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Introduction to GPS and PICAXE

Introduction

Welcome to this short tutorial introducing the use of GPS with the popular PICAXE system.

"The **Global Positioning System (GPS)** is a global navigation satellite system (GNSS) developed by the United States Department of Defence and managed by the United States Air Force 50th Space Wing. It is the only fully functional GNSS in the world, can be used freely by anyone, anywhere, and is often used by civilians for navigation purposes. It uses a constellation of between 24 and 32 medium Earth orbit satellites that transmit precise radiowave signals, which allow GPS receivers to determine their current location, the time, and their velocity."
http://en.wikipedia.org/wiki/Global_Positioning_System

In this tutorial we will be using the EM-410 GPS module manufactured by Globalsat, and a PICAXE 18X chip.

This is also the point where I say that I'm not responsible for the content of the external links provided. People always write this, surly someone is responsible for all the world's "external links". Maybe we will never know who is…

Background Reading

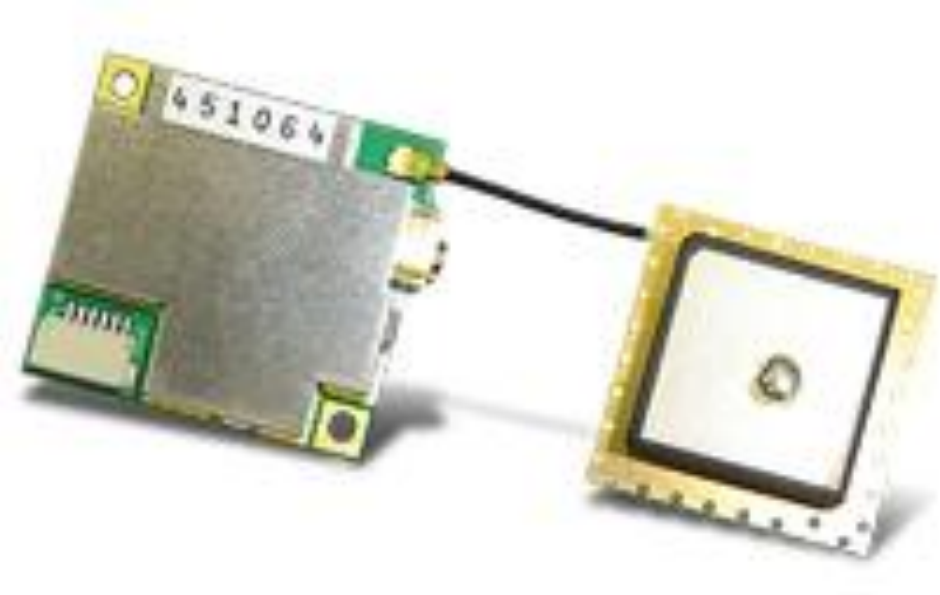
I recommend reading the following articles to build up your knowledge and understanding of GPS' and their interface.

- The sparkfun GPS tutorial:
http://www.sparkfun.com/commerce/tutorial_info.php?tutorials_id=68&page=1
- GPS tutorial by Michael Simpson, part 1 only (this deals more with PC interface of GPS) :
http://www.kronosrobotics.com/Projects/GPS.shtml
- NMEA reference guide:
http://www.sparkfun.com/datasheets/GPS/NMEA%20Reference%20Manual1.pdf
- sparkfun GPS buying guide :
http://www.sparkfun.com/commerce/tutorial_info.php?tutorials_id=127

The EM-410 is not mentioned in any of the GPS guides, however you can consider it to be almost exactly the same as the EM-406.

Once you have a good understanding of GPS, NMEA sentences and have reached a higher plane on enlightenment….continue on.

EM-410



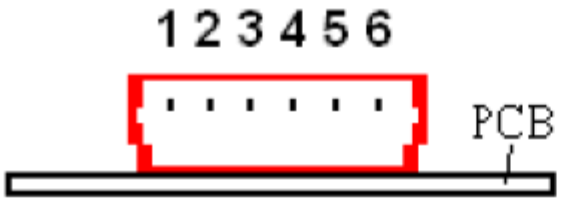
The Em-410 is a very small low cost GPS receiver. It uses an active antenna which can either be a ceramic chip antenna (shown in picture) or one on a wire. The connector is MMCX female on the board. A search for “MMCX” on eBay will give you a host of suitable antennas.

The module uses a rather annoying connector, this can be purchased from cool components or Sparkfun.

Annoying connector

EM-410 Datasheet

EM-410 Pins



PIN	NAME	
PIN 1	VDD	3.3v
PIN 2	GND	0v
PIN 3	GPS-TX	To PICAXE input
PIN 4	GPS-RX	To PICAXE output
PIN 5	GPS-LED	*
PIN 6	GPS-VBAT	3.3v

Taken and adapted from EM-410 Datasheet

*I still haven't figured out how to use this. I'm not risking putting power into it.

RS-232 Setup

This is if you want to have a direct PC link to first just to check the GPS is working or to see the output on a terminal window.

The RS-232 is a generic set up. All it does is change the voltage level of the input to a higher one. This is because the PC serial signals operate on up to 12v and often electronic components operate on 5v or 3.3v. So all you need to do to use this generic circuit: connect the GPS RX and TX to the chip, and don't forget to change the chip voltage to 3.3v. Connect to your PC serial port, and view the output with a terminal program.

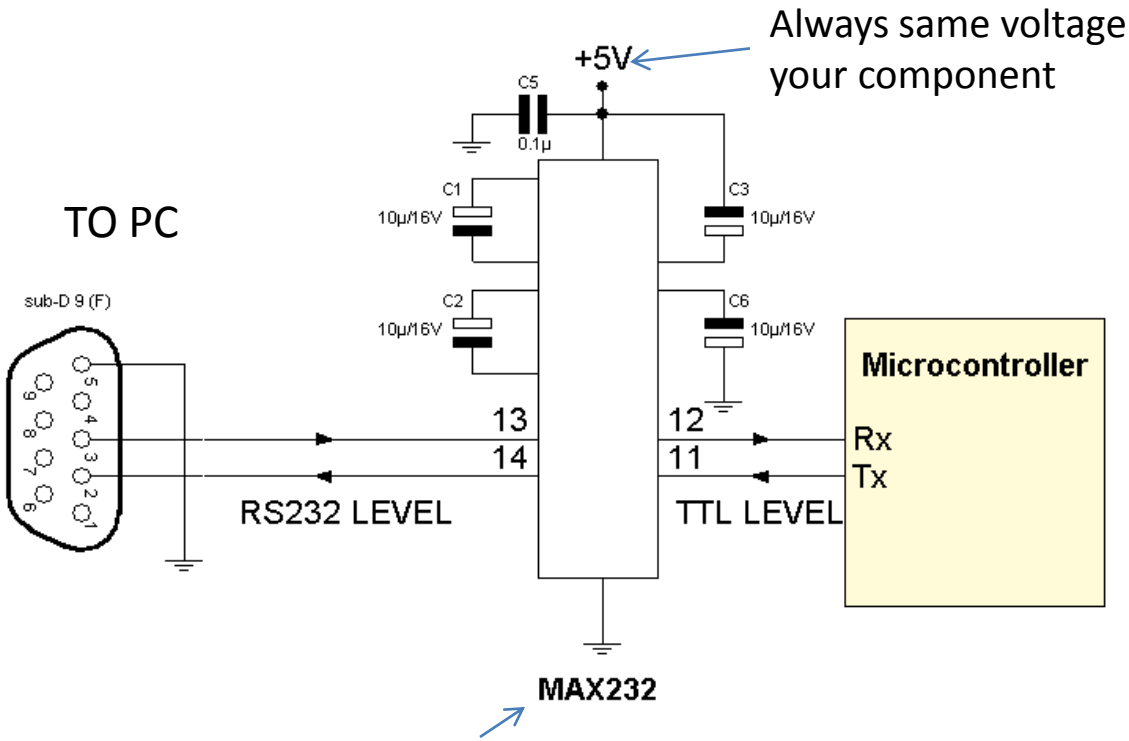
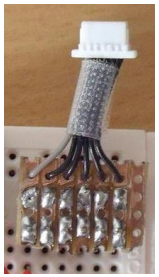
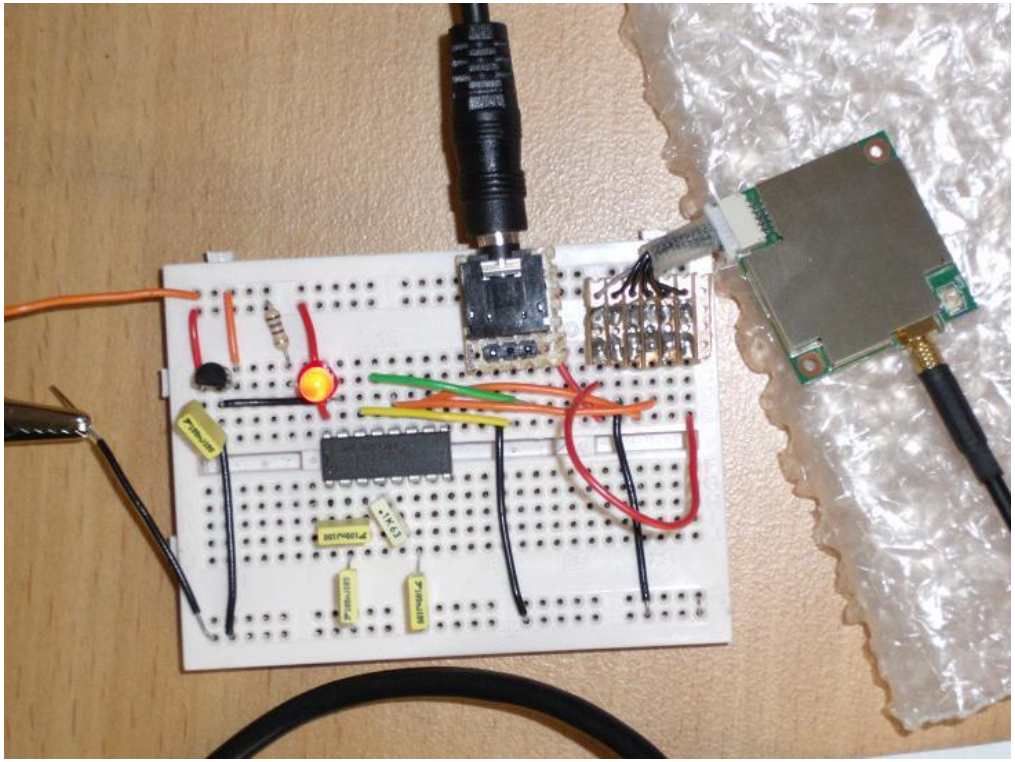


Image from
http://www.coolcircuit.com/circuit/rs232_driver/index.html

Setup



This is the annoying connector where the other end has been cut off and the wires have been broken out onto pins which then allow it to be plugged into a breadboard.



This is a picture of my setup, the GPS is connected to the PC via a RS-232 chip and serial cable.

Setup

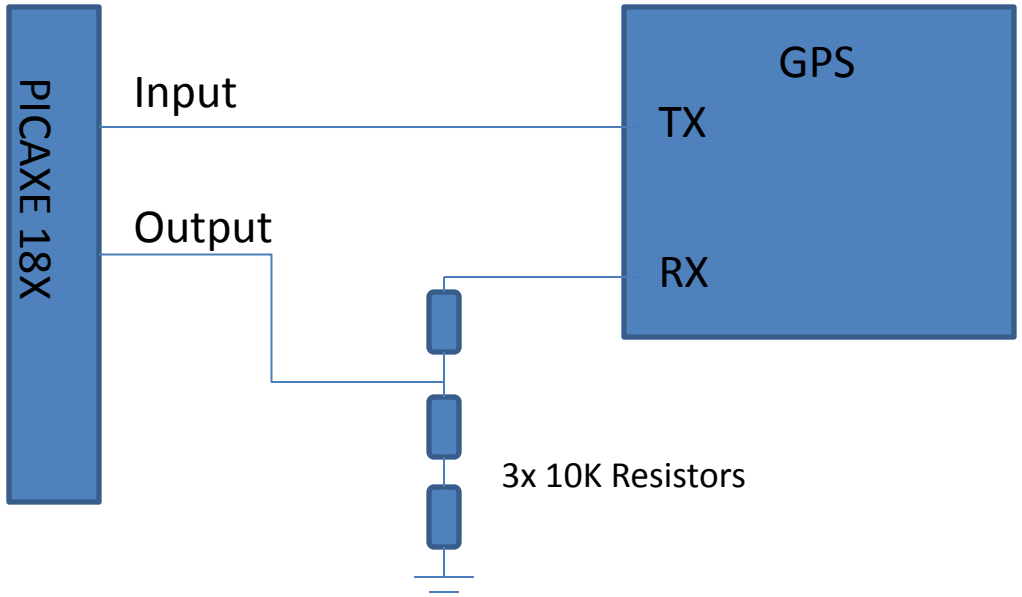
Getting the module up and running is easy.

•Power it up according to the datasheet, (note GPS-VBAT must be powered for operation) GPS module is 3.3V

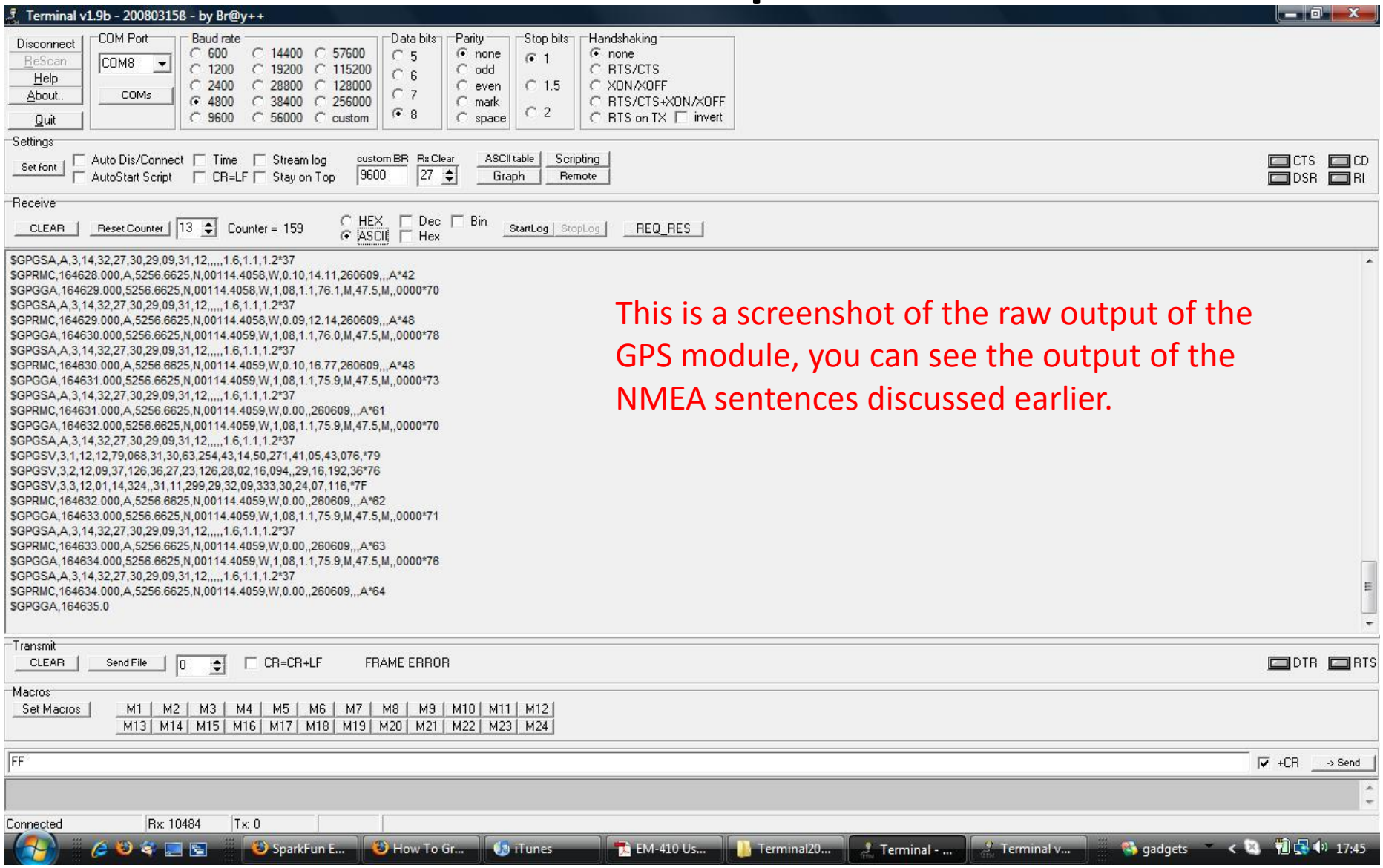
• Connect GPS-TX to a PICAXE input

•Connect GPS-RX to a PICAXE output

Once powered the module will immediately begin to output serial data. Check that it is with a logic probe on the GPS-TX pin.



Setup



This is a screenshot of the raw output of the GPS module, you can see the output of the NMEA sentences discussed earlier.

Programming

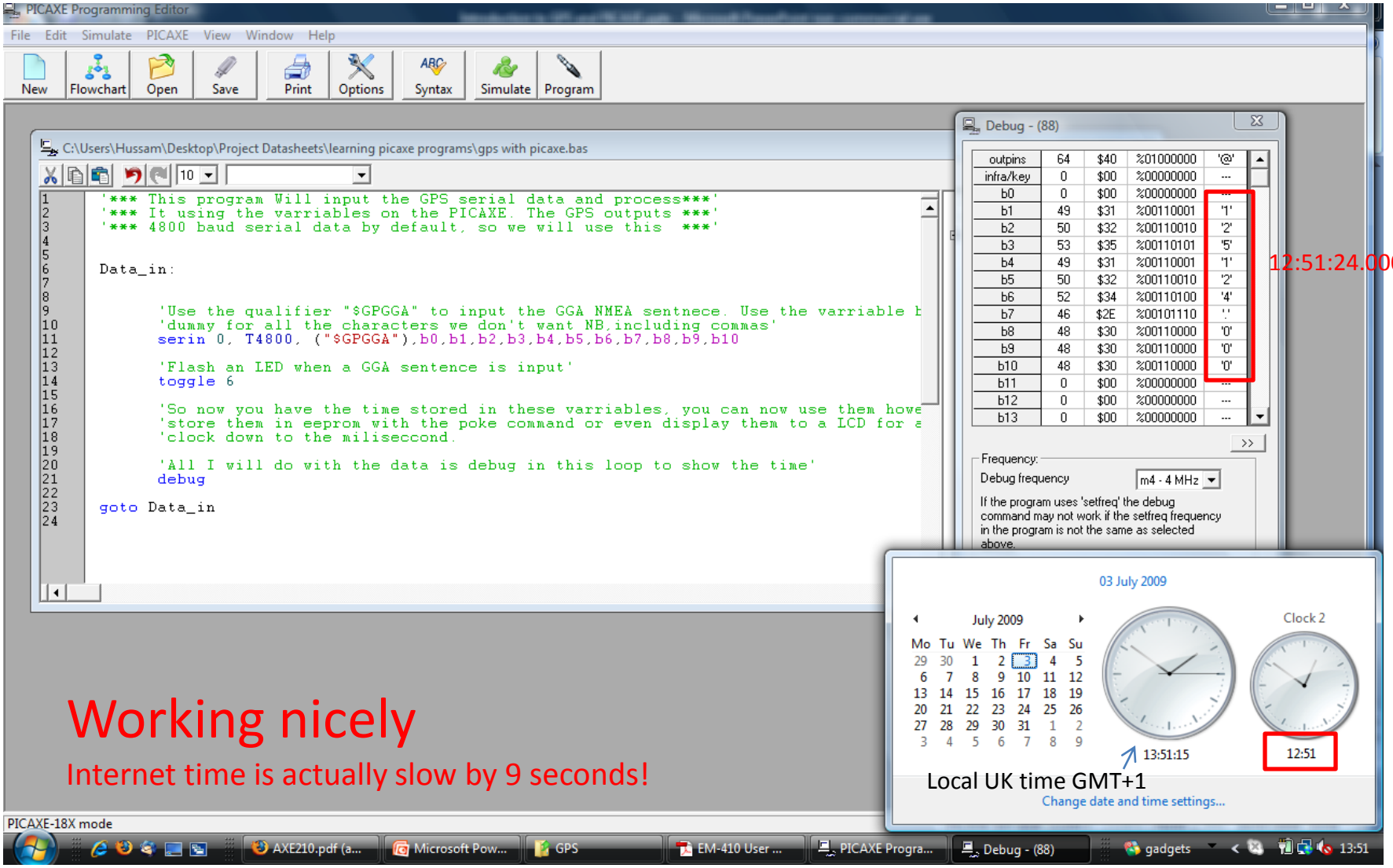
Now that you have a circuit up and running, and if you are already proficient with PICAXE programming you could probably now go off and start using the data from the GPS using only a few simple commands.

But next I will present a simple run through of a program that will demonstrate all you need to know to begin using GPS with PICAXE.

Program

```
'*** This program will input the GPS serial data and process***'
'*** It using the variables on the PICAXE. The GPS outputs ***'
'*** 4800 baud serial data by default, so we will use this  ***'


Data_in:


        'Use the qualifier "$GPGGA" to input the GGA NMEA sentence. Use the variable b0 as a
        'dummy for all the characters we don't want NB, including commas'
        serin 0, T4800, ("$GPGGA"),b0,b1,b2,b3,b4,b5,b6,b7,b8,b9,b10

        'Flash an LED when a GGA sentence is input'
        toggle 6

        'So now you have the time stored in these variables, you can now use them however you want,
        'store them in EEPROM with the poke command or even display them to a LCD for a very accurate
        'clock down to the millisecond.

        'All I will do with the data is debug in this loop to show the time'
        debug

goto Data_in
```

Program



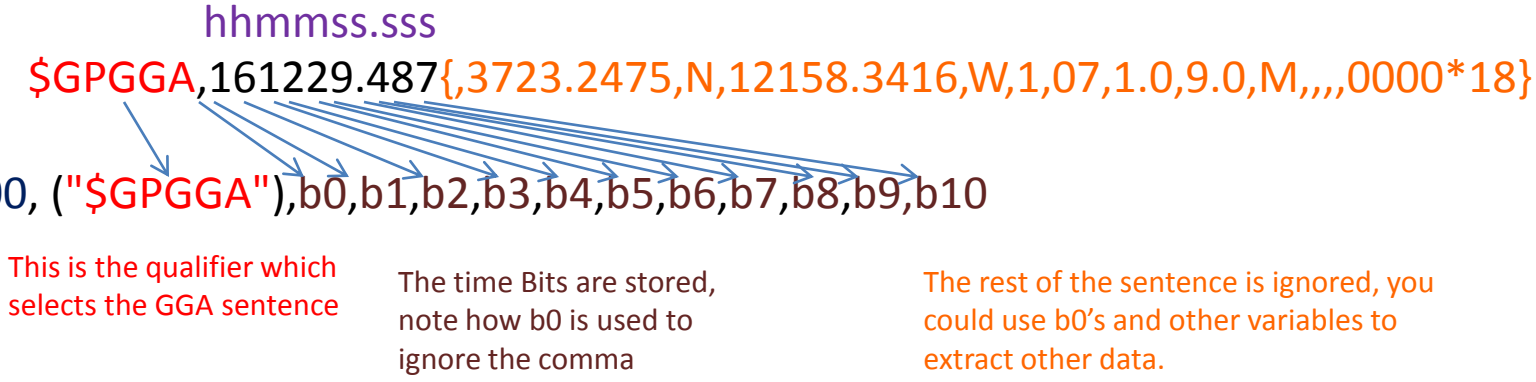
Working nicely

Internet time is actually slow by 9 seconds!

Program

The great thing about the GGA sentence is that its format never changes*, so we can write our serial in line as in the previous slide and simply count along and place variables where we want to extract the data. The b0 variable is a dummy and is used to maintain the formatting, however it is ignored.

If you are still unsure, with reference to page 6 of the EM-410 datasheet lets break it down…



So using the same idea you can extract other data, e.g. longitude and latitude.

* Yes the format never changes BUT some fields may be empty for whatever reason. If this is the case one solution I can think of is to store the entire GGA sentence using the peek/poke commands and then count the commas to find what you want. It is a clumsy method, however I have only seen empty fields when it's just starting up or finding satellites.

Troubleshooting

The EM-410 is a 3.3v device so as a result the serial it outputs is around 3v. If the serial input is connected to a pin which is a Schmitt trigger there will be insufficient voltage to drive it. See the following posts on the PICAXE forum for details:
http://www.picaxeforum.co.uk/showthread.php?t=11711
http://www.picaxeforum.co.uk/showthread.php?t=8609
Update: There is now a fix for this using a logic level shifter, see application note 1

4800 baud rate is not supported fully across the PICAXE range, read the “serin” section of the Basic commands PICAXE manual.

I recommend using an external resonator on the PICAXE for increased reliability.

As with any project make sure you read all relevant documentation if you want to use any other hardware as to not cause damage t your electronics.

If all else fails…. Just set up exactly as my example using the same pins and go from there. My full PICAXE schematic can be found at the end.

Conclusion

So there you have a simple introduction into interfacing any serial GPS module to a PICAXE microcontroller.

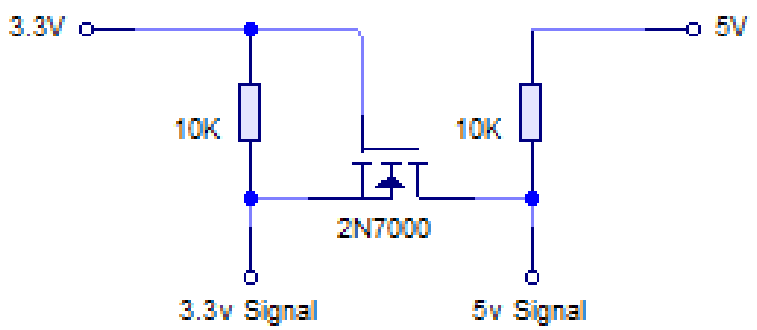
Once you are able to extract data freely, you can move onto more advanced operations. Using the longitude and latitude you could calculate bearings or you could send the coordinates to a computer and write a short C program which will interface with something like Google Earth, there are probably many discussions of such projects online. Hope this helps.

Application note 1

This is a solution to the problem of insufficient voltage levels to trigger a Schmitt Trigger pin on a PICAXE when using the “serin” command. The solution is a DC voltage level shifter.

A level shifter will change the voltage level according to the circuits’ power lines. E.g. for us the level shifter will change between 3.3v and 5v. Also its bi-directional.

It’s a very simple set up that uses any old MOSFET and two resistors.



I used the general purpose 2N7000 MOSFET, but I had used some 3A power MOSFET’s while I was waiting for the 2N7000’s to arrive!

The Gate is always connected to the LOWER voltage.

PICAXE Setup

Using a PICAXE 18X with the EM-410 (should also work for EM-406)