The M-Factor – What Is It and How Do You Calculate It?

Carl Luetzelschwab K9LA

The M-factor is defined as the MUF (maximum usable frequency) divided by the critical frequency (highest frequency sent straight up that is reflected back to Earth). The M-factor most used in propagation is for a 3000 km hop via the F_2 region. If you know the critical frequency foF_2 and the M-factor (two parameters reported by ionosondes), multiply them together to get the 3000 km MUF over the ionosonde.

The M-factor is inversely proportional to the sine of the angle of incidence on the ionosphere. A first-order approximation of the M-factor can be made using a model of the spherical Earth-ionosphere geometry.

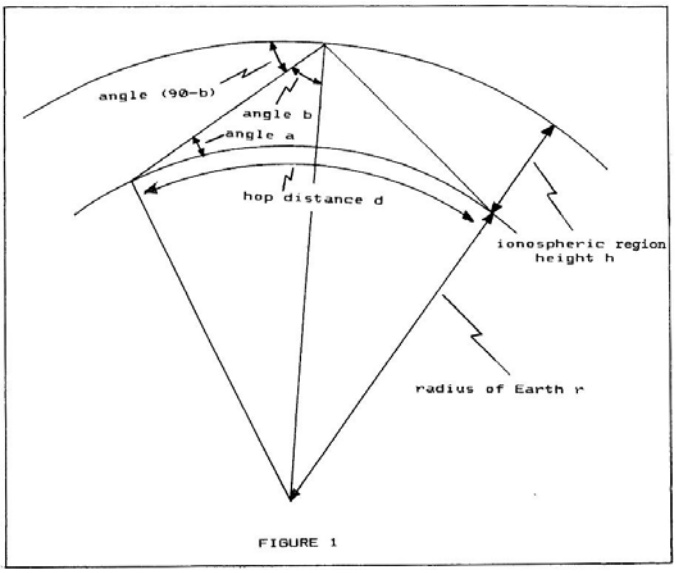

FIGURE 1

The take-off angle is the angle designated “a”. The angle of incidence on the ionosphere is the angle designated “90-b”. The height of the ionosphere “h” is a critical parameter in determining the M-factor. Here are some M-factors for various heights “h” at various take-off angles “a”.

height “h”	take-off angle “a”	hop distance “d”	angle of incidence “90-b”	M-factor
100 km	0 deg	2243 km	10.1 deg	5.7
	5 deg	1389 km	11.3 deg	5.1
	10 deg	927 km	14.2 deg	4.1
300 km	0 deg	3836 km	17.3 deg	3.4
	5 deg	2877 km	17.9 deg	3.3
	10 deg	2193 km	19.9 deg	2.9
400 km	0 deg	4401 km	19.8 deg	3.0
	5 deg	3422 km	20.4 deg	2.9
	10 deg	2687 km	22.1 deg	2.7

The E region M-factor is around 5 for low take-off angles. Thus if you know the E region critical frequency (also applicable to the sporadic E critical frequency), multiply it by 5 to estimate the highest MUF.

The F_2 region M-factor is around 3 for low take-off angles for an F2 region peak between 300 and 400 km. Also note that the angle of incidence on the ionosphere (“90-b”) at a take-off angle (“a”) of 0 degrees is not 0 degrees – it is limited to a higher angle due to the spherical Earth-ionosphere geometry.