RSSI Gain Step Calibration in AD9361

1. Introduction

The AD9361 receiver contains multiple analog gain stages. RSSI (Received Signal Strength Indicator) is measured after the ADC and depends on total receiver gain. Because gain changes with Gain Step Index (GSI), RSSI must be calibrated so that it reflects true RF input power.

2. Gain Step Index (GSI)

Gain in AD9361 is discrete and indexed. Each Gain Step Index corresponds to a combination of LNA, Mixer, TIA, and digital gain. Mathematically: $RSSI\_raw = P\_in + G\_total$ $P\_in = RSSI\_raw - G\_total$ Since hardware is non-ideal, calibration is required.

3. Role of LO (Local Oscillator)

The LO sets the RF center frequency and affects mixer conversion gain, frequency response, and matching. The same Gain Step Index produces slightly different gain at different LO frequencies. Therefore: $G\_total = f(LO\ frequency, GSI)$

4. What is RSSI Internally

RSSI is a digital power estimate based on averaged I/Q samples: $RSSI = 10 \log_{10}((1/N) * sum(I^2 + Q^2))$ It is initially measured in dBFS and later converted to dBm using calibration tables.

5. Calibration Concept

During calibration: 1. Inject known RF power (e.g., -60 dBm) 2. Fix LO frequency 3. Sweep Gain Step Index 4. Measure RSSI error 5. Store correction per (LO band, GSI) Final corrected power: $P\_corrected = RSSI\_measured - G\_calibrated$

6. AGC Context

In Automatic Gain Control (AGC) mode, Gain Step Index changes dynamically. Without gain calibration, RSSI would fluctuate even for constant input power. Correct formula: P_in = RSSI - GainTable[GSI]

7. Practical Considerations

- Gain steps are not perfectly linear - Small discontinuities exist between steps - LO frequency introduces gain ripple - Temperature affects gain In practice: G = f(GSI, LO, Temperature)

8. Final Summary

RSSI Gain Step Calibration in AD9361 is a mapping between Gain Step Index and true analog gain, corrected per LO frequency band, ensuring RSSI represents actual RF input power. Final Equation: P_in = RSSI - G(GSI, LO)