SULIT

POLITEKNIK MALAYSIA

BAHAGIAN PEPERIKSAAN DAN PENILAIAN
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI
KEMENTERIAN PENDIDIKAN MALAYSIA

JABATAN KEJURUTERAAN ELEKTRIK

PEPERIKSAAN AKHIR

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DEC5052: EMBEDDED SYSTEM APPLICATIONS

TARIKH : 25 APRIL 2019
MASA : 8.30 PAGI - 10.30 PAGI (2 JAM)

Kertas ini mengandungi **TUJUH (7)** halaman bercetak.
Bahagian A: Struktur (4 soalan)
Bahagian B: Esei (2 soalan)
Dokumen sokongan yang disertakan : Data sheet

JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

SECTION A: 60 MARKS
BAHAGIAN A: 60 MARKAH

INSTRUCTION:
This section consists of **FOUR (4)** structured questions. Answer **ALL** questions.

ARAHAN:
*Bahagian ini mengandungi **EMPAT (4)** soalan berstruktur. Jawab **SEMUA** soalan.*

QUESTION 1
SOALAN 1

CLO1 C1

a) List **THREE (3)** embedded systems attached to a smart home system.
*Senaraikan **TIGA (3)** sistem terbenam yang terdapat pada sebuah sistem rumah pintar.*

[3 marks]
[*3 markah*]

CLO1 C3

b) A programmer decides to make a home security system using a touch card at pin RB3, a smoke sensor at pin RC5, a temperature sensor at pin RC6 while a magnetic solenoid, buzzer and LED at PORT D. Complete the pins input and output declaration for the program using bit addressable format in C language.
Seorang pengaturcara memutuskan untuk membuat sistem keselamatan rumah dengan menggunakan kad sentuh pada pin RB3, penderia asap pada pin RC5, penderia suhu pada pin RC6 manakala solenoid magnet, buzzer dan LED pada PORT D. Lengkapkan pengisytiharan pin masukan dan keluaran dengan menggunakan format pengalamatan bit di dalam bahasa C.

[6 marks]
[*6 markah*]

CLO2 C3

c) Figure A1(c) shows a block diagram of a washing machine. Implement a C language program to configure the input and output pins using byte addressable format.

Rajah A1(c) menunjukkan rajah blok bagi sebuah mesin basuh. Laksanakan satu aturcara dalam Bahasa C untuk mengkonfigurasi pin masukan dan keluaran menggunakan format pengalamatan bait.

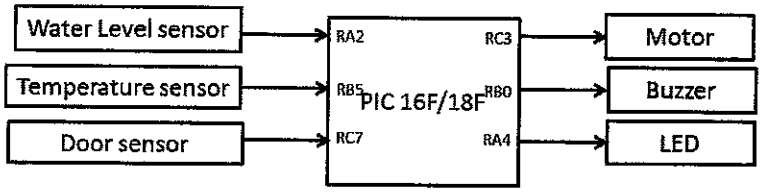

Figure A1(c) / *Rajah A1(c)*

[6 marks]
[*6 markah*]

QUESTION 2
SOALAN 2

CLO1 C2

a) Briefly **TWO (2)** functions of timer register in microcontroller.
*Terangkan secara ringkas **DUA(2)** fungsi pendaftar pemasa di dalam pengawal mikro.*

[3 marks]
[*3 markah*]

CLO1 C3

b) Calculate the value that need to be loaded into TMR0H and TMR0L register using 16 bit mode, assuming XTAL = 20 MHz with no prescalar and the desired time delay is 1ms.
Kira nilai yang diperlukan oleh pendaftar TMR0H dan TMR0L yang menggunakan mod 16 bit. Dengan menggunakan XTAL=20MHz dengan tiada nilai pra skala dan nilai lengah masa ialah 1ms.

[6 marks]
[*6 markah*]

CLO2 C3

c) Implement a function for void T0Delay( ) in C language to generate a 1ms delay based on Question 2 (b).
Laksanakan satu fungsi untuk void T0Delay ( ) dalam bahasa C bagi menghasilkan masa lengah selama 1ms berpandukan Soalan 2(b).

[6 marks]
[*6 markah*]

QUESTION 3
SOALAN 3

CLO1
C1

a) List **THREE (3)** external hardware interrupts in PIC.
*Senaraikan **TIGA (3)** sampukan perkakasan luaran di dalam PIC .*

[3 marks]
[*3 markah*]

CLO1
C2

b) Explain the negative edge triggered interrupt with appropriate register content to enable and disable the register.
Terangkan sampukan picuan pinggir negatif dengan daftar yang sesuai bagi membenarkan dan mematikan pendaftar berkenaan.

[5 marks]
[*5 markah*]

CLO1
C3

c) Construct a C language program for interface with external hardware interrupt pin RB0/INT0. An LED that is connected to pin RC0 will blink twice every time the INT0 is activated.
Binakan satu aturcara dalam bahasa C bagi sampukan perkakasan luar pin RB0/INT0. Satu LED yang disambungkan pada pin RC0 akan berkelip dua kali setiap kali INT0 ditekan.

[7 marks]
[*7 markah*]

QUESTION 4
SOALAN 4

CLO1
C2

a) Explain the function of Pulse Width Modulation (PWM) module in the PIC.
Terangkan fungsi modul Pulse Width Modulation (PWM) di dalam PIC.

[3 marks]
[*3 markah*]

CLO1
C3

b) An 8 bit ADC has reference voltage, Vref=2.56V. Verify D0-D7 output if the analog input is 1.7V.
A DC 8 bit mempunyai voltan rujukan, Vref=2.56V. Tentukan output D0-D7 jika input analog adalah 1.7V.

[6 marks]
[6 *markah*]

CLO2
C3

c) As a programmer, you need to design a forward-reverse motor system. When a switch 1 is pressed, the motor will run forward and when a switch 2 is pressed, the motor will run reverse. Use PORT A as input and PORT B as output in PIC16F/18F. Build a suitable program that will fulfil the requirement.
Sebagai seorang pengaturcara, kamu dikehendaki mereka bentuk satu sistem motor kehadapan-balikan. Apabila suis 1 ditekan, motor akan berpusing kehadapan dan apabila suis 2 ditekan, motor akan berpusing balikan. Gunakan PORT A sebagai masukan dan PORT B sebagai keluaran dalam PIC16F/18F. Bina program yang sesuai supaya dapat memenuhi keperluan yang diberikan.

[6 marks]
[6 *markah*]

SECTION B : 40 MARKS
BAHAGIAN B : 40 MARKAH

INSTRUCTION:
This section consists of **TWO (2)** essay questions. Answer **ALL** questions.

ARAHAN:
*Bahagian ini mengandungi **DUA (2)** soalan esei. Jawab **SEMUA** soalan.*

QUESTION 1
SOALAN 1

CLO2
C3

A switch is connected at pin RB0/INT0 and eight LEDs are connected at PORTC. When the switch is not pressed, the LEDs will turn on one by one with 500ms delay. When the switch is pressed, the microcontroller is interrupted and the ISR is executed. The ISR will toggle all the LEDs twice with 200ms delay. Construct a C language program to perform the operation.

Satu suis disambungkan pada pin RB0/INT0 dan lapan LED disambungkan pada PORTC. Apabila suis tidak ditekan, LED akan hidup satu per satu dengan lengah masa 500ms. Apabila suis ditekan, mikro pengawal diganggu dan ISR dilaksanakan. ISR akan togel ke semua LED sebanyak dua kali dengan lengah masa 200ms. Bangunkan sebuah aturcara program dalam bahasa C untuk melakukan operasi tersebut.

[20 marks]
[20 *markah*]

QUESTION 2
SOALAN 2

CLO2
C5

In order to increase the production and safety of the workers, a factory uses a semi-automatic busbar drilling system. The busbar is placed in the position of sensor A and B. When both sensors are triggered, the guard will close the work area, the wedge will hold the busbar and the drill will work. Sensor A and B are connected to pins RA0 and RA1 respectively, the wedge at pin RB0, the guard on RB2 and the drill at pin RB6. After 30 second of drilling, the guard will open, the wedge and drill will rise. Design a block diagram and build using C language program using PIC 16F / 18F to implement the system.

Bagi meningkatkan pengeluaran dan keselamatan pekerja, sebuah kilang menggunakan sistem menggerudi busbar secara separa automatik. Busbar diletakkan pada kedudukan penderia A dan B. Apabila kedua-dua penderia ini dipicu, pelindung akan menutup kawasan kerja, pengapit akan memegang busbar dan gerudi akan berfungsi. Penderia A dan B bersambung pada pin RA0 dan RA1, apit pada RB0, pelindung pada RB2 dan gerudi pada RB6. Selepas menggerudi selama 30 saat, pelindung akan terbuka, pengapit dan gerudi akan naik ke atas. Rekakan satu gambarajah blok dan program dengan menggunakan bahasa C dengan menggunakan PIC 16F/18F bagi melaksanakan sistem tersebut.

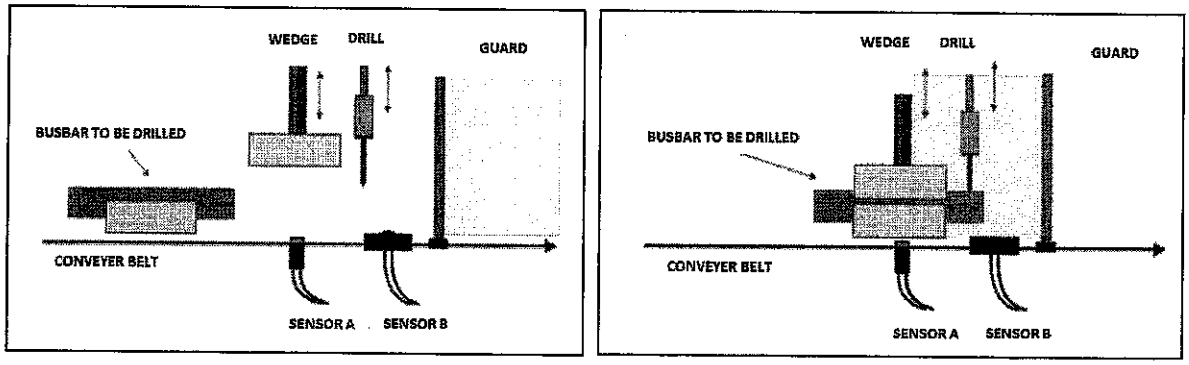

Figure 2B/ *Rajah 2B*

[20 marks]
[20 *markah*]

SOALAN TAMAT

REGISTER 21-1: ADCON0: A/D CONTROL REGISTER 0

U-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
—	—	CHS3	CHS2	CHS1	CHS0	GO/$\overline{\text{DONE}}$	ADON
bit 7							bit 0

bit 7-6 **Unimplemented:** Read as '0'

bit 5-2 **CHS3:CHS0:** Analog Channel Select bits
0000 = Channel 0 (AN0)
0001 = Channel 1 (AN1)
0010 = Channel 2 (AN2)
0011 = Channel 3 (AN3)
0100 = Channel 4 (AN4)
0101 = Channel 5 (AN5)(1,2)
0110 = Channel 6 (AN6)(1,2)
0111 = Channel 7 (AN7)(1,2)
1000 = Channel 8 (AN8)
1001 = Channel 9 (AN9)
1010 = Channel 10 (AN10)
1011 = Channel 11 (AN11)
1100 = Channel 12 (AN12)
1101 = Unimplemented(2)
1110 = Unimplemented(2)
1111 = Unimplemented(2)

bit 1 **GO/$\overline{\text{DONE}}$:** A/D Conversion Status bit
When ADON = 1:
1 = A/D conversion in progress
0 = A/D Idle

bit 0 **ADON:** A/D On bit
1 = A/D converter module is enabled
0 = A/D converter module is disabled

REGISTER 21-2: ADCON1: A/D CONTROL REGISTER 1

U-0	U-0	R/W-0	R/W-0	R/W-0(1)	R/W(1)	R/W(1)	R/W(1)
—	—	VCFG1	VCFG0	PCFG3	PCFG2	PCFG1	PCFG0
bit 7							bit 0

bit 7-6 **Unimplemented:** Read as '0'

bit 5 **VCFG1:** Voltage Reference Configuration bit (V_{REF-} source)
1 = V_{REF-} (AN2)
0 = V_{SS}

bit 4 **VCFG0:** Voltage Reference Configuration bit (V_{REF+} source)
1 = V_{REF+} (AN3)
0 = V_{DD}

bit 3-0 **PCFG3:PCFG0:** A/D Port Configuration Control bits:

PCFG3: PCFG0	AN12	AN11	AN10	AN9	AN8	AN7(2)	AN6(2)	AN5(2)	AN4	AN3	AN2	AN1	AN0
0000(1)	A	A	A	A	A	A	A	A	A	A	A	A	A
0001	A	A	A	A	A	A	A	A	A	A	A	A	A
0010	A	A	A	A	A	A	A	A	A	A	A	A	A
0011	D	A	A	A	A	A	A	A	A	A	A	A	A
0100	D	D	A	A	A	A	A	A	A	A	A	A	A
0101	D	D	D	A	A	A	A	A	A	A	A	A	A
0110	D	D	D	D	A	A	A	A	A	A	A	A	A
0111(1)	D	D	D	D	D	A	A	A	A	A	A	A	A
1000	D	D	D	D	D	D	A	A	A	A	A	A	A
1001	D	D	D	D	D	D	D	A	A	A	A	A	A
1010	D	D	D	D	D	D	D	D	A	A	A	A	A
1011	D	D	D	D	D	D	D	D	D	A	A	A	A
1100	D	D	D	D	D	D	D	D	D	D	A	A	A
1101	D	D	D	D	D	D	D	D	D	D	D	A	A
1110	D	D	D	D	D	D	D	D	D	D	D	D	A
1111	D	D	D	D	D	D	D	D	D	D	D	D	D

A = Analog Input D = Digital I/O

REGISTER 21-3: ADCON2: A/D CONTROL REGISTER 2

R/W-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
ADFM	—	ACQT2	ACQT1	ACQT0	ADCS2	ADCS1	ADCS0
bit 7							bit 0

bit 7 **ADFM:** A/D Result Format Select bit
1 = Right justified
0 = Left justified

bit 6 **Unimplemented:** Read as '0'

bit 5-3 **ACQT2:ACQT0:** A/D Acquisition Time Select bits
111 = 20 TAD
110 = 16 TAD
101 = 12 TAD
100 = 8 TAD
011 = 6 TAD
010 = 4 TAD
001 = 2 TAD
000 = 0 TAD(1)

bit 2-0 **ADCS2:ADCS0:** A/D Conversion Clock Select bits
111 = FRC (clock derived from A/D RC oscillator)(1)
110 = Fosc/64
101 = Fosc/16
100 = Fosc/4
011 = FRC (clock derived from A/D RC oscillator)(1)
010 = Fosc/32
001 = Fosc/8
000 = Fosc/2

T0CON Register

R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1
TMR0ON	T08BIT	T0CS	T0SE	PSA	T0PS2	T0PS1	T0PS0
bit 7							bit 0

bit 7 **TMR0ON:** Timer0 On/Off Control bit
1 = Enables Timer0
0 = Stops Timer0

bit 6 **T08BIT:** Timer0 8-bit/16-bit Control bit
1 = Timer0 is configured as an 8-bit timer/counter
0 = Timer0 is configured as a 16-bit timer/counter

bit 5 **T0CS:** Timer0 Clock Source Select bit
1 = Transition on T0CKI pin
0 = Internal instruction cycle clock (CLKO)

bit 4 **T0SE:** Timer0 Source Edge Select bit
1 = Increment on high-to-low transition on T0CKI pin
0 = Increment on low-to-high transition on T0CKI pin

bit 3 **PSA:** Timer0 Prescaler Assignment bit
1 = Timer0 prescaler is not assigned. Timer0 clock input bypasses prescaler.
0 = Timer0 prescaler is assigned. Timer0 clock input comes from prescaler output.

bit 2-0 **T0PS2:T0PS0:** Timer0 Prescaler Select bits
111 = 1:256 Prescale value
110 = 1:128 Prescale value
101 = 1:64 Prescale value
100 = 1:32 Prescale value
011 = 1:16 Prescale value
010 = 1:8 Prescale value
001 = 1:4 Prescale value
000 = 1:2 Prescale value

T1CON Register

R/W-0	R-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
RD16	T1RUN	T1CKPS1	T1CKPS0	T1OSCEN	$\overline{\text{T1SYNC}}$	TMR1CS	TMR1ON
bit 7							bit 0

bit 7 **RD16:** 16-bit Read/Write Mode Enable bit
1 = Enables register read/write of Timer1 in one 16-bit operation
0 = Enables register read/write of Timer1 in two 8-bit operations

bit 6 **T1RUN:** Timer1 System Clock Status bit
1 = Device clock is derived from Timer1 oscillator
0 = Device clock is derived from another source

bit 5-4 **T1CKPS1:T1CKPS0:** Timer1 Input Clock Prescale Select bits
11 = 1:8 Prescale value
10 = 1:4 Prescale value
01 = 1:2 Prescale value
00 = 1:1 Prescale value

bit 3 **T1OSCEN:** Timer1 Oscillator Enable bit
1 = Timer1 oscillator is enabled
0 = Timer1 oscillator is shut off
The oscillator inverter and feedback resistor are turned off to eliminate power drain.

bit 2 **$\overline{\text{T1SYNC}}$:** Timer1 External Clock Input Synchronization Select bit
When TMR1CS = 1:
1 = Do not synchronize external clock input
0 = Synchronize external clock input
When TMR1CS = 0:
This bit is ignored. Timer1 uses the internal clock when TMR1CS = 0.

bit 1 **TMR1CS:** Timer1 Clock Source Select bit
1 = External clock from pin RC0/T1OSO/T13CKI (on the rising edge)
0 = Internal clock (FOSC/4)

bit 0 **TMR1ON:** Timer1 On bit
1 = Enables Timer1
0 = Stops Timer1

REGISTER 13-1: T2CON: TIMER2 CONTROL REGISTER

U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
—	T2OUTPS3	T2OUTPS2	T2OUTPS1	T2OUTPS0	TMR2ON	T2CKPS1	T2CKPS0
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 7 **Unimplemented:** Read as '0'

bit 6-3 **T2OUTPS3:T2OUTPS0:** Timer2 Output Postscale Select bits
0000 = 1:1 Postscale
0001 = 1:2 Postscale
•
•
•
1111 = 1:16 Postscale

bit 2 **TMR2ON:** Timer2 On bit
1 = Timer2 is on
0 = Timer2 is off

bit 1-0 **T2CKPS1:T2CKPS0:** Timer2 Clock Prescale Select bits
00 = Prescaler is 1
01 = Prescaler is 4
1x = Prescaler is 16

REGISTER 9-1: INTCON: INTERRUPT CONTROL REGISTER

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-x
GIE/GIEH	PEIE/GIEL	TMR0IE	INT0IE	RBIE	TMR0IF	INT0IF	RBIF(1)
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 7 **GIE/GIEH:** Global Interrupt Enable bit
When IPEN = 0:
1 = Enables all unmasked interrupts
0 = Disables all interrupts
When IPEN = 1:
1 = Enables all high-priority interrupts
0 = Disables all interrupts

bit 6 **PEIE/GIEL:** Peripheral Interrupt Enable bit
When IPEN = 0:
1 = Enables all unmasked peripheral interrupts
0 = Disables all peripheral interrupts
When IPEN = 1:
1 = Enables all low-priority peripheral interrupts (if GIE/GIEH = 1)
0 = Disables all low-priority peripheral interrupts

bit 5 **TMR0IE:** TMR0 Overflow Interrupt Enable bit
1 = Enables the TMR0 overflow interrupt
0 = Disables the TMR0 overflow interrupt

bit 4 **INT0IE:** INT0 External Interrupt Enable bit
1 = Enables the INT0 external interrupt
0 = Disables the INT0 external interrupt

bit 3 **RBIE:** RB Port Change Interrupt Enable bit
1 = Enables the RB port change interrupt
0 = Disables the RB port change interrupt

bit 2 **TMR0IF:** TMR0 Overflow Interrupt Flag bit
1 = TMR0 register has overflowed (must be cleared in software)
0 = TMR0 register did not overflow

bit 1 **INT0IF:** INT0 External Interrupt Flag bit
1 = The INT0 external interrupt occurred (must be cleared in software)
0 = The INT0 external interrupt did not occur

bit 0 **RBIF:** RB Port Change Interrupt Flag bit(1)
1 = At least one of the RB7:RB4 pins changed state (must be cleared in software)
0 = None of the RB7:RB4 pins have changed state

Note 1: A mismatch condition will continue to set this bit. Reading PORTB, and then waiting one additional instruction cycle, will end the mismatch condition and allow the bit to be cleared.

REGISTER 15-1: CCPxCON: STANDARD CCPx CONTROL REGISTER

U-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
—(1)	—(1)	DCxB1	DCxB0	CCPxM3	CCPxM2	CCPxM1	CCPxM0
bit 7							bit 0

bit 7-6 **Unimplemented:** Read as '0'(1)

bit 5-4 **DCxB1:DCxB0:** PWM Duty Cycle Bit 1 and Bit 0 for CCPx Module
Capture mode:
Unused.
Compare mode:
Unused.
PWM mode:
These bits are the two LSbs (bit 1 and bit 0) of the 10-bit PWM duty cycle. The eight MSbs of the duty cycle are found in CCPR1L.

bit 3-0 **CCPxM3:CCPxM0:** CCPx Module Mode Select bits
0000 = Capture/Compare/PWM disabled (resets CCPx module)
0001 = Reserved
0010 = Compare mode: toggle output on match (CCPxIF bit is set)
0011 = Reserved
0100 = Capture mode: every falling edge
0101 = Capture mode: every rising edge
0110 = Capture mode: every 4th rising edge
0111 = Capture mode: every 16th rising edge
1000 = Compare mode: initialize CCPx pin low; on compare match, force CCPx pin high (CCPxIF bit is set)
1001 = Compare mode: initialize CCPx pin high; on compare match, force CCPx pin low (CCPxIF bit is set)
1010 = Compare mode: generate software interrupt on compare match (CCPxIF bit is set, CCPx pin reflects I/O state)
1011 = Compare mode: trigger special event, reset timer, start A/D conversion on CCPx match (CCPxIF bit is set)
11xx = PWM mode

Register 10-2: INTCON2 Register

R/W-1	R/W-1	R/W-1	R/W-1	U-0	R/W-1	U-0	R/W-1
$\overline{\text{RBPU}}$	INTEDG0	INTEDG1	INTEDG2	—	TMR0IP	—	RBIP
bit 7							bit 0

bit 7 **$\overline{\text{RBPU}}$**: PORTB Pull-up Enable bit
1 = All PORTB pull-ups are disabled
0 = PORTB pull-ups are enabled by individual port latch values

bit 6 **INTEDG0**:External Interrupt0 Edge Select bit
1 = Interrupt on rising edge
0 = Interrupt on falling edge

bit 5 **INTEDG1**: External Interrupt1 Edge Select bit
1 = Interrupt on rising edge
0 = Interrupt on falling edge

bit 4 **INTEDG2**: External Interrupt2 Edge Select bit
1 = Interrupt on rising edge
0 = Interrupt on falling edge

bit 3 **Unimplemented:** Read as '1'

bit 2 **TMR0IP**: TMR0 Overflow Interrupt Priority bit
1 = TMR0 Overflow Interrupt is a high priority event
0 = TMR0 Overflow Interrupt is a low priority event

bit 1 **Unimplemented:** Read as '1'

bit 0 **RBIP**: RB Port Change Interrupt Priority bit
1 = RB Port Change Interrupt is a high priority event
0 = RB Port Change Interrupt is a low priority event

Legend			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
- n = Value at POR reset	'1' = bit is set	'0' = bit is cleared	x = bit is unknown

Register 10-3: INTCON3 Register

R/W-1	R/W-1	U-0	R/W-0	R/W-0	U-0	R/W-0	R/W-0
INT2IP	INT1IP	—	INT2IE	INT1IE	—	INT2IF	INT1IF
bit 7							bit 0

bit 7 **INT2IP:** INT2 External Interrupt Priority bit
1 = INT2 External Interrupt is a high priority event
0 = INT2 External Interrupt is a low priority event

bit 6 **INT1IP:** INT1 External Interrupt Priority bit
1 = INT1 External Interrupt is a high priority event
0 = INT1 External Interrupt is a low priority event

bit 5 **Unimplemented:** Read as '0'

bit 4 **INT2IE:** INT2 External Interrupt Enable bit
1 = Enables the INT2 external interrupt
0 = Disables the INT2 external interrupt

bit 3 **INT1IE:** INT1 External Interrupt Enable bit
1 = Enables the INT1 external interrupt
0 = Disables the INT1 external interrupt

bit 2 **Unimplemented:** Read as '0'

bit 1 **INT2IF:** INT2 External Interrupt Flag bit
1 = The INT2 external interrupt occurred
(must be cleared in software)
0 = The INT2 external interrupt did not occur

bit 0 **INT1IF:** INT1 External Interrupt Flag bit
1 = The INT1 external interrupt occurred
(must be cleared in software)
0 = The INT1 external interrupt did not occur

Legend			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
- n = Value at POR reset	'1' = bit is set	'0' = bit is cleared	x = bit is unknown

Register 14-1: T1CON: Timer1 Control Register

R/W-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
RD16	—	T1CKPS1	T1CKPS0	T1OSCEN	$\overline{\text{T1SYNC}}$	TMR1CS	TMR1ON
bit 7							bit 0

bit 7 **RD16:** 16-bit Read/Write Mode Enable bit

1 = Enables register Read/Write of Timer1 in one 16-bit operation
0 = Enables register Read/Write of Timer1 in two 8-bit operations

bit 6 **Unimplemented:** Read as '0'

bit 5:4 **T1CKPS1:T1CKPS0**: Timer1 Input Clock Prescale Select bits

11 = 1:8 Prescale value
10 = 1:4 Prescale value
01 = 1:2 Prescale value
00 = 1:1 Prescale value

bit 3 **T1OSCEN**: Timer1 Oscillator Enable bit

1 = Timer1 Oscillator is enabled
0 = Timer1 Oscillator is shut off. The oscillator inverter and feedback resistor are turned off to eliminate power drain.

bit 2 **$\overline{\text{T1SYNC}}$**: Timer1 External Clock Input Synchronization Select bit

When TMR1CS = 1:

1 = Do not synchronize external clock input
0 = Synchronize external clock input

When TMR1CS = 0:

This bit is ignored. Timer1 uses the internal clock when TMR1CS = 0.

bit 1 **TMR1CS**: Timer1 Clock Source Select bit

1 = External clock from pin T1OSO/T13CKI (on the rising edge)
0 = Internal clock (FOSC/4)

bit 0 **TMR1ON**: Timer1 On bit

1 = Enables Timer1
0 = Stops Timer1

Legend			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
- n = Value at POR reset	'1' = bit is set	'0' = bit is cleared	x = bit is unknown

Register 15-1: T2CON: Timer2 Control Register

U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
—	TOUTPS3	TOUTPS2	TOUTPS1	TOUTPS0	TMR2ON	T2CKPS1	T2CKPS0
bit 7							bit 0

bit 7 **Unimplemented:** Read as '0'

bit 6-3 **TOUTPS3:TOUTPS0**: Timer2 Output Postscale Select bits

0000 = 1:1 Postscale
0001 = 1:2 Postscale
•
•
•
1111 = 1:16 Postscale

bit 2 **TMR2ON**: Timer2 On bit

1 = Timer2 is on
0 = Timer2 is off

bit 1-0 **T2CKPS1:T2CKPS0**: Timer2 Clock Prescale Select bits

00 = Prescaler is 1
01 = Prescaler is 4
1x = Prescaler is 16

Legend			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
- n = Value at POR reset	'1' = bit is set	'0' = bit is cleared	x = bit is unknown