

CMOS 4-BIT MICROCONTROLLER

TMP47CE820F

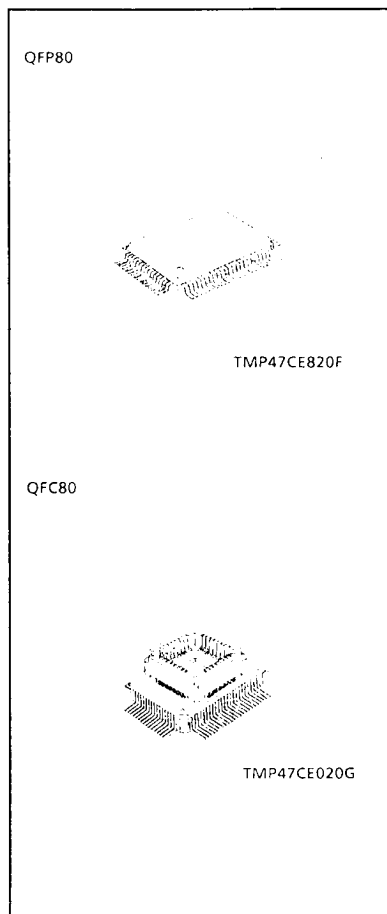
The 47CE820 is a high speed and high performance 4-bit single chip microcomputer based on the TLC5-470 CMOS series with E2PROM, LCD driver and high speed timer/counter.

PART No.	ROM	RAM	E2 PROM	PACKAGE	PIGGYBACK
*TMP47CE820F	8192 × 8-bit	512 × 4-bit	64 × 8-bit	QFP80	*TMP47CE020G

* Under development

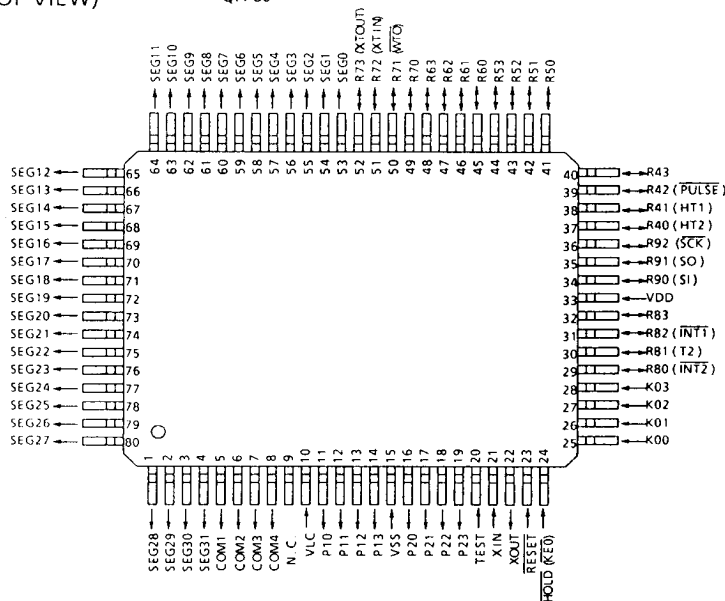
FEATURES

- ◆ 4-bit single chip microcomputer
- ◆ Instruction execution time :
 - 1.3μs (at 6MHz), 244μs (at 32.8KHz)
- ◆ 92 basic instructions
- ◆ Table look-up instructions
- ◆ 5-bit to 8-bit data conversion instruction
- ◆ Subroutine nesting : 15 levels max.
- ◆ 6 interrupt sources (External : 2, Internal : 4)
 - All sources have independent latches each, and multiple interrupt control is available.
- ◆ I/O port
 - Input 2 ports 5 pins
 - Output 2 ports 8 pins
 - I/O 6 ports 23 pins
- ◆ Interval Timer
- ◆ Two 12-bit Timer/Counters
 - Timer, event counter, and pulse width measurement mode
- ◆ Two 8-bit High-speed Timer/Counter
 - Timer, event counter, frequency measurement, and pulse output mode
- ◆ Watchdog Timer
- ◆ Serial Interface with 8-bit buffer
 - Simultaneous transmission and reception capability
 - External/internal colck, leading/trailing edge shift, 4/8-bit mode
- ◆ 512-bit E2PROM
 - 1 byte rewrite and chip erase
 - Self timed rewrite cycle (With Timer)
 - Ready / Busy status monitor and Interrupt function
 - Data retention time : 10 Years (Min.)
 - Rewrite cycle : 1×10^4 (Min.)
- ◆ High current outputs
 - LED direct drive capability (typ.20mA × 8bits)
- ◆ LCD driver
 - LCD direct drive is available (Max. 12-digit display at 1/4 duty LCD)
 - 1/4, 1/3 1/2 duties or static drive are programmably selectable.
- ◆ Dual-clock operation
 - High-speed/Low-power consumption operating mode
- ◆ Hold function : Battery/Capacitor back-up
- ◆ Emulator : BM47C820A

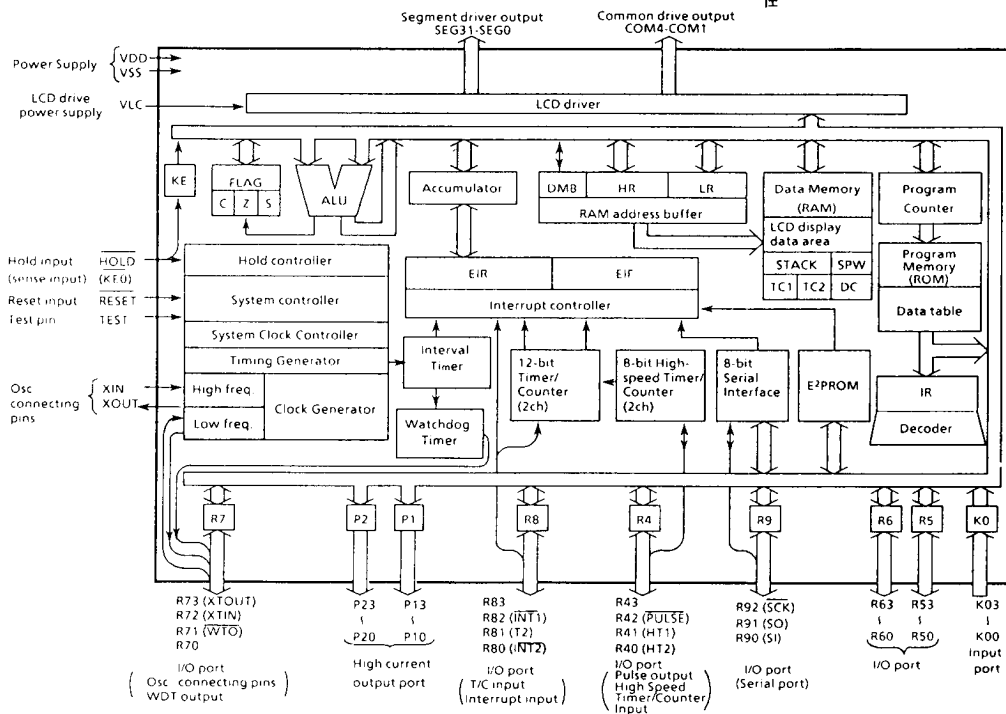


PIN ASSIGNMENT (TOP VIEW)

QFP80



BLOCK DIAGRAM



PIN FUNCTION

PIN NAME	Input/Output	FUNCTIONS	
K03 - K00	Input	4-bit input port	
P13 - P10	Output	4-bit output port with latch	
P23 - P20		8-bit data are output by the 5-bit to 8-bit data conversion instruction [OUTB @HL].	
R43	I/O	4-bit I/O port with latch.	Pulse output High speed timer/counter 1 input High speed timer/counter 2 input
R42 (PULSE)	I/O (Output)	When used as input port or high speed timer/counter, the latch must be set to "1".	
R41 (HT1)	I/O (Input)		
R40 (HT2)			
R53 - R50	I/O	4-bit I/O port with latch.	
R63 - R60		When used as input port, the latch must be set to "1".	
R73 (XTOUT)	I/O (Output)	4-bit I/O port with latch.	Resonator connecting pins. For inputting external clock. XIN is used and XOUT is opened. Watchdog timer output
R72 (XTIN)	I/O (Input)	When used as input port, watchdog timer output, the latch must be set to "1".	
R71 (WTO)	I/O (Output)		
R70	I/O		
R83	I/O	4-bit I/O port with latch.	Extrnal interrupt 1 input Timer/Counter 2 external input External interrupt 2 input
R82 (INT1)	I/O (Input)	When used as input port, external interrupt input pin, or timer/counter external input pin, the latch must be set to "1".	
R81 (T2)			
R80 (INT2)			
R92 (SCK)	I/O (I/O)	3-bit I/O port with latch.	Serial clock I/O Serial data output Serial data input
R91 (SO)	I/O (Output)	When used as input port, external interrupt input pin, or timer/counter external input pin, the latch must be set to "1".	
R90 (SI)	I/O (Input)		
SEG31 - SEG0	Output	LCD Segment driver output	
COM4 - COM1		LCD Common driver output	
XIN	Input	Resonator connecting pins.	
XOUT	Output	For inputting external clock, XIN is used and XOUT is opened.	
RESET	Input	Reset signal input	
HOLD (KE0)	Input (input)	Hold request/ release signal input	Sense input
TEST	Input	Test pin for out-going test. Be opened or fixed to low level.	
VDD	Power supply	+ 5V	
VSS		0V (GND)	
VLC		LCD drive power supply	

OPERATIONAL DESCRIPTION

The 47CE820 contains an E²PROM in the 47C820.

The configuration and function of the 47CE820 are similar to the 47C820 except the E²PROM. The technical data sheets for the 47C820 should also be referred to.

1. E²PROM

The 47CE820 contains 64 × 8-bit E²PROM (Electrically Erasable Programmable ROM).

1.1 Circuit configuration

The E²PROM circuit consists of the function blocks shown in Figure 1-1.

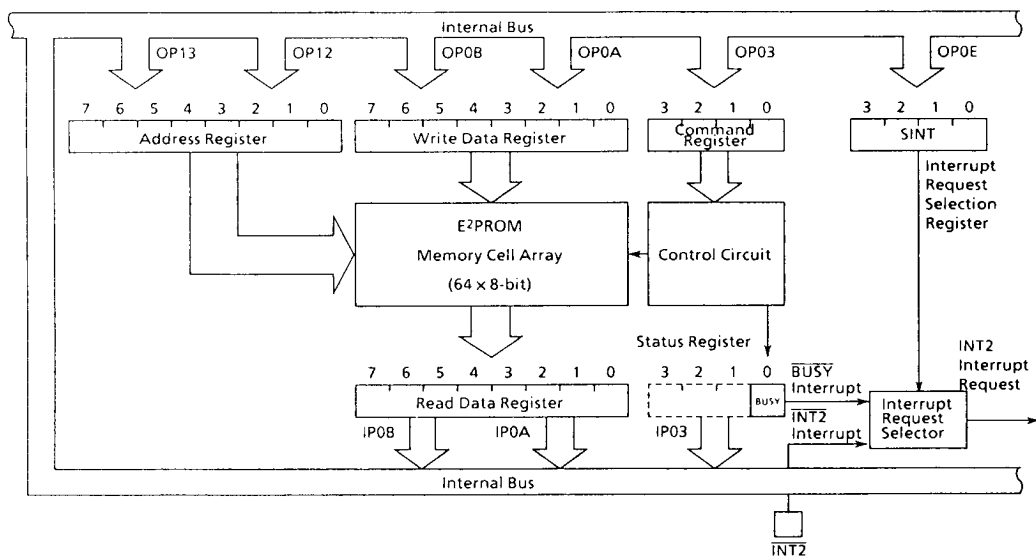


Figure 1-1. E²PROM

1.2 Control of E²PROM

E²PROM is controlled by 6 registers: the command register, address register, write data register, read data register, status register and interrupt request selection register.

(1) E²PROM command register

The E²PROM command register (OP03) selects the E²PROM operation mode. Operation starts at the point where the operation mode is set. When operation ends, the command register is automatically cleared to "0000_B".

E²PROM command register (Port address OP03)

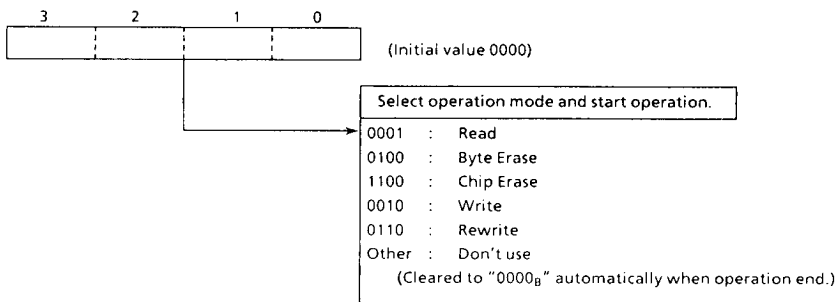


Figure 1-2. E²PROM command register

(2) E²PROM address register

The E²PROM address register is a 8-bit register which specifies the E²PROM address. The lower 4 bits are accessed as port address OP12 and the upper 4 bits are accessed as port address OP13.

The E²PROM address of the 47CE820 is 00_H to 3F_H. Don't select 40_H to FF_H of the E²PROM address.

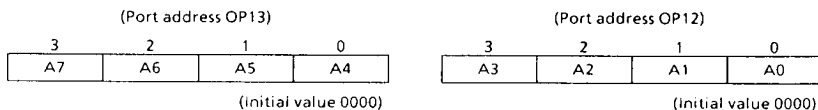


Figure 1-3. E²PROM address register

(3) E²PROM write data register

The E²PROM write data register is an 8-bit register used to store data to be written to the E²PROM. The lower 4 bits are accessed as port address OP0A and the upper 4 bits are accessed as port address OP0B.

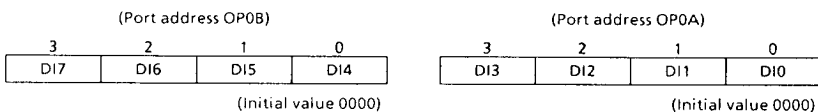


Figure 1-4. E²PROM write data register

(4) E2PROM read data register

The E2PROM read data register is an 8-bit register used to store data read from the E2PROM. The lower 4 bits are accessed as port address IP0A and the upper 4 bits are accessed as port address IP0B.

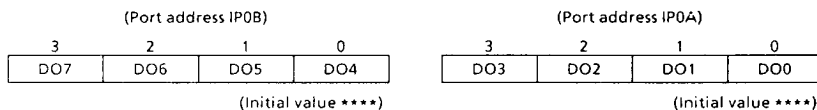


Figure 1-5. E2PROM read data register

(5) E2PROM status register

The operating status of an E2PROM can be monitored using the status register (IP03).

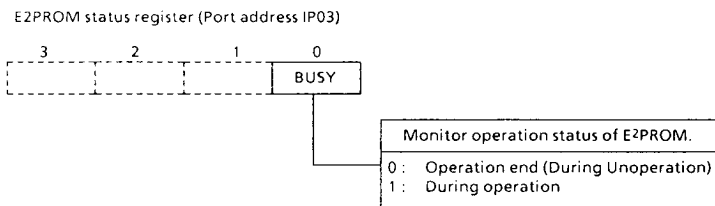


Figure 1-6. E2PROM status register

(6) Interrupt request selection register

The interrupt request selection register (OP0E) is a register used to select external interrupt (INT2) requests.

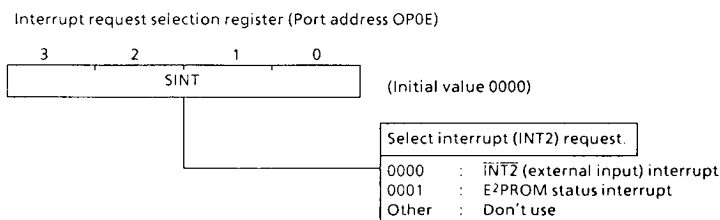


Figure 1-7. Interrupt request selection register

When SINT is "0", an interrupt is generated by an interrupt request from the $\overline{\text{INT2}}$ pin.

When SINT is "1", an interrupt is generated when E2PROM operation ends. (E2PROM status interrupt function)

SINT is switched when interrupt enable master F/F (EIF) or interrupt enable register (EIR) is "0" (inhibit).

1.3 Operation mode of E²PROM

E²PROM read operation is performed in real time, but it is necessary to wait during time set the built-in timer for erase or write operations. When the E²PROM is operating, the contents of the E²PROM command register, address register, write data register and interrupt request selection register cannot be changed. Thus, when changing the contents of these registers, it is necessary to either check that operation has ended using the E²PROM status register or the E²PROM status interrupt function.

The Erase, Write and Rewrite operations of the E²PROM can be executed during the normal mode.

(1) Read

When the E²PROM command register is set to the read mode, the data at the E²PROM specified by the address register are stored into the read data register.

The addresses must be loaded to the address register before read operation.

Example The contents at E²PROM address 2C_H are read, and are stored to location 30_H, 31_H in

```
RAM.
LD    A, #0CH          ; Set address of E2PROM
OUT   A, %OP12
LD    A, #2H
OUT   A, %OP13
OUT   #0001B, %OP03H ; Read operation
LD    HL, #30H         ; Store read data to RAM
IN    %IP0A, @HL
INC   L
IN    %IP0B, @HL
```

(2) Erase

Erasing clears the data in memory cells to "00_H".

① Byte Erase

When the E²PROM command register is set to the byte erase mode, the data at the E²PROM specified by the address register are erased.

The address must be loaded to the address register before byte erase operation.

Example The contents at location 1E_H in E²PROM are erased.

```
LD    A, #0EH          ; Set address of E2PROM
OUT   A, %OP12
LD    A, #1H
OUT   A, %OP13
OUT   #0100B, %OP03 ; Start byte erase operation.
```

② Chip Erase

When the E²PROM command register is set to the chip erase mode, all data at all Addresses of the E²PROM are erased as one batch.

Example All data at all Addresses of E²PROM are erased as one batch.

```
OUT   #1100B, %OP03 ; Start chip erase operation.
```

(3) Write

When the E2PROM command register is set to the write mode, the contents of the write data register are written to the E2PROM specified by the address register. (The data at the E2PROM specified the address register must be erased beforehand.)

Before writing, it is necessary to load the address to the address register and the write data to the write data register.

Example "5AH" is written at E2PROM address 32H.

```
LD    A, #2H          ; Set address of E2PROM
OUT   A, %OP12
LD    A, #3H
OUT   A, %OP13
OUT   #0AH, %OP0A     ; Set write data of E2PROM
OUT   #5H, %OP0B
LOOP : OUT #0100B, %OP03 ; Start byte erase operation
      TESTP %IP03, 0    ; Monitor operation status of E2PROM
      B      LOOP       ; Start write operation
      OUT   #0010B, %OP03
```

(4) Rewrite

When the E2PROM command register is set to the rewrite mode, the data at the E2PROM specified by the address register are erased and the contents of the write data register is written.

Before rewriting, it is necessary to load the address to the address register and the write data to the write data register.

Example Rewriting the data at E2PROM address 32H to "5AH."

```
LD    A, #2H          ; Set address of E2PROM
OUT   A, %OP12
LD    A, #3H
OUT   A, %OP13
OUT   #0AH, %OP0A     ; Set write data of E2PROM
OUT   #5H, %OP0B
OUT   #0110B, %OP03   ; Start rewrite operation
```


Note 1 : "—" means the reserved state. Unavailable for the user programs.

Note 2 : The 5-bit to 8-bit data conversion instruction [OUTB @HL], automatic access to ports P1 and P2.

Table 1-1 Port Address Assignments and Available I/O Instructions

ELECTRICAL CHARACTERISTICS

ABSOLUTE MAXIMUM RATINGS

(V_{SS} = 0V)

PARAMETER	SYMBOL	PINS	RATINGS	UNIT
Supply Voltage	V _{DD}		- 0.3 to 7	V
Supply Voltage (LCD drive)	V _{LC}		- 0.3 to V _{DD} + 0.3	V
Input Voltage	V _{IN}		- 0.3 to V _{DD} + 0.3	V
Output Voltage	V _{OUT1}	Except sink open drain pin	- 0.3 to V _{DD} + 0.3	V
	V _{OUT2}	Sink open drain pin	- 0.3 to 10	
Output Current (Per 1 pin)	I _{OUT1}	Ports P1, P2	15	mA
	I _{OUT2}	Ports R4 to R9	3.2	
Output Current (Total)	ΣI _{OUT1}	Ports P1, P2	60	mA
Power Dissipation [T _{opr} = 70°C]	PD		600	mW
Soldering Temperature (time)	T _{sld}		260 (10sec)	°C
Storage Temperature	T _{stg}		- 55 to 125	°C
Operating Temperature	T _{opr}		- 40 to 70	°C

RECOMMENDED OPERATING CONDITIONS

(V_{SS} = 0V, T_{opr} = - 40 to 70°C)

PARAMETER	SYMBOL	PINS	CONDITIONS	Min.	Max.	UNIT
Supply Voltage	V _{DD}		In the Normal mode	4.5	6.0	V
			In the SLOW mode	2.7		
			In the HOLD mode	2.0		
Input High Voltage	V _{IH1}	Except Hysteresis Input	V _{DD} ≥ 4.5V	V _{DD} × 0.7	V _{DD}	V
	V _{IH2}	Hysteresis Input		V _{DD} × 0.75		
	V _{IH3}		V _{DD} < 4.5V	V _{DD} × 0.9		
Input Low Voltage	V _{IL1}	Except Hysteresis Input	V _{DD} ≥ 4.5V	0	V _{DD} × 0.3	V
	V _{IL2}	Hysteresis Input			V _{DD} × 0.25	
	V _{IL3}		V _{DD} < 4.5V		V _{DD} × 0.1	
Clock Frequency	f _c	XIN, XOUT		0.4	6.0	MHz
	f _s	XTIN, XTOUT		30.0	34.0	KHz

Note. Input Voltage V_{IH3}, V_{IL3} : in the SLOW and HOLD mode.

D.C. CHARACTERISTICS

(V_{SS} = 0V, T_{opr} = -40 to 70°C)

PARAMETER	SYMBOL	PINS	CONDITIONS	Min.	Typ.	Max.	UNIT
Hysteresis Voltage	V _{H5}	Hysteresis Input		—	0.7	—	V
Input Current	I _{IN1}	Port K0, TEST, RESET, HOLD	V _{DD} = 5.5V,	—	—	± 2	μA
	I _{IN2}	Open drain R port	V _{IN} = 5.5V / 0V				
Input Low Current	I _{IL}	Push-pull R port	V _{DD} = 5.5V, V _{IN} = 0.4V	—	—	– 2	mA
Input Resistance	R _{IN1}	Port K0 with pull-up/pull-down		30	70	150	KΩ
	R _{IN2}	RESET		100	220	450	
Output Leakage Current	I _{LO}	Open drain ports P, R	V _{DD} = 5.5V, V _{OUT} = 5.5V	—	—	2	μA
Output High Voltage	V _{OH}	Push-pull R port	V _{DD} = 4.5V, I _{OH} = – 200μA	2.4	—	—	V
Output Low Voltage	V _{OL2}	Except XOUT XTOUT and ports P1, P2	V _{DD} = 4.5V, I _{OL} = 1.6mA	—	—	0.4	
Output Low Current	I _{OL1}	Ports P1, P2	V _{DD} = 4.5V, V _{OL} = 1.0V	—	10	—	mA
Segment Output Resistance	R _{OS}	SEG pin	V _{DD} = 5V, V _{DD} – V _{LC} = 3V	—	20	—	KΩ
Common Output Resistance	R _{OC}	COM pin					
Segment/Common Output Resistance	V _{O2/3}	SEG / COM pin		3.8	4.0	4.2	V
	V _{O1/2}			3.3	3.5	3.7	
	V _{O1/3}			2.8	3.0	3.2	
Supply Current (in the Normal mode)	I _{DD}		Except E2PROM operating V _{DD} = 5.5V, f _c = 4MHz	—	3	6	mA
	I _{DDF}		E2PROM operating V _{DD} = 5.5V, f _c = 4MHz	—	7	15	
Supply Current (in the SLOW mode)	I _{DD5}		V _{DD} = 3.0V, f _s = 32.768KHz	—	30	60	μA
Supply Current (in the HOLD mode)	I _{DDH}		V _{DD} = 5.5V	—	0.5	10	

Note 1. Typ. values show those at T_{opr} = 25°C, V_{DD} = 5V.

Note 2. Input Current I_{IN1} ; The current through resistor is not included, when the input resistor (pull-up/pull-down) is contained.

Note 3. Output Resistance R_{OS}, R_{OC} ; Shows on-resistance at the level switching.

Note 4. V_{O2/3} ; Shows 2/3 level output voltage, when the 1/4 or 1/3 duty LCD is used.

V_{O1/2} ; Shows 1/2 level output voltage, when the 1/2 duty or static LCD is used.

V_{O1/3} ; Shows 1/3 level output voltage, when the 1/4 or 1/3 duty LCD is used.

Note 5. Supply Current I_{DD} ; V_{IN} = 5.3V/0.2V

The K0 port is open when the input resistor is contained.

The voltage applied to the R port is within the valid range.

Note 6. Supply Current I_{DD5} ; V_{IN} = 2.8V/0.2V. Only low frequency clock is only osillated (connecting XTIN, XTOUT).

Note 7. Supply Current I_{DDF} ; Supply Current for a read operation only is specified with I_{DD}.

A.C. CHARACTERISTICS

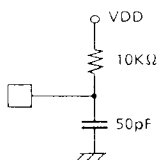
(V_{SS} = 0V, V_{DD} = 4.5 to 6.0V, T_{opr} = -40 to 70°C)

PARAMETER	SYMBOL	CONDITIONS	Min.	Typ.	Max.	UNIT
Instruction Cycle Time	t _{cy}	in the Normal mode	1.9	—	20	μs
		in the SLOW mode	235	—	267	μs
High Level Clock Pulse Width	t _{wCH}	For external clock operation	80	—	—	ns
Low Level Clock Pulse Width	t _{wCL}					
Shift data Hold Time	t _{SDH}		0.5t _{cy} - 300	—	—	ns
High Speed Timer/Counter input frequency	f _{HT}		—	—	f _c	MHz
E ² PROM Rewrite Cycle	N _{EW}		10 ⁴	—	—	cycles
E ² PROM Data Retention Time	t _{RET}		10	—	—	years

Note. Shift data Hold time :

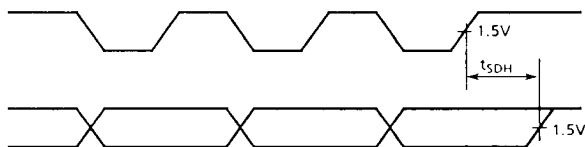
External circuit for SCK pin and SO pin

Serial port (completion of transmission)



SCK

SO



RECOMMENDED OSCILLATING CONDITIONS

(V_{SS} = 0V, V_{DD} = 4.5 to 6.0V, T_{opr} = -40 to 70°C)

(1) 6MHz

Ceramic Resonator

CSA6.00MGU

(MURATA)

C_{XIN} = C_{XOUT} = 30pF

KBR-6.00MS

(KYOCERA)

C_{XIN} = C_{XOUT} = 30pF

(2) 4MHz

Ceramic Resonator

CSA4.00MG

(MURATA)

C_{XIN} = C_{XOUT} = 30pF

KBR-4.00MS

(KYOCERA)

C_{XIN} = C_{XOUT} = 30pF

Crystal Oscillator

204B-6F 4.0000

(TOYOCOM)

C_{XIN} = C_{XOUT} = 20pF

(3) 400KHz

Ceramic Resonator

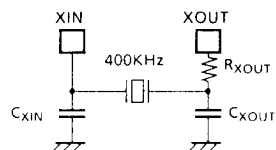
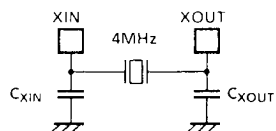
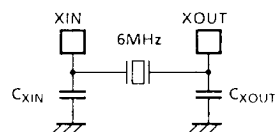
CSB400B

(MURATA)

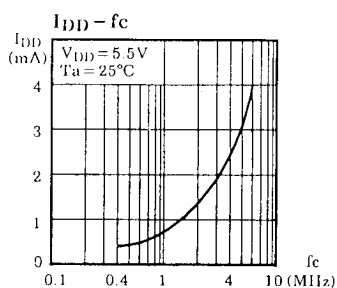
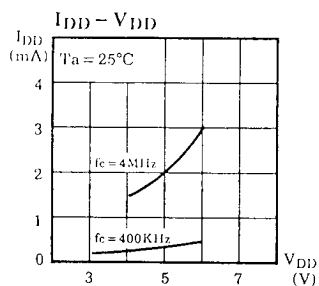
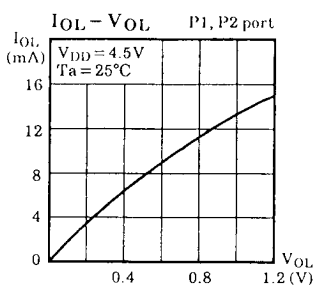
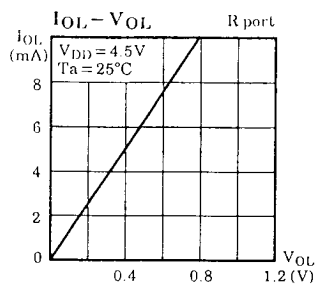
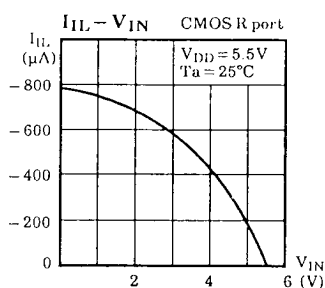
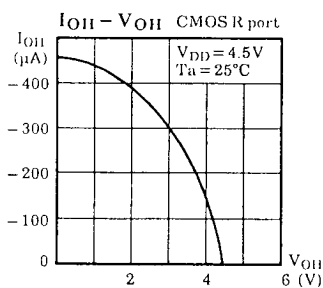
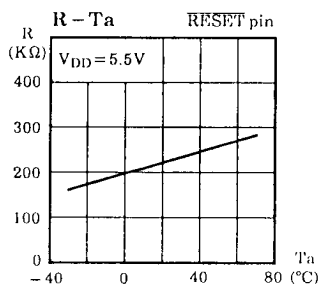
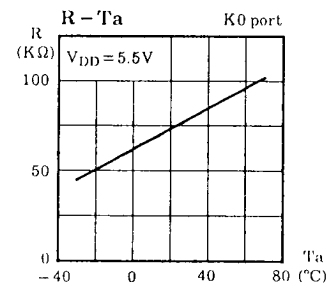
C_{XIN} = C_{XOUT} = 220pF, R_{XOUT} = 6.8KΩ

KBR-400B

(KYOCERA)

C_{XIN} = C_{XOUT} = 100pF, R_{XOUT} = 10KΩ

TYPICAL CHARACTERISTICS



INPUT/OUTPUT CIRCUITRY

(1) Control pins

The input/output circuitries of the 47CE820 control pins are similar to those of the 47C660/860.

(2) I/O Ports

The input/output circuitries of the 47CE820 I/O ports are shown as belows, any one of the circuitries can be chosen by a code (GA to GF) as a mask option.

PORT	I/O	INPUT/OUTPUT CIRCUITRY and CODE			REMARKS
		GA, GD	GB, GE	GC, GF	
K0	Input				Pull-up/pull-down resistor $R_{IN} = 70K\Omega$ (typ.) $R = 1K\Omega$ (typ.)
P1 P2	Output				Sink open drain output Initial "Hi-Z" High current $I_{OL} = 10mA$ (typ.)
R40 R41	I/O				Sink open drain output Initial "Hi-Z" (Hysteresis) = Input (HTC) $R = 1K\Omega$ (typ.)
R42 R43 R7	I/O				Sink open drain output Initial "Hi-Z" $R = 1K\Omega$ (typ.)
R6 R5	I/O	GA, GB, GC Initial "Hi-Z" 		GD, GE, GF Initial "High" 	Sink open drain output or Push-pull output $R = 1K\Omega$ (typ.)
R8 R9	I/O				Sink open drain output Initial "Hi-Z" Hysteresis input $R = 1K\Omega$ (typ.)