Appendix (ii) : Draft DTI Specification

Contents

1. General

1.1 Scope of specification

This specification covers the minimum performance requirements for SSB modulated radio transmitters and receivers used at fixed and mobile stations in the Private Mobile Radio Service. It covers simplex measurements only on equipment designed for use in the VHF or UHF bands up to   MHz. For equipments covered by

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

1.6 Declarations by the manufacturer

When submitting an equipment for type testing, the manufacturer shall supply the following information:

a Transmitter

- i Nominal frequency
- ii Crystal frequency and carrier generation formula
- iii Crystal type
- iv Single or multi-channel
- v Radio frequency switching range
- vi Rated radio frequency output power
- vii Continuous or intermittent rating

b Receiver

- i Nominal frequency
- [illegible]

The internal impedance of the test power source shall be low enough for its effect on the test results to be negligible. For the purpose of tests, the voltage of the power source 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 that measured at the point of connection of the power cable to the equipment.

In equipment with incorporated batteries the test power source shall be applied as close to the battery terminals as practicable.

During tests, the power source voltages shall be maintained within a tolerance of ± 3% relative to the voltage at the beginning of each test.

2.3 Normal test conditions

2.3.1 Normal temperature and humidity

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

Temperature + 15°C to + 35°C

of nickel-cadmium battery, the normal test voltage shall be the nominal voltage of the battery (1.2V per cell).

2.3.2.4 Other power sources

For operation from other power sources or 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° 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 $\pm$10%. The frequency of the test power source shall be between 49 and 51 Hz.

2.4.2.2 Regulated lead-acid 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 Nickel-cadmium battery

When the equipment is intended for operation from the usual type of nickel-cadmium battery, the extreme test voltages shall be 1.25 and 0.85 times the nominal voltage of the battery.

2.4.2.4 Other power sources

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

a For Leclanche' type of battery - 0.85 times the nominal voltage

b For mercury type of battery - 0.9 times the nominal voltage

c For other types of primary battery - end point voltage declared by the equipment manufacturer.

and the testing authority and shall be recorded with the test results.

2.5 Procedure for test at extreme temperatures

2.5.1 Test procedure

Before measurements are made the equipment shall have reached thermal balance in the test chamber. The equipment shall be switched off during the temperature stabilising period.*

If the thermal balance is not checked by measurements, a temperature stabilising period of at least one hour, or such

3. Electrical test 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 are applied to the receiver simultaneously.

The levels of the test signals shall be expressed in terms of the emf at the reciever input terminals.

The effects of any intermodulation products and noise produced in the signal generators should 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

3.4.2 Receiver normal test modulation

Normal test modulation is the modulation due to a reference carrier at a frequency and level specified by the manufacturer w.r.t. the wanted sideband signal and a modulation frequency at 1 kHz above the nominal carrier frequency of the wanted sideband.

3.5 Artificial antenna

Tests on the transmitter shall be carried out with a non-reactive non-radiating load of 50 ohms connected to the antenna terminals.

3.6 Reference sideband power

The power of one necessary sideband established during the measurement of the rated radio-frequency output power.

3.7 Reference carrier

Depending on the type of SSB equipment under test, this can be the carrier of the wanted sideband or a pilot tone with tone level and frequency specified by manufacturer (normally -10dB w.r.t. wanted sideband).

3.8 Peak envelope power

The average power supplied to the transmission line by a transmitter during one radio-frequency cycle at the highest crest of the modulation envelope.

3.9 Pre-emphasis

Pre-emphasis networks, if included in the transmitter, shall be operative unless otherwise specified.

3.10 Test site and general arrangements for measurements involving the use of radiated fields (see also Appendix A (as in MPT 1326)).

3.10.1 Test site

The test site shall be on a reasonably level surface or ground.

At one point on the site, a ground plane of at least 5 metres diameter shall be provided. In the middle of this ground plane, a non-conducting support, capable of rotation through 360° in the horizontal plane, shall be used to support the test sample at 1.5 metres above the ground plane. The test site shall be large enough to allow the erection of a measuring or transmitting antenna at a distance of $\lambda/2$ or 3 metres, whichever is the greater. The distance actually used shall be recorded with the results of the tests carried out on the site.

Sufficient precautions shall be taken to ensure that reflections from extraneous objects adjacent to the site and ground reflections do not degrade the measurement results.

3.10.2 Test antenna

The test antenna shall be used to detect the radiation from both

3.10.4 Alternative indoor site

When the frequency of the signals being measured is greater than 80 MHz, use may be made of an indoor site. If this alternative site is used, this shall be recorded in the test report.

The measurement site may be a laboratory room with a minimum area of 6 metres by 7 metres and at least 2.7 metres in height.

Apart from the measuring apparatus and the operator, the room shall be as free as possible from reflecting objects other than the walls, floor and ceiling.

The site arrangement is shown in principle in Figure 1 (as in MPT 1326).

The potential reflections from the wall behind the equipment under test are reduced by placing a barrier of absorbent material in front of it. The corner reflector around the test antenna is used to reduce the effect of reflections from the opposite wall and from the floor and ceiling in the case of horizontally polarised measurements.

3.11 Arrangement for test signals at the input of the transmitter

For the purpose of this specification, the transmitter audio frequency modulating signal shall be supplied by a signal generator applied at the microphone input, unless otherwise stated.

4. Transmitter

4.1 Frequency error

4.1.1 Definition

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

4.1.2 Method of measurement

The reference carrier frequency shall be measured in the absence of modulation with the transmitter connected to an artificial antenna (Clause 3.5). 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).

4.1.3 Limit

The frequency error, under both normal and extreme test conditions, shall not exceed the values given below:

Frequency error (kHz)		
5 to 100 MHz	100 to 300 MHz	300 to 500 MHz
± 0.3	± 0.3	± 0.3

4.2 Peak envelope and reference carrier power

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

4.2.1 Definition

The rated value of the transmitter peak envelope power shall be declared by the manufacturer and is the maximum value of the total output power for any conditions of modulation for which all the relevant specification requirements are met. The reference carrier power (Clause 3.7) shall be measured on its own in the absence of modulation.

4.2.2 Method of measurement

a The transmitter output shall be connected to an artificial antenna with means of measuring the peak envelope power delivered to this antenna. (Clause 3.5)

b The transmitter shall be modulated with the normal test modulation (B) (Sub-clause 3.4.1). The level of the modulation shall be 20 dB above that required to give a peak envelope power output of half the rated peak envelope power. The peak envelope power shall then be measured.

c The modulation shall then be removed and the reference carrier power shall be measured.

d 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 peak envelope power under normal test conditions shall be within ± 1.5 dB of the rated output power.

The peak envelope power under extreme test conditions shall be within +2 dB and -3 dB of the rated output power.

4.3 Audio frequency response

4.3.1 Definition

The audio frequency response is the variation of sideband power output as a function of modulation frequency.

4.3.2 Method of measurement

a Connect a spectrum analyser to the transmitter output via a suitable attenuator

b Apply normal test modulation (B) (Sub-clause 3.4.1) at a level to produce half the rated peak envelope power

c Reduce the level of the 1 kHz signal by 10dB

d Record the input level of the 1 kHz signal and the corresponding level of the wanted sideband

e While maintaining the input level recorded in step d), vary the frequency which was initially 1 kHz, over the range 100 Hz to 10 kHz audio-frequency range and record the corresponding level

4.3.3 Limits

a) The power of the wanted sideband signal at 300 Hz and 3 kHz shall be not more than 6dB below the level of the wanted sideband signal at 1 kHz.

b) The level of the wanted sideband signal at 100 Hz and 4 kHz shall be at least 20dB below the level of the wanted sideband signal at 1 kHz.

4.4 Adjacent channel power

4.4.1 Definition

The adjacent channel power is that part of the power output of a transmitter under defined conditions of modulation, which falls within a specified passband centred on the nominal frequency of either of the adjacent channels. This power is the sum of the mean power produced by the modulation, hum and noise of the transmitter.

4.4.2 Method of measurement

a. The transmitter output shall be connected to a suitable spectrum analyser via a 50 ohm attenuator, set to produce an appropriate level at the spectrum analyser input

4.2.

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

4.4.3 Limits

The adjacent channel power shall not exceed a value of 55 dB below the rated peak envelope power without the need to descend below 0.2 microwatt.

4.5 Spurious emissions

4.5.1 Definition

Spurious emissions are emissions at frequencies other than those

Radiation of any spurious components shall be detected by the test antenna and receiver, over the frequency range 30 to 2000 MHz, except for the channel on which the transmitter is intended to operate and its adjacent channels.

At each frequency at which a component is detected, the sample shall be rotated to obtain maximum response and the effective radiated power of that component determined by a substitution measurement.

The measurements shall be repeated with the test antenna in the orthogonal polarisation plane.

The measurements shall be repeated with the transmitter modulated by normal test modulation (A) (Sub-clause 3.4.1). The measurements shall be repeated with the transmitter in standby.

4.5.4 Limits

The power of any spurious emissions - fixed equipment, mobile and portable equipment, and for radiated spurious emissions - fixed equipment.

TX Mode	100 kHz to 1000 MHz	1000 MHz to 2000 MHz
Operating	0.25 microwatt	1 microwatt
Standby	2 nanowatt	20 nanowatt

For radiated spurious emissions - mobile and portable equipment.

TX Mode	30 MHz to 2000 MHz
Operating	2.5 micro watt
Standby	20 nanowatt

4.6 Intermodulation attenuation

This requirement applies only to transmitters to be used in fixed stations.

4.6.1 Definition

For the purpose of this specification the intermodulation attenuation is a measure of the capability of a transmitter to inhibit the generation of signals in its non-linear elements caused by the presence of the carrier and an interfering signal entering the transmitter via its output terminal (antenna).

4.6.2 Method of measurement

The output of the transmitter under test shall be connected to a signal source via a coupling device, presenting to the transmitter a load with an impedance of 50 ohms.

The coupling device can consist of a circulator, one port of which is to be connected by a coaxial cable to the output terminal of the transmitter, the second port is to be correctly terminated (nominal value 50 ohms). This termination is to be provided with means for connection to a selective measuring device (eg a spectrum analyser). The third port of the circulator is to be connected to the test signal source by means of an isolator.

Alternatively, the coupling device may consist of a resistive attenuator, which may be combined with an isolator, one end to be connected to the output terminal of the transmitter by coaxial cable and the other end to be connected to the test signal source. A selective measuring device is to be connected to the transmitter end of the attenuator by means of a sampling probe.

levels of the transmitter carrier and the intermodulation components are compared by means of the selective measuring device.

The length of the coaxial cable between the transmitter output and the coupling device shall be varied until the maximum level of the intermodulation component considered is obtained.

This measurement shall be repeated with the test signal at a frequency within 1 to 4 neighbouring channels below the transmitter frequency.

When the above measurements are performed, precautions must be taken, so that non-linearities in the selective measuring device do not influence the results appreciably. Furthermore, it should be ensured that the intermodulation components, which may be generated in the test signal source, are sufficiently reduced, eg by means of a circulator.

The intermodulation attenuation is expressed as the ratio in dB of the test signal power level to the power level of an intermodulation component.

4.6.3 Limit

The intermodulation attenuation shall be at least 15 dB for any intermodulation component.

For fixed station equipment to be used in special services (eg at communal sites) the intermodulation attenuation shall be at least 40 dB for any intermodulation component.

This may be achieved by means of isolating devices, such as circulators which must be supplied at the time of type approval.

5 Receiver

5.1 Maximum usable sensitivity

5.1.1 Definition

The maximum usable 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, which will produce an audio-frequency output signal having a SINAD ratio of 12 dB.

5.1.2 Method of measurement

A test signal with normal test modulation (Sub-clause 3.4.2) shall be applied to the receiver input terminal. The audio output of the reciever shall be connected to a distortion factor

(Clause 2.3) and repeated under extreme test conditions (Clause 2.4.1 and 2.4.2 applied simultaneously).

5.2.3 Limits

The adjacent channel selectivity shall not be less than 55 dB under normal test conditins, and not less than 50 dB under extreme test conditions.

5.3 Spurious response rejection

5.3.1 Definition

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

5.3.2 Method of measurement

Two input signals shall be applied to the receiver input via a combining network. The wanted signal shall have normal test modulation (Sub-clause 3.4.2). The unwanted signal shall be unmodulated.

The amplitude of the wanted input signal shall be adjusted until a SINAD ratio of 12 dB is obtained. The amplitude of the unwanted input signal shall be adjusted to a level of +86 dB relative to an emf of one microvolt. The frequency shall then be varied over the frequency range from 100 kHz to 2000 MHz.

At any frequency at which a response is obtained, the input level of the unwanted signal shall be adjusted until the SINAD ratio at the receiver output is reduced to 6 dB.

The spurious response rejection ratio shall then be expressed as the ratio in dB between the unwanted signal and the wanted signal

5.4.2 Method of measurement

Three signal generators, A, B and C shall be connected to the receiver via a combining network (see Clause 3.1). The wanted signal, represented by signal generator A shall have normal test modulation (Sub-clause 3.4.2). The unwanted signal from signal generator B shall be unmodulated and adjusted to the frequency separated by ten times the channel separation above (or below) the nominal frequency of the receiver plus 1 kHz. The second unwanted signal from signal generator C shall be unmodulated with a frequency equal to the carrier frequency of the channel, twenty channels above the nominal receiver channel plus 1 kHz.

The amplitude of the wanted input signal shall be set to 1 millivolt and the receiver volume control shall be adjusted to obtain approximately 50% of the rated audio output power (Clause 3.3). The amplitude of the wanted signal shall be reduced until a SINAD ratio of 12 dB is obtained. The amplitude of the two unwanted signals shall be maintained equal and shall be ajusted until a SINAD ratio of 12 dB is again obtained. If necessary, the frequency of either signal shall be varied slightly to obtain the maximum value of this ratio, their levels being readjusted to be varied between +2 to +10 MHz, and also between -2 to -10 MHz, relative to the nominal frequency of the receiver. The input level of the unwanted signal, at all frequencies in the specified ranges, shall be so adjusted that the unwanted signal causes:

a a reduction of 3 dB in the output level of the wanted signal,

or

b a reduction of 6 dB of the SINAD ratio at the receiver output,

whichever occurs first.

This input level is the blocking level for the frequency concerned.

5.5.3 Limit

The blocking level at any frequency within the specified ranges, shall not less than 90 dB relative to an emf of one microvolt, except at frequencies on which spurious responses are found (Clause 5.3).

5.6 Spurious emissions
5.6.1 Definition

Spurious emissions are any emissions from the receiver.

The level of spurious emissions shall be measured by:

a their power level in a specified load

and

b their effective radiated power when radiated by the cabinet and structure of the equipment

Note: (b) is also known as 'cabinet radiation'.

5.6.2 Method of measuring the power level

Spurious emissions shall be measured as the power level of any discrete signal at the input terminals of the receiver. The receiver input terminals are connected to a spectrum analyser or selective voltmeter having an input impedance of 50 ohms and the receiver is switched on.

If the detecting device is not calibrated in terms of power input, the level of any detected components shall be determined by a substitution method using a signal generator.

The measurements shall extend over a frequency range of 100 kHz to 2000 MHz.

5.6.3 Method of measuring the effective radiated power

On a test site fulfilling the requirements of Clause 3.10, the sample shall be placed at the specified height on a non-conducting support. The receiver shall be operated from a power source via a radio frequency filter to avoid radiation from the power leads.

Radiation of any spurious components shall be detected by the test antenna and receiver over the frequency range 30 to 2000 MHz.

At each frequency at which a component is detected, the sample shall be rotated to obtain maximum response and the effective radiated power of that component determined by a substitution measurement.

The measurements shall be repeated with the test antenna in the orthogonal polarisation plane.

5.6.4 Limits

The power of any spurious emission shall not exceed the values given in the table which follows.

100 kHz to 1000 MHz	1000 MHz to 2000 MHz
2 nanowatt	20 nanowatt

Appendix (iii) : Test Equipment

Test Equipment

Laboratory Test Equipment.

(1) Racal–Dana	1998	:Frequency Counter
(2) Quartzlock	2A	:Off Air Standard
(3) Hewlett Packard	8904A	:Audio Frequency Generator
(4)[a] Bird	4391	:RF Power Analyser
[b] Bird	25C	:25W Slug
(5) Airmec	363	:40dB Power Attenuator
(6) Anritsu	MS2601A	:Spectrum Analyser
(7) Advantest	R9211B	:FFT Analyser
(8) Hewlett Packard	8640B	:RF Generator (two off)
(9) Bird	43	:RF Power Meter
(10) Hewlett Packard	8644B	:RF Generator
(11) Mini–Circuits	ZSC–2–4	:RF Combiner/Splitter (two off)
(12) Marconi	2955A	:Radio Communications Test Set
(13)Aerial Facilities		:Circulator

Field Test Equipment.

(1) Bradford Univ.	–	:V.23 MODEM (two off)
(2) Bradford Univ.	–	:PRBS Generator
(3) Marconi Inst.	2871	:Data Communications Analyser
(4) [a] Anritsu	ML518A	:Field Strength Meter
[b] Anritsu	MP534A/B	:Calibrated Antenna
(5) Minigor	510	:Chart Plotter
(6) Sony	TC399	:Reel to Reel Tape Recorder
(7) Nagra	IV–SJ	:Professional Quality Portable Tape Recorder