Vehicle Mounted
RADAR DETECTORS
(Project 706)

An RTCG Project Report

March 2002

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Radio Technology & Compatibility Group

Project No. 706

Vehicle Mounted
RADAR DETECTORS
(version 2.1)

All work associated with this project was carried out in accordance with procedures specified in the RTCG Quality Manual and comply with the requirements of ISO/IEC 17025:1999.

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Abstract

The potential for vehicle-mounted ‘speed-trap’ radar detectors to cause interference to Ku-Band Earth Stations was identified in the Satellite Consultative Committee paper SCC(01)16.

As the WTAct provides no control for receive only radar detectors, the RTCG was requested to procure, and evaluate the emissions from, a small number of vehicle-mounted radar detectors. Specifically, the RTCG was requested to determine via measurement the frequency and e.i.r.p. of any significant emissions found (paying particular attention to those falling between 10 and 13 GHz), and assess whether these should be deemed excessive.

Measurements showed that all of the of vehicle-mounted radar detectors tested radiated high-level emissions across a range of frequencies in two distinct microwave bands (11.4 to 12.1 GHz, and 22.8 to 24.2 GHz approximately). The magnitude of these emissions was typically 3 mW in the lower frequency band and 12 mW in the upper frequency band.

Practical tests demonstrated that the radiated emissions in the lower frequency band (11.4 to 12.1 GHz) were of a sufficient magnitude to cause interference to a nearby Sky digital satellite installation.

A theoretical assessment indicated with reasonable confidence, that the radiated emissions in the upper frequency band (22.8 to 24.2 GHz) were of a sufficient magnitude to cause interference to police radar speed meters operating in the 24.05 to 24.15 GHz band.

It was noted that;

Emission limits are set in specifications and standards to protect radio services from interference. Although there appears to be no specification or limit applicable to the vehicle-mount radar detectors tested, their radiated spurious emissions would fail to meet the requirements of any known standard or specification, including those applicable to radio transmitters.

The radiated emissions from the DUT’s tested, which are in effect dual-band (12/24 GHz) receivers, exceed the 30 dBpW radiated limit for direct to home satellite receiving systems (EN 55013) by 60 dB at 12 GHz and 70 dB at 24 GHz. Radiated emissions of this magnitude must be considered excessive and unacceptable.

The magnitude of the radiated emissions measured suggest that the designer and manufacturer have made no attempt to limit the interference potential of the vehicle-mounted radar detectors.

CONTENTS

List of Abbreviations

dB	Decibel (Power Ratio, 0.1 Bels, $10.\log_{10}(P_1/P_2)$)
dBm	Decibels relative to 1 milli-Watt
dBpW	Decibels relative to 1 pico-Watt
DUT	Device Under Test
E.i.r.p.	Effective Isotropic Radiated Power
GHz	Giga-Hertz (10^9 cycles/second)
G-TEM	GHz Transverse Electromagnetic Mode
MHz	Mega-Hertz (10^6 cycles/second)
mW	milli-Watt (10^{-3} Watts)
WTAct	Wireless Telegraphy Act

1.0 Introduction

The potential for vehicle-mounted ‘speed-trap’ radar detectors to cause interference to Ku-Band Earth Stations was identified in the Satellite Consultative Committee paper SCC(01)16.

As the WTAct provides no control for receive only radar detectors, the RTCG was requested to procure, and evaluate the emissions from, a small number of vehicle-mounted radar detectors. Specifically, the RTCG was requested (by Mike Hailstone, RA3/FTSL) to determine via measurement the frequency and e.i.r.p. of any significant emissions found (paying particular attention to those falling between 10 and 13 GHz), and assess whether these should be deemed excessive.

2.0 Test Methods

2.1 Pre-test Assessment

The significant emissions emanating from the DUT were initially identified by placing the DUT in a G-TEM cell, and viewing the emissions via a spectrum analyser connected to the G-TEM cell's input/output port. This eliminated extraneous ambient signals and enabled the entire frequency range of interest could be viewed with ease. The G-TEM cell also provide a convenient environment to evaluate the effect of the DUT’s controls (operating modes) and supply voltage on the spectra emitted.

The following were assessed and recorded during the pre-assessment :-

a) The approximate centre frequency of the emissions identified
b) the start and stop frequency of specific emissions, together with an assessment of their sweep rate (measured using the spectrum analyser in the time domain i.e. zero span)
c) the effect of the DUT’s controls and supply voltage on the spectra (frequency and level)
d) the level of the emissions at the G-TEM cells input/output port

Finally, a radiating source was placed in the G-TEM to permit the approximate e.i.r.p. of the major emissions to be estimated, and thus provide a confidence check for the more accurate spurious emission (radiated, substitution, absolute) measurements that were to follow.

2.2 Spurious Emissions (Radiated, Substitution, Absolute) Measurements

The absolute effective radiated power of the DUT's spurious emissions were measured using RTCG procedure P-131A (modified to cover frequencies >5GHz). This procedure uses a substitution technique to reduce the measurement uncertainty.

The modifications required to extend the upper frequency range were; a) replacing calibrated dipoles with calibrated horn antennae; b) removing the matching pad (undesirable but necessary); and c) replacing the power meter with a spectrum analyser. The effect of these modifications on the measurement uncertainty was assessed, and the uncertainty re-calculated.

Finally, two confidence checks were performed :-

a) the measured e.i.r.p. was compared to the estimated e.i.r.p. obtained during the pre-test assessment
b) the power displayed on the spectrum analyser was compared with that expected from a source of known e.i.r.p. after taking account of the antenna gains, and the path and cable losses etc.

The RTCG standard measurement procedure (P-131A), together with full details of the modifications briefly detailed above, and the associated uncertainty measurement calculations, have not been included in this report but are retained on file.

2.3 Practical Exercise to Assess Interference to Satellite TV (digital)

The three DUT's were installed, one at a time, in the project managers car and driven around the RTCG's front car park whilst a second engineer observed the effect on a domestic Sky digital satellite receiver (belonging to the project manager).

Interference to a number of Sky channels, from numerous vehicle positions was assessed. The precise details of each assessment were not recorded as it would have been impractical to assess all of the variables desired if everything was recorded. The aim of this exercise was simply to confirm whether or not any interference that might be predicted theoretically, could actually be observed in practice.

Two-way radio (PMR 446) was used for communications between the viewer and the DUT/vehicle operator. It was confirmed that the two-way radio system was not causing interference to the Sky satellite receiving system.

3.0 Test Results

3.1 Pre-Test Assessment in G-TEM Cell

TABLE 1 Assessment of Radiated Emissions at ≈11.5 GHz

DUT	Start Frequency	Stop Frequency	Sweep Time	Estimated E.i.r.p.
1	≈11.433 GHz	≈11.794 GHz	≈130 ms	≈+3.6 dBm
2	≈11.833 GHz	≈12.110 GHz	≈100 ms	≈+6.1 dBm
3	≈11.592 GHz	≈11.846 GHz	≈70 ms	≈+2.6 dBm

Note: The frequencies and levels observed appeared to be unaffected by the DUT's 'mode' selected, or the supply voltage (10.5 to 16.0 Volt)
The measurement uncertainty has not been estimated for these pre-test assessments.

TABLE 2 Assessment of Radiated Emissions at ≈23 GHz

DUT	Start Frequency	Stop Frequency	Sweep Time	Estimated E.i.r.p.
1	≈22.862 GHz	≈23.590 GHz	≈130 ms	Not estimated
2	≈23.662 GHz	≈24.215 GHz	≈100 ms	Not estimated
3	≈23.190 GHz	≈23.693 GHz	≈70 ms	Not estimated

Note: The frequencies and levels observed appeared to be unaffected by the DUT's 'mode' selected, or the supply voltage (10.5 to 16.0 Volt)
The measurement uncertainty has not been estimated for these pre-test assessments.

TABLE 3 Assessment of Radiated Emissions at ≈34.5 GHz

DUT	Start Frequency	Stop Frequency	Sweep Time	Estimated E.i.r.p.
1	≈34.300 GHz	>35.000 GHz*	*	*
2	*	*	*	*
3	*	*	*	*

Note: Items marked* were unmeasureable due to SA noise floor (-83 dBm in 30 kHz RBW)
The measurement uncertainty has not been estimated for these pre-test assessments.

TABLE 4 Assessment of Radiated Emissions at Other Frequencies

DUT	Emission 1	Emission 2	Estimated E.i.r.p.
1	≈43 MHz (-90 dBm)	≈58 MHz (-90 dBm)	Not estimated
2	≈1.36 GHz (-81 dBm)	≈4.088 GHz (-82 dBm)	Not estimated
3	≈43 MHz (-62 dBm)	≈1.95 GHz (-81 dBm)	Not estimated

Note: The emission levels shown (dBm) are the power at the input/output port of the G-TEM cell. These levels, measured in a 30 kHz RBW, are for information only. They can not be readily translated to e.i.r.p.
The measurement uncertainty has not been estimated for these pre-test assessments.
No emissions, other than those detailed in Tables 1, 2, 3 & 4 were detected above the SA noise floor (-96 dBm <1 GHz, -93 dBm <5 GHz, -90 dBm <20 GHz, -83 dBm <50 GHz all in a 30 kHz RBW)

3.2 Spurious Emissions (Radiated, Substitution, Absolute) Measurements

TABLE 5	**Radiated Emissions at ≈11.5 GHz**	
DUT	Approximate Measurement Frequency	Measured E.i.r.p.
1	11.5 GHz	-0.1 dBm
2	12.0 GHz	+8.6 dBm
3	11.7 GHz	+2.8 dBm

Note: Supply voltage = +13.8 V, DUT warm-up period = 15 minutes, DUT 'mode' = mode selected by DUT when first switched on, ambient temperature = 18 - 22^{o} C
Measurement uncertainty = ±5.24 dB which is based upon a standard uncertainty multiplied by a coverage factor k=2 providing a level of confidence of approximately 95%.

TABLE 6	**Radiated Emissions at ≈23 GHz**	
DUT	Approximate Measurement Frequency	Measured E.i.r.p.
1	23.0 GHz	+5.5 dBm
2	24.0 GHz	+11.0 dBm
3	23.4 GHz	+12.8 dBm

Note: Supply voltage = +13.8 V, DUT warm-up period = 15 minutes, DUT 'mode' = mode selected by DUT when first switched on, ambient temperature = 18 - 22^{o} C
Measurement uncertainty = ±6.52 dB which is based upon a standard uncertainty multiplied by a coverage factor k=2 providing a level of confidence of approximately 95%.

3.3 Practical Exercise to Assess Interference to Satellite TV (digital)

All three DUT's were found to cause interference to the Sky digital satellite TV channels that used frequencies within the band occupied by the DUT's spurious emissions. These included the free to air services such as BBC1 & 2, as well as the premium and pay-per-view channels. The interference manifested itself as 'blocking' or 'freezing' of the picture, and/or a loss of sound.

Interference was observed from 100% of the locations when the distance between the DUT/vehicle and satellite dish was less than approximately 5 metres, and approximately 50% of the locations when the distance was increased to approximately 10 metres. Under these conditions the maximum interference did not occur when the DUT/vehicle was directly in front of the dish as might be expected, presumably because the main-lobe was not directed at the DUT/vehicle whereas the dish's side or back-lobes may have been. Interference from random locations at distances of upto 20 metres was also observed, often when the DUT was pointing away from the dish. This is believed to have been due to back-scatter from a group of large trees under the main-lobe of the dish.

It should be noted that dish used was a 1 metre offset feed, and not the standard Sky 'mini-dish'. The magnitude on the interference would, in practice, be expected to be greater than that observed because; a) the level of the wanted satellite signal would be lower with a 'mini-dish', and b) a 'mini-dish' would offer less rejection to 'off-axis' interference.

3.4 Theoretical Assessment of Interference to Police Radar Speed Meters

3.4.1 Basic Operation and Design of Police Radar Speed Meters

Police radar speed meters operate in the band 24.05 GHz to 24.15 GHz. Although precise information regarding the sensitivity and protection requirements of these meters is difficult to obtain (for obvious reasons); a manufacturer was willing to confirm that the receiver simply mixed a portion of the transmitted signal with the received signal in a schottky diode to produce a baseband signal. Signal processing is then performed on this baseband signal to determine a vehicle's speed. This manufacturer was also willing to confirm that the antenna gain was approximately 20 dBi, and that the e.i.r.p. was approximately +30 dBm.

3.4.2 Sensitivity Calculations

Due to the lack of precise information, a number of assumptions have to be made e.g. the receiver's bandwidth and noise figure. To aid confidence, the sensitivity was calculated twice using different methodologies.

3.4.2.1 Sensitivity Based on Noise Figure and Bandwidth etc.

The sensitivity of a receiver (including a speed meter) is given, approximately, by the following equation[1]

$$S = -174\ \text{dBm} + NF + 10 \log B + Ksn + Km$$

where:

S	=	sensitivity in dBm
-174 dBm	=	thermal (KTB) noise power in a 1 Hz bandwidth at room temperature
NF	=	noise figure in dB
B	=	bandwidth in Hz
Ksn	=	minimum signal to noise ratio in dB
Km	=	a variable in dB which is a function of the modulation characteristics

From knowledge of the basic operation and design of a speed meter, it is clear that these are not highly complex or sensitive devices. Assuming a noise figure of 8 dB (schottky diode mixer), a (DSP) bandwidth of 5 kHz (doppler shift at ≈135 m.p.h.), a minimum signal to noise ratio of 10 dB, and zero modulation of the received signal, this equation yields a sensitivity of –174 +8 +37 +10 + 0 = -119.0 dBm

[1] Watkins-Johnson Tech-notes, Vol. 7, March/April 1980

3.4.2.2 Sensitivity Based on the Standard Radar Equation.

The received signal power of a radar is given by the standard radar equation[2]:

$$Pr = \frac{Pt.Gt}{4.\pi.d^2} \cdot \frac{At}{4.\pi.d^2} \cdot Ae$$

where:

Pr	=	received power in W
Pt	=	power radiated in W
Gt	=	gain of radar antenna
d	=	distance to the target
At	=	effective aperture of target in m^2
Ae	=	effective aperture of radar in m^2

From knowledge of the basic operation and design of a speed meter the following can be assumed; Pt = 10 mW, Gt = 100 (20 dBi), d = 30 m (distance at which a reliable measurement of speed might be expected), At = 0.0625 m^2 (estimated effective specula reflection area of vehicle = 0.25 x 0.25), Ae = 0.002 m^2 (50 mm diameter, approximately 20 dBi). Applying these assumptions, this equation yields a received power of 11 x 10^{-9} Watts (-109.5 dBm), which equates to a sensitivity of –119.5 dBm (assuming a signal to noise ratio of 10 dB is required). This is very close to that calculated in 3.4.2.1 using a very different methodology.

[2] Merrill I Skolnik, Radar Handbook, 2nd Edition, McGraw-Hill publishing

3.4.3 Interference Potential

3.4.3.1 The isolation required to avoid interference is the difference between the e.i.r.p. of the interferer, and the sensitivity of the victim, taking account of the victim receiver's antenna gain.

$$I = Pi - S + Gsg$$

where:

I = isolation required to avoid interference in dB
Pi = effective isotropic radiated power of the interferer in dBm
S = sensitivity of the speed meter in dBm
Gsg = gain of speed meter antenna in dB

The isolation required to avoid interference is therefore;

$$I = +9.77_{[3]} - -119 + 20 = 148.77 \text{ dB}$$

[3] +9.77 dBm was the average e.i.r.p. of the three DUT's measured in this band (see Table 6)

3.4.3.2 The actual isolation will depend on the relative orientations of the police radar speed meter and the DUT, as well as their separation distance and any obstructions in the path. The most important scenario to be considered however, is when a vehicle fitted with a DUT is approaching a police radar speed meter directed toward it. Here there will be no obstructions and maximum coupling can be assumed. In this scenario, the only isolation is the free space path loss, which can be calculated using the standard equation;

$$FSPL = 32.45 + 20.\log d + 20.\log f$$

where:

d = distance in km
f = frequency in MHz

If we assume that the vehicle is 100 metres from the police radar speed meter, the free space isolation is 100 dB, which is 48 dB less than that required to avoid interference. This margin is sufficiently large to conclude, with reasonable confidence, that the DUT's tested do have the potential to cause interference to police radar speed meters, even if some of the assumptions made are inaccurate.

4.0 Conclusions

4.1 Findings

All of the DUT's radiated high-level emissions across a range of frequencies in two distinct microwave bands (11.4 to 12.1 GHz, and 22.8 to 24.2 GHz approximately). The magnitude of these emissions was typically 3 mW in the lower frequency band and 12 mW in the upper frequency band.

Practical tests demonstrated that the emissions in the lower frequency band (11.4 to 12.1 GHz) were of a sufficient magnitude to cause interference to a nearby Sky digital satellite installation.

A theoretical assessment indicates with reasonable confidence, that the DUT's tested do have the potential to cause interference to police radar speed meters operating in the 24.05 to 24.15 GHz band.

4.2 Observations

Emission limits are set in specifications and standards to protect radio services from interference. Although there appears to be no specification or limit for the DUT's, it is noted that the magnitude of the spurious emissions measured would fail to meet the requirements of any known standard or specification, including those applicable to radio transmitters.

The radiated emissions from the DUT's tested, which are in effect dual-band (12/24 GHz) receivers, exceed the 30 dBpW radiated limit for direct to home satellite receiving systems (EN 55013) by 60 dB at 12 GHz and 70 dB at 24 GHz. Radiated emissions of this magnitude must be considered excessive and unacceptable.

The magnitude of the radiated emissions measured suggest that the designer and manufacturer have made no attempt to limit the interference potential of these DUT's.

5.0 Equipment Used

Details of the test equipment and facilities used are given in annex 1.

Details of the three Devices Under Test (DUT's) have been withheld from this report to retain commercial confidentiality. A restricted annex (annex 2) detailing these devices is held on file at the RTCG.

6.0 References

RTCG Report 452 'Radiated Emissions from 24 to 26 GHz Radar Tank Level Gauges'

Watkins-Johnson Tech-notes, Vol. 7, March/April 1980

Merrill I Skolnik, Radar Handbook, 2nd Edition, McGraw-Hill publishing

Agency home page http://www.radio.gov.uk gives details of RA.)

7.0 Annex 1 Test Equipment and Facilities Used

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EQUIPMENT ISSUE REPORT - JOB No versus PLANT No

JOB NUMBER: 706

Plant Number	Person Issued To	Manufacturer	Model Number	Equipment Type	Serial Number	Date Out To Issue	Date In From Issue	Calib Class	Last Cal Date
52	John Mellish	ANRITSU WILTRON LTD.	MB0A	Tripod	M52167	06-FEB-02	19-FEB-02	1	
89	John Mellish	UNKNOWN	8N0	TECHNICAL FURNITURE	890	06-FEB-02	19-FEB-02	1	
134	John Mellish	COUTANT	LQT101	AC-DC Power Supply	CH12784	05-FEB-02	05-FEB-02	1	
134	John Mellish	COUTANT	LQT101	AC-DC Power Supply	CH12784	05-FEB-02	19-FEB-02	1	
160	John Mellish	ANRITSU WILTRON LTD.	MP651A	Antenna Dipole	M30483	05-FEB-02	19-FEB-02	1	22-MAY-01
167	John Mellish	MANFROTTO	055	Tripod	055/9840	07-FEB-02	19-FEB-02	3	
173	John Mellish	ANRITSU WILTRON LTD.	MP534A	Antenna Dipole	M61108	06-FEB-02	19-FEB-02	1	25-MAY-00
175	John Mellish	HEWLETT-PACKARD	83640A	Sweep Generator	3115A00689	06-FEB-02	06-FEB-02	1	29-MAY-01
175	John Mellish	HEWLETT-PACKARD	83640A	Sweep Generator	3115A00689	06-FEB-02	19-FEB-02	1	29-MAY-01
198	John Mellish	MANFROTTO	055	Tripod	055/8850	07-FEB-02	13-FEB-02	3	
198	John Mellish	MANFROTTO	055	Tripod	055/8850	13-FEB-02	19-FEB-02	3	
326	John Mellish	ANRITSU WILTRON LTD	MP651A	Antenna Dipole	M052418	06-FEB-02	19-FEB-02	1	25-MAY-00
328	John Mellish	ANRITSU WILTRON LTD	MP534A	Antenna Dipole	M05347	06-FEB-02	19-FEB-02	1	22-MAY-01
465	John Mellish	FLANN MICROWAVE.	16093-KF10	Waveguide to Coax	1094	06-FEB-02	06-FEB-02	1	
465	John Mellish	FLANN MICROWAVE.	16093-KF10	Waveguide to Coax	1094	06-FEB-02	19-FEB-02	1	
467	John Mellish	FLANN MICROWAVE.	20093-KF40	Waveguide to Coax	877	06-FEB-02	06-FEB-02	2	24-OCT-95
467	John Mellish	FLANN MICROWAVE.	20093-KF40	Waveguide to Coax	877	06-FEB-02	19-FEB-02	2	24-OCT-95
476	John Mellish	FLANN MICROWAVE.	1624-20	Antenna Horn	403	06-FEB-02	06-FEB-02	2	
476	John Mellish	FLANN MICROWAVE.	1624-20	Antenna Horn	403	06-FEB-02	19-FEB-02	2	
479	John Mellish	FLANN MICROWAVE.	2024-20	Antenna Horn	213	06-FEB-02	06-FEB-02	2	24-OCT-95
479	John Mellish	FLANN MICROWAVE.	2024-20	Antenna Horn	213	06-FEB-02	19-FEB-02	2	24-OCT-95
1101	John Mellish	HEWLETT-PACKARD	34336	Digital Multimeter	1406A18131	06-FEB-02	19-FEB-02	1	13-JUN-01
1113	John Mellish	EMCO	5117	GTEM CELL	9103-1013	05-FEB-02	06-FEB-02	2	
1118	John Mellish	HEWLETT-PACKARD	8566B	Spectrum Analyser	2140A01287	06-FEB-02	19-FEB-02	1	07-MAR-01
1134	John Mellish	SIMONS	61451-2	Antenna Conical	69	06-FEB-02	19-FEB-02	2	

7.0 Annex 1 Test Equipment and Facilities Used (continued)

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JOB NUMBER: 706

Plant Number	Person Issued To	Manufacturer	Model Number	Equipment Type	Serial Number	Date Out To Issue	Date In From Issue	Calib Class	Last Cal Date
1337	John Melliah	AILTECH	93490-1	Antenna Conical	NEW	06-FEB-02	19-FEB-02	2	
1349	John Melliah	EATON CORPORATION.	94455-1	Antenna Bi-conical	1261	06-FEB-02	19-FEB-02	2	
1675	John Melliah	HEWLETT-PACKARD	3478A	Digital Multimeter	2301A07538	06-FEB-02	19-FEB-02	1	26-JAN-02
1811	John Melliah	ADVANTEST	R9833	X-Y Plotter	0700482	06-FEB-02	19-FEB-02	2	
1870	John Melliah	TASCO EUROPE B.V.	E-290	Dish & Antenna Controller	28030839	05-FEB-02	06-FEB-02	3	
1871	John Melliah	TASCO EUROPE B.V.	S-250	Dish & Antenna Controller	NEW	05-FEB-02	06-FEB-02	3	
2031	John Melliah	FLANN MICROWAVE	16240-20	Antenna Horn	448	06-FEB-02	06-FEB-02	1	22-FEB-01
2031	John Melliah	FLANN MICROWAVE	16240-20	Antenna Horn	448	06-FEB-02	19-FEB-02	1	22-FEB-01
2032	John Melliah	FLANN MICROWAVE	16093-SF10	Waveguide to Coax	1219	06-FEB-02	06-FEB-02	1	22-FEB-01
2032	John Melliah	FLANN MICROWAVE	16093-SF10	Waveguide to Coax	1219	06-FEB-02	19-FEB-02	1	22-FEB-01
2038	John Melliah	FLANN MICROWAVE	20093-SF40	Waveguide to Coax	1416	06-FEB-02	06-FEB-02	1	27-FEB-01
2038	John Melliah	FLANN MICROWAVE	20093-SF40	Waveguide to Coax	1416	06-FEB-02	19-FEB-02	1	27-FEB-01
2133	John Melliah	FLANN MICROWAVE	22240-20-AA	Antenna Horn	21	06-FEB-02	06-FEB-02	1	27-FEB-01
2133	John Melliah	FLANN MICROWAVE	22240-20-AA	Antenna Horn	21	06-FEB-02	19-FEB-02	1	27-FEB-01
2356	John Melliah	AEL PLASTIC COMPONENTS		REFLECTOR	NEW	06-FEB-02	19-FEB-02	2	
2410	John Melliah	EMCO	1080-1.21	Turntable Controller	NEW	06-FEB-02	19-FEB-02	2	
2411	John Melliah	EMCO	1090	Turntable Controller	801-1499	06-FEB-02	19-FEB-02	2	
2443	John Melliah	HUBER+SUHNER AG.	SUCOFLEX102	Coaxial Cable	5557/2	06-FEB-02	06-FEB-02	2	
2443	John Melliah	HUBER+SUHNER AG.	SUCOFLEX102	Coaxial Cable	5557/2	06-FEB-02	19-FEB-02	2	
2747	John Melliah	HEWLETT-PACKARD	8566B	Spectrum Analyser	3745A03836	05-FEB-02	06-FEB-02	1	08-NOV-01
2747	John Melliah	HEWLETT-PACKARD	8566B	Spectrum Analyser	3745A03836	06-FEB-02	19-FEB-02	1	08-NOV-01
2505	John Melliah	THURLBY THANDAR INSTRUMENTS.	CPX200	AC-DC Power Supply	111798	06-FEB-02	19-FEB-02	3	
2550	John Melliah	HEWLETT-PACKARD	8491B	Attenuator Broadband 1 dB	2708A10001	06-FEB-02	19-FEB-02	1	07-JUN-01
3038	John Melliah	SEMFLEX INC	5151-DEP-0023	Coaxial Cable	NEW	06-FEB-02	06-FEB-02	2	
3038	John Melliah	SEMFLEX INC	5151-DEP-0023	Coaxial Cable	NEW	06-FEB-02	19-FEB-02	2	
3615	John Melliah	SEMFLEX INC	5151-DEP-0119	Coaxial Cable	NEW	06-FEB-02	19-FEB-02	2	

7.0 Annex 1 Test Equipment and Facilities Used (continued)

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Plant Number	Person Issued To	Manufacturer	Model Number	Equipment Type	Serial Number	Date Out To Issue	Date In From Issue	Calib Class	Last Cal Date
[illegible]	John Mellish	UNKNOWN	[illegible]	ANECHOIC CHAMBER	[illegible]	04-FEB-02	19-FEB-02	[illegible]	
3119	John Mellish	PERFORMANCE PRODUCTS LTD	[illegible] 01	DETECTOR.	[illegible]	05-FEB-02	06-FEB-02	3	
3119	John Mellish	PERFORMANCE PRODUCTS LTD	[illegible] 01	DETECTOR.	[illegible]	06-FEB-02	19-FEB-02	3	
3160	John Mellish	PERFORMANCE PRODUCTS LTD	[illegible]	DETECTOR.	[illegible]	05-FEB-02	06-FEB-02	3	
3160	John Mellish	PERFORMANCE PRODUCTS LTD	[illegible]	DETECTOR.	[illegible]	06-FEB-02	19-FEB-02	3	
3161	John Mellish	PERFORMANCE PRODUCTS LTD	[illegible] 05	DETECTOR.	2667	05-FEB-02	06-FEB-02	3	
3161	John Mellish	PERFORMANCE PRODUCTS LTD	[illegible] 05	DETECTOR.	2667	06-FEB-02	19-FEB-02	3	

8.0 Annex 2 Devices Under Test (DUT's)

Details of the three Devices Under Test (DUT's) have been withheld from this report to retain commercial confidentiality. A restricted annex (annex 2) detailing these devices is held on file at the RTCG.

(END OF REPORT)