Introduction

Antenna gain measurement and calculation. Final antenna gain is -4.2 dB.

Pump

This paper documents the method used to determine the antenna gain in twiist Pump, assembly DKPI-21073-007, board DKPI-50108-001. The twiist Pump communicates wirelessly using the Bluetooth 4.2 Low Energy protocol (BLE4.2). The pump utilizes a Nordic Semiconductor BLE System on Chip (nRF528410). This SoC offers configurable conducted output power level. During normal communication, the conducted output power of the SoC is set to 0 dBm. The The twiist Automated Insulin Delivery (AID) System uses the 40 BLE channels spaced 2 MHz apart in the 2.4 GHz – 2.4835 GHz ISM band.

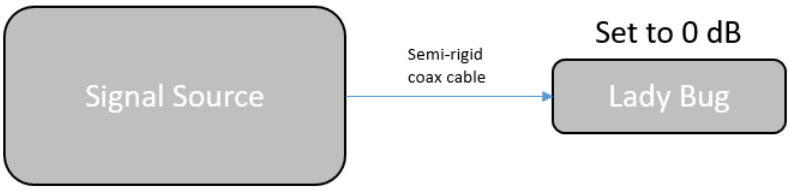
Pump Antenna

The twiist pump uses a slot cut into the metallized pump cover that is slightly longer than $\lambda/2$ for F_0 = 2.45 GHz. The PCB provides spring probes to the antenna which are offset to approximately 250 Ω. There are spring points on the PCB to connect the radio signal to the slot antenna in the cover. The calculated gain of the antenna is ~3 dB higher than the realized gain, due to difference in conductivity and surface roughness of the plating material.

Test Method

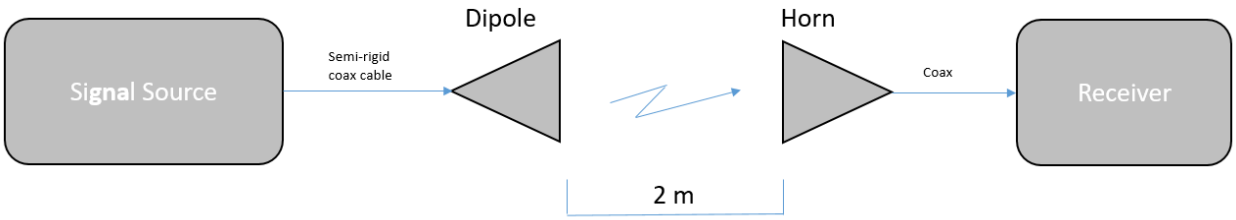
Set the baseline power level to 0 dB – P_{SOURCE}

Using a Network Analyzer, semi-rigid cox cable and a Ladybug LB478A power meter, set the output level at the end of the coax cable to 0 dB at 2.45 GHz at 2 m



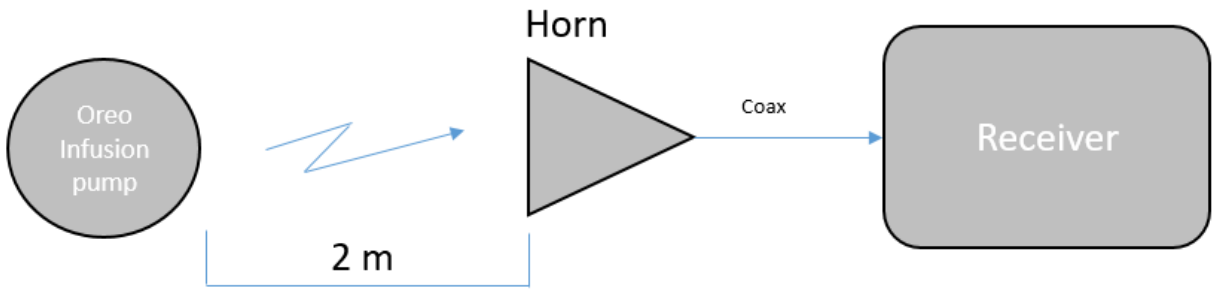
Measure the known source – P_{MEAS_SOURCE}

Measure the maximized 0 dB signal from a tuned dipole using a horn antenna and an EMI receiver



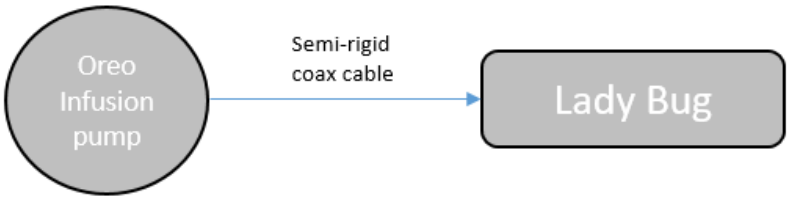
Replace the signal source with the Twiist pump transmitting at full power and channel 39 at 2.48 GHz – P_{PUMP}

Measure the maximized power level seen at the receiver.



Conducted power level from the Nordic Chip – $P_{CONDUCTED}$

Measure the power conducted power at a point just prior to the SAW filter.



Measurements and Correction Factors

P_{SOURCE}	0 dBm	Source power used to calibrate the dipole measured into a power meter
$P_{SOURCE\ -\ i}$	2.2 dBi	Isotropic equivalent of P_{MEAS_SOURCE}
P_{MEAS_SOURCE}	-50.4 dBm	Radiated power measured at the horn antenna due the source power from the dipole
P_{PUMP}	-56.1 dBm	Radiated power measured at the horn antenna due to the pump transmitting
$P_{CONDUCTED}$	-1.74 dBm	Conducted power measured from the pumps circuit before the SAW filter using a power meter
L_{CABLE}	1.0 dB	Estimated loss due to the semi-rigid coaxial cable
$C_{ISOTROPIC}$	2.2 dBi	Correction of +2.2 dB normalizing the dipole measurement to an isotropic antenna, dBi

Calculations

Equations:

1. Pump radiated power vs conducted power

$$P_{PUMP} + L_{CABLE} - P_{CONDUCTED} = (-56.1) + (1.0) + (-1.74) = -56.84 \text{ dB}$$

2. Source power

$$P_{MEAS\_SOURCE} - C_{ISOTROPIC} = (-50.4) – (2.2) = -52.6 \text{ dBi}$$

3. Antenna Gain

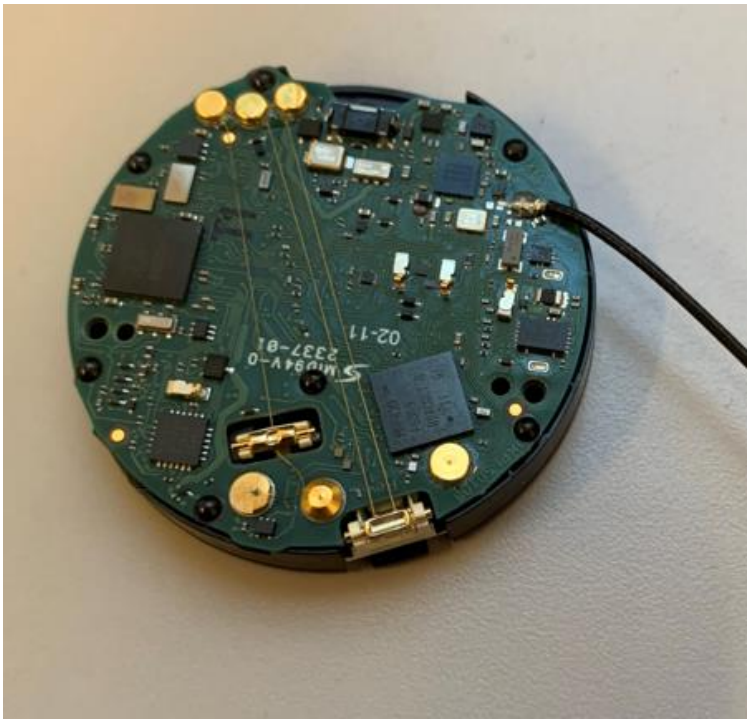
Eq. 1 – Eq. 2 = (-56.84) – (-52.6) = -4.2 dB

Photos

Dipole Verification

Power from 0 dB into Dipole Test Configuration

Pump PCB Conducted Configuration



Pump cover/antenna