205 Series Test Reports

1 Contents

2 Test report for 205 bases

2.1 Preface

2.1.1 Overview

This document reports on how a particular product group, achieves compliance to European directives that are relevant to it, and its environment.

2.1.2 Summary of test results

Test	Result
Low voltage directive	**PASS**
Markings	Pass (modification is progress)
Documentation	Pass
Creepages and clearances	UL
Storage temperature	UL
Operating temperature	UL
Humidity and dielectric strength	UL
Shock and vibration	Pass
Critical components	UL
Internal/ external voltage and current	UL
EMC directive	**PASS**
Voltage dips	Pass to industrial
Voltage interruptions	Pass to industrial
Voltage fluctuations	Pass to industrial
Fast transients	Pass to industrial
ESD	Pass to industrial
Radiated immunity	Pass to industrial
Radiated emissions	Pass to industrial, subject to use of appropriate filter
Conducted emissions	Pass to industrial, subject to use of appropriate filter

2.1.2.1 Overall result

PASS

The EUT complies with the standard EN 61010-1, which is under the low voltage directive.
The EUT complies with the below standards, as referenced by the EMC directive, and accordingly is suitable for industrial environments, subject to use of an appropriate filter as mentioned.

2.1.3 Prior modifications

Whilst testing earlier versions of the products, a modification was announced towards the end of 2000. This involved an internally mounted capacitor being placed between the ground of the 24v output winding and the LG terminal. This was found to greatly reduce radiated emissions from the EUT.

2.1.4 EUT (equipment under test)

Manufacturer		Koyo
Model name or number		D2 03B, D2 03BDC-1, D2 03BDC-2 D2 04B, D2 04BDC-1, D2 04BDC-2 D2 06B, D2 06BDC-1, D2 06BDC-2, D2 09B, D2 09BDC-1, D2 09BDC-2,
Serial numbers		N/A
Country of manufacture		Japan
Date of receipt	Sept 00 Jan 01 Feb 01	D2 04B, D2 06B, D2 09B, D2 09BDC-1 D2 03B D2 03BDC-1, D2 03BDC-2, D2 04BDC-1, D2 04BDC-2, D2 06B, D2 06BDC-1, D2 06BDC-2,
Report completion date		March 2001
Testing by		Alan Harbord/ Mike Wykes
Report by		Alan Harbord

2.1.5 Setup

2.1.5.1 General setup

The EUT was mounted within a steel industrial enclosure 600 x 800 x 250mm (RS 207-1587). A 3 core 0.5mm^2, 16 x 0.2, 3A flexible power lead of 2m in length, was used throughout (RS 377-940), with a mini in-line mains connector (RS 129-8567 for AC models and RS 284-1566 for DC models), mounted 80mm from the PLC.
A 2 core 0.5mm^2, 16 x 0.2, 3A flexible power lead of 2m in length (RS 377 978), was used to connect the 24vdc output of the EUT, to a resistive load, which fully loaded the output according to the current rating of the specific EUT. The below table illustrates how the output rails of the various bases were loaded.

		5v output for modules power		24v auxiliary output	
Base	Power supply used	I max (mA)	Resistive load used (Ω)	I max (mA)	Resistive load used (Ω)
D2 03B	240v ac mains	1550	3.2	200	120
D2 03BDC-1	24v dc linear	1550	3.2	NA	NA
D2 03BDC-2	125v dc linear	1550	3.2	200	120
D2 04B	240v ac mains	1550	3.2	200	120
D2 04BDC-1	24v dc linear	1550	3.2	NA	NA
D2 04BDC-2	125v dc linear	1550	3.2	200	120
D2 06B	240v ac mains	1550	3.2	200	120
D2 06BDC-1	24v dc linear	1550	3.2	NA	NA
D2 06BDC-2	125v dc linear	1550	3.2	200	120
D2 09B	240v ac mains	2600	1.9	300	80
D2 09BDC-1	24v dc linear	2600	1.9	NA	NA
D2 09BDC-2	125v dc linear	2600	1.9	300	80

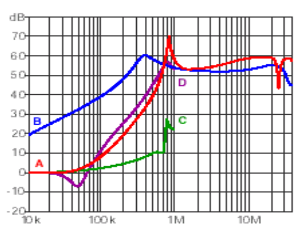
Note
Note: Numbers subsequent to ‘RS’ denote part numbers of the UK distributor ‘RS’ (Radio Spares). RS is a recognised distributor of standard parts to technical industries, mainly in the UK. Many products can be viewed on their website www.rswww.com

2.1.5.2 Filter

As part of the testing, it was necessary to use a small in line mains filter on certain EUT models.

Filter	
Manufacturer	Schaffner (web: Schaffner.com)
Model	FN 2010-01-06
RS Stock number	219 2757
Working voltage	110/250
Frequency	50-60Hz
Current rating	1A

Insertion loss



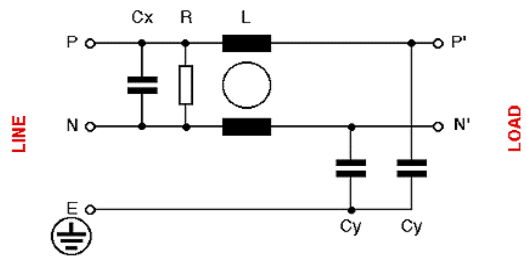
A = 50Ω / 50Ω sym

B = 50Ω / 50Ω asym

C = 0.1Ω / 100Ω sym

D = 100Ω / 0.1Ω sym

Circuit diagram



L (mH)	CX (µF)	CY (nF)	R (MΩ)
12	0.1	4.7	1

2.1.6 Relevant standards

2.1.6.1 Low voltage directive

EN 61010-1 Safety requirements for electrical equipment for measurement, control and laboratory use. This standard was adhered to throughout the safety aspects of the testing.

2.1.6.2 EMC directive

EN 50081-2 : 1994 Generic emission standard. Part 2: Industrial environments
EN 61000-6-2 : 1999 Generic standards –Immunity for industrial environments
(EN 50082-2 has been replaced by EN61000-6-2)

2.1.6.2.1 Basic standards

The basic standards 55011 and 55022 listed below, list the same limits and methods.
EN 55011: 1991 Limits and methods of measurement of radio disturbance characteristics of industrial, scientific and medical (ISM) radio frequency equipment
EN 55022: 1994 Limits and methods of measurement of radio disturbance characteristics of information technology equipment
EN 61000-4-2, Electrostatic discharge immunity test
EN 61000-4-3, Radio frequency fields immunity test
EN 61000-4-4, Electrical fast transient/burst immunity test
EN 61000-4-11, Voltage dips, short interruptions and voltage variations immunity tests
EN 61000-3-2, Limits for harmonic current emissions
EN 61000-3-3, Limitations of voltage fluctuations and flicker in low voltage supply

2.1.7 Limits and guard band overview

2.1.7.1 Guard Bands

	Radiated				Conducted
	FAC		OATS		
	<230MHz	*>230MHz*	*<230MHz*	*>230MHz*	
Requires OATS at	35dBuV/m	42dBuV/m	NA	NA	NA
Guard band	NA	NA	5dB	5dB	3dBuV
Limit with guard band	NA	NA	35 dBuV/m	42 dBuV/m	Use scan data and deduct 3dBuV
Counteractive measures (5dB below limit)	45 dBuV/m	52 dBuV/m	NA	NA	NA

2.1.7.2 Radiated limits –enclosure port

Frequency MHz	Limits	
	3m	**10m**
30 – 230	50 dBuV/m quasi-peak	40 dBuV/m quasi-peak
230 - 1000MHz	57 dBuV/m quasi-peak	47 dBuV/m quasi-peak

2.1.7.3 Conducted limits -AC mains port

Frequency MHz	Limits
0.15 - 0.5MHz	79 dB(uV) quasi-peak
	66 dB(uV) average
0.5 - 30MHz	73 dB(uV) quasi-peak
	60 dB(uV) average

2.1.8 Equipment used

Description	Manufacturer	Model	Last calibrated
Test receiver	Rhode & Schwarz	ESPC	30th January 2001
Log periodic/ bow tie antenna	EMCO	Biconilog 3142	7th February 2001
Pulse limiter	Rhode & Schwarz	ESH3-Z2	22 July 98
Spectrum analyser	Anritsu	R4131	Jan 98
Pre amplifier	Schaffner Chase	CPA 9231A	Sept 98
Line impedance stabilisation network	Thurlby Thandar	LISN 1600	Jan 2000
Fast transient/ ESD/ Dips Generator	Seeward	Mace	August 2000
Environmental chamber	In house	ENVC 1	NA
Flash tester	Clare	A203C	Jul 97

2.1.9 Test sites

Site	Manufacturer	Type	Calibrated
RFI chamber	Rainford EMC	Fully anechoic chamber	To EN 50147-3
Open area test site	In-house	10m test distance, 1-4m antenna elevation, uncovered, powered turntable and antenna mast	To ANSI C63.4:1992, EN 50147-2

2.2 Safety tests

2.2.1 Markings

The following markings were checked in accordance with EN 61010-1:

	Requirement	*Fulfilled?*
1.	Manufacturers name or trade mark on product.	Yes
2.	Part code on product.	Yes
3.	If the product is AC mains powered, is it marked with rated frequency or frequency range and the AC symbol is used.	The markings are currently being reviewed to include the AC symbol.
4.	If the product is DC powered, is it marked with appropriate symbol in EN 61010-1 table 1.	The markings are currently being reviewed to include the DC symbol.
5.	Rated value or range of supply voltages marked on product.	Yes
6.	Rated input power or current fully loaded marked on product.	The markings are currently being reviewed to include the maximum input power.
7.	Functional earth terminals are marked with the symbol EN 61010-1 table 1.	Yes
8.	Protective conductor terminals are marked with appropriate symbol in EN 61010-1 table 1.	Yes
9.	Logic ground, frame or chassis terminal marked with appropriate symbol in EN 61010-1 table 1.	Yes
10.	Terminals supplied from the interior of the equipment that carry hazardous live voltages are marked with voltage and current values.	The markings are currently being reviewed to include this.
11.	Equipment is supplied with a protective conductor terminal. If not, it is protected by double or reinforced insulation and marked with symbol 11 in the standard.	The EUT is supplied with a protective conductor terminal.
12.	Durability of markings has been checked by the following method as described in EN 61010-1 5.3.	Passed
	Overall result	The markings will be satisfactory once the above mentioned items are fulfilled

2.2.2 Documentation

The following documentation was checked in accordance with EN 61010-1

	Requirement	*Fulfilled?*	*Manual reference*
1.	EMC statement, if emissions levels do not meet domestic limits ‘ Warning. This is a class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.’	In manual	In next edition
2.	Documentation states that the equipment is suitable for installation category (1 or 2).	In manual	Appendix F8 ‘Items specific to the DL 205
3.	Documentation is available for safety purposes, which includes warning statements and a clear explanation of warning symbols.	In manual	Throughout
4.	Technical specification.	In manual	Specifications
5.	Name and address of manufacturer or supplier, where technical assistance may be obtained.	Website	Website
6.	Equipment ratings including supply voltage range, frequency range and power rating.	In manual	Specifications
7.	Descriptions of all input/output connections.	In manual	Throughout
8.	A statement informing that the rating between all circuits in the equipment are rated as BASIC INSULATION	In manual	Appendix F8 ‘Items specific to the DL 205

	ONLY, as appropriate for single fault conditions.		
9.	A statement informing that it is the responsibility of the system designer to earth one side of all control and power circuits, and to earth the braid of screened cables.	In manual	Appendix F8 'Items specific to the DL 205
10.	Environmental specification for use, transport and storage conditions. (see section 1.4. of standard).	In manual	2.7 Specifications
11.	The user is made aware by a notice in the documentation that if the equipment is used in a manner not specified by the manufacturer the protection provided by the equipment may be impaired.	In manual	Front warning page
12.	Instructions are given concerning preventative maintenance of the PLC equipment, including the regular changing of batteries, and the specific battery re-order code. Also a statement saying that only parts supplied by PLC-Direct or its agents should be used.	In manual	9.2 hardware maintenance
13.	Assembly, location and mounting instructions.	In manual	Installation section
14.	Identification of controls and their use.	In manual	Throughout
15.	Separate instructions for interconnection of accessories and optional parts.	In manual	Throughout
16.	Instructions for cleaning.	In manual	Appendix F8 'Items specific to the DL 205
17.	Statement highlighting the requirements for external switches or circuit breakers, external fusing and a recommendation that the switch or CB is mounted near the PLC equipment.	In manual	2.2 Safety guidelines
	Overall result	The documentation includes specific requirements of EN 61010-1	

2.2.3 Electrical and environmental

The following tests have been performed on certain models only as we are confident that the remaining models would pass the tests. This confidence is in part made up by the knowledge that all the products have been tested to UL specification, and thus have undergone or exceeded the following tests.

2.2.3.1 Creepages and clearances

Creepages and clearances were checked to UL requirements and found to meet its criteria. We are happy to accept UL accreditation for creepages and clearances. This covers EU requirements.

2.2.3.2 Operating low temperature test

The D2 04B and D2 09B were operated in a test chamber for 2 hours at -2°C whilst operational. This test level exceeds the product specification of 0°C. The product remained fully functional and within specifications.

2.2.3.3 Operating high temperature test

The D2 04B and D2 09B were operated in a test chamber for 2 hours at 57°C whilst operational. This test level exceeds the product specification of 55°C. The product remained fully functional and within specifications.

2.2.3.4 Storage low temperature test

The D2 04B and D2 09B were stored at -25°C in a test chamber for 2 hours whilst un-powered. This test level exceeds the product specification of -20°C The product operated correctly at 20°C 45mins after storing.

2.2.3.5 Storage high temperature test

The D2 04B and D2 09B were stored at 75°C in a test chamber for 2 hours whilst un-powered. This test level exceeds the product specification of 70°C. The product operated correctly at 20°C 45mins after storing.

2.2.3.6 Humidity and dielectric strength

Humidity and Dielectric strength tests were checked to UL requirements and found to meet its criteria. We are happy to accept UL accreditation for humidity and dielectric strength tests. This covers EU requirements.

2.2.3.7 Shock and vibration

Shock and vibration tests have been carried out on various 205 bases by Koyo in Tokyo, Japan. No effect to the EUT was seen in any of the tests.
Shock tests were performed to IEC 68-2-27 method 516.2 (see separate report).
Vibration tests were performed to MIL- STD-810C method 514.2 (see separate report).
The EUT passed both the tests.

2.3 EMC tests

2.3.1 Immunity tests

Voltage dips and interruptions, ESD, fast transients, radiated immunity.

The above tests have been performed on many of the modules in the 205 PLC range, (see the other test reports). Many different 205 PLC bases were used for these tests, and no adverse effects were suffered which could have been accountable to the base with the exception of voltage dips and interruptions as follows

2.3.1.1 Voltage dips and interruptions

Voltage dips were applied to the power line of the PLC base with each module having its turn in the setup. The following effects were exhibited on the majority of EUTs. The remaining EUTs exhibited no effects.
Dips of 30%, 60% and 100% were induced for 0.5 cycles, 5 cycles, 10 cycles, 25 cycles and 50 cycles. There was no affect to the EUT except for the application of the 100% dip for 50 cycles. Here the base would momentarily power down, and then recover again with full operation restored to the modules. Therefore the EUT passes to the required performance of criteria B.

2.3.2 Radiated emissions

2.3.2.1 Definitions

OATS	Open area test site
FAC	Fully anechoic chamber
EUT	Equipment under test
Horizontal/ vertical	This is the orientation of the test antenna
F	The frequency of the disturbance signal
A	The amplitude of the disturbance signal as tested on the OATS
Amb	Ambient signals. On the OATS, if an emission from the EUT falls at the same frequency as an ambient signal which itself is greater than 10dBs below the limit line, that disturbance signal is measured using different and more specialised techniques
ERS	Emissions reference source

2.3.2.2 Anechoic chamber and open area test site (OATS)

In order to obtain a picture of radiated emissions unique to each EUT without the adverse affects of ambient signals, testing was first carried out in the fully anechoic chamber (FAC). This enables exact location of each emission frequency, and hence decisions can be made as to whether further investigation is required.
The FAC used, exhibits a 100dB attenuation of ambient signals, while almost eliminating internal reflections. This way, only the EUT disturbance signal is measured, and with a known accuracy.

A shortlist of the worst case emissions was derived from the FAC scans, and taken to the OATS. The receiver was tuned to each frequency in turn and the quassi peak detector was used for measurements. The plots below illustrate the EUT's emissions. Further below are tables, which reveal the measurements taken on the OATS.

2.3.2.3 Setup

Within the FAC a 3m test distance was used between the EUT and the antenna. The EUT was placed on a 0.8m non conductive table. The antenna height was fixed to 1.5m and the receiver was set to scan the range of 30MHz to 1GHz as laid down in EN 50081-1/2.
Although a clear 'picture' of radiated disturbance was obtained by using the anechoic chamber, the higher emissions must be qualified on an OATS, as required by the aforementioned standards.

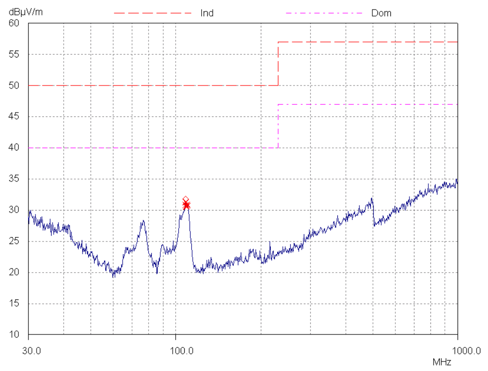
At the OATS a 10m test distance was used between the EUT and the antenna. The EUT was placed on a 0.8m non conductive table which stood over an electronically controlled, recessed turntable. The antenna was height scanned between 1 and 4 metres, until the maximal amplitude of the emission was reached. At this point the turntable was rotated, again to maximise the emission level. A 3 second quassi peak measurement was then taken.

2.3.2.4 Guard band

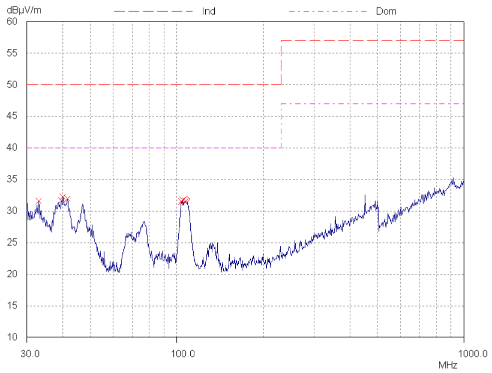
For radiated emissions measured within the FAC, a 15dBuv/m margin from the industrial limit is used to decide whether or not the EUT will be taken to the OATS.
For radiated emissions on the OATS, a 5dB guard band is applied, which includes measurement uncertainty. This must be observed when interpreting the figures.

2.3.2.5 The scans

D2-03B

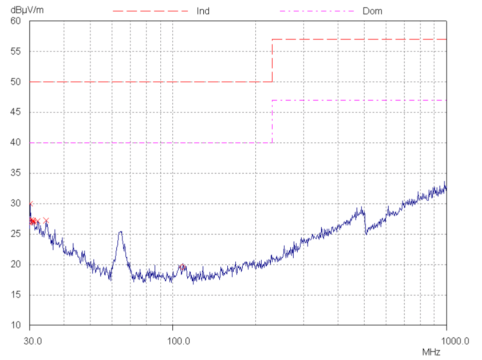


Horizontal antenna, m53h205

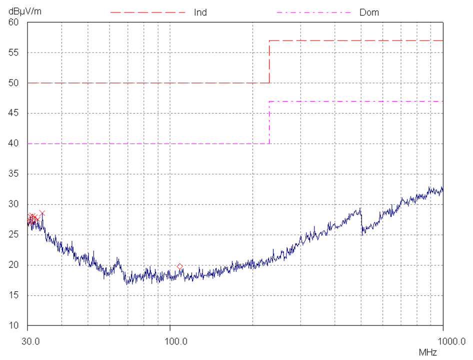


Vertical antenna, m53v205

D2-03B DC-1

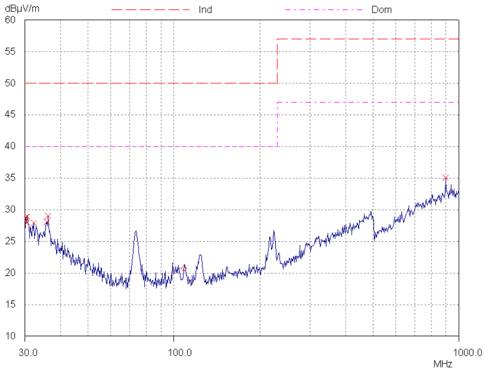


Horizontal antenna, m54h205

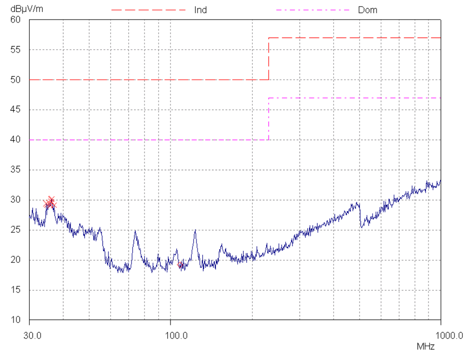


Vertical antenna, m54v205

D2-03B DC-2

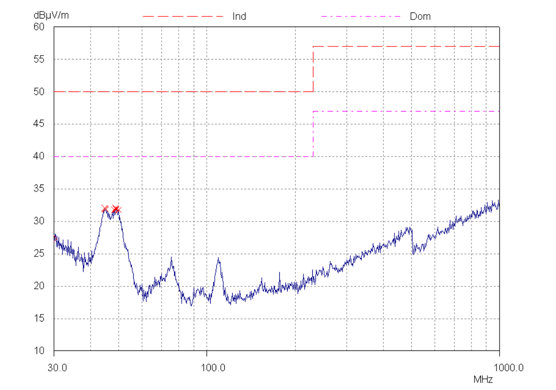


Horizontal antenna, m57h205

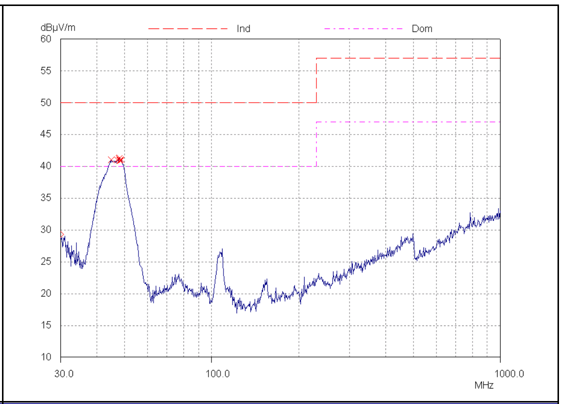


Vertical antenna, m57v205

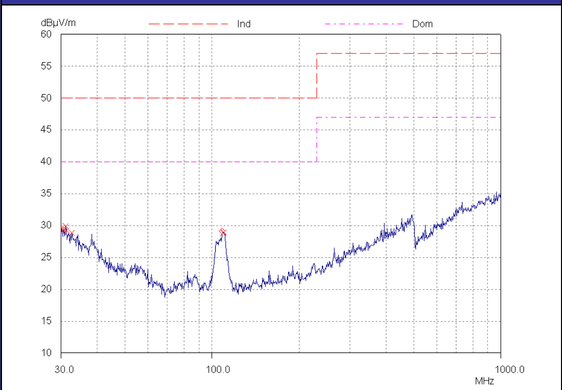
D2-04B



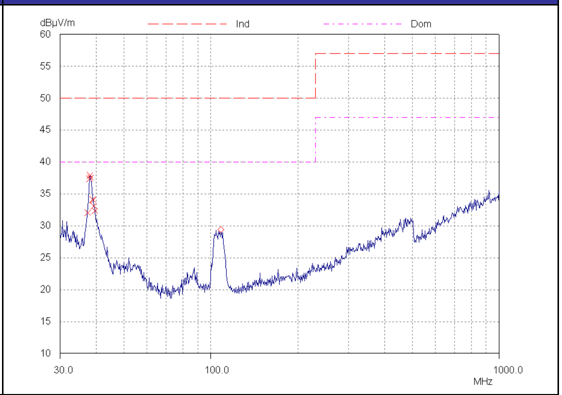
Horizontal antenna, m47h205



Vertical antenna, m47v205

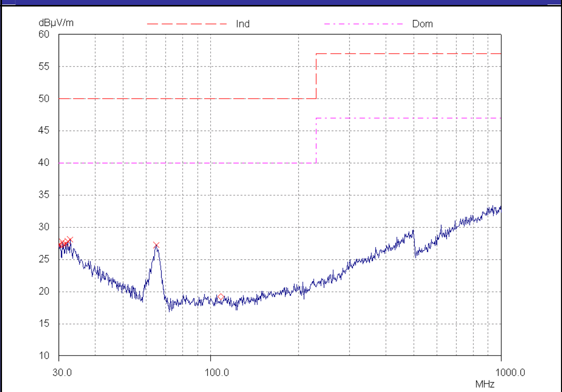


With Schaffner FN2010-1-06 filter (because of conducted emissions), horizontal antenna, m47h205a

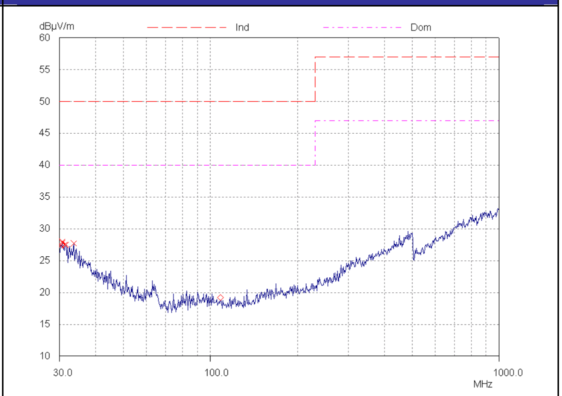


With Schaffner FN2010-1-06 filter (because of conducted emissions), vertical antenna, m47v205a

D2-04B DC-1

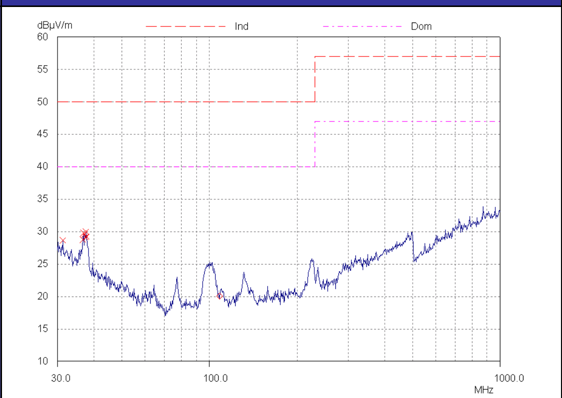


Horizontal antenna, m55h205

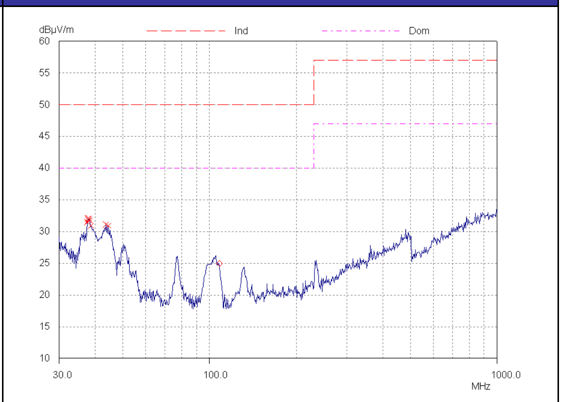


Vertical antenna, m55v205

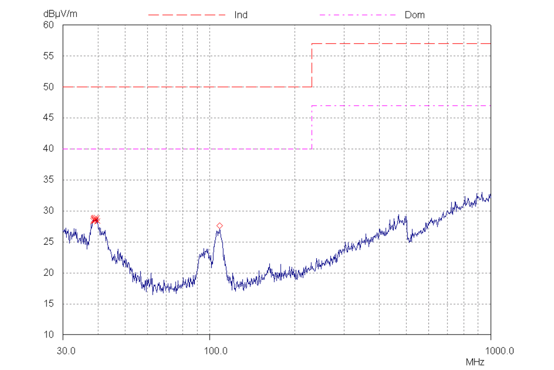
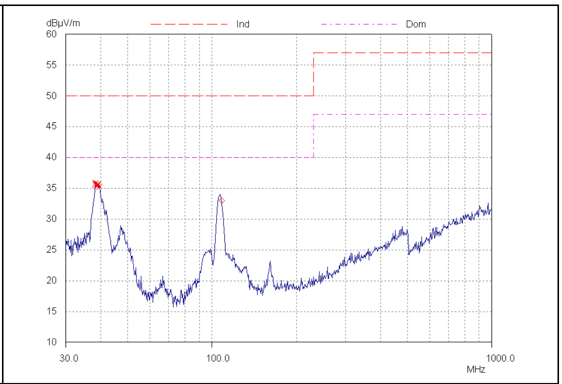
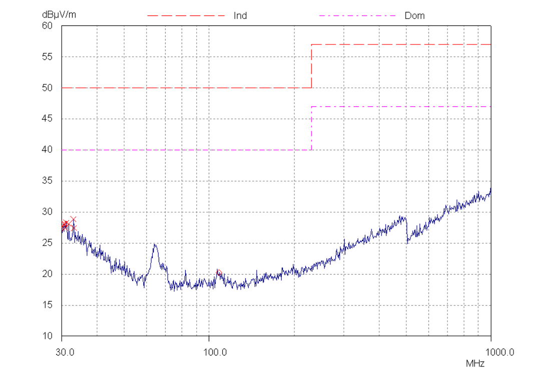
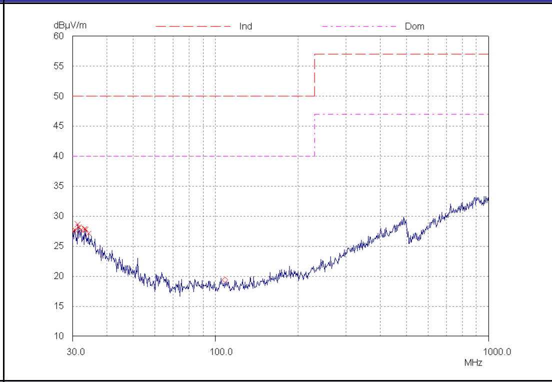
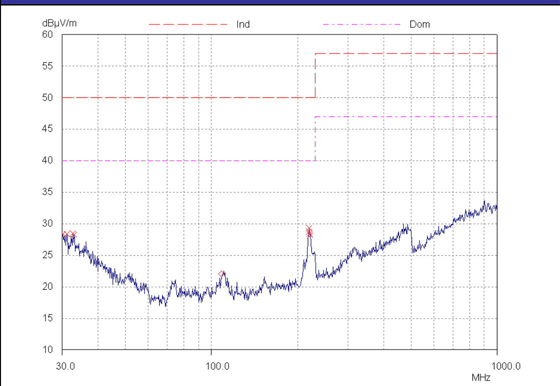
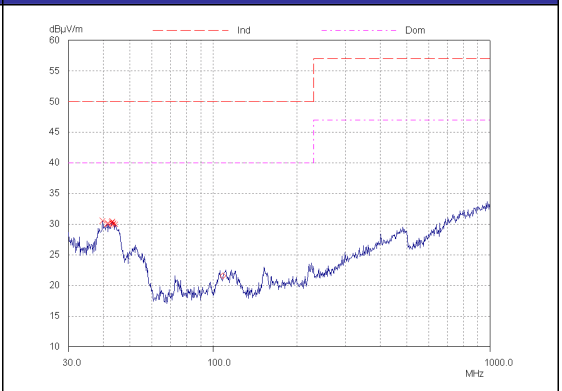
D2-04B DC-2



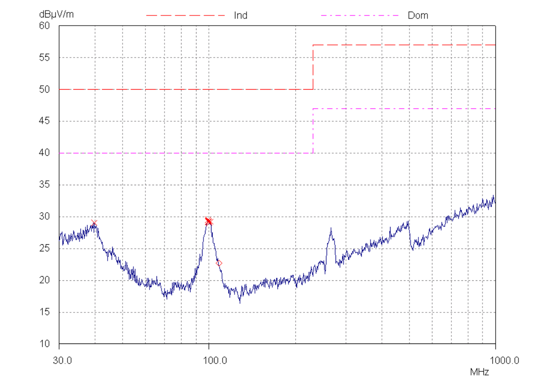
Horizontal antenna, m58h205



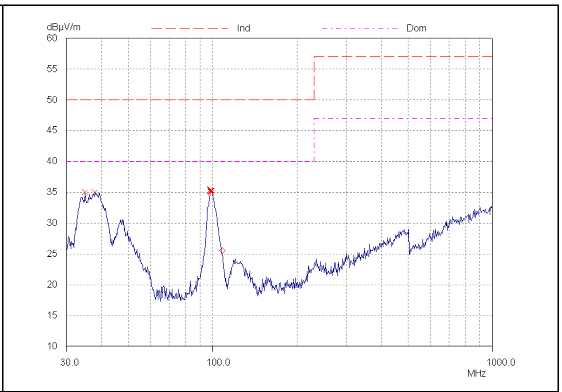
Vertical antenna, m58v205

D2-06B		
	Horizontal antenna, m48h205	Vertical antenna, m48v205
D2-06B DC-1		
	Horizontal antenna, m56h205	Vertical antenna, m56v205
D2-06B DC-2		
	Horizontal antenna, m59h205	Vertical antenna, m59v205

D2-09B

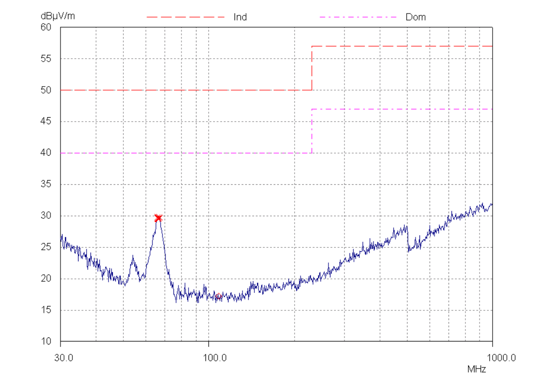


Horizontal antenna, m46h205

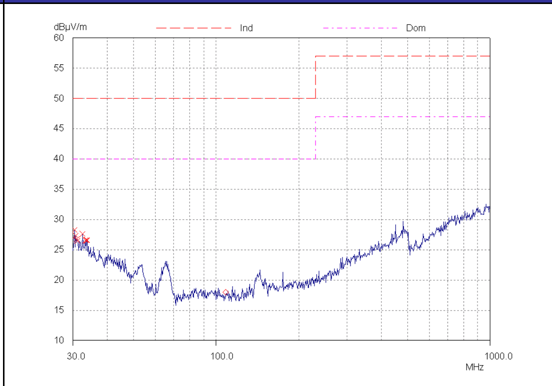


Vertical antenna, m46v205

D2-09B DC-1

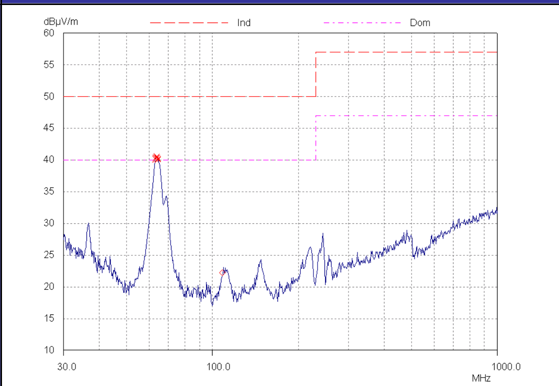


Horizontal antenna, m49h205

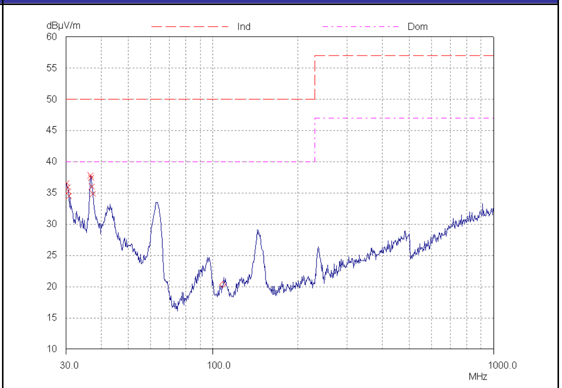


Vertical antenna, m49v205

D2-09B DC-2



Horizontal antenna, m50h205



Vertical antenna, m50v205

2.3.2.6 OATS measurements

The measurements that are in green type, illustrate that there was an ambient signal at that frequency, which had an amplitude greater than 11dBuv/m less than the test limit at that frequency. In this case further measurements were taken. See section on ‘Counteractive measurements for emissions coinciding with high ambient levels’.

D2 04B (with filter)				D2 06B			
Horizontal		Vertical		Horizontal		Vertical	
F	A	F	A	F	A	F	A
NA	NA	37.92	29.3	NA	NA	38.22	31.3
		38.04	30.0			38.34	31.5
		38.34	29.5			38.52	31.2

						38.64	31.1
						38.82	31.1
						38.94	30.7
						39.18	30.1
						39.48	29.9
D2 09B				D2 09B DC-2			
Horizontal		Vertical		Horizontal		Vertical	
F	A	F	A	F	A	F	A
NA	NA	34.86	29.6	63.06	12.1	30.06	20.4
		97.74	38.4	63.24	11.9	30.36	21.8
		97.98	36.5	63.54	12.0	30.48	22.5
		98.10	41.4	63.66	11.8	36.66	23.1
		98.34	32.5	63.84	11.6	36.84	23.0
		98.52	31.9	64.02	11.6	37.08	22.6
		98.64	40.4	64.26	11.3		
				64.44	11.4		

2.3.2.7 Counteractive measurements for emissions coinciding with high ambient levels

Where a measurement is taken on the OATS, which corresponds with the same frequency as an ambient signal, and that ambient signal is greater than 11dBuv/m less than the test limit at that frequency, a different method is used for that particular emission frequency.
The EUT is placed within the FAC and re measured with the quassi peak detector. The EUT is then replaced by an emissions reference source (ERS), which emits a calibrated and known amplitude at a range of frequencies spaced 2MHz apart. The closest ERS frequency to the EUT disturbance signal is measured, the amplitude of which is then compared to known values as derived on a reference site at the National Physics Laboratory (UK).

2.3.2.8 Explanation of table headings

Ant H/V	This is the antenna polarisation
Frequ	This is the frequency of disturbance signal
Limits	These are the test limits, which apply at this particular frequency The OATS limits will be for a 10m test distance and the FAC will be for 3m
EUT A	This is the amplitude of the EUT's disturbance signal, originally measured on the OATS
EUT B	This is the amplitude of the EUT's disturbance signal, measured in the FAC
Amb	This is the level of the ambient signal originally measured on the OATS Only applicable if within 11dBuv of limit
Max A	This is the maximum allowable ambient level, before the measurement becomes invalid
ERS A	This is the closest frequency from the ERS, which corresponds to the frequency of the EUT's disturbance signal
ERS B	This is the measured value of the ERS signal at the chosen frequency
ERS C	This is the amplitude of the emission, as measured by the manufacturers and traceable to the NPL
Cal	This is the calibration figure obtained. To deduce it, subtract ERS B from ERS C
Final	This is the calibrated value. Simply add the calibration figure (Cal above), to the EUT emission

D2 09B

Ant H/V	Freq dBuV/m	Limits		EUT A dBuV/m	EUT B dBuV/m	Amb dBuV/m	Max A DBuV/m	ERS A (MHz)	ERS B (dBuV/m)	ERS C (dBuV/m)	Cal dBuV/m	Final dBuV/m
		OATS	FAC									
V	97.74	40	50	38.4	29.2	37.1	29	98.0	55.2	55.1	-0.1	29.3
V	97.98	40	50	36.5	29.5	35.8	29	98.0	55.2	55.1	-0.1	29.6
V	98.10	40	50	41.1	30.0	40.8	29	98.0	55.2	55.1	-0.1	30.1
V	98.34	40	50	32.5	29.8	32.4	29	98.0	55.2	55.1	-0.1	29.9
V	98.64	40	50	40.4	29.9	39.7	29	98.0	55.2	55.1	-0.1	30.0

2.3.2.9 Conclusions from radiated emissions

All EUTs exhibited emissions which fell within the limit lines. Which areas of doubt due to high ambient levels existed, only those frequencies were then re tested within the FAC.

2.3.3 Conducted emissions

2.3.3.1 Definitions

LISN	Line impedance stabilisation network
FAC	Fully anechoic chamber
EUT	Equipment under test
L/N	Measurements taken between line and earth, or neutral and earth

2.3.3.2 Setup

A 2m square 1mm thick aluminium ground plane was placed inside the FAC and the LISN earth was bonded to it. The setup in EN 55011 was utilised with the exception of the EUT height above the ground plane, which was set to 0.4m as industrial controllers are neither tabletop or floor mounted devices.

Conducted emissions were carried out between live and earth, and neutral and earth from 150KHz to 30MHz. A pulse limiter with an inherent attenuation of 10dBs across the range was used and 10dBs of attenuation was applied at the LISN. Within the receiver software, a total of 20dB's was therefore added across that range.

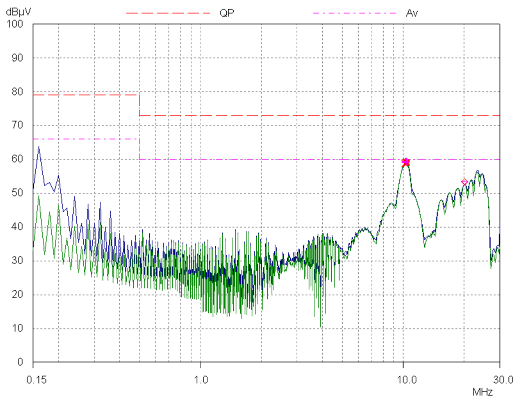
The following plots display average and quassi peak emissions and include limit lines for heavy industrial environments.

2.3.3.3 Guard band

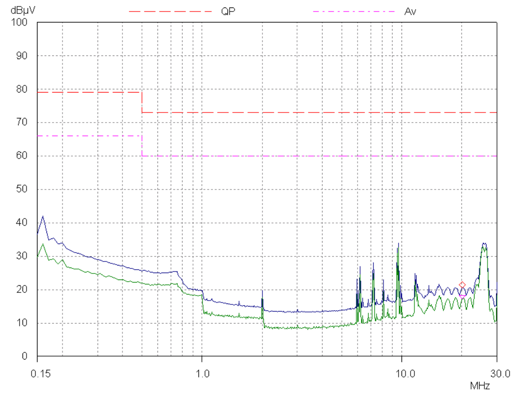
For conducted emissions, a 3dB guard band is applied, which includes measurement uncertainty. This must be observed when interpreting the figures.

2.3.3.4 The scans

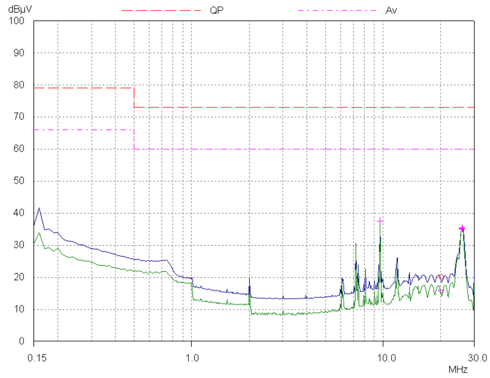
D2-03B



Live to earth, m35l205

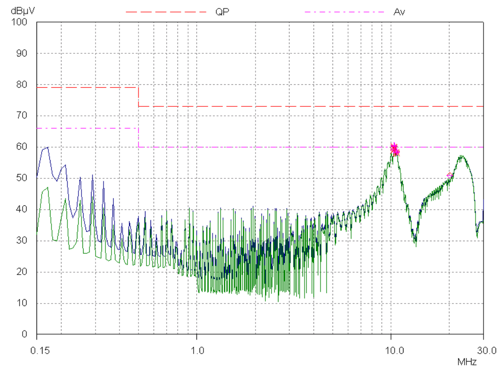


With Schaffner FN2010-1-06 mains filter live to earth, m35l205a

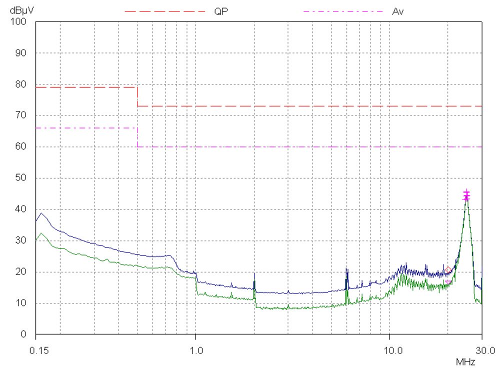


With Schaffner FN2010-1-06 mains filter neutral to earth, m35n205

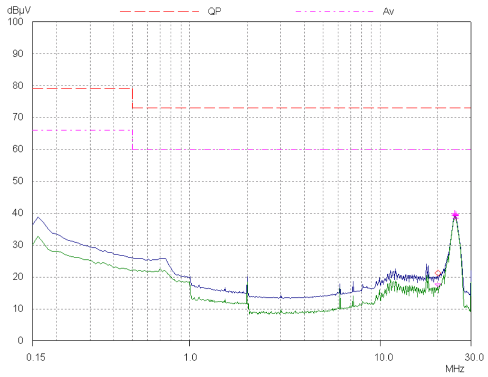
D2-06B



Live to earth, m34l205

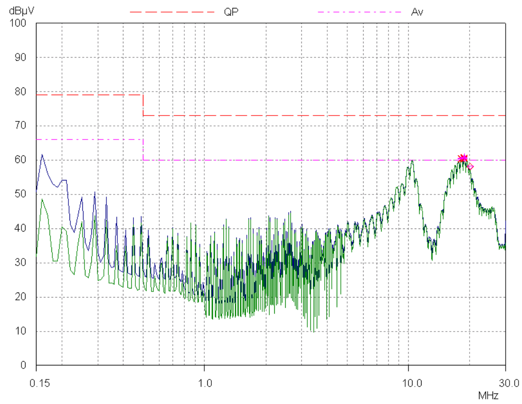


With Schaffner FN2010-1-06 mains filter live to earth, m34l205a

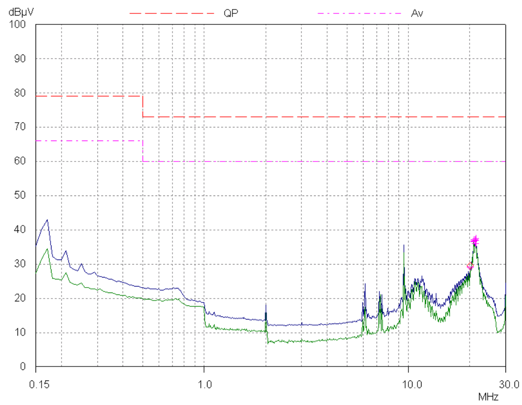


With Schaffner FN2010-1-06 mains filter neutral to earth, m34n205a

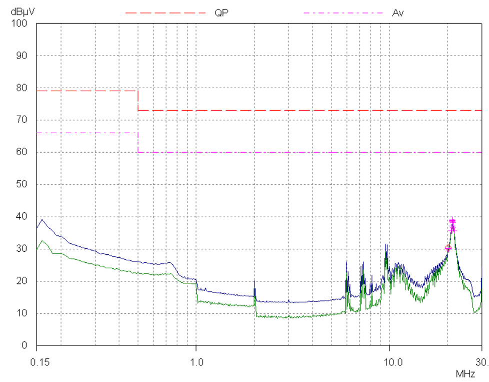
D2-09B



Live to earth, m36l205



With Schaffner FN2010-1-06 mains filter live to earth, m36l205a



With Schaffner FN2010-1-06 mains filter neutral to earth, m36n205

2.3.3.5 Conclusions from conducted emissions

As conducted noise on all three of the tested EUTs was exhibited above the 3dB guard band, only the first scan (live to earth) was initially performed.

On application of a common and widely used mains filter, the Schaffner FN 2010-1-06, emissions from all three models were reduced to levels that fall comfortably within the limits. This inexpensive filter has a dramatic effect on the conducted noise from these products, and its use with the EUTs, is an essential requirement if the products are to be used within the EU.

2.3.4 Other emissions tests

Voltage fluctuations and flicker, harmonic emissions

Certain models from the ADC product range were taken to a third party test house for the above tests. The emissions were negligible in all cases and a long way from the limits. Although a 205 bases was not in this test group, the tests, together with the knowledge of similar design between the 205 range and those products tested, provided us with the confidence to accept to 205 range for those test specifications.

3 Test report for 205 CPUs

3.1 Preface

3.1.1 EUT (equipment under test)

Manufacturer	Automation Direct.com
Model name or number	D2 230, D2 240 and D2 250 CPUs
Serial number	230:8128, 240: 9118, 250: 9040.
Country of manufacture	Japan
Date of receipt	April 99
Report completion date	11th May 2000

3.1.1.1 Test programs

For immunity tests, the EUT was pre loaded with a Direct Soft program, which used a DV1000 to display the CPU cycle count. For emission tests, no DV1000 was used.

3.1.1.2 Test setup

For emission tests the EUT was placed in a specially prepared base with its switched mode power supply replaced with a linear one, so as not to introduce additional noise onto the measurements. For immunity tests a standard ac powered base was used.
The EUT was mounted within a steel industrial enclosure 600 x 800 x 250mm (RS 207-1587). A 3 core $0.5mm^2$, 16 x 0.2, 3A flexible power lead was used throughout (RS 377-940), with a mini in-line mains connector (RS 464-038) mounted 80mm from the PLC.

Note: Numbers subsequent to ‘RS’ denote part numbers of the UK distributor ‘RS’ (Radio Spares). RS is a recognised distributor of standard parts to technical industries, mainly in the UK.

3.1.2 Procedure

The standard in house test procedure CETP0797, and other related ones were used. CETP0797 is based on the standards listed in the section ‘relevant standards’ in this document, and where any doubt existed from the procedure or further information was required, those standards were referenced.

3.1.3 Summary of test results

Test	Result
Low voltage directive	
Markings	Pass
Documentation	Pass
Creepages and clearances	Pass
Storage temperature	Pass
Operating temperature	Pass
Humidity and dielectric strength	Pass
Shock and vibration	Pass
Critical components	Pass
Internal/ external voltage and current	Pass
EMC directive	
Voltage dips	Pass to industrial
Voltage interruptions	Pass to industrial
Voltage fluctuations	Pass to industrial
Fast transients	Pass to industrial
ESD	Pass to industrial
Radiated emissions	Pass to industrial
Conducted emissions	Pass to industrial
Radiated immunity	Pass to industrial

3.1.4 Overall result

PASS

The EUT complies with the standard EN 61010-1, as referenced by the low voltage directive.
The EUT complies with the below standards, as referenced by the EMC directive, and accordingly is suitable for industrial environments.

3.1.5 Relevant standards

3.1.5.1 Low voltage directive

EN 61010-1 Safety requirements for electrical equipment for measurement, control and laboratory use.
This standard was adhered to throughout the safety aspects of the testing.

3.1.5.2 EMC directive

EN 50081-2 Generic emission standard for industrial environments
EN 50082-2 Generic immunity standard for industrial environments

3.1.5.3 Basic standards

EN 55011 Emissions
ENV 50140 Immunity
EN 61000-4-2 Electrostatic discharge
EN 61000-4-4 Fast transients
EN 61000-4-11 Voltage dips, short interruptions and voltage variations immunity tests

3.1.6 Equipment used

Description	Manufacturer	Model	Last calibrated
Test receiver	Rhode & Schwarz	ESPC	Jan 2000
Log periodic/ bow tie antenna	EMCO	Biconilog 3142	14 Apr 98
Pulse limiter	Rhode & Schwarz	ESH3-Z2	22 July 98
Spectrum analyser	Anritsu	R4131	Jan 98
Pre amplifier	Schaffner Chase	CPA 9231A	Sept 98
Line impedance stabilisation network	Thurlby Thandar	LISN 1600	Jan 2000
Fast transient/ ESD/ Dips Generator	Seeward	Mace	Dec 98
Environmental chamber	In house	ENVC 1	NA
Flash tester	Clare	A203C	Jul 97

3.1.7 Test sites

Site	Manufacturer	Type	Calibrated
RFI chamber	Rainford EMC	Fully anechoic chamber	June 98 to EN 50147-3
Open area test site	In house	10m test distance, 1-4m antenna elevation, uncovered, powered turntable and antenna mast	July 98 to ANSI C63.4:1992, EN 50147-2

3.2 Low voltage directive

3.2.1 Markings

The following markings were checked in accordance with EN 61010-1:

1. Manufacturers name or trade mark on product.
2. Part code on product.
3. Durability of markings has been checked by the following method as described in EN 61010-1 5.3.

All the markings are in order

3.2.2 Documentation

The following documentation was checked in accordance with EN 61010-1:

1. Documentation states that the equipment is suitable for installation category (1 or 2).
2. Documentation (as below) was available for safety purposes, which includes warning statements and a clear explanation of warning symbols.
3. Technical specification.
4. Name and address of manufacturer or supplier, where technical assistance may be obtained.
5. Equipment ratings including supply voltage range, frequency range and power rating.
6. Descriptions of all input/output connections.
7. A statement informing that the rating between all circuits in the equipment are rated as BASIC INSULATION ONLY, as appropriate for single fault conditions.
8. A statement informing that it is the responsibility of the system designer to earth one side of all control and power circuits, and to earth the braid of screened cables.
9. Environmental specification for use, transport and storage conditions. (see section 1.4. of standard).
10. The user is made aware by a notice in the documentation that if the equipment is used in a manner not specified by the manufacturer the protection provided by the equipment may be impaired.
11. Instructions are given concerning preventative maintenance of the PLC equipment, including the regular changing of batteries, and the specific battery re-order code. Also a statement saying that only parts supplied by PLC-Direct or its agents should be used.
12. Statement highlighting the requirements for external switches or circuit breakers, external fusing and a recommendation that the switch or CB is mounted near the PLC equipment.

Documentation was available that includes the following installation and specific commissioning instructions:

1. Assembly, location and mounting instructions.

Instructions for use were checked including:

1. Identification of controls and their use.
2. Separate instructions for interconnection of accessories and optional parts.
3. Instructions for cleaning.

The documentation is in order

3.2.3 Creepages and clearances

Creepages and clearances were checked to UL requirements and found to meet its criteria. We are happy to accept UL accreditation for creepages and clearances. This covers EU requirements.

3.2.4 Electrical and environmental

The following tests confirm the technical specifications of the EUT, and certain safety parameters.

3.2.4.1 Operating low temperature test

The EUT was operated in a test chamber for 2 hours at -2^{o}C whilst operational. This test level exceeds the product specification of 0°C. The product remained fully functional and within specifications.

3.2.4.2 Operating high temperature test

The EUT was operated in a test chamber for 2 hours at 57^{o}C whilst operational. This test level exceeds the product specification of 55°C. The product remained fully functional and within specifications.

3.2.4.3 Storage low temperature test

The EUT was stored at -25^{o}C in a test chamber for 2 hours whilst un-powered. This test level exceeds the product specification of -20°C The product operated correctly at 20^{o}C 45mins after storing.

3.2.4.4 Storage high temperature test

The EUT was stored at 75^{o}C in a test chamber for 2 hours whilst un-powered. This test level exceeds the product specification of 70°C. The product operated correctly at 20^{o}C 45mins after storing.

3.2.4.5 Humidity and dielectric strength

The EUT was pre-conditioned in the environmental chamber at 20^{o}C and relative humidity 95% ± 4% for 48 hours un-powered. Before applying the humidity the equipment was raised to 42^{o}C ± 2^{o}C for 4 hours.
After pre-conditioning the equipment is allowed to recover for 2 hours at room temperature (15 - 35^{o}C), and <75% RH, 75 - 106kPa air pressure. Under these conditions the equipment was functionally tested within 1 hour of the end of the pre-conditioning period.

3.2.4.6 Shock and vibration

Shock and vibration tests have been carried out on various 205 modules by Koyo in Tokyo, Japan, including the D2 250cpu. No effect to the EUT was seen in any of the tests.
Shock tests were performed to IEC 68-2-27 method 516.2 (see separate report).
Vibration tests were performed to MIL- STD-810C method 514.2 (see separate report).
The EUT passed both the tests.

3.3 EMC directive

3.3.1 Voltage dips and interruptions

Voltage dips were applied to the power line of the base as follows. All three CPUs returned the same level of immunity for this test.

% V dip	0.5 Cycles	5 Cycles	10 Cycles	25 Cycles	50 Cycles
30	4	4	4	4	4
60	4	4	4	4	4
100	4	4	4	*	*

* Temporary loss of function, self recoverable. The EUT recovered after approximately two seconds and ran as normal and therefore passes to the required performance of criteria B.

3.3.2 Full voltage interruptions

All EUTs recovered with program unchanged when powered up.

3.3.3 Voltage fluctuations

These were applied to the an AC powered base. Voltages applied were +10% at high end of supply range and -10% at low end of the supply range giving a new tested range of 90-132 and 180-264vac. The EUTs did not malfunction or experience any significant rise in temperature. The EUT therefore passed the required performance of criteria A

3.3.4 Fast transients

The same setup was used for fast transients as for conducted emissions (see 3.9). Positive and negative going fast transients were applied directly to the three terminals of the power port on the AC powered base, for 1 minute, at up to 2Kv each, as specified in EN 61000-4-4. Likewise up to 2Kv of fast transients were applied via the capacitive coupling clamp to the comms ports.
The following table reveals the outcomes.

D2 230	Voltage applied (KV)					
Port under test	0.5		1.0		2.0	
	+	-	+	-	+	-
Supply line						
Live	4	4	4	4	4	4
Neutral	4	4	4	4	4	4
Earth	4	4	4	4	4	Note 1
Port 1	4	4	4	4	4	4
Port 2	4	4	4	4	4	4
Key						
4	No effect					
Note 1	CPU halted. Resumed on power recycle					

D2 240	Voltage applied (KV)					
Port under test	0.5		1.0		2.0	
	+	-	+	-	+	-
Supply line						
Live	4	4	4	4	4	4
Neutral	4	4	4	4	4	4
Earth	4	4	4	4	Note 1	Note 1
Port 1	4	4	4	4	4	4
Port 2	4	4	4	4	4	4
Key						

4	No effect
Note 1	CPU halted. Resumed on power recycle

D2 250	Voltage applied (KV)					
Port under test	0.5		1.0		2.0	
	+	-	+	-	+	-
Supply line						
Live	4	4	4	4	Note 2	4
Neutral	4	4	4	Note 2	4	4
Earth	4	4	4	4	4	4
Port 1	4	4	4	4	4	4
Port 2	4	4	4	4	4	4
Key						
4	No effect					
Note 1	CPU halted. Resumed on power recycle					
Note 2	Loss of function for 1 second only					

The EUT passed the required performance of criteria B.

3.3.5 ESD

The EUT was placed within the industrial control cabinet and contact discharge tests were conducted. These were performed by using the pointed end probe directly on the area to test. The relay inside the probe is operated discharging up to 8Kv. These tests were repeated ten times.
There were no effects on any of the EUTs. The EUT therefore passed the required performance of criteria A

3.3.6 Identification of ports

The following is a list of ports on the EUT.

- Enclosure port
- Port 1
- Port 2 (not on 230 cpu)
- Power port (through the base)

3.3.7 Identification of potential sources of rfi

The EUT carries a CPU running at high speed. Emissions are expected from relevant ports i.e. Enclosure, power, and all comms ports.

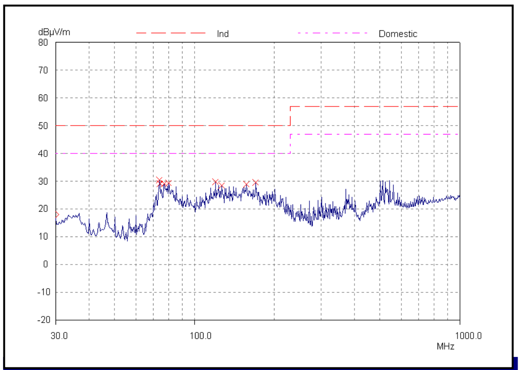
3.3.8 Radiated rf emissions

These tests can be divided into two types; those carried out in the anechoic chamber and those carried out on the open area test site.
Wherever possible attempts were made to maximise emissions as laid out in EN 50081-2 section 6 and EN 55011 section 7.4.
A 2m power lead was used throughout. The EUT was placed on a 0.8m high non conductive table for all the tests.
Although a clear 'picture' of emissions was obtained by using the anechoic chamber, they must be qualified on an OATS as required by the aforementioned standard.

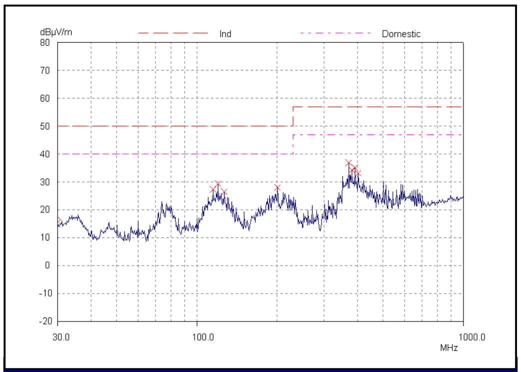
3.3.8.1 Anechoic chamber

In order to obtain a 'picture' of radiated emissions unique to each EUT without the adverse effects of ambient signals, testing was first carried out in the anechoic chamber. The antenna height was fixed to 1.5m and the receiver was set to scan the testing range of 30MHz to 1GHz as laid down in EN 50081-2. The test distance was 3m.
The plots below show these pictures of emissions for each EUT, with antenna polarisation in the horizontal and vertical positions.

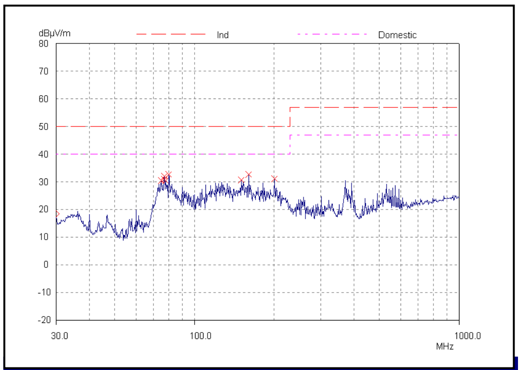
Both domestic and industrial limit lines are shown, although it must be taken into account that an anechoic chamber is not an official test site and actual values should not be taken from these plots.



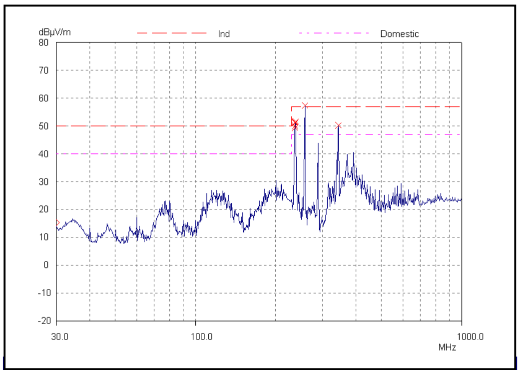
230 CPU horizontal polarisation (R20H205)



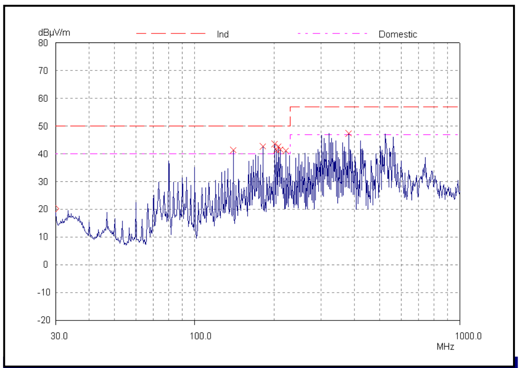
230 CPU vertical polarisation (R20V205)



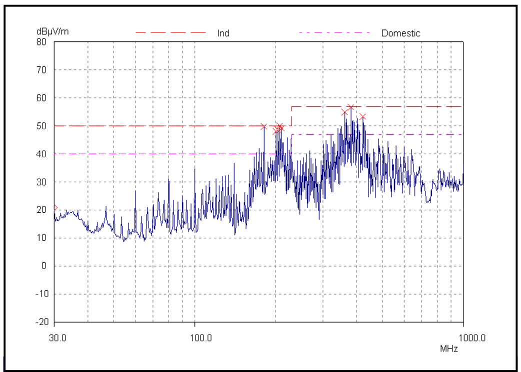
240 CPU horizontal polarisation (R21H205)



240 CPU vertical polarisation (R21V205)



250 CPU horizontal polarisation (R19H205)



250 CPU vertical polarisation (19V205)

3.3.8.2 Open area test site (OATS)

A shortlist of worst case emissions obtained by use of the anechoic chamber was used and each frequency was measured in turn. A 10m test distance was used. The antenna was height scanned until the highest emission was reached at which point the turntable was rotated, again to maximise the emission level.

Freq (MHz)	Limits (dBµv/m) @ 10m		Quassi peak emission dBµv/m @ 10m	Quassi peak emission dBµv/m @ 3m	Pol	Antenna elevation, metres	Turntable azimuth, degrees	Ambient	From industrial limit, (dBuV/m)
	Dom	Ind							
230 cpu									
73.62	30	40	19.0	NA	H	3.52	0	NA	21.0
76.68	30	40	19.4	NA	H	2.58	0	NA	20.6
79.98	30	40	20.9	NA	H	4.00	102	NA	19.1
120.00	30	40	19.9	NA	H	4.00	0	NA	20.1
169.98	30	40	18.5	NA	H	1.00	172	NA	21.5
120.0	30	40	18.3	NA	V	2.14	0	NA	21.7
199.98	30	40	19.5	NA	V	1.00	0	NA	20.5
370.02	37	47	24.8	NA	V	4.00	0	NA	22.2
390.0	37	47	25.0	NA	V	1.00	0	NA	22.0
400.02	37	47	25.6	NA	V	1.00	0	NA	21.4
240 cpu									
75.0	30	40	18.5	NA	H	1.00	0	NA	11.5
76.8	30	40	19.4	NA	H	4.00	0	NA	10.6
79.98	30	40	20.5	NA	H	4.00	0	NA	9.5
150.0	30	40	20.2	NA	H	3.57	0	NA	9.8
160.02	30	40	19.0	NA	H	1.00	0	NA	11.0
199.98	30	40	20.5	NA	H	1.00	0	NA	9.5
235.74	37	47	20.0	NA	V	1.00	0	NA	27.0
236.22	37	47	20.2	NA	V	4.00	87	NA	26.8
236.46	37	47	20.5	NA	V	1.00	0	NA	26.5
256.68	37	47	20.6	NA	V	1.00	0	NA	26.4
287.52	37	47	23.0	NA	V	4.00	0	NA	24.0
342.42	37	47	24.5	NA	V	1.00	0	NA	22.5
370.02	37	47	25.2	NA	V	3.55	180	NA	21.8
390.0	37	47	25.7	NA	V	1.00	0	NA	21.3
250 cpu									
79.98	30	40	13.7	NA	H	4.00	0	NA	26.3
90.00	30	40	26.0	NA	H	4.00	0	NA	14.0
130.02	30	40	10.7	NA	H	1.00	0	NA	29.3
139.98	30	40	12.2	NA	H	1.00	0	NA	27.8
160.02	30	40	12.5	NA	H	3.37	134	NA	27.5
166.68	30	40	11.4	NA	H	3.77	0	NA	28.6
169.98	30	40	10.0	NA	H	1.86	0	NA	30.0
173.34	30	40	9.6	NA	H	1.00	0	NA	30.4
180.00	30	40	14.2	NA	H	4.00	0	NA	25.8
199.98	30	40	10.2	NA	H	1.60	0	NA	29.8
203.34	30	40	9.9	NA	H	3.64	0	NA	30.1
206.64	30	40	12.6	NA	H	3.55	0	NA	27.4

Freq (MHz)	Limits (dBµv/m) @ 10m		Quassi peak emission dBµv/m @ 10m	Quassi peak emission dBµv/m @ 3m	Pol	Antenna elevation, metres	Turntable azimuth, degrees	Ambient	From industrial limit, (dBuV/m)
	Dom	Ind							
210.00	30	40	10.0	NA	H	2.46	0	NA	30.0
220.02	30	40	10.2	NA	H	3.00	0	NA	29.8
226.68	30	40	9.8	NA	H	1.00	0	NA	30.2
300.00	37	47	18.5	NA	H	1.92	0	NA	28.5
319.98	37	47	15.7	NA	H	1.91	0	NA	31.3
340.02	37	47	14.0	NA	H	1.00	0	NA	33.0
379.98	37	47	15.2	NA	H	4.00	111	NA	31.8
420.00	37	47	16.4	NA	H	4.00	0	NA	30.6
519.96	37	47	21.5	NA	H	4.00	0	NA	25.5
559.98	37	47	17.1	NA	H	4.00	0	NA	29.9
79.98	30	40	18.9	NA	V	2.25	95	NA	21.1
139.98	30	40	20.5	NA	V	4.0	0	NA	19.5
166.68	30	40	20.3	NA	V	4.0	0	NA	19.7
169.98	30	40	9.8	NA	V	4.0	0	NA	30.2
173.34	30	40	9.3	NA	V	1.0	0	NA	30.7
180.00	30	40	18.6	NA	V	4.0	97	NA	21.4
199.98	30	40	10.1	NA	V	1.0	0	NA	29.9
203.34	30	40	10.9	NA	V	4.0	0	NA	29.1
206.64	30	40	10.6	NA	V	4.0	0	NA	29.4
210.00	30	40	9.6	NA	V	1.0	0	NA	30.4
220.02	30	40	10.6	NA	V	1.0	180	NA	29.4
226.68	30	40	10.3	NA	V	1.0	0	NA	29.7
266.64	37	47	11.3	NA	V	4.0	0	NA	35.7
300.00	37	47	14.4	NA	V	3.11	289	NA	32.6
319.98	37	47	13.5	NA	V	1.0	0	NA	33.5
339.96	37	47	14	NA	V	4.0	0	NA	33.0
349.98	37	47	14.2	NA	V	1.0	0	NA	32.8
360.00	37	47	14.5	NA	V	4.0	0	NA	32.5
366.66	37	47	14.7	NA	V	4.0	0	NA	32.3
379.98	37	47	15.2	NA	V	4.0	0	NA	31.8
386.64	37	47	15.4	NA	V	1.0	0	NA	31.6
399.96	37	47	16.7	NA	V	1.0	310	NA	30.3
420.00	37	47	17.7	NA	V	4.0	0	NA	29.3
480.00	37	47	18.4	NA	V	4.0	0	NA	28.6
559.96	37	47	16.4	NA	V	4.0	0	NA	30.6
600.00	37	47	17.4	NA	V	4.0	0	NA	29.6
639.96	37	47	18.1	NA	V	4.0	0	NA	28.9

3.3.8.3 Conclusions from radiated emissions

The emissions fall comfortably below the industrial limit line, however they do exceed the domestic limit line in a number of areas.

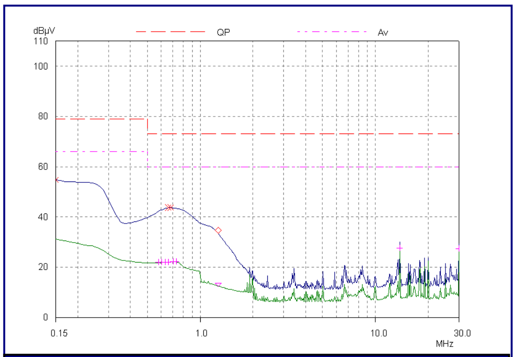
3.3.9 Conducted rf emissions

A 2m square 1mm thick aluminium ground plane was placed inside the anechoic chamber and the LISN earth was bonded to it. The setup in EN 55011 was utilised with the exception of the EUT height above the ground plane which was set to 0.4m as industrial controllers are neither tabletop nor floor mounted devices.

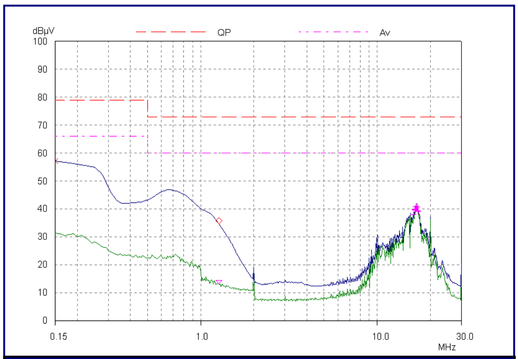
A 1m power lead and the standard D2 DS comms cable were used throughout.

Conducted emissions were carried out between live and earth, and neutral and earth from 150KHz to 30MHz. A pulse limiter with an inherent attenuation of 10dBs across the range was used and 10dBs of attenuation was applied at the LISN. Within the receiver software, a total of 20dB's was therefore added across that range.

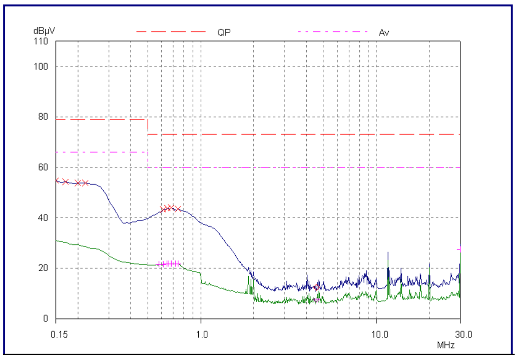
The following plots display average and quassi peak emissions and include limit lines for the stricter heavy industrial environments. Limits for domestic and light industrial environments are described in the table below.



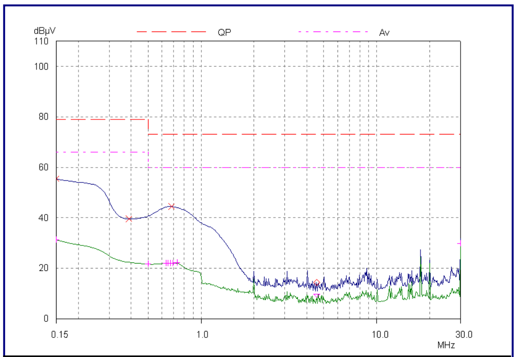
230 cpu, line to earth (M2L205)



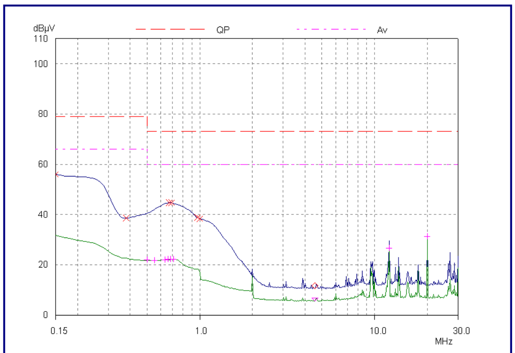
230 cpu, neutral to earth (M2N205)



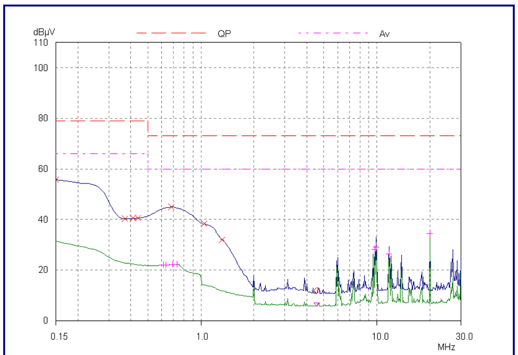
240 cpu, line to earth (M1L205)



240cpu, neutral to earth (M1N205)



250cpu line to earth (M3L205)



250cpu neutral to earth (M3N205)

3.3.9.1 The test limits

	Frequency range	Limits (dBuV)
Domestic	150-500KHz Limits decrease linearly with log frequency	66-56 quassi peak 56-46 average
	0.5-5MHz	56 quassi peak 46 average
	5-30MHz	60 quassi peak 50 average
Industrial	150-500KHz	79 quassi peak 66 average
	0.5-5MHz	73 quassi peak 60 average
	5-30MHz	73 quassi peak 60 average

3.3.9.2 Conclusions from conducted emissions

It can be seen from the above plots that the EUT's conducted emissions fall well within the industrial limit lines and that they may pass to the domestic ones. However, passing to the domestic limit lines is irrelevant in this case, as the radiated emissions exceed the domestic limit lines.

3.3.10 Radiated rf immunity

The EUT was taken to a third party test house and tested for susceptibility to radiated rf in accordance with EN 50082-2 which stipulates harsher levels for industrial environments. Test levels were 10v/m throughout the range 80MHz to 1GHz amplitude modulated, and a pulse at 900MHz at 10-25v/m was also applied.
The EUT's were unaffected throughout the tests.

4 Test report for 205 series general modules

4.1 Preface

4.1.1 EUT (equipment under test)

Manufacturer	Automation Direct.com
Products covered.	All are modules in the 205 range of PLCs
Module name or number	See table below
Serial numbers	No serial markings. Identified by date. Products received between July 96 and May 2000
Country of manufacture	Japan and US
Report completion date	2nd August 2000

4.1.1.1 Modules covered:

Basic IO	Analogue IO	Speciality IO
D2-08ND3	F2-04AD-1	F2-08SIM
D2-16ND3-2	F2-04AD-1L	D2-CTRINT
D2-08NA-1	F2-04AD-2	D2-HPP
D2-08NA-2	F2-04AD-2L	D2-HPP-U
D2-16NA	F2-08AD-1	F2-02DAS-1
D2-04TD1	F2-08AD-2	F2-08DA-2
D2-08TD1	F2-02DA-1	D2-RMSM
D2-16TD1-2	F2-02DA-2	D2-RSSS
D2-16TD2-2	F2-4AD2DA	D2-DCM
D2-08TA	F2-04RTD	H2 SERIO
D2-12TA	F2-04THM	**Others**
D2-04TRS		H2-WPLC1
D2-08TR		H2-WPLC2
F2-08TRS		H2-WPLC1-TD
D2-12TR		H2-WPLC2-TD
D2-08CDR		H2-WPLC1-KW
		H2-WPLC2-KW

4.1.1.2

4.1.1.3 Test programs

Programs were written specifically for different modules or module groups, depending on the function of the module, whether support modules or equipment were required, and what sort of monitoring was appropriate for immunity.
In general a DV 1000 display unit was used for the monitoring of immunity tests.

4.1.1.4 Test setup

For emission tests the EUT was placed in a specially prepared PLC base with its switched mode power supply replaced by a linear one, so as not to introduce additional noise onto the measurements. For immunity tests a standard ac powered base was used.
The EUT was mounted within a steel industrial enclosure 600 x 800 x 250mm (RS 207-1587). A 3 core $0.5mm^2$, 16 x 0.2, 3A flexible power lead was used throughout (RS 377-940), with a mini in-line mains connector (RS 464-038) mounted 80mm from the PLC.

Note: Numbers subsequent to ‘RS’ denote part numbers of the UK distributor ‘RS’ (Radio Spares). RS is a recognised distributor of standard parts to technical industries, mainly in the UK.

4.1.1.5 Guard band for emissions

We apply a 5dB guard band for radiated emissions and a 4dB guard band for conducted emissions. Measurement uncertainty is included within this. This must be observed when interpreting the emissions results.

4.1.2 Procedure

The standard in house test procedure CETP0797, and other related ones were used. CETP0797 is based on the standards listed in the section 'relevant standards' in this document, and where any doubt existed from the procedure or further information was required, those standards were referenced.

4.1.3 Summary of test results

Test	Result
Low voltage directive	
Markings	Pass
Documentation	Pending
Creepages and clearances	UL
Storage temperature	Pass
Operating temperature	Pass
Humidity and dielectric strength	Pass
Shock and vibration	Pass
Critical components	NA
Internal/ external voltage and current	Pass
EMC directive	
Voltage dips	Pass to industrial
Voltage interruptions	Pass to industrial
Voltage fluctuations	Pass to industrial
Fast transients	Pass to industrial
ESD	Pass to industrial
Radiated emissions	Pass to industrial
Conducted emissions	Pass to industrial
Radiated immunity	Pass to industrial

4.1.4 Overal result

PASS
All the listed modules comply with the standard EN 61010-1, as referenced by the low voltage directive.
All the listed modules comply with the standards below, as referenced by the EMC directive, and accordingly are suitable for industrial environments.

4.1.5 Relevant standards

4.1.5.1 Low voltage directive

EN 61010-1 Safety requirements for electrical equipment for measurement, control and laboratory use. This standard was adhered to throughout the safety aspects of the testing.

4.1.5.2 EMC directive

EN 50081-2 Generic emission standard for industrial environments
EN 50082-2 Generic immunity standard for industrial environments

4.1.5.3 Basic standards

EN 55011 Emissions
ENV 50140 Immunity
EN 61000-4-2 Electrostatic discharge
EN 61000-4-4 Fast transients
EN 61000-4-11 Voltage dips, short interruptions and voltage variations immunity tests

4.1.6 Equipment used

Description	Manufacturer	Model	Last calibrated
Test receiver	Rhode & Schwarz	ESPC	Jan 2000
Log periodic/ bow tie antenna	EMCO	Biconilog 3142	14 Apr 98
Pulse limiter	Rhode & Schwarz	ESH3-Z2	22 July 98
Spectrum analyser	Anritsu	R4131	Jan 98
Pre amplifier	Schaffner Chase	CPA 9231A	Sept 98
Line impedance stabilisation network	Thurlby Thandar	LISN 1600	Jan 2000
Fast transient/ ESD/ Dips Generator	Seeward	Mace	Dec 98
Environmental chamber	In house	ENVC 1	NA
Flash tester	Clare	A203C	Jul 97

4.1.7 Test sites

Site	Manufacturer	Type	Calibrated
RFI chamber	Rainford EMC	Fully anechoic chamber	June 98 to EN 50147-3
Open area test site	In house	10m test distance, 1-4m antenna elevation, uncovered, powered turntable and antenna mast	July 98 to ANSI C63.4:1992, EN 50147-2

4.2 Low voltage directive

4.2.1 Markings

The in house test procedure CETP0797 was referenced and the following markings were found to be relevant to the EUT.

4. Manufacturers name or trademark on product.
5. Part code on product.
6. Durability of markings has been checked by the method as described in EN 61010-1 5.3.

All the markings are in order

4.2.2 Documentation

The in house test procedure CETP0797 was referenced and the following items for documentation were found to be relevant to the EUT.

13. Documentation states that the equipment is suitable for installation category (1 or 2).
14. Documentation (as below) was available for safety purposes, which includes warning statements and a clear explanation of warning symbols.
15. Technical specification.
16. Name and address of manufacturer or supplier, where technical assistance may be obtained.
17. Equipment ratings including supply voltage range, frequency range and power rating.
18. Descriptions of all input/output connections.
19. A statement informing that the rating between all circuits in the equipment are rated as BASIC INSULATION ONLY, as appropriate for single fault conditions.
20. A statement informing that it is the responsibility of the system designer to earth one side of all control and power circuits, and to earth the braid of screened cables.
21. Environmental specification for use, transport and storage conditions. (see section 1.4. of standard).
22. The user is made aware by a notice in the documentation that if the equipment is used in a manner not specified by the manufacturer the protection provided by the equipment may be impaired.
23. Instructions are given concerning preventative maintenance of the PLC equipment, including the regular changing of batteries, and the specific battery re-order code. Also a statement saying that only parts supplied by PLC-Direct or its agents should be used.
24. Statement highlighting the requirements for external switches or circuit breakers, external fusing and a recommendation that the switch or CB is mounted near the PLC equipment.
25. Assembly, location and mounting instructions.
26. Identification of controls and their use.
27. Separate instructions for interconnection of accessories and optional parts.
28. Instructions for cleaning.

After consulting with the manual writers, various items from the above list which do not currently appear in the manual, will do so in time for the next revision.

4.2.3 Creepages and clearances

Creepages and clearances were checked to UL requirements and found to meet its criteria. We are happy to accept UL accreditation for creepages and clearances. This covers EU requirements.

4.2.4 Electrical and environmental

The following tests confirm the technical specifications of the EUT, and certain safety parameters.

4.2.4.1 Operating low temperature test

The EUT was operated in a test chamber for 2 hours at -2°C whilst operational. This test level exceeds the product specification of 0°C. The product remained fully functional and within specifications.

4.2.4.2 Operating high temperature test

The EUT was operated in a test chamber for 2 hours at 57^{o}C whilst operational. This test level exceeds the product specification of 55°C. The product remained fully functional and within specifications.

4.2.4.3 Storage low temperature test

The EUT was stored at -25^{o}C in a test chamber for 2 hours whilst un-powered. This test level exceeds the product specification of -20°C The product operated correctly at 20^{o}C 45mins after storing.

4.2.4.4 Storage high temperature test

The EUT was stored at 75^{o}C in a test chamber for 2 hours whilst un-powered. This test level exceeds the product specification of 70°C. The product operated correctly at 20^{o}C 45mins after storing.

4.2.4.5 Humidity and dielectric strength

A representative sample of modules was selected for these tests.
The EUT was pre-conditioned in the environmental chamber at 42^{o}C, and a relative humidity of 40–60%, for 4 hours.
The relative humidity was then raised to 95% $\pm$ 4% for 48 hours, the EUT being un-powered.
After humidity treatment the equipment was allowed to recover for 2 hours at 15 - 35^{o}C and <75% RH, 75 - 106kPa air pressure). Under these conditions the equipment was functionally tested within 1 hour of the end of the recovery period and found to be fully functional and within specifications.
Dielectric strength tests were then performed. This was done by connecting both the earth terminal and the power terminals on the PLC base together, and applying a voltage of 820v RMS AC between that and the I/O of the modules.
No breakdown occurred.

4.2.4.6 Shock and vibration

Shock and vibration tests have been carried out on various 205 modules by Koyo in Tokyo, Japan, (see separate report). No effect to the EUT was seen in any of the tests.
Shock tests were performed to IEC 68-2-27 method 516.2.
Vibration tests were performed to MIL- STD-810C method 514.2.

4.3 EMC directive

4.3.1 Voltage dips and interruptions

Voltage dips were applied to the power line of the PLC base with each module having its turn in the setup. The following effects were exhibited on the majority of EUTs. The remaining EUTs exhibited no effects.
Dips of 30%, 60% and 100% were induced for 0.5 cycles, 5 cycles, 10 cycles, 25 cycles and 50 cycles. There was no affect to the EUT except for the application of the 100% dip for 50 cycles. Here the base would momentarily power down, and then recover again with full operation restored to the modules. Therefore the EUT passes to the required performance of criteria B.

4.3.2 Full voltage interruptions

The EUT recovered with program unchanged when powered up. The EUT therefore passed the required performance of criteria A.

4.3.3 Voltage fluctuations

Voltages applied were +10% at high end of supply range and -10% at low end of the supply range giving a new tested range of 90-132 and 180-264vac. Each module was subjected to the test through the power supply/ base unit.
The EUTs did not malfunction or experience any significant rise in temperature. The EUT therefore passed the required performance of criteria A.

4.3.4 Fast transients

A 2m square 1mm thick aluminium ground plane was placed inside the anechoic chamber and the earth of the transient generator was bonded to it. The EUT was mounted in the aforementioned industrial control cabinet, which was placed on a support 100mm above the ground plane.
The setup in 61000-4-4 was used. A 1.5m power lead (1.0m outside the enclosure) was used throughout. In the case of analogue modules, a DV 1000 was used to display electrical current values at module inputs.
Positive and negative going fast transients were applied directly to the three terminals of the power port of the PLC base for 1 minute at up to 2Kv each, as specified in EN 61000-4-4. Likewise up to 2Kv fast transients were applied via the capacitive coupling clamp to cables attached to the IO terminals and comms ports, where applicable.
The EUT passed the required performance of criteria B.

4.3.5 ESD

A 2m square 1mm thick aluminium ground plane was placed inside the anechoic chamber and the earth of the ESD generator was bonded to it. The EUT was placed within the industrial control cabinet which was placed 100mm above the ground plane, and contact discharge tests were conducted. These were performed by using the pointed end probe directly on the area to test. The relay inside the probe was operated, discharging up to 8Kv. These tests were repeated ten times on each of six locations on the cabinet.
There was no affect to the EUT.

4.3.6 Identification of ports and potential sources of rfi

Every module has ports which can potentially radiate emissions, some more than others. In the case of relay output modules, any emissions reaching the output terminals will have been generated elsewhere and passed on by the module, whereas analogue modules and speciality modules have internal CPUs, which will create emissions of their own.

4.3.7 Radiated rf emissions

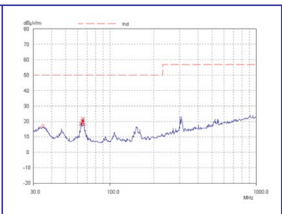
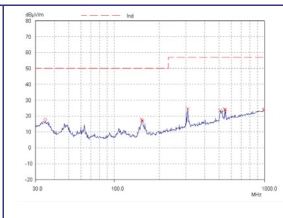
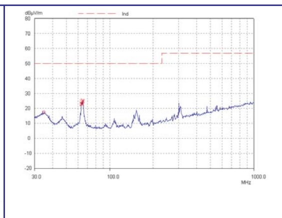
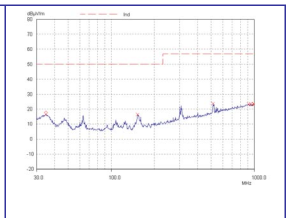
These tests can be divided into two types; those carried out in the anechoic chamber and those carried out on the open area test site.
Wherever possible attempts were made to maximise emissions as laid out in EN 50081-2 section 6 and EN 55011 section 7.4.

A 2.5m power lead (1.75m outside the enclosure) was used throughout. The EUT was placed in the industrial control cabinet, on a 0.8m high non conductive table for all the tests.

4.3.7.1 Anechoic chamber

In order to obtain a 'picture' of radiated emissions unique to each EUT without the adverse effects of ambient signals, testing was first carried out in the anechoic chamber. Here ambient signals are attenuated by around 100dBs. The antenna height was fixed to 1.5m and the receiver was set to scan the testing range of 30MHz to 1GHz as laid down in EN 50081-2. The test distance was 3m. Although a clear 'picture' of emissions was obtained by using the anechoic chamber, they must be qualified on an OATS as required by the aforementioned standard.

Both domestic and industrial limit lines are shown, although it must be taken into account that an anechoic chamber is not an official test site and actual values should not be taken from these plots. The following are emissions scans from a small selection of modules.

Basic				
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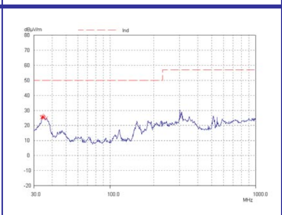
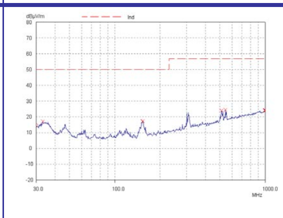
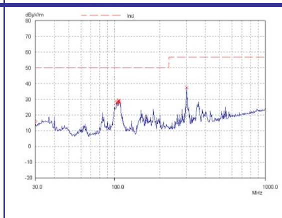
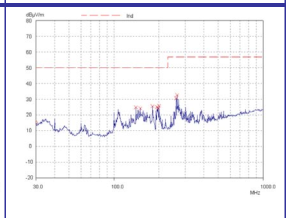
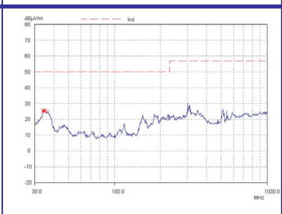
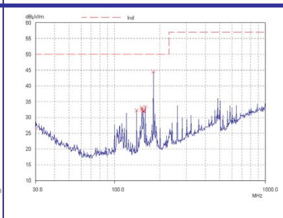
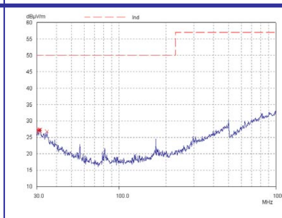
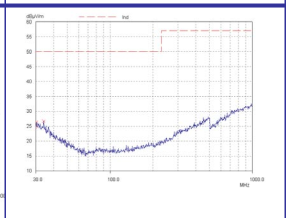
Analogue				
	F2 04AD-1 M11H205	F2 02DA-1 M3H205	F2 04RTD M15H205	F2 04THM M10H205
Speciality				
	D2 CTRINT M36H205	H2 WINPLC1-TD M37H205	D2RMSM 31H205	D2 DCM M33H205

4.3.7.2 Open area test site (OATS)

Looking at the pre scans, a selection of modules with the highest emissions was selected, for further measurements on the OATS, three of which are illustrated below. For each one, a shortlist of the highest emissions from each scan was then obtained, and each frequency was measured in turn. A 10m test distance was used.

The turntable was rotated until the emission was maximised, at which point the antenna was height scanned again to maximise the emission level. Finally the turntable was rotated again, before a 3 second quassi peak measurement was taken.

In addition to this, the ambient signals were measured at each of the EUT's emission frequency, and if high in comparison to the EUT's emission signal, it was noted.

Freq (MHz)	Limits (dBµv/m) @ 10m		Quassi peak emission dBµv/m @ 10m	Quassi peak emission dBµv/m @ 3m	Pol	Antenna elevation, metres	Turntable azimuth, degrees	Ambient	From industrial limit, (dBuV/m)
	Dom	Ind							
H2 WINPLC1-TD									
120.00	30	40	21.5	N/A	H	4.0	0		18.5
139.98	30	40	20.5	N/A	H	1.0	0		19.5
151.80	30	40	20.0	N/A	H	1.0	0		20.0
160.02	30	40	22.2	N/A	H	4.0	0		17.8
180.00	30	40	23.2	N/A	H	1.0	0		16.8
120.00	30	40	27.5	N/A	V	1.0	0		12.5
139.98	30	40	35.3	N/A	V	1.0	0	25.7	4.7
147.96	30	40	26.1	N/A	V	1.0	0		13.9
148.08	30	40	27.8	N/A	V	1.0	0		12.2
180.00	30	40	33.5	N/A	V	1.0	0	20.7	6.5
F2 04RTD									
106.80	30	40	10.7	N/A	H	2.9	0		29.3
107.88	30	40	9.7	N/A	H	1.0	0		30.6
108.12	30	40	9.4	N/A	H	2.7	0		30.6
300.00	37	47	20.4	N/A	H	2.1	0		19.6
106.62	30	40	24.0	N/A	V	1.0	0	24.0	16.0
106.80	30	40	16.5	N/A	V	4.0	0		23.5
107.94	30	40	10.4	N/A	V	1.0	0		29.6
108.12	30	40	9.6	N/A	V	1.0	0		30.4
108.96	30	40	8.6	N/A	V	1	0		31.4
109.98	30	40	10.6	N/A	V	1.9	0		29.4
150.00	30	40	17.8	N/A	V	1.2	0		22.2
300.00	37	47	21.9	N/A	V	1	91		25.1

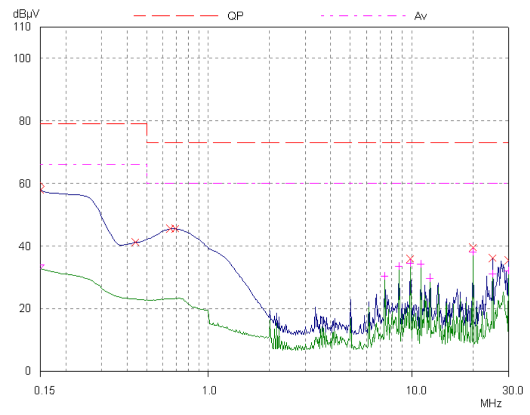
4.3.7.3 Conclusions from radiated emissions

The emissions fall below the industrial limit line, however they do exceed the domestic limit line in a number of areas. In the case of the WinPLC, its emission of 35.30 at 139.98MHz actually enters our guard band of 5dBs, however the level of ambient is also high.

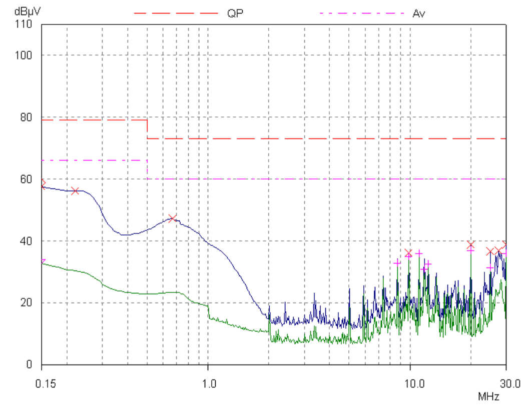
4.3.8 Conducted rf emissions

As with radiated emissions, the nosiest modules were selected and their results are illustrated below.
A 2m square 1mm thick aluminium ground plane was placed inside the anechoic chamber and the LISN earth was bonded to it. The setup in EN 55011 was utilised with the exception of the EUT height above the ground plane. This was set to 0.4m as industrial controllers are neither tabletop nor floor mounted devices and the equipment was mounted within the industrial control cabinet.
A 1.75m power lead (1.0m outside the enclosure) was used throughout.
Conducted emissions were carried out between live and earth, and neutral and earth from 150KHz to 30MHz. A pulse limiter with an inherent attenuation of 10dBs across the range was used and 10dBs of attenuation was applied at the LISN. Within the receiver software, a total of 20dB's was therefore added across that range.
The following plots display average and quassi peak emissions and include limit lines for the stricter heavy industrial environments. Limits for domestic and light industrial environments are described in the table below.

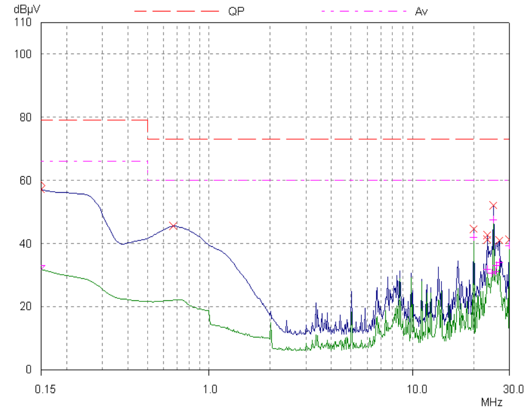
Analogue modules



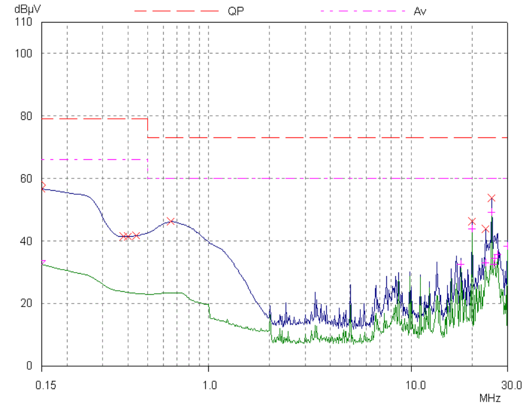
THM M5L205



THM M5N205

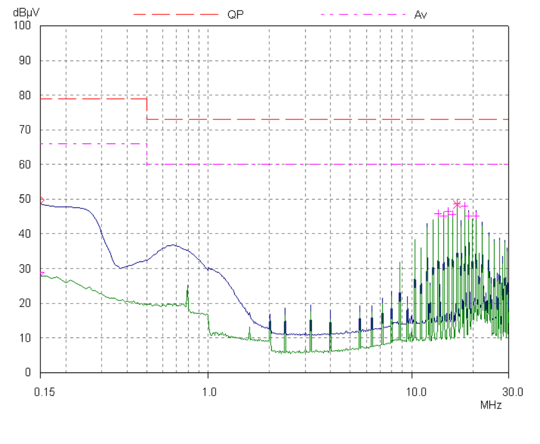


RTD M4L205

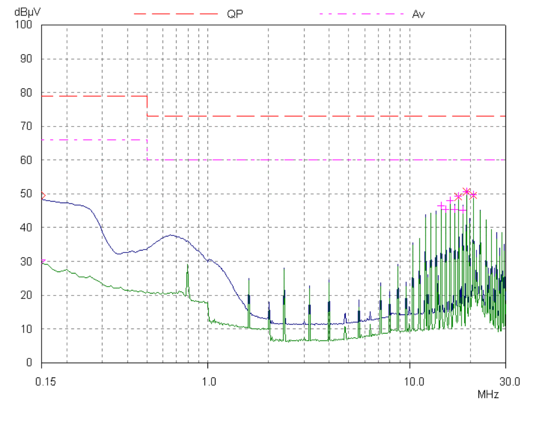


RTD M4N205

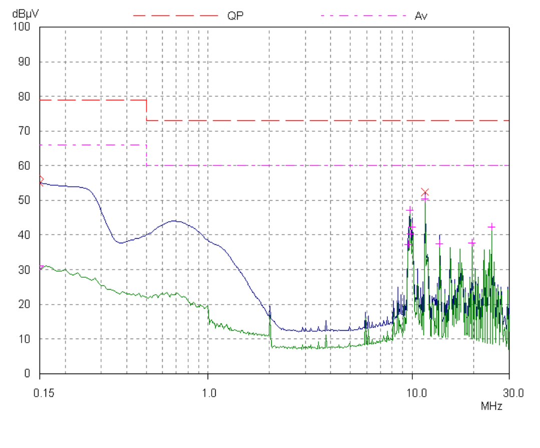
Speciality modules



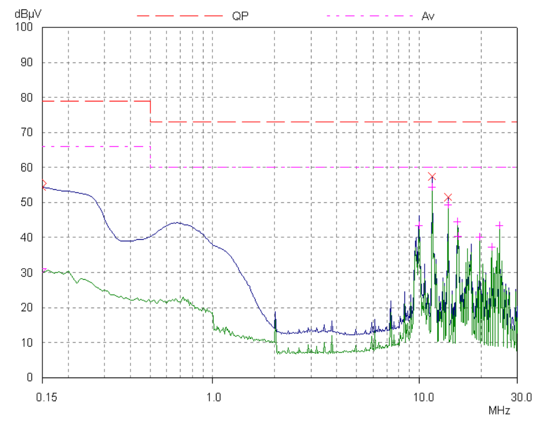
DCM M17L205A



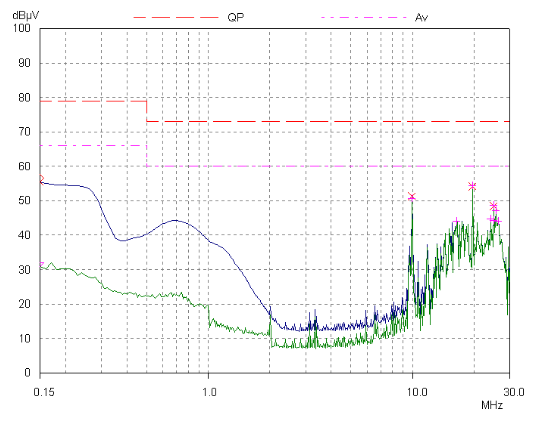
DCM M17N205A



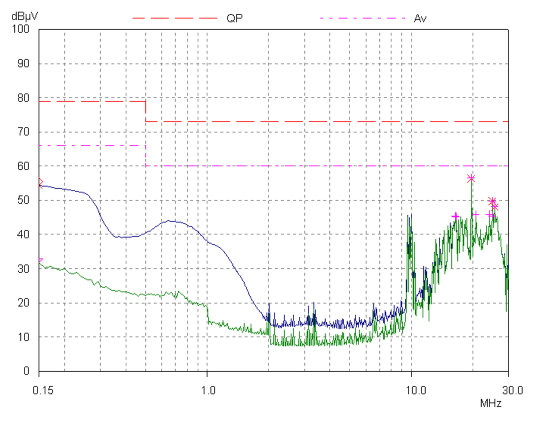
RMSM M14L205



RMSM M14N205



RSSS M13L205



RSSS M13N205

4.3.8.1 The test limits

	Frequency range	Limits (dBuV)
Domestic	150-500KHz Limits decrease linearly with log frequency	66-56 quassi peak 56-46 average
	0.5-5MHz	56 quassi peak 46 average
	5-30MHz	60 quassi peak 50 average
Industrial	150-500KHz	79 quassi peak 66 average
	0.5-5MHz	73 quassi peak 60 average
	5-30MHz	73 quassi peak 60 average

4.3.8.2 Conclusions from conducted emissions

It can be seen from the above plots that the EUT's conducted emissions fall within the industrial limit lines.

4.3.9 Radiated rf immunity

A selection of the EUTs were taken to a third party test house and tested for radiated rf immunity in accordance with EN 50082-2 which stipulates harsher levels for industrial environments. Test levels were 10v/m throughout the range 80MHz to 1GHz amplitude modulated, and a pulse at 900MHz at 10-25v/m was also applied. The EUTs exhibited no effects.

4.3.10 Further information

Further information is available upon request. This includes, finer detail of setups and results, emissions pre scans and raw scan data, data specific to individual products, etc.

5 Test report for 205 series modules group B

5.1 Preface

5.1.1 EUT (equipment under test)

Manufacturer	Automation Direct.com
List of products covered.	All are modules in the 205 range of PLCs: F2 DEVNETS, F2 CP128, F2 SDS, H2 ECOM, H2 EBC
Serial numbers	No serial markings. Identified by date. Products received between August 99 and May 2000
Country of manufacture	USA
Report completion date	29th Aug 2000

5.1.1.1 Test programs

Programs were written specifically for different modules. This depended upon the function of the module, whether support modules or equipment were required, and what sort of monitoring was appropriate for immunity testing.
In general a DV 1000 display unit was used for the monitoring of immunity tests.

5.1.1.2 Test setup

For emission tests the EUT was placed in a specially prepared base which had its switched mode power supply replaced with a linear one. This ensured that additional and unrelated noise was not introduced onto the measurements. For immunity tests a standard ac powered base was used.
The EUT was mounted within a steel industrial enclosure 600 x 800 x 250mm (RS 207-1587). A 3 core 0.5mm^2, 16 x 0.2, 3A flexible power lead was used throughout (RS 377-940), with a mini in-line mains connector (RS 464-038) mounted 80mm from the PLC.

Note: Numbers subsequent to 'RS' denote part numbers of the UK distributor 'RS' (Radio Spares). RS is a recognised distributor of standard parts to technical industries, mainly in the UK.

5.1.2 Procedure

The standard in house test procedure CETP0797, and other related ones were used. CETP0797 is based on the standards listed in the section 'relevant standards' in this document, and where any doubt existed from the procedure or further information was required, those standards were referenced.

5.1.3 Summary of test results

Test	Result
Low voltage directive	
Markings	Pass
Documentation	Modified items will appear in the next release
Creepages and clearances	Pass due to UL
Storage temperature	Pass
Operating temperature	Pass
Humidity and dielectric strength	Pass
Shock and vibration	Pass
Critical components	NA
Internal/ external voltage and current	Pass

EMC directive	
Voltage dips	Pass to industrial
Voltage interruptions	Pass to industrial
Voltage fluctuations	Pass to industrial
Fast transients	Pass to industrial
ESD	Pass to industrial
Radiated emissions	Pass to industrial
Conducted emissions	Pass to industrial
Radiated immunity	Pass to industrial, subject to the correct use of metallic conduit as specified in this document

5.1.4 Overall result

PASS
All the modules comply with the standard EN 61010-1, as referenced by the low voltage directive.
All the modules comply with the standards below, as referenced by the EMC directive, and accordingly are suitable for industrial environments, subject to the correct use of metallic conduit as specified in this document.

5.1.5 Relevant standards

5.1.5.1 Low voltage directive

EN 61010-1 Safety requirements for electrical equipment for measurement, control and laboratory use.
This standard was adhered to throughout the safety aspects of the testing.

5.1.5.2 EMC directive

EN 50081-2 Generic emission standard for industrial environments.
EN 50082-2 Generic immunity standard for industrial environments.

5.1.5.3 Basic standards

EN 55011 Emissions.
ENV 50140 Immunity.
EN 61000-4-2 Electrostatic discharge.
EN 61000-4-4 Fast transients.
EN 61000-4-11 Voltage dips, short interruptions and voltage variations immunity tests.

5.1.6 Equipment used

Description	Manufacturer	Model	Last calibrated
Test receiver	Rhode & Schwarz	ESPC	Jan 2000
Log periodic/ bow tie antenna	EMCO	Biconilog 3142	14 Apr 98
Pulse limiter	Rhode & Schwarz	ESH3-Z2	22 July 98
Spectrum analyser	Anritsu	R4131	Jan 98
Pre amplifier	Schaffner Chase	CPA 9231A	Sept 98
Line impedance stabilisation network	Thurlby Thandar	LISN 1600	Jan 2000
Fast transient/ ESD/ Dips Generator	Seeward	Mace	Dec 98
Environmental chamber	In house	ENVC 1	NA
Flash tester	Clare	A203C	Jul 97

5.1.7 Test sites

Site	Manufacturer	Type	Calibrated
RFI chamber	Rainford EMC	Fully anechoic chamber	June 98 to EN 50147-3
Open area test site	In house	10m test distance, 1-4m antenna elevation, uncovered, powered turntable and antenna mast	July 98 to ANSI C63.4:1992, EN 50147-2

5.2 Low voltage directive

5.2.1 Markings

The in house test procedure CETP0797 was referenced and the following markings were found to be relevant to the EUT.

7. Manufacturers name or trade mark on product.
8. Part code on product.
9. Durability of markings has been checked by the method as described in EN 61010-1 5.3.

All the markings are in order

5.2.2 Documentation

The in house test procedure CETP0797 was referenced and the following items for documentation were found to be relevant to the EUT.

29. Documentation states that the equipment is suitable for installation category (1 or 2).
30. Documentation (as below) was available for safety purposes, which includes warning statements and a clear explanation of warning symbols.
31. Technical specification.
32. Name and address of manufacturer or supplier, where technical assistance may be obtained.
33. Equipment ratings including supply voltage range, frequency range and power rating.
34. Descriptions of all input/output connections.
35. A statement informing that the rating between all circuits in the equipment are rated as BASIC INSULATION ONLY, as appropriate for single fault conditions.
36. A statement informing that it is the responsibility of the system designer to earth one side of all control and power circuits, and to earth the braid of screened cables.
37. Environmental specification for use, transport and storage conditions. (see section 1.4. of standard).
38. The user is made aware by a notice in the documentation that if the equipment is used in a manner not specified by the manufacturer the protection provided by the equipment may be impaired.
39. Instructions are given concerning preventative maintenance of the PLC equipment, including the regular changing of batteries, and the specific battery re-order code. Also a statement saying that only parts supplied by PLC-Direct or its agents should be used.
40. Statement highlighting the requirements for external switches or circuit breakers, external fusing and a recommendation that the switch or CB is mounted near the PLC equipment.
41. Assembly, location and mounting instructions.
42. Identification of controls and their use.
43. Separate instructions for interconnection of accessories and optional parts.
44. Instructions for cleaning.

After consulting with the manual writers, various items from the above list which do not currently appear in the manual, will do so in time for the next revision.

5.2.3 Creepages and clearances

Creepages and clearances were checked to UL requirements and found to meet its criteria. We are happy to accept UL accreditation for creepages and clearances. This covers EU requirements.

5.2.4 Electrical and environmental

The following tests confirm the technical specifications of the EUT, and certain safety parameters.

5.2.4.1 Operating low temperature test

The EUT was operated in a test chamber for 2 hours at -2°C whilst operational. This test level exceeds the product specification of 0°C. The product remained fully functional and within specifications.

5.2.4.2 Operating high temperature test

The EUT was operated in a test chamber for 2 hours at 57^{o}C whilst operational. This test level exceeds the product specification of 55°C. The product remained fully functional and within specifications.

5.2.4.3 Storage low temperature test

The EUT was stored at -25^{o}C in a test chamber for 2 hours whilst un-powered. This test level exceeds the product specification of -20°C The product operated correctly at 20^{o}C 45mins after storing.

5.2.4.4 Storage high temperature test

The EUT was stored at 75^{o}C in a test chamber for 2 hours whilst un-powered. This test level exceeds the product specification of 70°C. The product operated correctly at 20^{o}C 45mins after storing.

5.2.4.5 Humidity and dielectric strength

A representative sample of modules was selected for these tests.
The EUT was pre-conditioned in the environmental chamber at 42^{o}C, and a relative humidity of 40–60%, for 4 hours.
The relative humidity was then raised to 95% $\pm$ 4% for 48 hours, the EUT being un-powered.
After humidity treatment the equipment was allowed to recover for 2 hours at 15 - 35^{o}C and <75% RH, 75 - 106kPa air pressure). Under these conditions the equipment was functionally tested within 1 hour of the end of the recovery period and found to be fully functional and within specifications.
Dielectric strength tests were then performed. This was done by connecting both the earth terminal and the power terminals on the PLC base together, and applying a voltage of 820v RMS AC between that and the I/O of the modules.
No breakdown occurred.

5.2.4.6 Shock and vibration

Shock and vibration tests have been carried out on various 205 modules by Koyo in Tokyo, Japan, (see separate report). No effect to the EUT was seen in any of the tests.
Shock tests were performed to IEC 68-2-27 method 516.2.
Vibration tests were performed to MIL- STD-810C method 514.2.

5.3 EMC directive

5.3.1 Voltage dips and interruptions

Voltage dips were applied to the power line of the base with each module in turn in the setup.
Dips of 30%, 60% and 100% were induced for 0.5 cycles, 5 cycles, 10 cycles, 25 cycles and 50 cycles.
There was no affect to the EUT except for the application of the 100% dip for 50 cycles. Here the base would momentarily power down, and then recover again with full operation restored to the modules.
Therefore the EUT passes to the required performance of criteria B.

5.3.2 Full voltage interruptions

The EUT recovered with program unchanged when powered up. The EUT therefore passed the required performance of criteria A.

5.3.3 Voltage fluctuations

Voltages applied were +10% at high end of supply range and -10% at low end of the supply range giving a new tested range of 90-132 and 180-264vac. Each module was subjected to the test through the power supply/ base unit.
The EUTs did not malfunction or experience any significant rise in temperature. The EUT therefore passed the required performance of criteria A.

5.3.4 Fast transients

A 2m square 1mm thick aluminium ground plane was placed inside the anechoic chamber and the earth of the transient generator was bonded to it. The EUT was mounted in the aforementioned industrial control cabinet, which was placed on a support 100mm above the ground plane.
The setup in 61000-4-4 was used. A 1.5m power lead (1.0m outside the enclosure) was used throughout. In the case of analogue modules, a DV 1000 was used to display electrical current values at module inputs.
Positive and negative going fast transients were applied directly to the three terminals of the power port of the PLC base for 1 minute at up to 2Kv each, as specified in EN 61000-4-4. Likewise up to 2Kv fast transients were applied via the capacitive coupling clamp to cables attached to the IO terminals and comms ports, where applicable.
The EUT passed the required performance of criteria B.

5.3.5 ESD

A 2m square 1mm thick aluminium ground plane was placed inside the anechoic chamber and the earth of the ESD generator was bonded to it. The EUT was placed within the industrial control cabinet which was placed 100mm above the ground plane, and contact discharge tests were conducted. These were performed by using the pointed end probe directly on the area to test. The relay inside the probe was operated, discharging up to 8Kv. These tests were repeated ten times on each of six locations on the cabinet.
There was no affect to the EUT. The EUT therefore passed the required performance of criteria A.

5.3.6 Radiated rf emissions

These tests can be divided into two types; those carried out in the anechoic chamber (FAC), and those carried out on the open area test site.
Wherever possible attempts were made to maximise emissions as laid out in EN 50081-2 section 6 and EN 55011 section 7.4.
A 2m power lead was used throughout. The EUT was placed on a 0.8m high non conductive table for all the tests.

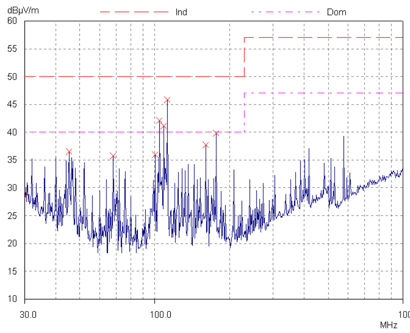
5.3.6.1 Fully anechoic chamber (FAC)

In order to obtain a ‘picture’ of radiated emissions unique to each EUT without the adverse effects of ambient signals, testing was first carried out in the anechoic chamber. Here ambient signals are

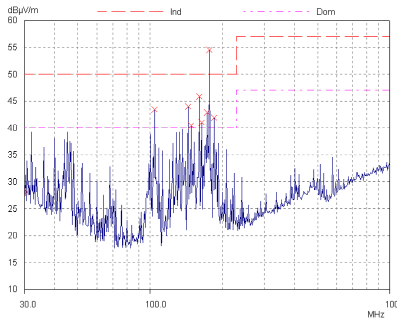
attenuated by around 100dBs. The antenna height was fixed to 1.5m and the receiver was set to scan the testing range of 30MHz to 1GHz as laid down in EN 50081-2. The test distance was 3m. Although a clear 'picture' of emissions was obtained by using the anechoic chamber, they must be qualified on an OATS as required by the aforementioned standard.
The plots below show these pictures of emissions for each EUT, with antenna polarisation in the horizontal and vertical positions.
Both domestic and industrial limit lines are shown, although it must be taken into account that an anechoic chamber is not an official test site and **actual values should not be taken from these plots**.
After the first set of scans and corresponding OATS measurements was completed, it was concluded that all the products had failed these tests. Scans were then run in the FAC with the cables inside the cabinet, and the results were dramatically better. The cabinet was then setup with conductive conduit mounted around its exterior, and the scans re run. Again the results were considerably better than earlier tests with the cabling outside the cabinet. The setup was then taken to the OATS and measurements taken.

5.3.6.2 The scans

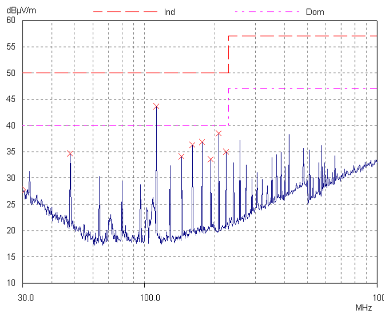
Scans with conventional set up



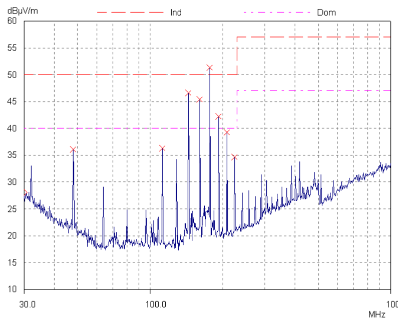
F2 DEVNETS horizontal polarisation (M40H205)



F2 DEVNETS vertical polarisation (M40V205)



F2 SDS horizontal polarisation (M39H205)



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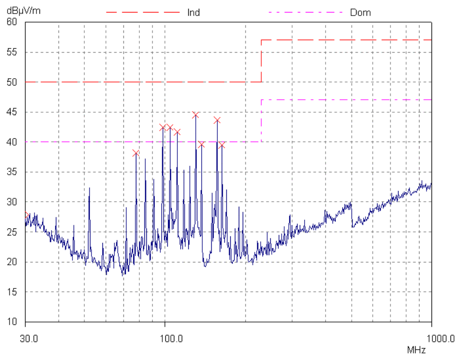
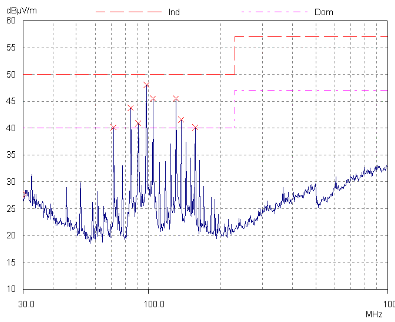
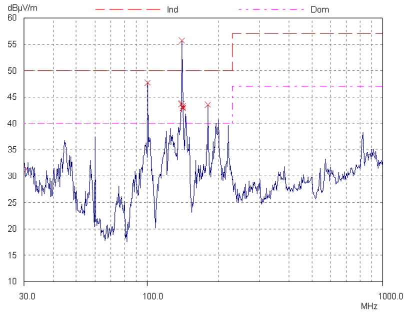


F2 CP128 horizontal polarisation (M38H205)



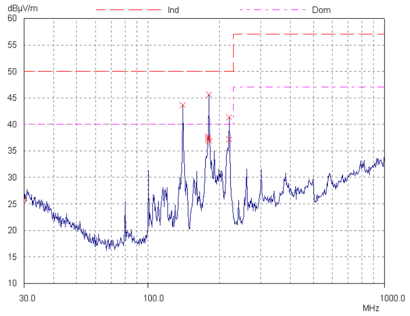
F2 CP128 vertical polarisation (M38V205)

Scans with conductive conduit

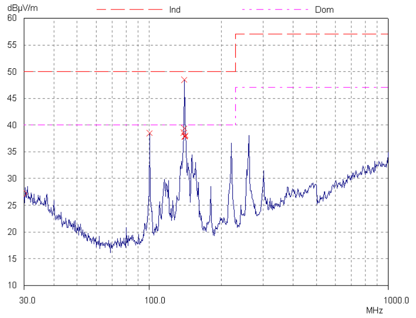


H2 EBC horizontal polarisation (M35H205)

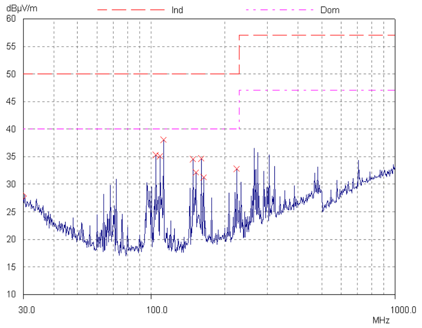
H2 EBC vertical polarisation (M35V205)



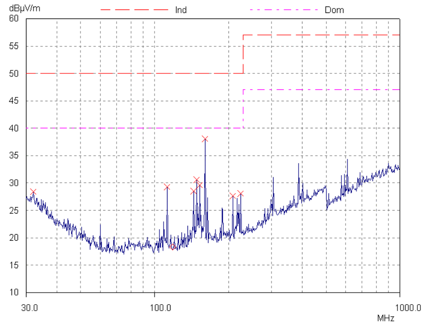
H2 ECOM horizontal polarisation (M34H205)



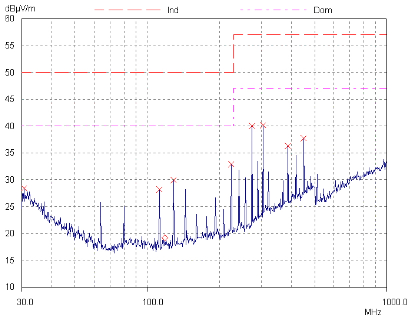
H2 ECOM vertical polarisation (M34VH205)



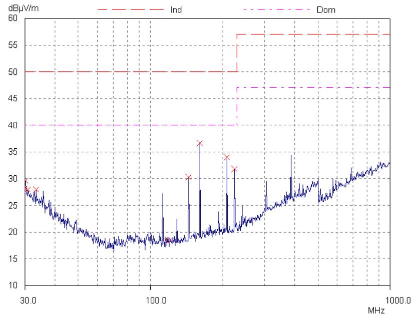
F2 DEVNETS horizontal polarisation (M40H205B)



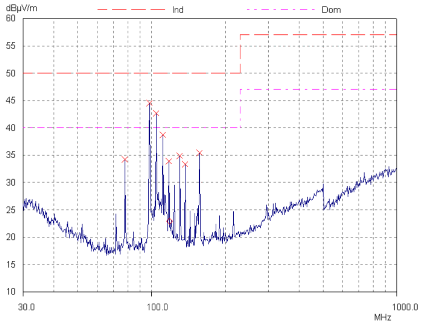
F2 DEVNETS vertical polarisation (M40V205A)



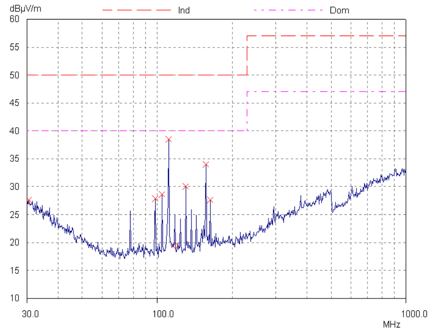
F2 SDS horizontal polarisation (M39H205B)



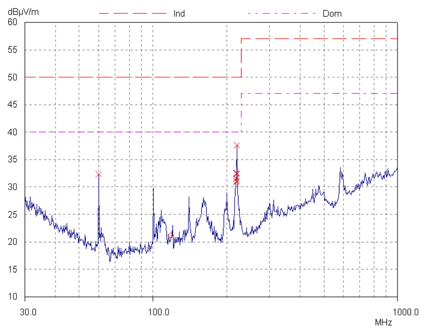
F2 SDS vertical polarisation (M39V205A)



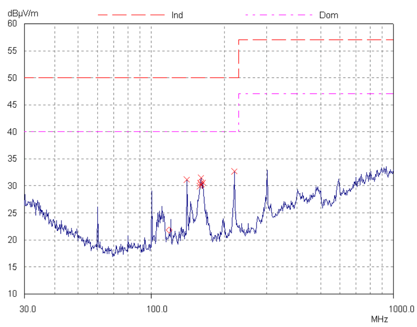
F2 CP128 horizontal polarisation (M38H205B)



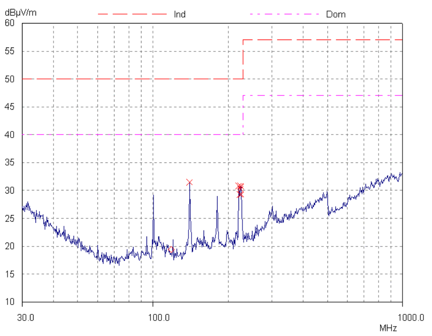
F2 CP128 vertical polarisation (M38V205A)



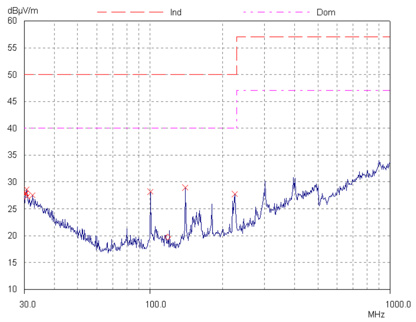
H2 EBC horizontal polarisation (M35H205C)



H2 EBC vertical polarisation (M35V205A)



H2 ECOM horizontal polarisation (M34H205D)



H2 ECOM vertical polarisation (M34V205A)

5.3.6.3 Photographs in the FAC

EUT inside the FAC

External cables in free air

External cables in conductive conduit

5.3.6.4 OATS measurements

OATS measurements with antenna in horizontal polarisation – Standard setup									
F2 DEVNETS		F2 SDS		F2 CP 128		H2 EBC		H2 ECOM	
Frequency	Amplitude	Frequency	Amplitude	Frequency	Amplitude	Frequency	Amplitude	Frequency	Amplitude
31.98	28.8	48.0	28.2	52.02	25.8	60.00	29.0	100.02	38.5
36.0	27.9	64.02	27.3	78.00	31.5	80.04	30.2	137.88	26.0
39.96	29.4	79.98	27.0	84.48	33.9	100.02	31.4	138.72	22.2
40.02	31.0	96.00	32.1	84.54	32.9	120.00	31.4	140.04	35.9
43.98	27.0	112.02	31.8	91.02	28.5	139.98	45.5	141.42	22.8
45.36	23.8	127.98	33.3	97.50	41.2	141.66	29.7	160.02	16.5
46.20	24.5	128.04	32.0	97.56	40.7	142.74	30.8	174.06	15.1
46.68	25.5	144.00	35.9	104.04	55.7	144.96	30.5	175.62	16.3
48.00	25.0	160.02	32.8	110.52	40.9	145.80	29.6	176.04	19.8
52.02	26.1	176.04	33.2	117.00	32.6	147.18	29.5	177.84	19.5
64.02	26.7	192.00	35.5	123.54	30.2	148.56	28.2	179.04	34.0
67.98	27.6	208.02	35.6	129.96	34.7	149.70	28.3	180.00	40.4
72.0	28.6	224.04	33.8	130.02	35.5	150.30	29.1	181.44	32.5
76.02	36.7	256.02	38.5	136.50	37.4	160.02	38.6	190.02	31.5
100.02	40.8	416.04	33.2	156.00	35.7	200.04	31.4	215.64	22.5
103.98	54.2			162.54	31.8	220.02	39.0	219.42	25.6
108.0	29.2					380.04	27.6	220.02	36.2
112.02	36.9					498.84	30.6		
127.98	33.5								
132.00	33.0								
136.02	26.7								
144.00	29.4								
160.02	35.7								
175.98	38.0								
208.02	8.0								
576.00	29.8								

OATS measurements with antenna in vertical polarisation – Standard setup									
F2 DEVNETS		F2 SDS		F2 CP 128		H2 EBC		H2 ECOM	
Frequency	Amplitude	Frequency	Amplitude	Frequency	Amplitude	Frequency	Amplitude	Frequency	Amplitude
31.98	33.4	31.98	32.4	71.52	27.5	40.40	26.4	100.02	45.1
36.00	32.4	48.00	37.8	78.00	38.5	44.82	26.6	138.06	49.8
39.96	30.1	64.02	28.5	84.48	39.7	60.00	32.2	138.72	32.0
40.02	31.4	112.02	43.0	84.54	39.2	97.32	40.8	140.04	43.5
43.98	31.5	127.98	40.2	91.02	40.0	97.62	37.8	140.22	38.1
44.88	28.2	128.04	39.6	97.50	42.0	98.34	35.1	141.20	29.1
45.36	26.8	144.00	41.4	97.56	40.0	100.02	45.8	150.00	25.0
46.2	29.1	160.02	33.9	104.04	57.8	100.98	54.4	220.02	34.4
46.68	30.3	176.04	33.8	123.48	40.0	101.52	38.0	260.04	26.1
48.00	33.8	192.00	34.9	129.96	43.4	102.30	50.0		
52.02	34.8	208.02	31.2	130.02	46.0	118.56	35.6		
55.98	29.5	224.04	29.0	136.50	45.4	119.04	35.0		
60.00	30.6			143.04	34.5	120.00	41.0		
67.98	33.7			149.52	32.0	124.86	35.5		
98.22	47.1			156.00	35.8	128.76	30.5		
100.02	50.3			162.54	24.0	129.54	35.8		
102.66	65.1					135.00	36.0		
103.98	63.8					138.78	40.8		
108.00	36.1					140.04	32.2		
112.02	46.0					141.18	41.1		
124.02	43.6					144.48	37.5		

127.98	43.8					180.00	32.2		
128.04	42.2					195.00	28.0		
132.0	40.0					200.04	30.1		
135.96	34.4					220.02	31.6		
136.02	37.3								
144.0	35.0								
148.02	34.0								
160.02	33.2								
163.98	26.5								
172.02	22.2								
175.98	37.0								
183.98	30.3								
184.02	32.0								
187.98	20.2								
192.00	33.0								
208.02	31.3								

OATS measurements with external cabling in metallic conduit - Horizontal antenna									
F2 DEVNETS		F2 SDS		F2 CP 128		H2 EBC		H2 ECOM	
Frequency	Amplitude	Frequency	Amplitude	Frequency	Amplitude	Frequency	Amplitude	Frequency	Amplitude
108.00	8.9	None		97.5	22.7	220.02	21.7	None	
112.02	17.5								

OATS measurements with external cabling in metallic conduit - Vertical antenna									
F2 DEVNETS		F2 SDS		F2 CP 128		H2 EBC		H2 ECOM	
Frequency	Amplitude	Frequency	Amplitude	Frequency	Amplitude	Frequency	Amplitude	Frequency	Amplitude
160.02	24.7	160.02	23.1	110.52	7.9	None		None	

5.3.6.5 Conclusions from radiated emissions

The affect of using metallic conduit is clearly dramatic, and in this case enables the EUT to pass radiated emissions tests to industrial limits.

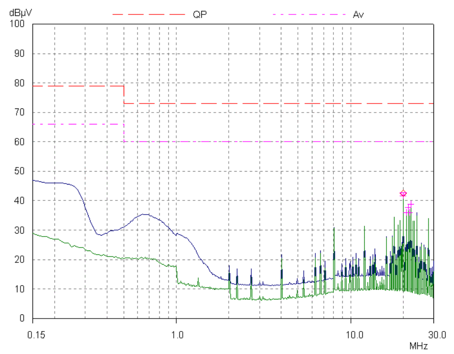
5.3.7 Conducted rf emissions

A 2m square 1mm thick aluminium ground plane was placed inside the anechoic chamber and the LISN earth was bonded to it, with three high frequency earth straps bonded in parallel. The setup in EN 55011 was utilised with the exception of the EUT height above the ground plane which was set to 0.4m as industrial controllers are neither tabletop nor floor mounted devices.

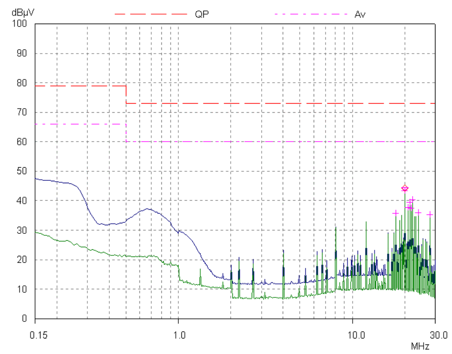
A 1m power lead and the standard D2 DS comms cable were used throughout.

Conducted emissions were carried out between live and earth, and neutral and earth from 150KHz to 30MHz. A pulse limiter with an inherent attenuation of 10dBs across the range was used and 10dBs of attenuation was applied at the LISN. Within the receiver software, a total of 20dB’s was therefore added across that range.

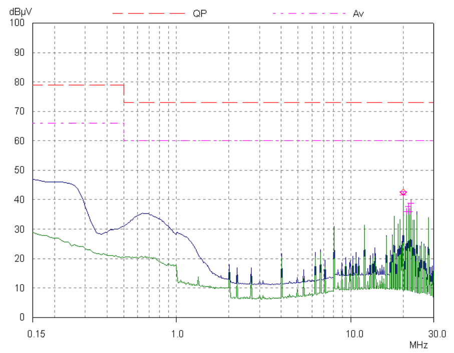
The following plots display average and quassi peak emissions and include limit lines for the stricter heavy industrial environments. Limits for domestic and light industrial environments are described in the below table.



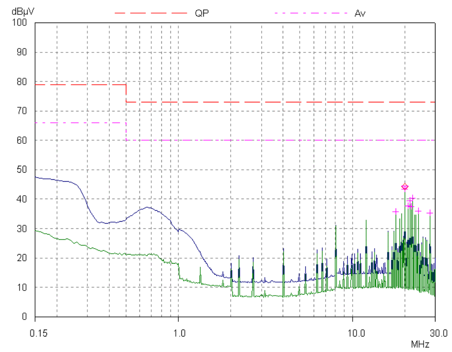
F2 DEVNETS, line to earth (M15L205A)



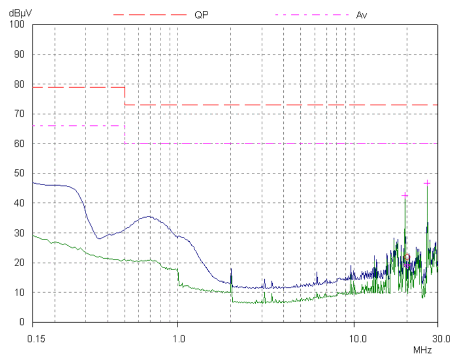
F2 DEVNETS, Neutral to earth (M15N205)



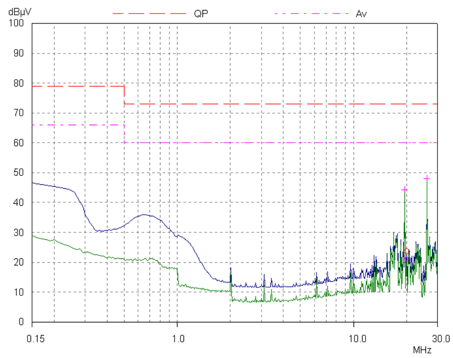
F2 SDS, line to earth (M16L205A)



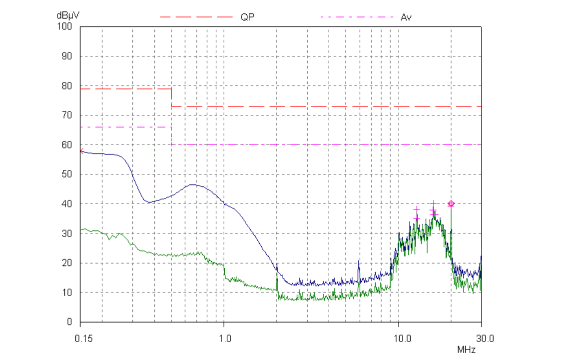
F2 SDS, Neutral to earth (M16N205A)



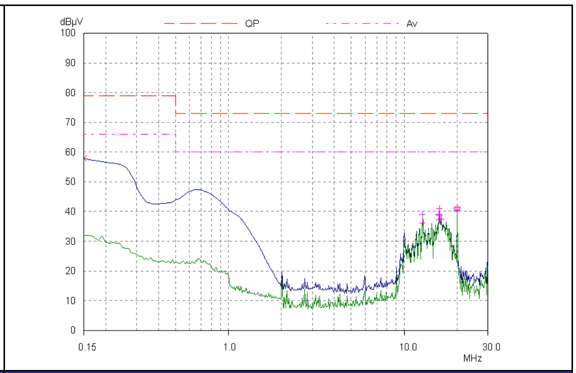
F2 CP128, line to earth (M22L205A)



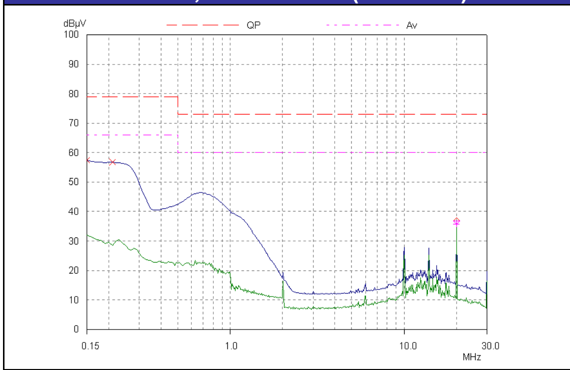
F2 CP128, Neutral to earth (M22N205A)



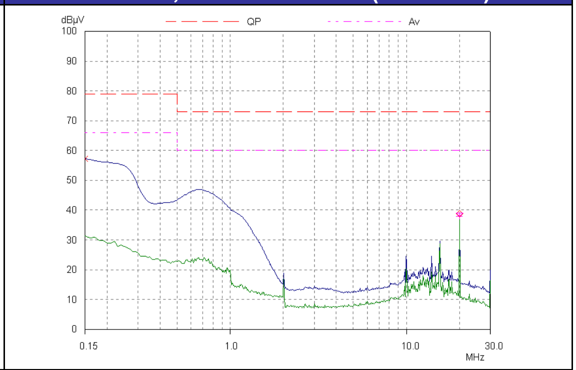
H2 EBC, line to earth (M18L205)



H2 EBC, Neutral to earth (M18N205)



H2 ECOM, line to earth (M20L205)



H2 ECOM, line to earth (M20N205)

5.3.7.1 The test limits for conducted emissions

	Frequency range	Limits (dBuV)
Domestic	150-500KHz Limits decrease linearly with log frequency	66-56 quassi peak 56-46 average
	0.5-5MHz	56 quassi peak 46 average
	5-30MHz	60 quassi peak 50 average
Industrial	150-500KHz	79 quassi peak 66 average
	0.5-5MHz	73 quassi peak 60 average
	5-30MHz	73 quassi peak 60 average

5.3.7.2 Conclusions from conducted emissions

It can be seen from the above plots that the EUT's conducted emissions although close in places, fall within the industrial limit lines.

5.3.8 Radiated rf immunity

The EUT was taken to a third party test house and tested for radiated rf immunity in accordance with EN 50082-2 which stipulates harsher levels for industrial environments. Test levels were 10v/m throughout the range 80MHz to 1GHz amplitude modulated, and a pulse at 900MHz at 10v/m was also applied.

✱✱✱✱✱✱✱✱✱✱✱✱✱