OFFICE OF COMMUNICATIONS

# Band II SRD Compatibility Tests

**RTCG Project No. 811**

**Issued:** 10 March 2005

# Executive summary

This report details tests carried out to assess radiated power levels of Short Range Devices (SRDs) operating in the Band II broadcast band (87.5MHz to 108MHz) typically for the purpose of listening to MP3/CD players on a home or car Band II radio. The findings of this work could be used to inform the debate regarding potential amendments to ETSI Standard EN301 357 for the inclusion of Band II FM devices.

The work was sponsored by Bernard Bond of the Operations – Innovation and Regulatory Compliance Unit, and focussed on:

- What radiated radio frequency power level(s) would be required to provide satisfactory domestic and in-car SRD performance.

- What would be the compatibility issues relating to a given radiated power level, e.g. required frequency separation to prevent interference to adjacent channels.

The above issues are addressed in the first part of the report, in which laboratory simulation were used to investigate two ERP levels proposed by the sponsor, namely 10nW and 250µW. The findings of this work were as follows:

<u>10nW ERP</u>

- Would only be suitable for operation over relatively unobstructed paths up to a maximum distance of approximately 3m. This would be typified by the use of an SRD in the same room as an Band II radio incorporating a whip antenna. Under these conditions, a frequency separation of some 250kHz to 300kHz would be required from an edge-of-service-area broadcast signal.

- Would not be suitable for a domestic application requiring transmission from an SRD inside a house (ground floor) to an outside antenna at 10m above ground level.

- In vehicle applications, the presence of signal nulls could necessitate careful siting of an SRD. This could be seen as reducing the flexibility of a product aimed at providing convenience.

<u>250µW ERP</u>

- Should be suitable for a domestic application requiring transmission from an SRD inside a house (ground floor) to an outside antenna at 10m above ground level.

- Effects of overload when used in close proximity (3m) to a typical Band II broadcast receiver could result in interference to broadcast signals over a wide band depending on the receiver design.

- Interference might not only be limited to within a household, there is also potential for interference to broadcast reception in adjacent properties.

- In contrast to vehicle tests at 10nW ERP, it was not possible to detect any signal nulls, or other form of signal degradation at 250µW ERP. Tests were not, however, conducted at power levels between 10nW and 250µW.

It was therefore concluded that although 250µW ERP might pose less problems for in-car applications, there would be a valid cause for concern regarding potential interference (inter-household and inter-property) in domestic applications.

The second part of the report details the results of tests carried out on two commercially available SRDs, referred to as:

- Equipment A
- Equipment B

Measurements were carried out in the Fully Anechoic Chamber at the RTCG to determine the maximum Effective Isotropic Radiated Power (EIRP) both equipment SRDs, the results were as follows:

- Equipment B 14.99nW
- Equipment A 49.09nW

Practical (subjective) tests were then carried out to assess the performance of both SRDs for in-car applications. The same three vehicles were used as in the earlier laboratory simulations, each having five adult occupants during the tests.

The findings showed that with the lower power Equipment B, signal nulls could be found in two of the vehicles, in the worst case nulls were particularly easy to locate. It is interesting to note that vehicles in which nulls were found had external wing/roof mounted antennas, while the vehicle with no nulls had a rear window heating element antenna. Tests with the higher power Equipment A SRD revealed that signal nulls could only be found in one vehicle (worst case with Equipment B), but to a much lesser degree.

To assess the potential distance over which signals of acceptable quality could be received from the SRDs in domestic use, simple range checks were conducted using a portable radio equipped with a whip antenna. The results of these tests were as follows:

- Equipment B 4.1m
- Equipment A 8.0m

The results indicated that the only practical domestic scenario for the use of both SRDs would be to operate into a receiver in close proximity, typically in the same room. They would not be capable of operating from a ground floor room to an outdoor antenna 10m above ground level.

In terms of interference potential, it was concluded that this would be largely confined to within the household in which the SRD was being operated, and could therefore be managed locally.

## CONTENTS

## List of Abbreviations

| | |
|---|---|
| a.g.l. | Above ground level |
| CD | Compact Disk |
| d | Distance in metres |
| dBµV | Voltage level expressed in decibels relative to one microvolt |
| dBµV/m | Electric field strength expressed in decibels relative to one microvolt per metre |
| dBm | Power level expressed in decibels relative to one milliwatt |
| EIRP | Effective Isotropic Radiated Power |
| EMI | Electromagnetic Interference |
| ERP | Effective Radiated Power |
| FCC | Federal Communications Commission |
| FM | Frequency Modulation |
| G | Gain (numeric over isotropic) |
| Hz | Hertz – the unit of frequency |
| kHz | Kilohertz – a frequency of one thousand Hertz |
| m | Metre – the basic unit of length |
| MHz | Megahertz – a frequency of one million Hertz |
| nW | Nanowatt – $1x10^{-9}$ Watts |
| P | Power in Watts |
| p.d. | Potential Difference |
| P.N. | RTCG test equipment plant number |
| RTCG | Radio Technology and Compatibility Group |
| SRD | Short Range Device |
| V | Volt – the unit of electrical potential |
| Ω | Ohm – the unit of electrical resistance |
| µV | Microvolt – $1 \times 10^{-6}$ Volts |
| µW | Microwatt – $1x\ 10^{-6}$ Watts |

# 1.0 Introduction

1.1 This report details the test methods used and results obtained during investigations into the compatibility issues relating to the radio frequency power levels of Short Range Devices (SRD) operating in the Band II broadcast band (87MHz to 108MHz).

1.2 Initial laboratory simulations were carried out to determine:

- What protection (frequency separation) would be required to prevent an SRD interfering with broadcast stations on adjacent channels (Section 2.0)
- Whether ERP levels, as proposed by the sponsor, of 10nW and 250µW would provide reliable performance with both car and home stereo radio systems (Section 3.0)

1.3 Subsequent practical tests were carried out using two commercially available SRDs, namely Equipment A (49nW e.i.r.p.) and Equipment B (15nW e.i.r.p.). These tests were of a more subjective nature to assess typical domestic and in-car performance (Section 5.0)

# 2.0 Protection Ratio

## 2.1 Test Method

2.1.1 The test setup used to determine the degree of protection (channel separation) required to prevent an SRD causing adjacent channel interference is shown in Figure.1 overleaf.

2.1.2 A Marconi 2026 multi-source signal generator provided both the wanted (broadcast – Gen A), and unwanted (SRD – Gen B) signals. Both signals were modulated with a 19kHz pilot tone to activate the receiver's stereo decoder, and essentially represented stereo signals with identical right and left hand channel programme material, i.e. no difference signal to modulate the 38kHz suppressed subcarrier. 99.650MHz was chosen as the test frequency to minimise levels of local broadcast interference.

2.1.3 The RF output level of Generator A was set to 41.6dBµV p.d. (50Ω) to provide a receiver input level of 37.7dBµV p.d.(75Ω) after the matching pad. This input would result (ignoring feeder losses) from a resonant dipole antenna in an incident field strength of 44dBµV/m. The figure of 44dBµV/m (10dB down on the edge-of-service-area planning level of 54dBµV/m at 10m), was chosen to approximate that which exists in a rural environment, 1.5m above ground level ignoring building losses[ref 6]. The receiver envisaged in this scenario would typically be equipped with a telescopic whip antenna. However, in the absence of performance data for such antennas, a somewhat optimistic dipole characteristic was used.

2.1.4 The signal generator level ($V_{gen}$ 50Ω) to produce the required receiver input voltage (75Ω) was calculated as follows:

$V_{gen}$ = [Field Strength(dBµV/m) – Antenna Factor(dB/m)] + Matching Pad Adjustment

= [44 – 6.3] + 3.94 = 41.64dBµV p.d.

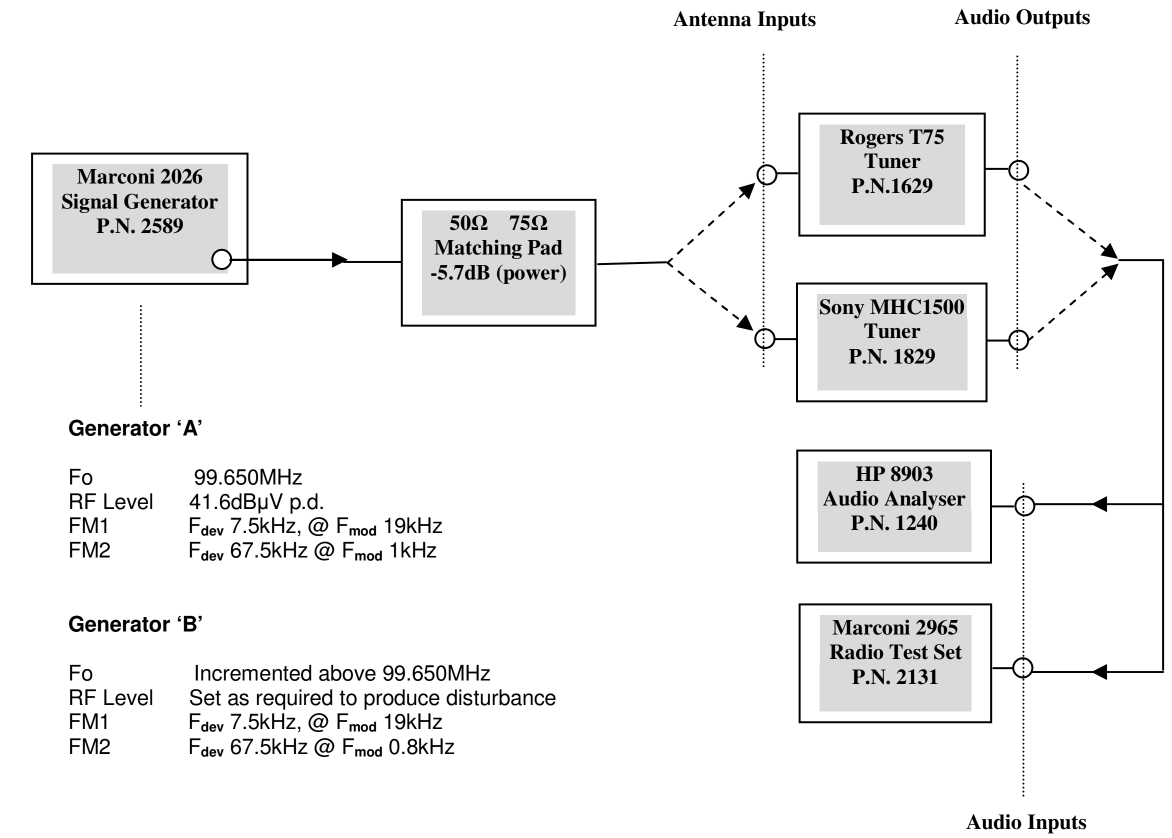


**Figure.1 - Protection Ratio Test Setup**

2.1.5 Two Band II stereo tuners were used in the tests, a Rogers type T75 and a Sony type MHC1500, the latter being part of a "Mini Hi-Fi System". At a receiver input level of 37.7dBμV p.d, both tuners produced a S+N/N ratio of approximately 51dB. The Rogers tuner produced a 50dB S+N/N ratio for an input level of approximately 35.2dBμV, 2.2dB worse than the specified sensitivity of 33dBμV.

2.1.6 S+N/N measurements were performed using the ratio (dB relative) function of an H.P. 8903 Audio Analyser with 30kHz low pass filtering selected. Signal quality was also monitored using the oscilloscope and loudspeaker facilities of a Marconi 2965 Radio Test Set.

2.1.7 While observing the S+N/N ratio produced by Generator A (1kHz modulating tone off), the signal from Generator B (800Hz modulating tone on) was introduced at various frequency offsets above 99.650MHz. At each offset, the output level of Generator B was adjusted until the resulting disturbance fell just below the level of audibility, and the generator level was noted. Figures were recorded up to an offset of +600kHz for both tuners.

## 2.2 Test Results

2.2.1 The figures obtained are reproduced below in the plot of Figure.2. A third curve (red) extending up to only 300kHz separation, represents protection ratio figures used by Band II planning authorities.[ref 7].

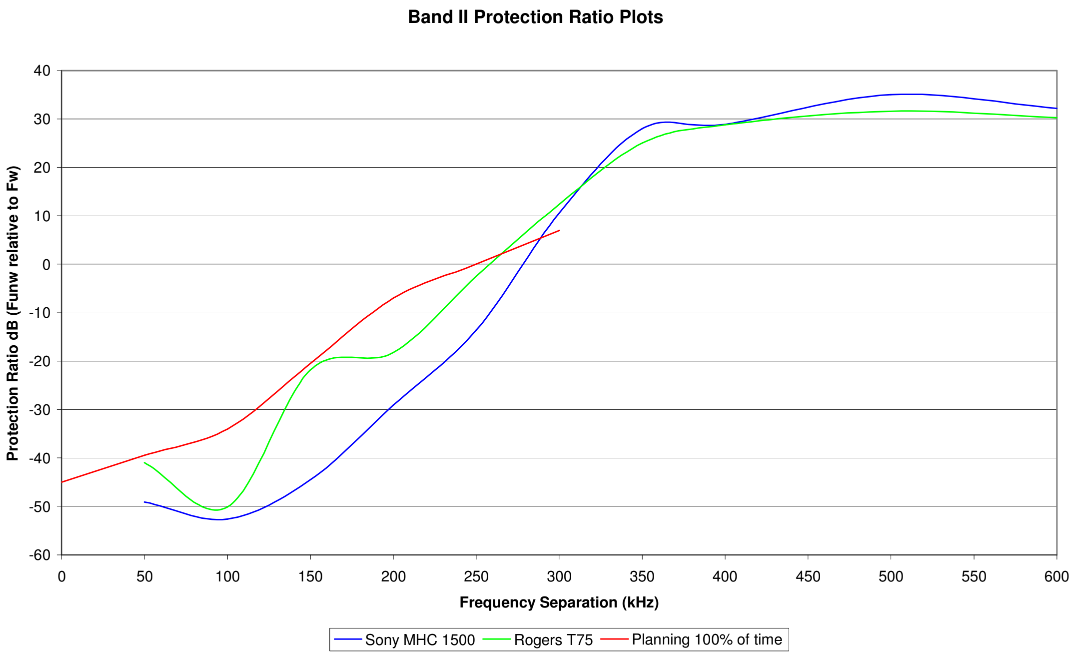


**Figure.2 – Protection Ratio Plot**

2.2.2 The curves show frequency offset plotted against the required protection ratio calculated from the relative amplitudes of the signals from Generators A and B as shown below.

$$\text{Protection Ratio (dB)} = 20 \, \text{Log}_{10} \, (V_{\text{gen B}} / V_{\text{gen A}})$$

As an example of how the information in the curves should be interpreted, it will be noted that where an SRD produces a field strength approximately 10dB higher than a broadcast station, then a 300kHz frequency separation will be required to prevent interference from the SRD.

2.2.3 It should be noted that as the signal from Generator A was unmodulated by an audio tone (but with stereo pilot tone enabled), the test method used probably represents a worst case as programme modulation would tend to mask lower level interference effects. This tends to be supported by the generally lower frequency separations indicated by the planning curve.

# 3.0 Proposed SRD Power Levels and Operating Range

## 3.1 General

3.1.1 Tests carried out in this phase of the work were designed to determine the effectiveness of SRDs when operated in the domestic and in-car environments at the proposed power (ERP) levels of 10nW and 250µW.

3.1.2 In terms of the home application, tests were based on a horizontally polarised receiving antenna (dipole) erected outdoors at a height of 10m, adjacent to the wall/roof transition of the RTCG building. Car tests were carried out using an electrically short dipole antenna as a probe within the passenger compartment of various vehicles, each vehicle being equipped with a different receiving antenna configuration.

## 3.2 Test Method – Domestic Operation

3.2.1 An initial confidence test was carried out using two horizontally polarised EMCO dipole antenna kits (P.N. 3220 and 3221), set up as shown in Figure.3 below.

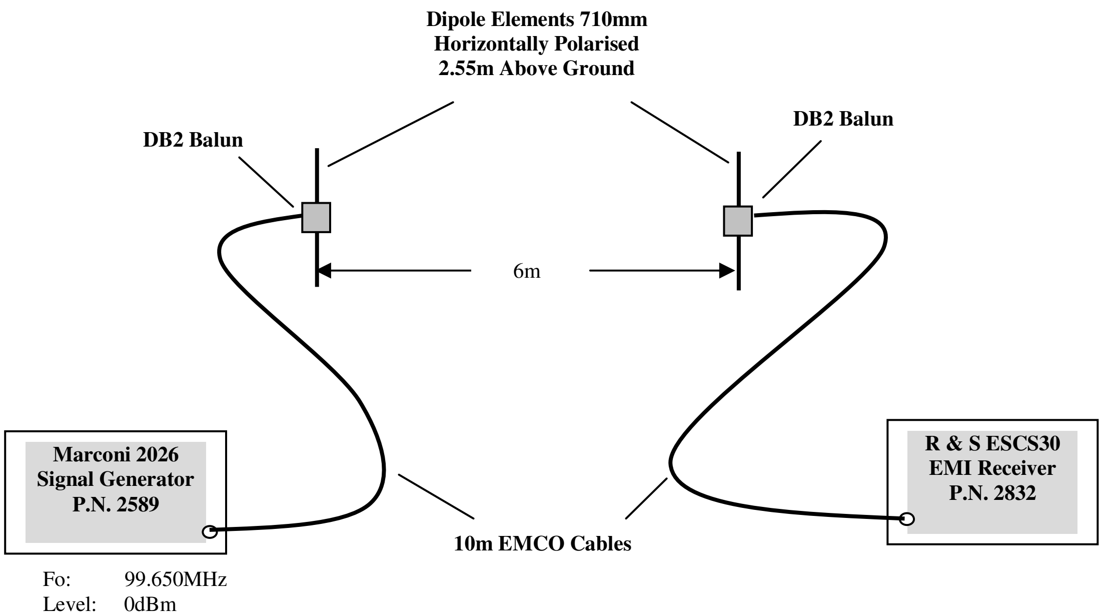


**Figure.3 – Antenna Confidence Test Setup**

3.2.2 With the signal source set at an output level of 0dBm, the expected field strength (ignoring feeder losses) was calculated from:

$$\text{Field Strength (V/m)} = \frac{(30 \times Px\ G)^{0.5}}{d}$$

$$= \frac{(30 \times 1 \times 10^{-3} \times 1.6)^{0.5}}{6} = 0.037\text{V/m} = 91.4\text{dB}\mu\text{V/m}$$

3.2.3 At a specified antenna factor of 8.2dB/m, the expected receiver input voltage would be 91.4 – 8.2 = 83.2dBµV p.d. The actual level measured was within 0.5dB of this calculated value, providing a satisfactory degree of confidence in the test dipole antennas.

3.2.4 The test setup was then reconfigured as shown below in Figure.4.

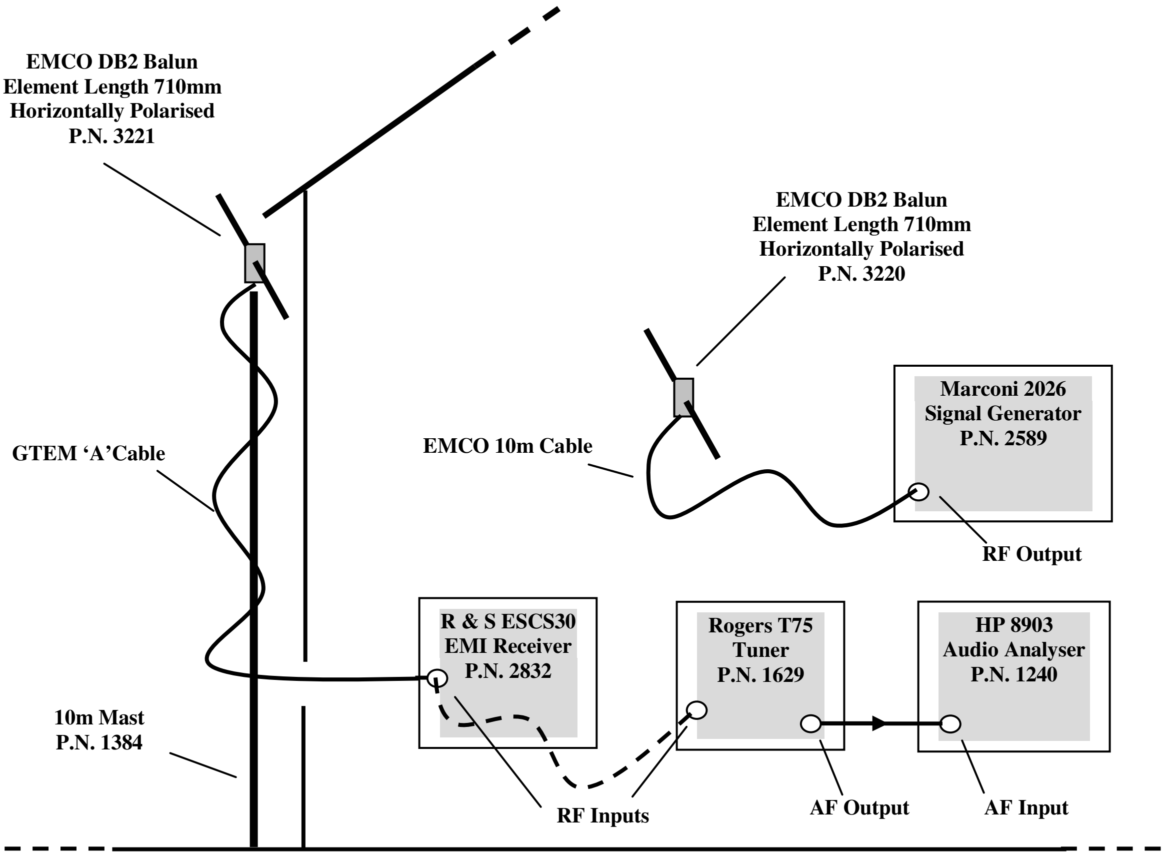


**Figure.4 – Test Equipment Setup in the Museum at the RTCG**

3.2.5 A fully extended 10m mast was used to support a horizontally polarised EMCO dipole antenna outside the RTCG Museum. This was connected to an EMI measuring receiver via a cable having a measured loss of less than 1dB at 100MHz. A second horizontally polarised EMCO dipole was set up inside the Museum (1.33m above ground level) and connected to the RF output of a Marconi 2026 Signal Generator, modulated as shown for Generator A in Figure.1.

3.2.6 The signal generator was set to a frequency of 99.650MHz at the following output levels, and the signal was monitored on the EMI measuring receiver.

- -50dBm for an ERP of 10nW.
- -6dBm for an ERP of 250µW

## 3.3 Test Results

3.3.1 At an ERP of 10nW, the signal monitored on the EMI receiver was just perceptible above the receiver noise floor. This indicated that a 10nW SRD operating inside a house to a Band II receiver with an outside antenna at 10m, would probably not provide an adequate service.

3.3.2 At an ERP of 250µW, the input signal level at the EMI receiver was recorded at 56dBµV. At a specified antenna factor of 8.2dB/m, this represented a field strength of 56 + 8.2 = 64.2dBµV/m, some 10dB up on the edge-of-service-area planning level of 54dBµV/m at 10m a.g.l. As 250µW is 44dB above 10nW, this implied a field strength of 20.2dBµV/m (64.2 – 44) for 10nW ERP.

3.3.3 The feeder cable from the outside dipole antenna was disconnected from the EMI receiver and connected (via a 50Ω - 75Ω matching pad) to the input of the Rogers T75 tuner. A S+N/N figure of 50dB was recorded for the 250µW ERP, as previously recorded in the laboratory for an input level equivalent to a field strength of approximately 44dBµV/m. This apparent degradation of S+N/N performance was almost certainly due to the noisier outside antenna environment. Some audio was just detectable on 99.65MHz on the 10m antenna with the pseudo SRD (signal generator) switched off.

3.3.4 It was therefore concluded that an ERP of 250µW would be required to provide adequate performance when operating into a 10m outside antenna, having a well screened feeder, from an SRD on the ground floor.

## 3.4 Test Method – In-Car Operation

3.4.1 To facilitate the production of SRD test signals within the passenger compartment of a vehicle, it was necessary to use an electrically short dipole driven at higher RF power levels to produce the required 10nW and 250µW ERP levels. The test equipment setup used is shown in Figure.5 below.

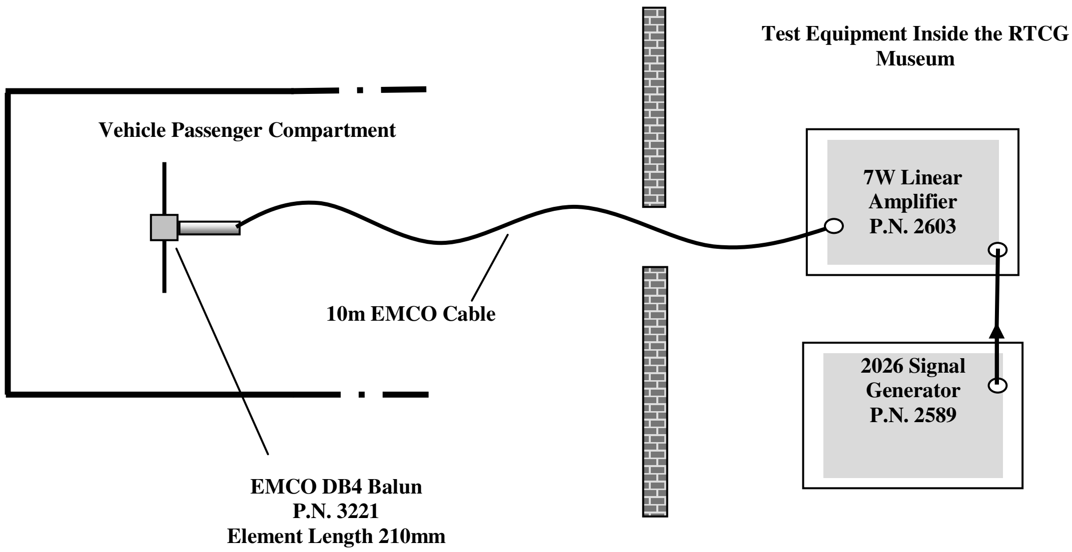


**Figure.5 – Vehicle Test Setup**

3.4.2 The RF power level required to drive the electrically short dipole was first determined as follows:

- The electrically short dipole was placed in the same position (horizontally polarised) as the full-size dipole that had previously produced a field strength of 64.2dBµV/m for an ERP of 250µW.

- The output level from the signal generator feeding the linear amplifier was gradually increased until the received signal level, as indicated on the EMI receiver, represented a field strength of 64.2dBµV/m. This was achieved at a signal generator level of -7.5dBm, representing an ERP of 250µW

- As 10nW is 44dB below 250µW, the required signal generator level for 10nW ERP was calculated as -7.5 - 44 = -51.5dBm.

3.4.3 In-car tests were carried out on three vehicles as follows:

- Mitsubishi Pajero with a nearside front wing mounted telescopic car radio antenna

- Nissan Almera with car radio antenna mounted centrally at the rear of the roof

- BMW 535i with heated rear window element car radio antenna

3.4.4 As noise was found to be present on 99.650MHz, the frequency used for all in-car tests was changed to 87.5MHz. With the test signal modulated with 1kHz and 19kHz tones (as per Gen A Fig.1), and the car radio tuned to 87.5MHz, the short dipole was moved around the interior of each vehicle while monitoring received signal quality. This procedure was performed at both the 10nW and 250µW ERP levels. Note that no occupants were present in the vehicles while this procedure was carried out.

## 3.5 Test Results

3.5.1 With the test signal set at 10nW ERP it was found possible to locate deep nulls at various locations in the passenger compartment of all three vehicles. Although not investigated, it was felt that the presence of occupants inside the vehicle might have exacerbated this situation.

3.5.2 With the test signal set at 250µW ERP it was not possible to locate any position, in any of the vehicles, that produced any perceptible degradation in signal quality.

3.5.3 It was therefore concluded that an ERP in excess of 10nW would be required for reliable in-car operation of an SRD, although tests were not carried out at levels between 10nW and 250µW.

# 4.0 Conclusions – Laboratory Simulations

## 4.1 10nw SRD Effective Radiated Power

4.1.1 The findings indicate that 10nW ERP would only be suitable for operation over unobstructed paths up to a maximum distance of approximately 3m. This would be typified by the use of an SRD in the same room as a Band II radio equipped with a whip antenna. At 3m, the SRD would produce a field strength of approximately 47dBµV/m, i.e. potentially 3dB higher than the field strength of an edge-of-service-area broadcast signal (1.5m a.g.l.) at a rural site ignoring building losses. Under such conditions, the protection ratio plots (Fig.2) indicate that the SRD frequency should be spaced some 250kHz to 300kHz from broadcast signals being received on other radios within a 3m radius.

4.1.2 An ERP of 10nW would almost certainly be unsuitable for a domestic application requiring transmission from an SRD inside the house to an outside antenna at 10m above ground level. By implication, interference to a Band II radio system in a neighbouring property would also be most unlikely. In vehicle applications at 10nW ERP the presence of signal nulls would probably detract from the degree of flexibility required in terms of where an SRD can be sited.

## 4.2 250µW SRD Effective Radiated Power

4.2.1 Tests indicate that an SRD ERP of 250µW would provide acceptable service in a domestic application requiring transmission from an SRD inside the house (ground floor), to an outside horizontal Band II antenna at 10m a.g.l. The RTCG simulation produced a field strength of 64dBµV/m at the outside antenna for 250µW ERP, i.e. 10dB up on the edge-of-service-area planning level of 54dBµV/m. This apparently effective inter-household communication, would, however, also create valid cause for concern regarding potential interference in domestic (inter-household and inter-property) applications.

4.2.2 In 4.1.1, the use of 10nW ERP was described for a domestic scenario in which an SRD operated 3m from a Band II radio would produce a field strength of approximately 47dBµV/m. This represents a point approximately +3dB on the protection ratio plot (Fig.2), indicating a required frequency separation of between 250kHz and 300kHz. The field strength that would be produced at 3m by an SRD operating at an ERP of 250µW would be approximately 91dBµV/m (+44dB on 10nW), i.e. a point that would occur at +47dB on the protection ratio plot (Fig.2). Reference to Figure.2 will show that a protection ratio of this magnitude is not defined, the maximum being a point +30.3dB for the Rogers T75 Tuner requiring a frequency separation of 600kHz. However, a single spot check on the Rogers Tuner, representing an SRD ERP of 250µW at 3m, suggested that a frequency separation of 1.3MHz would be required from a broadcast signal being received at a field strength of 44dBµV/m. This is thought to be due to tuner overload.

4.2.3 Vehicle tests (4.1.2) suggest that an ERP greater than 10nW would be required for reliable in-car operation. Although 250µW ERP would almost certainly be significantly more than required to achieve acceptable in-car performance, the transitory nature of interference from a mobile source would be less problematic than in a domestic environment.

4.2.4 It must, however, again be stressed that the protection ratio figures given in this paper are based on disturbances to an unmodulated wanted signal. Programme modulation would tend to mask low level interference effects; the protection figures should therefore be considered as worst case.

## 5.0 Practical Tests Using Commercially Available SRDs

### 5.1 General

5.1.1 Two commercially available SRDs were used for the practical phase of the work as follows:

- **Equipment A**
- **Equipment B**

5.1.2 It will be noted that both units have a short screened lead terminated in a 3.5mm stereo jack plug for audio input from a CD player/iPod etc. Both may be powered by two internal "AAA" alkaline cells, or by a 12V vehicle supply.

5.1.3 The Equipment A SRD enables operation on one of four switched frequencies, namely 88.1MHz, 88.3MHz, 88.5MHz and 88.7MHz. The Equipment B SRD is considerably more flexible, and will operate on any frequency between 88.1MHz and 107.9MHz in 100kHz increments. It also allows up to four frequencies to be stored in memory.

5.1.4 Both manufacturers claim compliance with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. Both manufacturers also claim an operating range of up to 30 feet, but suggest a range not exceeding 10 feet will provide the best interference-free reception.

## 5.2 EIRP Measurements

5.2.1 Measurements were carried out in the Fully Anechoic Chamber at the RTCG to determine the Effective Isotropic Radiated Power (EIRP) of both the SRDs.

5.2.2 EMCO Max EIRP automatic software was used to control the measurement process by rotating the SRD under test, changing the measuring antenna height and polarisation, while constantly measuring the received power level until a maximum is found. Using this technique, the following EIRP levels were determined:

- Equipment B 14.99nW
- Equipment A 49.09nW

## 5.3 In-Car Tests

5.3.1 Tests were performed with both SRDs in the same three vehicles used in the simulations of Section 3.4, namely:

- Mitsubishi Pajero with a nearside front wing mounted telescopic car radio antenna
  Car Radio Type: JVC KD-G301
- Nissan Almera with car radio antenna mounted centrally at the rear of the roof
  Car Radio Type: Nissan LW-MW-FM with Cassette Player – Type A
- BMW 535i with heated rear window element car radio antenna
  Car Radio Type: Kenwood KDC-8024

5.3.2 The tests were of a purely subjective nature, and consisted of monitoring the signal from the SRD on the vehicle radio while changing the position of the SRD within the vehicle. The modulating signal applied to the SRD was a 1kHz (mono) tone from a Casio PZ810 CD player. All tests were carried out on 88.3MHz, which although not a totally clear channel, was the clearest channel available in the RTCG car park.

5.3.3 To take account of the effects of signal absorption by vehicle occupants, all tests were conducted with five occupants in the vehicle in which the SRD was being tested. During tests, the vehicles were positioned side-by-side with a spacing of approximately 1.5m (see Figure.6 overleaf). To assess the potential for inter-vehicle interference, the SRD signals were also monitored in the two unoccupied adjacent vehicles not containing the SRD.

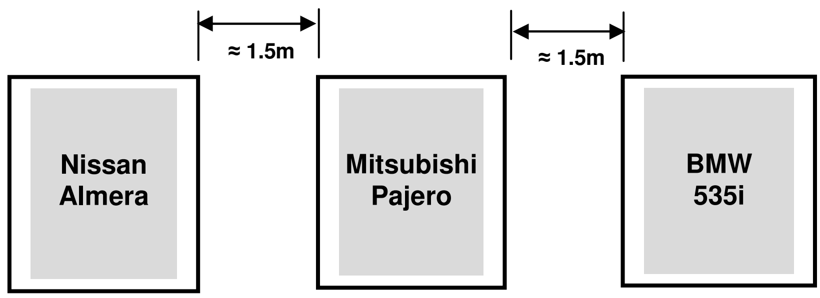


**Figure.6– Relative Test Vehicle Positions**

## 5.4 In-Car Test Results

5.4.1 The results of the in-car tests are summarised in Table.1 below.

| Test Vehicle | Equipment B | Equipment A | Adjacent Vehicles |
|---|---|---|---|
| **Nissan Almera** | Signal nulls with SRD positioned adjacent to rear passengers' feet. Signals satisfactory in what would be considered more practical locations. | No signal nulls found. | Equipment A audible in Pajero, and just discernible in the BMW. Equipment B audible in Pajero, but not in BMW. |
| | | | |
| **Mitsubishi Pajero** | Nulls easily located with the SRD in both the front and rear of the vehicle. | Some nulls detected, but to a much less extent than with the Equipment B. | Equipment B strong signal in the Almera, and strong enough to be annoying in the BMW. Equipment A strong in both Almera and BMW |
| | | | |
| **BMW 535i** | No signal nulls found | No signal nulls found | Both SRDs audible in both the Almera and Pajero. |

**Table.1**

5.4.2 It should be noted that the Mitsubishi Pajero has a heated front windscreen which might account for the relatively poor SRD performance, i.e. heating elements between the SRD and wing mounted car radio antenna.

## 5.5 Domestic Range Tests

5.5.1 A further subjective test was carried out to determine over what range the SRDs would give acceptable performance in a domestic environment. This test would, of course, also indicate the interference potential of the SRDs.

5.5.2 The principle used in the tests is shown in Figure.7 below. The SRD and CD player were mounted on a wooden support, and the maximum range that an acceptable signal could be received was determined. The receiver used was a Grundig Yacht Boy (YB400) with its whip antenna fully extended, and vertically polarised. The receiver was simply walked 360º around the SRD, while carefully assessing the range at which the signal from the SRD was perceived to fully quieten the receiver, and eliminate any trace of other broadcast signals. During tests it was found that signal quality degraded rapidly within a few metres beyond the recorded maximums.

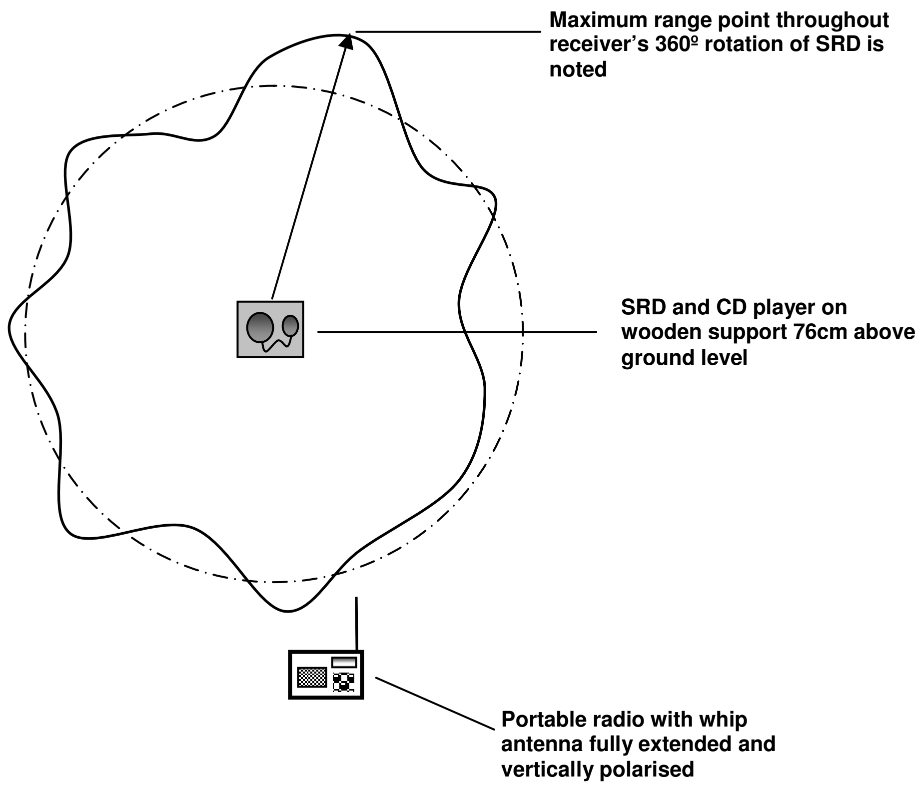


**Figure.7 – Maximum Range Test**

## 5.6 Domestic Range Test Results

5.6.1 Based on the assessment criterion of an acceptable signal given in 5.5.2, the following maximum ranges were obtained:

- Equipment B 4.1m
- Equipment A 8.0m

5.6.2 From the maximum range and SRD power levels it is possible to calculate the field strength at the receiver as follows:

$$\text{Field Strength (V/m)} = \frac{(30 \times Px\ G)^{0.5}}{d}$$

**Equip B**

$$= \frac{(30 \times 14.99 \times 10^{-9} \times 1)^{0.5}}{4.1} = 164\mu V/m = 44.3dB\mu V/m$$

**Equip A**

$$= \frac{(30 \times 49.09 \times 10^{-9} \times 1)^{0.5}}{8} = 151.4\mu V/m = 43.6dB\mu V/m$$

5.6.3 The relatively close correlation (<1dB) between the calculated field strengths gave satisfactory confidence in terms of the consistency of the results of the subjective range tests. It is also interesting to note that the maximum range calculated field strengths tend to support the choice of 44dBµV/m to represent an edge-of-service-area broadcast field strength.

# 6.0 Conclusions

## 6.1 In-Car Tests

6.1.1 The results of tests given in Table.1 clearly indicate that a lower power SRD (≈ 15nW EIRP) makes the task of locating a suitable operating position within a vehicle more difficult. The results also suggest that the location of the car radio antenna might have a significant bearing on this problem, a front wing mounted antenna appearing least favourable.

6.1.2 Increasing the SRD power by some 5dB ( ≈ 49nW EIRP), would appear to significantly alleviate the problem of siting an SRD. The results of tests showed that no signal nulls could be detected on the Nissan and BMW test vehicles, and were appreciably reduced on the Mitsubishi.

6.1.3 In terms of signal reception in adjacent vehicles, the results do not highlight a major problem in terms of interference potential as this would be of a transitory nature under most conditions. However, in the light of the domestic range test results (see 6.2), it is not surprising that signals were audible in the relatively closely spaced vehicles.

## 6.2 Domestic Range Tests

6.2.1 It must first be stressed that the range figures measured are probably best-case by virtue of the fact that the test site (lawn at the front of the RTCG) was totally unobstructed, and the receiver used (Grundig YB400) is probably more sensitive than radios used by the average SRD user.

6.2.2 Although as previously indicated (5.1.5), both manufacturers claim to comply with Part 15 of the FCC Rules, measurements suggest that only the B product meets the FCC requirement, i.e. field strength of any emissions within the 200kHz bandwidth shall not exceed 250µV/m at 3 metres. At 14.99nW EIRP, the B SRD would produce a field strength of approximately 224µV/m (47dBµV/m) at 3 metres. The A SRD at 49.09nW EIRP would, however, produce a field strength of approximately 405µV/m (52dBµV/m) at 3m.

6.2.3 It should be noted that neither of the SRDs would be capable of providing satisfactory quality signals when operating from a ground floor room to an outdoor antenna at 10m above ground level. The only practical domestic scenario for the use of both SRDs would be operating into a receiver in close proximity, typically in the same room as intended by the manufacturer.

6.2.4 In terms of interference potential, it is felt that this would be restricted to within the household in which the SRD is being operated, and could therefore be managed locally. Considering the 44dBµV/m planning level (1.5m above ground level, in a rural environment, ignoring building losses), at 3m both the SRDs would produce field strengths 3dB and 8dB above this level respectively. The protection ratio plot of Figure.2 indicates that a 300kHz frequency separation should negate interference effects from either SRD.

## 7.0 Equipment Used

| Equipment Type | Make/Model | RTCG Plant Number |
|---|---|---|
| Anechoic Chamber | TDK C1415 | 3173 |
| Audio Frequency Analyser | HP 8903B | 1240 |
| Band II Tuner | Rogers T75/2 | 1629 |
| Band II Tuner (Mini Hi Fi) | Sony MHC-1500 | 1829 |
| Bilog Antenna | TDK HLP 3003C | 3237 |
| Broadband Amplifier | ENI 607L-01 | 2603 |
| Coaxial Cable | Semflex 5151-DKF-040A | 2900 |
| Coaxial Cable | Semflex 5151-DKF-040A | 2905 |
| Coaxial Cable | Semflex 5151-DKF-040A | 2908 |
| Coaxial Cable | Semflex 5151-DKF-040A | 2909 |
| Coaxial Cable | Semflex 5151-DKF-040A | 2911 |
| Coaxial Cable | Semflex 5151-DKF-040A | 2915 |
| Coaxial Cable | Semflex 5151-DKF-040A | 2919 |
| Coaxial Cable | Semflex 5151-DKF-0079 | 3015 |
| Coaxial Cable | Semflex 5151-DKF-0079 | 3019 |
| Coaxial Cable | Semflex 5151-DKF-0119 | 3025 |
| Coaxial Cable | Semflex 5151-DKF-0394 | 3034 |
| Compact Disk Player | Casio PZ810 | ------ |
| Digital Camera | Nikon Coolpix 3100 | 3310 |
| Dipole Antenna | ETS Lindgren 3121C | 3220 |
| Dipole Antenna | ETS Lindgren 3121C | 3221 |
| EMI Receiver | R & S ESCS30 | 2832 |
| Measuring Receiver | R & S ESI 40 | 3125 |
| Mobile FM Transmitter | Equipment A | ------ |
| Multimeter | Philips PM2521 | 1529 |
| Portable Radio | Grundig YB400 | 3197 |
| Radio Test Set | Marconi 2965 | 2131 |
| Signal Generator | Marconi 2026 | 2589 |
| Tripod | 4-TR | 3250 |
| Tripod | 4-TR | 3251 |
| Mobile FM Transmitter | Equipment B | ------ |

## 8.0 References


| | |
|---|---|
| **[1]**<br>ETSI EN 300 220-1<br>V1.1.1 (2000-09) | Electromagnetic compatibility and radio spectrum matters (ERM); Short Range Devices (SRD); Radio equipment to be used in the 25MHz to 1000MHz frequency range with power levels ranging up to 500mW; Part 1: Technical characteristics and test methods |
| **[2]**<br>ETSI EN 300 220-3<br>V1.1.1 (2000-09) | Electromagnetic compatibility and radio spectrum matters (ERM); Short Range Devices (SRD); Radio equipment to be used in the 25MHz to 1000MHz frequency range with power levels ranging up to 500mW; Part 3: Harmonized EN covering essential requirements under article 3.2 of the R&TTE Directive |
| **[3]**<br>ETSI EN 301 357-1<br>V1.2.1 (2001-06) | Electromagnetic compatibility and radio spectrum matters (ERM); Cordless audio devices in the range 25MHz to 2000MHz; Consumer radio microphones and in-ear monitoring systems operating in the CEPT harmonized band 863MHz to 865MHz; Part 1: Technical characteristics and test methods |
| **[4]**<br>ETSI EN 301 357-2<br>V1.2.1 (2001-06) | Electromagnetic compatibility and radio spectrum matters (ERM); Cordless audio devices in the range 25MHz to 2000MHz; Consumer radio microphones and in-ear monitoring systems operating in the CEPT harmonized band 863MHz to 865MHz; Part 2: Harmonized EN under article 3.2 of the R&TTE Directive |
| **[5]**<br>OET Bulletin No.63<br>October 1993 | Office of Engineering and Technology Federal Communications Commission<br>"Understanding the FCC Regulations for Low –Power, Non-Licensed Transmitters" |
| **[6]**<br>Rec.ITU-R P.370-7 | RECOMMENDATION ITU-R P.370-7: VHF AND UHF Propagation Curves for the Frequency Range from 30MHz to 1000MHz |
| **[7]**<br>Rec.ITU-R BS.412-9 | RECOMMENDATION ITU-R BS.412-9: Planning standards for terrestrial FM sound Broadcasting at VHF |


(END OF REPORT)