EMC and LVD
Testing, Training
and Consultancy

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EMC Test Plan & Test Report

Prepared for	Multijet Ltd
Product	"Cell Profiler" Also known as the "Bio Field Scanner" or the "Inter Cellular Profiler"
Report No.	EMC0513125
Written by	Peter Metcalfe (METECC)
Checked By	Colin Petts (Petts Consulting Ltd)
Test Engineer	Peter Metcalfe
Tests witnessed by	Colin Petts (Petts Consulting Ltd) Stephen Urwin-Wright (Multijet) David Butler (Multijet)
Test Date(s)	Initial tests 22/01/13, 19/02/13 Final tests after modification 25/02/13, 11/05/13
Report Issue date	Issue 1: 18/05/13

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Introduction

- All results and findings in this report were gained from tests conducted at the facility of METECC based in Burgess Hill, West Sussex.
- All equipment calibration (except for 'indication only' items) is traceable to the UK National Physical Laboratory.
- All comments, recommendations or interpretations, while forwarded in good faith, should be treated with caution.

Please note:-

- All results contained within this report apply only to the particular unit presented for test and detailed in the "Description" section.
- METECC have no surveillance or supervision control for this or any similar product.
- The issuing of this test report does not indicate any measure of approval or certification of the product tested.
- This report is intended to be used as evidence to support a self-declaration document issued by the company responsible for manufacture or supply of this product into the EU.

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TABLES

PICTURES

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1 EMC Test Plan

1.1 EUT Description

Manufacturer: Cell Well-being Ltd
9/F China Merchants Building
303-307 Des Voeux Road Central
Sheung Wan
Hong Kong

EU Authorized Representative Multijet Ltd
Britty Hill
Fulbrook Lane
Elstead
Surrey GU8 6LG

Equipment reference: "Cell Profiler"
Also known as the "Bio Field Scanner"
Or the "Inter Cellular Profiler"

Details of equipment tested:

The EUT is a small (95 x 150 x 15mm) electronic device that is connected to a PC via a standard USB connector. It is used in conjunction with special software that initiates the process and stores the resulting data.

Picture 1 The complete unit

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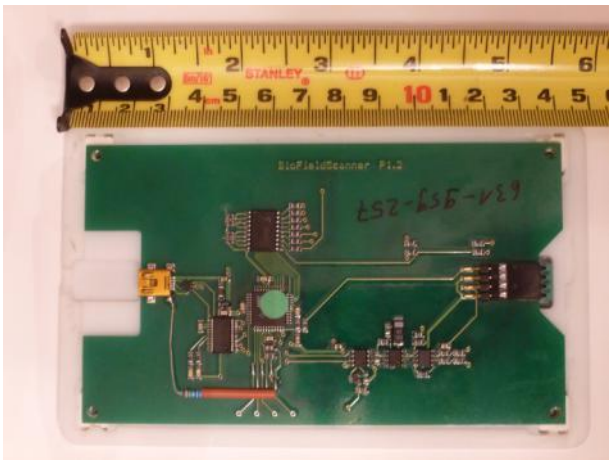
The electronics are located on a single PCB which and this is connected to the surface mounted Telsa Coil visible in the above image.

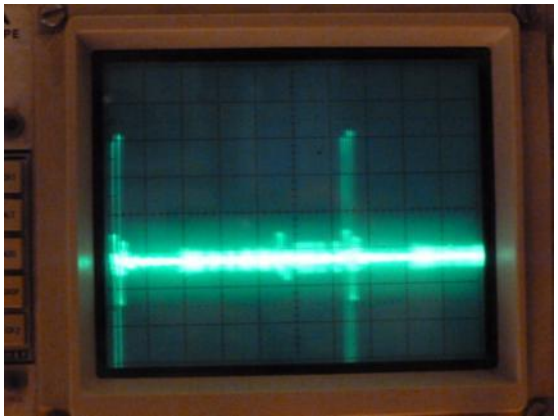


Picture 2 The main pcb

"The profiler is designed to interface bio-resonance information from hair or other cell samples, which is then stored in a data base format with corresponding personal data. This information is processed and used to provide an indication of bio-resonance factors for practitioners who require this data. It does not provide a physical diagnosis but provides another viewpoint for those who work with this type of indicator"

Operation

The hair specimen is placed on the Tesla coil. The host PC interfaces to the micro-controller via the USB port (using a FTDI convertor). When a specific command is sent to the micro-controller, a set of frequencies are generated - the amplitude and frequency of the pulses varies, across the given scan cycle <<cro.jpg>> (0.2V/div and 1uS/div). The sampling sequence last for approximately 10 seconds.
The hair specimen responds to specific frequencies by causing resonance. This is detected by the micro-controller and reported back to the pc where the data is stored for subsequent processing.



Picture 3 Generated waveform <cro.jpg>

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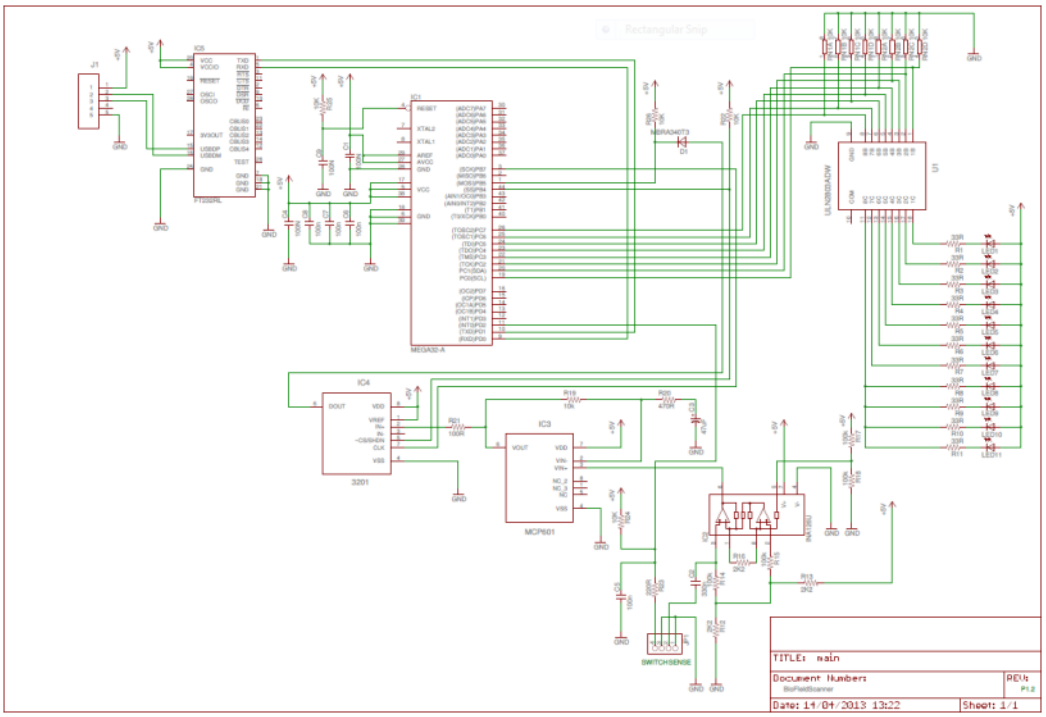
The operator interacts with the unit in the following ways,

- *Places samples on the coil*
- *Can initiate the process by pressing the Green button*
- *Can monitor the progress by observing the LED string under the coil or via the PC display.*



Key EMC features:

The normal installation of this unit could be within a controlled laboratory environment; However, due to the simplicity of installation (portable requiring only a suitable laptop) it may be possible for the unit to be installed within a Domestic environment.

Therefore, for emissions purposes it is recommended that the lower, Class B (Domestic & Light Industrial) level is employed.

Note that this could possibly raise an issue due to the host PC being certified only to industrial emission levels, however, it must be pointed out that the manufacturer does not supply the host pc for this unit. Therefore, their only obligation is to recommend “good engineering practice” regarding the choice and installation with a suitable host PC.

Should any ‘special’ arrangements be found necessary, the manufacturer must advise customers of these requirements.

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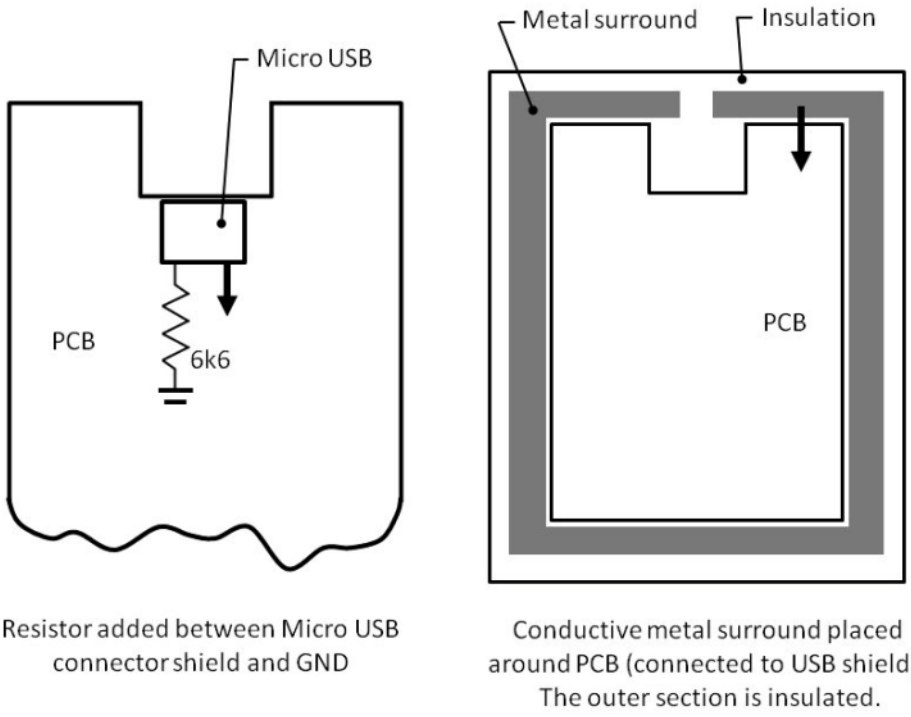
1.1.1 Revision level prior to test

Standard unit as supplied, connected to, and powered by a “typical” host PC.
For these tests the host pc was a Dell laptop model Inspiron 6400.

1.1.2 Revision level after test

Minor problems while ESD testing around the USB connector area of the unit showed the need for modifications to the wiring of this connector.



Picture 4 Modification to USB connection

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1.2 Referenced Standards and Levels

There could be a case for considering this unit as a piece of IT equipment as it is essentially a peripheral of a standard laptop PC. This would involve the application of EN55022 [1] and EN55024 [2] standards.

However, due to the nature of the unit, and the likely installation location, it would seem more appropriate to apply EN61326-1 [3] “Electrical equipment for measurement, control and laboratory use”.

The exact operating environment is not necessarily self-evident as the unit is, essentially, transportable and could be operated in a variety of locations.
It is possible that these locations could be in the vicinity of high RF generating appliances (mobile phones, data transmitters etc.).
It is also possible that this unit could be operated in the vicinity of sensitive devices (broadcast TV and radio receivers, security radio, mobile phones etc.)

EN61326-1 [3] specifies “Basic Immunity” requirements (table 1) these shall be referred to in the following plan.

The approach adopted will be to test the devices within a “typical” installation, i.e. a standard “off the shelf”, fully compliant laptop PC.

Under this regime, the PC will also be under test therefore, at all times, care should be taken to differentiate between the host PC and the EUT in any possible failure situations.

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1.3 Limits and levels – Basic requirements

1.3.1 Emissions

1.3.1.1 Enclosure Port, R.F. Emissions
Basic standard EN 55022 (and 55011) to Class B (Domestic and Light Industrial) limits

Note that it may be deemed necessary to carry out preliminary tests on the host PC without the EUT installed.

1.3.1.2 AC Power Port, Conducted Emissions

Not required – the unit derives its power from the USB port of the host laptop.

1.3.1.3 AC Power Port, Harmonic Emissions

Not required – the unit derives its power from the USB port of the host laptop.

1.3.1.4 AC Power Port, Flicker

Not required – the unit derives its power from the USB port of the host laptop.

1.3.1.5 DC Power Port, Conducted Emissions

Not required – the unit derives its power from the USB port of the host laptop.

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1.3.2 Immunity

As referenced in EN61326-1 Table 1 (Basic requirements)

1.3.2.1 Enclosure Port, R.F. Field

Basic standard EN 61000-4-3 at a level of:

- 3V/m, in the range 80 - 1,000MHz
- 3V/m, in the range 1,400 - 2,000MHz
- 1V/m, in the range 2,000 - 2,700MHz

1.3.2.2 Enclosure Port, Electrostatic Discharge (ESD)

Basic standard EN 61000-4-2 at a level of:

- 4kV Contact Discharge
- 4kV Air Discharge

1.3.2.3 Input AC Power Port, Fast Transients

Not required – No AC power port - the unit derives power from the USB port of the host laptop.

1.3.2.4 Input AC Power Port, Voltage Dips and Interruptions

Not required – No AC power port - the unit derives power from the USB port of the host laptop.

1.3.2.5 Input AC Power Port, Voltage Surges

Not required – No AC power port - the unit derives power from the USB port of the host laptop.

1.3.2.6 Input AC Power Port, R.F. Common Mode

Not required – No AC power port - the unit derives power from the USB port of the host laptop.

1.3.2.7 Input AC Power Port, Fast Transients

Not required – No AC power port - the unit derives power from the USB port of the host laptop.

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1.3.2.8 Signal port, Voltage Surges

USB cable NOT connected to low voltage (mains) distribution network
USB cable NOT connected to telecom lines
USB cable NOT >30m long
Therefore, this test is not required

1.3.2.9 Signal port, R.F. Common Mode

USB cable declared as NOT >3m long
Therefore, this test is not required

1.3.2.10 Signal port, Fast Transients

USB cable declared as NOT >3m long
Therefore, this test is not required

1.4 Voluntarily applied limits and levels

1.4.1 Immunity

Note that these levels are in addition to those previously stated.

1.4.1.1 Enclosure Port, R.F. Field
Basic standard EN 61000-4-3 at a level of:

- 6V/m, in the range 80 - 1,000MHz
- 6V/m, in the range 1,000 - 3,000MHz

1.4.1.2 Enclosure Port, Electrostatic Discharge (ESD)
Basic standard EN 61000-4-2 at a level of:

- 6kV Contact Discharge
- 8kV Air Discharge

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1.5 Variations to referenced requirements

1.5.1 Enclosure Port, R.F. Emissions

Test to be performed in semi-anechoic chamber rather than the requirement (quoted in EN55022) of an Open Air Test Site.
Advantages of this latter point are that signals measured are more easily distinguishable from ambient sources.
However, it is appreciated that there will be uncertainties introduced due to room resonances.
Note comments in 2.2.1 concerning uncertainty and confidence margins.

Note also that a test distance of 3m is chosen, with the appropriate variation to the limit line.

BS EN 55022 – clause 11.2.1 states that, …"whilst being aware of potential 'near field' problems at shorter distances than 30m (Class A) and 10m (Class B), a de-rating factor of 20 dB / decade could be employed"….
For 3m distance this is therefore an increase of 10dB for class B limits.

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1.6 Proposed test configuration.

1.6.1 Host PC

If the host laptop can be shown to be compliant then tests with this within the screened chamber and the supplied (short) USB lead should be possible.
However, it may be necessary to extend this lead such that the host PC is removed from the test environment.
It is appreciated that any extension of the USB lead could have an impact on the EMC characteristics of the EUT. Every attempt shall be made to isolate any effects and identify whether they are PC or EUT originated

1.6.2 Ancillary equipment outside/inside test environment:

Test PC – standard laptop running exercising software monitoring all functions.
Connected to the EUT via supplied (fixed to EUT) USB link – but see also [1.6.1]

1.6.3 Test software

The software to be run on the host laptop, is supplied by Multijet Ltd. And is designed to fully exercise and report on all aspects of the EUT operation.

1.6.4 Interface ports.

Single fixed lead terminated in standard USB “A” connector

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1.6.5 Pictures of set-up:

Picture 5 EUT in chamber

Picture 6 Laptop connected

Picture 7 Software running

Note that these pictures were taken during initial set-up procedures with the laptop in the chamber.

2 Test Report

2.1 Test Equipment & Calibration Status

- All equipment calibration (except for 'indication only' items) is traceable to the UK National Physical Laboratory.
- All "METECC Facility" tests are carried out in a 6.4m x 4.2m x 4m fully screened anechoic chamber supplied and installed by M&D Installation Services (Portsmouth) and **Rainford EMC Systems Ltd (**St. Helens).

Equipment	Manufacturer	Model	Serial No.	Cal Due
Spectrum Analyser (25GHz)	HP/Agilent	HP8593EM	3926A00306	21/10/2013
Spectrum Analyser	HP/Agilent	HP8591E	3412A02829	28/10/2013
EMI Receiver	Rohde & Schwarz	ESVP		25/09/2013
1GHz Bi-log Aerial	Chase/York	CBL-6121A	1013	13/10/2013
2GHz Bi-log Aerial (New)	Chase/York	CBL-6140	1009	11/11/2013
18GHz Horn Aerial	EMCO	3117	00066661	12/05/2013
Calibration Dipole Set	EMCO	EM6924	210	22/10/2013
Field Site Source 10-600MHz	EMCO	4610	9209-1221	30/06/2013
LF Active E Field Rod Aerial	EMCO	3301B	2430	22/10/2013
LF Active E Field Rod Aerial	EMCO	3301B/1	9802-3945	22/10/2013
LF Field "H" Aerial	EMCO	3107B	9002-2347	22/10/2013
LF Field "H" Aerial	EMCO	3107	2243	22/10/2013
Passive Magnetic Field Loop	EMCO	6509	9210-1315	22/10/2013
Active Magnetic Field Loop	EMCO	6502	2277	22/10/2013
3GHz Field Probe & Optical Link	PMM	EP-330 / OR-03	020WJ60515/1010J91027	18/09/2013
Field Probe, Meter, Optical Link	EMC Test Design	RFP-04CE / PI-01	152	20/09/2013
L.F. Magnetic Field Meter	Lutron	EMF-827	G68180	20/09/2013
Current Injection Probe (Blue)	Chase	CIP-8212	8	20/10/2013
Current Injection Probe (Black)	Fischer	Fischer 5133C	141	20/10/2013
Sensor Probe	Schaffner	CSP-9160	70223	20/10/2013
LISN (GPTE)	EMCO	3825/a	9108-1837	22/10/2013
LISN (USA)	EMCO	3825/2	8910-1564	20/10/2013
LISN	Tti	LISN1600	061977	20/10/2013
L.F. Conducted Reference Source	EMCO	4620	9310-1028	20/09/2013
FTB & Surge Generator	Omiran	HiLo CE Tester	96-20-77	20/09/2013
Dip/Surge/FTB/ESD Generator	EMC Partner	Transient 2000ASAD	502	20/10/2013
Surge coupling kit	EMC Partner	CDN-KIT-1000	TRA1Z10B	20/10/2013
ESD Discharge Network	EMC Partner	ESD-2000	502	20/10/2013
ESD System	Schaffner	NSG 433	218	20/09/2013
Power Analyser	Voltech	PM3000A	7061	16/05/2013
10MHz–4000MHz Pre-Amp	Mini Circuits	ZX60-6013/4016-S +2&3dB pad	M-0306-001	20/10/2013
0.1MHz–18000MHz Pre-Amp	Mini Circuits	2 x ZX60-14012 +2dB pad	M-0207-002	20/10/2013
0.1MHz-1000MHz Pre-Amp	Mini Circuits	ZFL-1000LN +6dB pad	M-1007-003	20/10/2013
Transient Limiter	HP/Agilent	11947A	3107A01354	20/10/2013
Transient Limiter	Chase	CFL 9206	1056	20/10/2013
Capacitive Clamp	EMC Partner	CN-EFT-1000	118	20/10/2014
Capacitive Clamp	Steward	L21	0831	20/09/2013
Signal Generator, L.F.	??	S325	1001	20/09/2013
Signal Generator, 3GHz	R&S	SME03 Opt.B11 1036.8720.02	842244/049	20/09/2013
Signal Generator, 1GHz	Marconi	2022E	119064/128	20/09/2013
Signal Generator, 3.3GHz (TES)	R&S	SML03/B1/B3	100013	15/03/2014
Signal Generator, 3.3GHz (Italy)	R&S	SML03/B19	101533	25/02/2014
Signal Generator, 18GHz	HP	HP8672A	800 211.0022	20/10/2013
Signal Generator, 20GHz	R&S	SMP02	836895/013	20/10/2013
L.F. Loop Amplifier	PDA	500/2	W/03115	20/10/2013
L.F. Power Amp	Data Physics	PA3000E	10/A6Q/25078	11/06/2013
10kHz – 220MHz, 250W Amp.	Kalmus	122C	072192-1	20/09/2013
200MHz – 1000MHz, 100W Amp.	Kalmus	717FC	031293-5	20/09/2013
10kHz – 1000MHz, 25W Amp.	Kalmus	737LC	7549-2	20/09/2013
1.0GHz – 2.0GHz, 5W Amp.	Comtech	PST/AR85729-5	N1A4A00-1009	20/09/2013
0.8GHz – 4.0 GHz, 30W Amp.	Ophir	5182	1005	20/09/2013
6.0GHz – 18GHz, 10W Amp.	Logimetrics	A240/IJ	2220	20/09/2013
3.6GHz – 10GHz, 5W	Eng. Elec. Valve Co.	N4132	51 8610	20/09/2013
10GHz – 18GHz, 5W	Eng. Elec. Valve Co.	N4256	52 8610	20/09/2013
Directional Coupler	A R	DC3001	17445	20/10/2013
20dB 20W Attenuator	Narda	40024	528	20/10/2013
3dB 75W Attenuator	EMCO	AN-N-3dB	603	20/10/2013
Ground Continuity Tester, Storage CRO, 50V DC psu, Temp/Humid/Pressure meters				Indic'n only

Table 1 Equipment calibration

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2.2 METECC Confidence Levels and Limitations

2.2.1 R.F. Emissions

The METECC test facility has conducted a full 'site uncertainty audit' in accordance with CISPR 16-4. [18]
As a result of this audit, it has been ascertained that the 'Expanded Uncertainty figure' for the METECC anechoic test chamber is better than 9.07dB.
This is 3.87dB above that recommended by CISPR and therefore METECC apply an uncertainty margin of 4dB to all radiated emissions limit lines in order that the desired 95% confidence factor can be reached.

Should any emissions fall within this 4dB uncertainty margin, they will be designated “Marginal”

2.2.2 Radiated R.F. Immunity

Calibration, in accordance with EN 61000-4-3 [8], shows that correct field uniformity is only possible, over a 3m test distance, within an area of 3.4m x 2.8m (3V/m) and 3.0m x 2.4m (10V/m).
Therefore, this represents a maximum permissible EUT size for the corresponding test levels.

The EUT in question falls well within the ‘uniform field' area.

2.2.3 All other tests

Equipment for all other tests is CISPR16 compliant and traceable to the UK National Physical Laboratory calibration.

2.2.4 Note on definition of ‘marginal’ as quoted in CISPR 16

(For results under the limit line)

The measured result is below the specification limit by a margin less than the measurement uncertainty; it is therefore not possible to state compliance based on the 95% level of confidence. However, the result indicates that compliance is more probable than non-compliance with the specification limit.

(For results above the limit line)

The measured result is above the specification limit by a margin less than the measurement uncertainty; it is therefore not possible to state non-compliance based on the 95% level of confidence. However, the result indicates that non-compliance is more probable than compliance with the specification limit.

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2.2.5 Note on 'product variations'

Complex devices, assemblies and installations will, inevitably, vary in its EM characteristics.

The more complex the system, and the more a device relies upon 'critical' production issues, the greater this variation could be.

Variation in the region of 6dB is easily achieved from one unit to the next even for simple devices. Where critical methods and devices are identified (usually in early investigative work) it is not unusual for 10 or 20dB variations to result!

Careful production control, for example as a part of a quality control system, can help reduce these variations – but can never completely eliminate them.

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2.3 Performance Criteria for Immunity Tests

The following performance criteria specified under EN 55024 [2], and modified for the specific EUT, were used as a basis for evaluation of the performance of the EUT during test.
Note that these are, in places considerably harsher than those required by EN61326 and hence a pass under these conditions can be considered a pass under all conditions.

Performance criterion A:

The apparatus shall continue to operate as intended during the test. No degradation of performance or loss of function is allowed below a performance level (or permissible loss of performance) specified by the manufacturer, when the apparatus is used as intended. If the minimum performance level or the permissible performance loss is not specified by the manufacturer, then either of these may be derived from the product description and documentation, and from what the user may reasonably expect from the apparatus if used as intended.

Performance criterion B:

The apparatus shall continue to operate as intended after the test. No degradation of performance or loss of function is allowed below a performance level (or permissible loss of performance) specified by the manufacturer, when the apparatus is used as intended. During the test, degradation of performance is allowed, however, no change of actual operating state or stored data is allowed. If the minimum performance level or the permissible performance loss is not specified by the manufacturer, then either of these may be derived from the product description and documentation, and from what the user may reasonably expect from the apparatus if used as intended.

Performance criterion C:

Temporary loss of function is allowed, provided the function is self- recoverable or can be restored by the operation of the controls, or by any operation specified in the instructions for use.

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In light of the above, the following, manufacturer imposed, restrictions will be applied:-

Criterion A:

- Operation mode should not change.
- Basic display parameters, as indicated on the host laptop should not change.
- Data link (USB) should remain stable, however, block error correction and request to resend, if consistent with normal practice will be allowed

Criterion B:

- Occasional USB corruption will be allowed as long as the software system/observer recognises this as an error.
- Otherwise all points noted in criterion A shall still apply.

Criterion C:

- Data interruption is allowable as long as normal operation is available after the relevant test
- No loss of recorded data/programme is to be allowed.
- Otherwise, as for criterion B.

At no time should the any state be entered which could be deemed “hazardous”

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2.4 Test & Result Summary

2.4.1 Emissions

Port	Test	Conditions	Test level	Result
Enclosure	RF Emissions Horizontal and vertical polarisation All faces of EUT tested	Medium sized ferrite (1 turn) on USB lead	Class B	Marginal Pass class B. Worst case Q-P emissions 3.5dBuV below limit
		Large ferrite (1 turn) on USB lead	Class B	Pass class B. Worst case Q-P emissions 8.2dBuV below limit

Table 2 Emissions test results summary

2.4.2 Immunity

Port	Test	Conditions	Test levels	Required Criterion for Pass	Result
Enclosure	RF field Horizontal and vertical polarisation All faces of EUT tested	Running test software	3V/m 80-3000MHz	A	No visible effect on operation. A confident pass at 3V/m level. Criterion “A”
			Also tested at 6V/m For confidence	-	No visible effect on operation. A confident pass at 6V/m
	ESD	Running test software NB Modifications required (addition of 6k6 resistor)	±2, 4 & 6kV contact ±2, 4, 6, 8kV air	B	Pass at all levels Criterion “A”

Table 3 Enclosure Port Immunity test results summary

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2.5 Results and Comments

2.5.1 Environmental conditions:

	22/01/13	19/02/13	25/02/13	11/05/13
Lab. Temperature	20°C	19°C	17°C	22°C
Humidity	31%	42%	34%	35%
Atmospheric Pressure	996hPa	1002hPa	1020hPa	1008hPa

2.5.2 Emissions

2.5.2.1 General notes:

Polarisation and height of the Bi-Log was hydraulically selected.
Manual rotation of the EUT was possible to ascertain 'worst case' conditions.

Note that the attached graphs show **Peak Detector** scans, not the required **Quasi-peak** scan.

It is a recorded fact that peak measurement is always higher than quasi-peak and so constitutes a 'worst possible case'.

Q.P. measurements were only taken in 'marginal' cases, or for confirmation of margins. These results are presented in tabular form. It is advisable, due to the nature of the screened room, measurement equipment etc. to impose a 'confidence' margin of around 4dB. [2.2.1]

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2.5.2.1 Radiated Emissions – initial experiments (22/01/13):

Initial scans showed:

- Problems with differentiating between Laptop or EUT sourced USB noise
- Initial tests with the laptop in the chamber were, at best 1 or 2 dB above limit

A sequence of investigative tests seemed to indicate that a large proportion of this noise could, indeed, be laptop sourced. But these tests were inconclusive and it was considered prudent to attempt improvements to the EUT.

- The addition of a large ferrite, with two complete turns, on the USB lead close to the EUT gave significant improvements.
- Adding a similar ferrite to the same lead close to the laptop produced even greater improvements
- Attempts to place the laptop outside the chamber were inconclusive due to the fact that the USB lead, to reach the chamber wall, needed to be extended with consequent changes in resonant length and emission characteristics.
- Adding a USB filter at the room breakout panel, to reduce laptop sourced noise entering the chamber, and adding a large ferrite close to the EUT gave a reasonable (though still ‘Marginal’) pass.
- Replacing the large ferrite by a more realistically sized device was unsuccessful and resulted in a Marginal failure.
- Checks with the EUT connected to the (external) laptop, but not running the profiler test software produced virtually identical results to those when running the test

2.5.2.2 Interim conclusions from initial tests

- Both the laptop and the EUT contribute to the unacceptable emissions
- After attempts to eliminate the laptop contribution, the EUT was found to source unacceptable emissions
- The addition of a large ferrite, with two complete turns produced just acceptable results
- Smaller ferrites, or fewer turns were found not to be sufficient

The interim recommendation was to investigate effective USB filtering, on board, close to the USB driver circuitry.

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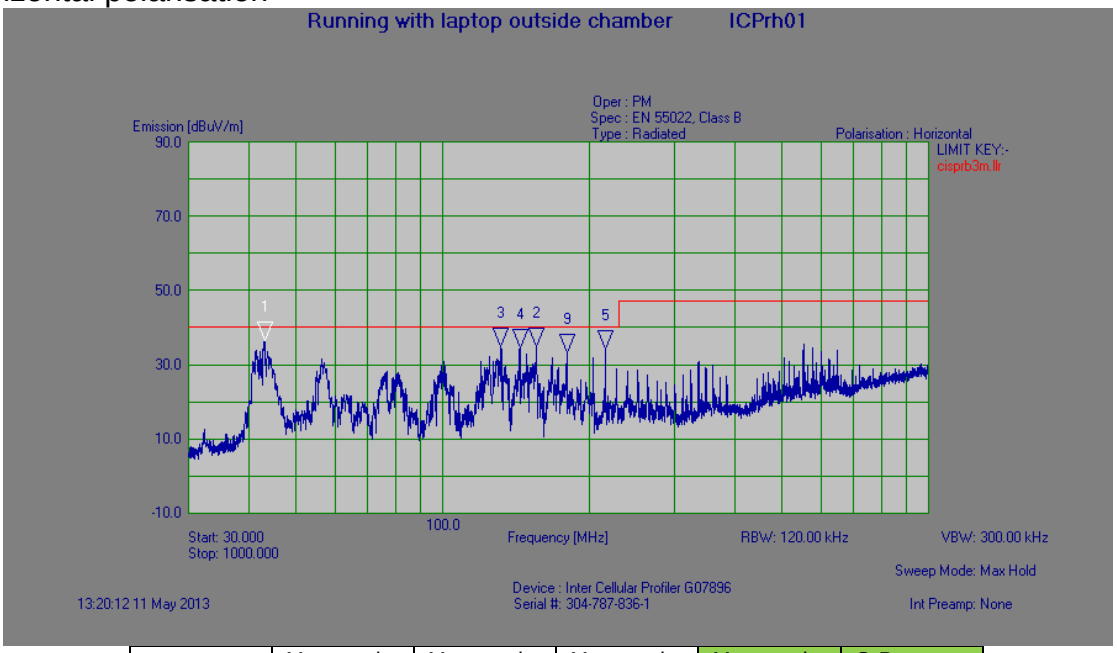
2.5.2.3 Radiated Emissions – Final sequence (11/05/13)

As a result of subsequent immunity testing, and, in particular ESD results, modifications to the EUT circuit were found necessary.
As a consequence of this it was decided to repeat radiated emissions testing after this modification was engineered.

From the outset it was decided to run the tests with the host laptop outside the chamber and a good quality filter placed at the breakout panel to reduce laptop sourced noise entering the chamber.

Horizontal polarisation



Marker	Measured Freq (MHz)	Measured Peak (dBµV/m)	Measured Aver (dBµV/m)	Measured Q-P (dBµV/m)	Q-P Limit (dBµV/m)
6 H	41.368	34.80	25.97	31.63	40.00
7 H	42.099	35.50	26.55	30.70	40.00
1	43.003	36.22	29.43	33.95	40.00
8 H	43.603	34.72	27.66	32.11	40.00
3	132.04	38.39	26.45	32.29	40.00
4	143.99	37.83	25.54	31.23	40.00
2	156.07	36.76	25.64	32.17	40.00
9	180.13	36.24	25.29	32.27	40.00
5	216.00	38.81	24.18	33.21	40.00

Worst case margin is >6dB below Class B limit (Pass)

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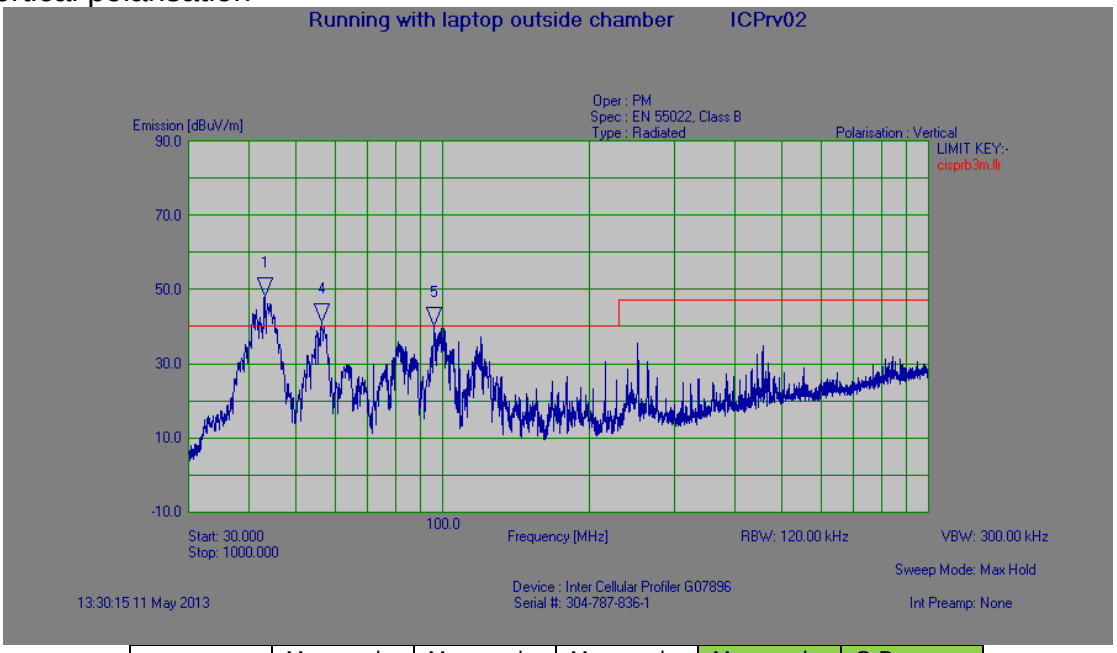
Vertical polarisation



	Measured	Measured	Measured	Measured	Q-P
Marker	Freq	Peak	Aver	Q-P	Limit
	(MHz)	(dBµV/m)	(dBµV/m)	(dBµV/m)	(dBµV/m)
3 H	41.333	45.73 *	36.87	42.10 *	40.00
1	43.003	48.15 *	41.12 *	46.07 *	40.00
2 H	43.629	47.07 *	39.07	44.07 *	40.00
4	56.331	41.61 *	34.52	39.05	40.00
5	96.062	49.46 *	34.47	40.48 *	40.00

Worst case margin is >6dB above Class B limit (Fail)

These results are broadly in line with those found, under similar circumstances, in the initial investigation.

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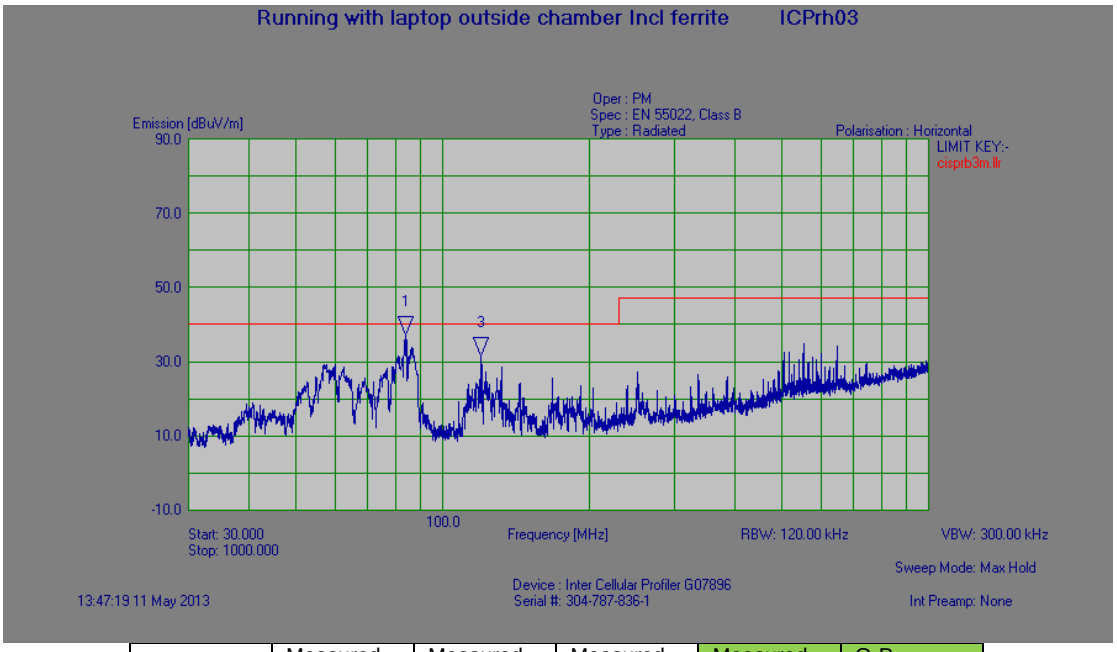
Wurth 742-711-12 (1 turn) ferrite added



	Measured	Measured	Measured	Measured	Q-P
Marker	Freq	Peak	Aver	Q-P	Limit
	(MHz)	(dBµV/m)	(dBµV/m)	(dBµV/m)	(dBµV/m)
1	84.049	41.94 *	30.18	36.51	40.00
2 H	86.622	34.53	28.53	32.44	40.00
3	120.06	35.14	24.98	30.22	40.00

Worst case margin is 3.5dB below Class B limit (Marginal Pass)

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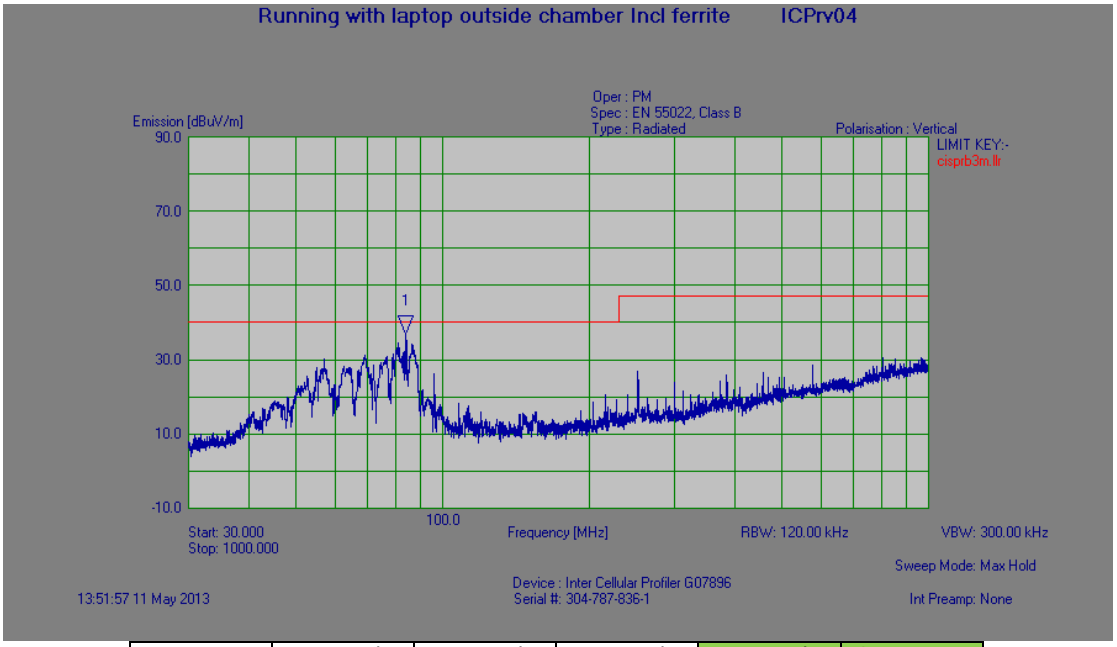

	Measured	Measured	Measured	Measured	Q-P
Marker	Freq	Peak	Aver	Q-P	Limit
	(MHz)	(dBµV/m)	(dBµV/m)	(dBµV/m)	(dBµV/m)
2 H	81.009	34.14	27.09	31.86	40.00
11 H	81.515	32.30	24.50	28.88	40.00
10 H	82.193	34.23	23.73	28.16	40.00
7 H	82.448	33.10	24.77	28.31	40.00
4 H	83.185	33.59	26.94	30.94	40.00
6 H	83.639	31.83	14.68	26.41	40.00
1	84.057	41.05 *	29.99	35.85	40.00
5 H	84.685	27.77	18.90	23.38	40.00
8 H	85.047	25.95	13.23	24.64	40.00
9 H	85.422	31.58	24.86	28.86	40.00
12 H	85.974	34.50	24.78	30.86	40.00
3 H	86.441	34.74	27.44	32.23	40.00

Worst case margin is >4.1dB below Class B limit (Pass)

Marginal, but possibly acceptable

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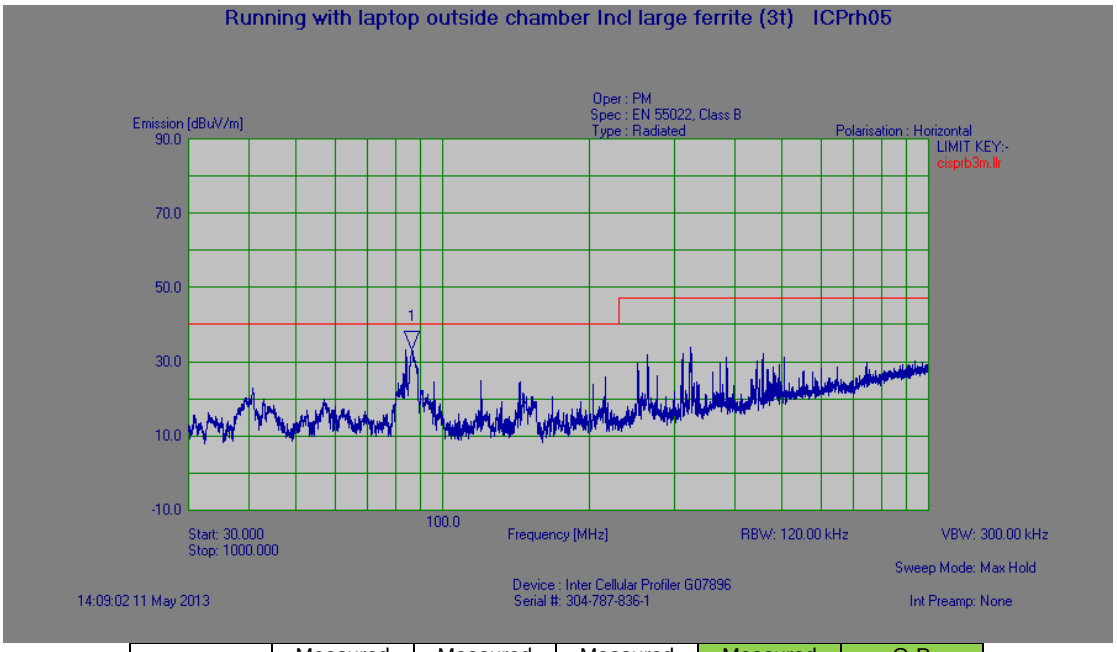
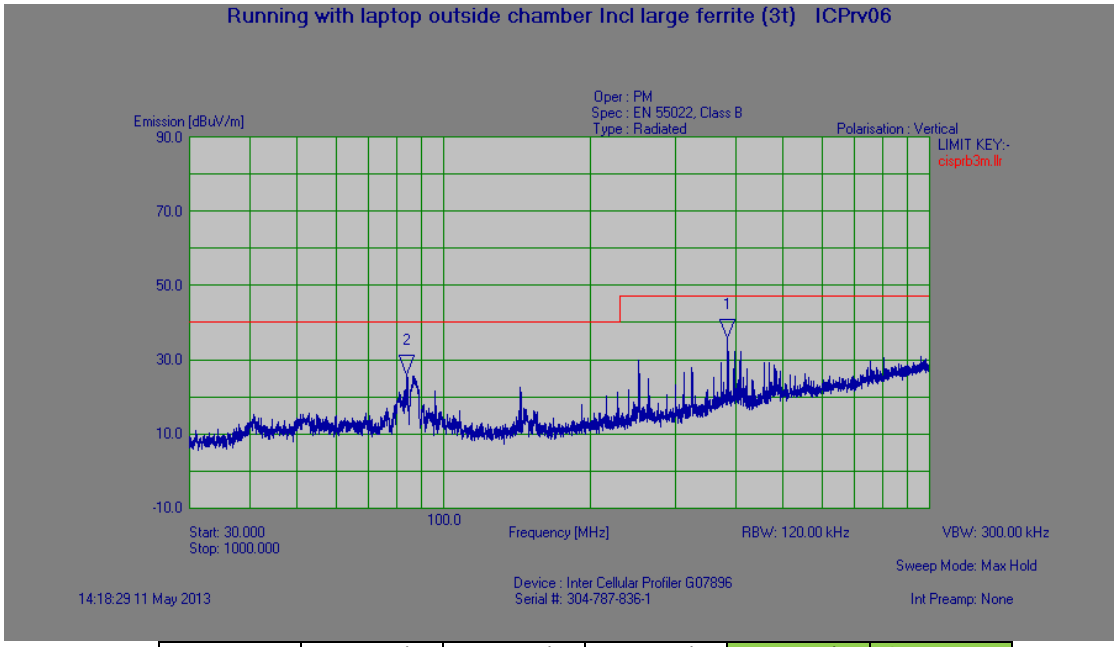
Large Wurth 742-712-21 (3 turns) ferrite added



	Measured	Measured	Measured	Measured	Q-P
Marker	Freq	Peak	Aver	Q-P	Limit
	(MHz)	(dBµV/m)	(dBµV/m)	(dBµV/m)	(dBµV/m)
2 H	84.050	37.03	25.52	31.65	40.00
1	86.622	33.87	27.45	31.78	40.00

Worst case margin is >8dB below Class B limit (Pass)



	Measured	Measured	Measured	Measured	Q-P
Marker	Freq	Peak	Aver	Q-P	Limit
	(MHz)	(dBµV/m)	(dBµV/m)	(dBµV/m)	(dBµV/m)
2	84.098	29.71	19.70	25.24	40.00
3 H	86.712	27.15	20.28	24.43	40.00
1	384.34	36.96	28.55	35.55	47.00
5 H	396.37	36.63	23.30	31.18	47.00
4 H	408.32	36.69	23.45	30.67	47.00

Worst case margin is >11.4dB below Class B limit (Pass)

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2.5.2.4 Worst case orientation search

- Variation in aerial height (1-2.5m) showed <2dB variation in the results reported above
- The results previously reported were “worst case”
- EUT rotation showed little significant variation to that reported above (further indicating that the largest contributing factor to emissions was the cable rather than the body of the EUT)

2.5.2.5 Radiated Emissions (1 – 18GHz)

The most recent edition of CISPR22 states that, for clock frequencies above certain values (notably, in this case, 108MHz), emission results are required to frequencies above 1GHz and, potentially, up to 6GHz.

The clock frequency used in this unit is unknown, but likely to be <<100MHz.

This means that the highest intentionally generated clock frequency within the EUT is likely to be well below 100MHz and hence testing for emissions above 1GHz is not required.

2.5.2.6 Final conclusions (Emissions)

- With the addition of a medium sized ferrite and one turn (a reasonably practical solution) the unit is a Marginal Pass with a ‘worst case’ margin of 3.5dB
- However, with the addition of a large ferrite and three turns the unit is a much more comfortable Pass with a ‘worst case’ margin of 8.2dB

Note that these results further emphasise that the EUT is a large contributing factor in USB emissions.

The earlier recommendation that an effective USB filter within the EUT should be researched is still valid and may, if implemented, remove the need for ferrites.

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2.5.3 Immunity

2.5.3.1 Radiated R.F. Field.

Tested on 22/01/13

Radiated RF Immunity		Basic Standard:			EN61000-4-3
Dwell time:	≥ 2 sec	Step size:	1%	Modulation:	80% A.M. @ 1kHz

Freq range (MHz)		Acceptance Criterion		Comments
		Required	Result	
(Class B - Residential & Light Industrial)				
80MHz – 1000MHz	3V/m Horizontal	A	A	Normal operation throughout
80MHz – 1000MHz	3V/m Vertical	A	A	
1.4 – 2.0GHz	3V/m Horizontal	A	A	
2.0 – 2.7GHz	1V/m Horizontal	A	A	
1.4 – 2.0GHz	3V/m Vertical	A	A	
2.0 – 2.7GHz	1V/m Vertical	A	A	
Final Test Levels (Voluntary, for confidence)				
80MHz – 1000MHz	6V/m Horizontal	A	A	Normal operation throughout
80MHz – 1000MHz	6V/m Vertical	A	A	
1.0 – 3.0GHz	6V/m Horizontal	A	A	
1.0 – 3.0GHz	6V/m Vertical	A	A	

Overall - this unit **conforms** to the requirements of EN61000-4-3
As referenced in EN55024 (Class B - Residential & Light Industrial)
and EN61326-1 (Table 1, Basic EM Environment)

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2.5.3.2 Electrostatic Discharge (ESD) Initial test before modifications

Tested on 22/01/13

- Contact discharge up to a severity level of ± 4 kV
- Air discharge up to a severity level of ± 8 kV

Numerous points around the EUT were chosen (see below)

- 'run-up' tests were performed at ± 2, 4 & 6 kV (as appropriate)
- each point was subjected to at least 10 discharges of each polarity

Test:	**Electrostatic Discharge (ESD)**	**Basic Standard:**	**EN61000-4-2**
Levels are the same for both Class B (Residential & Light Industrial) and Class A (Industrial)			
Contact discharge:		±2kV, ±4kV	
Location Tested	**Conditions**	**Acceptance Criterion** Required / Result	**Comments**
All conductive parts: Including front label	Running auto-test	B / C	Communications disrupted, unit requires power cycle and USB connection search to re-initialise and restart. Effect noted at levels above 1kV (either polarity)
Air discharge:		±4kV, ±6kV, ±8kV	
Location Tested	**Conditions**	**Acceptance Criterion** Required / Result	**Comments**
All insulated parts:	As above	B / -	Not tested at this time
Indirect discharge to horizontal coupling plane:		±2kV, ±4kV	
Location Tested	**Conditions**	**Acceptance Criterion** Required / Result	**Comments**
10cm from EUT	As above	B / C	Communications disrupted, unit requires power cycle and USB connection search to re-initialise and restart.

Overall - this unit **does not conform** to the requirements of EN61000-4-2
As referenced in EN55024 (Class B - Residential & Light Industrial)
and EN61326-1 (Table 1, Basic EM Environment)

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2.5.3.1 Electrostatic Discharge (ESD) Final test after modifications

Tested on 25/02/13
Modified unit with low value (6k) resistor to ground
For diagram of modification see [1.1.2]
Note inclusion of 6kV contact discharge for confidence

Test: Electrostatic Discharge (ESD)		**Basic Standard:**		**EN61000-4-2**
Levels are the same for both Class B (Residential & Light Industrial) and Class A (Industrial)				
Contact discharge:	±2kV, ±4kV & ±6kV (Medical requirement)			
Location Tested	**Conditions**	**Acceptance Criterion Required**	**Result**	**Comments**
All conductive parts: Front label (all points)	Running auto-test	B	A	Normal operation throughout
Air discharge:	±4kV, ±6kV, ±8kV			
Location Tested	**Conditions**	**Acceptance Criterion Required**	**Result**	**Comments**
All insulated parts:	As above	B	A	Normal operation throughout
Indirect discharge to horizontal coupling plane:	±2kV, ±4kV & ±6kV (Medical requirement)			
Location Tested	**Conditions**	**Acceptance Criterion Required**	**Result**	**Comments**
10cm from EUT	As above	B	A	Normal operation throughout

Overall - this unit **conforms** to the requirements of EN61000-4-2
As referenced in EN55024 (Class B - Residential & Light Industrial)
and EN61326-1 (Table 1, Basic EM Environment)

2.6 Final Conclusions

- After the modifications noted, this unit is a good pass for the Emission requirements as referenced in EN55022/EN55011 (Class B - Residential and Light Industrial) and EN61326-1 (Class B equipment).
- After the modifications noted, this unit is a good pass for the Immunity requirements as referenced in EN55024 (Class B - Residential and Light Industrial) and EN61326-1 (Table 1, Basic EM Environment).

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3 Appendix

3.1 Reference Documents

[1].	BS EN 55022	"Limits & methods of measurement of radio disturbance characteristics of information technology equipment"
[2].	BS EN 55024	"Limits & methods of measurement of Immunity characteristics of information technology equipment"
[3].	BS EN 61326-1	Electrical equipment for measurement, control and laboratory use. Part 1: General requirements.
[4].	EN 61000-6-2	"Generic standards – Immunity for industrial environments."
[5].	EN 61000-3-2:	"Limits of harmonic current emissions"
[6].	EN 61000-3-3:	"Limitation of voltage fluctuation & flicker"
[7].	EN 61000-4-2	"Testing & measurement techniques – Electrostatic discharge immunity test"
[8].	EN 61000-4-3	"Testing & measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test"
[9].	EN 61000-4-4	"Testing & measurement techniques – Electrical fast transient/burst immunity test"
[10].	EN 61000-4-5	"Testing & measurement techniques – Surge immunity test"
[11].	EN 61000-4-6	"Testing & measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields"
[12].	EN 61000-4-8	"Testing & measurement techniques – Power frequency magnetic field immunity test"
[13].	EN 61000-4-11	"Voltage dips, short interruptions and voltage variations immunity test"
[14].	IEE Colloquium	"EMC tests in screened rooms" Digest No. 1995/074 Professional Group E2
[15].	IEE Colloquium	"Correlation between measurements in screened rooms and in open area test sites" Ref. No. 1996/053 Professional Group E2
[16].	IEE Colloquium	"The implication of measurement uncertainties for EMC testing" Reference No. 1997/116 Professional Group E2
[17].	Report 92-0450	"Repeatability and accuracy" A.T.J. Hayward ERA
[18].	CISPR 16-4	"Uncertainty in EMC measurements"