# Understanding Microchip's Family of PIC Micro's

The Microchip family of PIC (Peripheral Interface Controller) microcontrollers is quickly becoming the preferred choice of designers and experimenters around the world. Microchip has continued to develop new parts at such a rapid pace that it can be difficult to keep up. If your presently using a PIC in any of your designs your probably familiar with at least some of the PIC's available. If your new to the PIC, the task of trying to figure out the differences in the family of parts can be difficult. My intent is to help guide you through by explaining the basic differences in the most common PIC microcontrollers.

**Overview**
The PIC family breaks up into three main groups which are:

12 bit instruction core (16C5X, 12C5XX)
14 bit instruction core (16C5XX,16C62X, 16C6X, 16C7X, 16C8X, 16F8X, 12C6XX, 16C9XX, 14C000)
16 bit instruction core (17CXX)

All three groups share the same core set of RISC instructions with additional instructions available on the 14 and 16 bit cores. This means that assembly code written for the 12 bit family can be easily upgraded to work on a 14 or 16 bit core part. This is one of the great advantages to the PIC. Microchip also decided to focus on making OTP (One Time Programmable) parts at affordable prices. This allows the experimenter, hobbiest or professional designer to build affordable products without shelling out major dollars for windowed EPROM parts or worse, custom silicon ROM parts. All instructions (except branch and goto instructions) execute within 1 clock cycle (crystal freq. / 4) which makes it easy to check the execution timing.

**12 bit instruction core**
This is the original core produced and are the most cost effective parts available from Microchip. They use only 33 instructions making it very easy to learn and remember all the instructions. Below are the group members.

**16C5X**
This is the group used in the Basic Stamp Controllers that are popular with the many readers of Nuts and Volts. They are very useful parts and offer several variations. They come in three different packages 18 pin, 28 pin (DIP or SOIC), or 20 pin package (SSOP) . They offer two different amounts of I/O to meet your design requirements 12 I/O or 20 I/O. Code space is available in three sizes 0.5K, 1K or 2K for your program (instructions are 12 bits wide). This can be deceiving though because the mnemonic and operand are included in the same word so your program will probably use less code space than compared to a Motorola 8 bit micro. Available RAM is 25 or 72 bytes (the 72 bytes are available in a banking arrangement only which is somewhat annoying). One 8 bit timer is included with no interrupt on timer overflow. They all have one internal watch dog timer that runs on its own RC circuit so it works during low power sleep mode. All parts

also share high I/O current capability of 20 ma source / 25 ma sink which is incredibly useful for driving LED's full bright or driving power transistors directly. They work over a large voltage range of 2.5 - 6.25 volts (it may be less if you choose the high frequency crystal option). They will run at crystal speeds of 20 Mhz which is an instruction time of 200 nanoseconds. With the fact most instructions execute within one clock cycle, very fast routines can be accomplished. These parts are limited to a two level stack which makes nested subroutines difficult but not impossible because the program counter on all PIC's can be written to.
The biggest difference between the 5X and the other PIC's is the lack of interrupts. If you need an external interrupt then you have to move up to the 14 bit core parts. Finally these parts in sleep mode can draw as little as 1.0 uA which is very useful for battery applications.

**12C5XX**
These parts also use the 12 bit core and have many of the same 5X features with one major difference, they come in an 8 pin package. These parts are very unique and are the smallest micro available today. Because of the 8 pin package constraint, creative solutions were required to allow for enough I/O to be useful. They have 1 input only pin and 5 I/O, Vdd (B+) and Vss (gnd) for a total of 8 pins. To achieve this Microchip developed an on board oscillator. It's not as accurate as a crystal or even resonator but it works great if timing is not critical (accuracy is about +- 2.5% over -40 to +85 C). This eliminates the need for any external oscillator parts although it can be used with a crystal or resonator at the cost of two I/O. These parts also share the MCLR reset pin with the I/O so if you need that function you lose another I/O. Microchip did add a form of interrupt. It's a wake up on state change interrupt. If the micro is in sleep mode, a change of state from low to high or high to low on any of 4 I/O will wake up the processor. Not much different than a external reset on the MCLR pin but it does allow simple switch hook-up to the micro.

**14 bit instruction core**
This group increases the number of instructions by two for a total of 35. Microchip actually added 4 instructions and replaced two with special function registers. Two math function commands are added and two return commands were added. One return command for the interrupts and one for subroutine returns which can be nested deeper on the 14 bit core because the stack increases to eight levels. The two instructions replaced by a special function register are the TRIS (port direction) and OPTION (special function). The 14 bit core will work with the 12 bit core code but these two instructions will have to change slightly.

**16C55X**
This is a recent addition to the 14 bit core group. The 16C55X are pin for pin compatible with their 5X 12 bit core cousins with a major addition, interrupts. They also add 1 more I/O pin by sharing the TOCKI external clock pin (used for incrementing the 8 bit timer from an external source). The interrupts include the 12CXXX wake up on state change interrupt along with a real interrupt pin for capturing an event. Also included is a timer overflow interrupt for the 8 bit timer. All the interrupts jump to a single redirection

register so your main interrupt routine will have to bit test the interrupt flags within the INTCON register. Your program can mask any and all interrupts through the INTCON register also. A final difference is the I/O characteristics increase to 25 ma sink and source.

**16C62X**

These parts are similar to the 55X group but add two on board comparators to the package.
The 62X have 13 I/O and 0.5K ,1K or 2K of 14 bit wide code space.
They share all the features of the 14 bit core group including the interrupts. If you need comparators in your design then these could reduce your overall parts count.

**16C6X**

These parts were of the original 14 bit core group. They consist of several parts with unique features. They start out with the 16C61 which isn't much different than the 16C556 part but the rest of the 16C6X group is very different. They add the following features to those parts mentioned above: 2k,4k or 8k of code space for your program, 22 or 33 I/O, synchronous serial port (shared with I/O), 1 or 2 Capture/Compare/ PWM pins (shared with I/O) and three timers ( two 8bit, one 16 bit). The 16 bit timer is great for accurate timing requirements. It can run from its own crystal separate from the main clock source. It will even run during sleep mode allowing time to increment while very little current is being consumed by the PIC. It has an overflow interrupt so you can wake up from sleep process the timer information and then sleep some more. The synchronous serial port can be used to communicate with serial devices. It operates in two modes 1) Serial Peripheral Interface(SPI) or 2) Inter-Integrated Circuit (I2C).
These are real powerful parts.

**16C7X**

These parts are identical to their 6X cousin with the addition of 4, 5 or 8 channels of 8-bit on board Analog to Digital converter (A/D). For example if your design uses a 16C62 and you need to add A/D then drop a 16C72 in its place. They are pin for pin compatible with each other. The A/D are shared with some of the port A and Port E I/O pins so its best to save these when doing a non A/D design that may later need A/D.

**16C67X**

These are the latest parts available as I write this and I think are the most unique. They are 8-pin package versions of the 14 bit core group. They share the I/O the same way the 12CXXX 8-pin parts do to maintain 1 input only and 5 I/O. The amazing thing is that they also have 2 channels of A/D that operate the same as the 16C7X parts (shared with the I/O). Code that was written to work with the 16C7X A/D will work on the 16C67X parts. They also have all the 14 bit core interrupts. One 8 bit timer with timer overflow interrupt and build in oscillator option. They offer 0.5K and 1K of code space. A lot of micro in a small package.

**16C8X,16F8X**

If your looking for a flash or EEPROM version of the PIC this is the group. Originally Microchip only offered EEPROM versions (16C8X) but have now released them in flash (16F8X). They have all the features of the base 14 bit core group. Interrupts, 13 I/O, one 8 bit timer, 0.5K or 1K of code space as EEPROM or flash and 36 or 68 bytes of RAM. Unique to these parts is the 64 bytes of EEPROM data memory. This data will stay even when power is removed so its great for storing calibration or variable data to be used when the program starts again.

**16C9XX**

This is a new addition to the 14 bit core group that shares many of the 16C63 and 16C73 features (3 -timers, interrupts, etc.). This group adds another feature, on board Liquid Crystal Display(LCD) drive circuitry. It can drive up to 122 segments using 4 commons. The 16C924 also has 5 channels of A/D on board making this a great part for measuring analog signals and then displaying the results on an LCD. With the 16 bit timer it could display time for possible datalog applications. With the synchronous serial port any kind of external data storage or PC interface is possible. These parts seem to have it all except on board EEPROM for non volatile memory storage.

**14C000**

This is a different numbering scheme and offers a different approach. It's a mixed signal processor. It has a slope type A/D rather than the sample and hold and also has D/A capability. It shares the higher end 14 bit core characteristics including the three timers and such. These are unique parts when compared to the rest of the PIC's but share the same code.

**16 bit instruction core**

This is the high end group from Microchip. They offer up to 33 Mhz clock speed for a 121 nanosecond instruction time. They have the same 35 instructions as the 14 bit core plus 23 more instructions. The stack increases to 16 levels. 33 I/O is standard with two open drain high voltage (12 V) and high current (60 ma) pins. They add another 16 bit timer for four total timers. These parts can also operate as a microprocessor rather than a microcontroller by accessing the program to be executed from external memory. These parts are numbered as **17CXX.** If you understand these parts then you probably didn't need to read everything I wrote above.

**Summary**

I think you'll find a part to meet your next design requirements within the Microchip family. I started with the 16C54 and never left. I continue to be amazed at how fast Microchip is creating new components. They are working on expanding the flash group which seems the be the desire these days. Microchip also offers a fine selection of EEPROM including some unique parts there also. Hopefully I can cover those in another article. My next goal is to explain the various options for programming these parts including the FREE simulator and assembler available from Microchip at www.microchip.com. Along with that I'd like to address the option of programming these

parts using the BASIC language which is great for beginners. Until next time, keep on PIC'n.  Comments or questions can be sent to the author at eproducts@juno.com.