# SOUNDNINE INC
*Helping build successful monitoring systems*

# Inline Compass and Accelerometer

The Inline Compass and Accelerometer (ICA) adds heading and tilt/acceleration data to RS232 data streams from serial devices such as anemometers.



Male Face View
MCBH 4M

## 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.

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

## Serial Communication

The ICA control interface always operates at 19200 baud, 8 bits, no parity, 1 stop bit.  The instrument serial port baud rate is set with the BUAD command.  The ICA does not respond to data arriving from the instrument serial port – all commands must be sent from the control port

## 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.

## 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:
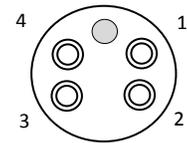
```
PWRUP
S9>
```

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 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

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 |

### 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.

### 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 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 |

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| | | |
|---|---|---|
| | | 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! |

## 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 commands

| Command | Description |
|---|---|
| ACM START<br>ACM ON | Starts accelerometer and compass measurements (default is started on power-up or wake-up from low power mode) |
| ACM STOP<br>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.<br>ACMD0:353.2,68.4,365,4.3,97.6,97.6,18.1<br>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 |

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**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>
```

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