PICPilot PIC microprocessor upgrade

6/2/2016

# Motivation

The motivation for upgrading the PIC microprocessor is due to the lack of PWM outputs. With the current PIC (dsPIC33FJ256GP710), there are 8 input and 8 output PWMs. However, for the VTOL there will be a lot more PWMs needed than 8. Listed below are the possible PWM outputs needed. These estimates are over approximated to accommodate future expansions.

|  |  |
| --- | --- |
| Hardware | # of PWM outputs |
| Motors | 4 |
| Wing tilt | 2 |
| Wing locking mechanism | 2 |
| Ailerons | 2 |
| Elevator | 1 |
| Rudder | 1 |
| Flaps | 1 |
| Probe Drops | 4 |
| Total | 17 |

Other possibilities were considered when deciding whether or not to upgrade the PIC. The other main design possibility was using an I2C PWM extender. The advantages to this design included already having a breakout board, and adding 16 extra channels which would be sufficient. The plan would include either using the breakout board, or adding the PWM extension circuitry onto the PICPilot board. The cons to this plan were that it would take up an I2C port, meaning we would have no extra I2C if we needed to add any more sensors, and it would either require another chip on the PIC, or another breakout board in the fuselage. There are also other advantages to upgrading PIC, including increased clock speed and more serial ports.

# Design Requirements

The following are the criteria that the new PIC would need to have:

* 2 or more ADC
* 2 or more SPI
* 2 or more UART
* 2 or more I2C
* Clock speed 40 or greater MIPS
* 16 or more input compares (PWM)
* 20 or more output PWM

# PIC Options

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Product | 5K Pricing | CPU Speed (MIPS) | Program Memory (KB) | I/O Pins | Pin count | ADC Modules | UART | SPI | I2C | Input Capture | Max. PWM Outputs |
| dsPIC33EP256MU810 | $5.49 | 70 | 256 | 83 | 100 | 2 | 4 | 4 | 2 | 16 | 28 |
| dsPIC33EP256MU814 | $6.10 | 70 | 256 | 122 | 144 | 2 | 4 | 4 | 2 | 16 | 30 |
| dsPIC33EP512MU810 | $6.16 | 70 | 512 | 83 | 100 | 2 | 4 | 4 | 2 | 16 | 28 |
| dsPIC33EP512MU814 | $6.78 | 70 | 512 | 122 | 144 | 2 | 4 | 4 | 2 | 16 | 30 |

From: http://www.microchip.com/ParamChartSearch/Chart.aspx?branchID=8194#

These are the PICs that meet the criteria listed in the design requirements. We selected PIC33EP512MU810 because of its pin smaller pin count, bigger memory, and enough PWM outputs. There is no reason to use a 144 pin chip that will take up more space, at it will be more advantageous to get the PIC with a bigger memory. There are more I/O pins on some of the other models, but the PICPilot does not use many I/O pins just for their I/O functionality.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Product | 5K Pricing | CPU Speed (MIPS) | Program Memory (KB) | Auxiliary Flash (KB) | RAM (Bytes) | I/O Pins | UART | SPI | # USB Modules | Input Capture | Max. PWM Outputs | PWM Resolution (ns) | Parallel Port |
| PIC33FJ256GP710A | $5.32 | 40 | 256 | 0 | 30720 | 85 | 2 | 2 | 0 | 8 | 8 | 25 | GPIO |
| PIC33EP512MU810 | $6.16 | 70 | 512 | 24 | 53248 | 83 | 4 | 4 | 1 | 16 | 28 | 7 | PMP |

The comparison between the old PIC (-710A) and the proposed upgrade (-810) offers multiple benefits. It provides twice as many inputs and over three times as many outputs. The new chip would also have a better PWM resolution. The new microprocessor would have a better CPU speed, which would give better performance. Although it is unclear how the 24k auxiliary flash is controlled, it could be used for saving settings.

# Other Improvements

## Multi-layer

We have decided to upgrade the board to have 4 layers, to give better power and ground distribution. This could help eliminate some of the problems we were having with PWM signals, and will also make trace routing much easier.

## Increased Relayed Channels

To upgrade to vtol, there will be more critical channels. Because of this, the PICPilot will be upgraded with more relays to facilitate safe transition into manual mode.

## External Memory

An SD card reader will be added for log file capability, and possibly also settings like gains. This will be helpful for debugging, especially in the event of losing radio communication to the ground station. The SD card communicates to the PIC using SPI.

# Contributors

Lead-Stephen Cholvat

PCB design-Mathew Di Lordo

Person to answer all PICPilot questions- Chris Hadjuk

# Resources

Microchip website:

Comparison between old and new chip:

Old datasheet:

New datasheet:

PICPilot PCB/schematic: