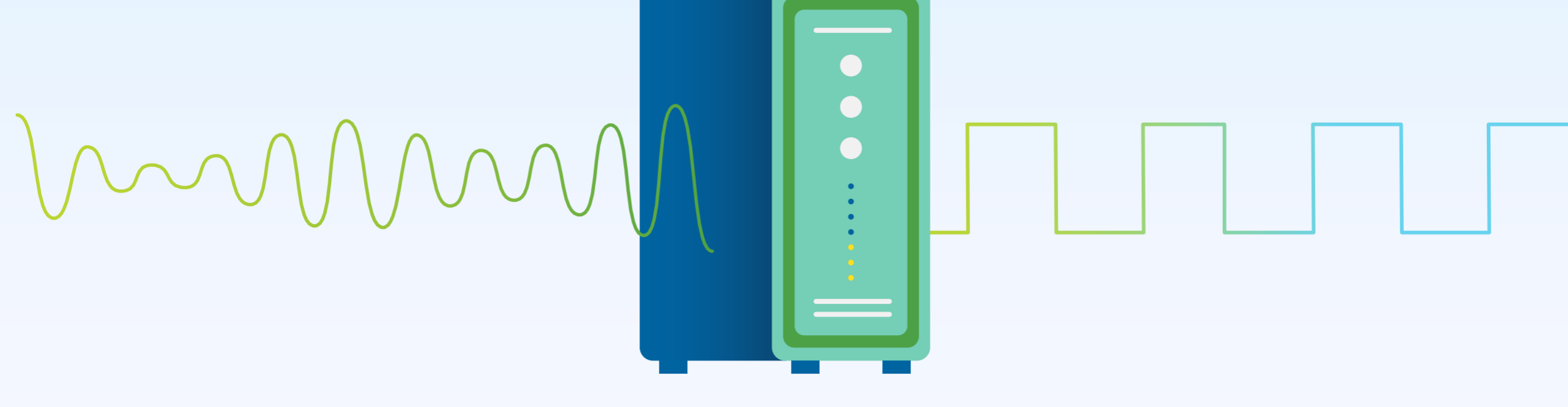


How electromagnetic waves transmit messages, media, and more

Data transmission starts with electromagnetic waves, but transmitting those waves without modulation is like trying to throw a feather across a room.



Before we walk about modulation, let's review some of the qualities of electromagnetic waves.

A diagram showing a white sine wave passing through three vertical blue bars. Three yellow dots are placed at the peaks of the wave, one on each bar, to illustrate the concept of frequency.

Frequency: The number of waves passing a given point in a second, measured in Hertz (1 wave per second = 1 Hertz)

A diagram showing a white sine wave. A yellow double-headed arrow spans the distance between two consecutive peaks of the wave, illustrating the concept of wavelength.

Wavelength: The distance from the crest of one wave to another

A diagram showing a white sine wave oscillating around a horizontal dashed line representing the rest position. A yellow arrow points from the rest position to the top of a crest, and another yellow arrow points from the rest position to the bottom of a trough, illustrating the concept of amplitude.

Amplitude: The maximum distance from the rest position to the top of a wave's crest or the lowest point in a trough

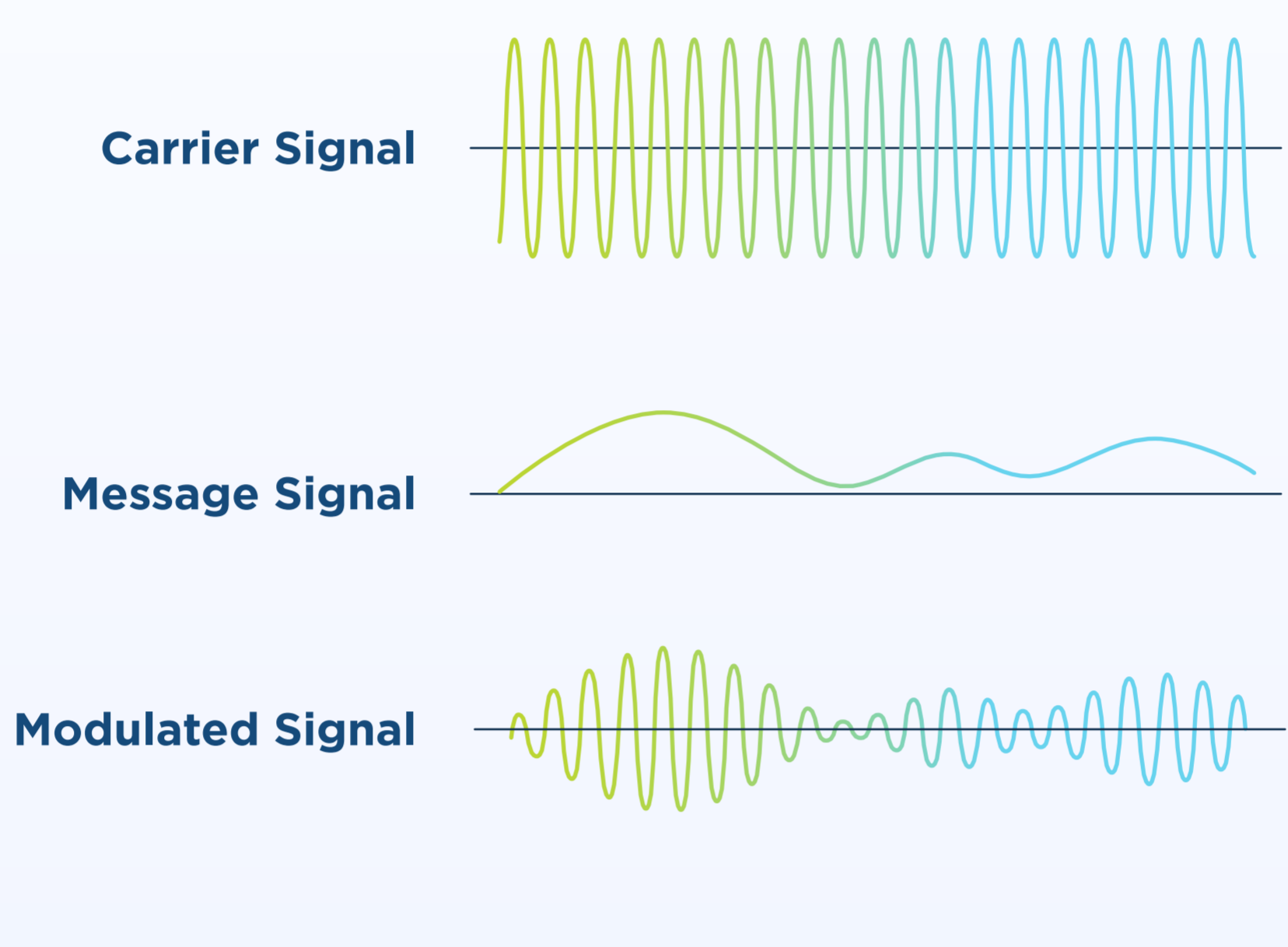
A diagram showing two sine waves, one white and one pink, with the same frequency and wavelength. Yellow arrows indicate the distance between peaks of the two waves. A text box explains that if the peaks are aligned, they are "in phase".

Phase: Relationship between the position of the amplitude crests and troughs of two waveforms with the same frequency and wavelength

► If the peaks of two signals are aligned at the same time, they're "in phase"

Modulation helps waves overcome interference.

Modulation uses a high-frequency wave as a carrier signal, varying a property of that signal in accordance with the message signal.



Analog modulation

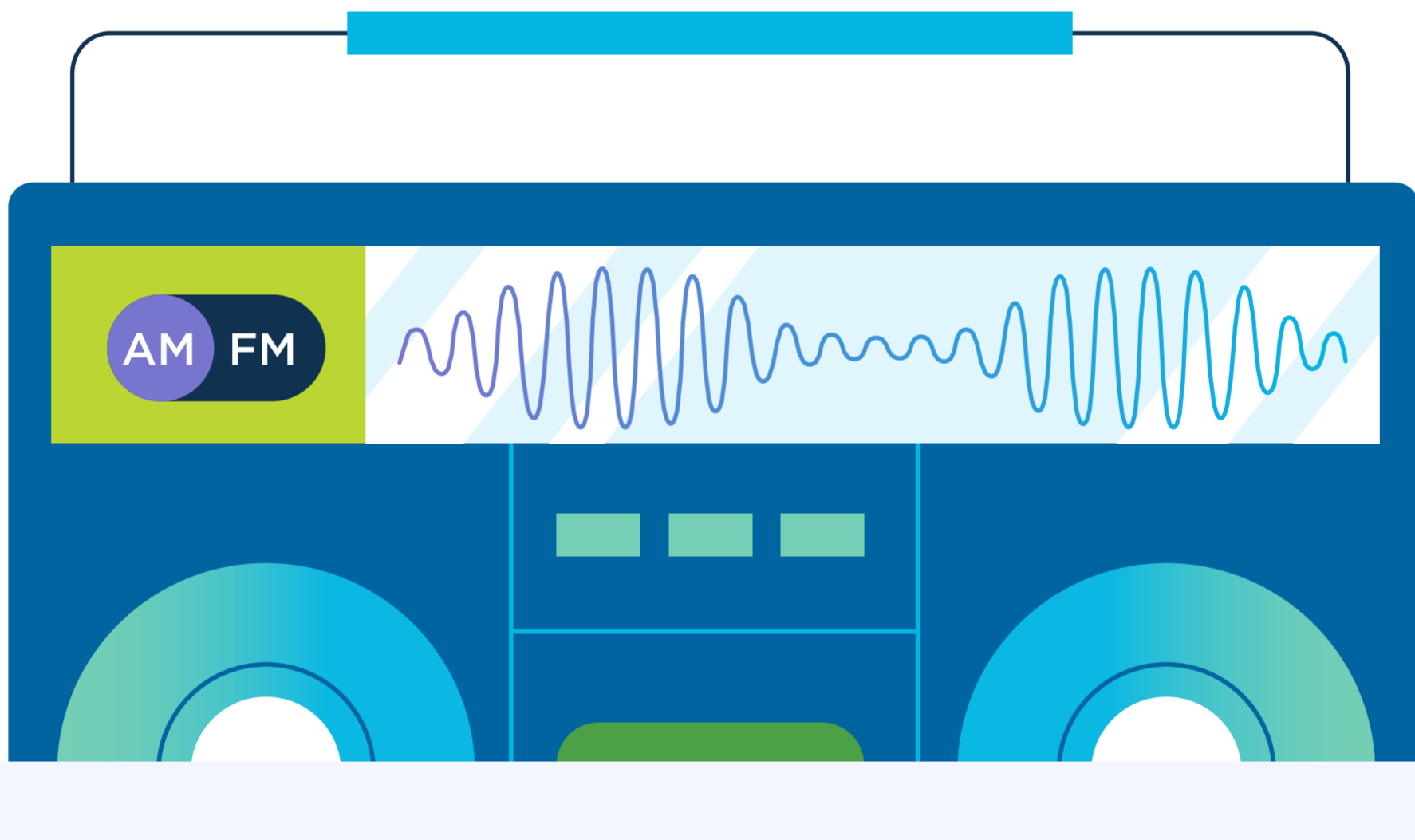
While analog modulation becomes less and less common in the digital space because of its susceptibility to noise and overall lack of capacity for data, we still see it used in everyday functions.

A diagram showing a blue sine wave whose amplitude varies in a way that represents a message signal, illustrating Amplitude Modulation (AM).

AM radio stations broadcast at a constant frequency and transmit their message using amplitude modulation

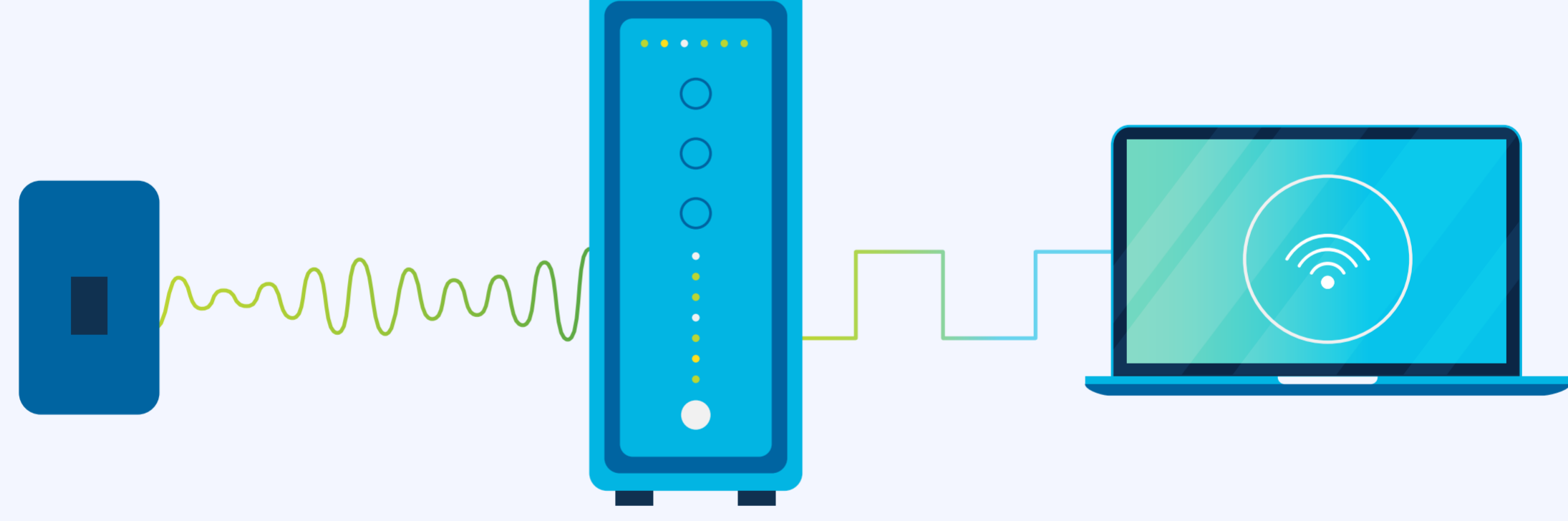
A diagram showing a green sine wave whose frequency varies in a way that represents a message signal, while its amplitude remains constant, illustrating Frequency Modulation (FM).

FM radio stations use frequency modulation — the carrier wave's amplitude remains constant



Digital modulation

The form of digital modulation called shift-keying uses a hardware component called a **modem** ("Modulator-Demodulator"). A modem allows a computer or another device to connect to the Internet.



It then converts or "modulates" an analog signal from telephone, cable or fiber wire to digital data that a computer can recognize (binary).

A large blue rounded rectangle containing information about shift-keying modulation. At the top, a row of six colored dots (yellow, yellow, white, yellow, yellow, yellow) represents a binary sequence. Below this, the text states: "Different types of shift-keying modulate different properties of the signal." Three circular icons are shown: "ASK" (Amplitude-shift keying), "FSK" (Frequency-shift keying), and "PSK" (Phase-shift keying). Below the icons, a white sine wave is shown with brackets underneath indicating shifts for binary digits 1, 0, 1, and 0. Below the sine wave, a square wave is shown with brackets underneath indicating high and low levels for binary digits 1, 0, 1, and 0. At the bottom, text explains: "For example, to send a binary '1', the signal might be shifted up by 20 Hertz. For '0', it might be shifted down 20 Hertz." and "At the other end, the receiver detects the FSK and converts that shift to a '1' or '0', which allows a computer to interpret the message signal sent."

Learn more about how the electromagnetic spectrum powers data transmission at howdatamoves.com