



Powering Business Worldwide

Eaton

DBA Cooper Industries (Electrical) Inc.
74 – 1833 Coast Meridian Road
Port Coquitlam BC Canada V3C6G5

XPD2400

THEORY OF OPERATION

Radu Oprea

05-IA9-XPD2400A_OperationalDescription.docx

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1 Summary of the antennas used with XPD2400 module

The module's emissions were measured with 5 different antennas, the first three antennas are used in mobile applications, where the distance between the person and the antenna is greater than 20cm, and the last 2 antennas are used in portable products.

Item	Description	Manufacturer	Model	Gain
1	2.4-2.5GHz $1/2\lambda$ Dipole	Laird	TRA24003NP	3dBi
2	2.4-2.5 Dual Closed Coil Whip	Pulse	NMO5E2400B	5dBi
3	2.4-2.5GHz Edge Inverted L	Cooper	ACAB-2683-07	5.06 dBi
4	2.4-2.5GHz $1/2\lambda$ Dipole	Wellshow	AR010-2.4G	2 dBi
5	2.4-2.5GHz SMD Ceramic	Yageo	ANT7020LL05R2400A	2.62dBi

The antennas and their characteristics are summarized in the table below.

Table 1. Antennas' characteristics

Antenna Information

Antenna 1

Manufacturer	Laird
Model	TRA24003NP
Type	Dome
Centre Frequency	2.45 GHZ
Bandwidth	100MHz
Height	58.42 mm
Gain	3dBi
Connection	N Female
Impedance	50 Ohm

Antenna 2

Manufacturer	Larsen/Pulse
Model	NMO5E2400B
Type	Whip
Centre Frequency	2.45 GHZ
Bandwidth	100MHz
Height	217 mm
Gain	5 dBi
Connection	NMO
Impedance	50 Ohm

Antenna 3

Manufacturer	Cooper Industries
Model	ACAB-2683-07
Type	Inverted L
Centre Frequency	2.45 GHZ
Bandwidth	80MHz
Height	70 mm Total length
Gain	5.06 dBi
Connection	Soldered
Impedance	50 ohm includes matching circuit on the host

Antenna 4

Manufacturer	Wellshow
Model	AR010-2.4G
Type	Rubber Duck
Centre Frequency	2.45 GHZ
Bandwidth	100MHz
Height	68 mm
Gain	2 dBi
Connection	UFL
Impedance	50 Ohm

Antenna 5

Manufacturer	Yageo
Model	ANT7020LL05R2400A
Type	Ceramic Chip Antenna
Centre Frequency	2.45 GHZ
Bandwidth	500MHz
Height	7 x 2 mm
Gain	2.62 dBi
Connection	Soldered
Impedance	50 ohm includes matching circuit on the host

2 Antenna 1 Laird TRA24003NP



PHANTOM® ANTENNA IS IDEAL FOR CELL, GSM, PCE, WIFI, 802.11 AND BLUETOOTH WIRELESS APPLICATIONS

Laird's unique patented Phantom® is a tough low-profile antenna for outdoor or indoor applications. Measuring only 2.7" tall, the Phantom 800 MHz to 5.8 GHz antenna models' revolutionary design features field diversity with both vertical and horizontal polarization components. This gives the antenna diversity, frequency agility, low visibility, wide bandwidth and a low angle radiation pattern that is superior to traditional gain antennas in most applications.

The industry standard NMO mounting socket mates with all Laird Technologies' magnetic, trunk lid, and hole mounts. A threaded permanent stud mount model is also available for vandal resistant mounting on brackets, panels, ceilings or any other kind of housing.

The Phantom® patented technology is beneficial when high performance is desired and extreme ruggedness and low profile is required.

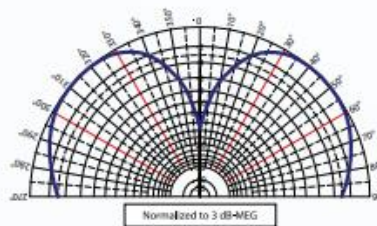
FEATURES

- True Field Diversity design ensures uninterrupted transmissions in urban canyons and rural drop off areas
- Phantom® outperforms a 3dB whip in many applications
- U.S. Patent Nos. 5,977,931 – 6,292,156 and 7,209,096

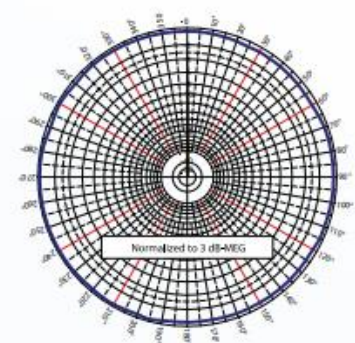
MARKETS

- Cell
- GSM and PCS
- WiFi
- 802.11
- Bluetooth wireless applications

ANTENNA PATTERNS



Elevation Pattern (Y, Z, or H-plane)



Azimuth Pattern (X, Y, or E-plane)

Americas: +1.847.839.6925
IAS-AmericasEastSales@lairdtech.com
Europe: +44.1628.858941
IAS-EUSales@lairdtech.com
Asia: IAS-AsiaSales@lairdtech.com

www.lairdtech.com

SPECIFICATIONS

ELECTRICAL	
VSWR	< 2.1
Nominal Gain	3 dB-M.E.G.
Maximum Power	100 W
Nominal Impedance	50 Ω
Polarization	Vertical
Pattern	Omnidirectional
Half-Power Beamwidth (Elevation° x Azimuth°)	130° x 360°
Coaxial Cable Length & Type	None
Terminations	NMO Socket or, type N-female

MECHANICAL	
Color	Black or White
Height (initially)	2¾"
Diameter	1.438"
Weight	0.173 lb
Material	ABS
Mounting Information	NMO (PN: MB8, MABB) Sold Separately
Noise Suppressor	BlackHawk NS1535 1-35 VOLT, 15 Amp Noise Suppressor (Sold Separately)

Permanent Mounting Option:

Please order by antenna model and insert letter "P" to indicate permanent mounting option (TRAB063P).

MODEL AND ORDERING INFORMATION

MODEL	DESCRIPTION
TRAB063	806-870 MHz 3 dB-MEG Phantom® ¾ NMO, White Radome
TRAB213	821-896 MHz 3 dB-MEG Phantom® ¾ NMO, White Radome
TRAB903	890-960 MHz 3 dB-MEG Phantom® ¾ NMO, White Radome
TRA9023	902-928 MHz 3 dB-MEG Phantom® ¾ NMO, White Radome
TRA18503	1.85 - 1.99 GHz 3dB-MEG Phantom® ¾ NMO, White Radome
TRA24003	2.4 – 2.5 GHz 3 dB-MEG Phantom® ¾ NMO, White Radome
TRA58003	4.9 – 6.0 GHz 3 dB-MEG Phantom® ¾ NMO, White Radome
TRADCAGP	G - Drop ceiling antenna adaptor for P-mount Phantom w/ 6"x6"x0.016" ground plane
Sealtube3	Heat shrink tubing 3"x1"DIA install (use for jaw protector on installation wrench)

Add "B" to model number for black radome. Example: TRAB8063

Add "P" to model number for Permanent Mount. Example: TRAB063P

3 Antenna 2 Larsen/Pulse NMO5E2400B

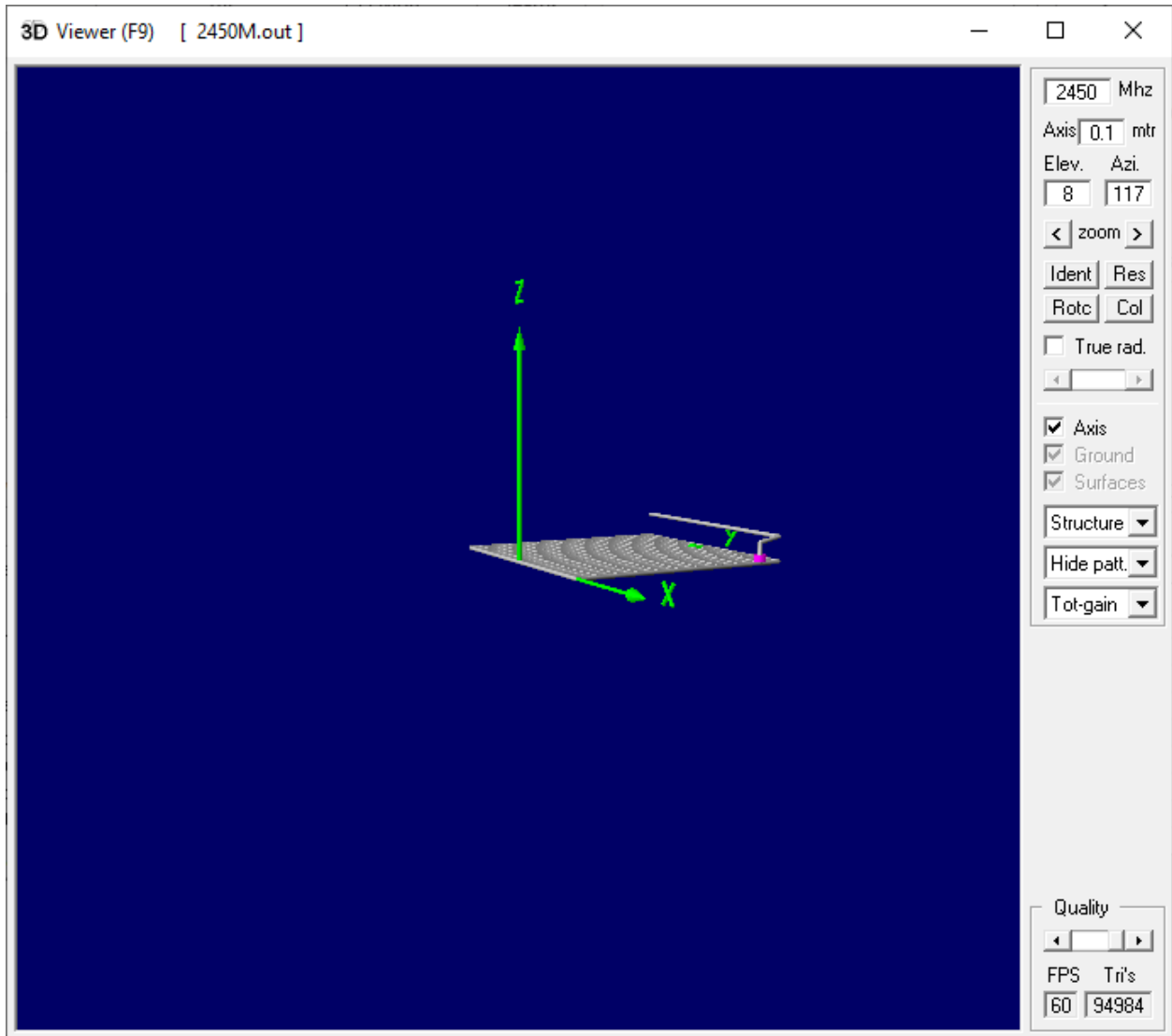


Mobile Antenna	
Frequency Range	2400-2500
Connector Type	None
Mobile Antenna Specs 2	
Gain	5 dB
Bandwidth	100 MHz
Power (watts)	100
Whip Material	17-7PH Stainless Steel
Whip Length	8.54" overall length
Base Style	NMO HF Style
Mount Style	None
Connector Type	None
Warranty	3 Year
Weight	2 lbs

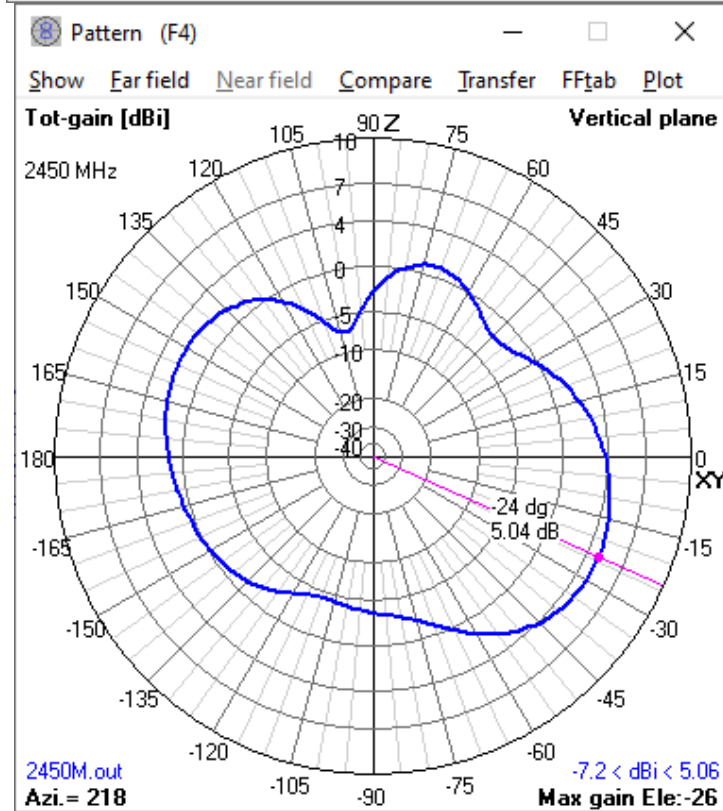
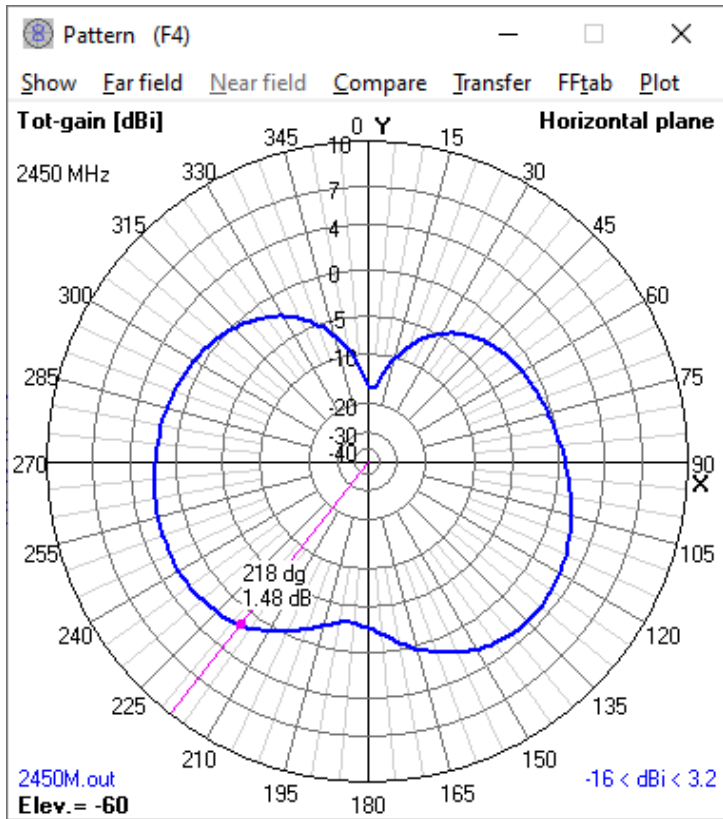
4 Antenna 3 Cooper Industries ACAB-2683-07

Inverted L antenna simulation.

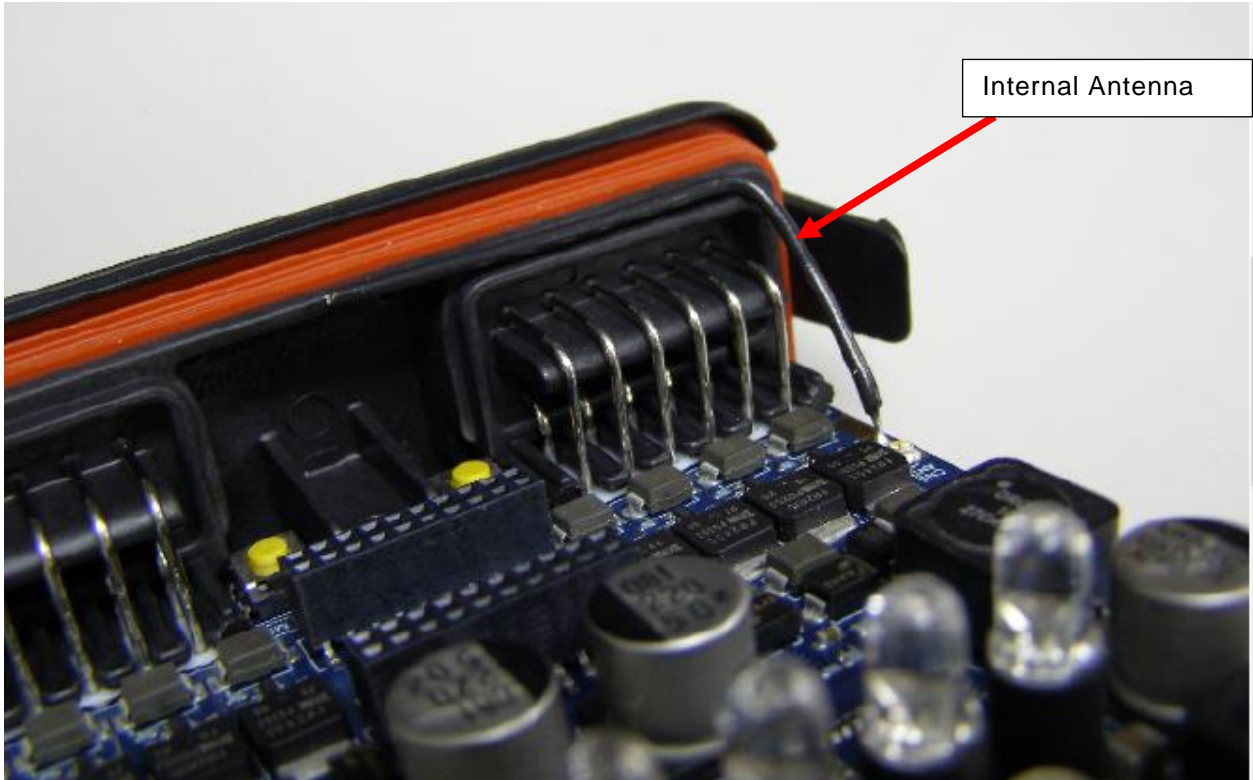
Radiating wire coated with soft PVC 0.8mm thick.



Impedance @2450MHz = 2036-j670. Antenna is matched very close to the soldering point.



H and V Radiation Pattern Cross Sections



Picture of internal antenna ACAB-2683-07 installed in product R260.

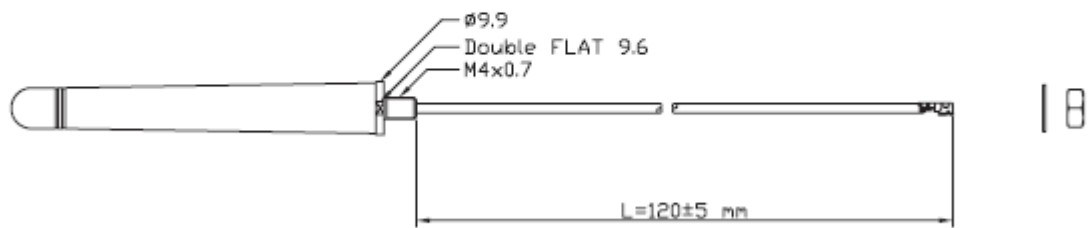
5 Antenna 4 Wellshow AR010-2.4G

2.4GHz M4 Type Antenna

to RG178(BR) to ipex,L120mm

Product No. 130826-03

Structure Figure



Unit: mm

Mechanical Properties

Antenna Cover	TPEE (Black)
Operating Temperature	-20°C~+60°C
Storage Temperature	-30°C~+70°C
Cable Type	RG178/U
Cable Color	Brown

Electrical

Frequency Range	2400MHz
Impedance	50 Ω
VSWR	2.0 Max
Gain	2.0 dBi
Electrical Wave	1/4λ, Dipole
Radiation	Omni
Polarization	Vertical

6 Antenna 5 Yageo ANT7020LL05R2400A

YAGEO *Phicomp*

Product specification

WIRELESS COMPONENTS

Ceramic Chip Antenna

3
a

SPECIFICATION

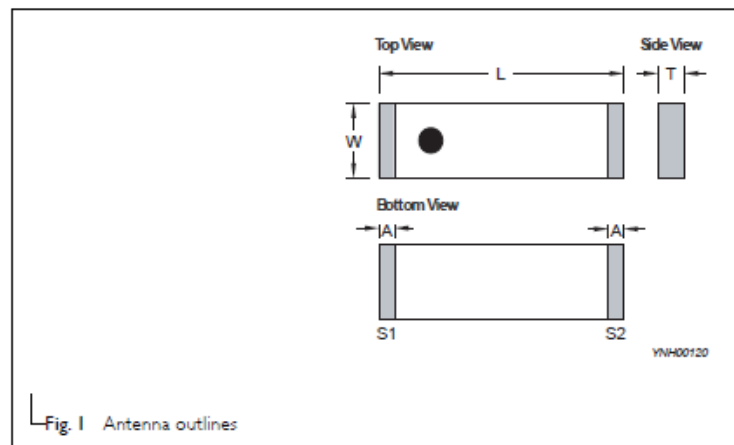
Table 1

DESCRIPTION	VALUE
Centre Frequency	2.45 GHz
Bandwidth	500 MHz (Typ.)
Return Loss	10 dB min
Polarization	Linear
Azimuth Beamwidth	Omni-directional
Peak Gain	2.62 dBi (Typ.)
Impedance	50 Ω
Operating Temperature	- 40~105 °C
Maximum Power	1 W
Termination	Ni / Sn (Environmentally-Friendly Leadless)
Resistance to Soldering Heats	260°C, 10sec

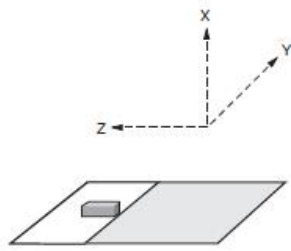
NOTE

1. The specification is defined on Yageo evaluation board

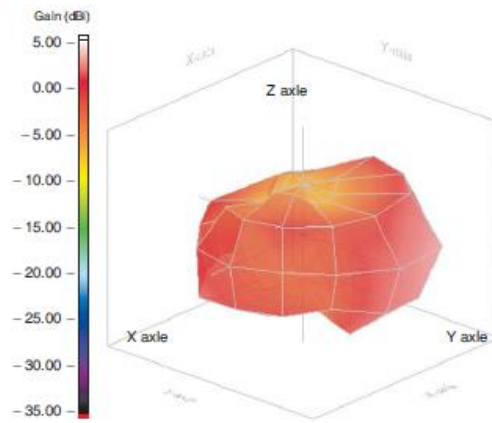
OUTLINES



IAL NAME	FUNCTION
	Feeding Point
	Soldering Point



Evaluation board and XYZ direction



YNH00123

Frequency= 2.45 GHz
Max gain = 2.62 dBi, at (90,120)
MEG (mean effective gain)= -2.28 dBi
Directivity (dB) = 3.67
Efficiency = -1.05 dB, 78.49%

Fig. 5 Radiation pattern

7 Revision History

Revision	Author	Date	Description
D0.1	Radu Oprea	2023-08-22	Create document.