- Disable the PWM pin (PxTCON) output drivers as an input by setting the associated TRIS bit.
- Set the PWM period by loading the TxTPER register.
- Configure the CCP module for the PWM mode by loading the PWMxCONy register with the appropriate values.
- Set the PWM duty cycle by loading the PxDCy register.
- Set the dead time by loading the PxDTCONy register.
- Configure and start Timer2.
- Enable the PWMx pin output driver by clearing the associated TRIS bit.

C. SVPWM USING ATmega328P

The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button as shown in Fig.3. Simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Arduino can do standard mathematical operations. While floating point numbers are allowed if declared as floats.

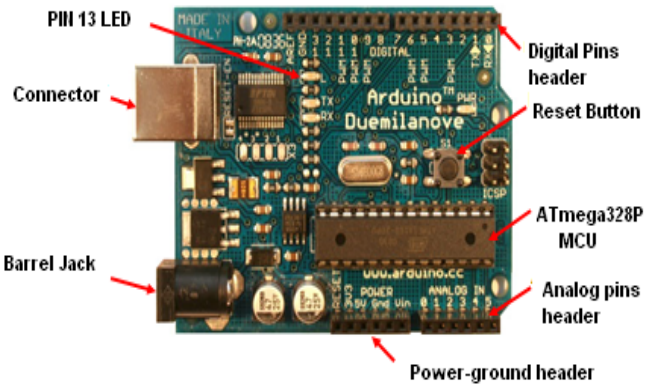

Figure 3: Arduino Board

D. Specifications

Microcontroller: ATmega328
Operating Voltage: 5V
Input Voltage (recommended): 7-12V
Input Voltage (limits): 6-20V
Digital I/O Pins: 14 (of which 6 provide PWM output)
Analog Input Pins: 6
DC Current per I/O Pin: 40 mA
DC Current for 3.3V Pin: 50 mA
Flash Memory: 32 KB (ATmega328) of which 0.5 KB used by boot loader
SRAM: 2 KB (ATmega328)
EEPROM: 1 KB (ATmega328)
Clock Speed: 16MHz

Arduino also created software which is compatible with all Arduino microcontrollers. The software, also called "Arduino", can be used to program any of the Arduino microcontrollers by selecting them from a drop-down menu. Being open source, and based around C.

The Arduino development environment contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions, and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them. Software written using Arduino is called sketches. These sketches are written in the text editor. It has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino environment including complete error messages and other information. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

E. PWM Module

The phase correct PWM mode (WGM2:0=1 or 5) provides a high resolution phase correct PWM waveform generation option. Phase correct PWM is based on a dual slope operation. The counter counts repeatedly from BOTTOM to TOP and then from TOP to BOTTOM. TOP is defined as 0xFF when WGM2:0=1, and OCR0A when WGM2:0=5[9].

In phase correct mode the counter is incremented until the counter value matches TOP. When the counter reached TOP, it changes the count direction. TCNT0 value will be equal to TOP for one timer clock cycle. The compare unit allows generation of PWM waveforms on the OC0xpins setting. COM0x1:0=2 will produce a non-inverting PWM. An inverting PWM output can be generated by setting the COM0x1:0=3. Setting the COM0A0=1allows the OC0A pin to toggle on compare matches if the WGM02 bit is set. The actual OC0x value will only be visible on the port pin if the direction for the port pin is set as output. The PWM waveform is generated by setting the OC0x register at the compare match between OCRx and TCNT0 when the counter increments and setting the OCRx register at compare match between OCRx and TCNT0 when the counter decrements[9].

The generations of Space vector pulse Width Modulation Waveforms are shown in below Fig.5.

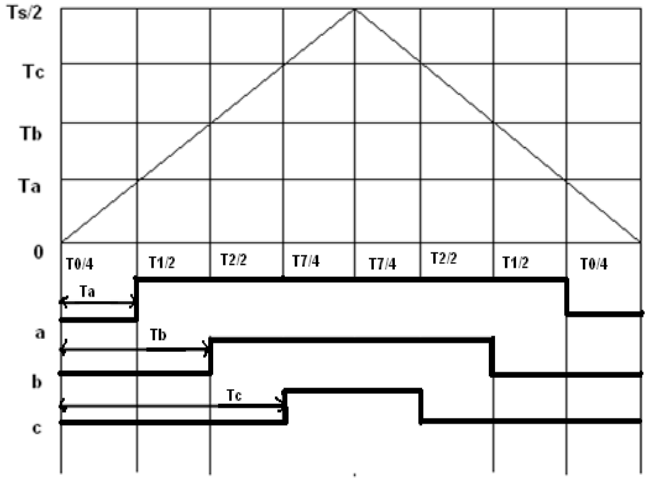

Figure 5: Generation of SVPWM waveforms

The algorithm used for implementing SVPWM inverter using ATmega is as follows

- Generate sine wave using look up table.

- Initialize Time base control registers where center aligned PWM operation takes place by selecting continuous up/down count mode.
- Initialize register values where duty cycles are loaded.
- Calculate Vs and φ based on the requirement of V_α and V_β.
- Given a period T of carrier wave, calculate T_1, T_2, and T_0.
- Calculate duty cycles T_a, T_b & T_c in TIM1, TIM2& TIM3 registers. At the beginning of a new cycle (PWM interrupt occurs) T_1, T_2, and T_0 are computed. And then, the active time of S_1, S_2,. . . , S_6 switches are consequently written in the TIM1, TIM2, and TIM3 registers of the ATmega328 microcontroller.

F. Flow Chart

The flow chart for implementing SVPWM using ATmega328p is shown in Fig.6.

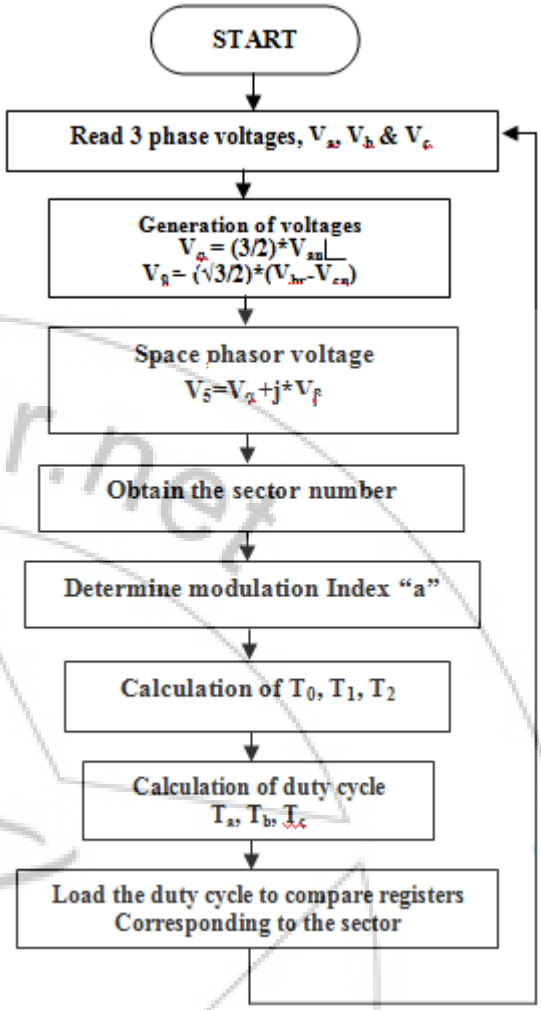

Figure 6: Flow chart for SVPWM Implementation

4. Results and Discussions

The space vector PWM waveforms generated are symmetric with respect to the middle of each PWM period. Symmetric waveform generation will eliminate even harmonics and reduces the odd harmonics. Symmetric space vector PWM generation is shown in Fig.7.

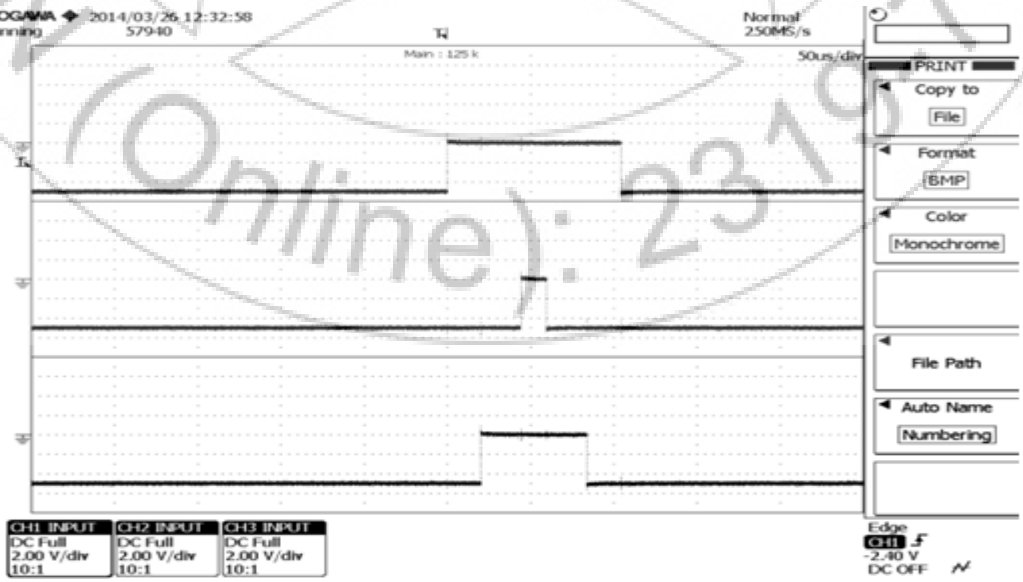

Figure 7: Symmetrical waveform generation

5. Conclusion

The basic principle of SVPWM, brief description about different processors like DSP, dsPIC and ATmega and the algorithm of SVPWM using ATmega has been discussed in this paper. It has been reviewed that ATmega with its advanced features and the advantages over other processors is the suitable processor for implementing Space Vector Pulse Width Modulation technique for the inverter switching control.

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