

1 Features

- ◆ 3-axis $\pm 2, \pm 4, \pm 8, \pm 16g$ accelerometer
- ◆ 3-axis gyroscope, ± 2000 °/sec
- ◆ 3-axis magnetometer (compass)
- ◆ User selectable sample rate of 25, 50, 100, 200 Hertz
- ◆ Data stream can be configured to include quaternion solutions
- ◆ Operates from internal rechargeable lithium-polymer battery
- ◆ Accurate time stamped data using Real Time Clock (RTC)
- ◆ Data recorded to a removable microSD card (8GB included)
- ◆ Easily readable comma separated text data files
- ◆ Data transfer compatible with Windows or Linux via Universal Serial Bus (USB) interface (no special software)
- ◆ LED indicator lights for system status
- ◆ Compact size (2.0"L 1.0"W 0.5"H, 0.6oz) (51mm 25 mm 13 mm, 17g)

2 Applications

The XGM is applicable to:

- ◆ Human or animal motion studies
- ◆ Game modeling
- ◆ Camera orientation

3 Description

The USB Accelerometer model XGM data logger uses the InvenSense MPU-9150 9-axis sensor fusion chip with a dynamic motion processing (DMP) engine for quaternion calculations. Data is time stamped using an independent real time clock and stored to a non-volatile microSD card. When connected via the USB to a personal computer, the XGM appears as a standard mass storage device containing the comma delimited data files and user setup files. The 250mAh internal lithium-polymer battery charges using the USB power and provides approximately 12 hours of logging at 200 Hz.



Figure 1: XGM

3.1 Electrical

The XGM is protected from general handling conditions by the plastic enclosure but is not protected from adverse environmental conditions, such as rain, sweat, splashes, and water submersion. The temperature range is limited primarily by the lithium-polymer battery capabilities.

Table 1: Operating Conditions

Parameter	Value
Temperature Range (Operating)	-5°F ~ 130°F (-20°C ~ 55°C)
Temperature Range (Storage)	-5°F ~ 80°F (-20°C ~ 25°C)
Relative Humidity (Operating and Storage)	<90%

3.1.1 Sensor

The XGM uses the InvenSense MPU-9150 9-axis sensor. This sensor combines a 3-axis accelerometer, 3-axis gyroscope, and 3-axis magnetometer (compass) with a Digital Motion Processor (DMP) engine to provide a spatial motion solution. The DMP uses data from the accelerometer and gyroscope sensors to calculate the quaternion solution for orientation. Table 2 lists the basic sensor and logger performance parameters but refer to the MPU-9150 specification for further details. Sensor orientation is illustrated in Figure 2.

Table 2: Sensor Characteristics

	Parameter	Condition	Min	Typical	Max	Units
Acceleration	Range	X, Y, Z axis		2		g
	Sensitivity			16384		counts/g
	Nonlinearity			0.5		%FS
	Zero-g Offset	X, Y axis	-80		+80	mg
Z axis		-150		+150	mg	
Gyroscope	Range	X, Y, Z axis		+/-2000		°/sec
	Sensitivity			16.4		counts/°/sec
	Nonlinearity			0.2		%FS
	Zero Rate			+/-20		°/sec
Magnetometer	Range	X, Y, Z axis		+/-1200		uT
	Sensitivity		3.17	3.34	3.51	counts/uT
	Zero-field		-1000		+1000	counts



The magnetic sensor detects the Earth's magnetic field lines, which is used to help determine orientation. Other magnetic fields, such as from permanent magnets and electromagnetic systems, will affect the sensor output. Therefore, do not use magnets as an attachment method for this logger.

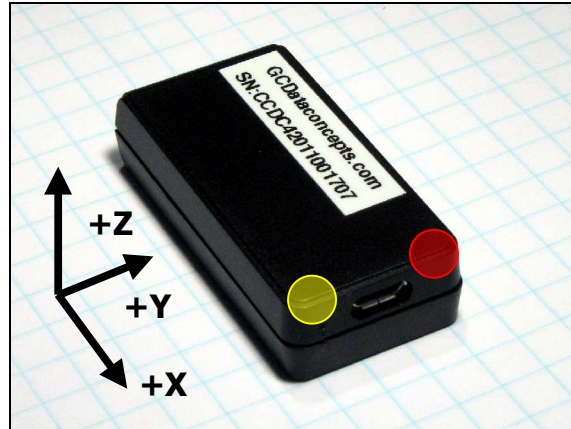


Figure 2: XGM Sensor Orientation

3.1.2 Indicator LEDs

System status is indicated by two LEDs located near the microB connector (see Figure 2). The yellow LED blinks once per second indicating a properly operating system. The yellow LED blinks when the XGM is recording data, in standby mode, or is connected to a computer via the USB port. The red LED blinks when data is written or read from the microSD memory card. In data logging mode, the period at which the red LED blinks depends on the sample rate and other configuration settings. The red LED also serves as the battery charge indicator and will turn off when the battery is fully charged. The yellow and red LEDs will flicker during a user initiated shutdown. The “statusindicators” tag in the system configuration file turns off or changes the brightness of the LEDs (see section 3.1.4.13).

3.1.3 Battery

The XGM is powered by a internal, hardwired 250mAh lithium-polymer rechargeable battery. The internal battery management system recharges the battery when the XGM is plugged into a USB port or attached to a USB 5v power adapter. The battery provides approximately 12 hours of operation sampling at 200 Hz with the deadband set to zero (maximum data recording capability). The battery is not used when the system is connected to a computer USB port. A discharged battery will fully charge in approximately 90 minutes.



The data logger may draw up to 250mA from the USB supply to recharge the battery. Plugging multiple data loggers into a USB hub can exceed the power capacity of the hub. This can cause “brown-outs” of the logger and possibly damage the microSD card.



A 5v supply via the USB connector provides extended operation of the device independent of the internal battery. Common USB power adapters or USB battery packs for consumer electronics can provide the required 5v supply.



The logger is always “on” maintaining the real time clock and will eventually discharge the battery completely after several months. The battery must be charged occasionally or remove the battery disconnect jumper to completely deactivate the device for long-term storage. Keep in a cool (20°C/ 68°F) dry environment to avoid damage of the battery.

3.1.4 System Configuration Options

The XGM is configured using a set of tags and settings stored in a text file named “config.txt”, which is located in the root directory of the microSD card. The system reads the configuration file at boot time. Table 3 lists the configuration file tags. A tag is followed by an equal sign (“=”) and an applicable tag setting. A line finishes with a newline character (0x0A). Tags are not case sensitive. Tab and space characters are ignored. Lines starting with a semicolon (“;”) are treated as comments and ignored by the system. The system will use the default settings listed in Table 3 if the config.txt file is not found. Section 3.1.4.14 describes an example configuration file.

Table 3: Configuration File Tags and Descriptions

Tag	Valid Settings	Default	Description
deadband	An integer between 0 and 16384	0	Sets the deadband to a range expressed in “counts”. A new sample is recorded if any sensor axis exceeds the previous recorded reading by the deadband value
deadbandtimeout	An integer between 0 and 65535	3	Specifies the period in seconds when a sample is recorded regardless of the deadband setting. This feature ensures periodic data is recorded during very long periods of inactivity.
dwel	An integer between 0 and 65535	1	The number of samples recorded after a deadband threshold triggered event
gyroOn	-	On	Adds the gyro sensor output into the data file
magOn	-	On	Adds the magnetic sensor output into the data file
microres	-	Off	The presence of this tag sets the device to record time stamps with 0.1ms effective precision.
mpu_accelFsr	2,4,8,16	2	Sets accelerometer range
mpu_gyro_Fsr	250, 500, 1000, and 2000	2000	Sets the gyro range in deg/sec
mpuSampleRate	25, 50, 100, 200	50	Sets the rate at which data is recorded to the microSD card.
quatOn	-	On	Activates the DMP and adds the quaternion output solution to the data file
rebootondisconnect	-	off on disconnect	The presence of this tag causes the system to start recording after disconnect from a USB port.
samplesperfile	An integer greater than 0	28896	The number of lines of data per data file before a new file is created
statusindicators	“Normal”, “High”, “Off”	Normal	LED status indicators can be activated with normal brightness (Normal), activated with high brightness (High), or completely deactivated (Off).
tempOn	-	On	Add sensor temperature to data stream



Do not use the Windows Notepad editor because it does not terminate new lines properly. GCDC recommends Windows Wordpad or Notepad++ to edit the config.txt file.

3.1.4.1 deadband

“deadband” defines the minimum difference between recorded sensor readings. A new sample from the accelerometer sensor must exceed the previous recorded reading before the logger records the data. The deadband setting is expressed in "counts" units and is applied to the output of each axis. The deadband value can be set to an integer between 0 and 32767. The deadband function is an effective way to reduce the amount of data collected by defining the granularity of the data.

The deadband functions as a event threshold limit when used in conjunction with the “dwell” feature.

Figure 3 illustrates the deadband feature filtering out small changes in acceleration from the recorded data. Only when the deadband limit is exceeded will a new data sample be pushed to the file. Note that this feature will result in samples with inconsistent time periods. Therefore, the data sets should be re-sampled to establish uniform time periods.

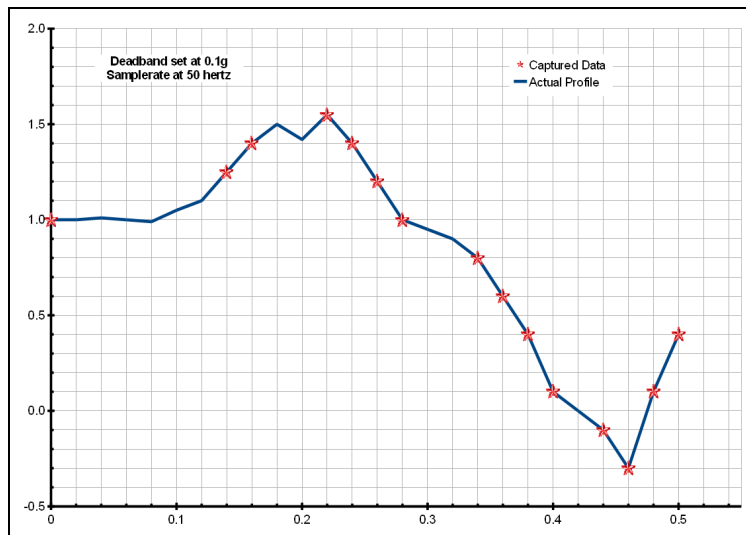


Figure 3: Graphical Illustration of the Deadband Feature

3.1.4.2 deadbandtimeout

“deadbandtimeout” defines the period in seconds when a sample is recorded by the logger regardless of the deadband setting. This feature ensures periodic data is recorded during extended periods of inactivity. A valid setting for the deadbandtimeout is an integer between 0 and 16384.

3.1.4.3 dwell

Use “dwell” together with “deadband” to create an event trigger configuraion. The “dwell” tag defines the number of consecutive samples recorded at the set sample rate after a deadband threshold event. The deadband threshold event occurs when a sensor reading exceeds the last recorded value by the deadband setting. A valid dwell setting is an integer between 0 and 65535. See section Error: Reference source not found for an example implementation of the deadband/dwell features.

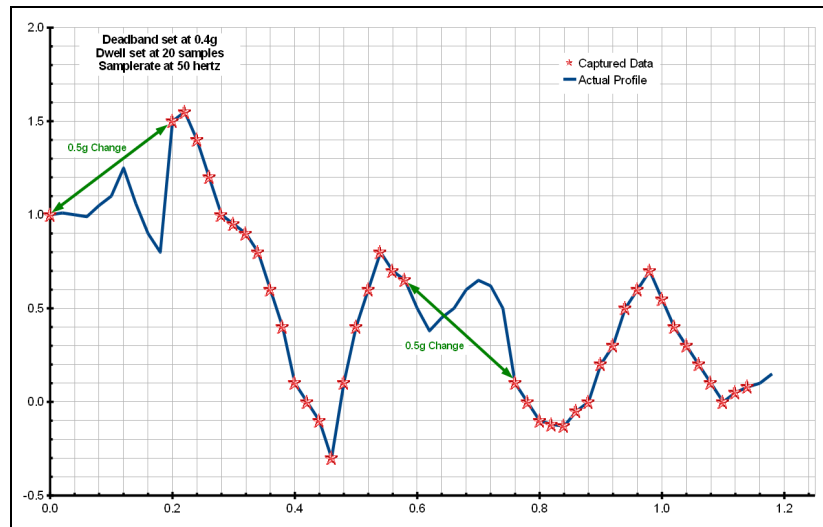


Figure 4: Graphical Illustration of the Dwell Feature

3.1.4.4 gyroOn

The gyroscope sensor is always on but the “gyroOn” option controls whether the data is presented in the data file.

3.1.4.5 magOn

The magnetometer sensor is always on but the “magOn” option controls whether the data is presented in the data file.

3.1.4.6 micros

The “micros” option sets the device to record time stamps with 0.1ms precision. In micro-resolution mode, the time stamps are recorded as XX.YYYYYZZ where XX are seconds, YYYY are 0.1 milliseconds, and ZZ are spurious digits that should be ignored. The micro-resolution option should be implemented at sample rates greater than 200 hertz to provide the best timing precision.



Micro-resolution is best suited for applications requiring precise timing, such as vibration analysis, and is recommended for sample rates above 200 Hz. The standard timing precision (default) of 1 milli-second is suitable for most general applications, such as monitoring human motion.

3.1.4.7 **mpu_accelFsr**

Sets the full scale range of the accelerometer sensor to ± 2 , ± 4 , ± 8 , or ± 16 g.

3.1.4.8 **mpu_gyroFsr**

Sets the full scale range of the gyroscope sensor to ± 250 , ± 500 , ± 1000 , or ± 2000 deg/sec.

3.1.4.9 **mpuSampleRate**

The “samplerate” tag defines the data rate recorded to the file in Hertz, or samples per second. Valid sample rate settings are 25, 50, 100, and 200 Hz. The sensor always operates at 200 Hz but the mpuSampleRate tag defines the sub-sample rate sent to the data file.



The XGM uses a digital MEMS type sensor technology similar to those used in cellphones, laptops, hard drives and other consumer electronics. The sensor streams data at a selected rate based on the timing of a clock internal to the sensor (data “push”). This sensor clock isn't perfect and the precision and drift are undefined. For example, a selected sample rate of 100 Hz may actually occur at 102 Hz. The XGM logger incorporates a precise real time clock to independently time stamp the sensor data and ensure that accurate timing is recorded to the data file. Therefore, always reference the time stamps to determine the actual sample rate.

3.1.4.10 **quatOn**

Adding “quatOn” to the configuration file activates the MPU-9150 dynamic motion processing engine (DMP). The DMP calculates the quaternion solution for orientation based on the accelerometer and gyroscope data. The quaternions are added to the data stream between the gyroscope and magnetometer data.

3.1.4.11 **rebootdisconnect**

Data recording is automatically started upon disconnect from a computer USB port if the tag word “rebootdisconnect” is included in the configuration file. This feature is useful to ensure logging occurs whenever the user disconnects the logger from a PC or USB charger.

3.1.4.12 samplesperfile

“samplesperfile” defines the number of data lines each file can have before a new file is created. This tag controls the size of the data files into easily manageable lengths for later processing. This setting is loaded as a signed 32-bit integer, which can translate into very large data files. The user should exercise caution before setting large files and test the end-user application for data limitations.

3.1.4.13 statusindicators

The brightness intensity of the LED status indicators is defined using the “statusindicators” tag and valid settings of “normal”, “high”, and “off”.

3.1.4.14 Example Configuration File

Example A) The following configuration records data at 50 hertz and each file is 72,000 lines long. Full timing precision is provided from the “microres” option. The complete data stream is added to the data file (accelerometer, gyroscope, quaternion, magnetometer, and temperature). The status indicators are set to normal brightness to indicate operation of the logger. “rebootOnDisconnect” is not active so the logger is turned on using a magnet passed near the USB connector.

```
; PRODUCT_ID = XGM
;deadband, deadbandtimeout, dwell options act
;upon the accelerometer sensor data
deadband = 0
DeadBandTimeout = 5
;dwell=100
;set the length of the data file
samplesperfile = 72000
;control brightness of LEDs
statusindicators = Normal
;uncomment following line to activate logger
;upon disconnect from USB
;rebootOnDisconnect
;activate max timing precision
microres
;add gyro to data stream
gyroOn
;add quaternion calculations to data stream
quaton
;add magnetometer data to data stream
;mag data occurs at slower rate than accel/gyro
magOn
;add temperature to data stream
tempOn
; sensor always operates at 200 hz
; but data stream to file can be subsampled to
; rates of 25, 50, 100 and 200 Hz
mpu_SampleRate = 50
; disregard initial 20 samples after start up, these
; are stale samples stored in the data buffer
SampleRate = 12
; available accelerometer full scale ranges are 2, 4, 8
and 16g (2g is the default)
mpu_accelFsr=16
; available gyro full scale ranges are 250, 500, 1000, and
2000 (2000 deg/sec is the default)
mpu_gyro_Fsr=2000
```

Figure 5: Configuration File Example A

3.1.5 Data Files

The XGM creates a new data file when the system is booted or when the maximum number of data lines is reached in the previous data file. A system boot condition occurs when the logger is turned on, or 5v power is restored to the system via the USB connector, or when the XGM is removed from a computer USB port with the “rebootondisconnect” feature enabled. Data files are placed in a folder named “GCDC” and are named data-XXX.csv, where XXX is a sequential number starting with 001. The system will create up to 999 files. At the beginning of each file, a header is written describing the system configuration and the current time when the file was created. Figure 6 represents an example data file.

```

;Title, http://www.gcdataconcepts.com, X16-MPU-mini, ADXL345, MPU-9150
;Version, 1051, Build date, Apr 28 2015, SN:CCDC3016131599E
;Start_time, 2015-05-27, 14:56:05.000
;Temperature, -999.00, deg C, Vbat, 4238, mv
;SampleRate, 12,Hz
;Deadband, 0, counts
;DeadbandTimeout, 0,sec
;Time, Ax, Ay, Az, Gx, Gy, Gz, Mx, My, Mz, T
0.013459, 120,-500,-16088, -8,-6,-4, 107,-76,-224, 33960
0.053772, 112,-410,-15848, -8,-7,-4
0.093384, 152,-398,-15974, -8,-5,-5
0.133332, 94,-364,-16114, -4,-8,-4, 107,-76,-227
0.173249, 150,-380,-15986, -6,-5,-4
0.213196, 110,-420,-16156, -9,-6,-4, 108,-79,-223
0.253510, 186,-392,-16266, -8,-6,-5
0.293091, 92,-440,-15968, -9,-7,-4
0.333069, 98,-374,-16032, -8,-5,-5, 113,-74,-220
0.373017, 128,-454,-16056, -6,-7,-6
0.412995, 160,-402,-16142, -6,-6,-6, 111,-79,-223
0.453430, 104,-340,-15958, -6,-6,-5
0.492859, 100,-364,-16046, -7,-6,-4
0.532807, 142,-328,-15990, -6,-7,-4, 113,-74,-220, 33925
    
```

Figure 6: Example Data File

3.1.5.1 Data Format

Data is written to files in comma separated text format starting with the file header information and followed by event data entries. Each data line contains a time entry followed by data from the MPU-9150 sensor. The time entry is seconds elapsed from the start time recorded in the header. Add the elapsed time to the start time to determine the complete date and time of the sample.

The sequence of data from the MPU-9150 is organized based on the sampling frequency of each sensor. The accelerometer and gyroscope sensors are sampled most often and simultaneously. These two sensors will occur first as Ax, Ay, Az, Gx, Gy, Gz. If the DMP is activated (quatOn), quaternion results are added to the data stream at the same frequency as the accelerometer and gyroscope. The quaternion results appear as Qw, Qx, Qy, Qz. The magnetometer sensor is sampled slower than the accelerometer or gyroscope and occurs as Mx, My, Mz. Finally, the temperature (T) from the MPU-9150 is added at a rate slower than the magnetometer.

The last line of the final data file records the reason for the termination, such as “shutdown: switched off”, “shutdown: low battery”, “shutdown: max files exceeded”, “shutdown: vbus disconnect”, or “connected to computer”. The line is designated as a comment with a semicolon (“;”).

3.1.5.2 Accelerometer Data Conversion (Ax, Ay, Az)

Divide the raw acceleration data by the factors listed in Table 4 to determine the value in units of “g”. Multiply this result by 9.81 to determine m/sec² or 32.17 to determine feet/sec².

Table 4: Accelerometer Data Conversion Factors

“mpu_accelFsr ” Range	Conversion Factor	New Units
2	16384	g
4	8192	g
8	4096	g
16	2048	g

3.1.5.3 Gyroscope Data Conversion (Gx, Gy, Gz)

Divide the raw gyroscope data by the factors listed in Table 5 to determine the value in “°/sec”.

Table 5: Gyroscope Data Conversion Factors

“mpu_gyroFsr ” Range	Conversion Factor	New Units
250	131.0	°/sec
500	65.5	°/sec
1000	32.8	°/sec
2000	16.4	°/sec

3.1.5.4 Quaternions Solution (Qw, Qx, Qy, Qz)

Quaternions are a dimensionless representation of orientation. The following wikipedia entries provide detailed discussion of quaternions:

<http://en.wikipedia.org/wiki/Quaternion>

http://en.wikipedia.org/wiki/Quaternions_and_spatial_rotation

http://en.wikipedia.org/wiki/Conversion_between_quaternions_and_Euler_angles

3.1.5.5 Magnetometer Data Conversion (Mx, My, MZ)

Divide the raw magnetometer data by 3.34 to determine micro-Telsa. Note that the Earth's magnetic field lines and intensity vary by location and the magnetometer data should be calibrated to direction at the specific location of deployment. In most cases, the absolute value is not important but the value registered at known directions (north, south, etc).

3.1.5.6 Temperature Conversion (T)

Divide the raw temperature value by 1000 to determine °C. The temperature is collected by a sensor internal to the MPU-9150.

3.1.5.7 Example Conversion of Data File

Table 4 lists the converted data from the file illustrated in Figure 6.

The time value listed in the table is the addition of the time stamp (elapsed time) and the Start_time listed in the data file header. In a spreadsheet, such as Excel or Calc, the Start_time will appear as two cell entries: date and time. First divide the individual time stamps by 86400 and then add to the time entry of the Start_time

$$\text{Time} = (\text{time stamp}) / 86400 + \text{Start_time}$$

To include the date as well, use the “concatenate” function to combine the date and time cells of the Start_time. Then, add the time stamp to the combined date/time.

Table 6: Converted Example Data

Time	Ax	Ay	Az	Gx	Gy	Gz	Mx	My	Mz	T
	g	g	g	°/sec	°/sec	°/sec	uT	uT	uT	°C
14:56:05.013	0.007	-0.031	-0.982	-0.488	-0.366	-0.244	32.0	-22.8	-67.1	34.0
14:56:05.054	0.007	-0.025	-0.967	-0.488	-0.427	-0.244				
14:56:05.093	0.009	-0.024	-0.975	-0.488	-0.305	-0.305				
14:56:05.133	0.006	-0.022	-0.984	-0.233	-0.488	-0.244	32.0	-22.8	-68.0	
14:56:05.173	0.009	-0.023	-0.976	-0.366	-0.305	-0.244				
14:56:05.213	0.007	-0.026	-0.986	-0.549	-0.366	-0.244	32.3	-23.7	-66.8	
14:56:05.254	0.011	-0.024	-0.993	-0.488	-0.366	-0.305				
14:56:05.293	0.006	-0.027	-0.975	-0.549	-0.427	-0.244				
14:56:05.333	0.006	-0.023	-0.979	-0.488	-0.305	-0.305	33.8	-22.2	-65.9	
14:56:05.373	0.008	-0.028	-0.980	-0.366	-0.427	-0.366				
14:56:05.413	0.010	-0.025	-0.985	-0.366	-0.366	-0.366	33.2	-23.7	-66.8	
14:56:05.453	0.006	-0.021	-0.974	-0.366	-0.366	-0.305				
14:56:05.493	0.006	-0.022	-0.979	-0.427	-0.366	-0.244	33.8	-22.2	-65.9	33.9

3.1.6 Real Time Clock

A real time clock (RTC) is integrated into the XGM and is used to determine time for each line of data recorded. The RTC is set using a text file named “time.txt” located in the root directory of the microSD card. The system looks for the time.txt file upon booting. If the file exists, the time stored in the file is loaded to the RTC and the time.txt file is deleted. The time information in the time.txt file must be in the exact “yyyy-MM-dd HH:mm:ss” 24-hour format, occur on the first line, and end with a newline character. Figure 7 provides an example time.txt file that will initialize the RTC to 2:26:30 pm June 16, 2014.

The time file method of setting the RTC does not require special communication drivers so it can be implemented using a simple text editor. Direct initialization of the RTC is possible but requires specific device drivers and software from Gulf Coast Data Concepts.

The RTC maintains 5 ppm accuracy (-40°C to +85°C), which means that it will drift accuracy about 1 second every 2 days. The RTC is powered by the battery at all times, even when the logger is “off”.

```
2014-06-16 14:26:30
```

Figure 7: Example Time Initialization File



Initializing the RTC ensures that the start time and individual time stamps can be correlated to an absolute time – the year, month, day, hour, minute, second, and fractional second. An uninitialized or reset of the RTC will lead to indeterminate time stamps.



After unplugging the logger from the USB port, the logger will load the time.txt file when it is activated with the magnetic switch or if the “rebootondisconnect” option is active. Therefore, there is a delay between when the time.txt was created and when the logger actually loads the time information. For most applications, this simple method of initializing the clock results in sufficient accuracy.

3.1.7 Memory Card

The XGM stores data to a removable 8GB microSD flash memory card and is compatible with microSD and microSDHC type cards. The logger includes a 8GB card but is compatible with cards up to 32GB. The XGM functions as a Mass Storage Device to computer operating systems when transferring data to and from the microSD memory card. The Mass Storage Device interface is supported by all desktop operating systems and special device drivers are not required. Tablet computers may not recognize the XGM due to USB device limitations set by the tablet manufacturer.

The logger needs only the config.txt file to operate. The XGM will use default configuration settings if the config.txt is not present. The “config.txt” and “time.txt” files must occur in the root directory (see section 3.1.4 and section 3.1.6). The XGM will create a folder called “GCDC”, if not already present, to place the data files (see section 3.1.5).



Interrupting the power to the logger can result in corruption of the microSD card. For example, removing the logger from the USB port during file transfers to the PC. Reformat the card if it becomes corrupted (FAT32 file structure). If data transfers to/from the card become slow, consider formatting the card using “SD Card Formatter” software provided by the SD Association (www.sdcard.org).

3.2 Mechanical

The XGM is protected by a plastic enclosure measuring 2.00x1.00x0.50 inch (51x25x13mm) and weighs 0.55oz (16 grams). The enclosure is not weatherproof and further protection is recommended for outdoor use. A sealed plastic bag or adhesive lined heat shrink can protect the XGM from moderate water exposure.

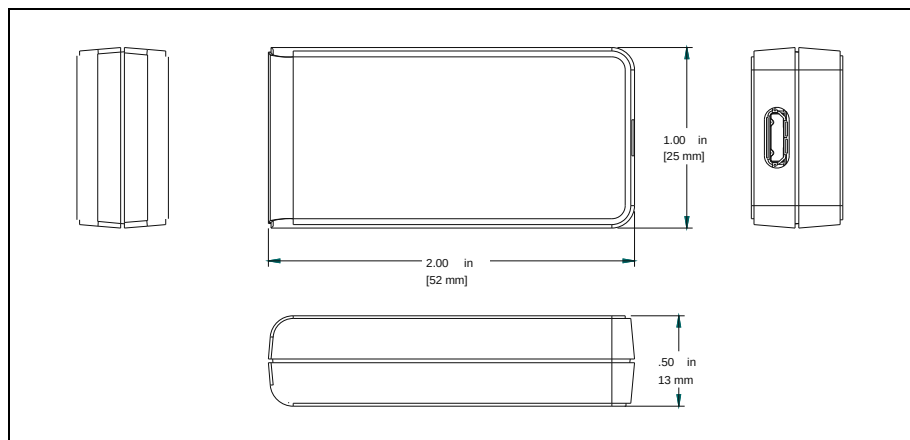


Figure 8: XGM



The XGM is small and very light weight so attachment methods do not need to be substantial. Double-sided tape, a spot of cyanoacrylate glue (contact cement), zip-ties, or adhesive putty are example methods of attachment. These methods do not cause adverse signal attenuation considering the relatively low frequency bandwidth of the XGM logger. Command Poster Adhesive strips by 3M offer excellent temporary attachment of the logger to most surfaces.

4 Software

The XGM records data to comma delimited text files and uses text based files for configuration settings. Therefore, no special software is required to utilize the XGM. For data analysis, Gulf Coast Data Concepts recommends using a commercial or open source mathematics package, such as MatLab, Microsoft Excel, OpenOffice Calc, Octave, R, or similar applications.

5 Troubleshooting

Problem	Resolution
<p>I pass a magnetic around the logger but it does not appear to activate and no LEDs blink.</p>	<p>Keep the magnet near the USB connector and turn the magnet orientation until the logger activates.</p>
	<p>Make sure the battery is charged.</p>
	<p>The logger could be operating correctly but the status indicators are turned off. Check the “statusindicator” option in the config.txt file.</p>
<p>I activated the logger, the yellow LED blinks once per second but the red LED does not indicate logging.</p>	<p>The logger is in standby mode waiting for a start time to occur. Check the config.txt file for the start/stop settings.</p>
<p>The yellow LED blinks slowly.</p>	<p>The microSD card or the config.txt file is corrupted. Run a check-disk test on the card or reformat the card.</p>
	<p>The microSD card is not present or is not inserted properly. In most cases, this is not an issue unless the XGM enclosure was opened. Re-open the enclosure and check that the card is inserted properly</p>
<p>I activate the logger but it records only for a short period of time.</p>	<p>Check that the battery is fully charged.</p>
	<p>The microSD card is full and data files must be deleted.</p>
<p>The logger seems to ignore the config.txt file and use default settings.</p>	<p>Check that the config.txt file is properly formatted and not corrupted. Each setting should occur on a separate line.</p>
	<p>Some IT organizations implement an automatic encryption of all removable media devices. This will encrypt the config.txt file and the logger will not be able to access the file. Do not allow encryption of the device.</p>

USB 9-Axis Logger Model XGM

Problem	Resolution
I plug the logger into a USB port but the PC does not indicate an external drive present.	The microSD card is corrupted or damaged. Reformat the card or replace the card.
	The microSD card is not present in the logger or is not inserted properly. Check that the card is fully inserted into the logger.
	The USB connection could be faulty or the extender cable (if present) could be faulty. Replace the USB cable and plug the logger into another USB port.
The start time in the data file header is incorrect.	Initialize the RTC.
The time.txt file doesn't load to the RTC	Check that the date/time is correctly formatted and the file name is "time.txt". Windows may hide the file extension so naming the file as "time.txt" may actually be named "time.txt.txt". Check the Windows file explorer options the view of regarding file extensions.
The logger is stationary but it registers 1g.	This is normal and indicates Earth's gravity is fully operational and stable.
But the logger actually registers something other than 1g when stationary.	The sensor will exhibit a slight offset error. Add or subtract the appropriate amount to correct the error. A 3-axis tumble calibration test is the best method to determine the sensor offset error for all three axis. The errors are particular to the sensor and are normally consistent throughout all data sets.
What are quaternions and why does my head hurt?	Quaternions are a fancy mathematical notion for representing orientation without the limitation of "gimbal lock" found with Euler angles. Quaternions are used commonly in 3D gaming software engines to render the orientation of objects.