M37470E4-XXXSP
M37470E8-XXXSP

PROM VERSION of M37470M4-XXXSP,M37470M8-XXXSP

DESCRIPTION

The M37470E4-XXXSP is a single-chip microcomputer designed with CMOS silicon gate technology. It is housed in a 32-pin shrink plastic molded DIP. The features of this chip are similar to those of the M37470M4-XXXSP except that this chip has a 8192 bytes PROM built-in. This single-chip microcomputer is useful for home electrical appliances and consumer appliance controllers.

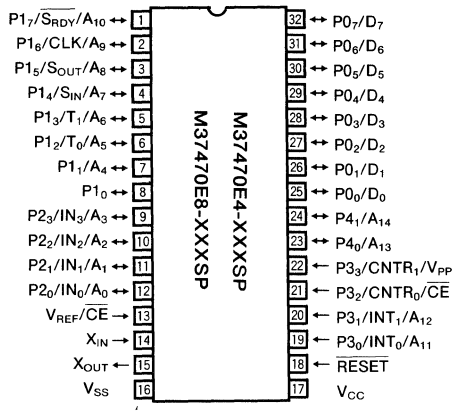
In addition to its simple instruction sets, the PROM, RAM, and I/O addresses are placed on the same memory map to enable easy programming. Since general purpose PROM writers can be used for the built-in PROM, this chip is suitable for small quantity production runs.

The differences between the M37470E4-XXXSP and the M37470E8-XXXSP are noted below. The following explanations apply to the M37470E4-XXXSP.

Specification variations for other chips are noted accordingly.

Type name	ROM size	RAM size
M37470E4-XXXSP	8192 bytes	192 bytes
M37470E8-XXXSP	16384 bytes	384 bytes

PIN CONFIGURATION (TOP VIEW)



Outline 32P4B

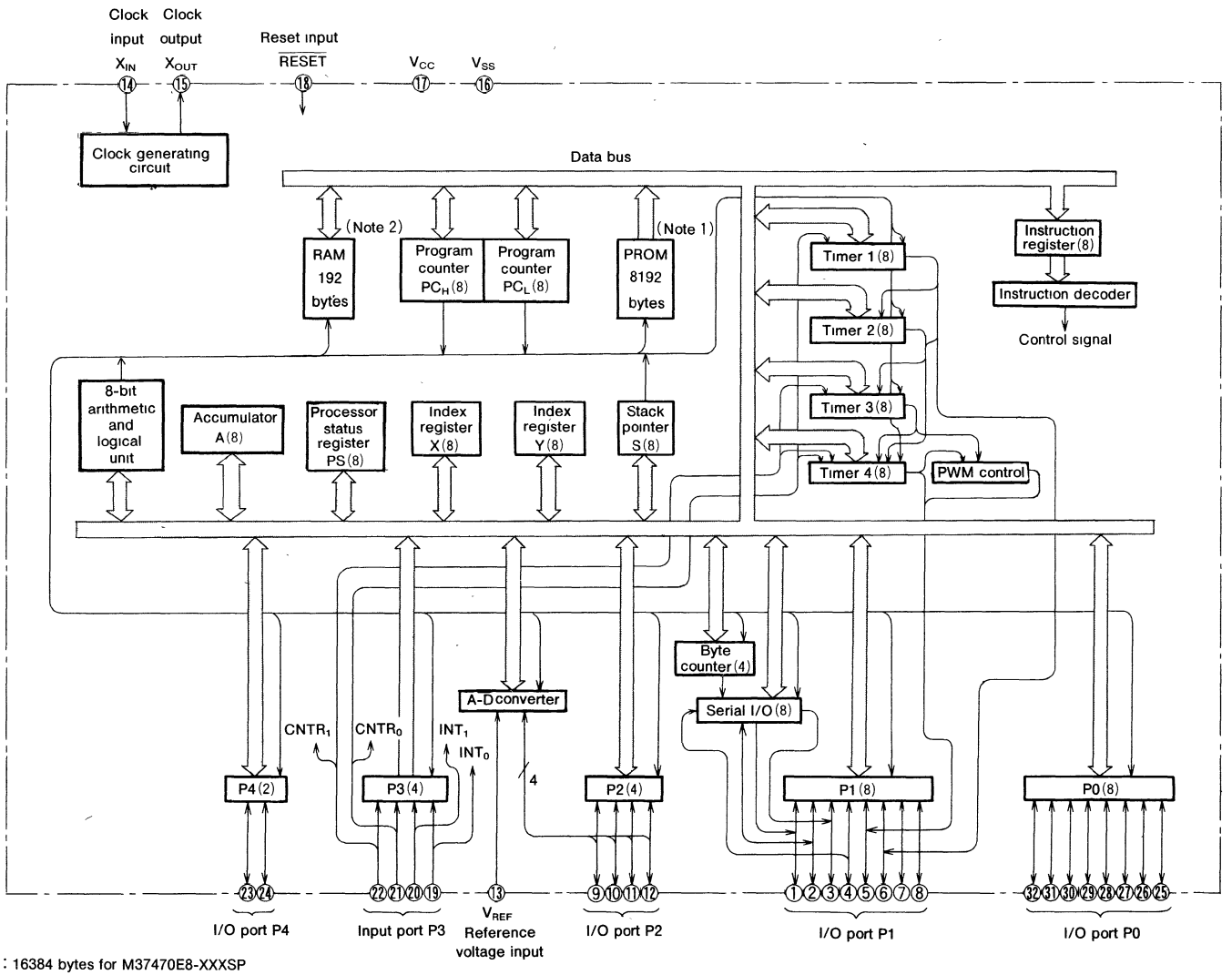
FEATURES

- Number of basic instructions 69
- Memory size PROM ..... 8192 bytes (M37470E4)
  16384 bytes (M37470E8)
  RAM ..... 192 bytes (M37470E4)
  384 bytes (M37470E8)
- Instruction execution time
  ..... 1μs (minimum instructions at 4MHz frequency)
- Single power supply ..... 2.7~5.5V
- Power dissipation
  normal operation mode (at 4MHz frequency) 17.5mW
- Subroutine nesting ..... 96 levels max. (M37470E4)
- Interrupt ..... 12 types, 10 vectors
- 8-bit timer 4
- Serial I/O ..... 8-bit×1
- Programmable I/O ports (Ports P0, P1, P2, P4) 22
- Input port (Port P3) 4
- A-D converter 8-bit, 4-channel
- PROM (equivalent to the M5L27256)
  program voltage 12.5V

APPLICATION

Office automation equipment, VCR, Tuner, Audio-visual equipment

M37470E4-XXXSP BLOCK DIAGRAM



Note 1 : 16384 bytes for M37470E8-XXXSP
2 : 384 bytes for M37470E8-XXXSP

FUNCTIONS OF M37470E4-XXXSP, M37470E8-XXXSP

Parameter			Functions
Number of basic instructions			69
Instruction execution time			1μs (minimum instructions, at 4MHz frequency)
Clock frequency			4MHz (max.)
Memory size	M37470E4-XXXSP	PROM	8192 bytes (Note 1)
		RAM	192 bytes
	M37470E8-XXXSP	PROM	16384 bytes (Note 1)
		RAM	384 bytes
Input/Output port	P0, P1	I/O	8-bit×2
	P2	I/O	4-bit×1
	P3	Input	4-bit×1
	P4	I/O	2-bit×1
Serial I/O			8-bit×1
Timers			8-bit timer×4
A-D converter			8-bit×1 (4channel)
Subroutine nesting	M37470E4-XXXSP		96 levels (max.)
	M37470E8-XXXSP		192 levels (max.)
Interrupt			Five external interrupts, six internal interrupts, one software interrupt
Clock generating circuit			Built-in with internal feedback resistor (ceramic or quartz crystal oscillator)
Supply voltage			2.7~5.5V
Power dissipation			17.5mW (at f(X_{IN})=4MHz)
Input/Output characteristics	Input/Output voltage		5V
	Output current		−5~10mA (ports P0, P1, P2, P4 CMOS tri-state output)
Operating temperature range			−20~85°C
Device structure			CMOS Silicon gate
Package			32-pin shrink plastic molded DIP

Note 1 : The PROM programming voltage is 12.5V (equivalent to the M5L27256).

PIN DESCRIPTION

Pin	Mode	Name	Input/ Output	Functions
V_{CC}, V_{SS}	Single-chip /EPROM	Supply voltage		Power supply inputs 2 7~5.5V to V_{CC} and 0V to V_{SS}
$\overline{RESET}$	Single-chip	RESET input	Input	To reset, keep this input terminal low for more than 2μs (min) under normal V_{CC} conditions.
	EPROM	RESET input		Connect to V_{SS}
X_{IN}	Single-chip /EPROM	Clock input	Input	Connect a ceramic or a quartz crystal oscillator between X_{IN} and X_{OUT} for clock oscillation If an external clock input is used, connect the clock input to the X_{IN} pin and open the X_{OUT} pin Feedback resistor is connected between the X_{IN} and X_{OUT} pins
X_{OUT}		Clock output	Output	
$P0_0$~$P0_7$	Single-chip	I/O port P0	I/O	Port P0 is an 8-bit I/O port The output structure is CMOS output When this port is selected for input, pull-up transistor can be connected in units of 1-bit and a key on wake up function is provided
	EPROM	Data input/output D_0~D_7	I/O	Port P0 works as an 8-bit data bus (D_0~D_7)
$P1_0$~$P1_7$	Single-chip	I/O port P1	I/O	Port P1 is an 8-bit I/O port The output structure is CMOS output When this port is selected for input, pull-up transistor can be connected in units of 4-bit $P1_2$, $P1_3$ are in common with timer output pins T_0, T_1 $P1_4$, $P1_5$, $P1_6$, $P1_7$ are in common with serial I/O pins S_{IN}, S_{OUT}, CLK, $\overline{S_{RDY}}$, respectively The output structure of S_{OUT} and $\overline{S_{RDY}}$ can be changed to N-channel open drain output
	EPROM	Address input A_4~A_{10}	Input	$P1_1$~$P1_7$ works as the 7-bit address input (A_4~A_{10}) $P1_0$ must be opened.
$P2_0$~$P2_3$	Single-chip	I/O port P2	I/O	Port P2 is an 4-bit I/O port. The output structure is CMOS output When this port is selected for input, pull-up transistor can be connected in units of 4-bit This port is in common with analog input pins IN_0~IN_3.
	EPROM	Address input A_0~A_3	Input	Port P2 works as the lower 4-bit address input (A_0~A_3)
$P3_0$~$P3_3$	Single-chip	Input port P3	Input	Port P3 is an 4-bit input port $P3_0$, $P3_1$ are in common with external interrupt input pins INT_0, INT_1 and $P3_2$, $P3_3$ are in common with timer input pins $CNTR_0$, $CNTR_1$
	EPROM	Address input A_{11}, A_{12} Select mode V_{PP} input	Input	$P3_0$, $P3_1$ works as the 2-bit address input (A_{11}, A_{12}) $P3_2$ works as $\overline{OE}$ input Connect to $P3_3$ to V_{PP} when programming or verifing
$P4_0$, $P4_1$	Single-chip	I/O port P4	I/O	Port P4 is an 2-bit I/O port The output structure is CMOS output When this port is selected for input, pull-up transistor can be connected in units of 2-bit
	EPROM	Address input A_{13}, A_{14}	Input	Port P4 works as the higher 2-bit address input (A_{13}, A_{14})
V_{REF}	Single-chip	Reference voltage input	Input	This is the reference voltage input pin for the A-D converter
	EPROM	Select mode	Input	V_{REF} works as $\overline{CE}$ input

EPROM MODE

The M37470E4-XXXSP, M37470E8-XXXSP feature an EPROM mode in addition to its normal modes. When the $\overline{\text{RESET}}$ signal level is low ("L"), the chip automatically enters the EPROM mode. Table 1 list the correspondence between pins and Figure 1 gives the pin connection in the EPROM mode. When in the EPROM mode, ports P0, $P1_1$~$P1_7$, P2, P3, P4, V_{REF} are used for the PROM (equivalent to the M5L27256). When in this mode, the built-in PROM can be written to or read from using these pins in the same way as with the M5L27256. The oscillator should be connected to the X_{IN} and X_{OUT} pins, or external clock should be connected to the X_{IN} pin.

Table 1. Pin function in EPROM mode

	M37470E4-XXXSP, M37470E8-XXXSP	M5L27256
V_{CC}	V_{CC}	V_{CC}
V_{PP}	$P3_3$	V_{PP}
V_{SS}	V_{SS}	V_{SS}
Address input	Ports $P1_1$~$P1_7$, $P2_0$~$P2_3$ $P3_0$, $P3_1$, $P4_0$, $P4_1$	A_0~A_{14}
Data I/O	Port P0	D_0~D_7
$\overline{CE}$	V_{REF}	$\overline{CE}$
$\overline{OE}$	$P3_2$	$\overline{OE}$

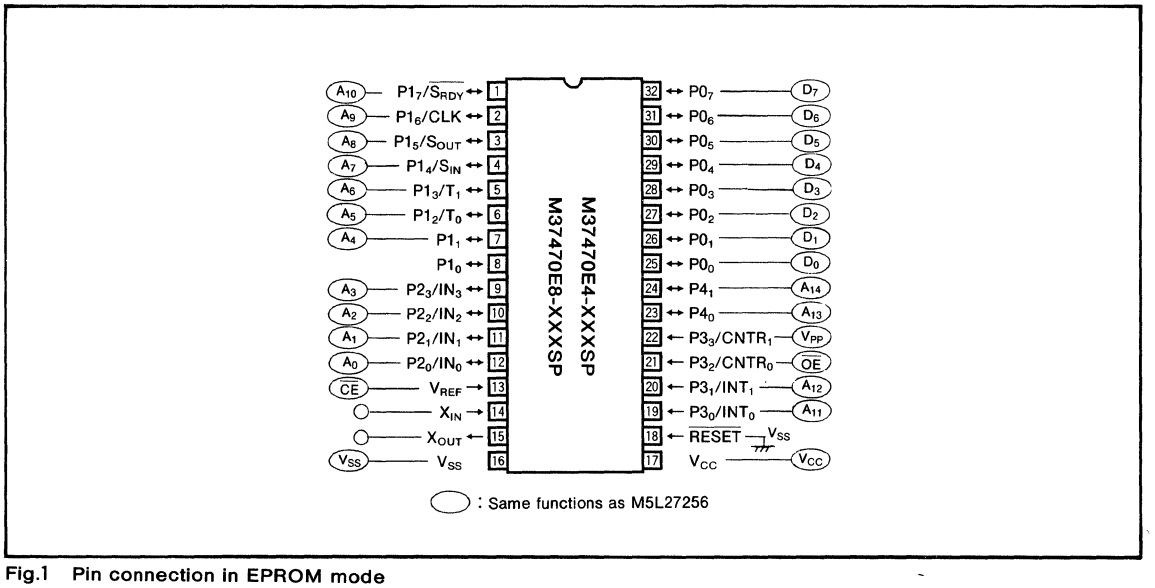


Fig.1 Pin connection in EPROM mode

MITSUBISHI ELECTRIC

PROM READING AND WRITING

Reading

To read the PROM, set the $\overline{CE}$ and $\overline{OE}$ pins to a "L" level. Input the address of the data ($A_0 \sim A_{14}$) to be read and the data will be output to the I/O pins $D_0 \sim D_7$. The data I/O pins will be floating when either the $\overline{CE}$ or $\overline{OE}$ pin is in the "H" state.

Writing

To write to the PROM, set the $\overline{OE}$ pin to a "H" level. The CPU will enter the program mode when V_{PP} is applied to the V_{PP} pin. The address to be written to is selected with pins $A_0 \sim A_{14}$, and the data to be written is input to pins $D_0 \sim D_7$. Set the $\overline{CE}$ pin to a "L" level to begin writing.

Notes on Writing

- M37470E4-XXXSP

  When using a PROM writer, the address range should be between 6000_{16} and $7FFF_{16}$. Read/write operations on addresses 0000_{16} to $5FFF_{16}$ cannot be performed correctly.

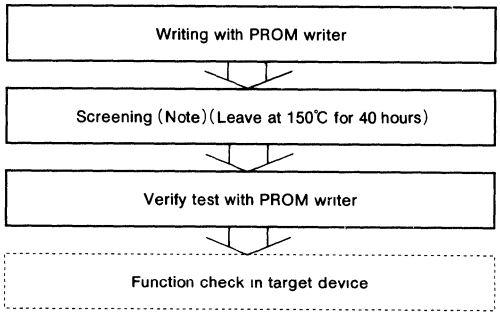
- M37470E8-XXXSP

  When using a PROM writer, the address range should be between 4000_{16} and $7FFF_{16}$. When data is written between addresses 0000_{16} and $7FFF_{16}$, fill addresses 0000_{16} to $3FFF_{16}$ with FF_{16}.

NOTES ON HANDLING

(1) Since a high voltage (12.5V) is used to write data, care should be taken when turning on the PROM writer's power.

(2) For the programmable microcomputer (shipped in blank or OTP type), Mitsubishi does not perform PROM write test and screening in the assembly process and following processes. To improve reliability after write, performing write and test according to the flow below before use is recommended.



Note : Since the screening temperature is higher than storage temperature, never expose to 150℃ exceeding 100 hours.

Table 2. I/O signal in each mode

Mode \ Pin	$\overline{CE}$(13)	$\overline{OE}$(21)	V_{PP}(22)	V_{CC}(17)	Data I/O (25~32)
Read-out	V_{IL}	V_{IL}	V_{CC}	V_{CC}	Output
Output disable	V_{IL}	V_{IH}	V_{CC}	V_{CC}	Floating
Programming	V_{IL}	V_{IH}	V_{PP}	V_{CC}	Input
Programming verify	V_{IH}	V_{IL}	V_{PP}	V_{CC}	Output
Program disable	V_{IH}	V_{IH}	V_{PP}	V_{CC}	Floating

Note 1 : V_{IL} and V_{IH} indicate a "L" and "H" input voltage, respectively

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage	With respect to V_{SS} Output transistors are at "OFF" state	−0.3∼7	V
V_I	Input voltage X_{IN}		−0.3∼V_{CC}+0.3	V
V_I	Input voltage $P0_0$∼$P0_7$, $P1_0$∼$P1_7$, $P2_0$∼$P2_3$, $P3_0$∼$P3_3$, $P4_0$, $P4_1$, V_{REF}, $\overline{RESET}$		−0.3∼V_{CC}+0.3 (Note 1)	V
V_O	Output voltage $P0_0$∼$P0_7$, $P1_0$∼$P1_7$, $P2_0$∼$P2_3$, $P4_0$, $P4_1$, X_{OUT}		−0.3∼V_{CC}+0.3	V
Pd	Power dissipation	T_a = 25℃	1000	mW
Topr	Operating temperature		−20∼85	℃
Tstg	Storage temperature		−40∼150	℃

Note 1 : In EPROM programming mode, $P3_3$ is 13V

RECOMMENDED OPERATING CONDITIONS

(V_{CC}=2.7∼5.5V, V_{SS}=0V, Ta=−20∼85℃ unless otherwise noted)

Symbol	Parameter	Limits			Unit
		Min	Typ	Max.	
V_{CC}	Supply voltage	2.7	5	5.5	V
V_{SS}	Supply voltage		0		V
V_{IH}	"H" Input voltage $P0_0$∼$P0_7$, $P1_0$∼$P1_7$, $P3_0$∼$P3_3$, $\overline{RESET}$, X_{IN}	0.8V_{CC}		V_{CC}	V
V_{IH}	"H" Input voltage $P2_0$∼$P2_3$, $P4_0$, $P4_1$	0.7V_{CC}		V_{CC}	V
V_{IL}	"L" Input voltage $P0_0$∼$P0_7$, $P1_0$∼$P1_7$, $P3_0$∼$P3_3$	0		0.2V_{CC}	V
V_{IL}	"L" Input voltage $P2_0$∼$P2_3$, $P4_0$, $P4_1$	0		0.25V_{CC}	V
V_{IL}	"L" Input voltage $\overline{RESET}$	0		0.12V_{CC}	V
V_{IL}	"L" Input voltage X_{IN}	0		0.16V_{CC}	V
$I_{OH(sum)}$	"H" sum output current $P0_0$∼$P0_7$, $P4_0$, $P4_1$			−30	mA
$I_{OH(sum)}$	"H" sum output current $P1_0$∼$P1_7$, $P2_0$∼$P2_3$			−30	mA
$I_{OL(sum)}$	"L" sum output current $P0_0$∼$P0_7$, $P4_0$, $P4_1$			60	mA
$I_{OL(sum)}$	"L" sum output current $P1_0$∼$P1_7$, $P2_0$∼$P2_3$			60	mA
$I_{OL(peak)}$	"L" peak output current $P0_0$∼$P0_7$, $P1_0$∼$P1_7$, $P2_0$∼$P2_3$, $P4_0$, $P4_1$			20	mA
$I_{OL(avg)}$	"L" average output current $P0_0$∼$P0_7$, $P1_0$∼$P1_7$, $P2_0$∼$P2_3$, $P4_0$, $P4_1$ (Note 2)			10	mA
$I_{OH(peak)}$	"H" peak output current $P0_0$∼$P0_7$, $P1_0$∼$P1_7$, $P2_0$∼$P2_3$, $P4_0$, $P4_1$			−10	mA
$I_{OH(avg)}$	"H" average output current $P0_0$∼$P0_7$, $P1_0$∼$P1_7$, $P2_0$∼$P2_3$, $P4_0$, $P4_1$ (Note 2)			−5	mA
$f_{(CNTR)}$	Timer input frequency $CNTR_0$ ($P3_2$), $CNTR_1$ ($P3_3$) (Note 1)			1	MHz
$f_{(CLK)}$	Serial I/O clock input frequency CLK ($P1_6$) (Note 1)			1	MHz
$f(X_{IN})$	Clock oscillating frequency (Note 1)			4	MHz

Note 1 : Oscillation frequency is at 50% duty cycle.
2 : The average output current $I_{OH(avg)}$ and $I_{OL(avg)}$ are the average value during a 100ms

ELECTRICAL CHARACTERISTICS (V_{CC}=2.7~5.5V, V_{SS}=0V, T_a=−20~85℃, unless otherwise noted)

Symbol	Parameter	Test Conditions		Limits Min	Limits Typ	Limits Max	Unit
V_{OH}	"H" output voltage $P0_0$~$P0_7$, $P1_0$~$P1_7$, $P2_0$~$P2_3$, $P4_0$, $P4_1$	V_{CC}=5V, I_{OH}=−5mA		3			V
		V_{CC}=3V, I_{OH}=−1.5mA		2			
V_{OL}	"L" output voltage $P0_0$~$P0_7$, $P1_0$~$P1_7$, $P2_0$~$P2_3$, $P4_0$, $P4_1$	V_{CC}=5V, I_{OL}=10mA				2	V
		V_{CC}=3V, I_{OL}=3mA				1	
$V_{T+}-V_{T-}$	Hysteresis $P0_0$~$P0_7$, $P3_0$~$P3_3$	V_{CC}=5V			0.5		V
		V_{CC}=3V			0.3		
$V_{T+}-V_{T-}$	Hysteresis $\overline{RESET}$	V_{CC}=5V			0.5		V
		V_{CC}=3V			0.3		
$V_{T+}-V_{T-}$	Hysteresis $P1_6$/CLK	use as CLK input	V_{CC}=5V		0.5		V
			V_{CC}=3V		0.3		
I_{IL}	"L" input current $P0_0$~$P0_7$, $P1_0$~$P1_7$, $P3_0$~$P3_2$, $P4_0$, $P4_1$	V_I=0V, not use pull-up transistor	V_{CC}=5V			−5	μA
			V_{CC}=3V			−3	
		V_I=0V, use pull-up transistor	V_{CC}=5V	−0.25	−0.5	−1.0	mA
			V_{CC}=3V	−0.08	−0.18	−0.35	
I_{IL}	"L" input current $P3_3$	V_I=0V	V_{CC}=5V			−5	μA
			V_{CC}=3V			−3	
I_{IL}	"L" input current $P2_0$~$P2_3$	V_I=0V, not use as analog input, not use pull-up transistor	V_{CC}=5V			−5	μA
			V_{CC}=3V			−3	
		V_I=0V, not use as analog input, use pull-up transistor	V_{CC}=5V	−0.25	−0.5	−1.0	mA
			V_{CC}=3V	−0.08	−0.18	−0.35	
I_{IL}	"L" input current $\overline{RESET}$, X_{IN}	V_I=0V (X_{IN} is at stop mode)	V_{CC}=5V			−5	μA
			V_{CC}=3V			−3	
I_{IH}	"H" input current $P0_0$~$P0_7$, $P1_0$~$P1_7$, $P3_0$~$P3_2$, $P4_0$, $P4_1$	V_I=V_{CC}, not use pull-up transistor	V_{CC}=5V			5	μA
			V_{CC}=3V			3	
I_{IH}	"H" input current $P3_3$	V_I=V_{CC}	V_{CC}=5V			5	μA
			V_{CC}=3V			3	
I_{IH}	"H" input current $P2_0$~$P2_3$	V_I=V_{CC}, not use as analog input, not use pull-up transistor	V_{CC}=5V			5	μA
			V_{CC}=3V			3	
I_{IH}	"H" input current $\overline{RESET}$, X_{IN}	V_I=V_{CC}, (X_{IN} is at stop mode)	V_{CC}=5V			5	μA
			V_{CC}=3V			3	
I_{CC}	Supply current	At normal operation, A-D conversion is not executed, X_{IN}=4MHz	V_{CC}=5V		3.5	7	mA
			V_{CC}=3V		1.8	3.6	
		At normal operation, A-D conversion is executed, X_{IN}=4MHz	V_{CC}=5V		4	8	
			V_{CC}=3V		2	4	
		At wait mode, X_{IN}=4MHz	V_{CC}=5V		1	2	
			V_{CC}=3V		0.5	1	
		Stop all oscillation, V_{CC}=5V	T_a=25℃		0.1	1	μA
			T_a=85℃		1	10	
V_{RAM}	RAM retention voltage	Stop all oscillation		2			V

A-D CONVERTER CHARACTERISTICS (V_{CC}=2.7~5.5V, V_{SS}=0V, T_a=−20~85℃, f(X_{IN})=4MHz, unless otherwise noted)

Symbol	Parameter	Test Conditions	Limits Min	Limits Typ	Limits Max	Unit
—	Resolution				8	bits
—	Non-linearity error				±2	LSB
—	Differential non-linearity error				±0.9	LSB
V_{OT}	Zero transition error	V_{CC}=V_{REF}=5.12V, $I_{OL(sum)}$=0mA			2	LSB
		V_{CC}=V_{REF}=3.072V, $I_{OL(sum)}$=0mA			3	
V_{FST}	Full-scale transition error	V_{CC}=V_{REF}=5.12V			4	LSB
		V_{CC}=V_{REF}=3.072V			7	
t_{CONV}	Conversion time				25	μs
V_{VREF}	Reference input voltage		0.5V_{CC}		V_{CC}	V
R_{LADDER}	Ladder resistance value		2	5	10	kΩ
V_{IA}	Analog input voltage		0		V_{REF}	V