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Electromagnetic compatibility and Radio spectrum Matters (ERM); Continuous Tone Controlled Signalling System (CTCSS) and Digitally Coded Squelch Signalling (DCSS) system

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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM).

1 Scope

The present document contains technical requirements for Continuous Tone Controlled Signalling System (CTCSS) and Digitally Coded Squelch Signalling (DCSS).

CTCSS and DCSS systems allow the audio in a receiver to be selectively enabled/disabled on receipt of a specific tone/code. These tones/codes are transmitted continuously during the transmission so the receiver would normally implement suitable process to remove them from the wanted audio signal.

The present document specifies signalling systems that may be used with analogue FM voice equipment complying with either EN 300 086-1 [i.1]/EN 300 086-2 [i.2] or EN 300 296-1 [i.3]/EN 300 296-2 [i.4].

The present document only applies to equipment that employs frequency or phase modulation.

The scope of the present document is similar to prior national standards [i.5], [i.6] and aspects of international standards [i.7].

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the reference document (including any amendments) applies.

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2.1 Normative references

The following referenced documents are necessary for the application of the present document.

None.

2.2 Informative references

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI EN 300 086-1: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Land Mobile Service; Radio equipment with an internal or external RF connector intended primarily for analogue speech; Part 1: Technical characteristics and methods of measurement".

[i.2] ETSI EN 300 086-2: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Land Mobile Service; Radio equipment with an internal or external RF connector intended primarily for analogue speech; Part 2: Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive ".

[i.3] ETSI EN 300 296-1: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Land Mobile Service; Radio equipment using integral antennas intended primarily for analogue speech; Part 1: Technical characteristics and methods of measurement".

[i.4] ETSI EN 300 296-2: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Land Mobile Service; Radio equipment using integral antennas intended primarily for analogue speech; Part 2: Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive".

[i.5] MPT1306: "Continuous tone controlled signalling system (CTCSS) for use in the Land Modile Services", October 1996.

[i.6] MPT1381: "Digitally Coded Squelch Signalling (DCSS) system for use in the Land Mobile Services", November 1996.

[i.7] TIA-603-D: "Land Mobile FM or PM communications equipment measurement and performance standards".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

Radio Frequency channel: radio frequency carrier (RF carrier)

SINAD Meter: measurement instrument used to measure SND/ND using a band-stop filter

Squelch: circuits or functionality provided that mutes the received signal (audio) under specified conditions, e.g. the absence of a wanted signal at the input of the receiver

3.2 Symbols

For the purposes of the present document, the following symbols apply:

f_1 lowest modulation frequency
f_2 highest modulation frequency

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

CTCSS	Continuous Tone Controlled Signalling System
DC	Direct Current
DCS	Digitally Coded Squelch
DCSS	Digitally Coded Squelch Signalling
DUT	Device Under Test
FM	Frequency Modulation
FSK	Frequency Shift Keying
LSB	Least Significant Bit
MPFD	Maximum Permissible Frequency Deviation
MSB	Most Significant Bit
NRZ	Non Return to Zero
RF	Radio Frequency
SINAD	Received signal quality based on (Signal + Noise + Distortion)/(Noise + Distortion)

4 Overview

4.1 CTCSS

CTCSS is a system in which the radio equipment is fitted with devices which at the transmitter generate a specified continuous tone during transmission and at the receiver respond to a specific continuous tone.

The CTCSS code frequency is the assigned tone frequency. The standard frequencies available for assignment are given in table 1.

Table 1: CTCSS Code Frequencies

Freq (Hz)	Freq (Hz)	Freq (Hz)	Freq (Hz)
67,0	94,8	131,8	186,2
69,3	97,4	136,5	192,8
71,9	100,0	141,3	203,.5
74,4	103,5	146,2	210,7
77,0	107,2	151,4	218,1
79,7	110,9	156,7	225,7
82,5	114,8	162,2	233,6
85,4	118,.8	167,9	241,8
88,5	123,0	173,8	250,3
91,5	127,3	179,9	

4.2 DCS

4.2.1 DCS codewords

The DCS codeword is a specific digitally coded signal transmitted continuously on the carrier frequency. The DCS codework consists of a 23 bit frame which is transmitted at 134,4 bit/s.

The structure of the codeword is shown in figure 1. Bits 1 to 9 are the originating DCS code and are normally expressed as a 3 digit octal number where bit 1 is the LSB. Bits 12 to 10 are fixed at 100_2. Bits 13 to 23 are check bits generated by a (23,12) cyclic Golay code.

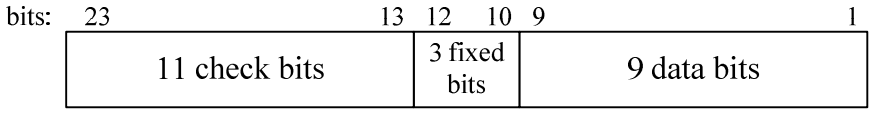

Figure 1: DCS codeword structure

The LSB is transmitted first (bit 1).

4.2.2 DCS codewords

Allowable codewords are shown in table 2. DCS codes may be separated in four groups as follows:

Group 1: codes have 3 contiguous bits (lowest frequency 22,33 Hz)

Group 2: codes have 4 contiguous bits (lowest frequency 16,75 Hz)

Group 3: codes have 5 contiguous bits (lowest frequency 13,40 Hz)

Group 4: codes have 6 contiguous bits (lowest frequency 11,17 Hz)

Table 2: DCS Codewords

Octal Code	Bit Pattern MSB LSB	Octal Code	Bit Pattern MSB LSB
023	111011000111000000010011	162	110101111001000011110010
025	110101101111000000010101	165	011000111011000011110101
026	110010111011000000010110	172	000010111111000011111010
031	101000111111000000011001	174	001100010111000011111100
032	101111101011000000011010	205	110111010011000010000101
043	101101101101000000100011	223	110100011101000010010011
047	000111111011000000100111	226	111101100001000010010110
051	111110010101000000101001	243	100010110111000010100011
054	110111101001000000101100	244	001111110101000010100100
065	101110100011000000110101	245	101100011111000010100101
071	110011110011000000111001	251	110001001111000010101001
072	110100100111000000111010	261	001011101111000010110001
073	010111001101000000111011	263	101111010001000010110011
074	111010001111000000111100	265	100001111001000010110101
114	011010111101000001001100	271	111100101001000010111001
115	111001010111000001001101	306	000110011111000011000110
116	111110000011000001001110	311	011100011011000011001001
125	000011110111000001010101	315	110110001101000011001101
131	011110100111000001011001	331	010001111101000011011001
132	011001110011000001011010	343	010100101111000011100011
134	010111011011000001011100	346	011101010011000011100110
143	011011110101000001100011	351	000111010111000011101001
152	001111011001000001101010	364	110100001011000011110100
155	100010011011000001101101	365	010111100001000011110101
156	100101001111000001101110	371	001010110001000011111001
411	111011101101001000001001	606	101110110011001100000110
412	111100111001001000001010	612	110011100011001100001010
413	011111010011001000001011	624	000111101011001100010100
423	100101110011001000010011	627	000000111111001100010111
431	110110001011001000011001	631	111001010001001100011001
432	110001011111001000011010	632	111110000101001100011010
445	111101110001001001001101	654	100110000111001101011100
464	010011111101001001101000	662	010010001111001101100010
465	110000010111001001101010	664	011100100111001101101000
466	110111000011001001101100	703	010001010111001111000011
503	011110001101001010000011	712	000101111011001111001010
506	010111110001001010001100	723	011100110001001110100011
516	100000110111001010011100	731	001111001001001110110001
532	000111000111001010110100	732	001000011101001110110100
546	001100111101001011001100	734	000110110101001110111000
565	000110001111001011101010	743	001010011011001111000011
		754	010000011111001111011000

4.2.3 DCS Modulation

DCS Modulation is a NRZ baseband FSK modulation. The polarity of the modulation shall be a negative frequency shift for a 0 and a positive frequency shift for a 1.

5 Test conditions, power sources and ambient temperatures

5.1 Normal and extreme test conditions

Testing shall be performed under normal test conditions, and also, where stated, under extreme test conditions.

The test conditions and procedures shall be as specified in clauses 5.2 to 5.5.

5.2 Test power source

During testing the power source of the equipment shall be replaced by a test power source capable of producing normal and extreme test voltages as specified in clauses 5.3.2 and 5.4.2. 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.

For battery operated equipment the battery shall be removed and the test power source shall be applied as close to the battery terminals as practicable.

During tests of DC powered equipment the power source voltages shall be maintained within a tolerance of < ±1 % relative to the voltage at the beginning of each test. The value of this tolerance is critical for power measurements. Using a smaller tolerance will provide better measurement uncertainty values.

5.3 Normal test conditions

5.3.1 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 these conditions, a note to this effect, stating the ambient temperature and relative humidity during the tests, shall be added to the test report.

5.3.2 Normal test power source

5.3.2.1 Mains voltage

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, 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 Hz and 51 Hz.

5.3.2.2 Regulated lead-acid battery power sources used on vehicles

When the radio equipment is intended for operation from the usual types of regulated lead-acid battery power source used on vehicles the normal test voltage shall be 1,1 times the nominal voltage of the battery (for nominal voltages of 6 V and 12 V, these are 6,6 V and 13,2 V respectively).

5.3.2.3 Other power sources

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

5.4 Extreme test conditions

5.4.1 Extreme temperatures

For tests at extreme temperatures, measurements shall be made in accordance with the procedures specified in clause 5.5, at the upper and lower temperatures of one of the following two ranges:

- -20 °C to +55 °C;
  All mobile and handportable equipment.
  Base stations for outdoor/uncontrolled climate conditions.

- 0 °C to +40 °C;
  Base stations for indoor/controlled climate conditions.

In the case of base station equipment, the manufacturer shall declare which conditions the equipment is intended to be installed in.

5.4.2 Extreme test source voltages

5.4.2.1 Mains voltage

The extreme test voltage for equipment to be connected to an ac mains source shall be the nominal mains voltage ±10 %.

5.4.2.2 Regulated lead-acid battery power sources used on vehicles

When the equipment is intended for operation from the usual types of regulated lead-acid battery power sources used on vehicles the extreme test voltages shall be 1,3 and 0,9 times the nominal voltage of the battery (for a nominal voltage of 6 V, these are 7,8 V and 5,4 V respectively and for a nominal voltage of 12 V, these are 15,6 V and 10,8 V respectively).

5.4.2.3 Power sources using other types of batteries

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

- for the nickel metal-hydride, leclanché or lithium type: 0,85 times the nominal battery voltage;

- for the mercury or nickel-cadmium type: 0,9 times the nominal battery voltage.

No upper extreme test voltages apply.

In the case where no upper extreme test voltage the nominal voltage is applicable, the corresponding four extreme test conditions are:

- V_{min}/T_{min}, V_{min}/T_{max};

- (V_{max} = nominal)/T_{min}, (V_{max} = nominal)/T_{max}.

5.4.2.4 Other power sources

For equipment using other power sources, or capable of being operated from a variety of power sources, the extreme test voltages shall be those declared by the equipment manufacturer.

5.5 Procedure for tests at extreme temperatures

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

In the case of equipment containing temperature stabilization circuits designed to operate continuously, the temperature stabilization 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 equipment the manufacturer shall provide for the power source circuit feeding the crystal oven to be independent of the power source for the rest of the equipment.

If the thermal balance is not checked by measurements, a temperature stabilizing period of at least one hour, or a longer period as may be decided by the testing laboratory, shall be allowed. The sequence of measurements shall be chosen, and the humidity content in the test chamber shall be controlled so that excessive condensation does not occur.

5.5.1 Procedure for equipment designed for continuous transmission

If the manufacturer states that the equipment is designed for continuous transmission, the test procedure shall be as follows.

Before tests at the upper extreme temperature, the equipment shall be placed in the test chamber, and left until thermal balance is attained. The equipment shall then be switched on in the transmit condition for a period of half an hour, after which the equipment shall meet the specified requirements.

Before tests at the lower extreme temperature, the equipment shall be left in the test chamber until thermal balance is attained, then switched to the standby or receive condition for a period of one minute, after which the equipment shall meet the specified requirements.

5.5.2 Procedure for equipment designed for intermittent transmission

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

Before tests at the upper extreme 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 extreme temperature, the equipment shall be left in the test chamber until thermal balance is attained, then switched to the standby or receive condition for one minute, after which the equipment shall meet the specified requirements.

5.6 Test signals

The test modulation signals are baseband signals that modulate a carrier or signal generator. They are dependent upon the type of equipment under test and also the measurement to be performed.

Test modulating signals are:

A-M1: a 1 000 Hz tone at a level which produces a deviation of 12 % of the channel separation plus a CTCSS tone or DCS code with a deviation equal to minimum deviation for the channel separation as specified in table 2.

For normal test modulation, the modulation frequency shall be 1 kHz and the resultant frequency deviation shall be 60 % of the maximum permissible frequency deviation for the clause 6.8.3.

The test signal shall be substantially free from amplitude modulation.

Sources of test signals for application to the receiver input shall be connected in such a way that the source impedance presented to the receiver input is 50 Ω. This requirement shall be met irrespective of whether one or more signals using a combining network are applied to the receiver simultaneously.

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

5.7 CTCSS/DCS Signal Generator

The CTCSS/DCS generator used in the tests shall be capable of providing all the CTCSS code frequencies and all the DCS code patters as defined in the present document. The generator shall have the following characteristics:

- generate a sineware or filtered NRZ data stream;
- the generated sinewave shall have a distortion of ≤ 1 %;
- the sinewave shall have an output flatness of ≤ 0,2 dB across the CTCSS code frequency range;
- the output level shall be sufficient to provide at least ±1 kHz of deviation when used with the RF signal generator;
- the sinewave frequency shall be accurate to within 0,05 %;
- the NRZ data stream shall be at a bit rate of 134,4 bps ± 0,5 bps;
- the power of the NRZ data stream above 300 Hz shall be less than 1 % of the total power.

5.8 CTCSS/DCS test frequencies/codes

Where tests are undertaken with multiple CTCSS/DCS codes the following test cases are recommended:

CTCSS: 67 Hz, 123 Hz and 250,3 Hz

DCS: code 027, code 172 and code 734

6 Technical Characteristics

6.1 CTCSS Encoder frequency

6.1.1 Definition

The encoder frequency is the frequency of the CTCSS modulation.

6.1.2 Method of measurement

a) The DUT including its associated encoder unit shall be connected via a suitable load and attenuator to a modulation meter and operated in accordance with the manufacturer/providers instructions;

b) the output of the modulation meter shall be connected to a frequency counter and the frequency of the CTCSS modulation measured;

c) the measurement shall be made under the normal test conditions (clause 5.3) and repeated under extreme test conditions (clauses 5.4.1 and 5.4.2 applied simultaneously).

6.1.3 Limits

The measured CTCSS frequency should under all test conditions be within ±0,75 % of the standard frequency, as defined in table 1.

6.2 Encoder Modulation

6.2.1 Definition

The encoder modulation is the frequency deviation used to transmit the CTCSS or DCS waveform on the RF carrier.

6.2.2 Method of measurement

For equipment supporting CTCSS and DCS this test shall be carried out first for CTCSS and then repeated for DCS. The measurement procedure shall be as follows:

a) the DUT including its associated encoder unit shall be connected via a suitable load and attenuator to a modulation meter and operated in accordance with the manufacturer/providers instructions;

b) the measurement shall be made under the normal test conditions (clause 5.3) and repeated under extreme test conditions (clauses 5.4.1 and 5.4.2 applied simultaneously).

6.2.3 Limits

The modulation should under all test conditions be with the limits given in table 3.

Table 3: Standard Modulation

Channel Separation (kHz)	Peak Deviation (Hz)
12,5	300 to 500
20	350 to 750
25	400 to 800

6.3 DCS encoder data rate

6.3.1 Definition

The DCS encoder data rate is the rate at which DCS data bits are transmitted on the RF carrier.

6.3.2 Method of measurement

The method of measurement shall be as follows:

a) the DUT including its associated encoder unit shall be connected via a suitable load and attenuator to a demodulator or modulation measurement device and operated in accordance with the manufacturer/providers instructions;

b) the bit rate clock, if available, shall be connected to a frequency counter;

c) if the bit rate clock is not available the DCS data rate shall be measured from the demodulated bit stream;

d) the measurement shall be made under the normal test conditions (clause 5.3) and repeated under extreme test conditions (clauses 5.4.1 and 5.4.2 applied simultaneously).

6.3.3 Limits

The DCS encoder data rate under all conditions shall be within ±2 % of the nominal bit rate in clause 4.2.1.

6.4 Tone signalling squelch threshold

6.4.1 Definition

The tone signalling squelch threshold is the minimum radio frequency level of the CTCSS or DCS signal at the receiver input required to operate the decoder.

6.4.2 Method of Measurement

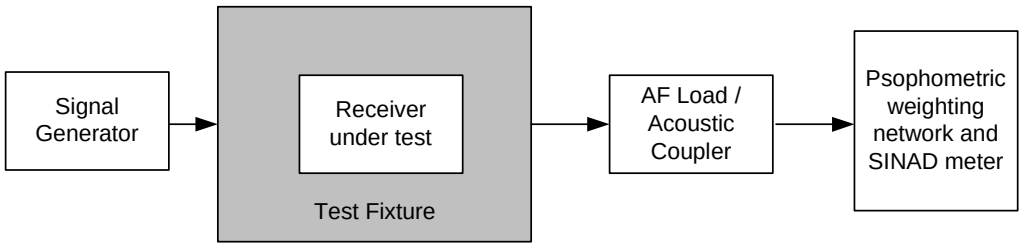

Figure 2: Measurement arrangement

The measurement arrangement of figure 2 shall be used. For equipment supporting CTCSS and DCS this test shall be carried out first for CTCSS and then repeated for DCS. The measurement procedure shall be as follows:

a) test signal A-M1 at the nominal frequency of the receiver, and modulated with the appropriate CTCSS or DCS code shall be applied to the input of the receiver;

b) initially the signal generator shall be switched off;

c) increase the input signal in 1 dB steps to the minimum level that produces a continuous audio output not lower than 10 dB below the rated audio output for a period of at least 10 seconds, record this level and the resulting psophometrically weighted SINAD;

d) the test shall be repeated for at least three CTCSS frequencies/DCS codes (see clause 5.8);

e) the highest value of SINAD recorded in step c) is the tone signalling squelch threshold.

6.4.3 Limits

The SINAD with CTCSS signalling shall be less than 14 dB, and the SINAD with DCS signalling shall be less than 16 dB.

6.5 Tone signalling false response rate

6.5.1 Definition

The tone signalling false response rate is the number of times that the CTCSS or DCS decoder circuits allows a burst of noise from the speaker when no signal is present at the input.

6.5.2 Method of Measurement

The measurement arrangement of figure 2 shall be used. For equipment supporting CTCSS and DCS this test shall be carried out first for CTCSS and then repeated for DCS. The measurement procedure shall be as follows:

a) test signal A-M1 at the nominal frequency of the receiver, and modulated with the appropriate CTCSS or DCS code shall be applied to the input of the receiver;

b) initially the signal generator shall be at the level recorded in clause 6.4.2 step e);

c) the signal generator shall be switched off;

d) record the number of times the receiver unmutes over the next 30 minute period;

e) if a single false response occurs within the thirty minute period, continue the test for another thirty minute period. If no false response occurs within that second period, disregard the first false response recorded in d);

f) the number recorded in step d) is the false response rate.

6.5.3 Limits

No false responses shall occur during a 30 minute period.

6.6 CTCSS code frequency selectivity

6.6.1 Definition

Code frequency selectivity is the ability of the CTCSS decoder to reject signals operating on the same radio frequency channel having alternate CTCSS code frequencies.

6.6.2 The Method of Measurement

The measurement arrangement of figure 2 shall be used. The measurement procedure shall be as follows:

a) test signal A-M1 at the nomincal frequency of the receiver, and modulated with the appropriate CTCSS shall be applied to the input of the receiver;

b) the signal generator shall be at the level 60 dB above the level recorded in clause 6.4.2 step e);

c) the signal generator shall be modulated with the next CTCSS code frequency in table 1 above that expected by the DUT minus 0,75 %;

NOTE 1: For example in the case of the receiver being set to expect a 100 Hz code frequency the signal generator modulation is set to 102,7 Hz (i.e. 103,5 - 0,8 Hz);

d) record the number of times the receiver unmutes over a 1 minute period;

e) the signal generator shall be modulated with the next CTCSS code frequency in table 1 below that expected by the DUT plus 0,75 %;

NOTE 2: For example in the case of the receiver being set to expect a 100 Hz code frequency the signal generator modulation is set to 98,1 Hz (i.e. 97,4 + 0,7 Hz);

f) record the number of times the receiver unmutes over a 1 minute period;

g) steps a) to f) shall be repeated for at least three CTCSS frequencies (see clause 5.8);

h) the measurement shall be made under the normal test conditions (clause 5.3) and repeated under extreme test conditions (clauses 5.4.1 and 5.4.2 applied simultaneously).

6.6.3 Limits

The receiver shall not unmute under all the specified test conditions.

6.7 Decoder response time

6.7.1 Definition

The decoder response time is the elapsed time from the application of a CTCSS or DCS signal modulated with the standard test modulation and the minimum tone signalling modulation at the receiver input to the time when the receiver output voltage reaches 75 % of the steady state level.

6.7.2 The Method of Measurement

The measurement arrangement of figure 2 shall be used. The measurement shall be made under the normal test conditions. For equipment supporting CTCSS and DCS this test shall be carried out first for CTCSS and then repeated for DCS. The measurement procedure shall be as follows:

a) test signal A-M1 at the nominal frequency of the receiver, and modulated with the lowest CTCSS tone frequency or a Group 4 DCS code (see clause 4.2.2, e.g. code 023) shall be applied to the input of the receiver;

b) initially the signal generator shall be switched off;

c) the receiver output shall be monitored by a storage oscilloscope and a mechanism shall be provided to synchronize the triggering of the oscilloscope to the application of the signal from the signal generator to the input of the DUT;

d) the signal generator shall be switched on at the level 20 dB above the level recorded in clause 6.4.2 step e);

e) the elapsed time from the application of the test signal to the DUT input terminals until the envelope of the receiver output voltage has reached 75 % of its steady state level shall be noted;

f) steps b) to e) shall be repeated four times and the average of the four values noted in step e) shall be the decoder response time.

6.7.3 Limits

The decoder response time with CTCSS signalling shall be less than 250 ms and the decoder response time with DCS signalling shall be less than 350 ms.

6.8 Maximum permissible frequency deviation

6.8.1 Definition

The frequency deviation is the maximum difference between the instantaneous frequency of the modulated radio frequency signal and the carrier frequency in the absence of modulation.

For equipment supporting continuous signalling systems such as CTCSS and DCS the frequency deviation is the total deviation caused by speech modulation and the signalling system.

The maximum permissible frequency deviation is the maximum value of frequency deviation stated for the relevant channel separation.

It shall not be necessary to perform this test if an equivalent test has been performed during testing of the DUT to a Harmonized Standard for RF co-existence (see [i.1] to [i.4]).

6.8.2 Method of measurement

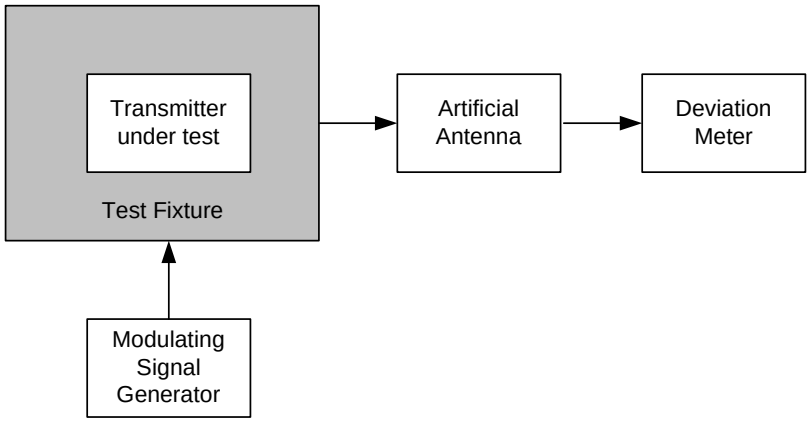

Figure 3: Measurement arrangement

The measurement arrangement in figure 3 shall be used. The frequency deviation shall be measured by means of a deviation meter capable of measuring the maximum permissible frequency deviation, including that due to any harmonics and intermodulation products, which may be produced in the transmitter. The deviation meter bandwidth shall be suitable to accommodate the highest modulating frequency and to achieve the required dynamic range.

The transmitter shall be operated under normal test conditions, clause 5.3.

a) continuous signalling systems (e.g. CTCSS and DCS) this shall be enabled;

b) the modulation frequency shall be varied between the lowest frequency considered to be appropriate and f_2 (see note), the level of this test signal shall be 20 dB above the level of the normal test modulation (clause 6.5);

NOTE: f_2 is equal to 3 kHz, for transmitters intended for 20 kHz and 25 kHz channel separation, or to 2,55 kHz for transmitters intended for 12,5 kHz channel separations;

c) the maximum (positive or negative) frequency deviation shall be measured by means of the deviation meter.

d) the test shall be repeated for at least three CTCSS frequencies/DCS codes (see clause 5.8);

e) the test shall be repeated for each signalling system supported by the equipment..

The manufacturer/provider shall select and record the tone or code used by each signalling system during the tests, it is only necessary to test with one tone or code for each signalling system.

6.8.3 Limits

The maximum permissible frequency deviation for modulation frequencies from the lowest frequency transmitted (f_1) by the equipment (as declared by the manufacturer) up to (f_2) shall be as given in table 4.

Table 4: Frequency deviation

Channel separation in kHz	Maximum Permissible Frequency Deviation (MPFD) in kHz
12,5	±2,5
20	±4,0
25	±5,0

6.9 DCS Waveform Distortion

6.9.1 Definition

DCS modulation is a direct frequency shift of the RF carrier that shall be decoded correctly at the receiving end. The waveform distortion is a measure of the error in the modulation.

NOTE: Since the code by definition is allowed to have six one's or zero's in a row, insufficient low frequency coupling or overshoot in the filters subsequent to the generation of the code could cause decoding problems at the receiver.

6.9.2 Method of Measurement

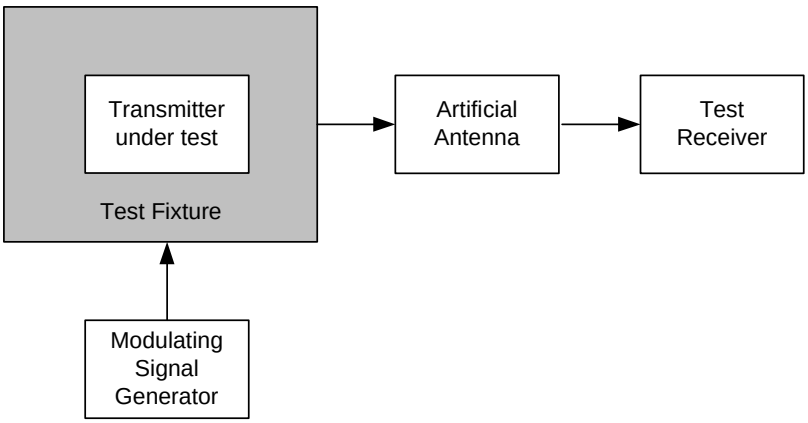

Figure 3: Measurement arrangement

a) the measurement arrangement in figure 3 shall be used;

b) adjust the transmitter according to the manufacturer's/providers instructions, the transmitter shall then be modulated with DCS modulation and program the DCS modulation for code 627 (octal);

c) set the test receiver audio bandwidth of ≤ 0,25 Hz to ≥ 15,000 Hz, ensure any de-emphasis function is off;

d) key the transmitter and measure the signal 'droop' as shown in figure 4 from the beginning of the long string of one's and zero's to the end of the string;

NOTE: Code 627 has the maximum length of one's and zero's.

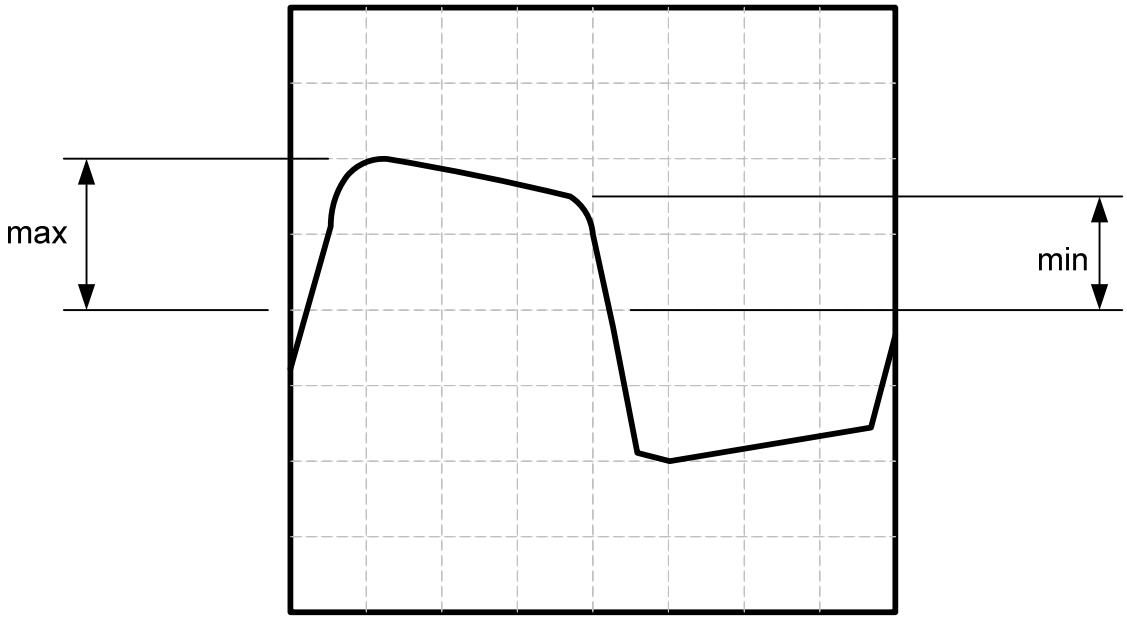

Figure 4: DCS waveform showing distortion measurement

e) Calculate the DCS waveform distortion as:

$$waveform\ \ distortion = \frac{Max - Min}{Max} 100\%$$

6.9.3 Limits

The total waveform droop shall be less than 30 % after a transmission of six ones or six zeros in a row.

History

Document history		
V1.1.1	January 2014	Publication