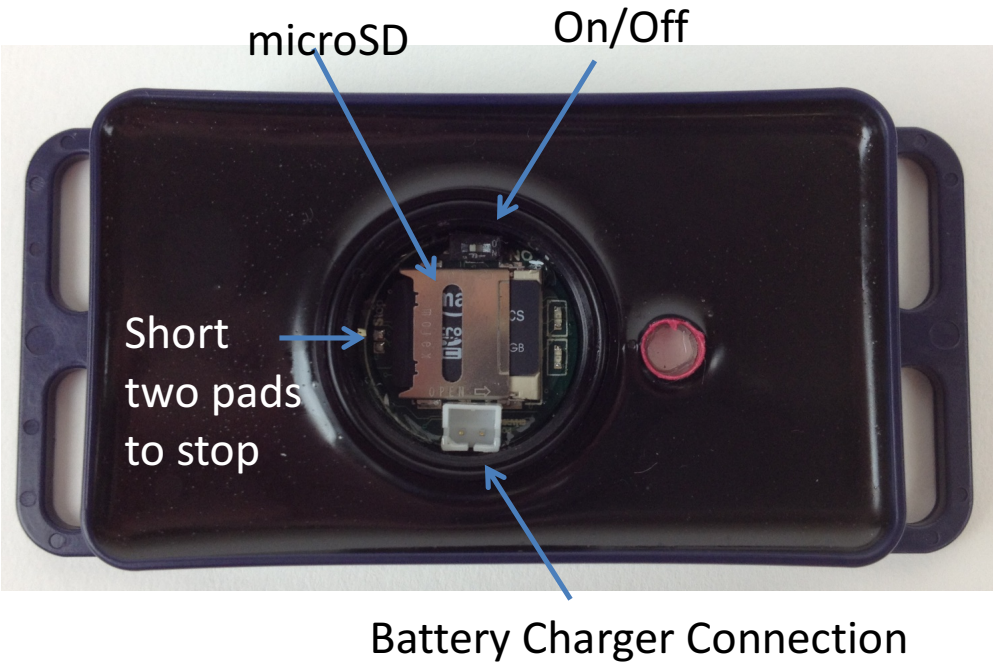
Open Tag Quick Start Manual

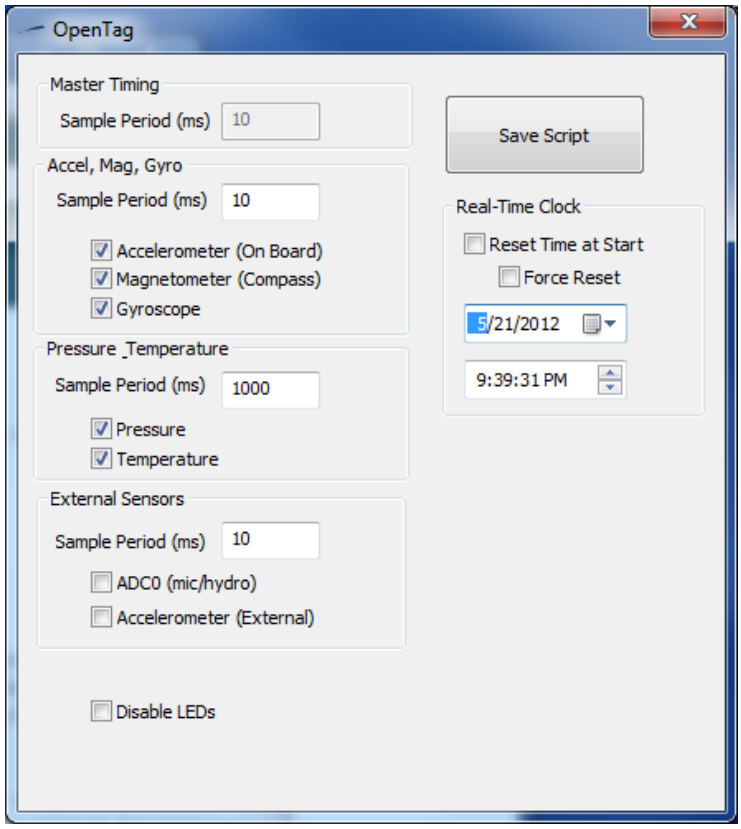


1. Programming the Settings File

OpenTag uses a settings file stored to the microSD card to configure the sensor sampling rates. This default.txt file contains codes for indicating which sensors to save and at what sampling periods. Default.txt is stored in a folder named Script.

The settings file can be created using the OpenTag program, although it is possible to edit the file with notepad. OpenTag.exe is available from loggerheadinstruments.com.

If the default.txt file is missing, the tag will record the accelerometer, magnetometer, and gyroscope with a 10 ms sample period, and the pressure and temperature with a 1000 ms sample period.



The sample period is entered into each box. For example, a sample period of 10 ms corresponds to a sample rate of 100 Hz (i.e. 100 samples per second). A sample period of 1000 ms corresponds to a sample rate of 1 Hz.

Sensors

OpenTag can stream all inertial sensors (accelerometer, magnetometer, and gyroscope) at approximately 100 Hz each. At higher rates, there will likely be data loss. However, one may record from just one sensor, for example the accelerometer, with a shorter sample period. For example, the accelerometer alone could be sampled at 200 Hz by using a sample period of 5 ms, and deselecting the check boxes next to magnetometer and gyroscope.

Pressure/Temperature: Pressure and temperature readings require the pressure sensor daughterboard that would be soldered to the main board. It is important to measure both pressure and temperature, since each measurement is used to compensate the other. The shortest sample period for pressure and temperature is about 100 ms (i.e. 10 readings per second).

TEST ALL SETTINGS PRIOR TO DEPLOYMENT. If OpenTag can not sustain the selected data rates, the red LED will light when there are data overflows (i.e. dropped data samples that are not saved to the card).

2. Setting the Time

The time is set by saving the default.txt card with a date and time, ejecting the card from the computer, and inserting the card into the Open Tag board. When the time stored on the card occurs, the power switch should be turned on to set the time on the clock.

Once the time is set, as long as a battery is connected to the board, the current time will be retained (even with the power dip switch off).

3. Starting Record

Insert the microSD card in the recorder. The card holder is flip top: slide and flip.

To start recording, slide the dip switch to the ON position. The recorder will set the time if present in the default.txt file and start recording. Pre-existing files on the card will not be overwritten.

4. Ending Record

There are two pads next to the microSD card holder labeled 'STOP'. Hold a paper clip or some other piece of metal across these for about 10 seconds, until the LED turns solid red. Then turn off the power switch. If the DIP switch is not turned off in 30 seconds, recording will resume.

The battery should remain connected to the board so that the clock retains the current time. Current draw is very low to retain the clock time.

OpenTag Setup

Default.txt Example File

```
//Open Tag Script File

// Set Date and Time

TM 09-19-12 18:18:00

// Set sample period

V1 10000

//IMU Sample Period in ms

SC 100

---------------------------------
```

// Indicate lines that are comments. Any line with // will be ignored

This will set the time to September 19, 2012, 18:18:00.

The V1 command sets the master sample period to 10000 us, which is 10 ms. So the master sample rate would be 100 Hz. The master sample rate controls the internal interrupt timer that is used to sample all sensors on a regular basis.

The inertial sensors (magnetometer, accelerometer, and gyro) will be sampled every 100 ms (10 Hz).

Default.txt Commands (dfh.Version=10250)

Command	Function	Example
TM	Sets time	
FT	Force set time	
V1	Master interrupt sample period (us)	
SC	IMU sample period (ms)	
PT	Pressure/Temp sample period (ms)	
AI	Board Accelerometer Enabled	
MG	Magnetometer Enabled	
GY	Gyroscope Enabled	
PR	Pressure Enabled	
TP	Temperature Enabled	
LD	Disables LEDS	
CP	Clock Prescaler	
BW	Burn Wire Time Set	
WT	Wake Time	
MW	Motion Wake	
ND	New File Every Day (default is every hour in v28)	
	V=10290 (April 2016)	
BT	Burn in HH:MM from start	BT 01:00 (burn 1 hour from power on)
IS	I2Cpower pin duty cycle and depth control; used in some tags to control when external VHF is powered on	IS 60 1 (on for 60s/off for 60 s; on when depth <1 m)

Default.txt Commands: Not implemented in default firmware, but hardware connections are available on the board.

Command	Function
A7	**ADC7 Enabled (not implemented in firmware)**
SW	**Saltwater Switch Enabled (not implemented in firmware)**
SP	**Serial Print Enabled (not implemented in firmware)**
A0	**ADC0 Enabled**
AE	**External Accelerometer enabled**

TM: Sets time. Time will only be set if it is later than the current time on the clock. (so if the device resets and reads the default.txt file, it won't reset the time). Format is MM-DD-YY .

FT: Force Time Set. Same as TM, but will reset time regardless of current time on clock.

V1: Master sample rate of microphone (hydrophone) on ADC6 in microseconds. V1 must be specified even if you are not using ADC6, because this is used to set the interrupt update rate that is also used by the inertial sensors.

SC: Sample period (ms) for magnetometer (compass), gyro, and accelerometer. This must evenly divide into the sample period (in ms) for the ADC.

LD: Disable LEDs. Will disable LEDs during file writing. LEDs will stay on until the clock changes to the next hour.

BW: Sets time burn wire will be energized. When the burn wire is activated the burn wire circuit is connected, and the burn wire sees the output of the battery directly. Requires an OpenTag with the burn wire connected. Example: BW 09-19-12 18:18:00.

Record Modes

Continuous

The default run mode (when none of the commands NH, WT, MW are in the script file) is to record continuously making a new file every day.

NH: When recording continuously, if NH is present in script, will start a new file every hour. The default is a new file every day.

Duty Cycle

WT: Wake Time. When set, the tag will wake up at the specified time (delay start) for the specified duration and interval. Wake Time takes three parameters.

WT (HH:MM time to wake up) (HH:MM duration to record after waking up) (HH:MM interval between recordings)

Example:

WT 08:00 01:00 02:00

Will wake at 0800 h for the first recording and record for 1 hour every 2 hours.

Note: WT was changed in version 30 to support full duty cycle. Support for waking on a particular day of the week was removed.

Record on Motion Detection

The accelerometer stays running during sleep mode, and when the threshold is exceeded, the OpenTag will wake up and start recording. Recording will continue until no motion is detected for a given duration. A lower value in the magnetometer threshold for staying awake translates to less motion being required to keep the tag recording after it wakes up.

MW: Motion Wake. Wakes on motion sensed by accelerometer. After waking, stays awake until no motion is sensed for a specified duration. The stay awake sensing is controlled by the magnetometer readings.

Motion Wake takes three parameters:

MW Acceleration_threshold magnetometer_threshold inactivity_duration

Where:

Acceleration_threshold = milli-g to wakeup

magnetometer threshold = threshold when exceeded resets inactivity counter to 0. This is the raw magnetometer value. 100 is a reasonable value to use as a threshold.

inactivity_duration = if inactivity duration (s) is exceeded with no movement, the tag will go back to sleep

Example:

MW 2000 100 30

1. Wake from sleep when accelerometer exceeds 2000 mg (note, these readings are AC coupled, so gravity does not affect them).
2. Stay awake unless there no motion above a magnetometer raw reading of 100 for 30 seconds. The algorithm is as follows.
    a. Every two seconds, OpenTag compare the magnetometer raw reading to the previous magnetometer raw reading from two seconds ago.
    b. If it is less than the threshold (e.g. 100), then increment a time counter for inactivity.
    c. If it is greater than the threshold, then reset the time counter for inactivity to 0 seconds.
    d. If the time counter for inactivity is > inactivity duration, go to sleep.

The Duty Cycle mode and Record on Motion modes can both be set at the same time.

Power Saving Modes

Sleep Mode

When using motion wake or wake on time, the OpenTag will go to sleep where it will draw approximately 0.3 mA.

Clock Prescaler

OpenTag runs the microcontroller at 8 MHz by default. To save power, this can be clocked at a lower speed by setting a clock prescaler.

CP: Clock pre-scaler

Clock Prescaler	Scaling Factor	Microcontroller Speed (MHz)
0	1	8
1	2	4
2	4	2
3	8	1

When the microcontroller speed is slowed down, the maximum sample rates for the sensors are decreased. The Master srate should be set to be evenly divisible by the scaling factor. The following example script will run OpenTag at 1 MHz sampling the IMU sensors at 10 Hz and the pressure and temperature at 1 Hz.

```
//OpenTag Script
//Set Date Time
TM 10-22-14 15:14:00
//Master srate (us)
V1 50000
//Imu Sample (ms)
SC 100
//PressTemp (ms)
PT 1000
//Accel Board
AI
//Magnetometer
MG
//Gyro
GY
//Pressure
PR
//Temperature
TP
// Clock Prescaler
CP 3
```

Tips about Sensor Calibration

All of the sensors used on OpenTag are digital, in that they have their own analog-to-digital converter. The values stored by OpenTag are calibrated using the calibration values supplied in the technical specification sheets. This is our way of saying....they could be off.

Accelerometer and Gyroscope Calibration:

Place device in a known orientation for a few seconds when recording starts. Generally a flat surface is a good idea. These readings can then be later used to compensate for offsets in the accelerometer and gyroscope values. We have noticed offsets in the Z direction of a few percent. When the tag is laying flat, you should get 1 g of acceleration (or -1 g depending on the orientation of the board).

Magnetometer Calibration:

The purpose of the magnetometer calibration is to record data from all possible orientations. This is used to correct for offsets in the magnetometer due to nearby metals. For the first recording, rotate the device in all possible orientations (both horizontally and vertically). Put on some LMFAO and do some shufflin'. These data can be used to determine the offset caused by nearby metals in post-processing.

Pressure and Temperature Calibration:

The pressure and temperature sensors come (supposedly) calibrated at the factory. There are six calibration coefficients stored on the memory of the pressure/temperature sensor, which are saved out to the PRESSTEMP.CAL file. The pressure and temperature sensor readings are calculated using these calibration constants and the equations from the specification sheet. Needless to say....one may have to adjust the calibration based on testing in the laboratory.

Data Files

Data files are stored as M0.DSG, M1.DSG, M2.DSG etc. If a file already exists, the next available file will be used.

The file lengths are fixed.

IMU data are written interleaved in the following order:

Accelerometer X, Y, Z

Magnetometer X, Y, Z

Gyroscope X, Y, Z

If LEDs are not disabled, the green LED will flash when data are written.

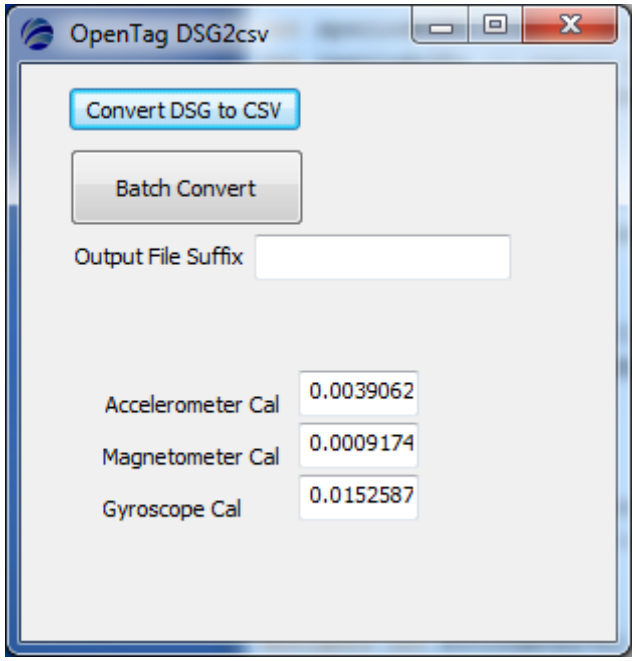
The red LED will light if there is an overflow (i.e. data are coming in too fast to write).

Converting DSG files to .csv files

The program DSG2csv will convert OpenTag .dsg files to comma separated value (.csv) text files.

The inertial sensor data will be extracted to one file, and the pressure and temperature data will be extracted to another file.

The conversion program will use the presstemp.cal file that is stored to the card to return corrected pressure and temperature measurements. It will also use the calibration constants for the accelerometer, magnetometer, and gyroscope contained in the dialog box to convert the raw inertial sensor measurements to calibrated values. These will not need to be changed, unless the Arduino firmware is modified to change the sensitivity of the sensors.



Convert DSG to CSV: Converts one selected file.

Batch Convert: Converts all files in a folder, and places the results in a folder named csv. Each file is converted to a separate csv file.

Units

Accelerometer units are in 'g'.

Magnetometer units are in Gauss.

Gyroscope units are in degrees/second.

Time stamps

Two clock sources are used to save times to the file. The column labeled File Time, is the time that the file was created from which those data were extracted. This time originates with the real-time clock chip and is read from the internal .dsg header. The column labeled 'Time from Start (s)' is calculated from the sampling intervals for the sensors, which ultimately derives the master sample rate.

Example Output from Open Tag DSG2csv program

Inertial Sensor File

FileName	FileDate	FileTime	Sample	Time from Start (s)	AccelIntX	AccelIntY	AccelIntZ	MagX
M0.DSG	5/1/2012	16:06:00	0	0	0.058594	0.050781	0.730469	0.318349
M0.DSG	5/1/2012	16:06:00	1	0.01	0.058594	0.042969	0.738281	0.317431
M0.DSG	5/1/2012	16:06:00	2	0.02	0.058594	0.042969	0.738281	0.317431
M0.DSG	5/1/2012	16:06:00	3	0.03	0.066406	0.046875	0.734375	0.318349
M0.DSG	5/1/2012	16:06:00	4	0.04	0.066406	0.0625	0.734375	0.320183
M0.DSG	5/1/2012	16:06:00	5	0.05	0.0625	0.050781	0.738281	0.322018
M0.DSG	5/1/2012	16:06:00	6	0.06	0.050781	0.0625	0.695313	0.322018
M0.DSG	5/1/2012	16:06:00	7	0.07	0.0625	0.054688	0.710938	0.318349

Pressure/Temperature File

FileName	FileDate	FileTime	Sample	Time from Start (s)	Pressure	Temperature
M0.DSG	5/1/2012	16:06:00	0	0	47804.551	20
M0.DSG	5/1/2012	16:06:00	1	1	47804.227	20
M0.DSG	5/1/2012	16:06:00	2	2	47802.21	20
M0.DSG	5/1/2012	16:06:00	3	3	47803.105	20

Loading DSG Files with MATLAB

Required m-files

ot_load.m: Loads OpenTag files and applies calibration coefficients.

oDSG.m: Called by ot_load to read the OpenTag files.

ot_plot.m: Plots data after loading with ot_load

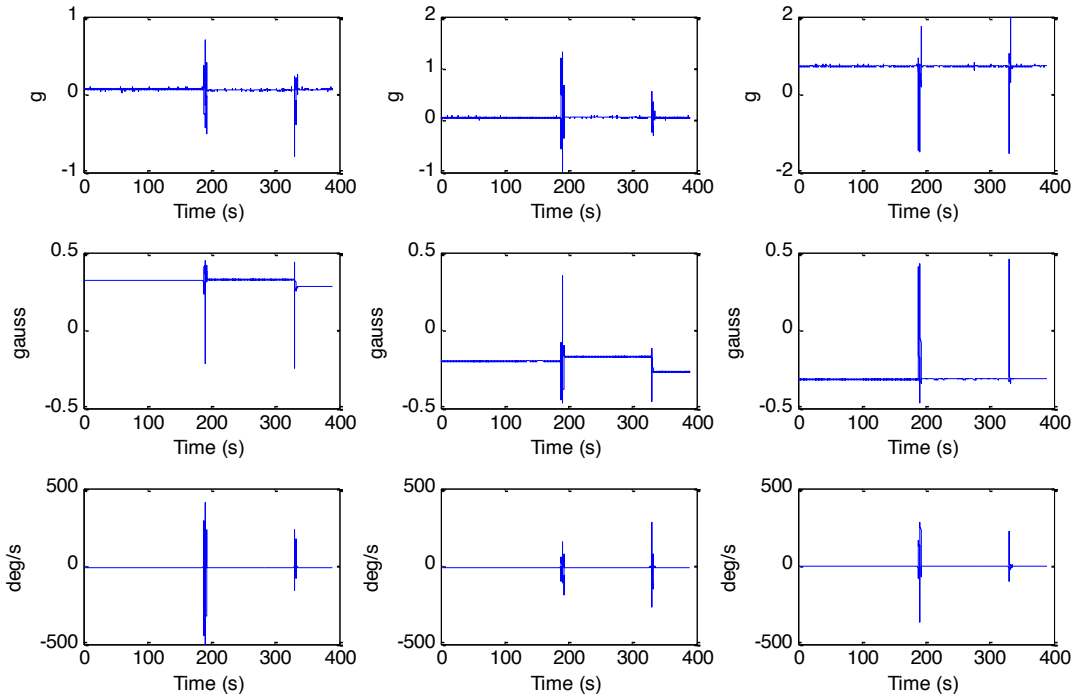
From MATLAB command prompt type:> ot_load

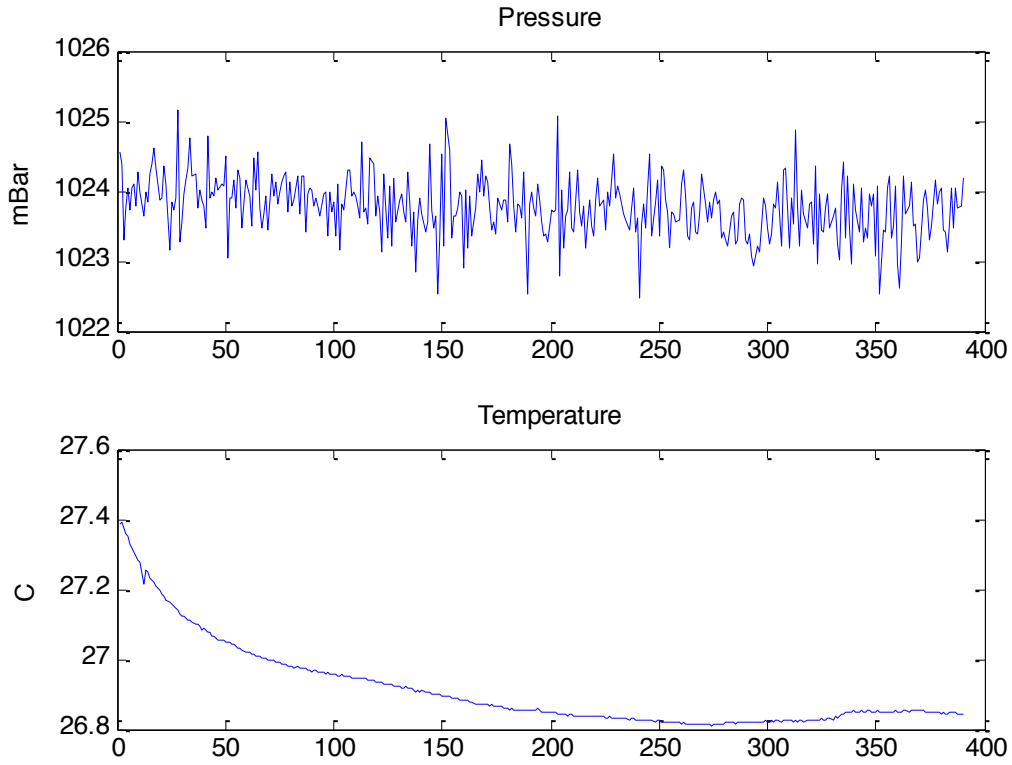
In the first dialog box, select the file to load.
In the second dialog box, select the calibration file named PRESSTMP.CAL

The MATLAB code **DOES NOT CORRECT** for hard iron offsets or offsets on the accelerometer or gyroscope.

Example output from ot_load

Data are plotted in three columns for X, Y, Z. Rows are accelerometer, magnetometer, and gyroscope.




Pressure
mBar
1026
1025
1024
1023
1022
0
50
100
150
200
250
300
350
400
Temperature
C
27.6
27.4
27.2
27
26.8
0
50
100
150
200
250
300
350
400

Charging

The lithium battery can be charged while it is connected to the OpenTag board through the white JST connector next to the flash card holder.

To charge with the USB charger:

Plug in the mini USB cable to a computer and the other end into the SparkFun charge board. The charge board is connected to the OpenTag board with a small JST cable.

When charging the red LED will be on. When charging is complete the LED will turn off. Charging will typically take less than 5 hours.