
GPS for amateur radio:

Location reporting for emergencies and public service using devices you already own

May 7, 2020

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Correctly understanding GPS coordinates for ham radio is an important skill for incidents...and your safety

- **Our objectives today:**

- **Getting the correct GPS coordinates with existing equipment to report incidents and keep you safe**
 - **Public safety dispatch systems based on street addresses**
 - **Not all places have street addresses (or hard to find)**
- **Recent and future changes in GPS systems**
- **Awareness of proprietary coordinate schemes**
- **Amateur radio experiences with GPS coordinates**

First, a few GPS basics

GPS Coordinates come from satellite signals...and cell sites

- **U.S. pioneered GPS: now 27 3rd-gen satellites at 12,600 mi. up**
 - **Frequencies: 1.57542 GHz, 1.22760 GHz**
- **Other countries later developed own GPS systems**
 - **Russia: GLONASS (24 satellites fully operational)**
 - **China: BeiDou (33 satellites, fully worldwide in 2018)**
 - **Europe: Galileo (30 satellites fully worldwide in 2020)**
 - **Japan: Quasi-Zenith (4 satellites now, 7 by 2023)**

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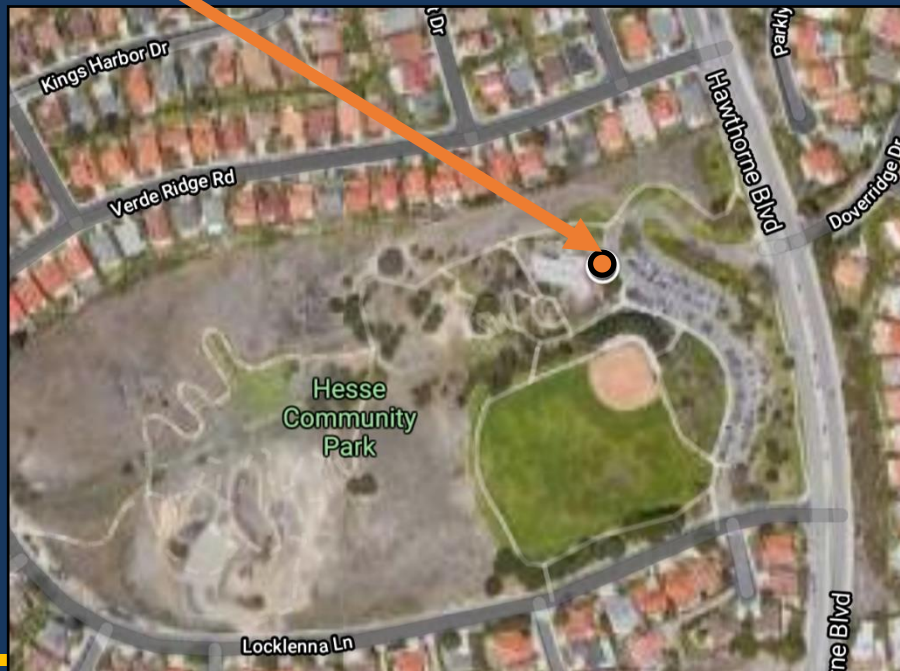
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- **Smartphones get GPS from cell towers...or direct from satellites**

The main civilian GPS formats have different user bases...you might need to do some translation

GPS Coordinates...unraveling the complications and avoiding errors

- We'll show coordinates for entrance to Hesse Park's building in five different GPS formats



Three main civilian GPS formats have different user bases...you might need to translate between formats

GPS formats for Hesse Park building front door entrance

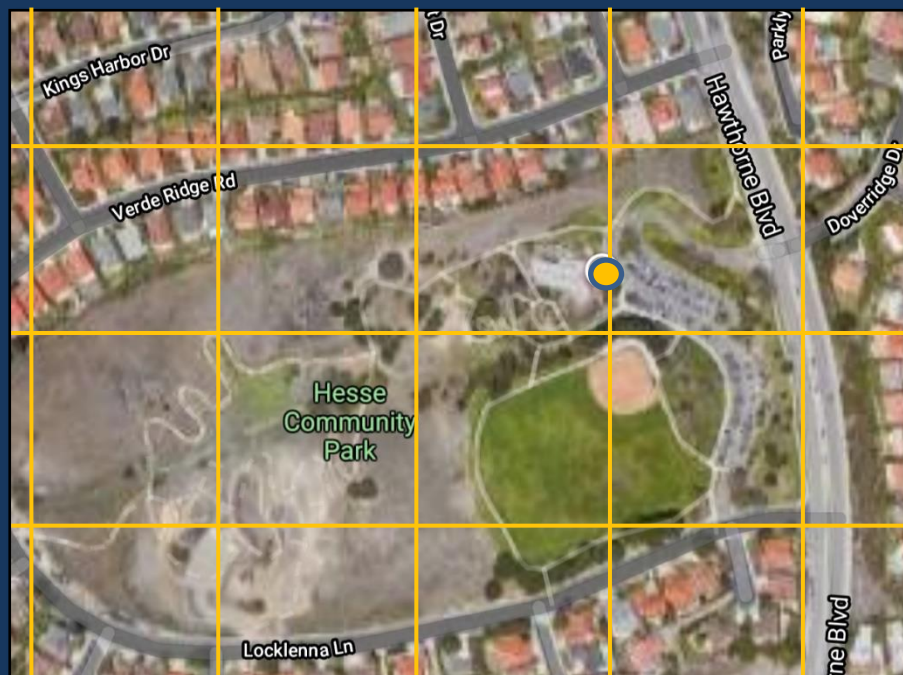
GPS Format ➔	Degrees, Minutes, Seconds	Degrees, Decimal Minutes	Decimal Degrees
Appears as:	<p>33° 46' 04" N 118° 23' 33" W <i>(or)</i> 33° 46' 04.15" N 118° 23' 32.94" W</p>	<p>33° 46.069' N 118° 23.549' W <i>(sometimes truncated)</i></p>	<p>33.767818 -118.392483</p>
Principal users of format:	<ul style="list-style-type: none"> ▪ Printed maps ▪ Hikers / campers ▪ Phone compass 	<ul style="list-style-type: none"> ▪ Maritime / boating ▪ Amateur radio (APRS) 	<ul style="list-style-type: none"> ▪ Aviation ▪ Apple Maps ▪ Google Maps ▪ MS (Bing) Maps

GPS coordinates in Degrees, Minutes, Seconds rooted in printed maps and atlases

The traditional DD MM SS format lends itself to creating grids
(note: W longitude also expressed with “-” before Degrees)

Hesse Park building front door entrance

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GPS coordinates in Degrees Decimal Minutes became ham radio's standard because of APRS

- Ham radios with GPS and Automatic Position Reporting System use DD MM.MM, but risk confusion with DD MM SS

Hesse Park building front door entrance

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Principal users of format:	<ul style="list-style-type: none">▪ Maritime / boating▪ Amateur radio (APRS)



- National Marine Electronics Assoc. standard
- Yaesu, Kenwood, Icom use this GPS format

GPS in Decimal Degrees likely future winner with integration to mapping, distance calculations

No ambiguity transmitting Decimal Degrees. Used with online maps and most aviation GPS systems handle all three formats

Hesse Park building front door entrance

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Appears as:	33.767818 -118.392483
Principal users of format:	<ul style="list-style-type: none">▪ Aviation▪ Apple Maps▪ Google Maps▪ MS (Bing) Maps




Unlike legacy ham brands, the AnyTone 878UV DMR HT radio has built-in GPS using Decimal Degrees...and BeiDou

Hams involved with Search And Rescue in the U.S will use Universal Transverse Mercator format

Hams might encounter two non-civilian GPS formats

- UTM splits Earth into 60 Zones each 6° longitude wide (*number*)
- Each UTM Zone has 20 Latitude Bands, each 8° high (*letter*)
- UTM square is Zone & Lat. Band; distances are from West & So.

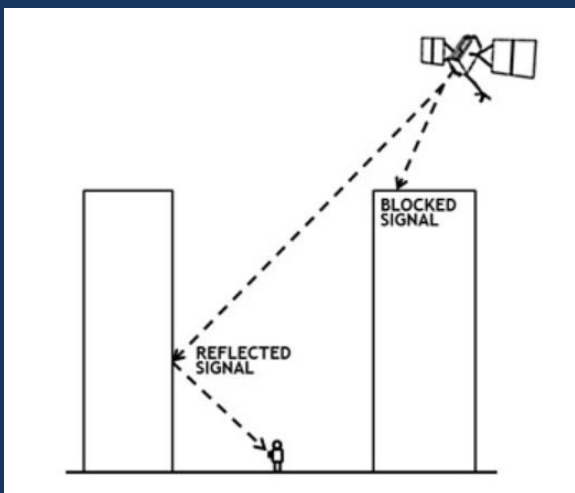
GPS Format →	Decimal Degrees	Universal Transverse Mercator (UTM)	Military Grid Reference System
Appears as:	33.767818 -118.392483	Easting: 371053.5 Northing: 3737283.6 Zone: 11S, north of Equator	11S LT 71053 37283 (Letters like “LT” are the 100,000 meter square ID)
Principal users:	<ul style="list-style-type: none"> ▪ Aviation ▪ Apple Maps ▪ Google Maps ▪ MS (Bing) Maps 		<ul style="list-style-type: none"> ▪ Military ▪ Not for general consumer use

How should hams get GPS coordinates?

Your smartphone is best even if no cell service

GPS Coordinates...unraveling the complications

- Most recent smartphones have GPS receiver, no need to buy separate GPS, but need a GPS app
- Report GPS coordinates using format you have
- Stand in open area away from buildings to avoid error
- Hold smartphone flat, wait two minutes for satellites to lock



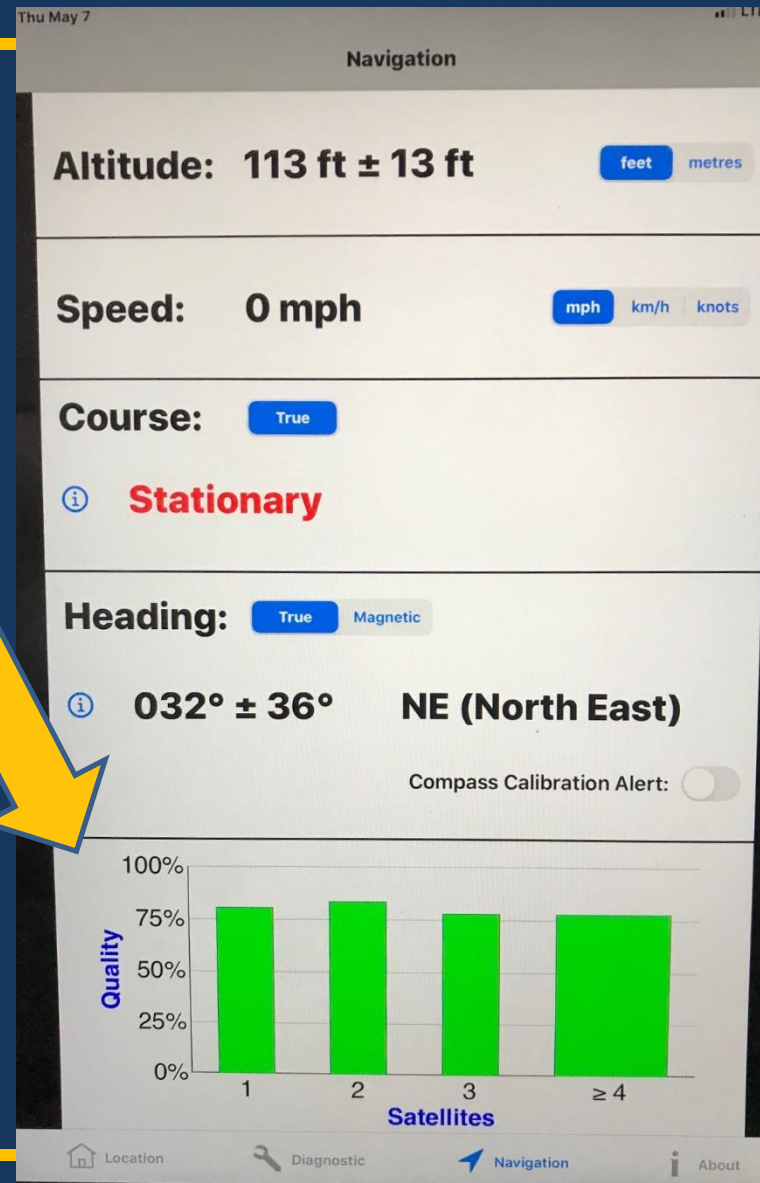
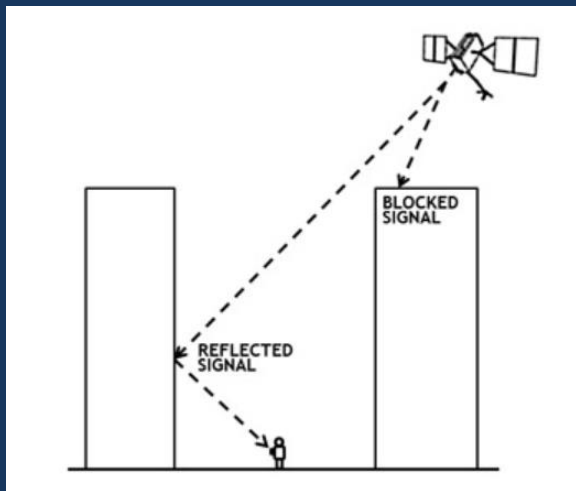
Causes of GPS error:

- Blocked signals
- Multi-path reflections off buildings
- Indoor / underground use
- Solar storms
- Signal jamming
- Inherent accuracy of GPS device

Also get a smartphone app like GPS Diagnostic that measures satellite signal strength

Weaker satellite signals may cause location errors

- If any of the four satellites have weak signal it might indicate reflection or shielding
- Measure location again



A low-cost GPS alternative to a smartphone is building a simple GPS receiver using readily-available parts

Jerry, NG6R, showed how he built a GPS receiver for under \$20.00 (see March 2020 QRO newsletter)

- Combines Arduino NANO processor with a GPS module
- Uses existing code library TinyGPS++ to parse satellite data



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Consumer GPS accuracy has improved greatly but other error factors are in your device

Comparative system accuracy (currently claimed)

System	Accuracy (meters) Civilian	Accuracy (meters) Military
GPS <i>(USA)</i>	5.00	0.71
Glonass <i>(Russia)</i>	4.50 – 10.00 (best at high latitudes)	0.60
BeiDou <i>(China)</i>	5.00	0.10
Galileo <i>(E.U.)</i>	1.00	0.01

As rescue beacons/vehicles implement these GPS systems, SAR's role becomes more "Rescue"

Search and rescue features in beacons or vehicles

System	Upcoming SAR characteristic	2 nd characteristic
GPS <i>(USA)</i>	By 2024: L5 signal, higher power + wider bandwidth= wider area & <1-m accuracy	--
Glonass <i>(Russia)</i>	ERA-GLONASS: in new vehicles since 2017 to detect / report crashes	--
BeiDou <i>(China)</i>	--	--
Galileo <i>(E.U.)</i>	Beacons will find missing boaters/hikers/pilots in < 10 minutes. vs. 3 hours currently	In 2018+ EU new car / van models to detect / report crashes

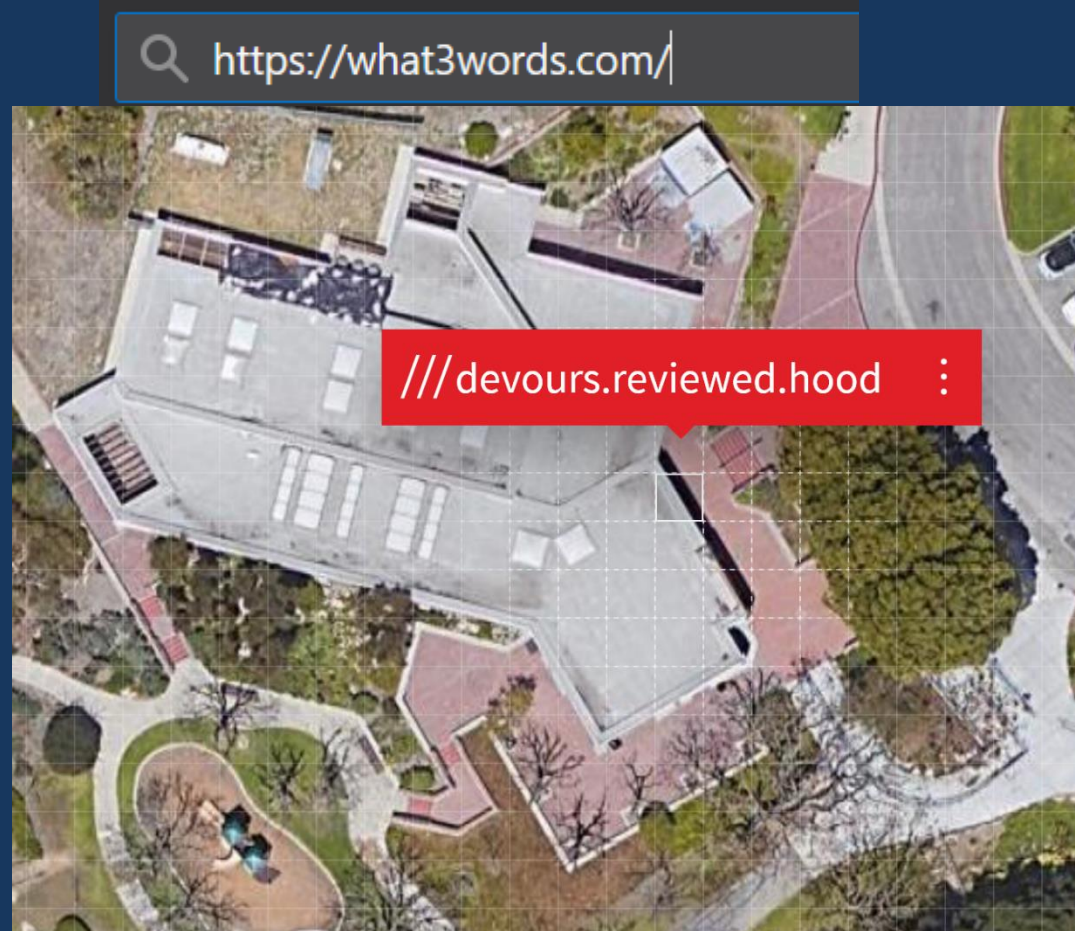
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Decimal Degrees seems simple enough but proprietary “What3Words” aims to be simpler (or is it?)

Other GPS formats can add length to voice traffic

- British geocoding format “What3Words” divides Earth into 57 trillion 3-meter squares
- ~ 40,000 words locate anywhere on Earth using three-word combinations
 - Conceived by a concert promoter
 - Gaining acceptance in Europe
 - Free to consumers
 - Businesses pay
 - Might work offline in apps

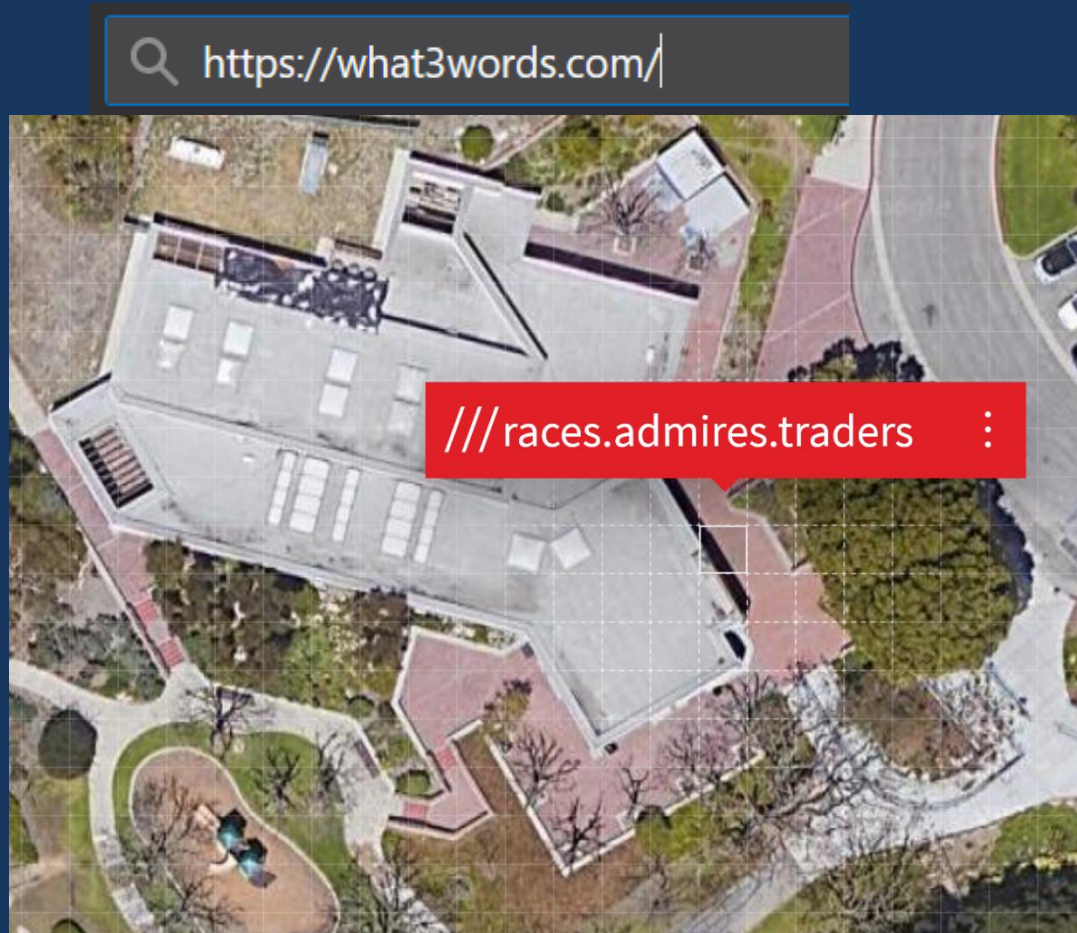


**What3Words address for Hesse
Park front door entrance**

Moving just a few feet produces a completely different set of “What3Words”

W3W needs a separate vocabulary for each language

- British geocoding format “What3Words” divides Earth into 57 trillion 3-meter squares
- ~ 40,000 words locate anywhere on Earth using three-word combinations, need to use phonetics in transmitting messages



What3Words address for bottom of Hesse Park steps to door

Google developed an open-source geocoding format, different from anything else, that works in emergencies

- Google Maps “Plus Codes” provide addresses where none exist (plus a town or city name)
- Estimated 50% of world urban population has no street address

Six characters define 14x14-m grids

A seventh character can be added for 3x3-m accuracy

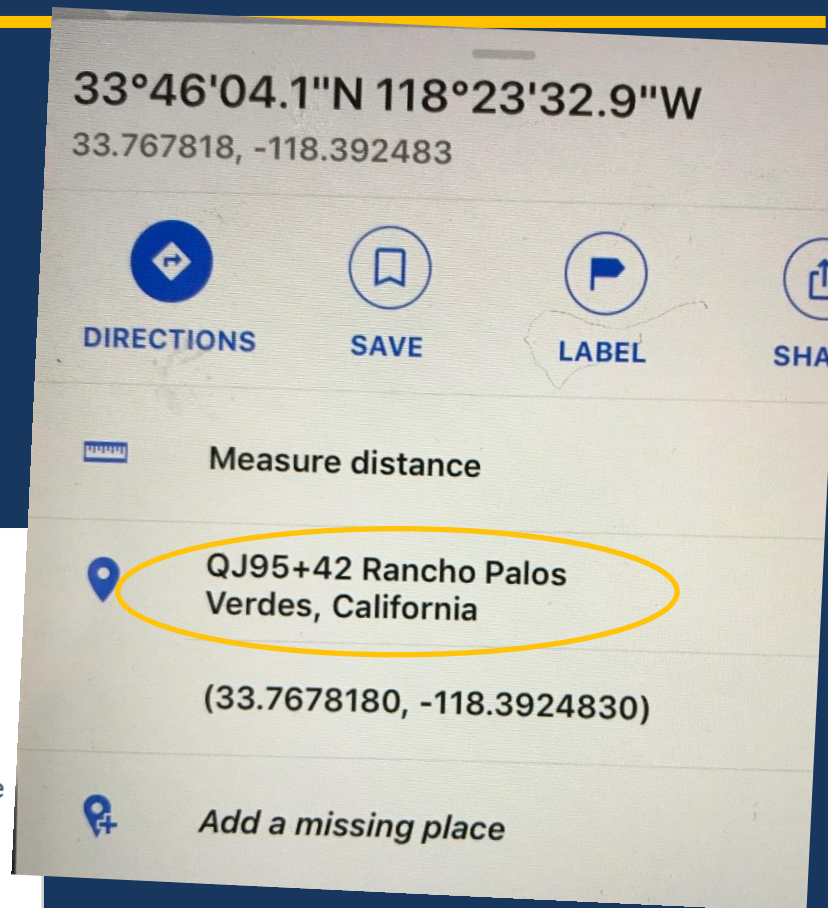
Find and share places using plus codes

Plus codes work just like street addresses. When an address isn't available, you can use a plus code to find or share a place on Google Maps, like your home or business.

A plus code includes:

- 6 or 7 letters and numbers
- A town or city

Here's an example of a plus code: `X4HM+3C`, Cairo, Egypt.



Google Plus Code for Hesse Park front door entrance

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Suggestions for hams who might use GPS in emergencies or public service

Using GPS

- Load a Map App on your devices
- Get a GPS coordinate app (or two) on your phone/tablet
 - Turn on phone or tablet “Location Services” to use
 - ...Be advised this drains battery more rapidly
- Download/save maps of your city and adjoining areas
- During event: Map and plot without cell / internet service
 - Locations of fellow members
 - Incident sites, other places
- For Decimal Degrees by voice: read decimal in three-digit groups
 - -118.176270 = “Minus 118 point 176...270”
 - Very brief pause greatly helps comprehension

You generally should not convert GPS coordinates between formats if relaying them in a message

GPS Coordinates and amateur radio

- **Never convert GPS coordinates in a relayed message for others...transmit coordinates as received**
- **Among ourselves hams may use whatever format they have, their net control can convert to what's needed.**
- **GPS valuable for many purposes**
 - **Lets your radio group know where you or others are**
 - **Report emergencies / incidents**
 - **Provide signal reports with accurate locations**
 - **Coordinating activity with others**

How GPS gets used in amateur radio also includes non-emergency applications

GPS in amateur radio

- Being GPS prepared for EmComm use is valuable skill
- Hams serving with Search and Rescue units communicate GPS coordinates extensively
- Some L.A. County Disaster Communication Service units practice GPS coordinates regularly

- APRS used in many ham radio events
 - Tracking vehicles or participants
 - Helium balloon tracking
- FT-8 and FT-4 digital modes: need highly accurate time clocks

GPS for amateur radio:

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Thanks for watching