[Instruction Code/Number of Cycles]

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[Operation]

If the size specifier (.size) is (.B)

R0L (quotient), R0H (remainder) ←R0 ÷ src

If the size specifier (.size) is (.W)

R0 (quotient), R2 (remainder) ←R2R0 ÷ src

[Function]

- This instruction divides R2R0 (R0)*1 by the signed value of *src* and stores the quotient in R0 (R0L)*1 and the remainder in R2 (R0H)*1. The remainder has the same sign as the divisor. Items in parentheses and followed by"*1" ( )*1 indicate registers that are the object of the operation when (.B) is selected as the size specifier (.size).
- If *src* is A0 or A1 and the selected size specifier (.size) is (.B), the operation is performed on the 8 low-order bits of A0 or A1.
- If (.B) is selected as the size specifier (.size), the O flag is set when the operation results in a quotient exceeding 8 bits or the divisor is 0. At this time, R0L and R0H are undefined.
- If (.W) is selected as the size specifier (.size), the O flag is set when the operation results in a quotient exceeding 16 bits or the divisor is 0. At this time, R0 and R2 are undefined.

[Selectable src]

src			
R0L/R0	R0H/R1	R1L/R2	R1H/R3
A0/A0	A1/A1	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	#IMM
~~R2R0~~	~~R3R1~~	~~A1A0~~	

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	○	—	—	—	—	—

Conditions

O : The flag is set when the operation results in a quotient exceeding 16 bits (.W) or 8 bits (.B) or the divisor is 0; otherwise cleared.

[Description Example]

```
DIVX.B    A0        ;Value of 8 low-order bits of A0 is the divisor.
DIVX.B    #4
DIVX.W    R0
```

[Related Instructions] DIV, DIVU, MUL, MULU

DSBB

Decimal subtract with borrow

Decimal SuBtract with Borrow

DSBB

[Syntax]

DSBB.size src,dest

B , W

[Instruction Code/Number of Cycles]

Page: 173

[Operation]

dest ← dest – src – $\overline{C}$

[Function]

- This instruction subtracts *src* and the inverted value of the C flag from *dest* as decimal data and stores the result in *dest*.

[Selectable src/dest]

src				dest			
~~R0L/R0~~	R0H/R1	~~R1L/R2~~	~~R1H/R3~~	R0L/R0	~~R0H/R1~~	~~R1L/R2~~	~~R1H/R3~~
~~A0/A0~~	~~A1/A1~~	~~[A0]~~	~~[A1]~~	~~A0/A0~~	~~A1/A1~~	~~[A0]~~	~~[A1]~~
~~dsp:8[A0]~~	~~dsp:8[A1]~~	~~dsp:8[SB]~~	~~dsp:8[FB]~~	~~dsp:8[A0]~~	~~dsp:8[A1]~~	~~dsp:8[SB]~~	~~dsp:8[FB]~~
~~dsp:16[A0]~~	~~dsp:16[A1]~~	~~dsp:16[SB]~~	~~abs16~~	~~dsp:16[A0]~~	~~dsp:16[A1]~~	~~dsp:16[SB]~~	~~abs16~~
~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	#IMM	~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	
~~R2R0~~	~~R3R1~~	~~A1A0~~		~~R2R0~~	~~R3R1~~	~~A1A0~~	

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	○	○	—	○

Conditions

S : The flag is set when the operation results in MSB = 1; otherwise cleared.

Z : The flag is set when the operation results in 0; otherwise cleared.

C : The flag is set when the operation results in any value equal to or greater than 0; otherwise cleared.

[Description Example]

```
DSBB.B    #3,R0L
DSBB.W    R1,R0
```

[Related Instructions] DADC, DADD, DSUB

DSUB

Decimal subtract without borrow

Decimal SUBtract

DSUB

[Syntax]

DSUB.size src,dest

B , W

[Instruction Code/Number of Cycles]

Page: 175

[Operation]

dest ← dest – src

[Function]

- This instruction subtracts *src* from *dest* as decimal data and stores the result in *dest*.

[Selectable src/dest]

src				dest			
R0L/R0	R0H/R1	R1L/R2	R1H/R3	R0L/R0	R0H/R1	R1L/R2	R1H/R3
A0/A0	A1/A1	[A0]	[A1]	A0/A0	A1/A1	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]	dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16	dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
dsp:20[A0]	dsp:20[A1]	abs20	#IMM	dsp:20[A0]	dsp:20[A1]	abs20	
R2R0	R3R1	A1A0		R2R0	R3R1	A1A0	

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	○	○	—	○

Conditions

S : The flag is set when the operation results in MSB = 1; otherwise cleared.

Z : The flag is set when the operation results in 0; otherwise cleared.

C : The flag is set when the operation results in any value equal to or greater than 0; otherwise cleared.

[Description Example]

```
DSUB.B    #3,R0L
DSUB.W    R1,R0
```

[Related Instructions] DADC, DADD, DSBB

ENTER

Build stack frame
ENTER function

ENTER

[Syntax]

ENTER src

[Instruction Code/Number of Cycles]

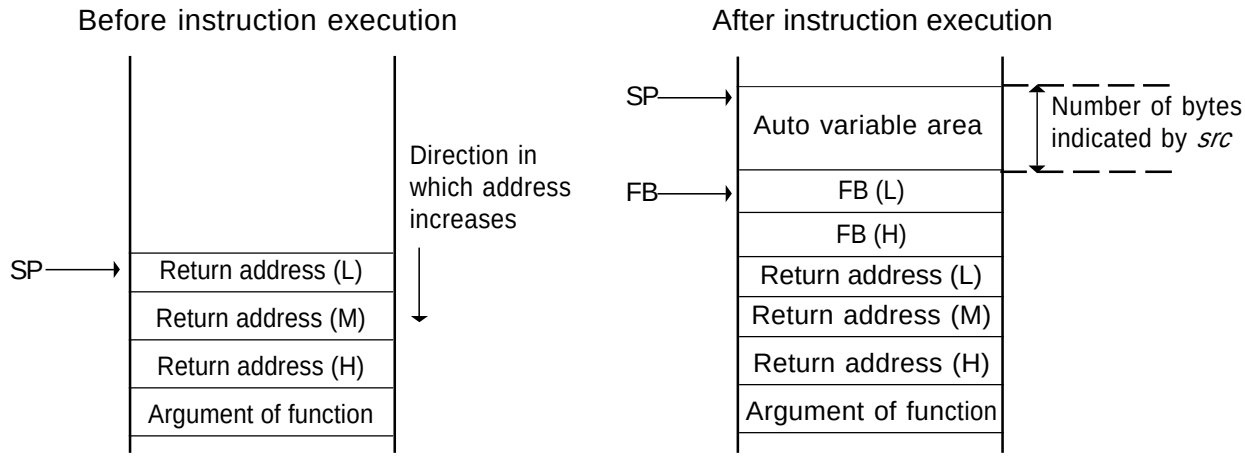
Page: 177

[Operation]

SP ← SP – 2
M(SP) ← FB
FB ← SP
SP ← SP – src

[Function]

- This instruction generates a stack frame. *src* represents the size of the stack frame.
- The diagrams below show the stack area status before and after the ENTER instruction is executed at the beginning of a called subroutine.



[Selectable src]

src
#IMM8

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	—	—	—	—

[Description Example]

```
ENTER    #3
```

[Related Instructions] EXITD

EXITD

Deallocate stack frame

EXIT and Deallocate stack frame

EXITD

[Syntax]

EXITD

[Instruction Code/Number of Cycles]

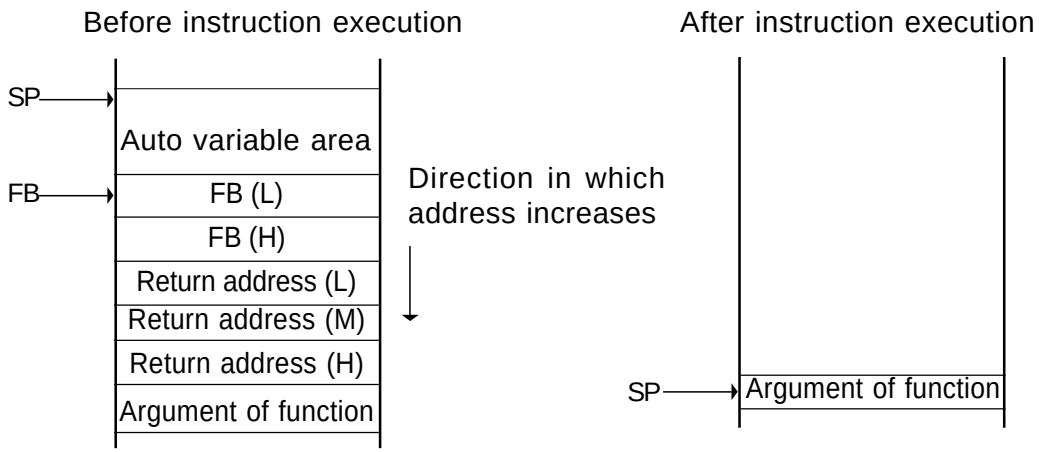
Page: 178

[Operation]

SP ← FB
FB ← M(SP)
SP ← SP + 2
PC_{ML} ← M(SP)
SP ← SP + 2
PC_{H} ← M(SP)
SP ← SP + 1

[Function]

- This instruction deallocates a stack frame and exits from the subroutine.
- Use this instruction in combination with the ENTER instruction.
- The diagrams below show the stack area status before and after the EXITD instruction is executed at the end of a subroutine in which an ENTER instruction was executed.



[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	—	—	—	—

[Description Example]

EXITD

[Related Instructions] ENTER

EXTS

Extend sign
EXTend Sign

EXTS

[Syntax]

EXTS.size dest

B , W

[Instruction Code/Number of Cycles]

Page: 178

[Operation]

dest ← EXT(dest)

[Function]

- This instruction sign extends *dest* and stores the result in *dest*.
- If (.B) is selected as the size specifier (.size), *dest* is sign extended to 16 bits.
- If (.W) is selected as the size specifier (.size), R0 is sign extended to 32 bits. In this case, R2 is used for the upper bytes.

[Selectable dest]

dest			
R0L/R0	~~R0H/R1~~	R1L~~/R2~~	~~R1H/R3~~
~~A0/A0~~	~~A1/A1~~	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	
~~R2R0~~	~~R3R1~~	~~A1A0~~	

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	○	○	—	—

Conditions

S : If (.B) is selected as the size specifier (.size), the flag is set when the operation results in MSB = 1; otherwise cleared. The flag does not change if (.W) is selected as the size specifier (.size).

Z : If (.B) is selected as the size specifier (.size), the flag is set when the operation results in 0; otherwise cleared. The flag does not change if (.W) is selected as the size specifier (.size).

[Description Example]

```
EXTS.B    R0L
EXTS.W    R0
```

FCLR

Clear flag register bit

Flag register CLeaR

FCLR

[Syntax]

FCLR dest

[Instruction Code/Number of Cycles]

Page: 179

[Operation]

dest ← 0

[Function]

- This instruction stores 0 in *dest*.

[Selectable dest]

dest							
C	D	Z	S	B	O	I	U

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	*1	*1	*1	*1	*1	*1	*1	*1

*1 The selected flag is cleared to 0.

[Description Example]

```
FCLR    I
FCLR    S
```

[Related Instructions] FSET

FSET

Set flag register bit
Flag register SET

FSET

[Syntax]

FSET dest

[Instruction Code/Number of Cycles]

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[Operation]

dest ← 1

[Function]

- This instruction stores 1 in *dest*.

[Selectable dest]

dest							
C	D	Z	S	B	O	I	U

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	*1	*1	*1	*1	*1	*1	*1	*1

*1 The selected flag is set (= 1).

[Description Example]

```
FSET    I
FSET    S
```

[Related Instructions] FCLR

INC

Increment
INCrement

INC

[Syntax]

INC.size dest

B , W

[Instruction Code/Number of Cycles]

Page: 180

[Operation]

dest ← dest + 1

[Function]

- This instruction adds 1 to *dest* and stores the result in *dest*.

[Selectable dest]

dest			
R0L*1	R0H*1	dsp:8[SB]*1	dsp:8[FB]*1
abs16*1	A0*2	A1*2	

*1 Only (.B) can be selected as the size specifier (.size).

*2 Only (.W) can be selected as the size specifier (.size).

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	○	○	—	—

Conditions

S : The flag is set when the operation results in MSB = 1; otherwise cleared.

Z : The flag is set when the operation results in 0; otherwise cleared.

[Description Example]

```
INC.W   A0
INC.B   R0L
```

[Related Instructions] DEC

INT

Interrupt by INT instruction
INTerrupt

INT

[Syntax]

INT src

[Instruction Code/Number of Cycles]

Page: 181

[Operation]

SP ← SP – 2
M(SP) ← (PC + 2)H, FLG
SP ← SP – 2
M(SP) ← (PC + 2)ML
PC ← M(IntBase + src × 4)

[Function]

- This instruction generates a software interrupt specified by *src*. *src* represents a software interrupt number.
- If *src* is 31 or smaller, the U flag is cleared to 0 and the interrupt stack pointer (ISP) is used.
- If *src* is 32 or larger, the stack pointer indicated by the U flag is used.
- The interrupts generated by the INT instruction are nonmaskable.

[Selectable src]

src
#IMM*1*2

*1 #IMM denotes a software interrupt number.

*2 The acceptable range of values is 0 ≤ #IMM ≤ 63.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	○	○	—	—	—	—	○	—

*3 The flags are saved to the stack area before the INT instruction is executed. After the interrupt, the flags change state as shown at left.

Conditions

U : The flag is cleared if the software interrupt number is 31 or smaller. The flag does not change if the software interrupt number is 32 or larger.

I : The flag is cleared.

D : The flag is cleared.

[Description Example]

```
INT     #0
```

[Related Instructions] BRK, INTO

INTO

Interrupt on overflow

INTerrupt on Overflow

INTO

[Syntax]

INTO

[Instruction Code/Number of Cycles]

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[Operation]

SP ← SP – 2
M(SP) ← (PC + 1)H, FLG
SP ← SP – 2
M(SP) ← (PC + 1)ML
PC ← M(FFFE016)

[Function]

- If the O flag is set to 1, this instruction generates an overflow interrupt. If the flag is cleared to 0, the next instruction is executed.
- The overflow interrupt is nonmaskable.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	○	○	—	—	—	—	○	—

*1 The flags are saved to the stack area before the INTO instruction is executed. After the interrupt, the flags change state as shown at left.

Conditions

U : The flag is cleared.
I : The flag is cleared.
D : The flag is cleared.

[Description Example]

```
INTO
```

[Related Instructions] BRK, INT

J*Cnd*

Jump on condition
Jump on Condition

J*Cnd*

[Syntax]

J*Cnd* label

[Instruction Code/Number of Cycles]

Page: 182

[Operation]

if true then jump label

[Function]

- This instruction causes program flow to branch after checking the execution result of the preceding instruction against the following condition. If the condition indicated by *Cnd* is true, control jumps to **label**. If false, the next instruction is executed.
- The following conditions can be used for *Cnd*:

Cnd	Condition		Expression	*Cnd*	Condition		Expression
GEU/C	C=1	Equal to or greater than C flag is 1.	≦	LTU/NC	C=0	Smaller than C flag is 0.	>
EQ/Z	Z=1	Equal to Z flag is 1.	=	NE/NZ	Z=0	Not equal Z flag is 0.	≠
GTU	C∧$\overline{Z}$=1	Greater than	<	LEU	C∧$\overline{Z}$=0	Equal to or smaller than	≧
PZ	S=0	Positive or zero	0≦	N	S=1	Negative	0>
GE	S∀O=0	Equal to or greater than (signed value)	≦	LE	(S∀O)∨Z=1	Equal to or smaller than (signed value)	≧
GT	(S∀O)∨Z=0	Greater than (signed value)	<	LT	S∀O=1	Smaller than (signed value)	>
O	O=1	O flag is 1.		NO	O=0	O flag is 0.	

[Selectable label]

label	***Cnd***
PC*1–127 ≦ label ≦ PC*1+128	GEU/C, GTU, EQ/Z, N, LTU/NC, LEU, NE/NZ, PZ
PC*1–126 ≦ label ≦ PC*1+129	LE, O, GE, GT, NO, LT

*1 PC indicates the start address of the instruction.

[Flag Change]

Flag	**U**	**I**	**O**	**B**	**S**	**Z**	**D**	**C**
Change	—	—	—	—	—	—	—	—

[Description Example]

```
JEQ     label
JNE     label
```

[Related Instructions] BM*Cnd*

JMP

Unconditional jump
JuMP

JMP

[Syntax]

JMP(.length) label

S , B , W , A (Can be specified)

[Instruction Code/Number of Cycles]

Page: 184

[Operation]

PC ← label

[Function]

- This instruction causes control to jump to **label**.

[Selectable label]

.length	label
.S	PC*1+2 ≦ label ≦ PC*1+9
.B	PC*1–127 ≦ label ≦ PC*1+128
.W	PC*1–32767 ≦ label ≦ PC*1+32768
.A	abs20

*1 PC indicates the start address of the instruction.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	—	—	—	—

[Description Example]

```
JMP     label
```

[Related Instructions] JMPI

JMPI

Jump indirect
JuMP Indirect

JMPI

[Syntax]

JMPI.length src

W , A

[Instruction Code/Number of Cycles]

Page: 185

[Operation]

When jump distance specifier (.length) is (.W)

PC ← PC ± src

When jump distance specifier (.length) is (.A)

PC ← src

[Function]

- This instruction causes control to jump to the address indicated by *src*. If *src* is a location in the memory, specify the address at which the low-order address is stored.
- If (.W) is selected as the jump distance specifier (.length), control jumps to the start address of the instruction plus the address indicated by *src* (added including the sign bits). If *src* is a location in the memory, the required memory capacity is 2 bytes.
- If *src* is a location in the memory and (.A) is selected as the jump distance specifier (.length), the required memory capacity is 3 bytes.

[Selectable src]

If (.W) is selected as the jump distance specifier (.length)

src			
~~R0L~~ R0	~~R0H~~ R1	~~R1L~~ R2	~~R1H~~ R3
~~A0~~ A0	~~A1~~ A1	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
~~dsp:16[A0]~~	~~dsp:16[A1]~~	dsp:16[SB]	abs16
dsp:20[A0]	dsp:20[A1]	~~abs20~~	
~~R2R0~~	~~R3R1~~	~~A1A0~~	

If (.A) is selected as the jump distance specifier (.length)

src			
~~R0L/R0~~	~~R0H/R1~~	~~R1L/R2~~	~~R1H/R3~~
~~A0/A0~~	~~A1/A1~~	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
~~dsp:16[A0]~~	~~dsp:16[A1]~~	dsp:16[SB]	abs16
dsp:20[A0]	dsp:20[A1]	~~abs20~~	
R2R0	R3R1	A1A0	

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	—	—	—	—

[Description Example]

```
JMPI.A    A1A0
JMPI.W    R0
```

[Related Instructions] JMP

JSR

Subroutine call
Jump SubRoutine

JSR

[Syntax]

JSR(.length) label

W , A (Can be specified)

[Instruction Code/Number of Cycles]

Page: 187

[Operation]

SP ← SP – 1
M(SP) ← (PC + n)H
SP ← SP – 2
M(SP) ← (PC + n)ML
PC ← label
*1 n denotes the number of instruction bytes.

[Function]

- This instruction causes control to jump to a subroutine indicated by **label**.

[Selectable label]

.length	label
.W	PC*1–32767 ≦ label ≦ PC*1+32768
.A	abs20

*1 PC indicates the start address of the instruction.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	—	—	—	—

[Description Example]

```
JSR.W    func
JSR.A    func
```

[Related Instructions] JSRI

JSRI

Indirect subroutine call
Jump SubRoutine Indirect

JSRI

[Syntax]

JSRI.length src

W , A

[Instruction Code/Number of Cycles]

Page: 188

[Operation]

When jump distance specifier (.length) is (.W)

SP ← SP – 1
M(SP) ← (PC + n)H
SP ← SP – 2
M(SP) ← (PC + n)ML
PC ← PC ± src
*1 n denotes the number of instruction bytes.

When jump distance specifier (.length) is (.A)

SP ← SP – 1
M(SP) ← (PC + n)H
SP ← SP – 2
M(SP) ← (PC + n)H
PC ← src

[Function]

- This instruction causes control to jump to a subroutine at the address indicated by *src*. If *src* is a location in the memory, specify the address at which the low-order address is stored.
- If (.W) is selected as the jump distance specifier (.length), control jumps to the subroutine at the start address of the instruction plus the address indicated by *src* (added including the sign bits). If *src* is a location in the memory, the required memory capacity is 2 bytes.
- If *src* is a location in the memory and (.A) is selected as the jump distance specifier (.length), the required memory capacity is 3 bytes.

[Selectable src]

If (.W) is selected as the jump distance specifier (.length)

src			
~~R0L~~ R0	~~R0H~~ R1	~~R1L~~ R2	~~R1H~~ R3
~~A0~~ A0	~~A1~~ A1	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
~~dsp:16[A0]~~	~~dsp:16[A1]~~	dsp:16[SB]	abs16
dsp:20[A0]	dsp:20[A1]	~~abs20~~	
~~R2R0~~	~~R3R1~~	~~A1A0~~	

If (.A) is selected as the jump distance specifier (.length)

src			
~~R0L/R0~~	~~R0H/R1~~	~~R1L/R2~~	~~R1H/R3~~
~~A0/A0~~	~~A1/A1~~	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
~~dsp:16[A0]~~	~~dsp:16[A1]~~	dsp:16[SB]	abs16
dsp:20[A0]	dsp:20[A1]	~~abs20~~	
R2R0	R3R1	A1A0	

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	—	—	—	—

[Description Example]

```
JSRI.A    A1A0
JSRI.W    R0
```

[Related Instructions] JSR

LDC

Transfer to control register
LoaD Control register

LDC

[Syntax]

LDC src,dest

[Instruction Code/Number of Cycles]

Page: 189

[Operation]

dest ← src

[Function]

- This instruction transfers *src* to the control register indicated by *dest*. If *src* is a location in the memory, the required memory capacity is 2 bytes.
- If the destination is INTBL or INTBH, make sure that bytes are transferred in succession.
- No interrupt requests are accepted immediately after this instruction.

[Selectable src/dest]

src				dest			
~~R0L~~ R0	~~R0H~~ R1	~~R1L~~ R2	~~R1H~~ R3	FB	SB	SP*1	ISP
~~A0~~ A0	~~A1~~ A1	[A0]	[A1]	FLG	INTBH	INTBL	
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]				
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16				
~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	#IMM				
~~R2R0~~	~~R3R1~~	~~A1A0~~					

*1 Operation is performed on the stack pointer indicated by the U flag.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	*2	*2	*2	*2	*2	*2	*2	*2

*2 The flag changes only when *dest* is FLG.

[Description Example]

```
LDC     R0,SB
LDC     A0,FB
```

[Related Instructions] POPC, PUSHC, STC, LDINTB

LDCTX

Restore context
LoaD ConTeXt

LDCTX

[Syntax]

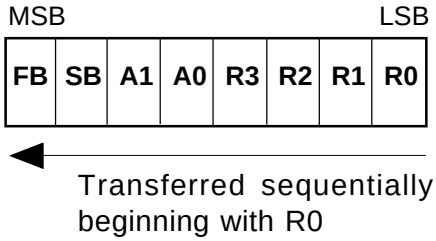
LDCTX abs16,abs20

[Instruction Code/Number of Cycles]

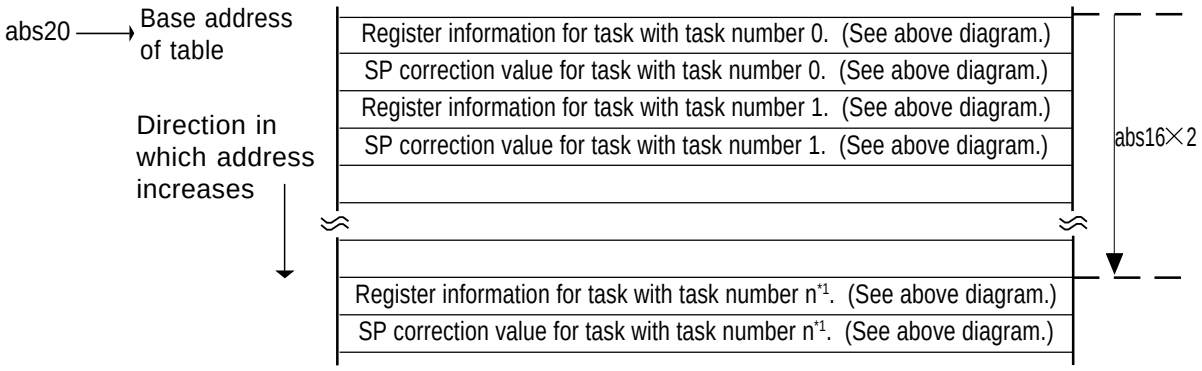
Page: 189

[Function]

- This instruction restores task context from the stack area.
- Set the RAM address that contains the task number in abs16 and the start address of table data in abs20.
- The required register information is specified from table data by the task number and the data in the stack area is transferred to each register according to the specified register information. Then the SP correction value is added to the stack pointer (SP). For this SP correction value, set the number of bytes to be transferred.
- Information on transferred registers is configured as shown below. Logical 1 indicates a register to be transferred and logical 0 indicates a register that is not transferred.



- The table data is configured as shown below. The address indicated by abs20 is the base address of the table. The data stored at an address twice the content of abs16 away from the base address indicates register information, and the next address contains the stack pointer correction value.



*1 n=0 to 255

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	—	—	—	—

[Description Example]

```
LDCTX    Ram,Rom_TBL
```

[Related Instructions] STCTX

LDE

Transfer from extended data area

LoaD from EXtra far data area

LDE

[Syntax]

LDE.size src,dest

B , W

[Instruction Code/Number of Cycles]

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[Operation]

dest ← src

[Function]

- This instruction transfers *src* from the extended area to *dest*.
- If *dest* is A0 or A1 and the selected size specifier (.size) is (.B), *src* is zero-expanded to transfer data in 16 bits.

[Selectable src/dest]

src				dest			
~~R0L/R0~~	~~R0H/R1~~	~~R1L/R2~~	~~R1H/R3~~	R0L/R0	R0H/R1	R1L/R2	R1H/R3
~~A0/A0~~	~~A1/A1~~	~~[A0]~~	~~[A1]~~	A0/A0	A1/A1	[A0]	[A1]
~~dsp:8[A0]~~	~~dsp:8[A1]~~	~~dsp:8[SB]~~	~~dsp:8[FB]~~	dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
~~dsp:16[A0]~~	~~dsp:16[A1]~~	~~dsp:16[SB]~~	~~abs16~~	dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
dsp:20[A0]	~~dsp:20[A1]~~	abs20	~~#IMM~~	~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	
~~R2R0~~	~~R3R1~~	~~A1A0~~	[A1A0]	~~R2R0~~	~~R3R1~~	~~A1A0~~	

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	○	○	—	—

Conditions

S : The flag is set when the transfer results in MSB of *dest* = 1; otherwise cleared.

Z : The flag is set when the transfer results in *dest* = 0; otherwise cleared.

[Description Example]

```
LDE.W    [A1A0],R0
LDE.B    Rom_TBL,A0
```

[Related Instructions] STE, MOV, XCHG

LDINTB

Transfer to INTB register

LoaD INTB register

LDINTB

[Syntax]

LDINTB src

[Instruction Code/Number of Cycles]

Page: 192

[Operation]

INTBHL ← src

[Function]

- This instruction transfers *src* to INTB.
- The LDINTB instruction is a macro-instruction consisting of the following:

```
LDC     #IMM, INTBH
LDC     #IMM, INTBL
```

[Selectable src]

src
#IMM20

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	—	—	—	—

[Description Example]

```
LDINTB      #0F0000H
```

[Related Instructions] LDC, STC, PUSHC, POPC

LDIPL

Set interrupt enable level

LoaD Interrupt Permission Level

LDIPL

[Syntax]

LDIPL src

[Instruction Code/Number of Cycles]

Page: 193

[Operation]

IPL ← src

[Function]

- This instruction transfers *src* to IPL.

[Selectable src]

src
#IMM*1

*1 The acceptable range of values is 0 ≤ #IMM ≤ 7

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	—	—	—	—

[Description Example]

```
LDIPL    #2
```

MOV

Transfer
MOVe

MOV

[Syntax]

MOV.size (:format) src,dest

G , Q , Z , S (Can be specified)

B , W

[Instruction Code/Number of Cycles]

Page: 193

[Operation]

dest ← src

[Function]

- This instruction transfers *src* to *dest*.
- If *dest* is A0 or A1 and the selected size specifier (.size) is (.B), *src* is zero-expanded to transfer data in 16 bits. If *src* is A0 or A1, the 8 low-order bits of A0 or A1 are transferred.

[Selectable src/dest]

(See next page for *src/dest* classified by format.)

src				dest			
R0L/R0	R0H/R1	R1L/R2	R1H/R3	R0L/R0	R0H/R1	R1L/R2	R1H/R3
A0/A0*1	A1/A1*1	[A0]	[A1]	A0/A0*1	A1/A1*1	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]	dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16	dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	#IMM*2	~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	
~~R2R0~~	~~R3R1~~	~~A1A0~~	dsp:8[SP]*3	~~R2R0~~	~~R3R1~~	~~A1A0~~	dsp:8[SP]*2 *3

*1 If (.B) is selected as the size specifier (.size), A0 or A1 cannot be chosen for *src* and *dest* simultaneously.
*2 If *src* is #IMM, dsp:8 [SP] cannot be chosen for *dest*.
*3 The operation is performed on the stack pointer indicated by the U flag. dsp:8 [SP] cannot be chosen for *src* and *dest* simultaneously.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	○	○	—	—

Conditions

S : The flag is set when the transfer results in MSB of *dest* = 1; otherwise cleared.

Z : The flag is set when the transfer results in 0; otherwise cleared.

[Description Example]

```
MOV.B:S    #0ABH,R0L
MOV.W      #–1,R2
```

[Related Instructions] LDE, STE, XCHG

[src/dest Classified by Format]

G format

src				dest			
R0L/R0	R0H/R1	R1L/R2	R1H/R3	R0L/R0	R0H/R1	R1L/R2	R1H/R3
A0/A0*1	A1/A1*1	[A0]	[A1]	A0/A0*1	A1/A1*1	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]	dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16	dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	#IMM*2	~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	~~SP/SP~~
~~R2R0~~	~~R3R1~~	~~A1A0~~	dsp:8[SP]*3	~~R2R0~~	~~R3R1~~	~~A1A0~~	dsp:8[SP]*2*3

*1 If (.B) is selected as the size specifier (.size), A0 or A1 cannot be chosen for *src* and *dest* simultaneously.
*2 If *src* is #IMM, dsp:8 [SP] cannot be chosen for *dest*.
*3 The operation is performed on the stack pointer indicated by the U flag. dsp:8 [SP] cannot be chosen for *src* and *dest* simultaneously.

Q format

src				dest			
~~R0L/R0~~	~~R0H/R1~~	~~R1L/R2~~	~~R1H/R3~~	R0L/R0	R0H/R1	R1L/R2	R1H/R3
~~A0/A0~~	~~A1/A1~~	~~[A0]~~	~~[A1]~~	A0/A0	A1/A1	[A0]	[A1]
~~dsp:8[A0]~~	~~dsp:8[A1]~~	~~dsp:8[SB]~~	~~dsp:8[FB]~~	dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
~~dsp:16[A0]~~	~~dsp:16[A1]~~	~~dsp:16[SB]~~	~~abs16~~	dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	#IMM*4	~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	~~SP/SP~~
~~R2R0~~	~~R3R1~~	~~A1A0~~		~~R2R0~~	~~R3R1~~	~~A1A0~~	

*4 The acceptable range of values is –8 ≤ #IMM ≤ +7.

S format

src				dest			
R0L*5*6*7	R0H*5*6*8	dsp:8[SB]*5	dsp:8[FB]*5	R0L*5*6	R0H*5*6		
abs16*5	~~#IMM~~			~~abs16~~	A0*5*8	A1*5*7	
R0L*5*6	R0H*5*6	~~dsp:8[SB]~~	~~dsp:8[FB]~~	R0L*5*6	R0H*5*6	dsp:8[SB]*5	dsp:8[FB]*5
~~abs16~~	~~#IMM~~			abs16*5	~~A0~~	~~A1~~	
~~R0L~~	~~R0H~~	~~dsp:8[SB]~~	~~dsp:8[FB]~~	R0L*5	R0H*5	dsp:8[SB]*5	dsp:8[FB]*5
~~abs16~~	#IMM*9			abs16*5	A0*9	A1*9	

*5 Only (.B) can be selected as the size specifier (.size).
*6 The same register cannot be chosen for *src* and *dest*.
*7 If *src* is R0L, only A1 can be selected for *dest* as the address register.
*8 If *src* is R0H, only A0 can be selected for *dest* as the address register.
*9 (.B) or (.W) can be selected as the size specifier (.size).

Z format

src				dest			
~~R0L~~	~~R0H~~	~~dsp:8[SB]~~	~~dsp:8[FB]~~	R0L	R0H	dsp:8[SB]	dsp:8[FB]
~~abs16~~	#0			abs16	~~A0~~	~~A1~~	

MOVA

Transfer effective address
MOVe effective Address

MOVA

[Syntax]

MOVA src,dest

[Instruction Code/Number of Cycles]

Page: 200

[Operation]

dest ← EVA(src)

[Function]

- This instruction transfers the affective address of *src* to *dest*.

[Selectable src/dest]

src				dest			
~~R0L/R0~~	~~R0H/R1~~	~~R1L/R2~~	~~R1H/R3~~	~~R0L~~/R0	~~R0H~~/R1	~~R1L~~/R2	~~R1H~~/R3
~~A0/A0~~	~~A1/A1~~	~~[A0]~~	~~[A1]~~	~~A0~~/A0	~~A1~~/A1	~~[A0]~~	~~[A1]~~
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]	~~dsp:8[A0]~~	~~dsp:8[A1]~~	~~dsp:8[SB]~~	~~dsp:8[FB]~~
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16	~~dsp:16[A0]~~	~~dsp:16[A1]~~	~~dsp:16[SB]~~	~~abs16~~
~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	~~#IMM~~	~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	
~~R2R0~~	~~R3R1~~	~~A1A0~~		~~R2R0~~	~~R3R1~~	~~A1A0~~	

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	—	—	—	—

[Description Example]

```
MOVA    Ram:16[SB],A0
```

[Related Instructions] PUSHA

MOV*Dir*

Transfer 4-bit data
MOVe nibble

MOV*Dir*

[Syntax]

MOV*Dir* **src,dest**

[Instruction Code/Number of Cycles]

Page: 201

[Operation]

Dir	Operation
HH	H4:dest ← H4:src
HL	L4:dest ← H4:src
LH	H4:dest ← L4:src
LL	L4:dest ← L4:src

[Function]

• Be sure to choose R0L for either *src* or *dest*.

Dir	Function
HH	Transfers src's 4 high-order bits to dest's 4 high-order bits.
HL	Transfers src's 4 high-order bits to dest's 4 low-order bits.
LH	Transfers src's 4 low-order bits to dest's 4 high-order bits.
LL	Transfers src's 4 low-order bits to dest's 4 low-order bits.

[Selectable src/dest]

src				**dest**			
R0L/R0	R0H/R1	R1L/R2	R1H/R3	R0L/R0	R0H/R1	R1L/R2	R1H/R3
A0/A0	A1/A1	[A0]	[A1]	A0/A0	A1/A1	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]	dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16	dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
dsp:20[A0]	dsp:20[A1]	abs20	#IMM	dsp:20[A0]	dsp:20[A1]	abs20	
R2R0	R3R1	A1A0		R2R0	R3R1	A1A0	
R0L/R0	R0H/R1	R1L/R2	R1H/R3	R0L/R0	R0H/R1	R1L/R2	R1H/R3
A0/A0	A1/A1	[A0]	[A1]	A0/A0	A1/A1	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]	dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16	dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
dsp:20[A0]	dsp:20[A1]	abs20	#IMM	dsp:20[A0]	dsp:20[A1]	abs20	
R2R0	R3R1	A1A0		R2R0	R3R1	A1A0	

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	—	—	—	—

[Description Example]

```
MOVHH   R0L,[A0]
MOVHL   R0L,[A0]
```

MUL

Signed multiply
MULtiple

MUL

[Syntax]

MUL.size src,dest

B , W

[Instruction Code/Number of Cycles]

Page: 203

[Operation]

dest ← dest × src

[Function]

- This instruction multiplies *src* and *dest* including the sign bits and stores the result in *dest*.
- If (.B) is selected as the size specifier (.size), *src* and *dest* are treated as 8-bit data for the operation and the result is stored in 16 bits. If A0 or A1 is specified as either *src* or *dest*, the operation is performed using the 8 low-order bits of A0 or A1.
- If (.W) is selected as the size specifier (.size), *src* and *dest* are treated as 16-bit data for the operation and the result is stored in 32 bits. If R0, R1, or A0 is specified as *dest*, the result is stored in R2R0, R3R1, or A1A0 accordingly.

[Selectable src/dest]

src				dest			
R0L/R0	R0H/R1	R1L/R2	R1H/R3	R0L/R0	R0H/R1	R1L/R2	R1H/R3
A0/A0*1	A1/A1*1	[A0]	[A1]	A0/A0*1	A1/A1	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]	dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16	dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
dsp:20[A0]	dsp:20[A1]	abs20	#IMM	dsp:20[A0]	dsp:20[A1]	abs20	
R2R0	R3R1	A1A0		R2R0	R3R1	A1A0	

*1 If (.B) is selected as the size specifier (.size), A0 or A1 cannot be chosen for *src* and *dest* simultaneously.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	—	—	—	—

[Description Example]

```
MUL.B   A0,R0L        ; 8 low-order bits of R0L and A0 are multiplied.
MUL.W   #3,R0
MUL.B   R0L,R1L
MUL.W   A0,Ram
```

[Related Instructions] DIV, DIVU, DIVX, MULU

MULU

Unsigned multiply
MULtiple Unsigned

MULU

[Syntax]

MULU.size src,dest

B , W

[Instruction Code/Number of Cycles]

Page: 205

[Operation]

dest ← dest × src

[Function]

- This instruction multiplies *src* and *dest* without the sign bits and stores the result in *dest*.
- If (.B) is selected as the size specifier (.size), *src* and *dest* are treated as 8-bit data for the operation and the result is stored in 16 bits. If A0 or A1 is specified as either *src* or *dest*, the operation is performed using the 8 low-order bits of A0 or A1.
- If (.W) is selected as the size specifier (.size), *src* and *dest* are treated as 16-bit data for the operation and the result is stored in 32 bits. If R0, R1, or A0 are specified as *dest*, the result is stored in R2R0, R3R1, or A1A0 accordingly.

[Selectable src/dest]

src				dest			
R0L/R0	R0H/R1	R1L/R2	R1H/R3	R0L/R0	R0H/R1	R1L/R2	R1H/R3
A0/A0*1	A1/A1*1	[A0]	[A1]	A0/A0*1	A1/A1	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]	dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16	dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
dsp:20[A0]	dsp:20[A1]	abs20	#IMM	dsp:20[A0]	dsp:20[A1]	abs20	
R2R0	R3R1	A1A0		R2R0	R3R1	A1A0	

*1 If (.B) is selected as the size specifier (.size), A0 or A1 cannot be chosen for *src* and *dest* simultaneously.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	—	—	—	—

[Description Example]

```
MULU.B   A0,R0L        ; 8 low-order bits of R0L and A0 are multiplied.
MULU.W   #3,R0
MULU.B   R0L,R1L
MULU.W   A0,Ram
```

[Related Instructions] DIV, DIVU, DIVX, MUL

NEG

Complement of two
NEGate

NEG

[Syntax]

NEG.size dest

B , W

[Instruction Code/Number of Cycles]

Page: 207

[Operation]

dest ← 0 – dest

[Function]

- This instruction takes the complement of two of *dest* and stores the result in *dest*.

[Selectable dest]

dest			
R0L/R0	R0H/R1	R1L/R2	R1H/R3
~~A0/~~A0	~~A1/~~A1	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	
~~R2R0~~	~~R3R1~~	~~A1A0~~	

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	○	—	○	○	—	○

Conditions

O : The flag is set when *dest* before the operation is –128 (.B) or –32768 (.W); otherwise cleared.
S : The flag is set when the operation results in MSB = 1; otherwise cleared.
Z : The flag is set when the operation results in 0; otherwise cleared.
C : The flag is set when the operation results in 0; otherwise cleared.

[Description Example]

```
NEG.B    R0L
NEG.W    A1
```

[Related Instructions] NOT

NOP

No operation
No OPeration

NOP

[Syntax]

NOP

[Instruction Code/Number of Cycles]

Page: 207

[Operation]

PC ← PC + 1

[Function]

- This instruction adds 1 to PC.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	—	—	—	—

[Description Example]

NOP

NOT

Invert all bits
NOT

NOT

[Syntax]

NOT.size (:format) dest

- **G , S** (Can be specified)
- **B , W**

[Instruction Code/Number of Cycles]

Page: 208

[Operation]

dest ← $\overline{\text{dest}}$

[Function]

- This instruction inverts *dest* and stores the result in *dest*.

[Selectable dest]

dest			
R0L*1/R0	R0H*1/R1	R1L/R2	R1H/R3
A0/A0	A1/A1	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]*1	dsp:8[FB]*1
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16*1
dsp:20[A0]	dsp:20[A1]	abs20	
R2R0	R3R1	A1A0	

*1 Can be selected in G and S formats.
In other cases, *dest* can be selected in G format.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	○	○	—	—

Conditions

S : The flag is set when the operation results in MSB = 1; otherwise cleared.

Z : The flag is set when the operation results in 0; otherwise cleared.

[Description Example]

```
NOT.B    R0L
NOT.W    A1
```

[Related Instructions] NEG

OR

Logically OR
OR

OR

[Syntax]

OR.size (:format) src,dest

- **G , S** (Can be specified)
- **B , W**

[Instruction Code/Number of Cycles]

Page: 209

[Operation]

dest ← src ∨ dest

[Function]

- This instruction logically ORs *dest* and *src* and stores the result in *dest*.
- If *dest* is A0 or A1 and the selected size specifier (.size) is (.B), *src* is zero-expanded to perform operation in 16 bits. If *src* is A0 or A1, operation is performed using the 8 low-order bits of A0 or A1.

[Selectable src/dest]

(See next page for *src/dest* classified by format.)

src				dest			
R0L/R0	R0H/R1	R1L/R2	R1H/R3	R0L/R0	R0H/R1	R1L/R2	R1H/R3
A0/A0*1	A1/A1*1	[A0]	[A1]	A0/A0*1	A1/A1*1	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]	dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16	dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	#IMM	~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	~~SP/SP~~
~~R2R0~~	~~R3R1~~	~~A1A0~~		~~R2R0~~	~~R3R1~~	~~A1A0~~	

*1 If (.B) is selected as the size specifier (.size), A0 or A1 cannot be chosen for *src* and *dest* simultaneously.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	○	○	—	—

Conditions

S : The flag is set when the operation results in MSB = 1; otherwise cleared.

Z : The flag is set when the operation results in 0; otherwise cleared.

[Description Example]

```
OR.B      Ram:8[SB],R0L
OR.B:G    A0,R0L          ; 8 low-order bits of A0 and R0L are ORed.
OR.B:G    R0L,A0          ; R0L is zero-expanded and ORed with A0.
OR.B:S    #3,R0L
```

[Related Instructions] AND, XOR, TST

[src/dest Classified by Format]

G format

src				dest			
R0L/R0	R0H/R1	R1L/R2	R1H/R3	R0L/R0	R0H/R1	R1L/R2	R1H/R3
A0/A0*1	A1/A1*1	[A0]	[A1]	A0/A0*1	A1/A1*1	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]	dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16	dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	#IMM	~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	~~SP/SP~~
~~R2R0~~	~~R3R1~~	~~A1A0~~		~~R2R0~~	~~R3R1~~	~~A1A0~~	

*1 If (.B) is selected as the size specifier (.size), A0 or A1 cannot be chosen for *src* and *dest* simultaneously.

S format*2

src				dest			
~~R0L~~	~~R0H~~	~~dsp:8[SB]~~	~~dsp:8[FB]~~	R0L	R0H	dsp:8[SB]	dsp:8[FB]
~~abs16~~	#IMM			abs16	~~A0~~	~~A1~~	
R0L*3	R0H*3	dsp:8[SB]	dsp:8[FB]	R0L*3	R0H*3	~~dsp:8[SB]~~	~~dsp:8[FB]~~
abs16	~~#IMM~~			~~abs16~~	~~A0~~	~~A1~~	

*2 Only (.B) can be specified as the size specifier (.size).

*3 The same register cannot be chosen for *src* and *dest*.

POP

Restore register/memory

POP

POP

[Syntax]

POP.size (:format) dest

G , S (Can be specified)

B , W

[Instruction Code/Number of Cycles]

Page: 211

[Operation]

If the size specifier (.size) is (.B)

dest ← M(SP)

SP ← SP + 1

If the size specifier (.size) is (.W)

dest ← M(SP)

SP ← SP + 2

[Function]

- This instruction restores *dest* from the stack area.

[Selectable dest]

dest			
R0L*1/R0	R0H*1/R1	R1L/R2	R1H/R3
~~A0/~~A0*1	~~A1/~~A1*1	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	
~~R2R0~~	~~R3R1~~	~~A1A0~~	

*1 Can be selected in G and S formats.

In other cases, *dest* can be selected in G format.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	—	—	—	—

[Description Example]

```
POP.B    R0L
POP.W    A0
```

[Related Instructions] PUSH, POPM, PUSHM

POPC

Restore control register
POP Control register

POPC

[Syntax]

POPC **dest**

[Instruction Code/Number of Cycles]

Page: 213

[Operation]

dest ← M(SP)
SP*1 ← SP + 2

*1 When *dest* is SP or when the U flag = 0 and *dest* is ISP, 2 is not added to SP.

[Function]

- This instruction restores data from the stack area to the control register indicated by *dest*.
- When restoring an interrupt table register, always be sure to restore INTBH and INTBL in succession.
- No interrupt requests are accepted immediately after this instruction.

[Selectable dest]

dest						
FB	SB	SP*2	ISP	FLG	INTBH	INTBL

*2 Operation is performed on the stack pointer indicated by the U flag.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	*3	*3	*3	*3	*3	*3	*3	*3

*3 The flag changes only when *dest* is FLG.

[Description Example]

```
POPC    SB
```

[Related Instructions] PUSHC, LDC, STC, LDINTB

POPM

Restore multiple registers
POP Multiple

POPM

[Syntax]

POPM **dest**

[Instruction Code/Number of Cycles]

Page: 213

[Operation]

dest ← M(SP)

SP ← SP + N*1 × 2

*1 Number of registers to be restored

[Function]

- This instruction restores the registers selected by *dest* collectively from the stack area.
- Registers are restored from the stack area in the following order:

FB	SB	A1	A0	R3	R2	R1	R0

Restored sequentially beginning with R0

[Selectable dest]

dest*2
R0 R1 R2 R3 A0 A1 SB FB

*2 More than one *dest* can be chosen.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	—	—	—	—

[Description Example]

```
POPM    R0,R1,A0,SB,FB
```

[Related Instructions] POP, PUSH, PUSHM

PUSH

Save register/memory/immediate data

PUSH

PUSH

[Syntax]

PUSH.size (:format) src

G , S (Can be specified)

B , W

[Instruction Code/Number of Cycles]

Page: 214

[Operation]

If the size specifier (.size) is (.B)

SP ← SP – 1

M(SP) ← src

If the size specifier (.size) is (.W)

SP ← SP – 2

M(SP) ← src

[Function]

- This instruction saves *src* to the stack area.

[Selectable src]

src			
R0L*1/R0	R0H*1/R1	R1L/R2	R1H/R3
~~A0/~~A0*1	~~A1/~~A1*1	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	#IMM
~~R2R0~~	~~R3R1~~	~~A1A0~~	

*1 Can be selected in G and S formats.

In other cases, *dest* can be selected in G format.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	–	–	–	–	–	–	–	–

[Description Example]

```
PUSH.B    #5
PUSH.W    #100H
PUSH.B    R0L
PUSH.W    A0
```

[Related Instructions] POP, POPM, PUSHM

PUSHA

Save effective address
PUSH effective Address

PUSHA

[Syntax]

PUSHA src

[Instruction Code/Number of Cycles]

Page: 216

[Operation]

SP ← SP – 2
M(SP) ← EVA(src)

[Function]

- This instruction saves the effective address of *src* to the stack area.

[Selectable src]

src			
~~R0L/R0~~	~~R0H/R1~~	~~R1L/R2~~	~~R1H/R3~~
~~A0/A0~~	~~A1/A1~~	~~[A0]~~	~~[A1]~~
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	
~~R2R0~~	~~R3R1~~	~~A1A0~~	

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	—	—	—	—

[Description Example]

```
PUSHA    Ram:8[FB]
PUSHA    Ram:16[SB]
```

[Related Instructions] MOVA

PUSHC

Save control register
PUSH Control register

PUSHC

[Syntax]

PUSHC src

[Instruction Code/Number of Cycles]

Page: 216

[Operation]

SP ← SP – 2

M(SP) ← src*1

*1 When *src* is SP or when the U flag = 0 and *src* is ISP, SP is saved before 2 is subtracted.

[Function]

- This instruction saves the control register indicated by *src* to the stack area.

[Selectable src]

src
FB SB SP*2 ISP FLG INTBH INTBL

*2 Operation is performed on the stack pointer indicated by the U flag.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	–	–	–	–	–	–	–	–

[Description Example]

```
PUSHC    SB
```

[Related Instructions] POPC, LDC, STC, LDINTB

PUSHM

Save multiple registers
PUSH Multiple

PUSHM

[Syntax]

PUSHM src

[Instruction Code/Number of Cycles]

Page: 217

[Operation]

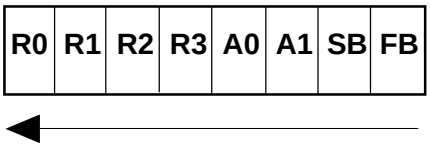
SP ← SP – N*1 × 2

M(SP) ← src

*1 Number of registers saved.

[Function]

- This instruction saves the registers selected by *src* collectively to the stack area.
- The registers are saved to the stack area in the following order:



Saved sequentially beginning with FB

[Selectable src]

src*2
R0 R1 R2 R3 A0 A1 SB FB

*2 More than one *src* can be chosen.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	–	–	–	–	–	–	–	–

[Description Example]

```
PUSHM    R0,R1,A0,SB,FB
```

[Related Instructions] POP, PUSH, POPM

REIT

Return from interrupt

REturn from InTerrupt

REIT

[Syntax]

REIT

[Instruction Code/Number of Cycles]

Page: 218

[Operation]

PC_{ML}	←	M(SP)
SP	←	SP + 2
PC_{H}, FLG	←	M(SP)
SP	←	SP + 2

[Function]

- This instruction restores the PC and FLG values that were saved when an interrupt request was accepted and returns from the interrupt handler routine.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	*1	*1	*1	*1	*1	*1	*1	*1

*1 The flags are reset to the FLG state before the interrupt request was accepted.

[Description Example]

```
REIT
```

RMPA

Calculate sum-of-products

Repeat MultiPle and Addition

RMPA

[Syntax]

RMPA.size

B , W

[Instruction Code/Number of Cycles]

Page: 218

[Operation][*1]

Repeat

R2R0(R0)[*2] ← R2R0(R0)[*2] + M(A0) × M(A1)
A0 ← A0 + 2 (1)[*2]
A1 ← A1 + 2 (1)[*2]
R3 ← R3 – 1

Until R3 = 0

*1 If R3 is set to 0, this instruction is ignored.

*2 Items in parentheses and followed by "*2"( )[*2] apply when (.B) is selected as the size specifier (.size).

[Function]

- This instruction performs sum-of-product calculations, with the multiplicand address indicated by A0, the multiplier address indicated by A1, and the count of operation indicated by R3. Calculations are performed including the sign bits and the result is stored in R2R0 (R0)[*1].
- If an overflow occurs during operation, the O flag is set to terminate the operation. R2R0 (R0)[*1] contains the result of the addition performed last. A0, A1, and R3 are undefined.
- The content of A0 or A1 when the instruction is completed indicates the next address after the last-read data.
- If an interrupt request is received during instruction execution, the interrupt is acknowledged after a sum-of-product addition is completed (i.e., after the content of R3 is decremented by 1).
- Make sure that R2R0 (R0)[*1] is set to the initial value.

Items in parentheses and followed by "*1"( )[*1] apply when (.B) is selected as the size specifier (.size).

[Fl ag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	○	—	—	—	—	—

Conditions

O : The flag is set when +2147483647 (.W) or –2147483648 (.W), or +32767 (.B) or –32768 (.B) is exceeded during operation; otherwise cleared.

[Description Example]

RMPA.B

ROLC

Rotate left with carry

ROtate to Left with Carry

ROLC

[Syntax]

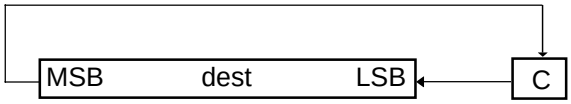
ROLC.size dest

B , W

[Instruction Code/Number of Cycles]

Page: 218

[Operation]



[Function]

- This instruction rotates *dest* one bit to the left including the C flag.

[Selectable dest]

dest			
R0L/R0	R0H/R1	R1L/R2	R1H/R3
~~A0/~~A0	~~A1/~~A1	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	
~~R2R0~~	~~R3R1~~	~~A1A0~~	

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	○	○	—	○

Conditions

S : The flag is set when the operation results in MSB = 1; otherwise cleared.

Z : The flag is set when the operation results in *dest* = 0; otherwise cleared.

C : The flag is set when the shifted-out bit is 1; otherwise cleared.

[Description Example]

```
ROLC.B    R0L
ROLC.W    R0
```

[Related Instructions] RORC, ROT, SHA, SHL

RORC

Rotate right with carry

ROtate to Right with Carry

RORC

[Syntax]

RORC.size dest

B , W

[Instruction Code/Number of Cycles]

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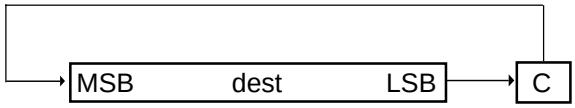
[Operation]



[Function]

- This instruction rotates *dest* one bit to the right including the C flag.

[Selectable dest]

dest			
R0L/R0	R0H/R1	R1L/R2	R1H/R3
~~A0/~~A0	~~A1/~~A1	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	
~~R2R0~~	~~R3R1~~	~~A1A0~~	

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	○	○	—	○

Conditions

S : The flag is set when the operation results in MSB = 1; otherwise cleared.

Z : The flag is set when the operation results in *dest* = 0; otherwise cleared.

C : The flag is set when the shifted-out bit is 1; otherwise cleared.

[Description Example]

```
RORC.B    R0L
RORC.W    R0
```

[Related Instructions] ROLC, ROT, SHA, SHL

ROT

Rotate
ROTate

ROT

[Syntax]

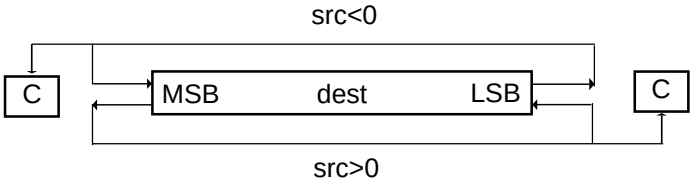
ROT.size src,dest

B , W

[Instruction Code/Number of Cycles]

Page: 220

[Operation]



[Function]

- This instruction rotates *dest* left or right the number of bits indicated by *src*. Bits overflowing from LSB (MSB) are transferred to MSB (LSB) and the C flag.
- The direction of rotation is determined by the sign of *src*. If *src* is positive, bits are rotated left; if negative, bits are rotated right.
- If *src* is an immediate value, the number of bits rotated is –8 to –1 or +1 to +8. Values less than –8, equal to 0, or greater than +8 are not valid.
- If *src* is a register and (.B) is selected as the size specifier (.size), the number of bits rotated is –8 to +8. Although a value of 0 may be set, no bits are rotated and no flags are changed. If a value less than –8 or greater than +8 is set, the result of the rotation is undefined.
- If *src* is a register and (.W) is selected as the size specifier (.size), the number of bits rotated is –16 to +16. Although a value of 0 may be set, no bits are rotated and no flags are changed. If a value less than –16 or greater than +16 is set, the result of the rotation is undefined.

[Selectable src/dest]

src				dest			
R0L/R0	R0H/R1	R1L/R2	R1H*1/R3	R0L/R0	R0H/R1*1	R1L/R2	R1H/R3*1
A0/A0	A1/A1	[A0]	[A1]	A0/A0	A1/A1	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]	dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16	dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
dsp:20[A0]	dsp:20[A1]	abs20	#IMM*2	dsp:20[A0]	dsp:20[A1]	abs20	
R2R0	R3R1	A1A0		R2R0	R3R1	A1A0	

*1 If *src* is R1H, R1 or R1H cannot be chosen for *dest*.

*2 The acceptable range of values is –8 ≤ #IMM ≤ +8. However, 0 is invalid.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	○	○	—	○

*1 If the number of bits rotated is 0, no flags are changed.

Conditions

S : The flag is set when the operation results in MSB = 1; otherwise cleared.

Z : The flag is set when the operation results in 0; otherwise cleared.

C : The flag is set when the bit shifted out last is 1; otherwise cleared.

[Description Example]

```
ROT.B   #1,R0L      ; Rotated left
ROT.B   #–1,R0L     ; Rotated right
ROT.W   R1H,R2
```

[Related Instructions] ROLC, RORC, SHA, SHL

RTS

Return from subroutine

ReTurn from Subroutine

RTS

[Syntax]

RTS

[Instruction Code/Number of Cycles]

Page: 221

[Operation]

$PC_{ML} \leftarrow M(SP)$

$SP \leftarrow SP + 2$

$PC_{H} \leftarrow M(SP)$

$SP \leftarrow SP + 1$

[Function]

- This instruction causes control to return from a subroutine.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	—	—	—	—

[Description Example]

RTS

SBB

Subtract with borrow
SuBtract with Borrow

SBB

[Syntax]

SBB.size src,dest

B , W

[Instruction Code/Number of Cycles]

Page: 222

[Operation]

dest ← dest – src – $\overline{C}$

[Function]

- This instruction subtracts *src* and the inverted value of the C flag from *dest* and stores the result in *dest*.
- If *dest* is A0 or A1 and the selected size specifier (.size) is (.B), *src* is zero-expanded to perform operation in 16 bits. If *src* is A0 or A1, the operation is performed using the 8 low-order bits of A0 or A1.

[Selectable src/dest]

src				dest			
R0L/R0	R0H/R1	R1L/R2	R1H/R3	R0L/R0	R0H/R1	R1L/R2	R1H/R3
A0/A0*1	A1/A1*1	[A0]	[A1]	A0/A0*1	A1/A1*1	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]	dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16	dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	#IMM	~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	
~~R2R0~~	~~R3R1~~	~~A1A0~~		~~R2R0~~	~~R3R1~~	~~A1A0~~	

*1 If (.B) is selected as the size specifier (.size), A0 or A1 cannot be chosen for *src* and *dest* simultaneously.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
	–	–	○	–	○	○	–	○

Conditions

O : The flag is set when a signed operation results in a value exceeding +32767 (.W) or –32768 (.W), or +127 (.B) or –128 (.B); otherwise cleared.

S : The flag is set when the operation results in MSB = 1; otherwise cleared.

Z : The flag is set when the operation results in 0; otherwise cleared.

C : The flag is set when an unsigned operation results in any value equal to or greater than 0; otherwise cleared.

[Description Example]

```
SBB.B   #2,R0L
SBB.W   A0,R0
SBB.B   A0,R0L      ; 8 low-order bits of A0 and R0L are the objects of the operation.
SBB.B   R0L,A0      ; Zero-expanded value of R0L and A0 are the objects of the operation.
```

[Related Instructions] ADC, ADCF, ADD, SUB

SBJNZ

Subtract and conditional jump
SuBtract then Jump on Not Zero

SBJNZ

[Syntax]

SBJNZ.size src,dest,label

B , W

[Instruction Code/Number of Cycles]

Page: 224

[Operation]

dest ← dest – src

if dest 0 **then** jump label

[Function]

- This instruction subtracts *src* from *dest* and stores the result in *dest*.
- If the operation results in any value other than 0, control jumps to **label**. If the operation results in 0, the next instruction is executed.
- The op-code of this instruction is the same as that of ADJNZ.

[Selectable src/dest/label]

src	dest			label
#IMM*1	R0L/R0 R1H/R3 [A0] dsp:8[A1] dsp:16[A0] abs16	R0H/R1 ~~A0/~~A0 [A1] dsp:8[SB] dsp:16[A1]	R1L/R2 ~~A1/~~A1 dsp:8[A0] dsp:8[FB] dsp:16[SB]	PC*2–126 ≤ label ≤ PC*2+129

*1 The acceptable range of values is –7 ≤ #IMM ≤ +8.

*2 PC indicates the start address of the instruction.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	—	—	—	—

[Description Example]

```
SBJNZ.W    #1,R0,label
```

[Related Instructions] ADJNZ

SHA

Shift arithmetic
SHift Arithmetic

SHA

[Syntax]

SHA.size src,dest

B , W , L

[Instruction Code/Number of Cycles]

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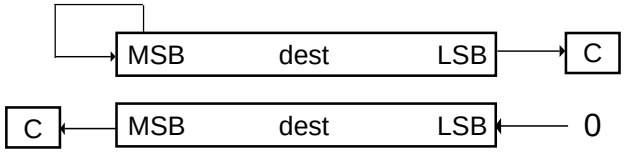
[Operation]

When *src* < 0

When *src* > 0



[Function]

- This instruction arithmetically shifts *dest* left or right the number of bits indicated by *src*. Bits overflowing from LSB (MSB) are transferred to the C flag.
- If *src* is an immediate value , the number of bits shifted is –8 to –1 or +1 to +8. Values less than –8, equal to 0, or greater than +8 are not valid.
- If *src* is a register and (.B) is selected as the size specifier (.size), the number of bits shifted is –8 to +8. Although a value of 0 may be set, no bits are shifted and no flags are changed. If a value less than –8 or greater than +8 is set, the result of the shift is undefined.
- If *src* is a register and (.W) or (.L) is selected as the size specifier (.size), the number of bits shifted is –16 to +16. Although a value of 0 may be set, no bits are shifted and no flags are changed. If a value less than –16 or greater than +16 is set, the result of shift is undefined.

[Selectable src/dest]

src				dest			
~~R0L/R0~~	~~R0H/R1~~	~~R1L/R2~~	R1H*1/~~R3~~	R0L/R0	R0H/R1*1	R1L/R2	R1H/R3*1
~~A0/A0~~	~~A1/A1~~	~~[A0]~~	~~[A1]~~	~~A0~~/A0	~~A1~~/A1	[A0]	[A1]
~~dsp:8[A0]~~	~~dsp:8[A1]~~	~~dsp:8[SB]~~	~~dsp:8[FB]~~	dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
~~dsp:16[A0]~~	~~dsp:16[A1]~~	~~dsp:16[SB]~~	~~abs16~~	dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	#IMM*2	~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	
~~R2R0~~	~~R3R1~~	~~A1A0~~		R2R0*3	R3R1*3	~~A1A0~~	

*1 If *src* is R1H, R1 or R1H cannot be chosen for *dest*.
*2 The acceptable range of values is –8 ≤ #IMM ≤ +8. However, 0 is invalid.
*3 Only (.L) can be selected as the size specifier (.size). (.B) or (.W) can also be specified for *dest*.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	○	—	○	○	—	○

*1 If the number of bits shifted is 0, no flags are changed.

Conditions

O : The flag is set when the operation results in MSB changing its state from 1 to 0 or from 0 to 1; otherwise cleared. However, the flag does not change if (.L) is selected as the size specifier (.size).
S : The flag is set when the operation results in MSB = 1; otherwise cleared.
Z : The flag is set when the operation results in 0; otherwise cleared. However, the flag value is undefined if (.L) is selected as the size specifier (.size).
C : The flag is set when the bit shifted out last is 1; otherwise cleared. However, the flag is indeterminate if (.L) is selected as the size specifier (.size).

[Description Example]

```
SHA.B   #3,R0L        ; Arithmetically shifted left
SHA.B   #–3,R0L       ; Arithmetically shifted right
SHA.L   R1H,R2R0
```

[Related Instructions] ROLC, RORC, ROT, SHL

SHL

Shift logical
SHift Logical

SHL

[Syntax]

SHL.size src,dest

B , W , L

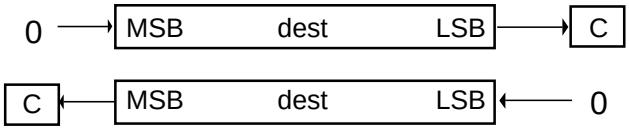
[Instruction Code/Number of Cycles]

Page: 228

[Operation]

When *src* < 0

When *src* > 0



[Function]

- This instruction logically shifts *dest* left or right the number of bits indicated by *src*. Bits overflowing from LSB (MSB) are transferred to the C flag.
- The direction of shift is determined by the sign of *src*. If *src* is positive, bits are shifted left; if negative, bits are shifted right.
- If *src* is an immediate value, the number of bits shifted is –8 to –1 or +1 to +8. Values less than –8, equal to 0, or greater than +8 are not valid.
- If *src* is a register and (.B) is selected as the size specifier (.size), the number of bits shifted is –8 to +8. Although a value of 0 may be set, no bits are shifted and no flags are changed. If a value less than –8 or greater than +8 is set, the result of the shift is undefined.
- If *src* is a register and (.W) or (.L) is selected as the size specifier (.size), the number of bits shifted is –16 to +16. Although a value of 0 may be set, no bits are shifted and no flags are changed. If a value less than –16 or greater than +16 is set, the result of the shift is undefined.

[Selectable src/dest]

src				dest			
~~R0L/R0~~	~~R0H/R1~~	~~R1L/R2~~	R1H*1/~~R3~~	R0L/R0	R0H/R1*1	R1L/R2	R1H/R3*1
~~A0/A0~~	~~A1/A1~~	~~[A0]~~	~~[A1]~~	~~A0~~/A0	~~A1~~/A1	[A0]	[A1]
~~dsp:8[A0]~~	~~dsp:8[A1]~~	~~dsp:8[SB]~~	~~dsp:8[FB]~~	dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
~~dsp:16[A0]~~	~~dsp:16[A1]~~	~~dsp:16[SB]~~	~~abs16~~	dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	#IMM*2	~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	
~~R2R0~~	~~R3R1~~	~~A1A0~~		R2R0*3	R3R1*3	~~A1A0~~	

*1 If *src* is R1H, R1 or R1H cannot be chosen for *dest*.
*2 The acceptable range of values is –8 ≤ #IMM ≤ +8. However, 0 is invalid.
*3 Only (.L) can be selected as the size specifier (.size). (.B) or (.W) can also be specified for *dest*.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	○	○	—	○

*1 If the number of bits shifted is 0, no flags are changed.

Conditions

S : The flag is set when the operation results in MSB = 1; otherwise cleared.
Z : The flag is set when the operation results in 0; otherwise cleared. However, the flag is undefined if (.L) is selected as the size specifier (.size).
C : The flag is set when the bit shifted out last is 1; otherwise cleared. However, the flag is undefined if (.L) is selected as the size specifier (.size).

[Description Example]

```
SHL.B   #3,R0L        ; Logically shifted left
SHL.B   #–3,R0L       ; Logically shifted right
SHL.L   R1H,R2R0
```

[Related Instructions] ROLC, RORC, ROT, SHA

SMOVB

Transfer string backward
String MOVe Backward

SMOVB

[Syntax]

SMOVB.size
└ **B , W**

[Instruction Code/Number of Cycles]

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[Operation][*1]

When size specifier (.size) is (.B)

Repeat

M(A1) ← M(2^{16} × R1H + A0)
A0[*2] ← A0 – 1
A1 ← A1 – 1
R3 ← R3 – 1

Until R3 = 0

When size specifier (.size) is (.W)

Repeat

M(A1) ← M(2^{16} × R1H + A0)
A0[*2] ← A0 – 2
A1 ← A1 – 2
R3 ← R3 – 1

Until R3 = 0

*1 If R3 is set to 0, this instruction is ignored.

*2 If A0 underflows, the content of R1H is decremented by 1.

[Function]

- This instruction transfers a string from a 20-bit source address to a 16-bit destination address by successively decrementing the address.
- Set the 4 high-order bits of the source address in R1H, the 16 low-order bits of the source address in A0, the destination address in A1, and the transfer count in R3.
- When the instruction is completed, A0 or A1 contains the next address after the last-read data.
- If an interrupt request is received during instruction execution, the interrupt is acknowledged after one data transfer is completed.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	—	—	—	—

[Description Example]

SMOVB.B

[Related Instructions] SMOVF, SSTR

SMOVF

Transfer string forward
String MOVe Forward

SMOVF

[Syntax]

SMOVF.size

B , W

[Instruction Code/Number of Cycles]

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[Operation][*1]

When size specifier (.size) is (.B)

Repeat

M(A1) ← M(2^{16} × R1H + A0)
A0[*2*] ← A0 + 1
A1 ← A1 + 1
R3 ← R3 – 1

Until R3 = 0

When size specifier (.size) is (.W)

Repeat

M(A1) ← M(2^{16} × R1H + A0)
A0[*2] ← A0 + 2
A1 ← A1 + 2
R3 ← R3 – 1

Until R3 = 0

*1 If R3 is set to 0, this instruction is ignored.

*2 If A0 overflows, the content of R1H is incremented by 1.

[Function]

- This instruction transfers a string from a 20-bit source address to a 16-bit destination address by successively incrementing the address.
- Set the 4 high-order bits of the source address in R1H, the 16 low-order bits of the source address in A0, the destination address in A1, and the transfer count in R3.
- When the instruction is completed, A0 or A1 contains the next address after the last-read data.
- If an interrupt request is received during instruction execution, the interrupt is acknowledged after one data transfer is completed.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	—	—	—	—

[Description Example]

SMOVF.W

[Related Instructions] SMOVB, SSTR

SSTR

Store string
String SToRe

SSTR

[Syntax]

SSTR.size

B , W

[Instruction Code/Number of Cycles]

Page: 231

[Operation][*1]

When size specifier (.size) is (.B)

Repeat
M(A1) ← R0L
A1 ← A1 + 1
R3 ← R3 – 1
Until R3 = 0

When size specifier (.size) is (.W)

Repeat
M(A1) ← R0
A1 ← A1 + 2
R3 ← R3 – 1
Until R3 = 0

*1 If R3 is set to 0, this instruction is ignored.

[Function]

- This instruction stores a string with the data to be stored indicated by R0, the transfer address indicated by A1, and the transfer count indicated by R3.
- When the instruction is completed, A0 or A1 contains the next address after the last-written data.
- If an interrupt request is received during instruction execution, the interrupt is acknowledged after one data transfer is completed.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	—	—	—	—

[Description Example]

SSTR.B

[Related Instructions] SMOVB, SMOVF

STC

Transfer from control register

STore from Control register

STC

[Syntax]

STC src,dest

[Instruction Code/Number of Cycles]

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[Operation]

dest ← src

[Function]

- This instruction transfers the content of the control register indicated by *src* to *dest*. If *dest* is a location in the memory, specify the address in which to store the low-order address.
- If *dest* is a location in the memory and *src* is PC, the required memory capacity is 3 bytes. If *src* is not PC, the required memory capacity is 2 bytes.

[Selectable src/dest]

src				dest			
FB	SB	SP*1	ISP	~~R0L~~/R0	~~R0H~~/R1	~~R1L~~/R2	~~R1H~~/R3
FLG	INTBH	INTBL		~~A0~~/A0	~~A1~~/A1	[A0]	[A1]
				dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
				dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
				~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	
				~~R2R0~~	~~R3R1~~	~~A1A0~~	
PC				~~R0L/R0~~	~~R0H/R1~~	~~R1L/R2~~	~~R1H/R3~~
				~~A0/A0~~	~~A1/A1~~	[A0]	[A1]
				dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
				dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
				~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	
				R2R0	R3R1	A1A0	

*1 The operation is performed on the stack pointer indicated by the U flag.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	—	—	—	—

[Description Example]

```
STC     SB,R0
STC     FB,A0
```

[Related Instructions] POPC, PUSHC, LDC, LDINTB

STCTX

Save context
STore ConTeXt

STCTX

[Syntax]

STCTX abs16,abs20

[Instruction Code/Number of Cycles]

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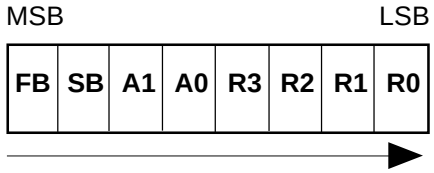
[Operation]

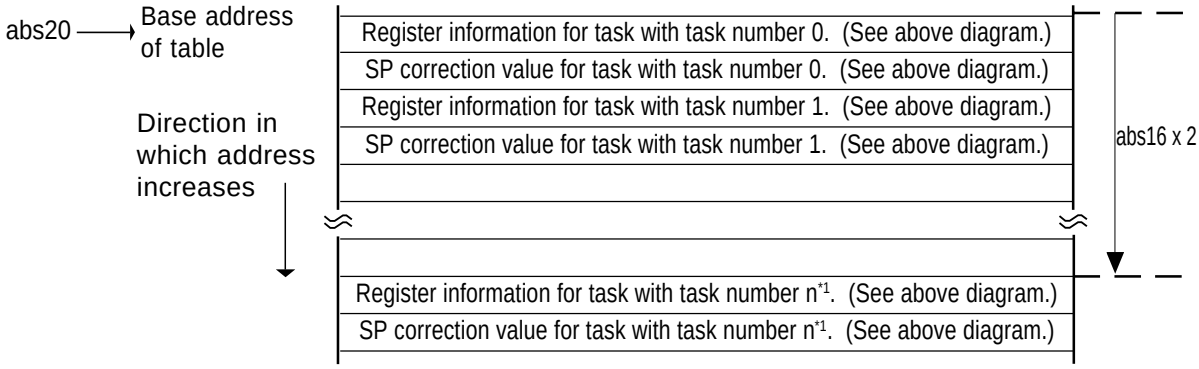
[Function]

- This instruction saves task context to the stack area.
- Set the RAM address that contains the task number in abs16 and the start address of table data in abs20.
- The required register information is specified from table data by the task number and the data in the stack area is transferred to each register according to the specified register information. Then the SP correction value is subtracted from the stack pointer (SP). For this SP correction value, set the number of bytes to be transferred.
- Information on transferred registers is configured as shown below. Logical 1 indicates a register to be transferred and logical 0 indicates a register that is not to be transferred.



Transferred sequentially beginning with FB

- The table data is configured as shown below. The address indicated by abs20 is the base address of the table. The data stored at an address twice the content of abs16 away from the base address indicates register information, and the next address contains the stack pointer correction value.



*1 n=0 to 255

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	—	—	—	—

[Description Example]

```
STCTX    Ram,Rom_TBL
```

[Related Instructions] LDCTX

STE

Transfer to extended data area

STore to EXtra far data area

STE

[Syntax]

STE.size **src,dest**

B , W

[Instruction Code/Number of Cycles]

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[Operation]

dest ← src

[Function]

- This instruction transfers *src* to *dest* in an extended area.
- If *src* is A0 or A1 and the selected size specifier (.size) is (.B), the operation is performed on the 8 low-order bits of A0 or A1. However, the flag changes depending on the A0 or A1 status (16 bits) before the operation is performed.

[Selectable src/dest]

src				dest			
R0L/R0	R0H/R1	R1L/R2	R1H/R3	~~R0L/R0~~	~~R0H/R1~~	~~R1L/R2~~	~~R1H/R3~~
A0/A0	A1/A1	[A0]	[A1]	~~A0/A0~~	~~A1/A1~~	~~[A0]~~	~~[A1]~~
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]	~~dsp:8[A0]~~	~~dsp:8[A1]~~	~~dsp:8[SB]~~	~~dsp:8[FB]~~
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16	~~dsp:16[A0]~~	~~dsp:16[A1]~~	~~dsp:16[SB]~~	~~abs16~~
~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	~~#IMM~~	dsp:20[A0]	~~dsp:20[A1]~~	abs20	
~~R2R0~~	~~R3R1~~	~~A1A0~~		~~R2R0~~	~~R3R1~~	[A1A0]	

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	○	○	—	—

Conditions

S : The flag is set when the operation results in MSB = 1; otherwise cleared.

Z : The flag is set when the operation results in 0; otherwise cleared.

[Description Example]

```
STE.B    R0L,[A1A0]
STE.W    R0,10000H[A0]
```

[Related Instructions] MOV, LDE, XCHG

STNZ

Conditional transfer
STore on Not Zero

STNZ

[Syntax]

STNZ **src,dest**

[Instruction Code/Number of Cycles]

Page: 235

[Operation]

if Z = 0 **then** dest ← src

[Function]

- This instruction transfers *src* to *dest* when the Z flag is 0.

[Selectable src/dest]

src	dest			
#IMM8	R0L	R0H	dsp:8[SB]	dsp:8[FB]
	abs16	A0	A1	

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	–	–	–	–	–	–	–	–

[Description Example]

STNZ #5,Ram:8[SB]

[Related Instructions] STZ, STZX

STZ

Conditional transfer
STore on Zero

STZ

[Syntax]

STZ src,dest

[Instruction Code/Number of Cycles]

Page: 235

[Operation]

if Z = 1 **then** dest ← src

[Function]

- This instruction transfers *src* to *dest* when the Z flag is 1.

[Selectable src/dest]

src	dest			
#IMM8	R0L	R0H	dsp:8[SB]	dsp:8[FB]
	abs16	A0	A1	

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	–	–	–	–	–	–	–	–

[Description Example]

```
STZ     #5,Ram:8[SB]
```

[Related Instructions] STNZ, STZX

STZX

Conditional transfer
STore on Zero eXtention

STZX

[Syntax]

STZX **src1,src2,dest**

[Instruction Code/Number of Cycles]

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[Operation]

If Z = 1 **then**

dest ← src1

else

dest ← src2

[Function]

- This instruction transfers *src1* to *dest* when the Z flag is 1. When the Z flag is 0, it transfers *src2* to *dest*.

[Selectable src/dest]

src	dest			
#IMM8	R0L	R0H	dsp:8[SB]	dsp:8[FB]
	abs16	~~A0~~	~~A1~~	

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	–	–	–	–	–	–	–	–

[Description Example]

```
STZX    #1,#2,Ram:8[SB]
```

[Related Instructions] STZ, STNZ

SUB

Subtract without borrow
SUBtract

SUB

[Syntax]

SUB.size (:format) src,dest

- **size**: **B , W**
- **format**: **G , S** (Can be specified)

[Instruction Code/Number of Cycles]

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[Operation]

dest ← dest – src

[Function]

- This instruction subtracts *src* from *dest* and stores the result in *dest*.
- If *dest* is A0 or A1 and the selected size specifier (.size) is (.B), *src* is zero-expanded to perform operation in 16 bits. If *src* is A0 or A1, operation is performed on the 8 low-order bits of A0 or A1.

[Selectable src/dest]

(See next page for *src/dest* classified by format.)

src				dest			
R0L/R0	R0H/R1	R1L/R2	R1H/R3	R0L/R0	R0H/R1	R1L/R2	R1H/R3
A0/A0*1	A1/A1*1	[A0]	[A1]	A0/A0*1	A1/A1*1	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]	dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16	dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	#IMM	~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	~~SP/SP~~
~~R2R0~~	~~R3R1~~	~~A1A0~~		~~R2R0~~	~~R3R1~~	~~A1A0~~	

*1 If (.B) is selected as the size specifier (.size), A0 or A1 cannot be chosen for *src* and *dest* simultaneously.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	○	—	○	○	—	○

Conditions

O : The flag is set when a signed operation results in a value in exceeding +32767 (.W) or –32768 (.W), or +127 (.B) or –128 (.B); otherwise cleared.

S : The flag is set when the operation results in MSB = 1; otherwise cleared.

Z : The flag is set when the operation results in 0; otherwise cleared.

C : The flag is set when an unsigned operation results in any value equal to or greater than 0; otherwise cleared.

[Description Example]

```
SUB.B   A0,R0L        ; 8 low-order bits of A0 and R0L are the objects of the operation.
SUB.B   R0L,A0        ; Zero-expanded value of R0L and A0 are the objects of the operation.
SUB.B   Ram:8[SB],R0L
SUB.W   #2,[A0]
```

[Related Instructions] ADC, ADCF, ADD, SBB

[src/dest Classified by Format]

G format

src				dest			
R0L/R0	R0H/R1	R1L/R2	R1H/R3	R0L/R0	R0H/R1	R1L/R2	R1H/R3
A0/A0*1	A1/A1*1	[A0]	[A1]	A0/A0*1	A1/A1*1	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]	dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16	dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	#IMM	~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	~~SP/SP~~
~~R2R0~~	~~R3R1~~	~~A1A0~~		~~R2R0~~	~~R3R1~~	~~A1A0~~	

*1 If (.B) is selected as for the size specifier (.size), A0 or A1 cannot be chosen for *src* and *dest* simultaneously.

S format*2

src				dest			
~~R0L~~	~~R0H~~	~~dsp:8[SB]~~	~~dsp:8[FB]~~	R0L	R0H	dsp:8[SB]	dsp:8[FB]
~~abs16~~	#IMM			abs16	~~A0~~	~~A1~~	
R0L*3	R0H*3	dsp:8[SB]	dsp:8[FB]	R0L*3	R0H*3	~~dsp:8[SB]~~	~~dsp:8[FB]~~
abs16	~~#IMM~~			~~abs16~~	~~A0~~	~~A1~~	

*2 Only (.B) can be selected as for the size specifier (.size).

*3 The same registers cannot be chosen for *src* and *dest*.

TST

Test
TeST

TST

[Syntax]

TST.size **src,dest**

B , W

[Instruction Code/Number of Cycles]

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[Operation]

dest ∧ src

[Function]

- Each flag in the flag register changes state depending on the result of a logical AND of *src* and *dest*.
- If *dest* is A0 or A1 and the selected size specifier (.size) is (.B), *src* is zero-expanded to perform operation in 16 bits. If *src* is A0 or A1, the operation is performed on the 8 low-order bits of A0 or A1.

[Selectable src/dest]

src				dest			
R0L/R0	R0H/R1	R1L/R2	R1H/R3	R0L/R0	R0H/R1	R1L/R2	R1H/R3
A0/A0*1	A1/A1*1	[A0]	[A1]	A0/A0*1	A1/A1*1	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]	dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16	dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	#IMM	~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	
~~R2R0~~	~~R3R1~~	~~A1A0~~		~~R2R0~~	~~R3R1~~	~~A1A0~~	

*1 If (.B) is selected as the size specifier (.size), A0 or A1 cannot be chosen for *src* and *dest* simultaneously.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	○	○	—	—

Conditions

S : The flag is set when the operation results in MSB = 1; otherwise cleared.

Z : The flag is set when the operation results in 0; otherwise cleared.

[Description Example]

```
TST.B    #3,R0L
TST.B    A0,R0L      ; 8 low-order bits of A0 and ROL are the objects of the operation.
TST.B    R0L,A0      ; Zero-expanded value of R0L and A0 are the objects of the operation.
```

[Related Instructions] AND, OR, XOR

UND

Interrupt for undefined instruction

UNDefined instruction

UND

[Syntax]

UND

[Instruction Code/Number of Cycles]

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[Operation]

SP ← SP – 2
M(SP) ← (PC + 1)H, FLG
SP ← SP – 2
M(SP) ← (PC + 1)ML
PC ← M(FFFDC16)

[Function]

- This instruction generates an undefined instruction interrupt.
- The undefined instruction interrupt is nonmaskable.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	○	○	—	—	—	—	○	—

*1 The flags are saved to the stack area before the UND instruction is executed. After the interrupt, the flag status becomes as shown at left.

Conditions

U : The flag is cleared.
I : The flag is cleared.
D : The flag is cleared.

[Description Example]

UND

WAIT

Wait
WAIT

WAIT

[Syntax]

WAIT

[Instruction Code/Number of Cycles]

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[Operation]

[Function]

- This instruction halts program execution. Program execution is restarted when an interrupt of a higher priority level than IPL is acknowledged or a reset is generated.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	—	—	—	—

[Description Example]

WAIT

XCHG

Exchange
eXCHanGe

XCHG

[Syntax]

XCHG.size src,dest

B , W

[Instruction Code/Number of Cycles]

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[Operation]

dest ←→ src

[Function]

- This instruction exchanges the contents of *src* and *dest*.
- If *dest* is A0 or A1 and the selected size specifier (.size) is (.B), the content of *src* is zero-expanded to 16 bits and placed in A0 or A1, and the 8 low-order bits of A0 or A1 are placed in *src*.

[Selectable src/dest]

src				dest			
R0L/R0	R0H/R1	R1L/R2	R1H/R3	R0L/R0	R0H/R1	R1L/R2	R1H/R3
~~A0/A0~~	~~A1/A1~~	~~[A0]~~	~~[A1]~~	A0/A0	A1/A1	[A0]	[A1]
~~dsp:8[A0]~~	~~dsp:8[A1]~~	~~dsp:8[SB]~~	~~dsp:8[FB]~~	dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
~~dsp:16[A0]~~	~~dsp:16[A1]~~	~~dsp:16[SB]~~	~~abs16~~	dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	~~#IMM~~	~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	
~~R2R0~~	~~R3R1~~	~~A1A0~~	~~[A1A0]~~	~~R2R0~~	~~R3R1~~	~~A1A0~~	

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	—	—	—	—

[Description Example]

```
XCHG.B    R0L,A0      ; 8 low-order bits of A0 and the zero-expanded value of R0L are exchanged.
XCHG.W    R0,A1
XCHG.B    R0L,[A0]
```

[Related Instructions] MOV, LDE, STE

XOR

Exclusive OR
eXclusive OR

XOR

[Syntax]

XOR.size src,dest

B , W

[Instruction Code/Number of Cycles]

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[Operation]

dest ← dest ∀ src

[Function]

- This instruction exclusive ORs *src* and *dest* and stores the result in *dest*.
- If *dest* is A0 or A1 and the selected size specifier (.size) is (.B), *src* is zero-expanded to perform operation in 16 bits. If *src* is A0 or A1, the operation is performed on the 8 low-order bits of A0 or A1.

[Selectable src/dest]

src				dest			
R0L/R0	R0H/R1	R1L/R2	R1H/R3	R0L/R0	R0H/R1	R1L/R2	R1H/R3
A0/A0*1	A1/A1*1	[A0]	[A1]	A0/A0*1	A1/A1*1	[A0]	[A1]
dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]	dsp:8[A0]	dsp:8[A1]	dsp:8[SB]	dsp:8[FB]
dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16	dsp:16[A0]	dsp:16[A1]	dsp:16[SB]	abs16
~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	#IMM	~~dsp:20[A0]~~	~~dsp:20[A1]~~	~~abs20~~	
~~R2R0~~	~~R3R1~~	~~A1A0~~		~~R2R0~~	~~R3R1~~	~~A1A0~~	

*1 If (.B) is selected as the size specifier (.size), A0 or A1 cannot be chosen for *src* and *dest* simultaneously.

[Flag Change]

Flag	U	I	O	B	S	Z	D	C
Change	—	—	—	—	○	○	—	—

Conditions

S : The flag is set when the operation results in MSB = 1; otherwise cleared.

Z : The flag is set when the operation results in 0; otherwise cleared.

[Description Example]

```
XOR.B   A0,R0L      ; 8 low-order bits of A0 and R0L are exclusive ORed.
XOR.B   R0L,A0      ; R0L is zero-expanded and exclusive ORed with A0.
XOR.B   #3,R0L
XOR.W   A0,A1
```

[Related Instructions] AND, OR, TST

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Chapter 4

Instruction Codes/Number of Cycles

4.1 Guide to This Chapter

This chapter lists the instruction code and number of cycles for each op-code.

An example illustrating how to read this chapter is shown below.

(1) **LDIPL**

(2) **(1) LDIPL #IMM**

(3)

b7							b0	b7				b0
0	1	1	1	1	1	0	1	1	0	1	0	IMM4

(4) **[Number of Bytes/Number of Cycles]**

Bytes/Cycles	2/2

(1) **MOV**

(2) **(1) MOV.size:G #IMM, dest**

(3)

b7							b0	b7				b0
0	1	1	1	0	1	0	SIZE	1	1	0	0	DEST

dest code

dsp8	#IMM8
dsp16/abs16	#IMM16

.size	SIZE
.B	0
.W	1

dest		DEST	dest		DEST
Rn	R0L/R0	0000	dsp:8[An]	dsp:8[A0]	1000
	R0H/R1	0001		dsp:8[A1]	1001
	R1L/R2	0010	dsp:8[SB/FB]	dsp:8[SB]	1010
	R1H/R3	0011		dsp:8[FB]	1011
An	A0	0100	dsp:16[An]	dsp:16[A0]	1100
	A1	0101		dsp:16[A1]	1101
[An]	[A0]	0110	dsp:16[SB]	dsp:16[SB]	1110
	[A1]	0111	abs16	abs16	1111

(4) **[Number of Bytes/Number of Cycles]**

dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	3/2	3/2	3/3	4/3	4/3	5/3	5/3	5/3

(1) Mnemonic

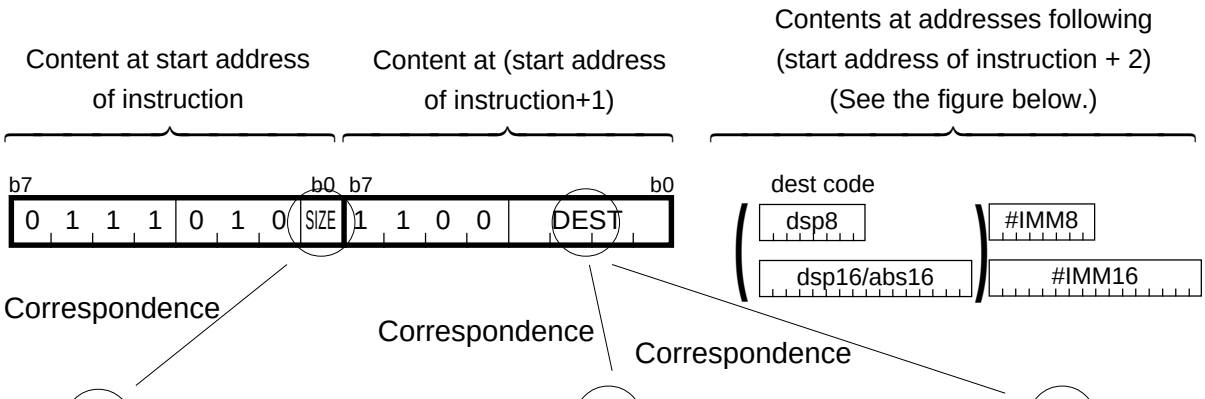
Shows the mnemonic explained in the page.

(2) Syntax

Shows an instruction syntax using symbols.

(3) Instruction code

Shows instruction code. Portions in parentheses ( ) may be omitted depending on the selected src/dest.

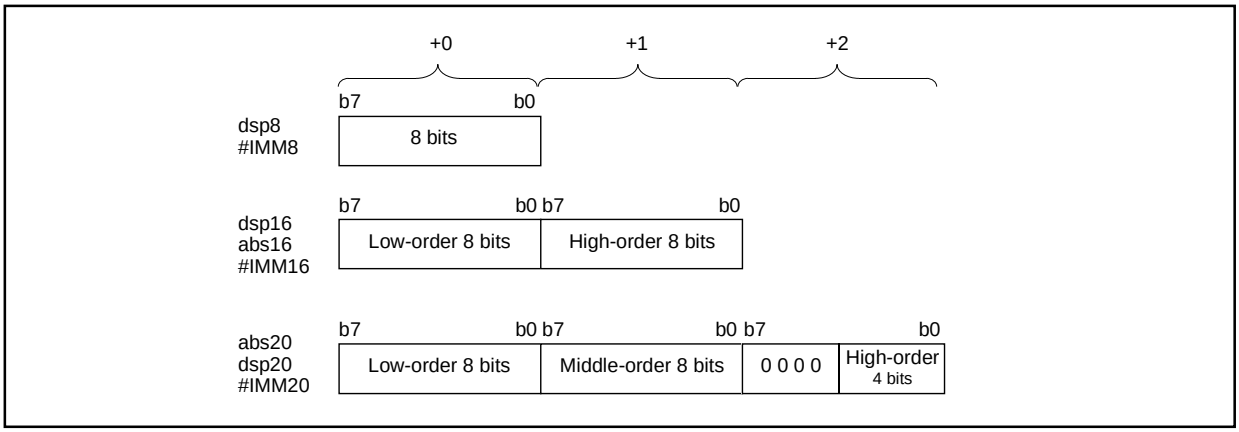


.size	SIZE
.B	0
.W	1

dest		DEST
Rn	R0L/R0	0000
	R0H/R1	0001
	R1L/R2	0010
	R1H/R3	0011
An	A0	0100
	A1	0101
[An]	[A0]	0110
	[A1]	0111

dest		DEST
dsp:8[An]	dsp:8[A0]	1000
	dsp:8[A1]	1001
dsp:8[SB/FB]	dsp:8[SB]	1010
	dsp:8[FB]	1011
dsp:16[An]	dsp:16[A0]	1100
	dsp:16[A1]	1101
dsp:16[SB]	dsp:16[SB]	1110
abs16	abs16	1111

Contents at addresses following (start address of instruction + 2) are arranged as follows:



(4) Table of cycles

Shows the number of cycles required to execute the instruction and the number of bytes in the instruction. The number of cycles may increase due to software wait states, etc.

The number of bytes in the instruction is indicated on the left side of the slash and the number of execution cycles is indicated on the right side.

ABS

(1) ABS.size dest

b7							b0	b7				b0
0	1	1	1	0	1	1	SIZE	1	1	1	1	DEST

dest code: dsp8 / dsp16/abs16

.size	SIZE
.B	0
.W	1

dest		DEST	dest		DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	2/3	2/3	2/5	3/5	3/5	4/5	4/5	4/5

ADC

(1) ADC.size #IMM, dest

b7							b0	b7				b0
0	1	1	1	0	1	1	SIZE	0	1	1	0	DEST

dest code: dsp8 / dsp16/abs16 — #IMM8 / #IMM16

.size	SIZE
.B	0
.W	1

dest		DEST	dest		DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	3/2	3/2	3/4	4/4	4/4	5/4	5/4	5/4

- If the size specifier (.size) is (.W), the number of bytes indicated is increased by 1.

ADC

(2) ADC.size src, dest

b7							b0	b7		b0
1	0	1	1	0	0	0	SIZE	SRC		DEST

src code: dsp8 / dsp16/abs16

dest code: dsp8 / dsp16/abs16

.size	SIZE
.B	0
.W	1

src/dest		SRC/DEST	src/dest		SRC/DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

src \ dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Rn	2/2	2/2	2/3	3/3	3/3	4/3	4/3	4/3
An	2/2	2/2	2/3	3/3	3/3	4/3	4/3	4/3
[An]	2/3	2/3	2/4	3/4	3/4	4/4	4/4	4/4
dsp:8[An]	3/3	3/3	3/4	4/4	4/4	5/4	5/4	5/4
dsp:8[SB/FB]	3/3	3/3	3/4	4/4	4/4	5/4	5/4	5/4
dsp:16[An]	4/3	4/3	4/4	5/4	5/4	6/4	6/4	6/4
dsp:16[SB]	4/3	4/3	4/4	5/4	5/4	6/4	6/4	6/4
abs16	4/3	4/3	4/4	5/4	5/4	6/4	6/4	6/4

ADCF

(1) ADCF.size dest

b7							b0	b7				b0
0	1	1	1	0	1	1	SIZE	1	1	1	0	DEST

dest code: dsp8 / dsp16/abs16

.size	SIZE
.B	0
.W	1

dest		DEST	dest		DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	2/1	2/1	2/3	3/3	3/3	4/3	4/3	4/3

ADD

(1) ADD.size:G #IMM, dest

b7							b0	b7				b0
0	1	1	1	0	1	1	SIZE	0	1	0	0	DEST

dest code: dsp8 / dsp16/abs16 — #IMM8 / #IMM16

.size	SIZE
.B	0
.W	1

dest		DEST	dest		DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	3/2	3/2	3/4	4/4	4/4	5/4	5/4	5/4

- If the size specifier (.size) is (.W), the number of bytes indicated is increased by 1.

ADD

(2) ADD.size:Q #IMM, dest

b7							b0	b7				b0
1	1	0	0	1	0	0	SIZE	IMM4				DEST

dest code

dsp8
dsp16/abs16

.size	SIZE
.B	0
.W	1

#IMM	IMM4	#IMM	IMM4
0	0 0 0 0	–8	1 0 0 0
+1	0 0 0 1	–7	1 0 0 1
+2	0 0 1 0	–6	1 0 1 0
+3	0 0 1 1	–5	1 0 1 1
+4	0 1 0 0	–4	1 1 0 0
+5	0 1 0 1	–3	1 1 0 1
+6	0 1 1 0	–2	1 1 1 0
+7	0 1 1 1	–1	1 1 1 1

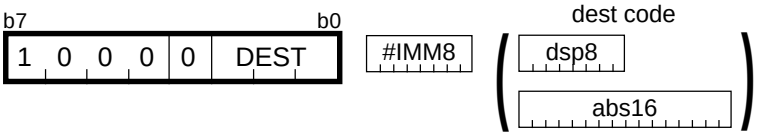
dest		DEST	dest		DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	2/1	2/1	2/3	3/3	3/3	4/3	4/3	4/3

ADD

(3) ADD.B:S #IMM8, dest



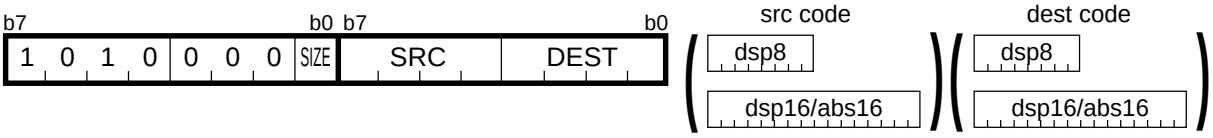
dest		DEST
Rn	R0H	0 1 1
	R0L	1 0 0
dsp:8[SB/FB]	dsp:8[SB]	1 0 1
	dsp:8[FB]	1 1 0
abs16	abs16	1 1 1

[Number of Bytes/Number of Cycles]

dest	Rn	dsp:8[SB/FB]	abs16
Bytes/Cycles	2/1	3/3	4/3

ADD

(4) ADD.size:G src, dest



.size	SIZE
.B	0
.W	1

src/dest		SRC/DEST	src/dest		SRC/DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

src \ dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Rn	2/2	2/2	2/3	3/3	3/3	4/3	4/3	4/3
An	2/2	2/2	2/3	3/3	3/3	4/3	4/3	4/3
[An]	2/3	2/3	2/4	3/4	3/4	4/4	4/4	4/4
dsp:8[An]	3/3	3/3	3/4	4/4	4/4	5/4	5/4	5/4
dsp:8[SB/FB]	3/3	3/3	3/4	4/4	4/4	5/4	5/4	5/4
dsp:16[An]	4/3	4/3	4/4	5/4	5/4	6/4	6/4	6/4
dsp:16[SB]	4/3	4/3	4/4	5/4	5/4	6/4	6/4	6/4
abs16	4/3	4/3	4/4	5/4	5/4	6/4	6/4	6/4

ADD

(5) ADD.B:S src, R0L/R0H

b7						b0
0	0	1	0	0	DEST	SRC

src code: dsp8 / abs16

src		SRC
Rn	R0L/R0H	0 0
dsp:8[SB/FB]	dsp:8[SB]	0 1
	dsp:8[FB]	1 0
abs16	abs16	1 1

dest	DEST
R0L	0
R0H	1

[Number of Bytes/Number of Cycles]

src	Rn	dsp:8[SB/FB]	abs16
Bytes/Cycles	1/2	2/3	3/3

ADD

(6) ADD.size:G #IMM, SP

b7							b0	b7							b0
0	1	1	1	1	1	0	SIZE	1	1	1	0	1	0	1	1

#IMM8

#IMM16

.size	SIZE
.B	0
.W	1

[Number of Bytes/Number of Cycles]

Bytes/Cycles	3/2

- If the size specifier (.size) is (.W), the number of bytes indicated is increased by 1.

ADD

(7) ADD.size:Q #IMM, SP

b7							b0	b7							b0
0	1	1	1	1	1	0	1	1	0	1	1	IMM4			

- The instruction code is the same regardless of whether (.B) or (.W) is selected as the size specifier (.size).

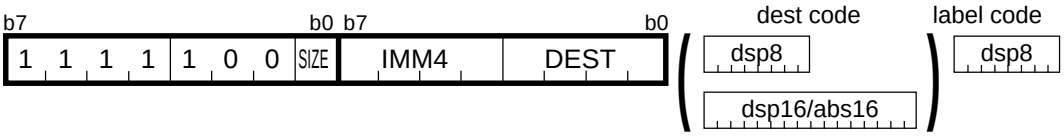
#IMM	IMM4	#IMM	IMM4
0	0 0 0 0	–8	1 0 0 0
+1	0 0 0 1	–7	1 0 0 1
+2	0 0 1 0	–6	1 0 1 0
+3	0 0 1 1	–5	1 0 1 1
+4	0 1 0 0	–4	1 1 0 0
+5	0 1 0 1	–3	1 1 0 1
+6	0 1 1 0	–2	1 1 1 0
+7	0 1 1 1	–1	1 1 1 1

[Number of Bytes/Number of Cycles]

Bytes/Cycles	2/1

ADJNZ

(1) ADJNZ.size #IMM, dest, label



dsp8 (label code) = address indicated by label – (start address of instruction + 2)

.size	SIZE
.B	0
.W	1

#IMM	IMM4	#IMM	IMM4
0	0 0 0 0	–8	1 0 0 0
+1	0 0 0 1	–7	1 0 0 1
+2	0 0 1 0	–6	1 0 1 0
+3	0 0 1 1	–5	1 0 1 1
+4	0 1 0 0	–4	1 1 0 0
+5	0 1 0 1	–3	1 1 0 1
+6	0 1 1 0	–2	1 1 1 0
+7	0 1 1 1	–1	1 1 1 1

dest		DEST	dest		DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

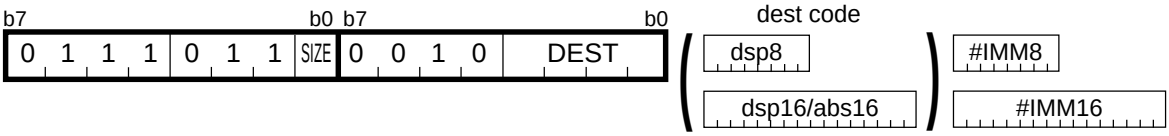
[Number of Bytes/Number of Cycles]

dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	3/3	3/3	3/5	4/5	4/5	5/5	5/5	5/5

- If the program branches to a label, the number of cycles indicated is increased by 4.

AND

(1) AND.size:G #IMM, dest



.size	SIZE
.B	0
.W	1

dest		DEST	dest		DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

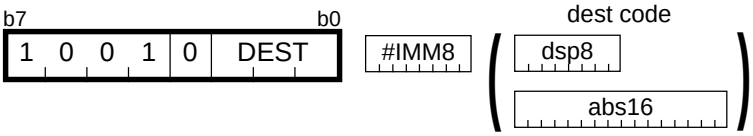
[Number of Bytes/Number of Cycles]

dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	3/2	3/2	3/4	4/4	4/4	5/4	5/4	5/4

- If the size specifier (.size) is (.W), the number of bytes indicated is increased by 1.

AND

(2) AND.B:S #IMM8, dest



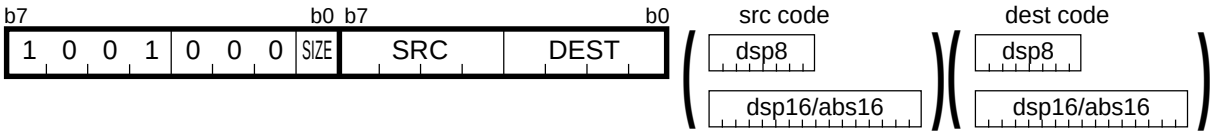
dest		DEST
Rn	R0H	0 1 1
	R0L	1 0 0
dsp:8[SB/FB]	dsp:8[SB]	1 0 1
	dsp:8[FB]	1 1 0
abs16	abs16	1 1 1

[Number of Bytes/Number of Cycles]

dest	Rn	dsp:8[SB/FB]	abs16
Bytes/Cycles	2/1	3/3	4/3

AND

(3) AND.size:G src, dest



.size	SIZE
.B	0
.W	1

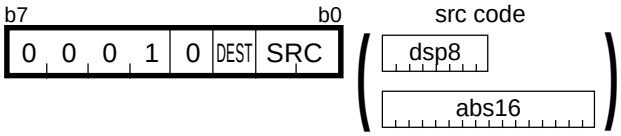
src/dest		SRC/DEST	src/dest		SRC/DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

src \ dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Rn	2/2	2/2	2/3	3/3	3/3	4/3	4/3	4/3
An	2/2	2/2	2/3	3/3	3/3	4/3	4/3	4/3
[An]	2/3	2/3	2/4	3/4	3/4	4/4	4/4	4/4
dsp:8[An]	3/3	3/3	3/4	4/4	4/4	5/4	5/4	5/4
dsp:8[SB/FB]	3/3	3/3	3/4	4/4	4/4	5/4	5/4	5/4
dsp:16[An]	4/3	4/3	4/4	5/4	5/4	6/4	6/4	6/4
dsp:16[SB]	4/3	4/3	4/4	5/4	5/4	6/4	6/4	6/4
abs16	4/3	4/3	4/4	5/4	5/4	6/4	6/4	6/4

AND

(4) AND.B:S src, R0L/R0H



src		SRC
Rn	R0L/R0H	0 0
dsp:8[SB/FB]	dsp:8[SB]	0 1
	dsp:8[FB]	1 0
abs16	abs16	1 1

dest	DEST
R0L	0
R0H	1

[Number of Bytes/Number of Cycles]

src	Rn	dsp:8[SB/FB]	abs16
Bytes/Cycles	1/2	2/3	3/3

BAND

(1) BAND src

b7							b0	b7				b0
0	1	1	1	1	1	1	0	0	1	0	0	SRC

src code

(dsp8 / dsp16)

src		SRC	src		SRC
bit,Rn	bit,R0	0 0 0 0	base:8[An]	base:8[A0]	1 0 0 0
	bit,R1	0 0 0 1		base:8[A1]	1 0 0 1
	bit,R2	0 0 1 0	bit,base:8 [SB/FB]	bit,base:8[SB]	1 0 1 0
	bit,R3	0 0 1 1		bit,base:8[FB]	1 0 1 1
bit,An	bit,A0	0 1 0 0	base:16[An]	base:16[A0]	1 1 0 0
	bit,A1	0 1 0 1		base:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	bit,base:16[SB]	bit,base:16[SB]	1 1 1 0
	[A1]	0 1 1 1	bit,base:16	bit,base:16	1 1 1 1

[Number of Bytes/Number of Cycles]

src	bit,Rn	bit,An	[An]	base:8 [An]	bit,base:8 [SB/FB]	base:16 [An]	bit,base:16 [SB]	bit,base:16
Bytes/Cycles	3/3	3/3	2/7	3/7	3/4	4/7	4/4	4/4

BCLR

(1) BCLR:G dest

b7							b0	b7				b0
0	1	1	1	1	1	1	0	1	0	0	0	DEST

dest code

(dsp8 / dsp16)

dest		DEST	dest		DEST
bit,Rn	bit,R0	0 0 0 0	base:8[An]	base:8[A0]	1 0 0 0
	bit,R1	0 0 0 1		base:8[A1]	1 0 0 1
	bit,R2	0 0 1 0	bit,base:8 [SB/FB]	bit,base:8[SB]	1 0 1 0
	bit,R3	0 0 1 1		bit,base:8[FB]	1 0 1 1
bit,An	bit,A0	0 1 0 0	base:16[An]	base:16[A0]	1 1 0 0
	bit,A1	0 1 0 1		base:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	bit,base:16[SB]	bit,base:16[SB]	1 1 1 0
	[A1]	0 1 1 1	bit,base:16	bit,base:16	1 1 1 1

[Number of Bytes/Number of Cycles]

dest	bit,Rn	bit,An	[An]	base:8 [An]	bit,base:8 [SB/FB]	base:16 [An]	bit,base:16 [SB]	bit,base:16
Bytes/Cycles	3/2	3/2	2/6	3/6	3/3	4/6	4/3	4/3

BCLR

(2) BCLR:S bit, base:11[SB]

b7					b0	dest code
0	1	0	0	0	BIT	dsp8

[Number of Bytes/Number of Cycles]

Bytes/Cycles	2/3

BM*Cnd*

(1) BM*Cnd* dest

b7				b0	b7				b0
0	1	1	1	1	1	1	0	0 0 1 0	DEST

dest code: (dsp8 / dsp16) CND

dest		DEST	dest		DEST
bit,Rn	bit,R0	0 0 0 0	base:8[An]	base:8[A0]	1 0 0 0
	bit,R1	0 0 0 1		base:8[A1]	1 0 0 1
	bit,R2	0 0 1 0	bit,base:8 [SB/FB]	bit,base:8[SB]	1 0 1 0
	bit,R3	0 0 1 1		bit,base:8[FB]	1 0 1 1
bit,An	bit,A0	0 1 0 0	base:16[An]	base:16[A0]	1 1 0 0
	bit,A1	0 1 0 1		base:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	bit,base:16[SB]	bit,base:16[SB]	1 1 1 0
	[A1]	0 1 1 1	bit,base:16	bit,base:16	1 1 1 1

Cnd	CND	*Cnd*	CND
GEU/C	0 0 0 0 0 0 0 0	LTU/NC	1 1 1 1 1 0 0 0
GTU	0 0 0 0 0 0 0 1	LEU	1 1 1 1 1 0 0 1
EQ/Z	0 0 0 0 0 0 1 0	NE/NZ	1 1 1 1 1 0 1 0
N	0 0 0 0 0 0 1 1	PZ	1 1 1 1 1 0 1 1
LE	0 0 0 0 0 1 0 0	GT	1 1 1 1 1 1 0 0
O	0 0 0 0 0 1 0 1	NO	1 1 1 1 1 1 0 1
GE	0 0 0 0 0 1 1 0	LT	1 1 1 1 1 1 1 0

[Number of Bytes/Number of Cycles]

dest	bit,Rn	bit,An	[An]	base:8 [An]	bit,base:8 [SB/FB]	base:16 [An]	bit,base:16 [SB]	bit,base:16
Bytes/Cycles	4/6	4/6	3/10	4/10	4/7	5/10	5/7	5/7

BM*Cnd*

(2) BM*Cnd* C

b7							b0	b7				b0
0	1	1	1	1	1	0	1	1	1	0	1	CND

Cnd	CND	*Cnd*	CND
GEU/C	0 0 0 0	PZ	0 1 1 1
GTU	0 0 0 1	LE	1 0 0 0
EQ/Z	0 0 1 0	O	1 0 0 1
N	0 0 1 1	GE	1 0 1 0
LTU/NC	0 1 0 0	GT	1 1 0 0
LEU	0 1 0 1	NO	1 1 0 1
NE/NZ	0 1 1 0	LT	1 1 1 0

[Number of Bytes/Number of Cycles]

Bytes/Cycles	2/1

- If the condition is true, the number of cycles indicated is increased by 1.

BNAND

(1) BNAND src

b7							b0	b7				b0
0	1	1	1	1	1	1	0	0	1	0	1	SRC

src code

(dsp8 / dsp16)

src		SRC	src		SRC
bit,Rn	bit,R0	0 0 0 0	base:8[An]	base:8[A0]	1 0 0 0
	bit,R1	0 0 0 1		base:8[A1]	1 0 0 1
	bit,R2	0 0 1 0	bit,base:8 [SB/FB]	bit,base:8[SB]	1 0 1 0
	bit,R3	0 0 1 1		bit,base:8[FB]	1 0 1 1
bit,An	bit,A0	0 1 0 0	base:16[An]	base:16[A0]	1 1 0 0
	bit,A1	0 1 0 1		base:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	bit,base:16[SB]	bit,base:16[SB]	1 1 1 0
	[A1]	0 1 1 1	bit,base:16	bit,base:16	1 1 1 1

[Number of Bytes/Number of Cycles]

src	bit,Rn	bit,An	[An]	base:8 [An]	bit,base:8 [SB/FB]	base:16 [An]	bit,base:16 [SB]	bit,base:16
Bytes/Cycles	3/3	3/3	2/7	3/7	3/4	4/7	4/4	4/4

BNOR

(1) BNOR src

b7				b0 b7				b0	
0	1	1	1	1	1	1	0	0 1 1 1	SRC

src code: (dsp8 / dsp16)

src		SRC	src		SRC
bit,Rn	bit,R0	0 0 0 0	base:8[An]	base:8[A0]	1 0 0 0
	bit,R1	0 0 0 1		base:8[A1]	1 0 0 1
	bit,R2	0 0 1 0	bit,base:8 [SB/FB]	bit,base:8[SB]	1 0 1 0
	bit,R3	0 0 1 1		bit,base:8[FB]	1 0 1 1
bit,An	bit,A0	0 1 0 0	base:16[An]	base:16[A0]	1 1 0 0
	bit,A1	0 1 0 1		base:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	bit,base:16[SB]	bit,base:16[SB]	1 1 1 0
	[A1]	0 1 1 1	bit,base:16	bit,base:16	1 1 1 1

[Number of Bytes/Number of Cycles]

src	bit,Rn	bit,An	[An]	base:8 [An]	bit,base:8 [SB/FB]	base:16 [An]	bit,base:16 [SB]	bit,base:16
Bytes/Cycles	3/3	3/3	2/7	3/7	3/4	4/7	4/4	4/4

BNOT

(1) BNOT:G dest

b7				b0 b7				b0	
0	1	1	1	1	1	1	0	1 0 1 0	DEST

dest code: (dsp8 / dsp16)

dest		DEST	dest		DEST
bit,Rn	bit,R0	0 0 0 0	base:8[An]	base:8[A0]	1 0 0 0
	bit,R1	0 0 0 1		base:8[A1]	1 0 0 1
	bit,R2	0 0 1 0	bit,base:8 [SB/FB]	bit,base:8[SB]	1 0 1 0
	bit,R3	0 0 1 1		bit,base:8[FB]	1 0 1 1
bit,An	bit,A0	0 1 0 0	base:16[An]	base:16[A0]	1 1 0 0
	bit,A1	0 1 0 1		base:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	bit,base:16[SB]	bit,base:16[SB]	1 1 1 0
	[A1]	0 1 1 1	bit,base:16	bit,base:16	1 1 1 1

[Number of Bytes/Number of Cycles]

dest	bit,Rn	bit,An	[An]	base:8 [An]	bit,base:8 [SB/FB]	base:16 [An]	bit,base:16 [SB]	bit,base:16
Bytes/Cycles	3/2	3/2	2/6	3/6	3/3	4/6	4/3	4/3

BNOT

(2) BNOT:S bit, base:11[SB]

b7					b0	dest code
0 1 0 1				0	BIT	dsp8

[Number of Bytes/Number of Cycles]

Bytes/Cycles	2/3

BNTST

(1) BNTST src

b7				b0	b7				b0	src code
0 1 1 1				1 1 1 0	0 0 1 1				SRC	(dsp8 / dsp16)

src		SRC	src		SRC
bit,Rn	bit,R0	0 0 0 0	base:8[An]	base:8[A0]	1 0 0 0
	bit,R1	0 0 0 1		base:8[A1]	1 0 0 1
	bit,R2	0 0 1 0	bit,base:8 [SB/FB]	bit,base:8[SB]	1 0 1 0
	bit,R3	0 0 1 1		bit,base:8[FB]	1 0 1 1
bit,An	bit,A0	0 1 0 0	base:16[An]	base:16[A0]	1 1 0 0
	bit,A1	0 1 0 1		base:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	bit,base:16[SB]	bit,base:16[SB]	1 1 1 0
	[A1]	0 1 1 1	bit,base:16	bit,base:16	1 1 1 1

[Number of Bytes/Number of Cycles]

src	bit,Rn	bit,An	[An]	base:8 [An]	bit,base:8 [SB/FB]	base:16 [An]	bit,base:16 [SB]	bit,base:16
Bytes/Cycles	3/3	3/3	2/7	3/7	3/4	4/7	4/4	4/4

BNXOR

(1) BNXOR src

b7				b0 b7				b0				
0	1	1	1	1	1	1	0	1	1	0	1	SRC

src code: (dsp8 / dsp16)

src		SRC	src		SRC
bit,Rn	bit,R0	0 0 0 0	base:8[An]	base:8[A0]	1 0 0 0
	bit,R1	0 0 0 1		base:8[A1]	1 0 0 1
	bit,R2	0 0 1 0	bit,base:8 [SB/FB]	bit,base:8[SB]	1 0 1 0
	bit,R3	0 0 1 1		bit,base:8[FB]	1 0 1 1
bit,An	bit,A0	0 1 0 0	base:16[An]	base:16[A0]	1 1 0 0
	bit,A1	0 1 0 1		base:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	bit,base:16[SB]	bit,base:16[SB]	1 1 1 0
	[A1]	0 1 1 1	bit,base:16	bit,base:16	1 1 1 1

[Number of Bytes/Number of Cycles]

src	bit,Rn	bit,An	[An]	base:8 [An]	bit,base:8 [SB/FB]	base:16 [An]	bit,base:16 [SB]	bit,base:16
Bytes/Cycles	3/3	3/3	2/7	3/7	3/4	4/7	4/4	4/4

BOR

(1) BOR src

b7				b0 b7				b0				
0	1	1	1	1	1	1	0	0	1	1	0	SRC

src code: (dsp8 / dsp16)

src		SRC	src		SRC
bit,Rn	bit,R0	0 0 0 0	base:8[An]	base:8[A0]	1 0 0 0
	bit,R1	0 0 0 1		base:8[A1]	1 0 0 1
	bit,R2	0 0 1 0	bit,base:8 [SB/FB]	bit,base:8[SB]	1 0 1 0
	bit,R3	0 0 1 1		bit,base:8[FB]	1 0 1 1
bit,An	bit,A0	0 1 0 0	base:16[An]	base:16[A0]	1 1 0 0
	bit,A1	0 1 0 1		base:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	bit,base:16[SB]	bit,base:16[SB]	1 1 1 0
	[A1]	0 1 1 1	bit,base:16	bit,base:16	1 1 1 1

[Number of Bytes/Number of Cycles]

src	bit,Rn	bit,An	[An]	base:8 [An]	bit,base:8 [SB/FB]	base:16 [An]	bit,base:16 [SB]	bit,base:16
Bytes/Cycles	3/3	3/3	2/7	3/7	3/4	4/7	4/4	4/4

BRK

(1) BRK

b7							b0
0	0	0	0	0	0	0	0

[Number of Bytes/Number of Cycles]

Bytes/Cycles	1/27

- If the target address of the BRK interrupt is specified using the interrupt table register (INTB), the number of cycles shown in the table increases by two. In this case, set FF_{16} in addresses $FFFE4_{16}$ through $FFFE7_{16}$.

BSET

(1) BSET:G dest

b7							b0	b7				b0
0	1	1	1	1	1	1	0	1	0	0	1	DEST

dest code: (dsp8 / dsp16)

dest		DEST	dest		DEST
bit,Rn	bit,R0	0 0 0 0	base:8[An]	base:8[A0]	1 0 0 0
	bit,R1	0 0 0 1		base:8[A1]	1 0 0 1
	bit,R2	0 0 1 0	bit,base:8 [SB/FB]	bit,base:8[SB]	1 0 1 0
	bit,R3	0 0 1 1		bit,base:8[FB]	1 0 1 1
bit,An	bit,A0	0 1 0 0	base:16[An]	base:16[A0]	1 1 0 0
	bit,A1	0 1 0 1		base:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	bit,base:16[SB]	bit,base:16[SB]	1 1 1 0
	[A1]	0 1 1 1	bit,base:16	bit,base:16	1 1 1 1

[Number of Bytes/Number of Cycles]

dest	bit,Rn	bit,An	[An]	base:8 [An]	bit,base:8 [SB/FB]	base:16 [An]	bit,base:16 [SB]	bit,base:16
Bytes/Cycles	3/2	3/2	2/6	3/6	3/3	4/6	4/3	4/3

BSET

(2) BSET:S bit, base:11[SB]

b7						b0	dest code
0	1	0	0	1	BIT		dsp8

[Number of Bytes/Number of Cycles]

Bytes/Cycles	2/3

BTST

(1) BTST:G src

b7							b0	b7					b0	src code
0	1	1	1	1	1	1	0	1	0	1	1	SRC		(dsp8 / dsp16)

src		SRC	src		SRC
bit,Rn	bit,R0	0 0 0 0	base:8[An]	base:8[A0]	1 0 0 0
	bit,R1	0 0 0 1		base:8[A1]	1 0 0 1
	bit,R2	0 0 1 0	bit,base:8 [SB/FB]	bit,base:8[SB]	1 0 1 0
	bit,R3	0 0 1 1		bit,base:8[FB]	1 0 1 1
bit,An	bit,A0	0 1 0 0	base:16[An]	base:16[A0]	1 1 0 0
	bit,A1	0 1 0 1		base:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	bit,base:16[SB]	bit,base:16[SB]	1 1 1 0
	[A1]	0 1 1 1	bit,base:16	bit,base:16	1 1 1 1

[Number of Bytes/Number of Cycles]

src	bit,Rn	bit,An	[An]	base:8 [An]	bit,base:8 [SB/FB]	base:16 [An]	bit,base:16 [SB]	bit,base:16
Bytes/Cycles	3/2	3/2	2/6	3/6	3/3	4/6	4/3	4/3

BTST

(2) BTST:S bit, base:11[SB]

b7					b0	src code
0 1 0 1				1	BIT	dsp8

[Number of Bytes/Number of Cycles]

Bytes/Cycles	2/3

BTSTC

(1) BTSTC dest

b7							b0	b7							b0	dest code
0 1 1 1				1 1 1 0				0 0 0 0				DEST				(dsp8 / dsp16)

dest		DEST	dest		DEST
bit,Rn	bit,R0	0 0 0 0	base:8[An]	base:8[A0]	1 0 0 0
	bit,R1	0 0 0 1		base:8[A1]	1 0 0 1
	bit,R2	0 0 1 0	bit,base:8 [SB/FB]	bit,base:8[SB]	1 0 1 0
	bit,R3	0 0 1 1		bit,base:8[FB]	1 0 1 1
bit,An	bit,A0	0 1 0 0	base:16[An]	base:16[A0]	1 1 0 0
	bit,A1	0 1 0 1		base:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	bit,base:16[SB]	bit,base:16[SB]	1 1 1 0
	[A1]	0 1 1 1	bit,base:16	bit,base:16	1 1 1 1

[Number of Bytes/Number of Cycles]

dest	bit,Rn	bit,An	[An]	base:8 [An]	bit,base:8 [SB/FB]	base:16 [An]	bit,base:16 [SB]	bit,base:16
Bytes/Cycles	3/3	3/3	2/7	3/7	3/4	4/7	4/4	4/4

BTSTS

(1) BTSTS dest

b7				b0	b7				b0
0	1	1	1	1	1	1	0	0 0 0 1	DEST

dest code: (dsp8 / dsp16)

dest		DEST	dest		DEST
bit,Rn	bit,R0	0 0 0 0	base:8[An]	base:8[A0]	1 0 0 0
	bit,R1	0 0 0 1		base:8[A1]	1 0 0 1
	bit,R2	0 0 1 0	bit,base:8 [SB/FB]	bit,base:8[SB]	1 0 1 0
	bit,R3	0 0 1 1		bit,base:8[FB]	1 0 1 1
bit,An	bit,A0	0 1 0 0	base:16[An]	base:16[A0]	1 1 0 0
	bit,A1	0 1 0 1		base:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	bit,base:16[SB]	bit,base:16[SB]	1 1 1 0
	[A1]	0 1 1 1	bit,base:16	bit,base:16	1 1 1 1

[Number of Bytes/Number of Cycles]

dest	bit,Rn	bit,An	[An]	base:8 [An]	bit,base:8 [SB/FB]	base:16 [An]	bit,base:16 [SB]	bit,base:16
Bytes/Cycles	3/3	3/3	2/7	3/7	3/4	4/7	4/4	4/4

BXOR

(1) BXOR src

b7				b0	b7				b0
0	1	1	1	1	1	1	0	1 1 0 0	SRC

src code: (dsp8 / dsp16)

src		SRC	src		SRC
bit,Rn	bit,R0	0 0 0 0	base:8[An]	base:8[A0]	1 0 0 0
	bit,R1	0 0 0 1		base:8[A1]	1 0 0 1
	bit,R2	0 0 1 0	bit,base:8 [SB/FB]	bit,base:8[SB]	1 0 1 0
	bit,R3	0 0 1 1		bit,base:8[FB]	1 0 1 1
bit,An	bit,A0	0 1 0 0	base:16[An]	base:16[A0]	1 1 0 0
	bit,A1	0 1 0 1		base:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	bit,base:16[SB]	bit,base:16[SB]	1 1 1 0
	[A1]	0 1 1 1	bit,base:16	bit,base:16	1 1 1 1

[Number of Bytes/Number of Cycles]

src	bit,Rn	bit,An	[An]	base:8 [An]	bit,base:8 [SB/FB]	base:16 [An]	bit,base:16 [SB]	bit,base:16
Bytes/Cycles	3/3	3/3	2/7	3/7	3/4	4/7	4/4	4/4

CMP

(1) CMP.size:G #IMM, dest

b7							b0	b7					b0
0	1	1	1	0	1	1	SIZE	1	0	0	0	DEST	

dest code

(dsp8 / dsp16/abs16) (#IMM8 / #IMM16)

.size	SIZE
.B	0
.W	1

dest		DEST	dest		DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	3/2	3/2	3/4	4/4	4/4	5/4	5/4	5/4

- If the size specifier (.size) is (.W), the number of bytes indicated is increased by 1.

CMP

(2) CMP.size:Q #IMM, dest

b7							b0	b7				b0
1	1	0	1	0	0	0	SIZE	IMM4			DEST	

dest code

dsp8
dsp16/abs16

.size	SIZE
.B	0
.W	1

#IMM	IMM4	#IMM	IMM4
0	0 0 0 0	–8	1 0 0 0
+1	0 0 0 1	–7	1 0 0 1
+2	0 0 1 0	–6	1 0 1 0
+3	0 0 1 1	–5	1 0 1 1
+4	0 1 0 0	–4	1 1 0 0
+5	0 1 0 1	–3	1 1 0 1
+6	0 1 1 0	–2	1 1 1 0
+7	0 1 1 1	–1	1 1 1 1

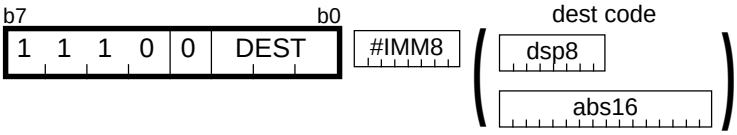
dest		DEST	dest		DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	2/1	2/1	2/3	3/3	3/3	4/3	4/3	4/3

CMP

(3) CMP.B:S #IMM8, dest



dest		DEST
Rn	R0H	0 1 1
	R0L	1 0 0
dsp:8[SB/FB]	dsp:8[SB]	1 0 1
	dsp:8[FB]	1 1 0
abs16	abs16	1 1 1

[Number of Bytes/Number of Cycles]

dest	Rn	dsp:8[SB/FB]	abs16
Bytes/Cycles	2/1	3/3	4/3

CMP

(4) CMP.size:G src, dest

b7							b0	b7		b0
1	1	0	0	0	0	0	SIZE	SRC	DEST	

src code: dsp8 / dsp16/abs16

dest code: dsp8 / dsp16/abs16

.size	SIZE
.B	0
.W	1

src/dest		SRC/DEST	src/dest		SRC/DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

src \ dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Rn	2/2	2/2	2/3	3/3	3/3	4/3	4/3	4/3
An	2/2	2/2	2/3	3/3	3/3	4/3	4/3	4/3
[An]	2/3	2/3	2/4	3/4	3/4	4/4	4/4	4/4
dsp:8[An]	3/3	3/3	3/4	4/4	4/4	5/4	5/4	5/4
dsp:8[SB/FB]	3/3	3/3	3/4	4/4	4/4	5/4	5/4	5/4
dsp:16[An]	4/3	4/3	4/4	5/4	5/4	6/4	6/4	6/4
dsp:16[SB]	4/3	4/3	4/4	5/4	5/4	6/4	6/4	6/4
abs16	4/3	4/3	4/4	5/4	5/4	6/4	6/4	6/4

CMP

(5) CMP.B:S src, R0L/R0H

b7						b0
0	0	1	1	1	DEST	SRC

(src code: dsp8 / abs16)

src		SRC
Rn	R0L/R0H	0 0
dsp:8[SB/FB]	dsp:8[SB]	0 1
	dsp:8[FB]	1 0
abs16	abs16	1 1

dest	DEST
R0L	0
R0H	1

[Number of Bytes/Number of Cycles]

src	Rn	dsp:8[SB/FB]	abs16
Bytes/Cycles	1/2	2/3	3/3

DADC

(1) DADC.B #IMM8, R0L

b7							b0	b7							b0
0	1	1	1	1	1	0	0	1	1	1	0	1	1	1	0

#IMM8

[Number of Bytes/Number of Cycles]

Bytes/Cycles	3/5

DADC

(2) DADC.W #IMM16, R0

b7							b0	b7							b0	
0	1	1	1	1	1	0	1	1	1	1	0	1	1	1	0	#IMM16

[Number of Bytes/Number of Cycles]

Bytes/Cycles	4/5

DADC

(3) DADC.B R0H, R0L

b7							b0	b7							b0
0	1	1	1	1	1	0	0	1	1	1	0	0	1	1	0

[Number of Bytes/Number of Cycles]

Bytes/Cycles	2/5

DADC

(4) DADC.W R1, R0

b7							b0	b7							b0
0	1	1	1	1	1	0	1	1	1	1	0	0	1	1	0

[Number of Bytes/Number of Cycles]

Bytes/Cycles	2/5

DADD

(1) DADD.B #IMM8, R0L

b7							b0	b7							b0	
0	1	1	1	1	1	0	0	1	1	1	0	1	1	0	0	#IMM8

[Number of Bytes/Number of Cycles]

Bytes/Cycles	3/5

DADD

(2) DADD.W #IMM16, R0

b7							b0	b7							b0	
0	1	1	1	1	1	0	1	1	1	1	0	1	1	0	0	#IMM16

[Number of Bytes/Number of Cycles]

Bytes/Cycles	4/5

DADD

(3) DADD.B R0H, R0L

b7							b0	b7							b0
0	1	1	1	1	1	0	0	1	1	1	0	0	1	0	0

[Number of Bytes/Number of Cycles]

Bytes/Cycles	2/5

DADD

(4) DADD.W R1, R0

b7							b0	b7							b0
0	1	1	1	1	1	0	1	1	1	1	0	0	1	0	0

[Number of Bytes/Number of Cycles]

Bytes/Cycles	2/5

DEC

(1) DEC.B dest

b7						b0
1	0	1	0	1	DEST	

(dest code: dsp8 / abs16)

dest		DEST
Rn	R0H	0 1 1
	R0L	1 0 0
dsp:8[SB/FB]	dsp:8[SB]	1 0 1
	dsp:8[FB]	1 1 0
abs16	abs16	1 1 1

[Number of Bytes/Number of Cycles]

dest	Rn	dsp:8[SB/FB]	abs16
Bytes/Cycles	1/1	2/3	3/3

DEC

(2) DEC.W dest

b7							b0
1	1	1	1	DEST	0	1	0

dest	DEST
A0	0
A1	1

[Number of Bytes/Number of Cycles]

Bytes/Cycles	1/1

DIV

(1) DIV.size #IMM

b7							b0	b7							b0
0	1	1	1	1	1	0	SIZE	1	1	1	0	0	0	0	1

#IMM8

#IMM16

.size	SIZE
.B	0
.W	1

[Number of Bytes/Number of Cycles]

Bytes/Cycles	3/22

- If the size specifier (.size) is (.W), the number of bytes and cycles indicated are increased by 1 and 6, respectively.
- The number of cycles may decrease if an overflow occurs or depending on the value of the divisor or dividend.

DIV

(2) DIV.size src

b7							b0	b7							b0
0	1	1	1	0	1	1	SIZE	1	1	0	1	SRC			

src code: dsp8 / dsp16/abs16

.size	SIZE
.B	0
.W	1

src		SRC	src		SRC
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

src	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	2/22	2/22	2/24	3/24	3/24	4/24	4/24	4/24

- If the size specifier (.size) is (.W), the number of cycles indicated is increased by 6.
- The number of cycles may decrease if an overflow occurs or depending on the value of the divisor or dividend.

DIVU

(1) DIVU.size #IMM

b7							b0	b7							b0
0	1	1	1	1	1	0	SIZE	1	1	1	0	0	0	0	0

#IMM8

#IMM16

.size	SIZE
.B	0
.W	1

[Number of Bytes/Number of Cycles]

Bytes/Cycles	3/18

- The number of cycles may decrease if an overflow occurs or depending on the value of the divisor or dividend.
- If the size specifier (.size) is (.W), the number of bytes and cycles indicated are increased by 1 and 7, respectively.

DIVU

(2) DIVU.size src

b7							b0	b7				b0
0	1	1	1	0	1	1	SIZE	1	1	0	0	SRC

src code: dsp8 / dsp16/abs16

.size	SIZE
.B	0
.W	1

src		SRC	src		SRC
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

src	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	2/18	2/18	2/20	3/20	3/20	4/20	4/20	4/20

- If the size specifier (.size) is (.W), the number of cycles indicated is increased by 7.
- The number of cycles may decrease if an overflow occurs or depending on the value of the divisor or dividend.

DIVX

(1) DIVX.size #IMM

b7							b0	b7							b0
0	1	1	1	1	1	0	SIZE	1	1	1	0	0	0	1	1

#IMM8 / #IMM16

.size	SIZE
.B	0
.W	1

[Number of Bytes/Number of Cycles]

Bytes/Cycles	3/22

- The number of cycles may decrease if an overflow occurs or depending on the value of the divisor or dividend.
- If the size specifier (.size) is (.W), the number of bytes and cycles indicated are increased by 1 and 6, respectively.

DIVX

(2) DIVX.size src

b7							b0	b7							b0
0	1	1	1	0	1	1	SIZE	1	0	0	1	SRC			

src code: dsp8 / dsp16/abs16

.size	SIZE
.B	0
.W	1

src		SRC	src		SRC
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

src	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	2/22	2/22	2/24	3/24	3/24	4/24	4/24	4/24

- If the size specifier (.size) is (.W), the number of cycles indicated is increased by 6.
- The number of cycles may decrease if an overflow occurs or depending on the value of the divisor or dividend.

DSBB

(1) DSBB.B #IMM8, R0L

b7							b0	b7							b0
0	1	1	1	1	1	0	0	1	1	1	0	1	1	1	1

#IMM8

[Number of Bytes/Number of Cycles]

Bytes/Cycles	3/4

DSBB

(2) DSBB.W #IMM16, R0

b7							b0	b7							b0	
0	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1	#IMM16

[Number of Bytes/Number of Cycles]

Bytes/Cycles	4/4

DSBB

(3) DSBB.B R0H, R0L

b7							b0	b7							b0
0	1	1	1	1	1	0	0	1	1	1	0	0	1	1	1

[Number of Bytes/Number of Cycles]

Bytes/Cycles	2/4

DSBB

(4) DSBB.W R1, R0

b7							b0	b7							b0
0	1	1	1	1	1	0	1	1	1	1	0	0	1	1	1

[Number of Bytes/Number of Cycles]

Bytes/Cycles	2/4

DSUB

(1) DSUB.B #IMM8, R0L

b7							b0	b7							b0	
0	1	1	1	1	1	0	0	1	1	1	0	1	1	0	1	#IMM8

[Number of Bytes/Number of Cycles]

Bytes/Cycles	3/4

DSUB

(2) DSUB.W #IMM16, R0

b7							b0	b7							b0	
0	1	1	1	1	1	0	1	1	1	1	0	1	1	0	1	#IMM16

[Number of Bytes/Number of Cycles]

Bytes/Cycles	4/4

DSUB

(3) DSUB.B R0H, R0L

b7							b0	b7							b0
0	1	1	1	1	1	0	0	1	1	1	0	0	1	0	1

[Number of Bytes/Number of Cycles]

Bytes/Cycles	2/4

DSUB

(4) DSUB.W R1, R0

b7							b0	b7							b0
0	1	1	1	1	1	0	1	1	1	1	0	0	1	0	1

[Number of Bytes/Number of Cycles]

Bytes/Cycles	2/4

ENTER

(1) ENTER #IMM8

b7							b0	b7							b0	
0	1	1	1	1	1	0	0	1	1	1	1	0	0	1	0	#IMM8

[Number of Bytes/Number of Cycles]

Bytes/Cycles	3/4

EXITD

(1) EXITD

b7							b0	b7							b0
0	1	1	1	1	1	0	1	1	1	1	1	0	0	1	0

[Number of Bytes/Number of Cycles]

Bytes/Cycles	2/9

EXTS

(1) EXTS.B dest

b7							b0	b7							b0
0	1	1	1	1	1	0	0	0	1	1	0	DEST			

(dest code: dsp8 / dsp16/abs16)

dest		DEST	dest		DEST
Rn	R0L	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	---	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	---	0 0 1 1		dsp:8[FB]	1 0 1 1
---	---	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	---	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

- Items marked **---** cannot be selected.

[Number of Bytes/Number of Cycles]

dest	Rn	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	2/3	2/5	3/5	3/5	4/5	4/5	4/5

EXTS

(2) EXTS.W R0

b7							b0	b7							b0
0	1	1	1	1	1	0	0	1	1	1	1	0	0	1	1

[Number of Bytes/Number of Cycles]

Bytes/Cycles	2/3

FCLR

(1) FCLR dest

b7							b0	b7							b0
1	1	1	0	1	0	1	1	0	DEST			0	1	0	1

dest	DEST
C	0 0 0
D	0 0 1
Z	0 1 0
S	0 1 1
B	1 0 0
O	1 0 1
I	1 1 0
U	1 1 1

[Number of Bytes/Number of Cycles]

Bytes/Cycles	2/2

FSET

(1) FSET dest

b7							b0	b7			b0
1	1	1	0	1	0	1	1	0	DEST	0 1 0 0	

dest	DEST
C	0 0 0
D	0 0 1
Z	0 1 0
S	0 1 1
B	1 0 0
O	1 0 1
I	1 1 0
U	1 1 1

[Number of Bytes/Number of Cycles]

Bytes/Cycles	2/2

INC

(1) INC.B dest

b7						b0
1	0	1	0	0	DEST	

dest code

(dsp8 / abs16)

dest		DEST
Rn	R0H	0 1 1
	R0L	1 0 0
dsp:8[SB/FB]	dsp:8[SB]	1 0 1
	dsp:8[FB]	1 1 0
abs16	abs16	1 1 1

[Number of Bytes/Number of Cycles]

dest	Rn	dsp:8[SB/FB]	abs16
Bytes/Cycles	1/1	2/3	3/3

INC

(2) INC.W dest

b7							b0
1	0	1	1	DEST	0	1	0

dest	DEST
A0	0
A1	1

[Number of Bytes/Number of Cycles]

Bytes/Cycles	1/1

INT

(1) INT #IMM

b7							b0
1	1	1	0	1	0	1	1

11	#IMM

[Number of Bytes/Number of Cycles]

Bytes/Cycles	2/19

INTO

(1) INTO

b7							b0
1	1	1	1	0	1	1	0

[Number of Bytes/Number of Cycles]

Bytes/Cycles	1/1

- If the O flag = 1, the number of cycles indicated is increased by 19.

J*Cnd*

(1) J*Cnd* label

b7						b0
0	1	1	0	1	CND	

label code
dsp8

dsp8 = address indicated by label – (start address of instruction + 1)

Cnd	CND	***Cnd***	CND
GEU/C	0 0 0	LTU/NC	1 0 0
GTU	0 0 1	LEU	1 0 1
EQ/Z	0 1 0	NE/NZ	1 1 0
N	0 1 1	PZ	1 1 1

[Number of Bytes/Number of Cycles]

Bytes/Cycles	2/2

- If the program branches to a label, the number of cycles indicated is increased by 2.

J*Cnd*

(2) J*Cnd* label

b7							b0	b7				b0	label code
0	1	1	1	1	1	0	1	1	1	0	0	CND	dsp8

dsp8 = address indicated by label – (start address of instruction + 2)

Cnd	CND	*Cnd*	CND
LE	1 0 0 0	GT	1 1 0 0
O	1 0 0 1	NO	1 1 0 1
GE	1 0 1 0	LT	1 1 1 0

[Number of Bytes/Number of Cycles]

Bytes/Cycles	3/2

- If the program branches to a label, the number of cycles indicated is increased by 2.

JMP

(1) JMP.S label

b7						b0
0	1	1	0	0	dsp	

dsp = address indicated by label – (start address of instruction + 2)

[Number of Bytes/Number of Cycles]

Bytes/Cycles	1/5

JMP

(2) JMP.B label

b7							b0	label code
1	1	1	1	1	1	1	0	dsp8

dsp8 = address indicated by label – (start address of instruction + 1)

[Number of Bytes/Number of Cycles]

Bytes/Cycles	2/4

JMP

(3) JMP.W label

b7							b0	label code
1	1	1	1	0	1	0	0	dsp16

dsp16 = address indicated by label – (start address of instruction + 1)

[Number of Bytes/Number of Cycles]

Bytes/Cycles	3/4

JMP

(4) JMP.A label

b7							b0
1	1	1	1	1	1	0	0

label code

abs20

[Number of Bytes/Number of Cycles]

Bytes/Cycles	4/4

JMPI

(1) JMPI.W src

b7							b0	b7				b0
0	1	1	1	1	1	0	1	0	0	1	0	SRC

src code

dsp8
dsp16/abs16
dsp20

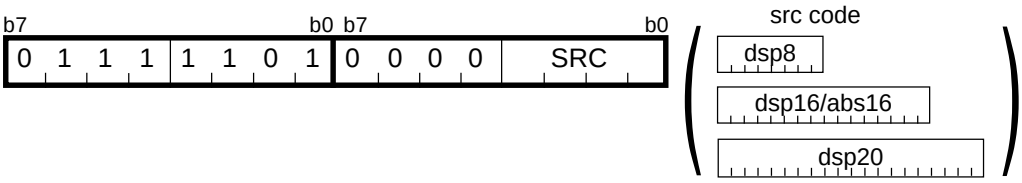
src		SRC	src		SRC
Rn	R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:20[An]	dsp:20[A0]	1 1 0 0
	A1	0 1 0 1		dsp:20[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

src	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:20[An]	dsp:16[SB]	abs16
Bytes/Cycles	2/7	2/7	2/11	3/11	3/11	5/11	4/11	4/11

JMPI

(2) JMPI.A src



src		SRC	src		SRC
Rn	R2R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R3R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	---	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	---	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A1A0	0 1 0 0	dsp:20[An]	dsp:20[A0]	1 1 0 0
	---	0 1 0 1		dsp:20[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

- Items marked **---** cannot be selected.

[Number of Bytes/Number of Cycles]

src	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:20[An]	dsp:16[SB]	abs16
Bytes/Cycles	2/6	2/6	2/10	3/10	3/10	5/10	4/10	4/10

JSR

(1) JSR.W label

b7							b0	label code
1	1	1	1	0	1	0	1	dsp16

dsp16 = address indicated by label – (start address of instruction + 1)

[Number of Bytes/Number of Cycles]

Bytes/Cycles	3/8

JSR

(2) JSR.A label

b7							b0	label code
1	1	1	1	1	1	0	1	abs20

[Number of Bytes/Number of Cycles]

Bytes/Cycles	4/9

JSRI

(1) JSRI.W src

b7							b0	b7				b0
0	1	1	1	1	1	0	1	0	0	1	1	SRC

src code
- dsp8
- dsp16/abs16
- dsp20

src		SRC	src		SRC
Rn	R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:20[An]	dsp:20[A0]	1 1 0 0
	A1	0 1 0 1		dsp:20[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

src	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:20[An]	dsp:16[SB]	abs16
Bytes/Cycles	2/11	2/11	2/15	3/15	3/15	5/15	4/15	4/15

JSRI

(2) JSRI.A src

b7							b0	b7				b0
0	1	1	1	1	1	0	1	0	0	0	1	SRC

src code
- dsp8
- dsp16/abs16
- dsp20

src		SRC	src		SRC
Rn	R2R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R3R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	---	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	---	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A1A0	0 1 0 0	dsp:20[An]	dsp:20[A0]	1 1 0 0
	---	0 1 0 1		dsp:20[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

- Items marked **---** cannot be selected.

[Number of Bytes/Number of Cycles]

src	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:20[An]	dsp:16[SB]	abs16
Bytes/Cycles	2/11	2/11	2/15	3/15	3/15	5/15	4/15	4/15

LDC

(1) LDC #IMM16, dest

b7							b0	b7			b0				
1	1	1	0	1	0	1	1	0	DEST			0	0	0	0

#IMM16

dest	DEST
---	0 0 0
INTBL	0 0 1
INTBH	0 1 0
FLG	0 1 1
ISP	1 0 0
SP	1 0 1
SB	1 1 0
FB	1 1 1

- Items marked **---** cannot be selected.

[Number of Bytes/Number of Cycles]

Bytes/Cycles	4/2

LDC

(2) LDC src, dest

b7							b0	b7			b0
0	1	1	1	1	0	1	0	1	DEST	SRC	

src code

(dsp8 / dsp16/abs16)

src		SRC	src		SRC
Rn	R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

dest	DEST
---	0 0 0
INTBL	0 0 1
INTBH	0 1 0
FLG	0 1 1
ISP	1 0 0
SP	1 0 1
SB	1 1 0
FB	1 1 1

- Items marked **---** cannot be selected.

[Number of Bytes/Number of Cycles]

src	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	2/1	2/1	2/3	3/3	3/3	4/3	4/3	4/3

LDCTX

(1) LDCTX abs16, abs20

b7							b0	b7							b0		
0	1	1	1	1	1	0	0	1	1	1	1	0	0	0	0	abs16	abs20

[Number of Bytes/Number of Cycles]

Bytes/Cycles	7/11+2×m

- m denotes the number of transfers to be performed.

LDE

(1) LDE.size abs20, dest

b7							b0	b7				b0
0	1	1	1	0	1	0	SIZE	1	0	0	0	DEST

dest code: dsp8 / dsp16/abs16

src code: abs20

.size	SIZE
.B	0
.W	1

dest		DEST	dest		DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	5/4	5/4	5/5	6/5	6/5	7/5	7/5	7/5

LDE

(2) LDE.size dsp:20[A0], dest

b7							b0	b7				b0
0	1	1	1	0	1	0	SIZE	1	0	0	1	DEST

dest code: dsp8 / dsp16/abs16

src code: dsp20

.size	SIZE
.B	0
.W	1

dest		DEST	dest		DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	5/4	5/4	5/5	6/5	6/5	7/5	7/5	7/5

LDE

(3) LDE.size [A1A0], dest

b7							b0	b7				b0
0	1	1	1	0	1	0	SIZE	1	0	1	0	DEST

dest code: dsp8 / dsp16/abs16

.size	SIZE
.B	0
.W	1

dest		DEST	dest		DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	2/4	2/4	2/5	3/5	3/5	4/5	4/5	4/5

LDINTB

(1) LDINTB #IMM

b7							b0	b7							b0
1	1	1	0	1	0	1	1	0	0	1	0	0	0	0	0
0	0	0	0	#IMM1				0	0	0	0	0	0	0	0
1	1	1	0	1	0	1	1	0	0	0	1	0	0	0	0
#IMM2															

- #IMM1 indicates the 4 high-order bits of #IMM.
  #IMM2 indicates the 16 low-order bits of #IMM.

[Number of Bytes/Number of Cycles]

Bytes/Cycles	8/4

LDIPL

(1) LDIPL #IMM

b7							b0	b7							b0
0	1	1	1	1	1	0	1	1	0	1	0	0	#IMM		

[Number of Bytes/Number of Cycles]

Bytes/Cycles	2/2

MOV

(1) MOV.size:G #IMM, dest

b7							b0	b7							b0
0	1	1	1	0	1	0	SIZE	1	1	0	0	DEST			

dest code

(dsp8 / dsp16/abs16) #IMM8 / #IMM16

.size	SIZE
.B	0
.W	1

dest		DEST	dest		DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	3/2	3/2	3/3	4/3	4/3	5/3	5/3	5/3

- If the size specifier (.size) is (.W), the number of bytes indicated is increased by 1.

MOV

(2) MOV.size:Q #IMM, dest

b7							b0	b7	b0
1	1	0	1	1	0	0	SIZE	IMM4	DEST

dest code

(dsp8 / dsp16/abs16)

.size	SIZE
.B	0
.W	1

#IMM	IMM4	#IMM	IMM4
0	0 0 0 0	–8	1 0 0 0
+1	0 0 0 1	–7	1 0 0 1
+2	0 0 1 0	–6	1 0 1 0
+3	0 0 1 1	–5	1 0 1 1
+4	0 1 0 0	–4	1 1 0 0
+5	0 1 0 1	–3	1 1 0 1
+6	0 1 1 0	–2	1 1 1 0
+7	0 1 1 1	–1	1 1 1 1

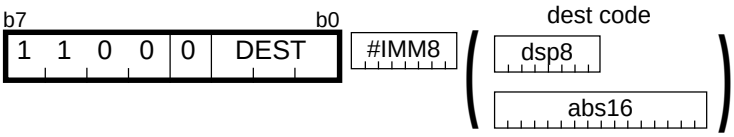
dest		DEST	dest		DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	2/1	2/1	2/2	3/2	3/2	4/2	4/2	4/2

MOV

(3) MOV.B:S #IMM8, dest



dest		DEST
Rn	R0H	0 1 1
	R0L	1 0 0
dsp:8[SB/FB]	dsp:8[SB]	1 0 1
	dsp:8[FB]	1 1 0
abs16	abs16	1 1 1

[Number of Bytes/Number of Cycles]

dest	Rn	dsp:8[SB/FB]	abs16
Bytes/Cycles	2/1	3/2	4/2

MOV

(4) MOV.size:S #IMM, dest

b7							b0
1	SIZE	1	0	DEST	0	1	0

#IMM8

#IMM16

.size	SIZE
.B	1
.W	0

dest	DEST
A0	0
A1	1

[Number of Bytes/Number of Cycles]

Bytes/Cycles	2/1

- If the size specifier (.size) is (.W), the number of bytes and cycles indicated are increased by 1 each.

MOV

(5) MOV.B:Z #0, dest

b7					b0
1	0	1	1	0	DEST

dest code

(dsp8 / abs16)

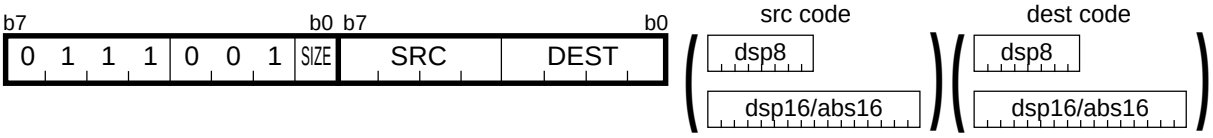
dest		DEST
Rn	R0H	0 1 1
	R0L	1 0 0
dsp:8[SB/FB]	dsp:8[SB]	1 0 1
	dsp:8[FB]	1 1 0
abs16	abs16	1 1 1

[Number of Bytes/Number of Cycles]

dest	Rn	dsp:8[SB/FB]	abs16
Bytes/Cycles	1/1	2/2	3/2

MOV

(6) MOV.size:G src, dest



.size	SIZE
.B	0
.W	1

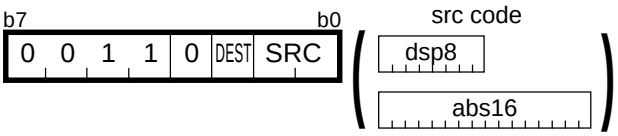
src/dest		SRC/DEST	src/dest		SRC/DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

src \ dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Rn	2/2	2/2	2/2	3/2	3/2	4/2	4/2	4/2
An	2/2	2/2	2/2	3/2	3/2	4/2	4/2	4/2
[An]	2/3	2/3	2/3	3/3	3/3	4/3	4/3	4/3
dsp:8[An]	3/3	3/3	3/3	4/3	4/3	5/3	5/3	5/3
dsp:8[SB/FB]	3/3	3/3	3/3	4/3	4/3	5/3	5/3	5/3
dsp:16[An]	4/3	4/3	4/3	5/3	5/3	6/3	6/3	6/3
dsp:16[SB]	4/3	4/3	4/3	5/3	5/3	6/3	6/3	6/3
abs16	4/3	4/3	4/3	5/3	5/3	6/3	6/3	6/3

MOV

(7) MOV.B:S src, dest



src		SRC
Rn	R0L/R0H	0 0
dsp:8[SB/FB]	dsp:8[SB]	0 1
	dsp:8[FB]	1 0
abs16	abs16	1 1

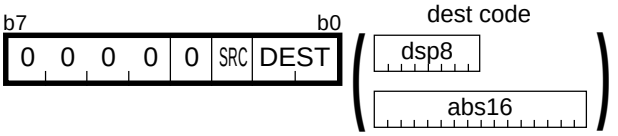
dest	DEST
A0	0
A1	1

[Number of Bytes/Number of Cycles]

src	Rn	dsp:8[SB/FB]	abs16
Bytes/Cycles	1/2	2/3	3/3

MOV

(8) MOV.B:S R0L/R0H, dest



src	SRC
R0L	0
R0H	1

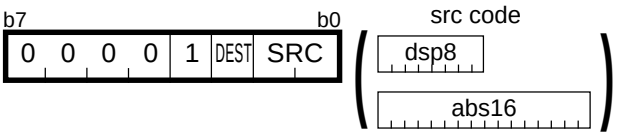
dest		DEST
dsp:8[SB/FB]	dsp:8[SB]	0 1
	dsp:8[FB]	1 0
abs16	abs16	1 1

[Number of Bytes/Number of Cycles]

dest	dsp:8[SB/FB]	abs16
Bytes/Cycles	2/2	3/2

MOV

(9) MOV.B:S src, R0L/R0H



src		SRC
Rn	R0L/R0H	0 0
dsp:8[SB/FB]	dsp:8[SB]	0 1
	dsp:8[FB]	1 0
abs16	abs16	1 1

dest	DEST
R0L	0
R0H	1

[Number of Bytes/Number of Cycles]

src	Rn	dsp:8[SB/FB]	abs16
Bytes/Cycles	1/2	2/3	3/3

MOV

(10) MOV.size:G dsp:8[SP], dest

.size	SIZE
.B	0
.W	1

dest		DEST	dest		DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	3/2	3/2	3/3	4/3	4/3	5/3	5/3	5/3

MOV

(11) MOV.size:G src, dsp:8[SP]

b7							b0	b7				b0
0	1	1	1	0	1	0	SIZE	0	0	1	1	SRC

src code: dsp8 / dsp16/abs16

dest code: dsp8

.size	SIZE
.B	0
.W	1

src		SRC	src		SRC
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	3/3	3/3	3/4	4/4	4/4	5/4	5/4	5/4

MOVA

(1) MOVA src, dest

b7							b0	b7		b0
1	1	1	0	1	0	1	1	0	DEST	SRC

src code: dsp8 / dsp16

src		SRC
dsp:8[An]	dsp:8[A0]	1 0 0 0
	dsp:8[A1]	1 0 0 1
dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	dsp:8[FB]	1 0 1 1
dsp:16[An]	dsp:16[A0]	1 1 0 0
	dsp:16[A1]	1 1 0 1
dsp:16[SB]	dsp:16[SB]	1 1 1 0
abs16	abs16	1 1 1 1

dest	DEST
R0	0 0 0
R1	0 0 1
R2	0 1 0
R3	0 1 1
A0	1 0 0
A1	1 0 1

[Number of Bytes/Number of Cycles]

src	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	3/2	3/2	4/2	4/2	4/2

MOV*Dir*

(1) MOV*Dir* R0L, dest

b7							b0	b7		b0		
0	1	1	1	1	1	0	0	1	0	DIR	DEST	

dest code: dsp8 / dsp16/abs16

Dir	DIR
LL	0 0
LH	1 0
HL	0 1
HH	1 1

dest		DEST	dest		DEST
Rn	---	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H	0 0 1 1		dsp:8[FB]	1 0 1 1
An	---	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	---	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

- Items marked --- cannot be selected.

[Number of Bytes/Number of Cycles]

dest	Rn	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
MOVHH, MOVLL	2/4	2/5	3/5	3/5	4/5	4/5	4/5
MOVHL, MOVLH	2/7	2/8	3/8	3/8	4/8	4/8	4/8

MOV*Dir*

(2) MOV*Dir* src, R0L

b7							b0	b7							b0
0	1	1	1	1	1	0	0	0	0	DIR		SRC			

dest code

(dsp8 / dsp16/abs16)

Dir	DIR
LL	0 0
LH	1 0
HL	0 1
HH	1 1

src		SRC	src		SRC
Rn	R0L	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H	0 0 1 1		dsp:8[FB]	1 0 1 1
An	---	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	---	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

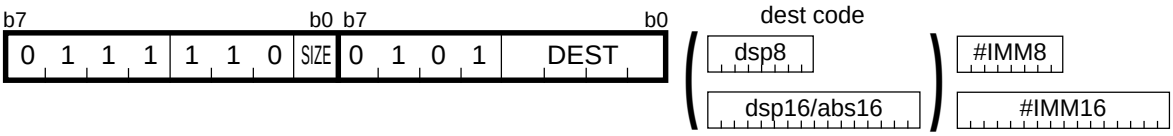
- Items marked --- cannot be selected.

[Number of Bytes/Number of Cycles]

src	Rn	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
MOVHH, MOVLL	2/3	2/5	3/5	3/5	4/5	4/5	4/5
MOVHL, MOVLH	2/6	2/8	3/8	3/8	4/8	4/8	4/8

MUL

(1) MUL.size #IMM, dest



.size	SIZE
.B	0
.W	1

dest		DEST	dest		DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	--- /R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/---	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	---	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	---	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

- Items marked --- cannot be selected.

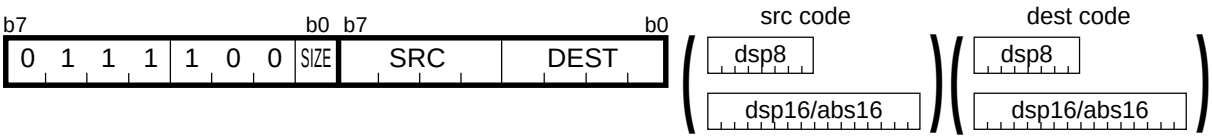
[Number of Bytes/Number of Cycles]

dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	3/4	3/4	3/5	4/5	4/5	5/5	5/5	5/5

- If dest is Rn or An and the size specifier (.size) is (.W), the number of bytes and cycles indicated are increased by 1 each.
- If dest is neither Rn nor An and the size specifier (.size) is (.W), the number of bytes and cycles indicated are increased by 1 and 2, respectively.

MUL

(2) MUL.size src, dest



.size	SIZE
.B	0
.W	1

src		SRC	src		SRC
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

dest		DEST	dest		DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	--- /R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/---	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	---	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	---	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

- Items marked --- cannot be selected.

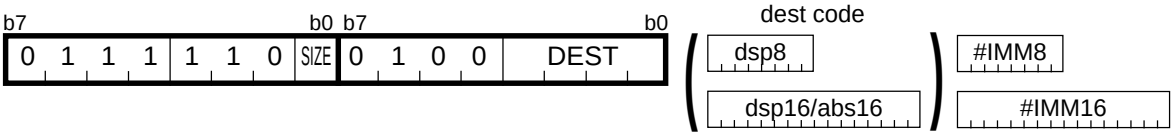
[Number of Bytes/Number of Cycles]

src \ dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Rn	2/4	2/4	2/5	3/5	3/5	4/5	4/5	4/5
An	2/4	2/5	2/5	3/5	3/5	4/5	4/5	4/5
[An]	2/6	2/6	2/6	3/6	3/6	4/6	4/6	4/6
dsp:8[An]	3/6	3/6	3/6	4/6	4/6	5/6	5/6	5/6
dsp:8[SB/FB]	3/6	3/6	3/6	4/6	4/6	5/6	5/6	5/6
dsp:16[An]	4/6	4/6	4/6	5/6	5/6	6/6	6/6	6/6
dsp:16[SB]	4/6	4/6	4/6	5/6	5/6	6/6	6/6	6/6
abs16	4/6	4/6	4/6	5/6	5/6	6/6	6/6	6/6

- If src is An and dest is Rn and the size specifier (.size) is (.W), the number of cycles indicated is increased by 1.
- If src is not An and dest is Rn or An and the size specifier (.size) is (.W), the number of cycles indicated is increased by 1.
- If dest is neither Rn nor An and the size specifier (.size) is (.W), the number of cycles indicated is increased by 2.

MULU

(1) MULU.size #IMM, dest



.size	SIZE
.B	0
.W	1

dest		DEST	dest		DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	--- /R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/---	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	---	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	---	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

- Items marked --- cannot be selected.

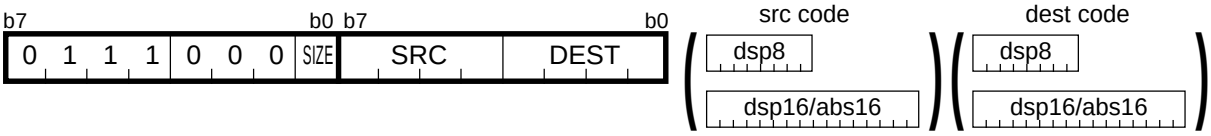
[Numbera of Bytes/Number of Cycles]

dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	3/4	3/4	3/5	4/5	4/5	5/5	5/5	5/5

- If dest is Rn or An and the size specifier (.size) is (.W), the number of bytes and cycles indicated are increased by 1 each.
- If dest is neither Rn nor An and the size specifier (.size) is (.W), the number of bytes and cycles indicated are increased by 1 and 2, respectively.

MULU

(2) MULU.size src, dest



.size	SIZE
.B	0
.W	1

src		SRC	src		SRC
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

dest		DEST	dest		DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	--- /R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/---	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	---	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	---	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

- Items marked --- cannot be selected.

[Number of Bytes/Number of Cycles]

src \ dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Rn	2/4	2/4	2/5	3/5	3/5	4/5	4/5	4/5
An	2/4	2/5	2/5	3/5	3/5	4/5	4/5	4/5
[An]	2/6	2/6	2/6	3/6	3/6	4/6	4/6	4/6
dsp:8[An]	3/6	3/6	3/6	4/6	4/6	5/6	5/6	5/6
dsp:8[SB/FB]	3/6	3/6	3/6	4/6	4/6	5/6	5/6	5/6
dsp:16[An]	4/6	4/6	4/6	5/6	5/6	6/6	6/6	6/6
dsp:16[SB]	4/6	4/6	4/6	5/6	5/6	6/6	6/6	6/6
abs16	4/6	4/6	4/6	5/6	5/6	6/6	6/6	6/6

- If src is An and dest is Rn and the size specifier (.size) is (.W), the number of cycles indicated is increased by 1.
- If src is not An and dest is Rn or An and the size specifier (.size) is (.W), the number of cycles indicated is increased by 1.
- If dest is neither Rn nor An and the size specifier (.size) is (.W), the number of cycles indicated is increased by 2.

NEG

(1) NEG.size dest

b7							b0	b7							b0
0	1	1	1	0	1	0	SIZE	0	1	0	1	DEST			

dest code: dsp8 / dsp16/abs16

.size	SIZE
.B	0
.W	1

dest		DEST	dest		DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	2/1	2/1	2/3	3/3	3/3	4/3	4/3	4/3

NOP

(1) NOP

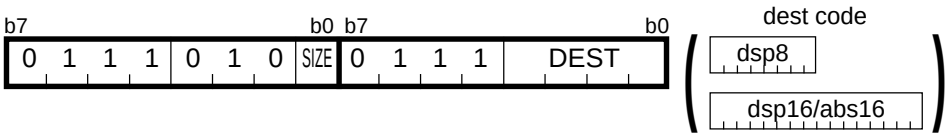
b7							b0
0	0	0	0	0	1	0	0

[Number of Bytes/Number of Cycles]

Bytes/Cycles	1/1

NOT

(1) NOT.size:G dest



.size	SIZE
.B	0
.W	1

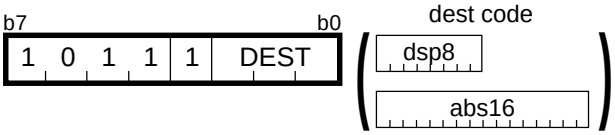
dest		DEST	dest		DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	2/1	2/1	2/3	3/3	3/3	4/3	4/3	4/3

NOT

(2) NOT.B:S dest



dest		DEST
Rn	R0H	0 1 1
	R0L	1 0 0
dsp:8[SB/FB]	dsp:8[SB]	1 0 1
	dsp:8[FB]	1 1 0
abs16	abs16	1 1 1

[Number of Bytes/Number of Cycles]

dest	Rn	dsp:8[SB/FB]	abs16
Bytes/Cycles	1/1	2/3	3/3

OR

(1) OR.size:G #IMM, dest

b7							b0	b7				b0
0	1	1	1	0	1	1	SIZE	0	0	1	1	DEST

dest code: dsp8 / dsp16/abs16 — #IMM8 / #IMM16

.size	SIZE
.B	0
.W	1

dest		DEST	dest		DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	3/2	3/2	3/4	4/4	4/4	5/4	5/4	5/4

- If the size specifier (.size) is (.W), the number of bytes indicated is increased by 1.

OR

(2) OR.B:S #IMM8, dest

b7					b0
1	0	0	1	1	DEST

#IMM8

dest code: dsp8 / abs16

dest		DEST
Rn	R0H	0 1 1
	R0L	1 0 0
dsp:8[SB/FB]	dsp:8[SB]	1 0 1
	dsp:8[FB]	1 1 0
abs16	abs16	1 1 1

[Number of Bytes/Number of Cycles]

dest	Rn	dsp:8[SB/FB]	abs16
Bytes/Cycles	2/1	3/3	4/3

OR

(3) OR.size:G src, dest

b7							b0	b7	b0
1	0	0	1	1	0	0	SIZE	SRC	DEST

src code: dsp8 / dsp16/abs16

dest code: dsp8 / dsp16/abs16

.size	SIZE
.B	0
.W	1

src/dest		SRC/DEST	src/dest		SRC/DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

src \ dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Rn	2/2	2/2	2/3	3/3	3/3	4/3	4/3	4/3
An	2/2	2/2	2/3	3/3	3/3	4/3	4/3	4/3
[An]	2/3	2/3	2/4	3/4	3/4	4/4	4/4	4/4
dsp:8[An]	3/3	3/3	3/4	4/4	4/4	5/4	5/4	5/4
dsp:8[SB/FB]	3/3	3/3	3/4	4/4	4/4	5/4	5/4	5/4
dsp:16[An]	4/3	4/3	4/4	5/4	5/4	6/4	6/4	6/4
dsp:16[SB]	4/3	4/3	4/4	5/4	5/4	6/4	6/4	6/4
abs16	4/3	4/3	4/4	5/4	5/4	6/4	6/4	6/4

OR

(4) OR.B:S src, R0L/R0H

b7						b0
0 0 0 1	1	DEST	SRC	(dest code: dsp8 / abs16)		

src		SRC
Rn	R0L/R0H	0 0
dsp:8[SB/FB]	dsp:8[SB]	0 1
	dsp:8[FB]	1 0
abs16	abs16	1 1

dest	DEST
R0L	0
R0H	1

[Number of Bytes/Number of Cycles]

src	Rn	dsp:8[SB/FB]	abs16
Bytes/Cycles	1/2	2/3	3/3

POP

(1) POP.size:G dest

b7							b0	b7					b0
0 1 1 1				0 1 0			SIZE	1 1 0 1				DEST	

(dest code: dsp8 / dsp16/abs16)

.size	SIZE
.B	0
.W	1

dest		DEST	dest		DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	2/3	2/3	2/4	3/4	3/4	4/4	4/4	4/4

POP

(2) POP.B:S dest

b7							b0
1	0	0	1	DEST	0	1	0

dest	DEST
R0L	0
R0H	1

[Number of Bytes/Number of Cycles]

Bytes/Cycles	1/3

POP

(3) POP.W:S dest

b7							b0
1	1	0	1	DEST	0	1	0

dest	DEST
A0	0
A1	1

[Number of Bytes/Number of Cycles]

Bytes/Cycles	1/3

POPC

(1) POPC dest

b7							b0	b7							b0
1	1	1	0	1	0	1	1	0	DEST			0	0	1	1

dest	DEST	dest	DEST
---	0 0 0	ISP	1 0 0
INTBL	0 0 1	SP	1 0 1
INTBH	0 1 0	SB	1 1 0
FLG	0 1 1	FB	1 1 1

- Items marked --- cannot be selected.

[Number of Bytes/Number of Cycles]

Bytes/Cycles	2/3

POPM

(1) POPM dest

b7							b0
1	1	1	0	1	1	0	1

DEST

dest							
FB	SB	A1	A0	R3	R2	R1	R0
DEST*2							

- The bit for a selected register is 1.
  The bit for a non-selected register is 0.

[Number of Bytes/Number of Cycles]

Bytes/Cycles	2/3

- If two or more registers need to be restored, the number of required cycles is 2 x m (m: number of registers to be restored).

PUSH

(1) PUSH.size:G #IMM

b7							b0	b7							b0
0	1	1	1	1	1	0	SIZE	1	1	1	0	0	0	1	0

#IMM8

#IMM16

.size	SIZE
.B	0
.W	1

[Number of Bytes/Number of Cycles]

Bytes/Cycles	3/2

- If the size specifier (.size) is (.W), the number of bytes indicated is increased by 1.

PUSH

(2) PUSH.size:G src

b7							b0	b7					b0
0	1	1	1	0	1	0	SIZE	0	1	0	0	SRC	

src code

(dsp8 / dsp16/abs16)

.size	SIZE
.B	0
.W	1

src		SRC	src		SRC
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

src	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	2/2	2/2	2/4	3/4	3/4	4/4	4/4	4/4

PUSH

(3) PUSH.B:S src

b7							b0
1	0	0	0	SRC	0	1	0

src	SRC
R0L	0
R0H	1

[Number of Bytes/Number of Cycles]

Bytes/Cycles	1/2

PUSH

(4) PUSH.W:S src

b7							b0
1	1	0	0	SRC	0	1	0

src	SRC
A0	0
A1	1

[Number of Bytes/Number of Cycles]

Bytes/Cycles	1/2

PUSHA

(1) PUSHA src

b7				b0	b7				b0	
0	1	1	1	1	1	0	1	1	0	0	1	SRC

src code: dsp8 / dsp16/abs16

src		SRC
dsp:8[An]	dsp:8[A0]	1 0 0 0
	dsp:8[A1]	1 0 0 1
dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	dsp:8[FB]	1 0 1 1
dsp:16[An]	dsp:16[A0]	1 1 0 0
	dsp:16[A1]	1 1 0 1
dsp:16[SB]	dsp:16[SB]	1 1 1 0
abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

src	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs:16
Bytes/Cycles	3/2	3/2	4/2	4/2	4/2

PUSHC

(1) PUSHC src

b7				b0	b7				b0
1	1	1	0	1	0	1	1	0	SRC	0	0	1	0

src	SRC	src	SRC
---	0 0 0	ISP	1 0 0
INTBL	0 0 1	SP	1 0 1
INTBH	0 1 0	SB	1 1 0
FLG	0 1 1	FB	1 1 1

- Items marked --- cannot be selected.

[Number of Bytes/Number of Cycles]

Bytes/Cycles	2/2

PUSHM

(1) PUSHM src

b7							b0	
1	1	1	0	1	1	0	0	SRC

src							
R0	R1	R2	R3	A0	A1	SB	FB
SRC*1							

- The bit for a selected register is 1.
  The bit for a non-selected register is 0.

[Number of Bytes/Number of Cycles]

Bytes/Cycles	2/2×m

- m denotes the number of registers to be saved.

REIT

(1) REIT

b7							b0
1	1	1	1	1	0	1	1

[Number of Bytes/Number of Cycles]

Bytes/Cycles	1/6

RMPA

(1) RMPA.size

b7							b0	b7							b0
0	1	1	1	1	1	0	SIZE	1	1	1	1	0	0	0	1

.size	SIZE
.B	0
.W	1

[Number of Bytes/Number of Cycles]

Bytes/Cycles	2/4+7×m

- m denotes the number of operations to be performed.
- If the size specifier (.size) is (.W), the number of cycles is (6+9×m).

ROLC

(1) ROLC.size dest

b7							b0	b7					b0
0	1	1	1	0	1	1	SIZE	1	0	1	0	DEST	

dest code

(dsp8 / dsp16/abs16)

.size	SIZE
.B	0
.W	1

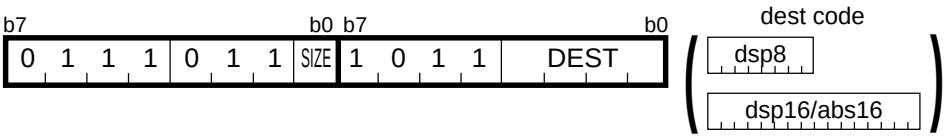
dest		DEST	dest		DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	2/1	2/1	2/3	3/3	3/3	4/3	4/3	4/3

RORC

(1) RORC.size dest



.size	SIZE
.B	0
.W	1

dest		DEST	dest		DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	2/1	2/1	2/3	3/3	3/3	4/3	4/3	4/3

ROT

(1) ROT.size #IMM, dest

b7							b0	b7				b0
1	1	1	0	0	0	0	SIZE	IMM4				DEST

dest code

dsp8
dsp16/abs16

.size	SIZE
.B	0
.W	1

#IMM	IMM4	#IMM	IMM4
+1	0 0 0 0	–1	1 0 0 0
+2	0 0 0 1	–2	1 0 0 1
+3	0 0 1 0	–3	1 0 1 0
+4	0 0 1 1	–4	1 0 1 1
+5	0 1 0 0	–5	1 1 0 0
+6	0 1 0 1	–6	1 1 0 1
+7	0 1 1 0	–7	1 1 1 0
+8	0 1 1 1	–8	1 1 1 1

dest		DEST	dest		DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	2/1+m	2/1+m	2/2+m	3/2+m	3/2+m	4/2+m	4/2+m	4/2+m

- m denotes the number of bits to be rotated.

ROT

(2) ROT.size R1H, dest

b7							b0	b7							b0
0	1	1	1	0	1	0	SIZE	0	1	1	0	DEST			

dest code: dsp8 / dsp16/abs16

.size	SIZE
.B	0
.W	1

dest		DEST	dest		DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/---	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	--- /R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

- Items marked --- cannot be selected.

[Number of Bytes/Number of Cycles]

dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	2/2+m	2/2+m	2/3+m	3/3+m	3/3+m	4/3+m	4/3+m	4/3+m

- m denotes the number of bits to be rotated.

RTS

(1) RTS

b7							b0
1	1	1	1	0	0	1	1

[Number of Bytes/Number of Cycles]

Bytes/Cycles	1/6

SBB

(1) SBB.size #IMM, dest

b7							b0	b7				b0
0	1	1	1	0	1	1	SIZE	0	1	1	1	DEST

dest code

dsp8	#IMM8
dsp16/abs16	#IMM16

.size	SIZE
.B	0
.W	1

dest		DEST	dest		DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

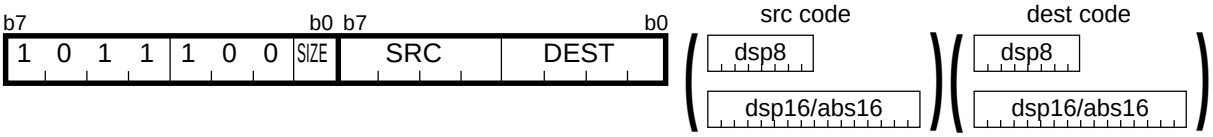
[Number of Bytes/Number of Cycles]

dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	3/2	3/2	3/4	4/4	4/4	5/4	5/4	5/4

- If the size specifier (.size) is (.W), the number of bytes indicated is increased by 1.

SBB

(2) SBB.size src, dest



.size	SIZE
.B	0
.W	1

src/dest		SRC/DEST	src/dest		SRC/DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

src \ dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Rn	2/2	2/2	2/3	3/3	3/3	4/3	4/3	4/3
An	2/2	2/2	2/3	3/3	3/3	4/3	4/3	4/3
[An]	2/3	2/3	2/4	3/4	3/4	4/4	4/4	4/4
dsp:8[An]	3/3	3/3	3/4	4/4	4/4	5/4	5/4	5/4
dsp:8[SB/FB]	3/3	3/3	3/4	4/4	4/4	5/4	5/4	5/4
dsp:16[An]	4/3	4/3	4/4	5/4	5/4	6/4	6/4	6/4
dsp:16[SB]	4/3	4/3	4/4	5/4	5/4	6/4	6/4	6/4
abs16	4/3	4/3	4/4	5/4	5/4	6/4	6/4	6/4

SBJNZ

(1) SBJNZ.size #IMM, dest, label

b7							b0	b7		b0
1	1	1	1	1	0	0	SIZE	IMM4	DEST	

dest code: dsp8 / dsp16/abs16

label code: dsp8

dsp8 (label code) = address indicated by label – (start address of instruction + 2)

.size	SIZE
.B	0
.W	1

#IMM	IMM4	#IMM	IMM4
0	0 0 0 0	+8	1 0 0 0
–1	0 0 0 1	+7	1 0 0 1
–2	0 0 1 0	+6	1 0 1 0
–3	0 0 1 1	+5	1 0 1 1
–4	0 1 0 0	+4	1 1 0 0
–5	0 1 0 1	+3	1 1 0 1
–6	0 1 1 0	+2	1 1 1 0
–7	0 1 1 1	+1	1 1 1 1

dest		DEST	dest		DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	3/3	3/3	3/5	4/5	4/5	5/5	5/5	5/5

- If the program branches to a label, the number of cycles indicated is increased by 4.

SHA

(1) SHA.size #IMM, dest

b7							b0	b7							b0
1	1	1	1	0	0	0	SIZE	IMM4				DEST			

dest code

dsp8
dsp16/abs16

.size	SIZE
.B	0
.W	1

#IMM	IMM4	#IMM	IMM4
+1	0 0 0 0	–1	1 0 0 0
+2	0 0 0 1	–2	1 0 0 1
+3	0 0 1 0	–3	1 0 1 0
+4	0 0 1 1	–4	1 0 1 1
+5	0 1 0 0	–5	1 1 0 0
+6	0 1 0 1	–6	1 1 0 1
+7	0 1 1 0	–7	1 1 1 0
+8	0 1 1 1	–8	1 1 1 1

dest		DEST	dest		DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	2/1+m	2/1+m	2/2+m	3/2+m	3/2+m	4/2+m	4/2+m	4/2+m

- m denotes the number of bits to be shifted.

SHA

(2) SHA.size R1H, dest

b7							b0	b7				b0
0	1	1	1	0	1	0	SIZE	1	1	1	1	DEST

dest code: dsp8 / dsp16/abs16

.size	SIZE
.B	0
.W	1

dest		DEST	dest		DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/---	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	--- /R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

- Items marked --- cannot be selected.

[Number of Bytes/Number of Cycles]

dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	2/2+m	2/2+m	2/3+m	3/3+m	3/3+m	4/3+m	4/3+m	4/3+m

- m denotes the number of bits to be shifted.

SHA

(3) SHA.L #IMM, dest

b7							b0	b7				b0
1	1	1	0	1	0	1	1	1	0	1	DEST	IMM4

#IMM	IMM4	#IMM	IMM4
+1	0 0 0 0	–1	1 0 0 0
+2	0 0 0 1	–2	1 0 0 1
+3	0 0 1 0	–3	1 0 1 0
+4	0 0 1 1	–4	1 0 1 1
+5	0 1 0 0	–5	1 1 0 0
+6	0 1 0 1	–6	1 1 0 1
+7	0 1 1 0	–7	1 1 1 0
+8	0 1 1 1	–8	1 1 1 1

dest	DEST
R2R0	0
R3R1	1

[Number of Bytes/Number of Cycles]

Bytes/Cycles	2/3+m

- m denotes the number of bits to be shifted.

SHA

(4) SHA.L R1H, dest

b7							b0	b7							b0
1	1	1	0	1	0	1	1	0	0	1	DEST	0	0	0	1

dest	DEST
R2R0	0
R3R1	1

[Number of Bytes/Number of Cycles]

Bytes/Cycles	2/4+m

- m denotes the number of bits to be shifted.

SHL

(1) SHL.size #IMM, dest

b7							b0	b7				b0
1	1	1	0	1	0	0	SIZE	IMM4				DEST

dest code: dsp8 / dsp16/abs16

.size	SIZE
.B	0
.W	1

#IMM	IMM4	#IMM	IMM4
+1	0 0 0 0	–1	1 0 0 0
+2	0 0 0 1	–2	1 0 0 1
+3	0 0 1 0	–3	1 0 1 0
+4	0 0 1 1	–4	1 0 1 1
+5	0 1 0 0	–5	1 1 0 0
+6	0 1 0 1	–6	1 1 0 1
+7	0 1 1 0	–7	1 1 1 0
+8	0 1 1 1	–8	1 1 1 1

dest		DEST	dest		DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	2/1+m	2/1+m	2/2+m	3/2+m	3/2+m	4/2+m	4/2+m	4/2+m

- m denotes the number of bits to be shifted.

SHL

(2) SHL.size R1H, dest

b7							b0	b7				b0
0	1	1	1	0	1	0	SIZE	1	1	1	0	DEST

dest code: dsp8 / dsp16/abs16

.size	SIZE
.B	0
.W	1

dest		DEST	dest		DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/---	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	--- /R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

- Items marked --- cannot be selected.

[Number of Bytes/Number of Cycles]

dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	2/2+m	2/2+m	2/3+m	3/3+m	3/3+m	4/3+m	4/3+m	4/3+m

- m denotes the number of bits to be shifted.

SHL

(3) SHL.L #IMM, dest

b7							b0	b7				b0
1	1	1	0	1	0	1	1	1	0	0	DEST	IMM4

#IMM	IMM4	#IMM	IMM4
+1	0 0 0 0	–1	1 0 0 0
+2	0 0 0 1	–2	1 0 0 1
+3	0 0 1 0	–3	1 0 1 0
+4	0 0 1 1	–4	1 0 1 1
+5	0 1 0 0	–5	1 1 0 0
+6	0 1 0 1	–6	1 1 0 1
+7	0 1 1 0	–7	1 1 1 0
+8	0 1 1 1	–8	1 1 1 1

dest	DEST
R2R0	0
R3R1	1

[Number of Bytes/Number of Cycles]

Bytes/Cycles	2/3+m

- m denotes the number of bits to be shifted.

SHL

(4) SHL.L R1H, dest

b7							b0	b7							b0
1	1	1	0	1	0	1	1	0	0	0	DEST	0	0	0	1

dest	DEST
R2R0	0
R3R1	1

[Number of Bytes/Number of Cycles]

Bytes/Cycles	2/4+m

- m denotes the number of bits to be shifted.

SMOVB

(1) SMOVB.size

b7							b0	b7							b0
0	1	1	1	1	1	0	SIZE	1	1	1	0	1	0	0	1

.size	SIZE
.B	0
.W	1

[Number of Bytes/Number of Cycles]

Bytes/Cycles	2/5+5×m

- m denotes the number of transfers to be performed.

SMOVF

(1) SMOVF.size

b7							b0	b7							b0
0	1	1	1	1	1	0	SIZE	1	1	1	0	1	0	0	0

.size	SIZE
.B	0
.W	1

[Number of Bytes/Number of Cycles]

Bytes/Cycles	2/5+5×m

- m denotes the number of transfers to be performed.

SSTR

(1) SSTR.size

b7							b0	b7							b0
0	1	1	1	1	1	0	SIZE	1	1	1	0	1	0	1	0

.size	SIZE
.B	0
.W	1

[Number of Bytes/Number of Cycles]

Bytes/Cycles	2/3+2×m

- m denotes the number of transfers to be performed.

STC

(1) STC src, dest

b7							b0	b7			b0
0	1	1	1	1	0	1	1	1	SRC	DEST	

dest Code: dsp8 / dsp16/abs16

src	SRC
---	0 0 0
INTBL	0 0 1
INTBH	0 1 0
FLG	0 1 1
ISP	1 0 0
SP	1 0 1
SB	1 1 0
FB	1 1 1

dest		DEST	dest		DEST
Rn	R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

- Items marked --- cannot be selected.

[Number of Bytes/Number of Cycles]

dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	2/1	2/1	2/2	3/2	3/2	4/2	4/2	4/2

STC

(2) STC PC, dest

b7							b0	b7			b0
0	1	1	1	1	1	0	0	1	1	0	0	DEST

dest Code: dsp8 / dsp16/abs16

dest		DEST	dest		DEST
Rn	R2R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R3R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	---	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	---	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A1A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	---	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

- Items marked --- cannot be selected.

[Number of Bytes/Number of Cycles]

dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	2/2	2/2	2/3	3/3	3/3	4/3	4/3	4/3

STCTX

(1) STCTX abs16, abs20

b7							b0	b7							b0		
0	1	1	1	1	1	0	1	1	1	1	1	0	0	0	0	abs16	abs20

[Number of Bytes/Number of Cycles]

Bytes/Cycles	7/11+2×m

- m denotes the number of transfers to be performed.

STE

(1) STE.size src, abs20

b7							b0	b7					b0	src code	dest code
0	1	1	1	0	1	0	SIZE	0	0	0	0	SRC		dsp8 / dsp16/abs16	abs20

.size	SIZE
.B	0
.W	1

src		SRC	src		SRC
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

src	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	5/3	5/3	5/4	6/4	6/4	7/4	7/4	7/4

STE

(2) STE.size src, dsp:20[A0]

b7							b0	b7				b0
0	1	1	1	0	1	0	SIZE	0	0	0	1	SRC

src code: dsp8 / dsp16/abs16

dest code: dsp20

.size	SIZE
.B	0
.W	1

src		SRC	src		SRC
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

src	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	5/3	5/3	5/4	6/4	6/4	7/4	7/4	7/4

STE

(3) STE.size src, [A1A0]

b7							b0	b7				b0
0	1	1	1	0	1	0	SIZE	0	0	1	0	SRC

src code: dsp8 / dsp16/abs16

.size	SIZE
.B	0
.W	1

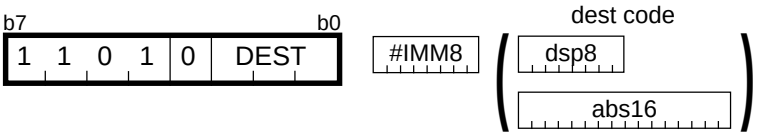
src		SRC	src		SRC
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

src	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	2/3	2/3	2/4	3/4	3/4	4/4	4/4	4/4

STNZ

(1) STNZ #IMM8, dest



dest		DEST
Rn	R0H	0 1 1
	R0L	1 0 0
dsp:8[SB/FB]	dsp:8[SB]	1 0 1
	dsp:8[FB]	1 1 0
abs16	abs16	1 1 1

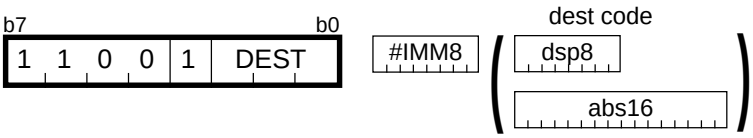
[Number of Bytes/Number of Cycles]

dest	Rn	dsp:8[SB/FB]	abs16
Bytes/Cycles	2/1	3/2	4/2

- If the Z flag = 0, the number of cycles indicated is increased by 1.

STZ

(1) STZ #IMM8, dest



dest		DEST
Rn	R0H	0 1 1
	R0L	1 0 0
dsp:8[SB/FB]	dsp:8[SB]	1 0 1
	dsp:8[FB]	1 1 0
abs16	abs16	1 1 1

[Number of Bytes/Number of Cycles]

dest	Rn	dsp:8[SB/FB]	abs16
Bytes/Cycles	2/1	3/2	4/2

- If the Z flag = 1, the number of cycles indicated is increased by 1.

STZX

(1) STZX #IMM81, #IMM82, dest

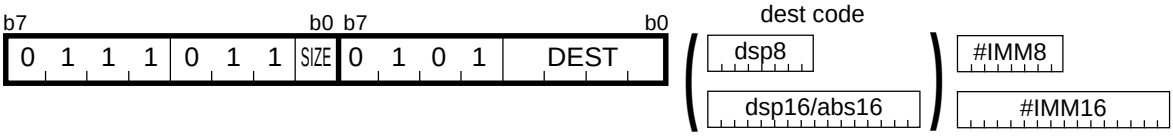
dest		DEST
Rn	R0H	0 1 1
	R0L	1 0 0
dsp:8[SB/FB]	dsp:8[SB]	1 0 1
	dsp:8[FB]	1 1 0
abs16	abs16	1 1 1

[Number of Bytes/Number of Cycles]

dest	Rn	dsp:8[SB/FB]	abs16
Bytes/Cycles	3/2	4/3	5/3

SUB

(1) SUB.size:G #IMM, dest



.size	SIZE
.B	0
.W	1

dest		DEST	dest		DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

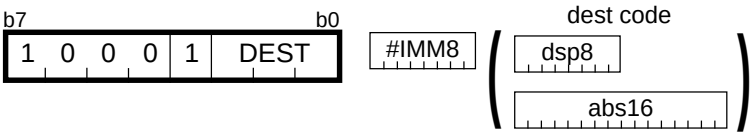
[Number of Bytes/Number of Cycles]

dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	3/2	3/2	3/4	4/4	4/4	5/4	5/4	5/4

- If the size specifier (.size) is (.W), the number of bytes indicated is increased by 1.

SUB

(2) SUB.B:S #IMM8, dest



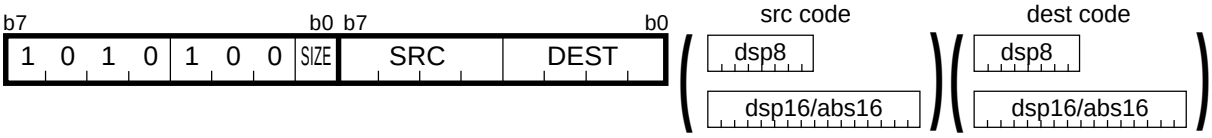
dest		DEST
Rn	R0H	0 1 1
	R0L	1 0 0
dsp:8[SB/FB]	dsp:8[SB]	1 0 1
	dsp:8[FB]	1 1 0
abs16	abs16	1 1 1

[Number of Bytes/Number of Cycles]

dest	Rn	dsp:8[SB/FB]	abs16
Bytes/Cycles	2/1	3/3	4/3

SUB

(3) SUB.size:G src, dest



.size	SIZE
.B	0
.W	1

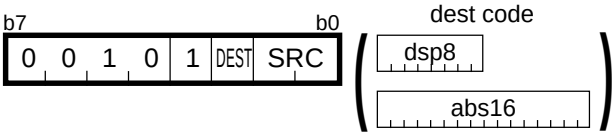
src/dest		SRC/DEST	src/dest		SRC/DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

src \ dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Rn	2/2	2/2	2/3	3/3	3/3	4/3	4/3	4/3
An	2/2	2/2	2/3	3/3	3/3	4/3	4/3	4/3
[An]	2/3	2/3	2/4	3/4	3/4	4/4	4/4	4/4
dsp:8[An]	3/3	3/3	3/4	4/4	4/4	5/4	5/4	5/4
dsp:8[SB/FB]	3/3	3/3	3/4	4/4	4/4	5/4	5/4	5/4
dsp:16[An]	4/3	4/3	4/4	5/4	5/4	6/4	6/4	6/4
dsp:16[SB]	4/3	4/3	4/4	5/4	5/4	6/4	6/4	6/4
abs16	4/3	4/3	4/4	5/4	5/4	6/4	6/4	6/4

SUB

(4) SUB.B:S src, R0L/R0H



src		SRC
Rn	R0L/R0H	0 0
dsp:8[SB/FB]	dsp:8[SB]	0 1
	dsp:8[FB]	1 0
abs16	abs16	1 1

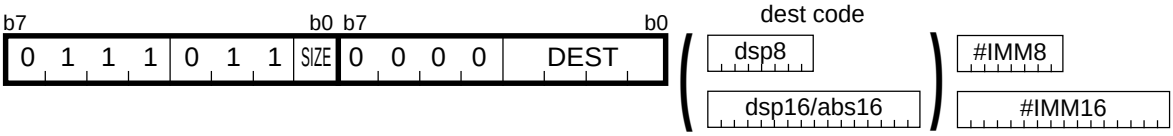
dest	DEST
R0L	0
R0H	1

[Number of Bytes/Number of Cycles]

src	Rn	dsp:8[SB/FB]	abs16
Bytes/Cycles	1/2	2/3	3/3

TST

(1) TST.size #IMM, dest



.size	SIZE
.B	0
.W	1

dest		DEST	dest		DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

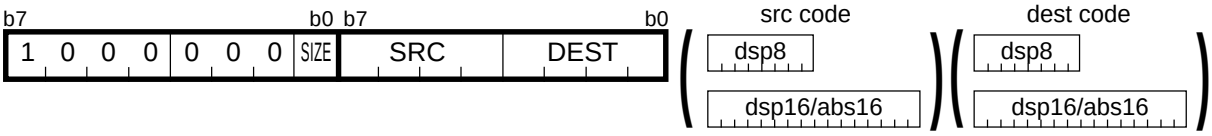
[Number of Bytes/Number of Cycles]

dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	3/2	3/2	3/4	4/4	4/4	5/4	5/4	5/4

- If the size specifier (.size) is (.W), the number of bytes indicated is increased by 1.

TST

(2) TST.size src, dest



.size	SIZE
.B	0
.W	1

src/dest		SRC/DEST	src/dest		SRC/DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

src \ dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Rn	2/2	2/2	2/3	3/3	3/3	4/3	4/3	4/3
An	2/2	2/2	2/3	3/3	3/3	4/3	4/3	4/3
[An]	2/3	2/3	2/4	3/4	3/4	4/4	4/4	4/4
dsp:8[An]	3/3	3/3	3/4	4/4	4/4	5/4	5/4	5/4
dsp:8[SB/FB]	3/3	3/3	3/4	4/4	4/4	5/4	5/4	5/4
dsp:16[An]	4/3	4/3	4/4	5/4	5/4	6/4	6/4	6/4
dsp:16[SB]	4/3	4/3	4/4	5/4	5/4	6/4	6/4	6/4
abs16	4/3	4/3	4/4	5/4	5/4	6/4	6/4	6/4

UND

(1) UND

b7							b0
1	1	1	1	1	1	1	1

[Number of Bytes/Number of Cycles]

Bytes/Cycles	1/20

WAIT

(1) WAIT

b7							b0	b7							b0
0	1	1	1	1	1	0	1	1	1	1	1	0	0	1	1

[Number of Bytes/Number of Cycles]

Bytes/Cycles	2/3

XCHG

(1) XCHG.size src, dest

b7							b0	b7							b0
0	1	1	1	1	0	1	SIZE	0	0	SRC		DEST			

dest code

dsp8
dsp16/abs16

.size	SIZE
.B	0
.W	1

src	SRC
R0L/R0	0 0
R0H/R1	0 1
R1L/R2	1 0
R1H/R3	1 1

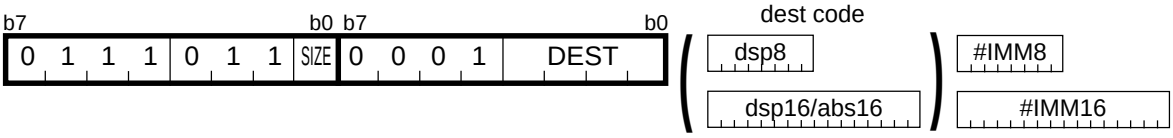
dest		DEST	dest		DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	2/4	2/4	2/5	3/5	3/5	4/5	4/5	4/5

XOR

(1) XOR.size #IMM, dest



.size	SIZE
.B	0
.W	1

dest		DEST	dest		DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

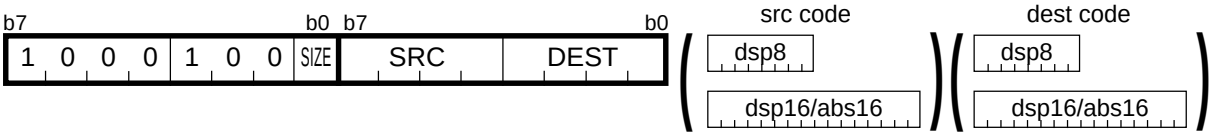
[Number of Bytes/Number of Cycles]

dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Bytes/Cycles	3/2	3/2	3/4	4/4	4/4	5/4	5/4	5/4

- If the size specifier (.size) is (.W), the number of bytes indicated is increased by 1.

XOR

(2) XOR.size src, dest



.size	SIZE
.B	0
.W	1

src/dest		SRC/DEST	src/dest		SRC/DEST
Rn	R0L/R0	0 0 0 0	dsp:8[An]	dsp:8[A0]	1 0 0 0
	R0H/R1	0 0 0 1		dsp:8[A1]	1 0 0 1
	R1L/R2	0 0 1 0	dsp:8[SB/FB]	dsp:8[SB]	1 0 1 0
	R1H/R3	0 0 1 1		dsp:8[FB]	1 0 1 1
An	A0	0 1 0 0	dsp:16[An]	dsp:16[A0]	1 1 0 0
	A1	0 1 0 1		dsp:16[A1]	1 1 0 1
[An]	[A0]	0 1 1 0	dsp:16[SB]	dsp:16[SB]	1 1 1 0
	[A1]	0 1 1 1	abs16	abs16	1 1 1 1

[Number of Bytes/Number of Cycles]

src \ dest	Rn	An	[An]	dsp:8[An]	dsp:8[SB/FB]	dsp:16[An]	dsp:16[SB]	abs16
Rn	2/2	2/2	2/3	3/3	3/3	4/3	4/3	4/3
An	2/2	2/2	2/3	3/3	3/3	4/3	4/3	4/3
[An]	2/3	2/3	2/4	3/4	3/4	4/4	4/4	4/4
dsp:8[An]	3/3	3/3	3/4	4/4	4/4	5/4	5/4	5/4
dsp:8[SB/FB]	3/3	3/3	3/4	4/4	4/4	5/4	5/4	5/4
dsp:16[An]	4/3	4/3	4/4	5/4	5/4	6/4	6/4	6/4
dsp:16[SB]	4/3	4/3	4/4	5/4	5/4	6/4	6/4	6/4
abs16	4/3	4/3	4/4	5/4	5/4	6/4	6/4	6/4

Chapter 5

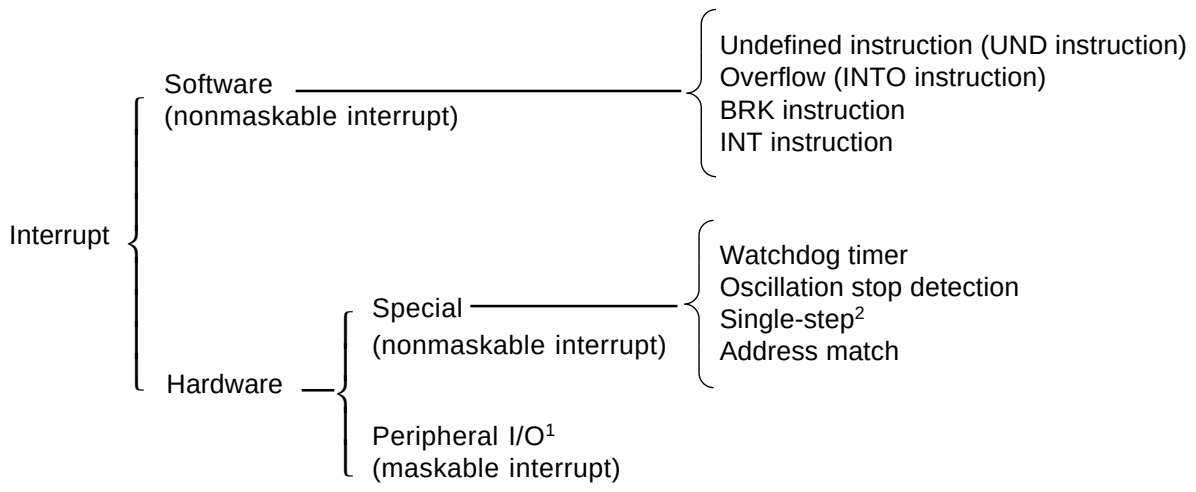
Interrupts

5.1 Outline of Interrupts

When an interrupt request is acknowledged, control branches to the interrupt routine that is set in an interrupt vector table. Each interrupt vector table must have had the start address of its corresponding interrupt routine set. For details about interrupt vector tables, refer to section 1.10, “Vector Tables”.

5.1.1 Types of Interrupts

Figure 5.1.1 lists the types of interrupts. Table 5.1.1 lists the source of interrupts (nonmaskable) and the fixed vector tables.



Notes 1: Peripheral function interrupts are generated by the peripheral functions built into the microcomputer system.
2: This is a dedicated interrupt for development support tools. Do not use this interrupt.

Figure 5.1.1 Classification of Interrupts

- Maskable interrupt: This type of interrupt **can** be controlled by using the I flag to enable (or disable) the interrupts or by changing the interrupt priority level.
- Nonmaskable interrupt: This type of interrupt **cannot** be controlled by using the I flag to enable (or disable) the interrupts or by changing the interrupt priority level.

Table 5.1.1 Interrupt Sources (Nonmaskable) and Fixed Vector Tables

Interrupt Source	Vector Table Addresses Address (L) to Address (H)	Description
Undefined Instruction	0FFDC16 to 0FFDF16	Interrupt generated by the UND instruction.
Overflow	0FFE016 to 0FFE316	Interrupt generated by the INTO instruction.
BRK Instruction	0FFE416 to 0FFE716	Executed beginning from address indicated by vector in variable vector table if 0FFE716 address contents are FF16.
Address Match	0FFE816 to 0FFEB16	Can be controlled by an interrupt enable bit.
Single Step[1]	0FFEC16 to 0FFEF16	Do not use this interrupt.
Watchdog Timer•Oscillation Stop Detection	0FFF016 to 0FFF316	
(Reserved)	0FFF416 to 0FFF716	
(Reserved)	0FFF816 to 0FFFB16	
Reset	0FFFC16 to 0FFFF16	

Note 1: This is a dedicated interrupt used by development support tools. Do not use this interrupt.

5.1.2 Software Interrupts

Software interrupts are generated by an instruction that generates an interrupt request when executed. Software interrupts are nonmaskable.

●Undefined-instruction interrupt

This interrupt occurs when the UND instruction is executed.

●Overflow interrupt

This interrupt occurs if the INTO instruction is executed when the O flag is set to 1 (arithmetic result is overflow).

The instructions that cause the O flag to change are as follows: ABS, ADC, ADCF, ADD, CMP, DIV, DIVU, DIVX, NEG, RMPA, SBB, SHA, SUB.

●BRK interrupt

This interrupt occurs when the BRK instruction is executed.

●INT instruction interrupt

This interrupt occurs when the INT instruction is executed. The software interrupt numbers which can be specified by the INT instruction are 0 to 63. Note that software interrupt numbers 4 to 31 are assigned to peripheral function interrupts. This means that it is possible to execute the same interrupt routines used by peripheral function interrupts by executing the INT instruction.

For software interrupt numbers 0 to 31, the U flag is saved when the INT instruction is executed and the U flag is cleared to 0 to choose the interrupt stack pointer (ISP) before executing the interrupt sequence. The U flag before the interrupt occurred is restored when control returns from the interrupt routine. For software interrupt numbers 32 to 63, when the instruction is executed, the U flag does not change and the SP selected at the time is used.

5.1.3 Hardware Interrupts

There are two types in hardware interrupts: special interrupts and peripheral function interrupts.

●Special interrupts

Special interrupts are nonmaskable.

(1) Watchdog timer interrupt

This interrupt is caused by the watchdog timer. Initialize the watchdog timer after the watchdog timer interrupt is generated. For details about the watchdog timer, refer to the R8C's hardware manual.

(2) Oscillation stop detection interrupt

This interrupt is caused by the oscillation stop detection function. For details about the oscillation stop detection function, refer to the R8C's hardware manual.

(3) Single-step interrupt

This interrupt is used exclusively by development support tools. Do not use this interrupt.

(4) Address-match interrupt

When the AIER0 or AIER1 bit in the AIER register is set to 1 (address-match interrupt enabled), the address-match interrupt is generated just before executing the instruction of the address indicated by the corresponding RMAD0 to RMAD1 register.

●Peripheral function interrupts

These interrupts are generated by the peripheral functions built into the microcomputer. Peripheral function interrupts are maskable.

The types of built-in peripheral functions vary with each R8C model, as do the interrupt sources. For details about peripheral function interrupts, refer to the R8C's hardware manual.

5.2 Interrupt Control

This section explains how to enable/disable maskable interrupts and set acknowledge priority. The explanation here does not apply to non-maskable interrupts.

Maskable interrupts are enabled and disabled by using the I flag, IPL, and bits ILVL2 to ILVL0 in each interrupt control register. Whether or not an interrupt is requested is indicated by the IR bit in each interrupt control register.

For details about the memory allocation and the configuration of interrupt control registers, refer to the R8C's hardware manual.

5.2.1 I Flag

The I flag is used to disable/enable maskable interrupts. When the I flag is set to 1 (enabled), all maskable interrupts are enabled; when the I flag is cleared to 0 (disabled), they are disabled.

When the I flag is changed, the altered flag status is reflected in determining whether or not to accept an interrupt request with the following timing:

- If the flag is changed by an REIT instruction, the changed status takes effect beginning with the REIT instruction.
- If the flag is changed by an FCLR, FSET, POPC, or LDC instruction, the changed status takes effect beginning with the next instruction.

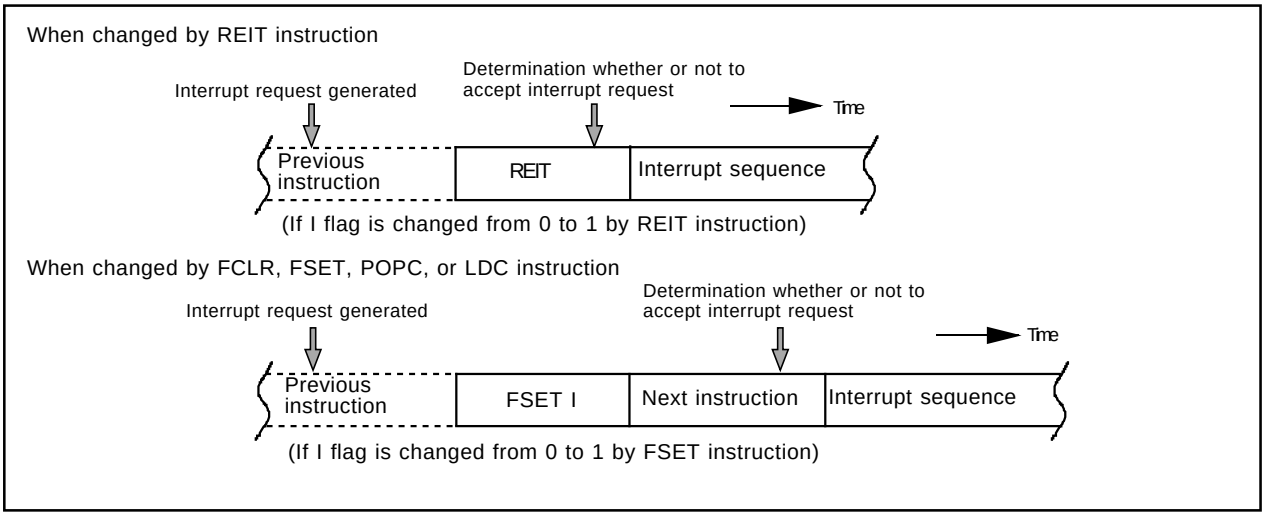


Figure 5.2.1 Timing with Which Changes of I Flag are Reflected in Interrupt Handling

5.2.2 IR Bit

The IR bit is set to 1 (interrupt requested) when an interrupt request is generated. The IR bit is cleared to 0 (interrupt not requested) after the interrupt request is acknowledged and the program branches to the corresponding interrupt vector.

The IR bit can be cleared to 0 by a program. Do not set it to 1.

5.2.3 ILVL2 to ILVL0 bis, IPL

Interrupt priority levels can be set using bits ILVL2 to ILVL0.
Table 5.2.1 shows how interrupt priority levels are set. Table 5.2.2 shows interrupt enable levels in relation to IPL.

The following lists the conditions under which an interrupt request is acknowledged:

- I flag = 1
- IR bit = 1
- Interrupt priority level > IPL

The I flag, bits ILVL2 to ILVL0, and IPL are independent of each other, and they do not affect each other.

Table 5.2.1 Interrupt Priority Levels

ILVL2–ILVL0	Interrupt Priority Level	Priority
000_2	Level 0 (interrupt disabled)	———
001_2	Level 1	Low
010_2	Level 2	↓
011_2	Level 3	
100_2	Level 4	
101_2	Level 5	
110_2	Level 6	
111_2	Level 7	High

Table 5.2.2 Interrupt Priority Levels Enabled by IPL

IPL	Enabled interrupt priority levels
000_2	Interrupt levels 1 and above are enabled.
001_2	Interrupt levels 2 and above are enabled.
010_2	Interrupt levels 3 and above are enabled.
011_2	Interrupt levels 4 and above are enabled.
100_2	Interrupt levels 5 and above are enabled.
101_2	Interrupt levels 6 and above are enabled.
110_2	Interrupt levels 7 and above are enabled.
111_2	All maskable interrupts are disabled.

When the IPL or the interrupt priority level of an interrupt is changed, the altered level is reflected in interrupt handling with the following timing:

- If the IPL is changed by an REIT instruction, the new level takes effect beginning with the instruction that is executed two clock cycles after the last clock cycle of the REIT instruction.
- If the IPL is changed by a POPC, LDC, or LDIPL instruction, the new level takes effect beginning with the instruction that is executed three clock cycles after the last clock cycle of the instruction used.
- If the interrupt priority level of a particular interrupt is changed by an instruction such as MOV, the new level takes effect beginning with the instruction that is executed two or three clock cycles after the last clock cycle of the instruction used.

5.2.4 Changing Interrupt Control Registers

(1) Individual interrupt control registers can only be modified while no interrupt requests corresponding to that register are generated. If interrupt requests managed by the interrupt control register are likely to occur, disable interrupts before changing the contents of the interrupt control register.

(2) When modifying an interrupt control register after disabling interrupts, care must be taken when selecting the instructions to be used.

Changing Bits Other Than IR Bit

If an interrupt request corresponding to the register is generated while executing the instruction, the IR bit may not be set to 1 (interrupt requested), with the result that the interrupt request is ignored. To get around this problem, use the following instructions to modify the register: AND, OR, BCLR, BSET.

Changing IR Bit

Even when the IR bit is cleared to 0 (interrupt not requested), it may not actually be cleared to 0 depending on the instruction used. Therefore, use the MOV instruction to set the IR bit to 0.

(3) When disabling interrupts using the I flag, refer to the following sample programs. (Refer to (2) above regarding changing interrupt control registers in the sample programs.)

Sample programs 1 to 3 are to prevent the I flag from being set to 1 (interrupt enabled) before writing to the interrupt control registers depending on the state of the internal bus or the instruction queue buffer.

Example 1: Use NOP instruction to prevent I flag being set to 1 before interrupt control register is changed

```
INT_SWITCH1:
    FCLR    I              ; Disable interrupts
    AND.B   #00H, 0056H    ; Set TXIC register to 00₁₆
    NOP
    NOP
    FSET    I              ; Enable interrupts
```

Example 2: Use dummy read to delay FSET instruction

```
INT_SWITCH2:
    FCLR    I              ; Disable interrupts
    AND.B   #00H, 0056H    ; Set TXIC register to 00₁₆
    MOV.W   MEM, R0        ; Dummy read
    FSET    I              ; Enable interrupts
```

Example 3: Use POPC instruction to change I flag

```
INT_SWITCH3:
    PUSHC   FLG
    FCLR    I              ; Disable interrupts
    AND.B   #00H, 0056H    ; Set TXIC register to 00₁₆
    POPC    FLG            ; Enable interrupts
```

5.3 Interrupt Sequence

The interrupt sequence — the operations performed from the instant an interrupt is accepted to the instant the interrupt routine is executed — is described here.

If an interrupt occurs during execution of an instruction, the processor determines its priority when the execution of the instruction is completed and transfers control to the interrupt sequence from the next cycle.

If an interrupt occurs during execution of the SMOVB, SMOVF, SSTR, or RMPA instruction, the processor temporarily suspends the instruction being executed and transfers control to the interrupt sequence.

In the interrupt sequence, the processor carries out the operations listed below. Figure 5.3.1 shows the interrupt sequence execution time.

(1) The CPU obtains the interrupt information (the interrupt number and interrupt request level) by reading address 00000_{16}. Then, the IR bit corresponding to the interrupt is set to 0 (interrupt not requested issued).

(2) The FLG register is saved as it was immediately before the start of the interrupt sequence in a temporary register[1] within the CPU.

(3) The I flag, the D flag, and the U flag in the FLG register are set as follows:

- The I flag is cleared to 0 (interrupts disabled)
- The D flag is cleared to 0 (single-step interrupt disabled)
- The U flag is cleared to 0 (ISP specified)

However, the U flag status does not change when the INT instruction for software interrupt numbers 32 to 63 is executed.

(4) The contents of the temporary register[1] are saved within the CPU in the stack area.

(5) The PC is saved in the stack area.

(6) The interrupt priority level of the accepted instruction is set in IPL.

(7) The first address of the interrupt routine set to the interrupt vector is set in the PC.

After the interrupt sequence is completed, the processor resumes executing instructions from the starting address of the interrupt routine.

Note 1: This register cannot be accessed by the user.

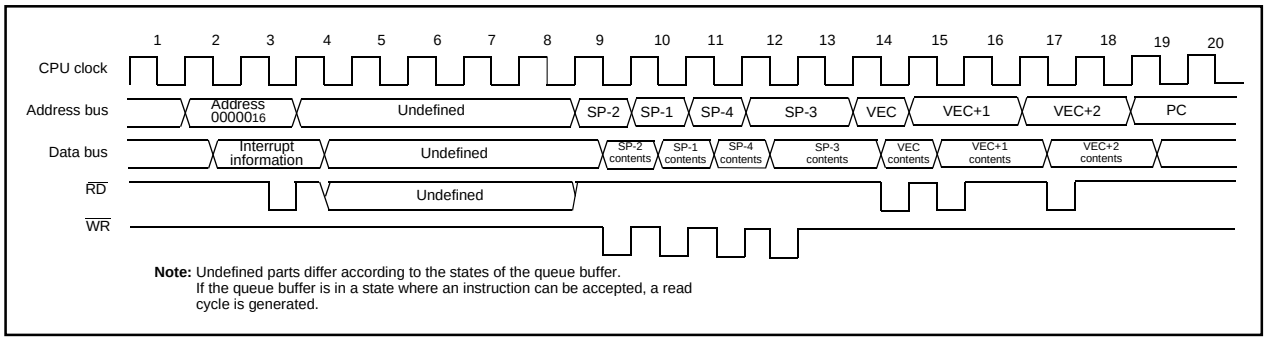
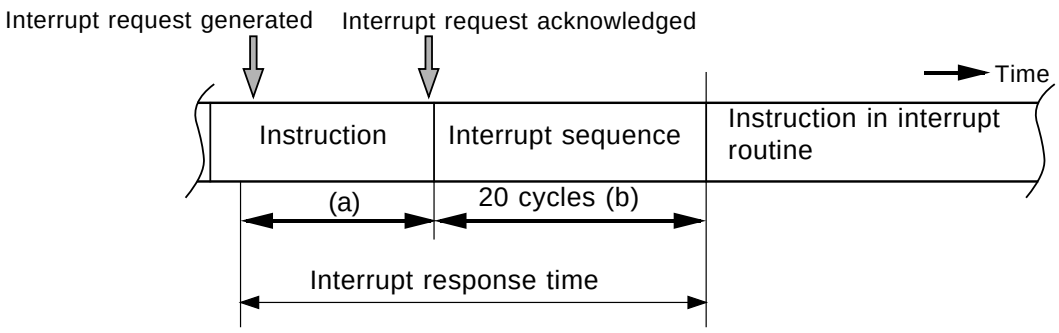


Figure 5.3.1 Interrupt Sequence Executing Time

5.3.1 Interrupt Response Time

Figure 5.3.2 shows the interrupt response time. The interrupt response time is the period from when an interrupt request is generated until the first instruction of the interrupt routine is executed. This period consists of the time ((a) in Figure 5.3.1) from when the interrupt request is generated to when the instruction then under way is completed and the time (20 cycles (b)) in which the interrupt sequence is executed.



(a) Time from when interrupt request is generated to when the instruction then under execution is completed. Time (a) varies with the instruction being executed. The DIVX instruction requires a maximum time of 30 cycles (cycle number: no wait states, divisor is stored in a register).

(b) The address-match interrupt and the single-step interrupt are each 21 cycles.

Figure 5.3.2 Interrupt Response Time

5.3.2 Changes of IPL when Interrupt Request Acknowledged

When an interrupt request of a maskable interrupt is acknowledged, the interrupt priority level of the acknowledged interrupt is set in IPL.

When a software interrupt request or a special interrupt request is acknowledged, the value shown in Table 5.3.1 is set in IPL. Table 5.3.1 shows the value of IPL when software interrupts and special interrupt requests are acknowledged.

Table 5.3.1 Value of IPL when Software Interrupt and Special Interrupt Request Acknowledged

Interrupt Sources Without Interrupt Priority Levels	Value that is set to IPL
Watchdog timer, oscillation stop detection	7
Software, address-match, single-step	Not changed

5.3.3 Saving Register Contents

In an interrupt sequence, the contents of the FLG register and the PC are saved to the stack area. The order in which these are saved is as follows. First, the 4 high-order bits of the PC and 4 high-order bits (IPL) and 8 low-order bits of the FLG register, a total of 16 bits, are saved to the stack area. Next, the 16 low-order bits of the PC are saved. Figure 5.3.3 shows the stack status before an interrupt request is acknowledged.

If there are any other registers to be saved, use a program to save them at the beginning of the interrupt routine. The PUSHM instruction can be used to save all registers, except SP, by a single instruction.

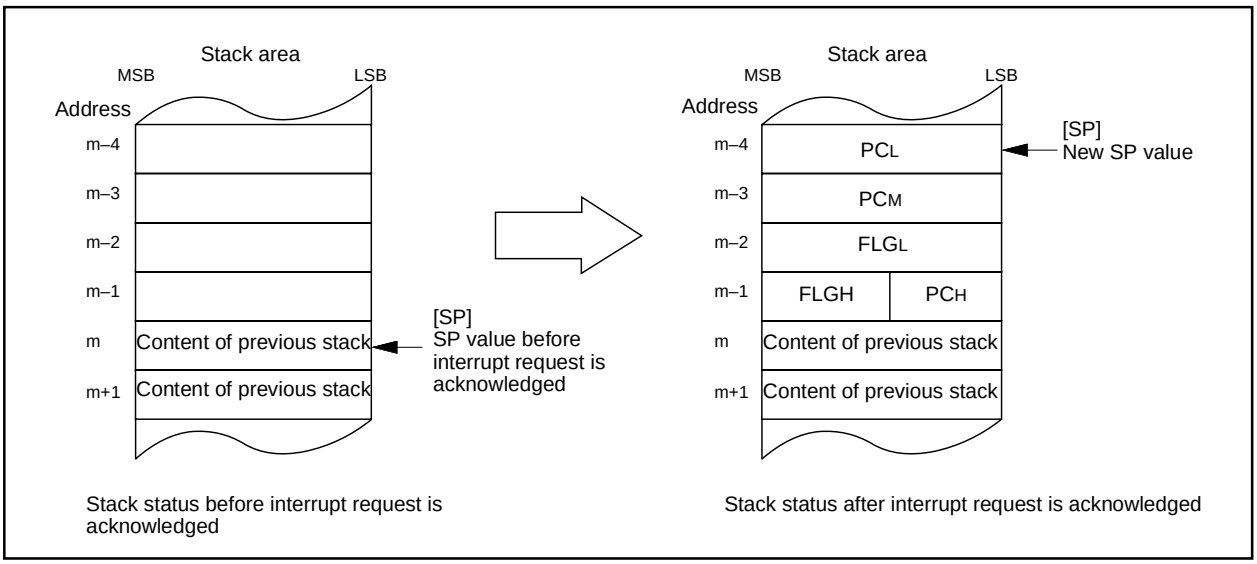


Figure 5.3.3 Stack Status Before and After an Interrupt Request is Acknowledged

The register save operations performed as part of an interrupt sequence are executed in four parts 8 bits at a time. Figure 5.3.4 shows the operations when saving register contents.

Note 1: When the INT instruction for software interrupt numbers 32 to 63 is executed, SP is indicated by the U flag. It is indicated by ISP in all other cases.

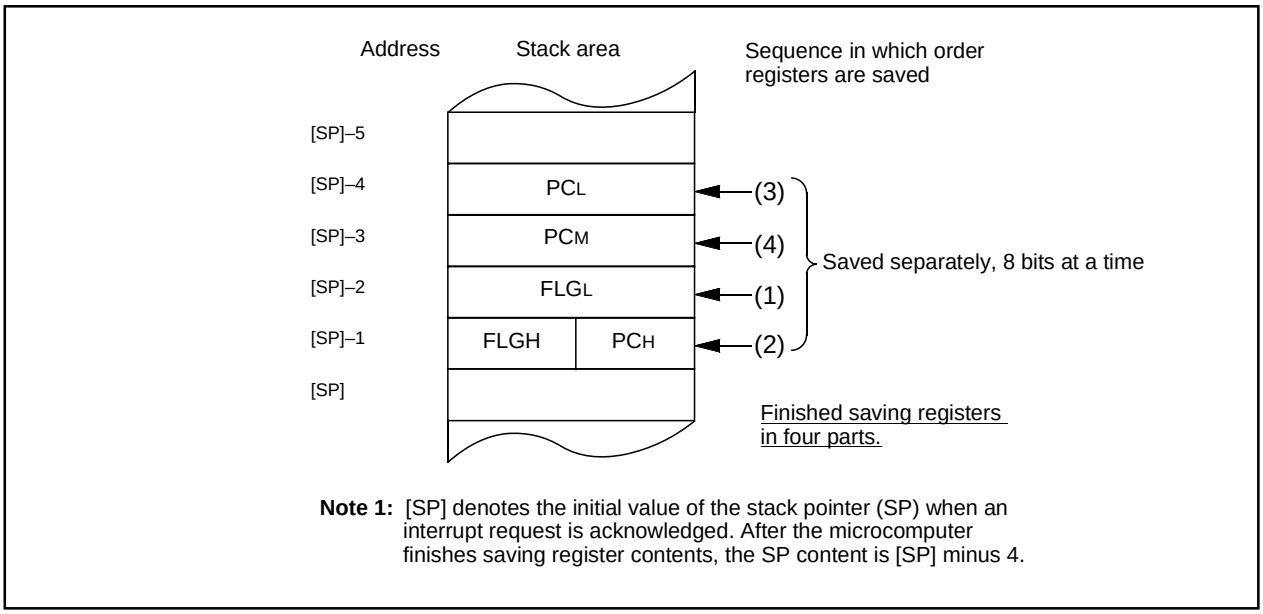


Figure 5.3.4 Operations when Saving Register Contents

5.4 Returning from Interrupt Routines

When the REIT instruction is executed at the end of the interrupt routine, the contents of the FLG register and PC that have been saved to the stack area immediately preceding the interrupt sequence are automatically restored. Then control returns to the routine that was under execution before the interrupt request was acknowledged.

If any registers were saved in the interrupt routine using a program, be sure to restore them using an instruction (e.g., the POPM instruction) before executing the REIT instruction.

5.5 Interrupt Priority

If two or more interrupt requests occur while a single instruction is being executed, the interrupt request that has higher priority is acknowledged.

The priority level of maskable interrupts (peripheral functions) can be selected arbitrarily by setting bits ILVL2 to ILVL0. If multiple maskable interrupts are assigned the same priority level, the priority that is set in hardware determines which is acknowledged.

Special interrupts such as the watchdog timer interrupt have their priority levels set in hardware. Figure 5.5.1 lists the interrupt priority levels of hardware interrupts.

Software interrupts are not affected by interrupt priority. They always cause control to branch to an interrupt routine when the relevant instruction is executed.

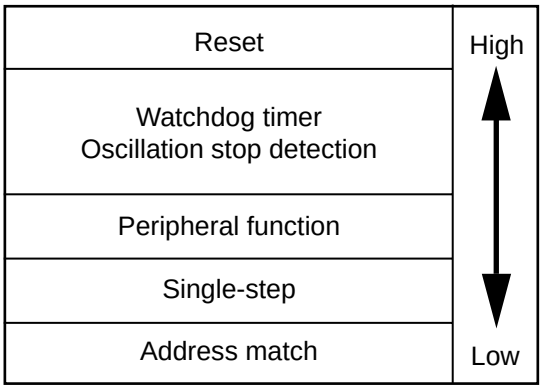


Figure 5.5.1 Interrupt Priority Levels of Hardware Interrupts

5.6 Multiple Interrupts

The internal bit states when control has branched to an interrupt routine are as follows:

- The interrupt enable flag (I flag) is cleared to 0 (interrupts disabled).
- The interrupt request bit for the acknowledged interrupt is cleared to 0.
- The processor interrupt priority level (IPL) equals the interrupt priority level of the acknowledged interrupt.

By setting the interrupt enable flag (I flag) to 1 in the interrupt routine, interrupts can be reenabled so that an interrupt request that has higher priority than the processor interrupt priority level (IPL) can be acknowledged. Figure 5.6.1 shows how multiple interrupts are handled.
Interrupt requests that have not been acknowledged due to low interrupt priority level are kept pending. When the IPL is restored by an REIT instruction and the interrupt priority is determined based on the IPL contents, the pending interrupt request is acknowledged if the following condition is met:

Interrupt priority level of pending interrupt request	>	Restored processor interrupt priority level (IPL)

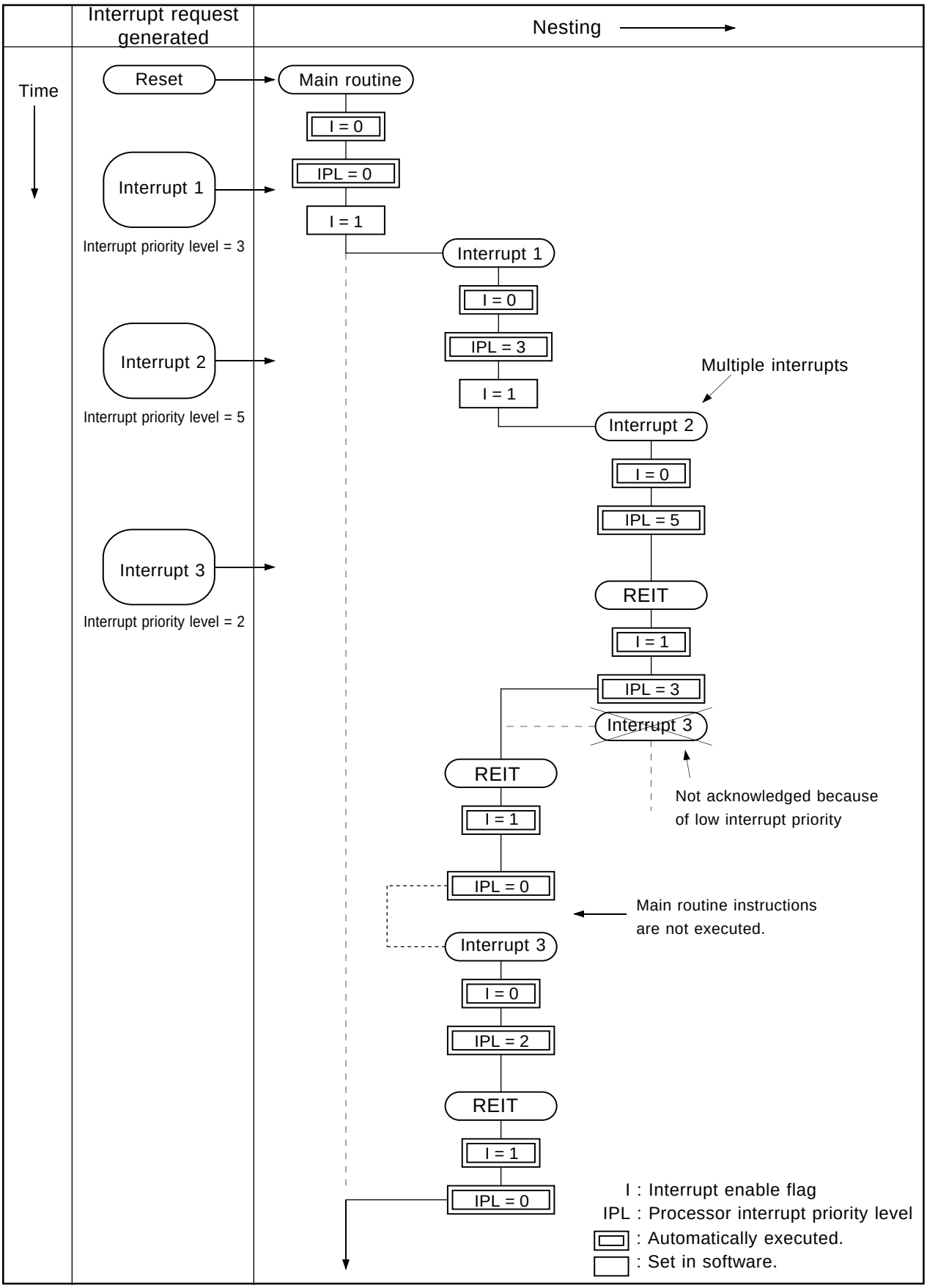


Figure 5.6.1 Multiple Interrupts

5.7 Note on Interrupts

5.7.1 Reading Address 00000_{16}

Avoid reading address 00000_{16} in a program. When a maskable interrupt request is accepted, the CPU reads interrupt information (interrupt number and interrupt request priority level) from address 00000_{16} during the interrupt sequence. At this time, the IR bit for the accepted interrupt is cleared to 0.
If address 00000_{16} is read in a program, the IR bit for the interrupt which has the highest priority among the enabled interrupts is set to 0. This may cause the interrupt to be canceled or an unexpected interrupt to be generated.

5.7.2 SP Setting

Set a value in SP before accepting an interrupt. SP is set to 0000_{16} after reset. Therefore, if an interrupt is accepted before setting a value in SP, the program may go out of control.

5.7.3 Changing Interrupt Control Register

(1) Individual interrupt control registers can only be modified while no interrupt requests corresponding to that register are generated. If interrupt requests managed by an interrupt control register are likely to occur, disable interrupts before changing the contents of the interrupt control register.

(2) When modifying an interrupt control register after disabling interrupts, care must be taken when selecting the instructions to be used.

Changing Bits Other Than IR Bit

If an interrupt request corresponding to the register is generated while executing the instruction, the IR bit may not be set to 1 (interrupt requested), with the result that the interrupt request is ignored. To get around this problem, use the following instructions to modify the register: AND, OR, BCLR, BSET.

When Changing IR Bit

Even when the IR bit is cleared to 0 (interrupt not requested), it may not actually be cleared to 0 depending on the instruction used. Therefore, use the MOV instruction to set the IR bit to 0.

(3) When disabling interrupts using the I flag, refer to the following sample programs. (Refer to (2) above regarding changing interrupt control registers in the sample programs.)

Sample programs 1 to 3 are to prevent the I flag from being set to 1 (interrupt enabled) before writing to the interrupt control registers depending on the state of the internal bus or the instruction queue buffer.

Example 1: Use NOP instruction to prevent I flag being set to 1 before interrupt control register is changed

```
INT_SWITCH1:
    FCLR    I              ; Disable interrupts
    AND.B   #00H, 0056H    ; Set TXIC register to 00₁₆
    NOP
    NOP
    FSET    I              ; Enable interrupts
```

Example 2: Use dummy read to delay FSET instruction

```
INT_SWITCH2:
    FCLR    I              ; Disable interrupts
    AND.B   #00H, 0056H    ; Set TXIC register to 00₁₆
    MOV.W   MEM, R0        ; Dummy read
    FSET    I              ; Enable interrupts
```

Example 3: Use POPC instruction to change I flag

```
INT_SWITCH3:
    PUSHC   FLG
    FCLR    I              ; Disable interrupts
    AND.B   #00H, 0056H    ; Set TXIC register to 00₁₆
    POPC    FLG            ; Enable interrupts
```

Chapter 6

Calculating the Number of Cycles

6.1 Instruction Queue Buffer

6.1 Instruction Queue Buffer

R8C/Tiny Series microcomputers have 4-stage (4-byte) instruction queue buffers. If the instruction queue buffer has free space when the CPU can use the bus, instruction codes are taken into the instruction queue buffer. This is referred to as “prefetching”. The CPU reads (fetches) the instruction codes from the instruction queue buffer as it executes a program.

The explanation of the number of cycles in chapter 4 assumes that all the necessary instruction codes are placed in the instruction queue buffer, and that 8-bit data is read or written to the memory without software wait states. In the following cases, more cycles may be needed than the number of cycles indicated in this manual:

- If not all of the instruction codes needed by the CPU have been placed in the instruction queue buffer.
  Instruction codes are read in until all of the instruction codes required for program execution are available. Furthermore, the number of read cycles increases in the following case:
  (1) The number of read cycles increases to match the number of wait cycles incurred when reading instruction codes from an area in which software wait cycles exist.
- When reading or writing data to an area in which software wait cycles exist.
  The number of read or write cycles increases to match the number of wait cycles incurred.
- When reading or writing 16-bit data from/to the SFR or the internal memory.
  The memory is accessed twice to read or write one 16-bit data item. Therefore, the number of read or write cycles increases by one for each 16-bit data item read or written.

Note that if prefetch and data access occur at the same time, data access has priority. Also, if more than three bytes of instruction codes exist in the instruction queue buffer, the CPU assumes there is no free space and, therefore, does not prefetch instruction code.

Figure 6.1.1 shows an example of starting a read instruction (without software wait).

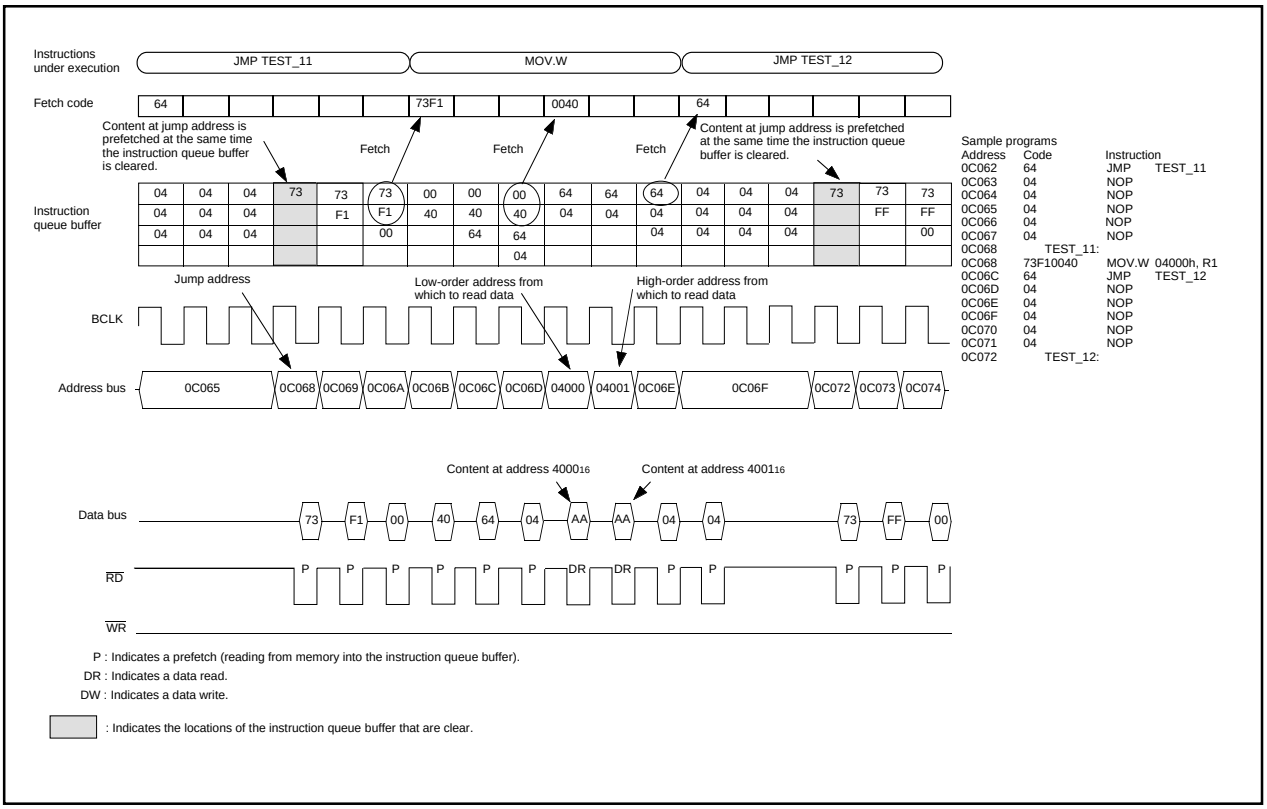


Figure 6.1.1 Starting a Read Instruction (without Software Wait States)

Q & A

Information in Q&A form to help the user make the most of the R8C/Tiny Series is provided in this section. In general, one question and its corresponding answer are given on one page; the upper section is used for the question, the lower for the answer.
Functions closely connected with the issue being discussed are indicated in the upper-right corner.

Q

How do I distinguish between the static base register (SB) and the frame base register (FB)?

A

SB and FB function in the same manner, so you can use them as you like when in programming in assembly language. If you write a program in C, use FB as a stack frame base register.

Q

Is it possible to change the contents of the interrupt table register (INTB) while a program is being executed?

A

Yes. But there is a possibility of program runaway if an interrupt request occurs while changing the contents of INTB. It is therefore not recommended to frequently change the contents of INTB while a program is being executed.

Q

What is the difference between the user stack pointer (USP) and the interrupt stack pointer (ISP)? What are their roles?

A

USP is used when using the OS. When several tasks are run, the OS secures stack areas to save the contents of registers for individual tasks. Also, stack areas have to be secured, task by task, to be used for handling interrupts that occur while tasks are being executed. If you use USP and ISP in such an instance, the stack for interrupts can be shared by these tasks. This allows efficient use of stack areas.

Q

What happens to the instruction code if I use a bit instruction in absolute addressing ?

A

This explanation takes BSET bit, base:16 as an example.
This instruction is a 4-byte instruction. The 2 higher-order bytes of the instruction code indicate the operation code, and the 2 lower-order bytes make up the addressing mode to expresse bit,base:16.
The relation between the 2 lower-order bytes and bit,base:16 is as follows:
2 lower-order bytes = base:16 × 8 + bit

For example, in the case of BSET 2,0AH (setting bit 2 of address $000A_{16}$ to 1), the 2 lower-order bytes become A × 8 + 2 = 52H.
In the case of BSET 18,8H (setting the 18th bit from bit 0 of address 0008_{16} to 1), the 2 lower-order bytes become 8 × 8 + 18 = 52H, which is equivalent to BSET 2,AH.

The maximum value of base:16 × 8 + bit, FFFFH, indicates bit 7 of address $1FFF_{16}$. This is the maximum bit you can specify when using a bit instruction in absolute addressing.

Q

What is the difference between the DIV instruction and the DIVX instruction?

A

The DIV instruction and the DIVX instruction are both instructions for signed division, but the sign of the remainder is different.
The sign of the remainder left after the DIV instruction is the same as that of the dividend, but the sign of the remainder of the DIVX instruction is the same as that of the divisor.
In general, the following relation among quotient, divisor, dividend, and remainder holds:
dividend = divisor × quotient + remainder
Since the sign of the remainder is different between these instructions, the quotient obtained either by dividing a positive integer by a negative integer or by dividing a negative integer by a positive integer using the DIV instruction is different from that obtained using the DIVX instruction.
For example, dividing 10 by –3 using the DIV instruction yields –3 and leaves a remainder of +1, while doing the same using the DIVX instruction yields –4 and leaves a remainder of –2.
Dividing –10 by +3 using the DIV instruction yields –3 and leaves a remainder of –1, while doing the same using the DIVX instruction yields –4 and leaves a remainder of +2.

Glossary

Technical terms used in this software manual are explained in this section. They apply to in this manual only.

Term	Meaning	Related word
borrow	To move a digit to the next lower position.	carry
carry	To move a digit to the next higher position.	borrow
context	Registers that a program uses.	
decimal addition	Addition using decimal values.	
displacement	The difference between the initial position and a later position.	
effective address	The address actually used after modification.	
extension area	For the R8C/Tiny Series, the area from 10000_{16} through $FFFFF_{16}$.	
LSB	Abbreviation for Least Significant Bit The bit occupying the lowest-order position in a data item.	MSB

Term	Meaning	Related word
macro instruction	An instruction, written in a source language, to be expressed in a number of machine instructions when compiled into a machine code program.	
MSB	Abbreviation for Most Significant Bit. The bit occupying the highest-order position in a data item.	LSB
operand	A part of instruction code that indicates the object of an operation.	operation code
operation	A generic term for move, comparison, bit processing, shift, rotation, arithmetic, logic, and branch.	
operation code	A part of an instruction code that indicates what sort of operation the instruction performs.	operand
overflow	To exceed the maximum expressible value as a result of an operation.	
pack	To join data items. Used to mean to form two 4-bit data items into one 8-bit data item, to form two 8-bit data items into one 16-bit data item, etc.	unpack
SFR area	Abbreviation for Special Function Register area. An area in which control bits for the on-chip peripheral circuits of the microcomputer and control registers are located.	

Term	Meaning	Related word
shift out	To move the content of a register either to the right or left until fully overflowed.	
sign bit	A bit that indicates either a positive or a negative (the highest-order bit).	
sign extension	To extend a data length in which the higher-order bits to be extended are made to have the same sign as the sign bit. For example, sign-extending FF_{16} results in $FFFF_{16}$, and sign-extending $0F_{16}$ results in $000F_{16}$.	
stack frame	An automatic conversion area used by C language functions.	
string	A sequence of characters.	
unpack	To restore combined items or packed information to its original form. Used to mean to separate 8-bit information into two parts — 4 lower-order bits and 4 higher-order bits, to separate 16-bit information into two parts — 8 lower-order bits and 8 higher-order bits, and the like.	pack
zero extension	To extend a data length by turning higher-order bits to 0's. For example, zero-extending FF_{16} to 16 bits results in $00FF_{16}$.	

Table of Symbols

The symbols used in this software manual are explained in the following table. They apply to this manual only.

Symbol	Meaning
←	Transposition from the right side to the left side
←→	Interchange between the right side and the left side
+	Addition
−	Subtraction
×	Multiplication
÷	Division
∧	Logical conjunction
∨	Logical disjunction
∀	Exclusive disjunction
¯	Logical negation
dsp16	16-bit displacement
dsp20	20-bit displacement
dsp8	8-bit displacement
EVA( )	An effective address indicated by what is enclosed in ( )
EXT( )	Sign extension
(H)	Higher-order byte of a register or memory
H4:	4 higher-order bits of an 8-bit register or 8-bit memory
| |	Absolute value
(L)	Lower-order byte of a register or memory
L4:	4 lower-order bits of an 8-bit register or 8-bit memory
LSB	Least Significant Bit
M( )	Content of memory indicated by what is enclosed in ( )
(M)	Middle-order byte of a register or memory
MSB	Most Significant Bit
PC_H	Higher-order byte of the program counter
PC_{ML}	Middle-order byte and lower-order byte of the program counter
FLG_H	4 higher-order bits of the flag register
FLG_L	8 lower-order bits of the flag register

Index

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