Duty Cycle Measurement of Shure ADXR

1. Purpose

ADXR Portable Wireless Receiver duty cycle measurement for FCC/ISED regulatory approval.

2. Test Equipment Used

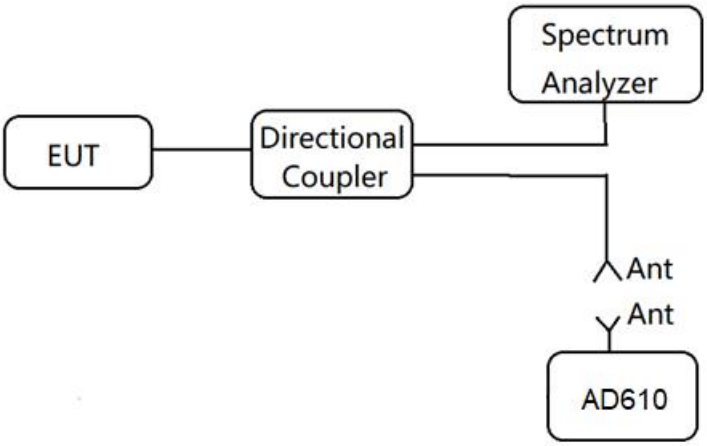
Spectrum Analyzer – Agilent N9020B

Directional Coupler – Narda 4226−10

3. Test Setup

Duty cycle measurement was tested using a conducted setup (Fig. 1). The RF output of ADXR was connected to the input of directional coupler. The output port of directional coupler was connected to 2.4 GHz half-wave antenna communicating with AD610. The coupled port of directional coupler was connected to Agilent spectrum analyzer N9020B which was used to monitor spectrum output of the ADXR.

Test Setup Photo



Duty Cycle Measurements

Duty cycle measurements were performed in the following steps:

1. Spectrum Analyzer screenshots were captured while the ADXR was communicating with AD610 for 10 times. With Zigbee based ShownLink using CSMA/CA communication protocol, all screenshots (Fig. 1-10) show different distribution packets being sent from the ADXR to the AD610. Several consecutive measurements were taken and the amount of captured packets was counted. The spectrum analyzer sweep time was set to 2 seconds. Sweep time intervals to ensure that the spectrum analyzer was capable to capture all packets. The standard deviation (SDEV) of sent packets / measurement was then calculated. In order to ensure statistical validity of the measurements, the value of Mean+3*SDEV was used for final calculation of the duty cycle (Table 1)

Note: The spectrum analyzer images presented in this report have significantly lower resolution than the spectrum analyzer due to resolution loss while saving from the spectrum analyzer to disk

2. A typical packet size was captured (Fig. 11) and it was then used for the final duty cycle calculation (Table 1)

3. ADXR duty cycle calculations were performed with the above results in section 4

Figure 1. ADXR communicating with AD610 - 7 packets in 2 second interval

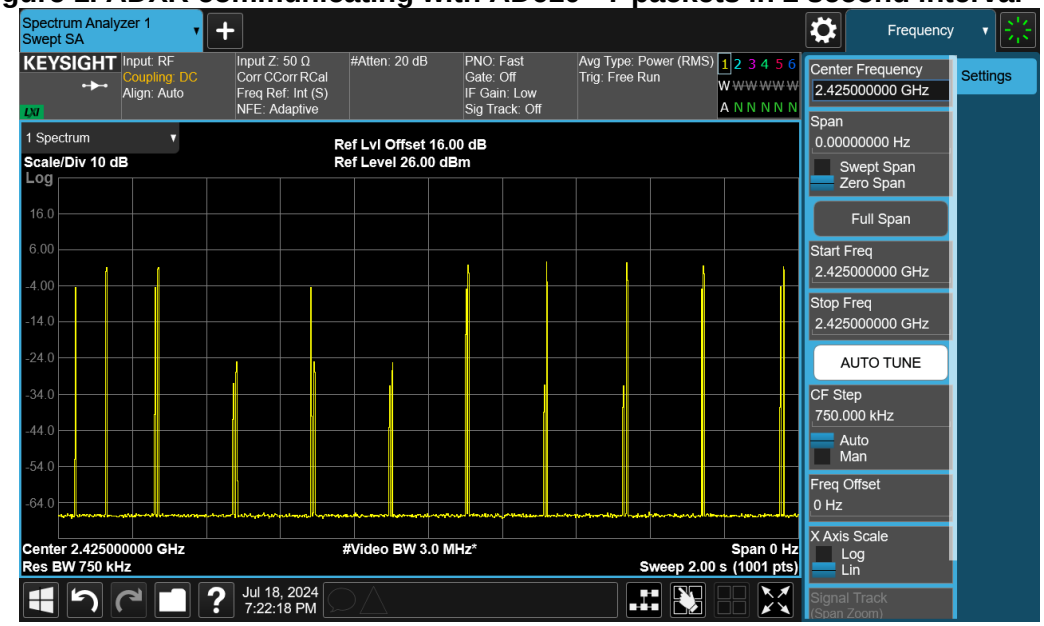


Figure 2. ADXR communicating with AD610 - 3 packets in 2 second interval

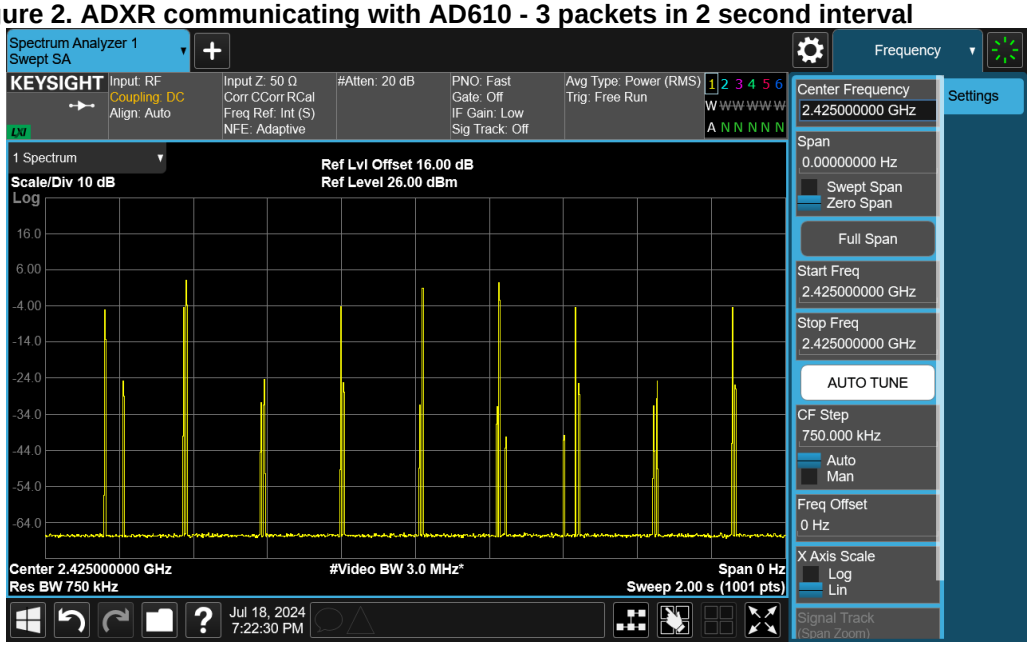


Figure 3. ADXR communicating with AD610 - 6 packets in 2 second interval

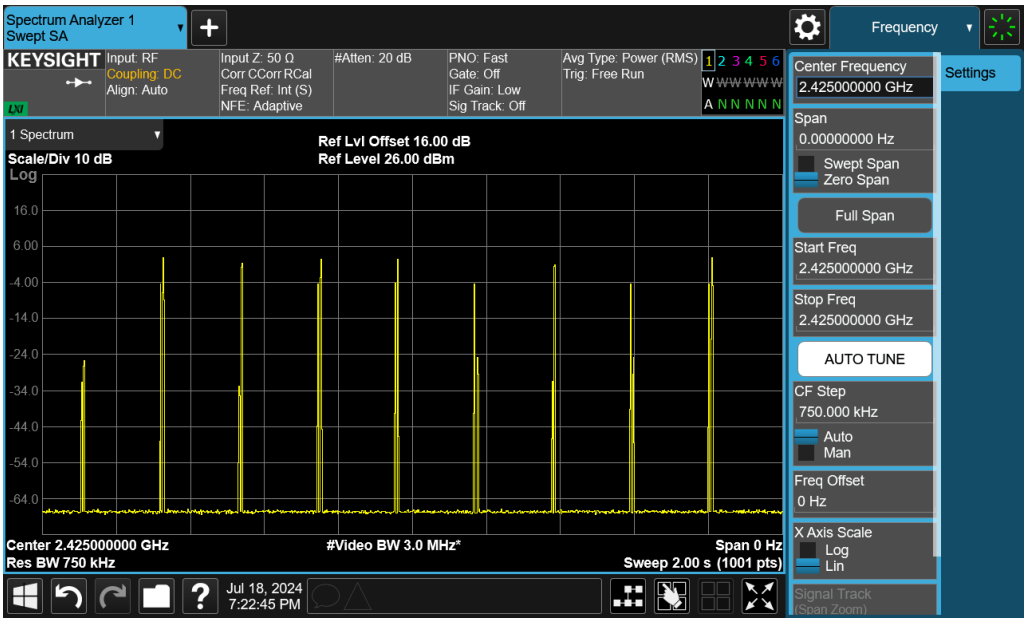


Figure 4. ADXR communicating with AD610 - 6 packets in 2 second interval

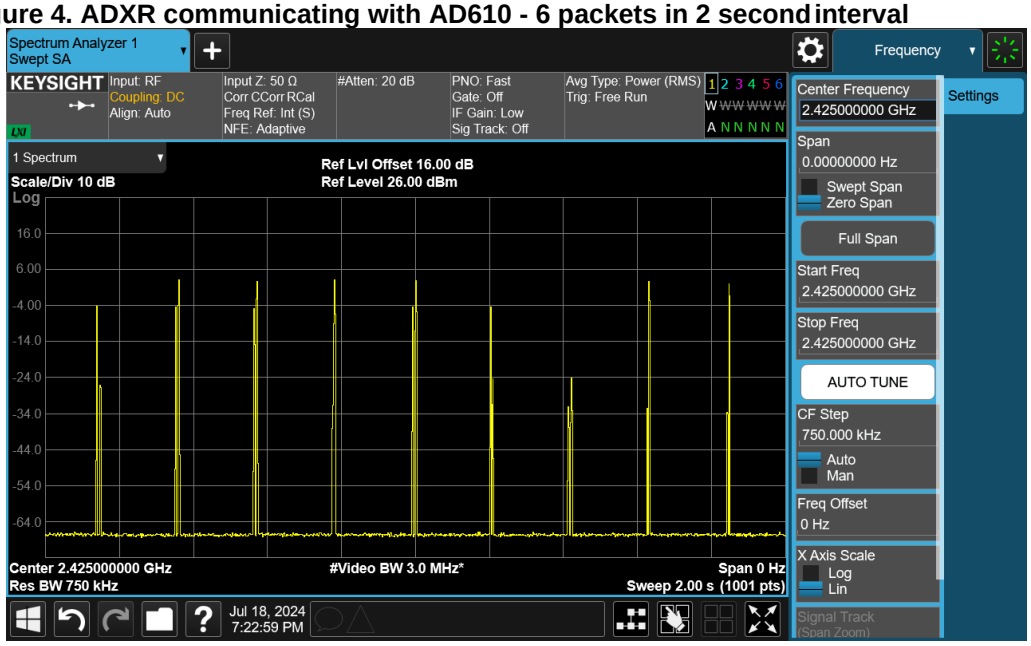


Figure 5. ADXR communicating with AD610 - 4 packets in 2 second interval

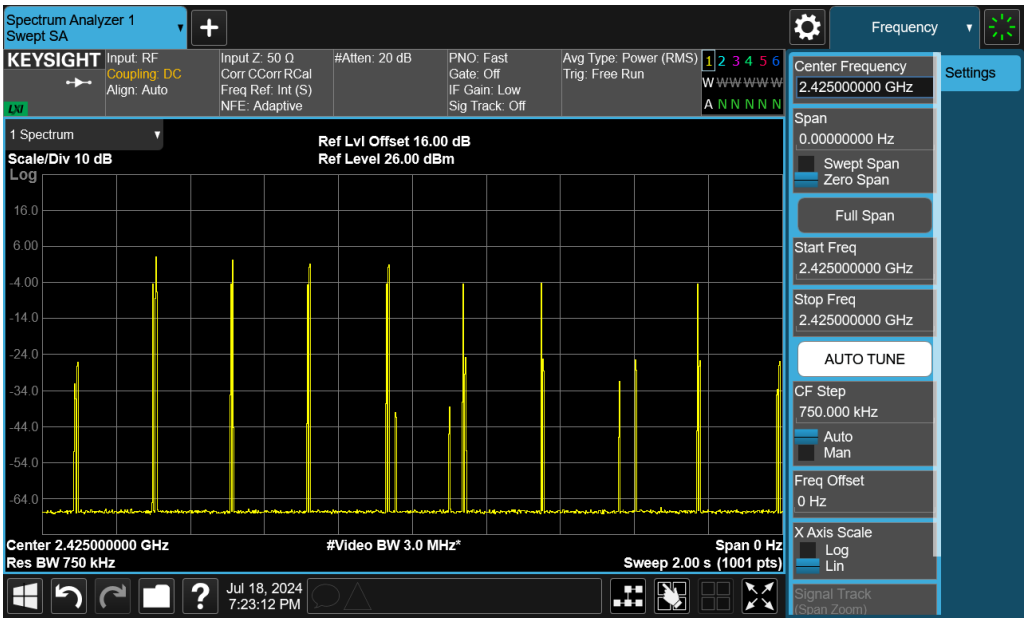


Figure 6. ADXR communicating with AD610 - 3 packets in 2 second interval

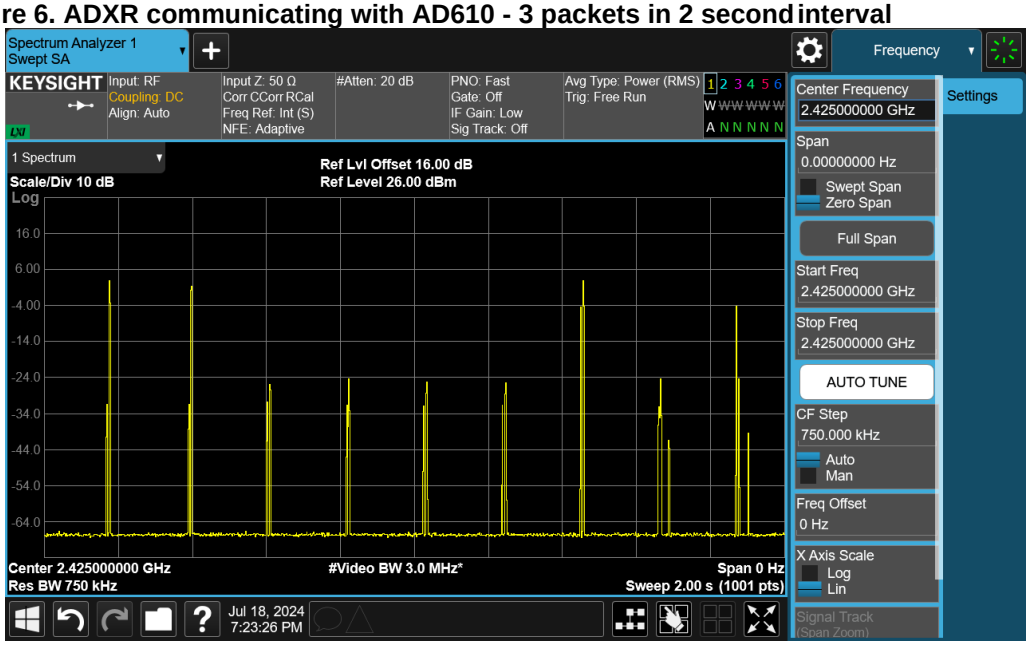


Figure 7. ADXR communicating with AD610 - 7 packets in 2 second interval

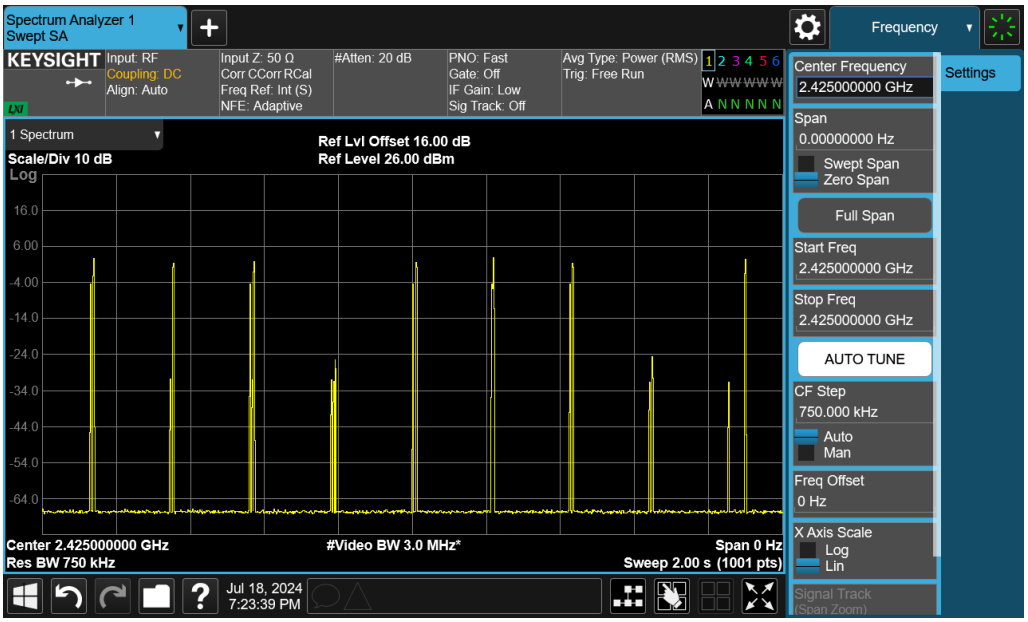


Figure 8. ADXR communicating with AD610 - 2 packets in 2 second interval

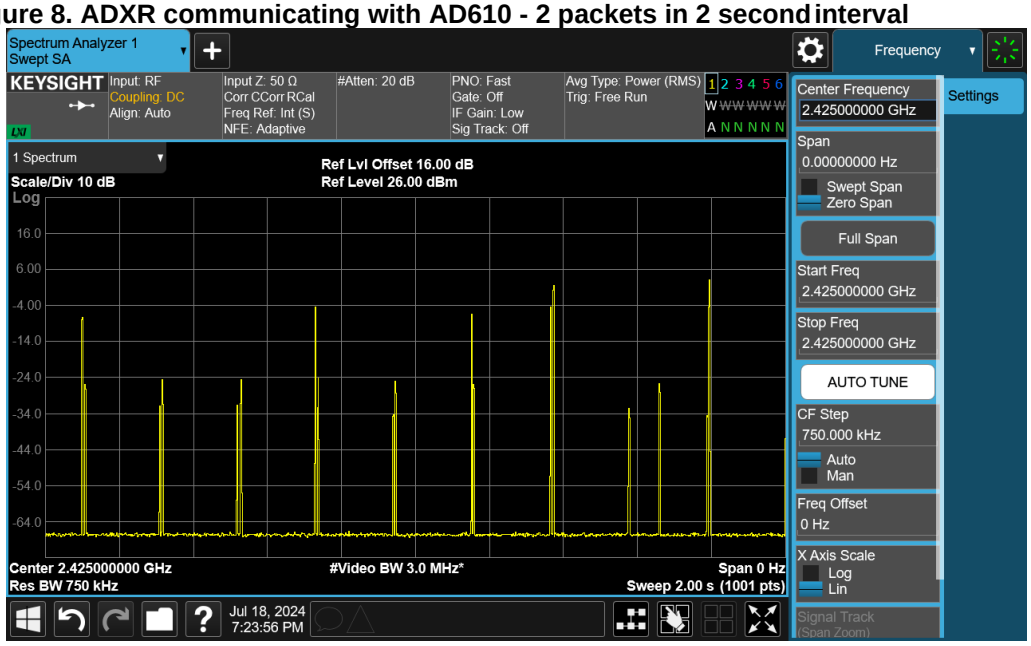


Figure 9. ADXR communicating with AD610 - 6 packets in 2 second interval

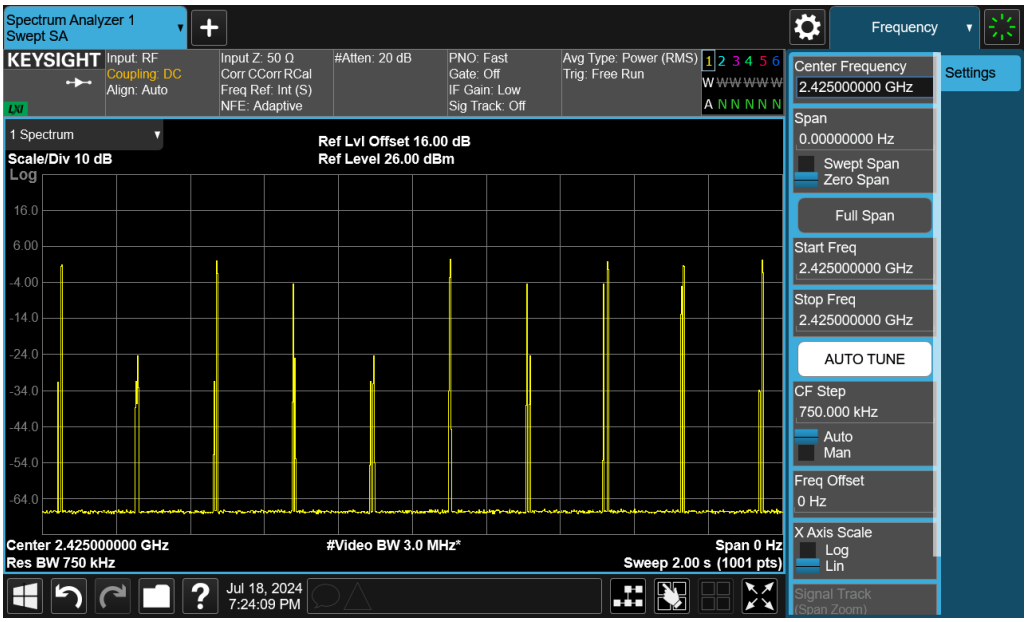


Figure 10. ADXR communicating with AD610 - 7 packets in 2 second interval

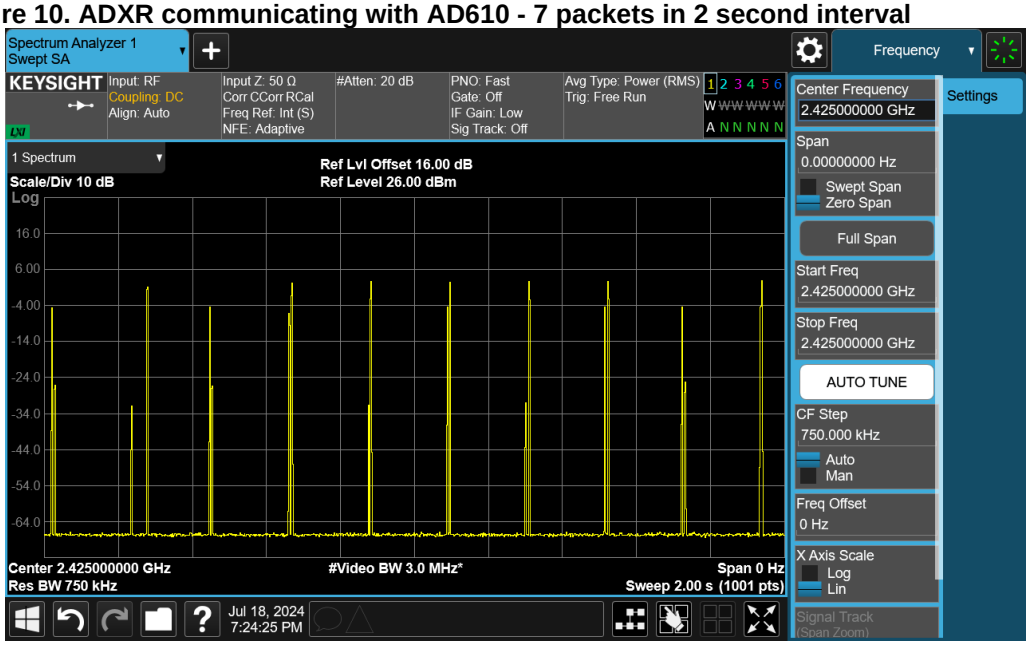
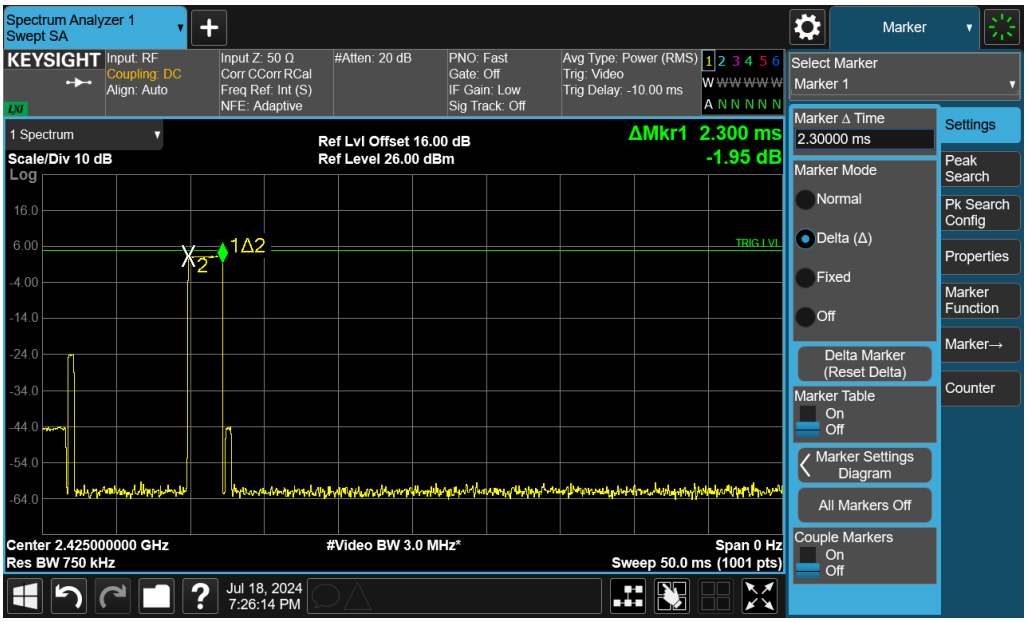


Figure 11 – Typical ADXR packet duration



Duty Cycle Calculations

Packet Count Distribution

Using the counted packets of several consecutive measurements, a standard deviation (SDEV) measurement was calculated. In order to ensure statistical validity of measurements, Mean+3*SDEV was used for final calculation of the duty cycle (Table 1)

Figure#	# packets
1	7
2	3
3	6
4	6
5	4
6	3
7	7
8	2
9	6
10	7
Mean	5.1
STDEV	1.81
Mean+3*STDEV	10.54

Table 1 - Packet count distribution

Duty Cycle

The duty cycle calculation is shown in Table 2 below.

# of Packets		Single Packet Duration (ms)	Total PA-ON Time in 2 sec. Interval (ms)	Duty Cycle (%)
Mean out of packets	5.1	2.3	11.73	0.59
Mean+3*STDEV	10.54	2.3	24.24	1.21

Table 2 - Duty cycle calculations

No_Packets_2sec = 10.54

Single_Packet_Period = 2.3 ms

No_Packets_100ms = No_Packets_2sec * 100ms / 2000ms

No_Packets_100ms = 0.527

δ = No_Packets_100ms * Single_Packet_Period / 100ms

δ = 0.0121

DutyCycle_correction_dB = 20 * log(δ)

DutyCycle_correction_dB = -38.33