



Recommendation ITU-R F.1778-1
(02/2015)

**Channel access requirements for HF
adaptive systems in the fixed
and land mobile services**

F Series
Fixed service

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Note: This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.

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RECOMMENDATION ITU-R F.1778-1

**Channel access requirements for HF adaptive systems
in the fixed and land mobile services**

(Question ITU-R 246/5)

(2007-2015)

Scope

This Recommendation describes channel access objectives and techniques for HF adaptive systems in the fixed and land mobile services to minimize interference to and from other systems.

Keywords

Land mobile service, HF adaptive systems, Dynamic frequency selection

The ITU Radiocommunication Assembly,

considering

- a) that the advancement in technologies and use of the Internet are creating new opportunities for HF fixed and land mobile services system applications using frequency-adaptive techniques;
- b) that the effectiveness of spectrum use will be improved by the use of HF frequency-adaptive systems in the fixed and land mobile services, which is required to operate effectively in its allocated spectrum;
- c) that Recommendation ITU-R F.1110 specifies the general characteristics of adaptive HF systems, and specifically recognizes that adaptive HF systems make it possible to achieve a higher quality of service, reduce transmission times, increase spectrum effectiveness and minimize interference between users;
- d) that Recommendation ITU-R F.1611 describes the frequency planning and operation of adaptive HF systems;
- e) that the ITU-R Handbook – Frequency adaptive communication systems and networks in the MF/HF bands, gives guidance on HF frequency-adaptive systems,

noting

that administrations may consider procedures to confirm the ability of interference avoidance mechanisms to function correctly for HF adaptive systems,

recommends

- 1 that frequency-adaptive HF systems should use the minimum number of active (in use at any moment) frequency channels out of its available frequency pool in order to limit the potential for interference to other users;
- 2 that, to minimize interference to and from other systems, HF fixed and land mobile services adaptive systems should use dynamic frequency selection (DFS) and procedures to evaluate the channel prior to and during operation as described in Annex 1.

Annex 1

Adaptive HF systems channel access requirements

1 Introduction

HF fixed and land mobile service adaptive systems operating below 30 MHz have the potential to mutually interfere when operating at the same frequencies and within range of other HF systems. This Annex describes objectives and means to mitigate such interference.

1.1 Dynamic frequency selection (DFS)

Modern technology now offers a solution to the problem of matching the HF system characteristics to the ionospheric channel variability. Adaptive radio systems operate by analysing link performance which evaluate the channel during operation and change the operating frequency, or other system parameters. Whilst the use of frequency agile systems may not necessarily use the minimum overall number of frequencies, the assurance of reliable communication given by such systems result in more efficient operation, and the minimization of the number of frequencies in use at any one time. Channel occupancy detection algorithms seek to avoid situations where interference might be caused by adaptive systems.

Moreover the assurance of circuit availability when required for traffic will result in a reduction of idling transmissions which are in use by some circuit operators to maintain a channel when there is no current traffic. The advantages of adaptive system operation were recognized by the World Radiocommunication Conference 2007 through the revision of Resolution **729 (Rev.WRC-07)**. This resolution sets a number of provisions to ensure that such use is contained within appropriate bands, to ensure that interference is minimized, and to safeguard continued use by non-adaptive systems. When adaptive systems become more widely used, there will be an improvement in spectrum utilization which will benefit both the users of adaptive systems as well as those who continue to use non-adaptive systems.

Resolution **729 (Rev.WRC-07)** provides framework for adaptive use and sharing between HF systems in the MF/HF bands.

DFS has then been envisaged to:

- ensure a spread of the loading across the available spectrum;
- avoid co-channel operation with other systems.

Adaptive HF systems manage call set-up and call progress using digital data formats with embedded network and station addresses. They are able to mitigate interference to other systems by implementing these DFS procedures to avoid occupied channels. Non-adaptive receivers may develop intelligent squelch systems to mitigate interference received from other co-channel adaptive systems.

1.2 Objective of the use of DFS with respect to HF adaptive systems

The objective of using DFS in HF adaptive systems is to protect users of HF bands from mutual interference. This is achieved by avoiding the use of, or vacating, a channel identified as being occupied by other systems on detection of their signals.

The implementation of detection mechanisms and procedures used by adaptive systems are outside the scope of this document. The main reasons for this are that:

- adaptive system design affects implementation;

- practical experience may lead to innovative and more efficient means than can be formulated today;
- manufacturers may choose different implementation methods to achieve a given level of performance; therefore only performance criteria rather than specifications for a particular mechanism should be given in regulatory documents.

2 DFS performance requirements

The DFS performance requirement is stated in terms of response to detection of a signal. Adaptive HF system channel access should meet the following detection and response requirements.

2.1 Detection requirements

The DFS mechanism should be able to detect signals for the purpose of in-service monitoring and channel availability checks above a minimum DFS detection threshold as shown in Table 1.

HF adaptive systems should correctly recognise that a channel is occupied at least as reliably as indicated in Table 1 during a listen-before-transmit period of 900 milliseconds, and should not transmit on that frequency.

TABLE 1
Detection requirements

Waveform	AWGN 3 kHz SNR (dB) ⁽¹⁾	Minimum detection probability
2G-ALE Waveform ⁽²⁾	0	50%
	6	90%
3G-ALE Robust LSU (BW0) ⁽³⁾	–9	50%
	–6	95%
3G-ALE (BW2) ⁽³⁾	0	30%
	6	70%
Single sideband (SSB) Voice	6	50%
	9	75%
9 600 bps 64-QAM ⁽⁴⁾	0	30%
	6	70%
2 400 bps 8-PSK ⁽⁵⁾	0	30%
	6	70%

Notes relative to Table 1:

- ⁽¹⁾ SNR measured in un-faded channel with additive white Gaussian noise (AWGN) and bandwidth of 3 kHz.
- ⁽²⁾ See § 7.2.1.1 FSK ALE modems (second generation) in the Handbook ITU-R Frequency adaptive communication systems and networks in the MF/HF bands, edition 2002.
- ⁽³⁾ See § 7.2.1.2 Burst PSK ALE modem (third generation) in the Handbook ITU-R Frequency adaptive communication systems and networks in the MF/HF bands, edition 2002.
- ⁽⁴⁾ Waveform described in Annex 6 of Recommendation ITU-R F.763-5 – Data transmission over HF circuits using phase shift keying or quadrature amplitude modulation.
- ⁽⁵⁾ Waveform described in Annex 2 of Recommendation ITU-R F.763-5 – Data transmission over HF circuits using phase shift keying or quadrature amplitude modulation.

2.2 Operational requirements

The HF adaptive system should be able to perform a channel availability check during which time the system listens on a particular radio channel for 900 milliseconds to identify whether there is another system operating on that radio channel.

The adaptive system should be able to perform in-service monitoring of the operating channel to check that a co-channel system has not started operation. During in-service monitoring the signal detection function continuously searches for other system signals in-between normal adaptive system transmissions. This requires the use of quiet spaces between successive transmissions.

If the adaptive HF system has not previously been in operation or has not continuously monitored the channel with in-service monitoring, it should not start transmission in any channel before completion of a channel availability check. The channel availability and in-service monitoring operations will utilize minimum DFS detection thresholds as shown in Table 1.

2.3 Response requirements

A channel that has been flagged as containing a radio transmitter, either by a channel availability check or in-service monitoring, is subject to a 2-min period (non-availability period) during which it should not be used by the adaptive HF system. The non-availability period should start at the time when the radio signal is detected. The non-availability period monitoring operation may be continuous or sampled in time.

Channel move time is defined as the period of less than or equal to 125 s needed by an adaptive HF system to cease transmissions on the operating channel upon detection of a signal above the DFS detection threshold. Transmissions during this period may consist of normal traffic for typically less than 125 s. Management and control signals can be sent during this time period to facilitate vacating the operating channel.

2.4 Summary of the DFS performance requirements

Table 2 provides a summary of the DFS performance requirements described above.

TABLE 2

Summary of the DFS performance requirements

Parameter	Value
DFS detection threshold	See Table 1
Channel availability check time	900 ms
Non-availability period	2 min
Channel move time	≤ 125 s