



Recommendation ITU-R BS.1514-2
(03/2011)

**System for digital sound broadcasting in
the broadcasting bands below 30 MHz**

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Broadcasting service (sound)



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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 BS.1514-2

System for digital sound broadcasting in the broadcasting bands below 30 MHz

(Question ITU-R 60/6)

(2001-2002-2011)

Scope

This Recommendation describes the characteristics of various digital terrestrial sound broadcasting systems currently in use, in the LF, MF and HF bands and encourages radio receiver manufacturers to develop portable, multiband, multi-standard digital radio receivers designed to receive emissions not only in the medium and short-wave bands but also in other bands intended for direct reception of sound broadcasts by the general public.

The ITU Radiocommunication Assembly,

considering

- a) that there is an increasing requirement worldwide for suitable means of broadcasting high-quality monophonic or stereophonic sound programmes to vehicular, portable and fixed receivers;
- b) that listeners to LF, MF, and HF broadcasts do not yet have an opportunity to benefit from the use of digital sound broadcasting;
- c) that digital terrestrial sound broadcasting in these bands offers the potential for new and improved services to listeners;
- d) that listeners would benefit from the existence of a single worldwide standard for terrestrial broadcasting of digital sound signals;
- e) that the present congestion of terrestrial sound broadcasting bands below 30 MHz in some countries causes a high level of interference and limits the number of programmes which can be transmitted;
- f) that broadcasters rely heavily upon the use of these bands because of their favourable propagation conditions, particularly for wide-area coverage requirements;
- g) that to facilitate the transition from analogue to digital sound broadcasting in a manner that ensures continuity of service, a simulcast (combined analogue and digital) solution may be necessary in addition to digital-only solutions;
- h) that Recommendation ITU-R BS.1348 on service requirements for digital sound broadcasting in these bands specifies a series of requirements that are focusing system developers in several countries to overcome the current deficiencies in audio quality and signal robustness and to provide new services;
- j) that subsequent to an ITU-R Call for Proposals asking for system descriptions and laboratory and field test results, two ITU-R Sector Members submitted documentation on two different digital terrestrial sound broadcasting systems for use in frequency bands below 30 MHz;
- k) that concise functional design specifications of the two proposals mentioned in *considering j)* appear in Annexes 1 and 2, with more extensive details referenced in Appendix 1;
- l) that each of the system proponents has submitted laboratory and field test results, referenced in Appendix 1 for prototype equipment, and that condensed versions of these test results, matched to evaluation criteria defined in Annex 3 are presented in Annexes 4 and 5,

further considering

- a) that other digital radio systems are now in use in different parts of the world, for radio services in various frequency bands, and that different systems sometimes require different IF filters to provide enhanced functionalities, e.g. to enable reception of analogue-digital simulcasts and stereo transmissions;
- b) that such a multiplicity of systems and applications might confuse the end users; it may also lead to the availability of radio receivers on the market, designed to only receive some digital radio systems;
- c) that it would be in the best interest of consumers, particularly of those who need to also use their radio receivers when travelling, if receivers were available on the market that can receive all the digital radio systems currently in use or proposed;
- d) that some interactive media, such as the Internet, allow upgrading of the software used to decode and present audio programmes and it would be useful if this feature were also available in digital radio receivers; this would also allow taking into account specific requirements of the hearing-impaired and elderly users,

recommends

- 1 that in the HF bands between 3 and 30 MHz:
 - the system characteristics outlined in Annex 1, with more extensive details referenced in Appendix 1, which meet the service requirements of Recommendation ITU-R BS.1348, and answer affirmatively Question ITU-R 60/6, comprise the single common digital sound broadcasting system that should be used in the broadcasting bands under Article 12 of the Radio Regulations provisions;
 - any implementation of digital sound broadcasting in these bands should embody the system characteristics in Annex 1;
- 2 that in the broadcasting bands below 3 MHz:
 - the system characteristics outlined in Annexes 1 and 2, with more extensive details referenced in Appendix 1, which meet the service requirements of Recommendation ITU-R BS.1348, and answer affirmatively Question ITU-R 60/6, comprise the digital sound broadcasting systems that should be used in these broadcasting bands; and
 - any implementation of digital sound broadcasting in these bands should embody the system characteristics in Annex 1 or Annex 2;
 - administrations that wish to implement systems for digital sound broadcasting in the broadcasting bands below 3 MHz, meeting some or all of the requirements stated in Recommendation ITU-R BS.1348, should use Table 1 to evaluate the respective merits of the systems that they are selecting,

invites radio receiver manufacturers to develop

- 1 economically viable, portable, multiband, multi-standard radio receivers designed to receive, through manual or preferably automatic selection, all the different analogue and digital radio broadcasting systems currently in use in all the relevant frequency bands;
- 2 digital radio receivers allowing downloading of upgrades for some of their specific functionalities such as decoding, navigation, management capability, etc.

NOTE 1 – The revision of this Recommendation, once adopted and approved, should be brought to the attention of ISO/IEC/TC 100, as appropriate.

TABLE 1

Compliance table of ITU requirements for DRM and IBOC systems

Systems features	Importance	In the design		Test status			Expected completion		
		DRM	IBOC	DRM		IBOC	DRM		IBOC
				MW	SW	MW	MW	SW	MW
1 <i>System standard requirement</i>									
a) Digital receiver should work worldwide	A	Yes	Yes	FUL	FUL	NYT			07/2002
2 <i>Capability for a gradual transition from analogue to digital</i>									
a) Simulcast (analogue and digital share a single channel)	A	Yes	Yes (allows gradual transition between analogue and digital)	FUL	UND	FUL		07/02	
b) Multicast (analogue and digital occupy separate channels)	A	Yes (where administration allows such operation)	Yes (where administration allows such operation)	FUL	FUL	NYT			
3 <i>Data casting</i>									
a) Audio and data i.e. data casting capability	B	Yes	Yes	FUL	FUL	FUL			
b) Provision of access control and scrambling	C	Yes (open issue)	Yes (open issue)	NYT	NYT	UND	03/03	03/03	07/02
4) <i>Audio performance requirements</i>									
a) Improve audio quality over that of equivalent analogue systems	A	Yes	Yes	FUL	FUL	FUL			
b) Multilanguage or dual mono	B	Yes	No	NYT	NYT		07/02	07/02	

TABLE 1 (continued)

Systems features	Importance	In the design		Test status			Expected completion		
		DRM	IBOC	DRM		IBOC	DRM		IBOC
				MW	SW	MW	MW	SW	MW
c) Stereo capability	B	Yes (pseudo stereo in 9 or 10 kHz)	Yes	FUL	FUL	FUL			
d) Dynamic bit rate division between audio and data (opportunistic data)	B	Yes	Yes	FUL	FUL	FUL			
e) Bit rate selectable in small steps and higher bit rate supported than achievable at the date of introduction	B	Yes	Yes	FUL	FUL	FUL			
5 <i>Spectral efficiency</i>									
a) Single frequency from geographically-separated or cosited transmitters	B	Yes	Yes	FUL	FUL	NYT			12/02
b) Comply with ITU RF channel bandwidth and spacing	A	Yes	Yes (all digital)	FUL	FUL	UND			03/02
c) Interference potential no more than equivalent amplitude modulation	A	Yes	Yes	FUL	FUL	FUL			
d) Interference susceptibility no more than equivalent amplitude modulation	A	Yes	Yes	FUL	FUL	FUL			
6 <i>Service reliability</i>									
a) Improve reception reliability	A	Yes	Yes	FUL	FUL	FUL			
b) Significantly reduced susceptibility to fading effects	A	Yes	Yes	FUL	FUL	FUL			
c) – automatic frequency switching of receiver	A	Yes	Yes	NYT	NYT	NYT	12/02	12/02	07/02
– inaudible automatic frequency switching of receiver	C	Yes	Yes	NYT	NYT	NYT	12/02	12/02	07/02

TABLE 1 (continued)

Systems features	Importance	In the design		Test status			Expected completion		
		DRM	IBOC	DRM		IBOC	DRM		IBOC
				MW	SW	MW	MW	SW	MW
d) Vehicular, portable and fixed reception	A	Yes	Yes	FUL	FUL	FUL			07/02
e) Rapid tuning	A	Yes	Yes	FUL	FUL	FUL			
f) Graceful degradation	B	Yes (Various modes + UEP)	Yes (hybrid mode)	UND	UND	FUL			
g) Maintain coverage area	A	Yes	Yes	FUL	UND	FUL		07/02	
h) Good indoor reception	A	Yes	Yes	FUL	FUL	FUL			
7 <i>Service information for tuning selection</i>									
a) Simplified selection of services by using programme-related data to select broadcaster and programme content	B	Yes (provided in the standard)	Yes	NYT	NYT	NYT	12/02	12/02	07/02
8 <i>Transmission system considerations</i>									
a) Use of existing modern transmitters capable of digital and analogue	A	Yes	Yes	FUL	FUL	FUL			
b) Power savings when covering the same service area with the same service reliability	C	Yes	Yes	FUL	FUL	FUL			
c) Spurious and out-of-band emissions adhere to ITU regulations	A	Yes	Yes	FUL	FUL	FUL			
9 <i>Receiver considerations</i>									
a) System complexity should not preclude low cost receivers	A	Yes (chipset under development, proven DSP-based)	Yes (chipset demonstrated CES2002)	UND	UND	FUL	12/02	12/02	

TABLE 1 (*end*)

Systems features	Importance	In the design		Test status			Expected completion		
		DRM	IBOC	DRM		IBOC	DRM		IBOC
				MW	SW	MW	MW	SW	MW
b) System complexity should allow low power consumption battery operated receivers	B	Yes (chipset technology allows it)	Yes	UND	UND	UND	06/03	06/03	06/03
10 <i>Variable trade-off</i>									
a) Possibility to select system parameters depending on broadcaster requirement	B	Yes	Yes	FUL	FUL	FUL			

Neither system A nor system B has finalized testing in LW. However, the results obtained in MW are probably representative for LW. The only possible bottleneck could be the antenna RF bandwidth.

DSP: Digital signal processing

FUL: Fully tested, therefore nothing is needed to be placed in the expected completion date

NYT: Not yet tested

UEP: Unequal error protection

UND: Under way

Annex 1

Summary description of the Digital Radio Mondiale (DRM) system

1 Key features of the system design for the markets to be served by the DRM system

The DRM system, is a flexible digital sound broadcasting (DSB) system for use in the terrestrial broadcasting bands below 30 MHz.

It is important to recognize that the consumer radio receiver of the near future will need to be capable of decoding any or all of several terrestrial transmissions; that is, narrow-band digital (for < 30 MHz RF), wider band digital (for >30 MHz RF), and analogue for the LF, MF, HF bands and the VHF/FM band. The DRM system will be an important component within the receiver. It is unlikely that a consumer radio receiver designed to receive terrestrial transmissions with a digital capability would exclude the analogue capability.

In the consumer radio receiver, the DRM system will provide the capability to receive digital radio (sound, program related data, other data, and still pictures) in all the broadcasting bands below 30 MHz. It can function in an independent manner, but, as stated above, will more likely be part of a more comprehensive receiver – much like the majority of today's receivers that include AM and FM band analogue reception capability.

The DRM system is designed to be used in either 9 or 10 kHz channels or multiples of these channel bandwidths. Differences in detail on how much of the available bit stream for these channels is used for audio, for error protection and correction, and for data depend on the allocated band (LF, MF, or HF) and on the intended use (for example, ground wave, short distance sky wave or long distance sky wave). In other words, there are modal trade-offs available so that the system can match the diverse needs of broadcasters worldwide. As indicated in the next section, when regulatory procedures are in place to use channels of greater bandwidth than 9/10 kHz, the DRM system's audio quality and total bit stream capability can be greatly improved.

The DRM system employs advanced audio coding (AAC), supplemented by spectral band replication (SBR) as its main digital encoding. SBR improves perceived audio quality by a technique of higher baseband frequency enhancement using information from the lower frequencies as cues. OFDM/QAM is used for the channel coding and modulation, along with time interleaving and forward error correction (FEC) using multi-level coding (MLC) based on a convolutional code. Pilot reference symbols are used to derive channel-equalization information at the receiver. The combination of these techniques results in higher quality sound with more robust reception within the intended coverage area when compared with that of currently used AM.

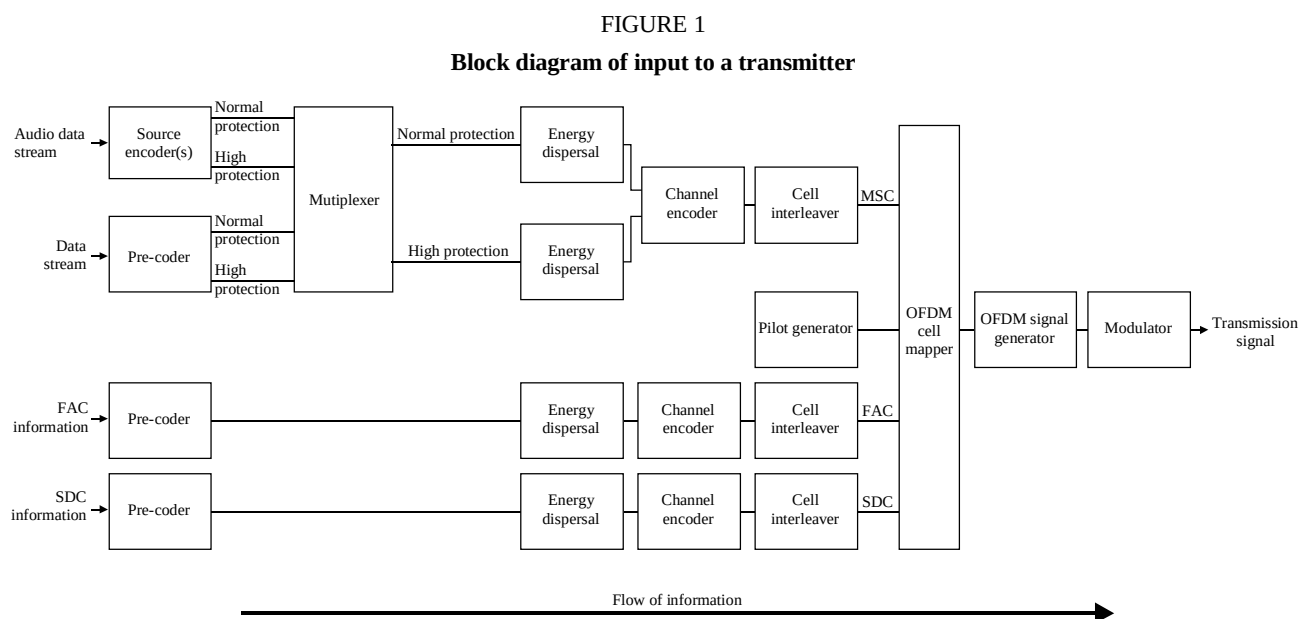
The system performs well under severe propagation conditions, such as those encountered under long distance multipath HF sky-wave propagation, as well as under easier to cope with MF ground-wave propagation. In the latter case, maximum use is made of the AAC and SBR source coding algorithms, leading to much higher quality audio than that achieved by AM, since a minimal amount of error correction has to be employed. For many HF propagation conditions, the necessity to achieve a high degree of robustness reduces the audio quality compared to MF digital; nevertheless, the audio quality is still better than current AM quality.

The design permits the use of the DRM system within a single frequency network (SFN).

It also provides the capability for automatic frequency switching, which is of particular value for broadcasters who send the same signals at different transmission frequencies. For example, this is done routinely by large HF broadcasting organizations using AM to increase the probability of at least one good signal in the intended reception area. The DRM system can enable a suitable receiver to select the best frequency for a programme automatically without any effort on the part of the listener.

2 Brief description of the DRM system

2.1 Overall design



MSC: main service channel

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Figure 1 describes the general flow of the different classes of information (audio, data, etc.) from encoding on the left of the Figure to a DRM system transmitter exciter on the right. Although a receiver diagram is not included as a figure, it would represent the inverse of this diagram.

On the left are two classes of input information:

- the encoded audio and data that are combined in the main service multiplexer;
- information channels that bypass the multiplexer that are known as fast access channel (FAC) and service description channel (SDC) whose purposes are described in § 2.3.

The audio source encoder and the data pre-coders ensure the adaptation of the input streams onto an appropriate digital format. Their output may comprise two parts requiring two different levels of protection within the subsequent channel encoder.

The multiplex combines the protection levels of all data and audio services.

The energy dispersal provides a deterministic, selective complementing of bits in order to reduce the possibility that systematic patterns result in unwanted regularity in the transmitted signal.

The channel encoder adds redundant information as a means for error correction and defines the mapping of the digital encoded information into QAM cells. The system has the capability, if a broadcaster desires, to convey two categories of “bits”, with one category more heavily protected than the other.

Cell interleaving spreads consecutive QAM cells onto a sequence of cells, quasi-randomly separated in time and frequency, in order to provide an additional element of robustness in the transmission of the audio in time-frequency dispersive channels.

The pilot generator injects information that permits a receiver to derive channel-equalization information, thereby allowing for coherent demodulation of the signal.

The OFDM cell mapper collects the different classes of cells and places them on a time-frequency grid.

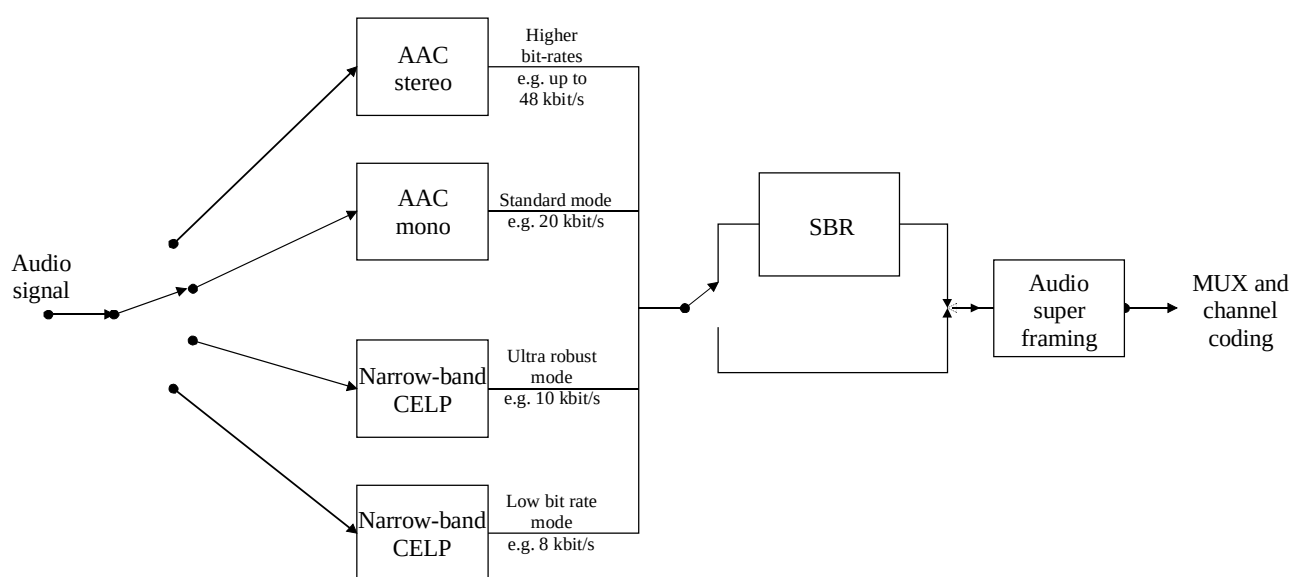
The OFDM signal generator transforms each ensemble of cells with the same time index to a time domain representation of the signal, containing a plurality of carriers. The complete time-domain OFDM symbol is then obtained from this time domain representation by inserting a guard interval – a cyclic repetition of a portion of the signal.

The modulator converts the digital representation of the OFDM signal into the analogue signal that will be transmitted via a transmitter/antenna over the air. This operation involves frequency up-conversion, digital-to-analogue conversion, and filtering so that the emitted signal complies with ITU-R spectral requirements.

With a non-linear high-powered transmitter, the signal is first split into its amplitude and phase components (this can advantageously be done in the digital domain), and then recombined (by the action of the transmitter itself) prior to final emission.

2.2 Audio source coding

FIGURE 2
Source coding overview



CELP: code excited linear prediction

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