OKI semiconductor MSC6458



OKI 4-BIT 1-CHIP MICROCONTROLLER

GENERAL DESCRIPTION

The MSC6458 is a high-speed, 4-bit 1-chip microcontroller with built-in FLT drivers/controllers developed to support relatively large control systems.

FEATURES

- ROM: 8000 × 8 bits
- RAM: 512 × 4 bits
- Ports: I/O 24 ports (8 having IOL = 20 mA) Input 9 (2 also serving as interrupt inputs)
- FLT drivers (Withstand 12 (IOH = 20mA) voltage 40V): 12 (IOH = 6mA)
- Interrupts: 7 lines (2 external, 5 internal)
- Built-in counters: 12 bits, timebase counter 16 bits, programmable counter 8 bits, high-speed programmable timer/event counter
- Serial I/O: Built-in 8-bit SIO register
- Oscillation circuit: Crystal or ceramic oscillation
- Number of instructions: 147
- Cycle time: 930 ns (4.3MHz)
- Operating ranges: 4.5 to 5.5V (4.3MHz) Voltage: 3.0 to 6.0V (1MHz) Temperature: -40 to +85°C
- Power dissipation (typical) (display off): 9mA (5V, 4.3MHz) 2mA (3V, 1MHz)
- Power down: STOP instruction
- Package: 64-pin shrink DIP/64- pin FLAT



BLOCK DIAGRAM

LOGIC SYMBOL



PIN CONFIGURATION (TOP VIEW)

64 PIN PLASTIC	MO 11	001 ND0
		353 SEGO
SHRINK DIP	SO P02 3	32) SEG1
	\$1 P03 4	SEG2
	CN 910 2	(362) SEGO
	TWO PIT CE	39) SEG4
	TCR P12 2	(58) 1805
	P13 0	37 5866
	INTO P20 3	55) sec/
	NTI P22 10	35 SEG8
	P30 [1]	54 5600
	P31 [12]	33) SEGIO
	P32 [13]	52 56011
	P33 16	B1) WILT
	P60 15	30 TH SEGI2
	P61 16	49 110 SEC13
	P62 17	46 TP SEG14
	P63 18	47 18 SEG15
	P80 [19]	40 17 OUT?
	P61 20	45) TE OUTE
	P62 [21]	TS OUTS
	P63 22	AD TA OUTA
	P70 23	42 T3 OUT3
	P71 24	41 12 OUT2
	P72 [25]	40 11 OUT1
	P40 26	39 Te oute
	P41 (27	38 P53
	P42 28	37 ***
	P43 29	35 P51
	05CT (36)	35 PS0
	OSCO (32)	34 1651
	GND CBE	(35) RESET

PIN DESCRIPTION

Terminal	Input/ Output	Function	When reset
P00 P01/SCK P02/SO P03/SI	Input/ Output	I/O port I/O port (also used as serial clock input SCK) I/O port (also used as serial data output SO) I/O port (also serial data input SI)	"1"
P10/ <u>CIN</u> P11/ <u>TMO</u> P12/TCK P13	Input/ Output	I/O port (also used as count input CIN) I/O port (also used as timer output TMO) I/O port (also used timer clock input TCK) I/O port	"1"
P20/I <u>NT0</u> P22/INT1	Input	Input Port with Latch (falling edge sensitive) also used as interrupt input INTO Input Port with Latch ('0' level sensitive) also used as interrupt input INT1	_
P30 ~ P33	Input/ Output	I/O port	"1"
P60 ~ P63	Input/ Output	I/O port	"0"
P40 ~ P43 P50 ~ P53	Output/ Input	I/O port (I _{OL} =20mA MAX)	"0"
P70 ~ P72 P80 ~ P83	Input	Input port with pull down register Pull down register of P70 \sim P72 can be removed by instruction	
SEG0 ~ SEG11	Output	FLT segment driver (dynamic)	"0"
T11/SEG12 ~ T8/SEG15	Output	FLT segment driver (dynamic)/Timing output	"0"
T7/OUT7 ~ T0/OUT0	Output	FLT segment driver (static)/Timing output	"0"
OSC0 OSC1	Input/ Output	Crystal connection terminal for system clock oscillation	-
RESET	Input	System reset input	-
TEST	Output	Test pin (Open)	_
VFLT	Input	Power supply for FLT driving	-
VDD GND	Input	System Power Supply	_

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FUNCTIONAL DESCRIPTION

1. ROM

The ROM, organized in 8 bits, has a maximum capacity of 8000 bytes.

2. RAM

The RAM is organized in 4 bits per word, with a capacity of 512 words.

It is separated into two banks each 256 words long. Bank selection is accomplished via internal ports. The RAM location in the banks is addressed by the H and L registers or by the second byte of each instruction.

3. Ports (24 I/O, 7 input)

The 24 pseudo-bidirectional I/O ports effect or control the exchange of data with external sources. The ports are specified by the L register or by codes contained in instructions. Ports 4 and 5 may draw IOL up to 20mA.

The seven input ports have built-in pulldown resistors. Up to 84 keys can be scanned by assembling them in key matrices with the timing outputs of the FLT drivers (with 12 segments \times 12 timings on display; also during automatic display).

4. Interrupt Input Pins (2 terminals)

The INTO/P20 and INT1/P22 pins are interrupt input pins. External interrupt request flags of INTO/P20 pin and INT1/P22 pin can be set by using interrupt input pins:

INTO/P20 pin ... positive edge or negative edge input.

INT1/P22 pin ... "0" level input.

These flags are automatically reset when the appropriate external interrupts occur. These pins are available for use as input ports when not used as interrupt input pins.

5. FLT Drivers/Controllers (Automatic Display)

The FLT drivers have a withstand voltage of 40V in the positive direction from the GND level. They comprise 12 ports that can draw 20mA as IOH (Timing outputs) and 12 ports that can draw 6mA as such (Segment outputs).

A choice of four display modes is supported as listed below. A display RAM area is allocated as part of the RAM space. Data is automatically displayed when transferred to the display RAM. (Two different display frequencies are selectable.) Static output data can be displayed by controlling the FLT drivers by programming.

Display modes (@4.194304 MHz)

- (1) 12 Segments × 12 Timings
 - 1/12 duty (85.3/341.3 Hz)
- (2) 16 Segments × 8 Timings

1/8 duty (128/512 Hz)

- (3) 16 Segments × 4 Timings +4 output* 1/4 duty (256/1024Hz)
- (4) 16 Segments+8 output*

Program controlled *output: static outputs

6. Stack (STACK) and Stack Pointer (SP)

The PC is saved in the stack when an interrupt occurs or a CAL instruction is executed. It is recovered by the execution of an RT instruction.

One fourth of the RAM space (128 words maximum, 32 levels) is available as a stack area. A 4-word RAM area is used for "one" level in the stack.

The stack pointer is an 8-bit up-down counter (the MSB and 2 bits from LSB being fixed at '1') indicating the next stack address to use. It enables the RAM space to be used as a pushdown stack. Data can also be transferred between stack pointer and the H/L registers.

7. Interrupts

Seven interrupt lines are provided for eight sources and eight levels of interrupts as follows (two external inputs):

(1) Display interrupt

- Update to timing signals (positive edge) (2) External interrupt1
- Negative edge on the INTO/P20 pin (3) External interrupt2
- Positive edge on the INT0/P20 pin (4) External interrupt3
 - '0' input on the INT1/P22 pin
- (5) Timebase interrupt 12-Bit timebase counter overflow
- (6) Timer interrupt
 16-Bit timer and timer register matched signal
 (7) Counter interrupt
- 8-Bit counter and counter register matched signal
- (8) Serial/O interrupt

8-Bit shift register shift end signal

8. 12-Bit Timebase Counter

The timebase counter is made up of a 12-bit binary counter. It generates an interrupt request every time it overflows as a result of dividing the OSC0 input 2¹².

9. 16-Bit Programmable Timer/Event Counter

Comprising a 16-bit register, a 16-bit binary counter, a comparator circiut, and a control circuit, the programmable timer generates an interrupt request when the register and counter values are matched.

10. 8-Bit High-Speed Programmable Timmer/Event Counter

The high-speed programmable timer/event counter comprises an 8-bit register, an 8-bit binary counter, a comparator circuit, and a control circuit. Starting and stopping the counter can be controlled by instructions. It generates an interrupt request when the register and counter values are matched.

11. 8-Bit Serial I/O

Serial I/O consists of an 8-bit shift register, a 3-bit shift counter, and a control circuit. It is used for serial data input and output. Serial data input and output takes place synchronized with a shift clock, which is selectable between internal and external clocks. The shift counter automatically terminates a data transfer on counting eight shift clock pulses and generates an interrupt request. MSC6458 •

12. Registers (Acc, H, L, F)

The accumulator (Acc) is a 4-bit register used to perform data transfers or calculations with the RAM, other registers, ports and so on.

The H and L registers are each a 4-bit register. They transfer data to and from Acc and SP (stack pointer) and address the RAM. The L register is also used to specify ports to use.

The F register is made up of four independent flip-flops. It can be used as a program "flag" or general-purpose register because each of these flip-flops permits set/reset testing and transferring 4-bit parallel data to and from Acc by instructions.

13. Timing Control (TC)

A '0' input on the RESET pin for a certain period initializes internal circuitry and ports.

As the input side of clock pulses, the OSC0 pin accepts clock pulses from an external source. Clock pulses may also be obtained by configuring an oscillation circuit with a crystal oscillator or ceramic resonator connected to OSC0 and OSC1.

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Load Instructions, etc.

Mne	monic	Code	Bytes	Cycles	Description
LAI	n	90–9F	1	1	A ← n
LLI	n	80-8F	1	1	L←n
LHI	n	3E · 7n	2	2	H←n
LHLI	nn	15 · nn	2	2	HL ← nn
LMI	nn	14 · nn	2	2	M (w) ← nn
LAL	÷	21	1	1	A←L
LLA		2D	1	1	L ← A
LAH		22	1	1	A←H
LHA		2E	1	1	H←A
LAM	*	38	1	1	A ← M
LMA		2F	1	1	M ← A
LAM+		24	1	1	$A \leftarrow M, L \leftarrow L+1, Skip if L = "0"$
LAM-		25	1	1	$A \leftarrow M, L \leftarrow L-1, Skip if L = "F"$
LMA+		26	1	1	M ← A, L ← L+1, Skip if L = "0"
LMA-		27	1	1	$M \leftarrow A, L \leftarrow L-1, Skip if L = "F"$
LAMM	n2	39–3B	1	1	$A \leftarrow M, H \leftarrow H + n2$
LAMD	mm	10 · mm	2	2	A ← Md
LMAD	mm	11 · mm	2	2	Md ← A
x		28	1	1	$A \longleftrightarrow M$
X+		3C	1	1	A \longleftrightarrow M, L \leftarrow L+1, Skip if L = "0"
X-		2C	1	1	$A \longleftrightarrow M, L \leftarrow L-1, Skip if L = "F"$
ХМ	n2	29-2B	1	1	$A \longleftrightarrow M, H \leftarrow H \neq n2$
LMT	mm	19 · mm	2	4	M (w) ← T (Md (w), A)
LAF		3E · 54	2	2	A←F
LFA		3E · 5C	2	2	F←A
LHLS	0	3E · 53	2	2	HL ← SP
LSHL		3E · 5B	2	2	SP ← HL
IP		20	1	1	A←P
OP		23	1	1	P←A
IPD	р	3D · pD	2	2	Α ← Ρρ
OPD	р	3D · pC	2	2	Pp ← A
OPT		18	1	3	P4, P5 ← T (M (w), A)

Interrupt Control Instructions

MEI 3E \cdot 60 2 2 MEIF \leftarrow "1" MD 3E \cdot 61 2 2 MEIF \leftarrow "0" EIXD 3D \cdot E8 2 2 EIXDF \leftarrow "1" EIXU 3D \cdot E8 2 2 EIXUF \leftarrow "1" EIXU 3D \cdot E8 2 2 EIXUF \leftarrow "1" EITB 3D \cdot D8 2 2 EITBF \leftarrow "1" EITB 3D \cdot D8 2 2 EITBF \leftarrow "1" EITM 3D \cdot D8 2 2 EITBF \leftarrow "1" EITM 3D \cdot D8 2 2 EITMF \leftarrow "1" EITM 3D \cdot D8 2 2 EIXUF \leftarrow "0" DIXD 3D \cdot E4 2 2 EIXUF \leftarrow "0" DIXL 3D \cdot E7 2 2 EITMF \leftarrow "0" DIXL 3D \cdot E7 2 2 EITMF \leftarrow "0" DITM 3D \cdot D6 2 2 EITMF \leftarrow "0" DITM 3D \cdot E1 2 2 Skip if EIXDF = "1" <th>Mnemonic</th> <th>Code</th> <th>Bytes</th> <th>Cycles</th> <th>Description</th>	Mnemonic	Code	Bytes	Cycles	Description
EIXD $3D \cdot E8$ 2 2 EIXDF $\leftarrow "1"$ EIXU $3D \cdot EA$ 2 2 EIXLF $\leftarrow "1"$ EIXL $3D \cdot EA$ 2 2 EIXLF $\leftarrow "1"$ EIDP $3D \cdot EB$ 2 2 EIXLF $\leftarrow "1"$ EITB $3D \cdot DA$ 2 2 EITMF $\leftarrow "1"$ EITM $3D \cdot DA$ 2 2 EITMF $\leftarrow "1"$ EITM $3D \cdot DA$ 2 2 EITMF $\leftarrow "1"$ EITM $3D \cdot DA$ 2 2 EIXPF $\leftarrow "1"$ EITM $3D \cdot DA$ 2 2 EIXPF $\leftarrow "0"$ DIXU $3D \cdot E5$ 2 2 EIXPF $\leftarrow "0"$ DIXL $3D \cdot E7$ 2 2 EIDPF $\leftarrow "0"$ DITM $3D \cdot D5$ 2 2 EITFF $\leftarrow "0"$ DITM $3D \cdot D7$ 2 2 EISR $\leftarrow "0"$ TIXD $3D \cdot E1$ 2 2 Skip if EIXUF = "1" TIXL $3D \cdot E3$ 2 2 Skip if EIXU	MEI	3E · 60	2	2	MEIF ← "1"
EIXU 3D \cdot E9 2 2 EIXUF \leftarrow "1" EIXL 3D \cdot EA 2 2 EIXUF \leftarrow "1" EIDP 3D \cdot EB 2 2 EIDPF \leftarrow "1" EITB 3D \cdot D8 2 2 EITBF \leftarrow "1" EITM 3D \cdot DA 2 2 EITBF \leftarrow "1" EICT 3D \cdot DA 2 2 EITMF \leftarrow "1" EIXD 3D \cdot DA 2 2 EIXDF \leftarrow "1" DIXD 3D \cdot E4 2 2 EIXDF \leftarrow "0" DIXU 3D \cdot E5 2 2 EIXDF \leftarrow "0" DIXU 3D \cdot E5 2 2 EIXDF \leftarrow "0" DIXU 3D \cdot E5 2 2 EIXDF \leftarrow "0" DIXU 3D \cdot E5 2 2 EIXDF \leftarrow "0" DIXU 3D \cdot E6 2 2 EIXDF \leftarrow "0" DITB 3D \cdot D5 2 2 EIXDF \leftarrow "0" DITM 3D \cdot D5 2 2 EIXDF \leftarrow "1" TIXU 3D \cdot E1 2 Skipi f EIXDF = "1"	MDI	3E · 61	2	2	MEIF ← "0"
EIXL 3D · EA 2 2 EIXL \leftarrow "1" EIDP 3D · EB 2 2 EIDPF \leftarrow "1" EITB 3D · D8 2 2 EITBF \leftarrow "1" EITM 3D · D8 2 2 EITFF \leftarrow "1" EITM 3D · DA 2 2 EITFF \leftarrow "1" EISR 3D · DA 2 2 EISFF \leftarrow "1" DIXD 3D · E4 2 2 EIXF \leftarrow "0" DIXU 3D · E5 2 2 EIXF \leftarrow "0" DIXU 3D · E6 2 2 EIXF \leftarrow "0" DIXU 3D · E7 2 2 EICF \leftarrow "0" DITM 3D · D5 2 2 EITF \leftarrow "0" DITM 3D · D6 2 2 EISF \leftarrow "0" DISR 3D · D7 2 2 EISF \leftarrow "0" TIXD 3D · E0 2 2 Skip if EIXF = "1" TIXL 3D · E2 2 Skip if EIXF = "1" TITM	EIXD	3D · E8	2	2	EIXDF ← "1"
EIDP 3D \cdot EB 2 2 EIDPF \leftarrow "1" EITB 3D \cdot D8 2 2 EITBF \leftarrow "1" EITM 3D \cdot DA 2 2 EITBF \leftarrow "1" EICT 3D \cdot DA 2 2 EICTF \leftarrow "1" EISR 3D \cdot DB 2 2 EISF \leftarrow "1" DIXU 3D \cdot E4 2 2 EIXF \leftarrow "0" DIXL 3D \cdot E5 2 2 EIXF \leftarrow "0" DIXL 3D \cdot E6 2 2 EIXF \leftarrow "0" DIVN 3D \cdot E7 2 EIDF \leftarrow "0" 0 DITB 3D \cdot D4 2 2 EITF \leftarrow "0" 0 DITM 3D \cdot D5 2 2 EITF \leftarrow "0" 0 DITM 3D \cdot D6 2 2 EISR \leftarrow "0" 0 DISR 3D \cdot D1 2 2 Skip if EIXUF = "1" 1 TIXU 3D \cdot E2 2 2 Skip if EIXUF = "1" 1 TITM<	EIXU	3D · E9	2	2	EIXUF ← "1"
EITB 3D \cdot D8 2 2 EITBF \leftarrow "1" EITM 3D \cdot D9 2 2 EITMF \leftarrow "1" EICT 3D \cdot DA 2 2 EICTF \leftarrow "1" EISR 3D \cdot DA 2 2 EISR \leftarrow "1" DIXD 3D \cdot E4 2 2 EIXDF \leftarrow "0" DIXU 3D \cdot E5 2 2 EIXUF \leftarrow "0" DIXL 3D \cdot E6 2 2 EIXUF \leftarrow "0" DIM 3D \cdot E6 2 2 EITMF \leftarrow "0" DITM 3D \cdot E6 2 2 EITMF \leftarrow "0" DITM 3D \cdot E6 2 2 EITMF \leftarrow "0" DITM 3D \cdot E7 2 2 EITMF \leftarrow "0" DITM 3D \cdot D6 2 2 EITMF \leftarrow "0" DITM 3D \cdot D6 2 2 Skip if EIXFF = "1" TIXU 3D \cdot E1 2 2 Skip if EIXFF = "1" TIXL 3D \cdot E3 2 2 Skip if	EIXL	3D · EA	2	2	EIXLF ← "1"
EITM $3D \cdot D9$ 2 2 EITMF \leftarrow "1" EICT $3D \cdot DA$ 2 2 EICTF \leftarrow "1" EISR $3D \cdot DA$ 2 2 EISRF \leftarrow "1" DIXD $3D \cdot E4$ 2 2 EIXUF \leftarrow "0" DIXU $3D \cdot E5$ 2 2 EIXUF \leftarrow "0" DIXU $3D \cdot E5$ 2 2 EIXUF \leftarrow "0" DIDP $3D \cdot E7$ 2 2 EIXUF \leftarrow "0" DITM $3D \cdot D5$ 2 2 EITFF \leftarrow "0" DITM $3D \cdot D5$ 2 2 EIGTF \leftarrow "0" DITM $3D \cdot D5$ 2 2 EIGTF \leftarrow "0" DITM $3D \cdot D5$ 2 2 EIGTF \leftarrow "0" DITM $3D \cdot D5$ 2 2 EISRF \leftarrow "1" TIXD $3D \cdot E0$ 2 2 Skip if EIXLF = "1" TIXL $3D \cdot E2$ 2 Skip if EIXLF = "1" TITM $3D \cdot D2$ 2	EIDP	3D · EB	2	2	EIDPF ← "1"
EICT $3D \cdot DA$ 2 2 EICTF \leftarrow "1" EISR $3D \cdot DB$ 2 2 EISRF \leftarrow "1" DIXD $3D \cdot E4$ 2 2 EIXRF \leftarrow "0" DIXU $3D \cdot E5$ 2 2 EIXF \leftarrow "0" DIXL $3D \cdot E5$ 2 2 EIXF \leftarrow "0" DIDP $3D \cdot E7$ 2 2 EIXF \leftarrow "0" DITB $3D \cdot D5$ 2 2 EITF \leftarrow "0" DITM $3D \cdot D5$ 2 2 EITF \leftarrow "0" DITM $3D \cdot D5$ 2 2 EISF \leftarrow "0" DITM $3D \cdot D5$ 2 2 EISF \leftarrow "0" DITM $3D \cdot D5$ 2 2 EISF \leftarrow "0" DITM $3D \cdot D5$ 2 2 Skip if EIXF $=$ "1" TIXD $3D \cdot E2$ 2 Skip if EIXF $=$ "1" TITM $3D \cdot D2$ 2 Skip if EIXF $=$ "1" TITM $3D \cdot D2$ 2 Skip if	EITB	3D · D8	2	2	EITBF ← "1"
EISR 3D \cdot DB 2 2 EISR \leftarrow "1" DIXD 3D \cdot E4 2 2 EIXD \leftarrow "0" DIXU 3D \cdot E5 2 2 EIXD \leftarrow "0" DIXL 3D \cdot E5 2 2 EIXD \leftarrow "0" DIXL 3D \cdot E5 2 2 EIXD \leftarrow "0" DITB 3D \cdot D4 2 2 EITB \leftarrow "0" DITB 3D \cdot D4 2 2 EITB \leftarrow "0" DITM 3D \cdot D5 2 2 EITB \leftarrow "0" DITM 3D \cdot D6 2 2 EISR \leftarrow "0" DITM 3D \cdot D5 2 2 Skip if EIXDF "1" TIXD 3D \cdot E0 2 2 Skip if EIXUF "1" TIXL 3D \cdot E1 2 2 Skip if EIXUF "1" TIXL 3D \cdot E3 2 2 Skip if EIXF "1" TIXL 3D \cdot D2 2 Skip if EIXF "1" TITM 3D \cdot	EITM	3D · D9	2	2	EITMF ← "1"
DIXD $3D \cdot E4$ 2 2 $EIXDF \leftarrow "0"$ DIXU $3D \cdot E5$ 2 2 $EIXUF \leftarrow "0"$ DIXL $3D \cdot E6$ 2 2 $EIXUF \leftarrow "0"$ DIDP $3D \cdot E7$ 2 2 $EIDFF \leftarrow "0"$ DITB $3D \cdot D5$ 2 2 $EITFF \leftarrow "0"$ DITM $3D \cdot D5$ 2 2 $EITFF \leftarrow "0"$ DITM $3D \cdot D5$ 2 2 $EITFF \leftarrow "0"$ DITM $3D \cdot D5$ 2 2 $EITFF \leftarrow "0"$ DISR $3D \cdot D5$ 2 2 $EISRF \leftarrow "0"$ TIXD $3D \cdot E0$ 2 2 $Skip if EIXUF = "1"$ TIXU $3D \cdot E3$ 2 2 $Skip if EIDFF = "1"$ TITB $3D \cdot D0$ 2 2 $Skip if EIDFF = "1"$ TITM $3D \cdot D1$ 2 2 $Skip if EIDFF = "1"$ TITM $3D \cdot D2$ 2 $Skip if EIDFF = "1"$ TITM $3D \cdot 2$	EICT	3D · DA	2	2	EICTF ← "1"
DIXU 3D \cdot E5 2 2 EIXUF \leftarrow "0" DIXL 3D \cdot E6 2 2 EIXLF \leftarrow "0" DIDP 3D \cdot E7 2 2 EIDF \leftarrow "0" DITB 3D \cdot D4 2 2 EITF \leftarrow "0" DITM 3D \cdot D5 2 2 EITF \leftarrow "0" DITM 3D \cdot D6 2 2 EITF \leftarrow "0" DITM 3D \cdot D5 2 2 EITF \leftarrow "0" DITM 3D \cdot D5 2 2 EISF \leftarrow "0" DITM 3D \cdot D5 2 2 EISF \leftarrow "0" TIXD 3D \cdot D7 2 2 EISF \leftarrow "0" TIXU 3D \cdot E3 2 2 Skip if EIXF = "1" TITB 3D \cdot D0 2 2 Skip if EITF = "1" TITM 3D \cdot D1 2 2 Skip if EITF = "1" TITM 3D \cdot D2 2 2 Skip if IRQXF = "1" TQXD 3D \cdot 20 2 2 Skip	EISR	3D · DB	2	2	EISRF ← "1"
DIXL 3D \cdot E6 2 2 EIXLF \leftarrow "0" DIDP 3D \cdot E7 2 2 EIDPF \leftarrow "0" DITB 3D \cdot D4 2 2 EITBF \leftarrow "0" DITM 3D \cdot D5 2 2 EITFF \leftarrow "0" DITM 3D \cdot D6 2 2 EITFF \leftarrow "0" DITM 3D \cdot D6 2 2 EISFF \leftarrow "0" DITM 3D \cdot D6 2 2 EISFF \leftarrow "0" DITM 3D \cdot D6 2 2 Skip if EIXF = "1" DITM 3D \cdot E0 2 2 Skip if EIXF = "1" TIXU 3D \cdot E2 2 Skip if EIXF = "1" TIXL 3D \cdot E2 2 Skip if EITFF = "1" TITM 3D \cdot D0 2 2 Skip if EITFF = "1" TITM 3D \cdot D2 2 2 Skip if EITFF = "1" TITM 3D \cdot D2 2 2 Skip if IROXF = "1" TOXD 3D \cdot 20 2 Skip if IROXF = "1" <t< td=""><td>DIXD</td><td>3D · E4</td><td>2</td><td>2</td><td>EIXDF ← "0"</td></t<>	DIXD	3D · E4	2	2	EIXDF ← "0"
DIDP 3D \cdot E7 2 2 EIDPF "0" DITB 3D \cdot D4 2 2 EITBF "0" DITM 3D \cdot D5 2 2 EITBF "0" DICT 3D \cdot D6 2 2 EITF "0" DISR 3D \cdot D7 2 2 EISRF "0" DISR 3D \cdot D7 2 2 Skip if EIXDF = "1" TIXD 3D \cdot E0 2 2 Skip if EIXDF = "1" TIXU 3D \cdot E1 2 2 Skip if EIXF = "1" TIXL 3D \cdot E2 2 2 Skip if EIXF = "1" TITB 3D \cdot D1 2 2 Skip if EIXF = "1" TITM 3D \cdot D2 2 2 Skip if EIXF = "1" TITM 3D \cdot D2 2 2 Skip if EIXF = "1" TITM 3D \cdot D2 2 2 Skip if IROXF = "1" TOXD 3D \cdot 20 2 2 Skip if IROXF = "1" TOXL 3D \cdot 21 2	DIXU	3D · E5	2	2	EIXUF ← "0"
DITB $3D \cdot D4$ 2 2 $EITBF \leftarrow "0"$ DITM $3D \cdot D5$ 2 2 $EITMF \leftarrow "0"$ DICT $3D \cdot D6$ 2 2 $EICTF \leftarrow "0"$ DISR $3D \cdot D7$ 2 2 $EISFF \leftarrow "0"$ TIXD $3D \cdot E0$ 2 2 $Skip if EIXDF = "1"$ TIXU $3D \cdot E1$ 2 2 $Skip if EIXUF = "1"$ TIXL $3D \cdot E2$ 2 $Skip if EIXUF = "1"$ TIXL $3D \cdot E3$ 2 2 $Skip if EIXUF = "1"$ TITB $3D \cdot D0$ 2 2 $Skip if EISFF = "1"$ TITM $3D \cdot D1$ 2 2 $Skip if EISFF = "1"$ TITM $3D \cdot D2$ 2 $Skip if EISFF = "1"$ TQXD $3D \cdot 20$ 2 2 $Skip if IROXDF = "1"$ TQXL $3D \cdot 21$ 2 2 $Skip if IROXDF = "1"$ TQXL $3D \cdot 23$ 2 2 $Skip if IROXDF = "1"$ TQTB <td>DIXL</td> <td>3D · E6</td> <td>2</td> <td>2</td> <td>EIXLF ← "0"</td>	DIXL	3D · E6	2	2	EIXLF ← "0"
DITM $3D \cdot D5$ 2 2 EITMF +- "0" DICT $3D \cdot D6$ 2 2 EICTF +- "0" DISR $3D \cdot D7$ 2 2 EISRF +- "0" TIXD $3D \cdot E0$ 2 2 Skip if EIXDF = "1" TIXU $3D \cdot E1$ 2 2 Skip if EIXDF = "1" TIXL $3D \cdot E2$ 2 2 Skip if EIXDF = "1" TIXL $3D \cdot E2$ 2 2 Skip if EIXDF = "1" TITM $3D \cdot E3$ 2 2 Skip if EIDFF = "1" TITB $3D \cdot D0$ 2 2 Skip if EISFF = "1" TITM $3D \cdot D1$ 2 2 Skip if EISFF = "1" TICT $3D \cdot D2$ 2 Skip if EISFF = "1" TQXD $3D \cdot 20$ 2 2 Skip if IROXDF = "1" TQXU $3D \cdot 21$ 2 2 Skip if IROXDF = "1" TQXL $3D \cdot 23$ 2 2 Skip if IROXDF = "1" TQXL $3D \cdot C1$ 2	DIDP	3D · E7	2	2	EIDPF ← "0"
DICT 3D \cdot D6 2 2 EICTF \leftarrow "0" DISR 3D \cdot D7 2 2 EISRF \leftarrow "0" TIXD 3D \cdot E0 2 2 Skip if EIXDF = "1" TIXU 3D \cdot E1 2 2 Skip if EIXDF = "1" TIXU 3D \cdot E2 2 2 Skip if EIXDF = "1" TIXL 3D \cdot E3 2 2 Skip if EIDFF = "1" TITB 3D \cdot D0 2 2 Skip if EITFF = "1" TITB 3D \cdot D1 2 2 Skip if EITFF = "1" TITT 3D \cdot D2 2 2 Skip if EICTF = "1" TITT 3D \cdot D2 2 2 Skip if EICTF = "1" TICT 3D \cdot D2 2 2 Skip if IRQXDF = "1" TQXD 3D \cdot 20 2 2 Skip if IRQXDF = "1" TQXL 3D \cdot 21 2 Skip if IRQXDF = "1" TQXL 3D \cdot 22 2 Skip if IRQXDF = "1" TQTB 3D \cdot C1 2 <t< td=""><td>DITB</td><td>3D · D4</td><td>2</td><td>2</td><td>EITBF ← "0"</td></t<>	DITB	3D · D4	2	2	EITBF ← "0"
DISR $3D \cdot D7$ 2 2 EISRF \leftarrow "0" TIXD $3D \cdot E0$ 2 2 Skip if EIXDF = "1" TIXU $3D \cdot E1$ 2 2 Skip if EIXDF = "1" TIXL $3D \cdot E2$ 2 2 Skip if EIDFF = "1" TIDP $3D \cdot E3$ 2 2 Skip if EIDFF = "1" TITB $3D \cdot D0$ 2 2 Skip if EIDFF = "1" TITM $3D \cdot D1$ 2 2 Skip if EITMF = "1" TICT $3D \cdot D2$ 2 2 Skip if EICTF = "1" TQXD $3D \cdot 20$ 2 2 Skip if IRQXDF = "1" TQXU $3D \cdot 21$ 2 2 Skip if IRQXDF = "1" TQXL $3D \cdot 23$ 2 2 Skip if IRQTBF = "1" TQTB $3D \cdot C0$ 2 2 Skip if IRQTFF = "1" TQTM $3D \cdot C1$ 2 2 Skip if IRQTFF = "1" TQCT $3D \cdot C2$ 2 Skip if IRQTFF = "1" <t< td=""><td>DITM</td><td>3D · D5</td><td>2</td><td>2</td><td>EITMF ← "0"</td></t<>	DITM	3D · D5	2	2	EITMF ← "0"
TIXD $3D \cdot E0$ 2 2 Skip if EIXDF = "1" TIXU $3D \cdot E1$ 2 2 Skip if EIXUF = "1" TIXL $3D \cdot E2$ 2 2 Skip if EIXUF = "1" TIDP $3D \cdot E3$ 2 2 Skip if EIDPF = "1" TITB $3D \cdot D0$ 2 2 Skip if EITBF = "1" TITM $3D \cdot D1$ 2 2 Skip if EITMF = "1" TITM $3D \cdot D2$ 2 2 Skip if EICTF = "1" TISR $3D \cdot D3$ 2 2 Skip if EIRAF = "1" TQXD $3D \cdot 20$ 2 2 Skip if EIRAF = "1" TQXU $3D \cdot 21$ 2 2 Skip if IRQXF = "1" TQXU $3D \cdot 22$ 2 2 Skip if IRQXF = "1" TQXL $3D \cdot 23$ 2 2 Skip if IRQXF = "1" TQDP $3D \cdot 23$ 2 2 Skip if IRQXF = "1" TQTM $3D \cdot C1$ 2 2 Skip if IRQXF = "1" TQCT $3D \cdot C2$ 2 Skip if IRQXF = "1" TQSR $3D \cdot C3$	DICT	3D · D6	2	2	EICTF "0"
TIXU 3D \cdot E1 2 2 Skip if EIXUF = "1" TIXL 3D \cdot E3 2 2 Skip if EIXLF = "1" TIDP 3D \cdot E3 2 2 Skip if EIDFF = "1" TITB 3D \cdot D0 2 2 Skip if EIDFF = "1" TITM 3D \cdot D1 2 2 Skip if EITFF = "1" TITM 3D \cdot D2 2 2 Skip if EITFF = "1" TICT 3D \cdot D2 2 2 Skip if EISFF = "1" TISR 3D \cdot D3 2 2 Skip if EISFF = "1" TQXD 3D \cdot 20 2 2 Skip if IRQXDF = "1" TQXU 3D \cdot 21 2 2 Skip if IRQXLF = "1" TQXU 3D \cdot 22 2 2 Skip if IRQXLF = "1" TQXL 3D \cdot 23 2 2 Skip if IRQXLF = "1" TQTB 3D \cdot C0 2 2 Skip if IRQTF = "1" TQSR 3D \cdot C1 2 2 Skip if IRQTF = "1" TQSR 3D \cdot C2 2 Skip if IRQTF = "1" TOSR RQXU	DISR	3D · D7	2	2	EISRF ← "0"
TIXL $3D \cdot E2$ 2 2 Skip if EIXLF = "1" TIDP $3D \cdot E3$ 2 2 Skip if EIDFF = "1" TITB $3D \cdot D0$ 2 2 Skip if EITFF = "1" TITM $3D \cdot D1$ 2 2 Skip if EITFF = "1" TITM $3D \cdot D2$ 2 2 Skip if EITFF = "1" TICT $3D \cdot D2$ 2 2 Skip if EICFF = "1" TISR $3D \cdot D3$ 2 2 Skip if EISFF = "1" TQXD $3D \cdot 20$ 2 2 Skip if IRQXDF = "1" TQXU $3D \cdot 21$ 2 2 Skip if IRQXUF = "1" TQXL $3D \cdot 22$ 2 2 Skip if IRQXUF = "1" TQXL $3D \cdot 23$ 2 2 Skip if IRQXUF = "1" TQTB $3D \cdot C0$ 2 2 Skip if IRQTBF = "1" TQCT $3D \cdot C1$ 2 2 Skip if IRQTF = "1" TQSR $3D \cdot C3$ 2 2 Skip if IRQSRF = "1" RQXU $3D \cdot 25$ 2 2 IRQXUF <- "0"	TIXD	3D · E0	2	2	Skip if EIXDF = "1"
TIDP $3D \cdot E3$ 2 2 Skip if EIDPF = "1" TITB $3D \cdot D0$ 2 2 Skip if EITBF = "1" TITM $3D \cdot D1$ 2 2 Skip if EITMF = "1" TITM $3D \cdot D1$ 2 2 Skip if EITMF = "1" TITM $3D \cdot D2$ 2 2 Skip if EICFF = "1" TITR $3D \cdot D2$ 2 2 Skip if EISRF = "1" TQXD $3D \cdot 20$ 2 2 Skip if IRQXDF = "1" TQXU $3D \cdot 21$ 2 2 Skip if IRQXUF = "1" TQXL $3D \cdot 22$ 2 2 Skip if IRQXLF = "1" TQXL $3D \cdot 23$ 2 2 Skip if IRQXLF = "1" TQDP $3D \cdot 23$ 2 2 Skip if IRQTBF = "1" TQTM $3D \cdot C1$ 2 2 Skip if IRQTMF = "1" TQTM $3D \cdot C2$ 2 2 Skip if IRQTMF = "1" TQCT $3D \cdot C2$ 2 2 Skip if IRQTMF = "1" TQAR $3D \cdot C2$ 2 2 Skip if IRQSRF = "1" RQXD	TIXU	3D · E1	2	2	Skip if EIXUF = "1"
TITB $3D \cdot D0$ 2 2 Skip if EITBF = "1" TITM $3D \cdot D1$ 2 2 Skip if EITMF = "1" TICT $3D \cdot D2$ 2 2 Skip if EITMF = "1" TISR $3D \cdot D3$ 2 2 Skip if EISRF = "1" TQXD $3D \cdot 20$ 2 2 Skip if EISRF = "1" TQXD $3D \cdot 20$ 2 2 Skip if IRQXDF = "1" TQXU $3D \cdot 21$ 2 2 Skip if IRQXUF = "1" TQXL $3D \cdot 22$ 2 2 Skip if IRQXUF = "1" TQXL $3D \cdot 23$ 2 2 Skip if IRQXUF = "1" TQDP $3D \cdot 23$ 2 2 Skip if IRQDFF = "1" TQTB $3D \cdot C0$ 2 2 Skip if IRQTFF = "1" TQTM $3D \cdot C1$ 2 2 Skip if IRQTFF = "1" TQCT $3D \cdot C2$ 2 Skip if IRQTFF = "1" TQSR $3D \cdot C3$ 2 2 Skip if IRQSRF = "1" RQXU $3D \cdot 25$ 2 2 IRQXUF < "0"	TIXL	3D · E2	2	2	Skip if EIXLF = "1"
TITM $3D \cdot D1$ 2 2 Skip if EITMF = "1" TICT $3D \cdot D2$ 2 2 Skip if EICTF = "1" TISR $3D \cdot D3$ 2 2 Skip if EISRF = "1" TQXD $3D \cdot 20$ 2 2 Skip if EISRF = "1" TQXD $3D \cdot 20$ 2 2 Skip if IRQXDF = "1" TQXU $3D \cdot 21$ 2 2 Skip if IRQXUF = "1" TQXU $3D \cdot 22$ 2 2 Skip if IRQXUF = "1" TQXL $3D \cdot 22$ 2 2 Skip if IRQXUF = "1" TQDP $3D \cdot 23$ 2 2 Skip if IRQXUF = "1" TQTB $3D \cdot C0$ 2 2 Skip if IRQTBF = "1" TQTM $3D \cdot C1$ 2 2 Skip if IRQTF = "1" TQTT $3D \cdot C2$ 2 2 Skip if IRQTF = "1" TQTT $3D \cdot C2$ 2 2 Skip if IRQTF = "1" TQCT $3D \cdot C2$ 2 2 Skip if IRQTF = "1" TQXL $3D \cdot C3$ 2 2 Skip if IRQXF = "0" RQXD	TIDP	3D · E3	2	2	Skip if EIDPF = "1"
TICT $3D \cdot D2$ 2 2 Skip if EICTF = "1" TISR $3D \cdot D3$ 2 2 Skip if EISRF = "1" TQXD $3D \cdot 20$ 2 2 Skip if IRQXDF = "1" TQXU $3D \cdot 21$ 2 2 Skip if IRQXDF = "1" TQXU $3D \cdot 21$ 2 2 Skip if IRQXLF = "1" TQXL $3D \cdot 22$ 2 2 Skip if IRQXLF = "1" TQDP $3D \cdot 23$ 2 2 Skip if IRQXLF = "1" TQTB $3D \cdot C0$ 2 2 Skip if IRQTBF = "1" TQTM $3D \cdot C1$ 2 2 Skip if IRQTF = "1" TQCT $3D \cdot C2$ 2 Skip if IRQTF = "1" TQSR $3D \cdot C3$ 2 2 Skip if IRQSRF = "1" RQXD $3D \cdot 24$ 2 2 IRQXDF (- "0" RQXU $3D \cdot 25$ 2 1RQXUF (- "0" RQXL $3D \cdot 26$ 2 1RQDF (- "0" RQTB $3D \cdot C4$ 2 2 IRQTF (- "0" RQTM $3D \cdot C5$ 2 2 IRQTF (- "	TITB	3D · D0	2	2	Skip if EITBF = "1"
TISR $3D \cdot D3$ 2 2 Skip if EISRF = "1" TQXD $3D \cdot 20$ 2 2 Skip if IRQXDF = "1" TQXU $3D \cdot 21$ 2 2 Skip if IRQXDF = "1" TQXL $3D \cdot 22$ 2 2 Skip if IRQXLF = "1" TQXL $3D \cdot 22$ 2 2 Skip if IRQXLF = "1" TQDP $3D \cdot 23$ 2 2 Skip if IRQXLF = "1" TQTB $3D \cdot C0$ 2 2 Skip if IRQTBF = "1" TQTM $3D \cdot C1$ 2 2 Skip if IRQTF = "1" TQCT $3D \cdot C2$ 2 Skip if IRQTF = "1" TQSR $3D \cdot C3$ 2 2 Skip if IRQSRF = "1" RQXD $3D \cdot 24$ 2 2 IRQXDF (- "0" RQXU $3D \cdot 25$ 2 2 IRQXUF (- "0" RQXL $3D \cdot 26$ 2 2 IRQDP (- "0" RQDP $3D \cdot 27$ 2 2 IRQDF (- "0" RQTB $3D \cdot C5$ 2 2 IRQTF (- "0" RQTM $3D \cdot C5$ 2	TITM	3D · D1	2	2	Skip if EITMF = "1"
TQXD $3D \cdot 20$ 2 2 Skip if IRQXDF = "1" TQXU $3D \cdot 21$ 2 2 Skip if IRQXUF = "1" TQXL $3D \cdot 22$ 2 2 Skip if IRQXLF = "1" TQDP $3D \cdot 23$ 2 2 Skip if IRQXLF = "1" TQDP $3D \cdot 23$ 2 2 Skip if IRQDPF = "1" TQTB $3D \cdot C0$ 2 2 Skip if IRQTBF = "1" TQTM $3D \cdot C1$ 2 2 Skip if IRQTF = "1" TQCT $3D \cdot C2$ 2 Skip if IRQTF = "1" TQSR $3D \cdot C3$ 2 2 Skip if IRQSRF = "1" RQXD $3D \cdot 24$ 2 2 Skip if IRQSRF = "1" RQXD $3D \cdot 24$ 2 2 IRQXDF \leftarrow "0" RQXU $3D \cdot 25$ 2 2 IRQXLF \leftarrow "0" RQXL $3D \cdot 26$ 2 2 IRQDF \leftarrow "0" RQDP $3D \cdot 27$ 2 2 IRQDF \leftarrow "0" RQTB $3D \cdot C5$ 2 2 IRQTF \leftarrow "0" RQCT 3	TICT	3D · D2	2	2	Skip if EICTF = "1"
TQXU $3D \cdot 21$ 2 2 Skip if IRQXUF = "1" TQXL $3D \cdot 22$ 2 2 Skip if IRQXLF = "1" TQDP $3D \cdot 23$ 2 2 Skip if IRQXF = "1" TQTB $3D \cdot 23$ 2 2 Skip if IRQTF = "1" TQTB $3D \cdot C0$ 2 2 Skip if IRQTF = "1" TQTM $3D \cdot C1$ 2 2 Skip if IRQTF = "1" TQCT $3D \cdot C2$ 2 2 Skip if IRQTF = "1" TQSR $3D \cdot C2$ 2 2 Skip if IRQSRF = "1" RQXD $3D \cdot 24$ 2 2 IRQXDF \leftarrow "0" RQXU $3D \cdot 25$ 2 2 IRQXUF \leftarrow "0" RQXL $3D \cdot 26$ 2 IRQXLF \leftarrow "0" RQDP $3D \cdot 27$ 2 IRQDF \leftarrow "0" RQTB $3D \cdot C5$ 2 2 IRQTF \leftarrow "0" RQTM $3D \cdot C5$ 2 2 IRQTF \leftarrow "0" RQCT $3D \cdot C6$ 2 2 IRQCTF \leftarrow "0"	TISR	3D · D3	2	2	Skip if EISRF = "1"
TQXL $3D \cdot 22$ 2 2 Skip if IRQXLF = "1" TQDP $3D \cdot 23$ 2 2 Skip if IRQDPF = "1" TQTB $3D \cdot C0$ 2 2 Skip if IRQTBF = "1" TQTM $3D \cdot C1$ 2 2 Skip if IRQTBF = "1" TQTM $3D \cdot C1$ 2 2 Skip if IRQTFF = "1" TQCT $3D \cdot C2$ 2 2 Skip if IRQTFF = "1" TQSR $3D \cdot C3$ 2 2 Skip if IRQSRF = "1" RQXD $3D \cdot 24$ 2 2 Skip if IRQSRF = "1" RQXU $3D \cdot 25$ 2 2 IRQXDF \leftarrow "0" RQXU $3D \cdot 25$ 2 2 IRQXLF \leftarrow "0" RQXL $3D \cdot 26$ 2 2 IRQDFF \leftarrow "0" RQTB $3D \cdot C4$ 2 2 IRQTF \leftarrow "0" RQTM $3D \cdot C5$ 2 2 IRQTMF \leftarrow "0" RQCT $3D \cdot C6$ 2 2 IRQTF \leftarrow "0"	TQXD	3D · 20	2	2	Skip if IRQXDF = "1"
TQDP $3D \cdot 23$ 2 2 Skip if IRQDPF = "1" TQTB $3D \cdot C0$ 2 2 Skip if IRQTBF = "1" TQTM $3D \cdot C1$ 2 2 Skip if IRQTBF = "1" TQCT $3D \cdot C2$ 2 2 Skip if IRQTFF = "1" TQSR $3D \cdot C3$ 2 2 Skip if IRQSRF = "1" RQXD $3D \cdot 24$ 2 2 Skip if IRQSRF = "1" RQXU $3D \cdot 25$ 2 2 IRQXDF (- "0" RQXL $3D \cdot 26$ 2 2 IRQXLF (- "0" RQXL $3D \cdot 27$ 2 2 IRQDPF (- "0" RQTB $3D \cdot C4$ 2 2 IRQTF (- "0" RQTM $3D \cdot C5$ 2 2 IRQTF (- "0" RQCT $3D \cdot C6$ 2 2 IRQTF (- "0"	TQXU	3D · 21	2	2	Skip if IRQXUF = "1"
TQTB 3D \cdot C0 2 2 Skip if IRQTBF = "1" TQTM 3D \cdot C1 2 2 Skip if IRQTMF = "1" TQCT 3D \cdot C2 2 2 Skip if IRQTFF = "1" TQSR 3D \cdot C3 2 2 Skip if IRQSRF = "1" RQXD 3D \cdot 24 2 2 Skip if IRQSRF = "1" RQXU 3D \cdot 25 2 2 IRQXDF \leftarrow "0" RQXL 3D \cdot 26 2 2 IRQXLF \leftarrow "0" RQDP 3D \cdot 27 2 2 IRQDPF \leftarrow "0" RQTB 3D \cdot C4 2 2 IRQTF \leftarrow "0" RQTM 3D \cdot C5 2 2 IRQTMF \leftarrow "0" RQCT 3D \cdot C6 2 2 IRQTF \leftarrow "0"	TQXL	3D · 22	2	2	Skip if IRQXLF = "1"
TQTM $3D \cdot C1$ 2 2 Skip if IRQTMF = "1" TQCT $3D \cdot C2$ 2 2 Skip if IRQCTF = "1" TQSR $3D \cdot C3$ 2 2 Skip if IRQSRF = "1" RQXD $3D \cdot 24$ 2 2 IRQXDF \leftarrow "0" RQXU $3D \cdot 25$ 2 2 IRQXUF \leftarrow "0" RQXL $3D \cdot 26$ 2 2 IRQXLF \leftarrow "0" RQDP $3D \cdot 27$ 2 2 IRQDPF \leftarrow "0" RQTB $3D \cdot C4$ 2 2 IRQTBF \leftarrow "0" RQTM $3D \cdot C5$ 2 2 IRQTMF \leftarrow "0" RQCT $3D \cdot C6$ 2 2 IRQTF \leftarrow "0"	TQDP	3D · 23	2	2	Skip if IRQDPF = "1"
TQCT $3D \cdot C2$ 2 2 Skip if IRQCTF = "1" TQSR $3D \cdot C3$ 2 2 Skip if IRQSRF = "1" RQXD $3D \cdot 24$ 2 2 IRQXDF \leftarrow "0" RQXU $3D \cdot 25$ 2 2 IRQXUF \leftarrow "0" RQXL $3D \cdot 26$ 2 2 IRQXLF \leftarrow "0" RQDP $3D \cdot 27$ 2 2 IRQDPF \leftarrow "0" RQTB $3D \cdot C4$ 2 2 IRQTBF \leftarrow "0" RQTM $3D \cdot C5$ 2 2 IRQTMF \leftarrow "0" RQCT $3D \cdot C6$ 2 2 IRQCTF \leftarrow "0"	ТОТВ	3D · C0	2	2	Skip if IRQTBF = "1"
TQSR 3D · C3 2 2 Skip if IRQSRF = "1" RQXD 3D · 24 2 2 IRQXDF \leftarrow "0" RQXU 3D · 25 2 2 IRQXUF \leftarrow "0" RQXL 3D · 26 2 2 IRQXLF \leftarrow "0" RQDP 3D · 27 2 2 IRQDPF \leftarrow "0" RQTB 3D · C4 2 2 IRQTBF \leftarrow "0" RQTM 3D · C5 2 2 IRQTMF \leftarrow "0" RQCT 3D · C6 2 2 IRQCTF \leftarrow "0"	TQTM	3D · C1	2	2	Skip if IRQTMF = "1"
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	TQCT	3D · C2	2	2	Skip if IRQCTF = "1"
RQXU $3D \cdot 25$ 2 2 IRQXUF (- "0") RQXL $3D \cdot 26$ 2 2 IRQXLF (- "0") RQDP $3D \cdot 27$ 2 2 IRQDPF (- "0") RQTB $3D \cdot C4$ 2 2 IRQTBF (- "0") RQTM $3D \cdot C5$ 2 2 IRQTMF (- "0") RQCT $3D \cdot C6$ 2 2 IRQCTF (- "0")	TQSR	3D · C3	2	2	Skip if IRQ\$RF = "1"
RQXL $3D \cdot 26$ 2 2 IRQXLF (= "0") RQDP $3D \cdot 27$ 2 2 IRQDPF (= "0") RQTB $3D \cdot C4$ 2 2 IRQTBF (= "0") RQTM $3D \cdot C5$ 2 2 IRQTMF (= "0") RQCT $3D \cdot C6$ 2 2 IRQCTF (= "0")	RQXD	3D · 24	2	2	IRQXDF ← "0"
RQDP $3D \cdot 27$ 2 2 IRQDPF (- "0") RQTB $3D \cdot C4$ 2 2 IRQTBF (- "0") RQTM $3D \cdot C5$ 2 2 IRQTMF (- "0") RQCT $3D \cdot C6$ 2 2 IRQCTF (- "0")	RQXU	3D · 25	2	2	IRQXUF ← "0"
RQTB $3D \cdot C4$ 2 2 IRQTBF \leftarrow "0" RQTM $3D \cdot C5$ 2 2 IRQTMF \leftarrow "0" RQCT $3D \cdot C6$ 2 2 IRQCTF \leftarrow "0"	RQXL	3D · 26	2	2	IRQXLF ← "0"
RQTM $3D \cdot C5$ 22IRQTMF \leftarrow "0"RQCT $3D \cdot C6$ 22IRQCTF \leftarrow "0"	RQDP	3D · 27	2	2	IRQDPF ← "0"
RQCT 3D · C6 2 2 IRQCTF ← "0"	RQTB	3D · C4	2	2	IRQTBF ← "0"
	RQTM	3D · C5	2	2	IRQTMF ← "0"
RQSR 3D · C7 2 2 IRQSRF ← "0"	RQCT	3D · C6	2	2	IRQCTF ← "0"
	RQSR	3D · C7	2	2	IRQSRF ← "0"

Mnemoni	c	Code	Bytes	Cycles	Description
INA		30	1	1	$A \leftarrow A+1$, Skip if $A = "0"$
INL		31	1	1	L ← L+1, Skip if L = "0"
INH		32	1	1	H ← H+1, Skip if H = "0"
INM		33	1	1	M ← M+1, Skip if M = "0"
DCA		34	1	1	$A \leftarrow A-1$, Skip if $A = "F"$
DCL		35	1	1	L ← L−1, Skip if L = "F"
DCH		36	1	1	H ← H−1, Skip if H = "F"
DCM		37	1	1	$M \leftarrow M-1$, Skip if $M = "F"$
INMD mi	m	12 · mm	2	2	Md ← Md+1, Skip if Md = "0"
DCMD m	m	13 · mm	2	2	$Md \leftarrow Md-1$, Skip if $Md = "F"$

Increment/Decrement Instructions

Bit Handling Instructions, etc.

Mne	monic	Code	Bytes	Cycles	Description
TAB	n2	54–57	1	1	Skip if A (n2) = "1"
RAB	n2	64-67	1	1	A (n2) ← "0"
SAB	n2	74–77	1	1	A (n2) ← "1"
TPB	n2	50-53	1	1	Skip if P (n2) = "1"
RPB	n2	60-63	1	1	P (n2) ← "0"
SPB	n2	70–73	1	1	P (n2) ← "1"
ТМВ	n2	58-5B	1	1	Skip if M (n2) = "1"
RMB	n2	68-6B	1	1	M (n2) ← "0"
SMB	n2	78–7B	1	1	M (n2) ← "1"
TFB	n2	5C-5F	1	1	Skip if F (n2) = "1"
RFB	n2	6C-6F	1	1	F (n2) ← "0"
SFB	n2	7C–7F	1	1	F (n2) ← "1"
TPBD	p, n2	3D · p0~3	2	2	Skip if Pp (n2) = "1"
RPBD	p, n2	3D · p4~7	2	2	Pp (n2) ← "0"
SPBD	p, n2	3D · p8∼B	2	2	Pp (n2) ← "1"
TC		09	1	1	Skip if C = "1"
RC		08	1	1	C ← "0"
SC		07	1	1	C ← "1"

Arithmetic Instructions

Mn	emonic	Code	Bytes	Cycles	Description
ADCS		01	1	1	C, A ← C+A+M, Skip if C = "1"
ADS		02	1	1	A ← A+M, Skip if Cy = "1"
ADC		03	1	1	$C, A \leftarrow C + A + M$
AIS	n	3E · 4n	2	2	A ← A+n, Skip if Cy = "1"
DAA		06	1	1	A ← A+6
DAS		0A	1	1	A ← A+10
AND		0D	1	1	$A \leftarrow A \land M$
OR		05	1	1	$A \leftarrow A \lor M$
EOR		04	1	1	A ← A ¥ M
CMA		0B	1	1	$A \leftarrow \overline{A}$
CIA		0C	1	1	A ← Ā+1
RAL		0E	1	1	$C \leftarrow 3 \leftarrow 2 \leftarrow 1 \leftarrow 0 \leq$
RAR		0F	1	1	$C \leftarrow 3 \leftarrow 2 \leftarrow 1 \leftarrow 0 \le$ $C \leftarrow 3 \rightarrow 2 \rightarrow 1 \rightarrow 0$
CAM		16	1	1	Skip if A = M
CAI	n	3E · 0n	2	2	Skip if A = n
CMI	n	3E · 1n	2	2	Skip if M = n
CLI	n	3E · 2n	2	2	Skip if L = n
CPI	p, n	17 · pn	2	2	Skip if Pp = n

Branch Instructions, etc.

Mne	emonic	Code	Bytes	Cycles	Description
JCP	a6	C0-FF	1	1	PC ← a6
JA		1A	1	2	PC ← (PC ← A) +1
JM		1B	1	2	PC ← (M (w), A)
JP	a12	40_4F 00 [_] FF	2	2	PC ← a12
CAL	a12	A0_AF 00_FF	2	4	ST ← PC+2, PC ← a12, SP ← SP-4
CZP	а	Ba	1	4	$ST \leftarrow PC+1, PC \leftarrow 2a, SP \leftarrow SP-4$
ωP	a13	3F 3F 00-1F 00 FF	3	4	PC ← a13
LCAL	a13	3F 3F 80-9F 00 FF	3	4	ST ← PC+3, PC ← a13, SP ← SP-4
RT		1E	1	4	$PC \leftarrow ST, SP \leftarrow SP+4$
RTS		1F	1	4	$PC \leftarrow ST, SP \leftarrow SP+4$, then Skip

Mnemonic	Code	Bytes	Cycles	Description
LCTM	3E · 51	2	2	CTR ← M (w)
LMCT	3E · 59	2	2	M (w) ← CT
ECT	3D · BB	2	2	CTF ← "1" (Counter Start)
DCT	3D · B7	2	2	CTF ← "0" (Counter Stop)
тст	3D · B3	2	2	Skip if CTF = "1"
LTMM	3E · 50	2	3	TMR ← M (2w)
LMTM	3E · 58	2	3	M (2w) ← TM
LSRM	3E · 52	2	2	$SR \leftarrow M$ (w), $SC \leftarrow "0"$ SC: Shift Counter
LMSR	3E · 5A	2	2	M (w) ← SR
ESR	3D · BA	2	2	SRF \leftarrow "1" (Shift Register Start)
DSR	3D · B6	2	2	SRF \leftarrow "0" (Shift Register Stop)
TSR	3D · B2	2	2	Skip if SRF = "1"

Counter Control Instructions, etc.

CPU Control Instructions, etc.

Мпетоліс	Code	Bytes	Cycles	Description
PUSH	1C	1	3	$ST \leftarrow C, A, H, L, SP \leftarrow SP-4$
POP	1D	1	3	C, A, H, L ← ST, SP ← SP+4
HALT	3D · B8	2	2	Halt CPU
STOP	3D · B9	2	2	Stop CPU
NOP	00	1	1	No Operation

Explanations of Instruction Symbols

A	: Accumulator (4-bit)	
н	: H register (4-bit)	
L	: L register (4-bit)	
F	: F register (4-bit)	
M	: RAM word addressed by the H and L registers	
Md	: RAM word addressed by second byte of an instruction code	
M (w)	: Two RAM words addressed by the H and L register/H3-0 and L3-1 (8-bit)	
Md (w)	: Two RAM words addressed by second byte of an instruction code (8-bit)	
M (2w)	: Four RAM words addressed by the H and L register/H3-0 and L3-2 (16-bit)	
ST	: Four RAM words (16-bit) allocated as a stack area	
SP	: Stack pointer (8-bit)	
PC P	: Program counter	
-	: Port specified by the L register (4-bit)	
Pp	: Port specified by 4 high-order bits of second byte of an instruction code (4-bit)	
CTR	: 8-Bit counter/register	
CT CTF	: 8-Bit programmable counter	
-	: Programmable counter start flag	
TMR	: 16-Bit timer/register	
TM SR	: 16-Bit programmable timer	
	: 8-Bit shift register	
SRF	: Shift register start flag	
(X, Y)	: ROM address data specified by a11-4 as X and a3-0 as Y (12-bit)	
• • •	: ROM table data specified by a11-4 as X and a3-0 as Y (8-bit)	
n	: Immediate data (4-bit)	
nn n0	: Immediate data (8-bit) : Two low-order bits of an instruction code	
n2 (=2)		
(n2)	: Bit specified by the two low-order bits of an instruction code	
a	: ROM address data	
aX	: ROM address data (X-bit)	
mm C	: RAM address data (8-bit)	
C	: Carry flag	

Cy : Flag indicating a carry in a calculation result