MPT 1411

Issue 3
Revision 1

Performance Specification

Performance Specifications and
Frequency Assignment Criteria for
Private Fixed Radio Equipment for
Telemetry and Telecontrol Purposes
Operating in the Bands
457·5 to 458·5 MHz and 463·0 to 464·0 MHz

January, 1995

Foreword

1. It is required by the Wireless Telegraphy Act, 1949 (as modified by the Post Office Act, 1969) that no radio apparatus shall be installed or used in the United Kingdom except under the authority of a licence granted by the Secretary of State. It is a condition of such a licence that the performance of the apparatus must meet certain minimum standards.

2. The minimum standards of performance are given in specifications prepared by the Radiocommunications Agency, in consultation with the relevant manufacturers and operators.

   For convenience, so as to avoid the need for tests on every piece of equipment, manufacturers are invited to make available representative production models of their equipment for testing by, or under the control of, the Agency.

   Manufacturers, or their specified agents, who wish to submit equipment for type approval testing should apply to:

   Radiocommunications Agency
   Fixed Services Section
   Room 309
   Waterloo Bridge House
   Waterloo Road
   London SE1 8UA Telephone 0171 215 2099

3. The application should state when and where the tests can be carried out and should be accompanied by a description of the apparatus, including drawings and test results obtained in the manner described in the appropriate performance specification.

   It should also list all type numbers that may apply to non-technical variants of the model submitted.

   The Radiocommunications Agency reserves the right to give separate type approval to models it consider to be technical variants and whose performance may differ as between types.

4. A charge is made for type approval testing to recover the Agency's costs incurred in performing such work. Details of current charges are available from the address above. Manufacturers are invoiced on completion of a type approval test and the type approval certificate is provided by the Agency on receipt of payment.

5. Performance specifications may be subject to amendment. Intending manufacturers should ensure they possess the latest copy of the relevant specification, complete with any amendments.

CONTENTS

Part 1

Performance Specification

Private Fixed Radio Equipment for
Telemetry and Telecontrol Purposes
Utilising Angle Modulated Transmitters and
Receivers with 12·5 kHz Carrier Frequency
Separation and a Maximum Deviation Not Exceeding
±2·5 kHz Operating in the Bands
457·5 to 458·5 MHz and 463·0 to 464·0 MHz

PAGE

1 GENERAL

1.1 Scope of Specification

This specification covers the minimum mandatory requirements for angle modulated radio transmitters and receivers used at both base stations and outstations in the Private Fixed Radio Service. It covers measurements only on equipment designed for use in the sub-bands 457·5 to 458·5 MHz and 463·0 to 464·0 MHz of the 450 to 470 MHz band for Telemetry and Telecontrol purposes. For equipments covered by this specification the nominal separation between adjacent channel carrier frequencies is 12·5 kHz. Details of minimum performance requirements of 460 MHz antennas are contained in Part 2 of this specification. Details of the frequency assignment criteria are described in Part 3 of this specification. Part 4 describes how to design scanning telemetry systems which will comply with this specification.

1.2 Operating Frequencies

The equipment shall provide for the transmission and reception of frequency or phase modulated emissions in sub-bands 457·5 to 458·5 MHz and 463·0 to 464·0 MHz of the frequency band 450 to 470 MHz. The precise operating frequencies will be quoted by the Secretary of State when a license is issued. For the purpose of type testing, the equipment may be submitted on a mutually agreed channel in the above sub-bands.

1.3 Labelling

The equipment shall be provided with a clear indication of the type number and description under which it is submitted for type testing. Each type number shall be unique and in the case where the testing Authority finds two manufacturers have used a similar type number, one manufacturer will be asked to change the type number.

1.4 Controls

Those controls which, if maladjusted, would increase the interfering potential of the equipment shall not be easily accessible.

1.5 Declarations by the Manufacturer

When submitting an item for type approval, the manufacturer shall supply the following:

a. Transmitter

   i. Nominal frequency of the transmitter
   ii. Crystal frequency and carrier generation formula
   iii. Crystal type

b. Receiver

   i. Nominal frequency of the receiver
   ii. Crystal frequency and local oscillator generation formula
   iii. Crystal type

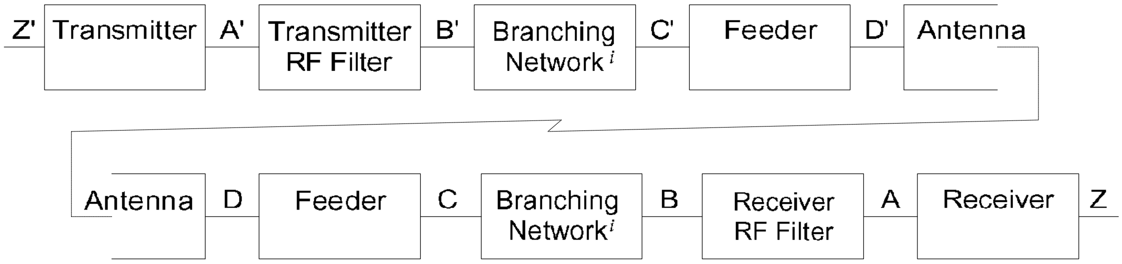
c. Rated radio frequency output power at the transmitter radio frequency output port

d. Nominal supply voltage

e. Value of resistive load into which the audio output is delivered.

1.6 Input and Output Ports - Definitions

For the purposes of this specification the terms 'transmitter input port', 'transmitter output port', 'receiver input port' and 'receiver output port' shall be taken to refer to those points corresponding respectively to the points Z', C', C and Z in figure 1. Points Z' and Z are the baseband input and output points respectively.



RF Block Diagram
Figure 1

2 TEST CONDITIONS: ATMOSPHERIC CONDITIONS AND POWER SUPPLIES

2.1 General

Type approval tests shall be made under normal test conditions (Clause 2.3) and also, where stated, under extreme test conditions (Clause 2.4).

2.2 Test Power Source

During type approval tests, the power supply for the equipment may be replaced by a test power source, capable of producing normal and extreme test voltages as specified in Clause 2.3.2 and 2.4.4.

The internal impedance of the test power source shall be low enough for its effects on the test results to be negligible.

For the purpose of type approval tests, the supply voltage shall be measured at the input terminals of the equipment.

If the equipment is provided with a permanently connected power cable, the test voltage shall be measured at the point of connection of the power cable to the equipment.

During the tests the power source voltage shall be maintained within a tolerance of ±3% relative to the voltage at the beginning of each test. In equipment in which batteries are incorporated, the test power source shall be applied as close to the battery terminals as practicable.

2.3 Normal Test Conditions

2.3.1 Normal Temperature and Humidity

The normal temperature and humidity conditions for tests shall be any convenient combination of temperature and humidity within the following ranges:

Temperature 15°C to 35°C
Relative humidity 20% to 75%

When it is impracticable to carry out the tests under the conditions stated above, a note to this effect stating the actual temperatures and relative humidity during the tests shall be added to the test report.

2.3.2 Normal Test Source Voltage

2.3.2.1 Mains Voltage

The normal test source voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the specification, the nominal voltage shall be the declared voltage or any of the declared voltages for which the equipment was designed. The frequency of the test power source corresponding to the AC mains shall be between 49 and 51 Hz.

NOTE *i* For the purpose of defining the measurement points, the branching network does not include a hybrid.

2.3.2.2 Regulated Lead Acid Battery Power Sources

When the radio equipment is intended for operation from the usual type of regulated lead acid battery source, the normal test source voltage shall be 1·1 times the nominal voltage of the battery (12 volts, 24 volts etc).

2.3.2.3 Other Power Sources

For operation from other power sources of types of battery, either primary or secondary, the normal test source voltage shall be that declared by the equipment manufacturer.

2.4 Extreme Test Conditions

2.4.1 Extreme Temperatures

For tests at extreme temperatures, measurements shall be made in accordance with the procedures specified in Clause 2.5 at an upper value of +55°C and at a lower value of -10°C.

2.4.2 Extreme Test Source Voltages

2.4.2.1 Mains Voltage

The extreme test source voltages for equipment to be connected to an AC mains source shall be the nominal mains voltage ±10%. The frequency of the test power source shall be between 49 and 51 Hz.

2.4.2.2 Battery Power Sources

When the equipment is intended for operation from the usual type of regulated lead acid power source, the extreme test voltages shall be 1·3 and 0·9 times the nominal voltage of the battery.

2.4.2.3 Other Power Sources

The lower extreme test voltages for equipment with power sources using primary batteries shall be as follows:

a. For the Leclanché type of battery: 0·85 times the nominal voltage of the battery;

b. For the mercury type of battery: 0·9 times the nominal voltage of the battery;

c. For other types of primary batteries: end point voltage declared by the equipment manufacturer.

For equipment using other power sources, or capable of being operated from a variety of power sources, the extreme test voltages shall be those agreed between the equipment manufacturer and the testing authority and shall be recorded in the test report.

2.5 Procedure for Tests at Extreme Temperatures

2.5.1 General

Before making measurements, the equipment shall be placed in a temperature controlled chamber for a period of one hour or for such period as may be judged necessary for thermal balance to be obtained. The equipment shall be switched off during the temperature stabilisation period. The sequence of tests shall be chosen and the humidity content in the test chamber shall be controlled so that excessive condensation does not occur.

2.5.2 Test Procedure

2.5.2.1 Equipment Designed for Continuous Operation

For tests at the upper temperature, after thermal balance[ii] has been attained (Clause 2.5.1), the equipment shall be switched on in the transmit condition for half an hour after which the appropriate tests shall be carried out.

For tests at the lower temperature, after thermal balance has been attained (Clause 2.5.1), the equipment shall be switched on in the receive or transmit condition for one minute after which the appropriate tests shall be carried out. If the equipment contains temperature stabilisation circuits designed to operate continuously, the equipment may be switched on for 15 minutes before measurements are made.

2.5.2.2 Equipment Designed for Intermittent Operation

If the manufacturer states that the equipment is designed for intermittent operation, the test procedure shall be as follows:

Before tests at the upper temperature the equipment shall be placed in the test chamber and left until thermal balance is attained. The equipment shall then be switched on for one minute in the transmit condition, followed by four minutes in the receive condition, after which the equipment shall meet the specified requirements. For tests at the lower temperature the equipment shall be left in the test chamber under thermal balance is attained, then switched to the standby or receive conditions for one minute after which the equipment shall meet the specified requirements.

3 GENERAL CONDITIONS

3.1 Arrangements for Test Signals Applied to the Receiver Input

Sources of test signals for application to the receiver input shall be connected in such a way that the impedance presented to the receiver input is 50 ohms. This requirement shall be met irrespective of whether one or more signals shall be expressed in terms of the power (in dBW) presented to the receiver input terminals.

The effects of any intermodulation products and noise produced in the signal generators shall be negligible.

3.2 Receiver Mute or Squelch Facility

If the receiver is equipped with a mute or squelch circuit, this shall be made inoperative for the duration of the type approval tests.

3.3 Receiver Rated Audio Output Power

The rated audio output shall be the maximum power, declared by the manufacturer, for which all the requirements of this specification are met. With normal test modulation applied (Clause 3.5) the audio output power shall be measured in a resistive load, simulating the load with which the receiver normally operates, which shall be declared by the manufacturer.

3.4 Receiver Signal to Noise Ratio

In all cases the receiver signal to noise shall be measured through an un-weighted network.

NOTE *ii* In the case of equipment containing temperature stabilisation circuits designed to operate continuously, the temperature stabilisation circuits may be switched on for 15 minutes after thermal balance has been obtained, and the equipment shall then meet the specified requirements. For such equipments the manufacturer shall provide for the power source circuit feeding the crystal oven to be independent of the power source to the rest of the equipment.

3.5 Normal Test Modulation

The standard test signal to be applied to the receiver shall be modulated to produce ±1·5 kHz deviation at 1000 Hz and be substantially free (less than 3%) from amplitude modulation. The total harmonic distortion of the modulated test signal shall not exceed 2%.

3.6 Transmitter Artificial Load

Tests on the transmitter shall be carried out using a non-reactive and non-radiating load of 50 ohms connected to the transmitter radio frequency output port.

4 TRANSMITTER

4.1 Frequency Error

4.1.1 Definition

The frequency error of the transmitter is the difference between the measured carrier frequency and its nominal value.

4.1.2 Method of Measurement

a. The transmitter output shall be connected to an artificial load (Clause 3.6) and operated in accordance with the manufacturer's instructions.

b. The emission shall be monitored by a frequency counter and the carrier frequency shall be measured in the absence of modulation.

c. The measurements shall be made under normal test conditions (Clause 2.3) and repeated under extreme test conditions (Clauses 2.4.1 and 2.4.2 applied simultaneously).

4.1.3 Limits

The frequency error, under both normal and extreme test conditions, or at any intermediate condition, shall not exceed ±1·5 kHz.

4.2 Carrier Power

The maximum value of the effective power of the carrier in an operating system will be a condition of the licence.

4.2.1 Definition

The carrier power of a transmitter is the average power supplied to the antenna transmission line by a transmitter during one radio frequency cycle taken under conditions of no modulation.

4.2.2 Method of Measurement

a. The transmitter output port shall be connected to an artificial load (Clause 3.6) with means of measuring the power delivered to this load.

b. In the absence of modulation, the transmitter shall be operated in accordance with the manufacturer's instructions. The carrier power shall be set to the manufacturer's maximum rated output.

c. The measurement shall be made under normal test conditions (Clause 2.3) and repeated under extreme test conditions (Clauses 2.4.1 and 2.4.2 applied simultaneously).

4.2.3 Limits

The carrier output power under extreme conditions shall be within +2 dB and -3 dB of the manufacturer's maximum rated output power. The maximum output power shall not exceed 10 watts under any conditions.

4.3 Frequency Deviation

The frequency deviation is the difference between the instantaneous frequency of the modulated radio frequency signal and the carrier frequency in the absence of modulation. For type approval purposes, only the maximum value of the frequency deviation available in the transmitter will be measured.

4.3.1 Maximum Permissible Frequency Deviation

4.3.1.1 Definition

The maximum permissible frequency deviation is the maximum value of deviation under any conditions of modulation.

4.3.1.2 Method of Measurement

a. The transmitter output shall be connected to an artificial load (Clause 3.6) and operated in accordance with the manufacturer's instructions.

b. The emission shall be monitored by a modulation meter, capable of measuring the peak value of both positive and negative frequency deviation, including that due to any harmonics and intermodulation products which may be produced in the transmitter.

c. The transmitter shall then be modulated by an audio frequency signal 20 dB above the level necessary to produce normal test modulation (Clause 3.5) and the modulation frequency varied from 300 Hz to 3 kHz.

d. At each test frequency, the peak deviation shall be measured.

4.3.1.3 Limits

At any modulating frequency, the frequency deviation shall not exceed ±2·5 kHz.

4.3.2 Response of the Transmitter at Modulating Frequencies above 3 kHz

4.3.2.1 Definition

Response of the transmitter at modulation frequencies above 3 kHz is the frequency deviation expressed as a function of modulation frequencies above 3 kHz.

4.3.2.2 Method of Measurement

a. The transmitter shall be arranged as described in Clause 4.3.1.2 and modulated with normal test modulation (Clause 3.5).

b. With a constant input level of the modulation signal, the frequency shall be varied from 3 kHz to 12·5 kHz.

c. At each test frequency, the resulting frequency deviation shall be measured.

4.3.2.3 Limits

The frequency deviation at modulation frequencies between 3 kHz and 6 kHz shall not exceed the frequency deviation at a modulation frequency of 3 kHz. At 6 kHz the deviation shall be at least 6 dB below the deviation at a modulation frequency of 1 kHz. The frequency deviation at modulation frequencies between 6 kHz and a frequency equal to the channel separation for which the equipment is intended shall not exceed that which would be given by a linear representation of the frequency deviation (dB) in relation to the modulation frequency, starting at a point where the modulation frequency is 6 kHz and the deviation 6 dB below the value at 1 kHz and having a slope of 14 dB per octave, the frequency deviation diminishing as the modulation frequency deviation diminishing as the modulation frequency is increased.

4.4 Adjacent Channel Power

4.4.1 Definition

The adjacent channel power is that part of the total output power of a transmitter, under defined conditions of modulation, which falls within the bandwidth of a receiver of the type normally used in the system and operating in either of the adjacent channels.

4.4.2 Method of Measurement

a. The transmitter output shall be connected to a power measuring receiver (Clause 4.4.4.) via a 50 ohm attenuator, set to produce an appropriate level at the receiver input.

b. The transmitter shall be operated at the carrier power determined in Clause 4.2.

c. The transmitter shall be modulated at 1250 Hz at a level 20 dB above that required to produce 60% of the maximum permissible frequency deviation (Clause 4.3.1).

d. The test receiver shall be tuned to the nominal frequency of such transmitter and the receiver attenuator adjusted to a value 'p' such that a meter reading of the order of 5 dB above the receiver noise level is obtained.

e. The test receiver shall then be tuned to the nominal frequency of the higher adjacent channel and the receiver attenuator re-adjusted to a value 'q' such that the same meter reading is again obtained.

f. The ratio, in decibels, of the adjacent channel power to the carrier power is the difference between the attenuator settings 'p' and 'q'.

g. The adjacent channel power shall be determined by applying this ratio to the carrier power as determined in Clause 4.2.

h. The measurement shall be repeated for the lower adjacent channel.

4.4.3 Limits

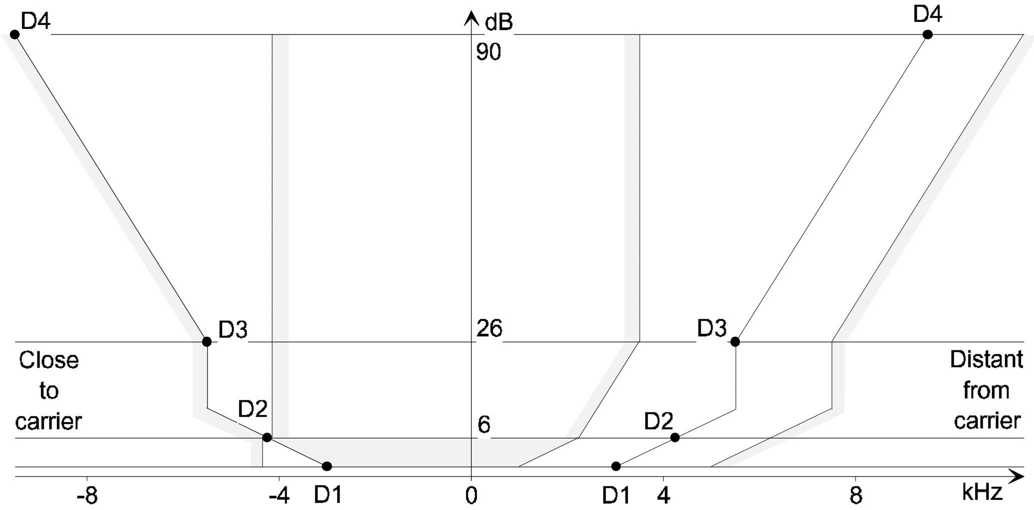
For a channel separation of 12·5 kHz, the adjacent channel power shall not exceed a value of 55 dB below the carrier power of the transmitter, without the need to be below -67 dBW.

4.4.4 Power Measuring Receiver Specification

The power measuring receiver consist of a mixer, an IF filter, an oscillator, an amplifier, a variable attenuator and an RMS value indicator. Instead of the variable attenuator with the RMS value indicator, it is also possible to use an RMS voltmeter calibrated in decibels. The technical characteristics of the power measuring receiver are given below;

4.4.4.1 IF Filter

The IF filter shall be within the limits of the following selectivity characteristics:



IF Filter Selectivity Characteristics
Figure 2

The selectivity characteristic of the filter shall be defined by values of frequency separation given in the following table:

Channel separation (kHz)	Frequency separation of filter curve from nominal centre frequency of adjacent channel (kHz)			
	D1	D2	D3	D4
12·50	3·00	4·25	5·50	9·50

The tolerances of the frequencies defining the attenuation points close to the carrier shall not exceed the values given in the following table:

Channel separation (kHz)	Tolerance range (kHz)			
	D1	D2	D3	D4
12·50	1·35	±0·10	-1·35	-5·35

Attenuation points distant from the carrier:

Channel separation (kHz)	Tolerance range (kHz)			
	D1	D2	D3	D4
12.50	±2·0	±2·0	±2·0	+2·0/-6.0

The minimum attenuation of the filter outside the 90 dB attenuation points must be equal to or greater than 90 dB.

4.4.4.2 Attenuation Indicator

The attenuation indicator shall have a minimum range of 80 dB and a reading accuracy of 1 dB. With a view to future regulations an attenuation of 90 dB or more is recommended.

4.4.4.3 RMS Value Indicator

The instrument shall indicate accurately non-sinusoidal signals in a ratio of up to 10:1 between peak value and RMS value.

4.4.4.4 Oscillator and Amplifier

The oscillator and the amplifier shall be designed in such a way that the measurement of the adjacent channel power of a low noise un-modulated transmitter, whose self noise has a negligible influence on the measurement result, yields a measured value of $\leq$-80 dB referred to the carrier of the oscillator.

4.5 Spurious Emissions

4.5.1 Definition

Spurious emissions are emissions at frequencies which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products but exclude emissions on frequencies immediately outside the necessary bandwidth which result from the modulation process.

4.5.2 Method of Measurements

a. The transmitter output shall be connected to either a spectrum analyser via an attenuator, or an artificial load, with means of monitoring the emission with the spectrum analyser or selective voltmeter.

b. The transmitter shall be un-modulated and at each spurious emission in the frequency range 100 kHz to 2 GHz, and the level of the emission shall be measured relative to the carrier emission.

c. The power level of each emission shall be determined by applying the ratio measured to the carrier power level determined in Clause 4.2.

4.5.3 Limits

The power of any spurious emission in the specified range of frequencies shall not exceed -56 dBW.

5 RECEIVER

5.1 Reference Sensitivity

5.1.1 Definition

The reference sensitivity of the receiver is the minimum level of signal at the receiver input, at the nominal frequency of the receiver and with normal test modulation, that will produce an audio frequency output signal having a minimum signal to noise ratio, un-weighted, of 27 dB.

5.1.2 Method of Measurement

a. A test signal at the nominal frequency of the receiver and with normal test modulation (Clause 3.5) shall be applied to the input of the receiver via the standard input network according to Clause 3.1 at a level of -124 dBW. The receiver shall then be adjusted for standard power output according to Clause 3.3.

b. With modulation removed the signal to noise ratio (Clause 3.4) shall be measured at the receiver output.

5.1.3 Limits

At a receiver input signal level of -124 dBW the minimum signal to noise ratio, un-weighted, shall be 27 dB.

5.2 Adjacent Channel Selectivity

5.2.1 Definition

The adjacent channel selectivity is a measure of the capability of a receiver to receive a wanted signal without exceeding a given degradation due to the presence of an unwanted modulated signal which differs in frequency from the wanted signal by the separation between adjacent channels for which the equipment is intended.

5.2.2 Method of Measurement

a. A test signal at the nominal frequency of the receiver and with normal test modulation (Clause 3.5) shall be applied to the input of the receiver via one path of a combining unit. This signal constitutes the wanted signal.

b. A second test signal shall be applied to the receiver via the second path of the combining unit. This test signal shall be set to the carrier frequency of the upper adjacent channel and shall be modulated with a frequency of 400 Hz at a deviation of ±2·5 kHz. This signal constitutes the unwanted signal.

c. In the absence of the unwanted signal the reference sensitivity shall be obtained as described in clause 5.1.2.

d. The unwanted signal shall then be applied at a level of -74 dBW at the receiver input. The signal to noise ratio (Clause 3.4) at the output of the receiver shall be measured.

e. This measurement shall be repeated using the frequency of the lower adjacent channel.

f. These measurements shall be made under normal test conditions (Clause 2.3) and repeated under extreme test conditions. (Clause 2.4.1 and 2.4.2 applied simultaneously).

5.2.3 Limits

For a channel separation of 12·5 kHz with an interfering signal in the adjacent channel the signal to noise ratio, un-weighted, shall not be less than 24 dB under both normal and extreme test conditions.

5.3 Spurious Response Rejection

5.3.1 Definition

The spurious response rejection is a measure of the ability of the receiver to discriminate between the wanted modulated signal at the nominal frequency and any unwanted signal at any other frequency at which a response is obtained.

5.3.2 Method of Measurements

a. A standard test signal according to Clause 3.5 shall be applied through the standard input network according to Clause 3.1 to the receiver input at a level of -64 dBW, and its frequency varied from the lowest intermediate frequency of the receiver to 2 GHz.

b. At each frequency at which a response is obtained the signal to noise ratio (Clause 3.4) at the output of the receiver shall be measured.

5.3.3 Limits

At any frequency separated from the nominal frequency of the receiver by more than 12·5 kHz the signal to noise ratio, un-weighted, shall not exceed 27 dB.

5.4 Receiver Spurious Emissions

5.4.1 Definition

Spurious emissions from receivers are any unwanted emissions present at the input port.

5.4.2 Method of Measurement

a. The receiver input port shall be connected to either a spectrum analyser or a selective voltmeter via an attenuator, or an artificial load with means of monitoring the emission with a spectrum analyser or a selective voltmeter.

b. At each emission up to 2 GHz the power level of the emission shall be measured.

5.4.3 Limits

The power of any spurious emission in the specified range of frequencies shall not exceed -77 dBW.

6 CABINET RADIATIONS

6.1 Definition

Cabinet radiations are emissions at any frequency other than those of the carrier and associated sidebands, radiated from the cabinet and structure of the equipment.

6.2 Specifications Limits

Cabinet radiations shall be minimised in order to avoid interference to other radio installations. In the event of interference being traced to cabinet radiations the licensees will be required to provide interference suppression to a degree which shall be satisfactory to the Secretary of State.

7 INTERPRETATION OF THIS SPECIFICATION

In the event of doubt arising over the interpretation of this specification or the methods of conducting the tests, the decisions of the Testing Authority shall be final.

8 ACCURACY OF MEASUREMENT

The tolerance for the measurement of the following parameters shall be given below:

Section	Parameter	Tolerance
8.1.1	DC Voltage.	±1%
8.1.2	AC Mains Voltage.	±1%
8.1.3	AC Mains Frequency.	±0·5%
8.2.1	Audio Frequency Voltage, Power, etc.	±0·5 dB
8.2.2	Audio Frequency.	±1%
8.2.3	Distortion and Noise, etc, of Audio Frequency Generators.	1%
8.3.1	Radio Frequency.	±50 Hz
8.3.2	Radio Frequency Power.	±1 dB
8.4.1	Impedance of Artificial Loads, Combining Units, Cables, Plugs and Attenuators.	±5%
8.4.2	Source Impedance of Generator.	±10%
8.4.3	Attenuation of Attenuators.	±0·5 dB
8.5.1	Temperature.	±1°C
8.5.2	Humidity.	±5%

PART 2

PERFORMANCE SPECIFICATION

Antennas for use by Private Fixed
Telemetry and Telecontrol Radio
Services Operating in the Bands
457·5 to 458·5 MHz and 463·0 to 464·0 MHz.

PAGE

1 GENERAL

1.1 Scope of Specification

This specification covers the minimum performance requirements for antennas to be used in the bands 457·5 to 458·5 MHz and 463·0 to 464·0 MHz allocated to private fixed telemetry and telecontrol services.

1.2 Licensee's Responsibility

The installation of equipment, either fixed or mobile, is subject to the issue of a licence by the Secretary of State. Under the conditions of the licence it shall be the responsibility of the licensee to ensure that the equipment provided conforms with and is maintained to the requirements of this specification.

1.3 Labelling

Complete antenna assemblies shall be clearly identified with a weather-proof and permanent mark (or marks) showing the manufacturer's name and type number. Additionally the antenna shall display a mark indicating the E-plane axis.

1.4 Polarisation

The polarisation of radiation shall be either vertical or horizontal. The polarisation to be used for any specific radio system will be specified when frequencies for the system are assigned.

Radiation in the main beam having a polarisation orthogonal to that which is intended shall not exceed a level of -20 dB relative to the radiation of energy having the intended polarisation. Measurement of this characteristic shall be made under "free space" conditions.

1.5 Construction

In the case of antennas (eg, colinear) designed to provide the either omni-directional or sector coverage any elements which if disturbed or re-positioned might increase the interfering potentialities of the antenna shall be secured in such a way as to prevent maladjustment.

1.6 Test Arrangements

All performance testing of antennas shall be carried out at a test site specified by the testing authority.

Arrangements will be made for the applicant to deliver his antenna to the test site at least 14 days before testing is scheduled to begin[i].

Manufacturers may be required to participate in the mounting and dismantling of the antenna. Applicants shall normally be expected to make arrangement to remove their antennas from the test site within 14 days of receiving notification from the testing authority that tests have been completed.

2 TECHNICAL REQUIREMENTS

2.1 Definitions

Radiation Pattern - A diagram relating power flux density or field strength at a constant (and usually large) distance from an antenna to azimuth direction relative to the antenna.

RPE - Radiation Pattern Envelope: an envelope below which the radiation pattern must fit.

Radome - A cover for an antenna systems which is weather-proof and intended to be transparent to radio frequency energy at the operational frequency of the antenna.

Feed Shroud - A cover for a primary radiator which is weather-proof and intended to be transparent to radio frequency energy at the operational frequency of the antenna.

Co-polar Pattern - A diagram representing the radiation pattern of a test antenna when the reference antenna is similarly polarised.

NOTE *i* Tests may from time to time be cancelled or postponed at short notice due to unsuitable weather conditions.

Cross-polar Pattern - A diagram representing the radiation pattern of a test antenna when the reference antenna is orthogonally polarised to the test antenna.

2.2 Method of Measurement

The antenna radiation pattern shall be measured at the test frequencies 458·0 and 463·5 MHz. The testing authority reserves the right to test at additional frequencies within the range 457·5 to 464·0 MHz should it be deemed necessary.

The co-polar and cross-polar pattern shall be measured and plotted at each frequency and with the antenna mounted in both the vertical and then the horizontal plane. If the antenna is designed for operation in one plane only then the measurements shall be performed with the antenna mounted in the intended plane of operation. If the antenna is designed for use with a radome, or feed shroud, measurements shall be made with this in place.

2.3 Specification Limits

The measured antenna performance shall meet the minimum requirements specified in table below:

Antenna Radiation Pattern Envelope Limits;

Antenna	Type	Limits
Base Station	Omni-directional	The radiation pattern when measured in azimuth shall not vary by more than ± 1·5 dB for vertically polarised antennas and ± 1·5 dB for horizontally polarised antennas.
Base Station	Sector coverage	See Figure 1.
Outstation	Directional	See Figures 2 and 3.

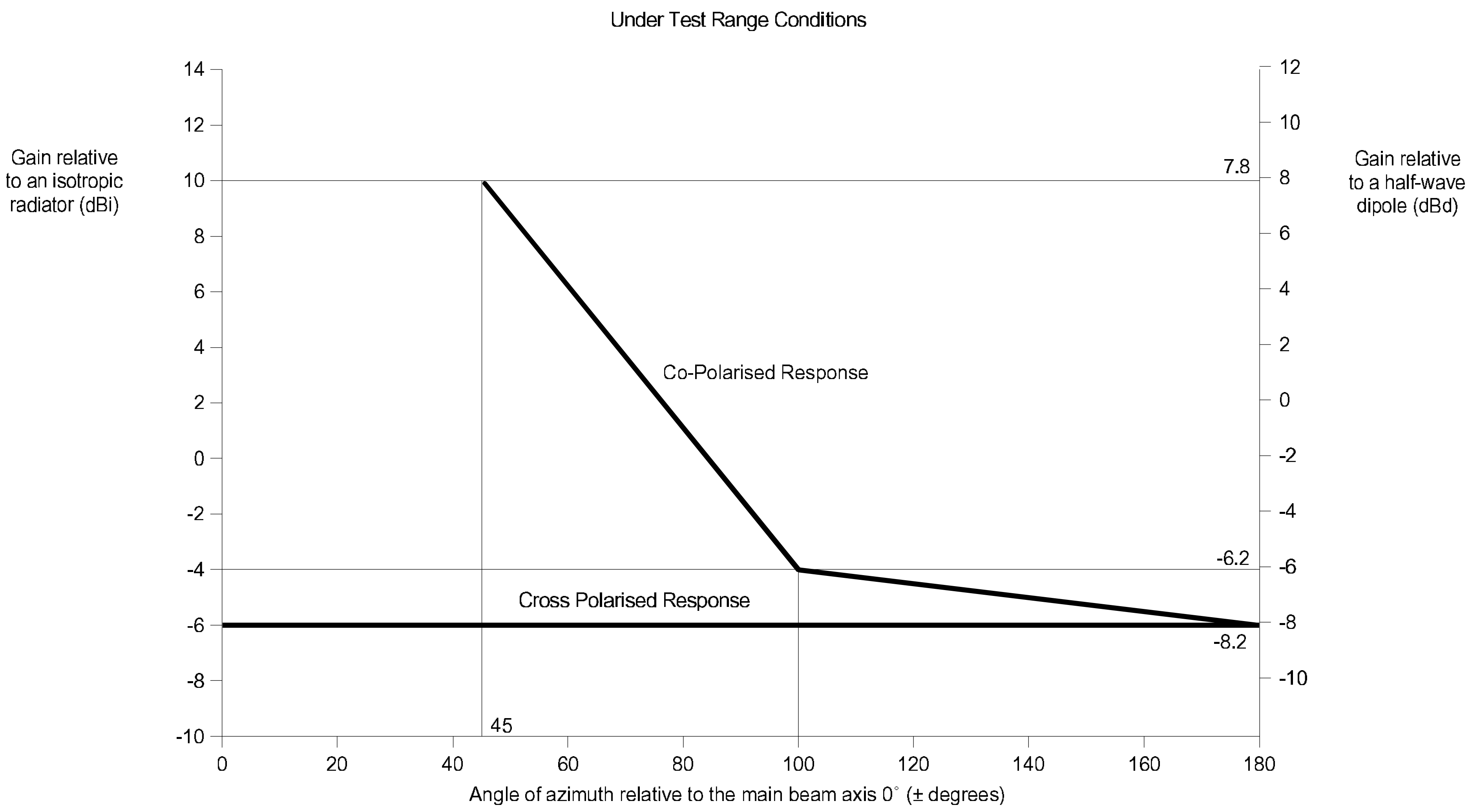
3 MISCELLANEOUS

3.1 Interpretation of this Specification

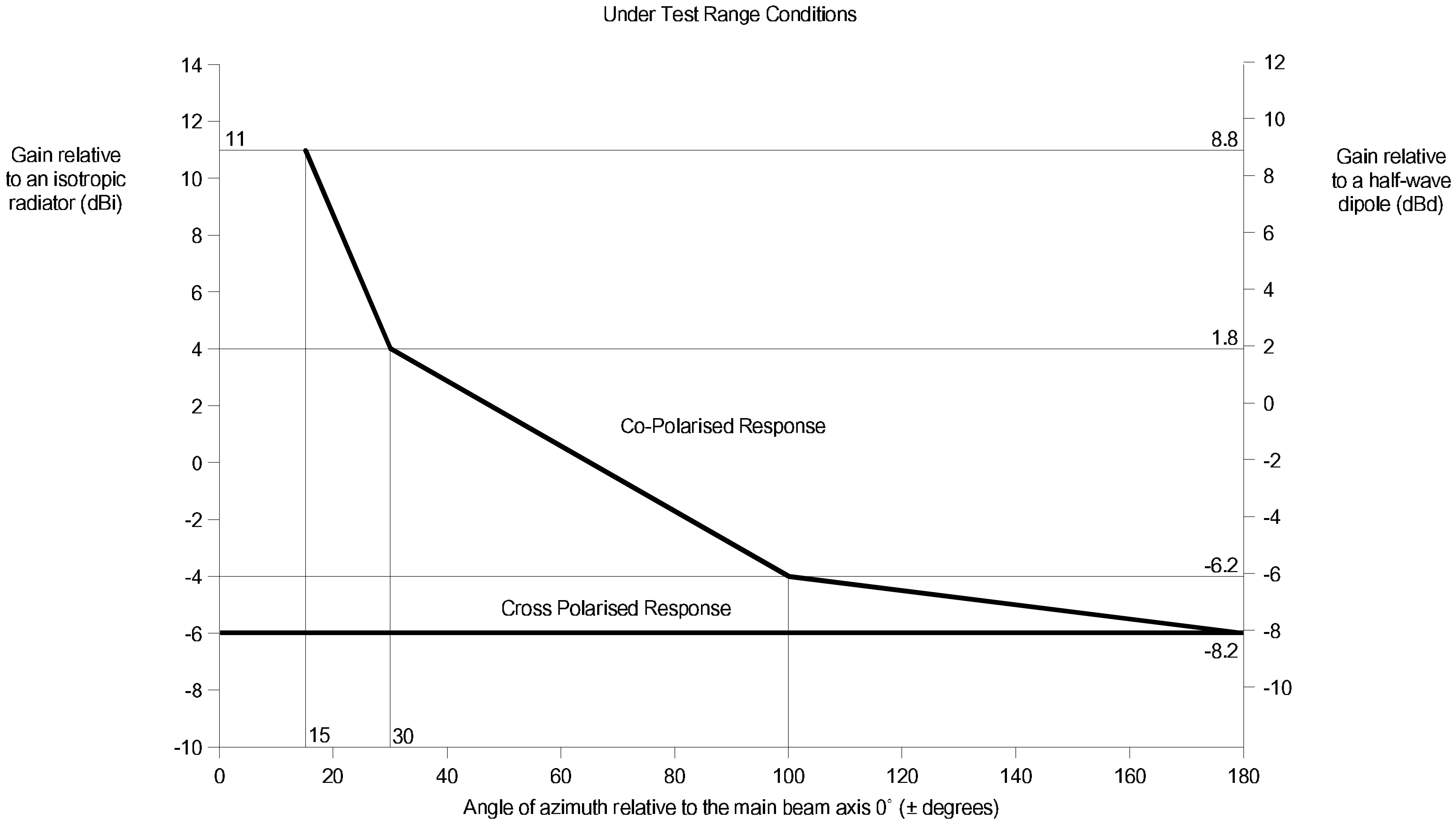
In case of doubt regarding the interpretation of this specification the decision of the testing authority shall be final.

3.2 Equivalent Isotopically Radiated Power (EIRP)

In the band 457·5 to 464·0 MHz the maximum equivalent isotropically radiated power (EIRP) shall not exceed 24 dBW.

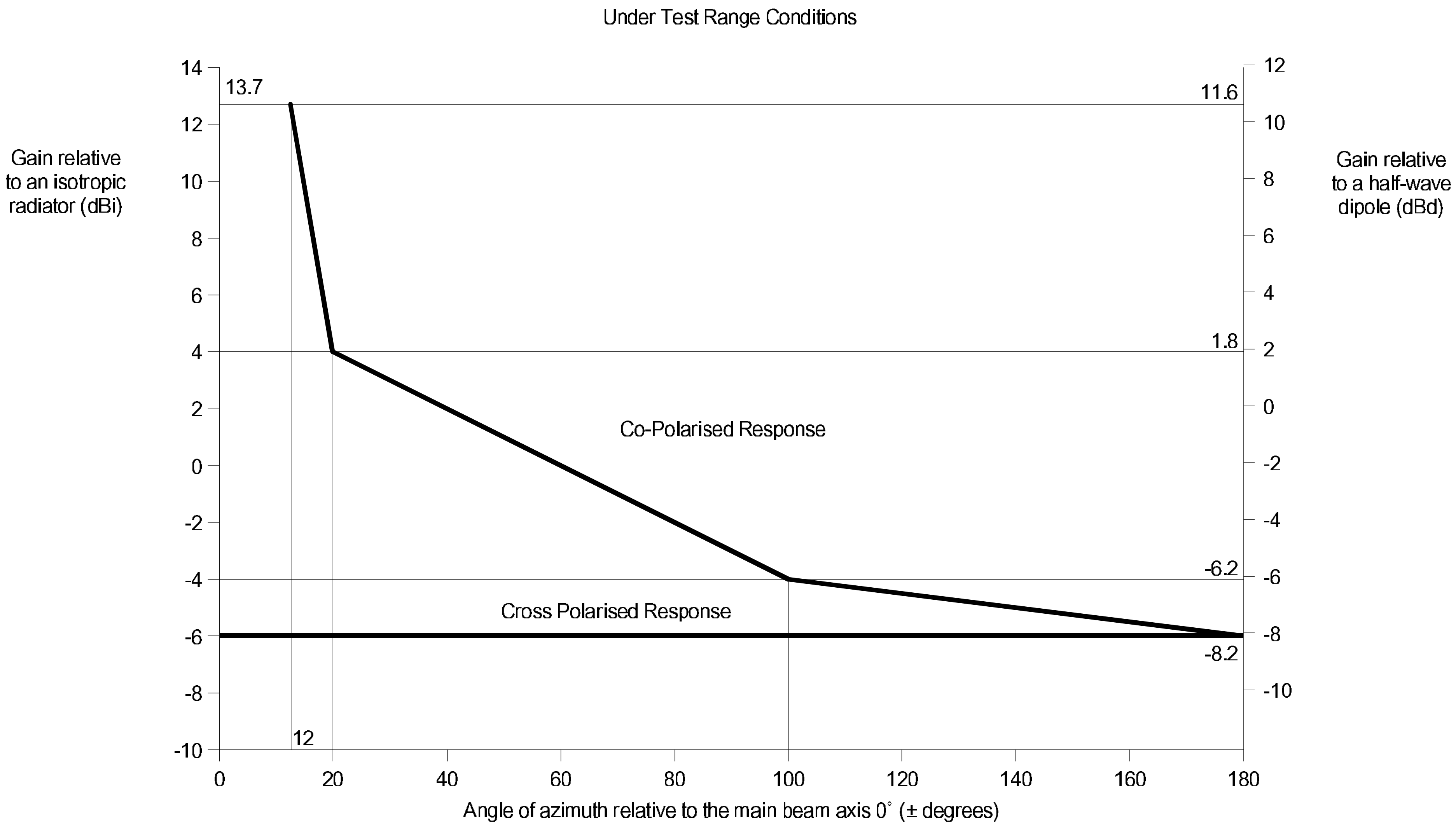


Sector Antenna Radiation Pattern Envelope for Base Stations
Figure 1



Antenna Radiation Pattern Envelope for Outstations - Standard Antenna

Figure 2



Antenna Radiation Pattern Envelope for Outstations - High Performance Antenna
Figure 3

PART 3

Frequency Assignment Criteria

Frequency Assignment Criteria for
Private Fixed Telemetry and Telecontrol
Radio Services Operating in the Bands
457·5 to 458·5 MHz and 463·0 to 464·0 MHz.

1 GENERAL

1.1 Introduction

This section outlines the frequency assignment criteria and principles that will be employed by the Radiocommunications Agency in the selection of frequencies for telemetry and telecontrol systems in the band 457·5 to 458·5 MHz and 463·0 to 464·0 MHz.

1.2 Licensee's Responsibility

The establishment, use or installation of the systems are subject to the issue of a licence by the Secretary of State for Trade and Industry. Under the conditions of the licence it will be the responsibility of the licensee to ensure that equipment conforms with and is maintained to the standard set out in Part 1 and Part 2 of this specification. Licences to authorise the use of equipment will only be granted to equipment which has been type approved to the relevant MPT specification.

2 TRANSMITTING AND RECEIVING INSTALLATIONS

2.1 General

The transmitting and receiving installations shall conform to clauses 2.2 and 2.3 below. The receiving installation shall conform to clause 2.2 below. The installations shall be in accordance with good engineering practice.

2.2 Antenna Directivity and Polarisation

The co-polarised and cross-polarised directivity of an individual antenna installed at the licensed premises shall be such that the effective isotropic gain in the horizontal plane (0° elevation) at any azimuth does not exceed the value specified in Part 2 of this publication.

The plane of polarisation of emissions for a particular system will be specified by the Radiocommunications Agency when frequencies for the system are assigned and in general will either be horizontal or vertical linear polarisation.

The antenna alignment for both vertically and horizontally polarised systems shall be within ±2° of the true vertical or horizontal plane respectively.

2.2.1 Directional Antenna Arrays

Complex directional arrays of type approved antennas will be considered on a case by case basis.

2.2.2 Antenna Nulling Techniques

Active and passive antenna nulling techniques and their arrays will be considered on a case by case basis.

2.2.3 Use of Non Type Approved Antennas

Use of non type approved transmitting antennas at standard stations for an interim period, whilst under-going type approval testing, will be considered on a case by case basis. If type approval is not attained by the specified date then further use of the antenna will be prohibited. Use of non type approved transmitting antennas at non-standard outstations will be considered on a case by case basis.

2.2.4 Mixed Polarisation Schemes

Mixed polarisation schemes will be considered on a case by case basis.

2.2.5 Alternative Polarisations

Other classes of polarisation will be considered on a case by case basis.

2.3 Equivalent Isotropically Radiated Power (EIRP)

The maximum value of EIRP will be a condition of the licence. In no circumstance will the Radiocommunications Agency issue a licence for any system which requires an EIRP in excess of 250 W (24 dBW).

3 PRINCIPLES OF ASSIGNMENT

3.1 General

In the interests of economy of use of the radio frequency spectrum and of limiting interference between different radio transmissions, it is the responsibility of the Secretary of State for Trade and Industry to decide the frequency, the limits of EIRP and other engineering characteristics to be permitted under the licence for each separate or group of radio installations.

Factors taken into account in order to determine the most suitable frequency include polarisation of the antennas, height of the antennas and the end to end circuit loss of potential interference paths together with Adaptable Cellular Plan[i], if appropriate. An evaluation may also be made of site intermodulation products, etc, before the final frequency assignment is made. Furthermore, when assigning frequencies which are in use in the same geographical area, due consideration shall be taken of the antenna discrimination available where this is deemed possible.

3.2 Frequency Channelling

The bands 457·5 to 458·5 MHz and 463·0 to 464·0 MHz may be considered as a lower half band "L" and an upper half band "H" respectively.

A frequency assignment will generally comprise a pair of transmit frequencies. One frequency chosen from the "L" half band will be assigned to the base station (scanner) and the corresponding frequency from the "H" half band to the outstation. There are both group A and interleaved group B channels within the band. The interleaved group B channels are offset from the group A channels by 6·25 kHz. The use of interleaved group B channels shall be considered on a case by case basis.

The frequency difference between two adjacent group A or group B channels in both the "L" and "H" half bands will be 12·5 kHz and the difference between a pair of corresponding "L" and "H" channels will be 5·5 MHz (See table 1).

Wherever possible frequency re-use will be employed. In the case of channels 1 to 72, together with their interleave channels, this will be in accordance with the Adaptable Cellular Plan where possible.

3.3 Maximum Path Length

In the interests of spectrum economy and the need to re-use frequencies wherever possible, the Radiocommunications Agency will generally consider only those outstations, whether standard, non-standard or relay, which are grouped within a 30 km radius of the associated base station. Outstations greater than 30 km from the base station will however be considered on a case by case basis.

3.4 Total Path Loss

The total path loss is that loss due to free space propagation, ground terrain obstruction and building and / or vegetation clutter losses.

An overriding total path loss maximum of 143 dB will apply.

3.4.1 Clutter Loss

Additional path loss due to clutter comprises of the components;

a. The loss due to the effects of buildings and vegetation on top of a terrain obstruction along the path.

NOTE: *i.* The Future of UHF Scanning Telemetry Frequency Assignments - A report for DTI, JRC and TAG, January 1989. Published by the Radiocommunications Division of the Department of Trade and Industry, now the Radiocommunications Agency.

b. The loss due to buildings and vegetation in the immediately locality of the outstation.

The clutter loss experienced by an outstation may comprise of one or both of the above two components.

Clutter losses are generally limited to 20 dB. However, values exceeding 20 dB, but not exceeding 30 dB, will be considered on a case by case basis. These limits will only apply to existing systems when an alteration to the scheme results in an increase of scanner EIRP.

3.5 End to End Circuit Loss

The end to end circuit loss comprises of the sum of all losses and gains between the transmitting station transmitter output port and the receiving station receiver input port[ii], inclusive of both stations' antenna radiation pattern in the direction under consideration; as shown below:

$$EECL = TPL + (SFL + SOL - SAG) + (OFL + OOL - OAG)$$

Where:

$EECL$ = The scanner to outstation end to end circuit loss (dB).
TPL = Total path loss to the outstation (dB).
SFL, OFL = Scanner and outstation feeder losses respectively (dB).
SOL, OOL = Scanner and outstation other[iii] losses respectively (dB).
SAG, OAG = Scanner and outstation antenna gains respectively (dBi).

The antenna gain is that gain along the direction of the path, as defined by the radiation pattern envelope.

An overriding end to end circuit loss maximum of 134 dB will apply.

3.6 Assigning Path

The assigning path is that path whose end to end circuit loss (EECL) does not exceed the calculated maximum outstation permissible value for that system, $EECL_{max}$. Those paths whose actual EECL exceeds $EECL_{max}$ will be assigned EIRP's corresponding to $EECL_{max}$. The $EECL_{max}$ is defined thus:

$$EECL_{max} = 1.6\sigma_{EECL} + \bar{x}_{EECL} \qquad \bar{x}_{EECL} = \frac{\sum_{i=1}^{n} EECL_i}{n} \qquad \sigma_{EECL} = \sqrt{\frac{\left(n \sum_{i=1}^{n} EECL_i^2\right) - \left(\sum_{i=1}^{n} EECL_i\right)^2}{n^2}}$$

Where:

σ_{EECL} = The standard deviation of the end to end circuit losses (dB).
$\bar{x}_{EECL}$ = The average end to end circuit loss for the outstations (dB).
n = The number of outstations attached to the scanner.
$EECL_{max}$ = The maximum End to End Circuit Loss for the outstations (dB).

The above will apply to existing schemes when an alteration to the system results in an increase of scanner EIRP.

NOTE: *ii.* The receiver input port shall include any antenna combining or branching elements which may be used between the antenna feeder connections and the receiver unit input connection. The receiver input port corresponds to points C and C' in figure 1 on page 1-5 of part 1 of this specification.

iii. Other losses are those additional system losses as described in Question 24 of form RA37; namely, connector and feeder tail losses, etc.

3.7 Path Profiles

To determine the maximum radiated power for both base station and associated outstations, the Radiocommunications Agency will require a suitably scaled path profile corresponding to an effective earth radius to real earth radius, K, of 4/3. The profile shall show the path having the assigning end to end circuit loss as defined in clause 3.6. Details of terrain features such as vegetation, buildings, etc, must be clearly identified along with their relative positions and heights.

3.8 Receiver Input Signal Level

The Radiocommunications Agency will calculate the permitted maximum EIRP on the assumption that the median signal level at the receiver input port does not exceed -117 dBW where duplicated receivers are employed. Where the equipment configuration does not employ a duplicated receiver the level at the receiver input shall not exceed -122 dBW. However, giving due consideration to clause 5, a design median signal level at the scanner receiver input port of up to, but not exceeding, -103 dBW will be considered on a case by case basis.

3.9 Calculation of Equivalent Isotropically Radiated Power (EIRP)

Calculation of the permitted maximum EIRP will be based on the appropriate receiver input port level, as determined in clause 3.8, and the end to end circuit loss, as defined in clause 3.5, for both the base station and outstations and the appropriate loss to scanner or loss to outstation as shown below:

$$Scanner\ \{EECL_{wc} \le EECL_{max}\} \quad LTO = EECL - SFL - SOL + SAG \quad EIRP_{Scanner} = RIL + LTO$$
$$Scanner\ \{EECL_{wc} > EECL_{max}\} \quad LTO = EECL_{max} - SFL - SOL + SAG \quad EIRP_{Scanner} = RIL + LTO$$
$$Outstation\ \{EECL \le EECL_{max}\} \quad LTS = EECL - OFL - OOL + OAG \quad EIRP_{Outstation} = RIL + LTS$$
$$Outstation\ \{EECL > EECL_{max}\} \quad LTS = EECL_{max} - OFL - OOL + OAG \quad EIRP_{Outstation} = RIL + LTS$$

Where:

$EECL_{wc}$ = Worst case outstation EECL (dB)
LTO = Loss to outstation (dB).
LTS = Loss to scanner (dB).
RIL = Receiver input port level (dBW).

The maximum assignable EIRP for a given scanner and its family of outstation(s) is that EIRP determined by clause 3.6.

The minimum assignable EIRP will normally not be less than -20 dBW, though in some circumstances a lower EIRP may have to be assigned.

3.10 Co-channel Interference Level

The Radiocommunications Agency will, as far as possible, assign frequencies on the basis that a wanted carrier to co-channel interference ratio (C/I) of 22 dB will be protected. Which in normal circumstances, for a single unwanted source at the receiver input, should not exceed - 144 dBW for 99·9% of the time.

For co-ordination purposes, the EIRP is that radiated in the horizontal plane (0° elevation).

4 SPECIAL SYSTEMS

It is considered that there are five basic classes of scanning telemetry system. These are:

a. Scanning systems incorporating some non-standard outstations.

b. Scanning systems incorporating only non-standard outstations.

c. Single hop relay systems for circumnavigating severe obstructions.

d. Single standard outstation scanning telemetry systems for obstructed paths.

e. Multi-hop single frequency relay systems.

It is foreseen that the following special systems fall within one of the above categories.

4.1 Regulated On-site and Local Area Telemetry and Telecontrol Services.

Telemetry and telecontrol services for on-site and local area schemes will be permitted and protected.

The coverage area shall be restricted to the site boundary or the desired area of coverage, in the case of a local area scheme, by means of suitable antenna(s) and EIRP (See clause 3.9). The EIRP shall not exceed 0 dBW.

4.2 Secondary Scanner Receive Only Stations

Secondary scanner receiver stations will be permitted and protected, where these form an extension to the main scanning system. They will typically be used after sectoring the main scanner receiver coverage area.

4.3 Relay Outstations

The use of relay outstations, to enable communications to be established to other outstations not directly accessible from a scanner, will be permitted and protected, where these form an extension to the main scanning system.

The assigning path is determined in accordance with clauses 3.6 of this specification. Non-standard outstations, as described in clause 4.4 below, are **included** in the calculations used to determine the assigning path. The calculation of the permitted maximum EIRP for the system shall be in accordance with clause 3.9 of this specification, except that the maximum assignable EIRP of the relay outstation and its corresponding target outstations, regardless of whether the target outstations are standard or non-standard, shall not exceed 0 dBW.

They are not intended as an alternative to the establishment of a main scanning site, but to give access to isolated outstations where the establishment of a new main scanner site is not practicable.

4.4 Non-standard Outstations

The establishment of a non-standard outstation utilising an antenna other than a standard or high performance type will be considered on a case by case basis.

The height of the antenna above ground of a non-standard outstation shall not exceed 10 metres. Non-standard outstations will be protected, however they may not necessarily be assigned with a C/I ratio of 22 dB.

They are not intended as an alternative to the establishment of a standard outstation, but to give a new class of outstation for use in those circumstance where the installation of a standard antenna is not practicable and / or safe. Where possible, the use of a directional antenna will be encouraged.

The method of assignment is governed by the class of system in which they are installed:

4.4.1 Systems which contain some Non-Standard Outstations

The assigning path is determined in accordance with clause 3.6 of this specification, except that the non-standard outstations are **excluded** from the calculations used to determine the assigning path. The assigning path is determined only by the standard outstations of the host system. The calculation of the permitted maximum EIRP for the system shall be in accordance with clause 3.9 of this specification, except that the maximum assignable EIRP for the non-standard outstations shall not exceed 0 dBW.

4.4.2 Systems which contain only Non-Standard Outstations

The assigning path is determined in accordance with clauses 3.6 of this specification. Non-standard outstations are **included** in the calculations used to determine the assigning path. The calculation of the permitted maximum EIRP for the system shall be in accordance with clause 3.9 of this specification, except that the maximum assignable EIRP for the scanner and the non-standard outstations shall not exceed 0 dBW.

4.5 Simplex Systems

Simplex systems will be permitted and protected.

Simplex systems will be assigned in accordance with clauses 3.6 or 4.4, and clause 3.9, of this specification depending upon the type of outstations employed.

These are intended for telemetry or telecontrol services and data distribution or gathering networks.

The un-used frequency of the two frequency pair may be assigned to another user if appropriate.

4.6 Single Standard Outstation Systems

Such systems will be permitted and protected where it can be demonstrated that the requirement cannot be met in another band. It is envisaged that such systems will be permitted where there is either a significant terrain obstruction to be overcome or that the benefits of the 460 MHz band propagation characteristics are required. Such systems will be assigned in accordance with clauses 3.6 and 3.9 of this specification.

4.7 Multi-Hop Single Frequency Relay Systems

Such systems will be permitted and protected where it can be demonstrated that the requirement cannot be met in another band. Such relay outstations will be assigned an EIRP which shall not exceed 0 dBW. It is envisaged that such systems are likely to operate on a single unpaired frequencies.

5 CONTINENTAL INTERFERENCE TO UK SCANNING TELEMETRY SYSTEMS

Due to the UK UHF bands being frequency reversed relative to Europe, users of scanning telemetry systems in south eastern England, as well as along the whole of the eastern and southern coastal areas, are susceptible to interference from European systems. This may be significant and protracted from time to time.

The Agency are willing to discuss any problems with affected, or potential, users of scanning telemetry and determine what can be done to ameliorate their difficulties. This will include the use of one, or more, of the following remedial measures which will be considered by the Agency on a case by case basis;

a. Horizontal polarisation.

b. An alternative group A or an interleave group B channel.

c. Sectoring scanner coverage areas, using a directional antenna or either passive or adaptive cancelling antenna arrays.

d. A revised median signal level at the receiver input port of up to, but not exceeding, -103 dBW.

e. Any other solution which can be accepted within the terms of this specification.

The above remedial measures can only be adopted providing the Agency has both granted consent to such solutions and that they can be successfully co-ordinated with other co-channel users.

6 ADAPTABLE CELLULAR PLAN

The Adaptable Cellular Plan was devised as a means of maximising the use of the scanning telemetry band and providing a defined planning and frequency co-ordinating environment for the major utilities; namely the Gas, Electricity and Water industries. It encompassed 72 channels on a twelve cell, six channels per cell, regular frequency re-use cellular strategy. Each of the three utilities had access to two exclusive channels per cell. Eight channels (T73 to T80) were reserved for other users of scanning telemetry services and these are not subject to the Adaptable Cellular Plan. A full description and discussion of the Adaptable Cellular Plan is given in the Radiocommunications Agency's report entitled 'The Future of UHF Scanning Telemetry Frequency Assignments - A report for DTI, JRC and TAG', published in January 1989.

The use of alternative planning and frequency co-ordination strategies by one or more of the aforementioned utilities within their own allotted channels is permitted by the Agency, providing that prior agreement is achieved and its efficacy over the present arrangement can be adequately demonstrated.

7 STATUS

The contents of Part 3 are for information and guidance only.

TABLE 1

Transmit frequencies for Private Fixed Telemetry and Telecontrol Radio Services operating in the bands 457·5 to 458·5 MHz and 463·0 to 464·0 MHz.

Channel	Nominally interference free		Scanner		Outstations	
	Group A	Group B	Group A	Group B	Group A	Group B
1			457.50625	457.51250	463.00625	463.01250
2	Y		457.51875	457.52500	463.01875	463.02500
3		Y	457.53125	457.53750	463.03125	463.03750
4			457.54375	457.55000	463.04375	463.05000
5		Y	457.55625	457.56250	463.05625	463.06250
6			457.56875	457.57500	463.06875	463.07500
7	Y		457.58125	457.58750	463.08125	463.08750
8			457.59375	457.60000	463.09375	463.10000
9			457.60625	457.61250	463.10625	463.11250
10	Y		457.61875	457.62500	463.11875	463.12500
11		Y	457.63125	457.63750	463.13125	463.13750
12			457.64375	457.65000	463.14375	463.15000
13		Y	457.65625	457.66250	463.15625	463.16250
14			457.66875	457.67500	463.16875	463.17500
15	Y		457.68125	457.68750	463.18125	463.18750
16			457.69375	457.70000	463.19375	463.20000
17			457.70625	457.71250	463.20625	463.21250
18	Y		457.71875	457.72500	463.21875	463.22500
19		Y	457.73125	457.73750	463.23125	463.23750
20			457.74375	457.75000	463.24375	463.25000
21		Y	457.75625	457.76250	463.25625	463.26250
22			457.76875	457.77500	463.26875	463.27500
23	Y		457.78125	457.78750	463.28125	463.28750
24			457.79375	457.80000	463.29375	463.30000
25			457.80625	457.81250	463.30625	463.31250
26	Y		457.81875	457.82500	463.31875	463.32500
27		Y	457.83125	457.83750	463.33125	463.33750
28			457.84375	457.85000	463.34375	463.35000
29		Y	457.85625	457.86250	463.35625	463.36250
30			457.86875	457.87500	463.36875	463.37500
31	Y		457.88125	457.88750	463.38125	463.38750
32			457.89375	457.90000	463.39375	463.40000
33			457.90625	457.91250	463.40625	463.41250
34	Y		457.91875	457.92500	463.41875	463.42500
35		Y	457.93125	457.93750	463.43125	463.43750
36			457.94375	457.95000	463.44375	463.45000
37		Y	457.95625	457.96250	463.45625	463.46250
38			457.96875	457.97500	463.46875	463.47500
39	Y		457.98125	457.98750	463.48125	463.48750
40			457.99375	458.00000	463.49375	463.50000
41			458.00625	458.01250	463.50625	463.51250

Channel	Nominally interference free		Scanner		Outstations	
	Group A	Group B	Group A	Group B	Group A	Group B
42	Y		458.01875	458.02500	463.51875	463.52500
43		Y	458.03125	458.03750	463.53125	463.53750
44			458.04375	458.05000	463.54375	463.55000
45		Y	458.05625	458.06250	463.55625	463.56250
46			458.06875	458.07500	463.56875	463.57500
47	Y		458.08125	458.08750	463.58125	463.58750
48			458.09375	458.10000	463.59375	463.60000
49			458.10625	458.11250	463.60625	463.61250
50			458.11875	458.12500	463.61875	463.62500
51		Y	458.13125	458.13750	463.63125	463.63750
52			458.14375	458.15000	463.64375	463.65000
53		Y	458.15625	458.16250	463.65625	463.66250
54			458.16875	458.17500	463.66875	463.67500
55			458.18125	458.18750	463.68125	463.68750
56			458.19375	458.20000	463.69375	463.70000
57			458.20625	458.21250	463.70625	463.71250
58	Y		458.21875	458.22500	463.71875	463.72500
59		Y	458.23125	458.23750	463.73125	463.73750
60			458.24375	458.25000	463.74375	463.75000
61		Y	458.25625	458.26250	463.75625	463.76250
62			458.26875	458.27500	463.76875	463.77500
63	Y		458.28125	458.28750	463.78125	463.78750
64			458.29375	458.30000	463.79375	463.80000
65			458.30625	458.31250	463.80625	463.81250
66			458.31875	458.32500	463.81875	463.82500
67		Y	458.33125	458.33750	463.83125	463.83750
68			458.34375	458.35000	463.84375	463.85000
69		Y	458.35625	458.36250	463.85625	463.86250
70			458.36875	458.37500	463.86875	463.87500
71			458.38125	458.38750	463.88125	463.88750
72			458.39375	458.40000	463.89375	463.90000
73			458.40625	458.41250	463.90625	463.91250
74	Y		458.41875	458.42500	463.91875	463.92500
75		Y	458.43125	458.43750	463.93125	463.93750
76			458.44375	458.45000	463.94375	463.95000
77		Y	458.45625	458.46250	463.95625	463.96250
78			458.46875	458.47500	463.96875	463.97500
79			458.48125	458.48750	463.98125	463.98750
80			458.49375		463.99375	

PART 4

User Design Guide

User Design Guide for
Private Fixed Telemetry and Telecontrol
Radio Services Operating in the Bands
457·5 to 458·5 MHz and 463·0 to 464·0 MHz.

PAGE

1 GENERAL

1.1 Introduction

This section discusses how telemetry and telecontrol systems may be designed to operate in the band 457·5 to 458·5 MHz and 463·0 to 464·0 MHz in compliance with this specification. These systems may be used for the transmission of telecontrol or telemetry signals, as well as data distribution and gathering systems.

Worked examples are included to show the practical application of the specification.

A discussion of the issues relating to the continental interference affecting UK scanning telemetry schemes and what measures may be undertaken to ameliorate the problem by making affected systems more resilient to the interference in the short term is also included.

Long term solutions to this problem have yet to be finalised and form no part of this specification.

1.2 Licensee's Responsibility

The **establishment, use or installation** of the systems are subject to the issue of a licence by the Secretary of State for Trade and Industry. Under the conditions of the licence it will be the responsibility of the licensee to ensure that equipment conforms with, and is maintained to, the standards set out in Part 1 and Part 2 of this specification. Licences to authorise the use of equipment will only be granted to equipment which has been type approved to this specification.

2 ADAPTABLE CELLULAR PLAN

The UHF scanning telemetry band comprises of 80 channels, 72 of which are reserved for use with the Adaptable Cellular Plan. This plan is for use by the major utility users of scanning telemetry services, that is the Gas, Electricity and Water industries. The remaining 8 channels fall outside the plan and are reserved for other scanning telemetry users.

The basic parameters of the plan, as conceived in 1989, are;

a. A system availability approaching 99·9%.

b. A co-channel carrier to interference ratio of 26 dB.

c. Data transmission speeds of 1200 to 2400 bits/second nominal.

d. Cells with 25 km radii.

e. 6 channels per cell, giving 2 channels per utility.

f. 12 cells per cluster, giving a co-channel re-use distance of 150 km.

g. A potential channel re-use of 23 times across the UK.

This issue of the MPT1411 specification varies some of the above parameters, as well as some other aspects of MPT1411, in light of current practice and the need to provide well defined methods of ameliorating continental interference to UK scanning telemetry systems, these variations are;

a. The carrier to interference ratio has been reduced from 26 dB to 22 dB.

b. The cell radii remain at 25 km, but outstations with path lengths of up to 30 km are allowed in the first instance, with longer paths permitted on a case by case basis.

c. The 90% rule has been replaced by a statistically based method for determining the assigning path. This makes use of the end to end circuit loss rather than the path loss.

d. Major user groups, such as the JRC[i] or the TAC[ii] may be permitted, subject to prior agreement with the Radiocommunications Agency, to use alternative planning, assignment and frequency co-ordination criteria so as to achieve improved frequency management and re-use across the UK.

NOTE: *i.* JRC - The Joint Radio Committee of the Fuel and Power Industries.

ii. TAC - The Telecommunications Advisory Committee of the Water Industry.

The distribution of channels between the three major utility operators of scanning telemetry systems on a per cell basis is shown in table 1 below;

Cell	Gas		Electricity		Water	
	Ch. 1	Ch. 2	Ch. 1	Ch. 2	Ch. 1	Ch. 2
A	57	59	3	12	44	47
B	69	65	32	6	21	36
C	48	50	29	40	31	56
D	49	51	13	24	14	16
E	64	66	27	7	30	37
F	60	62	41	25	35	45
G	70	72	10	11	19	17
H	61	63	9	34	38	46
J	52	54	23	28	5	15
K	67	58	2	33	1	39
L	68	71	8	26	20	43
M	53	55	4	42	18	22

Table 1

The cellular re-use strategy is illustrated in figure 1 and the cell centres are listed in table 10.

Users and manufacturers should refer to the Radiocommunications Agency's report entitled 'The Future of UHF Scanning Telemetry Frequency Assignments - A report for DTI, JRC and TAG', published in January 1989, for a comprehensive discussion of the ACP and its application.

3 MARITIME USE OF THE SCANNING TELEMETRY BAND

The use of on-ship communications is permitted in coastal waters, esturies and tidal rivers for maritime safety purposes. Three 25 kHz channels are available for this service and these encompass the following channels inclusively; Group A, T2 to T7 and Group B, T1b to T7b. Consequently these channels may not be assigned in areas subject to maritime traffic. This is illustrated table 2 below;

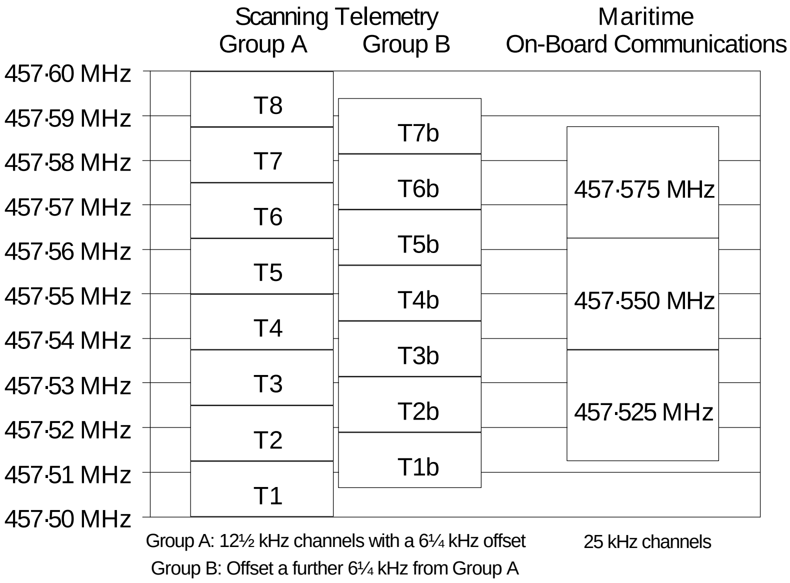
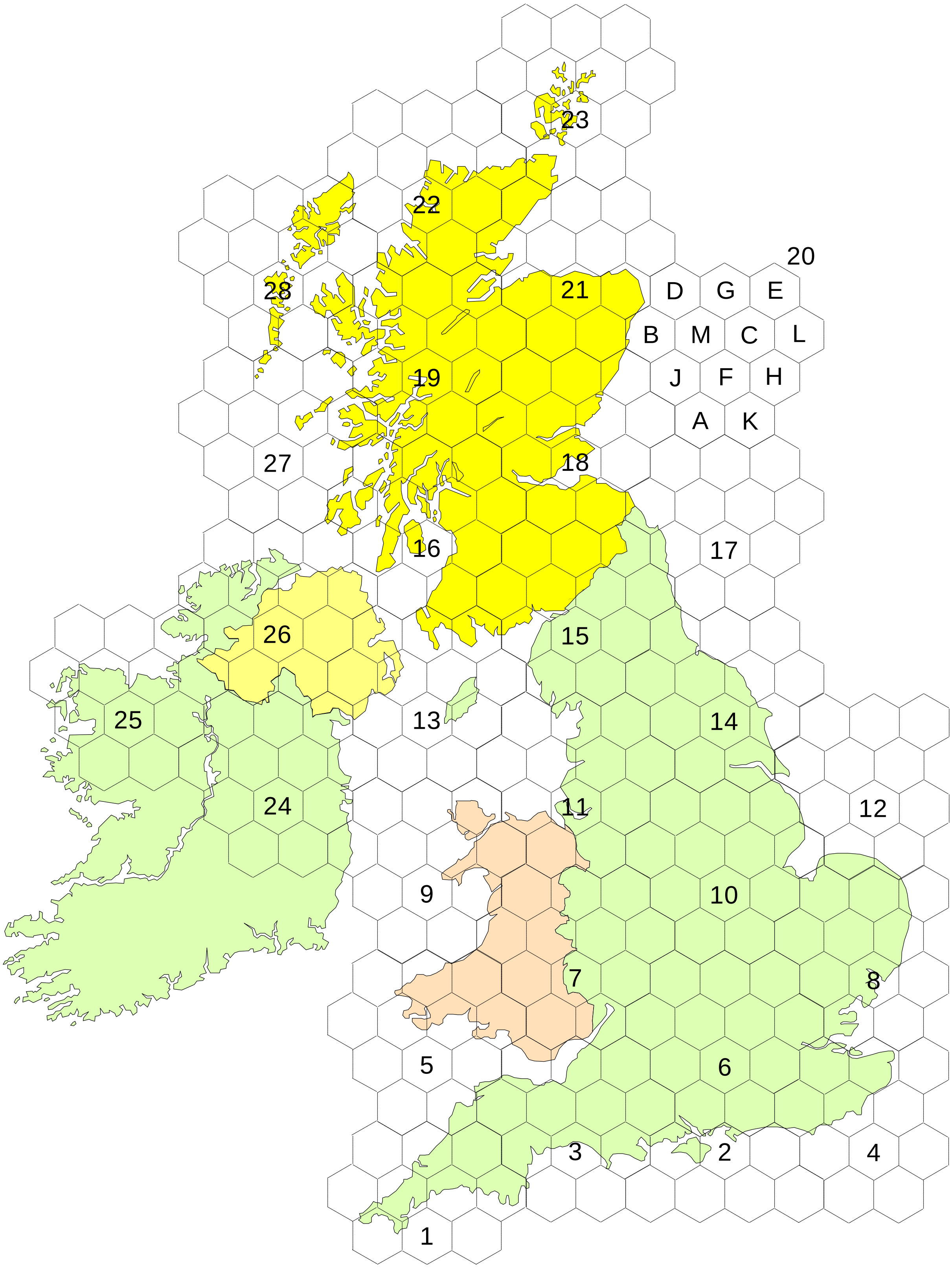


Table 2

UK Cellular Plan for Scanning Telemetry Services for the Utilities



1:4,572,165

Figure 1

4 DESIGNING SCANNING TELEMETRY SYSTEMS COMPLIANT WITH MPT1411

4.1 Maximum Equivalent Isotropically Radiated Power (EIRP)

The maximum permitted EIRP is 24 dBW.

4.2 Frequency Channelling

An interleave channel plan has been introduced, providing 79 additional 12½ kHz channels. These interleave channels will be defined as group B; the existing channels will be defined as group A.

A total of 15 group A and 20 group B channels have been identified as nominally interference free on account of their offset from adjacent continental cellular radio channels. Where feasible, the scanners in interference prone areas will be assigned on these channels. Scanners assigned group B channels will generally be polarised orthogonally to adjacent group A systems. **However there can be no guarantee that any channel will remain free from continental interference in the future**. The combination of the 6¼ kHz frequency offset and the use of cross-polar discrimination may provide 12 dB, or more, of isolation between adjacent group A and group B channels.

The allocation of interleave channels is largely user driven, since the user must establish whether the interleave channels are likely to be viable in his case. **Any interleave channel can only be assigned providing that it is both viable to the applicant and it can be successfully frequency co-ordinated with other co-channel and adjacent channel systems**. The applicant will be responsible for seeking the agreement and co-operation of all affected co-channel users.

The prefered optimum use of the interleave channels within the ACP on a per cell and per industry basis is shown in table 3 below;

Cell	Gas		Electricity		Water	
	Ch. 1x	Ch. 2x	Ch. 1x	Ch. 2x	Ch. 1x	Ch. 2x
A	63b	65b	6b	*31b*	*29b*	*55b*
B	59b	70b	10b	*56b*	19b	*47b*
C	51b	58b	2b	12b	*5b*	*23b*
D	*40b*	66b	27b	28b	30b	*39b*
E	60b	62b	3b	24b	44b	46b
F	71b	*72b*	7b	26b	36b	*64b*
G	61b	68b	25b	*34b*	20b	45b
H	52b	54b	*4b*	11b	18b	*22b*
J	*38b*	49b	9b	33b	*13b*	16b
K	50b	53b	*42b*	*48b*	15b	14b
L	*35b*	69b	32b	41b	17b	21b
M	57b	67b	*1b*	8b	37b	43b

Table 3

The interleaved channels have been allocated to cells so as to give a two cell radii separation between the cell centres of the adjacent channels both above and below the interleaved channel, whilst retaining the industry grouping of channels. The interleave channels shown in italics belong to another industry's group of channels, <u>thus they can only be used providing they have been successfully negotiated with the donor industry</u>.

There are a number of channels which are nominally free from continental interference, these are;

Group A: 2, 7, 10, 15, 18, 23, 26, 31, 34, 39, 42, 47, 58, 63, 74.

Group B: 3, 5, 11, 13, 19, 21, 27, 29, 35, 37, 43, 45, 51, 53, 59, 61, 67, 69, 75, 77.

4.3 Maximum Path Length

Outstations, whether standard, non-standard or relay, should generally have their path lengths restricted to 30 km; however path lengths of greater than 30 km will be considered on a case by case basis. This latter provision is to enable those outstations whose path lengths cannot readily be kept below 30 km due to either practical or external constraints, or any procedure that has been adopted in order to ameliorate the effects of continental interference.

Such outstations will need to be successfully frequency coordinated with other users and must comply with all aspects of the revised specification in order to be included in the assigning path determination process.

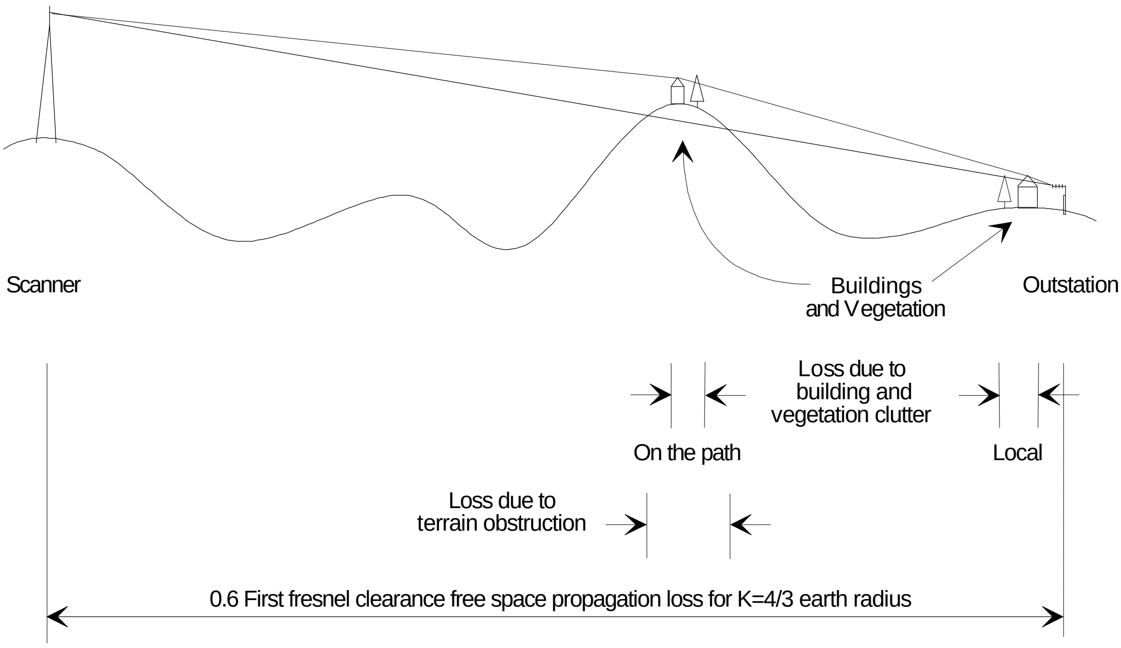
4.4 Total Path Loss

The total path loss is the sum of the free space propagation, ground terrain obstruction and building and vegetation clutter losses. In general, computer based prediction methods use the first two, however some models also predict clutter losses as well. The terrain obstruction loss may be zero for some paths, as may also be the case for clutter loss. The losses may alternatively be manually calculated. The various elements of the path loss are shown in figure 2.

Total path loss = free space path loss + terrain obstruction loss + building and vegetation clutter loss

The free space loss is that which corresponds to a first fresnel zone clearance of 0·6 and an earth curvature factor of K=4/3.

The total path loss for assignment purposes may not exceed 143 dB under any circumstances. When it does so, the value used for assignment purposes will be restricted to 143 dB.



Losses Along a Path
Figure 2

4.4.1 Clutter Losses

Additional path losses due to clutter comprise of two components;

a. The loss due to the effects of buildings and vegetation on top of a terrain obstruction along the path.

b. The loss due to buildings and vegetation in the immediate locality of the outstation.

The clutter loss experienced by an outstation may comprise of one or both of the above two components. This is illustrated in the attached diagram.

The clutter loss may be estimated by a generalised clutter database which is used by a prediction model in conjunction with a terrain height database. It may also be determined by the actual measurement of the end to end circuit loss. This measured value will include further losses which will be composed of the difference between the computer generated path profile and the actual path profile together with antenna radiation pattern anomalies created by its support structure. JRC and TAC experience indicates that clutter losses of up to 20 dB are relatively common, and up to 30 dB is sometimes unavoidable.

Any outstation whose measured path loss includes more than 20 dB of clutter ought to be re-engineered, where practicable, so as to reduce the clutter loss. This could be achieved by increasing antenna height and / or changing its spatial location on the site. There may be occasions when this is not possible, in which case the outstation may suffer poorer performance if the EIRP necessary to overcome the clutter loss cannot be successfully co-ordinated with co-channel systems. It will be the clutter losses in the locality of the outstation which are most likely to be reduced by the re-engineering of the outstation.

For practical assigning purposes, clutter loss is defined as the difference between the RA predicted and operator measured path losses (the path loss being extracted from the measured end to end circuit loss). The measured values are described in more detail in clause 3.8.

In order to encourage operators to minimise excessive local clutter, the nominal specification limit for clutter loss shall be 20 dB, although losses up to, but not exceeding, 30 dB will be considered on a case by case basis.

Where clutter losses exceed 20 dB, supporting documentation will be required which shall indicate the cause of the excess clutter and confirm that all reasonable attempts have been made to minimise local clutter effects.

For existing systems this limitation will only apply when the inclusion of additional outstations require an increase in the scanner EIRP. This limitation will apply to all new systems.

4.5 End to End Circuit Loss

In order to optimise frequency re-use it is necessary to keep scanner and outstation EIRP’s to the minimum compatible with achieving the system performance objective. This has in the past been achieved by limiting the total path loss, however this does not take into account other factors such as the antenna characteristics, or feeder loss, which could lead to significant increases in EIRP levels.

The end to end circuit loss comprises of the sum of all losses and gains between the transmitting station transmitter output port (C') and the receiving station receiver input port (C), inclusive of both stations’ antenna radiation pattern in the direction under consideration. C' and C are defined in figure 1 on page 1-5 of part 1 of this specification. The end to end circuit loss is defined in clause 3.5 of part 3.

A Worked Example for Determining the Assigning Path

Parameter	*Value*	*Comments*
Sc Ant Gain	8.1	*dBi {6 dBd colinear.}*
Sc Losses	3.0	*dB {Feeder, feeder tail and connectors.}*
Sc Rx Level	-117.0	*dBW {Duplicated scanner receivers with a common antenna.}*
O/S Ant Gain	14.1	*dBi {12 element yagi (12 dBd).}*
O/S Losses	-	*dB {See table below.}*
O/S Rx Level	-122.0	*dBW {Non-duplicated outstation receivers.}*

Outstation	*Free Space Loss*	*Obstruction Loss*	*Clutter Loss*	*Total Path Loss*	*Outstation Losses*	*End to End Circuit Loss*
OS08	98.9	0.0	11.2	110.1	3.0	93.9
OS02	103.8	0.0	8.3	112.1	2.0	94.9
OS09	104.9	0.5	9.7	115.1	2.0	97.9
OS10	107.4	0.0	9.7	117.1	2.0	99.9
OS04	104.0	1.8	11.6	117.4	2.0	100.2
OS11	101.0	0.0	16.1	117.1	3.0	100.9
OS01	110.5	2.4	5.2	118.1	2.0	100.9
OS06	103.1	0.0	18.0	121.1	3.0	104.9
OS03	107.9	2.0	13.2	123.1	2.0	105.9
OS07	105.0	0.0	18.1	123.1	2.0	105.9
OS05	107.9	1.2	16.0	125.1	2.0	107.9
OS13	108.1	0.8	16.2	125.1	3.0	108.9
OS14	104.2	1.2	26.7	132.1	3.0	115.9
OS12	107.2	3.0	24.9	135.1	2.0	117.9

Parameter	*Calculated Value*	*Comments*
Mean EECL	104.0	*Mean of all end to end circuit losses.*
Std Deviation	6.8	*Standard deviation (total population) of all end to end circuit losses.*
1.6*SD+Mean	114.9	*Maximum value of end to end circuit loss for assignment purposes .*

Table 4

Scanner and Outstation Antenna Configurations

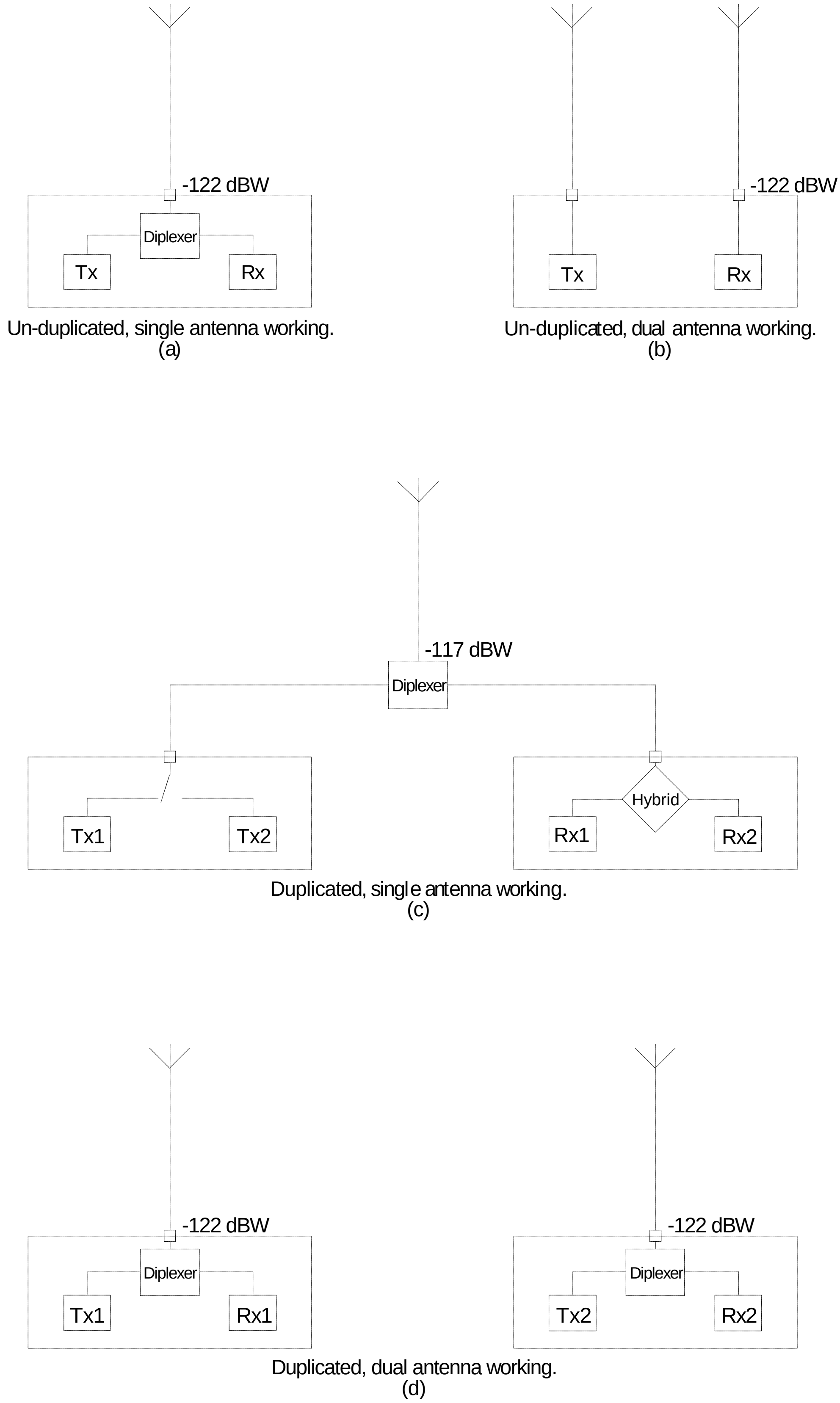


Figure 3

Typical values of the components are shown in table 5 below:

Parameter		*Value*	*Unit*
Scanner 'other' loss	(Connectors, etc.)	1	dB
Scanner feeder loss	(Antenna at 50m agl assumed)	3	dB
Scanner antenna gain	(Omni-directional assumed)	2	dBi
Maximum overall path loss		143	dB
Outstation antenna gain	(12 element yagi assumed)	14	dBi
Outstation feeder loss	(Antenna at 8m agl assumed)	2	dB
Outstation 'other' loss	(Connectors, etc.)	1	dB
Maximum end to end circuit loss		134	dB

Table 5

The reference values were chosen are from typical systems, but are based on those used in the Radiocommunications Agency's report entitled 'The Future of UHF Scanning Telemetry Frequency Assignments - A report for DTI, JRC and TAG' and the parameters are taken from the form RA37.

The values are not limiting values, except that **the total end to end circuit loss shall not exceed 134 dB and the total path loss shall not exceed 143 dB.**

4.6 Assigning Path

The method for determining the assigning path and hence the maximum outstation EIRP is described below. Note that this replaces the former 90% rule for all new systems.

In the new method the Standard Deviation of the scanner's own family of outstation end to end circuit losses, multiplied by 1·6, will be used to provide an offset value. This offset value is then added to the mean end to end circuit loss to enable the maximum assignable end to end circuit loss ($EECL_{max}$) for the family of outstations to be determined; see clause 3.6 of part 3. The assigning path defines the maximum end to end circuit loss ($EECL_{max}$) which will be allowed for that scanning telemetry system.

In the worked example shown in table 4, two outstations are excluded from having their desired EIRP, however if the OS14 outstation end to end circuit loss, by means of a better feeder, can be reduced by 2 dB to 113·9 dB, only one outstation will be excluded. If the OS14 outstation end to end circuit loss is reduced by 5 dB to 110·9 dB (3 dB total path loss and 2 dB feeder loss) and the OS12 outstation end to end circuit loss is reduced by 6 dB to 111·9 dB (5 dB total path loss and 1 dB feeder loss), then no outstations are denied their desired EIRP. Reduction of the end to end circuit loss by means of prudent RF engineering of the scanning system is the key to maximising the number of outstations which can be assigned their required EIRP. In a well engineered system this may be all the outstations.

4.7 Receiver Input Port Signal Level

Scanning telemetry systems shall be so designed that the receiver input port level will be -122 dBW for both un-protected equipments and duplicated stations utilising individual receive antennas, and -117 dBW for those operators who wish to use duplicated receivers with a common antenna. Outstations with end to end circuit losses that are less than the calculated maximum end to end circuit loss will benefit from a higher received signal at the receiver input port. A scanner receiver input port level of up to, but not exceeding, -103 dBW may be permitted in special circumstances and these **will be considered on a case by case basis**, the actual value being determined by the received level of continental interference and by what other ameliorating measures have been adopted by the operator.

New schemes to be installed in interference prone parts of the UK, for example, south east England, may be assigned levels greater than -122 / -117 dBW in the first instance.

In general, operators will be dissuaded from simply seeking EIRP increases and will be encouraged to implement alternative methods of improving the engineering of their scanning telemetry system. Increased receiver input port levels will only be assigned upon the operator providing adequate evidence of the duration and magnitude of the received continental interfering signal levels, together with a statement of what other ameliorating measures the user intends to adopt to assist in combating this interference. The new levels assigned will be chosen so as to overcome the continental interference in conjunction with other practicable changes that will make the system more resilient. It may be that they will be allowed greater increases of scanner receiver input port level, and hence EIRP, for a modest period of time whilst the other improvements are being implemented. It is accepted that there may be occasions when increased scanner receiver input port levels, and hence EIRP's, may be the only practicable solution.

The use of these higher EIRP's would be subject to satisfactory co-channel frequency coordination. This may require the operator requesting these increased levels to negotiate with the co-channel users, possible paying for the modification of their system so as to prevent it from suffering interference as a consequence of the operator's increased EIRP's.

The application of the receiver input port levels within a system is shown in figure 3. These are examples of the configurations most commonly employed.

4.8 Calculation of Equivalent Isotropically Radiated Power (EIRP)

The maximum system EIRP will be calculated using the greatest total path loss permitted by the limiting end to end circuit loss determined by the method described in clause 3.6.

The end to end circuit loss comprises of the total path loss + feeder losses + other losses - antenna gains in the direction under consideration. The free space and terrain obstruction loss value may be obtained by computer prediction, which may include a generalised figure for building / vegetation clutter loss.

Alternatively, the end to end circuit loss may be directly measured. This measured value will include a further additional loss which will be composed of the difference between the computer generated path profile and the actual path profile together with antenna radiation pattern anomalies created by its support structure, as well as all those parameters previously defined for the end to end circuit loss. It is assumed that the operator has already satisfied himself that the installations are fault free and that the measurements are taken in a prescribed manner.

When measurements are taken, it is usually the end to end circuit loss that is measured and hence these values may be used directly. However they will be compared with the predicted end to end circuit losses so as to examine the extent of the clutter loss. In the event that this exceeds 20 dB, the path and outstation will be investigated more closely by the RA; this may involve a site visit. The assigning process can then continue once the above investigation has taken place, as is current practice for the path loss.

The method for determining the maximum system EIRP now fully characterises a scanning telemetry system and thus ensures that no parameter need be excluded when applying the limiting rule. It is slightly more complicated than the former 90% rule, but gives the operator a greater degree of flexibility in 'fine tuning' their system so as to bring all, or most, of the outstations within the assigning rule.

The EIRP of the system will be calculated for each outstation and the scanner in the normal manner; in that the outstation EIRP is set so as to give the correct receiver input port level at the scanner, except that the maximum assignable EIRP is set by the method described in clause 3.6.

a. The scanner EIRP is determined from the Loss to Outstation value (LTO) and the outstation receiver input port level, as defined in clause 3.9 of part 3.

b. The outstation EIRP is determined from the loss to scanner value (LTS) and the scanner receiver input port level (RIL), as defined in clause 3.9 of part 3.

c. It must be noted that when the end to end circuit loss (EECL) for a scanner-outstation pair exceeds the calculated maximum end to end circuit loss ($EECL_{max}$) value, then the calculated maximum end to end circuit loss is substituted for the measured, or predicted, end to end circuit loss in the modified loss to scanner and loss to outstation formulae. It is this substitution which limits the EIRP which may be assigned to outstations with large end to end circuit losses, relative to the remainder of the outstations.

In the example in table 4, this results in outstations OS12 and OS14 being restricted to an end to end circuit loss of 114·9 dB for assignment purposes, rather than their actual end to end circuit loss of 117·9 and 115·9 dB. This maximum end to end circuit loss for the family of outstations results in Loss to Scanner values of 127 and 126 dB for OS12 and OS14 respectively and a Loss to Outstation value of 120 dB. The application of the above to the example in table 5 is shown in table 6.

Parameter	*Value (dBW)*
Scanner EIRP	-2

Outstation	*EIRP (dBW)*	
	Desired	*Assigned*
OS08	-12	-12
OS02	-10	-10
OS09	-7	-7
OS10	-5	-5
OS04	-4.7	-4.7
OS11	-5	-5
OS01	-4	-4
OS06	-1	-1
OS03	1	1
OS07	1	1
OS05	3	3
OS13	3	3
OS14	10	9
OS12	13	10

Table 6

In the event that no measured end to end circuit or path losses are provided, then the clutter losses will not be known and the assignment will be based on computer predicted end to end circuit losses only. Some computer models may estimate the prospective clutter losses, in which case an improved assignment will follow. The above does not inhibit an applicant from applying for a re-assignment using measured values at a later date once his system has been installed and commissioned; or indeed seeking a temporary channel to permit a survey of prospective receive signal levels for a new scanner in advance of the full application

Under normal circumstances, the EIRP that a scanner or outstation will be assigned will be limited to a minimum of -20 dBW, even though the calculated EIRP may be lower. There may be occasions where the assigned EIRP will be less than -20 dBW.

4.9 Co-Channel Interference Limit

This is now -144 dBW maximum.

What is important is that the C/I ratio between the existing co-channel operators and the applicant's systems should be maintained. The applicant's EIRP's should not degrade the co-channel operators' C/I ratios, however it may be that an acceptable degradation could be negotiated with the co-channel operator(s) which will permit increased EIRP's for the applicant. It will be the applicant's responsibility to demonstrate that a satisfactory agreement has been reached with the co-channel operator(s).

Interference limited frequency co-ordination will enable C/I ratios to be fully examined and protected.

A C/I ratio of 22 dB will be protected when making assignments, which in normal circumstances will equate to the new co-channel interference limit of -144 dBW.

4.10 Channel Selection and Assignment.

For applicants other than the Gas, Electricity and Water Industries, the choice of frequency to be assigned to the system(s) will depend on the ability of the Agency to co-ordinate a channel, selected from within channels T73 to T80, with existing co-channel operators. In the case of a multi-site scheme, the re-use of a chosen frequency within the scheme may be necessary.

In the case of the Gas, Electricity and Water Industries, the assignment will generally be in accordance with the Adaptable Cellular Plan. These channel allocations are shown in table 1.Where it is not possible to select a channel from table 1 which is appropriate to both the cell and the applicant's industry, which may be due either to existing assignments or maritime operations, or where it is required to import channels to satisfy increased demand for services, a channel will need to be selected by one of the following criteria.

a. Where there is a high density of scanning stations and it is either inappropriate, or not possible, to use an adjacent cell channel, then a channel can be selected from either the first or second tier non-adjacent cells. The selection strategy for the first and second tier non-adjacent cells is shown in tables 7, 8 and 9 for the Gas, Electricity and Water Industries respectively. For instance, if the home cell is 'A', the first tier channels for the gas industry will be T48, T50, T65 and T69, the second tier channels will be T53, T55, T61, T63, T64 and T66.

b. Where the density of existing scanning stations is low, or where the proposed site is on, or adjacent to, a coastal area, then it may very well be possible to import a channel from an adjacent sea-bound cell. Except in rare circumstances, the importing of an adjacent cell channel will result in the sterilisation of the channel in the adjacent donor cell, thus preventing the full capability of the ACP being realised in that locality.

With both the selection processes, the use of a channel will generally be at a lower system EIRP than usual because of the reduced co-channel frequency re-use distance. The use of imported channels may require both the adoption of a polarisation orthogonal to that used in the channel's home cell and directional scanner antennas. If either channel selection process fails to identify a suitable channel, then it may be possible to assign a channel from another industry's group of channels, providing this can be successfully negotiated with the donor industry. **In all cases, the choice of channel must be successfully frequency co-ordinated with existing co-channel systems**.

4.11 Antennas

This section refers primarily to the transmitting antenna of a station, since it is this which has the greatest potential to affect other users. In principle, it will be possible to use any antenna, or configuration of antennas for receive purposes without needing type approval, providing it can be coordinated with both co-channel and adjacent channel users, and meets the cross-polar rejection requirement. This should also extend to the use of more esoteric arrangements, such as passive or active cancellation techniques for the nulling of unwanted co-channel signals. The receive antenna configuration and its radiation pattern will however need to be registered with RA, and **acceptance for registration will still depend on successful frequency co-ordination with other co-channel systems.** Typical scenarios normally will involve the use of type approved antennas in non approved configurations, though occasionally non type approved antennas may have to be used. Note that frequency assignments will be made on the assumption that all antennas are type approved, any interference which results from the use of non-type approved receiving antennas will be the responsibility of the user.

4.12 General Issues

4.12.1 Mixed Polarisation Systems.

The use of vertical transmit and horizontal receive polarisation at the scanner for the purpose of improving system resilience is permitted.

The use of mixed polarisation receive antenna systems at the scanner for unusual circumstances: eg, due to re-direction of outstations, is permitted. A typical example would be the normal system being vertically polarised, but perhaps a more distant, possibly re-directed, outstation being 'pulled-in' by means of a horizontally polarised, say twelve element, yagi antenna. **Such scenarios will be considered on a case by case basis.**

4.12.2 Alternative Forms of Polarisation

The use of alternative polarisations as a means of solving unusual scenarios, providing they can be successfully assigned and frequency co-ordinated, will be permitted. **Such scenarios will be considered on a case by case basis.**

4.12.3 Choice of Outstation Antenna

A 12 element yagi is the minimum specification outstation antenna from a frequency management, spectrum conservation and good engineering point of view. <u>Existing 8 element yagi antennas need only be removed when a material change to the outstation is required.</u>

Other antennas may be considered where appropriate and their prospective use is discussed in clause 4.13.

The RA will encourage any operator who wishes to seek the type approval to MPT1411 of higher performance antennas, such as an 18 element yagi antenna with a forward gain of 16·7 dBi. These antennas will be particularly useful for re-directed outstations.

The RA will encourage any operator who wishes to seek the approval to MPT1411 of downward pointing antennas for regulated on-site low power telemetry and telecontrol services.

4.13 Special Systems

It is considered that there five basic classes of scanning telemetry system. These are:

a. Scanning systems incorporating some non-standard outstations.

b. Scanning systems incorporating only non-standard outstations.

c. Single hop relay systems for circumnavigating severe obstructions.

d. Single standard outstation scanning telemetry systems for obstructed paths.

e. Multi-hop single frequency relay systems.

The following special systems fall within one of the above catagories and consequently this governs their method of assignment.

4.13.1 Regulated On-site and Local Area Telemetry and Telecontrol Services.

The RA will permit the use of <u>regulated</u> scanning telemetry services for on-site and local area schemes. Major user groups may reserve one or more of their allocated channels for such a service if considered appropriate. Service areas of up to 1 km are envisaged. **The antenna height above ground shall normally not exceed 15 metres, however a height greater than 15 metres will be considered on a case by case basis.** Where non-standard outstations are employed, they will be assigned according to clause 4.4. Such systems shall utilise suitable antenna systems and EIRP so as to confine their service area to the curtilage of the site, or the extent of the local area under consideration, and to restrict their interference potential to wide area schemes.

4.13.2 Secondary Scanner Receive Only Stations.

The RA will permit the use of secondary scanner receive only stations as a means of maintaining communications to those outstations effected by the sectorisation of the scanner reception coverage area as a means of combating continental interference. It is assumed that the scanner transmit antenna remains omni-directional. This is described in more detail in clause 5.4.

4.13.3 Relay Outstations

The RA will permit the use of relay outstations as a means of communicating with other, difficult to reach, outstations. This technique is already used by some non utility operators. In effect, an outstation may contain a secondary scanner to address one, or more, other outstations which cannot be addressed from the existing parent scanner or other communications site. The relay outstation will onward route the transmission using either the parent scanner's transmit frequency or an alternative channel. Such relay outstations may only be used where they form an extension to a main telemetry scheme. The relay outstation will utilise antennas designated for outstation or scanner sector use and the antenna height above ground may not exceed 15 metres. The calculated EIRP will in many cases be below -20 dBW, but, where possible, a minimum EIRP of -20 dBW may be assigned. The relay outstation shall not be more than 30 km from the parent scanner.

The assigning path is determined in accordance with clause 3.6 of part 3 of this specification. Non-standard outstations are **included** in the calculations used to determine the assigning path and are assigned in accordance with clause 4.13.4 below.

Such relay outstations, together, with their target outstations, would have to be successfully frequency co-ordinated with all co-channel systems before an assignment could be made.

4.13.4 Non-standard Outstations

Outstations utilising antennas other than a standard or high performance type are now permitted and will be considered on a case by case basis. Such outstations are known as non-standard outstations. Such outstations are not intended as an alternative to the establishment of a standard outstation, but to give a new class of outstation for use in those circumstance where the installation of a standard antenna is not practicable and / or safe. Where possible, the use of a directional antenna will be encouraged.

The height of the antenna above ground of a non-standard outstation shall not exceed 10 metres. Non-standard outstations will be protected, however they may not necessarily be assigned with a C/I ratio of 22 dB.

The method of assignment is governed by the class of system in which they are installed:

4.13.4.1 Systems which contain some Non-Standard Outstations

These are considered to be main scanning systems which previously addressed standard outstations, but into which some non-standard outstations are to be introduced. The assigning path is determined in accordance with clause 3.6 of part 3 of this specification, except that the non-standard outstations are **excluded** from the calculations used to determine the assigning path. The assigning path is determined only by the standard outstations of the host system. The calculation of the permitted maximum EIRP for the system shall be in accordance with clause 3.9 of part 3 of this specification, except that the maximum assignable EIRP for the non-standard outstations shall not exceed 0 dBW.

4.13.4.2 Systems which contain only Non-Standard Outstations

These are considered to be small area scanning systems which are dedicated to addressing only non-standard outstations. The assigning path is determined in accordance with clauses 3.6 of part 3 of this specification. Non-standard outstations are **included** in the calculations used to determine the assigning path. The calculation of the permitted maximum EIRP for the system shall be in accordance with clause 3.9 of part 3 of this specification, except that the maximum assignable EIRP for the scanner and the non-standard outstations shall not exceed 0 dBW.

4.13.5 Simplex Systems

Such systems are currently operated by non utility users and are assigned within channels T73 to T80. 'Go' and 'return' channels could be assigned to separate users. In some cases such systems may be restricted to low power on-site or small area applications. Since such systems are currently operated by non utility users and are assigned within channels T73 to T80, the major benefit of this will be to such users. However, should JRC or TAC members subsequently require such systems within their own channel allocations, then the technique could be applied **providing successful co-ordination can be achieved.** <u>This may prove difficult in some circumstances.</u>

4.13.6 Single Standard Outstation Systems

Such systems will be permitted and protected where it can be demonstrated that they cannot be accommodated within the 1·5 GHz band. It is likely that only those links with paths that are severely obstructed, or those that require the propagation advantages acrued for the use of the 460 MHz band, will be considered acceptable.

4.13.7 Multi-Hop Single Frequency Relay Systems

Such systems will be permitted and protected where it can be demonstrated that the requirement cannot be met from another band. Clusters of such outstations need not have every path evaluated where terrain obstruction is not prevalent. Longer and / or obstructed paths will require closer examination. Whilst the EIRP for such relay systems shall not exceed 0 dBW, the assigned EIRP will be appropriate to the path lengths required.

It is envisaged that such systems may very well be met by store and forward techniques using a single frequency. Such relay stations may not necessarily be assigned with a C/I ratio of 22 dB.

5 CONTINENTAL INTERFERENCE TO UK SCANNING TELEMETRY SYSTEMS

Due to the UK UHF bands being frequency reversed relative to Europe, users of scanning telemetry systems in the south east quadrant of England, as well as along the whole UK east coast, are susceptible to interference from European systems. This may be significant and protracted from time to time.

A variety of measures can be adopted which will permit operators of scanning telemetry systems to ameliorate their difficulties. This will include the use of one, or more, of the following remedial measures which will be considered by the Agency on a case by case basis. **These remedial measures can only be adopted providing that the Agency has both granted consent to such solutions and that they can be successfully co-ordinated with other co-channel users**.

5.1 Increased Median Signal Level at the Receiver Input Port of up to -103 dBW.

The operator may wish to use an increased median signal level at the receiver input port of up to, but not exceeding, -103 dBW as a means of overcoming continental interference. <u>The choice of median signal level at the receiver input port will be based on the known, measured, level of received continental interference at the scanner site in question.</u>

Operators will be <u>expected to use other measures</u>, as described below, either instead of, or in addition to, increased EIRP via a revised median signal level at the receiver input port, so as to minimise the level of, or remove the need for, an increase.

5.2 Horizontal Polarisation.

The use of horizontal polarisation can be of benefit in a number of circumstances, whether this is for receive purposes only, where separate transmit and receive antennas are used at all sites in the system, or for combined transmit and receive where shared antennas are used. The former would result in a mixed polarisation scheme.

The use of horizontal polarisation can give between 6 dB and 15 dB polar discrimination protection against the unwanted interfering signal. However, the longer the path length of the interfering signal, the more likely it is to suffer greater depolarisation and hence the lower protection figure may apply. Operators in the south east of England have found this to be particularly beneficial, however care needs to be exercised in areas of flat terrain as excessive ground reflections may occur.

5.3 Use of an Alternative Group A or an Interleave Group B Channel.

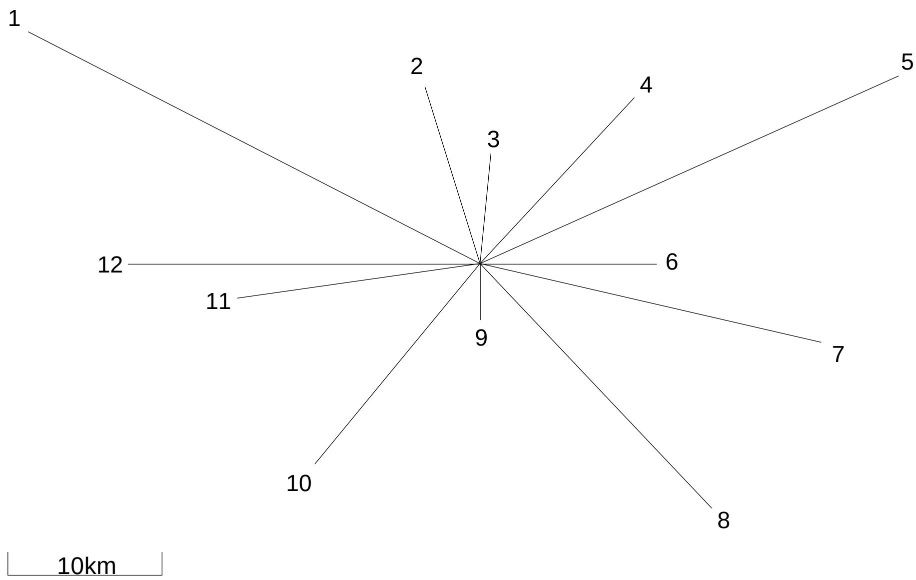
It may be possible to assign an alternative group A channel which is less likely to suffer continental interference, however it might be that an interleave group B channel may be more appropriate. In either case, the operator will have to satisfy himself that the said alternative channel, whether group A or group B, is free from continental interference.

There can be no guarantee that any channel will remain free from continental interference in the future.

5.4 Sectorisation of the Coverage Area.

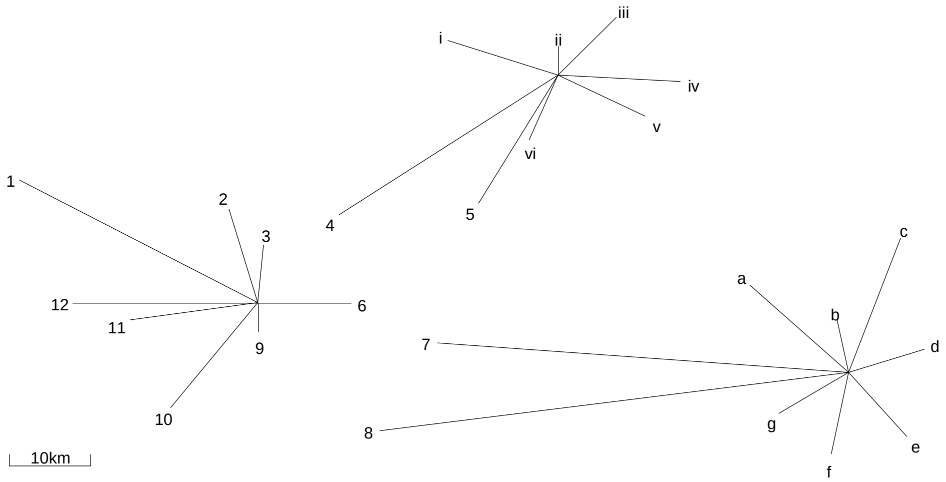
Sectoring the scanner coverage area, using a directional antenna or either passive or adaptive cancelling antenna arrays may provide a solution for some operators. This may be either for receive purposes only, where separate transmit and receive antennas are used, or for combined transmit and receive where a shared antenna is used.

This technique will probably result in some outstations being displaced from their original parent scanner. These displaced outstations will either be re-directed to more distant scanners or they will access a secondary scanner receive only station. A typical scanner and its family of outstations is shown in figure 4.



A typical omni-directional, vertically polarised scanner-outstation family
Figure 4

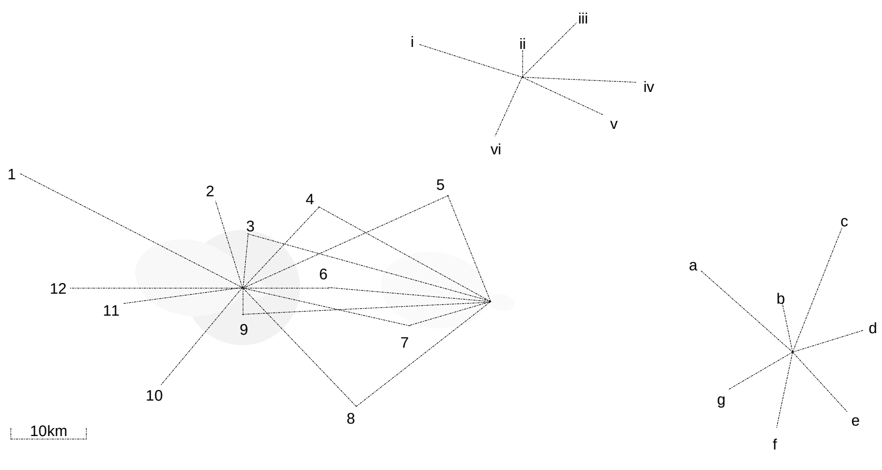
After sectorisation some outstations may need to be re-directed to more distant scanners, this system may now look as shown in figure 5.



The same scanner-outstation family employing sectorisation techniques.
Figure 5

In this solution, outstations 4, 5, 7 and 8 have been re-directed to alternative scanners. Outstation 6 is covered by the rear lobe of the sector antenna installed at the scanner. For some scanners such a solution may prove adequate, however there may very well be those where re-direction to more distant scanners is not viable.

An alternative approach may be to establish a secondary scanner receive only station at some convenient existing communications site. This would enable the displaced outstations to be re-directed to an alternative scanner receiver site which would be located at a more convenient distance from the epicentre of the outstation geographic distribution. It may be that there would be a suitable communications site conveniently located for the purpose. Such an arrangement is shown in figure 6.



The same scanner-outstation family employing sectorisation and secondary receiver techniques.
Figure 6

The above shows how such a scanner and its family of outstations would look if a secondary scanner receive only station were employed. Outstations 3, 4, 5, 6, 7, 8 and 9 have been re-directed to the secondary receive only scanner. The dashed lines indicate the outstation receive path and the solid lines the corresponding transmit path. The use of such an arrangement would be governed to some extent by the operators telecontrol software. Unlike mobile systems, no voting is necessary since each outstation will reply either to the main scanner or its secondary receive site. For some operators, such a configuration would not be practicable and hence the establishment of an additional main scanner would be required.

5.5 Operator Proposed Solutions.

Any other solution can be considered providing it complies with the terms of this specification and **can be frequency co-ordinated with co-channel systems.**

6 STATUS

The contents of Part 4 are for information and guidance only.

TABLE 7

Non-Adjacent Cell Channel Look-up Table for the Gas Industry.

Home Cell	Home Cell's Channels	First Tier Non-Adjacent Cells	First Tier Channels	Second Tier Non-Adjacent Cells	Second Tier Channels
A	57 59	B C	69 65 48 50	E H M	64 66 61 63 53 55
B	69 65	A C	57 59 48 50	G F L	70 72 60 62 68 71
C	48 50	A B	57 59 69 65	D J K	49 51 52 54 67 58
D	49 51	E F	64 66 60 62	C J K	48 50 52 54 67 58
E	64 66	D F	49 51 60 62	A H M	57 59 61 63 53 55
F	60 62	D E	49 51 64 66	B G L	69 65 70 72 68 71

G	70	H	61	B	69
	72		63		65
		J	52	F	60
			54		62
				L	68
					71
H	61	G	70	A	57
	63		72		59
		J	52	E	64
			54		66
				M	53
					55
J	52	G	70	C	48
	54		72		50
		H	61	D	49
			63		51
				K	67
					58
K	67	L	68	C	48
	58		71		50
		M	53	D	49
			55		51
				J	52
					54
L	68	K	67	B	69
	71		58		65
		M	53	F	60
			55		62
				G	70
					72
M	53	K	67	E	64
	55		58		66
		L	68	H	61
			71		63
				J	52
					54

TABLE 8

Non-Adjacent Cell Channel Look-up Table for the Electricity Industry.

Home Cell	Home Cell's Channels	First Tier Non-Adjacent Cells	First Tier Channels	Second Tier Non-Adjacent Cells	Second Tier Channels
A	3 12	B C	32 6 29 40	E H M	27 7 9 34 4 42
B	32 6	A C	3 12 29 40	G F L	10 11 41 25 8 26
C	29 40	A B	3 12 32 6	D J K	13 24 23 28 2 33
D	13 24	E F	27 7 41 25	C J K	29 40 23 28 2 33
E	27 7	D F	13 24 41 25	A H M	3 12 9 34 4 42
F	41 25	D E	13 24 27 7	B G L	32 6 10 11 8 26

G	10	H	9	B	32
	11		34		6
		J	23	F	41
			28		25
				L	8
					26
H	9	G	10	A	3
	34		11		12
		J	23	E	27
			28		7
				M	4
					42
J	23	G	10	C	29
	28		11		40
		H	9	D	13
			34		24
				K	2
					33
K	2	L	8	C	29
	33		26		40
		M	4	D	13
			42		24
				J	23
					28
L	8	K	2	B	32
	26		33		6
		M	4	F	41
			42		25
				G	10
					11
M	4	K	2	E	27
	42		33		7
		L	8	H	9
			26		34
				J	23
					28

TABLE 9

Non-Adjacent Cell Channel Look-up Table for the Water Industry.

Home Cell	Home Cell's Channels	First Tier Non-Adjacent Cells	First Tier Channels	Second Tier Non-Adjacent Cells	Second Tier Channels
A	44	B	21	E	30
	47		36		37
		C	31	H	38
			56		46
				M	18
					22
B	21	A	44	G	19
	36		47		17
		C	31	F	35
			56		45
				L	20
					43
C	31	A	44	D	14
	56		47		16
		B	21	J	5
			36		15
				K	1
					39
D	14	E	30	C	31
	16		37		56
		F	35	J	5
			45		15
				K	1
					39
E	30	D	14	A	44
	37		16		47
		F	35	H	38
			45		46
				M	18
					22
F	35	D	14	B	21
	45		16		36
		E	30	G	19
			37		17
				L	20
					43

G	19 17	H J	38 46 5 15	B F L	21 36 35 45 20 43
H	38 46	G J	19 17 5 15	A E M	44 47 30 37 18 22
J	5 15	G H	19 17 38 46	C D K	31 56 14 16 1 39
K	1 39	L M	20 43 18 22	C D J	31 56 14 16 5 15
L	20 43	K M	1 39 18 22	B F G	21 36 35 45 19 17
M	18 22	K L	1 39 20 43	E H J	30 37 38 46 5 15

Table 10

Adaptable Cellular Plan Cell Centre National Grid Reference Co-ordinates

Cluster / Cell	NGR	Cluster / Cell	NGR	Cluster / Cell	NGR
1A	XW834750	5A	SR834250	9A	SM834750
1B	SW401500	5B	SM401000	9B	SG401500
1C	SX268500	5C	SN268000	9C	SH268500
1D	SW618875	5D	SM618375	9D	SG618875
1E	SX484875	5E	SN484375	9E	SH484875
1F	SX051125	5F	SS051625	9F	SH051125
1G	SX051875	5G	SN051375	9G	SH051875
1H	SX484125	5H	SS484625	9H	SH484125
1J	SW618125	5J	SR618625	9J	SG618125
1K	XX268750	5K	SS268250	9K	SN268750
1L	SX701500	5L	SN701000	9L	SH701500
1M	SW834500	5M	SM834000	9M	SG834500
2A	XZ433750	6A	SU433250	10A	SP433750
2B	SZ000500	6B	SP000000	10B	SK000500
2C	SZ866500	6C	SP866000	10C	SK866500
2D	SZ216875	6D	SP216375	10D	SK216875
2E	TV082875	6E	TL082375	10E	TF082875
2F	SZ649125	6F	SU649625	10F	SK649125
2G	SZ649875	6G	SP649375	10G	SK649875
2H	TV082125	6H	TQ082625	10H	TF082125
2J	SZ216125	6J	SU216625	10J	SK216125
2K	XZ866750	6K	SU866250	10K	SP866750
2L	TV299500	6L	TL299000	10L	TF299500
2M	SZ433500	6M	SP433000	10M	SK433500
3A	SY134500	7A	SO134000	11A	SJ134500
3B	SS701250	7B	SN701750	11B	SC701250
3C	ST567250	7C	SO567750	11C	SD567250
3D	SS917625	7D	SH917125	11D	SC917625
3E	ST783625	7E	SJ783125	11E	SD783625
3F	SY350875	7F	SO350375	11F	SJ350875
3G	ST350625	7G	SJ350125	11G	SD350625
3H	SY783875	7H	SO783375	11H	SJ783875
3J	SX917875	7J	SN917375	11J	SH917875
3K	SY567500	7K	SO567000	11K	SJ567500
3L	SU000250	7L	SP000750	11L	SE000250
3M	ST134250	7M	SO134750	11M	SD134250
4A	TV732500	8A	TL732000	12A	TF732500
4B	TQ299250	8B	TL299750	12B	TA299250
4C	TR165250	8C	TM165750	12C	TB165250
4D	TQ515625	8D	TF515125	12D	TA515625
4E	TR381625	8E	TG381125	12E	TB381625
4F	TV948875	8F	TL948375	12F	TF948875
4G	TQ948625	8G	TF948125	12G	TA948625
4H	TW381875	8H	TM381375	12H	TG381875
4J	TV515875	8J	TL515375	12J	TF515875
4K	TW165500	8K	TM165000	12K	TG165500
4L	TR598250	8L	TM598750	12L	TB598250
4M	TQ732250	8M	TL327750	12M	TA732250

13A	SB834250	17A	NZ433750	21A	NJ134000
13B	NW401000	17B	NU000500	21B	NB701750
13C	NX268000	17C	NU866500	12C	NJ567750
13D	NW618375	17D	NU216875	21D	NC917125
13E	NX484375	17E	MQ082875	21E	ND783125
13F	SC051625	17F	NU649125	21F	NJ350375
13G	NX051375	17G	NU649875	21G	ND350125
13H	SC484625	17H	MQ082125	21H	NJ783375
13J	SB618625	17J	NU216125	21J	NH917375
13K	SC268250	17K	NZ866750	21K	NJ567000
13L	NX701000	17L	MQ299500	21L	NK000750
13M	NW834000	17M	NU433500	21M	NJ134750
14A	SE433250	18A	NT134500	22A	NG834750
14B	NZ000000	18B	NN701250	22B	NB401500
14C	NZ866000	18C	NO567250	22C	NC268500
14D	NZ216375	18D	NN917625	22D	NB618875
14E	MV082375	18E	NO783625	22E	NC484875
14F	SE649625	18F	NT350875	22F	NC051125
14G	NZ649375	18G	NO350625	22G	NC051875
14H	TA082625	18H	NT783875	22H	NC484125
14J	SE216625	18J	NS917875	22J	NB618125
14K	SE866250	18K	NT567500	22K	NH268750
14L	MV299000	18L	NP000250	22L	NC701500
14M	NZ433000	18M	NO134250	22M	NB834500
15A	NY134000	19A	NM834250	23A	ND134500
15B	NX701750	19B	NG401000	23B	HC701250
15C	NY567750	19C	NH268000	23C	HD567250
15D	NS917125	19D	NG618375	23D	HC917625
15E	NT783125	19E	NH484375	23E	HD783625
15F	NY350375	19F	NN051625	23F	ND350875
15G	NT350125	19G	NH051375	23G	HD350625
15H	NY783375	19H	NN484625	23H	ND783875
15J	NX917375	19J	NM618625	23J	NC917875
15K	NY567000	19K	NN268250	23K	ND567500
15L	NZ000750	19L	NH701000	23L	HE000250
15M	NY134750	19M	NG834000	23M	HD134250
16A	NW834750	20A	NP433250	24E	NW184375
16B	NR401500	20B	NK000000	27C	NL066250
16C	NS268500	20C	NK866000	27E	NM183625
16D	NR618875	20D	NK216375	27G	NL049625
16E	NS484875	20E	MF082375	27H	NR183875
16F	NS051125	20F	NP649625	27L	NM400250
16G	NS051875	20G	NK649375	28A	NF033000
16H	NS484125	20H	ML082625	28C	NF067752
16J	NR618125	20J	NP216625	28E	NB184128
16K	NX268750	20K	NP866250	28F	NF051375
16L	NS701500	20L	MF299000	28H	NG184375
16M	NR834500	20M	NK433000	28K	NF067000
				28L	NG401752

13B	J302441	26C	C807150	26H	J055795
13D	J486833	26D	C129467	26J	H193721
25L	H003329	26E	C991542	26K	H871403
26A	H440366	26F	H624758	26L	D238187
26B	B945075	26G	C560504	26M	C376112