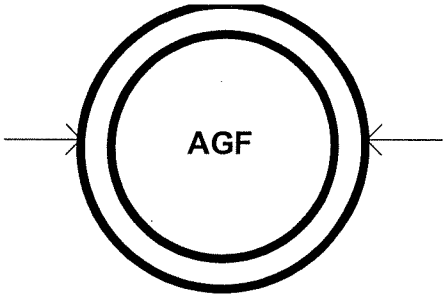
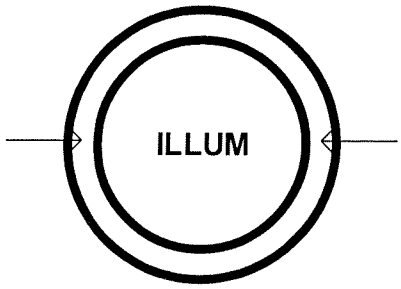
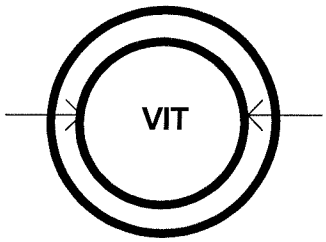
ANTENNA GAIN CALCULATION FOR THE 212-1621-501 & 212-1630-501 PCBAs



OUTSIDE DIAMETER



AVG DIAMETER



INSIDE DIAMETER

The Pneumatics RFID PCBA (212-1621-501) has 7 antennas, 6 of which are identical in size (marked VIT above). The 7th antenna is marked AGF above (largest of the 3). The Illuminator RFID PCBA (212-1630-501) has two antennas, identical in size (marked ILLUM above).

Antenna Gain was calculated for each of the three antenna sizes using 3 different lengths for D (diameter): OD, AVG, ID. The equation used to calculate gain:

$$G = \eta(\pi DF/c)^2$$

where η = is net efficiency and for a typical antenna = 0.55
where D = diameter in meters
where F = frequency, or 13.56MHz
where c = speed of light, or $3(10)^8$

diameter calculations

INCHES	OD	AVG	ID
AGF	1.065	0.91	0.76
ILLUM	1.105	0.945	0.81
VIT	0.865	0.725	0.605

METERS	OD	AVG	ID
AGF	0.027	0.023	0.019
ILLUM	0.028	0.024	0.02
VIT	0.021	0.018	0.015

from the table we can show that $G = D^2(1.109)10^{-2}$,

which provides:

GAIN	OD	AVG	ID
AGF	8.085E-06	5.867E-06	4.004E-06
ILLUM	8.695E-06	6.388E-06	4.436E-06
VIT	4.891E-06	3.593E-06	2.495E-06

Using 10log(Po/Pi) = dB, we plug the values from the gain table in for Po/Pi to get:

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GAIN (dBD)	OD	AVG	ID
AGF	-50.9233	-52.3161	-53.9755
ILLUM	-50.6074	-51.9464	-53.53
VIT	-53.1062	-54.4452	-56.0288

now, if we assume that the equation $G = \eta(\pi DF/c)^2$ assumes that the dB gain is with respect to a halfwave dipole (dBD), then to express the gain (dB) in dBi (with respect to an isotropol radiator) we must add 2.14 to the value to get:

GAIN (dBi)	OD	AVG	ID
AGF	-48.7833	-50.1761	-51.8355
ILLUM	-48.4674	-49.8064	-51.39
VIT	-50.9662	-52.3052	-53.8888

Based on the above, we can use a theoretical antenna gain of $\approx$-50 dBi as an average for the 3 different antennas.

Reference:
http://www.aticourses.com/antennas_tutorial.htm