



The Inline Compass Module includes a magnetometer and 3-axis accelerometer used to add heading and tilt/acceleration data to RS-232 data streams from serial devices such as ultrasonic wind sensors.

### General Operation

The ICM records compass data, accelerometer data and bytes received from the instrument serial port during a measurement period. At the end of each measurement period the collected data is sent to the control port and a new measurement period is started automatically.

There several settings offering different ways to terminate measurement periods. Refer to the ICM Measurement Period Settings and ICM Applications sections for details.

### Power Connection

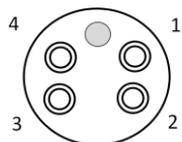
The ICM operates from 3.5VDC to 18VDC. The +VDC connection is directly wired from the control port to the instrument port. Typical power consumption is 10mA, regardless of input voltage.

### Serial Communication

The ICM control interface operates at 19200 baud, 8 bits, no parity, 1 stop bit. The BUAD command sets the instrument serial port baud rate. The ICM does not respond to data arriving from the instrument serial port. All commands must be sent from the control port.



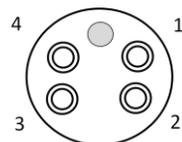
Instrument Port (top)



Male Face View  
 MCBH 4M

Signal	PCB Pin	Wire Color	MCBH4 Pin
GND	1	Black	1
+VDC	2	Green	4
Receive In	3	Red	3
Transmit Out	4	White	2

Control Port (bottom)



Male Face View  
 MCBH 4M

Signal	PCB Pin	Wire Color	MCBH4 Pin
GND	1	Black	1
+VDC	2	Green	4
Receive In	3	White	2
Transmit Out	4	Red	3



## Low Power (sleep) Mode

Power (VDC) remains connected through the ICM to the instrument port in low power mode.

After a hard power-down, a PWROFF command or a timeout, the ICM will be in low power mode. The ICM wakes from sleep within a few milliseconds after receiving a character on the control serial port.

Wakeup is signaled with:

```
PWRUP  
S9>
```

The ICM starts sampling and recording data from the instrument port automatically on wakeup.

## ICM Measurement Period Settings

### **TERM**

TERM is number from 0 to 255 representing a serial byte (typically an ASCII character). Then the ICM receives this byte from the instrument it ends the current measurement period, outputs the measurement and instrument data and starts a new measurement period. This does not affect the TIMEOUT counter. Set TERM to 0 to disable this function and have no termination character.

### **MAXLEN**

When more than MAXLEN bytes are received from the instrument in a measurement period the ICM ends the current measurement period early, outputs the measurement and instrument data and starts a new measurement period. This does not affect the TIMEOUT counter. The maximum value of MAXLEN is 2048.

### **MAXTIME**

This is the maximum length of a measurement period in seconds. When a measurement period lasts longer than MAXTIME seconds the ICM ends the measurement period, outputs the measurement and instrument data and starts a new measurement period. This does not affect the TIMEOUT counter.

### **TIMEOUT**

When the ICM has been active for more than TIMEOUT seconds (10 to 3600) it automatically returns to low power mode. Set TIMEOUT to 3601 to disable this feature.

## ICM Applications

Below are a few ways to use the ICM. These are not special operating modes, but are ways to use the available settings to achieve specific simple goals.



## Timed logging with no timeout

The ICM buffers data received from the connected instrument (if there is one) and every 30 seconds (MAXTIME setting) outputs both compass and acceleration data and any bytes received from the instrument during that measurement period.

Setting	Value
TERM	0 (no term char)
MAXLEN	2048 (maximum)
MAXTIME	30 (seconds)
TIMEOUT	3601 (disables timeout)

## Timed Logging with 5 Minute Timeout

The ICM buffers data received from the connected instrument (if there is one) and every 30 seconds (MAXTIME setting) outputs both compass and acceleration data and any bytes received from the instrument during that measurement period. After 300 seconds (5 minutes, TIMEOUT setting) the ICM automatically switches to low power mode and stops sampling.

Setting	Value
TERM	0 (no term char)
MAXLEN	2048 (maximum)
MAXTIME	30 (seconds)
TIMEOUT	300 (seconds)

## Instrument Data Append

The ICM buffers data received from the connected instrument until a carriage return (CR, hex 0D) is received from the instrument. After each CR character the ICM ends the current measurement period, outputs measurements and bytes received from the instrument and starts a new measurement period.

Setting	Value
TERM	13 (CR)
MAXLEN	2048 (maximum)
MAXTIME	120 (seconds)
TIMEOUT	3601 (disables timeout)

## Data Format

The standard XML data format replaces characters now allowed in XML with their standard entities. For example the > character is replaced with the string "&gt;". This feature is enabled when the FORMAT setting is 1. Set FORMAT to 2 to disable these character replacements.

At the end of each measurement period the ICM outputs a string like this:



```

<creport v='1' t='60'>
<S9CD v='1'>27.81,29.73,743,1.06,92.09,91.66,18.24,50,240</S9CD>
<S9CRD v='1'>624.58, 390.53, 288.14, -32.78, 1788.63, -46.83, 31.67, 240</S9CRD>
<PORT1>Data received from serial port goes here
</PORT1>
</creport>

```

S9CD is the processed data string.

S9CRD is the raw data string. We recommend recording the raw data whenever possible.

### Data in S9CD String

PSI, INC, MAG, THETA, PHI, TILT, TEMP, RATE, NS

Parameter	Units	
PSI	Degrees	Compass heading (rotation around z axis)
INC	Degrees	The angle of the magnetic vector from the XY plane
MAG	Gauss	Magnitude of the magnetic vector
THETA	Degrees	Rotation around y axis
PHI	Degrees	Rotation around x axis
TILT	Degrees	The angle of the acceleration vector from the XY plane
TEMP	Deg. C	Approximate sensor temperature
RATE	Hz	Sensor sample rate
NS		Number of samples in current sample period. The number of seconds in the sample period = NS/RATE

### Data in S9CRD String

MX, MY, MZ, AX, AY, AZ, RT, MCX, MCY, MCZ, MMAGR, MMAGC, MCTHETA, MCPHI, AMAG, ATHETA, APHI, TCPHI, TCTHETA, TCPSI

Parameter	Units	
MX	gauss	magnetometer x value
MY	gauss	magnetometer y value
MZ	gauss	magnetometer z value
AX	(g)	accelerometer x value
AY	(g)	accelerometer y value
AZ	(g)	accelerometer z value
RT		temperature reading
RATE	Hz	Sensor sample rate
NS		Number of samples in current sample period. The number of seconds in the sample period = NS/RATE

## Logging Mode

Logging mode allows limited internal data recording. S9 uses this mode to stamp high-speed data from wind sensors with compass and accelerometer data for calculation of true vector averages. Set MODE=1



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to enable logging mode. Use READ R to retrieve the recorded data. The ICM hardware is capable of computing vector averages in-situ, but requires custom firmware to match the wind sensor.

## ICM Commands

The ICM accepts a variety of commands suitable for use with an embedded controller or terminal program. Commands are terminated with a CR (hex 0D), the enter key on most terminal programs. When a command has a parameter it may be separated from the command by a space or '='. When commands have multiple parameters they may be separated by a space or a comma.

For example:

RATE 4

Is the same as

RATE=4

Either will set the RATE value.

### General Commands

Command	Parameters	Description
PWROFF SLEEP		Places the ICA in low-power mode (inactive).
START		Starts compass and accelerometer measurements and instrument serial port monitoring (default is started when ICM wakes from low-power mode)
STOP		Stops compass and accelerometer measurements and instrument serial port monitoring.
GETEC		displays the ICM event counter. Event counters are an important firmware debugging tool.
VER		Displays the ICM firmware version and build date
RESET		Resets the CPU in the ICA.
CONFIRM		Confirms version and checksums of firmware file in memory (prior to programming)
PROGRAM		Updates device firmware with file loaded to memory. (always confirm first). The firmware update takes only a few seconds. After the firmware update the device will be reset, so press enter a few times until you see a S> prompt.
GETCD		Displays all ICM settings
SETDEFAULTS		Sets all control parameters to their default values
BAUD		Sets the baud rate for the instrument serial port
WRITE F		Writes to the 'f' file (this is used in field firmware updates)
READ F		Read the 'f' file
READ R		Read the 'R' file – this is data recorded when MODE=1
RUN F		Executes the contents of the 'f' file as a script. (this is used in field firmware updates)
DUMPFLASH		Outputs the entire contents of the flash memory chip to the serial port. This is a data recovery/debugging command. NOTE: this



		command may take ten minutes or more to complete!
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### Configuration Commands

Command	Default	Min val	Max val	
RATE	4	1	50	Compass and Accelerometer sample rate in Hz.
ASCALE	3	0	500	2,4,6,8,16 g
MSCALE	0	0	500	2,4,8,12 gauss
ACX	0	-500	500	Accelerometer x axis calibration offset
ACY	0	-500	500	Accelerometer y axis calibration offset
ACZ	0	-500	500	Accelerometer z axis calibration offset
BCX	0	-500	500	Compass x axis hard iron calibration offset
BCY	0	-500	500	Compass y axis hard iron calibration offset
BCZ	0	-500	500	Compass z axis hard iron calibration offset
TERM	13	0	255	Termination character from instrument serial port. ICM generates trigger when this character is received. 0 means no termination character.
MAXLEN	128	16	2048	Maximum number of bytes from instrument serial port before trigger
MAXTIME	60	1	600	Maximum time between triggers (in seconds)
FORMAT	1	1	2	1 is XML, 2 is simple
RAWDATA	1	0	1	1 enables raw data output, 0 disables
TIMEOUT	120	10	3601	Maximum time before returning to low-power mode (in seconds). 3601 means no timeout.
MODE	0	0	1	Sets standard mode (0) or logging mode(1)



## ACM (Accelerator/Compass Module) commands

Command	Description
ACM START ACM ON	Starts accelerometer and compass measurements (default is started on power-up or wake-up from low power mode)
ACM STOP ACM OFF	Stops the accelerometer and compass measurements
ACM RESET	Resets the accelerometer / magnetometer acquisition chip
ACM MON	Starts a monitor mode which outputs data once per second. The accelerometer and compass are sampled at the rate shown in GETCD. The data output is the average of those samples over one second. ACMD0:353.2,68.4,365,4.3,97.6,97.6,18.1 Press escape to exit this mode
ACM RMON	Starts a monitor mode which outputs raw data at the programmed sample rate (up to 20Hz).
ACM LAST	Returns the last sample measured
ACM AVERAGE	Returns the average of samples since the last reset.
ACM MAX	Returns the maximum values measured since the last reset
ACM RAVERAGE	Returns the minimum values measured since the last reset
ACM RMIN	Returns the maximum raw values measured since the last reset
ACM RMAX	Returns the minimum raw values measured since the last reset

## GETCD Response

```
<Config type='Compass' mid='05N' v='0'>
<Hardware>
  <Assembly></Assembly>
  <Firmware>Compass V0.6</Firmware>
</Hardware>
<Settings>
  baud=19200
  rate=50
  ascale=3
  mscale=0
  acx=0
  acy=0
  acz=0
  bcx=0
  bcy=0
  bcz=0
  term=13
  maxLen=128
  maxTime=30
  format=1
  rawData=1
  timeout=3601
</Settings></Config>
```



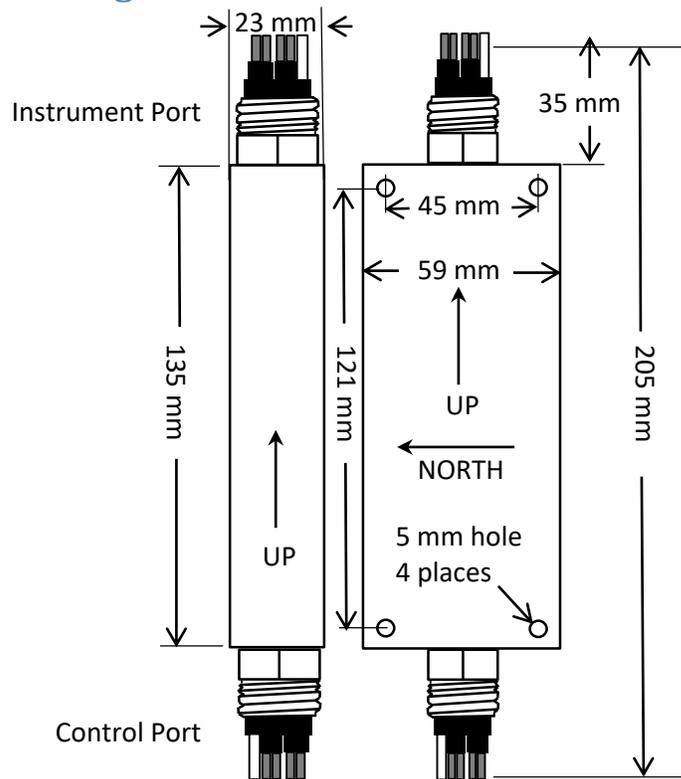
## Mechanical / Installation drawing

### Housing Materials:

Plastic (PET)  
Titanium

### Weight in air:

300 g (.66 lbs.)



Backside, titanium cover



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