

### 1. General Description

This OTP-Based 8-bit micro-controller uses a fully static CMOS technology process to achieve higher speed and smaller size with the low power consumption and high noise immunity. On chip memory includes 4K words of EPROM, and 192 bytes of static RAM.

### 2. Features

- ◆ RISC CPU
- ◆ Fully static design
- ◆ 37 single word instructions
- ◆ 4K x 14 program memory.
- ◆ 192 bytes RAM for data
- ◆ 35 bi-directional I/O
- ◆ Eight level hardware stacks
- ◆ Watchdog timer with on-chip RC oscillator.
- ◆ Interrupt capability
- ◆ Timer0 : 8-bit timer with 8-bit prescaler
- ◆ Timer1 : 8-bit timer with 8-bit compare register. This timer can be used as carrier generator.
- ◆ Sleep mode for power saving.
- ◆ PB and PD with port change wake-up interrupt.

### 3. Applications

The application areas of this MDT10P65 range from appliance motor control and high speed automotive to low power remote transmitters/receivers and telecommunications processors, such as Remote controller, small instruments, toy, automobile and keyboard ... etc.

PS : timer1 counter PC0 clock in low to high the counter data increase

4. Pin Diagram

MDT10P65 28 pin DIP/SOP

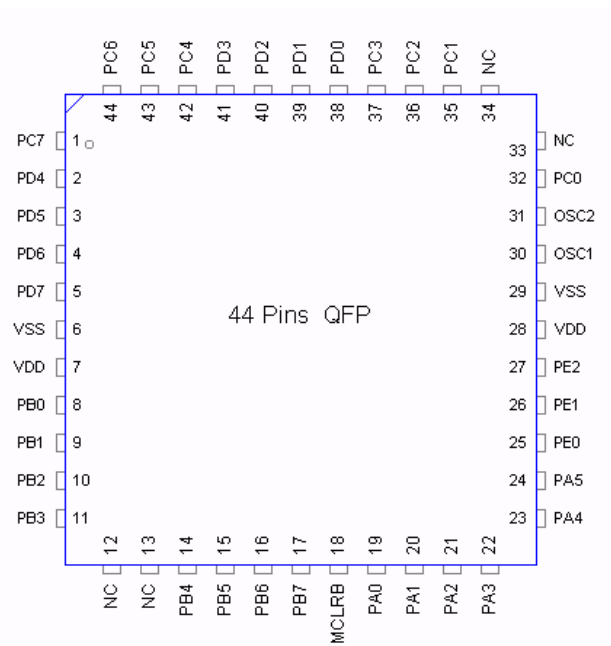
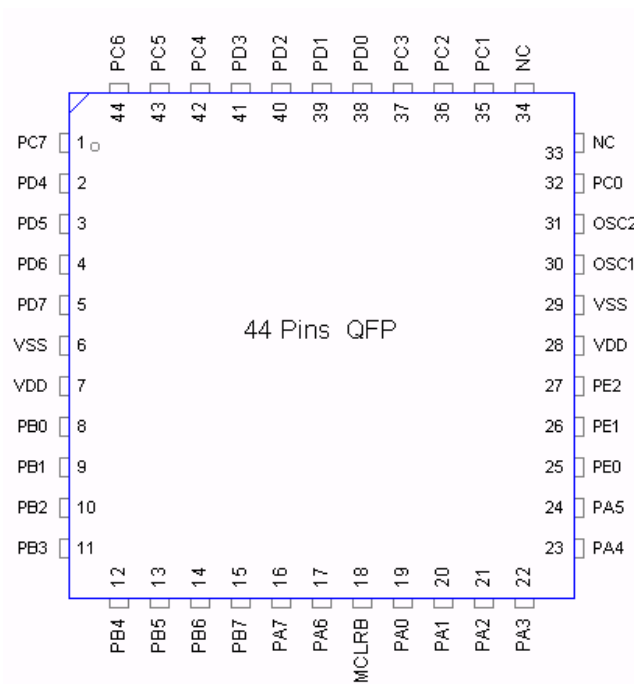
/RES	1	28	PB7
PA0	2	27	PB6
PA4/TOCLK	3	26	PB5
PE0	4	25	PB4
PE1	5	24	PB3
PE2	6	23	PB2
VSS	7	22	PB1
OSC1	8	21	PB0/IRQ
OSC2	9	20	VDD
PC0/T1OSC0	10	19	PD7
PC1/T1OSC1	11	18	PD6
PD0	12	17	PD5
PD1	13	16	PD4
PD2	14	15	PD3

MDT10P65SD42 pin Shrink PDIP

PA6	1	42	PA7
/RES	2	41	PB7
PA0	3	40	PB6
PA1	4	39	PB5
PA2	5	38	PB4
PA3	6	37	PB3
PA4/TOCLK	7	36	PB2
PA5	8	35	PB1
PE0	9	34	PB0/IRQ
PE1	10	33	VDD
PE2	11	32	VSS
VDD	12	31	PD7
VSS	13	30	PD6
OSC1	14	29	PD5
OSC2	15	28	PD4
PC0/T1OSCO	16	27	PC7
PC1/T1OSCI	17	26	PC6
PC2	18	25	PC5
PC3	19	24	PC4
PD0	20	23	PD3
PD1	21	22	PD2

MDT10P65A1Q

MDT10P65A2Q



### 5. Pin function description

Pin name	Type	Buffer type	Description
OSC1	I		Oscillator input
OSC2	O		Oscillator out
/RES(MCLR)	I	ST	Reset input with 130K ohm pull-up
PA0 PA1 PA2 PA3 PA4 PA5 PA6 PA7	I/O I/O I/O I/O I/O I/O I/O I/O	TTL TTL TTL TTL ST TTL TTL TTL	Bi-directional I/O port A. Port A can be software programmed for internal 45K ohm pull-up on all pins except PA5. The pull-up resistance on PA5 is 100K ohm.  Can be clock input to Timer0.
PB0/IQR PB1 PB2 PB3 PB4 PB5 PB6 PB7	I/O I/O I/O I/O I/O I/O I/O I/O	ST/TTL TTL TTL TTL TTL TTL TTL TTL	Bi-directional I/O port B. Port B can be software programmed for internal 25K ohm pull-up on all pins. PB0-PB7 can generate interrupt on pin state change. Can be the external interrupt pin.
PC0 PC1 PC2 PC3 PC4 PC5 PC6 PC7	I/O I/O I/O I/O I/O I/O I/O I/O	ST ST ST ST ST ST ST ST	Bi-directional I/O port C. Port C can be software programmed for internal 100K pull-up on all pins. Can be Timer1 oscillator output or Timer1 clock input. Can be Timer1 oscillator input.
PD0-PD7	I/O	ST	Bi-directional port. All pins can generate interrupt on pin state change. Port D can be software programmed for internal 100K pull-up on all pins.
PE0 PE1 PE2	I/O I/O I/O	ST ST ST	Bi-directional port E. Port E can be software programmed for internal 100K pull-up on all pins.
Vdd			Power input
Vss			Ground pin

**6. Memory Mapping**

6.1 Program memory :

0000h	Reset Vector
0001h	
0002h	
0003h	
0004h	Peripheral interrupt Vector
0005h	Program memory (Page 0)
07FFh	
0800h	
0FFFh	
	Program memory (Page 1)

6.2 Register file map :

	BANK 0	BANK 1		
00h	IAR	IAR	80h	
01h	RTCC	TMR	81h	
02h	PCL	PCL	82h	
03h	STATUS	STATUS	83h	
04h	MSR	MSR	84h	
05h	PORT A	CPIO A	85h	
06h	PORT B	CPIO B	86h	
07h	PORT C	CPIO C	87h	
08h	PORT D	CPIO D	88h	
09h	PORT E	CPIO E	89h	
0Ah	PCH	PCH	8Ah	
0Bh	INTS	INTS	8Bh	
0Ch	PIFB1	PIEB1	8Ch	
0Dh	PIFB2	PIEB2	8Dh	
0Eh	TMR1L	PSTA	8Eh	
0Fh			8Fh	
10h	T1STA	PPHE	90h	
11h			91h	
12h			92h	
13h			93h	
14h			94h	
15h	CCP1L		95h	
16h			96h	
17h	CCP1CTL		97h	
18h			98h	
1Fh			9Fh	
20h	General Purpose Register	General Purpose Register	A0h	
7Fh				

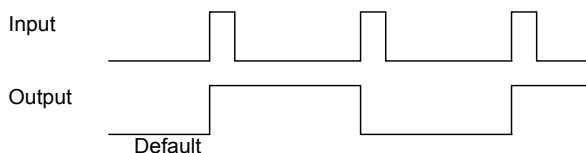
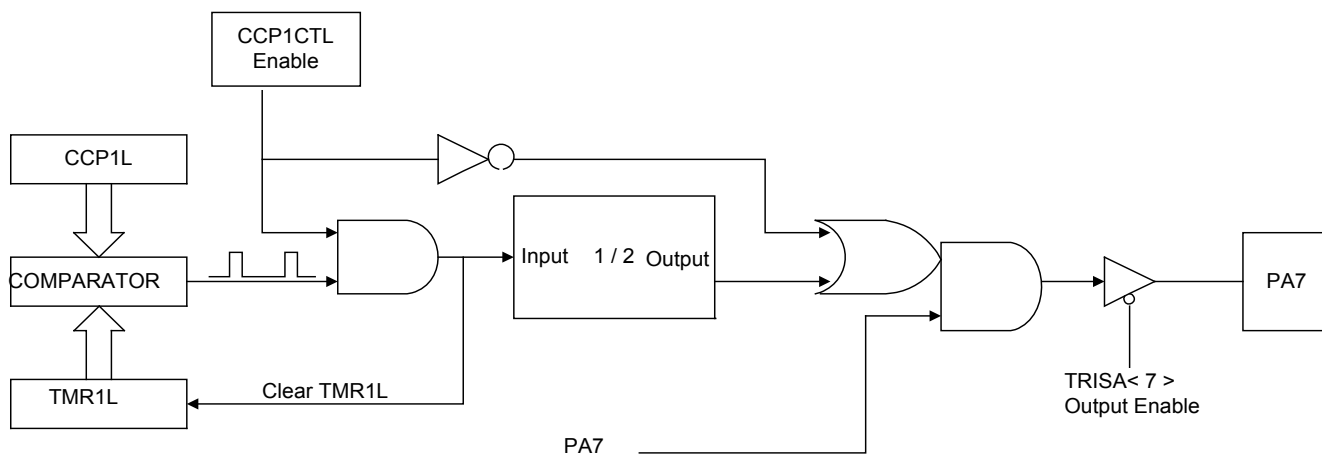
■ Unimplemented memory location.

- 00 Indirect addressing register
- 01 Timer0 register
- 02 Program counter low byte
- 03 Status register
  - Bit 0 : Carry
  - 1 : Digit carry
  - 2 : Zero flag
  - 3 : Power-down
  - 4 : WDT time-out
  - 5 : Register bank select (For direct addressing)
    - =0 Bank 0 (00h-7Fh)
    - =1 Bank 1 (80h-FFh)
  - 7-6 : Always read as zero.
- 04 Memory select register
- 05 Port A data register
- 06 Port B data register
- 07 Port C data register
- 08 Port D data register
- 09 Port E data register
  - Bit 2-0 – Port E data register.
  - 7-3 – Unimplemented. Always set as 0.
- 0A Program memory segment register
- 0B Interrupt control register
  - Bit 0 – PB port change interrupt flag bit.
  - 1 – PB0/IRQ external interrupt flag bit.
  - 2 – Timer0 overflow interrupt flag bit.
  - 3 – PB port change interrupt enable bit.
  - 4 – PB0/IRQ external interrupt enable bit.
  - 5 – Timer0 overflow interrupt enable bit.
  - 6 – Peripheral interrupt enable bit.
  - 7 – Global interrupt enable bit.
- 0C Peripheral interrupt flag register 1.
  - Bit 0 – Timer1 overflow interrupt flag bit
  - 7-1 – Unimplemented. Always read as 0.
- 0D Peripheral interrupt flag register 2.
  - Bit 6-0 – Unimplemented. Read as zero.
  - 7 – PD port change interrupt flag bit
- 0E Timer1 data register low byte.

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- 0F Unimplemented..
- 10 Timer1 control register  
Bit 0 – Timer1 enable bit  
1 – Timer1 clock source select  
2 – Timer 1 external clock synchronization control bit  
3 – Timer 1 oscillator enable control bit  
5-4 – Timer 1 prescaler select bits  
7-6 – Unimplemented. Always read as 0.
- 11-14 Unimplemented.
- 15 Timer1 compare register
- 16 Unimplemented.
- 17 Timer1 compare control register  
Bit 7-1 –Unimplemented. Always set as 0.  
0 – compare enable bit
- 18-1F Unimplemented.
- 20-7F General purpose register
- 80 Same as register 00.
- 81 TMR register  
Bit 2-0 – Prescaler rate select bits  
3 – Prescaler assign bit  
4 – Timer 0 edge select bit  
5 – Timer 0 clock source select bit  
6 – PB0/IRQ interrupt edge select bit  
7 – Port B pull-up enable bit.
- 82-84 Same as 02H-04H.
- 85 Port A data direction register.
- 86 Port B data direction register.
- 87 Port C data direction register.
- 88 Port D data direction register.
- 89 Port E data direction register.  
Bit 2-0 – Port E data direction register.  
7-3 – Unimplemented. Always set as 0.
- 8A -8B Same as 0AH-0BH.
- 8C Peripheral interrupt control register 1.  
Bit 0 – Timer1 overflow interrupt enable bit.  
7-1 – Unimplemented. Always set these bits to 0.
- 8D Peripheral interrupt control register 2  
Bit 6-0 – Unimplemented.  
7 – PD port change interrupt enable bit.
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- 8E Power control register.
  - Bit 0 – Unimplemented. Always read as 0.
  - 1 – Power-on reset status bit.
  - 7-2 – Unimplemented. Always read as 0.
- 8F Unimplemented.
- 90 PPHE register . ( “ 0 ” Enable ; “ 1 ” Disable )
  - Bit 0-3 – Unimplemented.
  - 4 – PA port pull-up enable bit.
  - 5 – PC port pull-up enable bit.
  - 6 – PD port pull-up enable bit.
  - 7 – PE port pull-up enable bit.
- 91-9F Unimplemented.
- A0-FF General purpose register.

### 7. Timer1 CCP Mode



**8. Reset Condition for all Registers**

Register	Address	Power-On Reset, Power range detector Reset	/MCLR or WDT Reset	Wake-up from SLEEP
IAR	00h(80h)	0000 0000	0000 0000	uuuu uuuu
RTCC	01h	xxxx xxxx	uuuu uuuu	uuuu uuuu
PCL	02h(82h)	0000 0000	0000 0000	0000 0100
STATUS	03h(83h)	0001 1xxx	000# #uuu	000# #uuu
MSR	04h(84h)	xxxx xxxx	uuuu uuuu	uuuu uuuu
PORT A	05h	xxxx xxxx	uuuu uuuu	uuuu uuuu
PORT B	06h	xxxx xxxx	uuuu uuuu	uuuu uuuu
PORT C	07h	xxxx xxxx	uuuu uuuu	uuuu uuuu
PORT D	08h	xxxx xxxx	uuuu uuuu	uuuu uuuu
PORT E	09h	---- -xxx	---- -uuu	---- -uuu
PCH	0Ah(8Ah)	---- 0000	---- 0000	---- uuuu
INTS	0Bh(8Bh)	0000 0001	0000 0001	uuuu uuuu
PIFB1	0Ch	---- ---x	---- ---u	---- ---u
PIFB2	0Dh	1--- ----	1--- ----	u--- ----
TMR1L	0Eh	xxxx xxxx	Uuuu uuuu	Uuuu uuuu
T1STA	10h	--00 0000	--00 0000	--uu uuuu
CCP1L	15h	Xxxx xxxx	uuuu uuuu	--uu uuuu
CCP1CTL	17h	---- ---0	---- ---0	---- ---u
TMR	81h	1111 1111	1111 1111	uuuu uuuu
CPIO A	85h	1111 1111	1111 1111	uuuu uuuu
CPIO B	86h	1111 1111	1111 1111	uuuu uuuu
CPIO C	87h	1111 1111	1111 1111	uuuu uuuu
CPIO D	88h	1111 1111	1111 1111	uuuu uuuu
CPIO E	89h	---- -111	---- -111	---- -uuu
PIEB1	8Ch	---- ---0	---- ---0	---- ---u
PIEB2	8Dh	0--- ----	0--- ----	u--- ----
PSTA	8Eh	---- --#-	---- --u-	---- --u-
PPHE	90h	1111 ----	1111 ----	uuuu ----

Note : u = unchanged , x = unknown , - = unimplemented , read as "0"  
# = value depends on the condition of the following table



Condition	Status bit 4	Status bit 3	PSTA bit 1
POWR ON RESET	1	1	0
/MCLR reset (not during SLEEP)	u	u	u
/MCLR reset during SLEEP	1	0	u
WDT reset (not during SLEEP)	0	1	u
WDT reset during SLEEP	0	0	u
Interrupt Wake-up during SLEEP	1	0	u

## 9. Instruction Set

Instruction Code	Mnemonic Operands	Function	Operation	Status
010000 00000000	NOP	No operation	None	
010000 00000001	CLRWT	Clear Watchdog timer	0→WT	TF, PF
010000 00000010	SLEEP	Sleep mode	0→WT, stop OSC	TF, PF
010000 00000011	TMODE	Load W to TMODE register	W→TMODE	None
010000 00000rrr	CPIO R	Control I/O port register	W→CPIO r	None
010001 1rrrrrrrr	STWR R	Store W to register	W→R	None
011000 trrrrrrr	LDR R, t	Load register	R→t	Z
111010 iiiiiiiii	LDWI I	Load immediate to W	I→W	None
010111 trrrrrrr	SWAPR R, t	Swap halves register	[R(0~3) ↔ R(4~7)]→t	None
011001 trrrrrrr	INCR R, t	Increment register	R + 1→t	Z
011010 trrrrrrr	INCRSZ R, t	Increment register, skip if zero	R + 1→t	None
011011 trrrrrrr	ADDWR R, t	Add W and register	W + R→t	C, HC, Z
011100 trrrrrrr	SUBWR R, t	Subtract W from register	R - W→t (R+/W+1→t)	C, HC, Z
011101 trrrrrrr	DECR R, t	Decrement register	R - 1→t	Z
011110 trrrrrrr	DECRSZ R, t	Decrement register, skip if zero	R - 1→t	None
010010 trrrrrrr	ANDWR R, t	AND W and register	R ∩ W→t	Z
110100 iiiiiiiii	ANDWI i	AND W and immediate	i ∩ W→W	Z
010011 trrrrrrr	IORWR R, t	Inclu. OR W and register	R ∪ W→t	Z
110101 iiiiiiiii	IORWI i	Inclu. OR W and immediate	i ∪ W→W	Z

Instruction Code	Mnemonic Operands	Function	Operation	Status
010100 trrrrrrrr	XORWR R, t	Exclu. OR W and register	$R \oplus W \rightarrow t$	Z
110110 iiiiiiiiii	XORWI i	Exclu. OR W and immediate	$i \oplus W \rightarrow W$	Z
011111 trrrrrrrr	COMR R, t	Complement register	$/R \rightarrow t$	Z
010110 trrrrrrrr	RRR R, t	Rotate right register	$R(n) \rightarrow R(n-1), C \rightarrow R(7), R(0) \rightarrow C$	C
010101 trrrrrrrr	RLR R, t	Rotate left register	$R(n) \rightarrow r(n+1), C \rightarrow R(0), R(7) \rightarrow C$	C
010000 1xxxxxxx	CLRW	Clear working register	$0 \rightarrow W$	Z
010001 0rrrrrrrr	CLRR R	Clear register	$0 \rightarrow R$	Z
0000bb brrrrrrrr	BCR R, b	Bit clear	$0 \rightarrow R(b)$	None
0010bb brrrrrrrr	BSR R, b	Bit set	$1 \rightarrow R(b)$	None
0001bb brrrrrrrr	BTSC R, b	Bit Test, skip if clear	Skip if $R(b)=0$	None
0011bb brrrrrrrr	BTSS R, b	Bit Test, skip if set	Skip if $R(b)=1$	None
100nnn nnnnnnnn	LCALL n	Long CALL subroutine	$n \rightarrow PC, PC+1 \rightarrow Stack$	None
101nnn nnnnnnnn	LJUMP n	Long JUMP to address	$n \rightarrow PC$	None
110001 iiiiiiiiii	RTWI i	Return, place immediate to W	$Stack \rightarrow PC, i \rightarrow W$	None
110111 iiiiiiiiii	ADDWI	Add immediate to W	$PC+1 \rightarrow PC, W+i \rightarrow W$	C,HC,Z
111000 iiiiiiiiii	SUBWI	Subtract W from immediate	$i-W \rightarrow W$	C,HC,Z
010000 00001001	RTFI	Return from interrupt	$Stack \rightarrow PC, 1 \rightarrow GIS$	None
010000 00000100	RET	Return from subroutine	$Stack \rightarrow PC$	None

Note :

W	: Working register	b	: Bit position
WT	: Watchdog timer	t	: Target
TMODE	: TMODE mode register	0	: Working register
CPIO	: Control I/O port register	1	: General register
TF	: Timer overflow flag	R	: General register address
PF	: Power loss flag	C	: Carry flag
PC	: Program Counter	HC	: Half carry
OSC	: Oscillator	Z	: Zero flag

Inclu.	: Inclusive 'U'	/	: Complement
Exclu.	: Exclusive '⊕'	x	: Don't care
AND	: Logic AND '∩'	i	: Immediate data ( 8 bits )
		n	: Immediate address

**10. Electrical Characteristics**

(A) Operating Voltage & Frequency

$V_{dd}$  : 2.3 V ~ 5.5 V

Frequency: 0 Hz ~ 20 MHz

(B) Input Voltage

@  $V_{dd}=5.0$  V, Temperature = 25 °C

	Port	Min.	Max.
$V_{il}$	PA0~3 & 5~7, PB	$V_{ss}$	1.0 V
	PA4,PC,PD,PE,/MCLR	$V_{ss}$	0.8 V
$V_{ih}$	PA0~3 & 5~7,PB	2.0V	$V_{dd}$
	PA4,PC,PD,PD,PE, /MCLR	3.4V	$V_{dd}$

**\*Threshold Voltage :**

Port A0~3 & 5~7, Port B  $V_{th}=1.61$ v

Port A4, Port C, Port D, Port E, /MCLR  $V_{il}=1.12$  V,  $V_{ih}=3.07$  V (Schmitt Trigger)

(C) Output Voltage

@  $V_{dd}=5.0$  V, Temperature = 25 °C, the typical value as followings :

PA4~7, PB, PC, PD, PE Port	
$I_{oh} = -20.0$ mA	$V_{oh} = 3.45$ V
$I_{ol} = 20.0$ mA	$V_{ol} = 0.47$ V
$I_{oh} = -5.0$ mA	$V_{oh} = 4.61$ V
$I_{ol} = 5.0$ mA	$V_{ol} = 0.18$ V

PA0~3 →  $I_{ol} = 5.6$ mA  $V_{ol} = 0.6$ V ;  $I_{ol} = 8.3$ mA  $V_{ol} = 0.87$ V

(D) Leakage Current

@  $V_{dd}=5.0$  V, Temperature = 25 °C, the typical value as followings :

$I_{il}$	- 1.0 $\mu$ A (Max.)
$I_{ih}$	+ 1.0 $\mu$ A (Max.)

(E) Sleep Current

@WDT – Enable, Temperature = 25 °C, the typical value as followings :

$V_{dd}=2.3\text{ V}$	$I_{dd}=1.5\ \mu\text{A}$
$V_{dd}=2.5\text{ V}$	$I_{dd}=2.2\ \mu\text{A}$
$V_{dd}=3.0\text{ V}$	$I_{dd}=3.9\ \mu\text{A}$
$V_{dd}=4.0\text{ V}$	$I_{dd}=9.6\ \mu\text{A}$
$V_{dd}=5.0\text{ V}$	$I_{dd}=21\ \mu\text{A}$
$V_{dd}=5.5\text{ V}$	$I_{dd}=30\ \mu\text{A}$

@WDT – Disable, Temperature = 25 °C, the typical value as followings :

$V_{dd}=2.3\text{ V} \sim 5.5\text{ V}$ ,  $I_{dd}<0.1\ \mu\text{A}$

(F) Operating Current / Voltage

Temperature = 25 °C, the typical value as followings :

(i) OSC Type = RC ; WDT – Enable; PED --- Disable @  $V_{dd}=5.0\text{ V}$

Cext. (F)	Rext. (Ohm)	Frequency (Hz)	Current (A)
3P	4.7 K	12.8 M	1.30 m
	10.0 K	6.54 M	741 $\mu$
	47.0 K	1.48 M	259 $\mu$
	100.0 K	705 K	181 $\mu$
	300.0 K	241 K	133 $\mu$
	470.0 K	151 K	125 $\mu$
20P	4.7 K	6.11 M	695 $\mu$
	10.0 K	3.17 M	441 $\mu$
	47.0 K	716 K	180 $\mu$
	100.0 K	339 K	149 $\mu$
	300.0 K	116 K	126 $\mu$
	470.0 K	73 K	122 $\mu$
100P	4.7 K	2.03 M	310 $\mu$
	10.0 K	1.02 M	205 $\mu$
	47.0 K	223 K	129 $\mu$
	100.0 K	105 K	118 $\mu$
	300.0 K	35.5 K	111 $\mu$
	470.0 K	22.4 K	110 $\mu$

Cext. (F)	Rext. (Ohm)	Frequency (Hz)	Current (A)
300P	4.7 K	816 K	181 $\mu$
	10.0 K	400 K	141 $\mu$
	47.0 K	90 K	112 $\mu$
	100.0 K	40.8 K	108 $\mu$
	300.0 K	13.8 K	105 $\mu$
	470.0 K	8.7 K	99 $\mu$

(ii) OSC Type=LF (C=10 p); WDT – Disable PED ---Disable

Voltage/Frequency	32 K	455 K	1 M	Sleep
2.3 V	10 $\mu$ A	X	35 $\mu$ A	<1 $\mu$ A
2.5 V	13 $\mu$ A	X	41 $\mu$ A	<1 $\mu$ A
3.0 V	19 $\mu$ A	40.8 $\mu$ A	52 $\mu$ A	<1 $\mu$ A
4.0 V	38 $\mu$ A	62.5 $\mu$ A	85 $\mu$ A	<1 $\mu$ A
5.0 V	65 $\mu$ A	99.1 $\mu$ A	121 $\mu$ A	<1 $\mu$ A
5.5 V	76 $\mu$ A	128.3 $\mu$ A	162 $\mu$ A	<1 $\mu$ A

(iii) OSC Type=XT (C=10 p); WDT – Enable PED – Enable

Voltage/Frequency	1 M	4 M	10 M	Sleep
2.3 V	59 $\mu$ A	174 $\mu$ A	369 $\mu$ A	1.5 $\mu$ A
2.5 V	73 $\mu$ A	205 $\mu$ A	418 $\mu$ A	2.2 $\mu$ A
3.0 V	110 $\mu$ A	274 $\mu$ A	561 $\mu$ A	3.9 $\mu$ A
4.0 V	263 $\mu$ A	464 $\mu$ A	891 $\mu$ A	9.6 $\mu$ A
5.0 V	489 $\mu$ A	704 $\mu$ A	1.23 mA	21 $\mu$ A
5.5 V	862 $\mu$ A	1.00 mA	1.64 mA	30 $\mu$ A

(iv) OSC Type=HF (C=10 p); WDT – Enable PED – Enable

Voltage/Frequency	4 M	10 M	20 M	Sleep
2.3 V	192 uA	396 uA	734uA	1.5 μA
2.5 V	222 uA	462 uA	841uA	2.2 μA
3.0 V	314 uA	622 uA	1068 uA	3.9 μA
4.0 V	532 uA	985 uA	1.62 mA	9.6 μA
5.0 V	803 uA	1.40 mA	2.37 mA	21 μA
5.5 V	1.19 mA	1.81 mA	3.08 mA	30 μA

(G) Pull\_High Resistance

@ Input Mode :  $V_{dd}=5.0$  V

PA7	PA6	PA5	PA4	PA3	PA2	PA1	PA0
46.7KΩ	46.2KΩ	96.1KΩ	47.6KΩ	47.1KΩ	47.1KΩ	46.7KΩ	46.2KΩ

PB 7~0	PC 7~0	PD 7~0	PE 2~0
26.4KΩ	92.5KΩ	92.5KΩ	92.5KΩ

***p.s. : It is only a reference value for the Pull High Resistance, and the accurate value of the Resistance depends on the various parameter of the Process. But the variation of the value will be not more than 20%.***

(H) Power Edge-detector Reset Voltage (Not in Sleep Mode), @  $V_{dd}=5.0$  V

$V_{pr} = 1.2$  V ~ 1.5 V       $V_{pr} : V_{dd}$  (Power Supply)

(I) The basic WDT time-out cycle time

@Temperature = 25 °C, the typical value as followings :

Voltage (V)	Basic WDT time-out cycle time (ms)
2.3	26.4
3.0	22.8
4.0	20.1
5.0	18.46
5.5	17.9