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REPORT ON ELECTROMAGNETIC COMPATIBILITY TESTS**Performed at:****TWENTY PENCE TEST SITE**

**Twenty Pence Road,
Cottenham,
Cambridge
U.K.
CB4 4PS**

on

Cardkey**P900**

Equipment Under Test (EUT): Cardkey P900

FCC ID EZO5PQP900

Test Commissioned by:
 Bewator Cotag Ltd
 Mercers Row
 Cambridge
 UK
 CB5 8EX

Representative: Martin Young

Date EUT Received: 20th August 1998

Test Started: 20th August 1998

Test Completed: 21st August 1998

Date of Report: 03 September 1998

Report Written by: Greg Halsall

Signature:

D.A. Smith pp G. Halsall

Report Checked By: Derek Barlow (Managing Director)

Signature:

D. Barlow

Date

8th September 1998

Test Standard: FCC Code of Federal Regulations 47 (1997) Part 15 Subpart C
Intentional Radiators

Summary of tests performed:

Test	Method	Limit/Severity	Result
Conducted Emissions	450kHz-30MHz ANSI C63.4-1992	FCC Subpart C,15.207	PASS
Radiated Emissions	30MHz-1GHz ANSI C63.4-1992	FCC Subpart C,15.209	PASS
Radiated Emissions	100kHz-30MHz ANSI C63.4-1992	FCC Subpart C,15.209	PASS

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1 Description of Equipment Under Test (EUT)

1.1 EUT and Peripherals

The P900 MII is a control unit for an inductive loop tag reading system. This monitors an intentional magnetic field generated by a loop source.

The EUT contained no clocks operating above 108MHz.

It had a metal case.

It is mains powered with an external power supply unit.

Details of the EUT, peripherals and cables used during the tests are listed below.
After conducted pre-scans two extra input output cables were added to ensure emissions did not increase as more cables were connected.

<u>Manufacturer</u>	<u>Model</u>	<u>Description</u>	<u>Serial No.</u>	<u>Cable</u>
Bewator Cotag	P900	EUT	0377-98G	
Bewator Cotag	280RH	280 Reading Head FCC ID NA	NA	1.5m braid screen (Belden 8777) to EUT
Bewator Cotag	090RH	090 Reading Head FCC ID NA	NA	1.5m braid screen (Belden 8777) to EUT
Dorado	644W	Swipe Reader FCC ID NA	NA	1.5m braid screen (Belden 8777) to EUT
		Unterminated i/o cable		1.5m braid screen from EUT
		Unterminated i/o cable		1.5m braid screen from EUT
Besler	A9526	110V-24V psu FCC ID NA	BE1164500AA 0001	1-2m loose spiral wrap screen, to EUT

See Figure 1 for System Layout

See Photographs 1 and 2 for Conducted Emissions Test Arrangement
and Photographs 3 and 4 for Radiated Emissions Test Arrangement

1.2 Modifications

For all of these tests ferrites were fitted to I/O leads in accordance with the instructions in the installation manual. This was the initial state of the equipment - referred to as Mod State 0.

The following modifications were made to the EUT during the course of the tests:

The wrap screen of the power cable was clamped to chassis, with its paint removed, where it exited the case.

The power cable was routed close to the chassis to minimise loop area before connecting to the input PCB

These modifications constituted Mod State 1. This is the production intent version for which the compliance results are valid.

1.3 EUT Operating Modes

The EUT was tested in the following operating mode.

The EUT was set up to drive the two reading heads (280 and 090). A card tag was placed close to the 280 reading head to activate the EUT. This was considered by the manufacturer to represent the worst case EMC situation.

1.4 Sampling Procedure

A sample of 1 item was used.

2 Test Equipment Used

	Serial No.	Last Cal	Cal interval
2.1 Conducted Emissions			
CHASE LHR 7000 Receiver			
EMCO 3825/2 LISN	1056	30 Jun 98	12 mths
	1358	21 Aug 97	12 mths
2.2 Radiated Emissions			
2.2.1 Above 30MHz			
HP 8595E Spectrum Analyser	3412A00701	13 Apr 98	12 mths
with 250k-1GHz Pre-amp	dB101	15 Apr 98	12 mths
CHASE UHR 4000 Receiver	6111	31 Jan 98	12 mths
EMCO 3104 Biconical Antenna	3449	01 Jun 98	12 mths
EMCO 3146 Log Periodic Antenna	2011	01 Jun 98	12 mths
Chase Bilog CBL6111A Antenna	1760	01 Jun 98	12 mths
2.2.2 Below 30MHz			
CHASE LHR 7000 Receiver	1056	30 Jun 98	12 mths
HP 8595E Spectrum Analyser	3412A00701	15 Apr 98	12 mths
EMCO 6502 Active Loop Antenna	2139	20 Aug 98	12 mths

3 Tests Carried Out on the EUT

3.1 Conducted Emissions

Conducted emission measurements were performed using the methods described in ANSI C63.4 1992. The limits of FCC subpart C section 15.207 were used to assess compliance. Due to one of the emissions marginally exceeding the standard limit, use was made of the 13dB relaxation for a quasi-peak reading.

The EUT and peripheral equipment were placed on a 0.8m high non-conducting bench which was positioned 0.4m from one of the metallic walls of a screened room.

Measurements were made on both the live and neutral lines using a 50ohm/50uH Line Impedance Stabilisation Network (LISN), through which the EUT was powered at 115V. Quasi-peak detection was used. The results of these scans are shown in Plots 1 and 2.

Significant emissions identified by the scans were measured and the the results are shown below

Freq MHz	Live/ Neut	Avg/ Q-Pk	Recv Readg	Total Correct	Emiss Level dB(uV)	Limit Part C dB(uV)	Margin Part C dB	
5.445	L	qp	48.3	0.41	48.7	48.0	-0.7	#1
5.445	L	av	40.1	0.41	40.5	48.0	7.5	
5.445	L	qp	35.3	0.41	35.7	48.0	12.3	#2
7.392	L	qp	37.4	0.45	37.8	48.0	10.2	
9.240	L	qp	35.0	0.48	35.5	48.0	12.5	
18.479	L	qp	33.6	0.67	34.3	48.0	13.7	
20.000	L	qp	32.8	0.70	33.5	48.0	14.5	
27.718	L	qp	37.5	0.85	38.4	48.0	9.6	
5.544	N	qp	47.4	0.41	47.8	48.0	-0.2	#1
5.544	N	av	39.0	0.41	39.4	48.0	8.6	
5.544	N	qp	34.4	0.41	34.8	48.0	13.2	#2
7.392	N	qp	36.7	0.45	37.1	48.0	10.9	
9.240	N	qp	33.9	0.48	34.4	48.0	13.6	
14.784	N	qp	32.8	0.60	33.4	48.0	14.6	
18.479	N	qp	33.0	0.67	33.7	48.0	14.3	
20.000	N	qp	32.2	0.70	32.9	48.0	15.1	
27.718	N	qp	37.3	0.85	38.2	48.0	9.8	

#1 These readings were close to or marginally exceeded the standard limit using the quasi-peak detector, however, the average reading was more than 6dB lower than the quasi-peak, therefore a 13dB reduction was made to the reading as per 15.207.

The EUT was then found to comply with the conducted emission requirements of 47CFR Part 15 Subpart C with a margin of 7.5dB.

3.2 Radiated Emissions

Radiated emission measurements were performed using the methods described in ANSI C63.4 1992. The limits of FCC subpart C section 15.209 were used to assess compliance.

3.2.1 Above 30MHz

Initial scans were performed in a semi-anechoic screened room a distance of 3m using peak detection. Scans were performed over the frequency range 30MHz to 1GHz with the antenna both horizontally and vertically polarised. During these scans the EUT and peripherals were rotated through 360°.

The results of these scans are shown in plots 3 and 4.

Radiated Emission Scan Test 1 and Test 2

Significant emissions identified by the scans were measured on an open area test site at the specified measuring distance of 3m using quasi-peak detection. Maximised readings were obtained by rotating the EUT through 360° and adjusting the height of the antenna from 1m to 4m. Measurements were made with the antenna both horizontally and vertically polarised.

Frequency MHz	Receiver Reading dB(uV)	Antenna Correctn dB	Field Strength dB(uV/m)	Limit FCC(C) dB(uV/m)	Margin dB
BICONICAL AERIAL @ 3m					
30.00 V	3.0	15.0	18.0	40.0	22.0
30.74 V	8.0	14.7	22.7	40.0	17.3
31.43 V	13.5	14.5	28.0	40.0	12.0
66.54 V	12.0	10.1	22.1	40.0	17.9
94.25 V	17.5	12.4	29.9	43.5	13.6
98.00 V	20.0	13.6	33.6	43.5	9.9
105.34 V	19.5	14.8	34.3	43.5	9.2
109.02 V	17.0	15.3	32.3	43.5	11.2
112.72 H	13.0	16.3	29.3	43.5	14.2
120.12 H	12.5	16.5	29.0	43.5	14.5
129.36 H	25.6	15.0	40.6	43.5	2.9
160.76 H	18.4	18.2	36.6	43.5	6.9
171.86 H	17.5	18.5	36.0	43.5	7.5
186.64 H	13.5	19.6	33.1	43.5	10.4
192.19 H	13.5	19.8	33.3	43.5	10.2
195.87 H	18.0	19.9	37.9	43.5	5.6
199.58 H	13.5	20.1	33.6	43.5	9.9
LOG PERIODIC AERIAL @ 3m					
214.35 H	21.5	15.2	36.7	43.5	6.8
218.04 H	20.7	15.1	35.8	46.0	10.2

V=vertical,H=horizontal, BB=broadband

LOG PERIODIC AERIAL @ 3m

214.35 H	21.5	15.2	36.7	43.5	6.8
218.04 H	20.7	15.1	35.8	46.0	10.2

V=vertical,H=horizontal, BB=broadband

The EUT was found to comply with the radiated emission requirements above 30MHz of FCC part 15 subpart C with a minimum margin of 2.9 dB at 129.36MHz.

3.2.2 Below 30MHz

Initial scans were performed in a semi-anechoic screened room a distance of 3m using peak detection. Scans were performed over the frequency range 100kHz to 30MHz with the antenna both Coaxial (parallel) and orthogonal to the EUT. During these scans the EUT and peripherals were rotated through 360° except for the intentional carrier frequency which was done from the front only.

The results of these scans are shown in plots 5 to 9

Radiated Emission Scan Test 3 to Test 7

Only one significant emission was identified by the scans - the intentional carrier frequency. This was re-measured on an open area test site at the measuring distances of 3m, 10m and 30m using peak and average detection.

Measurements were made with the antenna both coaxial and orthogonal to the EUT. Coaxial was significantly higher.

At the intentional carrier frequency of 132kHz the limit at 300m is 18.18uV/m or 25.2 dBuV/m. This is still in the near field (wavelength/(2 pi) = 362m).

A magnetic source being measured by a loop has a theoretical extrapolation factor of -60dB per decade of distance. However while the results from 3m to 10m (half a decade) support this, those from 10m to 30m suggest an extrapolation factor of 50dB per decade may be more appropriate (as per FCC 47 section 15.31(f)(2)).

A harsher scenario would be to only increase the limits by:

40dB per decade from 300m to 30m

and by 40dB per decade from 30m to 10m (20dB per half decade)
and by 60dB per decade from 10m to 3m (30dB per half decade)

This has been done for the results below and for frequencies below 490kHz see **Scans 3,4 and 7**

Peak Detector

Distance	Coaxial	Orthogonal	Limit dBuV/m dB	Margin
3m	111.2	97.6	115.2	4.0
10m	82.6	69.6	85.2	2.6
30m	57.6	Not measured	65.2	7.6
300m	Not measured	Not measured	25.2	NA

Average Detector

Distance	Coaxial	Orthogonal	Limit dBuV/m dB	Margin
3m	112.6	100.6	115.2	2.6
10m	81.6	66.6	85.2	6.6
30m	56.6	Not measured	65.2	8.6
300m	Not measured	Not measured	25.2	NA

For frequencies above 490kHz an extrapolation of 40dB per decade was used from 30m to 3m (as per FCC 47 section 15.31(f)(2)), see **Scans 5 and 6**.

The EUT was found to comply with the radiated emission requirements below 30MHz of FCC part 15 subpart C with a minimum margin of 2.6 dB at 132.0kHz at 3m and 10m distance.



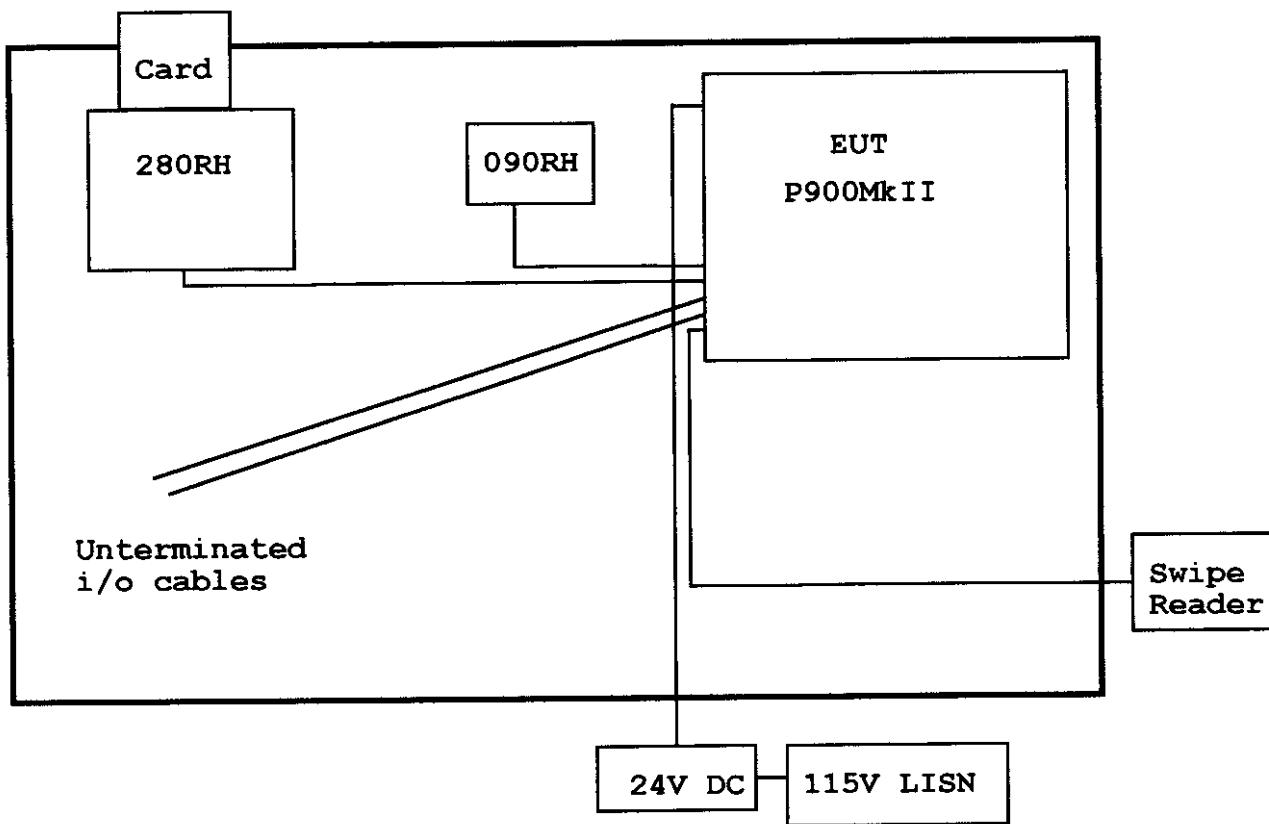
4 Summary of Results

The EUT with the modifications noted in section 1.2 (Mod State 1) was found to comply with the emissions requirements of FCC 47CFR Part 15 Subpart C.

It had minimum margins as follows:-

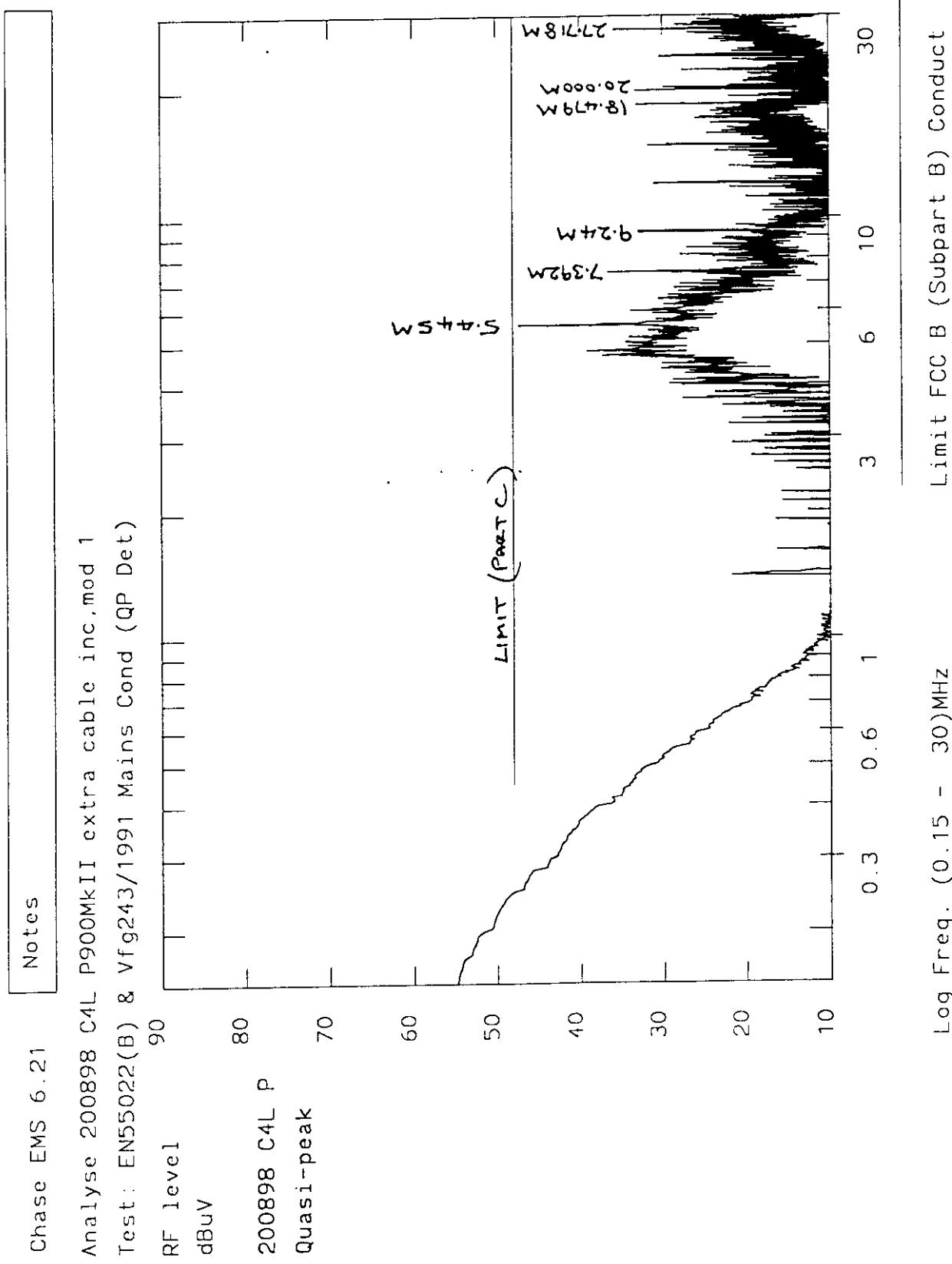
Conducted	7.5dB
Radiated above 30MHz	2.9dB @ 129.36MHz
Radiated below 30MHz	2.6dB @ 132kHz

Figure 1: General Arrangement of EUT and Peripherals



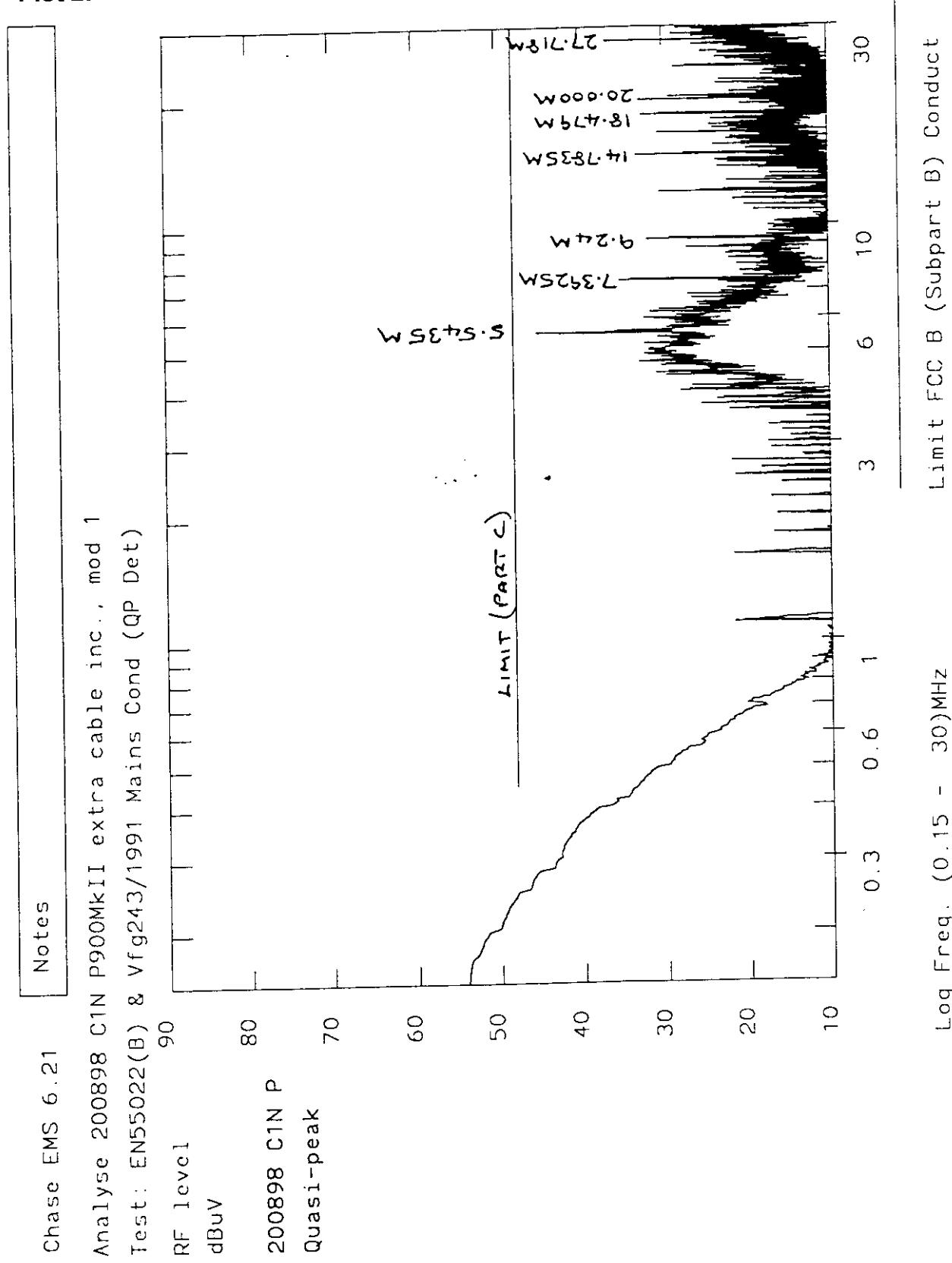
Plot 1:

Conducted Scan - Live Conductor



Plot 2:

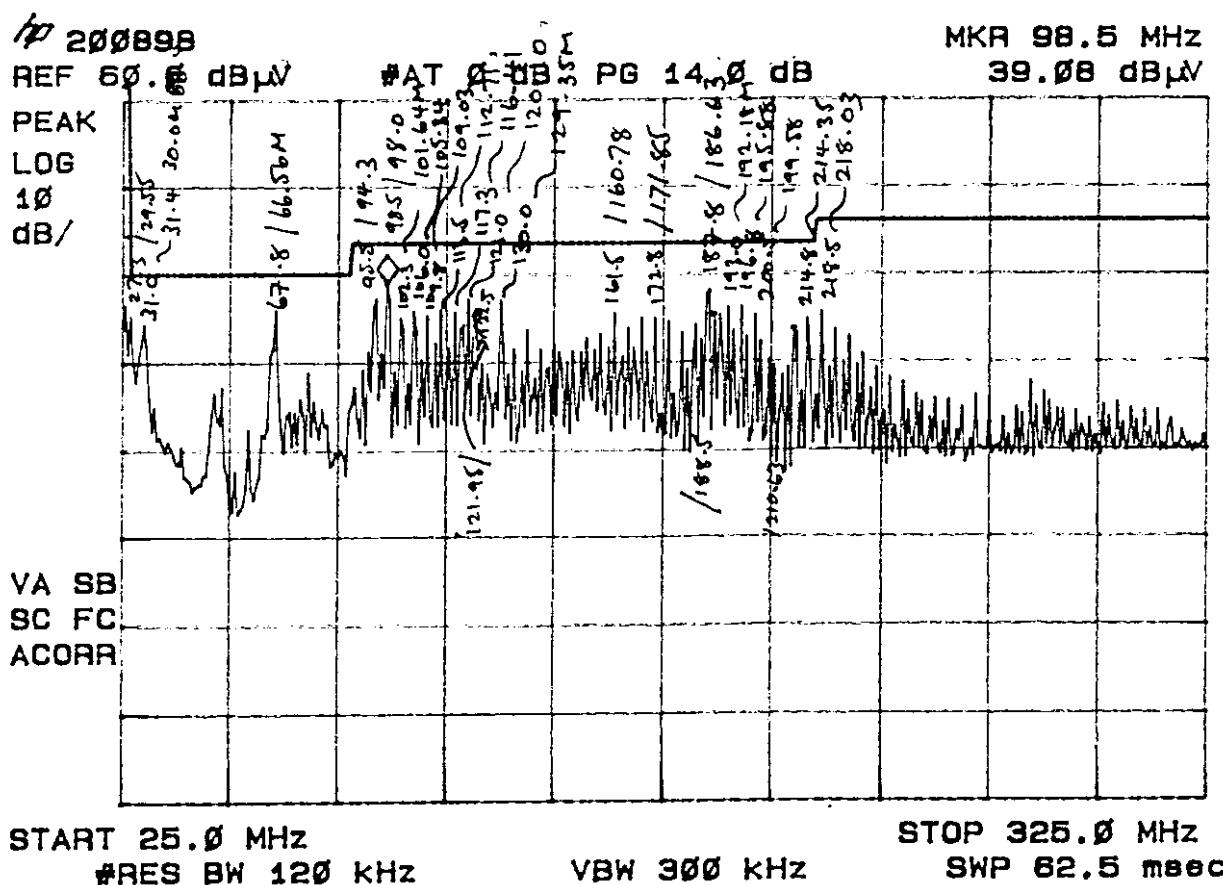
Conducted Scan - Neutral Conductor



Plot 3:

Radiated Scan - 30MHz to 300MHz

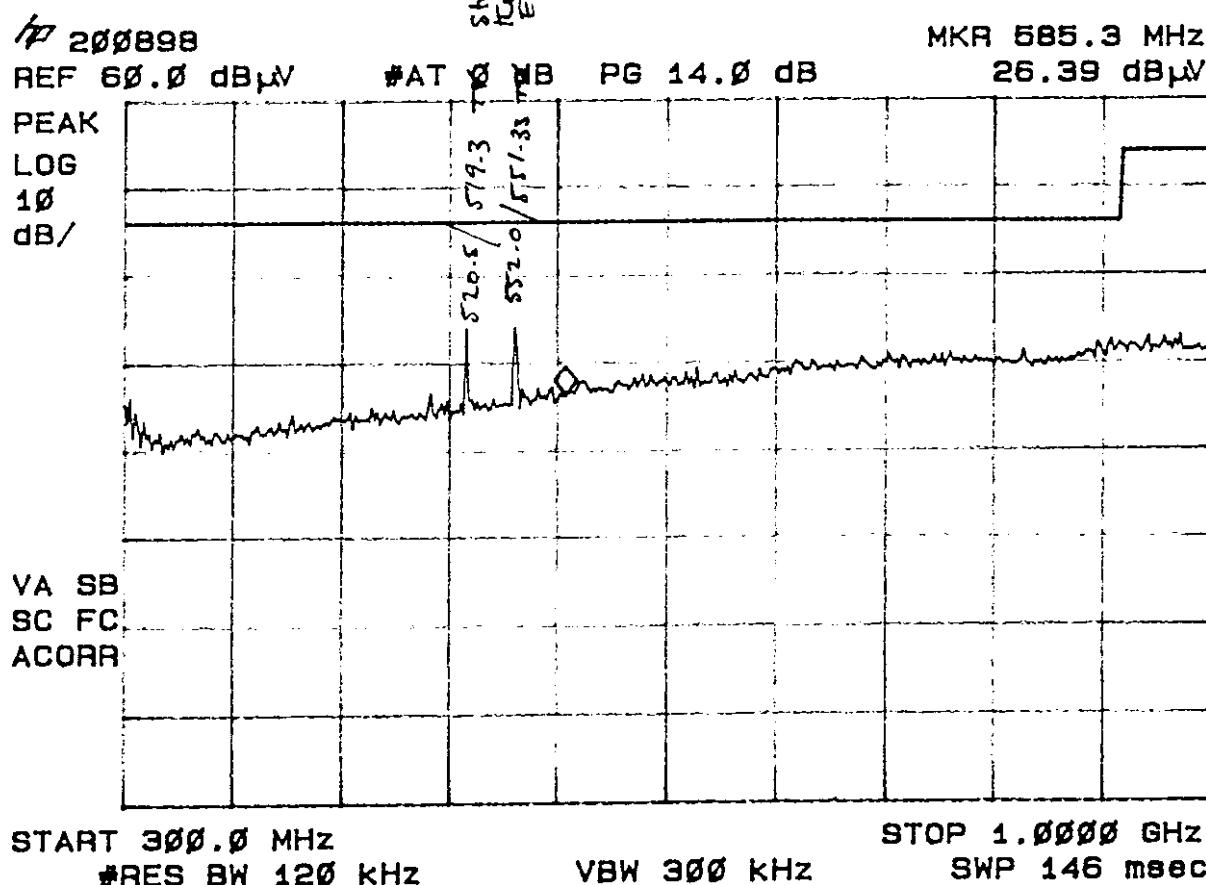
PLOT Radiated Emission Scan								
Test	Mod. State	Operating Mode	Detector	Antenna	Distance	Pol	Height	EUT Orientation
1	1	1	PK	AS	3	V	1.5	360
Company: <i>Conex</i>					3	H	1.5	360
Product: <i>P900 MkII</i>					+			
Date: <i>20/8/98</i>					+			
Test Engineer: <i>GJH</i>					+			
Test Equipment:					Scans performed in semi-anechoic screened room approx. 8m x 5m x 4.5m			



Plot 4:

Radiated Scan - 300MHz to 1GHz

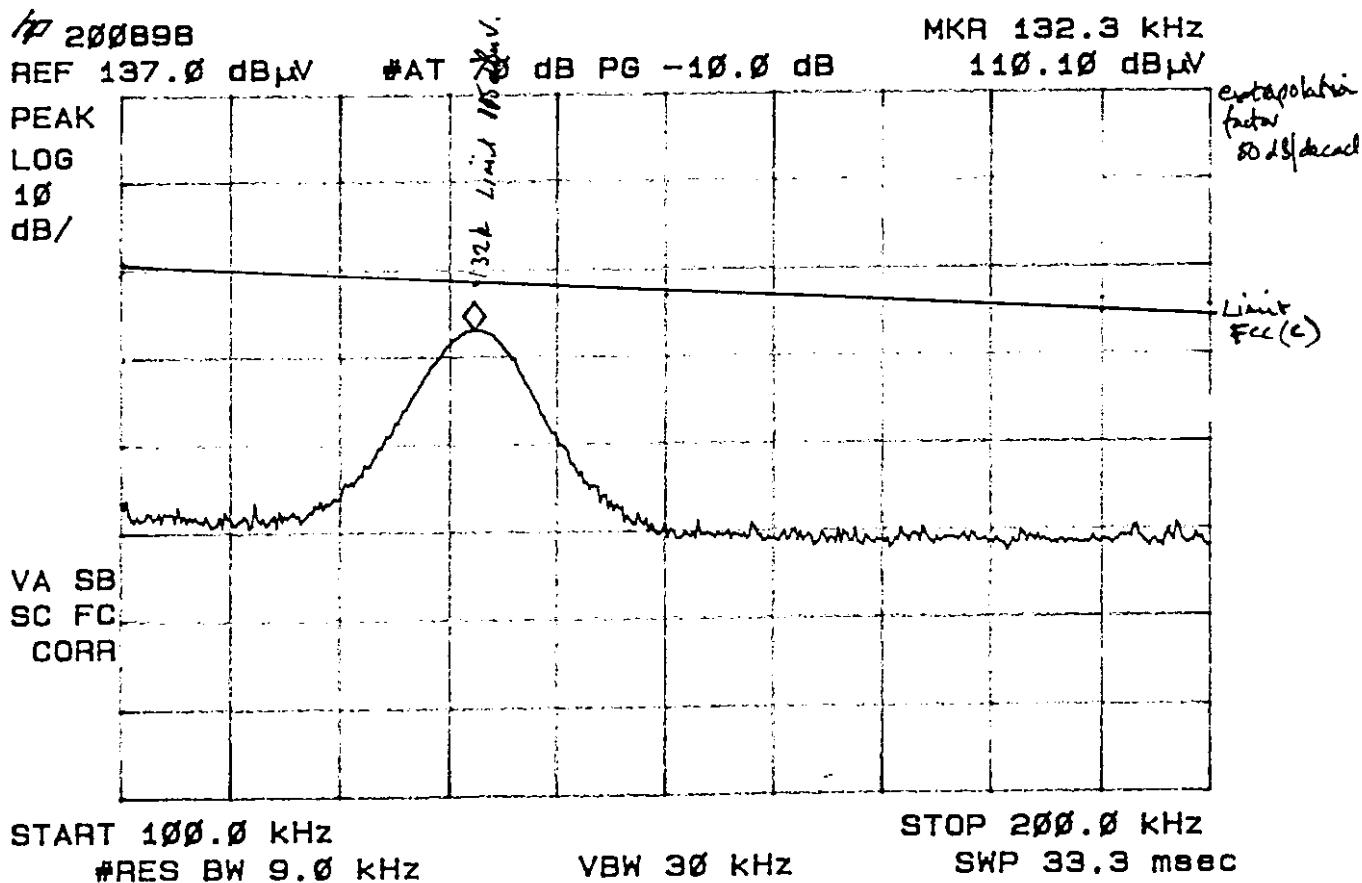
PLOT Radiated Emission Scan					Distance	Pol	Height	EUT Orientation
Test	Mod. State	Operating Mode	Detector	Antenna				
2	1	1	PIC	AS	3	V	1.5	360
Company:	GOTAG				3	H	1.5	360
Product:	P900 MKII							
Date:	20/8/18							
Test Engineer:	GJH							
Test Equipment:					Scans performed in semi-anechoic screened room approx. 8m x 5m x 4.5m			



Plot 5:

Radiated Scan - 100kHz to 200kHz

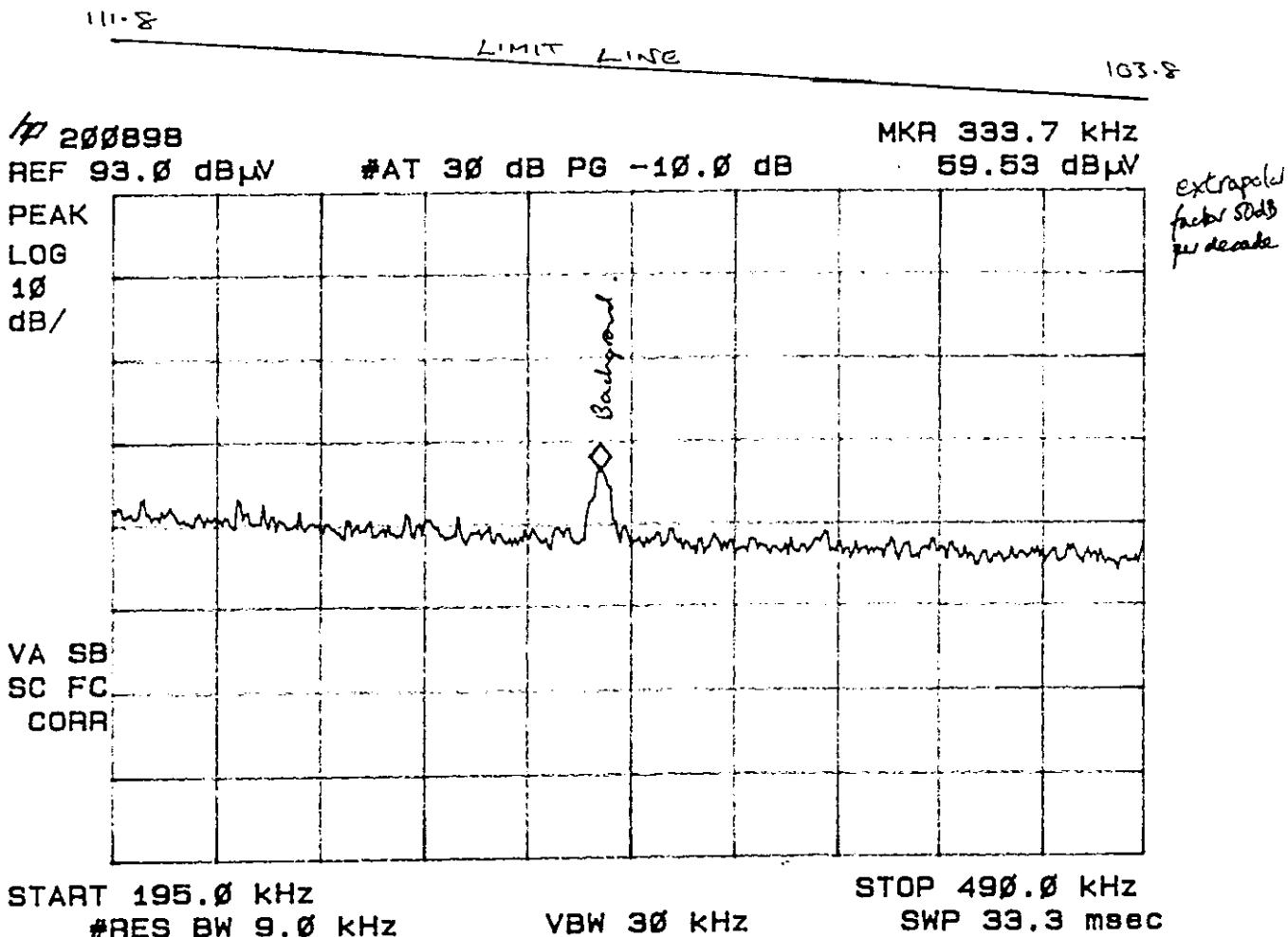
PLOT Radiated Emission Scan					EUT Orientation			
Test	Mod. State	Operating Mode	Detector	Antenna	Distance	Pol	Height	Orientation
3	1	1	PK	Loop	3	COAX	1.5	F
Company:	P900MKII				+			
Product:	CORAG				+			
Date:					+			
Test Engineer:					Scans performed in semi-anechoic screened room approx. 8m x 5m x 4.5m			
Test Equipment:								



Plot 6:

Radiated Scan - 200kHz to 450kHz

PLOT Radiated Emission Scan								
Test	Mod. State	Operating Mode	Detector	Antenna	Distance	Pol	Height	EUT Orientation
A	1	1	PK	LOOP	3	COAX	1.5	360
Company:	Compaq				+	ORTH	1.5	360
Product:	P900 MKII				+			
Date:					+			
Test Engineer:								
Test Equipment:								
					Scans performed in semi-anechoic screened room approx. 8m x 5m x 4.5m			

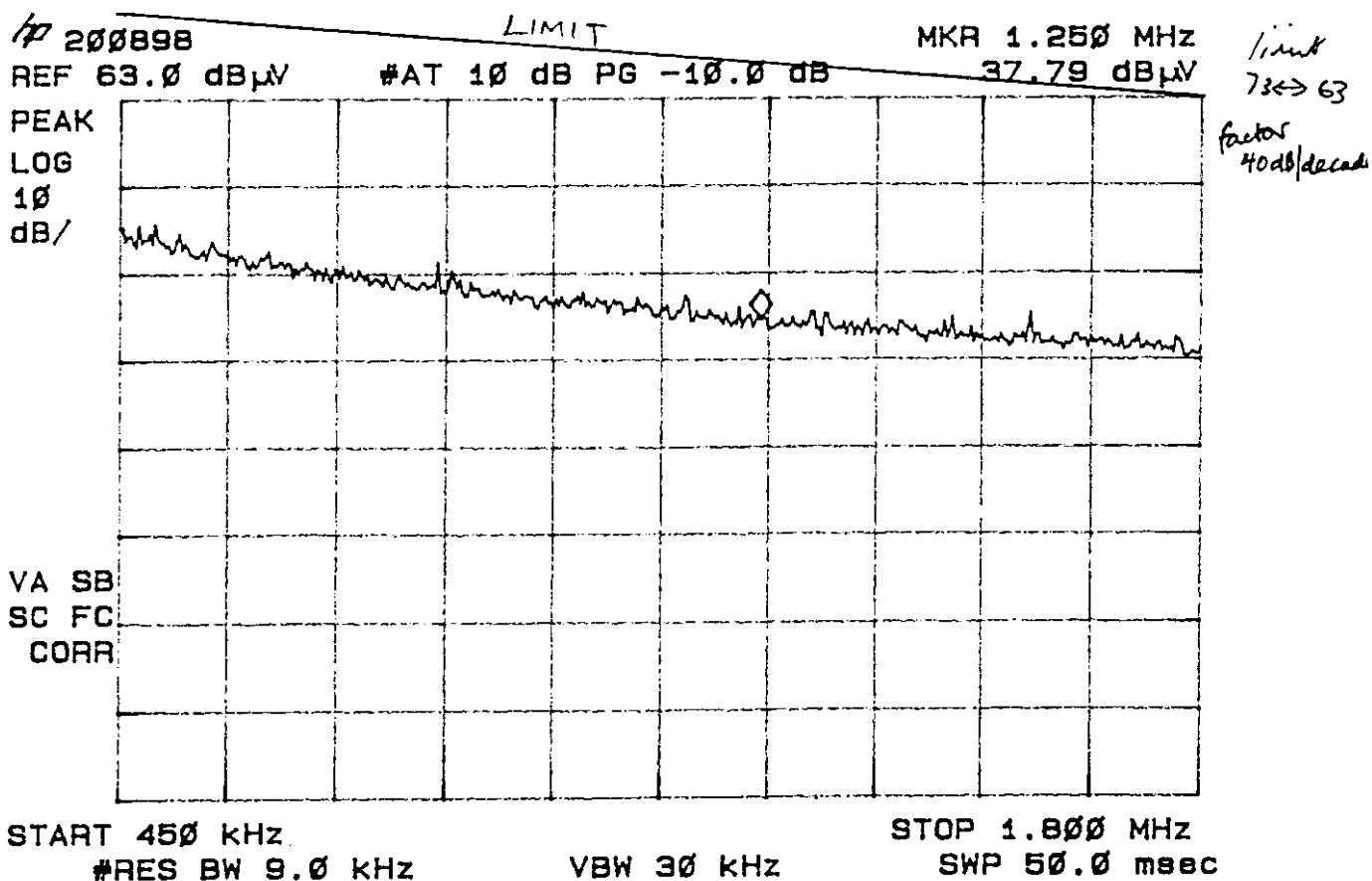




Plot 7:

Radiated Scan - 450kHz to 1.8MHz

PLOT Radiated Emission Scan								
Test	Mod. State	Operating Mode	Detector	Antenna	Distance	Pol	Height	EUT Orientation
5	1	1	PK	LOOP	3	CDAX	1.5	360
Company:	COAG				+	3	0RTH	1.5
Product:	P900 MKII				+			360
Date:					+			
Test Engineer:								
Test Equipment:								
Scans performed in semi-anechoic screened room approx. 8m x 5m x 4.5m								

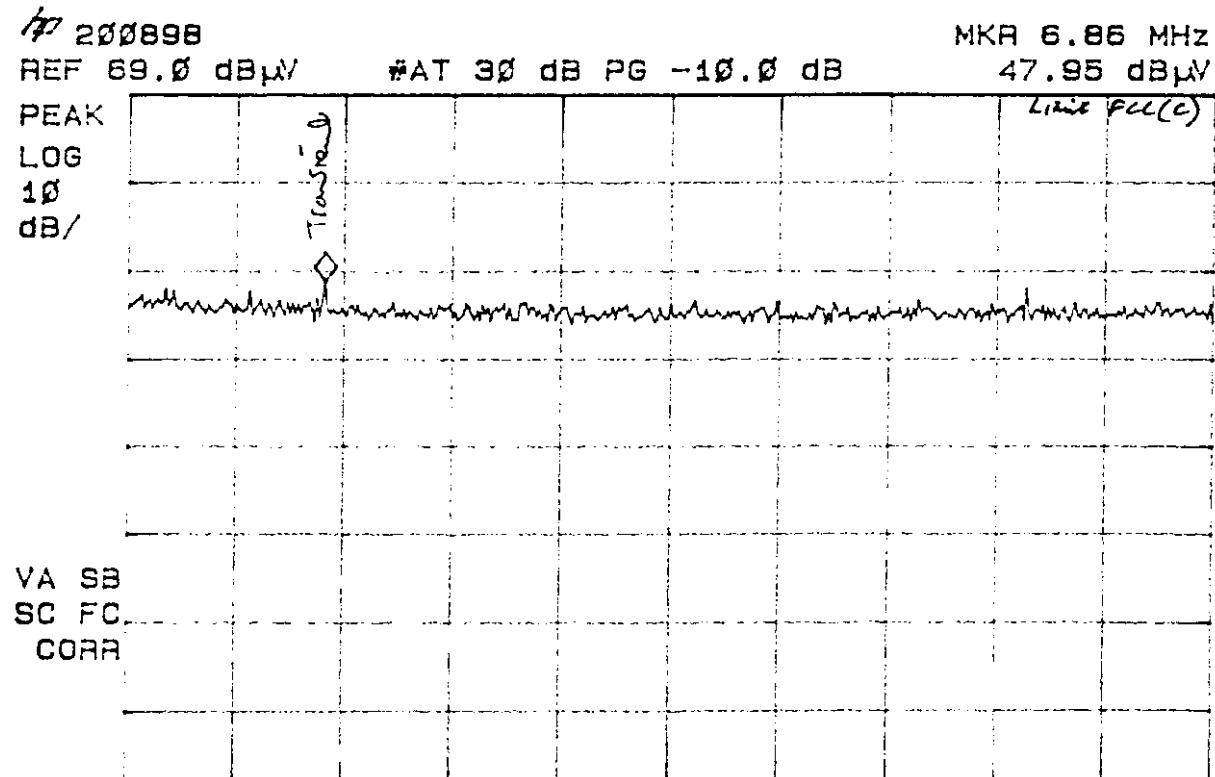


Plot 8:

Radiated Scan - 1.8MHz to 30MHz

PLOT Radiated Emission Scan

Test	Mod. State	Operating Mode	Detector	Antenna	Distance	Pol	Height	EUT Orientation
6	1	1	PK	Loop	3	COAX	1.5	360°
Company:					+	ORTH	1.5	360°
Product:					+			
Date:					+			
Test Engineer:								
Test Equipment:								
								Scans performed in semi-anechoic screened room approx. 8m x 5m x 4.5m



START 1.70 MHz
#RES BW 9.0 kHz

VBW 30 kHz

STOP 30.00 MHz
SWP 1.05 sec

Plot 9:

Radiated Scan - 150kHz to 200kHz
(Detail in tail of primary emission peak)

PLOT Radiated Emission Scan								
Test	Mod. State	Operating Mode	Detector	Antenna	Distance	Pol	Height	EUT Orientation
7	1	1	PK	Loop	3	COAX	1.5	360
Company:	COTAG				3	0TH	1.5	360
Product:	P900 MKII				+			
Date:					+			
Test Engineer:					+			
Test Equipment:								
Scans performed in semi-anechoic screened room approx. 8m x 5m x 4.5m								

LIMIT

