

5.3 DIRECT SEQUENCE SPREAD SPECTRUM

DSSS, direct sequence spread spectrum is a form of spread spectrum transmission which uses spreading codes to spread the signal out over a wider bandwidth than would normally be required.

The technique behind direct sequence spread spectrum, DSSS is at first sight counter-intuitive, but DSSS is used in a number of areas where it enables considerable benefits to be gained.

Direct sequence spread spectrum is a form of transmission that looks very similar to white noise over the bandwidth of the transmission. However once received and processed with the correct descrambling codes, it is possible to extract the required data.

When transmitting a DSSS spread spectrum signal, the required data signal is multiplied with what is known as a spreading or chip code data stream. The resulting data stream has a higher data rate than the data itself. Often the data is multiplied using the XOR (exclusive OR) function.

- Each bit represented by multiple bits using spreading code
- Spreading code spreads signal across wider frequency band
- In proportion to number of bits used
- 10 bit spreading code spreads signal across 10 times bandwidth of 1 bit code

One method:

- Combine input with spreading code using XOR
- Input bit 1 inverts spreading code bit
- Input zero bit doesn't alter spreading code bit
- Data rate equal to original spreading code
- Performance similar to FHSS

DIRECT SEQUENCE SPREAD SPECTRUM TRANSMITTER

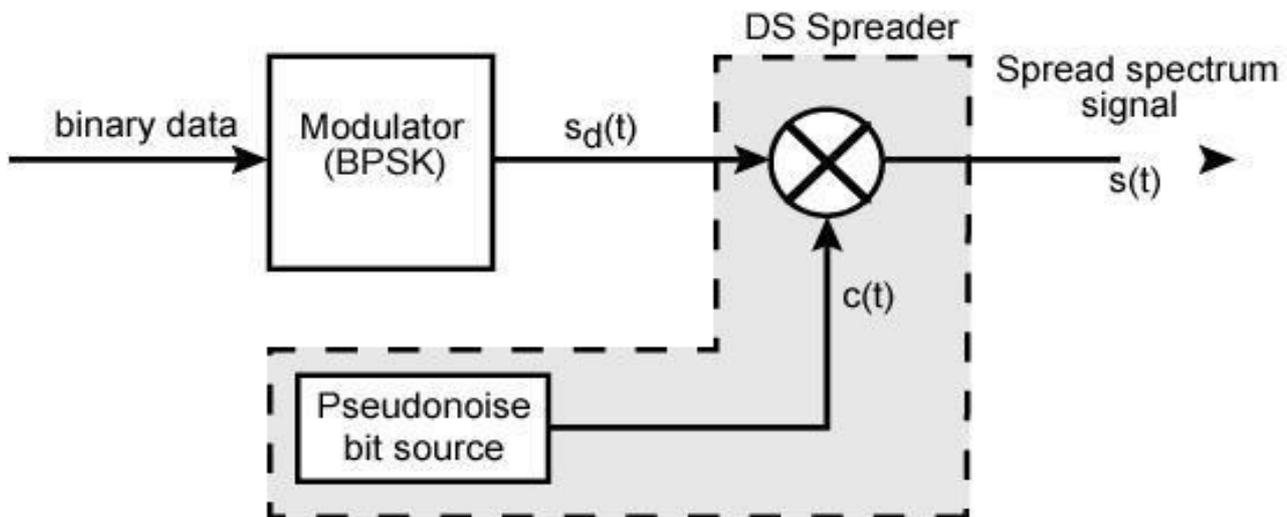


Figure 5.3.1 Direct Sequence Spread Spectrum Transmitter

Each bit in the spreading sequence is called a chip, and this is much shorter than each information bit. The spreading sequence or chip sequence has the same data rate as the final output from the spreading multiplier. The rate is called the chip rate, and this is often measured in terms of a number of M chips / sec.

The baseband data stream is then modulated onto a carrier and in this way the overall the overall signal is spread over a much wider bandwidth than if the data had been simply modulated onto the carrier. This is because, signals with high data rates occupy wider signal bandwidths than those with low data rates.

To decode the signal and receive the original data, the CDMA signal is first demodulated from the carrier to reconstitute the high speed data stream. This is multiplied with the spreading code to regenerate the original data. When this is done, then only the data with that was generated with the same spreading code is regenerated, all the other data that is generated from different spreading code streams is ignored.

DIRECT SEQUENCE SPREAD SPECTRUM RECEIVER

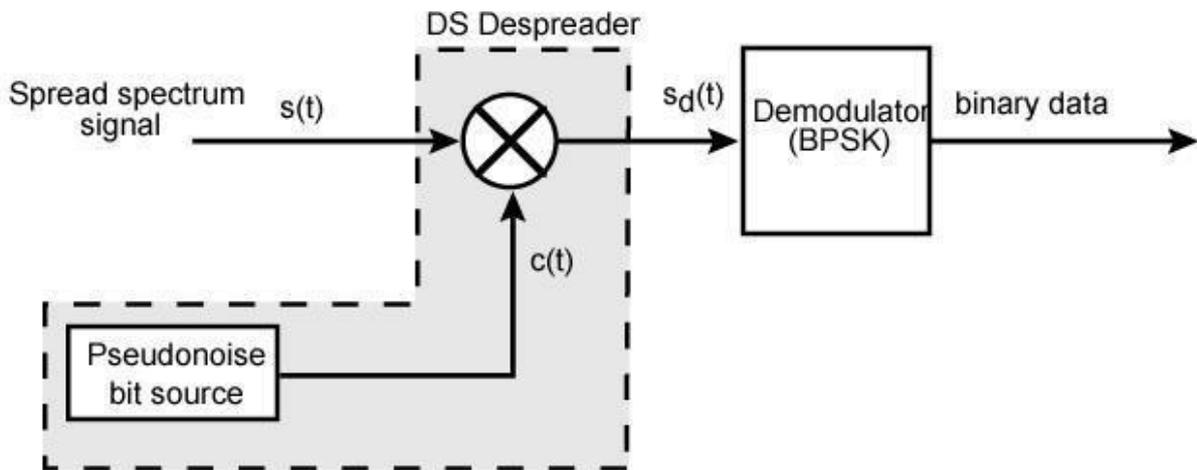


Figure 5.3.1 Direct Sequence Spread Spectrum Receiver

In order to visualize how the direct sequence spread spectrum process operates, the easiest method is to show an example of how the system actually operates in terms of data bits, and how the data is recovered from the DSSS, direct sequence spread spectrum signal.

The first part of the process is to generate the DSSS signal. Take as an example that the data to be transmitted is 1001, and the chip or spreading code is 0010. For each data bit, the complete spreading code is used to multiple the data, and in this way, for each data bits, the spread or expanded signal consists of four bits.

DSSS SPREADING GAIN

The bandwidth of the spread spectrum signal will be much wider than the original data stream. To quantify the increase in bandwidth, a term known as the spreading gain is used. If the bandwidth of the DSSS, direct sequence spread spectrum signal is W and the input data bit length or period $1/R$ then the DSSS spreading gain can be defined:

$$\text{Spreading gain} = \frac{W}{R}$$

DIRECT SEQUENCE SPREAD SPECTRUM APPLICATIONS

DSSS is used in a number of areas where its properties have enabled it to provide some unique advantages over other techniques.

- ***Covert communications:*** DSSS was first used to provide secure and covert communications. The signals were initially difficult to detect as they sounded like broadband noise and often would have been mistaken for that. Also to access the data it is necessary to know the code used to generate the signal
- ***CDMA cellphone technology:*** The DSSS technique was used to provide a multiple access scheme that was used for 3G cellphone technology. Each mobile used a different access code or spreading code and this enabled multiple users to access the base station on the same frequency.

