Motion Sensing Options for MOOS Deployment at 1850 m

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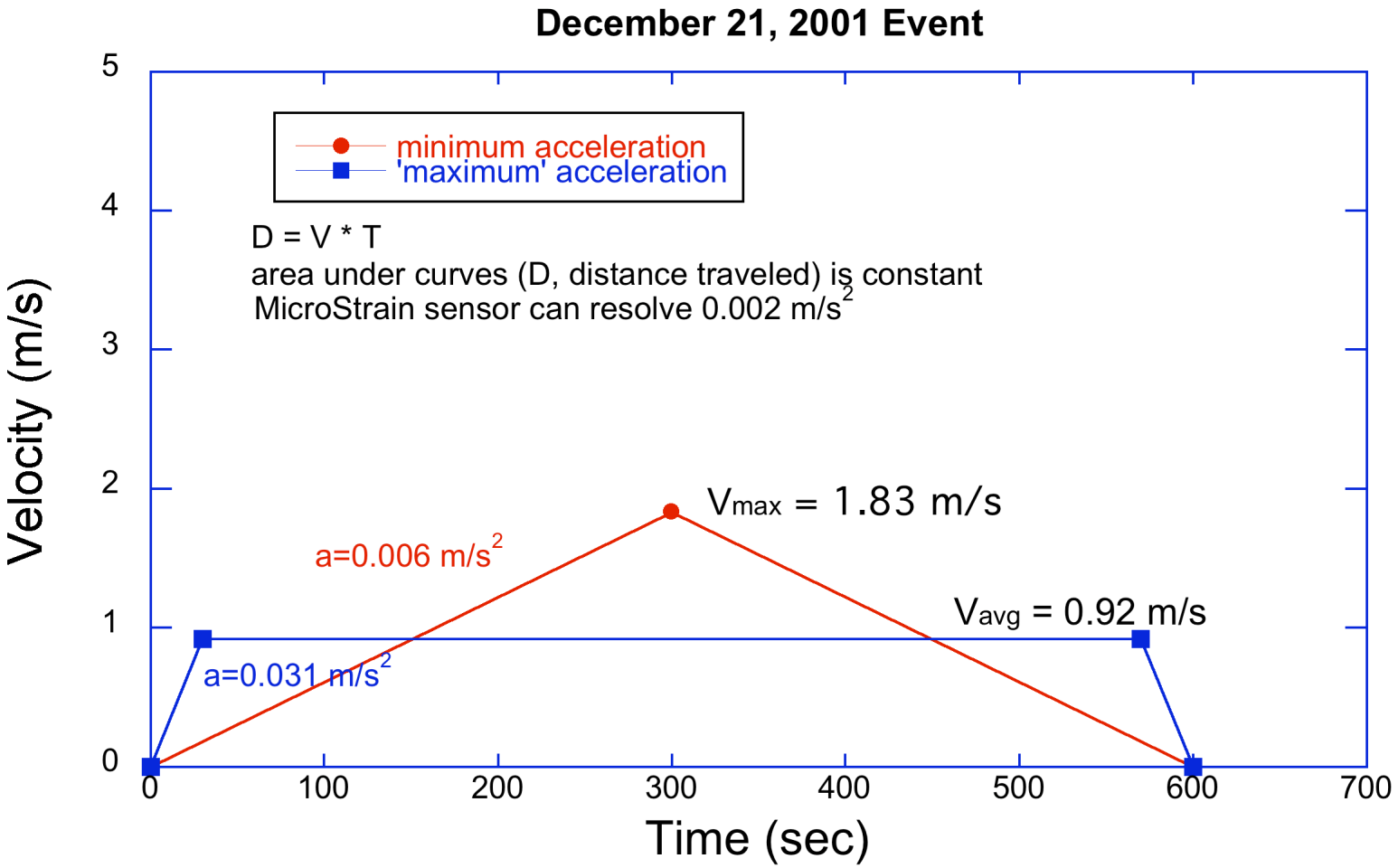
Acceleration Resolution/Interpretation



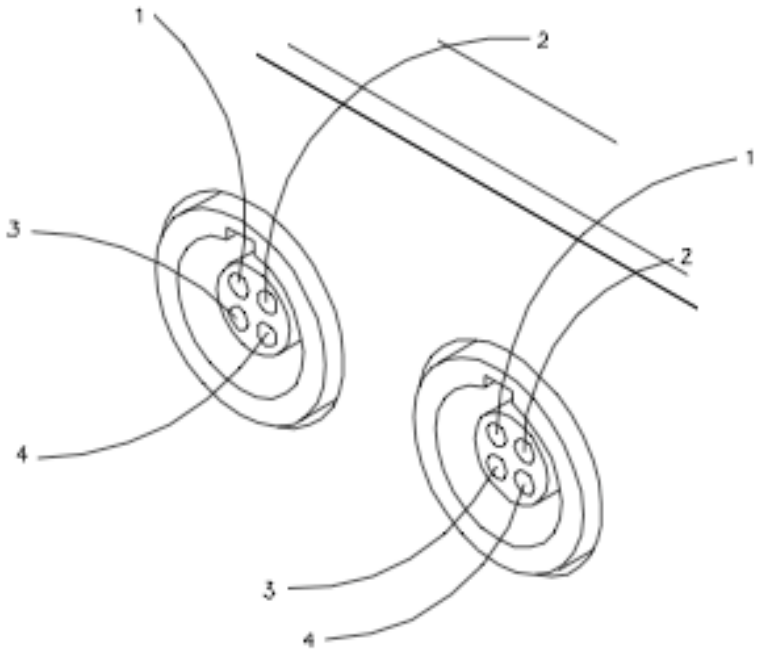
MicroStrain 3DM-GX1

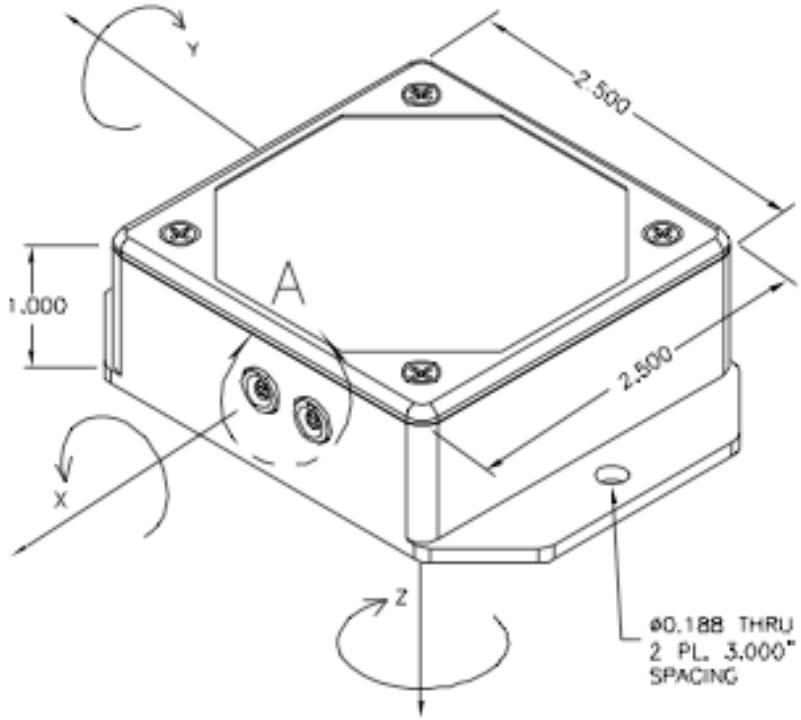
- Termed an **Orientation Sensor** by the manufacturer
- Used on MBARI AUVs
- Dynamic orientation - triaxial gyros
- Static orientation - triaxial DC accelerometers + triaxial magnetometers (relative to Earth mag field)
- Embedded μP contains programmable filter that combines static and dynamic responses
  - Fast response to vibration and quick movements
  - Eliminates drift
  - Temperature compensated
- Output is either a rotation matrix, Euler Angles, or quaternions

REVISIONS 3017-0008

ZONE	REV	DESCRIPTION	DATE	APPROVED
	A	REVISE FOR NEW CONNECTOR POSITION	7/23/02	S. MUNDELL
	B	REVISE RS485 CONNECTIONS	10/24/02	S. PENDO
	D	CHANGE AXIS OF ROTATION	1/2/03	S. MUNDELL

DETAIL A
SCALE 5:1





PIN#	RS232	RS485
1	Rxd (TO 3DM-G)	B(+)
2	Txd (FROM 3DM-G)	A(-)
3	GROUND	GROUND
4	V+	V+

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES.
TOLERANCES (UOS)
FRACTIONS: +/-1/64
DECIMALS: .XX +/-.01
.XXX +/-.005
ANGLES: +/-0.5 DEGREES
SURFACE FINISH: 63 MICROINCHES

DRAWN BY: Steven Mundell

APPROVED BY:

MicroStrain ©
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Burlington, VT
(P) 802-862-6629

TITLE

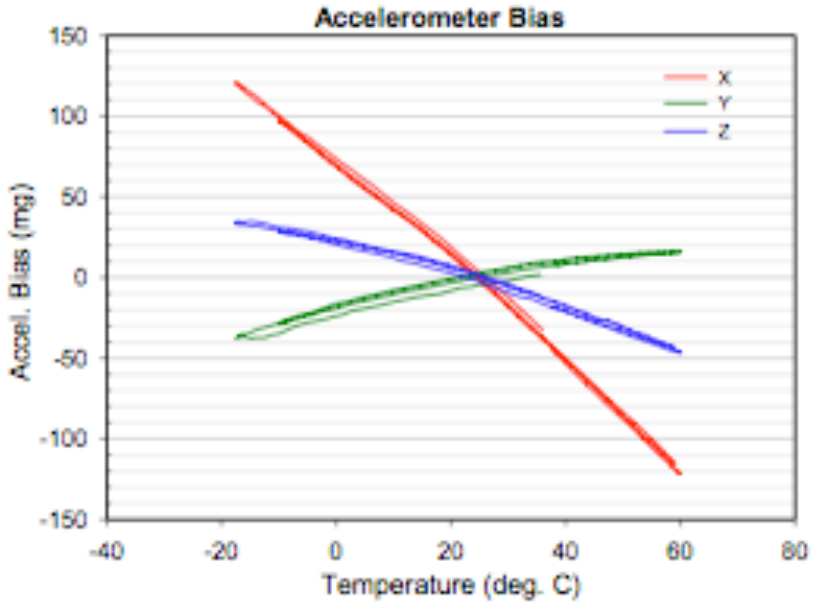
3DM-GYRO PIN OUT

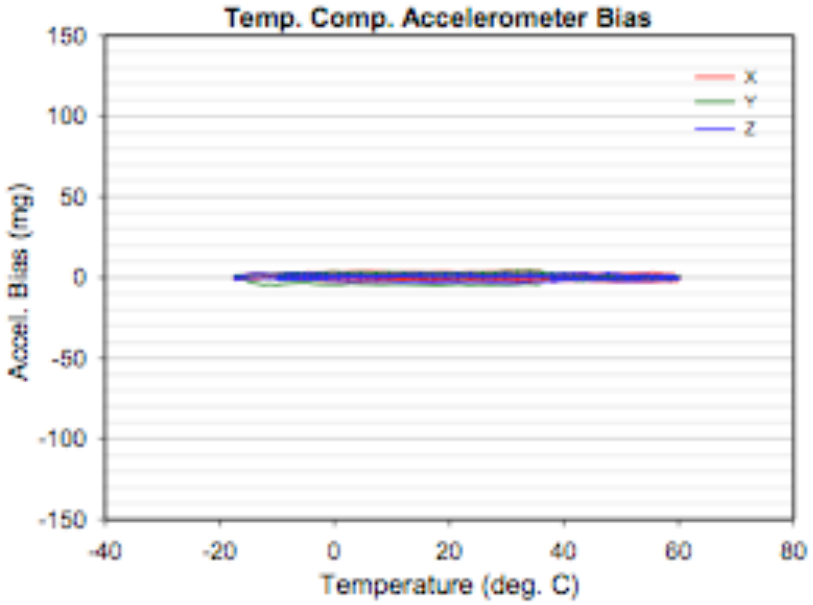
SIZE	CAGE CODE	DWG NO.	REV
A	0XYZ9	3017-0008	D

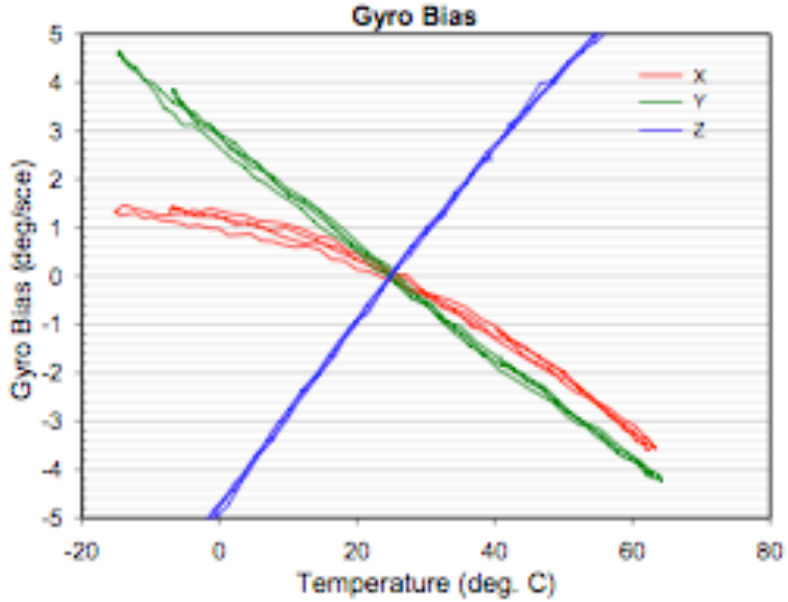
SCALE	DATE	SHEET
1:1	19 DEC, 2001	1 OF 1

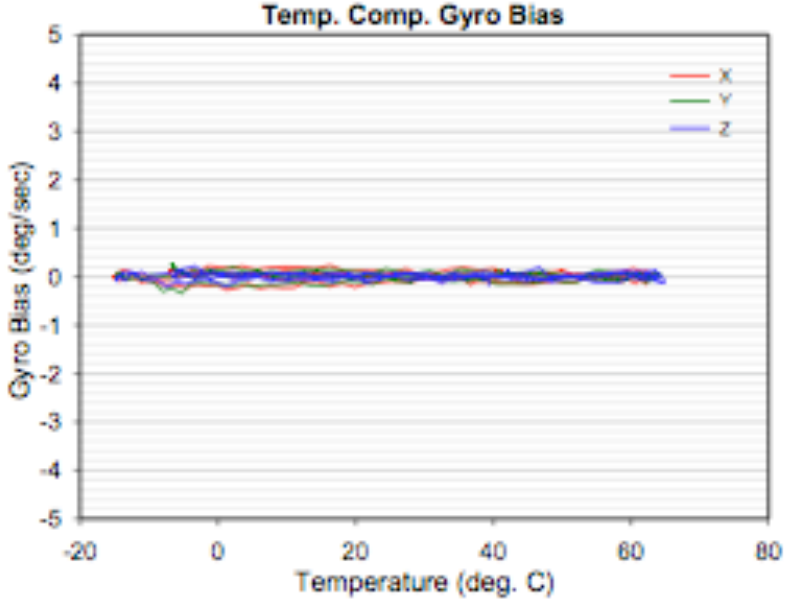
Technical Details

- Acceleration resolution - 0.002 m/s^2 (2 x 10^{-3} g)
- Digital serial output up to 100 Hz (RS-232) - but requires fiddling with timer tick interval; 3 timer ticks needed for 23 byte record; 50.86 Hz max
- Baud rate - 19.2/**38.4**/115.2 (No parity, 8, 1 stop)
- Output - rotation matrix, Euler Angles or quaternions
- 5.2 to 12 VDC
- 65 mA
- Minimum orientation resolution - 0.1°


Accelerometer Bias
Accel. Bias (mg)
Temperature (deg. C)
X
Y
Z


Temp. Comp. Accelerometer Bias
Accel. Bias (mg)
Temperature (deg. C)
X
Y
Z


Gyro Bias
Gyro Bias (deg/sce)
Temperature (deg. C)
X
Y
Z


Temp. Comp. Gyro Bias
Gyro Bias (deg/sec)
Temperature (deg. C)
X
Y
Z

Communications Commands

- Polled Mode (default) - 50.86 Hz max
  - Commands 1 byte length
  - Output depends on command byte code
  - Suggestion: Gyro-stabilized Euler Angles and Instantaneous Acceleration and drift-compensated Angular Rate Vectors (0x31) - 23 byte length record returned
  - Record is not an average; it's a single time-point measurement
- Continuous Mode (can be set in EEPROM on power-up) - 50.86 Hz max

Send Gyro-Stabilized Euler Angles & Accel & Rate Vector

Function:	The 3DM-GX1™ will transmit the gyro-stabilized Euler Angles and the Instantaneous Acceleration Vector and the drift compensated Angular Rate vector
Command Byte:	0x31
Command Data:	None
Response:	23 bytes defined as follows
Byte 1	Header byte = 0x31
Byte 2	Roll MSB
Byte 3	Roll LSB
Byte 4	Pitch MSB
Byte 5	Pitch LSB
Byte 6	Yaw MSB
Byte 7	Yaw LSB
Byte 8	Accel_X MSB
Byte 9	Accel_X LSB
Byte 10	Accel_Y MSB
Byte 11	Accel_Y LSB
Byte 12	Accel_Z MSB
Byte 13	Accel_Z LSB
Byte 14	CompAngRate_X MSB
Byte 15	CompAngRate_X LSB
Byte 16	CompAngRate_Y MSB
Byte 17	CompAngRate_Y LSB
Byte 18	CompAngRate_Z MSB
Byte 19	CompAngRate_Z LSB
Byte 20	TimerTicks MSB
Byte 21	TimerTicks LSB
Byte 22	Checksum MSB
Byte 23	Checksum LSB

Second Option

- Combination of a tiltmeter and 3 single-axis accelerometers interfaced with a Persistor CF2
- Proven use in deep sea on a hydrothermal vent field - Fabian and Villinger (2007, 2008)

Details

- Tiltmeter - Applied Geomechanics (AGI) Model 756 wide angle tilt sensor + Model 83162 signal conditioning board
  - ±8° range
  - 1.0 μrad (0.2 arc second; 5.6 x 10^{-5} deg) resolution (>3 order mag smaller than MicroStrain)
  - Reliability and long-term stability in deep-sea demonstrated
- Accelerometer - Kistler Servo K-Beam Model 8330A3
  - ~10^{-5} m/s^2 resolution (2 order mag smaller than MicroStrain)
  - Needs passive low pass filter 1 Hz corner freq; roll-off 18 dB/decade
- Persistor CF2 + AD24 Σ-Δ 24-bit A/D
  - RS-232 output

Advantages/Disadvantages of Option 2

- Advantages
  - Proven system, more or less turnkey
  - Direct measurement of tilt and acceleration
  - Higher resolution (24-bit versus 16-bit)
  - CF2 provides computation ability - averaging and statistics
- Disadvantages
  - Need to write Persistor code; SIAM interface (reuse Andy's Persistor code?)
  - More expensive
  - Needs bipolar power - +12VDC, GND, -12VDC

Issues to Resolve

- Mounting location inside MOOS pressure housing - establish orientation
- Software interface with MOOS
- Sampling rate
- Is an intermediate processor required (i.e., CF2)?

Power Budget

- MicroStrain - 0.8 W
- Option 2 - 1.3 W

One-time setup when on seafloor

- Tare Coordinate System
  - Send 0x0F 0xC1 0xC3 0xC5
  - Response 5 byte record (MOOS needs to capture this)
  - Must do this when the BIN is stationary on the seafloor; orients sensor to Earth-fixed reference system