GPS Series - Part 4

By Michael Simpson

Interface to a GPS Module or Receiver

As seen in January 2008 of Servo Magazine
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I closed out last month's article by showing you how to connect the GPSLoggerOut program on your PC to a microcontroller. Let's take a closer look at the interface needed for each of the GPS modules we have covered in this series.

Important: I inadvertently misspelled NMEA as NEMA in several locations in the code. While this has been corrected in this article, the original function names remain unchanged with the original misspelling.

EM-406A

The actual connections to the DiosWorkboard are shown in Figure 2. The module comes with a small connector that is used to connect the EM-406 to an evaluation board. We need to modify this cable as shown in Figure 3 so that we can plug it into a breadboard or prototype board.

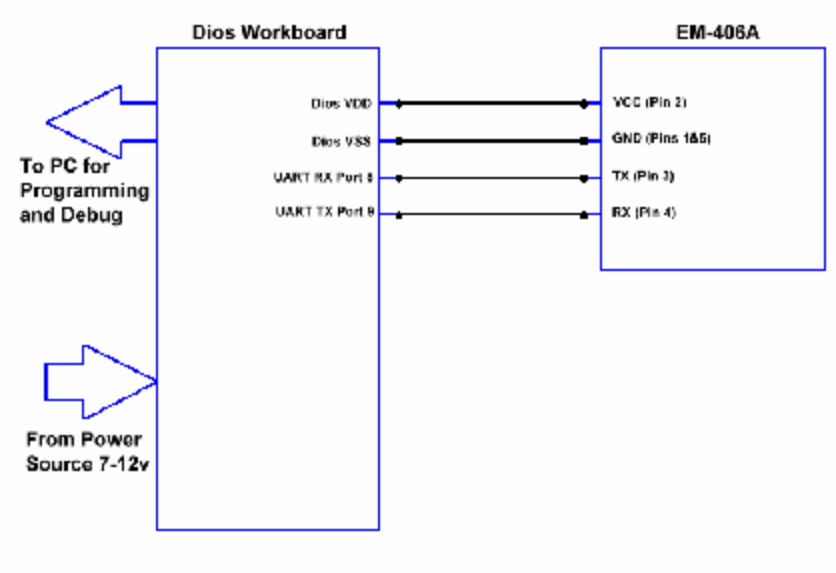

Figure 2

Figure 3

Figure 4 shows the actual pin-out on the connector from the EM-406 module's point of view. I placed a small piece of double-sided tape on the module to hold it in place on the breadboard as shown in Figure 5. I then made the following connections:

EM406, Pin 1 (GND) - DiosPro Vss
EM406, Pin 2 (VCC) - DiosPro Vcc (5v)
EM406, Pin 3 (TX) – DiosPro Port 8 (UART RX)

On the cable that I made I tied both Pin-1 and Pin-5 together. At this point you don't need to connect the PPS or RX pins.

EM-406A Observations

Of all the modules tested, I found the EM-406 to be the most sensitive and easiest to use. I was able to lock on to 4 or 5 satellites in my basement workshop. At times even the

WAAS receiver kicked in when in the basement. In normal operation outside, I found the EM-406 to be very accurate once the WAAS receiver connected. The only downside was the lack of an external antenna connector. There is no need to send commands to set up the module so only the TX lead is needed for the interface. I also liked the fact that the module could be operated at 5 volts. This makes the interface to both the PC and microcontroller very easy.

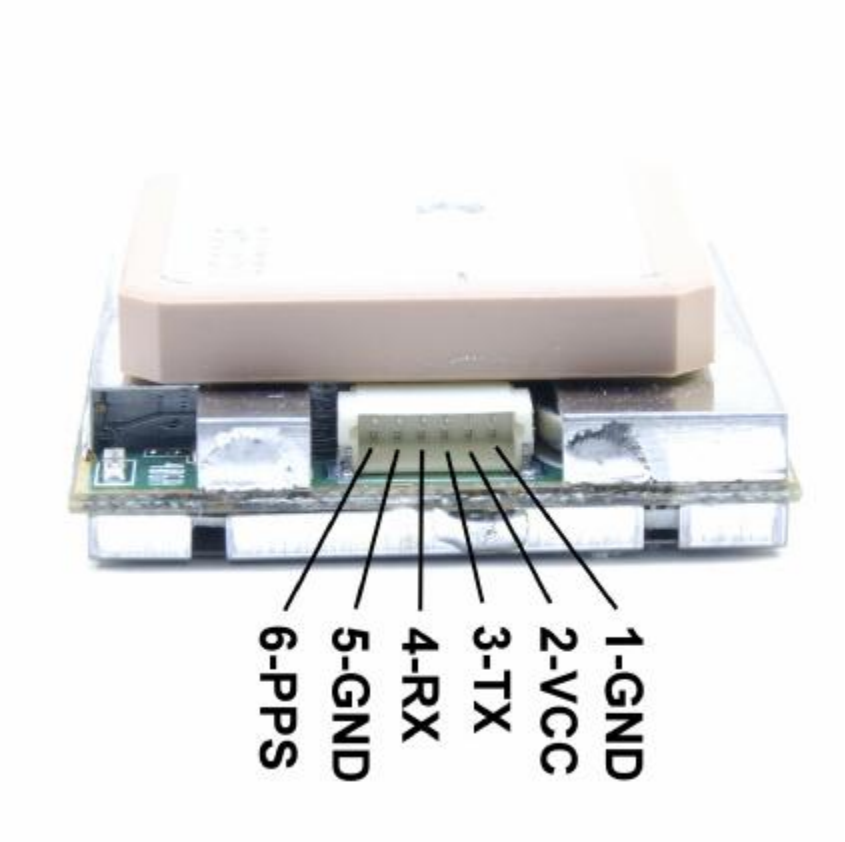

Figure 4

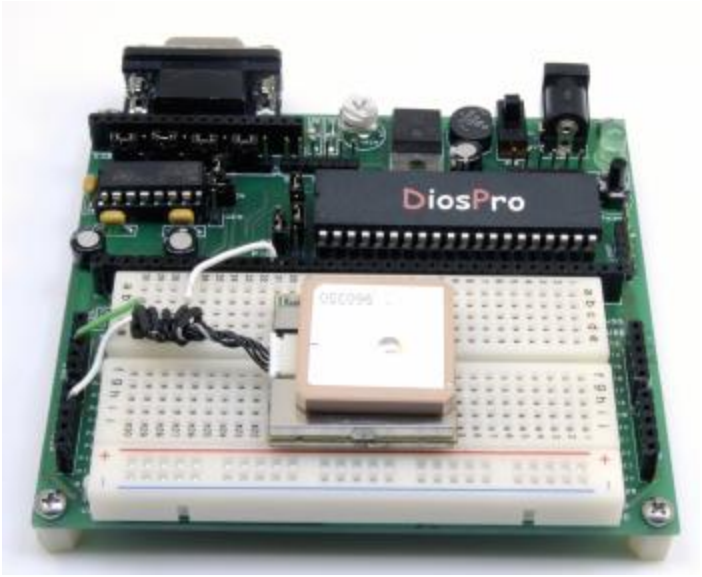

Figure 5

Etek EB-85A

I covered the connector modification in Part 2 of this series. Connect the pins on the connecter as shown in Figure 6. Unlike the EM-406, we need to connect the RX lead as we will need to send some setup commands to the EB-85.

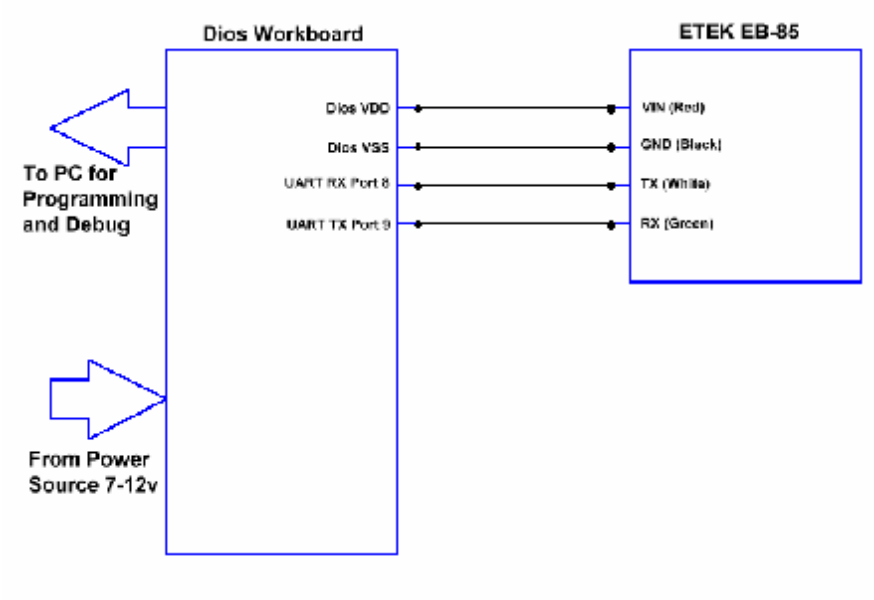

Figure 6

Etek EB-85A Observations

The EB-85 operates with 5volts as well, so it is one of my favorites. While it does support more channels than the EM-406, I was only able to lock on to seven or eight satellites at a time so I did not see any advantage over the EM-406. The EB-85 does need some set up to turn off some of the messages that are not needed and to turn on the WAAS receiver. The EB-85 sports a much faster default baud rate so more data can be received in a shorter period of time. This can be a double edged sword since you have to service the UART more often in order to keep from dropping data.

Holux GSPSlim236

The GPSSlim236 microcontroller interface is simpler than one would think. The mini USB connector on the unit is actually a TTL interface. With this connector you can both power/charge the unit and pull data from the receiver. I purchased a $3 mini USB cable from www.cyberguys.com (Part # 131 0995) for the interface. Cut off the large connector and strip the leads. Attach the red and black wires to a 2-pin header and the green and white leads to a 2-pin header as shown in Figure 7. The connection to the Workboard is shown in Figure 8.

Figure 7

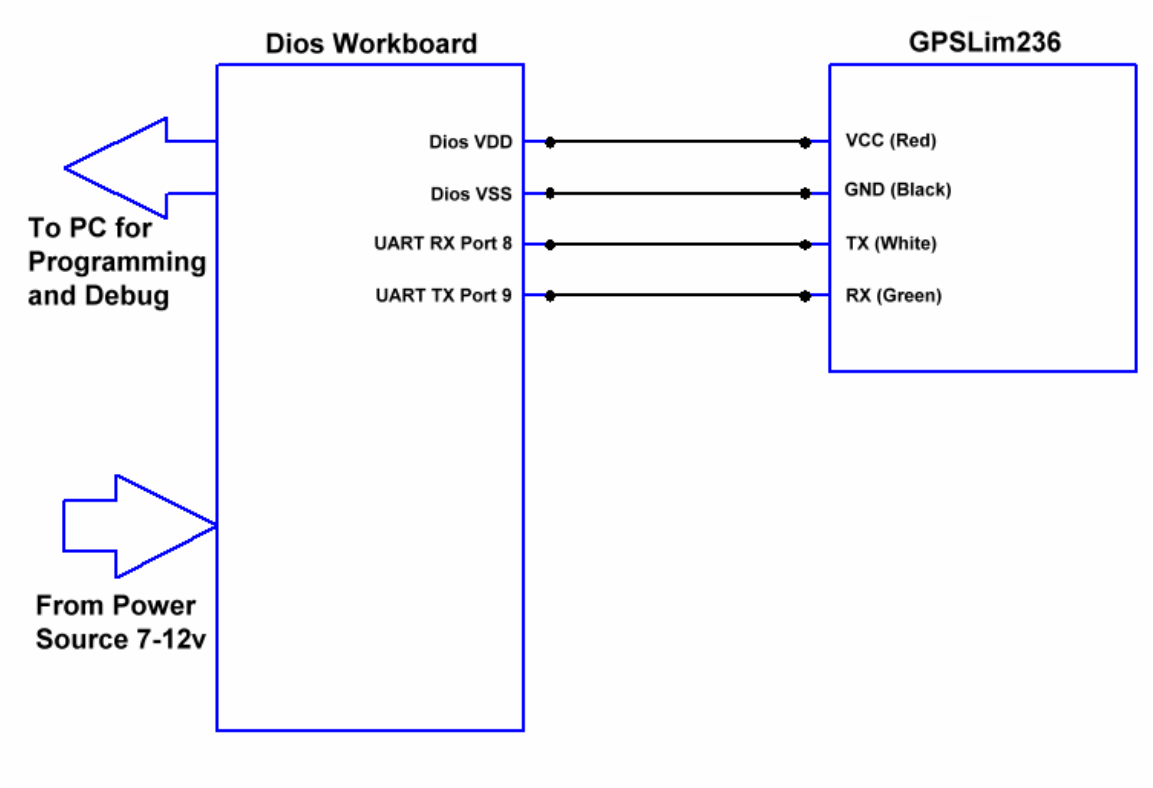

Figure 8

GPSLim236 Observations

While I like this receiver for its versatility, it does not support WAAS as indicated by the manufacturer. Even the GPS Viewer supplied by the manufacturer failed to turn on this feature. That being said I used the Bluetooth interface with my pocket PC for the last couple years with great success.

EM-408

The EM-408 module requires a bit more to interface to a microcontroller. The actual connecter configuration was shown in Part 1 of the series, but since the module operates at 3.3 volts you will need to add a 3.3v regulator as shown in Figure 9. Since the module does not need to be set up in order to operate, you can forgo the RX lead connection and the two resistors shown.

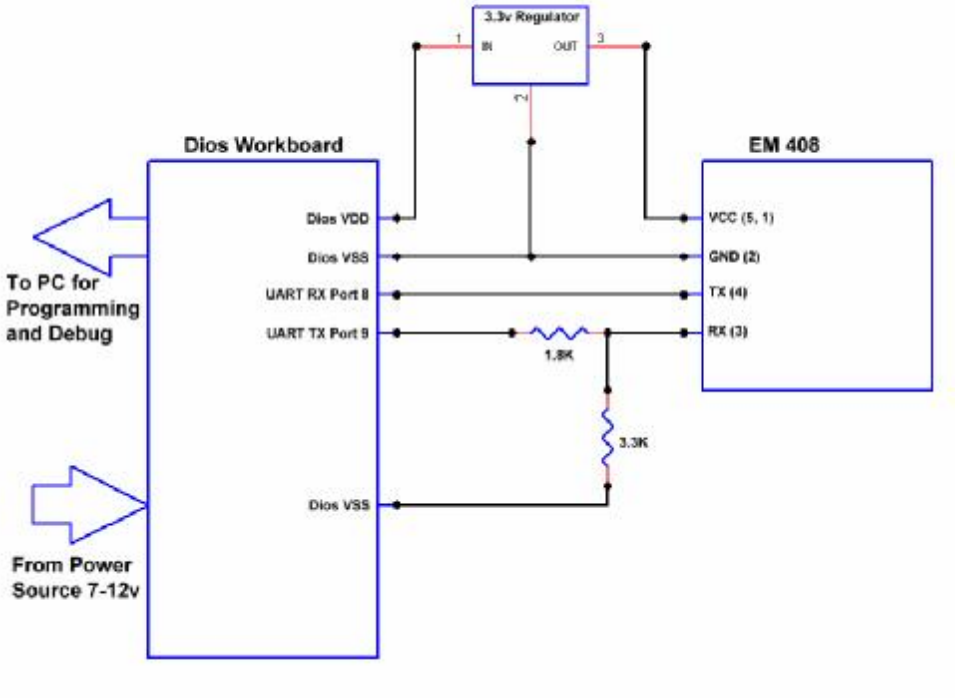

Figure 9

EM-408 Observations

Of the 3.3v units tested, I prefer the EM-408. In fact, if you decide to use a 3.3v microcontroller you may want to use this module. This module also supports an external antenna, so it can be located in a different location than the electronics.

Copernicus

Like the EM-408, the Copernicus module needs a 3.3 volt interface as shown in Figure 10. The Copernicus module I used came with a header board that will mount, with a bit of effort, on a breadboard as shown in Figure 11. Several of the leads on the module need to be connected to VCC. The actual pin out for the module is shown in Figure 12.

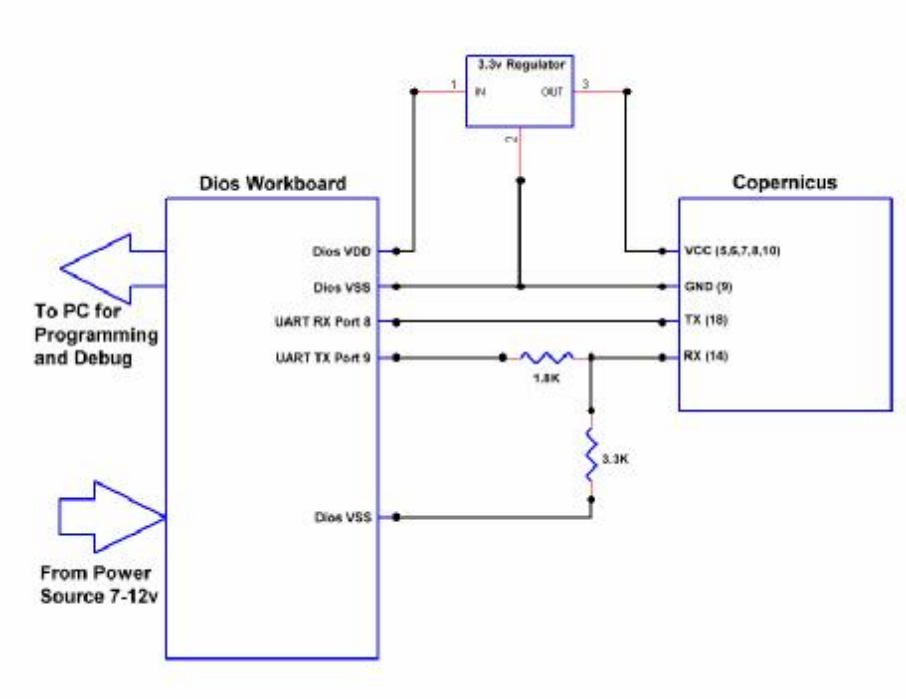

Figure 10

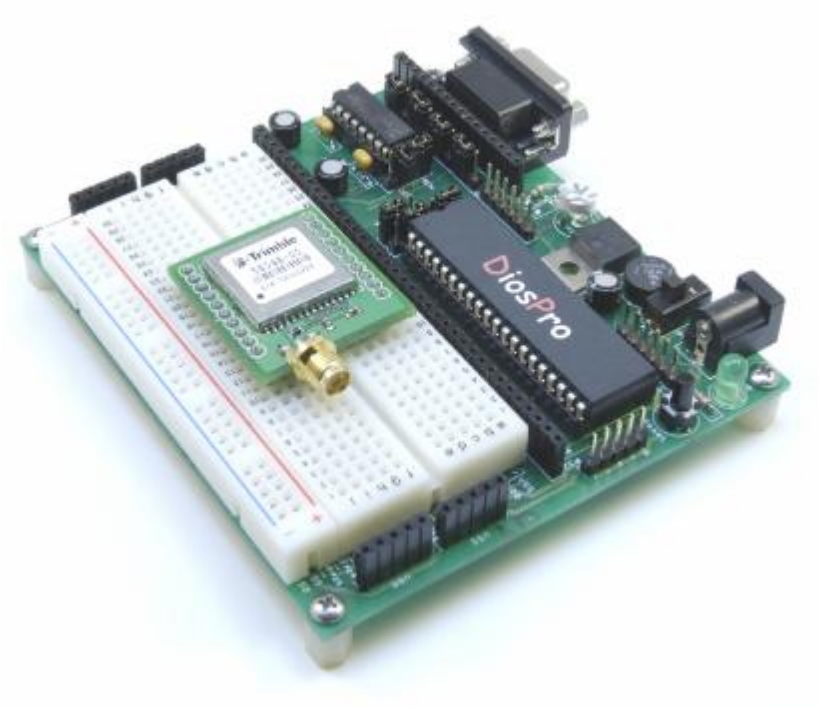

Figure 11

Figure 12

Copernicus Observations

The Copernicus module does not have a built in antenna so you must connect one. The headers can make hookup easier. The main disadvantage of using this module is the lack of WAAS support. Unlike the EM-408, the RX leads and interface resistors must be used since you have to set up the module.

Software Interface

I have included five programs listed in Table 1. All the programs are identical except for the baud rate and the use of a setup function for the Etek and the Copernicus modules.

Program Name	Description
DiosGPSEM406.txt	For use with the EM-406A module
DiosGPSEtek.txt	For use with the Etek EB-85A module
DiosGPSHolux.txt	For use with the Holux GPSlim236 receiver
DiosGPSEM408.txt	For use with the EM-408
DiosGPSCopernicus.txt	For use with the Copernicus module

Table 1

Wire the module according to the previous section and program the appropriate program into the DiosPro using the Dios compiler. Once the GPS module locks on to three satellites, the program will start to display the positional data shown in Figure 13.

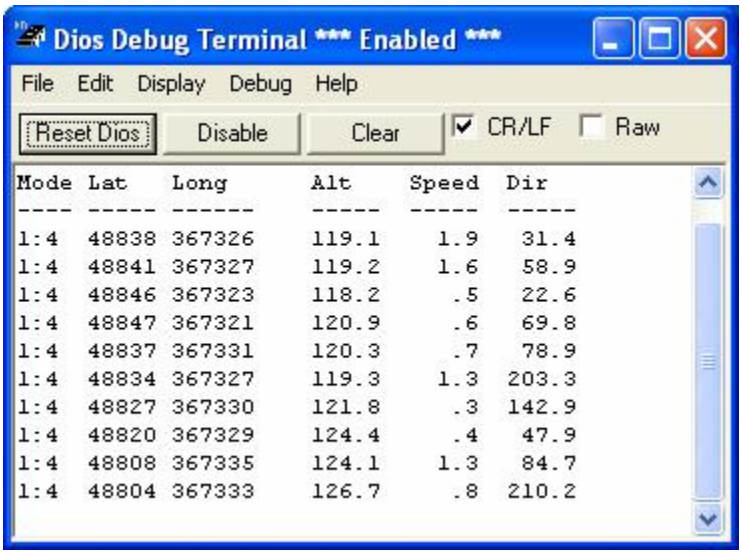

Figure 13

DiosNMEA library

The Dios Compiler has a NMEA library built-in called DiosNMEA. This library processes both the GGA and RMC commands and populates the global variables shown in Table 2 when the appropriate command is received.

Variable	Description
NMEAhour	UTC Hours (Integer) 0-23
NMEAmin	UTC Minutes (Integer) 0-59
NMEAsec	UTC Seconds (Integer) 0-59
NMEAday	UTC day in month (Integer) 1-31
NMEAmonth	UTC month in year (Integer) 1-12
NMEAyear	UTC year (Integer) 1-99 = 2001-2099
NMEAlongdeg	Longitude Degrees (Integer)
NMEAlatdeg	Latitude Degrees (Integer)
NMEAlatmin	Latitude in Minutes * 10000 (Float)
NMEAlongmin	Longitude in Minutes * 10000 (Float)
NMEAspeed	Speed in MPH (Float)
NMEAdir	Heading in Degrees (Float)
NMEAlatdir	N/S indicator for Latitude (Integer) 78=N 83=S
NMEAlongdir	E/W indicator for Longitude (Integer) 69=N 87=S
NMEAfix	Fix Mode (Integer) 0=No Fix 1=SPS Fix 2=DGPS/WAAS Fix
NMEAaltitude	Altitude in Meters (Float)
NMEAsats	Satellites used in Fix Calculation (Integer)
NMEAcmd	Command Received (Integer) 0=None 2=RMC 3=GGA
NMEAstrdat	95 byte character string holding received line of data. (String)
NMEAstrtest	80 byte character string used by library (String)
NMEAstrtemp	80 byte character string used by library (String)

Table 2

When a command is received, the variable NMEAcmd will be set to 1, 2, or 3 depending on the command received as shown below.

- 0 No command received
- 1 Non RMC or GGA command has been received
- 2 RMC command received
- 3 GGA command received

In most cases I don't do any processing unless the NMEAcmd is set to a value of 3. (GGA). Once I have a valid NMEA command, I then check the NMEAfix variable to see

if the module has a valid fix on at least 3 satellites. If it does not, then all the remaining variables are invalid.

There are a few other considerations you need to keep in mind when using the library. First, you must setup the UART using the hsersetup command shown in Program 1. In the case of the EM406, we have set the baud rate to 4800. The UART handler built into the DiosPro is interrupt driven so data is automatically placed into a 256 byte buffer for you. It is important that you call the procNMEA() frequent, enough to keep this buffer from filling up.

```
'Dios NMEA Proccessor
func main()

  clear
  hsersetup baud,HBAUD4800,start,txon,clear

  print "Mode Lat   Long      Alt    Speed  Dir"
  print "---- ----- ------    -----  -----  -----"

loop:
  procNMEA()
  printNMEA(9)

  if NMEAcmd = 3 then 'GGA
    if NMEAfix > 0 then
       print NMEAfix,":",NMEAsats," ",{-6.0} NMEAlatmin," ",NMEAlongmin;
       print " ",{6.1} NMEAaltitude," ",{4.1} NMEAspeed," ",NMEAdir
    else
       print "No Fix ",NMEAfix,":",NMEAsats
    endif
  endif

  goto loop

endfunc

include \lib\DiosNMEA.lib
```

Program 1

The DiosNMEA library also has a command called printNMEA. This command will allow you send the current NMEA text to the debug window. You pass a single argument to the function with the following results:

- 0 Display current value for NMEA text string
- 1 Display all processed NMEA commands
- 2 Display RMC and GGA NMEA commands only
- 3 Display GGA NMEA command only
- 9 Display nothing

NMEAlatmin and NMEAlongmin Values

The NMEAlatmin and NMEAlongmin values are actually whole numbers. The minute value is multiplied by 10,000. This is done to make processing easier and faster. You can also take the N/S and E/W direction indicators and set the minute values to negative or positive accordingly. However, I have found this is not needed for most robot projects unless you are near the equator or Meridian. If you need to process the actual degrees, you can use the NMEAlatdeg and NMEAlongdeg variables for your calculations.

In most robot applications, you will record or store waypoints in a set of variables or tables, then make calculations based on the current minute values and make course changes as necessary.

LCD Display Program

The DiosWorkboard Deluxe supports a 2-line or 4-line character LCD. I have created a series of programs to display GPS data on a 2-line LCD shown in Figure 14. The folks at Sparkfun have the perfect LCD for this project. They even have the 4-line LCDs if you want more display area.

Figure 14

Attach a 16-pin male header to the LCD and plug it into the LCD header as shown in Figure 14. Load up the appropriate program as indicated in Table 3. The LCD will display the positional data as shown in Figure 15

Program Name	Description
DiosLCDEM406.txt	For use with the EM-406A module
DiosLCDEtek.txt	For use with the Etek EB-85A module
DiosLCDHolux.txt	For use with the Holux GPSlim236 receiver
DiosLCDEM408.txt	For use with the EM-408
DiosLCDCopernicus.txt	For use with the Copernicus module

Table 3

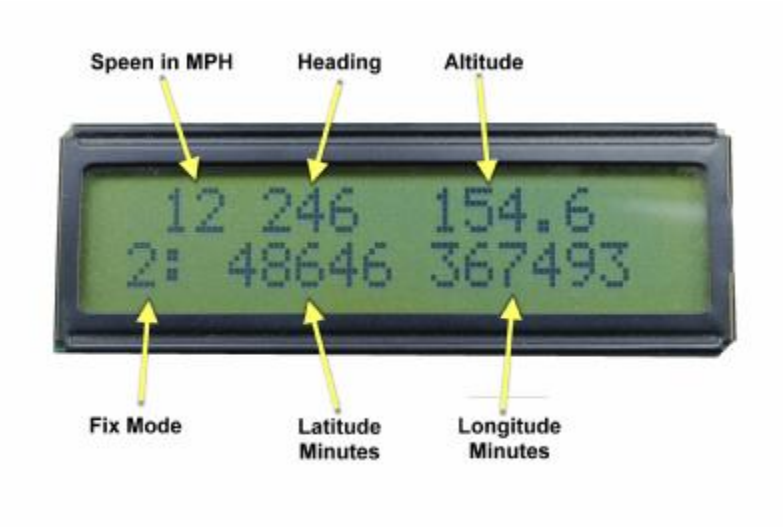

Figure 15

The program works much the same way as the DiosGPSxxx programs in the previous example. The only difference is that I have added a couple of LCD commands as shown in Program 2. In addition to displaying the LCD data, the program displays the positional data in the debug window when connected to the PC. By connecting a 9v battery to the coax connector, you can take the GPS into the field for further tests.

```
DiosPro
func main()

  clear

   'Start back light
   output 13
```

```
  low 13


  'LCD init string
  lcdinit 23,25,24,29,28,27,26 'RS, E, RW, D0,D1,D2,D3
  lcdcontrol 1 'cls

  hsersetup baud,HBAUD4800,start,txon,clear 'EM406

  print "Mode Lat   Long      Alt    Speed  Dir"
  print "---- ----- ------    -----  -----  -----"


loop:
  procNMEA()
  printNMEA(9) '-- Change to 1 to display all Messages

  if NMEAcmd = 3 then 'GGA

    if NMEAfix > 0 then
      lcdgoto 1,1
      if NMEAspeed < 10 then
        lcdwrite {-2.1} dec NMEAspeed," ",{-3.0} dec NMEAdir," ",{-5.1} dec NMEAaltitude
      else
       lcdwrite {-3.0} dec NMEAspeed," ",{-3.0} dec NMEAdir," ",{-5.1} dec NMEAaltitude
      endif
      lcdgoto 2,1
      lcdwrite {1} dec NMEAfix,": ", {-5.0} dec NMEAlatmin," ",{-6.0} dec NMEAlongmin_
      print NMEAfix,":",NMEAsats," ",{-6.0} NMEAlatmin," ",NMEAlongmin," “;
      print {6.1} NMEAaltitude," ",{4.1} NMEAspeed," ",NMEAdir
    else
      lcdgoto 1,1
      lcdwrite "     No Fix     "
      lcdgoto 2,1
      lcdwrite "                "
    endif
  endif

  goto loop

endfunc

include \lib\DiosNMEA.lib
```

Program 2

Going Further

We covered quite a bit of information in this series. I hope that I have inspired you to take it to the next level. Several breadboard components are included with the Dios Workboard Deluxe, including buttons and LEDs. Try connecting a couple of buttons to create the ability to set a way point. Then use the LCD display or a set of LEDs to indicate the direction toward the waypoint.

I am currently working on a project using the smaller DiosPro 18 chip and a SD memory card to create a very small GPS data logger. I hope to create an article featuring this project in the near future.

Be sure to check for updates and downloads for this article at:
http://www.kronosrobotics.com/Projects/GPS.shtml

Parts

The following is a breakdown of the source for all the components needed for Parts 2 and 3 of this project.

Spark Fun Electronics

EM-406A GPS module
http://www.sparkfun.com/commerce/product_info.php?products_id=465

EM-406 Evaluation Board
http://www.sparkfun.com/commerce/product_info.php?products_id=653

EM-408 GPS Module
http://www.sparkfun.com/commerce/product_info.php?products_id=8234

Copernicus Evaluation Board
http://www.sparkfun.com/commerce/product_info.php?products_id=8145

9-Pin Serial Cable
http://www.sparkfun.com/commerce/product_info.php?products_id=65

6V AC Adapter
http://www.sparkfun.com/commerce/product_info.php?products_id=737

External Antenna with SMA connector
http://www.sparkfun.com/commerce/product_info.php?products_id=464

SMA to MMCX adapter cable
http://www.sparkfun.com/commerce/product_info.php?products_id=285

2 Line Character LCD Blue
http://www.sparkfun.com/commerce/product_info.php?products_id=709

2 Line Character LCD Green
http://www.sparkfun.com/commerce/product_info.php?products_id=255

4 Line Character LCD
http://www.sparkfun.com/commerce/product_info.php?products_id=256

KRMicros

ZeusPro
http://www.krmicros.com/Development/ZeusPro/ZeusPro.htm

KronosRobotics

EZRS232
http://www.kronosrobotics.com/xcart/product.php?productid=16167

DiosPro Chip
http://www.kronosrobotics.com/xcart/product.php?productid=16428

Dios WorkBoard Deluxe
http://www.kronosrobotics.com/xcart/product.php?productid=16452

CyberGuys

Mini USB cable
http://www.cyberguys.com/templates/SearchDetail.asp?productID=3312