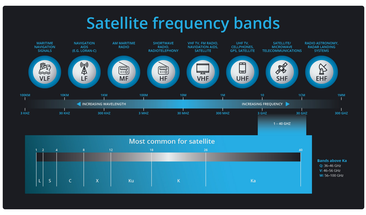
How satellites use the electromagnetic spectrum

Alex Miller
Technology
2 minutes

Satellites use different parts of the electromagnetic (EM) spectrum depending on their mission. Communications satellites primarily use the radio spectrum, and within that satellite operators choose the frequency that best suits their needs. In many cases, different spectrums can be used on a single satellite. For instance, a communications satellite may manage data uplink and downlink in one band but use another frequency for TT&C (telemetry, tracking and command).

The portion of the EM spectrum used for radio runs between 3 kilohertz (KHz) on the low end up to 100 gigahertz (GHz) on the upper end. The lowest frequency — very low frequency or VLF — is used for maritime navigation signals, and the familiar FM, which stands for frequency modulation, radio signals fall between 88 to 108 megahertz (MHz) — numbers you'd recognize from your car radio.



Today's satellites mostly operate in radio bands between 30 MHz and 40 GHz, and different sections of that "bandwidth" have been grouped like this:

VHF (30-300 MHz)

Very High Frequency is often used for TT&C since it can reliably transmit over long distances.

UHF (300 MHZ - 3 GHz)

Often used for military and maritime applications, can also be used for TT&C and a variety of Earth observation, weather and navigation applications.

L-band (1-2 GHz)

The "slow and steady" highly reliable band that's often used for text and small-data message transfer for asset tracking and other situational awareness applications.

S-band (2-4 GHz)

Often used for weather radar, ship radar and some communications satellites. This is the band used by NASA for communicating with the Space Shuttle and the International Space Station.

C-band (4-8 GHz)

A relatively low-frequency band often used for broadcast TV downlinks.

X-band (8-12 GHz)

Mostly used in military applications, X-band is also used for law enforcement speed detection as well as weather monitoring and air traffic control.

Ku-band (12-18 GHz)

This higher-frequency band is used widely in satellite communications, particularly satellite TV and mobile applications such as in-flight connectivity.

K-band (18-26 GHz)

The K-band portion of the radio spectrum is used in a number of satellite and terrestrial communications.

Ka-band (26-40 GHz)

As the numbers show, the Ka-band is a wide part of the higher-frequency satellite spectrum. Many geostationary satellites operate in the Ka-band, and the higher frequency allows for greater ability to move data.

Even higher bands: Q, V, W (36-100 GHz)

While less often used, satellite operators are always looking at areas of the EM spectrum that are "less crowded," as these bands are. The advantage of using them is high frequency and greater availability, but the challenge is that they require more complex and expensive equipment.

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Alex Miller leads editorial at E-Space. Based in Denver, he's a longtime journalist who's been involved with the satellite industry for over a decade.

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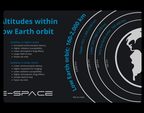

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