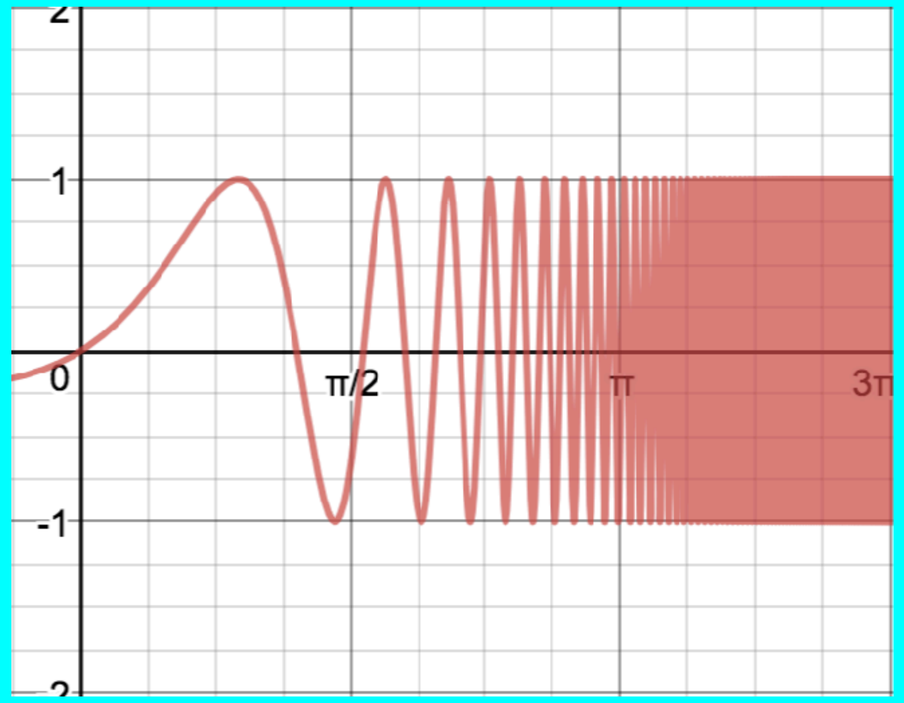
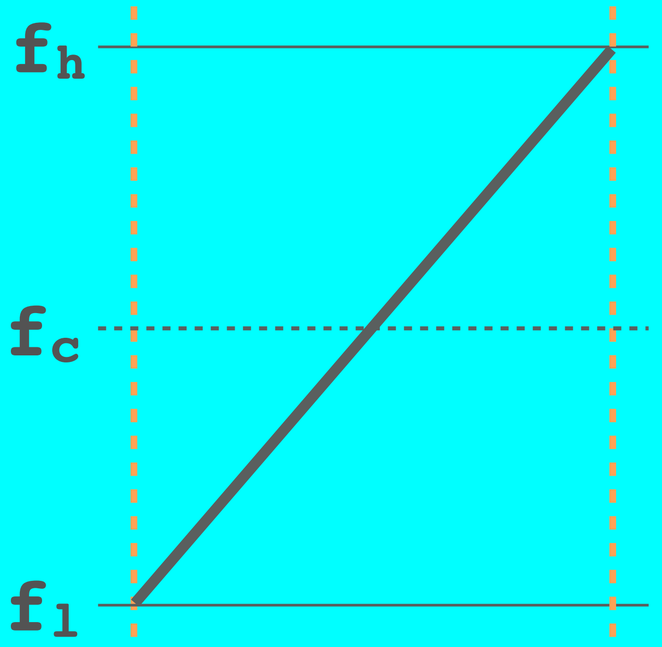
LORA / LORAWAN TUTORIAL 12

Modulation Types & Chirp Spread Spectrum





INTRO

- In this tutorial I will explain what the basic modulation types are and what Chirp Spread Spectrum is.

BASIC MODULATION TYPES

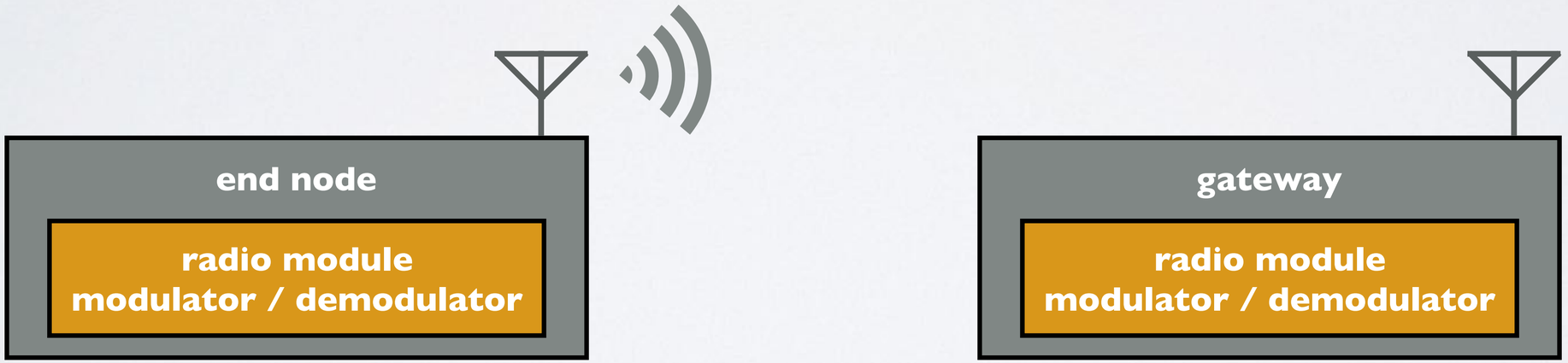
- Modulation means how analog or digital information are encoded onto a carrier signal.

- When **analog** information are encoded onto a carrier signal, three modulation types can be used:
  Amplitude Modulation (AM), Frequency Modulation (FM) and Phase modulation (PM)

- When **digital** information are encoded onto a carrier signal, three modulation types can be used:
  Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK) and Phase Shift Keying (PSK)

BASIC MODULATION TYPES

- As mentioned earlier an end node has a radio module. This radio module has a modulator which encodes information onto a carrier signal.
- This modulated signal is transmitted and received by a gateway.
- The gateway also has a radio module. This radio module has a demodulator which decodes the modulated signal and extracts the information.



TRANSCEIVERS

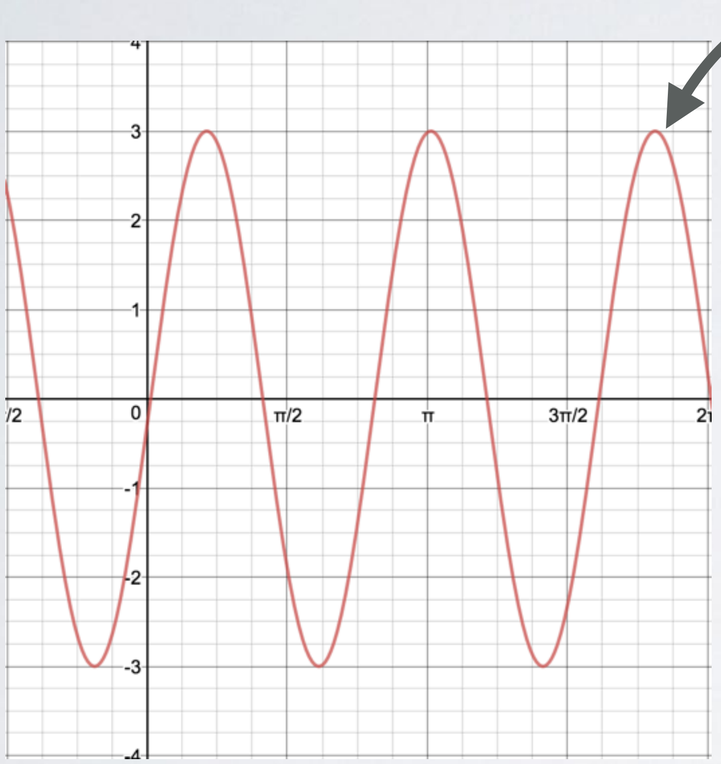
- The communication between the end node and gateway is bidirectional which means the end node can send data to the gateway but it can also receive data from the gateway.

- If a device can both transmit and receive signals this device is also called a transceiver.

- LoRa end nodes and gateways are transceivers.

BASIC MODULATION TYPES

- Lets only focus on modulating digital values onto a carrier signal.



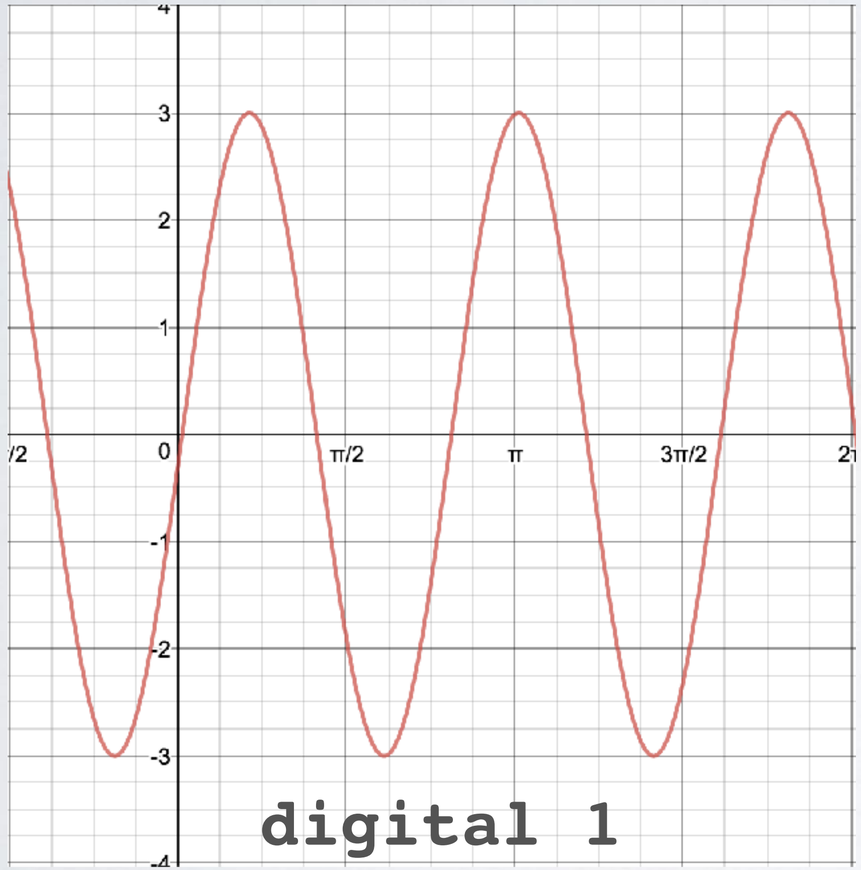
1101100111100101…

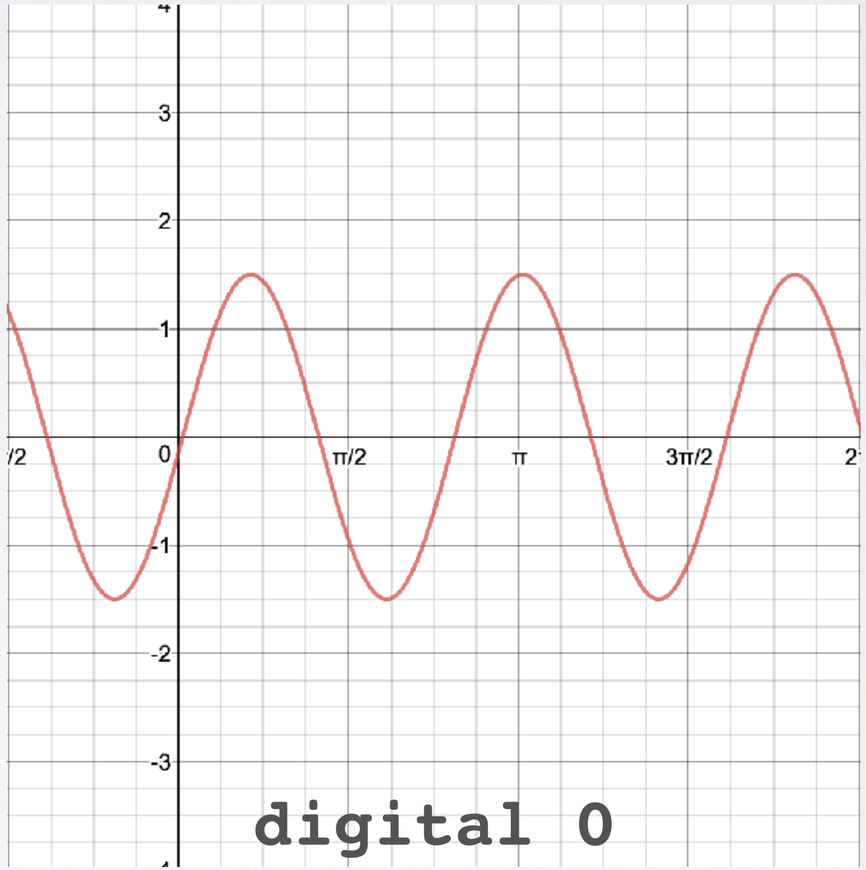
There are 3 basic modulation types:
- Amplitude Shift Keying (ASK)
- Frequency Shift Keying (FSK)
- Phase Shift Keying (PSK)

BASIC MODULATION TYPES

- Amplitude Shift Keying (ASK)

  Only the amplitude changes

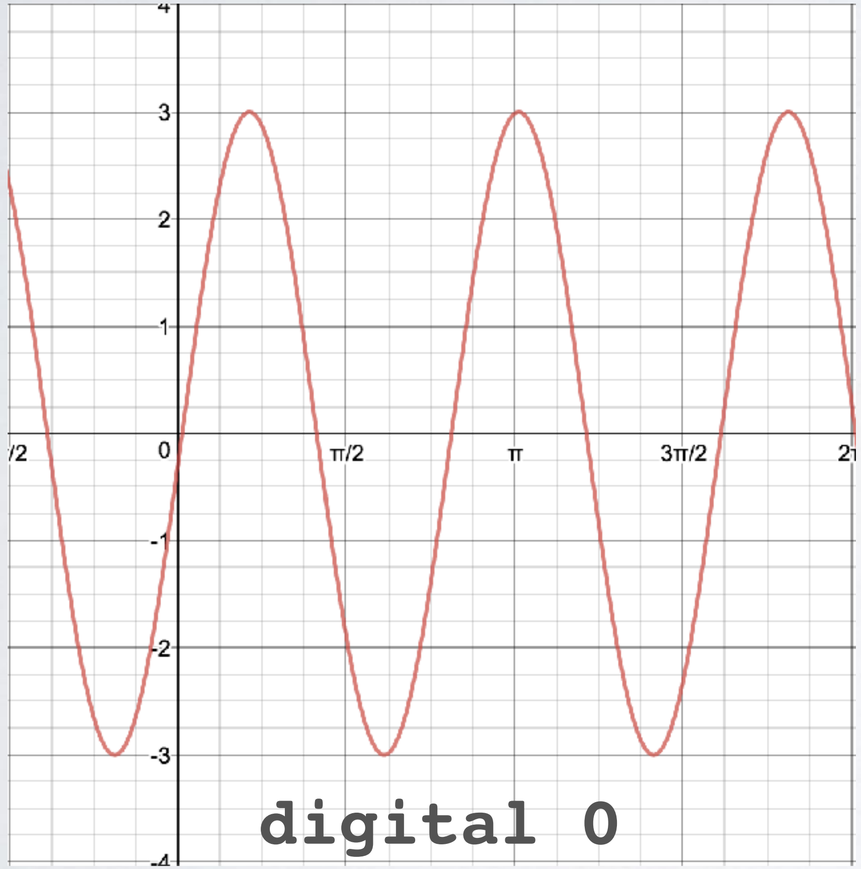


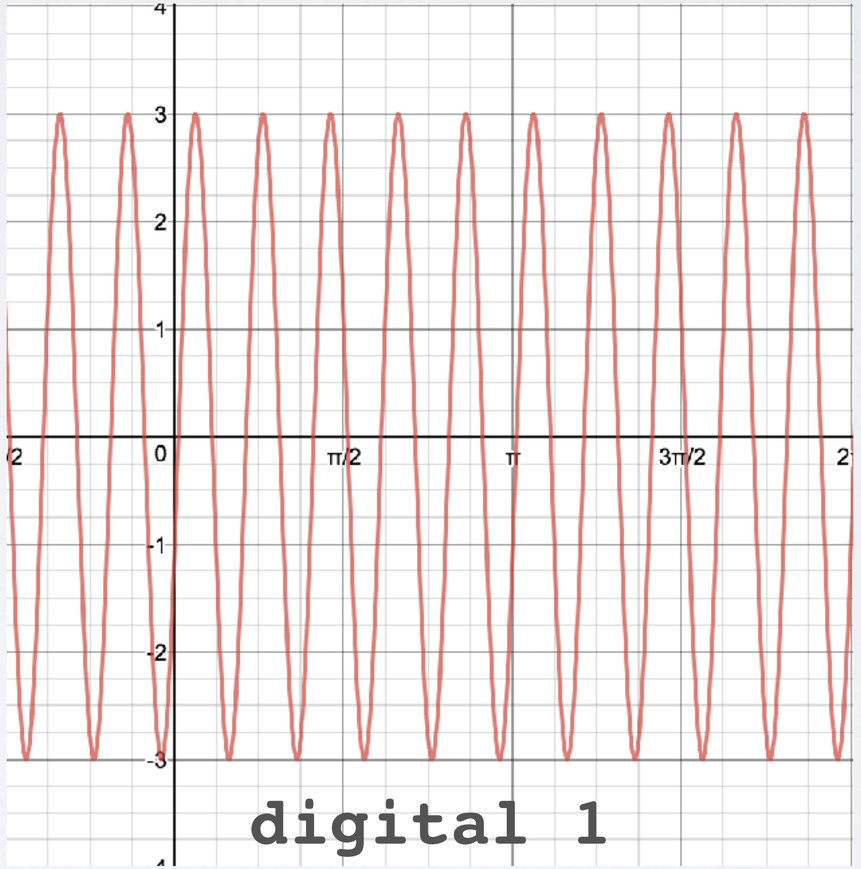


BASIC MODULATION TYPES

- Frequency Shift Keying (FSK)

  Only the frequency changes

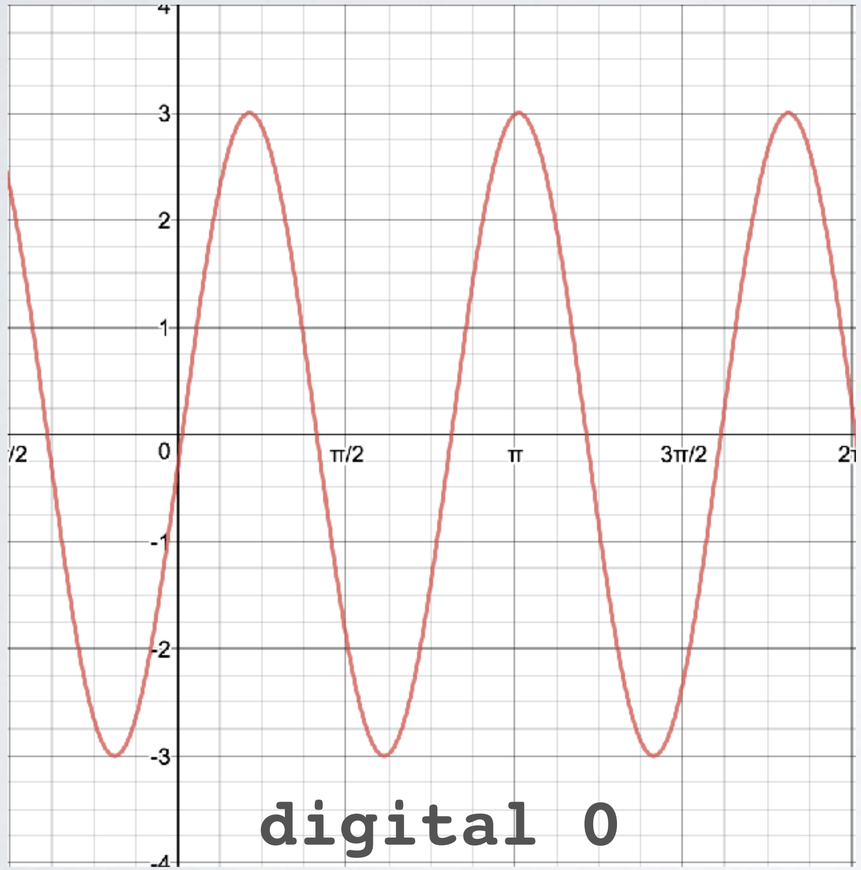


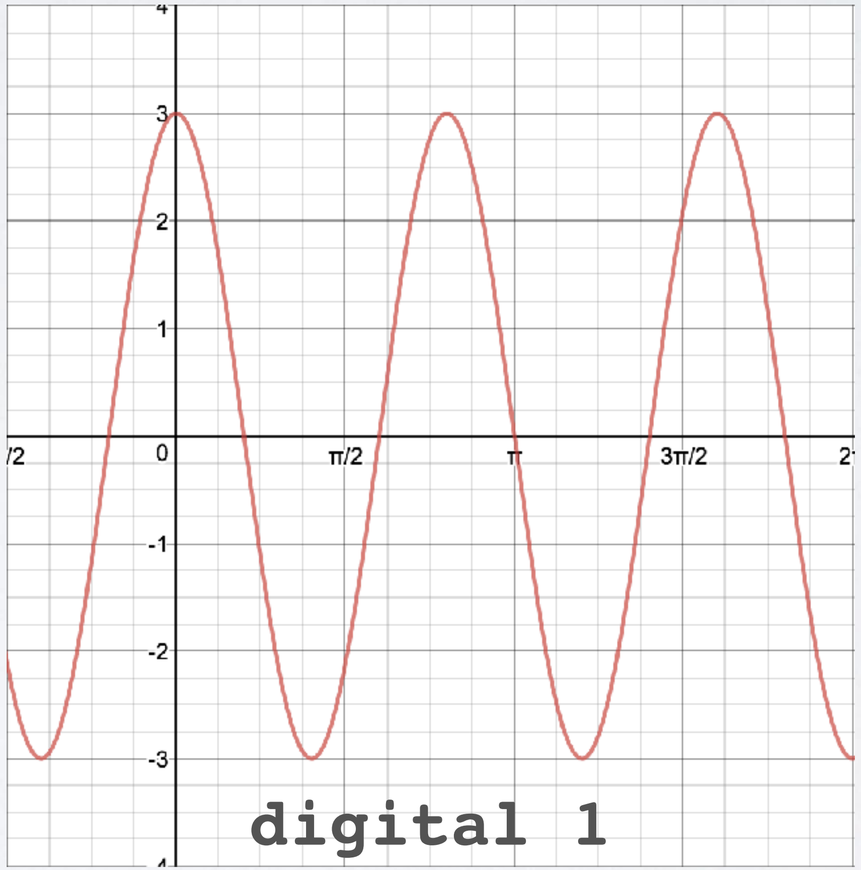


BASIC MODULATION TYPES

- Phase Shift Keying (PSK)

Only the phase changes





CHIRP SPREAD SPECTRUM (CSS)

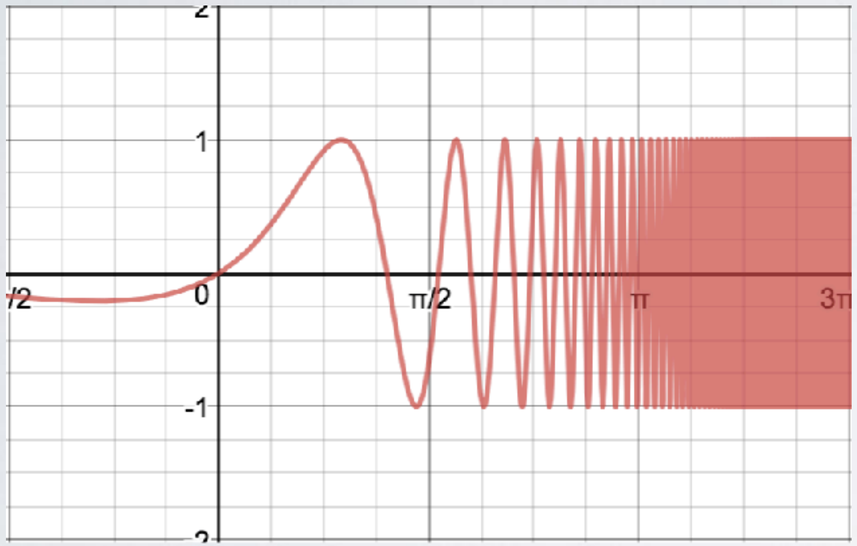
- Besides the 3 basic modulation types there are many other modulation types.
- LoRa is a proprietary spread spectrum modulation scheme that is based on Chirp Spread Spectrum modulation (CSS).
- Chirp Spread Spectrum is a *spread spectrum technique* that uses wideband linear frequency modulated *chirp* pulses to encode information.
- Spread spectrum techniques are methods by which a signal is deliberately spread in the frequency domain. For example a signal is transmitted in short bursts, "hopping" between frequencies in a pseudo random sequence. This is explained in Tutorial 11.

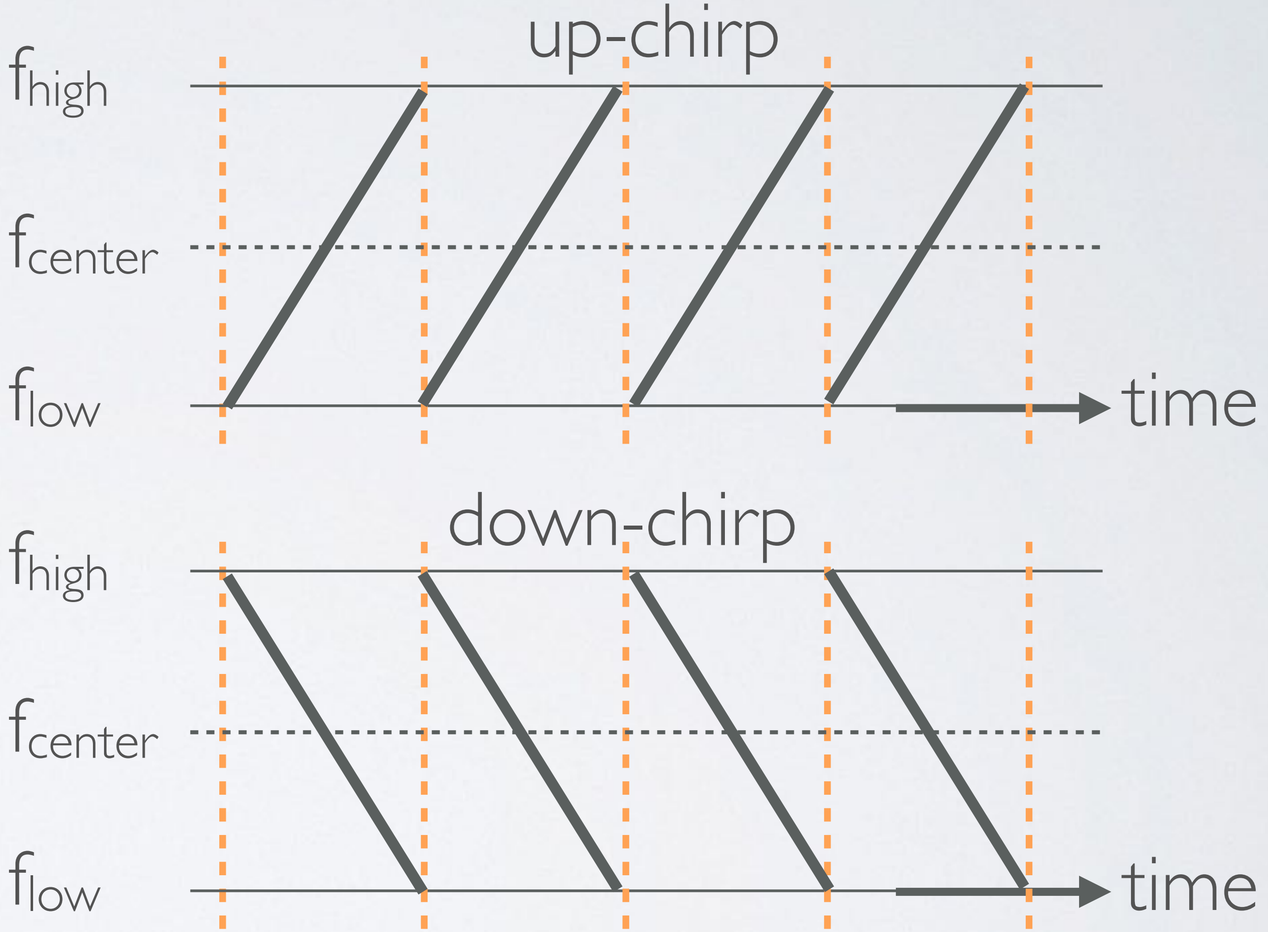
CHIRP SPREAD SPECTRUM (CSS)

- A chirp, often called a sweep signal, is a tone in which the frequency increases (up-chirp) or decreases (down-chirp) with time.

CHIRPS

Example of an up-chirp where the frequency increases in time.

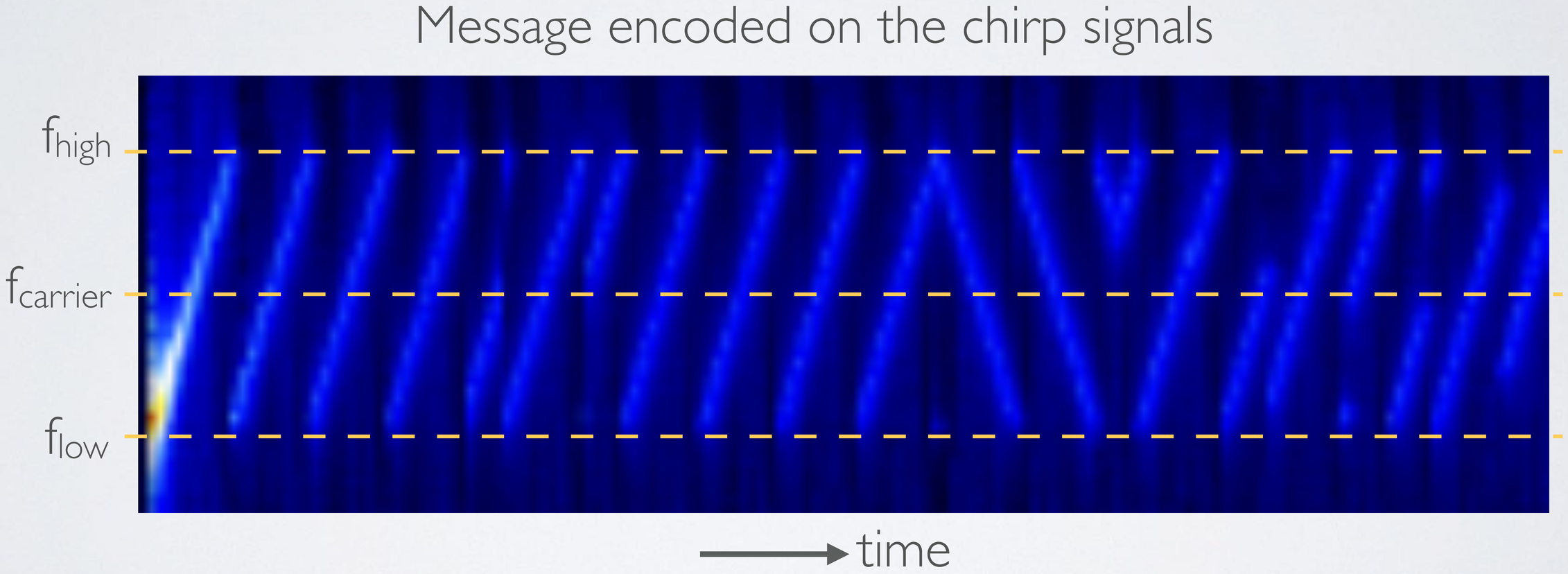




LORA MODULATED SIGNAL

- These chirp signals are used as carrier signals where a message is encoded on.

- Here is an actual LoRa modulated signal.



LORA MODULATED SIGNAL

- Another LoRa modulated signal example.