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Sparton Navigation Modules

Programmer's Quick Start Guide
Version 2.2

Applicable to Sparton GEDC-6, DC-4 and AHRS-8.

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NAVIGATION AND EXPLORATION
5612 Johnson Lake Rd • Deleon Springs, FL • 32130
800.824.0682 • 386.985.4631
www.sparton.com/ne • www.spartonnavex.com

Programmer's Quick Start

This quick start is intended for use by someone who wishes to obtain data from the Navigation Module (NavMod). This document provides examples of each of the protocols that are supported by the NavMod plus an example of how to perform an in-field calibration. References are given to relevant sections in the user manuals so that the user only needs to read manual sections in the area of interest.

The documents referenced in this Quick Start may be found on the NavMod CD or https://spartonnavex.com/technical-support/downloads/.

Reference the *Troubleshooting* section at the end of the *Software Interface User's Manual* if problems are encountered while following this Quick Start.

The NavMod supports four protocols where two are binary and two are ASCII. The binary protocols are Legacy Binary and RFS (Remote Function Select) and the ASCII protocols are NMEA and NorthTek. **Reference**: *Protocol Introduction* section in the *Software Interface User's Manual*.

This Quick Start provides examples of the different methods to get magnetic heading (yaw).

Prerequisites

It is assumed that the instructions in the NDS-1 Quick Start Guide have been followed to set up the NavMod hardware such that it can communicate with the NDS-1 Host Application. A terminal emulator is required to follow this Programmer's Quick Start procedure. See the Terminal Emulator Application Note for set-up examples or use the terminal emulator that is built into the NDS-1 Host Application. This Programmer's Quick Start will assume that the NDS-1 Host Application Terminal Emulator is being used but other terminal emulators could be used as well.

Procedure Set-up

In the NDS-1 Host Application, pull down Options->Terminal Emulator or use <ctrl-t>.

In the terminal emulator window, hit the "Enter" key and there should be an "OK" response. By default, the NavMod does not respond until a request is entered. If it is desired that the NavMod output data upon start-up, **reference** the *User Boot Program* section in the *Software Interface User's Manual.*

NorthTek Protocol

Reference: *NorthTek* section in the *Software Interface User's Manual.*

NorthTek is a programming language based on ANSI Forth. With NorthTek, the user has a lot of control in how the NavMod outputs its data using interpretive command line type instructions or by creating text files that define a NorthTek program script. NorthTek is case sensitive and lines are terminated with a carriage return.

NorthTek Display Command Word "di."

Reference: *Displaying Database Elements* section in the *Software Interface User's Manual*

Reference: *Internal Database Identifier Operations* section in the *NorthTek System Programming Manual* for similar command words.

The "di." command can be used to display any of the variables listed in the long list of available variables (**reference**: the *Variable Summary Table* and the *Variable Detailed Descriptions* table in the *Software Interface User's Manual*).

Enter:

```
yaw di.
```

Response example:

```
yaw = 215.102310
OK
```

NorthTek Streaming Sensor Data Functions

Reference: *Streaming Sensor Data* section in the *Software Interface User's Manual.*
A set of functions have been created that output comma separated (and sometimes ':' separated) data suitable for input to analysis tools such as Microsoft® Excel®, MATLAB® and Mathematica®. Terminal emulators usually supply a logging capability which can be used to capture the data.

Enter:

```
1 compass.p
```

Response example (repeats):

```
C,17324883,   2.45,   -0.12, 214.26
```

The letter 'C' identifies the data set, the next number is the timestamp (milliseconds), followed by pitch, roll and yaw respectively (degrees).

Notation such as <ctrl-s> below represents pressing the control key and the s key at the same time.

To stop the data streaming, enter:

```
<ctrl-s>
0 compass.p
<ctrl-q>
```

The <ctrl-s> causes the streaming to pause so you can enter the next command. The <ctrl-s> is not necessary but it makes it easier to see what is being typed. The <ctrl-q> unpauses which allows streaming due to future commands.

NorthTek Custom Combination Print Streaming

Applies to GEDC-6 2.3.2 or later, DC-4 2.2.0 or later and any AHRS-8

Reference: *Custom Combination Print Streaming* section in the *Software Interface User's Manual.*

This capability allows the user to select a custom combination of sensor data. In this example, suppose we want to have time, temperature and yaw and we want the data displayed every 10th time the yaw is computed.

First, we select what we want to display (see printmask below). NorthTek is based on Forth, so each item gets pushed on the stack and functions such as "or" operates on the top 2 items on the stack and puts the result on the stack. The "set" puts the result of the 2 "or"s into the variable "printmask". The "drop" is needed to clear the status result of the "set" off of the stack. **Reference**: *NPL Basics* section in the *NorthTek System Programming Manual*

Enter:

Inhibit print streaming with <ctrl-S> , select what gets displayed (time, yaw, temperature):

```
<ctrl-s>
printmask
time_trigger   yaw_trigger   or   temp_trigger   or   set  drop
```

Select the display rate (every 10 "triggers" specified by printtrigger below):

```
printmodulus   10 set  drop
```

Select the display rate trigger (in this case, an update of yaw is set to be a trigger) and enable print streaming with <ctrl-q>:

```
printtrigger   yaw_trigger   set  drop
<ctrl-q>
```

Response example (repeats):

```
P:,18754028,y,218.71,T,34.69
```

In the above response, the "P:" identifies the type of output. It is followed by the timestamp (milliseconds since power up), the 'y' identifies that the next number is yaw (degrees) and the 'T' identifies that the next number is the temperature (Celsius).

Note that if we print high rate data at a slower baud rate, it may not be possible to output all of the data due to the serial communication bandwidth limitations. In this case, entire lines of data will be dropped to ensure that the lines that do get output are complete. The data will still be computed at the normal rate within the NavMod.

To stop the streaming output, enter:

```
<ctrl-s>
printmask 0 set  drop
printmodulus 0 set  drop
printtrigger 0 set  drop
<ctrl-q>
```

The NorthTek search command "grep" can be used to find other trigger symbols. **Reference:** G*rep* section in the *NorthTek System Programming Manual.* Enter:

```
grep trigger
```

Response example:

```
Wordlist : stuff

Wordlist : Forth

Wordlist : Core

Wordlist : Defines
time_trigger temp_trigger quat_trigger yawt_trigger yaw_trigger
gyrop_trigger gyror_trigger accelp_trigger accelr_trigger magp_trigger
magr_trigger printtrigger
```

NMEA

Reference: *NMEA* section in the *Software Interface User's Manual* for an introduction.

The acronym NMEA is used here to represent NMEA 0183 which is a communication standard for marine electronic devices. This standard is defined by the National Marine Electronics Association.

NMEA Set-up

Turn on key stroke "local echo" if you are using a terminal emulator **OR** issue the following command (once per session) :

```
nmeaecho 1 set  drop
```

If you are using a terminal emulator other than the one built into the NDS-1 Host Application, set up the terminal emulator to transmit a carriage return and line feed (i.e. <cr><lf> or hex 0d0a) upon hitting enter **OR** some terminal emulators like Tera Term will do so if you type <ctrl-j>.

Standard NMEA command ($xxHDM):

There is a 5 second timeout on entering each character in a NMEA command to prevent the NavMod from getting stuck in the protocol.

To get heading using the standard NMEA command, enter:

```
$xxHDM
```

Response example:

```
$HCHDM,300.4,M*2E
```

The 2E is the checksum and the 'M' indicates magnetic heading. **Reference**: *NMEA* section in the *Software Interface User's Manual* for details on interpreting the response and for other NMEA protocol commands.

To get repeated values every 0.1 seconds, enter the command:

```
$xxHDM,RPT=0.1
```

To pause the output, enter:

```
<ctrl-s>
```

Enter any NMEA command to cancel the repeat, for example:

```
$xxHDM
<ctrl-q>
```

If you forget to enter the <ctrl-q>, then the next streaming command won't output.

Sparton Custom NMEA command:

A NMEA command has been created that allows access to almost any of a long list of available NavMod variables (**reference**: the *Variable Summary Table* and the *Variable Detailed Descriptions* table in the *Software Interface User's Manual*). For our magnetic heading example, the corresponding variable name is "yaw" (RPT can be applied to this one as well).

```
$PSRFS,yaw,get
```

Response example:

```
$PSRFS,yaw,286.672424*38
```

Legacy Binary

Reference: *Legacy Binary* section in the *Software Interface User's Manual.*

Legacy binary is intended to be backward compatible with the Sparton SP300X compasses when the DC4/6/AHRS8 is being used as a retrofit in an existing system. As a result, this protocol does not have access to any of the newer data such as the gyro data and is **not recommended** to be used with new designs.

Since it is a binary protocol, a terminal emulator that can send binary may be used or a custom interface program may be used to send the binary message.

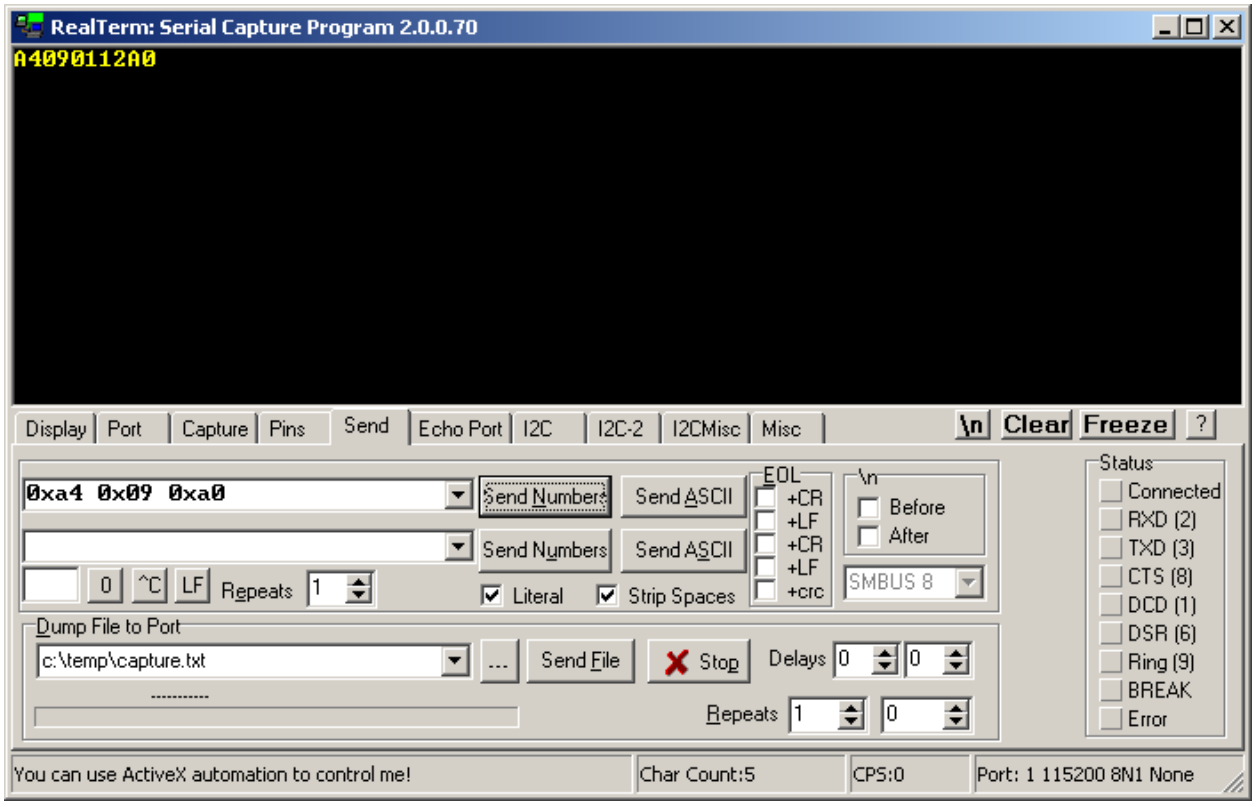
Legacy Binary uses a header byte (0xA4) and a termination byte (0xA0). The 0x indicates the following 2 digits are in hexadecimal form (i.e. don't send the 0x part). There is no checksum.

In this example, 0x09 is the identifier for magnetic heading. **Note**: The NDS-1 Host Application terminal emulator does not support this protocol. Use a terminal emulator that supports binary such as RealTerm.

The following example uses the RealTerm emulator. **Reference** the Terminal Emulator Application Note for RealTerm set-up instructions. In the Send tab, prefix the bytes with 0x and enter them in the "Send Numbers" window then press "Send Numbers". The Legacy Binary example is shown here with a send of:

0xA4 0x09 0xA0

Note the binary response shows up in the black window.



The heading value in the response is 112 hex = 274 decimal. To convert to degrees: 274*360/4096 = 24.1 degrees.

RFS

RFS is a flexible binary interface that provides a CRC for communication error checking. RFS can be used to access or control any of the variables listed in the long list of available variables (**reference**: the *Variable Summary Table* and the *Variable Detailed Descriptions* table in the *Software Interface User's Manual*).

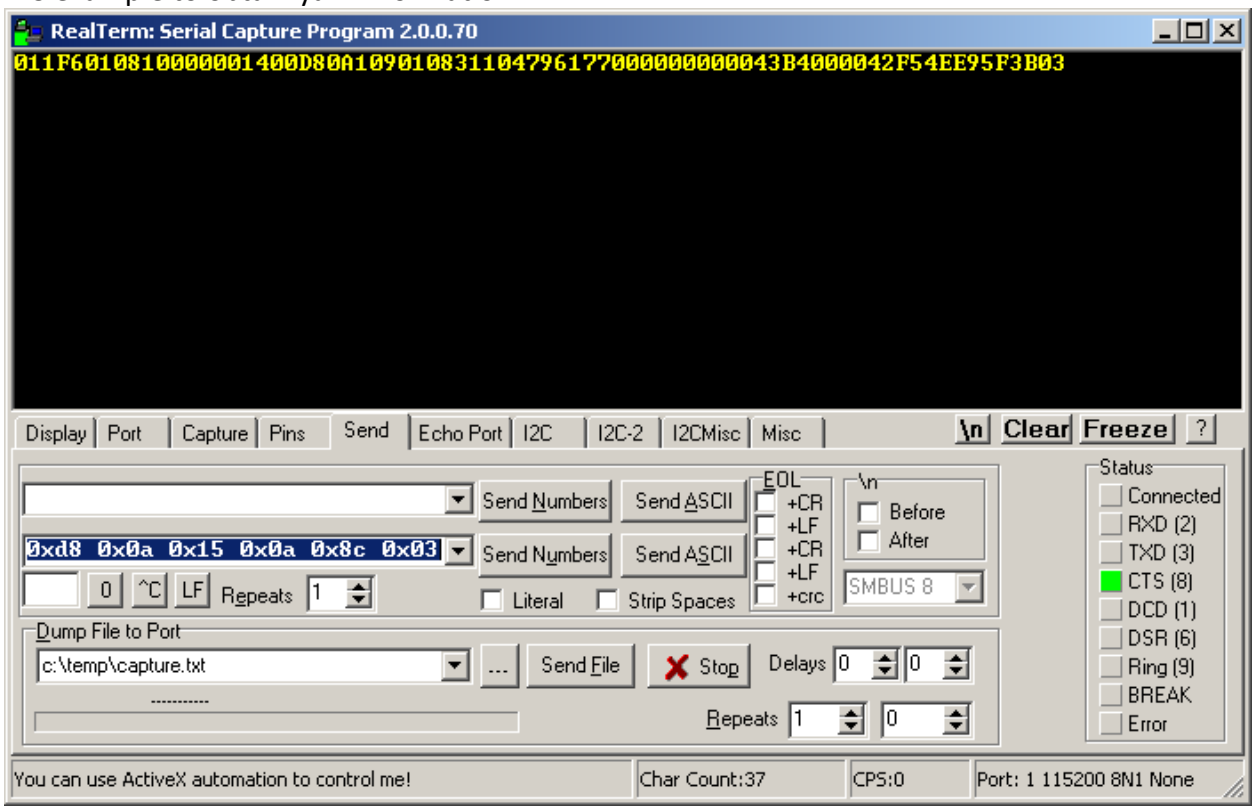
The big advantage of RFS is that it can be customized to efficiently provide just the data needed using "BitField"s (packed structures). There are three BitField variables defined, namely "position", "composite2" and "composite3". The "position" variable is unique in that it can be set up to repeat by using the "positionrate" variable to define the rate.

For an introduction and more examples, **reference** the *RFS* section in the *Software Interface User's Manual.*

Reference the document titled *Remote Function Select (RFS) Protocol Suite – Interface Design Description* for a more complete description.

The following example uses the RealTerm terminal emulator and is followed by an interpretation of the data sent and received. You will need the RFS manual to follow the interpretation. **Reference** the Terminal Emulator Application Note for RealTerm set-up instructions.

RFS example to obtain yaw information:



For this Quick Start, we only desire the yaw data so we will show the one “Get” out of many that obtains the yaw information. Once the desired VIDs are obtained after NavMod start-up, then only “Get Value” commands need be used. The messages to obtain yaw data are detailed below with the binary (hexadecimal) values on the left and the descriptions of the binary data on the right.

Send a “Get” information request for VID 10 (yaw):

```
01                              SOH - SAPP packet frame
0B                              SAPP packet body size
40                              Error Options/Protocol
                                SAPP Payload - Start of RFS packet
1081                               DLE substitution for 01 - RFS Revision 1
00000000                           RFS Payload size
1081                               DLE substitution for 01 - Get Command
D8                                 sequence number
0A                                 VID for yaw
0A8C                            2 CRC bytes for SAPP packet body
03                              ETX for SAPP packet frame
```

Receive the “GetResponse” message with a data description object plus the current value of yaw (see RealTerm figure above):

```
01                              SOH - SAPP packet frame
1F                              SAPP packet body size
60                              Error Options/Protocol
                                SAPP Payload - Start of RFS packet
1081                               DLE substitution for 01 - RFS Revision 1
00000014                           RFS Payload size
00                                 GetResponse (followed by Data Description plus Value)
D8                                 sequence number of associated get request
0A                                 VID for yaw
1090                               DLE substitution for 10hex - Scalar
1083                               DLE substitution for 03 - Type 3: Float32
11                                 Description Field size 11hex = 17 decimal
04                                    Text field length
79617700                              Name (Text Field): "yaw"
00000000                              Float Value Lower Limit   0.0
43B40000                              Float Value Upper Limit 360.0
42F54EE9                              Current Float32 Value   122.65
                                End of RFS packet (SAPP payload)
5F3B                            2 CRC bytes for SAPP packet body
03                              ETX for SAPP packet frame
```

Send a "Get Value" request for VID 10 (yaw):

```
01                              SOH - SAPP packet frame
0b                              SAPP packet body size
40                              Error Options/Protocol
                                SAPP Payload - Start of RFS packet
1081                               DLE substitution for 01 - RFS Revision 1
00000000                           RFS Payload size
08                                 Get Value Command
d9                                 sequence number
0A                                 VID for yaw
                                End of RFS packet (SAPP payload)
A72C                            2 CRC bytes for SAPP packet body
03                              ETX for SAPP packet frame
```

Receive the “Value” message in response:

```
01                              SOH - SAPP packet frame
```

```
                                12                              SAPP packet body size
                                60                              Error Options/Protocol
                          SAPP Payload - Start of RFS packet
1081                         DLE substitution for 01 - RFS Revision 1
00000007                     RFS Payload size
09                           "Value Is" command
D9                           sequence number of associated "Get Value" request
0A                           VID for yaw
1090                            DLE substitution for 10 hex - Scalar
1083                            DLE substitution for 03 - Type 3: Float32
04                              Field Size 4 bytes
43AF5D56                        Current Value for yaw - 351.3
                          End of RFS packet (SAPP payload)
B4EC                      2 CRC bytes for SAPP packet body
03                        ETX for SAPP packet frame
```

In-field Calibration

Fixed magnetic interferences in the host device can be calibrated out using the in-field calibration.

The NDS-1 Host Application can be used to perform the in-field calibration but the in-field calibration can also be performed using NorthTek, NMEA commands or RFS.
Reference: *In-Field Magnetic Calibration* section in the NDS-1 User's Manual
Reference: *Magnetic Field Calibration* section in the NMEA part of the *Software Interface User's Manual*
Reference: *3D Compass Calibration* section in the NorthTek part of the *Software Interface User's Manual*

In this example, we shall use the cal3D NorthTek script that is available on the website downloads section or on the NavMod CD.

In the NDS-1 Terminal Emulator, click the "…" button, change the "Files of type:" at the bottom to "All Files", and browse to the cal3D.4th script and click "Select". Click the "Send File" button which will now download the NorthTek program titled "cal3D". To confirm that the script loaded successfully, scroll back through the terminal emulator window and confirm that there are no "Huh"s.

Now run the script by entering:

```
cal3D
```

Change the NavMod's position and hit the space key. Repeat, attempting to achieve a variety of three dimensional orientations until calNumPoints is at least 4 and at most 12. Hit the Escape key when complete. When magErr has settled to a minimal value, hit the Escape key again to complete the procedure.

Someone who wishes to control in-field calibration from a host computer which is connected to the NavMod's user port can emulate the cal3D script. There are two command variables to set (calmode and calCommand) and two status variables to read (calNumPoints and magErr). **Reference** the *Variable Detailed Descriptions* section in the appendix of the *Software Interface User's Manual* for details on how to use these variables. These variables may be read or changed by any of the three protocols: NorthTek, NMEA and RFS.