

REPORT 1073-1

TELEVISION STANDARDS FOR THE BROADCASTING-SATELLITE SERVICE

(Question 2/10 and 11, Study Programme 2F/10 and 11)

(1986-1990)

1. Introduction

The present Report briefly describes in a comparative manner the basic characteristics of some of the systems which have been developed for television transmission with sound and data services for satellite broadcasting. Recognizing that there are advantages in reducing the number of modulation methods and the differences in the characteristics of these modulation methods, the basic parameters of each system were used to produce tables which stress the similarities between systems. Only fully specified systems adopted, or being seriously considered for adoption, by at least one administration, were considered in these tables. The detailed specifications of these systems are contained in a separate CCIR publication (*Specifications of transmission systems for the broadcasting-satellite service*).

Special considerations should be given to those systems that have adopted the general principle of time-division multiplexing since it permits an improvement in the quality of the signals by eliminating, in particular, the problems of intermodulation and cross-colour. A time-division multiplex structure also permits subsequent compatible introduction of further services or further improvements to the quality of the basic services. For example, wide-screen aspect ratio pictures can be transmitted. Displays of the 4:3 type can present the most interesting portion of the picture, selectable by a digital data signal. Further details are given concerning these improvements to the vision signal in Report 1074.

All systems described in this Report apply digital techniques for the sound (and for the data) in order to utilize to the greatest possible extent the capacity made available by the channels defined by the WARC-BS-77 and the RARC SAT-83, taking into account if necessary the need for direct translation on distribution networks with narrower bandwidths. The use of a sound/data multiplex (associated with the service-identification system) making available the capacity required, and at the same time the maximum flexibility, is also a very important asset. Possibilities of scrambling the signal for secure transmission and controlled reception are increasingly viewed as an important feature of such systems.

This Report presents a short summary of the main features of each of the fully specified systems considered. It is followed by tables listing values for the main characteristics of each system.

2. Summary description of the systems**2.1 MAC/packet family**

The MAC/packet family of standards has three members all suited to satellite broadcasting: C-MAC/packet, D-MAC/packet and D2-MAC/packet.

These systems have been optimized under different constraints and meet the various broadcasting-satellite service requirements in the 12 GHz band when the 625 line standard is used with a satellite channel of 27 MHz bandwidth.

The systems incorporate the following common features:

- time division multiplexing;
- MAC picture coding, with the capacity for extended aspect ratio (see Report 1074);
- packet multiplexing for sound and data;
- digital high and medium quality sound coding and error protection method (see Recommendation 651 and Report 632);
- service identification and conditional access systems with video and audio scrambling [OCTI, 1986-90a, b].
- full channel digital mode, when the area of the television frame normally reserved for the MAC vision signal (and its blanking interval) is replaced by data burst (see Report 1228).

The clock frequencies used in these three systems have simple relationships with the sampling frequencies of the digital studio standard defined in Recommendation 601.

This close relationship between these systems allows for the development and introduction of receivers capable of functioning with all of the standards.

2.1.1 C-MAC/packet

The C-MAC/packet system was, in part, developed to provide a high data channel capacity.

The particular features of the C-MAC/packet system are:

- the use of an RF time division multiplex wherein the carrier is frequency modulated by analogue picture signals during a certain fraction of line duration and 2-4-PSK modulated during the remainder of the line duration by a multiplex conveying several sound channels, synchronization and data signals;
- the capacity of the sound/data multiplex is about 3 Mbit/s, equivalent to eight high quality sound channels of 15 kHz bandwidth with near instantaneous 14/10 bit companding (protected by one parity bit per sample). The spare data capacity can be used for other services.

The C-MAC/packet system was adopted by the United Kingdom in 1983 and by Finland, Iceland, Norway and Sweden in August 1984* for broadcasting-satellite services.

2.1.2 D-MAC packet

The D-MAC/packet system was, in part, developed to provide both a high data channel capacity and a single baseband interface to other transmission and distribution media.

The particular features of the D-MAC/packet system are:

- a baseband time division multiplex in which the analogue picture signals are combined with duobinary encoded digital sound, synchronization and data signals;
- the capacity of the sound/data multiplex is about 3 Mbit/s, equivalent to eight high quality sound channels of 15 kHz bandwidth with near instantaneous 14/10 bit companding (protected by one parity bit per sample). The spare data capacity can be used for other services;
- the single baseband representation of the time division multiplex signal is frequency modulated for satellite broadcasting.

* The adoption was also supported by the Administration of Denmark.

The D-MAC/packet system has been under further investigation by experts of a number of organizations and has been shown to be also suitable for satellite broadcasting.

As a result of these developments, the United Kingdom now intends to use the D-MAC/packet system for broadcasting-satellite services.

2.1.3 D2-MAC/packet

The D2-MAC/packet system was, in part, developed to provide a single baseband interface to other transmission and distribution media.

The particular features of the D2-MAC/packet system are:

- a baseband time division multiplex in which the analogue picture signals are combined with duobinary encoded digital sound, synchronization and data signals;
- the capacity of the sound/data multiplex is about 1.5 Mbit/s, equivalent to four high quality 15 kHz sound channels with near instantaneous 14/10 bit companding (protected by one parity bit per sample). The spare data capacity can be used for other services;
- the single baseband representation of the time division multiplex signal is frequency modulated for satellite broadcasting.

The Federal Republic of Germany and France have adopted the D2-MAC/packet system for operational use with their broadcasting-satellite services (TV-SAT and TDF-1)* when implemented.

2.2 B-MAC systems

Two closely related implementations of the B-MAC system have been developed for 525 and 625 line applications. Both systems are well suited to use in broadcasting-satellite service applications in the 12 GHz band using either 24 MHz or 27 MHz channelling.

The B-MAC signal is a baseband time division multiplex comprising analogue picture signals combined with a four (or two) level data burst containing digital sound, synchronization and data information.

Vision signal coding is performed using the same time compression factors as the C-MAC/packet and D2-MAC/packet systems. The clock frequencies of 625/50 and 525/60 B-MAC systems are the same multiples of the relevant line scan frequencies to permit use of the same integrated circuit devices for both systems. In the 525 line version the clock frequencies are simply related to the NTSC sub-carrier frequency, facilitating simple transcoding to NTSC. Both B-MAC systems can be configured to permit transmission of pictures with 16:9 aspect ratios.

The B-MAC systems provide a total data capacity of about 1.6 Mbit/s. This can be used to provide six high quality 15 kHz audio channels using adaptive delta modulation which features error concealment and parity protection (see Report 953); alternatively these channels may be configured as 204 kbit/s data channels. A utility data channel makes use of spare capacity in the data multiplex.

Included in the B-MAC structure is a conditional access system based on line translational scrambling for video, and data encryption for digital audio. Because of the high degree of commonality between the 625 and 525 line B-MAC systems it will be possible to develop a single receiver capable of receiving either B-MAC system.

The B-MAC system provides a single baseband interface to other transmission and distribution media.

The 625 line B-MAC system has been adopted in Australia for the Homestead and Community Broadcasting-Satellite Service (HACBSS) which commenced operation in October 1985.

The 525 line B-MAC system is under active consideration by the Direct Broadcasting Satellite Association and the Advanced Television Systems Committee in the United States and also by Canada.

* Direct broadcasting 12 GHz band satellites of the Federal Republic of Germany (TV-SAT) and of France (TDF-1)."

2.3 *Digital sub-carrier/NTSC system*

In this system a digital sub-carrier is frequency multiplexed with the conventional NTSC vision signal. It has been developed for use in the broadcasting-satellite service.

The vision parameters of the system are based on those of system M/NTSC described in Report 624, thus the system is compatible with the terrestrial vision standard.

The sound/data signals are carried on a 5.73 MHz sub-carrier using differential 4-phase shift keying. This sub-carrier, together with the vision signal, frequency modulates the main carrier. The data capacity of the system is about 2 Mbit/s. This can provide four 15 kHz high quality audio channels using 14/10 bit near instantaneous companding, or two 20 kHz very high quality channels through the use of 16 bit linear coding. An additional data channel is also provided in both cases. Both schemes use BCH (63,56) coding error protection.

This system was adopted by the Japanese Administration in 1982 for use with its operational broadcasting-satellite service. This service commenced operation in May 1984 using BS-2a; it conforms to the WARC-BS-77 Plan.

Detailed specifications have been defined for the data channel, the capacity of which varies from 224 to 1 760 Kbps depending on the mode of sound transmission. A packet multiplexing scheme is used for the data channel (see Report 954, section 4.1) [CCIR, 1986-90c].

TABLE 1 – Vision/data multiplex structure

Parameter/System		MAC PACKET SYSTEMS			B-MAC (625 line)	B-MAC (525 line)	Digital sub-carrier/ NTSC					
		C	D	D2								
General parameters	1.1	Modulation frame frequency (Hz)				25		29.97				
	1.2	Number of lines per picture (frame)				625		525				
	1.3	Line frequency (Hz)				15 625		15 734				
	1.4	Number of time increments per line				1 296		1 365		—		
	1.5	Nominal reference clock frequency (MHz)				20.25		21.328		21.477	—	
Multiplex structure	1.6	Multiplexing principle		Radio frequency	Baseband				Sub-carrier			
	1.7	Vision coding		Time multiplexed analogue components					Composite ⁽¹⁾			
	1.8	Nominal transmitted vision bandwidth (MHz)		8.4 ⁽²⁾		7.5 ⁽²⁾		6.3 ⁽²⁾		4.5		
	1.9	Nominal vision amplitude (V peak-to-peak ⁽³⁾)		1.000								
	1.10	Data coding		See § 4.2 of Table IV	Duobinary		Quaternary/binary ⁽⁴⁾			See § 4.2 of Table IV		
	1.11	Symbol rate (Mbaud)		20.25		10.125		7.11		7.16	2.048	
	1.12	Occupied data spectrum (MHz)		Not applicable	10.0		5.0		7.11 ⁽⁵⁾		7.16 ⁽⁵⁾	1.2
	1.13	Nominal data amplitude (V peak-to-peak) ⁽³⁾		Not applicable	0.800		0.800		0.770			See Table IV
	1.14	Number of bits per symbol		1			2/1 ⁽⁴⁾			1		