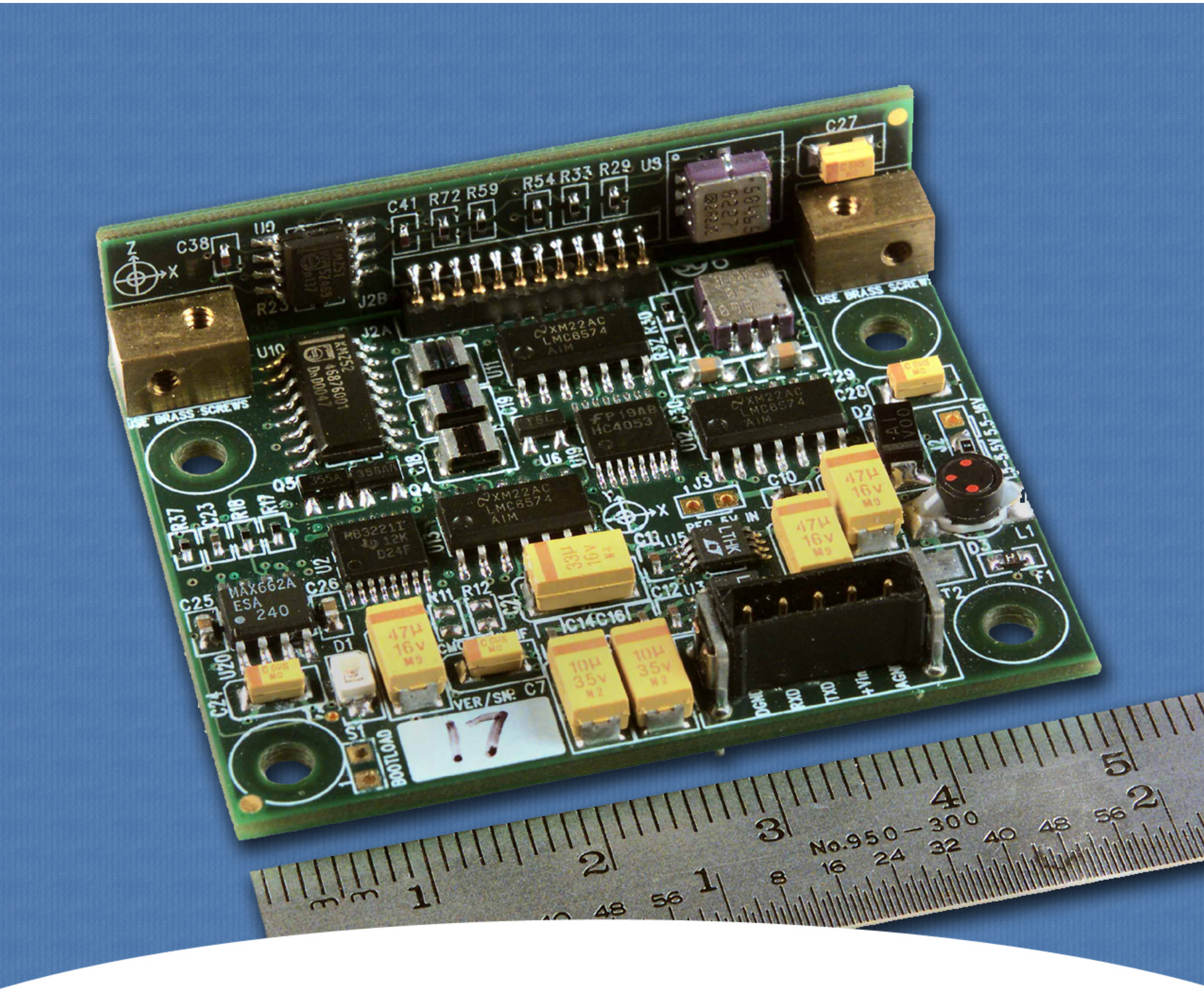
Honeywell Magnetic Sensor Products



HMR3500 TruePoint Digital Compass User's Guide

Honeywell

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HMR3500 User's Guide

1.0 INTRODUCTION

The HMR3500 TruePoint compass module is a 3-axis digital compass solution with a customizable coordinate system for mounting in any desired orientation. Three AMR sensors and three MEMS accelerometers are combined to provide compass heading as well as pitch and roll angles.

The HMR3500 has provisions for hard and soft-iron correction algorithms to handle magnetic distortion effects. In addition a World Magnetic Model feature is provided to add declination angle corrections for reference to true north (geographic north) automatically.

2.0 GETTING TO KNOW THE HMR3500 PRODUCT

2.1 IDENTIFYING THE HMR3500

The HMR3500 Compass module comes with two different options:

(1) PCB Compass Module with the RS-232 electrical interface
(2) Demonstration Kit (housed module, software and RS-232 cabling)

It is strongly suggested that your first HMR3500 purchase be the demonstration kit, to get you quickly into successfully using the compass with a personal computer and the Compass Host demonstration software. From the kit, you will have a known good operating condition when creating your customized interface firmware.

2.2 SETTING UP THE HMR3500

The RS-232 Interface and power supply cable for the HMR3500 digital compass module should be included in the demonstration kit.

Electrical connections are made via a 5-pin header. Mechanical mounting uses a four-point attachment with #2-56 screws. Additionally, the cable assembly can be ordered separately.

The HMR3500 requires an external DC power supply for the red (positive) and black (ground) wires of the cable assembly. By feeding 5 volts DC at about 60 milli-amperes into the HMR3500, the compass will begin to operate.

2.3 HMR3500 SPECIFICATIONS

Characteristics	Conditions	Min	Typ	Max	Units
Heading					
Accuracy	(Clean Magnetic Environment) Level Pitch 0° to ±30° Roll 0° to ±30°	-	0.5 0.5 0.75	1.0 1.5 1.5	(1 σ)
Resolution			0.1		deg
Repeatability	3 sweeps, 0º to 360º, level		0.2		deg rms
Pitch and Roll					
Roll Range	Default orientation, rotation about X-axis		±180°		deg
Pitch Range	Default orientation, rotation about Y-axis		±80°		deg
Accuracy	Roll ±30º, Pitch ±30º		0.5	1.0	deg rms
Null Accuracy[1]	Level		±0.5		deg
Resolution	Level, 1-sigma, 100 readings		0.04		deg

Characteristics	Conditions	Min	Typ	Max	Units
Roll Repeatability	Roll ±70º Pitch ±70º		0.2 0.2		deg rms
Pitch Repeatability	Roll ±70º Pitch ±70º		0.1 0.1		deg rms
Magnetic Field					
Range	Maximum Magnetic Flux Density		0.7		gauss
Resolution	1-sigma, 100 readings		0.45		milli-gauss
Dip Angle	Earth's Vertical Field Component	-70		+70	deg
Linearity			0.2		%FS
Electrical					
Input Voltage	Standard Product	2.5	5.0	5.2	volts DC
Power	Input Voltage 2.5 to 5.2V		300		mW
Digital Interface					
UART	ASCII	4800	9600	38,400	Baud
Update Rate	Continuous Heading Updates	0.05	10	25	Hz
Format	Bi-directional binary packet data protocol.		RS-232		-
Physical					
Dimensions	Circuit Board Assembly		1.97 x 1.65 x 0.52		inches
Weight	HMR3500 PCB only HMR3500 with case, no cable		0.6 3.0		ounce ounces
Connector	5-pin, 2mm pin spacing				-
Environment					
Temperature	Operating Storage (OEM only)	-40 -55	- -	+85 +125	°C °C

[1] Null zeroing prior to use of the HMR3500 and upon exposure to temperature excursions beyond the Operating Temperature limits is required to achieve highest performance.

2.4 PIN CONFIGURATION

Pin Number	Pin Number	Description
1	Ground	Power Supply Return and Ground Reference
2	RXD	RS-232 Receive Data
3	TXD	RS-232 Transmit Data
4	+Vin	Positive Power Supply Voltage Input
5	Ground	Ground Reference (for twisted pair routing with +Vin)

2.5 BASIC DEVICE OPERATION

The HMR3500 TruePoint Compass Module includes 3-axis Anisotropic Magneto-Resistive (AMR) sensors, 3-axis MEMS accelerometers, a temperature sensor, and 16-bit microprocessor with onboard Analog to Digital Converter (ADC). The HMR3500 is available as a printed circuit board assembly, or assembled in a black aluminum case with cable assembly. Additionally, the cable assembly can be ordered separately. A demonstration kit of the HMR3500 is available with the case, cable assembly, a CD of the CompassHost windows utility software for the user's personal computer.

The HMR3500 requires an external DC power supply for the red (positive) and black (ground) wires of the cable assembly. By feeding 5 volts at about 50 milli-amperes into the HMR3500, the compass will operate, and a red LED on the printed circuit board assembly will begin blinking at a 1Hz rate. Lack of a blinking LED or at a rapid rate is an indication of an error, and action should taken to cycle power on the compass electronics to reset the module.

As a factory default, the RS-232 interface is set at 9600 baud with one start bit, 8 data bits, one stop bit, and no parity bits. The HMR3500 does not require any hardware or software handshaking or related features. The baud rate can be changed by command after initial communication at the current baud rate.

The CompassHost utility software is a 32-bit Windows® application program that is provided with the HMR3500 kit, and can be used to evaluate the HMR3500's performance and demonstrate the compass features. With exception of the baud rate change command, the CompassHost is capable of sending and receiving all of the commands of the compass/computer interface. Host computers should be capable of running Windows 9x, ME, NT, 2000, XP and follow-on operating systems. An install program loads the executable file CompassHost.exe and ActiveX components. A readme.txt file is also included to describe the installation process.

2.6 PHYSICAL CHARACTERISTICS

The circuit board for the HMR3500 is 1.57 by 1.97 by 0.52 inches and composed of multi-layer, fiberglass-epoxy printed boards, with the main board horizontal and a vertical board for mounting the z-axis magnetic sensor and accelerometer. The vertical board is held orthogonal to the main board by two brass hardware blocks to ensure mechanical orthogonality.

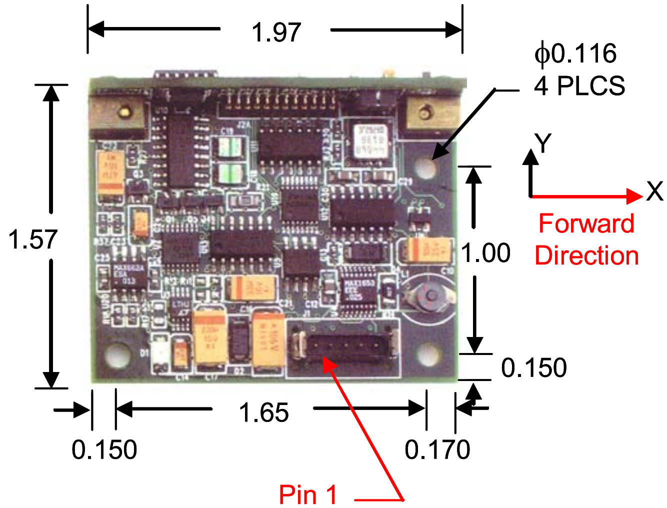


Figure 1
Top View and Dimensions

2.6.1 Mounting Considerations

The following is the recommend printed circuit board (PCB) footprint for the HMR3500. The reference direction (forward) is the right PCB assembly edge shown in Figure 1. Left to right, the interface connector is numbered pin 1 to pin 5 per the pin configuration table.

UNC 4-40 fastening hardware is recommended for mounting the printed circuit board with at least 0.125 inch nylon spacers to stand off the board from the mounting surface. Fastener hardware must be non-ferrous for full compass performance with brass or nylon screws the usual materials of choice.

2.6.2 Case Dimensions (in inches)

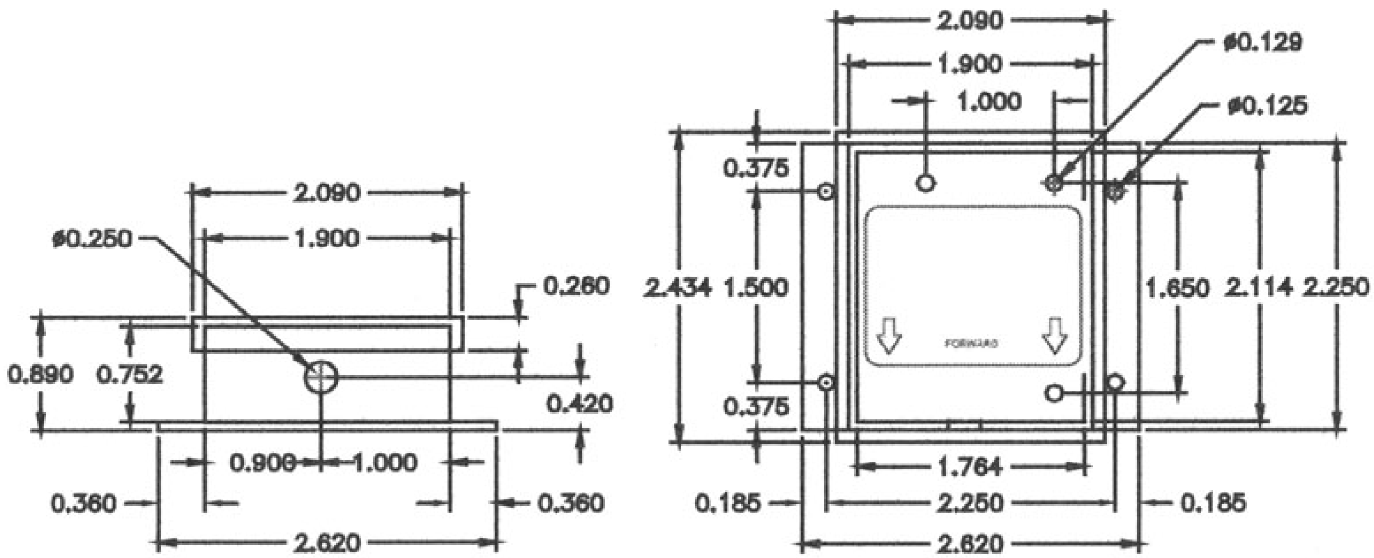


Figure 2
Case Dimensions

2.7 CIRCUIT DESCRIPTION

The HMR3500 circuit design starts with a microprocessor powered by power supply sub-circuit that takes the input voltage and creates regulated power for the various other circuits in the HMR3500. Two 2-axis MEMS accelerometers are mounted horizontally and vertically to combine into a 3-axis tilt sensing sub-circuit. Each accelerometer outputs a Pulse-Width-Modulated (PWM) digital signal that the microprocessor measures for pitch and roll angles.

Besides an integral temperature sensor, a 2-axis and 1-axis magnetic sensor devices are mounted horizontally and vertically to create a 3-axis measurement of the incident magnetic field upon the sensors. Each sensor output is amplified and sent to a multiplexed input ADC residing inside the microprocessor. After digitizing, the magnetic signals are corrected for hard and soft-iron magnetic errors created by the environment to which the compass is attached.

Heading computation uses the magnetic and tilt information inputs after compensation for errors. From the basic magnetic heading, a declination value may be added to arrive at a geographic north referenced heading. An index offset value may also be added to correct for mechanical installation misalignment on the target platform.

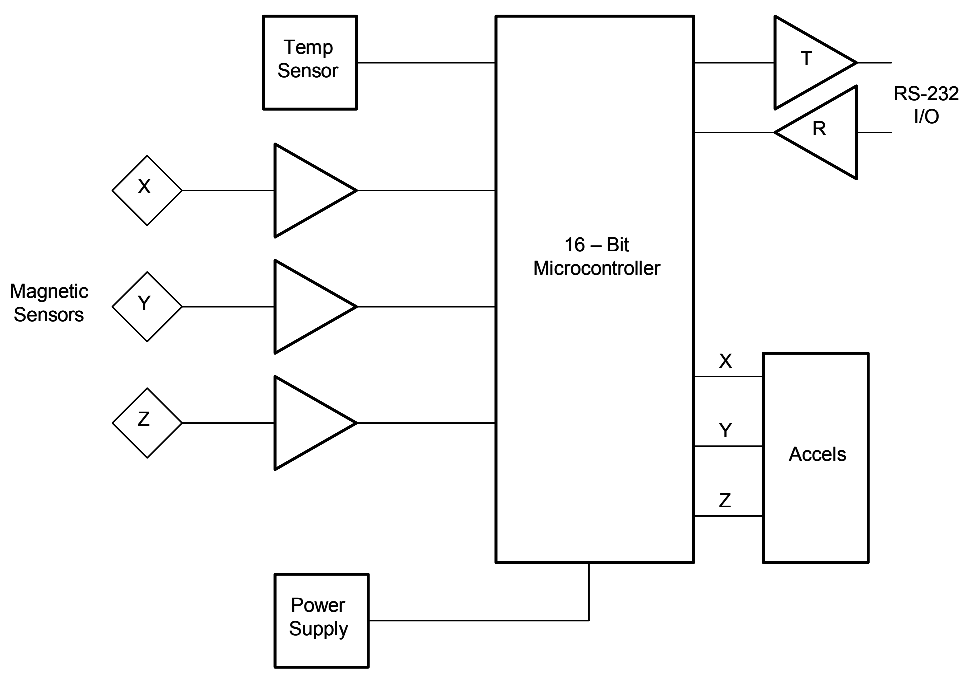


Figure 3
HMR3500 Block Diagram

3.0 UART COMMUNICATION INTERFACE

The 5-pin power supply and UART interface connector on the HMR3500, mates with a Harwin latching connector (Part # M80-8980505) per the pin configuration table earlier in this document. The interface hardware protocol is RS-232 without any further handshaking or hardware control lines.

3.1 PACKET FORMAT

The Serial Data Interface operates both ways with messages structured as packets. Each packet starts with a header followed by zero or more bytes of data, and ends with a checksum trailer.

Message Packet

	Header	Data	Trailer
Number of bytes:	5	Variable	1

Header Field

	Start of Packet	Packet ID	Count Byte
Number of bytes:	3	1	1

The first three bytes of the header field are fixed and are, in sequence, 0x0D, 0x0A, and 0x7E. These are ASCII codes for carriage return, line feed, and the tilde (~) and are intended to permit using a terminal emulator for diagnostic purposes. Using three fixed bytes also improves re-synchronizing if a transmission error upsets the determination of packet boundaries.

The fourth byte is a packet type identification, different for each message type, as defined later. With one exception (RSET), there is a corresponding message from the module for each message from the host, either to acknowledge a command or provide the requested data. Although different mnemonics are assigned, the actual codes for these corresponding types are the same. Almost all packet identification codes are printable ASCII, but are not themselves mnemonic.

The count byte contains, as a binary number, the number of bytes in the data section of the message.

Data Field
The size of the data field depends upon the message. Many messages have zero bytes of data. At this time, the longest data field is sent from the module with the DPOWER message, whose data is actually a readable ASCII string. Up to 80 bytes are currently allocated for it.

Trailer Field
The trailer field consists of one check byte, which is the sum of all other bytes in the message, that is, all five header bytes and the data bytes, modulo 256.

3.2 NUMERIC DATA FORMAT

Each packet type description below includes a detailed description of the function and the data passed in the message. Numeric data can be represented using specific data types described in Table 1 below.

Table 1: Numeric Data Formats

Data Type	Mnemonic	Size (bytes)	Description
Character	Char/uchar	1	May be signed or unsigned, or defined as bit flags.
Integer	Int/uint	2	May be signed or unsigned. Unsigned may be defined as bit flags.
Angle	Kang	2	Used for azimuth and related angles. May be considered signed or unsigned. If unsigned, value is 65536/360 times degrees and is in the range of 0° to 360°. If considered as signed, the same binary values correspond to ±180°.
Long Integer	Long/ulong	4	May be signed or unsigned.
Floating Point	Float	4	Format corresponds to IEEE 754 for single-precision. Used for latitude and longitude.

All multibyte numbers are transmitted "little-endian," that is, less or least significant byte first. This is common to Intel and some other architectures. Host computers which require "big endian" will need to rearrange bytes in software.

3.3 PROTOCOL

With one exception, the compass acknowledges every message, either with requested data, results of an operation, or a simple echo of the command. The reply messages from the compass are prefixed with a letter "D" to each corresponding host message name. The only exception to this is the RSET command which performs a complete processor reset immediately. However, upon startup, the module outputs a DPOWER message, and this can be considered as an acknowledgement of a RSET.

If there is any error in the form of a packet received by the module, or if the packet ID code is not supported, the module will ignore the message altogether. It is up to the host to re-request data for which it does not receive a response because of an error.

The compass may send some unsolicited messages to the host. Examples are DORIENT and DMCAL. There is no provision to resend any of these packets which may be lost.

3.4 MESSAGE DESCRIPTIONS

Most host-compass communication is a dialog—the host sends a command and the module replies. For this reason, most of the message descriptions below describe the host command and the module response together. The reply message names are listed with each corresponding host messages in the detail message description section.

Remember that some messages and/or replies have no data; the message type ID carries all necessary information. The length field in the headers of these messages will contain a zero, and there will be no data bytes.

Most packet (message type) ID's lie in the range 0x40 through 0x7d. These are all printable ASCII, and will not be confused with the first three characters in the header. Packets from the host are usually commands or requests; those from the compass are responses to those requests. The ID code of the response is the same as the request. However, since the data portion of the packet is usually different, the message ID's are named differently. The compass replies have the letter 'D' prefixed to the name of the corresponding host message.

Packet ID's that are not assigned in this document should not be used. There are a few message types reserved for production and calibration, or for development, which are not described here. Although the module is designed to be safe from harm from inadvertent sending of these messages, nothing helpful can come from using them.

Since the compass is closely related to Honeywell's DRM products, many messages are common to both the compass and Dead Reckoning Modules. A major exception is the ID codes for the VRSN/DVRSN messages which have been changed for the compass to prevent confusion among support programs.

Table 2: Message List

Start/Stop Messages

Msg	ID Code	Description
RSET	0x42	Software reset of the compass. This causes the DPOWER wake-up message to be sent.
VRSN	0xC3	Request firmware version, serial number, build options, and configured orientation.
POWER	0x44	Request the wake-up message.
BAUD	0x47	Switch to a new baud rate.

Diagnostic Messages

Msg	ID Code	Description
TEST	0x48	Performs self-test.
STAT	0x49	Supplies temperature and heading.

Initialization Messages

Msg	ID Code	Description
INICAL	0x50	Initialize mounting offset.
IMVAR	0x54	Initialize magnetic variation (declination).
WMM	0x55	Control calculation of declination from World Magnetic Model
ORIENT	0x70	Sets DORIENT output rate.

Compensation Message

Msg	ID Code	Description
MCAL	0x72	Perform compass magnetic compensation.

Other Messages

Msg	ID Code	Description
SDFLT	0x66	Set start-up defaults.

Software Reset

Name: RSET/none
ID: 0x42
Request Data: None
Reply Data: Not applicable

Software reset causes a restart from the beginning of the compass firmware. It is intended primarily for development purposes. As soon as the compass determines that it has received the RSET command, it initiates a reset of the microcontroller. There can be no direct acknowledgment to this command, since all resources are re-initialized. Instead, the host should recognize the receipt of the DPOWER message, which is sent as a normal part of the power-up sequence, as an indication that the compass has reset. Because of the full reset, all power-up defaults will be restored.

Power On

Name: POWER/DPOWER
ID: 0x44
Request Data: None
Reply Data: DPOWER Wakeup Message

The compass sends the DPOWER message upon power-up, hardware or software reset, and whenever it receives a POWER request message from the host. The reply data is a readable string of ASCII characters, terminated with a null. In addition to establishing copyright rights, this message also serves as a diagnostic aid since it is easily seen on a terminal emulator. An incorrect baud rate, parity, etc., will generate garbage characters; these should be readily recognizable.

A sample wakeup message might be:

0x0d, 0x0a, "~Copyright © 2000-2002 Point Research Corp. COMPASS Vrsn. 1.00CD"

The message ends with the firmware version, both major and minor, and suffixes which indicate build options which were in effect, information which could be helpful to Honeywell for diagnosing problems.

However, do not try to process this string with software. All information in it, and then some, is also available in the DVRSN message described on page 13.

Set Baud Rate

Name: BAUD/DBAUD
ID: 0x47
Request Data: 1 byte:

Data	Type	Byte Offset	Description
Rate Code	Uchar	0	Requested baud rate. Codes are: 0 = 4,800 baud 1 = 9,600 baud 2 = 19,200 baud 3 = 38,400 baud

Reply Data: 1 byte:

Data	Type	Byte Offset	Description
Rate Code	Uchar	0	New baud rate. Codes are same as above.

A few milliseconds after sending the DBAUD acknowledgment, the compass will switch the baud rate for both sending and receiving to the new rate. Any messages being received by the module during this switch will be lost. When the host requests a baud rate change, it should send no other messages for at least 25 milliseconds after the acknowledgment has been received.

Baud rate changing has no effect on other compass operations. Dead reckoning, etc., continue uninterrupted.
If a value other than 0 through 3 is supplied, the DBAUD reply is the code for the current rate, and there is no change.
A baud rate set with the BAUD command has no effect after a reset or power-up, both of which restore the default baud rate for which the module is configured at the factory. This will be 9600 baud unless other arrangements have been made.

Self-Test

Name: TEST/DTEST
ID: 0x48
Request Data: None
Reply Data: 2 bytes:

Data	Type	Byte Offset	Description
Results	Uint	0-1	Bit flags; 0 = pass, 1 = fail: 0 (0x0001) = ROM checksum 1 (0x0002) = RAM write/read 2 (0x0004) = temperature 3 (0x0008) = X accelerometer 4 (0x0010) = Y accelerometer 5 (0x0020) = Z accelerometer 6 (0x0040) = X magnetometer 7 (0x0080) = Y magnetometer 8 (0x0100) = Z magnetometer

Unassigned bits are set to zero, so an overall value of zero indicates that all tests were passed.
Self-testing is done automatically about 150 milliseconds after power-up or a reset, and the DTEST message will be sent shortly after the DPOWER message. Subsequently, it is done in response to a TEST command. For the most part, self testing does not interfere with normal operation. However it will cause brief delays (up to 200 milliseconds) in some functions, so the test should not be commanded when navigation output is critical.

Status

Name: STAT/DSTAT
ID: 0x49
Request Data: None
Reply Data: 6 bytes:

Data	Type	Byte Offset	Description
Temperature	Int	0-1	Module temperature in deci-degrees Celsius (degrees times 10).
Heading	Kang	2-3	Current bearing, corrected for magnetic declination and body offset
Reserved	Int	4-5	Unused.

Initialize Calibrations

Name: INICAL/DINICAL
ID: 0x50
Request Data: 7 bytes:

Data	Type	Byte Offset	Description
Request	Uchar	0	Bit flags; 1 = load corresponding value: 0 (0x01) = Azimuth offset. 1 (0x02) = Roll offset. 2 (0x04) = Pitch offset.
Azimuth offset	Kang	1-2	Azimuth (mounting) offset.
Roll offset	Kang	3-4	Roll offset.
Pitch offset	Kang	5-6	Pitch offset.

INICAL can query or set mounting offset. Mounting offset (along with magnetic declination) are critical compass calibrations, and they should always be loaded whenever the module is started. As an alternative, the start-up default for mounting offset can be set. (See “Set Power-Up Defaults.”)

Azimuth offset is added to uncorrected compass bearing, as is magnetic declination. So both have the same sign sense. Specifically, if the way the module is mounted causes north to appear east of true north, mounting offset should be positive.

Set Power-Up Defaults

Name: SDFLT/DSDFLT
ID: 0x66
Request Data: 12 bytes:

Data	Type	Byte Offset	Description
Req	uint	0-1	Bit flags; 1 = change corresponding value: 0 (0x01) = magnetic declination 1 (0x02) = azimuth offset 2 (0x04) = pitch offset 3 (0x08) = roll offset 4 (0x10) = DORIENT interval
MagDecl	Kang	2-3	Magnetic Declination
Azimuth Offset	Kang	4-5	Azimuth (mounting) offset.
Pitch Offset	Kang	6-7	Pitch offset.
Roll Offset	Kang	8-9	Roll offset.
DORIENT Int	int	10-11	Milliseconds between DORIENT messages

Reply Data: 12 bytes:

Data	Type	Byte Offset	Description
Result	uint	0-1	Bit flags; 1 = corresponding value changed. Codes are same as above. (A request to change may not be honored if an illegal value is supplied. In this case, the corresponding bit will be zero.)
MagDecl	Kang	2-3	Current setting.
Azimuth Offset	Kang	4-5	Current setting
Pitch Offset	Kang	6-7	Current setting
Roll Offset	Kang	8-9	Current setting
DORIENT Int	uchar	10-11	Current setting

Default values for several functions or values are stored in the compass’s flash memory for executable code. These values are those which are in effect immediately after power-up or reset. The SDFLT command permits changing these start-up values by rewriting a portion of the processor’s flash memory.

Do not confuse the quantities in these messages with the corresponding working variables. What are affected here are start-up defaults, and these may be, and probably are, different from the actual current values in effect.

Every one of the corresponding working variables can be changed by commands issued from the host computer, and this is how they should be set as much as possible. The flash memory in which the default values are written is not intended for frequent writing, and is not intended to support a large number of writes. *Use SDFLT sparingly!*

The SDFLT command can also be used merely to read out start-up default values without actually writing to the flash memory. A quantity whose bit in the REQ field is zero will not be changed. The current value, however, will be returned in DSDFLT.

Initialize Magnetic Declination

Name: IMVAR/DIMVAR
ID: 0x54
Request Data: 3 bytes:

Data	Type	Byte Offset	Description
Request	char	0	0 = Return current variation (ignore next field) non-zero = Set current variation
Magnetic variation/ declination	Kang	1-2	Magnetic variation (declination).

Reply Data: 3 bytes:

Data	Type	Byte Offset	Description
Request	char	0	Copy of field from IMVAR.
Magnetic variation/ declination	Kang	1-2	Current variation (declination).

This command returns or sets the difference between true north and magnetic north for the user's current location. "Variation" is normal nautical terminology; "declination" is often used on land to mean the same thing. The value varies with latitude, longitude, altitude, and slowly with time (years). Magnetic declination (variation) may be obtained from a mathematical magnetic model of the earth, or from other sources such as margin information on maps.

Magnetic declination, like mounting offset, is added to the magnetic compass heading to report true azimuth. Consequently, if magnetic north is east of true north, declination is a positive quantity. This is consistent with traditional usage.

Correct magnetic declination is important to accurate magnetic compass headings, and the local declination should always be loaded at start-up. As an alternative, the start-up default for declination can be set. (See Set Power-Up Defaults, on Page 11.)

World Magnetic Model – WMM

The compass unit is supplied with a built-in World Magnetic Model (WMM) and the ability to calculate magnetic declination from it. The WMM consists of 168 spherical-harmonic Gauss coefficients relating the earth's magnetic field to latitude and longitude, and an additional 168 coefficients to estimate time variations. The model is approved by both the United States and United Kingdom Departments of Defense and is intended for use only during a five-year "epoch." In the absence of local magnetic anomalies, the WMM declination is estimated to be accurate to within ±½°.

The local WMM magnetic declination is a function of latitude, longitude, altitude, and date. These input values are specified in the WMM message. When the compass receives a WMM message, it will compute the local WMM magnetic declination and issue a DWMM message reporting the computed declination. The declination value is saved to the compass' non-volatile memory and is used by the compass as the current declination value when computing azimuth.

The current magnetic declination is displayed in the Initialization dialog box (see Figure 7). To perform the calculation, issue a WMM message. Because the calculations are extensive, the compass performs them in background mode, but the calculated declination will be posted, and reported in a DWMM message, about one-half second later.

Name: WMM/DWMM
ID: 0x55
Request Data: 15 bytes:

Data	Type	Byte Offset	Description
Day	uchar	0	Day of month [1..31]
Month	uchar	1	Month of year [1.12]
Year	uchar	2	Year – 2000
Lat	float	3-6	Latitude (degrees)
Lon	float	7-10	Longitude (degrees)
Alt	float	11-14	Altitude (meters)

The Day, Month, Year and Lat, Lon, Alt fields contain the date and position information needed by the World Magnetic Model algorithm.

Reply Data: 23 bytes:

Data	Type	Byte Offset	Description
Status	uchar	0	0 = calculation inhibited 1 = calculation completed and posted 2 = calculation in process 3 = awaiting date and/or location 4 = flash write failure
Magnetic declination	Kang	1-2	Current variation (declination).
Source	char[20]	3-22	Name of USGS file from which model was derived (null terminated)

Version

Version Name: VRSN/DVRSN
ID: 0xC3
Request Data: None
Reply Data: 12 bytes:

Data	Type	Byte Offset	Description
Major	Int	0-1	Major firmware version number
Minor	Int	2-3	Minor firmware version number
Options	uint	4-5	Firmware builds options as individual bit flags. Contact Honeywell for details.
Serial Number	ulong	6-9	This unit's serial number.

Up Orientation	char	10	Specifies board direction taken as upward. Board orientations (X, Y, and Z) are marked on the boards and encoded here as: 1 = X –1 = –X 2 = Y –2 = –Y 3 = Z –3 = –Z
Forward Orientation	char	11	Direction taken as forward. Same codes as used for up orientation.

Note: For the most part, message type codes for the compass coincide with those for Honeywell's Dead Reckoning Module (DRM®), but that for VRSN/DVRSN is specifically different to prevent support software from confusing the two products.

Compass Orientation

Name: DORIENT

ID: 0x70

There is no ORIENT command. To set the rate at which DORIENT messages are sent, see ORRATE/DORRATE on page 16.

Output Data: 18 bytes:

Data	Type	Byte Offset	Description
Roll	Kang	0-1	Compass Roll
Pitch	Kang	2-3	Compass Pitch
Azimuth	Kang	4-5	Compass Azimuth
Rightward acceleration	int	6-7	Rightward acceleration
Forward acceleration	int	8-9	Forward acceleration
Upward acceleration	int	10-11	Upward acceleration
Rightward magnetometer	int	12-13	Magnetometer reading in the local-coordinates rightward direction
Forward magnetometer	int	14-15	Magnetometer reading in the local-coordinates forward direction
Upward magnetometer	int	16-17	Magnetometer reading in the local-coordinates upward direction

The DORIENT message is generated by the compass and contains orientation (roll, pitch, and azimuth) information from the compass. All quantities are corrected for their offsets, and azimuth is also corrected for magnetic declination.

Compass Magnetic Compensation

Name: MCAL/DMCAL
ID: 0x72
Request Data: 1 byte:

Data	Type	Byte Offset	Description
Request	uchar	0	0 = No Request 1 = Start compass compensation 2 = Request compass compensation status 3 = Abort compass compensation 4 = Revert to default compensation values Any other value = request status only

Reply Data: 13 bytes:

Data	Type	Byte Offset	Description
State	uchar	0	0 = Compass Compensation Off 1 = Compass Compensation Data Collection 2 = Compass Compensation Computation in Progress 3 = Compass Compensation Procedure Abort
Status Code	uchar	1	0 = No error 1 = Compass Compensation Success 2 = Compass Compensation Already Started 3 = Compass Compensation Not Started 4 = Compass Compensation Timeout 5 = Compass Compensation Computation Failure 6 = New Computed Parameters No Better 7 = Flash Write Fail
Bin 0 Data Count	uchar	2	Data Collection Count for Bin 0
Bin 1 Data Count	uchar	3	Data Collection Count for Bin 1
Bin 2 Data Count	uchar	4	Data Collection Count for Bin 2
Bin 3 Data Count	uchar	5	Data Collection Count for Bin 3
Bin 4 Data Count	uchar	6	Data Collection Count for Bin 4
Bin 5 Data Count	uchar	7	Data Collection Count for Bin 5
Bin 6 Data Count	uchar	8	Data Collection Count for Bin 6
Bin 7 Data Count	uchar	9	Data Collection Count for Bin 7
Computation Completion Count	uchar	10	Progress of Compensation Computation. 0 – 100.
Quality	int	11-12	Numeric Quality of Compass Compensation

The DMCAL message is generated by the compass in response to a MCAL message, whenever a data or computation count changes, when compensation completes, or in response to an error during the compass magnetic compensation procedure.

DORIENT Message Rate

Name: ORRATE/DORRATE
ID: 0x7F

Request Data: 2 bytes:

Data	Type	Byte Offset	Description
DORIENT interval	int	0-1	Milliseconds between DORIENT messages. If necessary, the module will round this to the nearest multiple of five. A value of zero disables DORIENT messages; a value of –1 causes the DORRATE message to return the current value without changing it.

Reply Data: 2 bytes:

Data	Type	Byte Offset	Description
DORIENT interval	int	0-1	Current value for milliseconds between DORIENT messages. Zero signifies none.

4.0 TEST SOFTWARE

4.1 TEST SOFTWARE DESCRIPTION

Host computer test software is provided in the Engineering Demonstration Kit that will permit a thorough evaluation and demonstration of the compass capabilities. CompassHost is a 32-bit Windows test program. It is capable of sending and receiving all messages described in this manual except the BAUD message. It can display all messages received from the module in the main window with scrolling text. It has a small window summarizing the current status of the module and a graphic display of the current compass heading, roll, and pitch.

CompassHost can be run under Windows 9x, ME, NT 4.0, 2000 or their successors. One available serial port is required for communicating with the compass. Processor, memory, and disk space requirements are minimal.

4.2 INSTALLATION

CompassHost is supplied as a single file, CompassHost.exe and a folder of ActiveX control files. Apart from the standard Windows services already present, it uses no DLL, and, although it will create a registry entry when running, does not require any such entries in advance. A Setup.bat file simplifies the installation process to install the ActiveX control and register it on the computer for future use. The ActiveX control files are necessary to data display which shows the graphical roll, pitch, and compass heading in real time. A Readme.txt file is also included to describe this installation process.

When the ActiveX controls have been installed, CompassHost can be run directly from the floppy disk, but you will probably want to copy it to a suitable directory on your hard disk, and you will probably want to create a shortcut for it. These are standard Windows operations. When creating a shortcut, you may want to pay attention to the “Start in:” text box on the “Shortcut” tab of the properties page. This specifies the current directory when CompassHost executes, and, when opening a log file, CompassHost displays the file dialog with the current directory as the default. You can control this default through shortcut properties.

4.3 DISPLAY OVERVIEW

CompassHost’s main window provides a scrolling list of messages from the module. Selecting an icon in the toolbar will cause a small window to pop up, called the Nav Console, with the graphical representation of the compass information, including a compass rose display of heading as well as roll and pitch in terms of (positive and negative) degrees. You can hide the small window by pushing the same button again.

The start-up display is the message list, as shown in Figure 4. The module’s serial number appears in the window title bar at the top. If it says “Serial number unknown” try issuing the “Serial No” command under the Compass menu. Immediately below the title bar is the usual menu bar, and immediately below that is a row of toolbar buttons. At the bottom of the window is a status bar with four panes. The leftmost contains context-sensitive help which describes the action of the toolbar button or menu item positioned under the cursor. To its right is the name of the data logging file currently open (if any). To the right of that is the module’s firmware version and other information returned in the DVRSN message. (See message details for Version, page 13.) Finally, the serial COM port currently active is shown at the lower right corner. Both the toolbar and the status bar can be hidden if desired.

The column on the left is the message type and corresponds to the mnemonics used in section 3.4, Message Descriptions, starting on page 7. Following the mnemonic is most or (usually) all of the data from the message, interpreted and formatted specifically for it.

4.4 STARTING UP

If a serial COM port was open the last time CompassHost terminated, it will attempt to reopen the same port upon startup. If this isn't possible, the "open COM port" dialog will come up automatically. This dialog can be brought up at any time to close the port or change to another one.

CompassHost adjusts its behavior based on the module's firmware version and build options, so it will send a VRSN request automatically whenever a COM port is opened or whenever a DPOWER message is received, implying module reset or power up. Depending on when the compass is powered on or connected to the corresponding serial port, the automatic requests may fail. If so, the window title bar will state "Serial number unknown," and the status bar will show "No version information available." Or perhaps you have connected a different module, and the old module's information persists. In either case, you should issue a "Serial No" request from the "Compass" menu. This sends a VRSN command, enforcing the module's reply with a timeout.

4.5 REQUESTS AND COMMANDS

This section describes the actions available from the menu bar. In some cases, they are also available through a button on the toolbar, and that button is shown with the description.

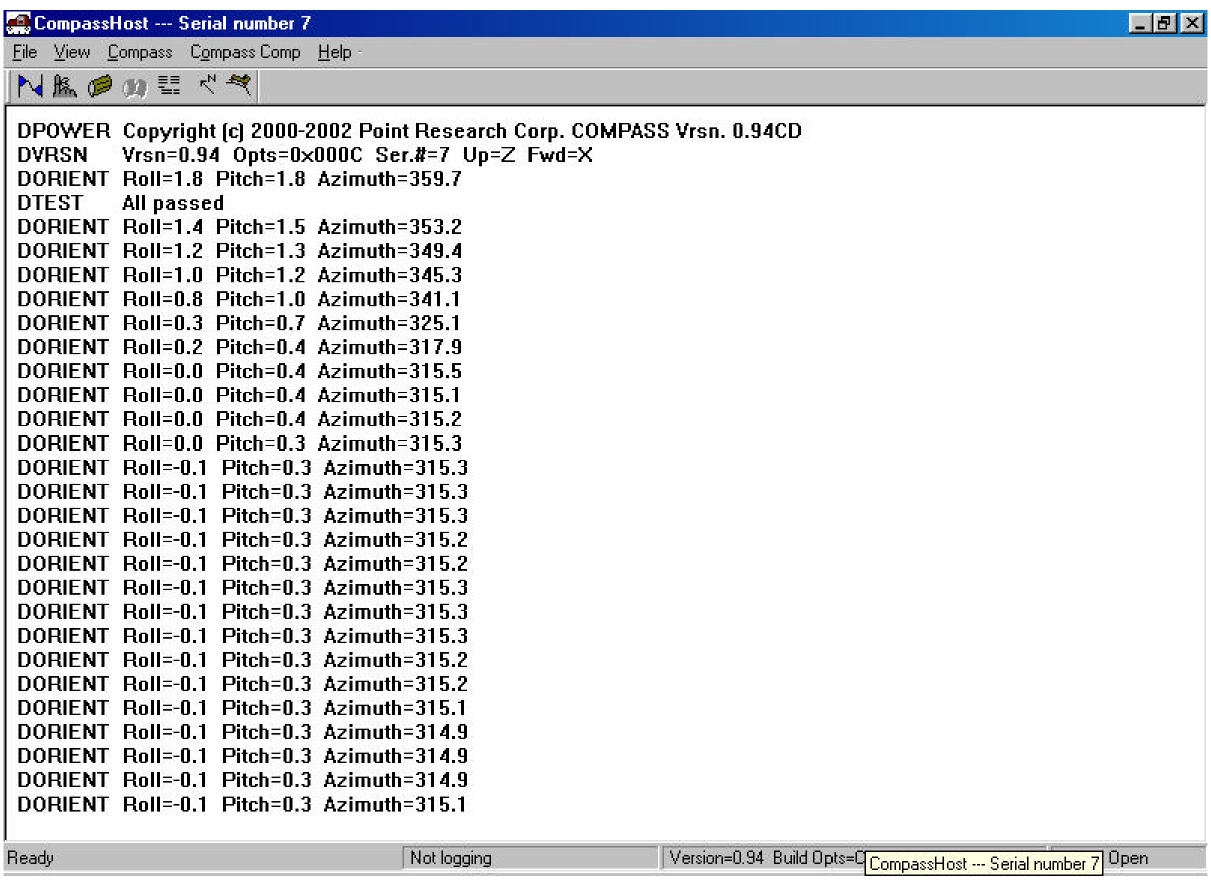
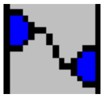


Figure 4: CompassHost Main Window Display

4.5.1 File Menu

COM Port

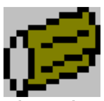


An open COM port dialog will appear, showing the current status of the input to CompassHost and listing all available COM ports in the range of COM1 through COM8. Select an available port and “open” (or you can double-click the port). If a port is currently open, you can choose “close” if needed. Exit with “quit.” If no port is open, most of CompassHost’s services are unavailable.

Log File

The dating logging facility can be used to store test data for later analysis and plotting. If a log file is open, CompassHost gathers information from several messages to create a set of data in the form of an ASCII file readily imported into spreadsheet programs, such as Excel. For more information, see Data Logging, on page 23.

Open

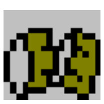


Opens a log file. By default, the directory is the current directory. The shortcut used to launch CompassHost can set the directory, and only existing files with the name Compass*.dta are shown. A default file name is created of the format Compass<module’s serial number>.dta. The “Files of type:” dropdown can be used to show all existing files. If you attempt to open an existing, non-empty file, you will be asked whether you want to overwrite it or append to it.

Close

Closes an open logging file.

Bump



If a log file is open, this command will close it and attempt to open a new file with an incremented name but with the same extension in the same directory. If a file with the new name already exists, a file open dialog box will come up. Otherwise, the new file is opened, and logging proceeds.

Exit

Terminates CompassHost.

4.5.2 View Menu

Toolbar

Toggles the visibility of the toolbar.

Status Bar

Toggles the visibility of the status bar.

Status View

Toggles a special child window on top of the main display. This view maintains a summary of current information taken from DORIENT and DRMC messages as illustrated in Figure 5.

Nav Console

Figure 5: Status View Window

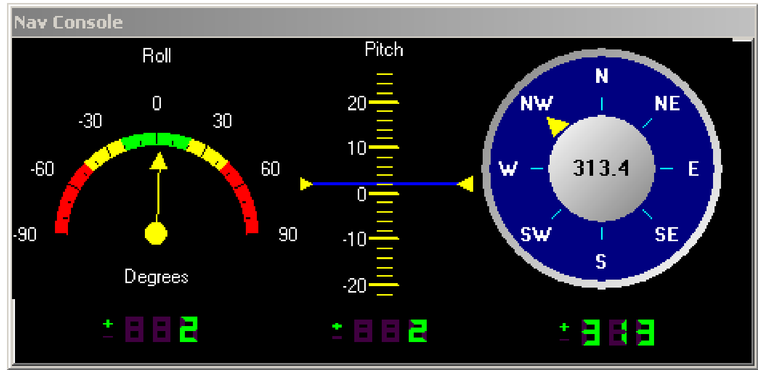


Figure 6: Nav Console Window

Toggles the Nav Console display window on and off. The display shows the data output from the compass in real time, as shown in Figure 6. By default, this window is displayed in the upper right corner of the track display, but it may be moved as well as hidden.

Font

By default, text in displays is shown with the system font, but you can specify any font installed on your machine with this command, in sizes from 8 through 20 points. Changing to a smaller size can fit more information on the screen. In particular, the main display (Figure 4) saves and can display up to the 50 most recent messages from the module. You cannot change the size of the default system font since it is not scalable.

4.5.3 Compass Menu

Serial Number

Issues a VRSN command to the module, with a timeout. You will be notified if there is no response. This menu item is checked if a version has been received, but it can be issued at any time if, for example, a different module is connected.

It is important that CompassHost have the serial number and related data for the module currently connected. Several of the program's features are enabled or disabled based on this information. If the automatic inquiry fails, you should issue this command explicitly when the compass has been powered up and connected.

Initialize

Several quantities should be supplied to the compass upon startup, and these are gathered together into this multi-purpose dialog, shown in Figure 7. The quantities are controlled by three messages, and this command solicits current values from the module for all of them before the dialog is displayed. Initializations will be overwritten by the startup defaults for these parameters that are stored in non-volatile memory.

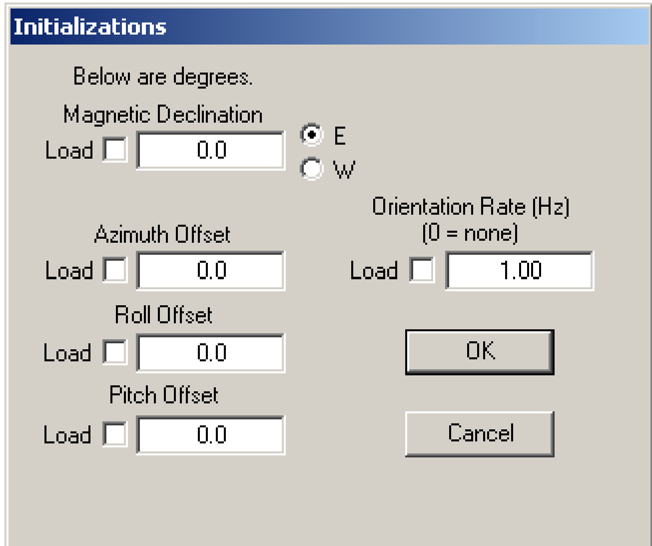


Figure 7: Initialization Dialog Box

4.6 MAGNETIC DECLINATION AND AZIMUTH OFFSET

Magnetic declination (also known as magnetic variation), is the angle between true north and magnetic north and is a function of location and, to lesser extents, date and altitude. Azimuth offset is defined as the horizontal angle between the forward axis of the module and the reference axis of the platform on which it is mounted. Azimuth offset is a constant that is a function of the mechanical mounting and installation of the compass. Both declination and offset angles directly affect azimuth accuracy, and the compass applies both corrections by adding them to the raw magnetic azimuth measurement. Both angles are provided as separate quantities to permit keeping track of them individually, even though their effect is simply additive. The sign convention used for both angles is positive for east. For example, if magnetic north is east of true north, the declination is positive.

If you don't know the magnetic declination for your current location, you can ask the compass to calculate it using the World Magnetic Model. See 4.12 Magnetic Declination, on page 21.

4.7 ROLL AND PITCH OFFSET

Roll and pitch offsets are defined as the angle between the horizontal plane of the module and the reference plane that is nominally "level" when the platform is stationary. It is a function of how the module is mounted with respect to the platform. For both angles, they can be either positive or negative. A positive roll offset means the left side of the module is lower than the reference plan. A positive pitch offset means the front side of the module is lower than the reference plan. The numbers in the boxes will be added to the final roll and pitch values calculated from the compass.

4.8 ORIENTATION RATE

The output rate of the orientation data provided by the compass may be set by the user from less than 0.1 Hz to 50 Hz. The specified frequency must have a period that is a multiple of five milliseconds. For this reason, the frequency you enter may be adjusted to the nearest integer value and will be shown.

4.9 RESET MODULE

The Reset command is equivalent to cycling the compass power, and will cause the power-up message to be displayed. The RSET command sent to the module is described on page 8). Also, serial number and version information stored in the CompassHost program will be reset. The module should respond with a DPOWER, which will cause CompassHost to solicit version information again.

4.10 SELF TEST

The TEST command (see page 10) is sent to the module. The reply will be displayed in the main display scrolling text. See the description of the command for details.

4.11 START-UP DEFAULTS

This brings up a dialog box almost identical to that for initializations (see Figure 7 above). The quantities in this box correspond to those in the initialization dialog but with one crucial difference: Power-up defaults are the values in effect immediately after power up or reset and before they have been set with normal initialization. The power up defaults is stored in the compass non-volatile memory.

There is no immediate change when using this dialog. It changes only the values which will be loaded after the next reset or power-up. Those currently in effect are not changed.

Warning: This function writes to the non-volatile memory in the compass's processor. There are a finite number of allowable write cycles specified by the chip manufacturer so please do not change power-up defaults unnecessarily.

4.12 MAGNETIC DECLINATION

The compass will calculate and apply the local magnetic declination based on its built-in World Magnetic Model. This model is provided by the U.S. Geological Survey and is endorsed by the Department of Defense. Four data items are required: latitude, longitude, altitude, and date, and these are provided through the dialog shown in Figure 8. Note that position accurate to about 1 degree is adequate.

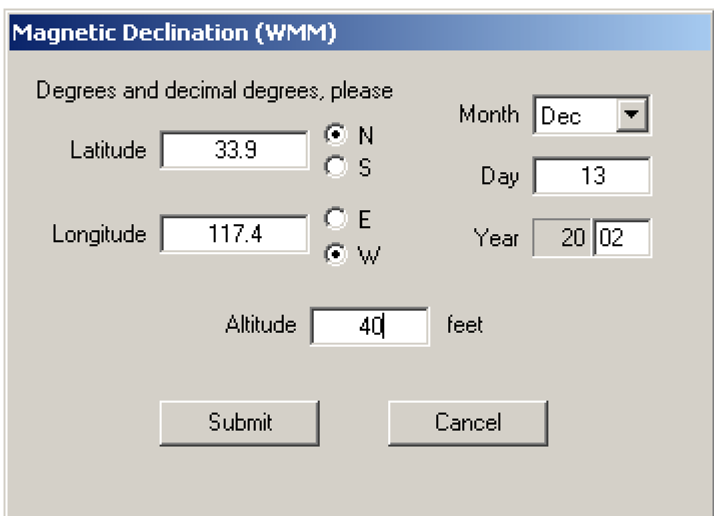


Figure 8: Magnetic Declination Dialog Box

The current date from the host computer is supplied as a default. Choosing "Submit" closes the dialog but only starts the calculation. Because the calculations are extensive, the compass performs them in its background mode. Nonetheless it should finish in less than one second. When finished, the new declination is put into effect immediately and is also loaded into flash memory as the new start-up default value.

4.13 BAUD RATE

Although the normal speed for serial communication with the compass is 9600 baud, it is possible to command the module to use a different rate. (See Set Baud Rate, on page 9.) The Compass/Baud Rate menu item leads to a drop-down menu with the possible speeds, and the speed currently used by CompassHost checked. Any of the speeds may be selected.

If, for any reason, you have a module operating at a different baud rate, this menu item can be used to set

CompassHost's rate to match.

This does not command the compass to change its baud rate. It only changes the rate used by CompassHost itself. Although the compass can be commanded to change its baud rate, CompassHost will not issue this command.

4.14 COMPASS COMPENSATION

This menu performs and controls the compass magnetic compensation process, using the MCAL/DMCAL messages. (See page 15.)

Status

An MCAL message with no action request is sent. The status returned is shown only in the main scrolling display.

Start

This choice sends an MCAL command to initiate the compass compensation process and also brings up the display of Figure 9, which shows the progress of the procedure. The purpose of the compass magnetic compensation is to determine the magnetic properties of the environment and derive factors which can be used to compensate the compass. Without this kind of correction, a magnetic compass mounted on a vehicle, for example, may produce substantial azimuth errors.

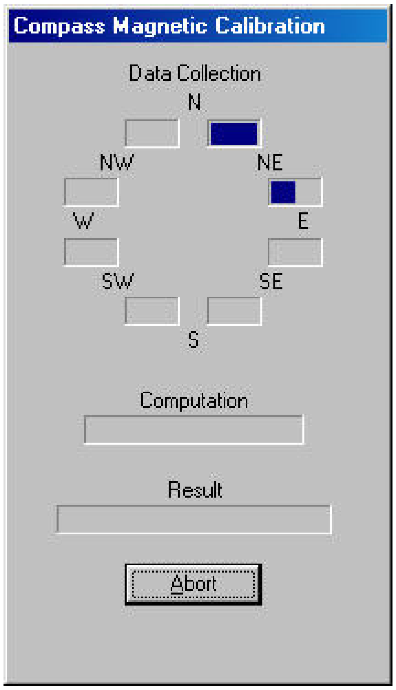


Figure 9: Compass Magnetic Compensation Process

When the compass is performing the magnetic compensation process, it sends regular DMCAL messages reporting on its progress. These are shown graphically in the display. During the first part of the procedure, the compass collects 16 data points from its sensors in each of eight azimuth sectors, and it is necessary to move it slowly in a horizontal circle while this is done. If the compass is mounted on a vehicle, it is done by driving the vehicle slowly in a small uniform circle on a level ground. The progress bars in the upper half of the display show the status of this operation. When all points have been collected in each sector, the module moves into the computation phase.

The computation may take a few minutes, during which the computation progress bar shows its status. When finished, the compass module returns a figure of merit indication which is shown below the computation progress bar in the box labeled

"Result". The lower the figure of merit the better the compass can compensate for disturbances. Results of 200-300 can be considered good. The Abort button will change to OK when the process is complete.

The rest of the compensation process is done by the compass automatically. If the results of the computation phase are satisfactory, the compass automatically loads the coefficients into its non-volatile memory and will use them for future corrections until changed. If, for any reason, it is necessary to abort the process, click on the "Abort" button. This will send the corresponding command to the compass and remove the display.

Abort

If it is necessary to abort the compass magnetic compensation process, this is normally done with the button shown in Figure 9. However, if necessary, the abort command can also be sent with this menu choice.

Revert

Sending the revert command deletes any user-performed magnetic compensation, restoring the factory values which were done without nearby magnetic disturbances when the unit was manufactured. Any successful compass magnetic compensation will overwrite a previous compensation, so normally there should be no need for the revert facility. However, it could be helpful if, for example, you remove the compass and use it in a different environment.

Help

Apart from menu and button explanations in the status bar, CompassHost has no on-line help at this time. Please refer to this manual. The help menu will display version and other information.

Data Logging

If a log file is open (see Log File, on page 18 for information as to how to do this), CompassHost will write extensive ASCII data from the module to a file. The primary source of information for logging is the DORIENT messages, supplemented by DINICAL and DIMVAR. DORIENT messages are output by the compass spontaneously.

4.15 Description of File

Data in the file is fixed field, separated by spaces only. There are no tabs, commas, or other delimiters. Each session starts with a date and time stamp and a header line to identify the columns. This header line is 103 characters as are the data lines themselves. The columns are listed below.

WinTime

Local time, hour, minute, and second as supplied by the Windows operating system.

Azim

Azimuth in degrees as determined by the compass with all corrections applied.

Pitch

Pitch attitude in degrees as determined by the compass.

Roll

Roll attitude in degrees as determined by the compass..

MOfst

Mounting offset in degrees. Although the compass treats this correction as a constant, it may be changed by command while the module is operating.

MDecl

Magnetic declination in degrees. Although the compass treats this correction as a constant, it may be changed by command while the module is operating.

5.0 ORDERING INFORMATION

Ordering Number	Product
HMR3500 HMR3500 Demo	TruePoint Compass Module PCB Only (RS232) TruePoint Compass Demonstration Kit

6.0 FIND OUT MORE

For more information on Honeywell's Magnetic Sensors visit us online at www.magneticsensors.com or contact us at 800-323-8295 (763-954-2474 internationally).

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