

MIDG SERIES INS/GPS

USER MANUAL



09 January 2012

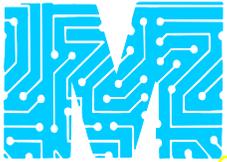
 **MICROBOTICS, INC.**
28 RESEARCH DRIVE, SUITE G
HAMPTON, VIRGINIA 23666
+1-757-865-7728
INNOVATIVE NAVIGATION AND CONTROLS
www.microboticsinc.com

TABLE OF CONTENTS

Section	Heading	Page
1.	Introduction.....	1
2.	Getting Started.....	1
3.	MIDG Series INS/GPS Software and Utilities.....	2
3.1	Installing the Software and Utilities.....	2
4.	GPS Antenna Specifications.....	4
4.1	Active GPS Antennas.....	4
4.2	Passive GPS Antennas.....	4
4.3	Installing and Using the MIDG Series INS/GPS Patch Antenna.....	5
5.	Installing and Using the SLC2JUSB Interface Cable.....	5
5.1	SLC2JUSB Driver Installation.....	5
5.1.1	Using the SLC2JUSB Interface Cable.....	5
5.2	Using the SLC2J09SF Interface Cable.....	6
5.2.1	Connecting the SLC2J09SF Interface Cable.....	6
6.	User Supplied Interface.....	7
6.1	General Connections.....	7
6.1.1	Power Connections.....	8
6.1.2	Digital Ground Connections.....	8
6.2	RS - 422 Data Connections.....	8
6.3	RS - 232 Data Connections.....	9
6.4	1 Pulse - Per - Second Output.....	10
6.4.1	Trigger Input.....	11
7.	MIDG Series INS/GPS Dimensions and Mounting.....	11
7.1	Physical Dimensions.....	11
7.1.1	Physical Characteristics.....	11
7.2	Mounting the MIDG Series INS/GPS.....	11
7.2.1	Hard Mounting the MIDG Series INS/GPS.....	11
7.2.2	Soft Mounting the MIDG Series INS/GPS.....	12
7.3	Mounting Orientation.....	12
7.3.1	Orientation Correction.....	12
8.	MIDG Series INS/GPS Messages.....	12
8.1	Microbotics Binary Protocol.....	12
8.1.1	Microbotics Binary Protocol Message Contents.....	12
8.1.2	Fletcher Checksum.....	13
9.	Help and Support.....	13
A.	ATTACHMENT A - SLC2JUSB.....	A1
B.	ATTACHMENT B - MIDG II Message Specification FW 2.1.x & Higher.....	B1
C.	ATTACHMENT C - MIDG Series INS/GPS Specifications.....	C1
D.	ATTACHMENT D - GPS Antenna Specifications.....	D1
E.	ATTACHMENT E - Installation File Directory Tree.....	E1

1 Introduction. Congratulations on your purchase of the MIDG Series INS/GPS; the smallest and most advanced Inertial Navigation System (INS) in its class. This guide is designed as a quick start guide and will get your MIDG Series INS/GPS up and running. Along with the MIDG Series INS/GPS is a whole host of tool and software which enables you to quickly custom tailor the MIDG's operation to fit your specific needs.

The MIDG Series INS/GPS is an inertial navigation system (INS) using GPS-aiding. The on-board GPS receiver can track up to sixteen satellites when the GPS antenna has a clear view of the sky and is WAAS and EGNOS compliant. The GPS provides a three-dimensional fix, allowing the INS to determine its current position within two meters. The system also contains an array of sensors, which, coupled with a GPS receiver, provide the input data to the internal microprocessor running an optimized Kalman filter. This Kalman filter considers all the data provided, estimates and adjusts for the sensor errors, and determines the vehicle's position, velocity, and attitude.

The MIDG Series INS/GPS provides a serial data stream which can be easily integrated with the user control computer and/or control center. Data outputs can be polled or automatically updated for position, attitude, etc., at intervals up to 50 Hz.

2 Getting Started. The MIDG Series INS/GPS will have been shipped several other items. Some of these items are optional and depending on your order, you may, or may not, have received them. Figure 1 shows the MIDG Series INS/GPS with all of the available accessories. Please verify the order contents with the purchase order to ensure that all items ordered have been received.

A standard MIDG Series INS/GPS will come with the following items:

- A. **MIDG Series INS/GPS:** SIS90031C, SIS90031C-SR, SIS90031C-G (Dependant on the model ordered.)
- B. **MIDG Utilities CD-ROM:** Contains all of the software, utilities, and documentation for the MIDG Series INS/GPS
- C. **Mating Connector:** An 18", 30 AWG Omnetics mating connector with pigtail and stainless capturing screw.
- D. **Mounting Screws:** Nonmagnetic stainless mounting screws 0-80 x 3/16"
- E. **Hex Wrench:** A 0.9mm hex wrench for use with the capturing screw on the mating connector.



Figure 1. MIDG Series INS/GPS with Accessories

Optional MIDG Series INS/GPS accessories which may be ordered are:

- F. **SLC2JUSB:** A pre-built MIDG Mating/USB interface cable to provide power and data connections to the MIDG Series INS/GPS.
- G. **SLC2J09SF:** A pre-built interface cable provides power and data connections to the MIDG Series INS/GPS to a PC's RS232 serial port and a 10-32 VDC 100 mW external power supply.
- H. **Active GPS Antenna:** A five (5) volts, Hi-Gain/Lo-Noise GPS patch antenna.
- I. **SLC10232:** A Serial Voltage Level Converter for RS232 to/from RS422 or TTL format.

OPTIONAL MIDG SERIES INS/GPS ACCESSORIES ARE DETAILED IN SECTION 4 AND SECTION 5. SECTION 4 APPLIES TO USERS WHO WILL BE ATTACHING A GPS ANTENNA TO THE MIDG SERIES INS/GPS. SECTION 5 APPLIES TO USERS WHO WILL BE INTERFACING THE MIDG SERIES INS/GPS WITH A PC OR LAPTOP VIA MIDG/PC INTERFACE CABLES.

3 MIDG Series INS/GPS Software and Utilities . The software and utilities package for the MIDG Series INS/GPS contains many tools to configure, optimize, and update the MIDG Series INS/GPS as well as all of the needed documentation for understanding how to perform various functions and operations.

Software included on the CD:

- A. **MIDG II Display Utility:** Used to configure, display, and optimize the MIDG output
- B. **MIDG II Flash Loader:** Used to update the MIDG Series INS/GPS firmware
- C. **INS Parser:** Used to parse inertial navigation data recorded from the MIDG while in INS Mode for post operation analysis.
- D. **II Parser:** Used to parse inertial measurement data recorded from the MIDG while in IMU Mode for post operation analysis.

Tools included on the CD:

- F. **MatLab™ Files (MFiles):** MatLab™ program files for various mapping and plotting of route/and or flight information. There are several examples which will enable the user to become familiar with the MIDG II binary output.
- G. **Interface Software:** Contains the "C" language tools needed to interface a computer to the MIDG Series INS/GPS. This tool kit may be adapted for flight, remote control systems, radio transmission, and/or employed in robotic interfaces.

Documentation included on the CD:

- H. **Application Notes:** Contains information about how the MIDG Series INS/GPS uses the different operational modes such as Vertical Gyro (VG) and Inertial Navigation System (INS).
- I. **Instructions:** Contains instructions on how to use all of the MIDG Series INS/GPS software as well as how to magnetically calibrate and set the accelerometer biases for the MIDG Series INS/GPS.
- J. **Message Specification:** Contains a current version of the MIDG Series Message Specification.

3.1 Installing the Software and Utilities. The MIDG Series INS/GPS software and utilities are all contained in a single installer package. The following steps will guide the user through the software and utilities installation process.

1. **Place the MIDG Software and Utilities CD into a CD reader.** Figure 2 shows the root of the CD-ROM. As shown, the root of the CD-ROM will contain the two (2) folders and a document file listed below:

- A. **Vista-Win 7:** Contains Window Vista and Windows 7 installer.
- B. **Win-2K to XP-64:** Contains Windows 2K to XP64 installer.
- C. **READ ME FIRST.doc:** Instructs on how to identify Windows® version.

VIEW THE "READ ME FIRST.DOC" FILE FOR INSTRUCTIONS ON HOW TO IDENTIFY THE PC OR LAPTOP'S SPECIFIC VERSION OF WINDOWS®.

2. **Open the folder which contains the specified version of Windows®.** Figure 3 shows the contents of the opened folder. The selected folder will contain three (3) files: (Win-2K to XP-64 used as an example)

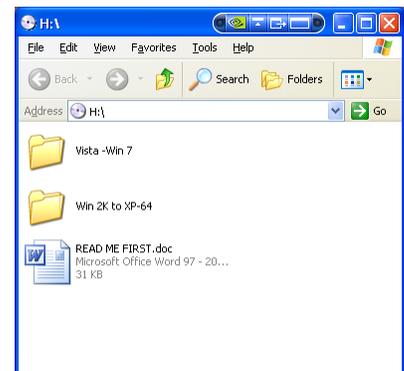


Figure 2. MIDG Series INS/GPS CD-ROM Contents.

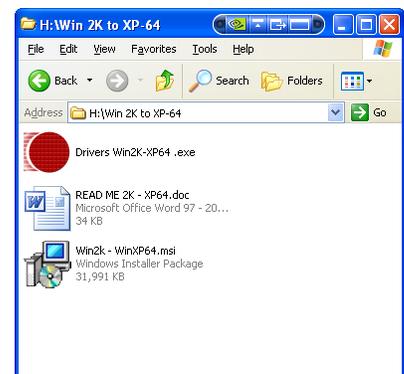


Figure 3. MIDG Series INS/GPS Installation Programs (Win 2k to Win XP-64)

- A. **Drivers Win2K to XP64.exe:** An installer package for the driver files for the SLC2JUSB Cable (optional).
- B. **Win2K - WinXP64.msi:** The installer package for the MIDG Series INS/GPS Software and Utilities.
- C. **READ ME.doc:** A document file detailing all Windows® versions which are supported.

VIEW THE "READ ME.DOC" FILE FOR INFORMATION ON SUPPORTED VERSIONS OF WINDOWS® FOR THE INSTALLATION FILE LOCATED IN THIS FOLDER.

- 3. **Select the installer file ("msi" extension) to begin the installation process.**
- 4. **On the "Welcome" screen, press the "Next" button to continue the installation process** (Figure 4).



Figure 4. Installation "Welcome" Screen

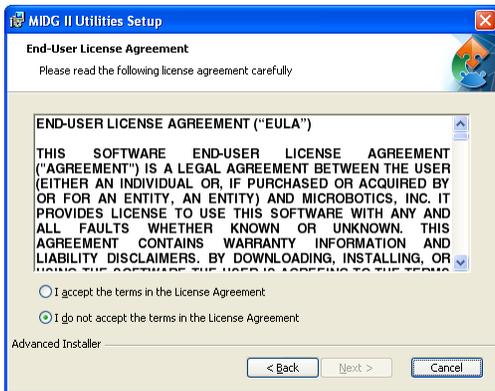


Figure 5. EULA Agreement Screen

- 5. **Read the End User License Agreement (EULA). Select the "I accept the terms in the License Agreement" radio button.** Figure 5 shows the End User License Agreement screen. The "Next" button will become active. If the license agreement radio button is not selected the installation will not continue.
- 6. **Select the "Next" button at the bottom of the EULA screen to continue.** A copy of the EULA agreement is installed with the rest of the software and documentation.

- 7. **Select the destination folder for the installation program.** Figure 6 shows the default path for the installation. However, the user may specify any location desired.
- 8. **Press the "Next" button at the bottom of the screen to continue with the installation.**

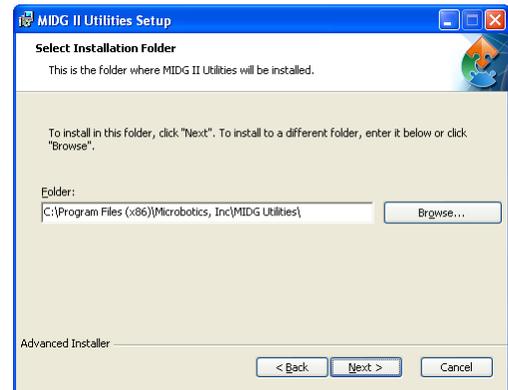


Figure 6. Select destination folder screen

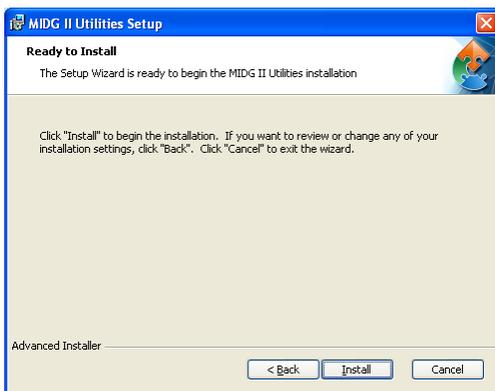


Figure 7. Ready Installation screen

- 9. **Press the "Install" button at the bottom of the screen to continue with the installation (Figure 7).** At this point the "Installer" screen will display the progress of the installer as it installs several files and programs on to hard drive of the PC or laptop. The location of these files will be where ever the installation location was designated in Step 7.

Once the installation is finished, the "Finished" screen (Figure 8) will appear. The user may open the "Read Me" file, or review the file at a later time.

10. Press the "Finish" button to complete the installation process.

FOR MORE INFORMATION ABOUT ANY OF THE MIDG SOFTWARE AND UTILITIES, PLEASE REFER TO THE APPROPRIATE INSTRUCTION MANUALS FOR EACH. ALL NECESSARY DOCUMENTATION HAS BEEN INSTALLED IN THE "DOCUMENTS" FOLDER OF THE INSTALLATION. ATTACHMENT "B" HAS A LISTING OF ALL FOLDERS AND FILES INSTALLED WITH THIS SOFTWARE AND THEIR RELATIVE LOCATIONS.

SECTION 4 IS OPTIONAL. THIS SECTION ONLY APPLY IF THE MIDG SERIES INS/GPS ACCESSORY ANTENNA IS PURCHASED (A-GPS5-SMA).

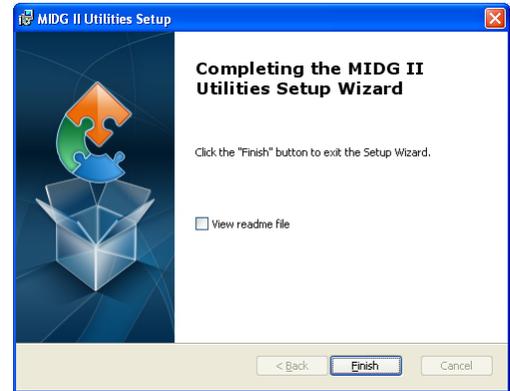


Figure 8. Finished Installation Screen

4 GPS Antenna Specifications. The MIDG Series INS/GPS must be connected to an external GPS antenna for reception of GPS signals. The MIDG Series INS/GPS can be use with active or passive GPS antennas. The SMA connector on the rear of the MIDG Series INS/GPS supplies +5 VDC to the user's GPS antenna.

4.1 Active GPS Antennas. For most applications an active GPS antenna is recommended. The antenna is powered through the SMA connector, which provides +5VDC on the center pin. Any antenna connected to a MIDG Series INS/GPS must be designed for +5VDC operation, and must not draw more than 25 mill-amperes. When an active antenna is used, it should have a rated gain of at least 15 dB, with greater gains needed for longer cables or obstructed view of the sky. The maximum gain (only when long cables are involved) must not be greater than 50 dB and if a high gain antenna is used, the user must make sure the actual signal at the SMA connector is less than -61 dBm (e.g., by having enough cable between the antenna and the MIDG Series INS/GPS to attenuate the antenna amplifier signal) in order to prevent swamping the GPS receiver and degrading the MIDG II performance. A typical useable antenna gain range is 15-30 dB.



Figure 9. MIDG Series INS/GPS Optional Patch Antenna A-GPS5-SMA

4.2 Passive GPS Antennas. If the cable length between the MIDG Series INS/GPS and the GPS antenna is short (less than 12 inches [300 mm]) and the antenna as a very clear view of the sky, a passive GPS antenna may be used.

*****WARNING*****

ONLY USE A GPS ANTENNA THAT IS RATED FOR +5V OPERATION AND DRAWS LESS THAN 25 MA.

USE OF A LOWER VOLTAGE ANTENNA CAN DAMAGE THE GPS ANTENNA POWER SUPPLY, DESTROY THE INTEGRATED GPS RECEIVER, OR DESTROY THE GPS ANTENNA AMPLIFIER.

DISCONNECT THE POWER TO THE MIDG SERIES INS/GPS BEFORE CONNECTING OR DISCONNECTING THE ANTENNA. IF THE MIDG SERIES INS/GPS MUST REMAIN POWERED WHEN THE ANTENNA IS CONNECTED OR DISCONNECTED, EXTREME CARE MUST BE TAKEN TO PREVENT THE CENTER CONDUCTOR OF THE SMA CONNECTOR FROM CONTACTING THE BODY OF THE CONNECTOR AS THIS WILL SHORT OUT THE GPS ANTENNA POWER SUPPLY AND CAN DESTROY THE INTEGRATED GPS RECEIVER. THESE TYPES OF DAMAGE ARE NOT COVERED BY WARRANTY.

*****WARNING*****

4.3 Installing and Using the MIDG Series INS/GPS Patch Antenna. The MIDG Series INS/GPS can be ordered with a patch antenna (Figure 9 - Microbotics Part Number A-GPS5-SMA). This antenna is designated for use with the MIDG Series INS/GPS to provide GPS reception to the onboard receiver. The complete antenna specifications are included in Attachment "D" of this manual.

1. **Place the patch antenna in a location with an unobstructed view of the sky.**
2. **Connect the SMA connector from the antenna cable to the SMA jack on the face-plate of the MIDG Series INS/GPS.**

SECTION 5 IS OPTIONAL. THIS SECTION ONLY APPLIES IF MIDG SERIES INS/GPS IS TO INTERFACED WITH A PC OR LAPTOP VIA MIDG INTERFACE CABLE (SLC2JUSB OR SLC2J09SF).

5 Installing and Using the SLC2JUSB Interface Cable. The MIDG Series INS/GPS can be ordered with a SLC2JUSB interface cable. This cable is specifically designed to interface the MIDG Series INS/GPS with any PC or laptop via USB port. The SLC2JUSB cable (Figure 10) provides both power and data lines for the MIDG Series INS/GPS.

5.1 SLC2JUSB Driver Installation. The driver installation is an automated process once it is started and will require only minimal user action.

1. **On the MIDG Software and Utilities CD-ROM, Select the driver file from the same folder from which the MIDG Software and utilities was selected. (Figure 11).** This is the appropriate drivers for the software installation.



Figure 10. SLC2JUSB Interface Cable

For Windows® Vista and Windows® 7 users, the PC or laptop may automatically search for the appropriate drivers. For specific information about the SLC2JUSB refer to Attachment "A," Section 3 in this manual.

Figure 12 shows the command prompt window. After the drivers have been installed, the command prompt window will display, "*FTDI CMD Driver Installation process completed.*" The command prompt window will then close and the driver installation is complete.

5.1.1 Using the SLC2JUSB. After the drivers have been installed, whether automatically or manually, the following will instruct the user on how to interface the MIDG Series INS/GPS with the PC or laptop.

1. **Plug the USB end of the interface cable into any port on the PC or laptop.** The first time the interface cable is used, the PC or laptop will have to identify the device and then assign the drivers previously installed for it to operate correctly. Figure 13 shows the notification for when the SCL2JUSB is first interfaced.
2. **Wait for the PC or laptop to finish "installing" the new hardware.** Once the PC or laptop shows the notification that the hardware has been successfully installed, the cable is ready to be used (Figure 14).

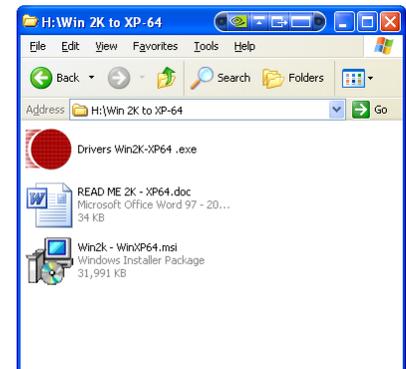


Figure 11. MIDG Software and Utilities CD-ROM folder containing SLC2JUSB Drivers.

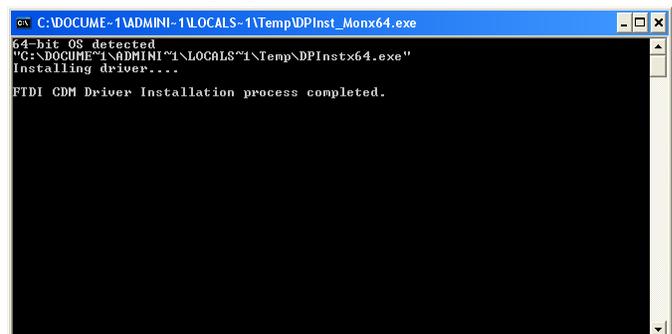


Figure 12. MIDG II Display and Help Box

*****WARNING*****

IF USING A GPS ANTENNA, ATTACH THE ANTENNA TO THE MIDG SERIES INS/GPS UNIT BEFORE PERFORMING STEP 3. ONCE THE UNIT IS PLUGGED IN, IT IS IMMEDIATELY POWERED.

*****WARNING*****

3. **Connect the MIDG Series INS/GPS to the SLC2JUSB interface cable.** Since the MIDG Series INS/GPS is powered by the USB port, no external power supply is required.
4. **Start an instance of the MIDG Display Utility and under the "Port" drop down menu, select the COM Port Number which is NOT native to the PC or laptop.** The MIDG Display Utilities should display the data outputted from the MIDG. If there is no data being displayed, verify that the "Baud" rate on the MIDG Display Utilities program and the MIDG Series INS/GPS are the same.



Figure 13. Found New Hardware Notification

DUE TO A LIMITATION IN THE MIDG DISPLAY UTILITIES PROGRAM, ALL COM PORTS ON THE PC OR LAPTOP WILL BE RECOGNIZED; HOWEVER, ONLY "COM 1" THROUGH "COM 9" ARE ACTIVE. FOR INSTRUCTIONS ON HOW TO ASSIGN DIFFERENT COM PORT NUMBERS, CONSULT ATTACHMENT A, SECTION 5 OF THIS MANUAL. FOR ANY ISSUES OR QUESTIONS REGARDING THE CORRECT OPERATION OF THE SLC2JUSB, REFER TO ATTACHMENT A.



Figure 14. MIDG II Display and Help Box

5.2 Using the SLC2J09SF Interface Cable. The MIDG Series INS/GPS can be ordered with a SLC209SF interface cable. This cable is specifically designed to interface the MIDG Series INS/GPS with any PC or laptop via serial port. Unlike the SLC2JUSB, the SLC2J09SF interface cable (Figure 15) requires no driver installation. The SLC2J09SF provides both power and data lines for the MIDG Series INS/GPS; however, unlike the SLC2JUSB interface cable, the SLC2J09SF requires an external power supply to power the MIDG Series INS/GPS. The external power supply must be able to provide, at a minimum 10 VDC and should not exceed 32 VDC (10 - 32VDC).

*****WARNING*****

INCORRECT POLARITY WILL DAMAGE THE MIDG SERIES INS/GPS. THIS TYPE OF DAMAGE IS NOT COVERED BY WARRANTY.

*****WARNING*****



Figure 15. SLC2J09SF MIDG Series INS/GPS Interface Cable.

5.2.1 Connecting the SLC2J09SF Interface Cable. The following will instruct the user on how to interface the MIDG Series INS/GPS to a PC or laptop via the SLC209SF interface cable.

1. **Verify that the external power supply is OFF. Connect the RED and BLACK "pig-tailed" wires on the SLC2J09SF interface cable to the external power supply.**

*****WARNING*****

IF USING A GPS ANTENNA, ATTACH THE ANTENNA TO THE MIDG SERIES INS/GPS UNIT BEFORE PERFORMING STEP 2.

*****WARNING*****

2. Connect the MIDG Series INS/GPS to the SLC2J09SF interface cable.
3. Connect the SLC2J09SF interface cable to a PC serial port.
4. Start an instance of the MIDG Display Utility and under the "Port" drop down menu, select the COM Port Number which the MIDG Series INS/GPS has been connector to.
5. Apply power to the MIDG Series INS/GPS. The MIDG Display Utility program should immediately begin to give a data read out from the MIDG Series INS/GPS. If there is no data being displayed, verify that the "Baud" rate on the MIDG Display Utilities program and the MIDG Series INS/GPS are the same.

6 User Supplied Interface. Users may construct their own interface cable or permanently mount the MIDG Series INS/GPS with in an application. This section will instruct the user on how to wire the MIDG Series INS/GPS into an application. The MIDG Series INS/GPS can easily be wired into a system using RS-422 signals, or it can be wired into a system with an RS-422 to RS-232 serial voltage level converter (such as the Microbotics SLC10232). Table 1 provides full information about each pin and Figure 16 shows a visual representation of the Omnetics Mating connector.

Table 1: MIDG Series INS/GPS Pin-Out		
Pin 1	R_b	RS-422 positive data <i>receipt into MIDG II</i> (MARK High)
Pin 2	R_a	RS-422 negative data <i>receipt into MIDG II</i> (MARK Low)
Pin 3	PPS_N	1 pulse-per-second (1 PPS-Pulse: <i>IDLE</i> High, Falling Active Edge)
Pin 4	PWR_IN	Power Input (10V to 32V input)
Pin 5	GND	Digital ground – tie to ground of user serial port
Pin 6	T_b	RS-422 positive data <i>transmit from MIDG II</i> (MARK High)
Pin 7	T_a	RS-422 negative data <i>transmit from MIDG II</i> (MARK Low)
Pin 8	PPS_P/AUX	1 pulse-per second (1 PPS-Pulse: <i>IDLE</i> Low, Rising Active Edge)
Pin 9	PWR_RTN	Power ground (negative side)
Pin 10	$SHIELD$	Shield for power cabling (if needed)

*****WARNING*****

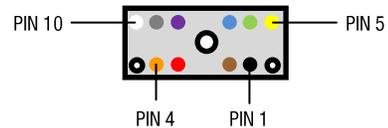
DAMAGE TO THE MIDG SERIES INS/GPS. BECAUSE OF INCORRECT WIRING IS NOT COVERED BY WARRANTY.

*****WARNING*****

6.1 General Connections. There are four connections which are common to RS-422 and RS-232. The common connections are as follows:

- A. **Power In:** Pin 4, Orange wire on the Omnetics mating connector, 10-32 VDC input.
- B. **Power Return:** Pin 9, Gray wire on the Omnetics mating connector, return.
- C. **Ground:** Digital Ground, Yellow wire on the Omnetics mating connector, tied to the ground of the user serial port.
- D. **Shield:** Pin 10, White wire on the Omnetics mating connector, tied to the shield of the user power cable

PERCEIVED LOOKING INTO THE FACE OF THE CONNECTOR FOR THE MIDG SERIES INS/GPS



Pin 1	Black	R_b	RS-422 (Receive Pos.)
Pin 2	Brown	R_a	RS-422 (Receive Neg.)
Pin 3	Red	PPS_N	1 PPS-Idle High, Falling Active Edge
Pin 4	Orange	PWR_IN	Power In (10 - 32 VDC)
Pin 5	Yellow	GND	Digital Ground
Pin 6	Green	T_b	RS-422 (Transmit Pos.)
Pin 7	Blue	T_a	RS-422 (Transmit Neg.)
Pin 8	Violet	PPS_P/AUX^*	1 PPS-Idle Low, Rising Active Edge *
Pin 9	Gray	PWR_RTN	Power Return
Pin 10	White	$SHIELD$	Shield

Note: Power Return and Shield are connected to Digital Ground.
*Trigger Input on Units with Trigger Option

Figure 16. MIDG II Display and Help Box

6.1.1 Power Connections. Steps one (1) and two (2) will instruct the user on the proper power input and power return connections. As stated in section 5.2, the MIDG Series INS/GPS requires a DC power source capable of a minimum of 10 VDC and not to exceed a maximum of 32 VDC (10-32 VDC). The unit uses a switch-mode power converter with a typical constant power dissipation of less than 1.2 watts.

1. Connect the positive side of the power source to the *PWR IN* (Pin 4-Red).
2. Connect the negative side of the power source to the *PWR RTN* (Pin 9-Gray).

6.1.2 Digital Ground Connections. Steps three "a" (3a) and three "b" (3b) will instruct the user on the proper connections for the Digital Ground. Special attention should be applied while making this connection because of the specific configuration of the user's system.

NOTE: STEP 3a IS APPLICABLE TO ONLY TO RS-422 SYSTEMS.

- 3a. Connect the *GND* line (Pin 5-Yellow) to the Ground of the user system's RS-422 port. This line is tied directly to the Digital Ground user's serial port.

NOTE: STEP 3b IS APPLICABLE TO ONLY TO RS-232 SYSTEMS.

- 3b. Connect the *GND* line (Pin 5-Yellow) to the Ground of the user's RS-232 serial voltage level converter. This line is tied to the user's Digital Ground on the RS-422 to RS-232 serial voltage level converter. The Digital Ground from this converter should also be tied to the user's Digital Ground on the RS-232 port.

6.1.2 Shield Connections. Steps four (4) will instruct the user on the proper connections for the Shield line. (Optional)

4. Connect the *Shield* line to the shield of the power cable. (If applicable)

*****WARNING*****

USE THE *PWR_RTN* LINE FOR POWER RETURN TO THE POWER SUPPLY (NEGATIVE SIDE). DO NOT USE THE *GND* SIGNAL LINE FOR POWER RETURN AS THIS USAGE CAN DAMAGE THE MIDG II AND VOIDS THE WARRANTY.

*****WARNING*****

6.2 RS-422 Data Connections. The MIDG Series INS/GPS uses a RS-422 differential-mode asynchronous serial data stream for communications to and from the user's system. Figure 17 shows a typical RS-422 to RS-422 connection. As shown, there are five signal lines which are used for serial communications: *T_a*, *T_b*, *R_a*, *R_b*, and *GND*.

NOTE: THE *GND* LINE SHOULD HAVE ALREADY BEEN CONNECTED IN ACCORDANCE WITH SECTION 6.1.2, STEP 3a.

1. Connect the *T_a* and *T_b* pair (Pin 6-Green; Pin 7-Blue, respectively) to the *R_a* and *R_b* pair of the user's system. The *T_a* pin is connected to the *R_a* pin of the user system. The *T_b* pin is connected to the *R_b* pin of the user system. The *T_a* and *T_b* pins are signals *transmitted from* the MIDG Series INS/GPS.
2. Connect the *R_a* and *R_b* pair (Pin 2-Brown; Pin 1-Black, respectively) to the *T_a* and *T_b* pair of the user's system. The *R_a* pin is connected to the *T_a* pin of the user system. The *R_b* pin is connected to the *T_b* pin of the user system. The *R_a* and *R_b* pins are signals *received by* the MIDG Series INS/GPS.

*****WARNING*****

FAILURE TO CONNECT THE *GND* LINE TO THE USER RS-422 PORT GROUND CAN CAUSE ELECTRICAL FAILURE OF THE MIDG SERIES INS/GPS. ELECTRICAL FAILURE OF THIS NATURE IS NOT COVERED BY THE WARRANTY.

*****WARNING*****

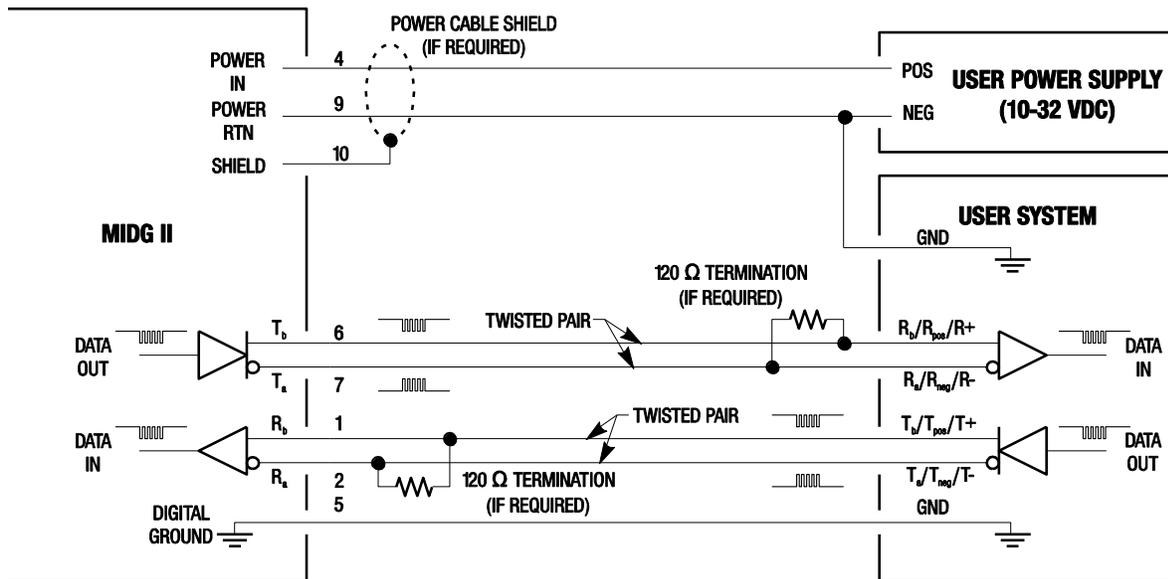


Figure 17. Typical RS-422 to RS-422 Data Connections

6.3 RS-232 Data Connections. The MIDG Series INS/GPS only supports RS-422 data communications. However, with a serial voltage level converter (such as the Microbotics SLC10232), the RS-422 data stream is easily converted into a RS-232 data stream. This enables the MIDG Series INS/GPS to communicate over an RS-232 port like those used on a PC or laptop computer. A typical connection to a PC-style serial port using the Microbotics SLC10232 Serial Voltage Level Converter is shown in Figure 18.

NOTE: SERIAL VOLTAGE LEVEL CONVERTERS NOT SUPPLIED BY MICROBOTICS, INC. MAY HAVE DIFFERENT WIRING REQUIREMENTS. REFER TO THE MANUAL WHICH CAME WITH THE SERIAL VOLTAGE LEVEL CONVERTER PRIOR TO USING.

NOTE: THE FOLLOWING STEPS ONLY APPLY TO THE MICROBOTICS SLC10232.

NOTE: THE GROUND LINE SHOULD HAVE ALREADY BEEN CONNECTED IN ACCORDANCE WITH SECTION 6.1.2, STEP 3b.

1. **Connect the T_a and T_b pair (Pin 6-Green; Pin 7-Blue, respectively) to the R_a and R_b pair of the SLC10232.** The T_a pin is connected to the R_a pin of the user system. The T_b pin is connected to the R_b pin of the user system. The T_a and T_b pins are signals *transmitted from* the MIDG Series INS/GPS.
2. **Connect the R_a and R_b pair (Pin 2-Brown; Pin 1-Black, respectively) to the T_a and T_b pair of the SLC10232.** The R_a pin is connected to the T_a pin of the user system. The R_b pin is connected to the T_b pin of the user system. The R_a and R_b pins are signals *received by* the MIDG Series INS/GPS.
3. **Connect the TxD line of the SLC10232 to the DATA IN pin of the PC.** Data is *transmitted from the MIDG* via T_a and T_b pins to the SLC10232. The SLC10232 converts the signal from RS-422 to RS-232 and *transmits the data to the PC's data in port via the TxD line.*
4. **Connect the RxD line of the SLC10232 to the DATA OUT pin of the PC.** Data is *transmitted to the SLC10232 via DATA OUT pin* of the PC. The SLC10232 converts the signal from RS-232 to RS-422 and *transmits the data to the MIDG via R_a and R_b pins* of the SLC10232.

*****WARNING*****

FAILURE TO CONNECT THE GROUND LINES BETWEEN THE MIDG SERIES INS/GPS, THE SERIAL VOLTAGE LEVEL CONVERTER, AND THE USER PC'S RS-232 PORT GROUND CAN CAUSE ELECTRICAL FAILURE OF THE MIDG SERIES INS/GPS. ELECTRICAL FAILURE OF THIS NATURE IS NOT COVERED BY THE WARRANTY.

*****WARNING*****

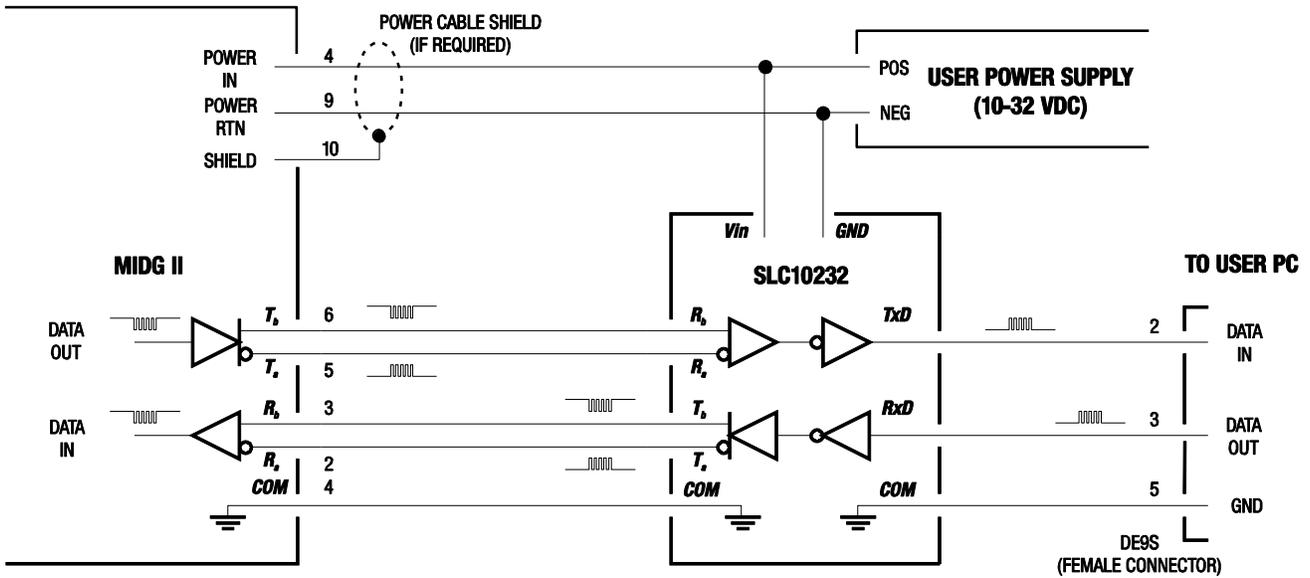


Figure 18. RS-422 to RS-232 serial voltage level converter connected between a MIDG Series INS/GPS and a PC

6.4 1 Pulse-per-Second Output. When the MIDG Series INS/GPS has a valid GPS input, the 1 Pulse-per-Second (1PPS) output is operational. This signal is derived from the data transmitted by the GPS satellites and generates a 100 microsecond pulse once every second. There are two outputs available at the MIDG Series INS/GPS connector:

- A. **PPS_N:** The PPS_N signal (Pin 3) is a 3 volt signal which remains *High* (3 Volts) and pulses *Low* (0 Volts) for 100 microseconds.
- B. **PPS_P:** The PPS_P signal (Pin 8) is a 0 volt which remains *Low* (0 Volts) and pulses *High* (3 Volts) for 100 microseconds.

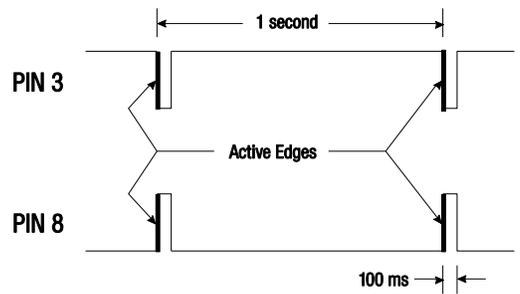


Figure 19. MIDG II Display and Help Box

*****WARNING*****

BOTH THE PPS_N AND PPS_P SIGNALS REQUIRE THE GND SIGNAL LINE FOR GROUND RETURN. THE GND LINE MUST BE CONNECTED TO THE USER SYSTEM. FAILURE TO CONNECT THE GND LINE TO THE USER PORT GROUND CAN DAMAGE THE MIDG SERIES INS/GPS. THIS TYPE OF DAMAGE IS NOT COVERED BY WARRANTY.

*****WARNING*****

NOTE: SECTION 6.4.1 ONLY APPLIES TO MIDG SERIES INS/GPS UNITS WITH THE TRIGGER INPUT MODIFICATION. (SIS90031C-SR).

6.4.1 Trigger Input. The MIDG Series INS/GPS may be ordered with a "Trigger Input" option (Microbotics SIS90031C-SR). This model in the MIDG Series INS/GPS has the *PPS_P* output (Pin 8) replaced with the *AUX_IN* input. This specific modification allows the user to send a signal to the MIDG Series INS/GPS. Upon receiving this signal, the modified unit will record the GPS Time when this event occurred and then send an output data message informing the user of this event.

The signal for the *AUX_IN* (Pin 8) must present a rising edge (*Low-to-High* transition). The *AUX_IN* input is TTL-compatible, 3V-CMOS-compatible, and is 5V-tolerant. The input of this model of MIDG Series INS/GPS has a 4.7K pull-up resistor to 3V and can be driven by a closure to *GND* or by an open-collector signal to *GND*. The *AUX_IN* input uses the *GND* signal line for ground return, and the *GND* line *must* be connected to the user system.

*****WARNING*****

THE *AUX_IN* SIGNAL VOLTAGE MUST NOT EXCEED THE RANGE OF 0-5 VDC. FAILURE TO CONNECT THE GND LINE TO THE USER PORT GROUND CAN DAMAGE THE MIDG SERIES INS/GPS. THIS TYPE OF DAMAGE IS NOT COVERED BY WARRANTY.

*****WARNING*****

7 MIDG Series INS/GPS Dimensions and Mounting. The MIDG Series INS/GPS has been mechanically designed to minimize both size and weight. This make the MIDG Series INS/GPS suitable for any application which size, weight, and power dissipation are key considerations.

7.1 Physical Dimensions. The MIDG Series INS/GPS physical dimensions and standard reference axis of the are shown in Figure 20.

7.1.1 Physical Characteristics. The side of the MIDG Series INS/GPS with the product label is considered the top, and the side with the connectors is considered the rear (the negative X axis). The MIDG Series INS/GPS was designed in order to maintain directional consistency with the Navigation Industry, the positive Y axis is to the right of the unit, and the positive Z axis is downwards. This axes orientation sets the standard positive roll rotation as right-side-down, the positive pitch rotation as front-end-up, and the standard positive yaw rotation as clockwise viewed from the top.

7.2 Mounting the MIDG Series INS/GPS. The MIDG Series INS/GPS allows the user several option for mounting the unit within an application. The unit can be hard mounted or soft mounted and can be mounted in any orientation.

7.2.1 Hard mounting the MIDG Series INS/GPS. The MIDG Series INS/GPS has four 0-80 threaded holes for hard mounting of the unit. If the unit is to be hard mounted into and application, the maximum depth of screw insertion is .187" (4.75 mm). Furthermore, if the unit is to be hard mounted, the unit must be arranged to be isolated from vehicle vibrations and shock.

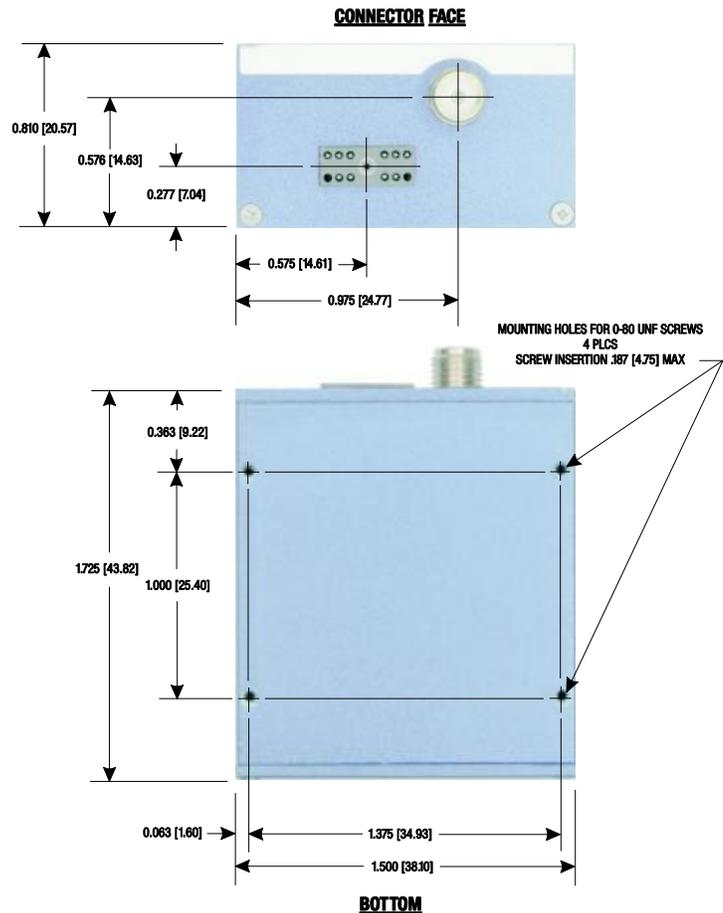


Figure 20. MIDG Series INS/GPS Mechanical Dimensions

*****WARNING*****

SCREW INSERTION DEEPER THAN .187" (4.75 MM) CAN DAMAGE THE MIDG HOUSING. THIS TYPE OF DAMAGE IS NOT COVERED BY WARRANTY.

*****WARNING*****

7.2.2 Soft Mounting the MIDG Series INS/GPS. Due to the small size and light weight of the MIDG Series INS/GPS, in most applications, the unit can be mounted via the use of 1/8" double-sided foam tape. This type of mounting not only helps to reduce vibration from coupling into unit, but also makes removal of the unit from an application easier.

7.3 Mounting Orientation. The MIDG Series INS/GPS can be mounted in any orientation within an application. However, for optimal performance, the MIDG Series INS/GPS should be mounted as closely to the center as possible and with the same orientation as the application (i.e. the front of the unit pointed in the same direction as the front of the application). Figure 21 shows the three axes of the MIDG Series INS/GPS for aiding in proper mounting of the unit.

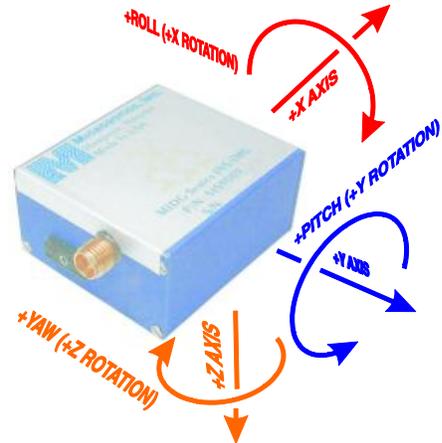


Figure 21. MIDG Series INS/GPS Axes

7.3.1 Orientation Correction. In applications where the MIDG Series INS/GPS cannot be mounted optimally, MIDG Series INS/GPS can be aligned to any orientation. The by using the "Transform" (Xform) function, the MIDG Series INS/GPS may be oriented into a perfect alignment within an application.

NOTE: THE "XFORM" FUNCTION IS PART OF THE MIDG DISPLAY UTILITY SOFTWARE. REFER TO THE MIDG DISPLAY UTILITY SOFTWARE MANUAL FOR MORE INFORMATION ON THE PROPER USE OF THIS FUNCTION.

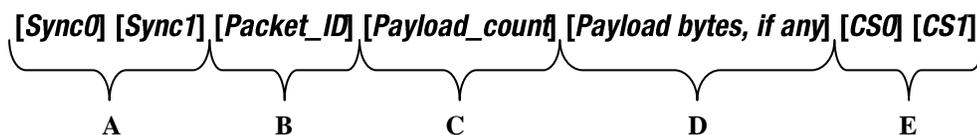
NOTE: ATTACHMENT "B" CONTAINS THE MIDG SERIES INS/GPS MESSAGE SPECIFICATION. REFER TO THE MIDG MESSAGE SPECIFICATION FOR MORE INFORMATION ON SPECIFIC MESSAGES, MESSAGE RATES, AND MESSAGE CONFIGURATION. VERIFY THAT THE MIDG MESSAGE SPECIFICATION IS THE APPROPRIATE TO THE FIRMWARE VERSION OF THE MIDG SERIES INS/GPS USED IN THE APPLICATION.

8 MIDG Series INS/GPS Messages. The MIDG Series INS/GPS sends message via an asynchronous serial port using RS-422 voltage levels. This type of communication makes the MIDG Series INS/GPS suitable for use in electrically noisy environments. The data is binary-encoded as eight data bits, no parity, and one stop bit ("8, N, 1") with no data flow control. The default baud rate is set at 115200 Baud; however, the user can change the baud rate by using the MIDG Display Utility software or by sending the appropriate BAUD Configuration Message to the unit. Table 2 shows the baud rates supported by the MIDG Series INS/GPS.

Table 2: MIDG Series INS/GPS Baud Rates	
	115200
	57600
	38400
	19200
	9600

8.1 Microbotics Binary Protocol. The MIDG Series INS/GPS uses the standard Microbotics Binary Protocol. All of the MIDG Series INS/GPS messages are based on the Microbotics binary protocol; an ASCII data terminal program (i.e. Microsoft® Hyper-Terminal) cannot read nor be used to communicate with a MIDG Series INS/GPS. Refer to Attachment "B" for a complete MIDG Series INS/GPS Message Specification

8.1.1 Microbotics Binary Protocol Message Contents. Microbotics binary protocol is a serial data stream comprised of 8-bit bytes with the following basic format:



- A. **Sync0 and Sync1:** The Sync0 and Sync1 bytes are used to indicate the beginning of a specific message and have the binary values of **0x81** and **0xA1**, respectively.
- B. **Packet_ID:** The Packet_ID is an unsigned 8-bit byte identifying the command type.
- C. **Payload_count:** The Payload_count is an unsigned 8-bit byte indicating the number of **bytes** in the payload to follow. The Payload_count can be **0x00** (no payload) through **0xFF** (255 theoretic maximum **bytes** in the actual payload).

NOTE: THE PAYLOAD_COUNT VALUE IS THE TOTAL NUMBER OF PAYLOAD BYTES FOLLOWING THE PAYLOAD_COUNT BYTE, REGARDLESS OF THE ACTUAL PAYLOAD DATA FORMAT(S). IF THERE IS NO PAYLOAD, THE PAYLOAD_COUNT VALUE IS ZERO.

- D. **Payload:** The payload is specific for the message is specified in the *Packet_ID*. The payload can be comprised of any mix of bytes, 16-bit words, or 32-bit words. All Payload values are sent in big-endian format – the first byte of each multi-byte value (16-bit or 32-bit data values) contains the most significant bits of that value.
- E. **CS0 and CS1:** The CS0 and CS1 part of the message forms a two-byte Fletcher checksum. This checksum includes of all **bytes** between **Sync1** and **CS0**.

8.1.2 Fletcher Checksum. The Microbotics Message Specification uses a Fletcher checksum regardless of the message type and payload. The Fletcher checksum is calculated in the following manner:

- | | | |
|----|---|-----------------------------|
| 1. | CS0 and CS1 are initially both set to zero | <i>CS0 = CS1 = 0;</i> |
| 2. | The next byte is added to the current CS0 value to form the new CS0 value [modulo-256] | <i>CS0 += [byte_value];</i> |
| 3. | The new CS0 value is added to the current CS1 value to form the new CS1 value [modulo-256] | <i>CS1 += CS0;</i> |
| 4. | Continue for all bytes | <i>loop;</i> |
| 5. | CS0 byte is sent first, followed by CS1 byte | <i>CS0; CS1;</i> |

NOTE: THE FLETCHER CHECKSUM IS A TWO-BYTE VALUE WHICH IS CALCULATED OVER ALL OF THE BYTES FROM, AND INCLUDING, THE PACKET_ID, THE PAYLOAD_COUNT, AND ANY PAYLOAD BYTES, REGARDLESS OF THE ACTUAL PAYLOAD DATA FORMAT(S).

9 Help and Support. Microbotics, Inc. is dedicated to supporting the missions of our clients and offers free thirty (30) days of support for all of our products. The MIDG Display utility, in the "Help" drop-down menu, contains the contact information for Microbotics, Inc (Figure 22).

- 1. **Start an instance of the MIDG Display Utility.**
- 2. **Select the Help drop-down menu.**
- 2. **Select the "About" option.**



Figure 22. MIDG Display Utility "About" information Box.

Visit Microbotics on our website at www.microboticsinc.com for more information about our entire product line. For pricing and availability, please visit our contact page at www.microboticsinc.com/contact.html. All technical inquires should be sent to support@microboticsinc.com

Attachment A SLC2JUSB

1 Introduction. The SLC2JUSB interface cable (MBI# - SLC2JUSB) is designed to take advantage of a computer's USB port to provide the MIDG Series INS/GPS with bidirectional communication and power (Figure 1).



Figure 1. SLC2JUSB

1.1. Description. The MIDG II INS USB Interface Cable is approximately forty-eight inches (48 in/121.92 cm) in length and covered with black plastic sheathing. At one end of the cable is a standard Type A male USB connector which will connect to any Type A female USB receptacle on the user's computer. The other end of the cable has an Omnetics 10 pin mating connector specifically designed to connect to any MIDG Series INS/GPS unit.



Figure 2. Recessed Power Button.

1.2. Functionality. The SLC2JUSB interface cable is designed to power a MIDG Series INS/GPS unit via USB port. Therefore, there is no requirement for an external power supply. The interface cable has a recessed "reset" button on the top of the USB connector housing (Figure 2 - Circled in Red) which provide the user with the ability to cycle the power to the MIDG Series INS/GPS without having to unplug the unit or the cable.

2 Installation. The SLC2JUSB interface cable may be ordered with a MIDG Series INS/GPS or it may be ordered separately. In both cases, a CD-ROM will arrive with the interface cable containing the drivers. These drivers will have to be installed prior to using the interface cable.

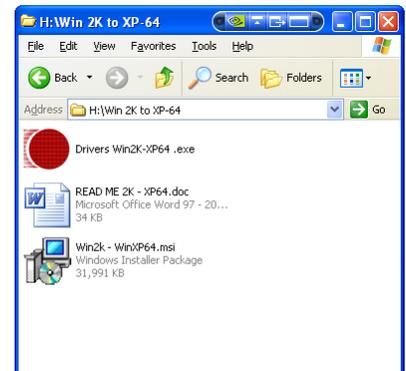


Figure 3. MIDG Software and Utilities CD-ROM folder containing SLC2JUSB Drivers.

2.1 SLC2JUSB Driver Installation. It is advised that all users install the drivers provided with the SLC2JUSB interface cable; however, depending on the specific version of the Windows®, the operating system may automatically search for and install the drivers. The driver installation is an automated process once it is started and requires only minimal user action.

1. **On the MIDG Software and Utilities CD-ROM, Select the driver file from the same folder from which the MIDG Software and utilities was selected. (Figure 3).** This is the appropriate drivers for the software installation.

Figure 4 shows the command prompt window. After the driver installation has been completed, the command prompt window will display, "**FTDI CMD Driver Installation process completed.**" and will close. The driver installation is complete.

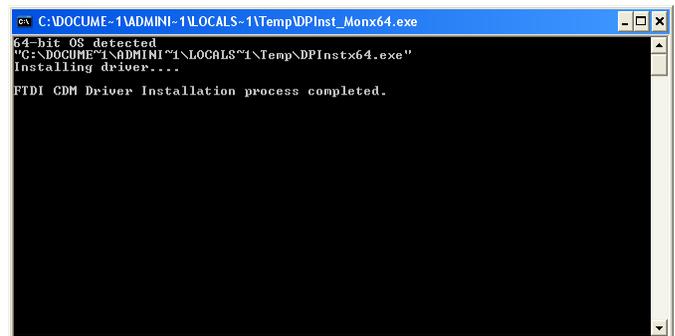


Figure 4. MIDG II Display and Help Box

2.2 Windows® 7. The Windows® 7 operating system will automatically install the drivers as soon as the cable is plugged into a USB port. Figure 5 shows the notifications of the driver installation after the SLC2JUSB is plugged into a USB port.



Figure 5. Windows® 7 automatically installing FTDI Drivers for the SLC2JUSB Interface Cable.

3 Using the SLC2JUSB. After the drivers have been installed, whether automatically or manually, the following will instruct the user on how to interface the MIDG Series INS/GPS with the PC or laptop.

- 1. Plug the USB end of the interface cable in any USB port on the PC or laptop.** The first time the interface cable is used, the PC or laptop will have to identify the device and then assign the drivers previously installed for it to operate correctly. Figure 6 shows the notification for when the SCL2JUSB is first interfaced with the computer.
- 2. Wait for the PC or laptop to finish "installing" the new hardware.** Once the PC or laptop shows the notification that the hardware has been successfully installed, the cable is ready to be used (Figure 7).



Figure 6. Found New Hardware Notification



Figure 7. New Hardware is Ready to Use Notification

*****WARNING*****

IF USING A GPS ANTENNA, ATTACH THE ANTENNA TO THE MIDG SERIES INS/GPS UNIT BEFORE PERFORMING STEP 3. ONCE THE UNIT IS PLUGGED IN, IT IS IMMEDIATELY POWERED.

*****WARNING*****

- 3. Connect the MIDG Series INS/GPS to the SLC2JUSB interface cable.** Since the MIDG Series INS/GPS is powered by the USB port, no external power supply is required.
- 4. Start an instance of the MIDG Display Utility and under the "Port" drop down menu, select the COM Port Number which is NOT native to the PC or laptop.** The MIDG Display Utilities should display the data outputted from the MIDG. If there is no data being displayed, verify that the "Baud" rate on the MIDG Display Utilities program and the MIDG Series INS/GPS are the same.

DUE TO A LIMITATION IN THE MIDG DISPLAY UTILITIES PROGRAM, ALL COM PORTS ON THE PC OR LAPTOP WILL BE RECOGNIZED; HOWEVER, ONLY "COM 1" THROUGH "COM 9" ARE ACTIVE.

5 Assigning COM Port Numbers. Due to user variations in the setup of their PC's or laptops, it is impossible to assign a standard COM port number for the SLC2JUSB interface cable. The current drivers are set to have the interface cable assigned to the first available COM port. Unfortunately, the MIDG Display Utility only supports nine (9) active COM ports (i.e. COM 1 through COM 9) this section will guide the user through the process of reassigning COM port numbers.

5.1 Accessing the Device Manager. The following steps are the instructions for opening the "Device Manager" in Windows® 2000 through Windows® XP-64.

- 1. Pressing the Windows key and the Pause key at the same time** to open the "System Properties" dialog box

Pressing the *Windows key* and the *Pause key* at the same time will open the System Properties dialog box on all versions of Windows®.

- 2. Select the "Hardware" tab** in the "System Properties" dialog box (Figure 8).

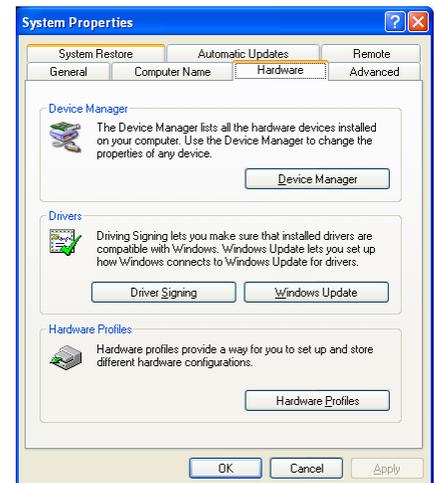


Figure 8. System Properties dialog box, Hardware Tab

3. **Select the "Hardware" tab** in the "System Properties" dialog box (Figure 8).
4. **Press the "Device Manager" button** to open the "Device Manager" (Figure 9).
5. **Double click on the "USB Serial Port" listing.** This will open the "USB Serial Port (COM 15) Properties" dialog box (Figure 10).

NOTE: The actual COM number may be different. Only numbers above 9 have to be changed.

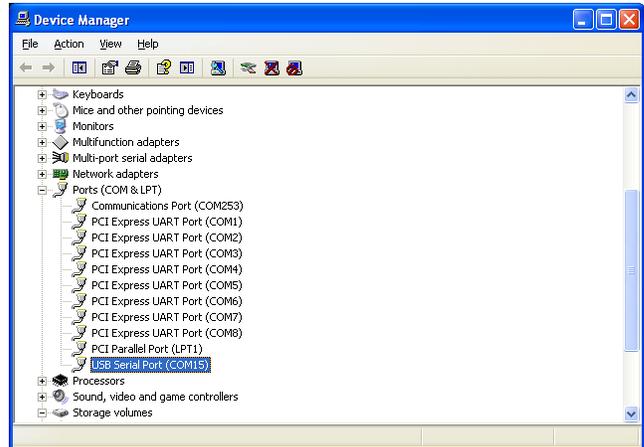


Figure 9. Device Manager with "Ports (COM&LPT)" expanded.

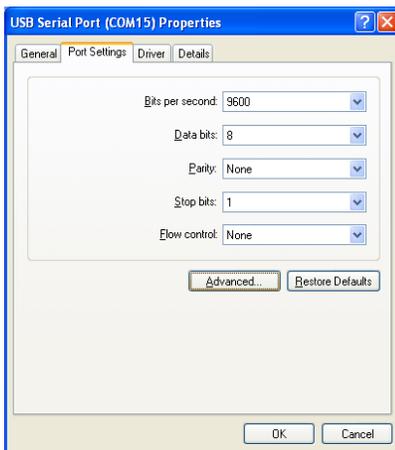


Figure 10. Port Settings Tab of the "USB Serial Port Properties" dialog box.

6. **Select the "Port Settings" Tab.** This will display the port settings (Figure 10).
7. **Press the "Advanced..." button.** This will open the "Advanced Settings for the COM port."
8. **Press the "Advanced..." button.** This will open the "Advanced Settings for the COM port."
9. **Press the "Advanced..." button.** This will open the "Advanced Settings for the COM port."

10. **Select the "COM Port Number" drop down menu and choose a COM Port which is not being used AND lower than COM Port 10.** This will open the "Advanced Settings for the COM port (Figure 11).
11. **Select the "OK" to complete the reassignment.** This will reassign the COM port to the number which was designated.
12. **After the COM port has been successfully reassigned, close all system windows.**

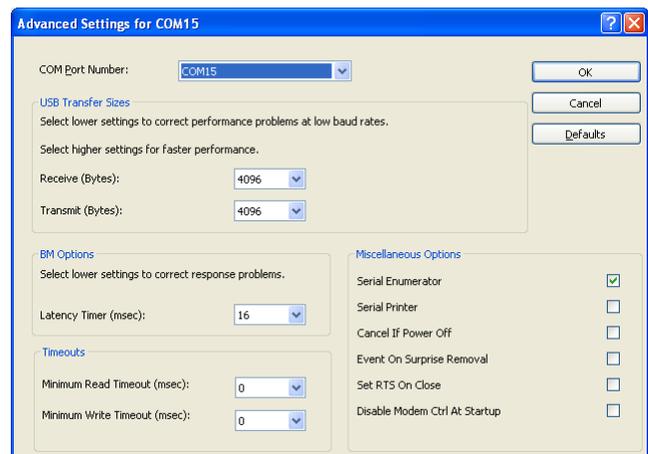


Figure 11. Advanced COM Port Settings.

6 Help and Support. Microbotics, Inc. is dedicated to supporting the missions of our clients and offers free thirty (30) days of support for all of our products.

Visit Microbotics on our website at www.microboticsinc.com for more information about our entire product line. For pricing and availability, please visit our contact page at www.microboticsinc.com/contact.html. All technical inquires should be sent to support@microboticsinc.com

MIDG IIC Message Specification for Firmware V2.1.x and Higher

9 January 2012

1 Scope. This document outlines the messages sent to and from the MIDG IIC via the serial communications port.

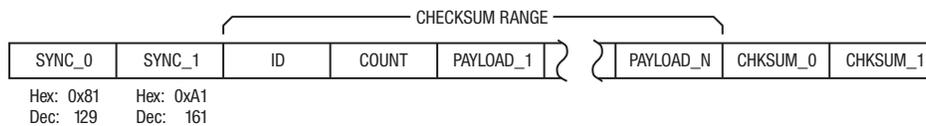
1.1 Differences Between This Message Specification and Previous Versions. This specification is an update to earlier Message Specifications. In particular, it addresses certain messages which are no longer supported (especially by firmware versions 2.3.1 and higher), corrects several errors, and better defines the Configuration Messages. Of particular importance are several data packets which are either no longer properly supported by the GPS module in the MIDG IIC, no longer of valid use to the client, or provide possible false information, thus the related messages should not be used in firmware versions below 2.3.x, and are no longer supported in firmware versions 2.3.1 and higher:

- Satellite Ephemeris (*TIM_EPH* Message)
- GPS Raw Data (*GPS_RAW* Message)
- GPS 1PPS Estimate (*GPS_PPS* Message)
- Time Error (*TIM_ERR* Message)
- RTCM Differential Corrections (*RTCM* Message)

Additionally, the various “VG” Modes previously used in earlier versions are now referred to by their actual operations (*STATUS* Message).

2 Serial Interface. Communication with the MIDG IIC occurs via an asynchronous communication port using the Microbotics Binary Interface Protocol (MBI). The Factory default is 115200 Baud, 8 data bits, no parity bit, and one stop bit (8, N, 1). The baud rate can be changed by the user via the MIDG Display/Configuration Program. The physical interface is an RS-422 differential serial link for high noise immunity.

3 Microbotics Binary Protocol. The MBI Protocol is a series of message packets, defined in the following sections, to communication with the host computer. These



messages provide sensor data transfer between MIDG IIC the host, as well as facilitate MIDG IIC configuration. The MBI Protocol is a standardized binary byte packet format that has the following structure:

3.1 SYNC Bytes. The two *SYNC* bytes are used to define the message packet. The first byte (*SYNC_0*) has the hexadecimal value of 0x81, while the second byte (*SYNC_1*) has the hexadecimal value of 0xA1.

3.2 ID Byte. The *ID* byte defines the specific message.

3.3 COUNT Byte. The *COUNT* byte is the number of bytes in the payload regardless of payload formatting, zero if the message has no payload bytes.

3.4 PAYLOAD. The payload is composed of a sequence of bytes that represent data values within a message. All payload values are bit-endian, meaning the most significant byte of a multi-byte payload value is sent first. In bit field values, Bit 0 represents the least significant bit of the payload value. In the section that follows, the application messages will be defined using the nomenclature shown below to indicate the type of value represented in the payload.

Payload Type	Description	Payload Type	Description
U1	Unsigned, 8 bit integer (one byte)	I1	Signed, 8 bit integer (one byte)
U2	Unsigned, 16 bit integer (two bytes)	I2	Signed, 16 bit integer (two bytes)
U4	Unsigned, 32 bit integer (four bytes)	I4	Signed, 32 bit integer (four bytes)
Bx	String of x bytes (x bytes)	R4	IEEE 754 single precision (four bytes)
BN	Variable length string of bytes	R8	IEEE 754 double precision (eight bytes)

3.5 CHECKSUM Bytes. The two-byte checksum is a Fletcher checksum as defined in internet RFC 1145. It is computed over all bytes between, and including, the *ID* byte, *COUNT* byte, and all payload bytes. The basic algorithm is as follows:

$$CHKSUM_0 = 0$$

$$CHKSUM_1 = 0$$

for each byte from *ID* to *PAYLOAD_N* (inclusive)

$$CHKSUM_0 = CHKSUM_0 + \text{byte} \quad \text{Only 8 bits maintained (modulo-256)}$$

$$CHKSUM_1 = CHKSUM_1 + CHKSUM_0 \quad \text{Only 8 bits maintained (modulo-256)}$$

Once the checksum has been calculated, the low 8 bits of *CHKSUM_0* are sent, followed by the low 8 bits of *CHKSUM_1*.

4 MIDG IIC Output Messages. The following messages are provide data output from the MIDG IIC. Any of these messages may be configured to be transmitted from the MIDG IIC at a user selectable rate from once every 5 seconds to 50Hz. Rates for these messages are set using the *CFG_SET* Message (*ID 35*) with the *MSG_DIV* Command (*ITEM_ID 5*). When a message is disabled (its output rate is set to zero), it may be polled by sending a message of the same *ID* to the MIDG IIC, but with no payload (the message payload length *COUNT* zero). Supported MIDG IIC output messages:

ID 1	STATUS	MIDG IIC Status
ID 2	IMU_DATA	IMU Data
ID 3	IMU_MAG	Magnetometer Data
ID 10	NAV_SENSOR	Navigation Sensor and Attitude Data
ID 12	NAV_PV	Navigation Position/Velocity Data
ID 13	NAV_HDG	Navigation Heading Data
ID 15	NAV_ACC	Navigation Accuracy Estimate
ID 20	GPS_PV	GPS Position/Velocity Data
ID 21	GPS_SVI	GPS Satellite Vehicle Data
[¶] ID 22	GPS_RAW	GPS Raw Measurement Data
ID 23	GPS_CLK	GPS Clock Data
[¶] ID 24	GPS_EPH	Ephemeris Data (polled only)
ID 25	TIM_UTC	UTC Time
* ID 26	TIM_ERR	Time Error
* ID 27	TIM_PPS	Time at 1 PPS
[§] ID 28	TIM_TM	Time at Time Mark pulse in

[¶] *Due to undocumented changes in GPS modules by the manufacturer, not all MIDG IIC units support the GPS_RAW or GPS_EPH Messages correctly. As it is impossible to determine in the field if the messages are available and valid, these messages should not be used in firmware versions below 2.3.x. These messages are not available in firmware versions 2.3.1 and higher.*

* *The TIM_ERR Message is a legacy message from the earliest MIDG-Series units, and provides no data useable to the user. This message is not available in firmware versions 2.3.1 and higher. TIM_PPS Message is a legacy message from when the MIDG-Series did not have 1PPS Time Pulse outputs. As communications latencies can cause errors, this message should not be used for estimating the Time Pulse timing. This message is not available in firmware versions 2.3.1 and higher.*

[§] *The TIM_TM Message is available only in MIDG IIC units with the Time Mark Option (Microbotics Part Number SIS90031C-SR).*



4.1 Message: **STATUS**
Description: Status Information

Message ID: 1 (0x01)

Payload Length: **8 Bytes (0x08)**
Applicable Modes: IMU, VG, INS

Payload Contents

Byte Offset	Number Format	Units	Purpose / Comment
0	U4	msec	Timestamp
4	U2	Bit field	System Status: Bits 8..15: (N/A, read zero) Bit 7: NV Configuration Valid Bit 6: Timestamp is GPS time Bit 5: DGPS (SBAS – WAAS, EGNOS, MSAS) Bit 4: (N/A, reads zero) Bits 3..0: Current operational mode: ⁽¹⁾ 0 = (N/A) 1 = IMU Mode 2 = Initialize Alignment 3 = Coarse Alignment 4 = Medium Alignment 5 = Fine Alignment 6 = Vertical Gyro Mode 7 = INS Mode
6	I2	0.01 °C	Internal Temperature

Notes:

⁽¹⁾ Operational mode definitions:

Current Designation	Previously Called	Definition
<i>IMU Mode</i>	<i>IMU Mode</i>	<i>IMU operational mode: only sensor data available, Kalman Filter not active</i>
<i>Initialize Alignment</i>	<i>VG Init</i>	<i>Sensor alignment initialization</i>
<i>Coarse Alignment</i>	<i>VG Fast</i>	<i>Sensor coarse alignment</i>
<i>Medium Alignment</i>	<i>VG Medium</i>	<i>Sensor medium alignment</i>
<i>Fine Alignment</i>	<i>VG Slow</i>	<i>Sensor fine alignment</i>
<i>Vertical Gyro Mode</i>	<i>VG SE</i>	<i>Vertical Gyro operational mode: all data available, Kalman Filter active without using GPS data</i>
<i>INS Mode</i>	<i>INS Mode</i>	<i>INS operational mode: all data available, Kalman Filter active using GPS data</i>



4.2 Message: **IMU_DATA**
Description: Inertial Measurements

Message ID: **2 (0x02)**

Payload Length: **23 Bytes (0x17)**
Applicable Modes: IMU, VG, INS

Payload Contents

Byte Offset	Number Format	Units	Purpose / Comment
0	U4	msec	Timestamp
4	I2	.01 °/s	X-Axis Angular Rate ⁽¹⁾
6	I2	.01 °/s	Y-Axis Angular Rate
8	I2	.01 °/s	Z-Axis Angular Rate
10	I2	milli-g	X-Axis Acceleration ^(1,2)
12	I2	milli-g	Y-Axis Acceleration
14	I2	milli-g	Z-Axis Acceleration
16	I2	Relative units	X-Axis Magnetic Field ⁽³⁾
18	I2	Relative units	Y-Axis Magnetic Field
20	I2	Relative units	Z-Axis Magnetic Field
22	U1	Bit field	Flags: Bit 7: GPS 1PPS flag Bit 6: Timestamp is GPS time Bits 5..0: (N/A, read zero)

Notes:

- ⁽¹⁾ The sensor readings are calibrated values not compensated by the Kalman Filter.
- ⁽²⁾ "1 g" is defined as 9.799096177 m/sec².
- ⁽³⁾ The magnetometer outputs are scaled so that the magnitude of the local field at MIDG IIC calibration is 5000 counts.

4.3 Message: **IMU_MAG**
Description: Magnetometer Measurements

Message ID: **3 (0x03)**

Payload Length: **11 Bytes (0x0B)**
Applicable Modes: IMU, VG, INS

Payload Contents

Byte Offset	Number Format	Units	Purpose / Comment
0	U4	msec	Timestamp
4	I2	Relative units	X-Axis Magnetic Field ⁽¹⁾
6	I2	Relative units	Y-Axis Magnetic Field
8	I2	Relative units	Z-Axis Magnetic Field
10	U1	Bit field	Flags: Bit 7: (N/A, reads zero) Bit 6: Timestamp is GPS time Bits 5..0: (N/A, read zero)

Notes:

- ⁽¹⁾ The magnetometer outputs are scaled so that the magnitude of the local field at MIDG IIC calibration is 5000 counts.

4.4 Message: **NAV_SENSOR**
Description: Navigation Sensor Data

Message ID: **10 (0x0A)**

Payload Length: **39 Bytes (0x27)**
Applicable Modes: VG, INS

Payload Contents

Byte Offset	Number Format	Units	Purpose / Comment																
0	U4	msec	Timestamp																
4	I2	.01 °/s	X-Axis Angular Rate ⁽¹⁾																
6	I2	.01 °/s	Y-Axis Angular Rate																
8	I2	.01 °/s	Z-Axis Angular Rate																
10	I2	milli-g	X-Axis Acceleration ^(1,2)																
12	I2	milli-g	Y-Axis Acceleration																
14	I2	milli-g	Z-Axis Acceleration																
16	I2	0.01deg	Yaw, Local Frame Z-Axis Attitude ⁽³⁾																
18	I2	0.01deg	Pitch, Local Frame Y-Axis Attitude																
20	I2	0.01deg	Roll, Local Frame X-Axis Attitude																
22	I4	2^{-30}	Orientation Quaternion Q_w ⁽⁴⁾																
26	I4	2^{-30}	Orientation Quaternion Q_x																
30	I4	2^{-30}	Orientation Quaternion Q_y																
34	I4	2^{-30}	Orientation Quaternion Q_z																
38	U1	Bit field	Flags: <table style="margin-left: 20px; border: none;"> <tr><td>Bit 7:</td><td>INS Mode</td></tr> <tr><td>Bit 6:</td><td>Timestamp is GPS time</td></tr> <tr><td>Bit 5:</td><td>DGPS</td></tr> <tr><td>Bit 4:</td><td>Magnetometer measurement applied</td></tr> <tr><td>Bit 3:</td><td>External heading measurement applied</td></tr> <tr><td>Bit 2:</td><td>External position measurement applied ⁽⁵⁾</td></tr> <tr><td>Bit 1:</td><td>External velocity measurement applied</td></tr> <tr><td>Bit 0:</td><td>External air data measurement applied ⁽⁵⁾</td></tr> </table>	Bit 7:	INS Mode	Bit 6:	Timestamp is GPS time	Bit 5:	DGPS	Bit 4:	Magnetometer measurement applied	Bit 3:	External heading measurement applied	Bit 2:	External position measurement applied ⁽⁵⁾	Bit 1:	External velocity measurement applied	Bit 0:	External air data measurement applied ⁽⁵⁾
Bit 7:	INS Mode																		
Bit 6:	Timestamp is GPS time																		
Bit 5:	DGPS																		
Bit 4:	Magnetometer measurement applied																		
Bit 3:	External heading measurement applied																		
Bit 2:	External position measurement applied ⁽⁵⁾																		
Bit 1:	External velocity measurement applied																		
Bit 0:	External air data measurement applied ⁽⁵⁾																		

Notes:

- ⁽¹⁾ The sensor readings are compensated by the Kalman Filter.
- ⁽²⁾ "1 g" is defined as 9.799096177 m/sec².
- ⁽³⁾ Rotation sequence is taken Yaw, Pitch, Roll.
- ⁽⁴⁾ The elements of the Orientation Quaternion must be multiplied by 2^{-30} ($9.31322574615 \times 10^{-10}$) to get a unit quaternion.
- ⁽⁵⁾ External Position and External Air Data aiding have not been implemented, bits read zero.

4.5 Message: **NAV_PV** Message ID: **12 (0x0C)**
 Description: Navigation Position and Velocity Solution

Payload Length: **29 Bytes (0x1D)**
 Applicable Modes: VG, INS

Payload Contents

Byte Offset	Number Format	Units	Purpose / Comment
0	U4	msec	Timestamp
4	I4	cm, 10 ⁻⁷ deg	X-Axis Position (ECEF X, Relative Position East, or Longitude) ⁽¹⁾
8	I4	cm, 10 ⁻⁷ deg	Y-Axis Position (ECEF Y, Relative Position North, or Latitude)
12	I4	cm	Z-Axis Position (ECEF Z, Relative Position Up, or Altitude)
16	I4	cm/s	X-Axis Velocity (ECEF Vx, or Relative Veast) ⁽²⁾
20	I4	cm/s	Y-Axis Velocity (ECEF Vy, or Relative Vnorth)
24	I4	cm/s	Z-Axis Velocity (ECEF Vz, or Relative Vup)
28	U1	Bit field	Solution Details: Bit 7: Position estimate invalid Bit 6: Timestamp is GPS time Bit 5: DGPS (SBAS – WAAS, EGNOS, MSAS) Bit 4: Velocity estimate invalid Bits 3..2: Position Format 0 = ECEF 1 = ENU Relative ⁽³⁾ 2,3 = LLA Bit 1: Velocity Format 0 = ECEF 1 = ENU Bit 0: ENU position relative to first fix ⁽³⁾

Notes:

- ⁽¹⁾ Position format: ECEF or ENU Relative in cm; Longitude and Latitude in 10⁻⁷ deg, Altitude in cm.
- ⁽²⁾ Velocity Format is either ECEF or ENU.
- ⁽³⁾ If Position Format is ENU Relative, position is relative to either the first GPS fix or location specified in configuration.

4.6 Message: **NAV_HDG**
Description: Navigation Heading Information

Message ID: **13 (0x0D)**

Payload Length: **17 Bytes (0x11)**
Applicable Modes: INS

Payload Contents

Byte Offset	Number Format	Units	Purpose / Comment
0	U4	msec	Timestamp
4	I2	0.01 deg	Magnetic Heading
6	I2	0.01 deg	Magnetic Declination ⁽¹⁾
8	I2	0.01 deg	Magnetic Dip
10	I2	0.01 deg	Course Over Ground ⁽²⁾
12	U2	cm/s	Speed Over Ground
14	I2	cm/s	Vertical Velocity
16	U1	Bit field	Flags: Bit 7: Declination and dip valid Bit 6: Timestamp is GPS time Bits 5..0: (N/A, read zero)

Notes:

- ⁽¹⁾ Magnetic Declination and Magnetic Dip are taken from the World Magnetic Model, which requires initialization with the current location. As a result, these values are not valid until position is known and Bit 7 is set in the Flags bit field.
- ⁽²⁾ Course Over Ground, Speed Over Ground, and Vertical Velocity are calculated from the navigation solution data and correspond to the velocities presented in the NAV_PV message.

4.7 Message: **NAV_ACC**
Description: Navigation Solution Accuracy Estimate

Message ID: **15 (0x0F)**

Payload Length: **17 Bytes (0x11)**
Applicable Modes: INS

Payload Contents

Byte Offset	Number Format	Units	Purpose / Comment
0	U4	msec	Timestamp
4	U2	cm	Horizontal position accuracy estimate ⁽¹⁾
6	U2	cm	Vertical position accuracy estimate
8	U2	cm/s	Horizontal velocity accuracy estimate ⁽¹⁾
10	U2	cm/s	Vertical velocity accuracy estimate
12	U2	0.01 deg	Tilt accuracy estimate ⁽¹⁾
14	U2	0.01 deg	Heading accuracy estimate
16	U1	Bit field	Flags: Bit 7: Content valid Bit 6: Timestamp is GPS time Bit 5: DGPS (SBAS – WAAS, EGNOS, MSAS) Bits 4..0: (N/A, read zero)

Notes:

- ⁽¹⁾ Values represents the probable standard deviation of error.

4.8 Message: **GPS_PV** ⁽¹⁾
 Description: GPS Position and Velocity Solution

Message ID: **20 (0x14)**

Payload Length: **38 Bytes (0x26)**
 Applicable Modes: IMU, VG, INS

Payload Contents

Byte Offset	Number Format	Units	Purpose / Comment
0	U4	msec	GPS Time
4	U2	Count	GPS week
6	U2	Bit field	Solution Details: Bits 15..12: Number of satellites used in solution Bits 11..8: GPS Fix Type: 0 = No Fix 1 = Dead reckoning only 2 = 2D Fix 3 = 3D Fix 4 = GPS + dead reckoning combined Bit 7: Time of week valid Bit 6: Week number valid Bit 5: Differential solution (WAAS, EGNOS, MSAS) Bit 4: GPS Fix valid Bits 3..2: Position Format: 0 = ECEF 1 = ENU Relative ⁽²⁾ 2,3 = LLA Bit 1: Velocity Format: 0 = ECEF 1 = ENU Bit 0: ENU Relative Position relative to first fix
8	I4	cm, 10 ⁻⁷ deg	X Axis Position (ECEF X, Relative East, or Longitude) ⁽³⁾
12	I4	cm, 10 ⁻⁷ deg	Y Axis Position (ECEF Y, Relative North, or Latitude)
16	I4	cm	Z Axis Position (ECEF Z, Relative Up, or Altitude)
20	I4	cm/s	X Axis Velocity (ECEF V _x , or Relative V _{east}) ⁽⁴⁾
24	I4	cm/s	Y Axis Velocity (ECEF V _y , or Relative V _{north})
28	I4	cm/s	Z Axis Velocity (ECEF V _z , or Relative V _{up})
32	U2	0.01	Position DOP
34	U2	cm	Position Accuracy ⁽⁵⁾
36	U2	cm/s	Speed Accuracy

Notes:

- ⁽¹⁾ This message is provided at the selected rate only if data is produced by the GPS receiver.
- ⁽²⁾ If Position Format is ENU Relative, position is relative to either the first GPS fix or location specified in configuration.
- ⁽³⁾ Position Format: ECEF or ENU Relative in cm; Longitude and Latitude in 10⁻⁷ deg, Altitude in cm.
- ⁽⁴⁾ Velocity Format is either ECEF or ENU.
- ⁽⁵⁾ Accuracy is the square root of the variance in the filtered estimate.

4.9 Message: **GPS_SVI** ⁽¹⁾
 Description: GPS Satellite Vehicle Information

Message ID: **21 (0x15)**

Payload Length: **(8 * NCh) + 6 Bytes** ⁽²⁾
 Applicable Modes: IMU, VG, INS

Payload Contents

Byte Offset	Number Format	Units	Purpose / Comment
0	U4	msec	GPS Time
4	U1		(Reserved, value indeterminate)
5	U1	Count	Number of satellites to follow (1..16)

After the 6 bytes above are sent, the following block is repeated *NCh* times (once for each satellite, 8 bytes per block) ⁽³⁾:

(8 * N) + 6	U1	Count	Receiver channel number (1..16)
(8 * N) + 7	U1	Address	Satellite ID on this receiver channel
(8 * N) + 8	U1	dB _{Hz}	Carrier to Noise ratio
(8 * N) + 9	U1	Bit field	Information regarding the satellite: Bits 7..5: (N/A, value indeterminate) Bit 4: Satellite is unhealthy, will not be used Bit 3: Orbit information is ephemeris Bit 2: Orbit information available for this satellite Bit 1: DGPS data available for this satellite Bit 0: Satellite used for navigation
(8 * N) + 10	I1	Value	Information regarding the receiver channel: 7: Code/carrier locked, receiving 50bps data 5,6: Code and carrier locked 4: Code locked 3: Signal detected but unusable 1,2: Channel is searching 0: Channel is idle
(8 * N) + 11	I1	deg	Satellite Elevation
(8 * N) + 12	I2	deg	Satellite Azimuth

Notes:

- ⁽¹⁾ This message is provided at the selected rate only if data is produced by the GPS receiver. The values in this message are data provided directly by the GPS module and passed to the output message without any intervening processing.
- ⁽²⁾ "NCh" is number of receiver channels in this message.
- ⁽³⁾ "N_i" goes from zero to (NCh - 1).

4.10 Message: **GPS_RAW** ^(1,2)
 Description: GPS Raw Measurement Data

Message ID: **22 (0x16)**

Payload Length: **(24 * nSVs) + 8 Bytes** ⁽³⁾
 Applicable Modes: IMU, VG, INS

Payload Contents

Byte Offset	Number Format	Units	Purpose / Comment
0	U4	msec	GPS Time
4	U2	Count	GPS week
6	U1		(Reserved, value indeterminate)
7	U1	Count	Number of satellites to follow (up to 10)

After the 8 bytes above are sent, the following block is repeated $nSVs$ times (once for each satellite, 24 bytes per block) ⁽⁴⁾:

$(24 * N) + 8$	R8	cycles	Carrier Phase
$(24 * N) + 16$	R8	m	Pseudo Range
$(24 * N) + 24$	R4	Hz	Doppler Measurement
$(24 * N) + 28$	U1	Address	Satellite ID
$(24 * N) + 29$	I1	Value	Information regarding the receiver channel: 7: Code/carrier locked, receiving 50bps data 5,6: Code and carrier locked 4: Code locked 3: Signal detected but unusable 1,2: Channel is searching 0: Channel is idle
$(24 * N) + 30$	U1	dB _{Hz}	Carrier to Noise ratio
$(24 * N) + 31$	U1		Loss of link indicator (RINEX definition)

Notes:

- (1) *Due to undocumented changes in GPS modules by the manufacturer, not all MIDG IIC units support the GPS_RAW Message. As it is impossible to determine in the field if the Raw Data are available from the GPS module, this message should not be used. The values in this message are data provided directly by the GPS module and passed to the output message without any intervening processing.*
- (2) *This message is provided at the selected rate only if data is produced by the GPS receiver.*
- (3) *"nSVs" is number of satellites in this message.*
- (4) *"N" goes from zero to (nSVs - 1).*

4.11 Message: **GPS_CLK** ⁽¹⁾
 Description: GPS Receiver Clock Solution

Message ID: **23 (0x17)**

Payload Length: **20 Bytes (0x14)**
 Applicable Modes: IMU, VG, INS

Payload Contents

Byte Offset	Number Format	Units	Purpose / Comment
0	U4	msec	GPS Time
4	I4	ns	Clock bias
8	I4	ns/s	Clock drift
12	U4	ns	Time accuracy estimate
16	U4	ps/s	Frequency accuracy estimate

Notes:

- (1) *This message is provided at the selected rate only if data is produced by the GPS receiver. The values in this message are data provided directly by the GPS module and passed to the output message without any intervening processing.*

4.12 Message: **GPS_EPH** ^(1,2)
 Description: GPS Satellite Ephemeris Data

Message ID: **24 (0x19)**

Payload Length: **77 Bytes (0x4D)** ⁽³⁾
 Applicable Modes: IMU, VG, INS

Payload Contents

Byte Offset	Number Format	Units	Purpose / Comment
0	U1	Address	Satellite ID ⁽³⁾
1	U4		GPS Handover word

After the 5 bytes above are sent, the following element is repeated 24 times. Each element is a 24-bit word of the GPS Navigation Message (see *ICD-GPS-200*). The 8 words following the Telemetry and Handover Words of Sub-frames 1 through 3 are included. Each word is arranged most significant byte first (big-endian):

5 + (N _i * 3)	U3	24-Bit Word	Navigation Words from Sub-frames 1 through 3 ^(4,5)
--------------------------	----	-------------	---

Notes:

- (1) *Due to undocumented changes in GPS modules by the manufacturer, not all MIDG IIC units support the GPS_EPH Message correctly (the Navigation Words contents may be invalid). As it is impossible to determine in the field if the Ephemeris Data are available from the GPS module or if the message contents are valid, this message should not be used in firmware versions below 2.3.x. This message is not available in firmware versions 2.3.1 and higher.*
- (2) *This message does not have a configurable message rate. Ephemeris data is polled for a satellite by sending a message to the MIDG IIC with ID = 24 (GPS_EPH) and a single payload byte which is the Satellite ID for the satellite for which ephemeris data is being requested. In order to prevent overrunning the MIDG IIC output queue, requests are cached and ephemeris messages are sent at a rate of only one ephemeris message per second.*
- (3) *If no valid ephemeris data is available for a satellite, this message will have a single byte payload, the Satellite ID, and the Handover Word and Navigation Words will not be included. In this case, the Payload Length will be 1.*
- (4) *"N_i" goes from zero to 23.*
- (5) *Each these elements are 24-bit (3-byte) words. Since the Navigation Words require significant byte splitting and parsing, no effort is made to align the 24-bit words on 4-byte boundaries.*

4.13 Message: **TIM_UTC** ⁽¹⁾
 Description: UTC Time

Message ID: **25 (0x19)**

Payload Length: **16 Bytes (0x10)**
 Applicable Modes: IMU, VG, INS

Payload Contents

Byte Offset	Number Format	Units	Purpose / Comment
0	U4	msec	GPS Time
4	I4	ns	Nanoseconds of Second (-5 x 10 ⁸ to +5 x 10 ⁸ , UTC)
8	U2	Value	Year (1999..2099, UTC)
10	U1	Value	Month (1..12, UTC)
11	U1	Value	Day of Month (1..31, UTC)
12	U1	Value	Hour of Day (0..23, UTC)
13	U1	Value	Minute of Hour (0..59, UTC)
14	U1	Value	Second of Minute (0..59, UTC)
15	U1	Bit field	Time information validity: Bits 7..3: (Reserved, value indeterminate) Bit 2: Valid UTC (leap seconds known) Bit 1: Week number valid Bit 0: Time of week valid

Notes:

- (1) *This message is provided at the selected rate only if data is produced by the GPS receiver. The values in this message are data provided directly by the GPS module and passed to the output message without any intervening processing.*

4.14 Message: **TIM_ERR** ⁽¹⁾
 Description: Time Error Information

Message ID: **26 (0x1A)**

Payload Length: **7 Bytes (0x07)**
 Applicable Modes: IMU, VG, INS

Payload Contents

Byte Offset	Number Format	Units	Purpose / Comment
0	U4	msec	GPS Time
4	I1	Counts	Time timer bias
5	I1	Counts	Data timer bias
6	U1	Bit field	Flags: Bit 7: (N/A, reads, zero) Bit 6: Timestamp is GPS time Bits 5..0: (N/A, read zero)

Notes:

- (1) *This message is a legacy message that actually provides no useful data to the user as the message only defines information used internally by the MIDG-Series units. This message is not available in firmware versions 2.3.1 and higher.*

4.15 Message: **TIM_PPS** ^(1,2)
 Description: Time Pulse Information

Message ID: **27 (0x1B)**

Payload Length: **16 Bytes (0x10)**
 Applicable Modes: IMU, VG, INS

Payload Contents

Byte Offset	Number Format	Units	Purpose / Comment
0	U4	msec	GPS time of next pulse
4	U4	msec / 2 ³²	Fractional millisecond of next pulse
8	I4	ps	Quantization error of next pulse ⁽³⁾
12	U2		GPS week number of next pulse
14	U1	Bit field	Flags: Bits 7..3: (N/A, read zero) Bit 1: UTC is available Bit 0: Time base is (0=GPS, 1=UTC)
15	U1		(Reserved, value indeterminate)

Notes:

- (1) *This message is a legacy from when the MIDG-Series units did not have a Time Pulse output signal (1PPS), and indicates the estimated time of the next GPS time pulse. This message is just passed through from the GPS module by the MIDG IIC, via two serial data transmissions with uncertain latencies. Thus the data in this message may be incorrect for the next pulse being output by the GPS module. As the 1PPS Time Pulse output signal is available at the MIDG IIC output connector, use of this message is not recommended. This message is not available in firmware versions 2.3.1 and higher.*
- (2) *The Time Pulse output signal is present only when the receiver is able to calculate a position solution. Accuracy of the Time Pulse output signal available at the MIDG IIC output connector is 50 ns_{rms}, with 99% < 100 ns error.*
- (3) *The time pulse signal is aligned to a 23.104 MHz clock, which results in a resolution of 43 ns. The resulting quantization is considered in the time accuracy estimation of the receiver.*

4.16 Message: **TIM_TM** ⁽¹⁾
 Description: Time Mark Information

Message ID: **28 (0x1C)**

Payload Length: **8 Bytes (0x08)**
 Applicable Modes: IMU, VG, INS

Payload Contents

Byte Offset	Number Format	Units	Purpose / Comment
0	U4	msec	GPS time of received pulse rising edge
4	U2	Count	GPS week number of received pulse rising edge
6	U2		(Reserved, value indeterminate)

Notes:

- (1) *This message is only available on MIDG IIC units that have the Time Mark Option (Microbotics Part Number SIS90031C-SR) supporting an external pulse input at Pin 8 of the MIDG IIC output connector. The MIDG IIC records the GPS time of the rising edge of the received pulse (+/- 1 ms), and sends this message at the first 50 Hz update slot of MIDG IIC processing (maximum update of 50 Hz). If multiple pulses are received in a 50 Hz period, only the time of the most recent rising edge is reported.*

5 MIDG IIC External Aiding Input Messages. The MIDG IIC messages defined in this section provide a mechanism for aiding the MIDG IIC Kalman filter with external measurements, including heading, magnetic vector, position, velocity, and air data. The MIDG IIC supports the following input aiding messages:

ID 31	HDG_MEAS	Heading Aiding
ID 32	AID_MAG	Magnetometer Vector Aiding
[§] ID 37	AID_POS	Position Aiding
ID 38	AID_VEL	Velocity Aiding
[§] ID 39	AID_AIR	Airspeed Aiding

[§] *The AID_POS and AID_AIR Messages have not yet been implemented and are non-functioning. While the HDG_MEAS, AID_MAG, and AID_VEL Messages have been implemented, they have not been fully tested, nor are their effects, especially with invalid entries, fully known at this time. The user accepts any and all risks and consequences when using any aiding message.*

5.1 Message: HDG_MEAS
Description: Heading Measurements

Message ID: **31 (0x1F)**

Payload Length: **8 Bytes (0x08)**
Applicable Modes: INS

Payload Contents

Byte Offset	Number Format	Units	Purpose / Comment
0	U4	msec	Time ⁽¹⁾
4	U2	Bit fields	Details and vertical position standard deviation: Bit 15: Time value format ⁽¹⁾ 1 = GPS Time 0 = Estimated delay Bits 14..12: (Reserved, send as zero) Bits 11..0: Heading Standard Deviation ⁽²⁾
6	I2	0.1 deg	Heading Measurement. Valid range is -1800 to +3600 ⁽³⁾

- Notes:**
- ⁽¹⁾ *The Time value is either the GPS Time of the measurement, or the estimated delay of the measurement from the time when the aiding message is sent and measurement was valid. The convention used depends on a Bit 15 of the Details field. If time delay is used (Bit 15 is zero), then the delay value is taken from the least significant byte of the Time value for a maximum delay of 255 milliseconds.*
 - ⁽²⁾ *The Heading Standard Deviation is used by the Kalman filter to merge the Heading Measurement into the final solution. A deviation value of zero causes the message to be ignored. A deviation value too small for the current heading estimates may cause instability in the final heading results.*
 - ⁽³⁾ *The Heading Measurement is in True Heading with North at 0 degrees and East at +90 degrees.*

5.2 Message: **AID_MAG**
 Description: Magnetometer Vector

Message ID: **32 (0x20)**

Payload Length: **12 Bytes**
 Applicable Modes: INS

Payload Contents

Byte Offset	Number Format	Units	Purpose / Comment
0	U4	msec	Time ⁽¹⁾
4	U2	Bit field	Details: Bit 15: Time value format ⁽¹⁾ 1 = GPS Time 0 = Estimated delay Bits 14..0: (Reserved, send as zero)
6	I2	Relative units	X magnetic component ⁽²⁾
8	I2	Relative units	Y magnetic component
10	I2	Relative units	Z magnetic component

Notes:

- ⁽¹⁾ The Time value is either the GPS Time of the measurement, or the estimated delay of the measurement from the time when the aiding message is sent and measurement was valid. The convention used depends on a Bit 15 of the Details field. If time delay is used (Bit 15 is zero), then the delay value is taken from the least significant byte of the Time value for a maximum delay of 255 milliseconds.
- ⁽²⁾ Units for the magnetic components may be selected arbitrarily. The maximum vector value should be high enough to provide good resolution, but low enough to avoid saturating the 16-bit signed integer field. A scaled range of ±10000 counts would be a good choice. Internally, the MIDG IIC will convert the vector components to a normalized unit vector for use as a measurement.

5.3 Message: AID_POS ⁽¹⁾
Description: Position Aiding

Message ID: 37 (0x25)

Payload Length: 20 Bytes ⁽³⁾
Applicable Modes: INS

Payload Contents

Byte Offset	Number Format	Units	Purpose / Comment
0	U4	msec	Time ⁽²⁾
4	U2	Bit fields	Details and Vertical Position Standard Deviation: Bit 15: Time value format ⁽²⁾ 1 = GPS Time 0 = Estimated delay Bit 14: Measurement reference coordinates ⁽³⁾ 1 = ECEF 0 = Altitude/Lon/Lat Bit 13: Calculate altitude bias ⁽⁴⁾ Bit 12: (Reserved, send as zero) Bits 11..0: Vertical Standard Deviation ⁽⁵⁾ 0.1 m
6	U2	0.1 m	Horizontal Standard Deviation ^(3,5)
8	I4	cm	ECEF X, or Altitude ⁽³⁾
12	I4	cm, 10 ⁻⁷ deg	ECEF Y, or Longitude
16	I4	cm, 10 ⁻⁷ deg	ECEF Z, or Latitude

Notes:

- ⁽¹⁾ *This message has not yet been implemented and is non-functioning. It is presented for reference only, and is subject to change without notice.*
- ⁽²⁾ *The Time value is either the GPS Time of the measurement, or the estimated delay of the measurement from the time when the aiding message is sent and measurement was valid. The convention used depends on a Bit 15 of the Details field. If time delay is used (Bit 15 is zero), then the delay value is taken from the least significant byte of the Time value for a maximum delay of 255 milliseconds.*
- ⁽³⁾ *If Bit 14 of Details is set (ECEF coordinates), the message must be full length. If it is cleared (Altitude/Lon/Lat), then a short message that includes a Horizontal Standard Deviation of zero and ends with the Altitude field (8th..11th bytes of the Payload) is accepted. The Payload Length in this case is 12 bytes.*
- ⁽⁴⁾ *If Bit 13 of Details is set, the MIDG IIC assumes it must calculate a bias for the altitude measurement when internal GPS data is available.*
- ⁽⁵⁾ *The Standard Deviation values are used by the Kalman filter to merge the Position Measurement(s) into the final solution. A deviation value too small for the current heading estimates may cause instability in the final position results. If a Standard Deviation field is zero, it indicates that the associated measurement should not receive an update: e.g., a packet that updates the Latitude and Longitude, but not the Altitude, would set the Vertical Standard Deviation (Bits 11..0 of Details) to zero.*

5.4 Message: **AID_VEL**
Description: Velocity Aiding

Message ID: **38 (0x26)**

Payload Length: **14 Bytes (0x0E)** ⁽²⁾
Applicable Modes: INS

Payload Contents

Byte Offset	Number Format	Units	Purpose / Comment
0	U4	msec	Time ⁽¹⁾
4	U2		Details and speed standard deviation: Bit 15: Time value format ⁽¹⁾ 1 = GPS Time 0 = Estimated delay Bit 14: Speed only ⁽²⁾ Bits 13..12: (Reserved, send zero) Bits 11..0: Vertical Speed Standard Deviation ^(2,3) 0.1 m/s
6	I2	cm/s	Up Velocity (or total Velocity Magnitude if Bit 14 is set) ⁽²⁾
8	I2	cm/s	East Velocity
10	I2	cm/s	North Velocity
12	U2	0.1 m/s	Horizontal Speed Standard Deviation ⁽³⁾

Notes:

- ⁽¹⁾ The Time value is either the GPS Time of the measurement, or the estimated delay of the measurement from the time when the aiding message is sent and measurement was valid. The convention used depends on a Bit 15 of the Details field. If time delay is used (Bit 15 is zero), then the delay value is taken from the least significant byte of the Time value for a maximum delay of 255 milliseconds.
- ⁽²⁾ Bit 14 of Details set indicates the Up Velocity is actually the absolute value of the total speed through space, and Bits 11-0 are the Standard Deviation of this speed measurement. If Bit 14 of Details is set, then all elements of the message after Up Velocity are ignored, and may be omitted by the sender. The Payload Length in this case is 8 bytes.
- ⁽³⁾ The Standard Deviation values are used by the Kalman filter to merge the Velocity Measurement(s) into the final solution. A deviation value too small for the current heading estimates may cause instability in the final velocity results. If a Standard Deviation field is zero, it indicates that the associated measurement should not receive an update: e.g., a packet that updates the East and North velocities, but not the Up Velocity, would set the Horizontal Speed Standard Deviation to zero; if Bits 11..0 of Details are zero, then the Up Velocity is not used in the measurement update.

Payload Contents

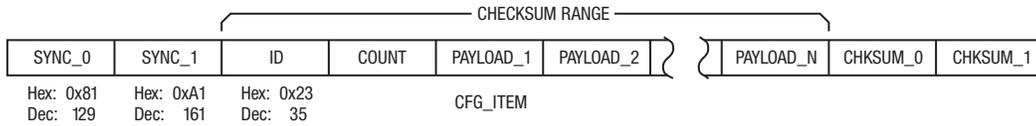
Byte Offset	Number Format	Units	Purpose / Comment
0	U4	msec	Time ⁽²⁾
4	U2	Bit fields	Details and airspeed standard deviation Bit 15: Time value format ⁽²⁾ 1 = GPS Time 0 = Estimated delay Bits 14..12: (Reserved, send as zero) Bits 11..0: True Airspeed Standard Deviation ⁽³⁾ 0.1 m/s
6	U2	0.1 m/s	True Airspeed ⁽⁴⁾
8	U2	Bit fields	Angle of Attack Details: Bits 15..12: Standard Deviation ⁽⁵⁾ Bits 11..0: Angle of Attack ⁽⁶⁾
10	U2	Bit fields	Angle of Slip Details: Bits 15..12: Standard Deviation ⁽⁵⁾ Bits 11..0: Angle of Slip ⁽⁶⁾

Notes:

- ⁽¹⁾ *This message has not yet been implemented and is non-functioning. It is presented for reference only, and is subject to change without notice.*
- ⁽²⁾ *The Time value is either the GPS Time of the measurement, or the estimated delay of the measurement from the time when the aiding message is sent and measurement was valid. The convention used depends on a Bit 15 of the Details field. If time delay is used (Bit 15 is zero), then the delay value is taken from the least significant byte of the Time value for a maximum delay of 255 milliseconds.*
- ⁽³⁾ *The Standard Deviation value for True Airspeed is used by the Kalman filter to merge the Speed Measurement into the final solution. A deviation value too small for the current speed estimates may cause instability in the final velocity results. If a Standard Deviation field is zero, it indicates that the measurement should not receive an update.*
- ⁽⁴⁾ *The provided airspeed is expected to be the ground speed plus the current wind, so that if the actual wind is estimated and removed from this measurement, it will be equivalent to the ground speed.*
- ⁽⁵⁾ *The Standard Deviation fields for Angle of Attack and Angle of Slip represent the standard deviations of the angle measurement. The actual deviation applied with the measurement is the deviation 4-bit value times 2 plus 1. A deviation value of 0 = 1 degree, 1 = 3 degrees, 2 = 5 degrees, ... , 15 = 31 degrees.*
- ⁽⁶⁾ *The Angle of Attack and Angle of Slip are represented as 12-bit scaled signed integers that represents approximately ±90 degrees. The scale factor is 90/2048, which gives slightly better than 0.05 degree resolution. For example, 123 = 5.4 degrees.*

7 Configuration. Configuration messages provide access to the setup information of the MIDG IIC. This includes the selected mode of operation, message rates, output formats, etc. Configuration operations use two MBI messages: *CFG_SET* (Message 35) and *CFG_QUERY* (Message 36).

7.1 Configuration Set Message (*CFG_SET*). The *CFG_SET* Message is used to set parameters of the MIDG IIC internal configuration. The general form of this message is:



The *ID* for the *CFG_SET* Message is 35 (0x23), with the first byte of the Payload being the specific *CFG_ITEM* being set. The balance of the Payload is configuration specific to the *CFG_ITEM*. The details for each *CFG_ITEM* are outlined in the sections below.

The MIDG IIC responds to each *CFG_SET* Message with either an Configuration Acknowledge Message (*CFG_ACK*) if the *CFG_ITEM* operation has been successful, or a Configuration Not-Acknowledge Message (*CFG_NAK*) if the operation was not successful.

7.1.1 Message: *CFG_ACK* Message ID: **40 (0x28)** Payload Length: **2 Bytes (0x02)**
 Description: Acknowledge (sent by MIDG IIC upon success) Applicable Modes: IMU, VG, INS

Payload Contents

Byte Offset	Number Format	Units	Purpose / Comment
0	U1	Message_ID	ID = 35 (0x23) , indicating this is a reply to <i>CFG_SET</i>
1	U1	CFG_ITEM	CFG_ITEM number that was successfully changed

7.1.2 Message: *CFG_NAK* Message ID: **41 (0x29)** Payload Length: **3 Bytes (0x03)**
 Description: Not-Acknowledge (sent by MIDG IIC upon failure) Applicable Modes: IMU, VG, INS

Payload Contents

Byte Offset	Number Format	Units	Purpose / Comment
0	U1	Message_ID	ID = 35 (0x23) , indicating this is a reply to <i>CFG_SET</i>
1	U1	CFG_ITEM	CFG_ITEM number that was unsuccessfully changed
2	U1	Code	Failure codes: 1 Wrong number of parameters 2 Bad <i>CFG_ITEM</i> number 3 Invalid request 4 Change would exhaust the serial port bandwidth 5 Subsystem busy – retry message

7.1.3 Message: **CFG_SET: BAUD_RATE** ⁽¹⁾
 Description: Set serial communication baud rate

Message ID: **35 (0x23)**

Payload Length: **2 Bytes (0x02)**
 Applicable Modes: IMU, VG, INS

Payload Contents

Byte Offset	Number Format	Units	Purpose / Comment
0	U1	CFG_ITEM	CFG_ITEM = 1 (0x01)
1	U1	Code	Baud Rate: 0 = 115200 1 = 57600 2 = 38400 3 = 19200 4 = 9600

Notes:

⁽¹⁾ Changes take effect on reset.

7.1.4 Message: **CFG_SET: PROTOCOL** ⁽¹⁾
 Description: Set serial communication protocol

Message ID: **35 (0x23)**

Payload Length: **2 Bytes (0x02)**
 Applicable Modes: IMU, VG, INS

Payload Contents

Byte Offset	Number Format	Units	Purpose / Comment
0	U1	CFG_ITEM	CFG_ITEM = 2 (0x02)
1	U1	Code	Protocol ⁽¹⁾ 0 = Microbotics Binary Interface Protocol (only valid protocol)

Notes:

⁽¹⁾ Changes take effect on reset. The only valid protocol is Microbotics Binary Interface Protocol.

7.1.5 Message: **CFG_SET: FORMAT**

Message ID: **35 (0x23)**

Payload Length: **2 Bytes (0x02)**

Description: Set output format for position and velocity

Applicable Modes: IMU, VG, INS

Payload Contents

Byte Offset	Number Format	Units	Purpose / Comment
0	U1	CFG_ITEM	CFG_ITEM = 3 (0x03)
1	U1	Bit field	Solution Status: Bits 4-7: (Reserved, send zero) Bits 2-3: Position Format 0 = ECEF 1 = ENU Relative ⁽¹⁾ 2,3 = LLA Bit 1: Velocity Format 0 = ECEF 1 = ENU Bit 0: ENU position relative to first fix ⁽¹⁾

Notes:

⁽¹⁾ If ENU Relative is selected for Position Format, the position will be relative to either the first GPS fix (Bit 0 set) since reset or a location specified in configuration (Bit 0 cleared).

7.1.6 Message: **CFG_SET: RUN_MODE**

Message ID: **35 (0x23)**

Payload Length: **2 Bytes (0x02)**

Description: Set MIDG IIC Run Mode

Applicable Modes: IMU, VG, INS

Payload Contents

Byte Offset	Number Format	Units	Purpose / Comment
0	U1	CFG_ITEM	CFG_ITEM = 4 (0x04)
1	U1	Code	Run Mode select value: 0 = IMU Mode 1 = Vertical Gyro Mode 2 = INS Mode

7.1.7 Message: **CFG_SET: MSG_DIV**
 Description: Set message interval divider

Message ID: **35 (0x23)**

Payload Length: **3 Bytes (0x03)**
 Applicable Modes: IMU, VG, INS

Payload Contents

Byte Offset	Number Format	Units	Purpose / Comment
0	U1	CFG_ITEM	CFG_ITEM = 5 (0x05)
1	U1	Value	Output Message <i>ID</i> for which the divisor is to be set
2	U1	Value	Message Rate Divisor: 0, 1..255 ⁽¹⁾

Notes:

⁽¹⁾ If the Message Rate Divisor is non-zero, the update rate will be (50 / Message Rate Divisor) Hz. If the Message Rate Divisor is zero, the specific message requested will be disabled, although it may still be queried.

7.1.8 Message: **CFG_SET: POS_REF**
 Description: Set *ENU Relative* position reference

Message ID: **35 (0x23)**

Payload Length: **16 Bytes (0x10)**
 Applicable Modes: IMU, VG, INS

Payload Contents

Byte Offset	Number Format	Units	Purpose / Comment
0	U1	CFG_ITEM	CFG_ITEM = 6 (0x06)
1	U1		(Reserved, send zero)
2	U2		(Reserved, send zero)
4	I4	cm	X Position, ECEF coordinates ⁽¹⁾
8	I4	cm	Y Position, ECEF coordinates
12	I4	cm	Z Position, ECEF coordinates

Notes:

⁽¹⁾ The specified location is used as the reference point against which relative *ENU Relative* position is calculated.

7.1.9 Message: **CFG_SET: XFORM** Message ID: **35 (0x23)**
 Description: Set Transform from Platform to MIDG IIC

Payload Length: **8 Bytes (0x08)**
 Applicable Modes: IMU, VG, INS

Payload Contents

Byte Offset	Number Format	Units	Purpose / Comment
0	U1	CFG_ITEM	CFG_ITEM = 10 (0x0A)
1	U1		(Reserved, send zero)
2	I2	0.01 deg	Transform Yaw ⁽¹⁾
4	I2	0.01 deg	Transform Pitch
6	I2	0.01 deg	Transform Roll

Notes:

⁽¹⁾ The Yaw, Pitch, and Roll indicate the Euler angles that define the direction cosine matrix to rotate a vector in the vehicle coordinates to a vector in the MIDG IIC sensor coordinates. The rotation is taken Yaw, Pitch, Roll

7.1.10 Message: **CFG_SET: HDG** Message ID: **35 (0x23)**
 Description: Set Transform from Platform to MIDG IIC

Payload Length: **8 Bytes (0x08)**
 Applicable Modes: IMU, VG, INS

Payload Contents

Byte Offset	Number Format	Units	Purpose / Comment
0	U1	CFG_ITEM	CFG_ITEM = 11 (0x0B)
1	U1	Bit fields	Magnetometer operation settings: Bit 7: (Reserved, send zero) Bits 6-4: Internal magnetometer aiding Threshold Level ⁽¹⁾ Bit 3: Use velocity vector for heading even when turning Bit 2: Use velocity vector for heading ⁽²⁾ Bit 1: Enable internal magnetometer in VG Mode Bit 0: Enable internal magnetometer in INS Mode
2	I2	Relative units	X axis magnetometer bias ⁽³⁾
4	I2	Relative units	Y axis magnetometer bias
6	I2	Relative units	Z axis magnetometer bias

Notes:

⁽¹⁾ The internal magnetometer will not be used if the current heading accuracy is better than the selected Threshold Level. The Threshold Levels correspond to 1 sigma error estimates as follows:

Threshold Level	Error Estimate (1 sigma)
0	0.5 degree
1	1.0 degree
2	2.0 degrees
3	4.0 degrees
4	8.0 degrees
5	12.0 degrees
6	20.0 degrees
7	30.0 degrees

⁽²⁾ Bit 2 allows the velocity vector, from the GPS or an external measurement, to be used as heading aiding. This assumes that the MIDG IIC is aligned with the vehicle such that heading is equivalent to direction of motion, and is generally applicable for ground vehicles. If the velocity vector is different from heading when turning, select Bit 3 also.

⁽³⁾ The provided bias values are subtracted from the magnetometer data.

7.1.11 Message: **CFG_SET: CFG_SAVE** ⁽¹⁾ Message ID: **35 (0x23)**
 Description: Save configuration to NV memory

Payload Length: **1 Byte (0x01)**
 Applicable Modes: IMU, VG, INS

Payload Contents

Byte Offset	Number Format	Units	Purpose / Comment
0	U1	CFG_ITEM	CFG_ITEM = 100 (0x64)

Notes:

⁽¹⁾ This configuration message must be issued for any configuration changes to be preserved across resets.

7.1.12 Message: **CFG_SET: CFG_LOAD** ⁽¹⁾ Message ID: **35 (0x23)**
 Description: Load configuration from NV memory

Payload Length: **1 Byte (0x01)**
 Applicable Modes: IMU, VG, INS

Payload Contents

Byte Offset	Number Format	Units	Purpose / Comment
0	U1	CFG_ITEM	CFG_ITEM = 101 (0x65)

Notes:

⁽¹⁾ This configuration message resets the MIDG IIC configuration information to the values stored in NV memory.

7.1.13 Message: **CFG_SET: CFG_ERASE** ⁽¹⁾ Message ID: **35 (0x23)**
 Description: Erase configuration in NV memory, reset to default

Payload Length: **1 Byte (0x01)**
 Applicable Modes: IMU, VG, INS

Payload Contents

Byte Offset	Number Format	Units	Purpose / Comment
0	U1	CFG_ITEM	CFG_ITEM = 102 (0x66)

Notes:

⁽¹⁾ This configuration message erases the configuration in the non-volatile memory and resets the configuration in the MIDG IIC to its Factory default values. This erasure also forces the NV Configuration Valid flag in the STATUS Message (Bit 7) to remain reset until a new configuration is saved via a CFG_SET: CFG_SAVE Message.

7.2 Configuration Query Message (CFG_QUERY). The *CFG_QUERY* Message is used to query the parameters of the MIDG IIC internal configuration. The message takes on two forms: *CFG_QUERY: GENERAL* where a specific *CFG_ITEM* is being queried, or the *CFG_QUERY: INFO* where MIDG IIC Product Information is being queried.

The MIDG IIC responds to each *CFG_QUERY: GENERAL* Message with either an Query Acknowledge Message (*QUERY_ACK*) if the operation has been successful, or a Query Not-Acknowledge Message (*QUERY_NAK*) if the operation was not successful. The MIDG IIC responds to each *CFG_QUERY: INFO* Message with an Information Acknowledge Message (*INFO_ACK*).

7.2.1 Message: CFG_QUERY: GENERAL
Description: Query status of *CFG_ITEM*

Message ID: **36 (0x24)**

Payload Length: **1 Byte (0x01)**
Applicable Modes: IMU, VG, INS

Payload Contents

Byte Offset	Number Format	Units	Purpose / Comment
0	U1	<i>CFG_ITEM</i>	<i>CFG_ITEM</i> number being queried (See <i>CFG_SET</i> Messages above)

7.2.2 Message: QUERY_ACK

Message ID: **36 (0x24)**

Payload Length: **Variable** ⁽¹⁾
Applicable Modes: IMU, VG, INS

Description: Acknowledge (sent by MIDG IIC upon success)

Payload Contents

Byte Offset	Number Format	Units	Purpose / Comment
0	U1	<i>CFG_ITEM</i>	<i>CFG_ITEM</i> number that was successfully queried ⁽¹⁾
1	BN		Configuration data for the <i>CFG_ITEM</i> queried ⁽¹⁾

Notes:

⁽¹⁾ The Payload of a successful *CFG_QUERY: GENERAL* message has the same format as the corresponding *CFG_SET* Message for the specific *CFG_ITEM* requested, with the data indicating the actual values present in the MIDG IIC internal configuration.

7.2.3 Message: QUERY_NAK

Message ID: **36 (0x24)**

Payload Length: **3 Bytes (0x03)**
Applicable Modes: IMU, VG, INS

Description: Not-Acknowledge (sent by MIDG IIC upon failure)

Payload Contents

Byte Offset	Number Format	Units	Purpose / Comment
0	U1	<i>Message_ID</i>	ID = 36 (0x24) , indicating this is a reply to <i>CFG_QUERY: GENERAL</i>
1	U1	<i>CFG_ITEM</i>	<i>CFG_ITEM</i> number that was unsuccessfully queried
2	U1	Code	Failure code: 2 Bad <i>CFG_ITEM</i> number

7.2.4 Message: **CFG_QUERY: INFO** Message ID: **36 (0x24)**
 Description: Query Product Information from the MIDG IIC

Payload Length: **2 Bytes (0x02)**
 Applicable Modes: IMU, VG, INS

Payload Contents

Byte Offset	Number Format	Units	Purpose / Comment
0	U1	CFG_ITEM	CFG_ITEM = 20 (0x14) , indicating this is a query for <i>CFG_QUERY: INFO</i>
1	U1	Code	Product ID queried: 0 = Manufacturer 1 = Product 2 = Part Number 3 = Serial Number 4 = Support Key 5 = Firmware Version

7.2.5 Message: **INFO_ACK** Message ID: **36 (0x24)**
 Description: Product Information (sent by the MIDG IIC)

Payload Length: **Variable** ⁽¹⁾
 Applicable Modes: IMU, VG, INS

Payload Contents

Byte Offset	Number Format	Units	Purpose / Comment
0	U1	CFG_ITEM	CFG_ITEM = 20 (0x14) , indicating this is a reply to <i>CFG_QUERY: INFO</i>
1	U1	Code	<i>Product ID</i> queried
2	BN	ASCII string	Information requested returned as a NULL-terminated ASCII string ⁽¹⁾

Notes:

⁽¹⁾ The requested information is returned after the Product ID byte as a NULL-terminated string. If the requested Product ID is not recognized, or the information is not available, the reply will be a NULL string (a single byte of 0x00).

MIDG IIC SPECIFICATIONS (SIS90031C and SIS90031C-SR)

December 15, 2011



The MIDG IIC is a GPS aided inertial navigation system (INS) for use in applications requiring attitude, position, velocity, acceleration, and angular rates for navigation or control. An internal GPS receiver measures position and velocity and passes this information to the data fusion processor to be combined with the inertial data to generate an optimal solution. An internal three-axis magnetometer provides a magnetic heading reference when needed.

A build option (SIS90031C-SR) uses Pin 8 as a Time Mark input to allow GPS time tagging of the rising edge of an input signal pulse.

Features

- ① Full INS Solution
- ① Low Power
- ① Light Weight
- ① Small Size

Standard Sensor Axes (can be changed by user)



MIDG IIC Specifications ¹

Power Requirements

Input Voltage	10 VDC - 32 VDC
Power	1.2W max (including GPS antenna)

GPS Antenna ²

Connector Type	50-Ohm SMA, right hand thd
Antenna Power	+5V at center conductor, 25 ma max
RF Power Input	-145 dBm min, -61dBm max
Antenna Pre-Amplifier	45 dB maximum gain

Measurements

Angular rate (all axes)	
Range	±300 °/sec
Non-Linearity	0.1% of FS
Noise Density	0.1 °/sec / √Hz
3dB Bandwidth	20 Hz
Acceleration (all axes)	
Range	±6 g
Non-Linearity	0.3% of FS
Noise Density	150 μg / √Hz
3dB Bandwidth	20 Hz
Attitude Accuracy (pitch and roll, with GPS)	0.4° (1 σ)
Heading Accuracy (with GPS and maneuvering)	2° (1 σ)
Position Accuracy	2m (CEP) with WAAS/EGNOS available, 3 m (CEP) otherwise
Velocity Accuracy	< 0.2 m/s
Altitude Accuracy	3m (SEP) with WAAS/EGNOS available, 5m (SEP) otherwise
Data Output Rates	Position , Velocity, attitude, rates, accelerations - 50 Hz GPS measurements - 4 Hz

Environment

Temperature	-40° C to 85° C, operating and storage
Humidity	10% to 90% RH, non-condensing
Survival Shock	100 g, 8ms., ½ sine
Survival Vibration	6 g _{rms} , 10 Hz to 2000 Hz, random

¹ Typical values.

² See section on active/passive antennas.

MIDG IIC SPECIFICATIONS (SIS90031C and SIS90031C-SR)

December 15, 2011

Output

Electrical
Pulse Per Second ³
Data Format

RS422 async., 115200 baud (configurable), 8-N-1
Complementary pair, each side TTL compatible
Microbotics Binary Protocol

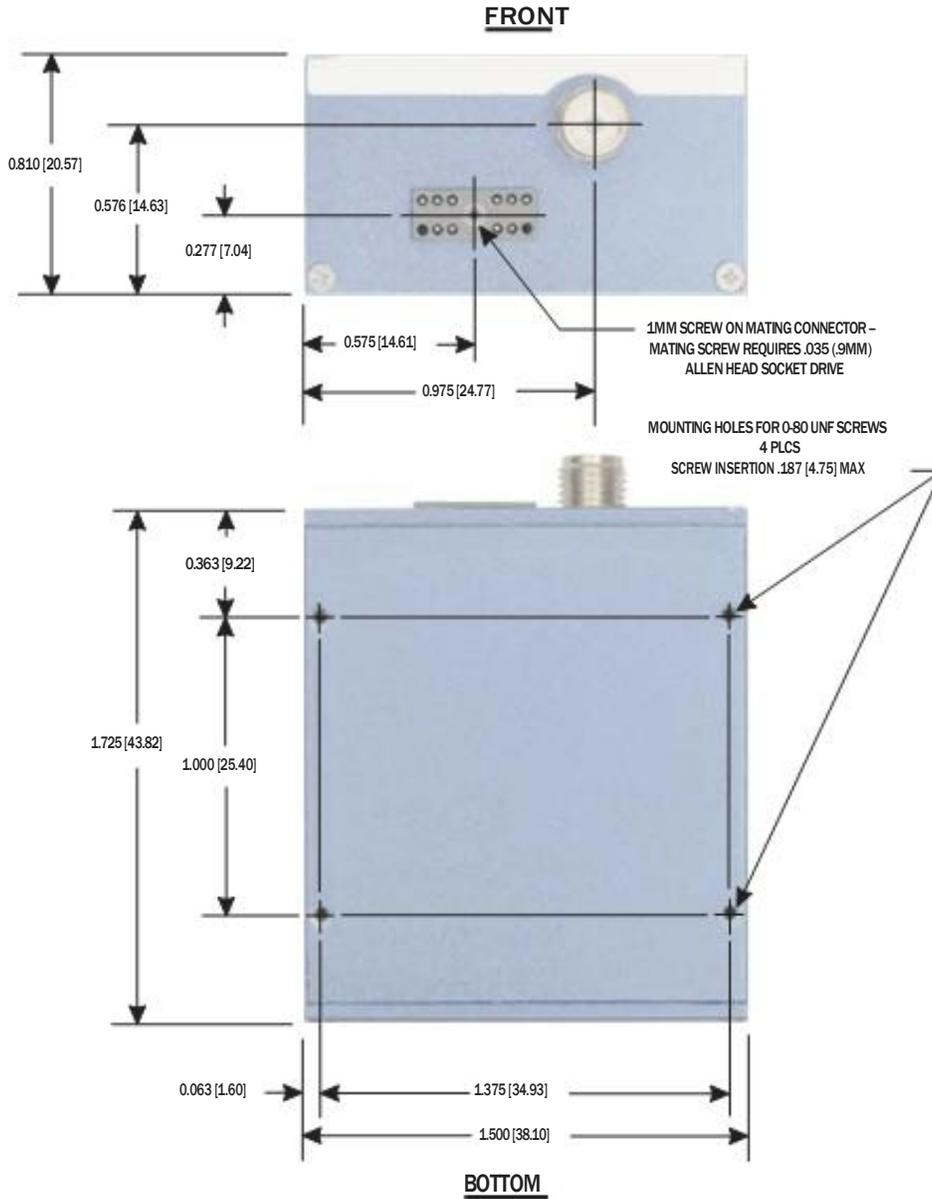
Physical

Size
Weight

1.500" W x .810" H x 1.725" D
55 grams

³ One side used for Trigger Input when Time Mark Option ordered (SIS90031C-SR).

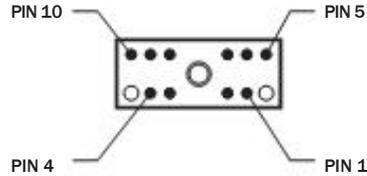
MIDG IIC MOUNTING DIMENSIONS



MIDG IIC SPECIFICATIONS (SIS90031C and SIS90031C-SR)

December 15, 2011

MIDG IIC CONNECTOR PIN-OUT



(VIEWED FROM FACE OF MIDG CONNECTOR)

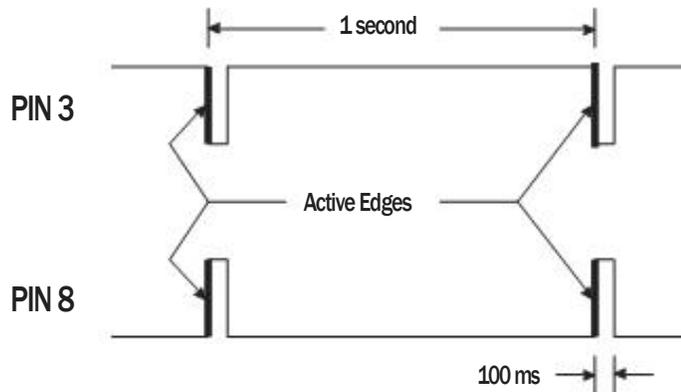
CONNECTOR PIN-OUT (Colors refer to mating connector cable)

PIN 1	BLACK	Rb (Receive pos: MARK high, SPACE low)
PIN 2	BROWN	Ra (Receive neg: MARK low, SPACE high)
PIN 3	RED	PPS_N (1 PPS pulse: Idle high, falling active edge)
PIN 4	ORANGE	Power In (10-32 VDC, 1.2 w max)
PIN 5	YELLOW	Digital Ground (do not use for Power Return)
PIN 6	GREEN	Tb (Transmit pos: MARK high, SPACE low)
PIN 7	BLUE	Ta (Transmit neg: MARK low, SPACE high)
PIN 8	VIOLET	PPS_P/Aux * (1 PPS pulse: Idle low, rising active edge)
PIN 9	GRAY	Power Return
PIN 10	WHITE	Shield

Note: Power Return and Shield connected to Digital Ground

(* Pin 8 Rising-edge Trigger Input with Time Mark Option - SIS90031C-SR)

STANDARD 1 PPS OUTPUT SIGNALS



NOTE: If the MIDG IIC is equipped with the Time Mark option (SIS90031C-SR), pin 8 becomes the Trigger Input. A rising edge on this input causes the TIM_TM message to be sent by the MIDG IIC indicating the time of the rising edge to within 1 msec. The input is TTL compatible (high recognized above 2V, low recognized below 0.4V, do not exceed 5V).

December 15, 2011

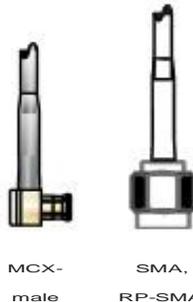
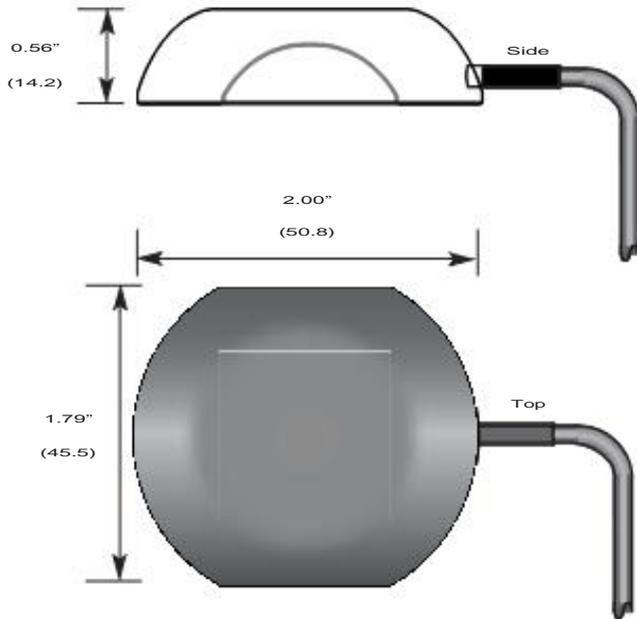
GPS ANTENNA REQUIREMENTS

1. Antenna mounting must be non-magnetic and not use a magnetic mount, as this magnet will interfere with the MIDG magnetometers.
2. Antenna and Ground Plane. A GPS antenna ground plane is recommended. Antenna ground plane of 7 x 7 cm (2.75 x 2.75 in.), minimum, is recommended for use with the GPS antenna available from Microbotics, Inc (Part Number A-GPS5-SMA).
3. Note on Active/Passive Antennas. (The following information is supplied by GPS receiver manufacturer.) Passive antennas contain only the radiating element, e.g. the ceramic patch or the helix structure. The use of an active antenna is always advisable if the RF-cable length between receiver and antenna exceeds about 10 cm. Care should be taken that the gain of the LNA inside the antenna does not lead to an overload condition at the receiver. A gain of 15-21 dB is usually sufficient, even for cable lengths up to 5 m. There's no need for the antenna LNA gain to exceed 26 dB for use with this receiver. With short antenna cables, gains in excess of 25dB may swamp the GPS RF front end.

When comparing gain measures of active and passive antennas, one has to keep in mind that the gain of an active antenna is composed of two components: the antenna gain of the passive radiator, given in dBic; and the LNA power gain, given in dB. A low antenna gain cannot be compensated by high LNA gain. If a manufacturer provides one total gain figure, it is not sufficient to judge the quality of the antenna. One would need information on antenna gain (in dBic), amplifier gain, and amplifier noise figure.

ALERT REGARDING ANTENNA CONNECTION: 5v power for active antennas is supplied via the MIDG GPS SMA connector. The GPS antenna must never be connected or disconnected while the MIDG is powered. Connecting or disconnecting the GPS antenna with power applied to the MIDG may damage the GPS receiver, and will void the MIDG warranty.

Product Dimensions



Description



UC Series GPS antennas deliver high-gain, low-noise performance in a rugged and cosmetically attractive package. They feature a wide operating temperature and low current consumption. The antennas attach via a standard SMA, Part 15 compliant RP-SMA or MCX connector.

Features

- Compact
- High-gain, low-noise design
- Low current consumption
- Wide operating temperature
- Fully weatherized / waterproof
- Rugged & damage-resistant
- Magnetic mount

Electrical Specifications

- Center Freq. 1575.42MHz
- Bandwidth 9MHz minimum
- Impedance 50 ohms
- VSWR 1.5 maximum
- Ant. Gain 90° 3.0dBi
- Polarization RHCP
- Axial Ratio 90° 3.0dBi maximum
- System Gain 28dBi typ.
- Noise 2.2dB maximum
- Input Voltage 3.0-5.0 VDC
- Power Consum. 20mA maximum
- Oper. Temp. -31°F to +185°F (-35°C to +85°C)
- Mounting Magnetic
- Cable RG-174
- Cable Length 197" +/-6" (5m +/-150mm)
- Connector SMA, RP-SMA or MCX male

Ordering Information

- ANT-GPS-UC-SMA (with SMA connector)
- ANT-GPS-UC-RPS (with RP-SMA connector)
- ANT-GPS-UC-MCX (with MCX connector)

Attachment E Installation Directory Tree

1 Introduction. This attachment is designed to show the user where all of the files for the MIDG Series INS/GPS are installed on the user's PC or laptop. There may be differences in the root path of the directory depending on the installation path chosen by the user during installation; however, the rest of the installation will be the same.

2 Start Menu. During the installation process of the MIDG Software and Utilities, a start menu item will be created named "Microbotics, Inc." This start menu contains all of the shortcuts for the software, utilities, and documents included in the software package (Figure 1).

3 Directory File Tree. The directory file tree shows all of the files and their respective installation locations. The Microbotics Installer is designed to maintain all files installed by Microbotics within a central file location for ease of search and access.

NOTE: THE ROOT DIRECTORY OF THE INSTALLATION MAY BE DIFFERENT. THE SYMBOL "%DIR%" REPRESENTS THE USER'S ROOT INSTALLATION DIRECTORY.

```

%DIR%\Microbotics, Inc\MIDG Utilities\
    \Core Files\
        \MIDG II Display\
            \Air.ocx
            \borIndmm.dll
            \cc3250mt.dll
            \gmsair.bpl
            \gmsinst.bpl
            \Lgauge.ocx
            \midgdsp.exe
            \Strip.ocx
            \tee50.bpl
            \vcl50.bpl
            \vcldb50.bpl
        \MIDG II Flash Loader\
            \borIndmm.dll
            \cc3250mt.dll
            \Flash Utility.txt
            \Flash Utility.txtexe
            \midgflash.dll
            \MIDGFlashUtil.exe
            \vcl50.bpl
            \vcldb50.bpl
        \Parsers\
            \borIndmm.dll
            \cc3250mt.dll
            \II Parse.bat
            \iiparse.exe
            \INS Parse.bat
            \insparse.exe
            \vcl50.bpl
    \Documents\
        \Application Notes\
            \AN001 OpModes.pdf
    
```



Figure 1. Start Menu Listing for Installed Software

- \AN002 CalculatingGroundTrack.pdf
- \Instructions\
 - \Transform Correction\
 - \ Transform Correction.pdf
 - \Display Utility\
 - \MIDG Display Utility v_2_0_17.pdf
 - \Flash Utility\
 - \MIDG II Flash Loader.pdf
 - \Magnetic Calibration\
 - \Mag_cal.html
 - \MIDG II Magnetic Declination Calibration Instructions.pdf
 - \swfobject.js
 - \VAN_mag_cal.swf
 - \Parser\
 - \Parser Instructions.pdf
- \Message Specification\
 - \MIDG II Message Specification V2_1 and Higher.pdf
- \MIDG II Features\
 - \Features of v2_3 release.pdf
 - \Introducing the MIDG II.doc
 - \Introducing the MIDG II.pdf
 - \license.rtf
 - \MIDG_IIC_Specifications 20111215.pdf
- \Tools\
 - \interface software\
 - \COMPORT.cpp
 - \COMPORT.h
 - \ecef.c
 - \ecef.h
 - \eph_parse.c
 - \Interface Software.pdf
 - \main.c
 - \mBin.c
 - \mBin.h
 - \mQueue.h
 - \NMEAOut.c
 - \rotate.c
 - \rotate.h
 - \MFiles\
 - \BIT2NUM.M
 - \BITTEST.M
 - \CreateQ_ned2ecef.m
 - \CreateQ_YPR.m
 - \ecef2enu.m
 - \ecef2lla.m
 - \lla2ecef.m
 - \lla2enu.m
 - \Mfiles.pdf
 - \MultQ_V.m
 - \NormalizedQ.m
 - \SolveQ_YPR.m
 - \TransposeQ.m
 - \vecef2venu.m
 - \venu2vbc.m

\PSPAD Editor\ *None of the Files are listed. Microbotics, Inc has provided this software under license. This software is simply provided as a convenience and is protected under copyright © 2002-2004 Jan Fiala.