Appendix C: Additional Test and Sample Details

This appendix contains details of:

1. The samples submitted for testing.
2. Details of EUT operating mode(s)
3. Details of EUT configuration(s) (see below).
4. EUT arrangement (see below).

Throughout testing, the following numbering system is used to identify the sample and it's modification state:

Sample No: Sxx Mod w

where:

xx = sample number eg. S01
w = modification number eg. Mod 2

The following terminology is used throughout the test report:

Support Equipment (SE) is any additional equipment required to exercise the EUT in the applicable operating mode. Where relevant SE is divided into two categories:

SE in test environment: The SE is positioned in the test environment and is not isolated from the EUT (e.g. on the table top during REFE testing).

SE isolated from the EUT: The SE is isolated via filtering from the EUT. (e.g. equipment placed externally to the ALSR during REFE testing).

EUT configuration refers to the internal set-up of the EUT. It may include for example:

Positioning of cards in a chassis.
Setting of any internal switches.
Circuit board jumper settings.
Alternative internal power supplies.

Where no change in EUT configuration is **possible**, the configuration is described as “single possible configuration”.

EUT arrangement refers to the termination of EUT ports / connection of support equipment, and where relevant, the relative positioning of samples (EUT and SE) in the test environment.

For further details of the test procedures and general test set ups used during testing please refer to the related document "EMC Test Methods - An Overview", which can be supplied by TRaC Telecoms & Radio upon request.

C1) Test samples

The following samples of the apparatus were submitted by the client for testing :

Sample No.	Description	Identification
S18	WT41-A (Conducted Sample)	None
S20	WT41-A with PCB antenna Murata ANGC12G44SAA145	S/N: 101206
S21	WT41-N antenna with external Pulse W1010	S/N: 101202

See Appendix D for antenna data sheets

The following samples of apparatus were supplied by TRaC Telecoms & Radio as support or drive equipment (auxiliary equipment):

Identification	Description
RFG464	dc Power Supply
REF829	N4010A Wireless connectivity Test Set

C2) EUT Operating Mode During Testing.

During testing, the EUT was exercised as described in the following tables :

Test	Description of Operating Mode
All Transmitter tests detailed in this report	EUT active transmitting, operating at 1Mbps, 2Mbps and 3Mbps data rates and on highest middle and lowest operating frequencies at each data rate.

Test	Description of Operating Mode:
Receiver conducted and radiated spurious emissions	EUT active but non-transmitting.

C3) EUT Configuration Information.

The EUT was submitted for testing in one single possible configuration.

C4) List of EUT Ports

The tables below describe the termination of EUT ports:

Sample : S18
Tests : Conducted

Port	Description of Cable Attached	Cable length	Equipment Connected
Antenna	None	N/A	REF909
dc Power Port	2 core unscreened	2m	REF053

Sample : S20
Tests : Radiated Emissions

Port	Description of Cable Attached	Cable length	Equipment Connected
dc Power Port	2 core unscreened	2m	RFG464

Sample : S21
Tests : Radiated Emissions

Port	Description of Cable Attached	Cable length	Equipment Connected
Antenna	None	N/A	
dc Power Port	2 core unscreened	2m	RFG464

* Only connected during setup.

C5 Details of Equipment Used

For Radiated Measurements:

For Radiated TX and Standby/RX spurious emissions 30MHz to 1GHz

RFG No	Type	Description	Manufacturer	Date Calibrated.
REF886	Lab 16	Large Anechoic Chamber	TRaC	10/06/10
095	96002	Bicon Antena (30-200MHz)	Eaton	12/05/10
191	3146	Log Periodic Antenna (200-1000MHz)	EMCO	12/05/10
673	310	Pre-Amp (9kHz-1GHz)	Sonoma	14/09/10
REF847	ESU	Spectrum Analyser	R&S	14/06/10
454		HF RF coaxial cable	Teledyne Reynolds	04/05/10
REF881		HF RF coaxial cable	Teledyne Reynolds	10/06/10
REF882		HF RF coaxial cable	Teledyne Reynolds	10/06/10
REF884		HF RF coaxial cable	Teledyne Reynolds	10/06/10
464	6220B	dc Power Supply	HP	N/A
REF883		HF RF coaxial cable		10/06/10
REF829	N4010A	Wireless connectivity Test Set	Agilent	02/03/11

Radiated TX and Standby/RX spurious emissions 1GHz to 12.75GHz

RFG No	Type	Description	Manufacturer	Date Calibrated
REF886	Lab 16	Large Anechoic Chamber	TRaC	10/06/10
REF880	HL050	Log Perodic Antenna (1-26.5GHz)	R&S	14/05/10
307	HP8449B	Microwave Pre-Amp (1-26.5GHz)	HP	01/03/10
REF847	ESU	Spectrum Analyser	R&S	14/06/10
454		HF RF coaxial cable	Teledyne Reynolds	04/05/10
REF881		HF RF coaxial cable	Teledyne Reynolds	10/06/10
REF882		HF RF coaxial cable	Teledyne Reynolds	10/06/10
REF884		HF RF coaxial cable	Teledyne Reynolds	10/06/10
464	6220B	dc Power Supply	HP	N/A
REF883		HF RF coaxial cable		10/06/10
REF829	N4010A	Wireless connectivity Test Set	Agilent	02/03/11

For Conducted Measurements

RFG No	Type	Description	Manufacturer	Date Calibrated
REF909	FSU	Spectrum Analyser	R&S	14/06/10
REF053	6634A	dc Power Supply	HP	Cal before Use
REF887	34405A	DMM	Agilent	25/08/10

For Power Line Conducted Measurements

RFG No	Type	Description	Manufacturer	Date Calibrated
404	E4407B	Spectrum Analyser	Agilent	10/05/10
125	ESHS10	Test receiver	R&S	23/11/10
232	ESH2-Z5	LISN	R&S	22/05/10
674	0357.8810.54	Pulse Limiter	R&S	08/07/11
296	BNC	Cable	TRaC	17/09/10
298	BNC	Cable	TRaC	17/09/10

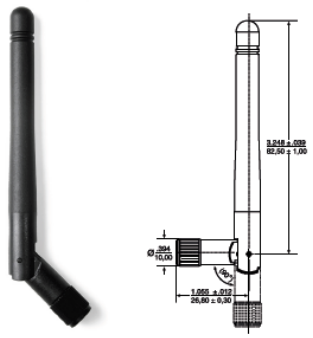
Appendix D: Additional Information

Data Sheet for Pulse W1010 antenna (WT41-N)

W1010 Datasheet version 1.1 2/2008. Wireless External Antenna for 2.4 GHz Application

Wireless External Antenna for 2.4 GHz Application

Pulse Part Number: W1010



Features

- Shortest antennas in product line Omnidirectional radiation
- For WLAN devices using WiFi (802.11b/g), Bluetooth®, ZigBee™ and other applications in the ISM 2.4GHz band
- Omnidirectional radiation pattern provides broad 360° coverage
- One-quarter wavelength dipole configuration
- Connection and color options easily integrate with OEM designs

Connector

- SMA (Male)

Weight 6.3 grams
Carton 20/bag; 500/carton

Dimensions: Inches / mm

Unless otherwise specified, all tolerances are ± 0.10 / 0.25

Electrical Specifications @ +25 °C

Note: This part number is lead-free and RoHS compliant. No additional suffix or identifier is required.

Frequency [GHz]	Gain [dBi]	Impedance [Nom]	VSWR	Polarization	Electrical Length	Radiation
2.4 – 2.5	2.0	50 Ω	≤ 2.0	Vertical	¼, dipole	Omni

Pulse Finland Oy
Takatie 6
90440 Kempele, Finland
Tel: +358 207 935 500
Fax: +358 207 935 501
www.pulseeng.com/antennas

Pulse A TECHNITROL COMPANY

W1010 Datasheet version 1.1 2/2008. Wireless External Antenna for 2.4 GHz Application

Wireless External Antenna for 2.4 GHz Application

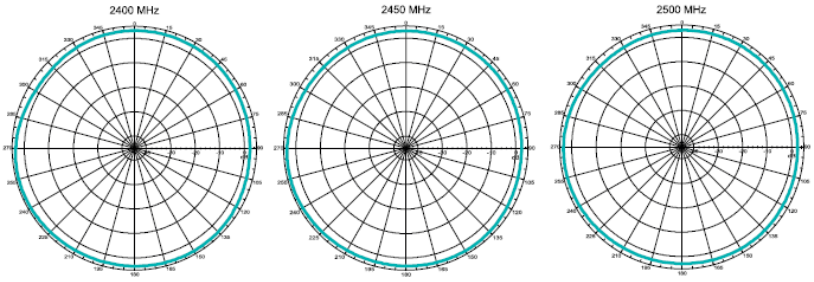
Pulse Part Number: W1010

Application Notes

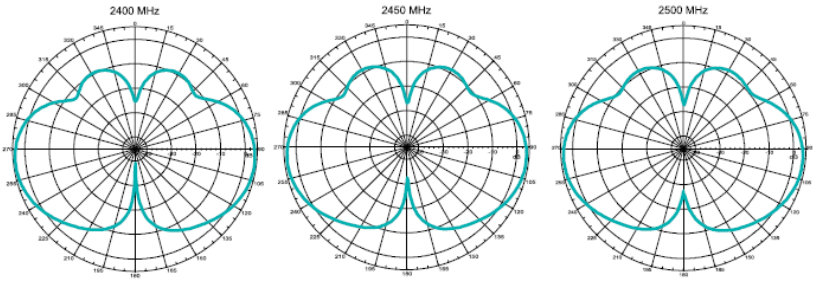
Omni-directional antennas provide a uniform, donut-shaped, 360° radiation pattern. The omni-directional pattern is suitable for point-to-multipoint broadcasting in all directions. This antenna is primarily used for WLAN applications. However, it can also be used for a variety of other applications withing the spec ified frequency range. When used as an access point, the antenna is ideally located at the center of the coverage area.

Gain Performance W1010

Horizontal Position



Vertical Position



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www.pulseeng.com/antennas

Pulse
A TECHNITROL COMPANY

Data Sheet for Murata ANGC12G44SAA145 antenna (WT41-A)

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TDSK0703-SE_BT/WLAN_6Location
May 08, 2008

Technical Data Sheet Of Chip Dielectric Antenna for BT/WLAN

Antenna : ANCG12G44SAA145
PWB size : 37x80mm

Note
Please confirm the latest specification for antenna shape and dimensions.
Capacitors and Inductors used in this report are as follows unless otherwise specified.
The values of each components are mentioned in the report.
In case using different series or manufactures' components, another value may be required to get the proper result.
Capacitors: GRM15 series (Murata)
Inductors: LQG15HS series (Murata)

Kanazawa Murata Mfg.Co.,Ltd
Antenna Products Department

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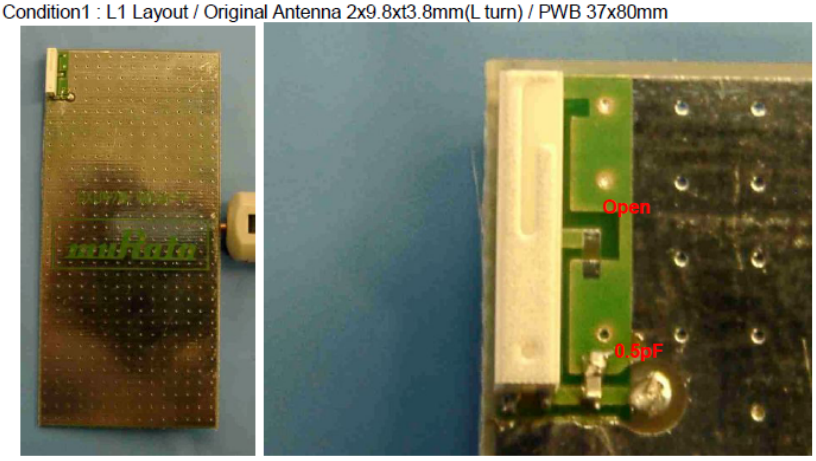
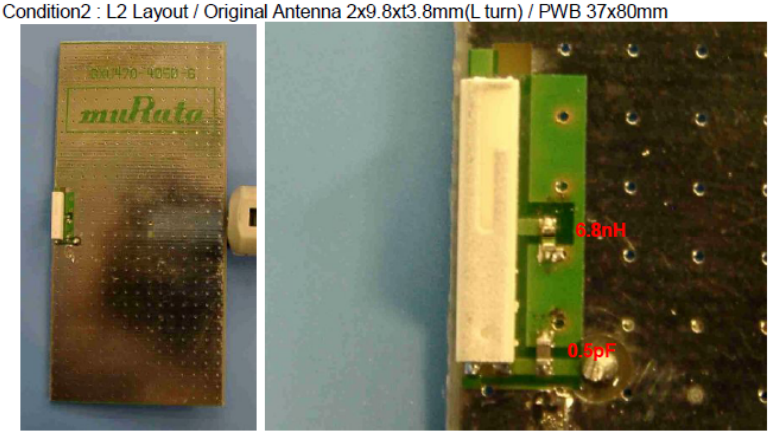
TDSK0703-SE_BT/WLAN_6Location
May 08, 2008

Measurement condition

Condition1 : L1 Layout / Original Antenna 2x9.8xt3.8mm(L turn) / PWB 37x80mm



Condition2 : L2 Layout / Original Antenna 2x9.8xt3.8mm(L turn) / PWB 37x80mm



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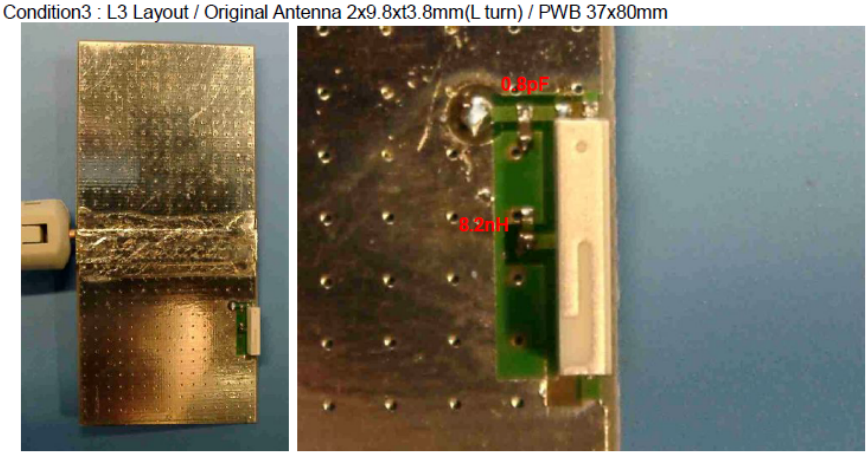
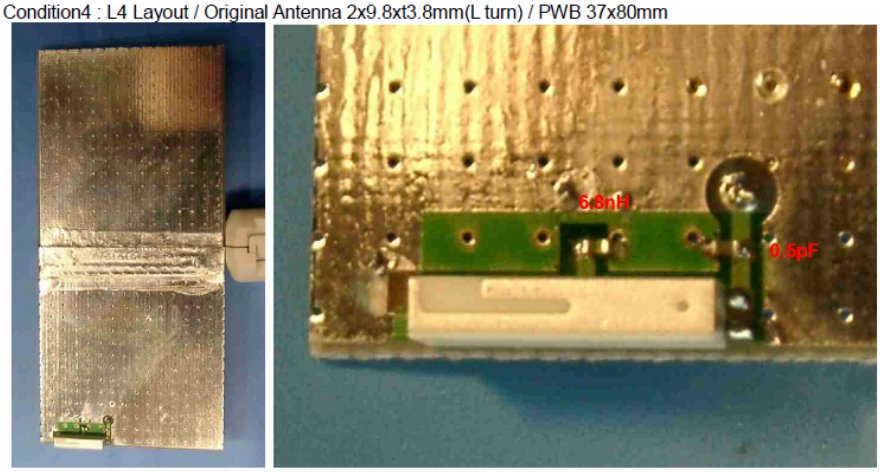
TDSK0703-SE_BT/WLAN_6Location
May 08, 2008

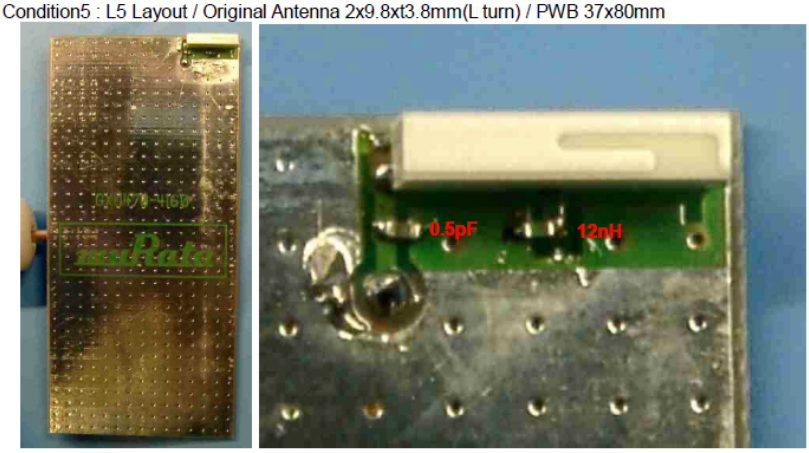
Condition3 : L3 Layout / Original Antenna 2x9.8xt3.8mm(L turn) / PWB 37x80mm



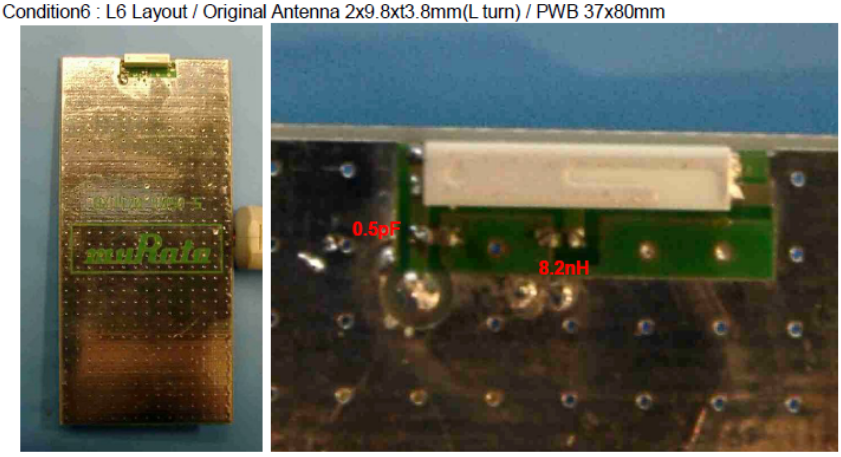
Condition4 : L4 Layout / Original Antenna 2x9.8xt3.8mm(L turn) / PWB 37x80mm



Condition5 : L5 Layout / Original Antenna 2x9.8xt3.8mm(L turn) / PWB 37x80mm

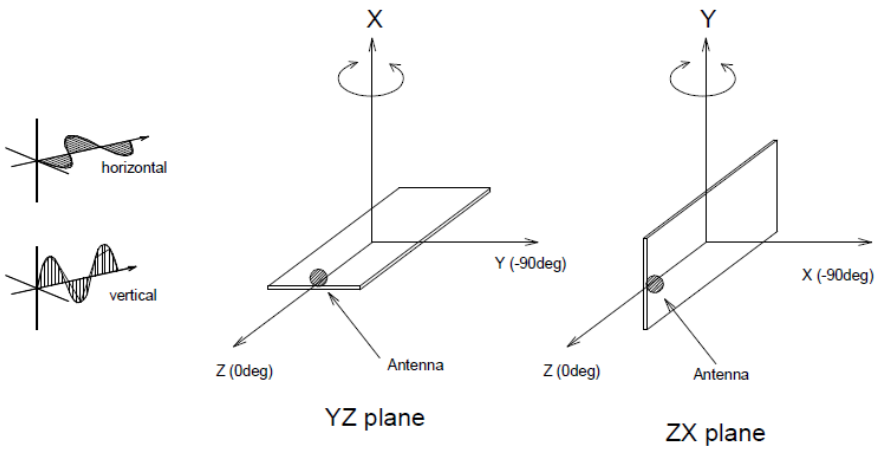


Condition6 : L6 Layout / Original Antenna 2x9.8xt3.8mm(L turn) / PWB 37x80mm



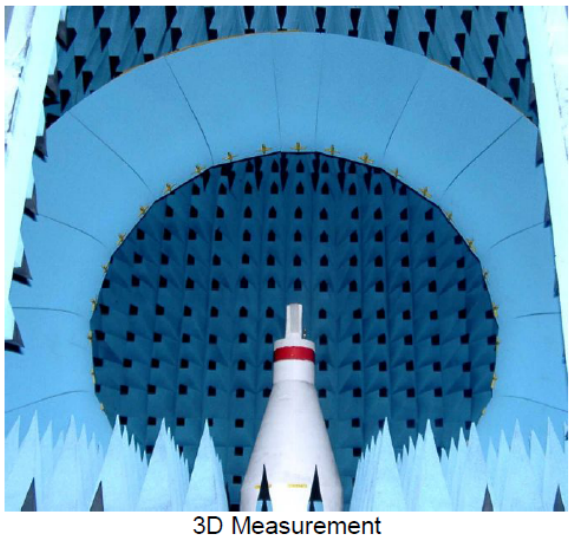
TDSK0703-SE_BT/WLAN_6Location
May 08, 2008

Measurement direction



YZ plane

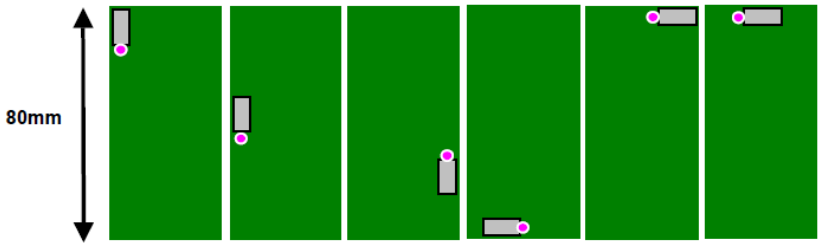
ZX plane



3D Measurement
Stargate32 (Satimo)

TDSK0703-SE_BT/WLAN_6Location
May 08, 2008

Measurement Conclusion



	Condition1	Condition2	Condition3	Condition4	Condition5	Condition6
Antenna	ANCG1series	ANCG1series	ANCG1series	ANCG1series	ANCG1series	ANCG1series
PWB Size [mm]	37x80	37x80	37x80	37x80	37x80	37x80
Shunt [pF]	0.5	0.5	0.8	0.5	0.5	0.5
Fine tune	–	6.8nH	8.2nH	6.8nH	12nH	8.2nH

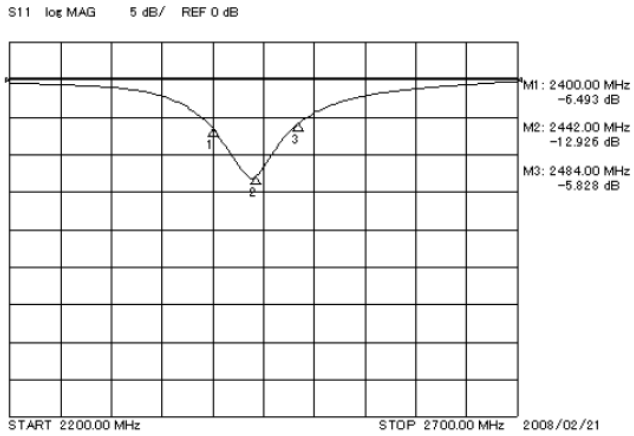
Efficiency [dB]

at 2400MHz	−2.3	−2.8	−2.5	−3.0	−2.1	−3.0
at 2442MHz	−1.7	−1.7	−1.8	−2.3	−1.6	−2.0
at 2484MHz	−2.5	−2.6	−2.7	−2.9	−2.2	−2.9
ave. at 3 Freq.	−2.2	−2.4	−2.3	−2.7	−2.0	−2.7
Band Width	94MHz	93MHz	86MHz	103MHz	112MHz	80MHz

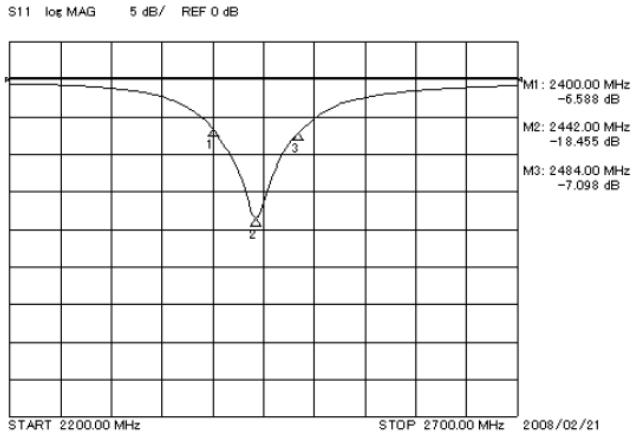
Measurement result

Return loss

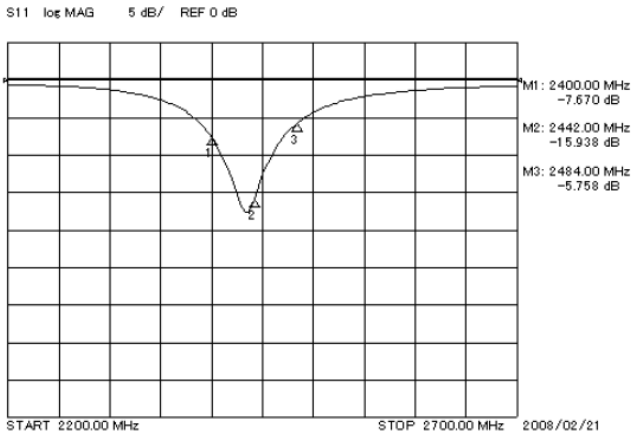
Condition1 : L1 Layout / Original Antenna 2x9.8xt3.8mm(L turn) / PWB 37x80mm



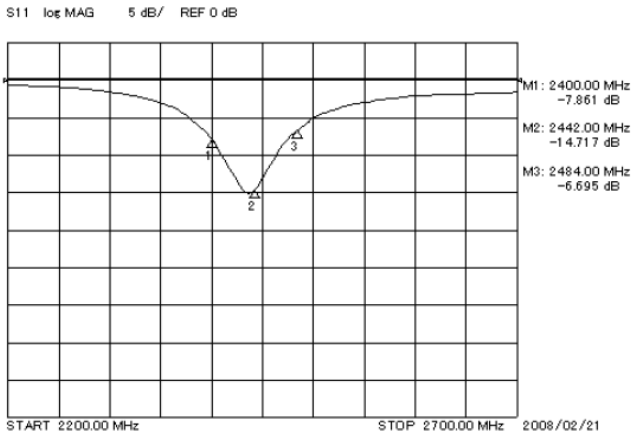
Condition2 : L2 Layout / Original Antenna 2x9.8xt3.8mm(L turn) / PWB 37x80mm



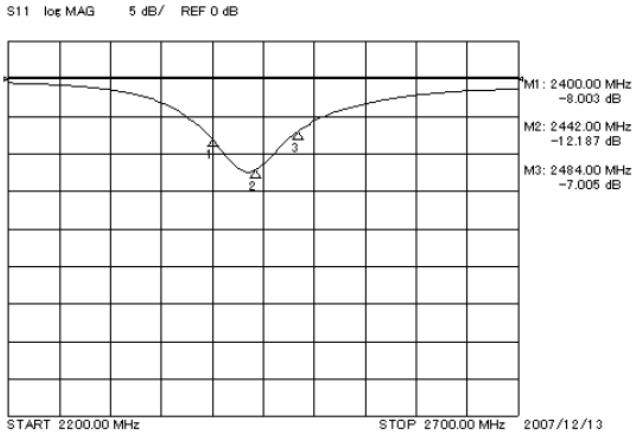
Condition3 : L3 Layout / Original Antenna 2x9.8xt3.8mm(L turn) / PWB 37x80mm



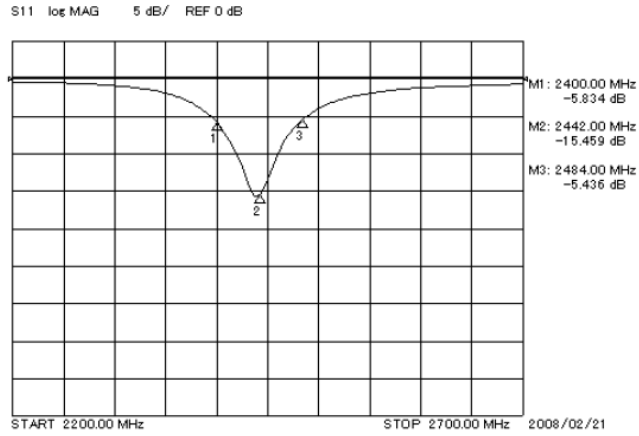
Condition4 : L4 Layout / Original Antenna 2x9.8xt3.8mm(L turn) / PWB 37x80mm



Condition5 : L5 Layout / Original Antenna 2x9.8xt3.8mm(L turn) / PWB 37x80mm



Condition6 : L6 Layout / Original Antenna 2x9.8xt3.8mm(L turn) / PWB 37x80mm



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May 08, 2008

Antenna gain
3D measurement

Condition1 : L1 Layout / Original Antenna 2x9.8xt3.8mm(L turn) / PWB 37x80mm

[dBi] [dB]

LINEAR POLARIZATION		YZ-plane hor.	YZ-plane ver.	ZX-plane hor.	ZX-plane ver.	Efficiency
2400 MHz	MAX	2.5	-7.1	1.8	-1.0	
	AVE	-4.5	-10.6	-4.9	-4.5	-2.3
2442 MHz	**MAX**	**2.9**	**-6.5**	**2.5**	**-0.4**	
	AVE	**-3.9**	**-10.1**	**-4.5**	**-3.9**	**-1.7**
2484 MHz	MAX	2.2	-7.5	1.7	-0.7	
	AVE	-4.6	-10.9	-5.4	-4.5	-2.5

Condition2 : L2 Layout / Original Antenna 2x9.8xt3.8mm(L turn) / PWB 37x80mm

[dBi] [dB]

LINEAR POLARIZATION		YZ-plane hor.	YZ-plane ver.	ZX-plane hor.	ZX-plane ver.	Efficiency
2400 MHz	MAX	-0.5	-8.0	0.5	-3.0	
	AVE	-5.2	-13.0	-5.3	-5.8	-2.8
2442 MHz	**MAX**	**0.6**	**-6.5**	**1.5**	**-1.7**	
	AVE	**-4.1**	**-11.6**	**-4.1**	**-4.4**	**-1.7**
2484 MHz	MAX	-0.5	-7.8	0.5	-2.6	
	AVE	-5.1	-12.4	-5.2	-5.3	-2.6

Condition3 : L3 Layout / Original Antenna 2x9.8xt3.8mm(L turn) / PWB 37x80mm

[dBi] [dB]

LINEAR POLARIZATION		YZ-plane hor.	YZ-plane ver.	ZX-plane hor.	ZX-plane ver.	Efficiency
2400 MHz	MAX	0.6	-8.6	1.2	-1.7	
	AVE	-4.4	-12.5	-5.0	-4.4	-2.5
2442 MHz	**MAX**	**1.0**	**-7.1**	**1.5**	**-0.9**	
	AVE	**-4.0**	**-11.7**	**-4.7**	**-3.7**	**-1.8**
2484 MHz	MAX	-0.4	-8.0	0.0	-1.9	
	AVE	-5.3	-12.7	-6.2	-4.8	-2.7

Condition4 : L4 Layout / Original Antenna 2x9.8xt3.8mm(L turn) / PWB 37x80mm

[dBi] [dB]

LINEAR POLARIZATION		YZ-plane hor.	YZ-plane ver.	ZX-plane hor.	ZX-plane ver.	Efficiency
2400 MHz	MAX	-0.9	-10.6	-3.3	-1.8	
	AVE	-4.0	-13.5	-9.5	-4.1	-3.0
2442 MHz	**MAX**	**-0.7**	**-10.5**	**-2.3**	**-1.1**	
	AVE	**-3.2**	**-13.1**	**-8.6**	**-3.3**	**-2.3**
2484 MHz	MAX	-0.9	-11.2	-2.4	-1.4	
	AVE	-3.8	-13.8	-9.1	-3.9	-2.9

Condition5 : L5 Layout / Original Antenna 2x9.8xt3.8mm(L turn) / PWB 37x80mm

[dBi] [dB]

LINEAR POLARIZATION		YZ-plane hor.	YZ-plane ver.	ZX-plane hor.	ZX-plane ver.	Efficiency
2400 MHz	MAX	0.4	-7.5	-1.6	-0.4	
	AVE	-3.4	-10.1	-8.0	-3.2	-2.1
2442 MHz	**MAX**	**0.7**	**-6.6**	**-1.3**	**0.2**	
	AVE	**-3.0**	**-9.6**	**-7.3**	**-2.6**	**-1.6**
2484 MHz	MAX	-0.5	-7.4	-2.0	-0.5	
	AVE	-3.6	-10.4	-7.9	-3.2	-2.2

Condition6 : L6 Layout / Original Antenna 2x9.8xt3.8mm(L turn) / PWB 37x80mm

[dBi] [dB]

LINEAR POLARIZATION		YZ-plane hor.	YZ-plane ver.	ZX-plane hor.	ZX-plane ver.	Efficiency
2400 MHz	MAX	-0.9	-7.6	-2.6	-1.7	
	AVE	-4.9	-10.8	-8.7	-4.5	-3.0
2442 MHz	**MAX**	**0.0**	**-6.2**	**-1.1**	**-0.3**	
	AVE	**-3.7**	**-9.7**	**-7.5**	**-3.3**	**-2.0**
2484 MHz	MAX	-1.1	-7.9	-2.0	-1.0	
	AVE	-4.7	-10.8	-8.5	-4.3	-2.9

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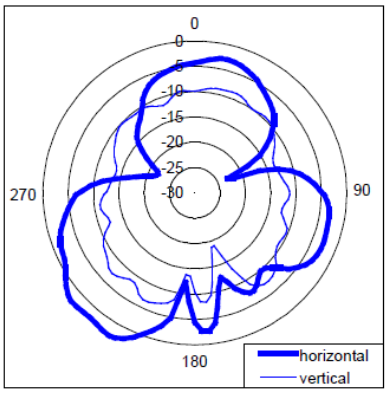
TDSK0703-SE_BT/WLAN_6Location
May 08, 2008

Radiation Pattern

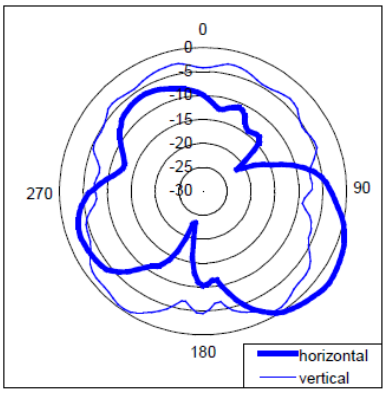
Condition1 : L1 Layout / Original Antenna 2x9.8xt3.8mm(L turn) / PWB 37x80mm

YZ plane



	HOR.	VER.
MAX	2.9	-6.5
AVE	-3.9	-10.1

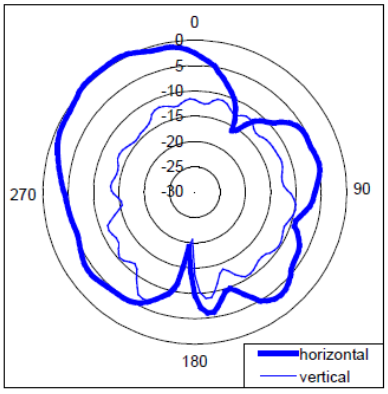
ZX plane



	HOR.	VER.
MAX	2.5	-0.4
AVE	-4.5	-3.9

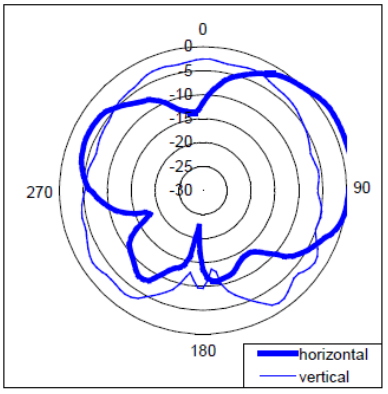
Condition2 : L2 Layout / Original Antenna 2x9.8xt3.8mm(L turn) / PWB 37x80mm

YZ plane



	HOR.	VER.
MAX	0.6	-6.5
AVE	-4.1	-11.6

ZX plane



	HOR.	VER.
MAX	1.5	-1.7
AVE	-4.1	-4.4

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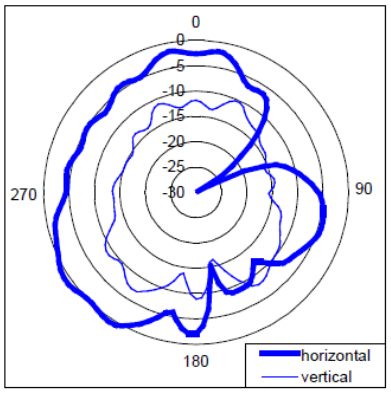
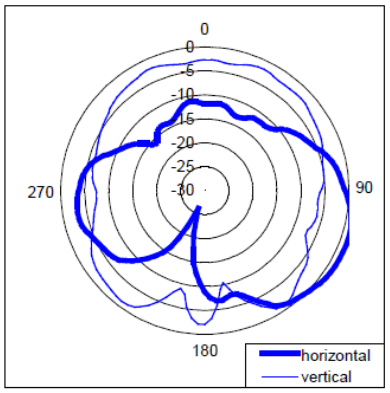
Condition3 : L3 Layout / Original Antenna 2x9.8xt3.8mm(L turn) / PWB 37x80mm

YZ plane



	HOR.	VER.
MAX	1.0	-7.1
AVE	-4.0	-11.7

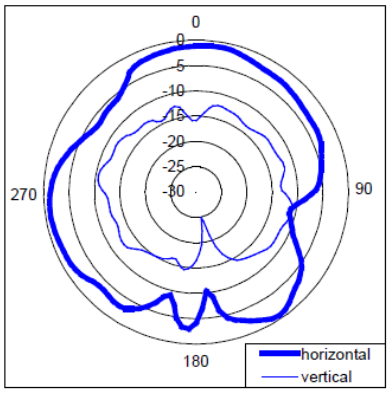
ZX plane



	HOR.	VER.
MAX	1.5	-0.9
AVE	-4.7	-3.7

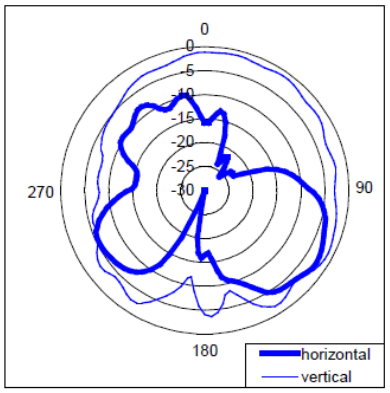
Condition4 : L4 Layout / Original Antenna 2x9.8xt3.8mm(L turn) / PWB 37x80mm

YZ plane



	HOR.	VER.
MAX	-0.7	-10.5
AVE	-3.2	-13.1

ZX plane



	HOR.	VER.
MAX	-2.3	-1.1
AVE	-8.6	-3.3

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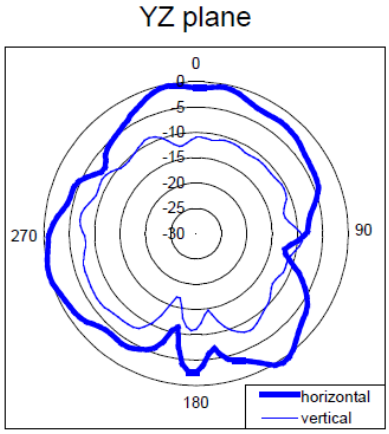
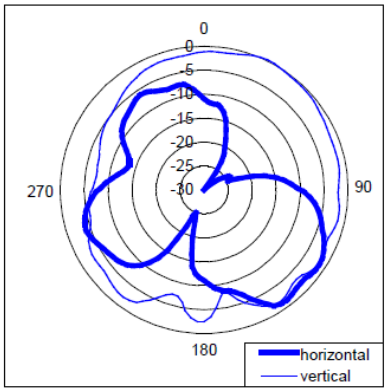
Condition5 : L5 Layout / Original Antenna 2x9.8xt3.8mm(L turn) / PWB 37x80mm

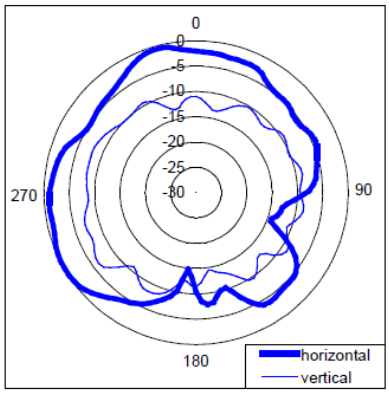


	HOR.	VER.
MAX	0.7	-6.6
AVE	-3.0	-9.6

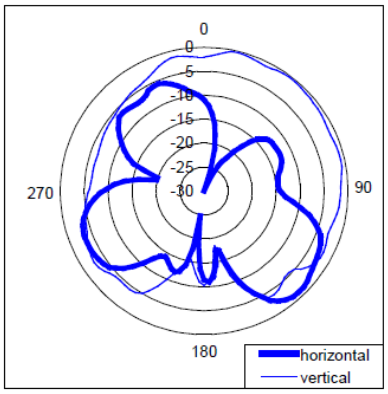


	HOR.	VER.
MAX	-1.3	0.2
AVE	-7.3	-2.6

Condition6 : L6 Layout / Original Antenna 2x9.8xt3.8mm(L turn) / PWB 37x80mm



	HOR.	VER.
MAX	0.0	-6.2
AVE	-3.7	-9.7



	HOR.	VER.
MAX	-1.1	-0.3
AVE	-7.5	-3.3

Appendix E: Calculation of the duty cycle correction factor

Using a spectrum analyser in zero span mode, centred on the fundamental carrier frequency with a RBW of 1MHz and a video Bandwidth of 1MHz the sweep time was set accordingly to capture the pulse train. The transmit pulsewidths and period was measured. A plots of the pulse train is contained in Appendix B of this test report.

If the pulse train was less than 100 ms, including blanking intervals, the duty cycle was calculated by averaging the sum of the pulsewidths over one complete pulse train. However if the pulse train exceeds 100ms then the duty cycle was calculated by averaging the sum of the pulsewidths over the 100ms width with the highest average value. (The duty cycle is the value of the sum of the pulse widths in one period (or 100ms), divided by the length of the period (or 100ms). The duty cycle correction factor was then expressed in dB and the peak emissions adjusted accordingly to give an average value of the emission.

Correction factor dB = 20 x (Log_{10} Calculated Duty Cycle)

Therefore the calculated duty cycle was determined:

The pulse train period was greater than >100ms and in as shown from the plots in contained in appendix B of this test report.

Duty cycle = $\frac{\text{the sum of the highest average value pulsewidths over 100ms}}{\text{100ms}}$

e.g

$$= \frac{7.459ms}{100ms} = 0.07459$$

0.07459 or 7.459%

Correction factor (dB) = 20 x (Log_{10} 0.07459) = -22.54dB

Appendix F: Photographs and Figures

The following photographs were taken of the test samples:

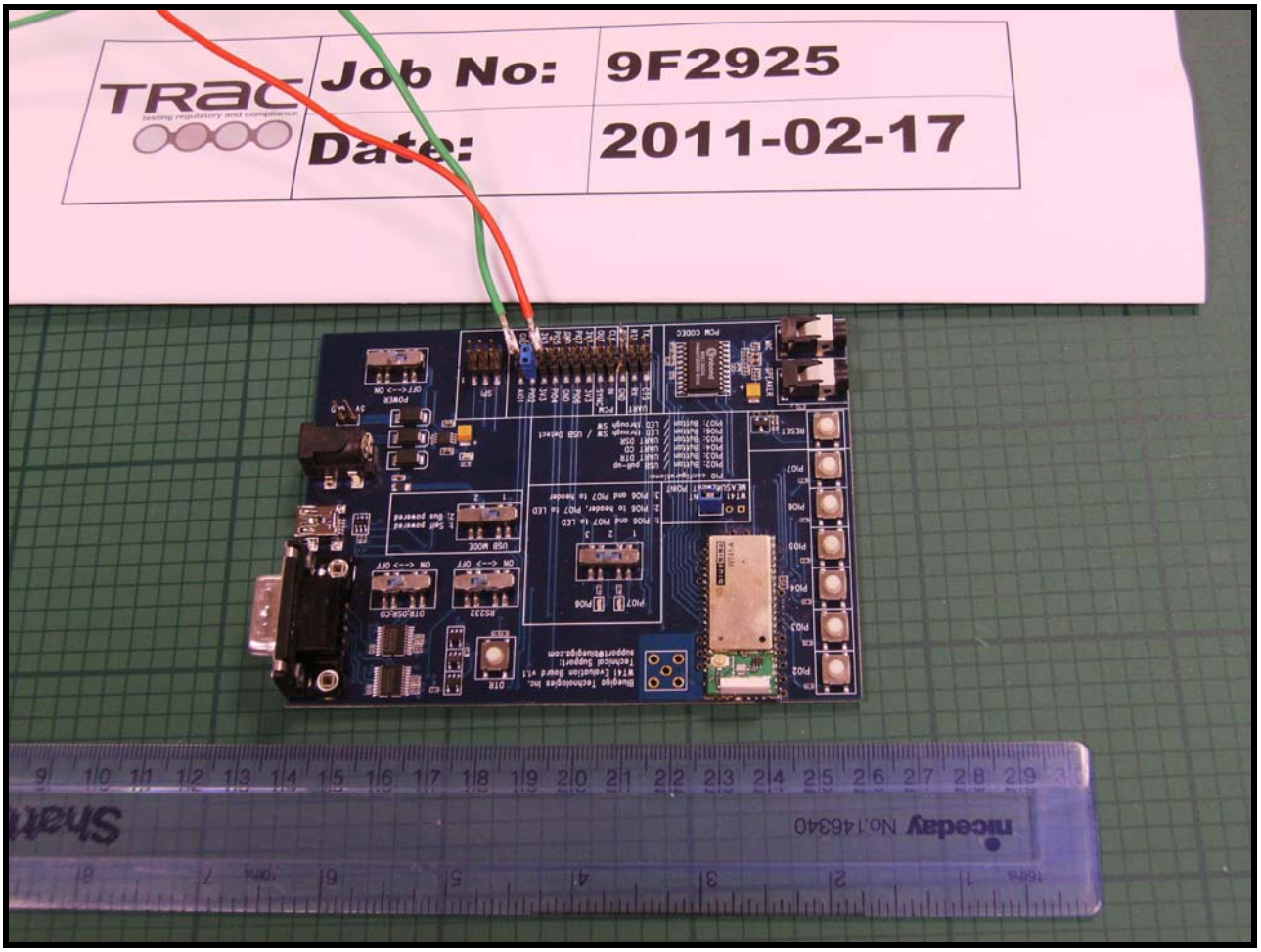
1. Radiated emissions Overview: Front view WT41-A
2. Radiated emissions Overview: Back view WT41-A
3. Radiated emissions Overview: Front view WT41-N
4. Radiated emissions Overview: Back view WT41-N
5. Photo of the WT41-A top overview
6. Photo of the WT41-A bottom overview
7. Photo of the WT41-N top overview
8. Photo of the WT41-N bottom overview

Photograph 1

Photograph 2

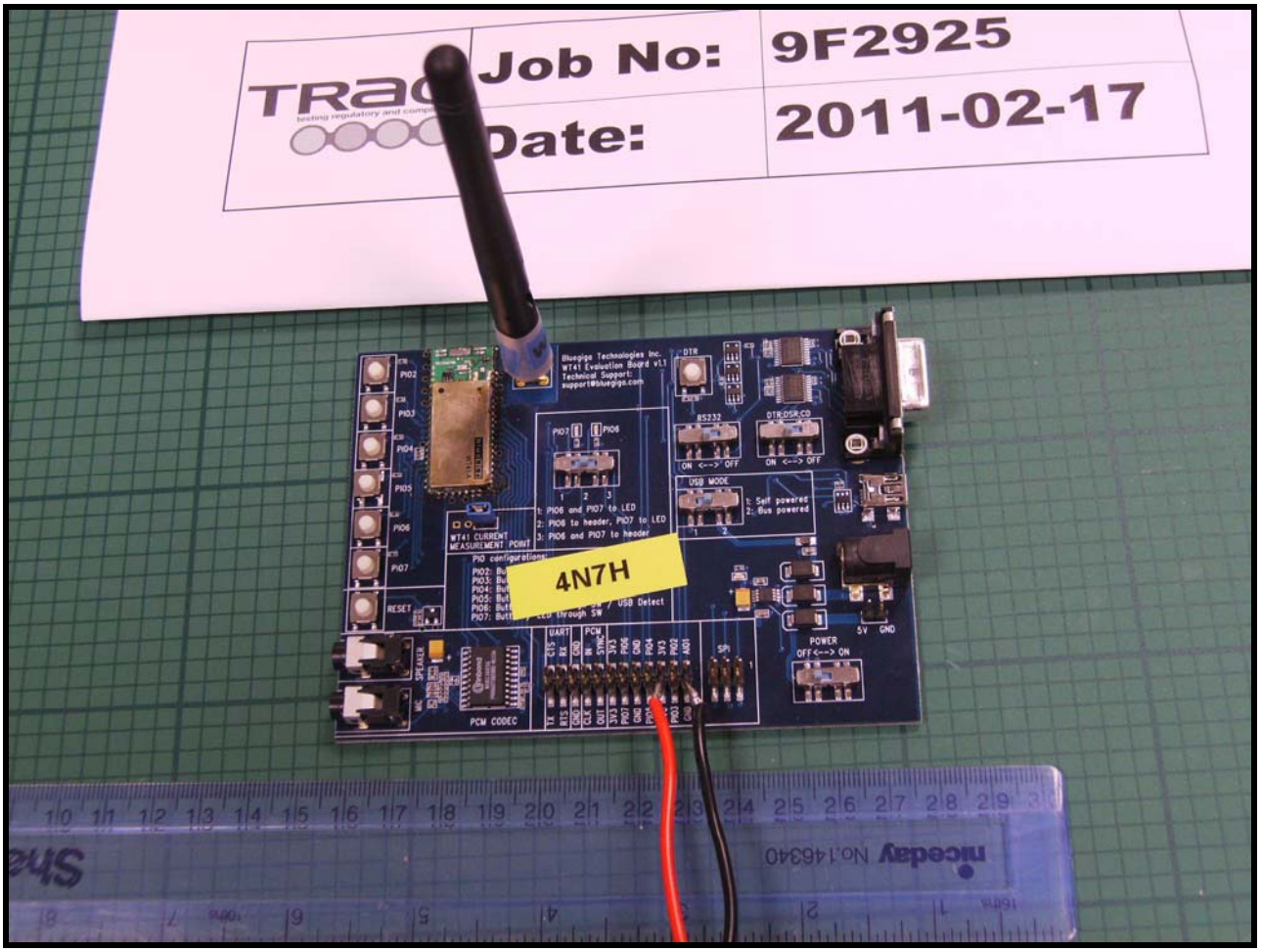
Photograph 3

Photograph 4



Photograph 5

Photograph 6



Photograph 7

Photograph 8