
MDT1020

1. General Description

This ROM-Based 8-bit micro-controller uses a fully static CMOS design technology combines higher speed and smaller size with the low power and high noise immunity of CMOS. On chip memory system includes 2.0 K bytes of ROM, and 80 bytes of static RAM.

2. Features

The followings are some of the features on the hardware and software :

- ◆ Fully COMS static design
- ◆ 8-bit data bus
- ◆ On chip ROM size : 2 K words
- ◆ Internal RAM size : 80 bytes
(72 general purpose, 8 special registers)
- ◆ 36 single word instructions
- ◆ 14-bit instructions
- ◆ 2-level stacks
- ◆ Operating voltage : 2.3 V ~ 6.3 V
- ◆ Operating frequency : 0 ~ 20 MHz
- ◆ The fastest execution time is 200 ns under 20 MHz in all single cycle instructions except the branch instruction.
- ◆ Addressing modes include direct, indirect and relative addressing modes
- ◆ Power-on Reset
- ◆ Power Edge-detector Reset
- ◆ Sleep mode for power saving
- ◆ 4 oscillator start-up time :
150 μ s, 20 ms, 40 ms, 80 ms
- ◆ 8-bit real time clock/counter(RTCC) with 8-bit programmable prescaler
- ◆ 4 types of oscillator can be selected by code options :
RC - Low cost RC oscillator
LFXT - Low frequency crystal oscillator
XTAL - Standard crystal oscillator
HFXT - High frequency crystal oscillator
- ◆ On-chip RC oscillator based Watchdog Timer(WDT) can be operated freely
- ◆ Pull up resistors for the following pins :
PA0~PA3, PB0~PB7, PC0~PC7, /MCLR, RTCC

- ◆ Pull down resistors for the following pins :
PA0~PA3, PB0~PB7, PC0~PC7, RTCC
- ◆ 20 I/O pins with their own independent direction control

3. Applications

The application areas of this MDT1020 range from appliance motor control and high speed automotive to low power remote transmitters/receivers, pointing devices, and telecommunications processors, such as Remote controller, small instruments, chargers, toy, automobile and PC peripheral ..etc.

4. Pin Assignment

RTCC	1	28	/MCLR
V _{dd}	2	27	OSC1
N/C	3	26	OSC2
V _{ss}	4	25	PC7
N/C	5	24	PC6
PA0	6	23	PC5
PA1	7	22	PC4
PA2	8	21	PC3
PA3	9	20	PC2
PB0	10	19	PC1
PB1	11	18	PC0
PB2	12	17	PB7
PB3	13	16	PB6
PB4	14	15	PB5

5. Pin Function Description

Pin Name	I/O	Function Description
PA0~PA3	I/O	Port A, TTL input level
PB0~PB7	I/O	Port B, TTL input level
PC0~PC7	I/O	Port C, TTL input level
RTCC	I	Real Time Clock/Counter, Schmitt Trigger input levels
/MCLR	I	Master Clear, Schmitt Trigger input levels
OSC1	I	Oscillator Input
OSC2	O	Oscillator Output
V _{dd}		Power supply
V _{ss}		Ground

6. Memory Map

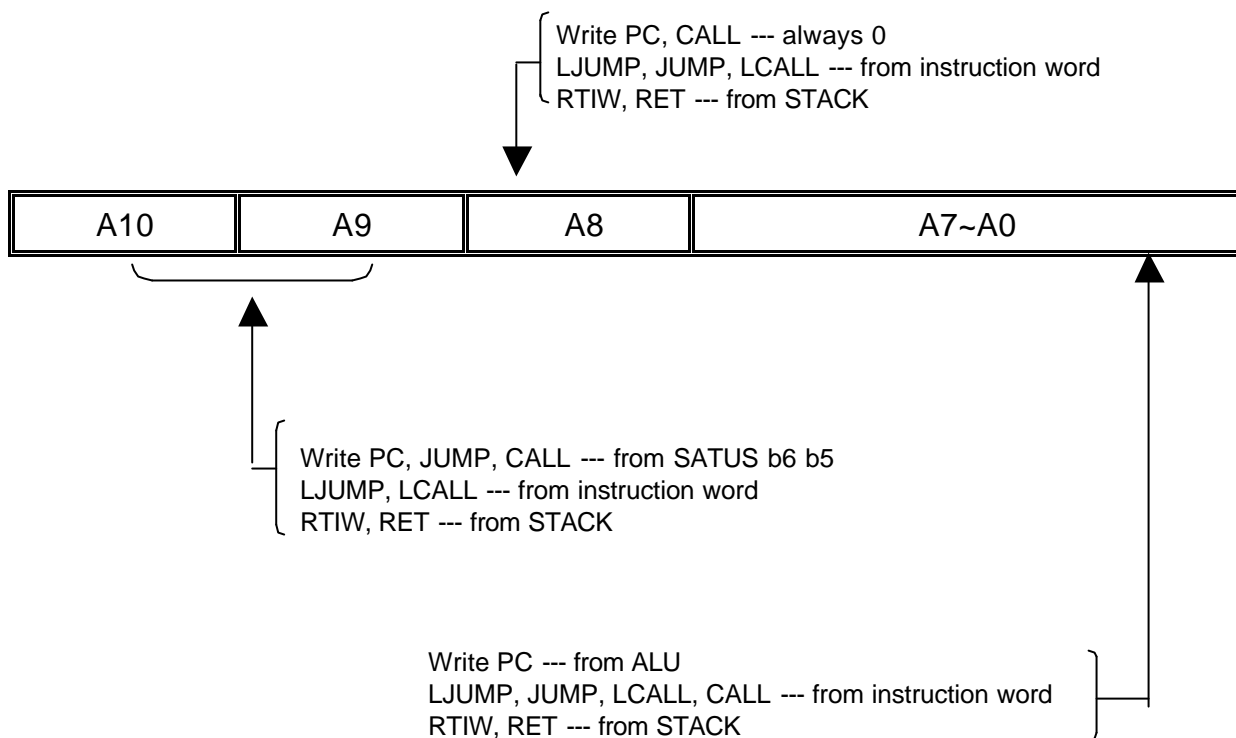
(A) Register Map

Address	Description
00	Indirect Addressing Register
01	RTCC
02	PC
03	STATUS
04	MSR
05	Port A
06	Port B
07	Port C
08~0F	Internal RAM, General Purpose Register
10~1F	Internal Memory Select Register
30~3F	Internal Memory Select Register
50~5F	Internal Memory Select Register
70~7F	Internal Memory Select Register

(1) IAR (Indirect Address Register) : R0

(2) RTCC (Real Time Counter/Counter Register) : R1

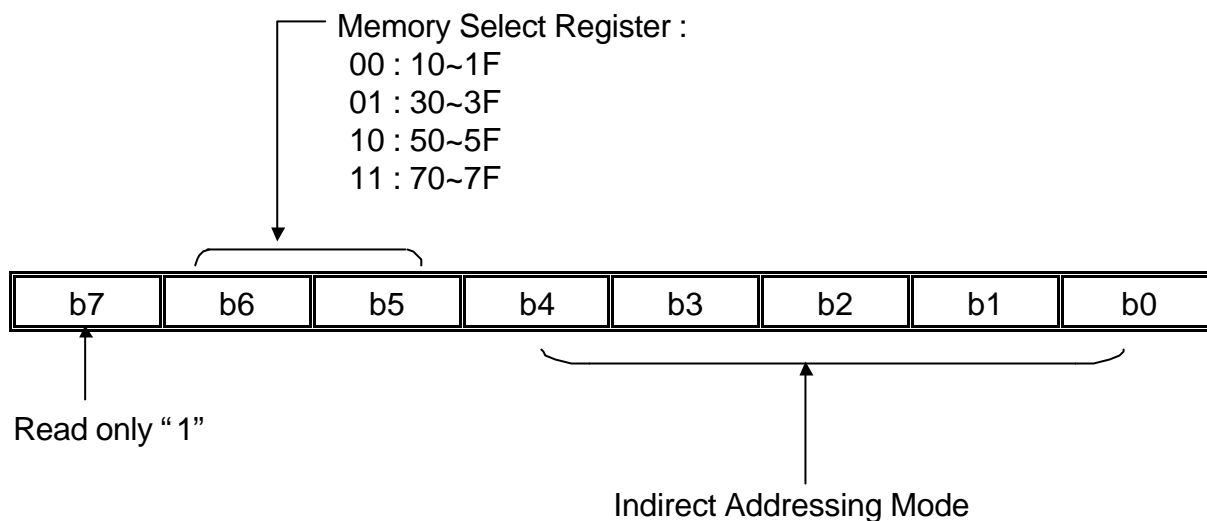
(3) PC (Program Counter) : R2



(4) STATUS (Status register) : R3

Bit	Symbol	Function
0	C	Carry bit
1	HC	Half Carry bit
2	Z	Zero bit
3	PF	Power loss Flag bit
4	TF	Time overflow Flag bit
6—5	page	Page select bit : 00 : 000H --- 1FFH 01 : 200H --- 3FFH 10 : 400H --- 5FFH 11 : 600H --- 7FFH
7	—	General purpose bits

(5) MSR (Memory Select Register) : R4



(6) PORT A : R5

PA3~PA0, I/O Register

(7) PORT B : R6

PB7~PB0, I/O Register

(8) PORT C : R7

PC7~PC0, I/O Register

(9) TMR (Time Mode Register)

Bit	Symbol	Function		
2—0	PS2—0	Prescaler Value	RTCC rate	WDT rate
		0 0 0	1 : 2	1 : 1
		0 0 1	1 : 4	1 : 2
		0 1 0	1 : 8	1 : 4
		0 1 1	1 : 16	1 : 8
		1 0 0	1 : 32	1 : 16
		1 0 1	1 : 64	1 : 32
		1 1 0	1 : 128	1 : 64
1 1 1	1 : 256	1 : 128		
3	PSC	Prescaler assignment bit : 0 — RTCC 1 — Watchdog Timer		
4	TCE	RTCC signal Edge : 0 — Increment on low-to-high transition on RTCC pin 1 — Increment on high-to-low transition on RTCC pin		
5	TCS	RTCC signal set : 0 — Internal instruction cycle clock 1 — Transition on RTCC pin		

(10) CPIO A, CPIO B, CPIO C (Control Port I/O Mode Register)

The CPIO register is “write-only”

= “0”, I/O pin in output mode;

= “1”, I/O pin in input mode.

(11) Configuration ROM :

Bit 1	Bit 0	Oscillator Type
0	0	RC Oscillator
0	1	LFXT Oscillator
1	0	XTAL Oscillator
1	1	HFXT Oscillator

Bit 3	Bit 2	Oscillator Start-up Time
0	0	150 μ s
0	1	20 ms
1	0	40 ms
1	1	80 ms

Bit 4	Watchdog Timer control
0	Watchdog timer disable all the time
1	Watchdog timer enable all the time

(B) Program Memory

Address	Description
000-7FF	Program memory
7FF	The starting address of the power on, external reset or WDT

7. Reset Condition for all Registers

Register	Address	Power-On Reset	/MCLR or WDT Reset
IAR	00h	-	-
RTCC	01h	xxxx xxxx	uuuu uuuu
PC	02h	1111 1111	1111 1111

Register	Address	Power-On Reset	/MCLR or WDT Reset
STATUS	03h	0001 1xxx	000# #uuu
MSR	04h	100x xxxx	100u uuuu
PORT A	05h	---- xxxx	---- uuuu
PORT B	06h	xxxx xxxx	uuuu uuuu
PORT C	07h	xxxx xxxx	uuuu 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
/MCLR reset (not during SLEEP)	u	u
/MCLR reset during SLEEP	1	0
WDT reset (not during SLEEP)	0	1
WDT reset during SLEEP	0	0

8. Instruction Set

Instruction Code	Mnemonic Operands	Function	Operating	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 00000100	RET	Return	Stack PC	None
010000 00000rrr	CPIO R	Control I/O port register	W CPIO r	None
010001 1rrrrrr	STWR R	Store W to register	W R	None
011000 trrrrrr	LDR R, t	Load register	R t	Z
111010 iiiiiii	LDWI I	Load immediate to W	I W	None
010111 trrrrrr	SWAPR R, t	Swap halves register	[R(0~3) ↔ R(4~7)] t	None
011001 trrrrrr	INCR R, t	Increment register	R + 1 t	Z
011010 trrrrrr	INCRSZ R, t	Increment register , skip if zero	R + 1 t	None
011011 trrrrrr	ADDWR R, t	Add W and register	W + R t	C , HC , Z

Instruction Code	Mnemonic Operands	Function	Operating	Status
011100 trrrrrr	SUBWR R, t	Subtract W from register	R - W t (R+/W+1 t)	C, HC, Z
011101 trrrrrr	DECR R, t	Decrement register	R - 1 t	Z
011110 trrrrrr	DECRSZ R, t	Decrement register, skip if zero	R - 1 t	None
010010 trrrrrr	ANDWR R, t	AND W and register	R W t	Z
110100 iiiiiii	ANDWI i	AND W and immediate	i W W	Z
010011 trrrrrr	IORWR R, t	Inclu. OR W and register	R W t	Z
110101 iiiiiii	IORWI i	Inclu. OR W and immediate	i W W	Z
010100 trrrrrr	XORWR R, t	Exclu. OR W and register	R W t	Z
110110 iiiiiii	XORWI i	Exclu. OR W and immediate	i W W	Z
011111 trrrrrr	COMR R, t	Complement register	/R t	Z
010110 trrrrrr	RRR R, t	Rotate right register	R(n) R(n-1), C R(7), R(0) C	C
010101 trrrrrr	RLR R, t	Rotate left register	R(n) r(n+1), C R(0), R(7) C	C
010000 1xxxxxxx	CLRW	Clear working register	0 W	Z
010001 0rrrrrr	CLRR R	Clear register	0 R	Z
0000bb brrrrrr	BCR R, b	Bit clear	0 R(b)	None
0010bb brrrrrr	BSR R, b	Bit set	1 R(b)	None
0001bb brrrrrr	BTSC R, b	Bit Test, skip if clear	Skip if R(b)=0	None
0011bb brrrrrr	BTSS R, b	Bit Test, skip if set	Skip if R(b)=1	None
100nnn nnnnnnnn	LCALL n	Long CALL subroutine	n PC, PC+1 Stack	None
101nnn nnnnnnnn	LJUMP n	Long JUMP to address	n PC	None
110000 nnnnnnnn	CALL n	Call subroutine	n PC, PC+1 Stack	None
110001 iiiiiii	RTIW i	Return, place immediate to W	Stack PC, i W	None
11001n nnnnnnnn	JUMP n	JUMP to address	n 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 ‘ ’	/	: Complement
Exclu.	: Exclusive ‘ ’	x	: Don't care
AND	: Logic AND ‘ ’	i	: Immediate data (8 bits)
		n	: Immediate address

9. Electrical Characteristics

(A) Operating Voltage & Frequency

V_{dd} : 2.3 V ~ 6.3 V

Frequency : 0 Hz ~ 20 MHz

(B) Input Voltage

@ V_{dd} = 5.0 V, Temperature = 25

	Port	Min.	Max.
V_{il}	PA, PB, PC	V_{ss}	1.0 V
	RTCC, /MCLR	V_{ss}	0.8 V
V_{ih}	PA, PB, PC	2.0 V	V_{dd}
	RTCC, /MCLR	3.4 V	V_{dd}

*** Threshold Voltage :**

Port A, Port B, Port C V_{th} = 1.3 V

RTCC, /MCLR V_{il} = 1.3 V, V_{ih} = 3.0 V (Schmitt Trigger)

(C) Output Voltage

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

PA, PB, PC Port	
I_{oh} = - 20.0 mA	V_{oh} = 3.60 V
I_{ol} = 20.0 mA	V_{ol} = 0.35 V
I_{oh} = - 5.0 mA	V_{oh} = 4.70 V
I_{ol} = 5.0 mA	V_{ol} = 0.08 V

(D) Leakage Current

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

I_{il}	- 1.0 μA (Max.)
I_{ih}	+ 1.0 μA (Max.)

(E) Sleep Current

@WDT - Disable, Temperature = 25 , the typical value as followings :

$V_{dd} = 2.3\text{ V} \sim 6.3\text{ V}$, $I_{dd} < 0.1\ \mu\text{A}$

@WDT - Enable, Temperature = 25 , the typical value as followings :

$V_{dd} = 2.3\text{ V}$	$I_{dd} < 1.0\ \mu\text{A}$
$V_{dd} = 3.0\text{ V}$	$I_{dd} = 2.0\ \mu\text{A}$
$V_{dd} = 4.0\text{ V}$	$I_{dd} = 5.0\ \mu\text{A}$
$V_{dd} = 5.0\text{ V}$	$I_{dd} = 10.0\ \mu\text{A}$
$V_{dd} = 6.3\text{ V}$	$I_{dd} = 20.0\ \mu\text{A}$

(F) Operating Current / Voltage

Temperature = 25 , the typical value as followings :

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

Cext. (F)	Rext. (Ohm)	Frequency (Hz)	Current (A)
3P	4.7 K	11.76 M	1.90 m
	10.0 K	7.40 M	1.12 m
	47.0 K	1.96 M	315.00 μ
	100.0 K	952.50 K	175.00 μ
	300.0 K	310.00 K	90.00 μ
	470.0 K	196.1 K	75.00 μ
20P	4.7 K	6.45 M	950.0 μ
	10.0 K	3.70 M	540.0 μ
	47.0 K	869.60 K	160.0 μ
	100.0 K	416.80 K	105.0 μ
	300.0 K	137.90 K	65.0 μ
	470.0 K	88.88 K	60.0 μ

Cext. (F)	Rext. (Ohm)	Frequency (Hz)	Current (A)
100P	4.7 K	2.00 M	325.0 μ
	10.0 K	1.11 M	190.0 μ
	47.0 K	256.40 K	80.0 μ
	100.0 K	121.20 K	65.0 μ
	300.0 K	40.00 K	55.0 μ
	470.0 K	25.60 K	50.0 μ
300P	4.7 K	833.20 K	160.0 μ
	10.0 K	454.00 K	105.0 μ
	47.0 K	105.30 K	65.0 μ
	100.0 K	50.00 K	55.0 μ
	300.0 K	16.60 K	50.0 μ
	470.0 K	10.50 K	49.0 μ

(ii) OSC Type = LF (C=20 p); WDT - Disable

Voltage/Frequency	32 K	455 K	1 M	Sleep
2.3 V	4.0 μ A	X	X	< 0.1 μ A
3.0 V	7.0 μ A	48.0 μ A	X	< 0.1 μ A
4.0 V	10.0 μ A	70.0 μ A	150.0 μ A	< 0.1 μ A
5.0 V	15.0 μ A	105.0 μ A	210.0 μ A	< 0.1 μ A
6.3 V	30.0 μ A	150.0 μ A	290.0 μ A	< 0.1 μ A

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

Voltage/Frequency	1 M	4 M	10 M	Sleep
2.1 V	70.0 μ A	220.0 μ A	500.00 μ A	< 0.1 μ A
3.0 V	130.0 μ A	365.0 μ A	820.00 μ A	2.0 μ A
4.0 V	250.0 μ A	560.0 μ A	1.20 mA	5.0 μ A
5.0 V	470.0 μ A	780.0 μ A	1.70 mA	10.0 μ A
6.3 V	530.0 μ A	1.2 mA	2.30 mA	20.0 μ A

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

Voltage/Frequency	4 M	10 M	20 M	Sleep
2.1 V	230.0 μ A	530.00 μ A	970.00 μ A	< 0.1 μ A
3.0 V	400.0 μ A	890.00 μ A	1.60 mA	2.0 μ A
4.0 V	620.0 μ A	1.30 mA	2.40 mA	5.0 μ A
5.0 V	890.0 μ A	1.90 mA	3.40 mA	10.0 μ A
6.3 V	1.3 mA	2.60 mA	5.00 mA	20.0 μ A

(G) Pull Resistance

@ Input Mode : $V_{dd} = 3.0$ V

PORT	Pull-High Resistance	$R_{hi} = 370.0$ KOhm
	Pull-Low Resistance	$R_{lo} = 370.0$ KOhm
RTCC	Pull-High Resistance	$R_{hi} = 370.0$ KOhm
	Pull-Low Resistance	$R_{lo} = 370.0$ KOhm
/MCLR	Pull-High Resistance	$R_{hi} = 370.0$ KOhm

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

PORT	Pull-High Resistance	$R_{hi} = 170.0$ KOhm
	Pull-Low Resistance	$R_{lo} = 170.0$ KOhm
RTCC	Pull-High Resistance	$R_{hi} = 170.0$ KOhm
	Pull-Low Resistance	$R_{lo} = 170.0$ KOhm
/MCLR	Pull-High Resistance	$R_{hi} = 170.0$ KOhm

p.s. : It is only a reference value for the Pull High/Low 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} 1.1~1.3 V

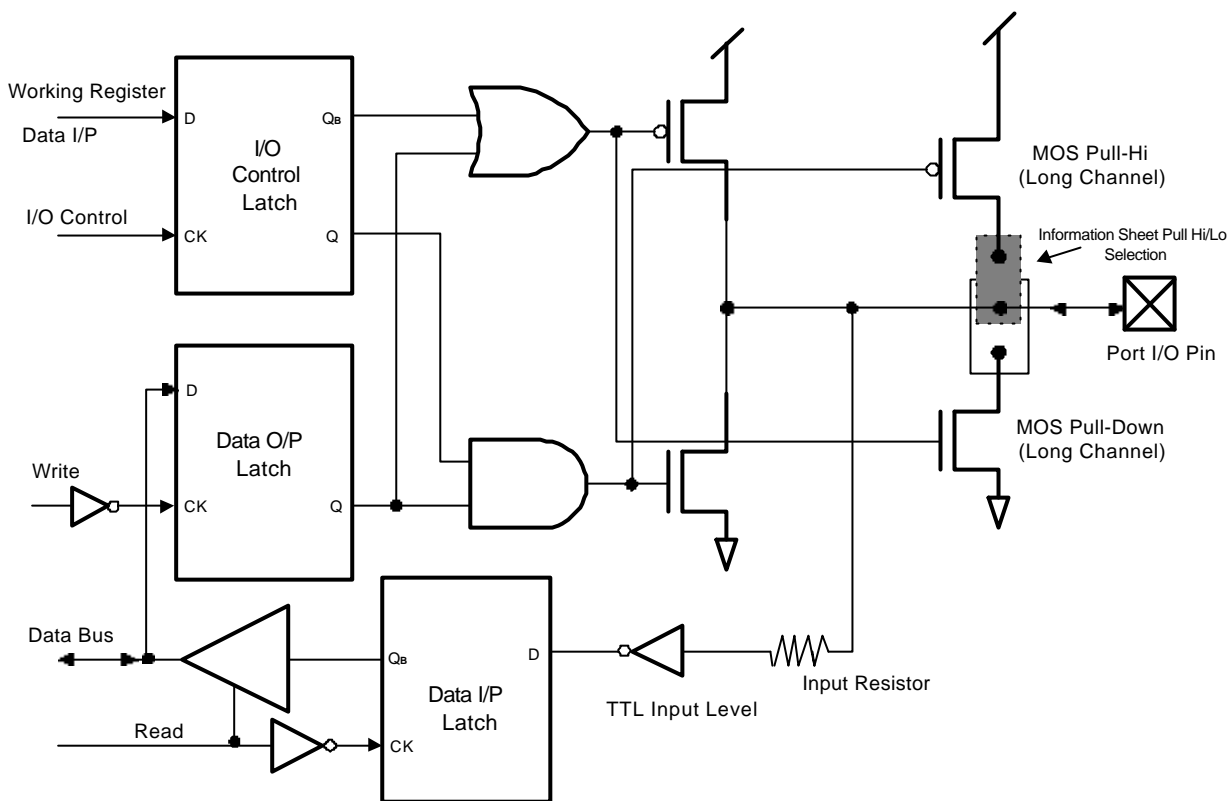
$V_{pr} : V_{dd}$ (Power Supply)

(I) The basic WDT time-out cycle time

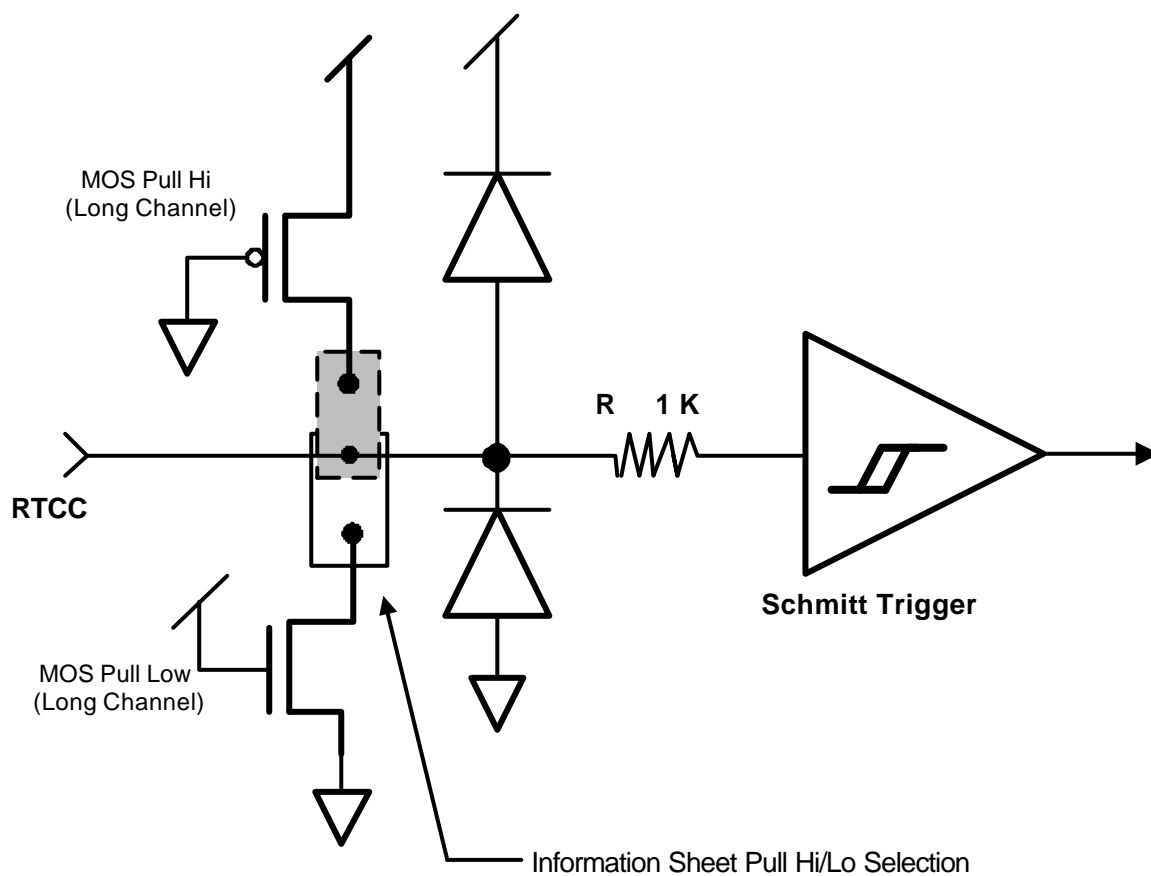
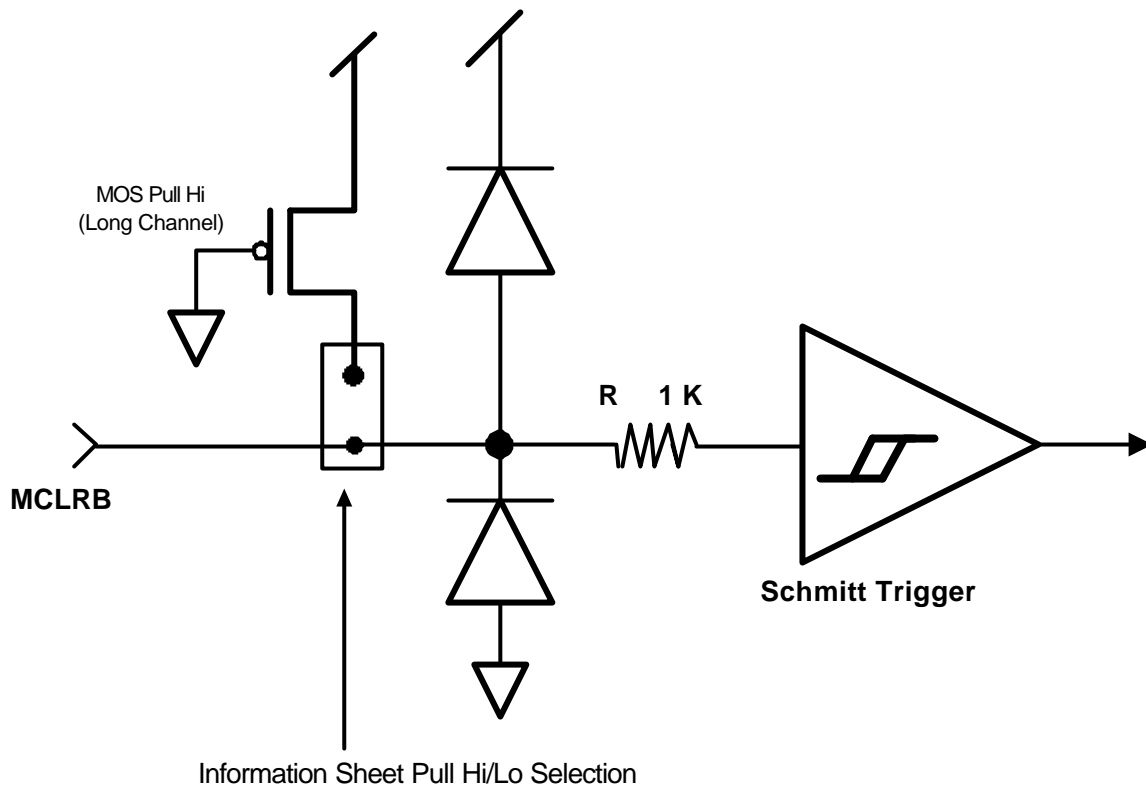
@Temperature = 25 , the typical value as followings :

Voltage (V)	Basic WDT time-out cycle time (ms)
2.3	29.84
3.0	26.88
4.0	23.91
5.0	20.70
6.3	18.98

10. Port A ,Port B and Port C Equivalent Circuit

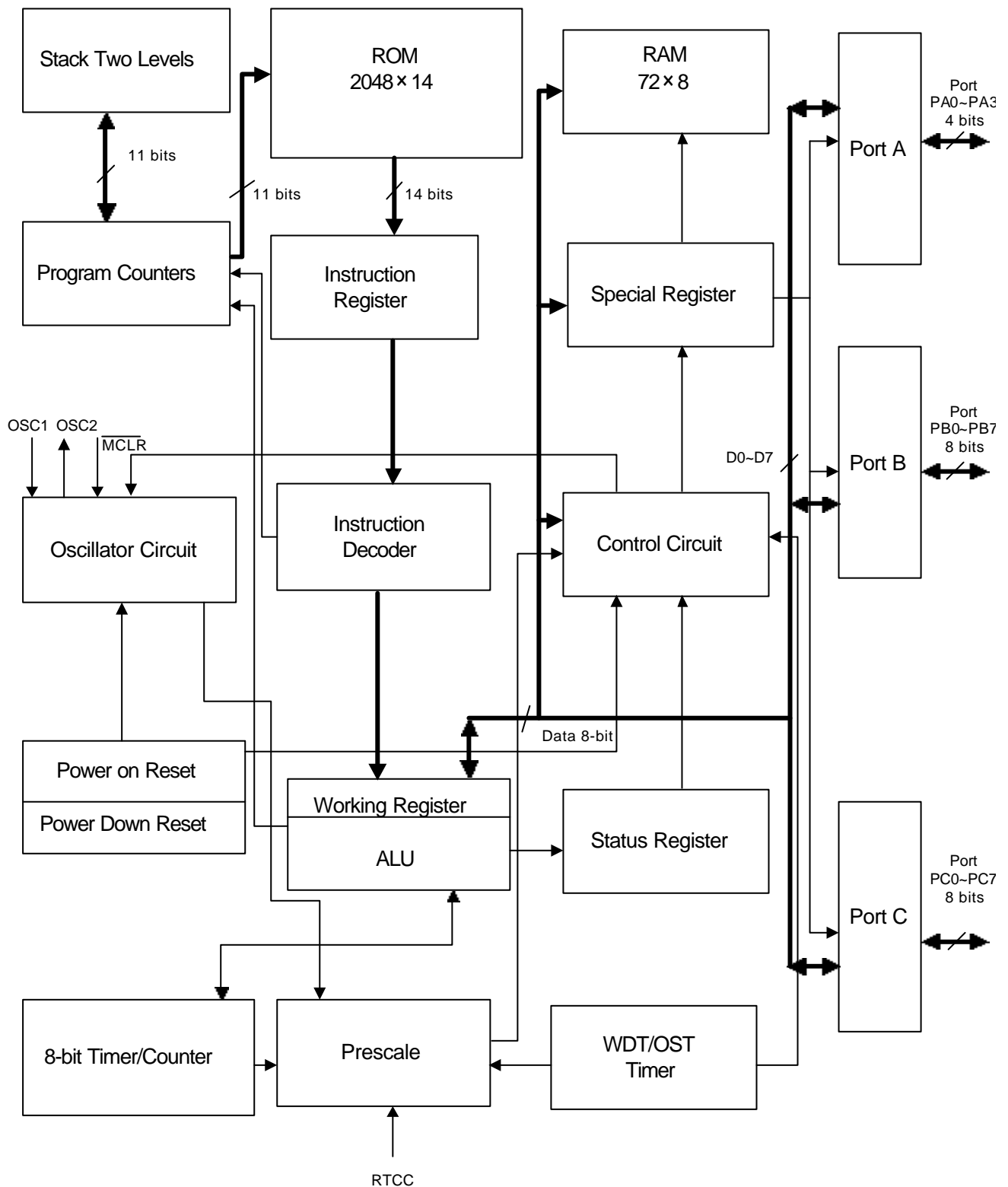


11. MCLR and RTCC Input Equivalent Circuit



This specification are subject to be changed without notice. Any latest information please preview

12. Block Diagram

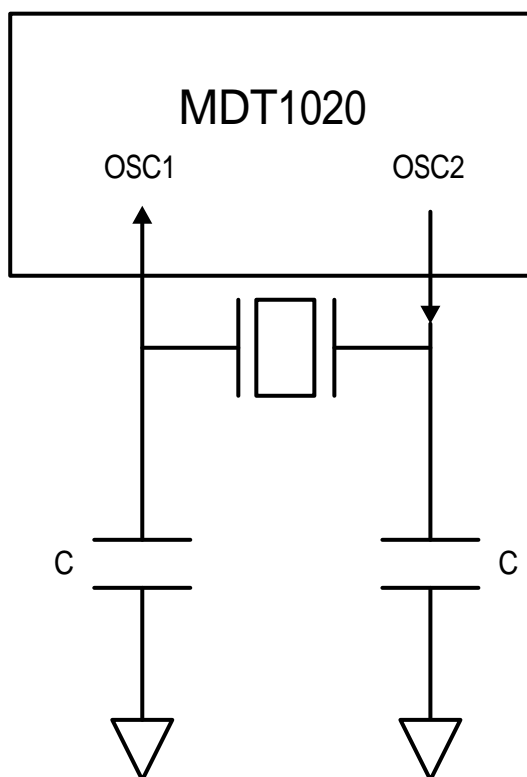


This specification are subject to be changed without notice. Any latest information please preview

13. External Capacitor Selection For Crystal Oscillator

@ $V_{dd} = 5.0\text{ V}$

Osc. Type	Resonator Freq.	Capacity Range
HF	20 MHz	10 pF~30 pF
	10 MHz	20 pF ~50 pF
	4 MHz	20 pF ~50 pF
XT	10 MHz	10 pF ~30 pF
	4 MHz	20 pF ~50 pF
	1 MHz	20 pF ~50 pF
LF	1 MHz	3 pF ~10 pF
	455 K	20 pF ~50 pF
	32 K	20 pF ~30 pF



To increase the stability of oscillator and the ability of anti-noise, the above values of the external capacitor range can be recommended for reference, but the higher capacitance also increases the start-up time.

This specification are subject to be changed without notice. Any latest information please preview