Laboratory Report

Laboratory Exercise No.:	4.0	**Date Performed:**	March 13, 2024
Laboratory Exercise Title:	Timers (Timer1, Timer2 and CCP Module)		
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Part I. Data

Table 1.0 – *LE4-7 Calculations for PIC16F877A PWM Implementation*

FREQUENCIES (Hz)	DUTY CYCLE (%)	FOSC	PRESCALER	PERIOD (s)	DUTY CYCLE (s)	PR2 (HEX)	CCPR1L: CCP1CON<5: 4> (HEX)
300 Hz	10%	4Mhz	16	0.003333333	0.000333333	CF	53
300 Hz	25%	4Mhz	16	0.003333333	0.000833333	CF	D0
300 Hz	50%	4Mhz	16	0.003333333	0.001666667	CF	1A1
300 Hz	75%	4Mhz	16	0.003333333	0.0025	CF	271
300 Hz	95%	4Mhz	16	0.003333333	0.003166667	CF	318
500 Hz	10%	4Mhz	16	0.002	0.0002	7C	32
500 Hz	25%	4Mhz	16	0.002	0.0005	7C	7D
500 Hz	50%	4Mhz	16	0.002	0.001	7C	FA
500 Hz	75%	4Mhz	16	0.002	0.0015	7C	177
500 Hz	95%	4Mhz	16	0.002	0.0019	7C	1DB
1000 Hz	10%	4Mhz	16	0.001	0.0001	3E	19
1000 Hz	25%	4Mhz	16	0.001	0.00025	3E	3F
1000 Hz	50%	4Mhz	16	0.001	0.0005	3E	7D
1000 Hz	75%	4Mhz	16	0.001	0.00075	3E	BC
1000 Hz	95%	4Mhz	16	0.001	0.00095	3E	EE

NOTE: We can skip manual calculations for CCP1CON and CCP1L. Since we have a total of 10 bits available (CCP1L: 8 MSB + CCP1CON<5:4>: 2 LSB), we can directly use bit shifting to set the duty cycle value if we know the timer's maximum count (CCPR1L:CCP1CON<5:4>)

Part II. Calculations

LE4 – 7:

300 Hz:

Period = 1/f
Period = 1/300
Period = 0.0033 s

PR2 = [(Period)/(4 x T_{osc} x Prescale Value)] – 1
PR2 = [(0.0033s) / (4 x 4,000,000 x 16)] – 1
PR2 = 207_{10} or 0xCF

300 Hz w/ 10% Duty Cycle
PWM Duty Cycle = 0.1 x 0.0033s
PWM Duty Cycle = 0.00033s
(CCPR1:CCP1CON<5:4>) = (PWM Duty Cycle) / (T_{osc} x Prescale Value)
(CCPR1:CCP1CON<5:4>) = (0.00033s) / ([1/4,000,000] x 16)
(CCPR1:CCP1CON<5:4>) = 83_{10} or 0x53

300 Hz w/ 25% Duty Cycle
PWM Duty Cycle = 0.25 x 0.0033s
PWM Duty Cycle = 0.00083s
(CCPR1:CCP1CON<5:4>) = (PWM Duty Cycle) / (T_{osc} x Prescale Value)
(CCPR1:CCP1CON<5:4>) = (0.00083s) / ([1/4,000,000] x 16)
(CCPR1:CCP1CON<5:4>) = 208_{10} or 0xD0

300 Hz w/ 50% Duty Cycle
PWM Duty Cycle = 0.50 x 0.0033s
PWM Duty Cycle = 0.001666667s
(CCPR1:CCP1CON<5:4>) = (PWM Duty Cycle) / (T_{osc} x Prescale Value)
(CCPR1:CCP1CON<5:4>) = (0.001666667s) / ([1/4,000,000] x 16)
(CCPR1:CCP1CON<5:4>) = 417_{10} or 0x1A1

300 Hz w/ 75% Duty Cycle
PWM Duty Cycle = 0.75 x 0.0033s
PWM Duty Cycle = 0.0025s
(CCPR1:CCP1CON<5:4>) = (PWM Duty Cycle) / (T_{osc} x Prescale Value)
(CCPR1:CCP1CON<5:4>) = (0.0025s) / ([1/4,000,000] x 16)
(CCPR1:CCP1CON<5:4>) = 625_{10} or 0x271

300 Hz w/ 95% Duty Cycle
PWM Duty Cycle = 0.95 x 0.0033s
PWM Duty Cycle = 0.003166667s
(CCPR1:CCP1CON<5:4>) = (PWM Duty Cycle) / (T_{osc} x Prescale Value)
(CCPR1:CCP1CON<5:4>) = (0.003166667s) / ([1/4,000,000] x 16)
(CCPR1:CCP1CON<5:4>) = 792_{10} or 0x318

500 Hz:

Period = 1/f
Period = 1/500
Period = 0.002 s

PR2 = [(Period)/(4 x T_{osc} x Prescale Value)] – 1
PR2 = [(0.002s) / (4 x 4,000,000 x 16)] – 1
PR2 = 124_{10} or 0x7C

500 Hz w/ 10% Duty Cycle
PWM Duty Cycle = 0.1 x 0.002s
PWM Duty Cycle = 0.0002s
(CCPR1:CCP1CON<5:4>) = (PWM Duty Cycle) / (T_{osc} x Prescale Value)
(CCPR1:CCP1CON<5:4>) = (0.0002s) / ([1/4,000,000] x 16)
(CCPR1:CCP1CON<5:4>) = 50_{10} or 0x32

500 Hz w/ 25% Duty Cycle
PWM Duty Cycle = 0.25 x 0.002s
PWM Duty Cycle = 0.0005s
(CCPR1:CCP1CON<5:4>) = (PWM Duty Cycle) / (T_{osc} x Prescale Value)
(CCPR1:CCP1CON<5:4>) = (0.0005s) / ([1/4,000,000] x 16)
(CCPR1:CCP1CON<5:4>) = 125_{10} or 0x7D

500 Hz w/ 50% Duty Cycle
PWM Duty Cycle = 0.50 x 0.002s
PWM Duty Cycle = 0.001s
(CCPR1:CCP1CON<5:4>) = (PWM Duty Cycle) / (T_{osc} x Prescale Value)
(CCPR1:CCP1CON<5:4>) = (0.001s) / ([1/4,000,000] x 16)
(CCPR1:CCP1CON<5:4>) = 250_{10} or 0xFA

500 Hz w/ 75% Duty Cycle
PWM Duty Cycle = 0.75 x 0.002s
PWM Duty Cycle = 0.0015s
(CCPR1:CCP1CON<5:4>) = (PWM Duty Cycle) / (T_{osc} x Prescale Value)
(CCPR1:CCP1CON<5:4>) = (0.0015s) / ([1/4,000,000] x 16)
(CCPR1:CCP1CON<5:4>) = 375_{10} or 0x177

500 Hz w/ 95% Duty Cycle

PWM Duty Cycle = 0.95 x 0.002s
PWM Duty Cycle = 0.0019s
(CCPR1:CCP1CON<5:4>) = (PWM Duty Cycle) / (T_{osc} x Prescale Value)
(CCPR1:CCP1CON<5:4>) = (0.0019s) / ([1/4,000,000] x 16)
(CCPR1:CCP1CON<5:4>) = 475_{10} or 0x1DB

1000 Hz:

Period = 1/f
Period = 1/1000
Period = 0.001 s

PR2 = [(Period)/(4 x T_{osc} x Prescale Value)] – 1
PR2 = [(0.001s) / (4 x 4,000,000 x 16)] – 1
PR2 = 62_0 or 0x3E

1000 Hz w/ 10% Duty Cycle

PWM Duty Cycle = 0.1 x 0.001s
PWM Duty Cycle = 0.0001s
(CCPR1:CCP1CON<5:4>) = (PWM Duty Cycle) / (T_{osc} x Prescale Value)
(CCPR1:CCP1CON<5:4>) = (0.0001s) / ([1/4,000,000] x 16)
(CCPR1:CCP1CON<5:4>) = 25_{10} or 0x19

1000 Hz w/ 25% Duty Cycle

PWM Duty Cycle = 0.25 x 0.001s
PWM Duty Cycle = 0.00025s
(CCPR1:CCP1CON<5:4>) = (PWM Duty Cycle) / (T_{osc} x Prescale Value)
(CCPR1:CCP1CON<5:4>) = (0.00025s) / ([1/4,000,000] x 16)
(CCPR1:CCP1CON<5:4>) = 63_{10} or 0x3F

1000 Hz w/ 50% Duty Cycle

PWM Duty Cycle = 0.50 x 0.001s
PWM Duty Cycle = 0.0005s
(CCPR1:CCP1CON<5:4>) = (PWM Duty Cycle) / (T_{osc} x Prescale Value)
(CCPR1:CCP1CON<5:4>) = (0.0005s) / ([1/4,000,000] x 16)
(CCPR1:CCP1CON<5:4>) = 125_{10} or 0x7D

1000 Hz w/ 75% Duty Cycle

PWM Duty Cycle = 0.75 x 0.001s
PWM Duty Cycle = 0.00075s
(CCPR1:CCP1CON<5:4>) = (PWM Duty Cycle) / (T_{osc} x Prescale Value)
(CCPR1:CCP1CON<5:4>) = (0.00075s) / ([1/4,000,000] x 16)
(CCPR1:CCP1CON<5:4>) = 188_{10} or 0Xbc

1000 Hz w/ 95% Duty Cycle

PWM Duty Cycle = 0.95 x 0.001s

PWM Duty Cycle = 0.00095s

(CCPR1:CCP1CON<5:4>) = (PWM Duty Cycle) / (T_{osc} x Prescale Value)

(CCPR1:CCP1CON<5:4>) = (0.00095s) / ([1/4,000,000] x 16)

(CCPR1:CCP1CON<5:4>) = 238_{10} or 0xEE