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SERIES J: CABLE NETWORKS AND TRANSMISSION
OF TELEVISION, SOUND PROGRAMME AND OTHER
MULTIMEDIA SIGNALS

Digital transmission of television signals

Transmission equipment for transferring multi-channel television signals over optical access networks by frequency modulation conversion

Recommendation ITU-T J.185



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Transmission equipment for transferring multi-channel television signals over optical access networks by frequency modulation conversion

Summary

Recommendation ITU-T J.185 describes a transmission method for transferring multi-channel television signals over optical access networks. ITU-T J.185 transmission equipment is capable of realizing multi-channel AM-VSB, 64-QAM, and 256-QAM video signal transmission through the use of frequency modulation conversion.

History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T J.185	2002-02-13	9
2.0	ITU-T J.185	2012-06-13	9

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at <http://www.itu.int/ITU-T/ipr/>.

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Recommendation ITU-T J.185

Transmission equipment for transferring multi-channel television signals over optical access networks by frequency modulation conversion

1 Scope

This Recommendation describes a method of transmitting multi-channel television signals over an optical access network that utilizes frequency modulation (FM) conversion. In this FM transmission system, multi-channel frequency-division multiplexing (FDM) television signals are simultaneously converted into one single wideband FM signal. This FM signal is then transmitted through the optical access network by using the intensity modulation technique. The video-optical network terminal (V-ONT) at the customer premises converts the received single FM signal into the original multi-channel FDM video signals, i.e., coaxial cable television (CATV) signals. The interface for this FM transmission system is the same as that of the amplitude modulation sub-carrier multiplexing (AM-SCM) system. Therefore, the FM transmission system can replace the AM-SCM system. The FM transmission system is required to have an FM converter, i.e., frequency modulator and frequency demodulator, in addition to the AM-SCM transmission system's equipment. However, it has a better efficiency than the AM-SCM transmission system against the noise deterioration caused by optical transmission/splitter loss and optical reflections.

In the SCM technique, the main carrier is the optical frequency signal carrier; the sub-carriers transfer the electrically multiplexed FDM video signals in the optical sideband.

This system can be added to the ITU-T G.983.1 series B-PON system by using ITU-T G.983.3 wavelength-division multiplexing (WDM) technology, to the ITU-T G.984 series G-PON system and ITU-T G.987 series XG-PON system by using ITU-T G.984.5 WDM technology, and to the IEEE 802.3ah/802.3av EPON systems. This integration would allow the system to offer broadcast services and also data and voice communication services over the same optical access network. By using the bidirectional data PON system, upstream signals, e.g., control functionality and upstream data indicating the user's requirements, can be transmitted as well.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

- [ITU-T J.83] Recommendation ITU-T J.83 (2007), *Digital multi-programme systems for television, sound and data services for cable distribution*.
- [ITU-R BO.1408-1] Recommendation ITU-R BO.1408-1 (2002), *Transmission system for advanced multimedia services provided by integrated services digital broadcasting in a broadcasting-satellite channel*.
- [ITU-R BT.1306-3] Recommendation ITU-R BT.1306-3 (2006), *Error-correction, data framing, modulation and emission methods for digital terrestrial television broadcasting*.
- [IEC 60728-1] IEC 60728-1 (2007), *Cable networks for television signals, sound signals and interactive services-Part 1; System performance of forward paths*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 access network [b-ITU-T K.44]: That part of the overall telecommunication network that is located between a telecommunication centre and the customer premises building.

3.1.2 carrier [b-ITU-R V.662-3]: An oscillation or wave, usually periodic, some characteristic of which is intended to be constrained by modulation to follow the values of a signal or of another oscillation.

3.1.3 sub-carrier multiplexing [b-ITU-T G.982]: Multiplexing multiple electrical frequencies onto a single fibre at a single wavelength to provide an individual frequency to each multipoint-to-point path.

3.1.4 trunk network [b-ITU-T K.44]: That part of the telecommunication system that is located between two telecommunication centres and that provides the communication between the centres.

3.2 Terms defined in this Recommendation

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AC	Alternating Current
AM-SCM	Amplitude Modulation Sub-Carrier Multiplexing
AM-VSB	Amplitude Modulation Vestigial Sideband
AMP/BRC-U	Amplifier and Branch Unit
APD	Avalanche Photo Diode
BER	Bit Error Rate
B-PON	Broadband Passive Optical Network
CATV	Cable Television
CNR	Carrier-to-Noise Ratio
CSO	Composite Second Order distortion
CTB	Composite Triple Beat distortion
DC	Direct Current
DI	Discrete Interference
D/U	Desired-to-Undesired signal ratio
E/O	Electrical to Optical converter
EPON	Ethernet Passive Optical Network
FEC	Forward Error Correction
FDM	Frequency-Division Multiplexing
FM	Frequency Modulation
G-PON	Gigabit Passive Optical Network

IF	Intermediate Frequency
IM	Intensity Modulated
ISDB-T	Integrated Services Digital Broadcasting – Terrestrial
MER	Modulation Error Rate
NTSC	National Television System Committee
OFDM	Orthogonal Frequency Division Multiplexing
OMI	Optical Modulation Index
PAL	Phase Alternating Line
PIN-PD	p-i-n Photo Diode
PON	Passive Optical Network
PSK	Phase Shift Keying
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
RA	Repeater Amplifier
RF	Radio Frequency
RIN	Relative Intensity Noise
RMS	Root Mean Square
SBS	Stimulated Brillouin Scattering
SCM	Sub-Carrier Multiplexing
SECAM	Séquentiel couleur à mémoire
STB	Set-Top Box
TC8PSK	Trellis-Coded Eight Phase Shift Keying
TX	Transmitter
V-OLT	Video-Optical Line Terminal
V-ONT	Video-Optical Network Terminal
VSWR	Voltage Standing Wave Ratio
WDM	Wavelength-Division Multiplexing
XG-PON	10-Gigabit Passive Optical Network
XM	Cross Modulation distortion

5 Conventions

In this Recommendation:

The keywords "is required to" indicate a requirement which must be strictly followed and from which no deviation is permitted, if conformance to this Recommendation is to be claimed.

The keywords "is recommended" indicate a requirement which is recommended but which is not absolutely required. Thus, this requirement need not be present to claim conformance.

The keywords "can optionally" indicate an optional requirement which is permissible, without implying any sense of being recommended. This term is not intended to imply that the vendor's

implementation must provide the option, and the feature can be optionally enabled by the network operator/service provider. Rather, it means the vendor may optionally provide the feature and still claim conformance with this Recommendation.

6 System description

Figure 1 is a system description of multi-channel television signals transmission employing frequency modulation (FM) conversion. Video signal from the headend is input to the transmitter (TX) and E/O converted, and then transmitted to the video-optical network terminal (V-ONT) via the video-optical line terminal (V-OLT). For actual installations, this system covers not only the optical access network, but also the optical trunk network with cascaded V-OLTs.

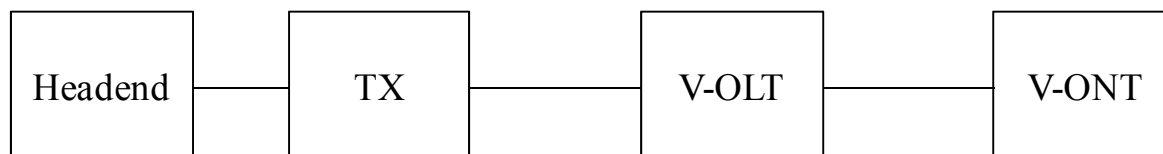


Figure 1 – System configuration of an FM-converted multi-channel television signal transmission system

7 Performance of analogue and/or digital video transmission system

7.1 Specified transmission quality for analogue video signal

Table 1 shows specified transmission quality for the amplitude modulation vestigial sideband (AM-VSB) analogue video signal. The carrier power of the analogue video signal is measured as the peak envelope power.

Table 1 – Specified transmission quality for analogue video signal

TV system	M-system NTSC	B, G-system PAL	L-system SECAM
Noise bandwidth	4.0 MHz	4.75 MHz	5.0 MHz
CNR	≥ 43 dB (Note)	≥ 44 dB	≥ 44 dB
CSO	≤ -53 dB	≤ -52 dB	≤ -52 dB
CTB	≤ -54 dB	≤ -52 dB	≤ -52 dB
XM	≤ -46 dB	≤ -46 dB	≤ -46 dB
DI	≤ -57 dB (Note)	Not specified	Not specified
NOTE – Refer to [IEC 60728-1].			

7.2 Specified transmission quality for digital video signal

Tables 2 and 3 show specified transmission quality for the digital video signal.

Table 2 – Specified transmission quality for the digital video signal

	64-QAM signal			256-QAM signal	
	Annex A of [ITU-T J.83]	Annex B of [ITU-T J.83]	Annex A of [ITU-T J.83]	Annex B of [ITU-T J.83]	Annex A of [ITU-T J.83]
Symbol rate	Not specified	5.057 Mbaud	5.274 Mbaud	5.36 Mbaud	5.274 Mbaud
CNR (Note 4)	≥ 27 dB (Notes 1, 2)	≥ 27 dB (Notes 1, 2)	≥ 26 dB (Note 2)	≥ 40 dB (Notes 1, 2)	≥ 34 dB (Notes 1, 2)
MER	Not specified	Not specified	Not specified	≥ 32 dB (Note 1)	Not specified
CSO/CTB	Not specified	Not specified	≤ -39 dB (Note 3)	≤ -47 dB (Note 3)	≤ -45 dB (Note 3)
Pre-FEC BER	Not specified	1×10^{-5}	Not specified	1×10^{-9}	Not specified
Post-FEC BER	Not specified	1×10^{-12}	Not specified	1×10^{-15}	Not specified
NOTE 1 – This value includes the simultaneous presence of all impairments in the 6-MHz channel bandwidth, including composite distortion or other discrete interference. NOTE 2 – The carrier power is measured as the average root mean square (RMS) signal power. NOTE 3 – These undesired signals are caused by interference among AM-VSB channels. NOTE 4 – Noise bandwidth is defined by symbol rate.					

Table 3 – Specified transmission quality for the digital video signal

	QPSK signal (Note 5)	TC8PSK signal (Note 5)	ISDB-T (Note 6)
Noise bandwidth	28.86 MHz	28.86 MHz	5.6 MHz
CNR (Note 4)	≥ 8 dB (Notes 1, 2)	≥ 11 dB (Notes 1, 2)	≥ 24 dB (Notes 1, 2)
CSO/CTB	Not specified	Not specified	≤ -45 dB (Note 3)
NOTE 1 – This value includes the simultaneous presence of all impairments in the 6-MHz channel bandwidth, including composite distortion or other discrete interference. NOTE 2 – The carrier power is measured as the average RMS signal power. NOTE 3 – These undesired signals are caused by interference among AM-VSB channels. NOTE 4 – Noise bandwidth is defined by symbol rate. NOTE 5 – Refer to [ITU-R BO.1408-1]. NOTE 6 – Refer to [ITU-R BT.1306-3].			