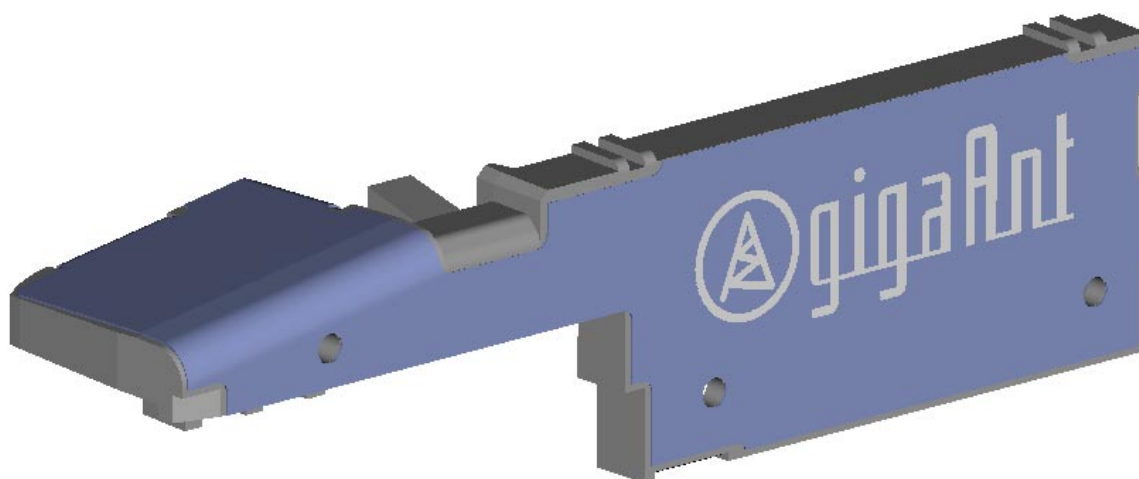


Prepared by: Ola Carmonius & Elisabeth Wieslander		File name: Specifications of iPAQX BT/WLAN Antenna	Creation date: 2004-01-13	Page: 1
Approved by: Rune Nilsson		Document number: AA040002	Last rev. date: 2004-04-21	Revision: PA4
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Specification Of iPAQX BT/WLAN Antenna



Prepared by: Ola Carmonius & Elisabeth Wieslander		File name: Specifications of iPAQX BT/WLAN Antenna	Creation date: 2004-01-13	Page: 1
Approved by: Rune Nilsson		Document number: AA040002	Last rev. date: 2004-04-21	Revision: PA4
Distribution:	EA			

Contents

1	OVERVIEW	4
1.1	Definitions	4
2	INTERFACES	5
2.1	Electrical	5
2.2	Mechanical	5
2.2.1	Dimensions	5
2.2.2	Connector	5
2.2.3	PDA Frame	5
2.3	Hardware platform	5
3	ELECTRICAL SPECIFICATION	6
3.1	Electrical measurement methods	6
3.1.1	General	6
3.1.2	Output Power	6
3.1.3	Return Loss	6
3.1.4	Efficiency	6
3.1.5	Gain and Radiation Patterns	6
3.2	Electrical Requirements	6
3.2.1	Frequency	6
3.2.2	Output Power	6
3.2.3	Return Loss	7
3.2.4	Efficiency	9
3.2.5	Gain and Radiation Patterns	9
4	MECHANICAL SPECIFICATION	12
4.1	Mechanical Performance	12
4.2	Mechanical test methods	12
4.2.1	Drop Test	12
4.3	Mechanical requirements	13
4.3.1	Drop Test	13
4.4	Environmental Performance	13
4.4.1	Temperature, Steady state	13
4.4.2	Temperature, Cycling	13
4.4.3	Salt Mist Resistance	14

Prepared by: Ola Carmonius & Elisabeth Wieslander		File name: Specifications of iPAQX BT/WLAN Antenna	Creation date: 2004-01-13	Page: 1
Approved by: Rune Nilsson		Document number: AA040002	Last rev. date: 2004-04-21	Revision: PA4
Distribution:	EA			

4.4.4	Damp heat, steady state	14
4.4.5	Vibration Test	14
4.5	Environmental requirements	14
4.5.1	Temperature, Steady state	14
4.5.2	Temperature, Cycling	14
4.5.3	Salt Mist Resistance	15
4.5.4	Damp heat, steady state	15
4.5.5	Vibration Test	15
5	VERIFICATION TEST SEQUENCE	16
6	MATERIAL SPECIFICATION	18
6.1	Antenna Radiator	18
6.2	Antenna Carrier	18
7	PACKAGING SPECIFICATION	18
8	MARKING	18
9	DESIGN CHANGES	18
10	ENCLOSURES	19
11	APPROVAL	19
12	REVISION HISTORY	19

Prepared by: Ola Carmonius & Elisabeth Wieslander		File name: Specifications of iPAQX BT/WLAN Antenna	Creation date: 2004-01-13	Page: 1
Approved by: Rune Nilsson		Document number: AA040002	Last rev. date: 2004-04-21	Revision: PA4
Distribution:	EA			

1 Overview

This is the specification for a gigaAnt dual-band antenna. The antenna is to be used in an iPAQ Personal Digital Assistant (PDA) for the BT and WLAN band.

1.1 Definitions

dB _i	Decibel relative isotropic antenna
T _x	Transmit frequency
R _x	Receive frequency
R.L.	Return Loss
PCB	Printed Circuit Board
TBD	To Be Defined
TBA	To Be Advised
TBF	To Be Finalized
ASD	Acceleration Spectral Density
CW	Continuous Wave
PDA	Personal Digital Assistant
BT	Bluetooth
WLAN	Wireless Local Area Network

Prepared by: Ola Carmonius & Elisabeth Wieslander		File name: Specifications of iPAQX BT/WLAN Antenna	Creation date: 2004-01-13	Page: 1
Approved by: Rune Nilsson		Document number: AA040002	Last rev. date: 2004-04-21	Revision: PA4
Distribution:	EA			

2 Interfaces

2.1 Electrical

Nominal antenna impedance: 50Ω

2.2 Mechanical

2.2.1 Dimensions

gigaAnt interface drawing B5969 defines the mechanical interface of the antenna. The drawing can be seen in Enclosure 1. Encircled dimensions represent critical parameters and will be measured.

2.2.2 Connector

The antenna is connected via an external separate connector, manufactured by Acon. A specification of this connector can be seen in Enclosure 2. The nominal stroke length of the connector legs is 1.5mm.

2.2.3 PDA Frame

The antenna will be mounted in the PDA frame. Three snap hooks are used for fastening the antenna.

2.3 Hardware platform

The chassis used for the development and verification of this antenna is an iPAQ (PDA) that consists of the customer handset reference number (TBA).

Prepared by: Ola Carmonius & Elisabeth Wieslander		File name: Specifications of iPAQX BT/WLAN Antenna	Creation date: 2004-01-13	Page: 1
Approved by: Rune Nilsson		Document number: AA040002	Last rev. date: 2004-04-21	Revision: PA4
Distribution:	EA			

3 Electrical Specification

The electrical performance is dependent on the proper fixation of the antenna in order to ensure stable electrical characteristics.

3.1 Electrical measurement methods

3.1.1 General

All measurements are performed at room temperature, $20^{\circ}\text{C} \pm 3,0^{\circ}\text{C}$.

3.1.2 Output Power

The power is measured during a period of 10 minutes. The frequency is the middle frequency of the BT/WLAN band. The test signal is a CW signal.

3.1.3 Return Loss

The Return Loss is measured with a Network Analyser. The Return Loss is measured in free space.

3.1.4 Efficiency

The efficiency is measured in a calibrated 3D anechoic chamber. The efficiency is the total radiated power divided by the total power sent to the antenna, which in some literature is referred to as total efficiency.

3.1.5 Gain and Radiation Patterns

The pictures in Figure 3 to Figure 4 show the polar plots of the measured cuts. The vertical and horizontal polarisation are measured and summed up to the total polarisation, which is used to calculate the efficiency. The coaxial feed cable is not electrically interfering with the antenna.

3.2 Electrical Requirements

3.2.1 Frequency

Both the WLAN and Bluetooth antennas operate in the frequency band: 2,4 – 2,5 GHz

3.2.2 Output Power

The maximum output power for the WLAN and Bluetooth antennas is: 5W CW

Prepared by: Ola Carmonius & Elisabeth Wieslander		File name: Specifications of iPAQX BT/WLAN Antenna	Creation date: 2004-01-13	Page: 1
Approved by: Rune Nilsson		Document number: AA040002	Last rev. date: 2004-04-21	Revision: PA4
Distribution:	EA			

3.2.3 Return Loss

Loss graphs for typical values across the entire bandwidth are listed in Table 1 below. The typical Return Loss the two antennas are showed in Figure 1 and Figure 2.

Frequency / [GHz]	2,40	2,45	2,50
WLAN Return Loss [dB] No cards	15	14	9
WLAN Return Loss [dB] With cards, worst case	13	12	8
Bluetooth Return Loss [dB] No cards	5	4	3
Bluetooth Return Loss [dB] With cards, worst case	5	3	3

Table 1. Return Loss values for the WLAN and Bluetooth antennas in the iPAQX.

The Return Loss plot in Figure1 shows the WLAN resonance frequency without the memory cards inserted.

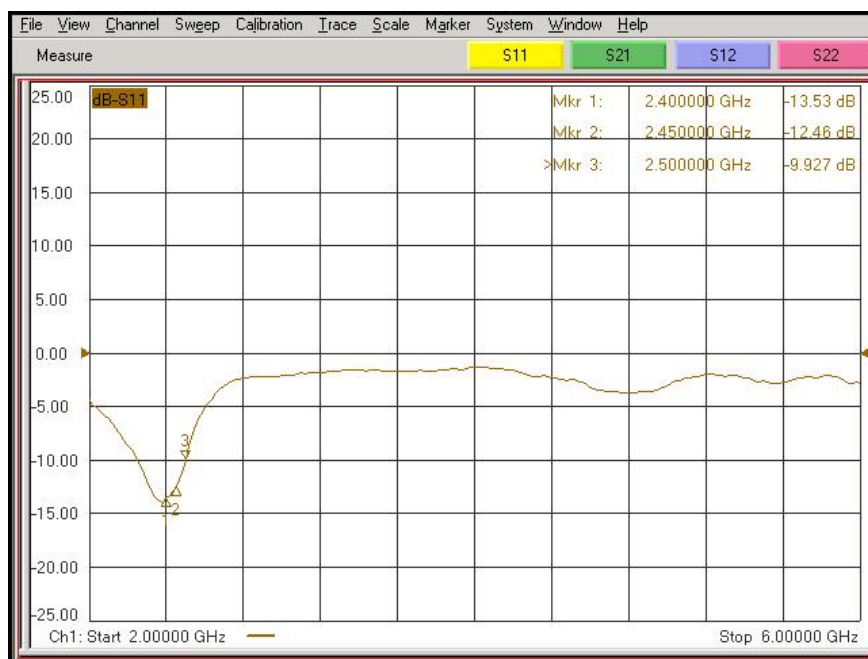


Figure 1. Return loss plot for the WLAN antenna in the iPAQX without any cards inserted.

Prepared by: Ola Carmonius & Elisabeth Wieslander		File name: Specifications of iPAQX BT/WLAN Antenna	Creation date: 2004-01-13	Page: 1
Approved by: Rune Nilsson		Document number: AA040002	Last rev. date: 2004-04-21	Revision: PA4
Distribution:	EA			

Since the two antennas are coupling very hard due to being close as well as in the same frequency band, the Bluetooth antenna is matched to be slightly off frequency. In Figure 2 the Bluetooth resonance frequency is shown without cards inserted into the IPAQX. When the cards are inserted the resonance is lowered in frequency and hence a slightly better values are obtained. However, it is important to not make it too good in order not to interfere too much with the WLAN antenna performance.



Figure 2. Return loss plot for the Bluetooth antenna in the IPAQX without any cards inserted.

Prepared by: Ola Carmonius & Elisabeth Wieslander		File name: Specifications of iPAQX BT/WLAN Antenna	Creation date: 2004-01-13	Page: 1
Approved by: Rune Nilsson		Document number: AA040002	Last rev. date: 2004-04-21	Revision: PA4
Distribution:	EA			

3.2.4 Efficiency

The calculated efficiency values from the gain measurements done in the 3D anechoic chamber are listed in Table 2 below.

Frequency / [GHz]	2,40	2,45	2,50
WLAN Efficiency / [%] No cards	54	54	50
WLAN Efficiency / [%] With cards, worst case	52	52	45
Bluetooth Efficiency / [%] No cards	27	22	21
Bluetooth Efficiency / [%] With cards, worst case	23	18	17

Table 2. Efficiency values for the WLAN and Bluetooth antennas in the IPAQX.

3.2.5 Gain and Radiation Patterns

Gain values from the measurements in the 3D anechoic chamber are listed in Table 3 below.

Frequency / [GHz]	2,40	2,45	2,50
WLAN Gain / [dBi] No cards	2.0	2.0	1,8
WLAN Gain / [dBi] With cards, worst case	1.9	1,9	1.0
Bluetooth Gain / [dBi] No cards	0	-1.1	-1.2
Bluetooth Gain / [dBi] With cards, worst case	-1.1	-1.4	-1.5

Table 3. Gain values for the WLAN and Bluetooth antennas in the IPAQX.

Prepared by: Ola Carmonius & Elisabeth Wieslander	File name: Specifications of iPAQX BT/WLAN Antenna	Creation date: 2004-01-13	Page: 1
Approved by: Rune Nilsson	Document number: AA040002	Last rev. date: 2004-04-21	Revision: PA4
Distribution:	EA		

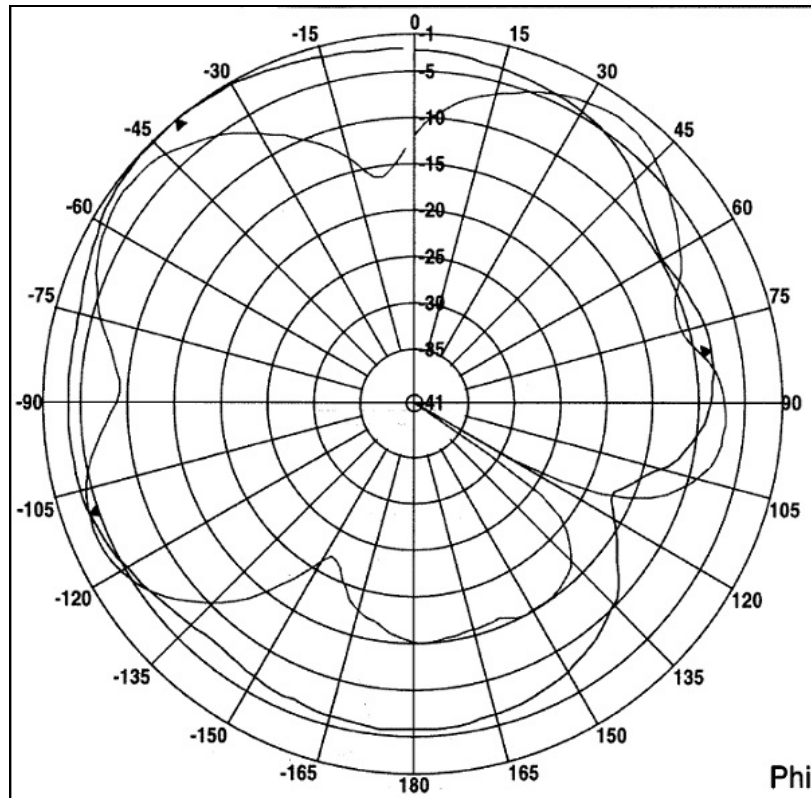


Figure 3. Gain pattern for the WLAN antenna in the $\phi = 90$ degree plane at the frequency 2,45 GHz. Both horizontal and vertical polarization is drawn in the plot.

Prepared by: Ola Carmonius & Elisabeth Wieslander	File name: Specifications of iPAQX BT/WLAN Antenna	Creation date: 2004-01-13	Page: 1
Approved by: Rune Nilsson	Document number: AA040002	Last rev. date: 2004-04-21	Revision: PA4
Distribution:	EA		

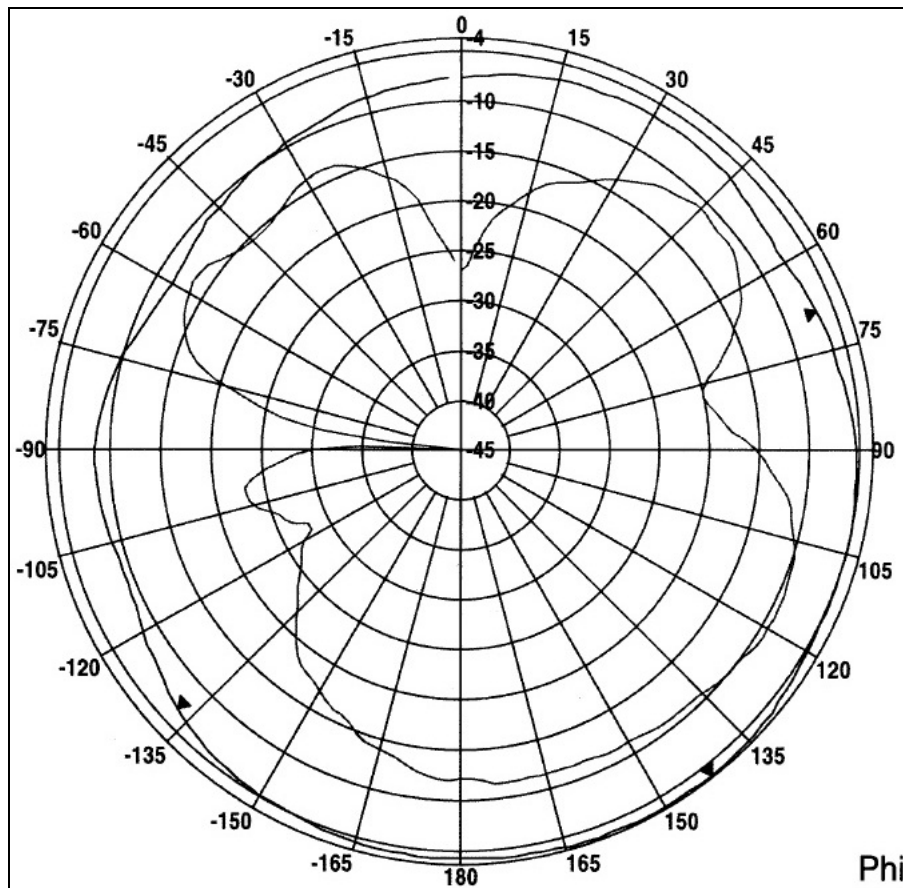


Figure 4. Gain pattern for the Bluetooth antenna in the $\phi = 90$ degree plane at the frequency 2,45 GHz. Both horizontal and vertical polarization is drawn in the plot.

Prepared by: Ola Carmonius & Elisabeth Wieslander		File name: Specifications of iPAQX BT/WLAN Antenna	Creation date: 2004-01-13	Page: 1
Approved by: Rune Nilsson		Document number: AA040002	Last rev. date: 2004-04-21	Revision: PA4
Distribution:	EA			

4 Mechanical Specification

4.1 Mechanical Performance

4.2 Mechanical test methods

General

All tests shall be performed in room temperature (T_0) $20^{\circ}\text{C} \pm 3^{\circ}\text{C}$ if not otherwise stated. All tests shall be performed with the real PDA framing to the maximum extent that is possible.

4.2.1 Drop Test

The antenna shall be mounted in the PDA or a dummy.

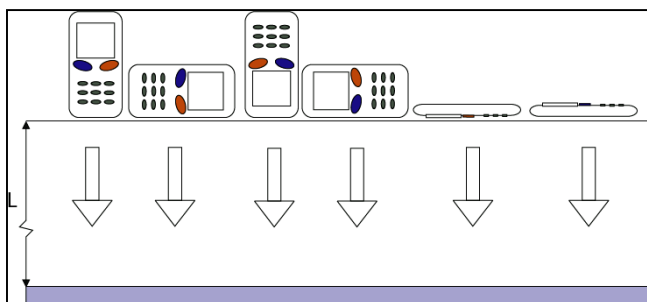
One drop on each side of the PDA

Total number of drops 6.

L=1.2 m, onto concrete floor.

Weight of dummy or PDA: TBA

Number of drops/side: 3



Prepared by: Ola Carmonius & Elisabeth Wieslander		File name: Specifications of iPAQX BT/WLAN Antenna	Creation date: 2004-01-13	Page: 1
Approved by: Rune Nilsson		Document number: AA040002	Last rev. date: 2004-04-21	Revision: PA4
Distribution:	EA			

4.3 Mechanical requirements

4.3.1 Drop Test

The antenna shall meet the electrical specification after the test but can have remaining deformation. The flexible film shall stay attached to the carrier after the test. Visual deterioration or damage of the PDA will not be taken into consideration.

4.4 Environmental Performance

General

All tests shall be performed with antenna mounted to the PCB placed in the PDA chassis to the maximum. (T_0)= 20°C±3°C.

4.4.1 Temperature, Steady state

Test according to IEC 60068-2-1 Test Ab (Cold) and IEC 60068-2-2 Test Bb (Dry heat)

The antenna is stored in a climatic chamber with the following temperature and time periods:

Low temp/Duration: $T_1 = -40^\circ\text{C} / t_1 = 72\text{hr}$

High temp/Duration: $T_2 = +85^\circ\text{C} / t_2 = 72\text{hr}$

4.4.2 Temperature, Cycling

Test according to IEC 60068-2-14 Test Na (Change of temperature)

Low temp (T_1): -40°C

High temp (T_2): $+85^\circ\text{C}$

Steady state time (t_1): 30 min

Transition time (t_2): <30 s.

Duration: 5 cycles

Prepared by: Ola Carmonius & Elisabeth Wieslander		File name: Specifications of iPAQX BT/WLAN Antenna	Creation date: 2004-01-13	Page: 1
Approved by: Rune Nilsson		Document number: AA040002	Last rev. date: 2004-04-21	Revision: PA4
Distribution:	EA			

4.4.3 Salt Mist Resistance

Test according to ASTM B117 with 5% NaCl at 35° C.

Duration: 24h

The antenna shall be mounted in the device during the test.

4.4.4 Damp heat, steady state

Test according to EN/IEC 60068-2-1, Test Cb: Damp heat, steady state.

Temperature: +40°C

Relative humidity: 93 % RH

Duration: 24 hours

The antenna shall be mounted in the device during the test.

4.4.5 Vibration Test

Test according to IEC 60068-2-6 Test Fc (Sinusoidal)

Frequency 10 - 500 -10 Hz (1 cycle) Sweep rate 1 octave per minute (logarithmic).

10-15.8 Hz Amplitude: 2.0 mm

15.8-1000 Hz Acceleration: 20 m/s²

15-8-10 Hz Amplitude: 2.0 mm

Direction: 3 axes (x,y,z)

Duration: 3 cycles / axes (one cycle is from 10Hz to 1000Hz and back to 10Hz)

4.5 Environmental requirements

4.5.1 Temperature, Steady state

The antenna shall fulfil mechanical and electrical requirements after recovered to room temperature. No visual deterioration shall occur.

4.5.2 Temperature, Cycling

The antenna shall fulfil mechanical and electrical requirements after recovered to room temperature. No visual deterioration shall occur.

Prepared by: Ola Carmonius & Elisabeth Wieslander		File name: Specifications of iPAQX BT/WLAN Antenna	Creation date: 2004-01-13	Page: 1
Approved by: Rune Nilsson		Document number: AA040002	Last rev. date: 2004-04-21	Revision: PA4
Distribution:	EA			

4.5.3 Salt Mist Resistance

The antenna shall fulfil mechanical and electrical after recovered to room temperature.

4.5.4 Damp heat, steady state

The antenna shall fulfil mechanical and electrical after recovered to room temperature.

4.5.5 Vibration Test

The antenna shall fulfil mechanical and electrical requirements after recovered to room temperature. No visual deterioration shall occur.

Prepared by: Ola Carmonius & Elisabeth Wieslander		File name: Specifications of iPAQX BT/WLAN Antenna	Creation date: 2004-01-13	Page: 1
Approved by: Rune Nilsson		Document number: AA040002	Last rev. date: 2004-04-21	Revision: PA4
Distribution:	EA			

5 Verification test sequence

The antenna shall be tested according to above electrical- and environmental tests. To verify the antenna the tests will be performed in a certain sequence, see Table 4. The testing will be performed on hard tool details.

Prepared by: Ola Carmonius & Elisabeth Wieslander		File name: Specifications of iPAQX BT/WLAN Antenna	Creation date: 2004-01-13	Page: 1
Approved by: Rune Nilsson		Document number: AA040002	Last rev. date: 2004-04-21	Revision: PA4
Distribution:	EA			

No	Test Paragraph	Test sequence	Test sequence	Test sequence
2.2.1	Dimensions	Separate test		
3.1.3	Return Loss		1, 3, 5	1, 4
3.1.5	Gain and Radiation Patterns	Separate test		
3.1.4	Efficiency	Separate test		
4.2.1	Drop Test	Separate test		
4.4.1	Temperature, Steady state			3
4.4.2	Temperature, Cycling			2
4.4.3	Salt Mist Resistance		4	
4.4.4	Damp Heat, Steady State		2	
4.4.5	Vibration Test	Separate test		
	Number of samples	3 each test	3	5

Table 4. Test Sequence, TBD

Prepared by: Ola Carmonius & Elisabeth Wieslander		File name: Specifications of iPAQX BT/WLAN Antenna	Creation date: 2004-01-13	Page: 1
Approved by: Rune Nilsson		Document number: AA040002	Last rev. date: 2004-04-21	Revision: PA4
Distribution:	EA			

6 Material Specification

6.1 Antenna Radiator

The material for the antenna radiator is a flexible film. The radiator connecting areas are plated with 1-2µm Ni and 0.1-0.3µm Au.

6.2 Antenna Carrier

The material for the antenna holder is a PC/ABS plastic named Cyclopedia 6600. A material data sheet for the plastic can be seen in Enclosure 4 (TBD).

7 Packaging Specification

The antennas are packaged in trays. The design of the tray can be seen in Enclosure 3. Each tray contains 60 antennas. Five trays are packaged in each box, 4 with antennas and one empty on top. Total numbers of antennas per box equal 240. If the quantity differs from 240, this will be marked on the box.

Each cartoon contains 8 boxes, in total 1920 antennas per cartoon.

8 Marking

All individual parts shall have sufficient marking for tracking cavities and other relevant information.

9 Design Changes

The design, dimensions and tolerances are defined by gigaAnt interface drawing.

Changes of parameters, which have an influence on design and/or performance, will be communicated in writing to customer. If interface drawing is changed or if the specification is changed, a new revision of this specification will be issued and sent to customer.

Prepared by: Ola Carmonius & Elisabeth Wieslander		File name: Specifications of iPAQX BT/WLAN Antenna	Creation date: 2004-01-13	Page: 1
Approved by: Rune Nilsson		Document number: AA040002	Last rev. date: 2004-04-21	Revision: PA4
Distribution:	EA			

10 Enclosures

- Enclosure 1; Antenna drawing (TBF)
- Enclosure 2; Connector drawing
- Enclosure 3; Tray drawing
- Enclosure 4; Material data A5968
- Enclosure 5; MSDS A5967
- Enclosure 6; MSDS A5968 (To be added)

11 Approval

gigaAnt
Date:

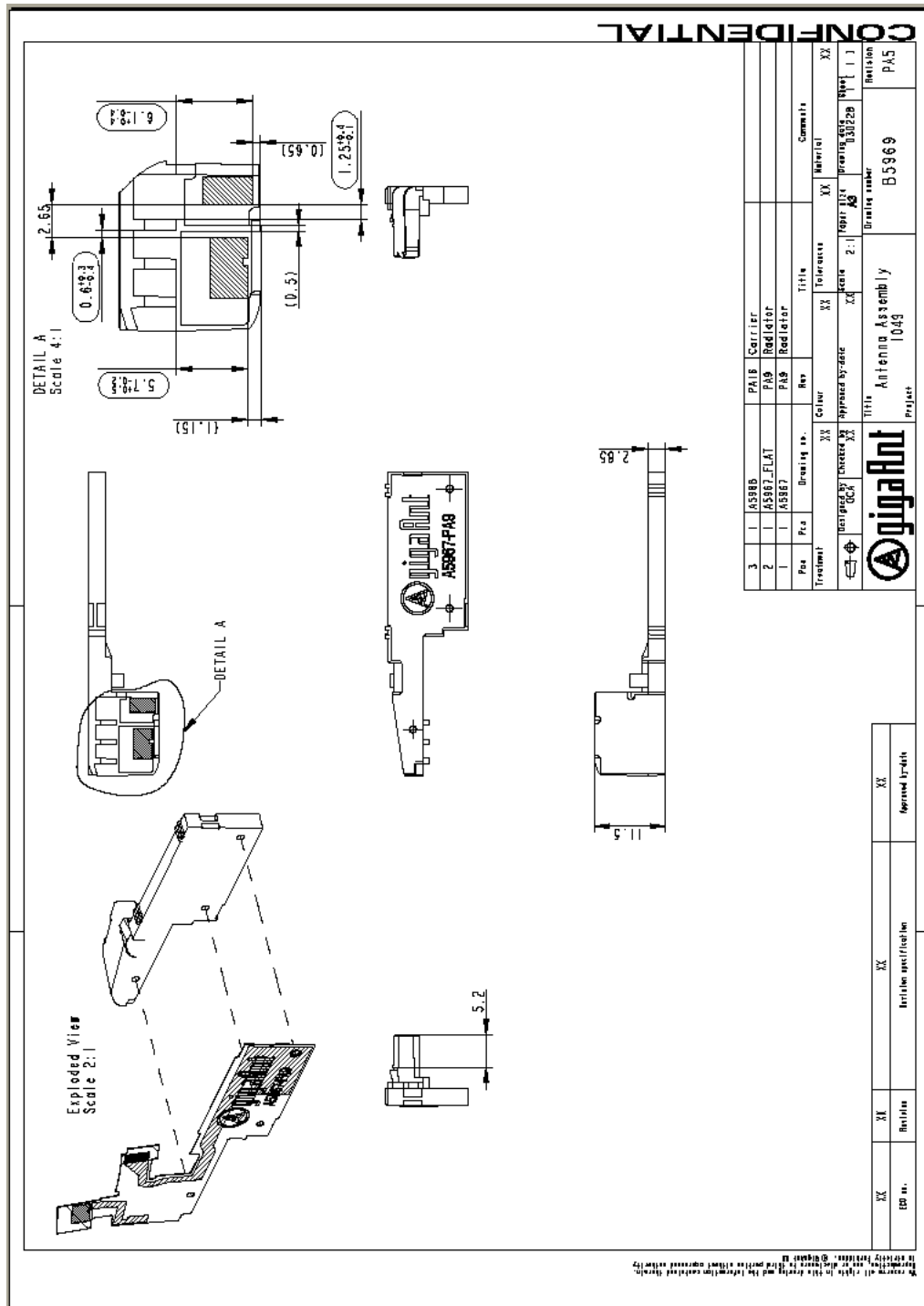
Customer
Date:

12 Revision history

Revision	Reason	Date	Approved

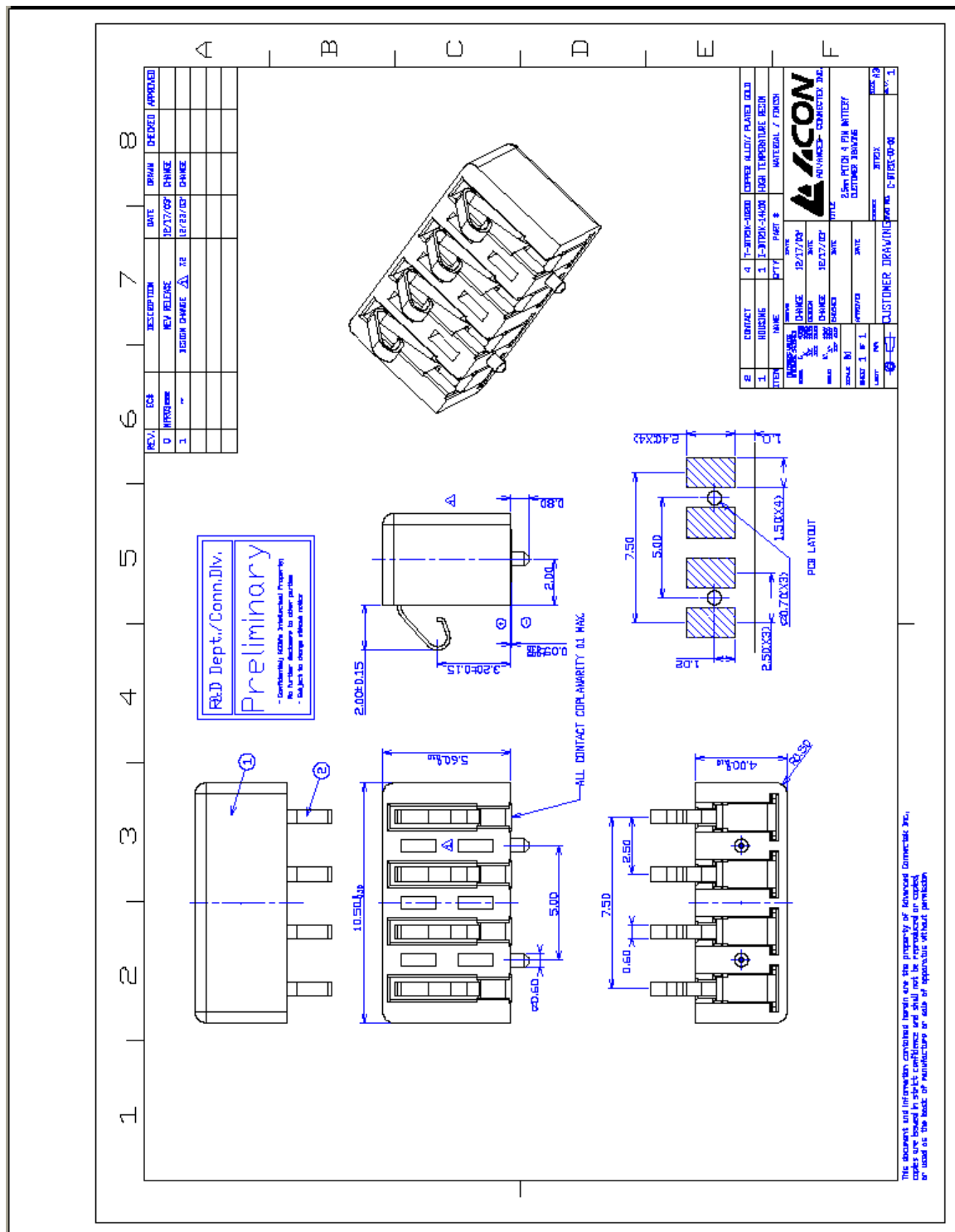
Prepared by: Ola Carmonius & Elisabeth Wieslander		File name: Specifications of iPAQX BT/WLAN Antenna	Creation date: 2004-01-13	Page: 1
Approved by: Rune Nilsson		Document number: AA040002	Last rev. date: 2004-04-21	Revision: PA4
Distribution:	EA			

Enclosure 1; Antenna drawing (TBF)



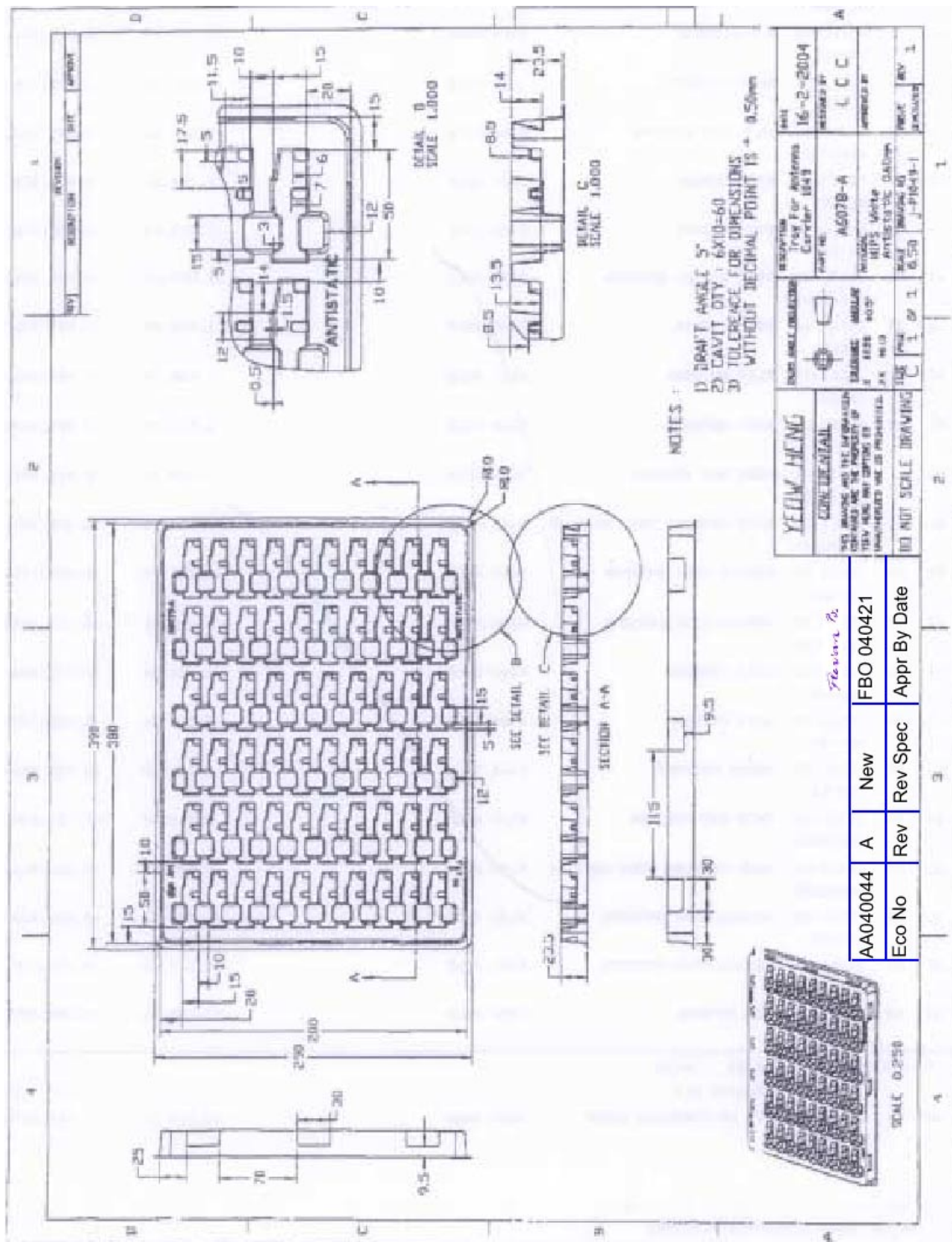
Prepared by: Ola Carmonius & Elisabeth Wieslander		File name: Specifications of iPAQX BT/WLAN Antenna	Creation date: 2004-01-13	Page: 1
Approved by: Rune Nilsson		Document number: AA040002	Last rev. date: 2004-04-21	Revision: PA4
Distribution:	EA			

Enclosure 2; Connector drawing



Prepared by: Ola Carmonius & Elisabeth Wieslander		File name: Specifications of iPAQX BT/WLAN Antenna	Creation date: 2004-01-13	Page: 1
Approved by: Rune Nilsson		Document number: AA040002	Last rev. date: 2004-04-21	Revision: PA4
Distribution:	EA			

Enclosure 3; Tray drawing



Prepared by: Ola Carmonius & Elisabeth Wieslander	File name: Specifications of iPAQX BT/WLAN Antenna	Creation date: 2004-01-13	Page: 1
Approved by: Rune Nilsson	Document number: AA040002	Last rev. date: 2004-04-21	Revision: PA4
Distribution: EA			

Enclosure 4; Material data A5968

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TYPICAL PROPERTIES ¹	TYPICAL VALUE	UNIT	STANDARD
MECHANICAL			
Tensile Str, yld, Type I, 50 mm/min	63	MPa	ASTM D 638
Tensile Str, brk, Type I, 50 mm/min	49	MPa	ASTM D 638
Tensile Elong, yld, Type I, 50 mm/min	4	%	ASTM D 638
Tensile Elong, brk, Type I, 50 mm/min	80	%	ASTM D 638
Tensile Modulus, 50 mm/min	3000	MPa	ASTM D 638
Flex Stress, yld, 1.3 mm/min, 50 mm span	94	MPa	ASTM D 790
Flex Mod, 1.3 mm/min, 50 mm span	2620	MPa	ASTM D 790
IMPACT			
Izod Impact, notched, 23°C	587	J/m	ASTM D 256
Instrumented Impact Total Energy, 23°C	51	J	ASTM D 3763
Instrumented Impact Total Energy, -30°C	51	J	ASTM D 3763
THERMAL			
Vicat Softening Temp, Rate B	99	°C	ASTM D 1525
HDT, 0.45 MPa, 3.2 mm, unannealed	98	°C	ASTM D 648
HDT, 1.84 MPa, 3.2mm, unannealed	90	°C	ASTM D 648
Relative Temp Index, Elec	80	°C	UL 746B
Relative Temp Index, Mech w/impact	70	°C	UL 746B
Relative Temp Index, Mech w/o impact	80	°C	UL 746B
PHYSICAL			
Specific Gravity	1.19	-	ASTM D 792
Water Absorption, 24 hours	0.11	%	ASTM D 570
Mold Shrinkage, flow, 3.2 mm	0.4 - 0.6	%	ASTM D 955
Melt Flow Rate, 260°C/2.16 kgf	21.5	g/10 min	ASTM D 1238
ELECTRICAL			
Volume Resistivity	>1.E+15	Ohm-cm	IEC 60093
Surface Resistivity, ROA	>1.E+15	Ohm	IEC 60093
Dielectric Strength, in oil, 3.2 mm	17	kV/mm	IEC 60243-1
Relative Permittivity, 50/60 Hz	2.7	-	IEC 60250
Relative Permittivity, 1 MHz	2.7	-	IEC 60250
Dissipation Factor, 50/60 Hz	0.004	-	IEC 60250

¹⁾ Typical values only. Variations within normal tolerances are possible for various colours. All values are measured at least after 48 hours storage at 23°C/20% relative humidity.
All properties, except the melt volume rate are measured on injection moulded samples.
All samples are prepared according to ISO 294.

²⁾ Only typical data for material selection purpose. Not to be used for part or tool design.
³⁾ This rating is not intended to reflect hazards presented by this or any other material under actual fire conditions.
⁴⁾ Own measurement according to UL.

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Page 1

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Prepared by: Ola Carmonius & Elisabeth Wieslander	File name: Specifications of iPAQX BT/WLAN Antenna	Creation date: 2004-01-13	Page: 1
Approved by: Rune Nilsson	Document number: AA040002	Last rev. date: 2004-04-21	Revision: PA4
Distribution:	EA		



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TYPICAL PROPERTIES ¹	TYPICAL VALUE	UNIT	STANDARD
Dissipation Factor, 1 MHz	0.006	-	IEC 60250
Comparative Tracking Index	600	V	IEC 60112
FLAME CHARACTERISTICS			
UL Recognized, 94V-2 Flame Class Rating (3)	0.8	mm	UL 94
UL Recognized, 94V-0 Flame Class Rating (3)	1.5	mm	UL 94
UL Recognized, 94-5VB Rating (3)	2	mm	UL 94

¹) Typical values only. Variations within normal tolerances are possible for various colours. All values are measured at least after 48 hours storage at 23°C/50% relative humidity.
All properties, except the melt volume rate are measured on injection moulded samples.
All samples are prepared according to ISO 294.

²) Only typical data for material selection purpose. Not to be used for part or tool design.
³) This rating is not intended to reflect hazards presented by this or any other material under actual fire conditions.
⁴) Own measurement according to UL.

Source: GMD, Last Update 06/12/2002

Page 2

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Prepared by: Ola Carmonius & Elisabeth Wieslander	File name: Specifications of iPAQX BT/WLAN Antenna	Creation date: 2004-01-13	Page: 1
Approved by: Rune Nilsson	Document number: AA040002	Last rev. date: 2004-04-21	Revision: PA4
Distribution:	EA		

Enclosure 5; MSDS A5967



1210 Qianjin Road(E), Jiujiang Jiangxi, China 332006
Tel: 86-792-8355813, Fax: 86-792-8355803

MATERIAL SAFETY DATA SHEET

Product name: Copper-Polyester Laminates Product code: LPET#&/@

SECTION 1 - PRODUCT AND COMPANY IDENTIFICATION

1.1 Material Name: Copper-Polyester Laminates
 1.2 Material Code: LPET#&/@
 1.3 Chemical name: NA
 1.4 Chemical family: Modified Epoxy
 1.5 Company Identification: Jiujiang Flex Co., Ltd.
 1210Qianjin Road (E) Jiujiang, Jiangxi, China 332006
 1.6 Emergency Telephone Number: 86-792-8355813
 1.7 Telephone number for information: 86-792-8355813

Notes:
 #-Thickness of PET film: 1 mil, 2mil, 3mil, 4mil and 5mil(0.125mm);
 &-Copper Type: RA and EDHD Copper
 Copper Thickness: 0.5Oz/SF(0.018mm), 1.0Oz/SF(0.035mm), and 2Oz/SF(0.070mm).
 @-S: single side; D: double sides

SECTION 2 – HAZARDOUS INGREDIENTS

Chemical Name	OSHA PEL	ACGIH TLV	%
Copper	1mg/m ³	1mg/m ³	<60%
Methyl ethyl ketone	200ppm	200ppm	<1%
Formaldehyde	0.75ppm	0.3ppm	<0.1%
Methylene bisphenyl isocyanate	0.02ppm	0.005ppm	<0.1%

Components not listed above are either non-hazardous or proprietary as defined in the OSHA Hazard.

SECTION 3 -PHYSICAL AND CHEMICAL PROPERTIES

3.1 Physical/Chemical characteristics

State	Solid
Boiling Point	Not Applicable
Vapor Pressure	Not Applicable
Solubility in Water:	Nil
Appearance:	Adhesive coated Polyester film clad with copper
Evaporation Rate:	Not Applicable

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Page 1 of 5



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PH:	Not Applicable
Odor:	None
Vapor Density(air=1)	Not Applicable
Flash Point:	Not Applicable
Melting Point	No Data

3.2 Main Property to be tested and test method

Testing Method	Standard Value
Peel Strength, minimum, lb./in-width, IPC-TM-650-2.4.9	(1) (2)
As received Method B	6.0 7.0
After sold float Method D	6.0 7.0
After temperature cycling Method F	6.0 7.0
Dimensional, Stability, maximum percentage, IPC-TM-650-2.2.4	
Method B	+/-0.20
Method C	+/-0.40
Solder Float, IPC-TM-650-2.4.13 Method A	400°F/5sec. Pass
Method B	
Flammability, IPC-TM-650-2.3.8	U.L.94V-0
Chemical Resistance percentage, IPC-TM-650-2.3.2 Method A	80
Moisture and insulation resistance, minimum, megohms, IPC-TM-650-2.6.3.2	10 ⁵
Moisture Absorption, maximum, percent, IPC-TM-650-2.6.2	1.0

Note: (1) The data is applied to 1mil PET film clad 1Oz/SF EDHD copper structure.
(2) The data is applied to 3mil PET film clad 1Oz/SF EDHD copper structure.

SECTION 4- FIRE AND EXPLOSION HAZARD DATA

4.1 Auto-ignition Temperature Not Applicable
 Lower Explosive Limit Not Applicable
 Upper Explosive Limit Not Applicable

4.2 Extinguishing Agents
 Use the following extinguishing media when fighting involving this material:
 -carbon dioxide-dry chemical-water spray-foam

4.3 Unusual Fire and Explosion Hazards
 Material will generate toxic fumes in extreme heat or fire.

4.4 Personal Protective Equipment

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Distribution:	EA		

Page 2 of 5



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As in any fire, wear self-contained breathing apparatus and full protective gear.

4.5 Hazardous Decomposition Products

CO, CO₂, formaldehyde, aliphatic and aromatic hydrocarbons.

SECTION 5 - STABILITY AND REACTIVITY

- 5.1 Stability: Stable
- 5.2 Conditions to Avoid: Not Applicable
- 5.3 Hazardous Polymerization: Does Not Occur
- 5.4 Incompatibility: There are no known incompatible with this product.

SECTION 6-HEATH HAZARD DATA

6.1 Effects of Overexposure: Heating and lasing operations may produce toxic vapors which be controlled by local exhaust. Excessive skin contact may cause irritation, or rash in sensitive individuals.

6.2 First Aid Procedures

- Inhalation: Remove to fresh air and seek medical attention.
- Eye Contact: Flush thoroughly with water and seek medical attention.
- Skin Contact: Wash contacted area thoroughly with soap and water. Seek medical attention if irritation persists or rash is present.
- Ingestion: Not a likely route of exposure-treat symptomatically.

SECTION 7-PRECAUTIONS FOR SAFE HANDLING AND USE

7.1 Respiratory Protection

Not generally required. If machining, lasting, or processing generates dust, vapors, or fumes are an irritant to employees, use NIOSH/MSHA approved respirator protection. Engineering controls should preclude need for respiratory protection.

7.2 Local Exhaust

Required where exposure limits are exceeded or fumes/dust/vapors are noticeable. Local exhaust is recommended with all heating operations.

7.3 Mechanical (General)

Optimize whenever possible following good industrial practice.

7.4 Eye Protection

Safety glasses are recommended for all industrial operations.

7.5 Protective Clothing

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Approved by: Rune Nilsson		Document number: AA040002	Last rev. date: 2004-04-21	Revision: PA4
Distribution:	EA			

Page 3 of 5



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Impermeable gloves as needed to avoid unnecessary skin contact and irritation. (Suggest butyl rubber, nitrile, or neoprene)

7.6 This product may contain the following substances

Copper
Formaldehyde
Methyl ethyl ketone
Methylene bisphenyl isocyanate

7.7 Other: NA

SECTION 8-ECOLOGICAL INFORMATION

8.1 No ecological testing has been conducted on this product.

8.2 Waste Disposal Method

Dispose of in accordance with national, province, and local regulations.

8.3 Container Disposal: NA

SECTION 9-TRANSPORTATION INFORMATION

9.1 This product is NOT REGULATED for domestic and international transportation.

SECTION 10- SPETLL OR LEAK PROCEDURES

10.1 Response to Spills: Not Applicable

10.2 Reportable Quantity: Not Applicable

SECTION 11-STORAGE

11.1 Storage conditions

The material can be stored for 24 months at dry, ambient temperature wrapped with PE film.

11.2 Keep away from heat, ignition sources, and direct sunlight.

11.3 Keep cartons tightly closed when not in use.

SECTION 12-OTHER INFORMATION

12.1 Legend:

PET film: Polyester Film

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Page 4 of 5



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NA: Not Applicable

RA: Rolled anneal

EDHD: Electro-deposited high-ductility

12.2 Users Responsibility/Disclaimer of Liability

AS the conditions or methods of use are beyond our control, we do not assume any responsibility and expressly disclaim any liability for any use of this material. Information contained herein is believed to be true and accurate but all statements or suggestions are made without warranty, expressed or implied, regarding accuracy of the information, the hazards connected with the use of the material or the result to be obtained from the use thereof.

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