MIDG II Message Specification

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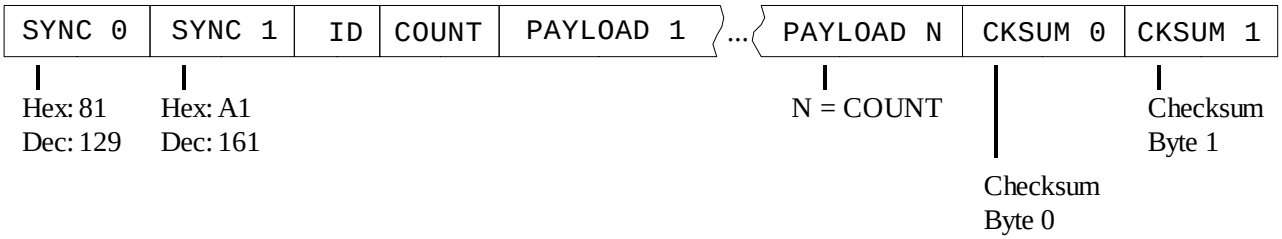
1 Software Interface

This section defines the MIDG II software interface. The MIDG II uses the Microbotics binary protocol, defined in the following section, to communication with the host computer. The defined messages provide sensor data transfer between the host and the MIDG II and facilitate MIDG II configuration.

1.1 Microbotics Binary Protocol

Communication with the MIDG II occurs over the selected primary communication port using the Microbotics binary protocol, herein referred to as mBin. The mBin protocol is a standard binary packet format that has the following structure.



mBin Packet Frame

The checksum is a Fletcher checksum as defined in internet RFC 1145. It is computed over the bytes between the head and checksum. In other words, it includes the message ID, Count byte, and the payload bytes. The basic algorithm is as follows:

```
cksum0 = 0                                  <- unsigned character
cksum1 = 0                                  <- unsigned character
for each byte from ID to Payload_N (inclusive)
  cksum0 = cksum0 + byte                    <- only 8 bits preserved
  cksum1 = cksum1 + cksum 0                 <- only 8 bits preserved
```

The payload is composed of a sequence of bytes that represent values within a message. 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. All payload values are big endian, meaning that the most significant byte of a multi-byte value is sent first. In bit fields, bit zero represents the least significant bit.

Type	Description
U1	Unsigned, 8 bit integer
U2	Unsigned, 16 bit integer
U4	Unsigned, 32 bit integer
B*x*	String of *x* bytes
BN	Variable length string of bytes

Type	Description
I1	Signed, 8 bit integer
I2	Signed, 16 bit integer
I4	Signed, 32 bit integer
R4	IEEE 754 single precision
R8	IEEE 754 double precision

1.2 MIDG II Messages

The MIDG II messages are divided into several groups: data sent from the MIDG II to the host, data and commands sent from the host to the MIDG II, handshaking messages, and configuration messages.

1.2.1 MIDG II To Host

Currently, the following messages are provided from the MIDG II. Any of these messages may be configured to be transmitted from the MIDG II at a user selectable rate from once every 5 seconds to 50Hz. 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 II, but with no payload, so that the message payload length is zero. Rates for these messages are set using the configuration-set message MSG_DIV. See section 1.3.1 for details.
Supported output messages (message IDs):

- MIDG Status (1)
- IMU Data (2)
- Magnetometer Data (3)
- Navigation Sensor Data (10)
- Navigation Position/Velocity Data (12)
- Navigation Accuracy Estimate (15)
- GPS Position/Velocity Data (20)
- GPS Satellite Vehicle Data (21)
- GPS Raw Measurement Data (22)
- GPS Clock Data (23)
- UTC Time (25)
- Time Error (26)
- Time at 1 PPS (27)

Message	STATUS	**Description**	Status Information		
Message ID	1	**Payload Length**	8 Bytes	**Applicable Modes**	IMU, VG, INS

Payload Contents

Byte Offset	**Number Format**	**Notes**	**Name**	**Unit**	**Purpose / Comment**
0	U4		ts	msec	Timestamp
4	U2	1	status		System Status: bits 8-15: reserved bit 7: NV configuration valid bit 6: Timestamp is GPS time bit 5: DGPS bit 4: reserved bits 0-3: Current Mode 1 = IMU Mode 2 = VG Initialization 3 = VG Fast 4 = VG Medium 5 = VG Slow 6 = VG SE 7 = INS Mode
6	I2		Temperature	0.01 °C	Internal temperature

Notes:
1. VG is Vertical Gyro Mode. SE means slow, eligible for INS mode.

Message	IMU_DATA	**Description**	Inertial Measurements		
Message ID	2	**Payload Length**	23 Bytes	**Applicable Modes**	IMU, VG, INS

Payload Contents

Byte Offset	Number Format	Notes	Name	Unit	Purpose / Comment
0	U4		ts	msec	Timestamp
4	I2		p	1e-2 deg/s	X Axis Angular Rate
6	I2		q	1e-2 deg/s	Y Axis Angular Rate
8	I2		r	1e-2 deg/s	Z Axis Angular Rate
10	I2		ax	milli-g	X Axis Acceleration
12	I2		ay	milli-g	Y Axis Acceleration
14	I2		az	milli-g	Z Axis Acceleration
16	I2	1	mx		X Axis Magnetic Field
18	I2		my		Y Axis Magnetic Field
20	I2		mz		Z Axis Magnetic Field
22	U1		Flags	bitfield	Flags bit 7: GPS 1PPS flag bit 6: Timestamp is GPS time

Notes:
1. The magnetometer outputs are scaled so that the magnitude of the local field at calibration is 5000 counts.

Message	IMU_MAG	**Description**	Magnetometer Measurements		
Message ID	3	**Payload Length**	11 Bytes	**Applicable Modes**	IMU, VG, INS

Payload Contents

Byte Offset	Number Format	Notes	Name	Unit	Purpose / Comment
0	U4		ts	msec	Timestamp
4	I2	1	mx		X Axis Magnetic Field
6	I2		my		Y Axis Magnetic Field
8	I2		mz		Z Axis Magnetic Field
10	U1		Flags	bitfield	Flags bit 6: Timestamp is GPS time

Notes:
1. The magnetometer outputs are scaled so that the magnitude of the local field at calibration is 5000 counts.

Message	NAV_SENSOR	**Description**	Navigation Sensor Data		
Message ID	10	**Payload Length**	39 Bytes	**Applicable Modes**	VG, INS

Payload Contents

Byte Offset	**Number Format**	**Notes**	**Name**	**Unit**	**Purpose / Comment**
0	U4		ts	msec	Timestamp
4	I2		p	1e-2deg/s	X Axis Angular Rate
6	I2		q	1e-2deg/s	Y Axis Angular Rate
8	I2		r	1e-2deg/s	Z Axis Angular Rate
10	I2		ax	milli-g	X Axis Acceleration
12	I2		ay	milli-g	Y Axis Acceleration
14	I2		az	milli-g	Z Axis Acceleration
16	I2		yaw	0.01deg	Yaw
18	I2		pitch	0.01deg	Pitch
20	I2		roll	0.01deg	Roll
22	I4	1	Qw	2^{-30}	Orientation Quaternion
26	I4		Qx	2^{-30}	Orientation Quaternion
30	I4		Qy	2^{-30}	Orientation Quaternion
34	I4		Qz	2^{-30}	Orientation Quaternion
38	U1		Flags	bitfield	Flags bit 7: INS Mode bit 6: Timestamp is GPS time bit 5: DGPS bit 4: Magnetometer measurement applied bit 3: External heading measurement applied

Notes:

1. The elements of the quaternion must be multiplied by 2^{-30} (i.e., $9.31322574615 \times 10^{-10}$) to get a unit quaternion.

Message	NAV_PV	**Description**	Navigation Position and Velocity Solution		
Message ID	12	**Payload Length**	29 Bytes	**Applicable Modes**	VG, INS

Payload Contents

Byte Offset	**Number Format**	**Notes**	**Name**	**Unit**	**Purpose / Comment**
0	U4		ts	msec	Timestamp
4	I4	1	PosX		X Axis Position
8	I4	1	PosY		Y Axis Position
12	I4	1	PosZ		Z Axis Position
16	I4	2	VelX	cm/s	X Axis Velocity
20	I4	2	VelY	cm/s	Y Axis Velocity
24	I4	2	VelZ	cm/s	Z Axis Velocity
28	U1	3,4	Details	bitfield	Solution Status: bit 7: Solution source 0=GPS 1=INS bit 6: Timestamp is GPS time bit 5: DGPS bit 4: GPS position and velocity valid bits 2-3: Position Format 0=ECEF 1=ENU 2,3=LLA bit 1: Velocity Format 0=ECEF 1=ENU bit 0: ENU position relative to first fix

Notes:

1. Units are output-dependent: cm for ECEF and ENU relative; $1e^{-7}$deg for Lon/Lat, with cm for Alt
2. Format is either ECEF or ENU
3. When the MIDG is not in INS mode, the data in this message comes directly from the GPS receiver. Fresh data is presented at no more than 5Hz when the solution source is GPS, regardless of the update rate selected for this message. If solution source is GPS, bit 4 indicates whether the GPS position and velocity are valid.
4. If position is reported in ENU coordinates, the position will be relative to either the first GPS fix since reset or a location specified in configuration.

Message	NAV_ACC	**Description**	Navigation Solution Accuracy Estimate		
Message ID	15	**Payload Length**	17 Bytes	**Applicable Modes**	INS

Payload Contents

Byte Offset	**Number Format**	**Notes**	**Name**	**Unit**	**Purpose / Comment**
0	U4		ts	msec	Timestamp
4	U2	1	HPos	cm	Horizontal position accuracy estimate
6	U2	1	VPos	cm	Vertical position accuracy estimate
8	U2	1	HVel	cm/s	Horizontal velocity accuracy estimate
10	U2	1	VVel	cm/s	Vertical velocity accuracy estimate
12	U2	1	Att	0.01 deg	Tilt accuracy estimate
14	U2	1	Hdg	0.01 deg	Heading accuracy estimate
16	U1		Flags	bitfield	Flags bit 7: Content valid bit 6: Timestamp is GPS time bit 5: DGPS

Notes:
1. Value represents the probable standard deviation of error.

Message	GPS_PV	**Description**	GPS Position and Velocity Solution		
Message ID	20	**Payload Length**	38 Bytes	**Applicable Modes**	IMU, VG, INS

Payload Contents

Byte Offset	Number Format	Notes	Name	Unit	Purpose / Comment
0	U4		GPS_ts	msec	GPS Time
4	U2		GPS_week		GPS week
6	U2	2	Details	bitfield	Solution Details: bits 12-15: Number of SVs used in solution bits 8-11: 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 bit 4: GPS Fix valid bits 2-3: Position Format 0=ECEF 1=ENU 2,3=LLA bit 1: Velocity Format 0=ECEF 1=ENU bit 0: ENU position relative to first fix
8	I4	3	GPS_PosX		X Axis Position
12	I4	3	GPS_PosY		Y Axis Position
16	I4	3	GPS_PosZ		Z Axis Position
20	I4		GPS_VelX	cm/s	X Axis Velocity
24	I4		GPS_VelY	cm/s	Y Axis Velocity
28	I4		GPS_VelZ	cm/s	Z Axis Velocity
32	U2		PDOP	0.01	Position DOP
34	U2	4	PAcc	cm	Position Accuracy
36	U2	4	SAcc	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 is reported in ENU coordinates, the position will be relative to either the first GPS fix since reset or a location specified in configuration.
3. Units are output-dependent: cm for ECEF and ENU relative; $1e^{-7}$deg for Lon/Lat, with cm for Alt
4. Accuracy is the root of the variance in the filtered estimate

Message	GPS_SVI	**Description**	GPS Satellite Vehicle Information		
Message ID	21	**Payload Length**	8*NCh + 6	**Applicable Modes**	IMU, VG, INS

Payload Contents

Byte Offset	**Number Format**	**Notes**	**Name**	**Unit**	**Purpose / Comment**
0	U4		GPS_ts	msec	GPS Time
4	U1		reserved		Reserved
5	U1		NCh		Number of SVs to follow
The following block is repeated NCh times.					
8*ChN_i + 6	U1	2	ChN		Receiver channel number
8*ChN_i + 7	U1		SVID		SV on this receiver channel
8*ChN_i + 8	U1		CNo	dbHz	Carrier to Noise ratio
8*ChN_i + 9	U1		Flags	bitfield	Information regarding the SV bit 4: SV is unhealthy, will not be used bit 3: Orbit info is Ephemeris bit 2: Orbit info available for this SV bit 1: DGPS data available for this SV bit 0: SV used for navigation
8*ChN_i + 10	I1		QI	bitfield	Information regarding the receiver channel bit 7: Code/carrier locked, receiving 50bps data bit 5,6: Code and carrier locked bit 4: Code locked bit 3: Signal detected but unusable bit 1,2: Channel is searching bit 0: Channel is idle
8*ChN_i + 11	I1		Elev	deg	SV elevation
8*ChN_i + 12	I2		Az	deg	SV azimuth

Notes:
1. This message is provided at the selected rate only if data is produced by the GPS receiver.
2. ChN_i goes from zero to NCh-1

Message	GPS_RAW	**Description**	GPS Raw Measurement Data		
Message ID	22	**Payload Length**	24*nSVs + 8	**Applicable Modes**	IMU, VG, INS

Payload Contents

Byte Offset	Number Format	Notes	Name	Unit	Purpose / Comment
0	U4		GPS_ts	msec	GPS Time
4	U2		GPS_week		GPS week
6	U1		reserved		reserved
7	U1		nSVs		Number of SVs to follow (upto 10)
The following block is repeated nSVs times.					
$24*nSVs_i + 8$	R8		CP	cycles	Carrier Phase
$24*nSVs_i + 16$	R8		PR	m	Pseudo Range
$24*nSVs_i + 24$	R4		Doppler	Hz	Doppler Measurement
$24*nSVs_i + 28$	U1		SVID		SV number
$24*nSVs_i + 29$	I1		QI	bitfield	Information regarding the receiver channel bit 7: Code/carrier locked, receiving 50bps data bit 5,6: Code and carrier locked bit 4: Code locked bit 3: Signal detected but unusable bit 1,2: Channel is searching bit 0: Channel is idle
$24*nSVs_i + 30$	U1		CNo	dbHz	Carrier to Noise ratio
$24*nSVs_i + 31$	U1		LLI		Loss of link indicator (RINEX definition)

Notes:
1. This message is provided at the selected rate only if data is produced by the GPS receiver.
2. This message is available in MIDG II firmware versions 2.0.8 and higher.

Message	GPS_CLK	**Description**	GPS Receiver Clock Solution		
Message ID	23	**Payload Length**	20 Bytes	**Applicable Modes**	IMU, VG, INS

Payload Contents

Byte Offset	Number Format	Notes	Name	Unit	Purpose / Comment
0	U4		GPS_ts	msec	Timestamp
4	I4		CLKB	ns	Clock bias
8	I4		CLKD	ns/s	Clock drift
12	U4		TAcc	ns	Time accuracy estimate
16	U4		FAcc	ps/s	Frequency accuracy estimate

Notes:

Message	TIM_UTC	**Description**	UTC Time		
Message ID	25	**Payload Length**	16 Bytes	**Applicable Modes**	IMU, VG, INS

Payload Contents

Byte Offset	**Number Format**	**Notes**	**Name**	**Unit**	**Purpose / Comment**
0	U4		GPS_ts	msec	GPS Time
4	U4	2	TAcc	ns	Time accuracy estimate (deprecated)
8	U2		Year		Year (1999..2099)
10	U1		Month		Month (1..12)
11	U1		Day		Day of Month (1..31)
12	U1		Hour		Hour of Day (0..23)
13	U1		Min		Minute of Hour (0..59)
14	U1		Sec		Second of Minute (0..59)
15	U1		Valid	bitfield	Time information validity bit 2: Valid UTC 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.
2. The TAcc field is meaningless in regard to this message and will be disabled in a future firmware release.

Message	TIM_ERR	**Description**	Time Error Information		
Message ID	26	**Payload Length**	7 Bytes	**Applicable Modes**	IMU, VG, INS

Payload Contents

Byte Offset	**Number Format**	**Notes**	**Name**	**Unit**	**Purpose / Comment**
0	U4		ts	msec	Timestamp
4	I1		TTB	counts	Time timer bias
5	I1		DTB	counts	Data timer bias
6	U1		Flags	bitfield	Flags bit 6: Timestamp is GPS time

Notes:

Message	TIM_PPS	**Description**	Time Pulse Information		
Message ID	27	**Payload Length**	16 Bytes	**Applicable Modes**	IMU, VG, INS

Payload Contents

Byte Offset	**Number Format**	**Notes**	**Name**	**Unit**	**Purpose / Comment**
0	U4		TOW	msec	GPS time of next pulse
4	U4		Frac	msec/2^32	Fractional millisecond of next pulse
8	I4	2	QErr	ps	Quantization error of next pulse
12	U2		Week		GPS week number of next pulse
14	U1		Flags	bitfield	Flags bit 0: Time base is (0=GPS, 1=UTC) bit 1: UTC is available
15	U1		res		Reserved

Notes:

1. This message indicates the estimated time of the next GPS time pulse. The time pulse signal is available externally as an order option. The pulse signal is present only when the receiver is able to calculate a position solution. Accuracy of the pulse is 50ns RMS, <100ns 99%.
2. The time pulse signal is aligned to a 23.104 MHz clock, which results in a resolution of 43ns. The resulting quantization is considered in the time accuracy estimation of the receiver.

1.2.2 Host To MIDG II

Several message are provided for commanding and providing information to the MIDG II.
Supported input messages (message IDs):

- RTCM Data (30)
- Heading Measurement (31)
- Reset (99)

Message	RTCM				
Description	RTCM DGPS corrections			**Message Rate**	
Message ID	30	**Payload Length**	variable	**Applicable Modes**	IMU, VG, INS

Payload Contents

Byte Offset	Number Format	Notes	Name	Unit	Purpose / Comment
0	BN	1	RTCM		RTCM data for differential GPS corrections

Notes:

1. RTCM corrections are provided to the MIDG II as a stream of bytes. Typically, GPS ground stations that create differential GPS corrections provide a serial stream of these corrections to the user. The contents of this stream must be encapsulated in this packet and provided to the MIDG II. The MIDG II accepts RTCM message types 1, 2, 3, and 9.

Message	HDG_MEAS				
Description	Heading measurements			**Message Rate**	
Message ID	31	**Payload Length**	2 Bytes	**Applicable Modes**	INS

Payload Contents

Byte Offset	Number Format	Notes	Name	Unit	Purpose / Comment
0	I2	1	hdg_meas		Heading measurement defined as follows: bits 15-3: Heading measurement, 2's compliment, 13 bit integer. Units of 0.1 degrees. bits 2-0: Confidence value (0 to 7)

Notes:

1. The heading measurement should be provided in the range of -1800 to 3600. The confidence level is a measure of how accurate the supplied heading is assumed to be. The internal magnetometer provides updates at confidence level 3, when enabled. If the internal magnetometer updates are enabled, external updates should be provided at confidence level 2 or lower, or they will not be effective. Maneuvering in INS mode (no explicit heading measurement) provides heading information with confidence near level 1. While the measurements may be provided at any frequency, the filter uses the measurements at a maximum of 5Hz.

Message	RESET				
Description	Soft reset command			**Message Rate**	
Message ID	99	**Payload Length**	n Bytes	**Applicable Modes**	IMU, VG, INS

Payload Contents

Byte Offset	Number Format	Notes	Name	Unit	Purpose / Comment
0	U4		code		Value must be 0x01310655 for reset to occur

Notes:

1.2.3 Configuration

Configuration messages provide access to the setup information of the MIDG II. This includes the selected mode of operation, message rates, output formats, etc. All configuration takes place through only two packets that allow for setting and querying the configuration information. Of course, the handshaking packets are used as well. The set and query packets are defined below, but the actual configuration items are described in a separate section that is applicable to the mBin protocol and legacy protocols (MIDG) with which the MIDG II is compatible.

- Configuration Set (35)
- Configuration Query (36)

Message	CFG_SET				
Description	Sets configuration items			**Message Rate**	
Message ID	35	**Payload Length**	variable	**Applicable Modes**	IMU, VG, INS

Payload Contents

Byte Offset	Number Format	Notes	Name	Unit	Purpose / Comment
0	BN	1	data		Zero or more bytes that are configuration item specific

Notes:
1. The possible payloads for configuration are described in a separate section of this document. If configuration change is successful, the MIDG II will reply with an ACK message. If configuration change is not successful, the MIDG II will reply with a NACK message indicating the reason for failure.

Message	CFG_QUERY				
Description	Queries configuration items			**Message Rate**	
Message ID	36	**Payload Length**	variable	**Applicable Modes**	IMU, VG, INS

Payload Contents

Byte Offset	Number Format	Notes	Name	Unit	Purpose / Comment
0	BN	1	data		Zero or more bytes that are configuration item specific

Notes:
1. See note 1 for the CFG_SET message.

1.2.4 Handshaking

Handshaking messages provide a method by which the MIDG II and host can acknowledge requests and commands.
Supported messages (message IDs):

- Acknowledge (40)
- Negative Acknowledge (41)

Message	ACK				
Description	Message acknowledgement			**Message Rate**	
Message ID	40	**Payload Length**	variable	**Applicable Modes**	IMU, VG, INS

Payload Contents

Byte Offset	**Number Format**	**Notes**	**Name**	**Unit**	**Purpose / Comment**
0	U1		to		Message ID to which this is a reply
1	BN		data		Zero or more bytes that are reply specific

Notes:

Message	NACK				
Description	Message negative acknowledgement			**Message Rate**	
Message ID	41	**Payload Length**	variable	**Applicable Modes**	IMU, VG, INS

Payload Contents

Byte Offset	**Number Format**	**Notes**	**Name**	**Unit**	**Purpose / Comment**
0	U1		to		Message ID to which this is a reply
1	BN		data		Zero or more bytes that are reply specific

Notes:

1.3 Configuration Subsystem

The MIDG II provides configuration options to ensure that it is flexible to meet a wide variety of customer applications. This section deals with the configuration messages that are accepted and the replies that are generated. There are two classes of configuration request: configuration-set requests, and configuration-query requests.

1.3.1 Configuration-Set Requests

Configuration-set requests are sent to the MIDG II using the CFG_SET message. The payload of the CFG_SET message determines the specific configuration change that is requested. In all cases, the first byte indicates the configuration item being addressed. The remaining byes contain the details of the change request. The following tables describe the payload of each possible configuration-set request.

Item	BAUD				
Description	Sets the serial interface baud rate			**Bytes**	2
Item ID	1				
Byte Offset	**Number Format**	**Notes**	**Name**	**Unit**	**Purpose / Comment**
0	U1		item		Item ID
1	U1	1,2	baud		Baud rate select value 0 = 115200 1 = 57600 2 = 38400 3 = 19200 4 = 9600
Notes: 1. Changes take effect on reset. 2. Protocol is only selectable for the mBin protocols. The others are fixed at 115200.					

Item	PROTOCOL				
Description	Sets the serial interface protocol			**Bytes**	2
Item ID	2				
Byte Offset	**Number Format**	**Notes**	**Name**	**Unit**	**Purpose / Comment**
0	U1		item		Item ID
1	U1	1	protocol		Protocol select value 0 = Microbotics Binary Protocol 1 = ASCII-Hex Protocol 2 = ZNBin Protocol
Notes: 1. Changes take effect on reset.					

Item	FORMAT				
Description	Output format for position and velocity			**Bytes**	2
Item ID	3				
Byte Offset	**Number Format**	**Notes**	**Name**	**Unit**	**Purpose / Comment**
0	U1		item		Item ID
1	U1	1	format	bitfield	Solution Status: bits 4-7: Reserved bits 2-3: Position Format 0=ECEF 1=ENU 2,3=Lon,Lat,Alt bit 1: Velocity Format 0=ECEF 1=ENU bit 0: ENU position relative to first fix
Notes: 1. If ENU position format is selected, the position will be relative to either the first GPS fix since reset or a location specified in configuration, depending on bit 0.					

Item	MODE				
Description	Sets the desired run mode			**Bytes**	2
Item ID	4				
Byte Offset	**Number Format**	**Notes**	**Name**	**Unit**	**Purpose / Comment**
0	U1		item		Item ID
1	U1		mode		Mode select value 0 = IMU 1 = VG (Vertical Gyro) 2 = INS
Notes:					

Message	MSG_DIV				
Description	Sets message divisor			**Bytes**	3
Item ID	5				
Byte Offset	**Number Format**	**Notes**	**Name**	**Unit**	**Purpose / Comment**
0	U1		item		Item ID
1	U1		msg		Message for which the divisor is to be changed
2	U1		divisor		The message rate for the specified message will be 50/divisor. If divisor is zero, the message will be disabled, although it may still be queried.
Notes:					

Message	POS_REF				
Description	Sets position reference for relative position			**Bytes**	16
Item ID	6				
Byte Offset	**Number Format**	**Notes**	**Name**	**Unit**	**Purpose / Comment**
0	U1		item		Item ID
1	U1		res1		reserved
2	U2		res2		reserved
4	I4	1	POS_X	cm	X Position, ECEF coordinates
8	I4		POS_Y	cm	Y Position, ECEF coordinates
12	I4		POS_Z	cm	Z Position, ECEF coordinates

Notes:
1. The specified location is used as the reference point against which relative ENU position is calculated, assuming that bit 0 of the FORMAT configuration message is cleared.

Message	XFORM				
Description	Sets the output transform			**Bytes**	8
Item ID	10				
Byte Offset	**Number Format**	**Notes**	**Name**	**Unit**	**Purpose / Comment**
0	U1		item		Item ID
1	U1		res		reserved
2	I2	1	yaw	0.01 deg	Transform yaw
4	I2		pitch	0.01 deg	Transform pitch
6	I2		roll	0.01 deg	Transform roll

Notes:
2. The yaw, pitch, and roll indicated in this packet are the Euler angles that define a rotation from the MIDG II sensor coordinates to the vehicle coordinates. In other words, the resulting direction cosine matrix would be able to transform vectors from vehicle coordinates to MIDG II sensor coordinates.

Message	MAG				
Description	Sets magnetometer			**Bytes**	8
Item ID	11				
Byte Offset	**Number Format**	**Notes**	**Name**	**Unit**	**Purpose / Comment**
0	U1		item		Item ID
1	U1		cfg		Magnetometer operation settings: bits 1-7: reserved bit 0: Enable mag updates in INS mode
2	I2		X bias		X axis magnetometer bias
4	I2		Y bias		Y axis magnetometer bias
6	I2		Z bias		Z axis magnetometer bias

Notes:
1. The provided bias values are subtracted from the magnetometer data. They are estimated biases, not bias corrections.

Message	DEBUG				
Description	Enables/disables debug information			**Bytes**	2
Item ID	12				
Byte Offset	**Number Format**	**Notes**	**Name**	**Unit**	**Purpose / Comment**
0	U1		item		Item ID
1	U1	1	cfg		Magnetometer operation settings: bits 1-7: reserved bit 0: Enable IMU data output in INS mode.

Notes:
1. This configuration item is only effective when the selected protocol is ASCII-Hex or ZNBin.

Message	CFG_SAVE				
Description	Stores configuration in non-volatile memory			**Bytes**	1
Item ID	100				
Byte Offset	**Number Format**	**Notes**	**Name**	**Unit**	**Purpose / Comment**
0	U1		item		Item ID

Notes:
This configuration message must be issued for any configuration changes to be preserved across resets.

Message	CFG_LOAD				
Description	Reloads configuration from NV memory			**Bytes**	1
Item ID	101				
Byte Offset	**Number Format**	**Notes**	**Name**	**Unit**	**Purpose / Comment**
0	U1		item		Item ID
Notes: This configuration message resets the configuration information to stored values.					

Message	CFG_ERASE				
Description	Stores configuration in non-volatile memory			**Bytes**	1
Item ID	102				
Byte Offset	**Number Format**	**Notes**	**Name**	**Unit**	**Purpose / Comment**
0	U1		item		Item ID
Notes: This configuration message erases non-volatile memory. If non-volatile configuration memory does not contain valid configuration information upon reset, default values are used.					

1.3.2 Configuration-Set Replies

The MIDG II will respond to each configuration set request with either an ACK or a NACK message. The formats for these replies are as follows:

Payload of ACK reply to CFG_SET Message					
Byte Offset	**Number Format**	**Notes**	**Name**	**Unit**	**Purpose / Comment**
0	U1		CFG_SET		Value is 35, indicating that this is a reply to CFG_SET
1	U1		item		Configuration item number that was successfully changed

Payload of NACK reply to CFG_SET Message					
Byte Offset	**Number Format**	**Notes**	**Name**	**Unit**	**Purpose / Comment**
0	U1		CFG_SET		Value is 35, indicating that this is a reply to CFG_SET
1	U1		item		Configuration item number that was successfully changed
2	U1		code		Failure codes 1 wrong number of parameters 2 bad configuration item number 3 invalid request 4 change would exhaust the serial port bandwidth 5 subsystem busy, please retry

1.3.3 Configuration-Query Requests

Configuration-query requests are sent to the MIDG II using the CFG_QUERY message. The payload of CFG_QUERY messages from the host consist of a single unsigned character which is the information item that is being requested. See section 1.3.1, *Configuration-Set Requests*, to get a list of configuration items that can be queried. In addition to querying configuration information, the configuration-query requests are also used to retrieve general information from the MIDG II such as part number, serial number, and installed firmware version. Information requests are formulated in the same way as configuration requests; the structure is as follows:

Message	INFO				
Description	Retrieves information			**Bytes**	2
Item ID	20				
Byte Offset	**Number Format**	**Notes**	**Name**	**Unit**	**Purpose / Comment**
0	U1		item		Item ID
1	U1		info		Info ID 0 = Manufacturer 1 = Product 2 = Part number 3 = Serial number 4 = Support key 5 = Firmware version
Notes:					

The response to an information query will be the same as the response to a configuration query (see section 1.3.4, Configuration-Query Replies). It will include the item ID (20 in this case), the info ID, and a null terminated string. If the requested info ID is not recognized, the reply will be a null string.

1.3.4 Configuration-Query Replies

Replies to configuration-query requests are not issued in ACK packets, although NACK packets are used to indicate a failed query. Configuration-query replies have the same ID as the configuration-query packet, and the content is identical to the corresponding configuration-set message.

Payload of CFG_QUERY reply to CFG_QUERY Message					
Byte Offset	**Number Format**	**Notes**	**Name**	**Unit**	**Purpose / Comment**
0	U1		item		Configuration item number that was successfully queried
…	*The remaining bytes match the configuration-set request (section 1.3.1) corresponding to the item number.*				

Payload of NACK reply to CFG_QUERY Message					
Byte Offset	**Number Format**	**Notes**	**Name**	**Unit**	**Purpose / Comment**
0	U1		CFG_QUERY		Value is 36, indicating this is a reply to CFG_QUERY
1	U1		item		Configuration item number that was successfully changed
2	U1		code		Failure codes 2 bad configuration item number

Revision History

September 7, 2005	Corrected Payload Length field in GPS_RAW (22) message table.
May 26, 2005	Added GPS_CLK message. NAV_PV: Added Details bit 4 to indicate valid GPS position and velocity. TIM_UTC: Deprecated TAcc field of message. TIM_PPS: Updated notes for message.
November 30, 2004	Added GPS_RAW message.
October 27, 2004	Specified payload byte order and bit field order.
September 2, 2004	Fixed STATUS message, NV valid bit (previously read NV invalid).
July 19, 2004	Updated for firmware 2.0.3. New TIM_PPS message.
June 18, 2004	Fixed length and byte offset error in NAV_ACC message specification.
March 11, 2004	First release document