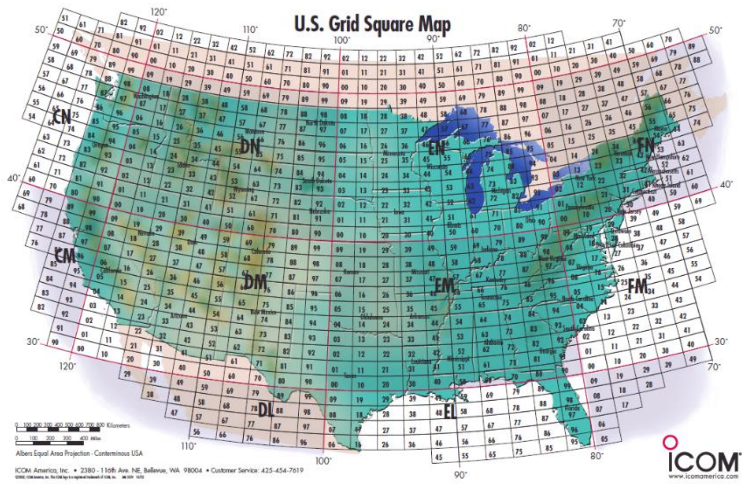
The Maidenhead Grid System

Bruce E. Hall, W8BH



In the Maidenhead grid system, longitude and latitude are divided into 18 bands, creating a world grid of 324 zones called Fields. Each field is divided into 100 smaller units, called Squares. Therefore, there are 32,400 grid squares in all. Each square is 1 degree latitude and 2 degrees longitude in size, which at moderate latitudes is an area of 170 x 220 km (70 x 100 miles).

A Maidenhead locator consists of a short string of characters. The first two characters are letters, “A” through “R”, corresponding to longitude and latitude, respectively. For example, my QTH field is “EM”, an area that covers roughly a quarter of the US. Squares within the field are represented by 2 additional digits, 00-99. The first digit represents longitude and the second represents latitude. My grid square is EM79. There are 488 grid squares in the contiguous US, as shown above.

Each square is further divided into 576 sub-squares, represented by two additional characters, ‘aa’ through ‘xx’. The sub-square designators are often shown in lower-case, rather than upper-case, to distinguish them from the field designators. My sub-square is EM79vr. Sub-squares cover an area of roughly 7 x 9 km (4 x 6 miles).

Smaller divisions are possible but infrequently used. Sub-squares are divided into 100 extended squares, numbered 00 through 99, each about 700 x 900 meters in size. A fifth division into 576 extended-extended or “super-extended” squares specify very small regions about 30 x 40 meters in size. An example of a super-extended locator is “FM18lv53SL”.

Just a note on how to determine grid square size: the circumference of Earth is about 40M meters. Pole to pole is half of this, or 20M meters. Therefore, each degree of latitude covers 20M/180 = 111.111 km = 69 miles. Each degree of longitude at the equator = 40M/360, which is also 111.111 km = 69 miles. As you get closer to the poles, however, those vertical lines of longitude get closer together. Distance per degree varies according to the cosine of latitude, and equals 111.111 km * cos (latitude). At my QTH of about 40 degrees latitude, one degree longitude covers 85 km or 52.9 miles.

How to calculate Grid Square from Lat/Long:

The good news is that you don’t have to. There are plenty of resources on the web. For example:

From Lat/Long: https://www.amsat.org/amsat-new/tools/grids.php
From City or Ham Call: https://www.levinecentral.com/ham/grid_square.php
Mapping super-extended (10 character) grid squares: https://k7fry.com/grid/

If you really want to know how to do it, however, here is a detailed example:

Washington Monument

Lat/Long: (38.889484, -77.035278)

LOC: FM18lv53SL

The 10-character grid square contains five pairs of coordinates: FM, 18, lv, 53, and SL. Each pair corresponds to long/lat coordinates within increasingly smaller regions. Use the following 3-step process to calculate each of the five pairs.

FIRST COORDINATE PAIR ("FM"):

1. Add 180 to long and 90 to lat, making their ranges positive:

   Long = -77.035278 + 180 = 102.964722

   Lat = 38.889484 + 90 = 128.889484

2. Divide Lon by 20 and Lat by 10 to get the first pair of coordinates, which will represent a Field 20 x 10 degrees in size:

   Lon1 = 102.964722/20 = 5.1482361

   Lat1 = 128.889484/10 = 12.889484

3. Use the integer parts of these numbers as the field coordinates ("FM"). Notice that A=0, B=1, and so on.

   Lon1 = 5 ("F")

   Lat1 = 12 ("M")

SECOND COORDINATE PAIR ("18"):

4. "F" represents the fifth longitude band, beginning at 5*20 = 100 degrees. "M" represents the 12th latitude band, beginning at 12*10 = 120 degrees. Subtract these values from the current Lat/Long values to get the remainders. You can think of these remainder values as the coordinates within the FM field.

   LonR = 102.964722 - 100 = 2.964722

   LatR = 128.889484 - 120 = 8.889484

5. Divide Lon by 2 and Lat by 1 to get the second pair of coordinates that represents a grid square 2 degrees by 1 degree in size:

   Lon2 = 1.1482361

   Lat1 = 8.889484

6. Use the integer part of each number as the grid coordinates ("FM18")

   Lon2 = 1

   Lat2 = 8

THIRD COORDINATE PAIR ("lv"):

7. As in step 4, get the long/lat remainders by subtracting the integer amounts. This will leave you with the coordinates within the grid square:

   LonR = 2.964722 - (1*2) = 0.964722

   LatR = 8.88984 - (8*1) = 0.889484

8. The third pair of coordinates divides each 2 x 1 degree grid square into 576 sub-squares that are each 5 minutes x 2.5 minutes in size. We will need to divide both by the size of the sub-square, which is 1/12th and 1/24th of a degree (which is the same as multiplying by 12 and 24), respectively:

   Lon3 = 0.964722 * 12 = 11.576664

   Lat3 = 0.889484 * 24 = 21.347616

9. Use the integer part of each number as the sub-square coordinates ("FM18lv")

   Lon3 = 11 (L)

   Lat3 = 21 (V)

This sub-square level ("FM18lv") is precise enough for most ham radio applications. Continue the same process to determine the extended and super-extended squares.

FOURTH COORDINATE PAIR (“53”):

10. As in steps 4 and 7, get the long/lat remainders by subtracting the integer amounts. This will leave you with the coordinates within the grid square:

    LonR = 0.964722 - (11/12) = 0.048055

    LatR = 0.889484 - (21/24) = 0.014484
11. The fourth pair of coordinates divides each sub-square into 100 extended squares that are 30 seconds x 15 seconds in size. We will need to divide both by the size of the extended square, which is 1/120th and 1/240th of a degree (which is the same as multiplying by 120 and 240), respectively:

    Lon3 = 0.048055 * 120 = 5.76660

    Lat3 = 0.014484 * 240 = 3.47616
12. Use the integer part of each number as the extended square coordinates (“FM18lv53”)

    Lon3 = 5

    Lat3 = 3

FIFTH COORDINATE PAIR (“SL”):

13. As in steps 4, 7, and 11, get the long/lat remainders by subtracting the integer amounts. This will leave you with the coordinates within the extended square:

    LonR = 0.048055 - (5/120) = 0.006388

    LatR = 0.014484 - (3/240) = 0.001984
14. The fifth pair of coordinates divides each extended square into 576 super-extended squares that are 1.25 seconds x 0.625 seconds in size. We will need to divide both by the size of the super-extended square, which is 1/2880th and 1/5760th of a degree (which is the same as multiplying by 2880 and 5760), respectively:

    Lon3 = 0.006388 * 2880 = 18.398

    Lat3 = 0.001984 * 5760 = 11.427
15. Use the integer part of each number for the final coordinate pair (“FM18lv53SL”)

    Lon3 = 18 (“S”)

    Lat3 = 11 {“L”)

Do the reverse: calculate Long/Lat from Grid Square “FM18lv53SL”

1. Divide locator into Longitude Locator “F1l5S” and Latitude Locator “M8v3L”.
2. Set up tables for both:

Grid Char	Units	Degrees/Unit	Degrees = Units * Deg/Unit
F	5	20	100
1	1	2	2
l	11	0.0833333	0.91666
5	5	0.0083333	0.04166
S	18	0.0003472	0.00625

Grid Char	Units	Degrees/Unit	Degrees = Units * Deg/Unit
M	12	10	120
8	8	1	8
v	21	0.0416666	0.875000
3	3	0.0041666	0.012500
L	11	0.0001736	0.001910

3. Add up degree contributions (last column of each table):
    a. Long = 100 + 2 + 0.9167 + 0.0417 + 0.0063 = 102.9647
    b. Lat = 120 + 8 + 0.8750 + 0.0125 + 0.0019 = 128.8894

4. For the final result, subtract 180 from Lon, 90 from Lat:
    a. Long = -77.0353
    b. Lat = 38.8894