THE EFFECT OF SPREADING FACTOR ON LORA TRANSMISSION

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Abstract

The conditions of a different area can affect the transmission of data so that transmission is needed that is resistant to interference and in certain conditions a device that can monitor several places is needed at once. The concept of Wireless Sensor Network (WSN) is applied to meet these demands. This research is shown to determine the effect of Spreading Factor (SF) on Long Range (LORA) transmission on distance by analyzing Quality of Service (QOS). The test is divided into 2 conditions, namely: The Line of Sight (LOS) condition & Non-Line of Sight (NLOS) condition. The test results show that the maximum distance that the LoRa transmitter can reach is 1100m in LOS conditions while for NLOS conditions it can only reach a distance of 300m. The QOS parameters used to consist of Delay, Throughput, RSSI, & SNR. Spreading Factor (SF) affects Delay and Throughput, not RSSI and SNR. The best value of Delay (9.64 ms), Throughput (667.60 Bps), and RSSI (-94.25 dBm) is at Spreading Factor (SF) 6 and SNR (5.23 dB) is Spreading Factor (SF) 8 and for the distance, the value of RSSI (-76.45 dBm) and SNR (5.23 dB) is at a distance of 10m. This applies in LOS and NLOS conditions.

Keywords: *WSN, spreading factor, LORA, quality of service, LOS, N-LOS*

1. INTRODUCTION

The application of Wireless Sensor Network (WSN) must use data transmission that is capable of and resistant to interference so that it can transmit data properly so LoRa was chosen. LORA is a wireless communication technology featuring long distance capabilities, with low power consumption, even at low data rates. Developed by Cycleo and acquired by Semtech in 2012, uses the license-free sub-gigahertz radio frequency band. Its characteristics make it suitable for IoT and Machine-to-Machine (M2M) communications over a large area, requiring the simplicity of the amount of traffic exchanged. LoRa modulation scheme is derived from Chirp Spread Spectrum (CSS) [2].

LoRaWAN implements a star topology to deliver messages to a central server through a gateway. The purpose of using a star topology is to maintain battery power as well as to increase the communication range. Each end node transmits data to the gateway. The gateway will forward the data to the network server. During this transmission, redundancy detection, security, and scheduling for message delivery are carried out. In addition, by using a topology as shown in Figure 1, it will be easier to track devices, because end nodes can communicate to multiple gateways without

the need for the gateway to gateway communication. Having a centralized server can also reduce the problem of collisions [4].

LORA has a feature that can be used to improve data transmission based on user needs, using Spreading Factor (SF). SF is the ratio between symbol rate and chip rate. A higher spread factor increases the Signal to Noise Ratio (SNR), and therefore sensitivity and range, but also increases packet airtime. The number of chips per symbol is counted as 2SF. For example, with SF 12 (SF12) 4096 chips/symbols are used. Each SF increase halves the transmission rate and, accordingly, doubles the transmission duration and ultimately energy consumption. The scatter factor can be selected from 6 to 12 [1].

The Spreading Factor (SF) value shows how many chips are used to represent one symbol. The more chips used to represent a single symbol, the greater the processing gain of the receiver system. The greater the SF value, the greater the processing gain, this allows the receiver to receive data signals that have a negative SNR [3].

2. RESEARCH METHODOLOGY

The research methodology in this study is as follows.

a. Study of literature

The literature study was conducted to obtain information that supports the final thesis in the form of basic theories and concepts obtained from books, the internet, and journals.

b. Design

At this stage, the design for the sensors and hardware that will be used along with the topology used is carried out. Here is the hardware design used:

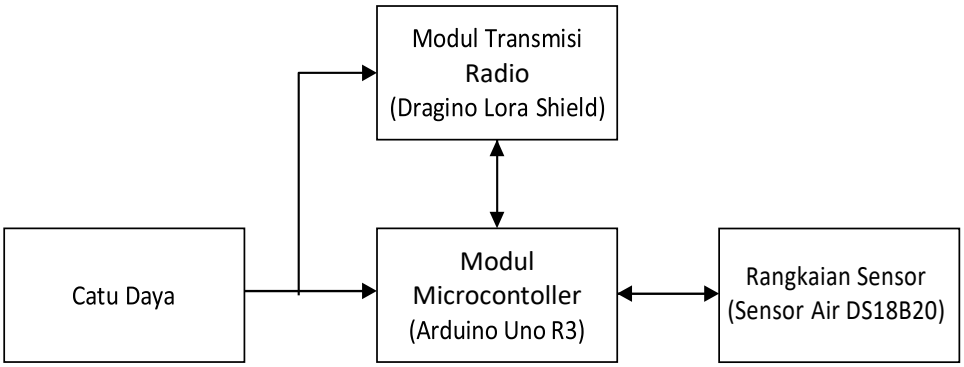

Figure 1. The design of the circuit on the sender

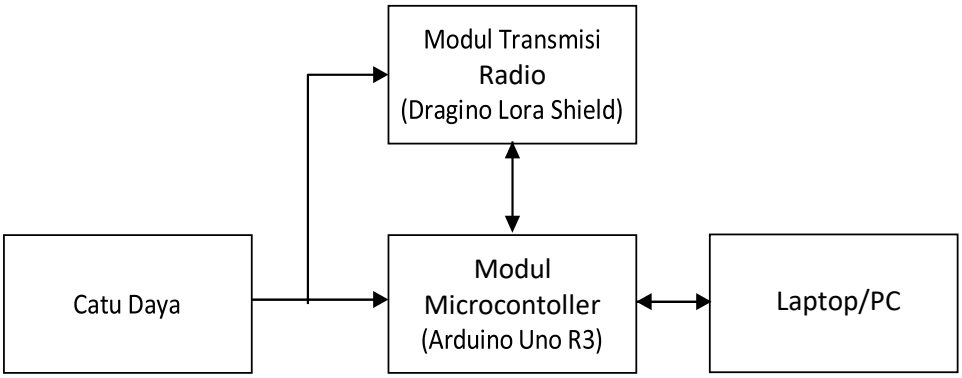

Figure 2. The design of the circuit on the receiver

c. Implementation

The implementation carried out is applying the results of the sensor design which is processed based on a wireless sensor network (WSN) using LORA data transmission based on the Spreading Factor (SF) along with the scenarios used.

d. Test

This stage is carried out to test the results of the implementation of the scenario instrument design that is determined based on the minimum distance (10m) to the maximum range for later data collection based on Quality Of Service (QOS) parameters referring to distance, Line of Sight (LOS) and Non-Line of Sight (NLOS).

e. Conclusion

Conclude from the results of the tests that have been carried out.

3. RESULTS AND DISCUSSION

3.1 Delay And Throughput Results

3.1.1 Line Of Sight (LOS) Conditions

The following are the results of the delay and throughput values for LOS conditions that can be seen in the graphs and tables.

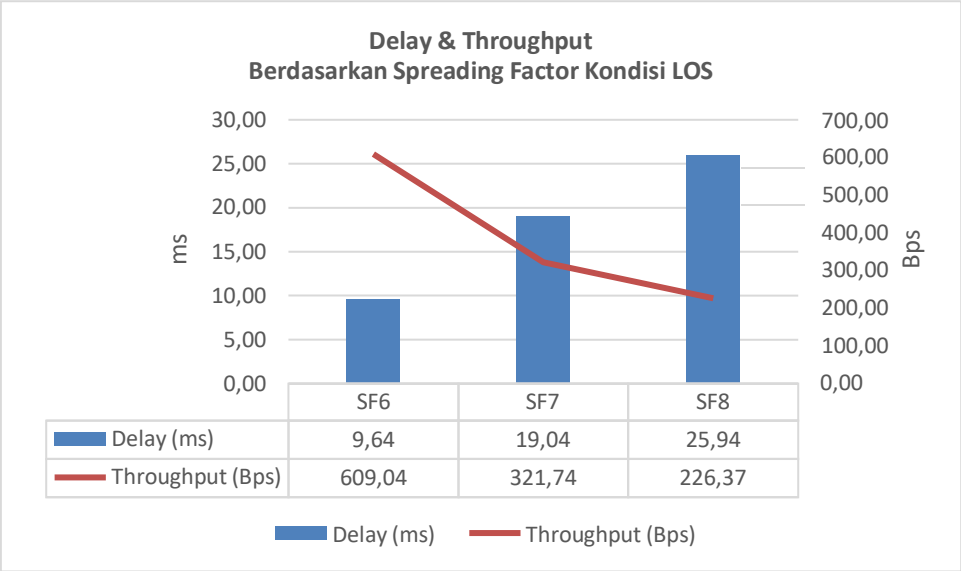

Figure 3. SF Delay and Throughput values for LOS . conditions

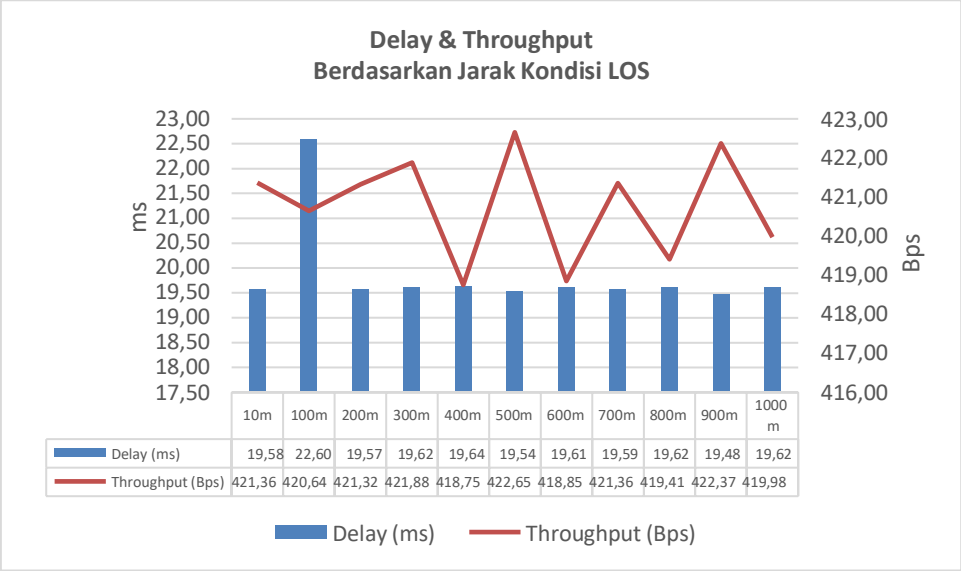

Figure 4. Delay and Throughput values for LOS . conditions

It can be seen that the Throughput value is significantly influenced by the Spreading Factor (SF), the Throughput value of 609.04 Bps is the highest (best) value in the SF 6 value and the 226.37 Bps value is the lowest value at the SF 8 value but the Throughput value is not affected by distance. Likewise, the delay value is also significantly affected by SF, the Delay value of 25.94 ms is the highest value at SF 8 and 9.64 ms is the lowest (best) value at SF 6 but the delay

value is also not affected by distance.

3.1.2 Non Line Of Sight (NLOS) Conditions

The following are the results of the delay and throughput values for NLOS conditions that can be seen in the graphs and tables.

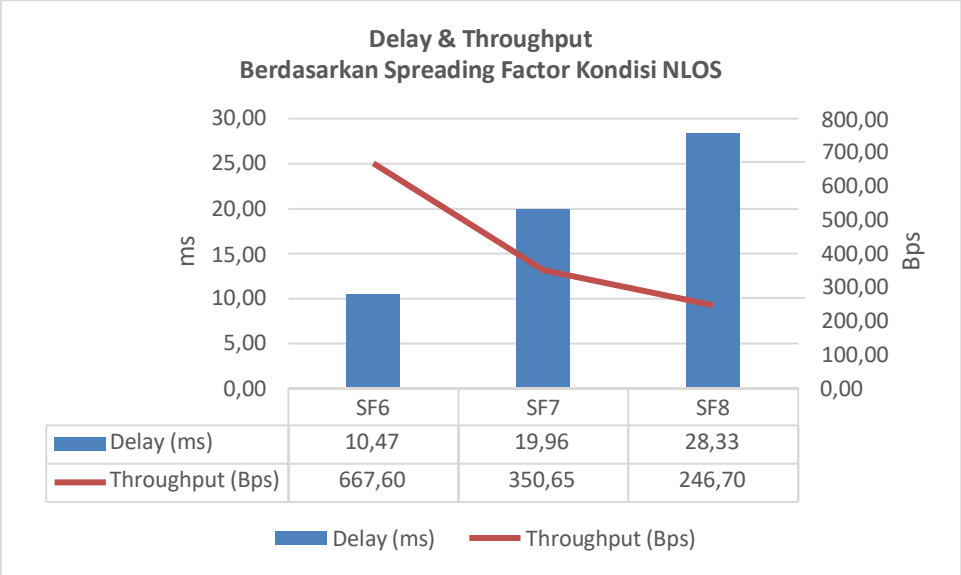

Figure 5. SF Delay and Throughput values for NLOS. Conditions

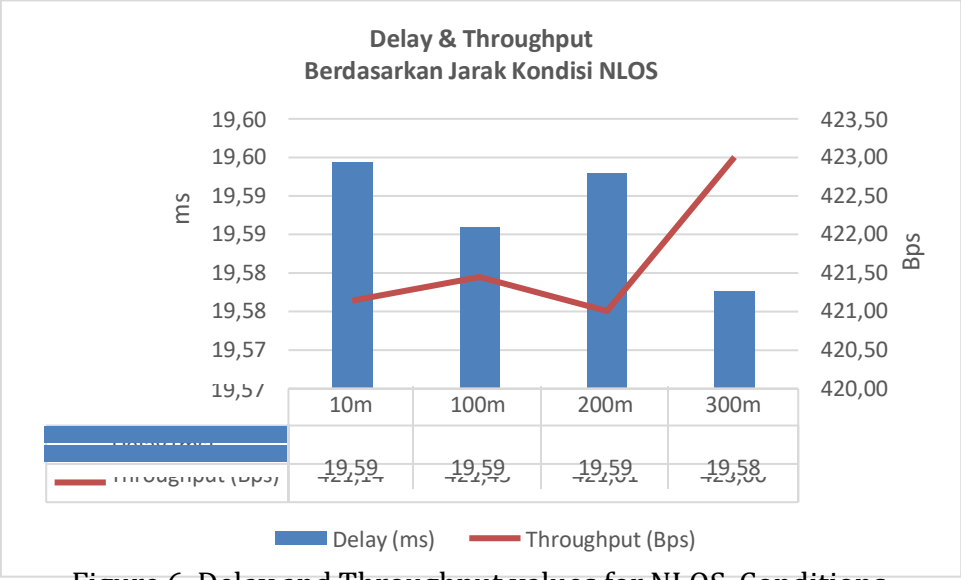

Figure 6. Delay and Throughput values for NLOS. Conditions

Similarly, under LOS conditions, the Throughput value in the NLOS condition is also significantly affected by the Spreading Factor (SF), the Throughput value of 667.60 Bps is the highest (best) value in the SF 6 value and the 246.70 Bps value is the lowest value in the SF value. 8 but the Throughput value is not affected by distance. Likewise, the delay value is also significantly affected by SF, the Delay value of 28.33 ms is the highest value at SF 8 and 10.47

ms is the lowest (best) value at SF 6 but the delay value is also not affected by distance.

3.2 RSSI And SNR Results

3.2.1 Line Of Sight (LOS) Conditions

The following are the results of the delay and throughput values for LOS conditions that can be seen in the graphs and tables.

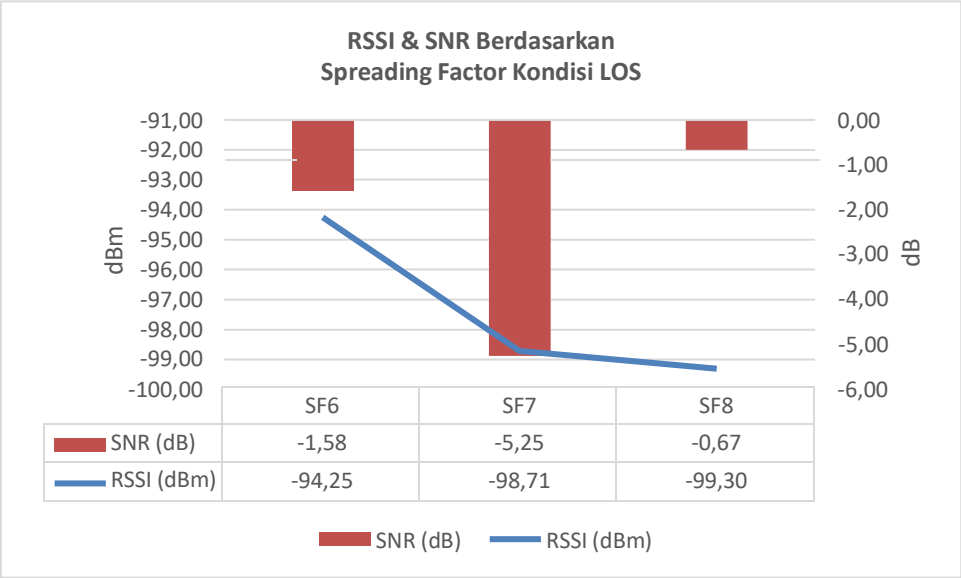

Figure 7. The value of RSSI and SNR SF under LOS. Conditions

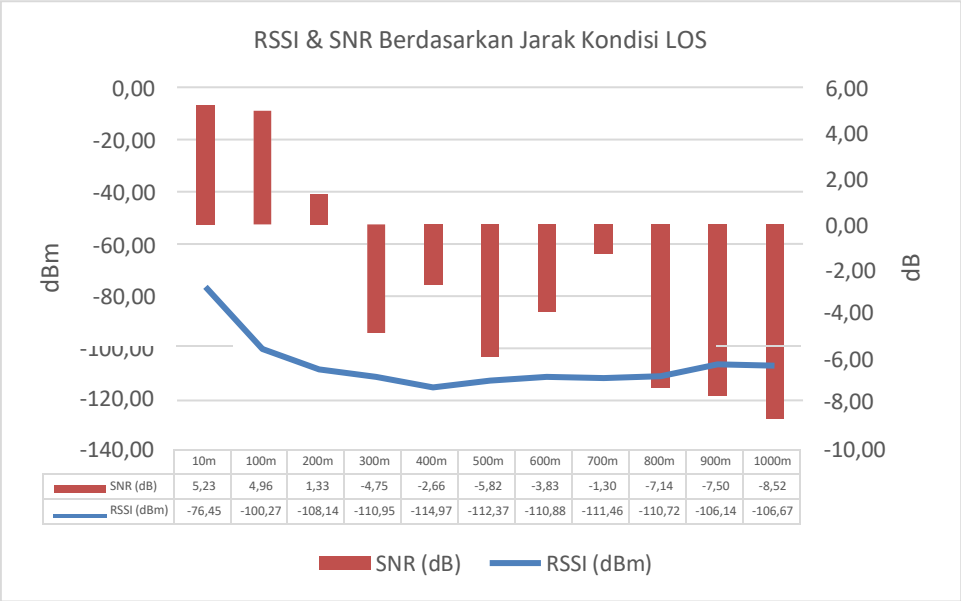

Figure 8. RSSI and SNR values for LOS. Conditions

The RSSI value has a significant difference with distance, the best value is at a distance of 10m with a value of -76.45 dBm and a distance of 1000m with a value of -106.67 dBm, the smaller the RSSI value, the better the signal quality of

transmission. Then the value of SnR to SF has a fluctuating value that tends to be erratic with the best value of -0.67 dB on SF8 while for the distance the SNR value has a significant difference as the distance increases, the highest (best) value with a value of 5.23 dB is at distance 10m and the lowest value with a value of -8.52 is at a distance of 1000.

3.2.2 Non Line Of Sight (NLOS) Conditions

The following are the results of the delay and throughput values for NLOS conditions that can be seen in the graphs and tables.

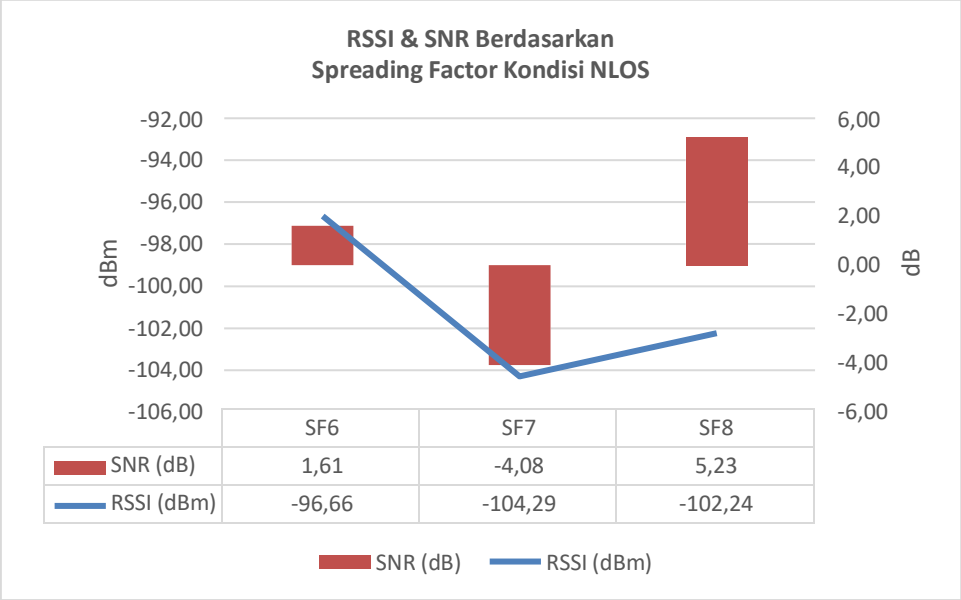

Figure 9. RSSI and SNR SF values for NLOS. Conditions

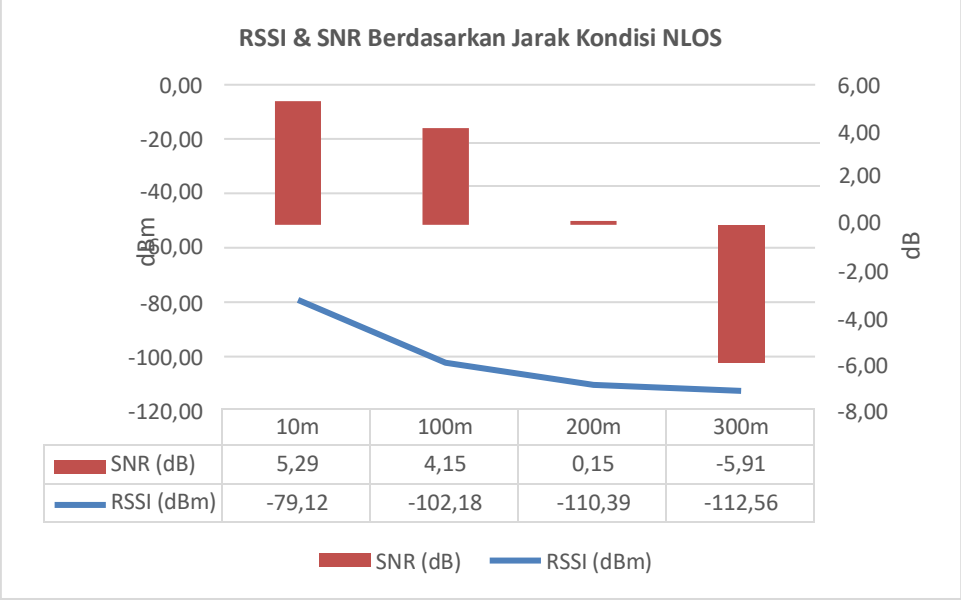

Figure 10. RSSI and SNR values for NLOS. Conditions

In NLOS conditions, the RSSI value is not significantly affected by SF with fluctuating values with the best value of -96.66 dBm in SF6, while the RSSI value has a significant difference, the best value is at a distance of 10m with a value of -79.12 dBm, the smaller the RSSI value, the better the signal quality of transmission. Then the SNR value is also affected by SF with a fluctuating value that tends to be erratic with the best value being 5.23 dB on SF8, while for the distance the SNR value has a significant difference as the distance increases, the highest (best) value with a value of 5.29 dB is at distance 10m and the lowest value with a value of -5.91 is at a distance of 300.

4 CONCLUSION

Based on the results of testing and analysis of Quality of Service (QoS) on Throughput, Delay, RSSI, and SnR on the Spreading Factor (SF) and distance, it can be concluded that the distance of 1100m is the maximum distance that can be reached by LORA in LOS conditions, while in NLOS conditions it can only be reached. at a distance of 300m and Spreading Factor (SF) affects Delay and Throughput does not significantly affect RSSI and SNR because there are external factors that influence it, the best values are Delay (9.64 ms), Throughput (667.60 Bps), and RSSI (- 94.25 dBm) at the Spreading Factor (SF) 6 and the SNR (5.23 dB) at the Spreading Factor (SF) 8 and with respect to the distance the RSSI (-76.45 dBm) and SNR (5.23 dB) values are at a distance This 10m applies in LOS and NLOS conditions.

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