

Recommendation

ITU-T J.196.2 (03/2024)

SERIES J: Cable networks and transmission of television,
sound programme and other multimedia signals

Cable modems and home networking

Physical layer specification for second-generation HiNoC

ITU-T J-SERIES RECOMMENDATIONS

Cable networks and transmission of television, sound programme and other multimedia signals

GENERAL RECOMMENDATIONS	J.1-J.9
GENERAL SPECIFICATIONS FOR ANALOGUE SOUND-PROGRAMME TRANSMISSION	J.10-J.19
PERFORMANCE CHARACTERISTICS OF ANALOGUE SOUND-PROGRAMME CIRCUITS	J.20-J.29
EQUIPMENT AND LINES USED FOR ANALOGUE SOUND-PROGRAMME CIRCUITS	J.30-J.39
DIGITAL ENCODERS FOR ANALOGUE SOUND-PROGRAMME SIGNALS - PART 1	J.40-J.49
DIGITAL TRANSMISSION OF SOUND-PROGRAMME SIGNALS	J.50-J.59
CIRCUITS FOR ANALOGUE TELEVISION TRANSMISSION	J.60-J.69
ANALOGUE TELEVISION TRANSMISSION OVER METALLIC LINES AND INTERCONNECTION WITH RADIO-RELAY LINKS	J.70-J.79
DIGITAL TRANSMISSION OF TELEVISION SIGNALS	J.80-J.89
ANCILLARY DIGITAL SERVICES FOR TELEVISION TRANSMISSION	J.90-J.99
OPERATIONAL REQUIREMENTS AND METHODS FOR TELEVISION TRANSMISSION	J.100-J.109
INTERACTIVE SYSTEMS FOR DIGITAL TELEVISION DISTRIBUTION (DOCSIS FIRST AND SECOND GENERATIONS)	J.110-J.129
TRANSPORT OF MPEG-2 SIGNALS ON PACKETIZED NETWORKS	J.130-J.139
MEASUREMENT OF THE QUALITY OF SERVICE - PART 1	J.140-J.149
DIGITAL TELEVISION DISTRIBUTION THROUGH LOCAL SUBSCRIBER NETWORKS	J.150-J.159
IPCABLECOM (MGCP-BASED) - PART 1	J.160-J.179
DIGITAL TRANSMISSION OF TELEVISION SIGNALS - PART 1	J.180-J.189
CABLE MODEMS AND HOME NETWORKING	J.190-J.199
APPLICATION FOR INTERACTIVE DIGITAL TELEVISION - PART 1	J.200-J.209
INTERACTIVE SYSTEMS FOR DIGITAL TELEVISION DISTRIBUTION (DOCSIS THIRD TO FIFTH GENERATIONS)	J.210-J.229
MULTI-DEVICE SYSTEMS FOR CABLE TELEVISION	J.230-J.239
MEASUREMENT OF THE QUALITY OF SERVICE - PART 2	J.240-J.249
DIGITAL TELEVISION DISTRIBUTION THROUGH LOCAL SUBSCRIBER NETWORKS	J.250-J.259
IPCABLECOM (MGCP-BASED) - PART 2	J.260-J.279
DIGITAL TRANSMISSION OF TELEVISION SIGNALS - PART 2	J.280-J.289
CABLE SET-TOP BOX	J.290-J.299
APPLICATION FOR INTERACTIVE DIGITAL TELEVISION - PART 2	J.300-J.309
MEASUREMENT OF THE QUALITY OF SERVICE - PART 3	J.340-J.349
IPCABLECOM2 (SIP-BASED) - PART 1	J.360-J.379
DIGITAL TRANSMISSION OF TELEVISION SIGNALS - PART 3	J.380-J.389
MEASUREMENT OF THE QUALITY OF SERVICE - PART 4	J.440-J.449
IPCABLECOM2 (SIP-BASED) - PART 2	J.460-J.479
DIGITAL TRANSMISSION OF TELEVISION SIGNALS - PART 4	J.480-J.489
TRANSPORT OF LARGE SCREEN DIGITAL IMAGERY	J.600-J.699
SECONDARY DISTRIBUTION OF IPTV SERVICES	J.700-J.799
MULTIMEDIA OVER IP IN CABLE	J.800-J.899
TRANSMISSION OF 3-D TV SERVICES	J.900-J.999
CONDITIONAL ACCESS AND PROTECTION	J.1000-J.1099
SWITCHED DIGITAL VIDEO OVER CABLE NETWORKS	J.1100-J.1119
SMART TV OPERATING SYSTEM	J.1200-J.1209
IP VIDEO BROADCAST	J.1210-J.1219
CLOUD-BASED CONVERGED MEDIA SERVICES FOR IP AND BROADCAST CABLE TELEVISION	J.1300-J.1309
TELEVISION TRANSPORT NETWORK AND SYSTEM DEPLOYMENT IN DEVELOPING COUNTRIES	J.1400-J.1409
ARTIFICIAL INTELLIGENCE (AI) ASSISTED CABLE NETWORKS	J.1600-J.1649

For further details, please refer to the list of ITU-T Recommendations.

Recommendation ITU-T J.196.2

Physical layer specification for second-generation HiNoC

Summary

Recommendation ITU-T J.196.2 specifies the physical (PHY) layer specification for second-generation high-performance networks over coax (HiNoC) which provides 1 Gbit/s data transmission over coaxial networks in the cable industry. The HiNoC architecture consists of a HiNoC bridge (HB) and HiNoC modems (HMs) and the HiNoC protocol stack includes the medium access control (MAC) layer and PHY layer. This Recommendation contains descriptions for the signal transmission mode of the PHY layer, including frame structure, channel coding and modulation techniques.

Edition 2.0 only updates the title of this and other HiNoC Recommendations without introducing any technical changes.

History*

Edition	Recommendation	Approval	Study Group	Unique ID
1.0	ITU-T J.196.2	2016-10-14	9	11.1002/1000/13049
2.0	ITU-T J.196.2	2024-03-26	9	11.1002/1000/15882

Keywords

HiNoC, Physical layer, Second generation HiNoC.

* To access the Recommendation, type the URL <https://handle.itu.int/> in the address field of your web browser, followed by the Recommendation's unique ID.

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.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure, e.g., interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents/software copyrights, 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 appropriate ITU-T databases available via the ITU-T website at <http://www.itu.int/ITU-T/ipr/>.

© ITU 2024

All rights reserved. No part of this publication may be reproduced, by any means whatsoever, without the prior written permission of ITU.

Table of Contents

	Page
1 Scope	1
2 References.....	1
3 Definitions	1
3.1 Terms defined elsewhere	1
3.2 Terms defined in this Recommendation.....	2
4 Abbreviations and acronyms	2
5 Conventions	3
6 PHY layer structure	4
6.1 Overview	4
6.2 Scrambler.....	4
6.3 FEC coding.....	4
6.4 Constellation mapping.....	10
6.5 Constellation scrambler	11
6.6 OFDM modulation	12
7 PHY frame format	13
7.1 Overview	13
7.2 Preamble A	14
7.3 Preamble B	15
7.4 Payload A	17
7.5 Payload B.....	18
7.6 Payload C.....	21
7.7 Payload D	22
8 Spectrum mask	23
Appendix I – HiNoC 2.0 and 1.0 PHY layer brief comparison.....	24
Appendix II – Operational notes.....	25
Bibliography.....	26

Recommendation ITU-T J.196.2

Physical layer specification for second-generation HiNoC

1 Scope

This Recommendation specifies the physical (PHY) layer protocol and is part of a series of second-generation HiNoC Recommendations for high-speed data transmission over coaxial cable.

This Recommendation applies to bidirectional high-performance wideband access digital systems that use coaxial cable connected between fibre-to-the-building (FTTB) and HiNoC modems (HMs).

Frequency planning, safety and electromagnetic compatibility (EMC) requirements are a national matter and are not covered by this Recommendation. Compliance remains the operators' responsibility.

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 G.972] Recommendation ITU-T G.972 (2016), *Definition of terms relevant to optical fibre submarine cable systems*.
- [ITU-T J.112] Recommendation ITU-T J.112 (1998), *Transmission systems for interactive cable television services*.
- [ITU-T J.195.1] Recommendation ITU-T J.195.1 (2024), *Functional requirements for first-generation HiNoC*.
- [ITU-T J.195.2] Recommendation ITU-T J.195.2 (2024), *Physical layer specification for first-generation HiNoC*.
- [ITU-T J.195.3] Recommendation ITU-T J.195.3 (2024), *MAC layer specification for first-generation HiNoC*.
- [ITU-T J.196.1] Recommendation ITU-T J.196.1 (2016), *Functional Requirements for second-generation HiNoC*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 available sub-carrier [ITU-T J.195.2]: Sub-carriers of OFDM symbol for data bearing.

3.1.2 constellation mapping [ITU-T J.195.1]: The process of mapping the data bits to the constellation symbol.

3.1.3 control frame [ITU-T J.195.2]: Frame of the MAC layer used for access control and channel allocation.

- 3.1.4 cyclic prefix** [ITU-T J.195.2]: Data located at the front of an OFDM symbol, which is a copy of the data from the end of the OFDM symbol.
- 3.1.5 cyclic redundancy check** [ITU-T J.112]: A method of error detection using cyclic code.
- 3.1.6 data frame** [ITU-T J.195.2]: Frame of the MAC layer used to carry data of the upper layer.
- 3.1.7 downlink** [ITU-T J.195.2]: Link from HiNoC bridge (HB) to HiNoC modem (HM).
- 3.1.8 forward error correction** [ITU-T G.972]: A technique which consists of transmitting the data in an encoded form such that the redundancy added by the coding allows the decoding to detect and correct errors.
- 3.1.9 frame check sequence** [ITU-T J.195.2]: A redundant sequence that is used for verifying the correctness of the received data.
- 3.1.10 Pd cycle** [ITU-T J.195.2]: A time interval between two adjacent downlink probe frames.
- 3.1.11 probe frame** [ITU-T J.195.2]: Frame of the physical layer used for carrying signalling frames of the MAC layer.
- 3.1.12 scrambler** [ITU-T J.195.2]: Process that randomizes data using a pseudo-random binary sequence.
- 3.1.13 signalling frame** [ITU-T J.195.2]: Frame of the MAC layer used for node admission, node quitting/deletion and link maintenance.
- 3.1.14 unavailable sub-carrier** [ITU-T J.195.2]: Sub-carriers of OFDM symbol for adjacent channel protection and zero frequency sub-carrier.
- 3.1.15 uplink** [ITU-T J.195.2]: Link from HiNoC modem (HM) to HiNoC bridge (HB).

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

- 3.2.1 pilot sub-carrier:** Sub-carriers for transmission of specific symbols in an orthogonal frequency division multiplexing (OFDM) symbol.
- 3.2.2 constellation scrambler:** The process that takes phase rotation of the constellation symbols in 4 quadrants by using binary pseudo random sequence.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

BCH	Bose-Chaudhuri-Hocquenghem (code)
Cd	Control down
CP	Cyclic Prefix
Dd	downlink Data
DQPSK	Differential Quadrature Phase-Shift Keying
Du	uplink Data
EMC	Electromagnetic Compatibility
FEC	Forward Error Correction
FTTB	Fibre-To-The-Building
GSM	Global System for Mobile communications
HB	HiNoC Bridge

HiNoC	High performance Network over Coax
HM	HiNoC Modem
IFFT	Inverse Fast Fourier Transform
LDPC	Low Density Parity Check Code
MAC	Medium Access Control
MAP	Media Access Plan
MSO	Multiple Systems Operator
OFDM	Orthogonal Frequency Division Multiplexing
OFDMA	Orthogonal Frequency Division Multiple Access
Pd	downlink Probe
PSD	Power Spectral Density
Pu	uplink Probe
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase-Shift Keying
RF	Radio Frequency
Ru	Report up
SC	Sub-Channel
SCG_Ru	Sub-Carrier Group for Ru frame
SSC	Symbol Sub-Cell
TDMA	Time Division Multiple Access

5 Conventions

The keywords "is/are 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 "is prohibited from" 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 "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 the specification.

In the body of this Recommendation and its annexes, the words *shall*, *shall not*, *should* and *may* sometimes appear, in which case they are to be interpreted, respectively, as *is required to*, *is prohibited from*, *is recommended* and *can optionally*. The appearance of such phrases or keywords in an appendix or in material explicitly marked as *informative* are to be interpreted as having no normative intent.

The keywords "HiNoC 1.0" indicate the HiNoC system defined by the ITU-T J.195 series.

The keywords "HiNoC 2.0" indicate the second generation HiNoC.

6 PHY layer structure

6.1 Overview

The functional blocks of the transmitter include scrambler, forward error correction (FEC) coding, constellation mapping, constellation scrambler, orthogonal frequency division multiplexing (OFDM) modulation, cyclic prefix (CP) insertion, framing (into different types of PHY packets) and up conversion to radio frequency (RF) signals. The sequence of the blocks is shown in Figure 1, in which scrambler, FEC coding, constellation scrambler and framing can be optionally closed or opened according to different types of data stream.

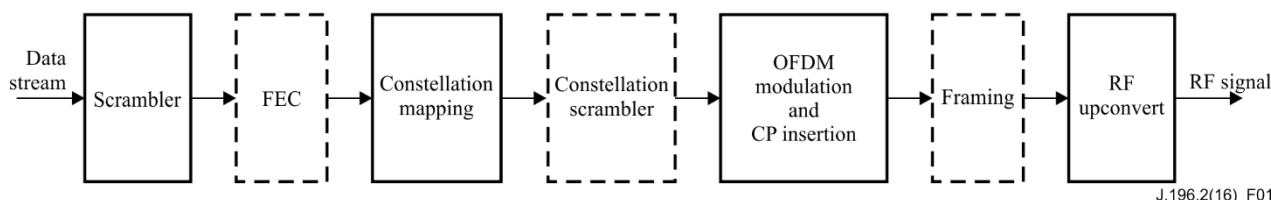


Figure 1 – Functional block diagram of the transmitter

6.2 Scrambler

The procedure of scrambler is required to conform to clause 6.2 of [ITU-T J.195.2].

6.3 FEC coding

6.3.1 Overview

The FEC encoder is required to support Bose-Chaudhuri-Hocquenghem (BCH) codes and can optionally support the low density parity check (LDPC) codes specified in clause 6.3.3.

6.3.2 BCH code

6.3.2.1 Overview

The BCH encoder is required to support three truncated BCH codes with the following code parameters: (392, 248), (1920, 1040) and (1920, 1744).

6.3.2.2 (392, 248) truncated BCH code

The (392, 248) BCH code is truncated from (511, 367) BCH code, a systematic code with the octal representation for the generator polynomial shown as follows:

(1126657202505666323017001652245562614435511600655)₈.

6.3.2.3 (1920, 1040) truncated BCH code

The (1920, 1040) BCH code is truncated from (2047, 1167) BCH code, a systematic code with the octal representation for the generator polynomial shown as follows:

(2607213617224645406577025220731152106357217602413642657023052056326613650555607
46124155122706374565474720414262325513114121607751671240010170277341021754016552
31230342573577525607211634376436714210307434573616501027347554213212451363043514
3515626347123264462606121045647652066606334120024047475)₈.

6.3.2.4 (1920, 1744) truncated BCH code

The (1920, 1744) BCH code is truncated from (2047, 1871) BCH code, a systematic code with the octal representation for the generator polynomial shown as follows:

(64372013435571223560747633451755373433074714007120505460007)₈.