IMU8420 V1.03 Release Notes

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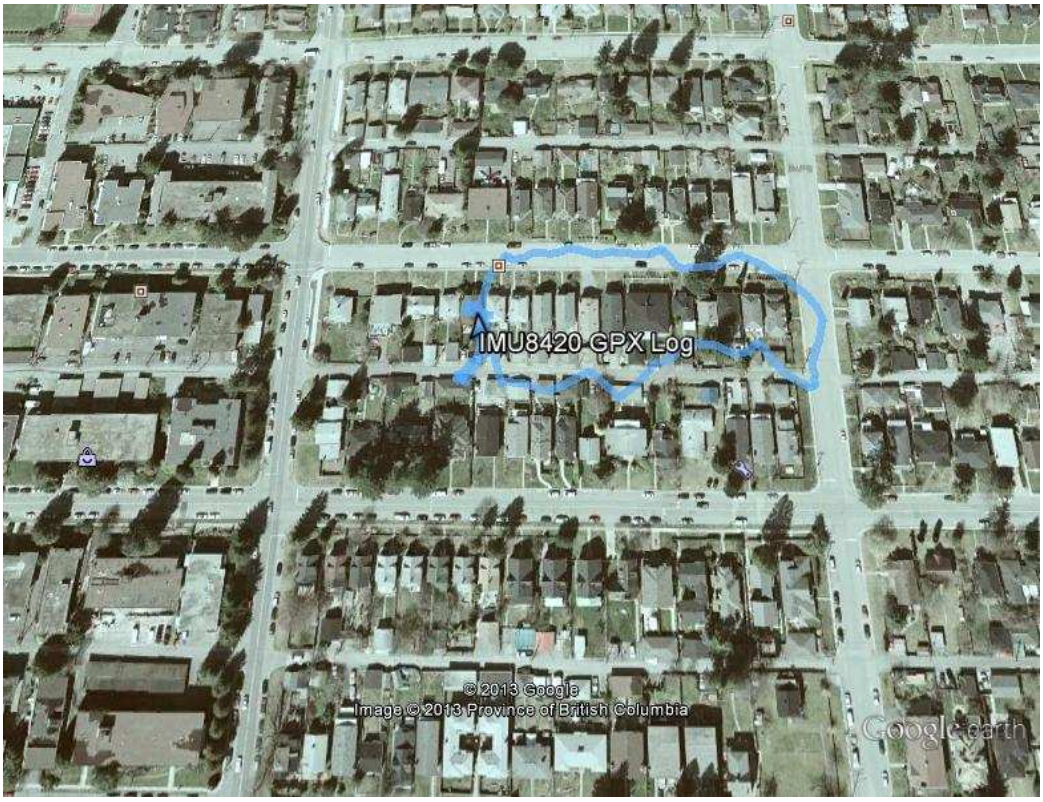
Overview

Version 1.03 adds a number of additional features to 1.02 and fixes a few bugs:

- GPX file generation is now supported. The GPX file created by the IMU8420 can be directly loaded into Google Earth displaying GPS track formation captured by the GP1.
- c command has been changed to support saving and loading logging config files
- g command expanded to the support the new GPX file modes
- GNUPLOT Application Note showing how to use GNUPLOT to graph log files
- f command now supports top level file list, delete and dump

GPX File

Version 1.03 supports the creation and saving of GPS GPX files. GPX is an XML format for GPS data. If logging of IMU8420 GPS data is enabled then a file called IMU8420.gpx is created and valid GPS fix data is logged to this file in GPX format. Note that GPS fix data is also logged to IMU8420.txt along with the MEMs data. GPX files can be dropped into Google Earth and the track viewed if track creation is selected. An example of GPX file format and an actual IMU8420 captured GPX file is shown in Appendix 2 and below.



MediaTek MT3329 GPS Receiver

Support for the GP1 GPS daughter card is now implemented. The GP1 uses the Mediatek MT3329 GPS receiver. The MT3329 outputs one or more NEMA compatible records 1, 5 or 10 times per second. One of several different NEMA records is captured, parsed and appended to the MEMs sensor log. A record type character ('m' 'g' or 'a') is inserted at the beginning of each record to identify if GPS sensor data or other optional data has been appended to the MEMs sensor log. Analysis software uses the record type to determine how to parse the record. Several NEMA records include GMT time. Once the GPS receiver sync's to a sufficient number of satellites precise time is available. Several IMU8420's with GP1's can be precisely time sync'd using the GMT signal.

The following NEMA MediaTek specific records are available. Some records have more information than others. For example, it is possible to log latitude, longitude, altitude, heading and direction tracked by the GPS receiver. The default record that is logged is GPGGA. See the Mediatek MT3329 Technical Manual (included with IMU8420 project folder) for more information.

GPGGA - Time, position and fix type data (default record).
GPGLL - Position and time.
GPVTG - Course and speed information relative to the ground.
GPGSA - GPS receiver operating mode, active satellites used in the position solution and DOP values.
GPRMC - Time, date, position, course and speed data. Recommended Minimum Navigation Information.
GPGSV - The number of GPS satellites in view satellite ID numbers, elevation, azimuth, and SNR values.

The GPS has a top level command menu is entered using the 'g' command. GPS logging can be enabled or disable, baud rate set to 9600, 19200 or 38400, GPS to be recorded set, GMT hour/minute offset and recorded format selected.

Data logging records now have the first character set to either m, g or a indicating a MEMs sensor record, MEMs plus GPS or MEMS plus other data respectively. Parsing software can use the first character to determine how to parse the record. A sample record is appended to the end of document.

uSD Data Logging Configuration Commands

Data logging configuration settings can now be loaded from the uSD using either a default file called "logconfg.txt" or a user defined file. If file logconfg.txt is on the uSD its contents are loaded at power up and acted on. These settings are not loaded automatically into Flash. If the file logconfg.txt is not on the uSD then the contents of Flash are acted on. Most of the data logging menu commands can be placed in the configuration file. Several new commands have been added to support the GPS receiver.

A new top level command 'c' allows the user to load/save/list logging configuration parameters. It is now possible to save several configuration files and load them individually. Six commands are supported:

sd	- save logging parameters to logconfg.txt
sn filename	- save logging parameters to file filename
ld	- load contents of logconfg.txt
ln filename	- save contents of file filename
dd	- list contents of logconfg.txt
dn filename	- list contents of file filename

The Logging configuration file contains parameters followed by a value. Only parameters to be changed need be in the file and can be entered in any order. The following parameters are supported with example entries:

```
data2log agmks
poweruplogmode o
terminatemode h
timeoutperiod 140
timedstartmode y
delaystarttimesec 0
thresholdmode i
thresholds yyyyyyyyy
logrestart n
lograte 5
logrestartmax 32000
storeminmax d
usdfilenamemode u
logfilename imu8420.txt
usdfilenamenumber 1
printoutput y
armswitch n
logekf a
loggpsmode a
loggpstype p
loggpsrecord GPGGA
gpsbaudrate 38400
gpsupdaterate 10
gmthouroffset -7
gmtminuteoffset 0
loggpxmode y
loggpsfixavailable y
logimuifgpsfixavailable n
loggpxrate 10
loggpxmems n
gpsgmtsync n
```

An example logconfg.txt file is included with the new project.

Extended Kalman Filter (EKF)

The output of the Extended Kalman Filter (EKF) can be added as a logged parameter. The EKF outputs roll, pitch and yaw in real time. Enabling EKF logging adds approximately 1.5msec to the data acquisition/processing loop. EKF information is added after the accelerometer, gyrocompass and magnetometer output but before the temperature and barometer.

IMU8420 Data Logger V1.03 Source Code

The latest application was developed using AVR Studio 6.1. The complete source code and project file is available by request.

The project hex file and documentation is available at:

http://www.soc-robotics.com/downloads/IMU8420%20V1.03%20Release.zip

Proposed Version 1.04 Features

The next version will support a tighter integration of GPS data with MEMs sensor data. GPS GMT time will be used to synchronize the IMU8420 clock and GPS heading and height information will be used to adjust the barometer height readings and EKF data. Version 1.04 will support the new version of IMULINK for real time integration with the desktop. GPS and wireless daughter cards will be automatically detected and integrated rather than as a compile time option.

Appendix 1. logconfg.txt Command Summary

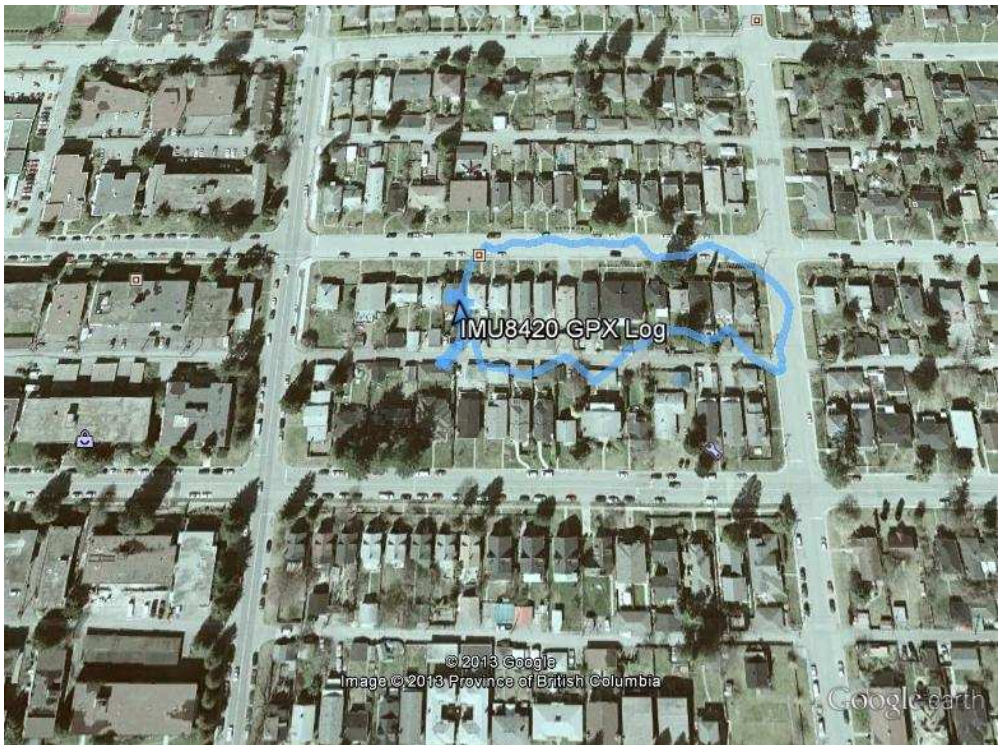
At power up if the file logconfg.txt is on the uSD its' contents are loaded, parsed and the parameters used to control logging function in precedence over defaults or values stored in Flash. Note that logging can start if the correct parameters are set regardless of connection to USB.

```
data2log agmks      - Log accelerometer, gyro, magnetometer, ekf and GPS
poweruplogmode o    - Start logging on power up – o-on/f-off
terminatemode h     - Terminate logging on any key press (must be connected)
timeoutperiod 140   – Stop logging after 140 seconds if time out logging set
timedstartmode y    - Stop starting only if start time delay mode is set
delaystarttimesec 0 – Timed start delay value (seconds)
thresholdmode i     - Start logging if threshold mode active (set to inactive)
thresholds yyyyyyyyy – Thresholds to check – all will be checked
logrestart n        - Automatically restart logging when stopped – yes/no
lograte 5           - Logging rate in mseconds
logrestartmax 32000 – Maximum number of logging restarts
storeminmax d       - Track and log min/max values for each sensor – d-disable
usdfilenamemode u   - Log to uSD file
logfilename imu8420.txt – Log file name – for non incremental appended data
usdfilenamenumber 1 – Starting number for increment file name logging
printoutput y       - Output logged data to the screen as well as file
armswitch n         - Start logging is switch pressed
logekf a            - Log EKF data – also set by data2log value
loggpsmode a        - Log GPS data – a-active, i-inactive
loggpstype p        - Log raw or processed GPS record
loggpsrecord GPGGA  – NEMA record to log
gpsbaudrate 38400   - GPS baudrate – default is 9600 so must switch to 38400
gpsupdaterate 10    - Update rate of GPS logging – set to 1, 5 or 10Hz
gmthouroffset -7    - Hour difference between local time and GMT time
gmtminuteoffset 0   - Minutes difference between local time and GMT time
loggpxmode y        - Create GPX file and log GPS data – default IMU8420.gpx
loggpsfixavailable y – Only log valid fix data to GPX file if y
logimuifgpsfixavailable n – Add MEMs data to GPX file (not implemented yet)
loggpxrate 10       - Rate of GPX data output – once every 10 GPS fixes
loggpxmems n        - Add MEMs data to GPX record
gpsgmtsync n        - Use valid GPS fix GMT to set IMU8420 clock (TBD)
```

Appendix 2. GPX File Format

```
<?xml version="1.0" encoding="UTF-8" standalone="no" ?>

<gpx xmlns="http://www.topografix.com/GPX/1/1"
 xmlns:gpxx="http://www.soc-robotics.com/xmlschemas/GpxExtensions"
 creator="IMU8420" version="1.0" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
 xsi:schemaLocation="http://www.topografix.com/GPX/1/1 http://www.topografix.com/gpx">
 <metadata>
  <link href="http://www.soc-robotics.com">
  <text>SOC Robotics, Inc.</text>
  </link>
<time>2013-10-04T00:00:39Z</time>
 </metadata>
 <trk>
  <name>IMU8420 GPX Log</name>
    <trkseg>
      <trkpt lat="49.326946" lon="-122.932503"> <ele>104.199997</ele> <time>2013-10-
04T00:00:39Z</time> </trkpt>
      <trkpt lat="49.326996" lon="-122.932434"> <ele>104.219994</ele> <time>2013-10-
04T00:00:40Z</time> </trkpt>
      <trkpt lat="49.327045" lon="-122.932365"> <ele>104.239990</ele> <time>2013-10-
04T00:00:41Z</time> </trkpt>
      <trkpt lat="49.327095" lon="-122.932297"> <ele>104.259987</ele> <time>2013-10-
04T00:00:42Z</time> </trkpt>
      <trkpt lat="49.327145" lon="-122.932228"> <ele>104.279984</ele> <time>2013-10-
04T00:00:43Z</time> </trkpt>
      <trkpt lat="49.327194" lon="-122.932159"> <ele>104.299980</ele> <time>2013-10-
04T00:00:44Z</time> </trkpt>
      <trkpt lat="49.327244" lon="-122.932091"> <ele>104.319977</ele> <time>2013-10-
04T00:00:45Z</time> </trkpt>
      <trkpt lat="49.327293" lon="-122.932022"> <ele>104.339973</ele> <time>2013-10-
04T00:00:46Z</time> </trkpt>
      <trkpt lat="49.327343" lon="-122.931953"> <ele>104.359970</ele> <time>2013-10-
04T00:00:47Z</time> </trkpt>
      <trkpt lat="49.327393" lon="-122.931885">
   </trkseg>
 </trk>
</gpx>
```



Appendix 3. GNUPLOT Example

To plot 3 axis accelerometer data in log file 'imu8420.txt' the batch file pa.bat is run.

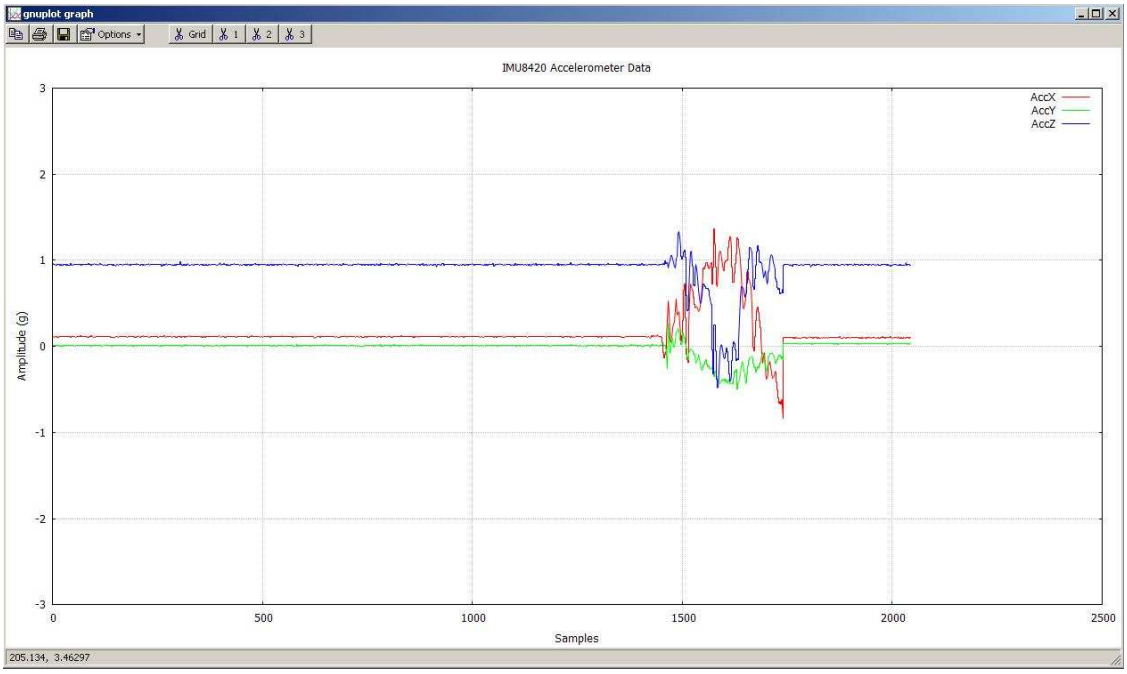
Contents of pa.bat

```
gnuplot -persist <a.txt
```

Contents of a.txt

```
  set term win
  set yrange [-3.000:3.000]
  set title 'IMU8420 Accelerometer Data
  set xlabel 'Samples
  set ylabel 'Amplitude (g)
  set ytics 1
  set mytics 0.1
  set grid
  plot 'imu8420.txt' using 3 with lines ti 'AccX'
  replot 'imu8420.txt' using 4 with lines ti 'AccY'
  replot 'imu8420.txt' using 5 with lines ti 'AccZ'
  pause mouse any
```

This generates the graph below. The '–persist' and 'pause mouse any' parameters keep the image on screen until a mouse or keyboard action causes the app to exit. The acceleration on all three axis are displayed. Hot buttons at the top turn each axis displayed on or off. The Option menu allows the image to be printed, converted to EMF file or copied to the clip board. The yrange parameter sets the y axis range. The plot command draws the contents of each log value. In this case log tokens 4, 5 and 6 pertain to x, y and z axis acceleration respectively.



Appendix 4. Tables of Mediatek NEAM Records

Table-2 contains the values for the following example:
$GPGGA,064951.000,2307.1256,N,12016.4438,E,1,8,0.95,39.9,M,17.8,M,,*65

GGA Data Format			Table-2
Name	**Example**	**Units**	**Description**
Message ID	$GPGGA		GGA protocol header
UTC Time	064951.000		hhmmss.sss
Latitude	2307.1256		ddmm.mmmm
N/S Indicator	N		N=north or S=south
Longitude	12016.4438		dddmm.mmmm
E/W Indicator	E		E=east or W=west
Position Fix Indicator	1		See Table-3
Satellites Used	8		Range 0 to 14
HDOP	0.95		Horizontal Dilution of Precision
MSL Altitude	39.9	meters	Antenna Altitude above/below mean-sae-level
Units	M	meters	Units of antenna altitude
Geoidal Separation	17.8	meters	
Units	M	meters	Units of geoidal separation
Age of Diff. Corr.		second	Null fields when DGPS is not used
Checksum	*65		
<CR> <LF>			End of message termination

Position Fix Indicator	Table-3
Value	**Description**
0	Fix not available
1	GPS fix
2	Differential GPS fix

Table-4 contains the values for the following example:
$GPGSA,A,3,29,21,26,15,18,09,06,10,,,,,2.32,0.95,2.11*00

GSA Data Format			Table-4
Name	**Example**	**Units**	**Description**
Message ID	$GPGSA		GSA protocol header
Mode 1	A		See Table-5
Mode 2	3		See Table-6
Satellite Used	29		SV on Channel 1
Satellite Used	21		SV on Channel 2
....	....	....	....
Satellite Used			SV on Channel 12
PDOP	2.32		Position Dilution of Precision
HDOP	0.95		Horizontal Dilution of Precision
VDOP	2.11		Vertical Dilution of Precision
Checksum	*00		
<CR> <LF>			End of message termination

Mode 1	Table-5
Value	**Description**
M	Manual—forced to operate in 2D or 3D mode
A	2D Automatic—allowed to automatically switch 2D/3D

Table-7 contains the values for the following example:
$GPGSV,3,1,09,29,36,029,42,21,46,314,43,26,44,020,43,15,21,321,39*7D
$GPGSV,3,2,09,18,26,314,40,09,57,170,44,06,20,229,37,10,26,084,37*77
$GPGSV,3,3,09,07,,,26*73

GSV Data Format			Table-7
Name	**Example**	**Units**	**Description**
Message ID	$GPGSV		GSV protocol header
Number of Messages	3		Range 1 to 3 *(Depending on the number of satellites tracked, multiple messages of GSV data may be required.)*
Message Number1	1		Range 1 to 3
Satellites in View	09		
Satellite ID	29		Channel 1 (Range 1 to 32)
Elevation	36	degrees	Channel 1 (Maximum 90)
Azimuth	029	degrees	Channel 1 (True, Range 0 to 359)
SNR (C/No)	42	dBHz	Range 0 to 99, (null when not tracking)
....	....	....	....
Satellite ID	15		Channel 4 (Range 1 to 32)
Elevation	21	degrees	Channel 4 (Maximum 90)
Azimuth	321	degrees	Channel 4 (True, Range 0 to 359)
SNR (C/No)	39	dBHz	Range 0 to 99, (null when not tracking)
Checksum	*7D		
<CR> <LF>			End of message termination

Table-8 contains the values for the following example:
$GPRMC,064951.000,A,2307.1256,N,12016.4438,E,0.03,165.48,260406,3.05,W,A*2C

RMC Data Format			Table-8
Name	**Example**	**Units**	**Description**
Message ID	$GPRMC		RMC protocol header
UTC Time	064951.000		hhmmss.sss
Status	A		A=data valid or V=data not valid
Latitude	2307.1256		ddmm.mmmm
N/S Indicator	N		N=north or S=south
Longitude	12016.4438		dddmm.mmmm
E/W Indicator	E		E=east or W=west
Speed Over Ground	0.03	knots	
Course Over Ground	165.48	degrees	True
Date	260406		ddmmyy
Magnetic Variation	3.05, W	degrees	E=east or W=west **(Need customization service)**
Mode	A		A= Autonomous mode D= Differential mode E= Estimated mode
Checksum	*2C		
<CR> <LF>			End of message termination

Table-9 contains the values for the following example:
$GPVTG,165.48,T,,M,0.03,N,0.06,K,A*37

VTG Data Format			Table-9
Name	**Example**	**Units**	**Description**
Message ID	$GPVTG		VTG protocol header
Course	165.48	degrees	Measured heading
Reference	T		True
Course		degrees	Measured heading
Reference	M		Magnetic *(Need customization service.)*
Speed	0.03	knots	Measured horizontal speed
Units	N		Knots
Speed	0.06	km/hr	Measured horizontal speed
Units	K		Kilometers per hour
Mode	A		A= Autonomous mode D= Differential mode E= Estimated mode
Checksum	*06		
<CR> <LF>			End of message termination

Appendix 2. Example MEMs Sensor Record

MEMs sensor data with record type, time, 3 axis accelerometer and GPS data. The GPS data is appended to the end of the record at a 10Hz rate. Note that the GPS record wraps to the next line in this document but does not in the recorded file. The first character of each record is either a m or g indicating record contents.

```
m 00:38:34.8879  0.105  0.016  0.948
m 00:38:34.8947  0.113  0.012  0.944
m 00:38:34.9013  0.113  0.012  0.944
m 00:38:34.9079  0.117  0.012  0.936
m 00:38:34.9144  0.117  0.012  0.940
m 00:38:34.9210  0.113  0.012  0.940
m 00:38:34.9279  0.113  0.008  0.952
m 00:38:34.9344  0.113  0.008  0.952
m 00:38:34.9410  0.113  0.016  0.944
g 00:38:34.9476  0.109  0.012  0.948 GPGGA 185228.300 4919.6334 N
12304.0940 W 1 5 1.48 152.1 M -16.8 M
m 00:38:34.9547  0.109  0.012  0.948
m 00:38:34.9623  0.113  0.008  0.944
m 00:38:34.9688  0.113  0.016  0.963
m 00:38:34.9754  0.117  0.016  0.940
m 00:38:34.9820  0.117  0.016  0.940
m 00:38:34.9885  0.113  0.008  0.952
m 00:38:34.9954  0.113  0.008  0.952
m 00:38:35.0019  0.113  0.012  0.944
m 00:38:35.0085  0.109  0.012  0.936
m 00:38:35.0151  0.109  0.012  0.936
m 00:38:35.0217  0.113  0.008  0.944
m 00:38:35.0284  0.109  0.012  0.948
m 00:38:35.0351  0.109  0.012  0.948
m 00:38:35.0417  0.117  0.012  0.944
g 00:38:35.0492  0.109  0.012  0.948 GPGGA 185228.400 4919.6316 N
12304.0920 W 1 5 1.48 152.1 M -16.8 M
m 00:38:35.0564  0.109  0.012  0.948
m 00:38:35.0629  0.117  0.008  0.952
m 00:38:35.0695  0.113  0.008  0.952
m 00:38:35.0761  0.113  0.008  0.952
m 00:38:35.0826  0.109  0.023  0.956
m 00:38:35.0895  0.109  0.016  0.944
m 00:38:35.0960  0.109  0.016  0.944
m 00:38:35.1026  0.109  0.020  0.936
m 00:38:35.1091  0.113  0.020  0.932
m 00:38:35.1157  0.113  0.020  0.932
m 00:38:35.1233  0.113  0.004  0.948
m 00:38:35.1298  0.117  0.016  0.948
m 00:38:35.1364  0.117  0.016  0.948
m 00:38:35.1430  0.109  0.008  0.952
g 00:38:35.1496  0.117  0.008  0.932 GPGGA 185228.500 4919.6291 N
12304.0887 W 1 5 1.48 152.2 M -16.8 M
m 00:38:35.1569  0.117  0.008  0.932
m 00:38:35.1634  0.117  0.012  0.928
m 00:38:35.1700  0.109  0.012  0.948
m 00:38:35.1766  0.109  0.012  0.948
m 00:38:35.1832  0.109  0.020  0.944
m 00:38:35.1900  0.109  0.012  0.944
m 00:38:35.1966  0.109  0.012  0.944
m 00:38:35.2039  0.117  0.016  0.948
m 00:38:35.2105  0.109  0.016  0.936
m 00:38:35.2171  0.109  0.016  0.936
m 00:38:35.2239  0.109  0.012  0.952
```