

Description

The μ PD78C05A and μ PD78C06A are advanced CMOS 8-bit general purpose, single-chip microcomputers intended for applications requiring 8-bit microprocessor control and extremely low power consumption. They are ideally suited for portable, battery-powered/backed-up products. Subsets of the μ PD7801, the μ PD78C05A/06A integrate an 8-bit ALU, 4K-byte ROM, 128-byte RAM, 46 I/O lines, an 8-bit timer, and a serial I/O port on a single die. Expanded system operation can easily be implemented using industry standard peripheral and memory components. Total memory space can be increased to 64K bytes.

The μ PD78C05A/06A lend themselves well to low-power, portable applications by featuring two power-down modes to further conserve power when the processor is not active. The μ PD78C06A is packaged in a 64-pin plastic miniflat package. The μ PD78C05A is a ROM-less version, packaged in a 64-pin QUIP, and designed for prototype development and small volume production.

Features

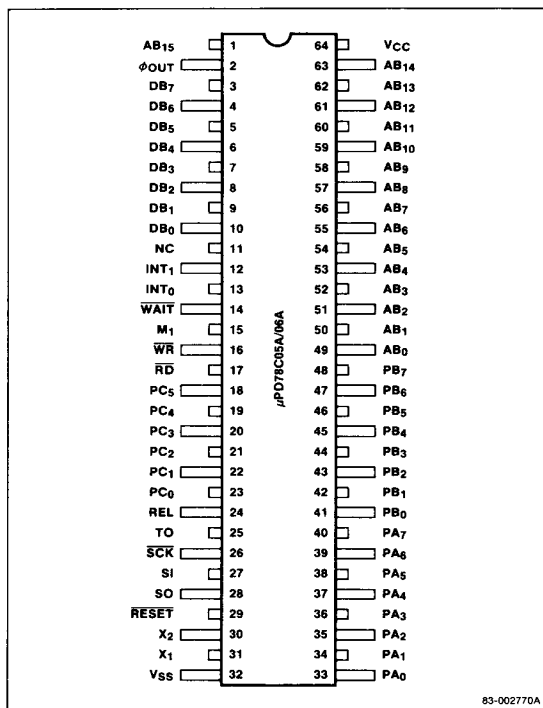
- ☐ CMOS silicon gate technology; +5 V supply
- ☐ Complete single-chip microcomputer
 - 8-bit ALU
 - 4K-byte ROM
 - 128-byte RAM
- ☐ 6.25 MHz
- ☐ Low power consumption
- ☐ 46 I/O lines
- ☐ Expansion capabilities
 - 60K-byte external memory address range
 - 8080A bus compatible
- ☐ Serial I/O port
- ☐ 101 instructions with multiple address modes
- ☐ Power-down modes
 - Halt mode
 - Stop mode
- ☐ 8-bit timer
- ☐ Prioritized interrupt structure
 - Two external
 - One internal
- ☐ On-chip clock generator
- ☐ ROM-less version available (78C05A)

Ordering Information

Part Number	Package Type
μ PD78C05AG-36	64-pin plastic QUIP
μ PD78C06AG-12	64-pin plastic miniflat

Pin Configurations

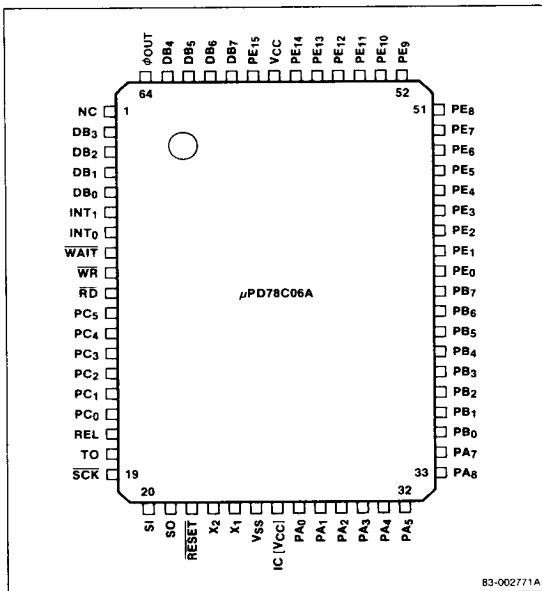
64-Pin Plastic QUIP



83-002770A

Pin Configurations (cont)

64-Pin Plastic Miniflat



Pin Identification

Plastic QUIP

No.	Symbol	Function
1	PE ₁₅ (78C06A) AB ₁₅ (78C05A)	Address bus/output port E, bit 15 Address bus, bit 15
2	φ _{OUT}	Clock output
3-10	DB ₇ -DB ₀	Bidirectional data bus
11	NC	Not connected
12, 13	INT ₁ , INT ₀	Interrupt inputs 1 and 0
14	WAIT	Wait request input
15	M ₁	Machine cycle 1 output
16	WR	Write strobe output
17	RD	Read strobe output
18-23	PC ₅ -PC ₀	Input port C
24	REL	STOP release input
25	TO	Timer output
26	SCK	Serial clock input/output

Plastic QUIP (cont.)

No.	Symbol	Function
27	SI	Serial data input
28	SO	Serial data output
29	RESET	Reset input
30, 31	X ₂ , X ₁	Crystal connections
32	V _{SS}	Ground potential
33-40	PA ₀ -PA ₇	I/O port A, bits 0-7
41-48	PB ₀ -PB ₇	I/O port B, bits 0-7
49-63	PE ₀ -PE ₁₄ (78C06A) AB ₀ -AB ₁₄ (78C05A)	Address bus/output port E, bits 0-14 Address bus, bits 0-14
64	V _{CC}	Power supply

Plastic Miniflat

No.	Symbol	Function
1	NC	Not connected
2-5	DB ₃ -DB ₀	Bidirectional data bus, bits 3-0
6, 7	INT ₁ , INT ₀	Interrupt inputs 1 and 0
8	WAIT	Wait request input
9	WR	Write strobe output
10	RD	Read strobe output
11-16	PC ₅ -PC ₀	Input port C
17	REL	STOP release input
18	TO	Timer output
19	SCK	Serial clock input/output
20	SI	Serial data input
21	SO	Serial data output
22	RESET	Reset input
23, 24	X ₂ , X ₁	Crystal connections
25	V _{SS}	Ground potential
26	IC (V _{CC})	Internally connected to V _{CC}
27-34	PA ₀ -PA ₇	I/O port A, bits 0-7
35-42	PB ₀ -PB ₇	I/O port B, bits 0-7
43-57	PE ₀ -PE ₁₄	Address bus/output port E, bits 0-14
58	V _{CC}	Power supply
59	PE ₁₅	Address bus/output port E, bit 15
60-63	DB ₇ -DB ₄	Bidirectional data bus, bits 7-4
64	φ _{OUT}	Clock output

Pin Functions

DB₀-DB₇ [Data Bus]

The 8-bit bidirectional data bus transfers data between the accumulator and external memory or memory-mapped I/O.

INT₀, INT₁ [Interrupts 0 and 1]

INT₀ is a rising-edge-triggered external interrupt input. INT₁ is an active-high external interrupt input. Both inputs must be held high for a least 2 μs to be recognized as valid.

WAIT [Wait Request]

The WAIT input is used to interface with slow memories or peripherals. WAIT is sampled at the end of machine cycle T₂. If it is low, then the processor goes into a wait state until WAIT returns high.

M₁ [Machine Cycle 1]

(78C05A only) The M₁ output is high during machine cycles T₁ through T₃ of the first opcode fetch of an instruction.

WR [Write Strobe]

When the WR output is low, valid output data is available on the data bus.

RD [Read Strobe]

The processor loads data from the data bus into the accumulator on the rising edge of the RD output.

PC₀-PC₅ [Port C]

The 6-bit input port has internal pull-up resistors. When contents of the port buffer are transferred to the accumulator, they fill the least significant six bits.

REL [STOP Release]

The STOP release input has an internal pull-down resistor. High level on REL releases the processor from stop mode, allowing the clock generator to restart.

TO [Timer Output]

Frequency of square wave output at TO is determined by the timer register contents. TO outputs a low level after reset.

SCK [Serial Clock]

The control clock for the serial data port is user-programmable as an input or output.

SI [Serial Data Input]

The SI input loads into the serial register on the rising edge of SCK.

SO [Serial Data Output]

On the falling edge of SCK, the serial register outputs data to SO, most significant bit first.

RESET [Reset]

A low level on RESET input of more than 8 μs resets the processor.

X₁, X₂ [Crystal Connections]

These pins connect to the internal clock generator circuit. If an external clock generator is used, then it is connected to X₁.

V_{SS} [Ground]

This is the power supply ground potential input.

IC [V_{CC}]

(78C06A only) This is the internal connection to V_{CC} through a high impedance. It should be left open.

PA₀-PA₇ [Port A]

Port A is an 8-bit latched output port. Data can be readily transferred between the accumulator and the output latch buffers. The contents of the output latches can be modified using arithmetic and logic instructions. Data remains latched at port A unless it is acted on by another port A instruction or a RESET is issued.

PB₀-PB₇ [Port B]

Port B is an 8-bit I/O port. Data is latched at port B in both the input and output modes. Each bit of port B can be independently set to either input or output mode. The mode B register programs the individual lines of port B to be either an input (mode B_n = 1) or an output (mode B_n = 0).

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Absolute Maximum Ratings

Supply voltage, V_{CC}	-0.3 to +7.0 V
Input voltage, V_I	-0.3 V to $V_{CC} + 0.3$ V
Output voltage, V_O	-0.3 V to $V_{CC} + 0.3$ V
Output high current, I_{OH} (device total)	-5 mA
Output low current, I_{OL} (device total)	43.5 mA
Operating temperature, T_{OPR}	-40 to +85°C
Storage temperature, T_{STG}	-65 to +150°C

Comment: Exposing the device to stresses above those listed in Absolute Maximum Ratings could cause permanent damage. The device is not meant to be operated under conditions outside the limits described in the operational sections of this specification. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Capacitance

$T_A = +25^\circ\text{C}$; $V_{CC} = \text{GND} = 0$ V

Parameter	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Input capacitance	C_I			15	pF	$f_c = 1$ MHz; unmeasured pins returned to 0 V
Output capacitance	C_O			15	pF	
I/O capacitance	$C_{I/O}$			15	pF	

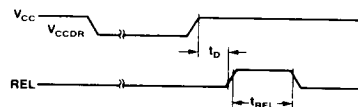
Low-Power Data Memory Retention in Stop Mode

$T_A = -40$ to $+85^\circ\text{C}$

Parameter	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Data retention voltage	V_{CCDR}	2.0			V	
Data retention supply current	I_{CCDR}		0.8	20	μA	$V_{CCDR} = 2.0$ V, ($X_1 = 0$ V, $X_2 = \text{open}$)
Data retention input low RESET voltage	V_{ILDR}	0		0.2 V_{CCDR}		
Data retention input high RESET voltage	V_{IHDR}	0.8 V_{CCDR}		V_{CCDR}	V	
REL input delay time	t_D	500			μs	
REL input high time	t_{REL}	10			μs	

Note:

- (1) In data retention mode, input voltages to $\overline{\text{WAIT}}$ and PC_0 - PC_5 pins (with pull-up resistors) should be maintained the same as V_{CCDR} level; other input voltages should be kept less than V_{CCDR} level.



DC Characteristics

T_A = -40 to +85°C; V_{CC} = +5 V ±10%

Parameter	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Input high voltage	V _{IH1}	0.7 V _{CC}		V _{CC}	V	INT ₀ , INT ₁ , WAIT, PB ₀ -PB ₇ , PC ₀ -PC ₅
	V _{IH2}	0.75 V _{CC}			V	RESET, SCK, REL, SI
	V _{IH3}	V _{CC} - 2.0		V _{CC}	V	DB ₀ -DB ₇
	V _{IH4}	V _{CC} - 0.5		V _{CC}	V	X ₁
Input low voltage	V _{IL1}	0		0.3 V _{CC}	V	INT ₀ -INT ₁ , WAIT, PB ₀ -PB ₇ , PC ₀ -PC ₅
	V _{IL2}	0		0.25 V _{CC}	V	RESET, SCK, REL, SI
	V _{IL3}	0		0.8	V	DB ₀ -DB ₇
	V _{IL4}	0		0.5	V	X ₁
Output high voltage	V _{OH1}	2.4			V	I _{OH} = -100 μA
	V _{OH2}	V _{CC} - 0.5			V	I _{OH} = -50 μA
Output low voltage	V _{OL}			0.45	V	I _{OL} = 1.8 mA
Input high current	I _{IH1}	7		100	μA	V _{IN} = V _{CC} (REL)
	I _{IH2}			45	μA	V _{IN} = V _{CC} (X ₁)
Input low current	I _{IL1}	-7		-100	μA	V _{IN} = 0 V (WAIT, PC ₀ -PC ₅)
	I _{IL2}			-45	μA	V _{IN} = 0 V (X ₁)
Input high leakage current	I _{LIH}			3.2	μA	V _{IN} = V _{CC} (except REL, X ₁)
Input low leakage current	I _{LIL1}			-3.2	μA	V _{IN} = 0 V (except WAIT, PC ₀ -PC ₅ , X ₁)
	I _{LIL2}			-3.2	μA	V _{IN} = 0 V (Stop mode, X ₁)
Output high leakage current	I _{LOH}			3.2	μA	V _{OUT} = V _{CC}
Output low leakage current	I _{LOL}			-3.2	μA	V _{OUT} = 0 V
V _{CC} supply current	I _{CC1}		4	7.5	mA	Operation mode
	I _{CC2}		1.2	2.7	mA	Halt mode
	I _{CC3}		1	20	μA	Stop mode (X ₁ = 0 V, X ₂ = Open)

AC Characteristics

Read/Write Operation

78C05A, t_{CY}φ = 660 ns; 78C06A, t_{CY}φ = 1320 ns

Parameter	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
RD low time	t _{RR}	1070 + 660			ns	
RD LE to WAIT LE	t _{RWT}			460	ns	
Address (PE ₀ -PE ₁₅) to WAIT LE	t _{AWTI}			790	ns	
WAIT set-up time to φ _{OUT} LE	t _{WTS}	370			ns	
WAIT hold time after φ _{OUT} LE	t _{WTH}	0			ns	
M ₁ to RD LE (1)	t _{MR}	108			ns	
RD TE to M ₁ (1)	t _{RM}	130			ns	
φ _{OUT} LE to WR LE	t _{φW}			175	ns	
Address (PE ₀ -PE ₁₅) to φ _{OUT} TE	t _{Aφ}	420			ns	
Address (PE ₀ -PE ₁₅) to φ _{OUT} TE (1)	t _{Aφ} *	90			ns	
Address (PE ₀ -PE ₁₅) to data output	t _{AD2}	510			ns	
Data output to WR TE	t _{φW}	740 + 660N			ns	
WR TE to data stable time	t _{WD}	130			ns	
Address (PE ₀ -PE ₁₅) to WR LE	t _{AW}	460			ns	
WR TE to address stable time	t _{WA}	180			ns	
WR low time	t _{WW}	690 + 900N			ns	
WR LE to WAIT LE	t _{WWT}			110	ns	

Note:

- (1) Applies only to 78C05A.
- (2) N is number of WAIT states (T_{WAIT}). In the 78C06A, two WAIT states are automatically inserted when accessing internal ROM.
- (3) LE is leading edge and TE is trailing edge.

AC Characteristics (cont)

Bus Timing Depending on $t_{CY\phi}$

$T_A = -40$ to $+85^\circ\text{C}$

Symbol	Formula	Min/Max	Unit
$t_{R\phi}$	$(1/2)T - 150$	Min	ns
t_{AD1}	$(3/2 + N)T - 200$	Max	ns
$t_{RA}(T3)$	$(1/2)T - 150$	Min	ns
$t_{RA}(T4)$	$(3/2)T - 150$	Min	ns
t_{RD}	$(1 + N)T - 200$	Max	ns
t_{RR}	$(2 + N)T - 250$	Min	ns
t_{RWT}	$T - 200$	Max	ns
t_{AWT1}	$(3/2)T - 200$	Max	ns
t_{WTS}	$(1/3)T + 150$	Min	ns
$t_{MR}(1)$	$(3/8)T - 140$	Min	ns
$t_{RM}(1)$	$(1/2)T - 200$	Min	ns
$t_{A\phi}(1)$	$(1/2)T - 240$	Min	ns
$t_{A\phi}$	$T - 240$	Min	ns
t_{AD2}	$T - 150$	Min	ns
t_{DW}	$(3/2 + N)T - 250$	Min	ns
t_{WD}	$(1/2)T - 200$	Min	ns
t_{AW}	$T - 200$	Min	ns
t_{WA}	$(1/2)T - 150$	Min	ns
t_{WW}	$(3/2 + N)T - 300$	Min	ns
t_{WWT}	$(1/2)T - 220$	Max	ns
t_{CYK}	$2T$	Min	ns
t_{KKL}	$T - 120$	Min	ns
t_{KKH}	$T - 120$	Min	ns

Note:

- (1) For 78C05A only
- (2) N = Number of T_{WAIT} states
In the 78C06A, two wait states are automatically inserted when accessing internal ROM.
 $T = t_{CY\phi}$ for 78C05A
 $T = 2t_{CY\phi}$ for 78C06A
 t_{CY} assumes 50% duty cycle on X_1 .

Serial Operation

78C05A, $t_{CY\phi} = 660$ ns; 78C06A, $t_{CY\phi} = 1320$ ns

Parameter	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
SCK cycle time	t_{CYK}	1270 1280		80,000	ns ns	SCK input SCK output
SCK low time	t_{KKL}	515 520			ns ns	SCK input SCK output
SCK high time	t_{KKH}	515 520			ns ns	SCK input SCK output
SI set-up time to SCK TE	t_{SIS}	200			ns	
SI hold time after SCK TE	t_{SIH}	250			ns	
SCK LE to SO delay time	t_{KO}			300	ns	

Note:

- (1) Input timings are measured at V_{IH} min and V_{IL} max.
- (2) Output timings are measured at $V_{OH} = 2.4$ V, $V_{OL} = 0.45$ V, and load = one TTL + 200 pF.
- (3) LE is leading edge and TE is trailing edge.

Clock Timing

$T_A = -40$ to $+85^\circ\text{C}$ $V_{DD} = +5$ V $\pm 10\%$

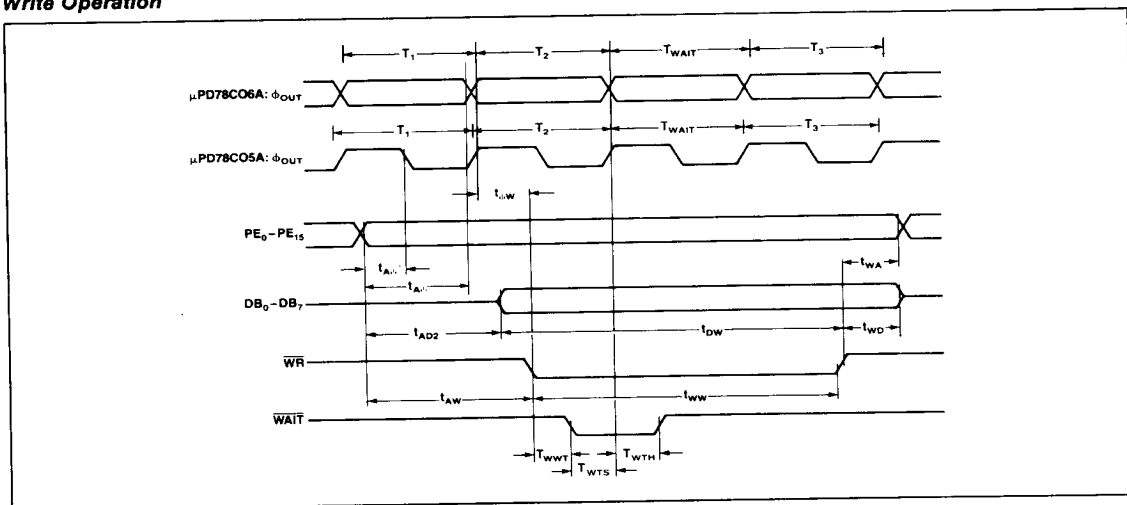
Parameter	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
X_1 input cycle time	t_{CYX}	160		10,000	ns	
X_1 input low time	t_{XXL}	75			ns	
X_1 input high time	t_{XXH}	75			ns	
ϕ_{OUT} cycle time (2)	$t_{CY\phi}$	1,280		80,000	ns	
ϕ_{OUT} low time (2)	$t_{\phi\phi L}$	515			ns	
ϕ_{OUT} high time (2)	$t_{\phi\phi H}$	515			ns	
ϕ_{OUT} cycle time (1)	$t_{CY\phi}$	640		40,000	ns	
ϕ_{OUT} Low time (1)	$t_{\phi\phi L}$	195			ns	
ϕ_{OUT} high time (1)	$t_{\phi\phi H}$	195			ns	
ϕ_{OUT} rise/fall time	t_R, t_F			120	ns	

Note:

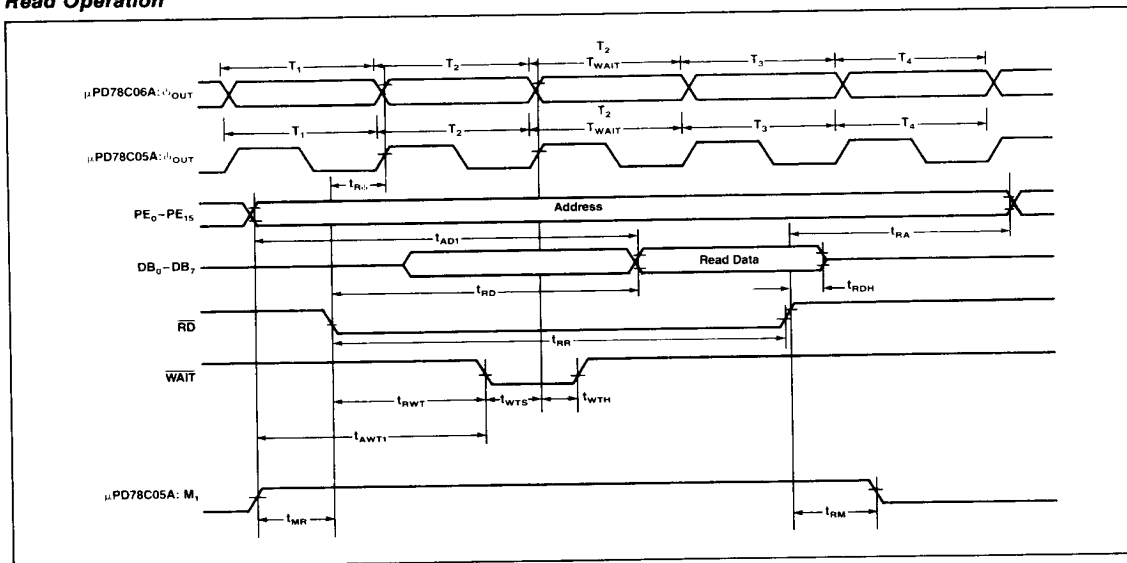
- (1) Applies only to 78C05A. ($t_{CY\phi} = 4/f_{OSC}$)
- (2) Applies only to 78C06A. ($t_{CY\phi} = 8/f_{OSC}$)

Timing Waveforms

Write Operation

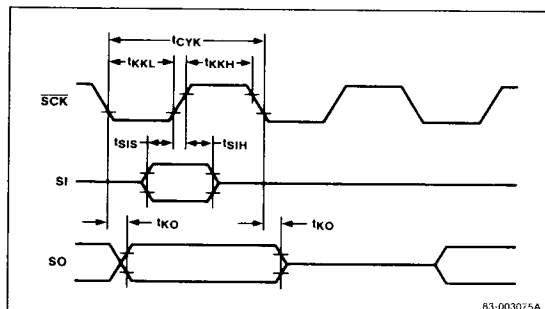


Read Operation

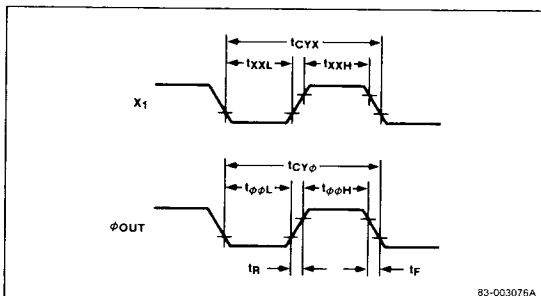


Timing Waveforms (cont)

Serial Operation



Clock Timing



Functional Description

Memory Map

The μPD78C06A can directly address up to 64K bytes of memory. Except for the on-chip ROM (0-4,095) and RAM (65,408-65,535), any memory location can be used as either ROM or RAM. Figure 1 defines the 0-64K-byte memory space for the μPD78C06A showing that the reset start address, interrupt start address, call tables, etc, are located in the internal ROM area.

Timer Operation

A programmable 8-bit timer (figure 2) is provided on-chip for measuring time intervals, generating pulses, and general time-related control functions. It is capable of measuring time intervals from 5 μs to 21 ms in duration. The timer consists of a prescaler that decrements an 8-bit counter at a fixed 5-μs or 82-μs rate.

Countup operation is initiated upon execution of the STM instruction. When the contents of the upcounter are incremented and a coincidence with the Timer Reg. occurs, an internal interrupt (INT_T) is generated. The duration of the time-out may be altered by loading new contents into the timer register.

The timer flip-flop is set by the STM instruction and reset on a countup operation. Its output (TO) is available externally and may be used for general external synchronization.

Serial Port Operation

The on-chip serial port (figure 3) provides basic synchronous serial communication functions allowing the μPD78C05A/06A to serially interface with external devices.

Serial transfers are synchronized with either the internal clock or an external clock input (SCK). The transfer rate is fixed at $f_{OSC}/8$ if the internal clock is used or is variable between dc and $f_{OSC}/8$ when an external clock is used. The clock source select is determined by the serial mode register. Data on the SI (serial input) line is latched into the serial register on each rising edge of the serial clock (SCK). Concurrently, data is transferred out of the serial register onto the SO (serial output) line with each falling edge of SCK. At this time, receive and transmit operations through the SI/SO port are enabled. Receive and transmit operations are performed MSB first.

Interrupt Structure

The μPD78C05A/06A provide a maskable interrupt structure capable of handling vectored prioritized interrupts. Interrupts can be generated from three different sources: two external interrupts and a timer interrupt. When activated, each interrupt branches to a designated memory vector location for that interrupt. See table 1.

Table 1. Interrupt Structure

INT	Vectored Memory Location	Priority	Type
INT _T	8	2	Internal, timer overflow
INT ₀	4	1	External, level sensitive
INT ₁	16	3	External, rising-edge sensitive

Figure 1. Memory Map

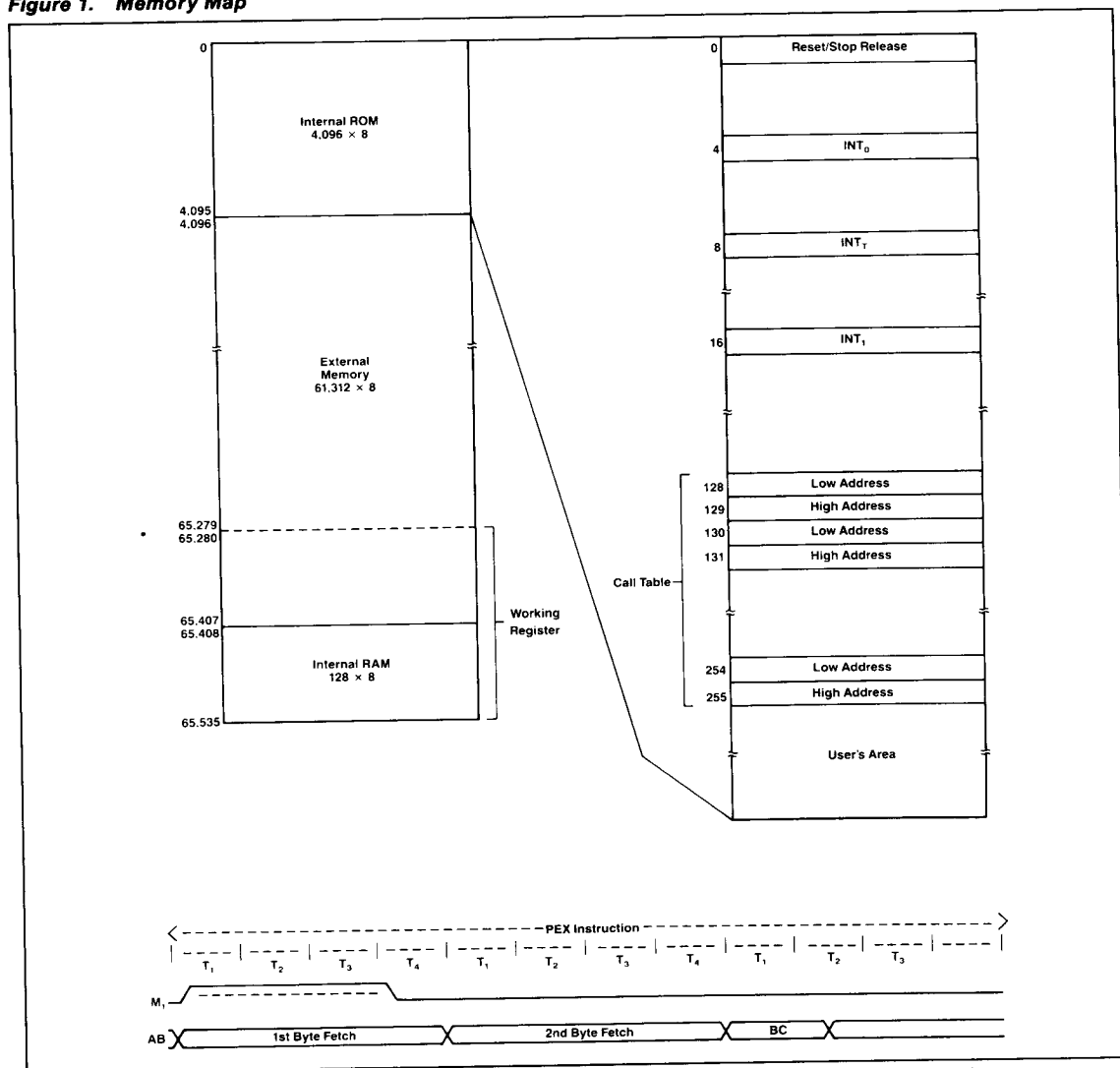


Figure 2. Timer Block Diagram

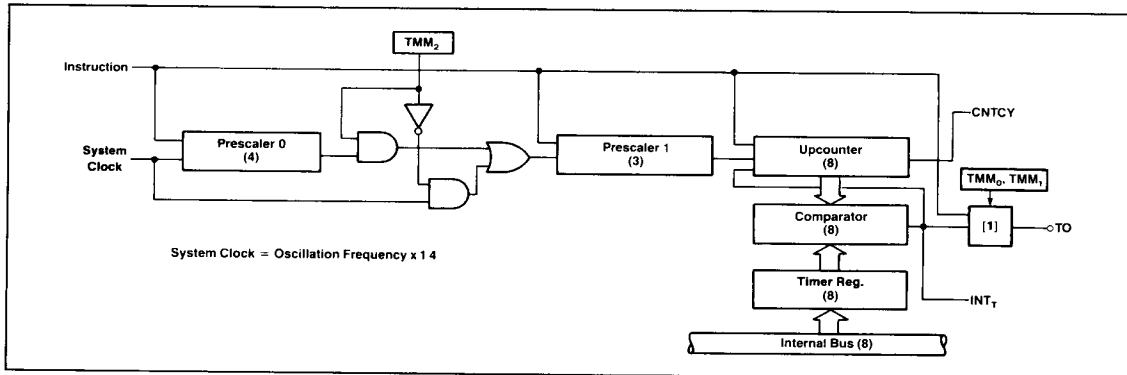
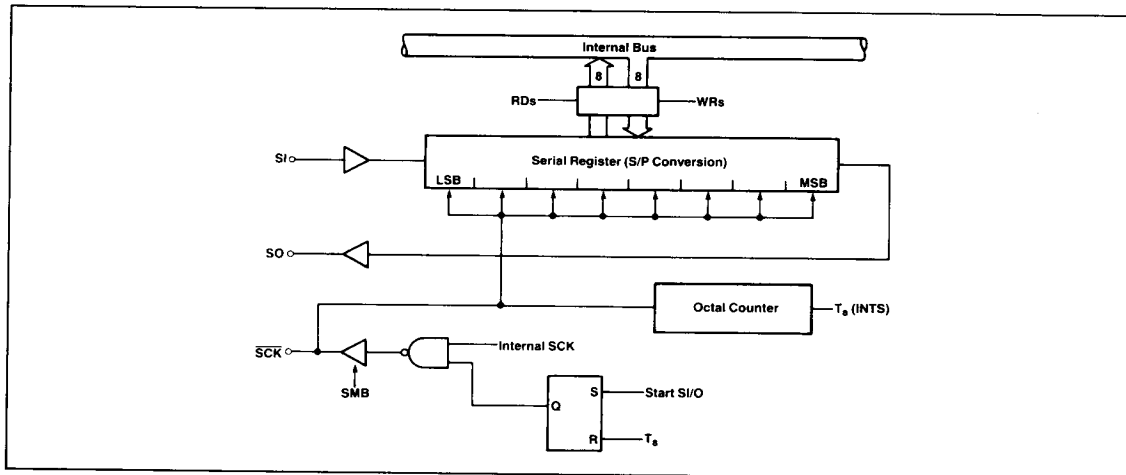


Figure 3. Serial Port Diagram



Reset

An active-low signal on the $\overline{\text{RESET}}$ input for more than 4 μs forces the μPD78C05A/06A into a reset condition, which affects the following internal functions:

- The interrupt enable flags are reset, and interrupts are inhibited.
- The interrupt request flag is reset.
- The halt flip-flop is reset, and the halt state is released.
- The contents of the mode B register are set to FFH, and port B becomes an input port.
- All flags are reset to 0.
- The internal count register for timer operation is set to FFH and the timer F/F is reset.
- The contents of the program counter are set to 0000H.
- Data bus (DB₀-DB₇), $\overline{\text{RD}}$, and $\overline{\text{WR}}$ go to a high-impedance state.

Once the $\overline{\text{RESET}}$ input goes high, the program is started at location 0000H.

Stop and Halt Modes

The μPD78C05A/06A have a stop and a halt mode. The effects of stop and halt on various functions are shown in table 2.

Registers

The μPD78C05A/06A contain seven 8-bit registers and two 16-bit registers. See figure 4.

General Purpose Registers

The general purpose registers B, C, D, E, H, L can function as auxiliary registers to the accumulator or in pairs as data pointers (BC, DE, HL). Automatic increment and decrement addressing mode capabilities extend the uses for the DE and HL register pairs.

Figure 4. Registers

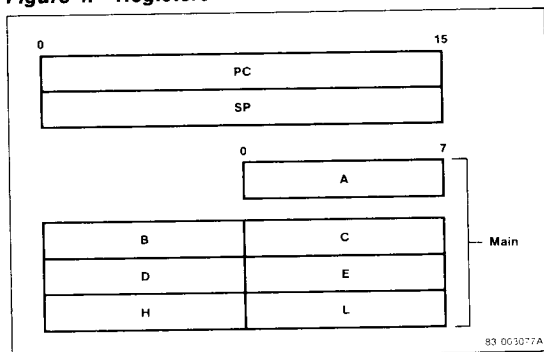


Table 2. Halt and Stop Modes

Function	Halt Mode	Stop Mode
Oscillator	Run	Stop
Internal system clock	Stop	
Timer	Run	
Timer register	Hold	Set
Upcounter, prescaler 0, 1	Run	Cleared
Serial interface	Run	Run (1)
Serial clock	Hold	Hold
Interrupt control circuit	Run	Stop
Interrupt enable flag	Hold	Reset
INT ₀ , INT ₁ input	Active	Inactive
INT _T		—
T ₈ (INTFS)		—
Mask register	Hold	Set
Pending interrupts (INTFX)		Reset
REL input	Inactive	Active
RESET input	Active	
On-chip RAM	Hold	Hold
Output latch in ports A, B, E		
Program counter (PC)		Cleared
Stack pointer (SP)		Unknown
General registers (A, B, C, D, E, F, L)		
Program status word (PSW)		Reset
Mode B register		Hold
Standby control register (SC ₀ -SC ₃)		
Standby control register (SC ₄)		Set
Timer mode register (TMM ₀ -TMM ₁)		Hold
Timer mode register (TMM ₁)		Set
Serial mode register (SM)		Hold
Data bus (DB ₀ -DB ₇)	High-Z	High-Z
RD, WR output	High	High

Note:

- (1) Serial clock counter is running and T₈ is generated; however, there are no effects from it.

Accumulator [A]

All data transfers between the μPD78C05A/ 06A and external memory or I/O are done through the accumulator.

Program Counter [PC]

The PC is a 16-bit register containing the address of the next instruction to be fetched. Under normal program flow, the PC is automatically incremented. However, in the case of a branch instruction, the PC contents are from another register or an instruction's immediate data. A reset sets the PC to 0000H.

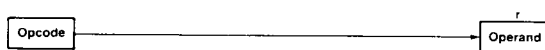
Stack Pointer [SP]

The stack pointer is a 16-bit register used to maintain the top of the stack area (last-in/first-out). The contents of the SP are decremented during a Call or Push instruction or if an interrupt occurs. The SP is incremented during a Return or POP instruction.

Address Modes

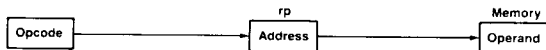
Register Addressing

The instruction opcode specifies a register that contains the operand.



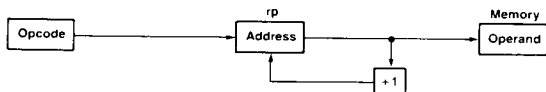
Register Indirect Addressing

The instruction opcode specifies a register pair that contains the memory address of the operand. Mnemonics with an X suffix indicate this address mode.

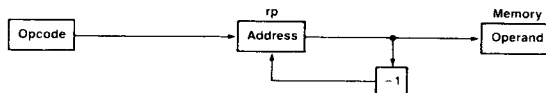


Automatic Increment Addressing

The opcode specifies a register pair that contains the memory address of the operand. The contents of the register pair are automatically incremented to point to a new operand. This mode provides automatic sequential stepping when working with a table of operands.

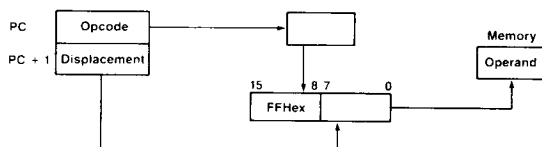


Automatic Decrement Addressing



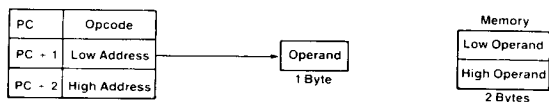
Working-Register Addressing

The contents of the register are linked with the byte following the opcode to form a memory address that contains the operand. The V register is used to indicate the memory page. This address mode is useful as a short-offset address mode when working with operands in a common memory page where only one additional byte is required for the address. Mnemonics with a W suffix indicate this address mode. In the μPD78C05A/ 06A, the V register is always FFH.



Direct Addressing

The two bytes following the opcode specify an address of a location containing the operand.



Immediate Addressing

PC
PC + 1



Immediate Extended Addressing

PC
PC + 1
PC + 2

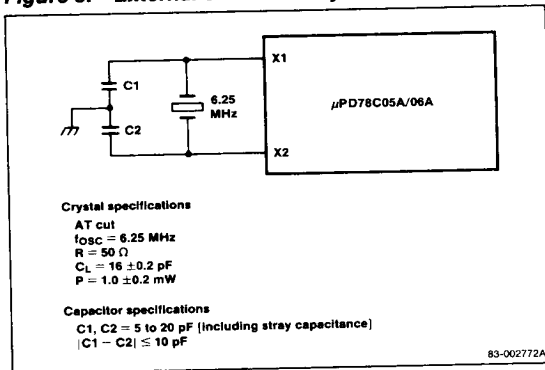


Clock Driver Circuit

The 6.25-MHz master timing signal is from an external oscillator connected to pin X1 or from an internal oscillator controlled by an external 6.25-MHz crystal connected to pins X1 and X2 (figure 5). Dividing f_{osc} by four creates the internal CPU clock ($f_{\phi} = 1.5625$ MHz).

A system clock is available for external use at the ϕ_{OUT} pin. Its frequency is 1.5625 MHz (6.25/4) or 0.78125 MHz (6.25/8) for 78C05A and 78C06A, respectively.

Figure 5. External 6.25-MHz Crystal



Instructions

Instruction Set Definitions

Operand	Description
r	A, B, C, D, E, H, L
r1	B, C, D, E, H, L
r2	A, B, C
sr	PA, PB, PC, MK, MB, TM ₀ , TM ₁ , S, SM, SC
sr1	PA, PB, PC, MK, S, TM ₀ , TM ₁ , SC
sr2	PA, PB, PC, MK
rp	SP, B, D, H
rp1	B, D, H
rpa	B, D, H, D ⁺ , H ⁺ , D ⁻ , H ⁻
wa	8-bit immediate data used to access working register area
word	16-bit immediate data
byte	8-bit immediate data
bit	1-bit immediate data
if	F0, F1, FT, FS
F	CY, Z
fa	10-bit immediate data used to access fixed area in locations 0-2047
ta	5-bit immediate data used to access table in locations 128-191
n	Number of bytes in an instruction

Note:

- When special register operands sr, sr1, sr2 are used, PA = port A, PB = port B, PC = port C, MK = mask register, MB = mode B register, SM = serial mode register, SC = standby control register, TM₀ = timer register 0, TM₁ = timer register 1, S = serial register.
- When register pair operands rp, rp1 are used, SP = stack pointer, B = BC, D = DE, H = HL.
- Operands rpa, rp1, wa are used in indirect addressing and auto-increment/auto-decrement addressing modes. B = (BC), D = (DE), H = (HL), D⁺ = (DE)⁺, H⁺ = (HL)⁺, D⁻ = (DE)⁻, and H⁻ = (HL)⁻.
- When the interrupt operand "if" is used, F0 = INTF0, F1 = INTF1, FT = INTFT, FS = INTFS.
- When the operand F is used, CY = Carry and Z = Zero.
- The V register is always FFH.

Instruction Set

Mnemonic	Operand	Bytes	*Clocks	Operation	Skip Condition	Flags	
						CY	Z
8-Bit Data Transfer							
MOV	r1,A	1	4/6	(r1) ← (A)			
MOV	A,r1	1	4/6	(A) ← (r1)			
MOV	sr,A	2	10/14	(sr) ← (A)			
MOV	A,sr1	2	10/14	(A) ← (sr1)			
MOV	r,word	4	17/25	(r) ← (word)			
MOV	word,r	4	17/25	(word) ← (r)			
MV1	r,byte	2	7/11	(r) ← (byte)			
STAW	wa	2	10/14	(FFH,wa) ← (A)			
LDAW	wa	2	10/14	(A) ← (FFH,wa)			
STAX	rpa	1	7/9	((rpa)) ← (A)			
LDAX	rpa	1	7/9	(A) ← ((rpa))			
16-Bit Data Transfer							
SBCD	word	4	20/28	(word) ← (C), (word + 1) ← (B)			
SDED	word	4	20/28	(word) ← (E), (word + 1) ← (D)			
SHLD	word	4	20/28	(word) ← (L), (word + 1) ← (H)			
SSPD	word	4	20/28	(word) ← (SP _L), ((word) + 1) ← (SP _H)			
LBCD	word	4	20/28	(C) ← (word), (B) ← (word + 1)			
LDED	word	4	20/28	(E) ← (word), (D) ← (word + 1)			
LHLD	word	4	20/28	(L) ← (word), (H) ← (word + 1)			
LSPD	word	4	20/28	(SP _L) ← (word)			
POP	rp1	2	14/18	(rp1 _L) ← ((SP)) (rp1 _H) ← ((SP) + 1), (SP) ← (SP) + 2			
LXI	rp,word	3	10/16	(rp) ← word			
Arithmetic							
ADD	A,r	2	8/12	(A) ← (A) + (r)		↑	↑
ADDX	rpa	2	11/15	(A) ← (A) + ((rpa))		↑	↑
ADC	A,r	2	8/12	(A) ← (A) + (r) + (CY)		↑	↑
ADCX	rpa	2	11/15	(A) ← (A) + ((rpa)) + (CY)		↑	↑
SUB	A,r	2	8/12	(A) ← (A) − (r)		↑	↑
SUBX	rpa	2	11/15	(A) ← (A) − ((rpa))		↑	↑
SBB	A,r	2	8/12	(A) ← (A) − (r) − (CY)		↑	↑
SBBX	rpa	2	11/15	(A) ← (A) − ((rpa)) − (CY)		↑	↑
ADDNC	A,r	2	8/12	(A) ← (A) − (r)	No carry	↑	↑
ADDNCX	rpa	2	11/15	(A) ← (A) − ((rpa))	No carry	↑	↑
SUBNB	A,r	2	8/12	(A) ← (A) − (r)	No borrow	↑	↑
SUBNBX	rpa	2	11/15	(A) ← (A) − (rpa)	No borrow	↑	↑

Instruction Set (cont)

Instruction Set (cont)						Flags	
Mnemonic	Operand	Bytes	*Clocks	Operation	Skip Condition	CY	Z
Logical							
ANA	A,r	2	8/12	$(A) \leftarrow (A) \wedge (r)$			↑
ANAX	rpa	2	11/15	$(A) \leftarrow (A) \wedge ((rpa))$			↑
ORA	A,r	2	8/12	$(A) \leftarrow (A) \vee (r)$			↑
ORAX	rpa	2	11/15	$(A) \leftarrow (A) \vee ((rpa))$			↑
XRA	A,r	2	8/12	$(A) \leftarrow (A) \vee (r)$			↑
XRAX	rpa	2	12/15	$(A) \leftarrow (A) \vee ((rpa))$			↑
GTA	A,r	2	8/12	$(A) \leftarrow (r) - 1$	No borrow	↑	↑
GTAX	rpa	2	11/15	$(A) \leftarrow ((rpa)) - 1$	No borrow	↑	↑
LTA	A,r	2	8/12	$(A) \leftarrow (r)$	Borrow	↑	↑
LTAX	rpa	2	11/15	$(A) \leftarrow ((rpa))$	Borrow	↑	↑
ONAX	rpa	2	8/12	$(A) \wedge ((rpa))$	No zero	↑	↑
OFFAX	rpa	2	11/15	$(A) \wedge ((rpa))$	Zero	↑	↑
NEA	A,r	2	8/12	$(A) \leftarrow (r)$	No zero	↑	↑
NEAX	rpa	2	11/15	$(A) \leftarrow ((rpa))$	No zero	↑	↑
EQA	A,r	2	8/12	$(A) \leftarrow (r)$	Zero	↑	↑
EQAX	rpa	2	11/15	$(A) \leftarrow ((rpa))$	Zero	↑	↑
Immediate Data Transfer (Accumulator)							
XRI	A,byte	2	7/11	$(A) \leftarrow (A) \vee \text{byte}$			↑
ADINC	A,byte	2	7/11	$(A) \leftarrow (A) - \text{byte}$	No carry	↑	↑
SUINB	A,byte	2	7/11	$(A) \leftarrow (A) - \text{byte}$	No borrow	↑	↑
ADI	A,byte	2	7/11	$(A) \leftarrow (A) + \text{byte}$		↑	↑
ACI	A,byte	2	7/11	$(A) \leftarrow (A) + \text{byte} + (CY)$		↑	↑
SUI	A,byte	2	7/11	$(A) \leftarrow (A) - \text{byte}$		↑	↑
SBI	A,byte	2	7/11	$(A) \leftarrow (A) - \text{byte} - (CY)$		↑	↑
ANI	A,byte	2	7/11	$(A) \leftarrow (A) \wedge \text{byte}$			↑
ORI	A,byte	2	7/11	$(A) \leftarrow (A) \vee \text{byte}$			↑
GTI	A,byte	2	7/11	$(A) \leftarrow \text{byte} - 1$	No borrow	↑	↑
LTi	A,byte	2	7/11	$(A) \leftarrow \text{byte}$	Borrow	↑	↑
ONI	A,byte	2	7/11	$(A) \wedge \text{byte}$	No zero	↑	↑
OFFi	A,byte	2	7/11	$(A) \wedge \text{byte}$	Zero		↑
NEi	A,byte	2	7/11	$(A) \leftarrow \text{byte}$	No zero	↑	↑
EQi	A,byte	2	7/11	$(A) \leftarrow \text{byte}$	Zero	↑	↑
Immediate Data Transfer (Special Register)							
ANI	sr2,byte	3	17/23	$(sr2) \leftarrow (sr2) \wedge \text{byte}$			↑
ORI	sr2,byte	3	17/23	$(sr2) \leftarrow (sr2) \vee \text{byte}$			↑
OFFi	sr2,byte	3	14/20	$(sr2) \wedge \text{byte}$	Zero		↑
ONI	sr2,byte	3	14/20	$(sr2) \wedge \text{byte}$	No zero		↑

Instruction Set (cont)

Mnemonic	Operand	Bytes	*Clocks	Operation	Skip Condition	Flags	
						CY	Z
Working Register							
ANIW	wa,byte	3	16/22	$(FFH, wa) \leftarrow (FFH, wa) \wedge \text{byte}$			↑
ORIW	wa,byte	3	16/22	$(FFH, wa) \leftarrow (FFH, wa) \vee \text{byte}$			↑
GTIW	wa,byte	3	13/19	$(FFH, wa) - \text{byte} - 1$	No borrow	↑	↑
LTIW	wa,byte	3	13/19	$(FFH, wa) - \text{byte}$	Borrow	↑	↑
ONIW	wa,byte	3	13/19	$(FFH, wa) \wedge \text{byte}$	No zero		↑
OFFIW	wa,byte	3	13/19	$(FFH, wa) \wedge \text{byte}$	Zero		↑
NEIW	wa,byte	3	13/19	$(FFH, wa) - \text{byte}$	No zero	↑	↑
EQIW	wa,byte	3	13/19	$(FFH, wa) - \text{byte}$	Zero	↑	↑
Increment/Decrement							
INR	r2	1	4/6	$(r2) \leftarrow (r2) + 1$	Carry		↑
INRW	wa	2	13/17	$(FFH, wa) \leftarrow (FFH, wa) + 1$	Carry		↑
DCR	r2	1	4/6	$(r2) \leftarrow (r2) - 1$	Borrow		↑
DCRW	wa	2	13/17	$(FFH, wa) \leftarrow (FFH, wa) - 1$	Borrow		↑
INX	rp	1	7/9	$(rp) \leftarrow (rp) + 1$			
DCX	rp	1	7/9	$(rp) \leftarrow (rp) - 1$			
Miscellaneous							
DAA		1	4/6	Decimal adjust accumulator		↑	↑
STC		2	8/12	$(CY) \leftarrow 1$		1	
CLC		2	8/12	$(CY) \leftarrow 0$		0	
Rotate and Shift							
RLD		2	17/21	Rotate left digit			
RRD		2	17/21	Rotate right digit			
RAL		2	8/12	$(A_{m+1}) \leftarrow (A_m), (A_0) \leftarrow (CY),$ $(CY) \leftarrow (A_7)$		↑	
RAR		2	8/12	$(A_{m-1}) \leftarrow (A_m), (A_7) \leftarrow (CY),$ $(CY) \leftarrow (A_0)$		↑	
Jump							
JMP	word	3	10/16	$(PC) \leftarrow \text{word}$			
JB		1	4/6	$(PC_H) \leftarrow (B), (PC_L) \leftarrow (C)$			
JR	word	1	10/12	$(PC) \leftarrow (PC) + 1 + \text{jdisp1}$			
JRE	word	2	13/17	$(PC) \leftarrow (PC) + 2 + \text{jdisp}$			

Instruction Set

Instruction Set						Flags	
Mnemonic	Operand	Bytes	*Clocks	Operation	Skip Condition	CY	Z
Call							
CALL	word	3	16/22	$((SP) - 1) \leftarrow ((PC) + 3)_H$, $((SP) - 2) \leftarrow ((PC) + 3)_L$, $(PC) \leftarrow \text{word}$			
CALF	word	2	13/17	$((SP) - 1) \leftarrow ((PC) + 2)_H$, $((SP) - 2) \leftarrow ((PC) + 2)_L$, $(PC_{15}\text{-}PC_{11}) \leftarrow 00001$, $(PC_{10}\text{-}PC_0) \leftarrow \text{fa}$			
CALT	word	1	19/21	$((SP) - 1) \leftarrow ((PC) + 1)_H$, $((SP) - 2) \leftarrow ((PC) + 1)_L$, $(PC_L) \leftarrow (128 + 2ta)$, $(PC_H) \leftarrow (129 + 2ta)$			
Return							
RET		1	10/12	$(PC_L) \leftarrow ((SP))$, $(PC_H) \leftarrow ((SP) + 1)$, $(SP) \leftarrow (SP) + 2$			
RETS		1	10+n/12+n	$(PC_L) \leftarrow ((SP))$, $(PC_H) \leftarrow ((SP) + 1)$, $(SP) \leftarrow (SP) + 2$, $(PC) \leftarrow (PC) + n$			
RETI		1	13/15	$(PC_L) \leftarrow ((SP))$, $(PC_H) \leftarrow ((SP) + 1)$, $(PSW) \leftarrow ((SP) + 2)$, $(SP) \leftarrow (SP) + 3$			
Skip							
SKNC		2	8/12	Skip if no carry	CY = 0		
SKNZ		2	8/12	Skip if co zero	Z = 0		
SKNIT	f	2	8/12	Skip if no INT X otherwise reset INT X	f = 0		
CPU Control							
NOP		1	4/6	No operation			
EI		2	8/12	Enable interrupt			
DI		2	8/12	Disable interrupt			
Serial Port Control							
SIO		1	4/6	Start (trigger) serial I/O			
STM		1	4/6	start timer			
Port E Control							
PEX		2	11/15	$(PE_{15}\text{-}PE_8) \leftarrow (B)$, $(PE_7\text{-}PE_0) \leftarrow (C)$			
PER		2	8/12	Port E AB mode			

Program Status Word (PSW) Operation

Operation				D ₆	D ₅	D ₄	D ₃	D ₂	D ₀	
Reg. Memory		Immediate		Skip	Z	SK	HC	L1	LD	CY
ADD	ADDX	ADI			↑	0	↑	0	0	↑
ADC	ADCX	ACI								
SUB	SUBX	SUI								
SBB	SBBX	SBI								
ANA	ANAX	ANI	ANIW		↑	0	•	0	0	•
ORA	ORAX	ORI	ORIW							
XRA	XRAX	XRI								
ADDNC	ADDNCX	ADINC			↑	↑	↑	0	0	↑
SUBNB	SUBNBX	SUINB								
GTA	GTAX	GTI	GTIW							
LTA	LTAX	LTI	LTIW							
	ONAX	ONI	ONIW		↑	↑	•	0	0	•
	OFFAX	OFFI	OFFIW							
NEA	NEAX	NEI	NEIW		↑	↑	↑	0	0	↑
EQA	EQAX	EI	EIW							
INR	INRW				↑	↑	↑	0	0	•
DCR	DCRW									
DAA					↑	0	↑	0	0	↑
RLL, RLR					•	0	•	0	0	↑
RLD-RRD					•	0	•	0	0	•
STC					•	0	•	0	0	↑
CLC					•	0	•	0	0	0
		MVI A, byte			•	0	•	0	0	0
		MVI L, byte			•	0	•	1	0	•
		LXI H, word			•	0	•	0	1	•
			SKNC		•	↑	•	0	0	•
			SKNZ							
			SKNIT							
			RETS		•	1	•	0	0	•
All other instructions					•	0	•	0	0	•

Flag Symbols:

- ↑ Flag affected according to result of operation.
- 1 Flag set
- 0 Flag reset
- Flag not affected.