CMPE242 Review Part II
HL

1. PWM Design

1.1. Characterization of an PWM devices, frequency range, duty cycle range, number of PWM channels, output voltage range of the PWM signal.

3.2. Architectural aspects of ADC, in particular, the special purpose registers responsible for setting up PWM frequency and duty cycle init&config. Four (4) step operation to set up PWM clock rate.

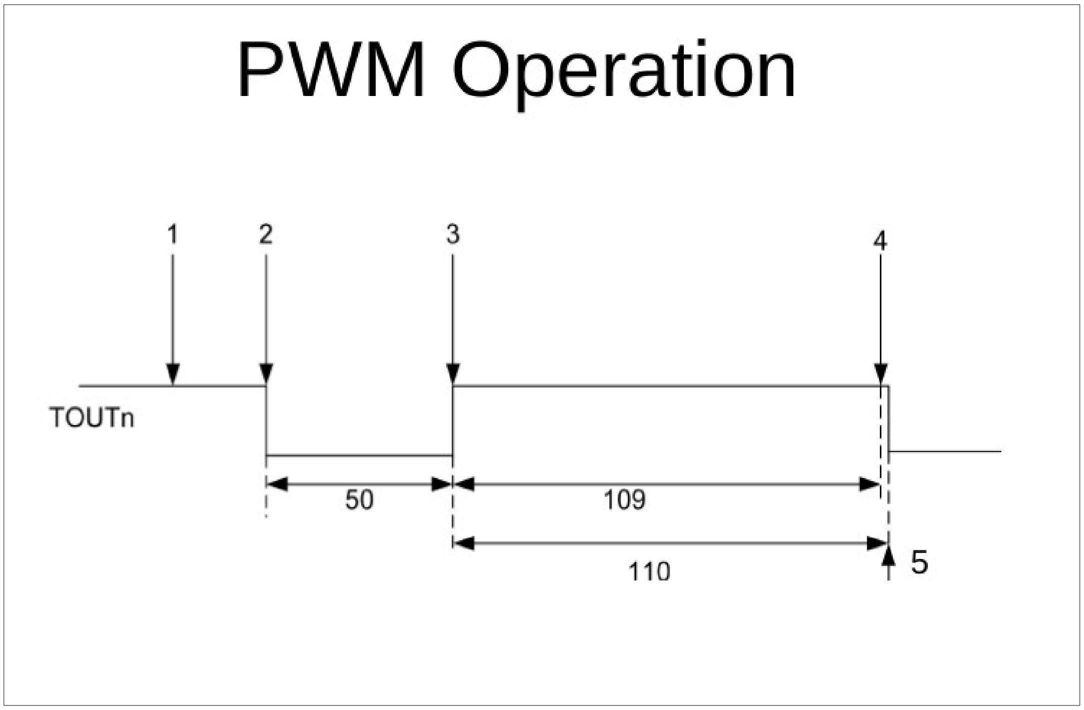

Figure 1.

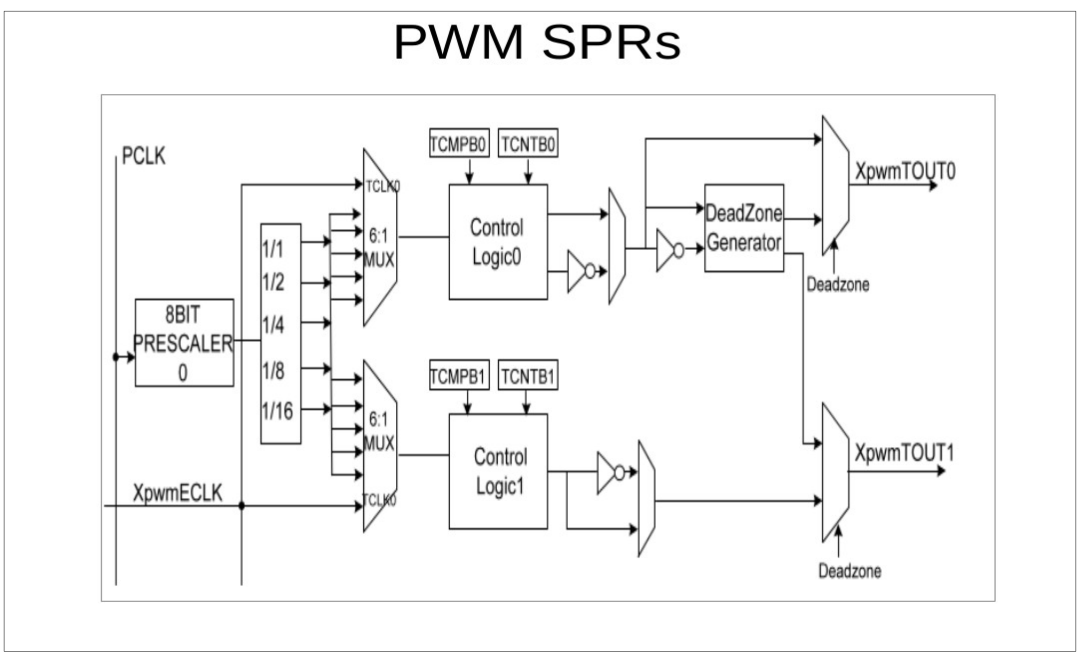

Figure 2.

Step 1. The down-counter is initially loaded from the Timer Count Buffer register (TCNTBn).

Step 2. For each clk, it will counts down, when the down count value in TCNTBn matches TCMPBn (Timer Compare Buffer) register. The output level changes. (e.g. the compare register determines the turn-on time of a PWM output.the

Step 3. When down-counter TCNTBn reaches 0, the interrupt is generated, one cycle is finished.

Step 4. TCNTBn can be automatically reloaded to start the next cycle.

Note: The TCNTBn and TCMPBn registers are double buffered to allow the timer parameters to be updated in the middle of a cycle. The new values will not take effect until the current timer cycle completes.

Figure 3.

3.3. Kernel space device driver and its modification to add control of both frequency and duty cycle, user application program to call PWM device driver program.

3.4. Use PWM signal in PID loop for stepper motor control, such as mapping Error_sigma (=Proportion Error + Derivative Error + Integral Error), the design of mapping functions to find proper PWM frequency and proper duty cycle. (note we do change duty cycle often then frequency in Robotics for example)

3.5. Applications, such as driving a electric car or robot, one motor/wheel control vs. two motors/wheels control for example.

2. IoT Sensor Interface

2.1. Digital sensor interface protocols, such as UART/RS232, SPI, I2C, GPP etc.

2.2. Analog sensor interface, analog current protocol 4-20 mA.

2.3. OpAmp preprocessing design for industrial analog sensors interface design. Inverting and non-inverting configuration.

2.4. Design and build OpAmp based sensor interface circuit for IoT applications, basic building blocks such as addition, subtraction, multiplication and division, etc. Circuit design for SPICE simulation with industrial SPICE simulation tool such as those from Linear Inc. tool.

2.5. Characterization of ISE (Ion Selective Electrode) sensors, e.g., its characteristics curve.

2.6. Design analog ISE sensor interface to meet the best engineering practice requirements for full dynamic range of ADC input.

3. ADC Design

3.1. Characterization of an ADC devices, number of samples per second, number of bits per sample, linearity (or non-linearity, maximum distortion in terms of LSB and conversion to the analog signal input level).

3.2. Architectural aspects of ADC, in particular, the special purpose registers responsible for init&config, and their settings.

3.3. Kernel space device driver and its modification, user application program to call ADC device driver program.

3.4. Experimental characterization of ADC and characteristics curve of ADC. Analyze the characteristics and calculate the maximum ADC data distortion and find its impact on the analog input signal values (either in voltage or in current).

3.5. Compensation function design and C/C++ implementation. Performance issues, number of clocks added to the compensation and result in sampling frequency reduction.

3.6. Data validation, DFT and signal power spectrum computation, analyze the energy distribution, and improve energy distribution techniques to satisfy Nyquest theory.

3.7. Integration of ADC into PWM/GPP based PID controller to drive stepper motors, such as NEMA17 with angular motion sensor input.

(End)