Group 3 CPE 3201 LE4

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Part I.

Frequency (Hz)	Period displayed at LCD (ms)	Calculated Period (ms)
1	472	1000
10	96	100
20	48	50
30	32	32
40	24	25
50	16	20
60	16	17
70	8	14
80	8	13
90	8	11
100	8	10
200	0	5
500	0	2
1000	0	1

PART II. CALCULATIONS

Formulas:

Formula for PR2 finding the value for PWM Period:

$$PWM\ Period = [PR2 + 1] \times 4\ \times T_{osc}\ \times TMR2\ Prescaler\ Value$$

Formula for PWM Duty Cycle:

$$PWM\ Duty\ Cycle = (CCPR1L{:}\,CCP1CON < 5{:}4 >) \times T_{osc} \times\ TMR2\ Prescaler\ Value$$

Formula for Period:

$$Period\ (s) = 1/Frequency$$

Frequency: 500Hz, 1000Hz, 2000Hz

PWM Period = 1/Frequency

Using a TMR2 Prescaler value of 1:16

$$T_{osc} = \frac{1}{4MHz}$$

$$PR2 = \frac{PWM\ Period}{[4 \times T_{osc} \times TMR2\ Prescaler\ Value]} - 1$$

PR2:

For PR2 @ 500Hz:

$$PR2 = \frac{PWM\ Period}{[4 \times T_{osc} \times TMR2\ Prescaler\ Value]} - 1$$

$$PR2 = \frac{\frac{1}{500}}{4 \times \frac{1}{4MHz} \times 16} - 1$$

$$\boldsymbol{PR2 = 124_{10}\ or\ 7C_{16}}$$

For PR2 @ 1000Hz:

$$PR2 = \frac{PWM\ Period}{[4 \times T_{osc} \times TMR2\ Prescaler\ Value]} - 1$$

$$PR2 = \frac{\frac{1}{1000}}{4 \times \frac{1}{4MHz} \times 16} - 1$$

$$\boldsymbol{PR2 = 62_{10}\ or\ 3E_{16}}$$

For PR2 @ 2000Hz:

$$PR2 = \frac{PWM\ Period}{[4 \times T_{osc} \times TMR2\ Prescaler\ Value]} - 1$$

$$PR2 = \frac{\frac{1}{2000}}{4 \times \frac{1}{4MHz} \times 16}$$

$$\boldsymbol{PR2 = 30_{10}\ or\ 1E_{16}}$$

Duty Cycle: 10%, 25%, 50%, 75%, 95%

$$PWM\ Duty\ Cycle\ = \left(\frac{Duty\ Cycle(\%)}{100}\right) \times PWM\ Period$$

CCPR1L:CCP1CON<5:4>:

Period @500Hz:

PWM Duty Cycle @ 10%:

$$PWM\ Period\ = \frac{1}{500} Hz = 0.002s$$

$$PWM\ Duty\ Cycle\ @\ 10\% =\ .10\ \times 0.002s = 0.0002s$$

$$T_{on} = 0.0002s$$

$$PWM\ Duty\ Cycle = (CCPR1L{:}CCP1CON < 5{:}4 >) \times T_{osc} \times\ TMR2\ Prescaler\ Value$$

$$0.0002s = (CCPR1L{:}CCP1CON < 5{:}4 >) \times \frac{1}{4MHz} \times\ 16$$

$$CCPR1L{:}CCP1CON < 5{:}4 > = \frac{0.0002s}{\frac{1}{4MHz} \times 16} = 50_{10} = 0000110010_2$$

$$CCPR1L =\ 00001100_2$$

$$CCP1CON < 5{:}4 > = 10_2$$

PWM Duty Cycle @ 25%:

$$PWM\ Period\ = \frac{1}{500} Hz = 0.002s$$

$$PWM\ Duty\ Cycle\ @\ 25\% =\ .25\ \times 0.002s = 0.0005s$$

$$T_{on} = 0.0005s$$

$$PWM\ Duty\ Cycle = (CCPR1L{:}CCP1CON < 5{:}4 >) \times T_{osc} \times\ TMR2\ Prescaler\ Value$$

$$0.0005s = (CCPR1L{:}CCP1CON < 5{:}4 >) \times \frac{1}{4MHz} \times\ 16$$

$$CCPR1L{:}CCP1CON < 5{:}4 > = \frac{0.0005s}{\frac{1}{4MHz} \times 16} = 125_{10} = 0001111101_2$$

$$CCPR1L =\ 00011111_2$$

$$CCP1CON < 5{:}4 > = 01_2$$

PWM Duty Cycle @ 50%:

$$PWM\ Period\ = \frac{1}{500} Hz = 0.002s$$

$$PWM\ Duty\ Cycle\ @\ 50\% = \ .50\ \times 0.002s = 0.001s$$

$$T_{on} = 0.001s$$

$$PWM\ Duty\ Cycle = (CCPR1L{:}CCP1CON < 5{:}4 >) \times T_{osc} \times\ TMR2\ Prescaler\ Value$$

$$0.001s = (CCPR1L{:}CCP1CON < 5{:}4 >) \times \frac{1}{4MHz} \times\ 16$$

$$CCPR1L{:}CCP1CON < 5{:}4 > = \frac{0.001s}{\frac{1}{4MHz} \times 16} = 250_{10} = 0011111010_2$$

$$CCPR1L = \ 00111110_2$$

$$CCP1CON < 5{:}4 > = 10_2$$

PWM Duty Cycle @ 75%:

$$PWM\ Period\ = \frac{1}{500} Hz = 0.002s$$

$$PWM\ Duty\ Cycle\ @\ 75\% = \ .75\ \times 0.002s = 0.0015s$$

$$T_{on} = 0.0015s$$

$$PWM\ Duty\ Cycle = (CCPR1L{:}CCP1CON < 5{:}4 >) \times T_{osc} \times\ TMR2\ Prescaler\ Value$$

$$0.0015s = (CCPR1L{:}CCP1CON < 5{:}4 >) \times \frac{1}{4MHz} \times\ 16$$

$$CCPR1L{:}CCP1CON < 5{:}4 > = \frac{0.0015s}{\frac{1}{4MHz} \times 16} = 375_{10} = 0101110111_2$$

$$CCPR1L = \ 01011101_2$$

$$CCP1CON < 5{:}4 > = 11_2$$

PWM Duty Cycle @ 95%:

$$PWM\ Period\ = \frac{1}{500} Hz = 0.002s$$

$$PWM\ Duty\ Cycle\ @\ 95\% = \ .95\ \times 0.002s = 0.0019s$$

$T_{on} = 0.0019s$

$PWM\ Duty\ Cycle = (CCPR1L{:}CCP1CON<5{:}4>) \times T_{osc} \times\ TMR2\ Prescaler\ Value$

$0.0019s = (CCPR1L{:}CCP1CON<5{:}4>) \times \frac{1}{4MHz} \times\ 16$

$CCPR1L{:}CCP1CON<5{:}4> = \frac{0.0019s}{\frac{1}{4MHz} \times 16} = 475_{10} = 0111011011_2$

$CCPR1L = \ 01110110_2$

$CCP1CON<5{:}4> = 11_2$

Period @1000Hz:

PWM Duty Cycle @ 10%:

$PWM\ Period\ = \frac{1}{1000} Hz = 0.001s$

$PWM\ Duty\ Cycle\ @\ 10\% = \ .10\ \times 0.001s = 0.0001s$

$T_{on} = 0.0001s$

$PWM\ Duty\ Cycle = (CCPR1L{:}CCP1CON<5{:}4>) \times T_{osc} \times\ TMR2\ Prescaler\ Value$

$0.0001s = (CCPR1L{:}CCP1CON<5{:}4>) \times \frac{1}{4MHz} \times\ 16$

$CCPR1L{:}CCP1CON<5{:}4> = \frac{0.0001s}{\frac{1}{4MHz} \times 16} = 25_{10} = 0000011001_2$

$CCPR1L = \ 00000110_2$

$CCP1CON<5{:}4> = 01_2$

PWM Duty Cycle @ 25%:

$PWM\ Period\ = \frac{1}{1000} Hz = 0.001s$

$PWM\ Duty\ Cycle\ @\ 25\% = \ .25\ \times 0.001s = 0.00025s$

$T_{on} = 0.00025s$

$PWM\ Duty\ Cycle = (CCPR1L{:}CCP1CON<5{:}4>) \times T_{osc} \times\ TMR2\ Prescaler\ Value$

$0.00025s = (CCPR1L{:}CCP1CON<5{:}4>) \times \frac{1}{4MHz} \times\ 16$

$CCPR1L:CCP1CON<5:4>=\frac{0.00025s}{\frac{1}{4MHz}\times 16}=62_{10}=0000111110_2$

$CCPR1L=\ 00001111_2$

$CCP1CON<5:4>=10_2$

PWM Duty Cycle @ 50%:

$PWM\ Period\ =\frac{1}{1000}Hz=0.001s$

$PWM\ Duty\ Cycle\ @\ 50\%=\ .50\ \times 0.001s=0.0005s$

$T_{on}=0.0005s$

$PWM\ Duty\ Cycle=(CCPR1L:CCP1CON<5:4>)\times T_{osc}\times\ TMR2\ Prescaler\ Value$

$0.0005s=(CCPR1L:CCP1CON<5:4>)\times\frac{1}{4MHz}\times\ 16$

$CCPR1L:CCP1CON<5:4>=\frac{0.0005s}{\frac{1}{4MHz}\times 16}=125_{10}=0001111101_2$

$CCPR1L=\ 00011111_2$

$CCP1CON<5:4>=01_2$

PWM Duty Cycle @ 75%:

$PWM\ Period\ =\frac{1}{1000}Hz=0.001s$

$PWM\ Duty\ Cycle\ @\ 75\%=\ .75\ \times 0.001s=0.00075s$

$T_{on}=0.00075s$

$PWM\ Duty\ Cycle=(CCPR1L:CCP1CON<5:4>)\times T_{osc}\times\ TMR2\ Prescaler\ Value$

$0.00075s=(CCPR1L:CCP1CON<5:4>)\times\frac{1}{4MHz}\times\ 16$

$CCPR1L:CCP1CON<5:4>=\frac{0.00075s}{\frac{1}{4MHz}\times 16}=187_{10}=0010111011_2$

$CCPR1L=\ 00101110_2$

$CCP1CON<5:4>=11_2$

PWM Duty Cycle @ 95%:

$$PWM\ Period\ = \frac{1}{1000} Hz = 0.001s$$

$$PWM\ Duty\ Cycle\ @\ 95\% = \ .95\ \times 0.001s = 0.00095s$$

$$T_{on} = 0.00095s$$

$$PWM\ Duty\ Cycle = (CCPR1L{:}CCP1CON < 5{:}4 >) \times T_{osc} \times\ TMR2\ Prescaler\ Value$$

$$0.00095s = (CCPR1L{:}CCP1CON < 5{:}4 >) \times \frac{1}{4MHz} \times\ 16$$

$$CCPR1L{:}CCP1CON < 5{:}4 > = \frac{0.00095s}{\frac{1}{4MHz} \times 16} = 237_{10} = 0011101101_2$$

$$CCPR1L = \ 00111011_2$$

$$CCP1CON < 5{:}4 > = 01_2$$

Period @2000Hz:

PWM Duty Cycle @ 10%:

$$PWM\ Period\ = \frac{1}{2000} Hz = 0.0005s$$

$$PWM\ Duty\ Cycle\ @\ 10\% = \ .10\ \times 0.0005s = 0.00005s$$

$$T_{on} = 0.00005s$$

$$PWM\ Duty\ Cycle = (CCPR1L{:}CCP1CON < 5{:}4 >) \times T_{osc} \times\ TMR2\ Prescaler\ Value$$

$$0.00005s = (CCPR1L{:}CCP1CON < 5{:}4 >) \times \frac{1}{4MHz} \times\ 16$$

$$CCPR1L{:}CCP1CON < 5{:}4 > = \frac{0.00005s}{\frac{1}{4MHz} \times 16} = 12_{10} = 0000001100_2$$

$$CCPR1L = \ 00000011_2$$

$$CCP1CON < 5{:}4 > = 00_2$$

PWM Duty Cycle @ 25%:

$$PWM\ Period\ = \frac{1}{2000} Hz = 0.0005s$$

$$PWM\ Duty\ Cycle\ @\ 25\% = \ .25\ \times 0.0005s = 0.000125s$$

$$T_{on} = 0.000125s$$

$$PWM\ Duty\ Cycle = (CCPR1L{:}CCP1CON<5{:}4>) \times T_{osc} \times\ TMR2\ Prescaler\ Value$$

$$0.000125s = (CCPR1L{:}CCP1CON<5{:}4>) \times \frac{1}{4MHz} \times\ 16$$

$$CCPR1L{:}CCP1CON<5{:}4> = \frac{0.000125s}{\frac{1}{4MHz}\times 16} = 31_{10} = 0000011111_2$$

$$CCPR1L = \ 00000111_2$$

$$CCP1CON<5{:}4> = 11_2$$

PWM Duty Cycle @ 50%:

$$PWM\ Period\ = \frac{1}{2000} Hz = 0.0005s$$

$$PWM\ Duty\ Cycle\ @\ 50\% = \ .50\ \times 0.0005s = 0.00025s$$

$$T_{on} = 0.00025s$$

$$PWM\ Duty\ Cycle = (CCPR1L{:}CCP1CON<5{:}4>) \times T_{osc} \times\ TMR2\ Prescaler\ Value$$

$$0.00025s = (CCPR1L{:}CCP1CON<5{:}4>) \times \frac{1}{4MHz} \times\ 16$$

$$CCPR1L{:}CCP1CON<5{:}4> = \frac{0.00025s}{\frac{1}{4MHz}\times 16} = 62_{10} = 0000111110_2$$

$$CCPR1L = \ 00001111_2$$

$$CCP1CON<5{:}4> = 10_2$$

PWM Duty Cycle @ 75%:

$$PWM\ Period\ = \frac{1}{2000} Hz = 0.0005s$$

$$PWM\ Duty\ Cycle\ @\ 75\% = \ .75\ \times 0.0005s = 0.000375s$$

$$T_{on} = 0.000375s$$

$$PWM\ Duty\ Cycle = (CCPR1L{:}CCP1CON<5{:}4>) \times T_{osc} \times\ TMR2\ Prescaler\ Value$$

$$0.000375s = (CCPR1L{:}CCP1CON<5{:}4>) \times \frac{1}{4MHz} \times\ 16$$

$$CCPR1L:CCP1CON<5:4>=\frac{0.000375s}{\frac{1}{4MHz}\times 16}=93_{10}=0001011101_2$$

$$CCPR1L=\ 00010111_2$$

$$CCP1CON<5:4>=01_2$$

PWM Duty Cycle @ 95%:

$$PWM\ Period\ =\frac{1}{2000}Hz=0.0005s$$

$$PWM\ Duty\ Cycle\ @\ 95\%=\ .95\ \times 0.0005s=0.000475s$$

$$T_{on}=0.000475s$$

$$PWM\ Duty\ Cycle=(CCPR1L:CCP1CON<5:4>)\times T_{osc}\times\ TMR2\ Prescaler\ Value$$

$$0.000475s=(CCPR1L:CCP1CON<5:4>)\times\frac{1}{4MHz}\times\ 16$$

$$CCPR1L:CCP1CON<5:4>=\frac{0.000475s}{\frac{1}{4MHz}\times 16}=118_{10}=0001110110_2$$

$$CCPR1L=\ 00011101_2$$

$$CCP1CON<5:4>=10_2$$