DTM Sentence

Talker ID: GNSS Receiver	Sentence Content: Datum reference information	Local datum code †	††	Latitude offset in minutes †††		Longitude offset in minutes †††		†††	Altitude Offset, meters †††	Reference Datum ††††	Check Sum
$GN	DTM	,P90	,,	0000.000026	,S	,00000.000002	,E		,0.977	,W84	*51

Ortho Height (H)
h = height above ellipsoid
H = orthometric height
N = geoidal separation

H = h - N

Geoidal separation (N)
h = height above ellipsoid
H = elevation, orthometric height
N = geoidal separation or geoidal height

N = h - H

GGA Sentence

Talker ID: GNSS Receiver	Sentence Content: Time, position and fix-related data	UTC of position fix (hhmmss.ss)	Latitude (ddmm.mmmmm)	N or S	Longitude (dddmm.mmmmm)	E or W	♦	Satellites in use	HDOP ♦♦	Ortho Height (H)	Meters	Geoidal separation (N) ♦♦♦	Meters	♦♦♦♦ ♦♦♦♦₂	Check Sum
$GN	GGA	,192527.00	,4432.671782	,N	,06825.027936	,W	,1	,12	,0.7	,66.3	,M	,-45.0	,M	,,	*7D

GNS Sentence

Talker ID: GNSS Receiver	Sentence Content: GNSS fix data	UTC of position fix (hhmmss.ss)	Latitude (ddmm.mmmmm)	N or S	Longitude (dddmm.mmmmm)	E or W	Mode Indicator ‡	Satellites in use	HDOP ‡‡‡	Ortho Height (H)	Geoidal separation meters (N) ‡‡‡‡	‡‡1	‡‡2	?	Check Sum
$GN	GNS	,192526.14	,4432.671759	,N	,06825.027904	,W	,AAANNN	,19	,0.7	,66.5	,-45.0	,	,	,V	*2C

GN = GNSS
GP = GPS only
GL = GLO only

NMEA 0183 Standards used here are from online sources[1], use with discretion.

1 Trimble; NVS Technologies; NMEA Revealed; Pratiques et Techniques de la Plaisance; note that these sources may contain dated information

Earth surface

h

H

N

ELLIPSOID

geopotential surface

Illustration by V. Kelly Bellis, PLS
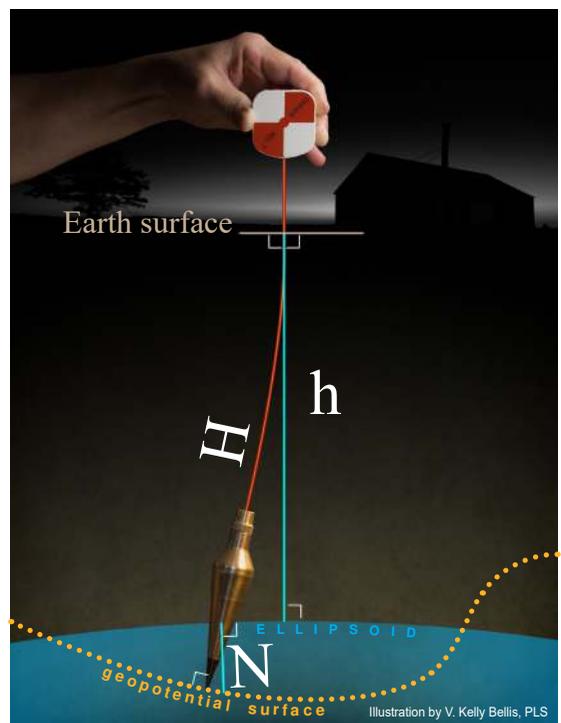
What's Up with Android's Heights?

Have you ever looked at your smartphone's displayed ground elevation, often referred to as Alt MSL, and wondered if something wasn't quite correct? Well, trying to get to the bottom of it will take a little effort, but thanks to the growing list of Android apps capable of capturing NMEA sentences, most of the work is in deciphering the terse NMEA messages.

DTM - Datum Reference

Local geodetic datum and datum offsets from a reference datum. This sentence is used to define the datum to which a position location, and geographic locations in subsequent sentences, is referenced. Latitude, longitude and altitude offsets from the reference datum, and the selection of reference datum, are also provided.

Cautionary Note:
The datum sentence should be transmitted immediately prior to every positional sentence (e.g., GLL, BWC, WPL) which is referenced to a datum other than WGS84, which is the datum recommended by IMO.
For all datums the DTM sentence should be transmitted prior to any datum change and periodically at intervals of not greater than 30 seconds.

† Local datum code

```
Code  Local Datum
W84   WGS84
W72   WGS72
S85   SGS85
P90   PE90 (PZ-90)
999   User defined
IHO   IHO datum code
```

Three character alpha code for local datum. If not one of the listed earth-centered datums, or 999 for user defined datum, use IHO datum code from International Hydrographic Organization Publication S-60 Appendices B and C. Null field if unknown.

Users should be aware that chart transformations based on IHO S60 parameters may result in significant positional errors when applied to chart data.

†† Local datum subcode

One character subdivision datum code when available or user defined reference character for user defined datums, null field otherwise. Subdivision character from IHO Publication S-60 Appendices B and C.

††† Alt, Lat, & Long Offsets

Latitude and longitude offsets are positive numbers, the altitude offset may be negative. Offsets change with position; position in the local datum is offset from the position in the reference datum in the directions indicated:

$$P_{local\ datum} = P_{ref\ datum} + offset$$

†††† Reference datum code

```
Code  Local Datum
W84   WGS84
W72   WGS72
S85   SGS85
P90   PE90 (PZ-90)
```

There are 2 primary sentence types to look for, GGA and GNS as they contain the geoidal separation values[1] from which the orthometric (H) values are derived. To discover the correct geoidal separation (N) value for your location, search online for interactive calculation tools[2], and then compare it to the value in the NMEA

1 Geoid models that are used by chipset manufacturers and OEMs may vary
2 E.g., xGEOID20 Interactive Computation Page; Computation of GEOID18 Geoid Height; GeoidEval; Geoid Height Calculator EGM96;

GGA - Global Positioning System Fix Data

Time, position and fix related data for a GPS receiver.

♦ GPS Quality Indicator

Mode Indicator. A variable length valid character field type with the first two characters currently defined. The first character indicates the use of GPS satellites, the second character indicates the use of GLONASS satellites. If another satellite system is added to the standard, the mode indicator will be extended to three characters, new satellite systems shall always be added on the right, so the order of characters in the Mode Indicator is: GPS, GLONASS, other satellite systems in the future. The characters shall take one of the following values:

```
Code  Meaning
0     Fix not available or invalid
1     GPS SPS Mode, fix valid
2     Differential GPS, SPS Mode, fix valid
3     GPS PPS Mode, fix valid
4     Real Time Kinematic. System used in RTK mode with fixed integers
5     Float RTK. Satellite system used in RTK mode, floating integers
6     Estimated (dead reckoning) Mode
7     Manual Input Mode
8     Simulator Mode
```

The GPS Quality Indicator shall not be a null field.

♦♦ HDOP

HDOP calculated using all the satellites (GPS, GLONASS, and any future satellites) used in computing the solution reported in each GNS sentence.

♦♦♦ Geoidal Separation

Geoidal Separation: the difference between the earth ellipsoid surface and mean-sea-level (geoid) surface defined by the reference datum used in the position solution, "-" = mean-sea-level surface below ellipsoid. The reference datum may be specified in the DTM sentence.

♦♦♦♦ Age of differential data and Differential Reference Station ID:

1.) *Age of Differential GNSS data. Time in seconds since last SC104 Type 1 or 9 update, null field when DGPS is not used.*
2.) *Differential reference station ID, 0000-1023. Null field when DGNSS is not used*

My ask of you

There are many Android apps capable of logging NMEA messages. You will need only one for this request: 2 to 3 minutes worth of static data on any station under open view of the sky. If you're undecided, these 3 apps offer NMEA logging, and much more: GPSTest (barbeauDev); GnssLogger (Google); Ultra GPS Logger (FlashLight)

*Email your results with any screenshots, and please include the name of the manufacturer, make and model of your android device to kellybellis at gwi.net with the subject: **NMEA data for you!**, and thank you very much for your participation!*

sentence. The DTM message is also worth looking at as it can play a role in determination of heights[3].

Most apps will give you your ellipsoid height (h), often referred to as Alt, and some apps may only display this value.

and my personal favorite free stand alone PC application, VDatum.

3 Local geodetic datums and datum offsets from the reference datum used by chipset manufacturers and OEMs may vary

GNS -GNSS Fix Data

Fix data for single or combined satellite navigation systems (GNSS). This sentence provides fix data for GPS, GLONASS, possible future satellite systems, and systems combining these. This sentence could be used with the talker identification of GP for GPS, GL for GLONASS, GN for GNSS combined systems, as well as future identifiers. Some fields may be null fields for certain applications, as described below.

If a GNSS receiver is capable simultaneously of producing a position using combined satellite systems, as well as a position using only one of the satellite systems, then separate $GPGNS and $GLGNS sentences may be used to report the data calculated from the individual systems.

If a GNSS receiver is set up to use more than one satellite system, but for some reason one or more of the systems are not available, then it may continue to report the positions using $GNGNS, and use the mode indicator to show which satellite systems are being used.

‡ Mode Indicator

Mode Indicator. A variable length valid character field type with the first two characters currently defined. The first character indicates the use of GPS satellites, the second character indicates the use of GLONASS satellites. If another satellite system is added to the standard, the mode indicator will be extended to three characters, new satellite systems shall always be added on the right, so the order of characters in the Mode Indicator is: GPS, GLONASS, other satellite systems in the future. The characters shall take one of the following values:

```
Code  Meaning
N     No fix. Satellite system not used in position fix, or fix not valid
A     Autonomous. Satellite system used in non-differential mode in position fix
D     Differential. Satellite system used in differential mode in position fix
P     Precise. Satellite system used in precision mode. Precision mode is defined as: no deliberate degradation (such as Selective Availability) and higher resolution code (Pcode) is used to compute position fix
R     Real Time Kinematic. Satellite system used in RTK mode with fixed integers
F     Float RTK. Satellite system used in real time kinematic mode with floating integers
E     Estimated (dead reckoning) Mode
M     Manual Input Mode
S     Simulator Mode
```

The Mode Indicator shall not be a null field.

‡‡ Age of differential data and Differential Reference Station ID:

1.) *When the talker is GN and more than one of the satellite systems are used in differential mode, then the "Age of differential data" and "Differential reference station ID" fields shall be null. In this case, the "Age of differential data" and "Differential reference station ID" fields shall be provided in following GNS sentences with talker IDs of GP, GL, etc. These following GNS messages shall have the latitude, N/S, longitude, E/W, altitude, geoidal separation, mode, and HDOP fields null. This indicates to the listener that the field is supporting a previous $GNGNS sentence with the same time tag. The "Number of satellites" field may be used in these following sentences to denote the number of satellites used from that satellite system.*

Example: A Combined GPS/GLONASS receiver using only GPS differential corrections has the following GNS sentence sent.
`$GNGNS,122310.2,3722.425671,N,12258.856215,W,DA,14,0.9,1005.543,6.5,5.2,23*59<CR><LF>`

Example: A Combined GPS/GLONASS receiver using both GPS differential corrections and GLONASS differential corrections may have the following three GNS sentences sent in a group.
`$GNGNS,122310.2,3722.425671,N,12258.856215,W,DD,14,0.9,1005.543,6.5,,*74<CR><LF>`
`$GPGNS,122310.2, , , , , , ,7, , , ,5.2,23*4D<CR><LF>`
`$GLGNS,122310.2, , , , , , ,7, , , ,3.0,23*55<CR><LF>`

2.) *Age of Differential Data*
   a.) *For GPS Differential Data:*
      i.) *This value is the average age of the most recent differential corrections in use. When only RTCM SC104 Type 1 corrections are used, the age is that of the most recent Type 1 correction. When RTCM SC104 Type 9 corrections are used solely, or in combination with Type 1 corrections, the age is the average of the most recent corrections for the satellites used. Null field when Differential GPS is not used.*
   b.) *For GLONASS Differential Data:*
      i.) *This value is the average age of the most recent differential corrections in use. When only RTCM SC104 Type 31 corrections are used, the age is that of the most recent Type 31 correction. When RTCM SC104 Type 34 corrections are used solely, or in combination with Type 31 corrections, the age is the average of the most recent corrections for the satellites used. Null field when differential GLONASS is not used.*

‡‡‡ HDOP

HDOP calculated using all the satellites (GPS, GLONASS, and any future satellites) used in computing the solution reported in each GNS sentence.

‡‡‡‡ Geoidal Separation

Geoidal Separation: the difference between the earth ellipsoid surface and mean-sea-level (geoid) surface defined by the reference datum used in the position solution, "-" = mean-sea-level surface below ellipsoid. The reference datum may be specified in the DTM sentence.