

MicroStrain, Inc.**3DM-GX1 Analog Output Option**

Comm Spec Rev 3.1.00 and higher

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Overview

This document describes the operation of the optional analog output capability of the 3DM-GX1. These features are only available in 3DM-GX1's which have had the analog output option installed.

The analog output option provides four channels of reconstructed analog output at 12 bit resolution. The full scale is 0 to 5V referenced to the power supply common. Several different data quantities can be driven to the analog outputs. In all cases, the analog output is reconstructed from the equivalent digital values computed by the on-board microprocessor. Therefore, the analog outputs are entirely equivalent to the digital outputs. The analog outputs are not simply the raw voltage outputs of the individual sensors (accelerometers, magnetometers, and rate gyroscopes).

The analog outputs are accessed through the second connector that is installed with the analog output option. This connector is set off-center to the right of the standard digital and power connector. The user should take care to connect the analog output cable to the off-center connector, and the conventional digital and power cable to the standard center connector. Even if digital communications are not necessary, the standard cable must be used in addition to the analog output cable in order to provide power to the 3DM-GX1.

The analog output connector has four contacts, one for each of the four analog output channels. When using the MicroStrain supplied analog output cable, the conductor colors correspond to the analog output channels as shown in the following table.

Analog Output Cable Color Code

Connector Pin	Conductor Color*	Analog Output Channel
1	Green	1
2	White	2
3	Black	3
4	Red	4

*Using the MicroStrain supplied analog output cable.

The function of the analog outputs is controlled by selecting the desired the Analog Output Command. This is an integer value stored in non-volatile (EEPROM) memory location #202. A summary of the possible choices are shown below.

Analog Output Functionality Summary

Analog Output Command Value	Function
0x00 (0 decimal)	Off
0x01 (1 decimal)	Test
0x02 (2 decimal)	Instantaneous Euler Angles
0x03 (3 decimal)	Gyro-Stabilized Euler Angles
0x04 (4 decimal)	Instantaneous Quaternion
0x05 (5 decimal)	Gyro-Stabilized Quaternion
0x06 (6 decimal)	Instantaneous Acceleration
0x07 (7 decimal)	Gyro-Stabilized Acceleration
0x08 (8 decimal)	Instantaneous Magnetic Field
0x09 (9 decimal)	Gyro-Stabilized Mag. Field
0x0A (10 decimal)	Instantaneous Angular Rate
0x0B (11 decimal)	Compensated Angular Rate

The Analog Output Command can be set using the Configuration menu item in the 3DM-GX1 Data Acquisition Software shipped with every 3DM-GX1. Alternatively, the user can implement their own software which utilizes the 0x09 “Program EEPROM value” communications command to write the appropriate value to memory.

Since the analog outputs are reconstructed from digital data, the microprocessor must perform the required calculations at every time increment to compute the relevant quantities. If the analog outputs are not in use, faster calculation cycle times may be achievable by turning the analog outputs off (by writing a value of 0 to EEPROM location 202).

Digital communications can always be used normally even when the analog outputs are enabled. Doing so, however, may slow the calculation cycle rate because additional data quantities may have to be calculated. Under most conditions, this will not detrimentally affect performance.

The system defaults to a configuration which provides a full scale voltage output swing corresponding to the full scale range of the quantity it represents. Under most conditions, this will be appropriate. In some cases, however, the user may want to modify the sensitivity and/or offset of the analog output. The sensitivities and offsets are stored in EEPROM locations which can be modified by the user. In general, the output channel sensitivities are integer values which have units of (Bits/physical unit) for example, bits/G in the case of the accelerometer output sensitivity. Bits refers to the 12 bit digital to analog converter codes which range from 0 representing 0 volts to 4095 representing 5 volts.

Detailed Description of Analog Output Functionality

Off

Description:	The 3DM-GX1 will not generate any analog outputs
Analog Cmd. Byte:	0x00
Channel 1 (green)	undefined
Channel 2 (white)	undefined
Channel 3 (black)	undefined
Channel 4 (red)	undefined

Test

Description:	Constant test voltages will be output at each channel
Analog Cmd. Byte:	0x01 (1 decimal)
Channel 1 (green)	0.000 V (default): Set by value in EEPROM #204
Channel 2 (white)	1.250 V (default): Set by value in EEPROM #206
Channel 3 (black)	2.500 V (default): Set by value in EEPROM #208
Channel 4 (red)	5.000 V (default): Set by value in EEPROM #210

This function generates constant test voltages on each output channel. It can be used for testing and calibration purposes. By default, the voltages tabulated above will be generated. These values can be modified by the user by adjusting the numerical values stored in EEPROM locations 204 through 210. These values have units of output bits. A value of 0 will cause a voltage of 0.000V to be generated, while a value of 4095 will cause a voltage of 5.000V to be generated.

Instantaneous Euler Angles

Description:	This function will output the Instantaneous Euler Angles
Analog Cmd. Byte:	0x02 (2 decimal)
Channel 1 (green)	Roll
Channel 2 (white)	Pitch
Channel 3 (black)	Yaw
Channel 4 (red)	Midscale Reference (2.500V)

This function will generate analog outputs equivalent to the Digital Instantaneous Euler Angle quantities. By default, an output of 2.500V represents 0 degrees, and the output sensitivity is 2.500V/180degrees of rotation.

The Midscale Reference is a constant voltage output normally maintained at 2.500V. If the Roll, Pitch and Yaw outputs are referenced to this voltage (rather than the power supply ground), then the differential outputs will provide 0V at 0 degrees, +2.500V at +180degrees, and -2.500V at -180degrees.

Under most conditions, the default offset and scale factor will be appropriate. If other output characteristics are desired, these may be changed. The scale factor is stored in EEPROM location 218, and has units of (output bits/360 degrees). The default value is 4096. The Offset is stored in EEPROM location 222, and has units of output bits. Its default value is 2048. Changing the offset will also change the output of channel 4 (Midscale Reference).

Gyro-Stabilized Euler Angles

Description:	This function will output the Gyro-Stabilized Euler Angles
Analog Cmd. Byte:	0x03 (3 decimal)
Channel 1 (green)	StabRoll
Channel 2 (white)	StabPitch
Channel 3 (black)	StabYaw
Channel 4 (red)	Midscale Reference (2.500V)

This function will generate analog outputs equivalent to the Digital Gyro-Stabilized Euler Angle quantities. By default, an output of 2.500V represents 0 degrees, and the output sensitivity is 2.500V/180degrees of rotation.

The Midscale Reference is a constant voltage output maintained at 2.500V. If the Roll, Pitch and Yaw outputs are referenced to this voltage (rather than the power supply ground), then the differential outputs will provide 0V at 0 degrees, +2.500V at +180degrees, and -2.500V at -180degrees.

Under most conditions, the default offset and scale factor will be appropriate. If other output characteristics are desired, these may be changed. The scale factor is stored in EEPROM location 218, and has units of (output bits/360 degrees). The default value is 4096. The Offset is stored in EEPROM location 222, and has units of output bits. Its default value is 2048. Changing the offset will also change the output of channel 4 (Midscale Reference).

Instantaneous Quaternion

Description:	This function will output the Instantaneous Quaternions
Analog Cmd. Byte:	0x04 (4 decimal)
Channel 1 (green)	Q_0
Channel 2 (white)	Q_1
Channel 3 (black)	Q_2
Channel 4 (red)	Q_3

This function will generate analog outputs equivalent to the Digital Instantaneous quaternions. By default, an output of 0.000V represents -1, 2.500V represents 0, and 5.000V represents +1.

Under most conditions, the default offset and scale factor will be appropriate. If other output characteristics are desired, the user may change them. The scale factor is stored in EEPROM location 220, and has units of (output bits/1). The default value is 2048. The Offset is stored in EEPROM location 222, and has units of output bits. Its default value is 2048.

Gyro-Stabilized Quaternion

Description:	This function will output the Gyro-Stabilized Quaternions
Analog Cmd. Byte:	0x05 (5 decimal)
Channel 1 (green)	StabQ_0
Channel 2 (white)	StabQ_1
Channel 3 (black)	StabQ_2
Channel 4 (red)	StabQ_3

This function will generate analog outputs equivalent to the Digital Gyro-stabilized quaternions. By default, an output of 0.000V represents -1, 2.500V represents 0, and 5.000V represents +1.

Under most conditions, the default offset and scale factor will be appropriate. If other output characteristics are desired, the user may change them. The scale factor is stored in EEPROM location 220, and has units of (output bits/1). The default value is 2048. The Offset is stored in EEPROM location 222, and has units of output bits. Its default value is 2048.

Instantaneous Acceleration

Description:	This function will output the instantaneous Acceleration
Analog Cmd. Byte:	0x06 (6 decimal)
Channel 1 (green)	Accel_X
Channel 2 (white)	Accel_Y
Channel 3 (black)	Accel_Z
Channel 4 (red)	Midscale Reference (2.500V)

This function will generate analog outputs equivalent to the Digital Instantaneous Acceleration Vector. By default, an output of 2.500 represents 0G, and the output sensitivity is 1.25V/G.

The Midscale Reference is a constant voltage output normally maintained at 1.250V. If the Accel outputs are referenced to this voltage (rather than the power supply ground), then the differential outputs will provide 0V at 0G, +2.500V at +2G, and -2.500V at -2G.

Under most conditions, the default offset and scale factor will be appropriate. If other output characteristics are desired, these may be changed. The scale factor is stored in EEPROM location 212, and has units of (output bits/G). The default value is 1024. The Offset is stored in EEPROM location 222, and has units of output bits. Its default value is 2048. Changing the offset will also change the output of channel 4 (Midscale Reference).

Gyro-Stabilized Acceleration

Description:	This function will output the Gyro-Stabilized Acceleration
Analog Cmd. Byte:	0x07 (7 decimal)
Channel 1 (green)	StabAccel_X
Channel 2 (white)	StabAccel_Y
Channel 3 (black)	StabAccel_Z
Channel 4 (red)	Midscale Reference (2.500V)

This function will generate analog outputs equivalent to the Digital Gyro-Stabilized Acceleration Vector. By default, an output of 2.500V represents 0G, and the output sensitivity is 1.250V/G.

The Midscale Reference is a constant voltage output normally maintained at 2.500V. If the StabAccel outputs are referenced to this voltage (rather than the power supply ground), then the differential outputs will provide 0V at 0G, +2.500V at +2G, and -2.500V at -2G.

Under most conditions, the default offset and scale factor will be appropriate. If other output characteristics are desired, these may be changed. The scale factor is stored in EEPROM location 212, and has units of (output bits/G). The default value is 1024. The Offset is stored in EEPROM location 222, and has units of output bits. Its default value is 2048. Changing the offset will also change the output of channel 4 (Midscale Reference).

Instantaneous Magnetic Field

Description:	This function will output the instantaneous Mag. Field
Analog Cmd. Byte:	0x08 (8 decimal)
Channel 1 (green)	Mag_X
Channel 2 (white)	Mag_Y
Channel 3 (black)	Mag_Z
Channel 4 (red)	Midscale Reference (2.500V)

This function will generate analog outputs equivalent to the Digital Instantaneous Magnetic Field Vector. The magnetic field is measured in arbitrary units of Gauss. By default, an output of 2.500V represents 0 Gauss, and the output sensitivity is 1.250V/Gauss.

The Midscale Reference is a constant voltage output normally maintained at 2.500V. If the Mag outputs are referenced to this voltage (rather than the power supply ground), then the differential outputs will provide 0V at 0G, +2.500V at +2G, and -2.500V at -2G.

Under most conditions, the default offset and scale factor will be appropriate. If other output characteristics are desired, these may be changed. The scale factor is stored in EEPROM location 214, and has units of (output bits/Gauss). The default value is 1024. The Offset is stored in EEPROM location 222, and has units of output bits. Its default value is 2048. Changing the offset will also change the output of channel 4 (Midscale Reference).

Gyro-Stabilized Magnetic Field

Description:	This function will output the Gyro-Stabilized Mag. Field
Analog Cmd. Byte:	0x09 (9 decimal)
Channel 1 (green)	StabMag_X
Channel 2 (white)	StabMag_Y
Channel 3 (black)	StabMag_Z
Channel 4 (red)	Midscale Reference (2.500V)

This function will generate analog outputs equivalent to the Digital Gyro-Stabilized Magnetic Field Vector. The magnetic field is measured in arbitrary units of Gauss. By default, an output of 2.500V represents 0 Gauss, and the output sensitivity is 1.250V/Gauss.

The Midscale Reference is a constant voltage output normally maintained at 1.250V. If the StabMag outputs are referenced to this voltage (rather than the power supply ground), then the differential outputs will provide 0V at 0G, +2.500V at +2G, and -2.500V at -2G.

Under most conditions, the default offset and scale factor will be appropriate. If other output characteristics are desired, these may be changed. The scale factor is stored in EEPROM location 214, and has units of (output bits/Gauss). The default value is 1024. The Offset is stored in EEPROM location 222, and has units of output bits. Its default value is 2048. Changing the offset will also change the output of channel 4 (Midscale Reference).

Instantaneous Angular Rate

Description:	This function will output the Instantaneous Angular Rate
Analog Cmd. Byte:	0x0A (10 decimal)
Channel 1 (green)	Rate_X
Channel 2 (white)	Rate_Y
Channel 3 (black)	Rate_Z
Channel 4 (red)	Midscale Reference (2.500V)

This function will generate analog outputs equivalent to the Digital Instantaneous Angular Rates. By default, an output of 2.500V represents 0 rad/sec, and the output sensitivity is 0.41504V/rad/sec.

The Midscale Reference is a constant voltage output normally maintained at 2.500V. If the Rate outputs are referenced to this voltage (rather than the power supply ground), then the differential outputs will provide 0V at 0 rad/sec, +2.500V at +6.023rad/sec, and -2.500V at -6.023rad/sec.

Under most conditions, the default offset and scale factor will be appropriate. If other output characteristics are desired, these may be changed. The scale factor is stored in EEPROM location 216, and has units of (output bits/rad/sec). The default value is 340. The Offset is stored in EEPROM location 222, and has units of output bits. Its default value is 2048. Changing the offset will also change the output of channel 4 (Midscale Reference).

Bias Compensated Angular Rate

Description:	This function will output the Compensated Angular Rate
Analog Cmd. Byte:	0x0B (11 decimal)
Channel 1 (green)	CompRate_X
Channel 2 (white)	CompRate_Y
Channel 3 (black)	CompRate_Z
Channel 4 (red)	Midscale Reference (2.500V)

This function will generate analog outputs equivalent to the Digital Bias Compensated Angular Rates. By default, an output of 2.500V represents 0 rad/sec, and the output sensitivity is 0.41504V/rad/sec.

The Midscale Reference is a constant voltage output normally maintained at 2.500V. If the Rate outputs are referenced to this voltage (rather than the power supply ground), then the differential outputs will provide 0V at 0 rad/sec, +2.500V at +6.023rad/sec, and -2.500V at -6.023rad/sec.

Under most conditions, the default offset and scale factor will be appropriate. If other output characteristics are desired, these may be changed. The scale factor is stored in EEPROM location 216, and has units of (output bits/rad/sec). The default value is 340. The Offset is stored in EEPROM location 222, and has units of output bits. Its default value is 2048. Changing the offset will also change the output of channel 4 (Midscale Reference).