

MNAV100CA User's Manual

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About this Manual

The following annotations have been used to provide additional information.

NOTE

Note provides additional information about the topic.

EXAMPLE

Examples are given throughout the manual to help the reader understand the terminology.

IMPORTANT

This symbol defines items that have significant meaning to the user

WARNING

The user should pay particular attention to this symbol. It means there is a chance that physical harm could happen to either the person or the equipment.

The following paragraph heading formatting is used in this manual:

1 Heading 1

1.1 Heading 2

1.1.1 Heading 3

Normal

1 Introduction

The MNAV100CA is a calibrated digital sensor system with servo drivers, designed for miniature ground and air robotic vehicle navigation and control. All sensors required for complete airframe stabilization and navigation are integrated into one compact module. The MNAV100CA includes 3-axis accelerometers, 3-axis angular rate sensors, and 3-axis magnetometers; static pressure (altitude) and dynamic pressure (airspeed) sensors; and a GPS receiver module.

The MNAV100CA R/C servo controller allows direct connection of R/C servos to MNAV100CA. The R/C Receiver PPM interface allows for software interpretation of R/C receiver commands (PPM) and switching between software control and R/C receiver control for human “takeover” capability.

The MNAV100CA has two RS-232 serial ports. The sensor data may be requested via serial port ‘0’ as a single measurement or streamed continuously. And GPS can be directly read from serial port ‘1’.

The MNAV100CA can plug into a Crossbow Stargate via the 51-pin connector to form a sophisticated open-source inertial platform. As an option, the MNAV100CA, like a sensor board, can also be plugged into Crossbow Mote. (See ‘Section 2.3 Connectors’ for details.)

The MNAV100CA firmware and tool chain is open-source for maximum user flexibility. PC based MICRO-VIEW software is included to facilitate recalibration of the MNAV100CA sensors.

1.1 MNAV100CA Features

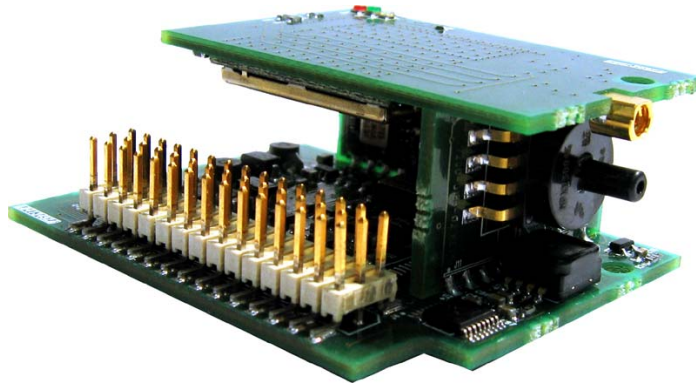


Figure 1.1 MNAV100CA Robotics Sensor Suites

- Miniature, Low Cost Robotic Vehicle Sensor Suite
- Onboard R/C Servo Controller
- Standard 51-Pin Connector for Optional Stargate Auto-Pilot Interface
- Pre-installed with Open Source Inertial Firmware
- Sensor Calibration and Servo Control via MICRO-VIEW GUI

1.2 Package Contents

In addition to your MNAV100CA sensor product you should have:

- **Three Cables**
 - two digital signal cables
 - one power cable
- **GPS Antenna**
- **One CD with Manual, Open Source Code, Software and development tool chain**

The open source code is an application program that you can use on MNAV100CA, and it is a good starting point for you to write your own code. The boot loader software is offered for loading the firmware image file into the microcontroller via an RS-232 link.

The user interface software, MICRO-VIEW will allow you to immediately view the outputs of the MNAV100CA on a PC running Microsoft® Windows™. The software also allows users to recalibrate the MNAV100CA sensors in some situations.

The development tool chain is AVR GCC installation software.

The MNAV100CA User's Manual contains helpful hints on programming, installation and valuable digital interface information including command structure, data packet formats and conversion factors.

2 MNAV100CA Overview

2.1 MNAV100CA Layouts

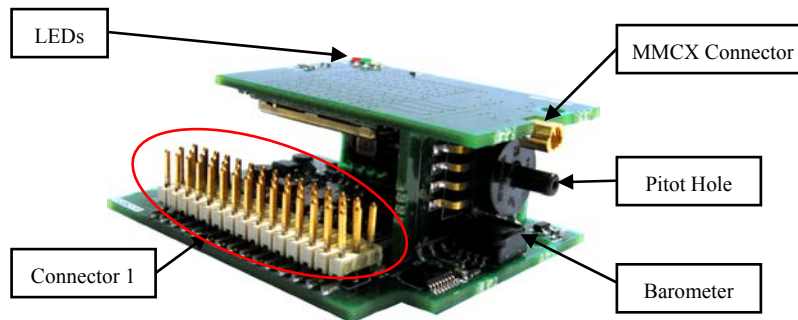
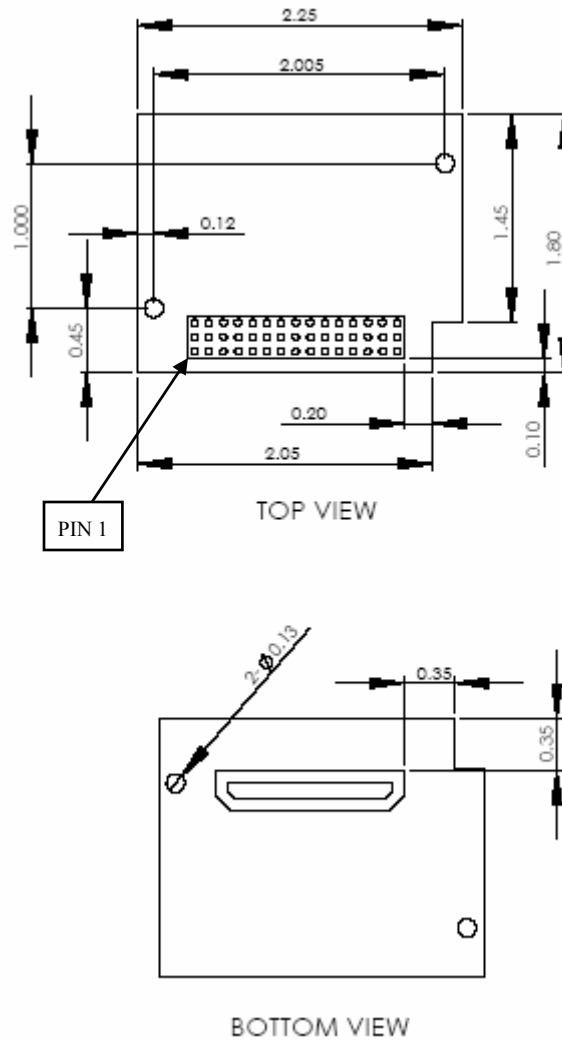


Figure 2.1 MNAV100CA Board

2.2 MNAV100CA Board Size

Figure 2.2 shows the outline dimensions of the MNAV100CA board.



(All dimensions are in inches)

Figure 2.2 MNAV100CA Board Dimensions

2.3 Connectors

Connector 1 (See Figure 2.1) provides an interface to the power supply connector, the servo battery connector, two RS232 connectors, a PPM input connector, 9 servo connectors and a high speed servo connector. These are compatible with standard servo battery and servo connectors. Figure 2.3 shows the top view of Connector 1 showing the pin numbers and the dimensions. The orientation of Fig 2.3 is identical to the orientation described above in Figure 2.2. Table 2.1 lists the pin assignments for this connector.

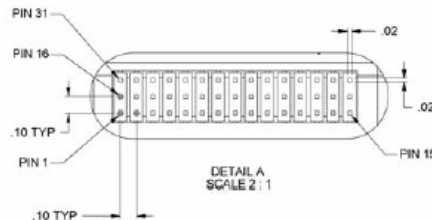


Figure 2.3 Connector 1 Pin-out

Table 2.1 Connector 1 Pin Assignments

Pin	Function
1 – 15,31	Ground
16,32	Input Power
17,20-30	Servo Power
18	RS-232 Receive Port 0
33	RS-232 Transmit Port 0
19	RS-232 Receive Port 1
34	RS-232 Transmit Port 1
35	PPM Input
36	High Speed Servo PWM
37	Servo#8 PWM
38	Servo#7 PWM
39	Servo#6 PWM
40	Servo#5 PWM
41	Servo#4 PWM
42	Servo#3 PWM

43	Servo#2 PWM
44	Servo#1 PWM
45	Servo#0 PWM

The 51-pin male connector (See Figure 2.2) on the bottom side of the MNAV100CA board provides the interface to connect to the Stargate or to Crossbow Mote. Table 2.2 shows the pin assignments for this connector.

Table 2.2 51-Pin Connector Pin Assignments

Pin	Function
1	Ground
2 – 15	Not Connected
16	Serial Program MOSI
17	Serial Program MISO
18	SPI Serial Clock
19	GPS UART1 RXD
20	GPS UART1 TXD
21 – 26	Not Connected
27	MCU UART0 RXD (PE2=LOW) or MCU UART0 TXD (PE2=HIGH)
28	MCU UART0 TXD (PE2=LOW) or MCU UART0 RXD (PE2=HIGH)
29 ~ 35	Not Connected
36	JTAG Port TDI
37	JTAG Port TDO
38	JTAG Port TMS
39	JTAG Port TCK
40 – 47	Not Connected
48	Reset
49	Not Connected
50	Input Power
51	Ground

IMPORTANT

If the MNAV100CA is attached directly to the Stargate via a 51-pin connector, PE2 of ATmega128L on MNAV100CA must be set as output pin and logic 0. If the MNAV100CA is attached directly to a Crossbow Mote via 51-pin connector, PE2 must be set as output pin and logic 1.

The MMCX connector (See Figure 2.1) provides connectivity to the GPS antenna.

2.4 Power Supply

The MNAV100CA can be powered by using a 4.5V to 16V DC power supply through a 3-pin connector, or powered by 3.3V through the 51-pin connector.

Pin 1, 16 and 31 in Figure 2.3 form a 3-pin connector for the power supply. The input voltage can range from 4.5V to 16V. The typical power consumption is 140 mA @ 5.0V, and less than 60 mA @ 16V.

Pin 2 and 17 form a connector for the servo battery. Pin 2 is Ground and Pin 17 is the Servo Power.

For some applications, only one battery is used to drive both the MNAV100CA and the servos and the MNAV100CA hardware allows this. To enable this, power the system from Pin 1, 16 and 31, and use a jumper connector to short Pin 17 and 32. Care should be taken to make sure that:

1. The supply voltage is the standard servo voltage;
2. The power supply has the capability of driving the MNAV100CA and all the servos together. (Generally, the peak current of each servo can be as high as 1 A.)

If the MNAV100CA is powered through the 51-pin connector, it is recommended not to connect a power supply to the 3-pin power supply connector. For example, plug MNAV100CA onto the Stargate board and power up the Stargate. The Stargate and MNAV100CA will work together!

2.5 GPS

A GPS receiver is integrated into the MNAV100CA. A GPS antenna with the MMCX male connector can be directly plugged into the MNAV100CA MMCX connector (See Figure 2.1). This GPS receiver has two serial ports: GPS USART1 (9600 Baud, 8 bits, no parity bit, 1 stop bit) and GPS USART2 (57600 Baud, 8 bits, no parity bit, 1 stop bit). The GPS USART2 is connected to MCU USART1 of the onboard AVR microcontroller.

2.6 Pressure sensor

The relative pressure sensor has an axial port shown as Pitot Hole in Figure 2.1. The diameter of the axial port is 0.12 inch, and the length is 0.25 inch.

2.7 Serial Ports

The MNAV100CA has two serial ports: Serial Port 0 (Pin 3, 18 and 33) and Serial Port 1 (Pin 3, 19 and 34). USART0 of the onboard ATmega128L microcontroller is converted to standard RS-232 and forms Serial Port 0 of the MNAV100CA. The onboard GPS Receiver's Serial Port 1 is converted to standard RS-232 and made available as Serial Port 1 of the MNAV100CA.

2.8 Talk with R/C Transmitter

The control of the servo output can be taken over by either MNAV100CA or R/C transmitter. This function is implemented in the MNAV100CA firmware for the automatic R/C robotic platform. Please see 'Section 4.4 Control Modes' for details.

3 Quick Start

3.1 MICRO-VIEW Software

Crossbow includes MICRO-VIEW software to allow use of the MNAV100CA right out of the box and makes the evaluation straightforward. Install the MICRO-VIEW software, connect the MNAV100CA to your serial port, apply power to your unit and start taking measurements.

NOTE

The MICRO-VIEW is a good GUI for a PC to talk to the MNAV100CA factory installed firmware. The MNAV100CA firmware and tool chain are open-source, Crossbow cannot guarantee compatibility with MICRO-VIEW if the onboard firmware is altered.

IMPORTANT

MICRO-VIEW 2.1 is only compatible with MNAV firmware version Rev -04_B or later. Please use the MICRO-VIEW 1.x with MNAV firmware Rev -01 and -02, and use MICRO-VIEW 2.0 to communicate with the MNAV firmware Rev -03, Rev -04_A or later. See the table as follows:

Table 3.1: MICRO-VIEW Firmware Version Compatibility

Firmware Version	Software Version
Rev -01 and -02	MICRO-VIEW 1.x
Rev -03 and -04_A	MICRO-VIEW 2.0
Rev -04_B and later	MICRO-VIEW 2.1

3.1.1 MICRO-VIEW Computer Requirements

The following are minimum capabilities that your computer should have to run MICRO-VIEW successfully:

- CPU: Pentium-class
- RAM Memory: 64MB minimum
- Hard Drive Free Memory: 80MB
- Operating System: Windows 2000, XP

3.1.2 Install MICRO-VIEW

To install MICRO-VIEW in your computer:

1. Insert the CD in the CD-ROM drive.
2. Run <CDROM>:\ MICRO-VIEW2.X\setup.exe, follow the wizard to install MICRO-VIEW.

3.2 Connections

The MNAV100CA is shipped with 3 cables: two digital signal cables and one power cable to connect the MNAV100CA to a PC Serial port and power supply. Follow the instructions below:

1. Connect the 3-pin end of the power cable to the power pins (1, 16 and 31) of Connector 1 of the MNAV100CA.
2. Connect the other end of the power cable to the batteries or other DC power supply.

WARNING

Do not reverse the power leads! Applying the wrong power to the MNAV100CA can damage the unit; although there is reverse power protection, Crossbow Technology is not responsible for resulting damage to the unit should the reverse voltage protection electronics fail.

Table 3.2 Power Cable Connections

Wire Color	Function
Red	Power Input (4.5-16V)
Brown	Power Ground

3. Connect the 3-pin end of the digital signal cable to the RS232 pins (3, 18 and 33) of Connector 1 of the MNAV100CA.
4. Connect the 9-pin end of the digital signal cable to the serial port of your computer.

Table 3.3 Digital Signal Cable Connections

Wire Color	Function
Grey / Yellow	RS-232 Transmit Data
White / Green	RS-232 Receive Data
Black / Blue	RS-232 Signal Ground

Let the MNAV100CA warm up for 10 minutes when powered on for temperature stability before attempting a calibration.

3.3 Setting up MICRO-VIEW

With the MNAV100CA connected to your PC serial port and powered, open the MICRO-VIEW software.

1. MICRO-VIEW should automatically detect the MNAV100CA, display the serial number and firmware version. Set the MNAV100CA to default status: voltage output data packet, 100 Hz update rate and 38400 baud.
2. If the text in connection frame is “Disconnected”, that shows that MICRO-VIEW cannot connect. Verify that you have the correct COM port selected. This can be changed from the “Serial Port” dropdown menu. If it still does not work, check the connections between the MNAV100CA and the computer; check the power; check the serial COM port assignment on your computer. If you change the port number of a COM, or add/remove a COM port, please restart MICRO-VIEW. MICRO-VIEW will search all existing COM ports automatically.
3. Set the update rate and serial communication baud rate as needed, select output packet type from the “Output” dropdown menu. In Voltage packet, only the voltage output of the sensors is displayed; in Scaled packet, the scaled sensor output and the static attitude & heading angles with a cubic demo are displayed.

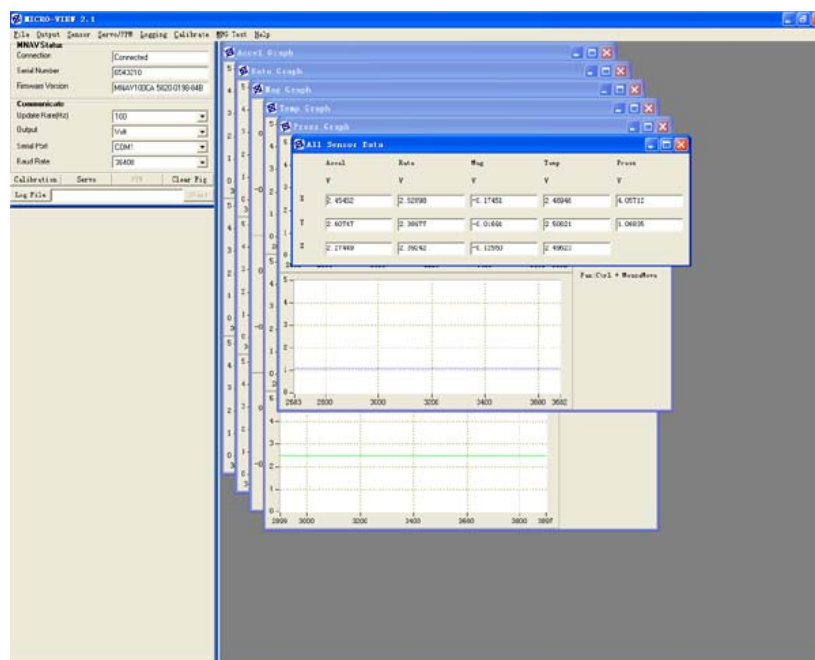


Figure 3.1 Main Window of MICRO-VIEW

4. Select the type of sensor data you want to display in Graphs from the “Sensor” menu. You can zoom into the waveform by “Shift + Click Mouse Left/Right Button” and pan it by “Ctrl + Press Mouse Left Button”. By selecting the submenu “Tile” or “Cascade” of “Windows”, you can tile or cascade the sensor Graph windows.
5. You can log data to a data file from the “Logging” menu.
6. You can calibrate the MNAV100CA sensors in voltage mode. Select “Start Cali” from the “Calibration” menu and the calibration interface window will appear. See Appendix B for detailed calibration instructions.
7. You can debug the servos by selecting “Servo” from the “Servo/PPM” menu. See Appendix C for detailed servo debug.
8. PPM GUI is enabled when the output rate is less than 100 Hz in scaled mode. Select “PPM” from the “Servo/PPM” menu and the PPM window will appear. See Appendix D for detailed instructions.
9. You can replay from data file by selecting “Load and Replay” from the “File” menu and select submenu “Halt” or “Stop” if you

want to halt or stop the replay. Please note that only the data file logged by MICRO-VIEW can be replayed.

3.4 Take Measurements

Once you have configured MICRO-VIEW to work with your MNAV100CA, select the kind of measurement you wish to see. The Graphs for rates, acceleration, magnetic flux or pressure can be displayed. Now you're ready to use the MNAV100CA!

4 MNAV100CA Details

4.1 MNAV100CA Architecture

The MNAV100CA is a nine-axis measurement system that outputs acceleration, angular rates and magnetic orientation.

The MNAV100CA consists of the following subsystems:

- 1) Inertial Sensor Array: This is an assembly of three accelerometers, three gyros (rate sensors) with temperature sensors.
- 2) Three axis magneto-resistive magnetometers that can be used to compute heading.
- 3) A GPS receiver for position and velocity measurement.
- 4) A static pressure sensor and a dynamic pressure sensor that can be used to compute the altitude and airspeed.
- 5) Servo Driving Circuit: The integrated circuit that can support up to 9 servos.
- 6) The R/C Receiver PPM interface that can be used to read the PPM signal from the R/C receiver.
- 7) Data processing module, which receives the signals from all the sensors, GPS and PPM interface, and transmits digital data via the serial link, and outputs standard servo signals.

See the Appendix E for the sensor list.

These blocks are shown in the system block diagram below in Figure 4.1.

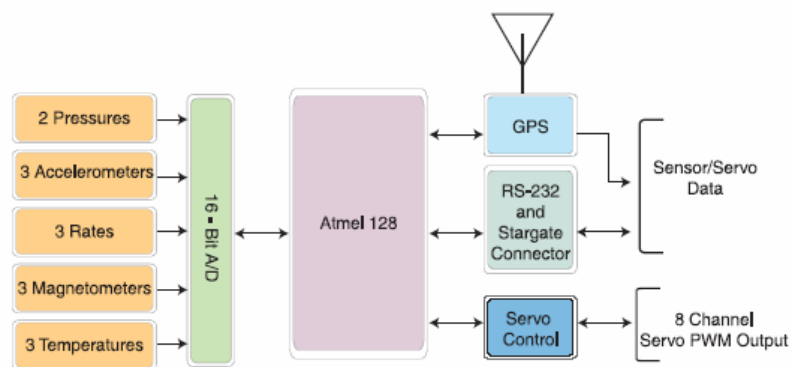


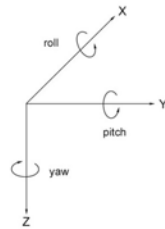
Figure 4.1 the MNAV100CA System Architecture

The MNAV100CA analog sensor signals are sampled and converted to digital data at 100 Hz. The rate gyros and accelerometers data are filtered by five-pole Bessel filters and all sensors are sampled by 16-bit A/D

converters. The firmware inside the onboard processor produces calibrated angular rate measurements, calibrated acceleration measurements, and calibrated magnetometer measurements.

4.2 MNAV100CA Coordinate System

The MNAV100CA coordinate system is shown in Figure 4.2. With the port of the relative pressure sensor facing the front and the mounting plate down, the axes are defined as:



X-axis – along the top pointing to the side of the relative pressure sensor

Y-axis – from the side of LEDs to the side of connectors

Z-axis – from the top to the bottom

Figure 4.2 the MNAV100CA Coordinate System

The axes form an orthogonal SAE right-handed coordinate system. The angular rate sensors are aligned with these same axes. The rate sensors measure angular rotation rate around a given axis. The rate measurements are labeled by the appropriate axis. The direction of a positive rotation is defined by the right-hand rule. With the thumb of your right hand pointing along the axis in a positive direction, your fingers curl around in the positive rotation direction. For example, if the MNAV100CA is sitting on a level surface and you rotate it clockwise on that surface, this will be a positive rotation around the z-axis. The x- and y-axis rate sensors would measure zero angular rates, and the z-axis sensor would measure a positive angular rate.

4.3 Measurement Modes

The MNAV100CA can be set to operate in one of two measurement modes: Voltage mode or Scaled mode. The measurement mode selects the information that is sent in the data packet over the RS-232 interface. See the “Data Packet Format” section for the actual structure of the data packet in each measurement mode. The default system operation is Voltage mode.

4.3.1 Voltage Mode

In voltage mode, the analog sensors are sampled and converted to digital data with 0.1 mV resolution. The digital data represents the direct output from the sensors. The data is 16-bit for each sensor and is sent as 2 bytes in

the data packet over the serial interface. The data of the accelerometers, absolute pressure sensor and pitot pressure sensor are sent as unsigned integers where as the data of the angular rates, temperatures and magnetometers are sent as signed integers.

The voltage data is scaled as:

For angular rate and temperature:

$$\text{Voltage} = 2.5V + \text{data} * (5V) / 2^{16};$$

For other sensor:

$$\text{Voltage} = \text{data} * (5V) / 2^{16}$$

Where **voltage** is the voltage measured at the sensor. See the “Data Packet Format” section for a complete description of the voltage mode outputs.

4.3.2 Scaled mode

In scaled mode, the analog sensors are sampled and GPS data is extracted, then converted to digital data and scaled to engineering units. The digital data represents the actual value of the quantities measured. The sensor data is sent as signed 16-bit integers; GPS data for velocity, altitude, longitude and latitude is sent as signed 32-bit integers and the data for ITOW (low 2-byte) is sent as 16-bit unsigned integer. See the “Data Packet Format” section for a complete description of the scaled mode outputs.

To convert the acceleration data into G's, use the following conversion:

$$\text{Accel} = \text{data} * (\text{GR}) / 2^{15}$$

Where **accel** is the actual measured acceleration in G's, **data** is the digital data sent by the MNAV100CA, and **GR** is the G Range: 2 G (1 G = 9.80 m s⁻²).

To convert the angular rate data into degrees per second, use the following conversion:

$$\text{Rate} = \text{data} * (\text{RR}) / 2^{15}$$

Where **rate** is the actual measured angular rate in °/sec, **data** is the digital data sent by the MNAV100CA, and **RR** is the Angular rate Range: 200 °/sec.

To convert the magnetic data into Gauss, use the following conversion:

$$\text{Magn} = \text{data} * (\text{MR}) / 2^{15}$$

Where **magn** is the actual measured magnetic in Gauss, **data** is the digital data sent by the MNAV100CA, and **MR** is the Magnetic Range: 2 Gauss.

To convert the temperature data into °C, use the following conversion:

$$\text{Temp} = \text{data} * (\text{TR}) / 2^{15}$$

Where **temp** is the actual measured temperature in °C, **data** is the digital data sent by the MNAV100CA, and **TR** is the Temperature Range: 200 °C.

To convert the absolute pressure data into altitude and velocity, use the following conversion:

$$\text{Press} = \text{data} * (\text{PR}) / 2^{15}$$

Where **press** is the altitude in meters and velocity in m/s, **data** is the digital data sent by the MNAV100CA, and **PR** is the pressure Range: 10000m for absolute pressure and 80m/s for pitot pressure.

The GPS data is directly scaled and represents velocity in cm/s, altitude in millimeters, longitude & latitude in 10e-7 degrees and ITOW in milliseconds.

4.4 Control Modes

The MNAV100CA has three control modes, on which the mode is determined by the PPM Signal. If the MNAV cannot detect a valid PPM signal, the unit will assume that the connection with R/C transmitter or R/C transmitter is OFF and it will revert to UAV mode. If MNAV detect a valid PPM signal, it will tell if the pulse width of the 5th channel (assuming a switch channel in the R/C transmitter) of PPM signal is high or low: if it is high, MNAV will be in RC mode; if low, in RPV mode.

In 'mainloop.c', new codes can be added to do a loop control, which will goes to different case depending on the mode, for the purpose of automatic control strategy.

The green LED will show which control mode the MNAV is in.

- * It is ON in UAV mode
- * It blinks in RPV mode.
- * It is OFF in RC mode.

In the RC mode, the servo is directly controlled by the PPM signal. (In other words, the human will take over the maneuver through the joysticks on the R/C transmitter.) In the other two modes, the servo is controlled by the program (including servo command over RS232 port).

4.4 Sensor Calibration

A calibration procedure performed at the factory will provide initial parameters for sensors. The user can also re-calibrate sensors using the MICRO-VIEW software. The firmware will then apply these parameters to each of the sensors to provide a scaled output.

- Rate sensors are calibrated for bias and scale factor.
- Accelerometers are calibrated for bias and scale factor.

- Magnetometers are calibrated for bias and scale factor.
- Pressure sensors are calibrated for bias, and default scale factor is stored in EEPROM.

See Appendix B for detailed calibration instructions.

4.5 Commands

The MNAV100CA has a simple command packet structure. You send a command to the MNAV100CA over the RS-232 interface and the MNAV100CA will execute the command. All communications to and from the unit are packets that start with a two-byte header 0x5555. This is the ASCII string "UU". All communications packets except for the ping command and response end with a two-byte checksum. The checksum is calculated in the following manner:

1. Byte-wise sum packet contents excluding the header and checksum itself.
2. The least significant 16-bits are the checksum.

MICRO-VIEW is the tool to use when troubleshooting your device.

MICRO-VIEW formulates the proper command structures and sends them over the RS-232 interface. You can use MICRO-VIEW to verify that the MNAV100CA is functioning correctly. MICRO-VIEW does not use any commands that are not listed here.

IMPORTANT

The commands and MICRO-VIEW support the factory firmware. If the user alters the open source code and loads the new image file into the Atmega128L, neither the commands nor MICRO-VIEW can be guaranteed to function properly.

4.5.1 Input Packets

All communications sent to the unit except for the ping command are input packets with the following format:

UU	<2-byte command>	<variable length data>	<2-byte checksum>
----	------------------	------------------------	-------------------

This generalized input structure allows input commands to carry data for advanced user interaction. All input packets can be no longer than 128 bytes. All two-byte input commands consist of a pair of ASCII characters. As a semantic aid, consider the following single character acronyms:

P = packet

F = fields (these are settings or data contained in the unit)

R = read (pertains to default non-volatile fields)

- G = get (pertains to current fields or settings)
- W = write (pertains to default non-volatile fields)
- S = set (pertains to current fields or settings)

G and S refer to current fields. Modifying current fields with S takes effect immediately and is lost on a power cycle. R and W refer to default power up fields. These fields are stored in non-volatile memory and determine the unit’s behavior on power up. Modifying default fields takes effect on the next power up and thereafter.

There are 5 user input commands: PK, GP, WF, SF and SS.

NOTE

The MNAV100CA commands are case sensitive!

4.5.2 Output Packets

All communications received from the unit except for the ping response are output packets with the following format:

UU	<1-byte packet type>	<variable length data>	<2-byte checksum>
----	----------------------	------------------------	-------------------

All packet types will be single printable ASCII characters. All output packets can be no longer than 128 bytes.

There are 5 output packet types: P, D, V, S and N. the P is response type packet, which is sent in response to a Ping request. And the D is sent in response to a ‘Query Serial Number and Firmware Version’ request. The remaining packets are available using the get packet command (polling) or can be configured for continuous (fixed rate) output.

4.5.3 Command List

Command	Ping	
Input Packet	UU	PK
Response Packet	UU	P
Description	Pings MNAV100CA to verify communications. The ping command does not have data or a checksum to facilitate human interaction from a keyboard. Sending the ping command will cause the unit to send a ping response. All bytes sent and received during the ping command and responses are ASCII printable characters.	

Command	Request Data			
Input Packet	UU	GP	<packet type>	Checksum
Response Packet	Data Packet (See Table 4)			
Description	This command allows the user to poll for non response-type output packets. The <i>packet type</i> options available are: V – Voltage Mode Packet; S – Scaled Mode Packet; Refer to Table 4 for data packet format in different modes.			

Command	Query Serial Number and Firmware Version				
Input Packet	UU	GP	D	Checksum	
Response Packet	UU	D	Serial Number	Version String	Checksum
Description	<p>This queries the MNAV100CA for its serial number and firmware version. The serial number contains 4-bytes and should be interpreted as two words, lowest-order-word first, but with highest-order-byte of each word sent first.</p> <p>For example, if the expected serial number is 4003012 or hex 0x003D14C4, then the byte sequence in the serial stream is: 0x14C4003D.</p> <p>The firmware version is an ASCII string that describes the MNAV100CA firmware version.</p>				

Command	Write/Set Fields					
Input Packet	UU	WF or SF	<1-byte num of fields>	<list of fields>	<field data>	Checksum
Response	None					
Description	<p>This command allows the user to write default power-up configuration fields to the EEPROM (WF) or set the unit's current configuration (SF) fields, which will be lost on power down. Writing the default configuration will not take affect until the unit is power cycled. The <i>Num of fields</i> is the number of words to be written / set. The <i>list of fields</i> is the field IDs that will be written with the <i>field data</i>, respectively. The unit will not write to calibration or</p>					

algorithm fields. The unit will not respond to this command.

Command Change Baud Rate

Input Packet	UU	WF	0x01	0x0002	Value	Checksum
---------------------	----	----	------	--------	-------	----------

Response None

Description This changes the default power-up baud rate of the MNAV100CA. Upon sending the command, the change will take effect. However, the change will not be saved into the unit. Therefore, every time when the MNAV100CA is powered up, the baud rate is 38,400 bps. The available 2-byte Value options and their corresponding baud rates are listed below:

Value	Hex Value	Baud Rate
0	0x0000	9600
1	0x0001	19200
2	0x0002	38400
3	0x0003	57600

For example, to change the default baud rate to 9600, send 0x55555746010002000000A0

Command Change Packet Type

Input Packet	UU	WF or SF	0x01	0x0003	Value	Checksum
---------------------	----	----------	------	--------	-------	----------

Response None

Description This command allows the user to change the measurement mode. If you want to change the packet type only temporarily, use SF instead of WF in the command packet above. The available 2-byte Value options and their corresponding power-up modes are listed below:

Value	Hex Value	Measurement Mode
'V'	0x0056	Voltage Packet
'S'	0x0053	Scaled Packet

For example, to temporarily change the packet type to Scaled, send 0x55555346010003005300F0

Command Change Packet Output Rate

Input Packet	UU	WF or SF	0x01	0x0001	Value	Checksum
---------------------	----	----------	------	--------	-------	----------

Response None

Description This command allows the user to change the packet output rate. If you want to change the packet rate only temporarily, use SF instead of WF in the command packet above. The available 2-byte Value options and their corresponding power-up modes are listed below:

Value	Hex Value	Output Rate
0	0x0000	Quiet
1	0x0001	100 Hz*
2	0x0002	50 Hz*
4	0x0004	25 Hz
5	0x0005	20 Hz
10	0x000A	10 Hz
50	0x0032	2 Hz

When the output rate is set to Quiet, the unit goes into Polled mode. For example, to set the unit temporarily into Polled mode, send 0x555553460100010000009B

* The 100 Hz and 50 Hz update rates can be achieved only at baud rates 38400 and higher.

Command Set Servos output
(In MICRO-VIEW 2.X and MNAV firmware later than Rev -03.)

Input Packet	UU	SS	<2-byte output value of servo#0>	<2-byte output value of servo#1>	...
	<2-byte output value servo#8>	2-byte Checksum			

Response None

Description This command allows the user to set the position of the 9 channels of servos,
The 2-byte value of 0xFFFF corresponds with the maximum pulse width of the servo, similarly the value of 0x0000 is for

the minimum of pulse width of the servo.

IMPORTANT

This “set servo output” command packet format that is used in MICRO-VIEW version 2.x, is only compatible with MNAV firmware later than Rev -03. The old servo command packet in MICRO-VIEW 1.x and MNAV firmware Rev -01 and -02, is described in Appendix C.

Command Set Reverse Bits of PPM Signals

Input Packet

UU	SP	<1-byte Reverse Bits>	Checksum
----	----	-----------------------	----------

Response None

Description This command allows the user to set the motion direction of the servos. Bit 0~7 of 1-byte Reverse Bits in this command is the motion direction flags of the servos from channel 0 to 7 respectively. For example, if Bit 0 is reset, the pulse width of channel 0 in PPM signal will be directly output to channel 0 of servo interface. If Bit 0 is set, the pulse width of channel 0 in PPM signal will be reversed and then output to channel 0 of servo interface.

4.6 Data Packet Format

In general, the digital sensor data representing each measurement is sent as a 16-bit number (two bytes). Between voltage and scaled mode, the data packet format is different as below:

- 1) In voltage mode: only the voltage outputs of sensors are provided in a 33 byte packet. See Table 4.1-1 as reference.
- 2) In scaled mode: the output data packet consists of the scaled outputs of sensors (28 bytes), the GPS data (35 bytes, Table 4.1-6) if available, and the PPM data (18 bytes, Table 4.1-7) if output rate is less than 100 Hz. The content and length of the data packet under different conditions is described in the following table.

Conditions		Output data packet		
Output rate	GPS available	Content	Length (Bytes)	Reference
100 Hz	No	Scaled	33	Table 4.1-2
	Yes	Scaled, GPS1	38	Table 4.1-3

<=50 Hz	No	Scaled, PPM	51	Table 4.1-4
	Yes	Scaled, GPS2, PPM	86	Table 4.1-5

In the table, “Scaled” represents “Scaled output of sensors”; “GPS1” is a five byte packet divided from the whole GPS packet, see Table 4.2; “GPS2” is the whole GPS packet, see Table 4.1-6. The above table is valid for baud rates 38,400 or higher.

When the update rate is 100 Hz, the GPS data is divided into 7 packets (each packet contains 5 bytes), See Table 4.1-3 and 4.2 as reference.

Each data packet will begin with a two-byte header (hex 5555) and end with a two-byte checksum. The checksum is calculated in the following manner:

1. Byte-wise sum packet contents excluding the header and checksum itself.
2. The least significant 16-bits data is the checksum.

The packet also contains a byte representing the MNAV100CA working mode. The detailed description of the data packet is shown in table 4.1.

Table 4.1 MNAV100CA Data Packet Format**4.1-1 Voltage Mode Packet**

Bytes	Description	Range	Units
1,2	Header (0x5555)		
3	'V'		
4,5	X-Axis Acceleration	[0, 5]	V
6,7	Y-Axis Acceleration	[0, 5]	V
8,9	Z-Axis Acceleration	[0, 5]	V
10,11	X-Axis Angular Rate	[0, 5]	V
12,13	Y-Axis Angular Rate	[0, 5]	V
14,15	Z-Axis Angular Rate	[0, 5]	V
16,17	X-Axis Magnetic Field	[-1, 1]	V
18,19	Y-Axis Magnetic Field	[-1, 1]	V
20,21	Z-Axis Magnetic Field	[-1, 1]	V
22,23	X-Axis Temperature	[0, 5]	V
24,25	Y-Axis Temperature	[0, 5]	V
26,27	Z-Axis Temperature	[0, 5]	V
28,29	Abs Pressure	[0, 5]	V
30,31	Pitot Pressure	[0, 5]	V
32,33	Checksum		

4.1-2 Scaled Mode Packet (Output Rate =100 Hz, Without GPS Data)

Bytes	Description	Range	Units
1,2	Header (0x5555)		
3	's'		
4,5	X-Axis Acceleration	[-2, 2]	G
6,7	Y-Axis Acceleration	[-2, 2]	G
8,9	Z-Axis Acceleration	[-2, 2]	G
10,11	X-Axis Angular Rate	[-200, 200]	Deg/sec
12,13	Y-Axis Angular Rate	[-200, 200]	Deg/sec
14,15	Z-Axis Angular Rate	[-200, 200]	Deg/sec
16,17	X-Axis Magnetic Field	[-1, 1]	Gauss
18,19	Y-Axis Magnetic Field	[-1, 1]	Gauss
20,21	Z-Axis Magnetic Field	[-1, 1]	Gauss
22,23	X-Axis Temperature	[-200, 200]	°C
24,25	Y-Axis Temperature	[-200, 200]	°C

26,27	Z-Axis Temperature	[-200, 200]	°C
28,29	Abs Pressure	[-100,10000]	m
30,31	Pitot Pressure	[0, 80]	m/s
32,33	Checksum		

4.1-3 Scaled Mode Packet (Without PPM, With GPS Data, output rate = 100 Hz)

Bytes	Description	Range	Units
1,2	Header (0x5555)		
3	'n'		
4,5	X-Axis Acceleration	[-2, 2]	G
6,7	Y-Axis Acceleration	[-2, 2]	G
8,9	Z-Axis Acceleration	[-2, 2]	G
10,11	X-Axis Angular Rate	[-200, 200]	Deg/sec
12,13	Y-Axis Angular Rate	[-200, 200]	Deg/sec
14,15	Z-Axis Angular Rate	[-200, 200]	Deg/sec
16,17	X-Axis Magnetic Field	[-1, 1]	Gauss
18,19	Y-Axis Magnetic Field	[-1, 1]	Gauss
20,21	Z-Axis Magnetic Field	[-1, 1]	Gauss
22,23	X-Axis Temperature	[-200, 200]	°C
24,25	Y-Axis Temperature	[-200, 200]	°C
26,27	Z-Axis Temperature	[-200, 200]	°C
28,29	Abs Pressure	[-100,10000]	m
30,31	Pitot Pressure	[0, 80]	m/s
32~36	Divided five byte of GPS package		
37,38	Checksum		

4.1-4 Scaled Mode Packet (Output rate < 100 Hz, with PPM, without GPS Data)

Bytes	Description	Range	Units
1,2	Header (0x5555)		
3	'S'		
4,5	X-Axis Acceleration	[-2, 2]	G
6,7	Y-Axis Acceleration	[-2, 2]	G
8,9	Z-Axis Acceleration	[-2, 2]	G
10,11	X-Axis Angular Rate	[-200, 200]	Deg/sec
12,13	Y-Axis Angular Rate	[-200, 200]	Deg/sec
14,15	Z-Axis Angular Rate	[-200, 200]	Deg/sec

16,17	X-Axis Magnetic Field	[-1, 1]	Gauss
18,19	Y-Axis Magnetic Field	[-1, 1]	Gauss
20,21	Z-Axis Magnetic Field	[-1, 1]	Gauss
22,23	X-Axis Temperature	[-200, 200]	°C
24,25	Y-Axis Temperature	[-200, 200]	°C
26,27	Z-Axis Temperature	[-200, 200]	°C
28,29	Abs Pressure	[-100,10000]	m
30,31	Pitot Pressure	[0, 80]	m/s
32~49	PPM data packet		
50,51	Checksum		

4.1-5 Scaled Mode Packet (Output rate < 100 Hz, with PPM and GPS Data)

Bytes	Description	Range	Units
1,2	Header (0x5555)		
3	'N'		
4,5	X-Axis Acceleration	[-2, 2]	G
6,7	Y-Axis Acceleration	[-2, 2]	G
8,9	Z-Axis Acceleration	[-2, 2]	G
10,11	X-Axis Angular Rate	[-200, 200]	Deg/sec
12,13	Y-Axis Angular Rate	[-200, 200]	Deg/sec
14,15	Z-Axis Angular Rate	[-200, 200]	Deg/sec
16,17	X-Axis Magnetic Field	[-1, 1]	Gauss
18,19	Y-Axis Magnetic Field	[-1, 1]	Gauss
20,21	Z-Axis Magnetic Field	[-1, 1]	Gauss
22,23	X-Axis Temperature	[-200, 200]	°C
24,25	Y-Axis Temperature	[-200, 200]	°C
26,27	Z-Axis Temperature	[-200, 200]	°C
28,29	Abs Pressure	[-100,10000]	m
30,31	Pitot Pressure	[0, 80]	m/s
32~66	GPS data packet		
67~84	PPM data packet		
85,86	Checksum		

NOTE

The 200 deg/sec is digital scaling range of the angular rate sensors. The actual measurement range of angular rate sensors is ± 150 deg/sec.

4.1-6 GPS Data Packet

Bytes	Description	Units	Notes
1,2	Header (0x5555)		
3	'G'		
4,5,6,7	North Velocity	Cm/s	LSB first
8,9,10,11	East Velocity	Cm/s	LSB first
12,13,14,15	Earth Velocity	Cm/s	LSB first
16,17,18,19	Longitude	10e-7 Deg	LSB first
20,21,22,23	Latitude	10e-7 Deg	LSB first
24,25,26,27	Altitude	mm	LSB first
28,29	ITOW	ms	LSB first
30,31,32,33	Reserved		= 0
34,35	Checksum		

4.1-7 PPM Data Packet

Bytes	Description	Notes
1	'F' (0x46)	Header
2	Status Byte	(1)
3,4	Channel 0	MSB first
5,6	Channel 1	
7,8	Channel 2	
9,10	Channel 3	
11,12	Channel 4	
13,14	Channel 5	
15,16	Channel 6	
17,18	Channel 7	

NOTE

- (1) Bits 0~7 of the Status Byte are the motion direction flags of the servos from channel 0 to 7 respectively. For example, if Bit 0 is reset, the pulse width of channel 0 in PPM signal will be directly output to channel 0 of servo interface. If Bit 0 is set, the pulse width of channel 0 in PPM signal will be reversed and then output to channel 0 of servo interface.

When the output rate is 100 Hz, the GPS data is divided into 7 packets following the sensor data as shown in Table 4.2.

Suppose the time is “0” when one complete GPS data-packet is valid, and the GPS update rate is F Hz ($F=1 \sim 4$).

Define one complete GPS data transport cycle as $1/F$ seconds $\{0 \sim (1/F - 0.01)\}$. In each cycle, the GPS data is transported from time “0” and after these 7 packets are completed, the data packet format changes to Scaled Mode Data packet without GPS data (see table 4.1-2).

The data format is shown as below.

Table 4.2 GPS Data Transport Cycle, MNAV100CA output rate = 100 Hz, GPS output rate=F Hz

Time (s)	Bytes					Packet Length
	1,2	3	4~31	32~36 (see Table 4.1-3)	37,38	
0	0x5555	'n'	Sensors data	GPS Packet Bytes: 1~5	Checksum	38 Bytes
0.01	0x5555	'n'	Sensors data	GPS Packet Bytes: 6~10	Checksum	
0.02	0x5555	'n'	Sensors data	GPS Packet Bytes: 11~15	Checksum	
0.03	0x5555	'n'	Sensors data	GPS Packet Bytes: 16~20	Checksum	
0.04	0x5555	'n'	Sensors data	GPS Packet Bytes: 21~25	Checksum	
0.05	0x5555	'n'	Sensors data	GPS Packet Bytes: 26~30	Checksum	
0.06	0x5555	'n'	Sensors data	GPS Packet Bytes: 31~35	Checksum	
0.07	Scaled Mode Packet without GPS Data, see Table 4.1-2					33 Bytes
...	...					
...	...					
...	...					
1 / F-0.01	Scaled Mode Packet without GPS Data, see Table 4.1-2					

5 MNAV100CA as a Development Platform

5.1 MNAV100CA hardware development platform

The MNAV100CA utilizes an ATmega128L microcontroller to manage two 8-channel 16-bit A/D converters, GPS receiver, 9 servo interfaces, also the PPM input interface and sensor calibration in the internal EEPROM. Refer to Atmel Website at <http://www.atmel.com> for the datasheet of the ATmega128L.

5.2 Using the AVR GCC Tool chain

The firmware of the MNAV100CA is compiled under AVR GCC version: 20040404. The AVR-GCC is a freeware C compiler (and assembler) that is made available through the GNU project. AVR GCC version: 20040404 installation software is located at <CD-ROM>:\Software Tools\WinAVR-20040404-bin-install.exe.

These tools may also be obtained directly from <http://www.avrfreaks.net/> or <http://sourceforge.net/projects/winavr/>. You can refer to these sites for updates and changes to the tools.

IMPORTANT

The firmware was made from WinAVR-20040404, which includes gcc 3.3.2 and avr-libc 1.0.3 etc.

The source code may not work if it is compiled under the WinAVR later than WinAVR-20040404, because the WinAVR later than WinAVR-20040404 may include the later gcc or avr-libc.

Go to the following websites to find the changes of gcc and avr-libc.

<http://www.nongnu.org/avr-libc/>

<http://gcc.gnu.org/>

5.3 Loading the New Application into MNAV100CA

The boot loader in the Boot Flash Section of the ATmega128L allows the CPU to program the application flash of the ATmega128L via MNAV100CA Serial Port 0. The Boot Loader Tool for the PC is shipped with the CD-ROM, located at <CD-ROM>:\Software Tools\MNAV PC Loader.exe. Please read the instructions in the GUI of the software before using it.

6 Limitations

6.1 Installation

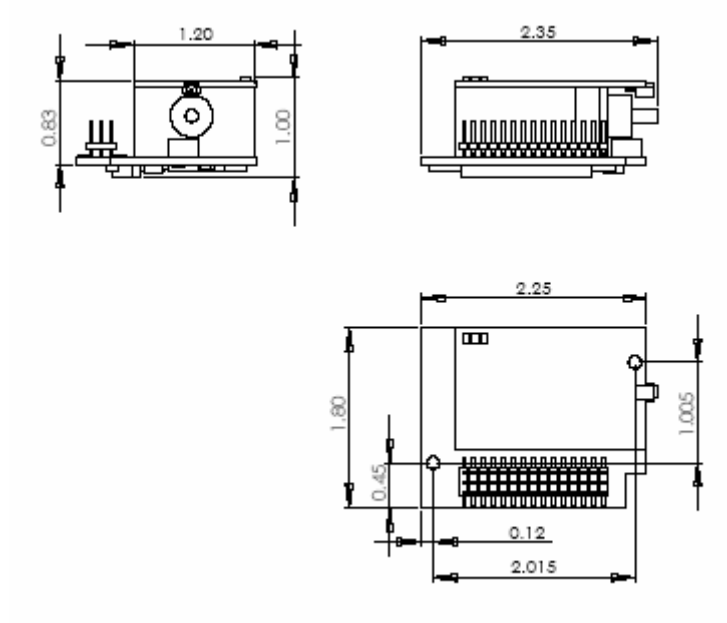
The MNAV100CA should be mounted as close to the center of gravity (CG) of your system as possible.

6.2 Range Limitations

The internal sensors in the MNAV100CA are limited to maneuvers of less than 150 deg/sec and less than 2 Gs in acceleration.

7 Appendix A. Mechanical Specifications

7.1 MNAV100CA Outline Drawing



(All dimensions are in inches)

8 Appendix B. Sensor Calibration

8.1 Introduction

The sensors of the MNAV100CA output voltages, which can be converted to the scaled values to represent physical units. The zero bias and scale factor are necessary for this conversion. So it is necessary to perform a calibration to get the accurate zero-bias and scale factor values for the sensors.

The parameters mentioned above are provided from the factory calibration, users can also re-calibrate the sensors by using MICRO-VIEW software. Please refer to 6740-0001-02 for detail calibration procedure.

8.2 Sensor Calibration Procedure using MICRO-VIEW

When you use the MICRO-VIEW software for calibration, the software gathers data from the MNAV100CA via RS232, and then processes this data to compute the parameters.

The calibration procedure involves several steps:

- 1) Place the MNAV100CA with the x-axis positive up on the level surface, connect RS232 cable to PC, power on the MNAV100CA, then wait for 10 minutes
- 2) Start up the software "MICRO-VIEW", select COM Port, Update Rate and set the MNAV100CA in "Volt Mode". Click the Button "Calibration" to enter the calibration interface. Each above operation can also be achieved by click relevant menu.
- 3) Calibrate the bias of gyro:
Click button "Keep Still", keep the unit still and wait for 10 seconds, then click button "Finish this Step", the calibration result will be displayed in relevant area..
- Step 4 ~ 7: Calibrate Scale Factors of Gyroscopes
- 4) In gyroscope group frame, select the angle you want to rotate when you calibrate scale factors of gyroscope.
- 5) Calibrate the scale factor of gyro-X:
Click button "X-Rotate", rotate the MNAV100CA for the angle (selected in step 4) around positive x-axis direction, then click button "Finish This Step", the calibration result will be displayed in relevant area.
- 6) Calibrate the scale factor of gyro-Y:
Similar with step 5, click button "Y-Rotate", rotate the MNAV100CA for the angle (selected in step 4) around positive y-axis direction, then click button "Finish This Step".

7) Calibrate the scale factor of gyro-Z:

Similar with step 5, click button “Z-Rotate”, rotate the MNAV100CA for the angle (selected in step 4) around positive z-axis direction, then click button “Finish This Step”.

Step 8 ~ 13: Calibrate Bias and Scale Factors of Accelerometers and Magnetometers

8) Select sensor type you want to calibrate: you can choose to calibrate none, either or both of accelerometers and magnetometers.

9) For X-axis Accelerometer and/or magnetometer:

Place the MNAV100CA with the x-axis positive up on the level surface, then click button “X-Up”, keep the unit still and wait for 10 seconds, then click button “Finish this Step”.

10) For X-axis Accelerometer and/or magnetometer:

Place the MNAV100CA with the x-axis negative up on the level surface, then click button “X-Down”, keep the MNAV100CA still and wait for 10 seconds, then click button “Finish This Step”, the calibration result will be displayed in relevant area.

Step 11~12, calibrate the Y-axis Accelerometer and/or magnetometer, similar with in step 9~10 for the X-axis Accelerometer and magnetometer:

11) Place the MNAV100CA with the y-axis positive up on the level surface, then click button “Y-Up”, keep the MNAV100CA still and wait for 10 seconds, then click button “Finish This Step”.

12) Place the MNAV100CA with the y-axis negative up on the level surface, then click button “Y-Down”, keep the MNAV100CA still and wait for 10 seconds, then click button “Finish This Step”, the calibration result will be displayed in relevant area.

Step 13~14, calibrate the Z-axis Accelerometer and/or magnetometer, similar with in step 9~10 for the X-axis Accelerometer and magnetometer:

13) Place the MNAV100CA with the z-axis positive up on the level surface, then click button “Z-Up”, keep the MNAV100CA still and wait for 10 seconds, then click button “Finish This Step”.

14) Place the MNAV100CA with the z-axis negative up on the level surface, then click button “Z-Down”, keep the MNAV100CA still and wait for 10 seconds, then click button “Finish This Step”, the calibration result will be displayed in relevant area.

Step 15~16: Calibrate the zero bias of pressure sensors:

15) Calibrate the zero bias of absolute pressure sensors

In pressure group frames, click button “Ground Level Zero”, keep the MNAV100CA still and wait for 10 seconds, then click button “Finish This Step”, the calibration result will be displayed in relevant area.

16) Calibrate the zero bias of REL pressure sensors:

Keep the port of REL pressure sensor open to the static air. Click button “Static Zero”, keep the MNAV100CA still and wait for 10 seconds, then click button “Finish This Step”, the calibration result will be displayed in relevant area.

- 17) The default scale factors of absolute pressure and pitot pressure have been shown in relevant text frame, and stored in EEPROM.
- 18) Click the button “Check Cali Result”, if “Pass” is shown, the calibration result is eligible; if “Failure” with some help message are shown, please operate referring to the help message.
- 19) Click the little button “R” beside the text frame if you want to read parameter of certain sensor, and click the button “Read all Parameters from EEPROM” if you want to read parameters of all sensors from EEPROM. The bias and scale factor of sensors will be displayed in relevant area.
- 20) The Zero Bias and Scale Factor of gyroscopes, accelerometers and magnetometers are shown in text frames. Click the little button “W” beside the text frame if you want to write parameter of certain sensor, and click the button “Write all Parameters to EEPROM” if you want to write parameters of all sensors to EEPROM.
- 21) Click the button “Page Setup”, “Print Preview”, and “Print” to print this calibration result.
- 22) Re-power-up the MNAV100CA, and set MICRO-VIEW in ‘Scaled Mode’, open all the graph of sensors output. You can check whether the unit works well.

9 Appendix C. Servo control

9.1 Introduction

The MNAV100CA provides the ability to control servos, which can help users to make a complete control system. The MNAV100CA can support a maximum of 9 servo channels. You can drive the servos by sending the command “Set Servo Output” described in 4.5.3, and you also can debug the servos by using the MICRO-VIEW software.

9.2 Debugging Servos using MICRO-VIEW

When you use the MICRO-VIEW software to debug servos, the software outputs commands to the MNAV100CA via RS232, and then the MNAV100CA sends relevant signals to drive the servo. See the figure 9.1 for reference.

Follow the instructions below to debug the servo:

- 1) Power the MNAV100CA and connect it to a PC, start MICRO-VIEW, and then select “Servo” under the menu “Servo/PPM” to enter the Servo interface.
- 2) Move the track bar (relevant to servo channel) up or down, the servo will respond with the specified action; you also can input the value (0~65535) in the text frame under the track bar and click on “S”. The servo will respond accordingly.
- 3) You can input the position value of any channel in relevant text frame, then click button “Set All value”, all servos will respond to the target position you set.
- 4) Click the button “Reset All Value”, the target position of all channels will be set to zero.

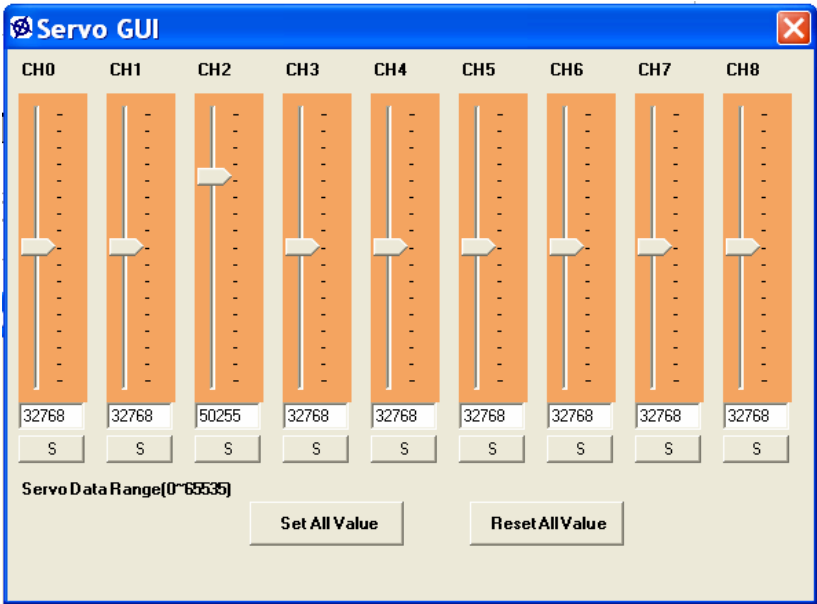


Figure 9.1 Servo Interface of MICRO-VIEW

9.3 The “set servo output” command packet in MICRO-VIEW 1.x and MNAV firmware Rev -01 and Rev -02.

The “set servo output” command packet in MICRO-VIEW 1.x and MNAV firmware Rev -01 and Rev -02 is described below, which is quite different from the newer version – MICRO-VIEW 2.x and MNAV firmware later than Rev -03. Please refer to section 4.5.3 for the new command packet.

Command Set Servos output
(In MICRO-VIEW and MNAV firmware version Rev -01 and Rev -02)

Input Packet	UU	SS	<1-byte num of servos>	<1-byte No. of the first servo>	<2-byte output value of the first servo>
	<1-byte No. of the second servo>	<2-byte output value of the second servo>	...	<1-byte No. of the last servo>	<2-byte output value of the last servo>
	Checksum				

Response None

Description This command allows the user to set the position of the servos, the number of servos set in this command ranges from 1 to 9, which is specified as 1 byte *num of servos* in the input packet.

The servo channels and their corresponding byte value is listed below:

Servo Channel ID	Byte Value
0	0x07
1	0x03
2	0x06
3	0x02
4	0x00
5	0x01
6	0x05
7	0x04
8	0x08

For example, to set the servo 0 to maximum pulse width, send 0x55555353 01 07 FFFF 02AC; to set TWO servos - servo 0 at minimum pulse width and servo 1 at the middle point, send 0x55555353 02 07 0000 03 8000 0132.

10 Appendix D. PPM GUI

10.1 Introduction

The MNAV100CA provides a PPM interface, which can receive and extract the PPM signal from the R/C transmitter. A convenient GUI is integrated into the MICRO-VIEW software, as shown in Figure 10.1.

10.2 PPM GUI in MICRO-VIEW

Follow the instructions below to view PPM using MICRO-VIEW:

- 1) Power on the MNAV100CA and connect it to a PC, start MICRO-VIEW, set the unit to Scaled mode, set the output rate to less than 100 Hz, and then click on “PPM” to enter the PPM interface.
- 2) MICRO-VIEW supports 8 channels of PPM signal, the data from each channel is represented by the position of a bar, and also displayed in the relevant text box.
- 3) You can reverse the signal of each PPM channel by clicking the relevant button “Rev”, and the checkbox under this button will display the current status of this channel. This change will be stored into EEPROM.
- 4) The CH4 signal works as a switch between PPM and serial port control of servos using R/C channel 5 (PPM CH4 in PPM GUI). If the value of the CH4 signal is more than 10,000 (decimal), the servos will be controlled by the PPM signal of the R/C transmitter. Otherwise, servos will be controlled by servo setting commands via serial port.

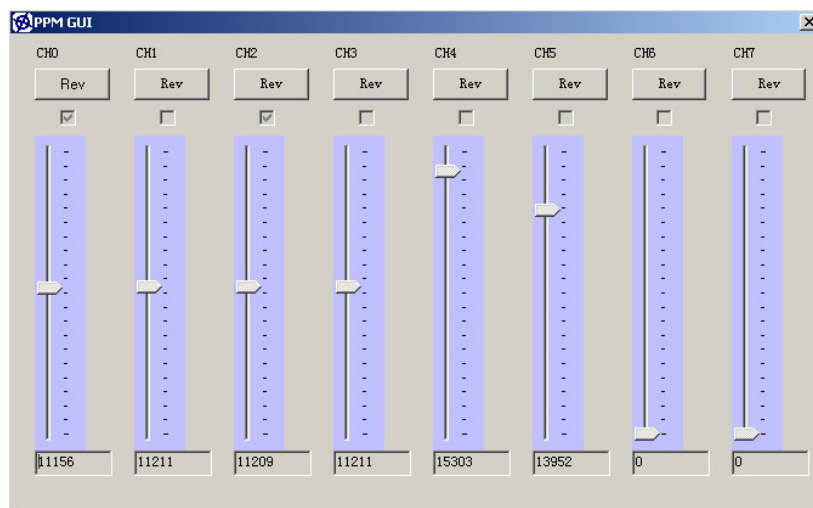


Figure 10.1 PPM GUI of MICRO-VIEW

NOTE

The CH0~CH7 in the PPM GUI are the sequent by the time order in the PPM signal. The CH0~CH8 in the Servo GUI match with Servo#0~Servo#8, ordered by the connector. So, CH0 in PPM GUI and Servo GUI is different.

In RC Mode (See 'Section 4.4 Control Mode'), the RC transmitter takes over the control of the servos. The change of CH0 data of PPM signal, which is shown in CH0 track bar in PPM GUI, will not control Connector#0. Table 10.1 shows the mapping between PPM channels and Servo Channels.

Table 10.1 Mapping between PPM Channels and Servo Channels

PPM Channel No.*	Servo Channel No.
0	4
1	5
2	3
3	1
4	7
5	2
6*	0
7*	8

* The firmware offered with MNAV100CA only supports from CH0 to CH5 of PPM signal. For your applications, please change the value of PPM_MAX_PULSES into the channel number, in <ppm.h> in the source code.

11 Appendix E. Sensors List

Table 11.1 shows the sensor information used in MNAV100CA.

Table 11.1 MNAV100CA Sensors

Sensor Type	Sensor Name	Manufacture
Angular rate	ADXRS150ABG	Analog Device (http://www.analog.com)
Accelerometer	ADXL202JE	Analog Device (http://www.analog.com)
Magnetometer	HMC1052	Honeywell (http://www.honeywell.com)
Magnetometer	HMC1051ZL	Honeywell (http://www.honeywell.com)
Pressure gage	MPXV5004GC6U	Motorola(Freescale) (http://www.freescale.com)
Pressure abs	MPXH6115A6U	Motorola(Freescale) (http://www.freescale.com)
GPS receiver	TIM-LP	u-blox (http://www.u-blox.com)

To obtain the latest datasheets for these sensors and the GPS receiver, please visit the vendor websites listed above.

12 Appendix F. Warranty and Support Information

12.1 Customer Service

As a Crossbow Technology customer you have access to product support services, which include:

- Single-point return service
- Web-based support service
- Same day troubleshooting assistance
- Worldwide Crossbow representation
- Onsite and factory training available
- Preventative maintenance and repair programs
- Installation assistance available

12.2 Contact Directory

United States: Phone: 1-408-965-3300 (8 AM to 5 PM PST)

Fax: 1-408-324-4840 (24 hours)

Email: techsupport@xbow.com

Non-U.S.: Refer to website www.xbow.com

12.3 Return Procedure

12.3.1 Authorization

Before returning any equipment, please contact Crossbow to obtain a Returned Material Authorization number (RMA).

Be ready to provide the following information when requesting an RMA:

- Name
- Address
- Telephone, Fax, Email
- Equipment Model Number
- Equipment Serial Number
- Installation Date
- Failure Date
- Fault Description
- Will it connect to MICRO-VIEW?

12.3.2 Identification and Protection

If the equipment is to be shipped to Crossbow for service or repair, please attach a tag TO THE EQUIPMENT, as well as the shipping container(s), identifying the owner. Also indicate the service or repair required, the problems encountered and other information considered valuable to the service facility such as the list of information provided to request the RMA number.

Place the equipment in the original shipping container(s), making sure there is adequate packing around all sides of the equipment. If the original shipping container(s) were discarded, use heavy boxes with adequate padding and protection.

12.3.3 Sealing the Container

Seal the shipping container(s) with heavy tape or metal bands strong enough to handle the weight of the equipment and the container.

12.3.4 Marking

Please write the words, "**FRAGILE, DELICATE INSTRUMENT**" in several places on the outside of the shipping container(s). In all correspondence, please refer to the equipment by the model number, the serial number, and the RMA number.

12.3.5 Return Shipping Address

Use the following address for all returned products:

Crossbow Technology, Inc.
4145 N. First Street
San Jose, CA 95134
Attn: RMA Number (XXXXXX)

12.4 Warranty

The Crossbow product warranty is one year from date of shipment.