

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

G.9963

Corrigendum 1
(04/2016)

SERIES G: TRANSMISSION SYSTEMS AND MEDIA,
DIGITAL SYSTEMS AND NETWORKS

Access networks – In premises networks

Unified high-speed wireline-based home networking
transceivers – Multiple input/multiple output
specification

Corrigendum 1

Recommendation ITU-T G.9963 (2015) –
Corrigendum 1

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Recommendation ITU-T G.9963

Unified high-speed wireline-based home networking transceivers – Multiple input/multiple output specification

Corrigendum 1

Summary

Recommendation ITU-T G.9963 belongs to the family of ITU-T G.996x Recommendations. Recommendation ITU-T G.9963 specifies the additions and modifications to Recommendations ITU-T G.9960 and ITU-T G.9961 that are needed for a multiple input multiple output (MIMO) home networking transceiver capable of operating over premises power-line wiring. MIMO transceivers are able to transmit and receive over three power-line conductors (phase, neutral and ground). This Recommendation also specifies the means by which transceivers that comply with ITU-T G.9960, ITU-T G.9961 and ITU-T G.9963 interoperate when used on the same wires.

Corrigendum 1 contains text changes to align with the latest versions of ITU-T G.9960 and ITU-T G.9961.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T G.9963	2011-12-16	15	11.1002/1000/11404
1.1	ITU-T G.9963 (2011) Amd.1	2014-01-13	15	11.1002/1000/12083
1.2	ITU-T G.9963 (2011) Cor.1	2014-04-04	15	11.1002/1000/12082
2.0	ITU-T G.9963	2015-07-03	15	11.1002/1000/12402
2.1	ITU-T G.9963 (2015) Cor. 1	2016-04-13	15	11.1002/1000/12819
2.2	ITU-T G.9963 (2015) Amd. 1	2016-07-22	15	11.1002/1000/12820

* To access the Recommendation, type the URL <http://handle.itu.int/> in the address field of your web browser, followed by the Recommendation's unique ID. For example, <http://handle.itu.int/11.1002/1000/11830-en>.

FOREWORD

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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.

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As of the date of approval of this Recommendation, ITU had 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 G.9963

Unified high-speed wireline-based home networking transceivers – Multiple input/multiple output specification

Corrigendum 1

Editorial note: This is a complete-text publication. Modifications introduced by this corrigendum are shown in revision marks relative to Recommendation ITU-T G.9963 (2015).

1 Scope

This Recommendation describes the modifications to [ITU-T G.9960] and [ITU-T G.9961] that are needed to define MIMO home networking transceivers for operation over power-line wiring. More specifically, this Recommendation includes the following:

- the PHY functional models of the MIMO transceivers;
- detailed descriptions of the modifications (changes and additions) needed in the PHY and DLL sections relative to [ITU-T G.9960] and [ITU-T G.9961];
- the means by which transceivers that comply with [ITU-T G.9960], [ITU-T G.9961] and this Recommendation ITU-T G.9963 interoperate when operating on the same wires; and
- the means by which transmissions from ITU-T G.9963 transceivers do not degrade the performance of transceivers that comply with [ITU-T G.9960] and [ITU-T G.9961] when operating on the same wires.

An ITU-T G.9963 transceiver shall be fully compliant with [ITU-T G.9960] and [ITU-T G.9961].

NOTE – In those regions, or particular installations, where only two conductors are used for mains sockets, a modem equipped with a MIMO transceiver will behave as an ITU-T G.9960 transceiver.

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.9960]	Recommendation ITU-T G.9960 (2015), <i>Unified high-speed wireline-based home networking transceivers – System architecture and physical layer specification</i> .
[ITU-T G.9961]	Recommendation ITU-T G.9961 (2015), <i>Unified high-speed wireline-based home networking transceivers – Data link layer specification</i> .
[ITU-T G.9964]	Recommendation ITU-T G.9964 (2011), <i>Unified high-speed wireline-based home networking transceivers – Power spectral density specification</i> .

3 Definitions

3.1 Terms defined elsewhere

Unless otherwise noted, the definitions in [ITU-T G.9960] and [ITU-T G.9961] shall apply.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 ground conductor (G): A conductor in an electrical branch circuit that does not carry mains current under normal operation. It provides a low-impedance return path for ground-fault current back to the service entrance panel for the purposes of protecting personnel and equipment and ensuring circuit breaker trip. At the service entrance panel, this conductor is bonded to an earthing (grounding) electrode. In regulations in some regions this is commonly referred to as the equipment grounding conductor (EGC).

NOTE 1 – Some electrical appliances do not connect to the ground conductor.

NOTE 2 – The neutral and ground conductors are commonly bonded together in the service entrance panel and nowhere else, by virtue of their common bonding to the earthing electrode.

3.2.2 MIMO channel: A channel that has multiple input ports (Tx ports) and multiple output ports (Rx ports). A "2 X 2" MIMO channel has 2 Tx ports and 2 Rx ports.

3.2.3 MIMO transmission: Transmission where one or two spatial streams are converted into two transmit streams.

3.2.4 neutral conductor (N): A conductor in an electrical branch circuit that serves as the reference conductor and return path for current supplied by the circuit's phase conductor(s). At the service entrance panel, this conductor may be bonded to an earthing (ground) electrode. In such cases, regulations in some regions refer to it as the "grounded conductor".

NOTE – Not all branch circuits include a neutral conductor. The term "grounded conductor" should not be confused with the term "ground conductor" or EGC.

3.2.5 phase conductor (P): A conductor in an electrical branch circuit that is energized with mains' voltage with respect to the circuit's reference conductor. In regulations in some regions, this is commonly referred to as a "line conductor".

3.2.6 spatial stream: A stream of data that may be mapped for transmission over one or more ports.

3.2.7 transmit stream: A stream of symbols created by the Tx port mapper. Each transmit stream is assigned for transmission over a specific Tx port.

3.2.8 Tx (or Rx) port: A physical connection to the power-line medium using a combination of the available three conductors (phase (P), neutral (N) and ground (G)) for transmitting and receiving signals. An example of a port is a pair of conductors, such as P-N, N-G or P-G. A port used for transmission is called a "Tx port". A port used for reception is called an "Rx port".

3.2.9 Tx port mapper: A function that maps pairs of constellation points assigned to the two spatial streams on the same sub-carrier, to a modified pair of signals that (after orthogonal frequency division multiplexing (OFDM) modulation, i.e., inverse discrete Fourier transform (IDFT) are connected to Tx ports.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

ACE	Additional Channel Estimation
APC	Application Protocol Convergence
BAT	Bit Allocation Table
BMAT	Bit and Tx port Mapping Allocation Table
DLL	Data Link Layer

DOD	Domain identifier
DSL	Digital Subscriber Line
EGC	Equipment Grounding Conductor
FEC	Forward Error Correction
IDFT	Inverse Discrete Fourier Transform
IDPS	Inter-Domain Presence Signal
ISC	Inactive Sub-Carrier
LFSR	Linear Feedback Shift Register
LSB	Least Significant Bit
MAC	Medium Access Control
MAP	Medium Access Plan
MAT	Mapping Allocation Table
MDI	Medium-Dependent Interface
MIMO	Multiple Input/Multiple Output
MPDU	Media access control Protocol Data Unit
MSC	Masked Sub-Carrier
OFDM	Orthogonal Frequency Division Multiplexing
PCS	Physical Coding Sub-layer
PG	Precoding Grouping
PHY	Physical layer
PMA	Physical Medium Attachment
PMD	Physical Medium Dependent
PMI	Physical Medium-independent Interface
PMSC	Permanently Masked Sub-Carrier
PR	Priority Resolution
PSD	Power Spectral Density
QoS	Quality of Service
RMAP	Relayed Medium Access Plan
RMSC	Regionally Masked Sub-Carrier
SM	Sub-carrier Mark
SS	Spatial Stream
SSC	Supported Sub-Carrier
TPM	Tx Port Mapping
TS	Time Slot
TXOP	Transmission Opportunity

5 Home network architecture and reference models

See clause 5 of [ITU-T G.9960].

6 Profiles

See clause 6 of [ITU-T G.9960].

7 Physical layer specification

7.1 Medium independent specification

7.1.1 Functional model of the physical layer (PHY)

As stated in clause 1, an ITU-T G.9963 compliant transceiver (i.e., a MIMO transceiver) shall be fully compliant with [ITU-T G.9960] and [ITU-T G.9961]. As such, a MIMO transceiver is able to operate based upon the functional models described in clause 7.1.1 (general PHY model), clause 7.1.2 (PCS), clause 7.1.3 (PMA) and clause 7.1.4 (PMD) of [ITU-T G.9960]. Such an operation, resulting in ITU-T G.9960 transmission, may be used for certain transmission cases, as described in clause 7.1.2.1.

The functional model of the PHY layer of a MIMO transceiver, for cases of MIMO transmission, is presented in Figure 7-1. The physical medium-independent interface (PMI) and the medium-dependent interface MDI are, respectively, two demarcation reference points between the PHY and the medium access control (MAC), and between the PHY and transmission medium. Internal reference points δ and α show separation between the physical medium dependent (PMD) and physical medium attachment (PMA), and between the physical coding sub-layer (PCS) and PMA, respectively.

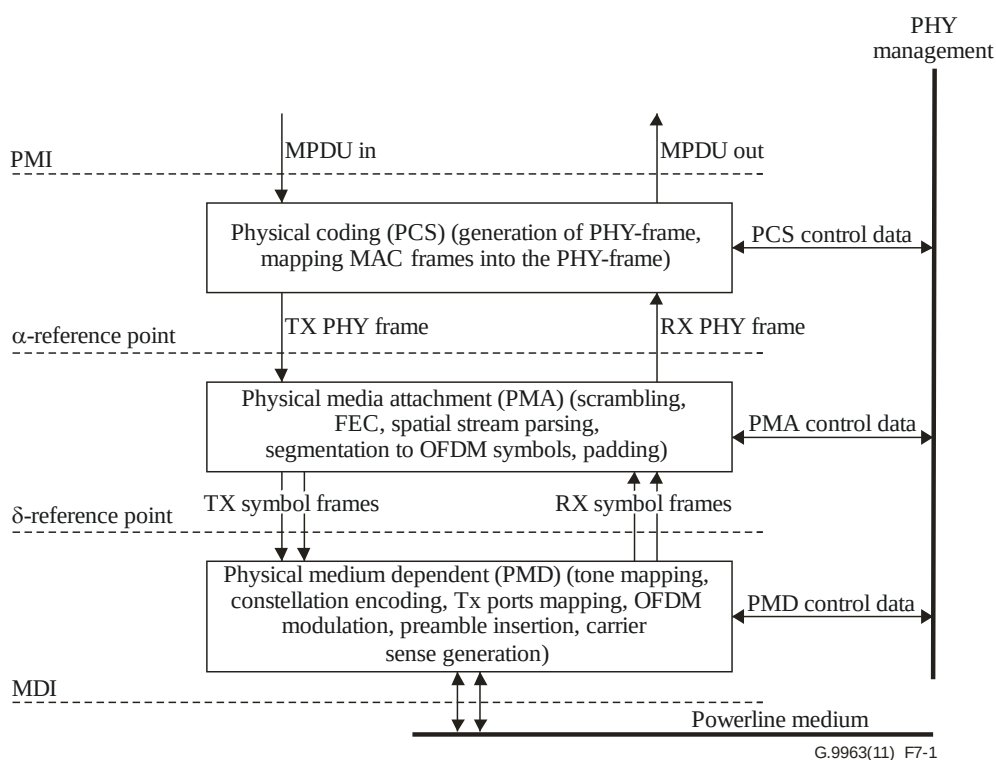


Figure 7-1 – PHY functional model of the MIMO transceiver

In the transmit direction, data enters the PHY from the MAC via the PMI in blocks of bytes called MAC protocol data units (MPDUs). The incoming MPDU is mapped into a PHY frame in the PCS.

The PHY frame is scrambled, encoded and parsed into spatial streams (SS), which are then segmented into orthogonal frequency division multiplexing (OFDM) symbol frames in the PMA. The symbol frames of each of the spatial streams is mapped to OFDM sub-carriers, modulated and mapped to Tx ports in the PMD and transmitted over the power-line medium using OFDM modulation with relevant parameters. In the PMD, a preamble is added to assist synchronization and channel estimation in the receiver.

In the receive direction, frames entering from the medium (reception is also done via multiple Rx ports) via the MDI are demodulated and decoded. The recovered MPDUs are forwarded to the MAC via the PMI. The recovered PHY-frame headers (PFH) are processed in the PHY to extract the relevant frame parameters specified in clause 7.1.2.3.

7.1.2 Physical coding sublayer (PCS)

The functional model of the PCS is presented in Figure 7-2. It is intended to describe in more detail the PCS functional block presented in Figure 7-1.

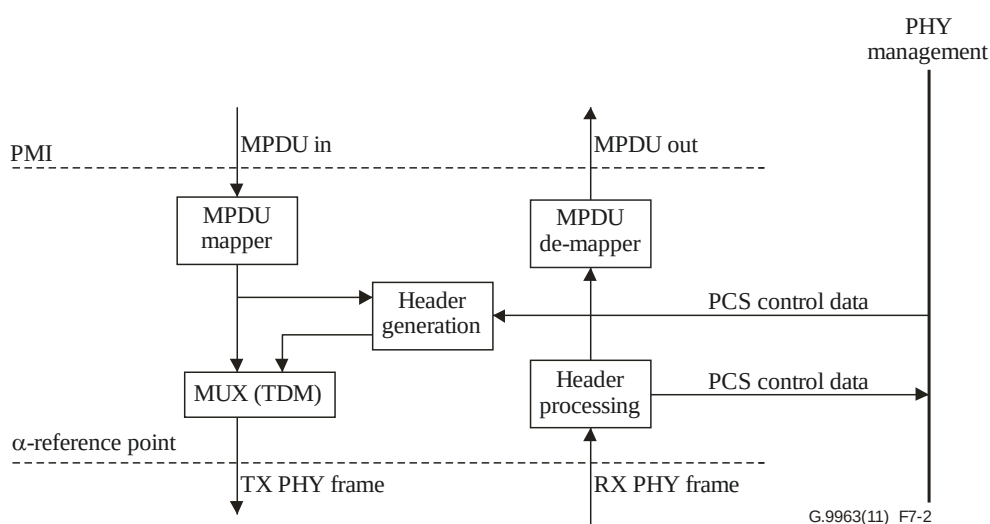


Figure 7-2 – Functional model of PCS

In the transmit direction, the incoming MPDU is mapped into a payload field of a PHY frame (clause 7.1.2.1) as described in clause 7.1.2.2. The PHY-frame header (clause 7.1.2.3) is then added to form a TX PHY frame. The TX PHY frame is passed across the α -reference point for further processing in the PMA.

In the receive direction, the decoded PHY-frame payload and header are processed and originally transmitted MPDUs are recovered from the payloads of received PHY frames and submitted to the PMI. Relevant control information conveyed in the PHY-frame header is processed and submitted to the PHY management entity.

7.1.2.1 PHY frame

As stated in clause 7.1.1, a MIMO transceiver shall be capable of transmitting using the following two transmission schemes:

- ITU-T G.9960 transmission based on the reference models and PHY frame format defined in [ITU-T G.9960].
- MIMO transmission based on the reference models and PHY frame format defined in [ITU-T G.9963].

The format of the PHY frame for ITU-T G.9960 transmission is presented in clause 7.1.2.1 of [ITU-T G.9960]. The format of the PHY frame for MIMO transmission is presented in this section.

Table 7-1 specifies the transmission rule (PHY frame format) that shall be used by an ITU-T G.9963 node when it transmits to an ITU-T G.9960/G.9961 node or to an ITU-T G.9963 node, or both.

Table 7-1 – Transmission rule (PHY frame format) for an ITU-T G.9963 node depending on the type of intended receiver

	Source devices	Destination devices	Number of spatial streams for payload	MIMO_IND	Transmission details	Transmission scheme
1	ITU-T G.9963	ITU-T G.9963	N/A	N/A	Frames without payload intended for ITU-T G.9963 receivers (e.g., RTS, CTS, ACK, ACKRQ).	MIMO transmission or ITU-T G.9960 transmission (Note).
2	ITU-T G.9963	ITU-T G.9960	N/A	N/A	Frames without payload intended for ITU-T G.9960 receivers.	MIMO transmission or ITU-T G.9960 transmission (Note).
3	ITU-T G.9963	ITU-T G.9963 and ITU-T G.9960	N/A	N/A	Frames without payload intended for ITU-T G.9963 and ITU-T G.9960 receivers (no such frame type exists).	N/A
4a	ITU-T G.9963	ITU-T G.9963	2	1	Frames with payload intended for ITU-T G.9963 receivers (e.g., MSG, BMSG, BACK, PROBE).	MIMO transmission
4b			1	0		MIMO transmission or ITU-T G.9960 transmission (Note).
5	ITU-T G.9963	ITU-T G.9960	1	0	Frames with payload intended for ITU-T G.9960 receivers.	MIMO transmission or ITU-T G.9960 transmission (Note).
6	ITU-T G.9963	ITU-T G.9963 and ITU-T G.9960	1	0	Frames with payload intended for ITU-T G.9963 and ITU-T G.9960 receivers (e.g., broadcast, MAP).	MIMO transmission or ITU-T G.9960 transmission (Note).

Table 7-1 – Transmission rule (PHY frame format) for an ITU-T G.9963 node depending on the type of intended receiver

	Source devices	Destination devices	Number of spatial streams for payload	MIMO_IND	Transmission details	Transmission scheme
7	ITU-T G.9963	ITU-T G.9963 and ITU-T G.9960	N/A	N/A	Signals (e.g., INUSE, PR, NACK, IDPS).	MIMO transmission or ITU-T G.9960 transmission (Note).
NOTE – The decision concerning which scheme to use shall be made by the source device at the time of registration and shall not change as long as the device is still registered, regardless of the type of destination device it is communicating with.						

The format of the PHY frame for MIMO transmission is presented in Figure 7-3. The PHY frame at the α -reference point includes a header and a payload. The preamble and additional channel estimation (ACE) symbols are added to the PHY frame in the PMD. Both the preamble and ACE symbols do not carry any user or management data and are intended for synchronization and channel estimation. At the MDI interface the transmission shall adhere to the following (as described in detail in clause 7.1.4):

- The preamble/header/ACE symbol(s)/payload shall be transmitted simultaneously on both Tx ports.
- The preamble and header symbol(s) to be transmitted on the second Tx port shall be copies of the preamble and header symbol(s) to be transmitted on the first Tx port.
- The payload may be created as either two spatial streams (indicated by setting the field MIMO_IND in the PFH to one) or a single spatial stream (indicated by setting the field MIMO_IND in the PFH to zero).
- ACE symbols:
 - For the case where the transmission is created as two spatial streams (i.e., case "4a" in Table 7-1):
 - The odd numbered ACE symbols (starting from the first ACE symbol, which is odd numbered) to be transmitted on the second Tx port shall be inverted versions of the same numbered ACE symbols to be transmitted on the first Tx port.
 - The even numbered ACE symbols to be transmitted on the second Tx port shall be identical to the same numbered ACE symbols to be transmitted on the first Tx port.
 For this case one ACE symbol is mandatory. Additional ACE symbols are optional.
 - In all other cases where the transmission includes payload created as a single spatial stream (i.e., cases "4b", "5" and "6" in Table 7-1), the ACE symbols to be transmitted on the second Tx port shall be identical to the same numbered ACE symbols to be transmitted on the first Tx port. In these cases all ACE symbols are optional.
- Transmission on the second Tx port shall be done with a cyclic shift with respect to the transmission on the first TX port.

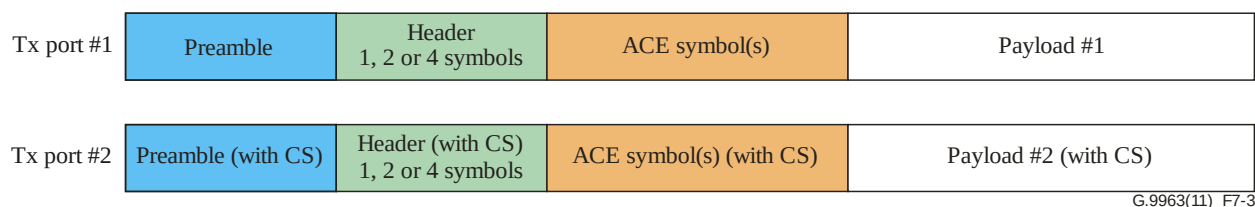


Figure 7-3 – Format of the PHY frame in a MIMO transmission

The PHY-frame header and payload shall each contain an integer number of OFDM symbols.

The PHY-frame header always fits into an integer number of OFDM symbols and is transmitted using a single predefined set of modulation and coding parameters (see clause 7.1.3.4).

The presence of ACE symbols is frame type dependent (e.g., see clause 7.1.2.3.2.2.17).

The length of the payload may vary from frame to frame; the payload may be of zero length. For the payload, different coding parameters and bit loading can be used in different frames, depending on the channel/noise characteristics and QoS requirements.

For all of the cases shown in Table 7-1 where a node can choose either ITU-T G.9960 transmission or MIMO transmission, the node shall select one transmission rule at the time of registration and shall not change this decision as long as it is still registered. For example, if a node decides to use ITU-T G.9960 transmission rule, it shall use ITU-T G.9960 transmission rule for cases 1, 2, 4b, 5, 6 and 7. A node may select a different transmission rule if it resigns from a domain and re-registers to the domain.

NOTE – Since the transmission rule for a given node for a single spatial stream does not change from frame to frame, the channels perceived by other nodes in the domain are consistent from frame to frame.

The types of PHY frames used in this Recommendation are summarized in Table 7-1 of [ITU-T G.9960].

7.1.2.2 MPDU mapping

See clause 7.1.2.2 of [ITU-T G.9960].

7.1.2.3 PHY-frame header

See clause 7.1.2.3 of [ITU-T G.9960].

7.1.2.3.1 Common part fields

See clause 7.1.2.3.1 of [ITU-T G.9960].

7.1.2.3.2 Variable part fields

See clause 7.1.2.3.2 of [ITU-T G.9960].

7.1.2.3.2.1 MAP and RMAP PHY-frame type specific fields

See clause 7.1.2.3.2.1 of [ITU-T G.9960].

7.1.2.3.2.2 MSG PHY-frame type specific fields

Table 7-2 lists the PHY-frame header fields specific to the MSG frame type.

Table 7-2 – MSG PHY-frame type specific fields

Field	Octet	Bits	Description	Reference
MSG_DUR	0 and 1	[15:0]	Duration for MSG frame	Clause 7.1.2.3.2.2.1
BLKSZ	2	[1:0]	Block size of FEC codeword for MSG frame payload	Clause 7.1.2.3.2.2.2
FEC_RATE		[4:2]	FEC coding rate for MSG frame payload	Clause 7.1.2.3.2.2.3
REP		[7:5]	Number of repetitions used for encoding the MSG frame payload	Clause 7.1.2.3.2.2.4
FCF	3	[2:0]	FEC concatenation factor	Clause 7.1.2.3.2.2.5
SI		[6:3]	Scrambler initialization	Clause 7.1.2.3.2.2.6
MDET		[7]	Master is detected	Clause 7.1.2.3.2.2.7
BAT_ID/BMAT_ID	4	[4:0]	Bit allocation table identifier/Bit and Tx port mapping allocation table identifier for MIMO	Clause 7.1.2.3.2.2.8
BNDPL/GRP_ID		[7:5]	Bandplan identifier/sub-carrier grouping identifier	Clause 7.1.2.3.2.2.9
GI_ID	5	[2:0]	Guard interval identifier	Clause 7.1.2.3.2.2.10
APSD_MAX-M		[7:3]	~~Actual PSD ceiling~~ APSD_MAX of MSG frame	Clause 7.1.2.3.2.2.11
CONNECTION_ID	6	[7:0]	Connection identifier	Clause 7.1.2.3.2.2.12
RPRQ	7	[1:0]	Reply required	Clause 7.1.2.3.2.2.13
BRSTCnt		[3:2]	Burst frame count	Clause 7.1.2.3.2.2.14
BEF		[4]	Burst end flag	Clause 7.1.2.3.2.2.15
AIFG_IND		[5]	AIFG indication	clause 7.1.2.3.2.2.16
MIMO_IND		[6]	MIMO indication	Clause 7.1.2.3.2.2.24
Reserved		[7]	Reserved	Reserved by ITU-T (Note 1)
ACE_SYM	8	[2:0]	Number of ACE symbols	Clause 7.1.2.3.2.2.17
CNN_MNGMT		[6:3]	Connection management	Clause 7.1.2.3.2.2.18
Reserved		[7]	Reserved	Reserved by ITU-T (Note 1)
BRURQ	9 and 10	[15:0]	Bandwidth reservation update request	Clause 7.1.2.3.2.2.19 (Note 2)
START_SSN	9 and 10	[15:0]	Start segment sequence number	Clause 7.1.2.3.2.2.20 (Note 3)
CURRTS	11	[6:0]	Current TS	Clause 7.1.2.3.2.2.21
BTXRQ		[7]	Request for bidirectional transmission	Clause 7.1.2.3.2.2.22

Table 7-2 – MSG PHY-frame type specific fields

Field	Octet	Bits	Description	Reference
NUM_MCACK_SLOTS	12	[2:0]	Number of Mc-ACK slots	Clause 7.1.2.3.2.2.23
ADVISED_WIN_SIZE		[7:3]	In connection establishment this field may specify advised window size	Clause 7.1.2.3.2.2.25 (Note 4)
Reserved	13 and 14	[15:0]	Reserved	Reserved by ITU-T (Note 1)

NOTE 1 – Bits that are reserved by ITU-T shall be set to zero by the transmitter and ignored by the receiver.

NOTE 2 – The BRURQ field is defined when the START_SSN field is not defined (see Note 3).

NOTE 3 – The START_SSN field is defined only when CNN_MNGMT = 0001, CNN_MNGMT = 0011, CNN_MNGMT = 0101 or CNN_MNGMT = 0111. Otherwise, the meaning of this field is BRURQ.

NOTE 4 – The ADVISED_WIN_SIZE field is defined only when CNN_MNGMT = 0101, otherwise these bits are reserved by ITU-T and shall be set to zero by the transmitter and ignored by the receiver.

7.1.2.3.2.2.1 Duration for MSG frame (MSG_DUR)

See clause 7.1.2.3.2.2.1 of [ITU-T G.9960].

7.1.2.3.2.2.2 Block size (BLKSZ)

See clause 7.1.2.3.2.2.2 of [ITU-T G.9960].

7.1.2.3.2.2.3 FEC coding rate (FEC_RATE)

See clause 7.1.2.3.2.2.3 of [ITU-T G.9960].

7.1.2.3.2.2.4 Repetitions (REP)

See clause 7.1.2.3.2.2.4 of [ITU-T G.9960].

7.1.2.3.2.2.5 FEC concatenation factor (FCF)

See clause 7.1.2.3.2.2.5 of [ITU-T G.9960].

7.1.2.3.2.2.6 Scrambler initialization (SI)

See clause 7.1.2.3.2.2.6 of [ITU-T G.9960].

7.1.2.3.2.2.7 Master is detected indication (MDET)

See clause 7.1.2.3.2.2.7 of [ITU-T G.9960].

7.1.2.3.2.2.8 BAT_ID/BMAT_ID

When this field is interpreted as BAT_ID (i.e., when MIMO_IND = 0), see clause 7.1.2.3.2.2.8 of [ITU-T G.9960].

When this field is interpreted as BMAT_ID (i.e., when MIMO_IND = 1), the BMAT_ID field shall identify the BMAT, which is composed of the following elements:

- The bit allocation tables (BATs) of the two spatial streams of the PHY frame (i.e., the BAT of spatial stream 1, BAT⁽¹⁾ and the BAT of spatial stream 2, BAT⁽²⁾).
- The Tx port mapping allocation table (MAT) of the PHY frame.

The BMAT_ID shall be represented as a 5-bit unsigned integer with valid values assigned as shown in Table 7-3.

Table 7-3 – Assignment of BMAT_ID

BMAT_ID	Type of MAT	Type of BAT ⁽¹⁾	Type of BAT ⁽²⁾	Description
0	Predefined MAT, Type 0	Predefined-BAT, Type 0	Note 1	Predefined BMAT, single port transmission on Tx port 1
1	Predefined MAT, Type 0	Predefined-BAT, Type 1		
2	Predefined MAT, Type 0	Predefined-BAT, Type 3	Note 2	
3	Predefined MAT, Type 0	Predefined-BAT, Type 2		
4	Predefined MAT, Type 1	Note 1	Predefined-BAT, Type 0	Predefined BMAT, single port transmission on Tx port 2
5	Predefined MAT, Type 1		Predefined-BAT, Type 1	
6	Predefined MAT, Type 1	Note 2	Predefined-BAT, Type 3	
7	Predefined MAT, Type 1		Predefined-BAT, Type 2	
8	Predefined MAT, Type 2	Predefined-BAT, Type 0	Predefined-BAT, Type 0	Predefined BMAT, MIMO, direct mapping (<i>TPM</i> #0)
9	Predefined MAT, Type 2	Predefined-BAT, Type 1	Predefined-BAT, Type 1	
10	Predefined MAT, Type 2	Predefined-BAT, Type 3	Predefined-BAT, Type 3	
11	Predefined MAT, Type 2	Predefined-BAT, Type 2	Predefined-BAT, Type 2	
12 to 15	Reserved by ITU-T for predefined MATs	Reserved by ITU-T for predefined BATs	Reserved by ITU-T for predefined BATs	Reserved by ITU-T for predefined BMATs
16 to 27	Runtime MATs	Runtime BATs	Runtime BATs	Runtime BMATs, Runtime MATs and BATs
28 to 31	Reserved by ITU-T	Reserved by ITU-T	Reserved by ITU-T	Reserved by ITU-T
NOTE 1 – The BAT is a uniform 0-bit loading on all sub-carriers except the PMSC set (i.e., no data bits are loaded on this spatial stream).				
NOTE 2 – The BAT is uniform 0-bit loading on all sub-carriers except the PMSC set and the RMSC sets (a complete SSC set) (i.e., no data bits are loaded on this spatial stream).				

One or more BMAT_IDs can be assigned for each destination (per unicast DID, see clause 7.1.2.3.1.5 of [ITU-T G.9960]).

7.1.2.3.2.2.9 Bandplan identifier/sub-carrier grouping identifier (BNDPL/GRP_ID)

If MIMO_IND is set to zero, see clause 7.1.2.3.2.2.9 of [ITU-T G.9960].

If MIMO_IND is set to one, the following applies.

For predefined BMATs with uniform loading (using predefined BATs of type 0, type 1, type 2 or type 3), the BNDPL field shall contain the identifier for the bandplan used by the node and shall be coded as shown in Table 7-10 of [ITU-T G.9960].

For Runtime BMATs, this field shall be set at 0 by the transmitter and ignored by the receiver.

7.1.2.3.2.2.10 Guard interval identifier (GI_ID)

See clause 7.1.2.3.2.2.10 of [ITU-T G.9960].

7.1.2.3.2.2.11 ~~Actual PSD ceiling~~Maximum Actual PSD of MSG frame (APSD~~E~~ MAX-M)

See clause 7.1.2.3.2.2.11 of [ITU-T G.9960].

7.1.2.3.2.2.12 Connection identifier (CONNECTION_ID)

See clause 7.1.2.3.2.2.12 of [ITU-T G.9960].

7.1.2.3.2.2.13 Reply required (RPRQ)

See clause 7.1.2.3.2.2.13 of [ITU-T G.9960].

7.1.2.3.2.2.14 Burst frame count (BRSTCnt)

See clause 7.1.2.3.2.2.14 of [ITU-T G.9960].

7.1.2.3.2.2.15 Burst end flag (BEF)

See clause 7.1.2.3.2.2.15 of [ITU-T G.9960].

7.1.2.3.2.2.16 AIFG indication (AIFG_IND)

See clause 7.1.2.3.2.2.16 of [ITU-T G.9960].

7.1.2.3.2.2.17 ACE symbols (ACE_SYM)

See clause 7.1.2.3.2.2.17 of [ITU-T G.9960].

If MIMO_IND is set to one, ACE_SYM shall not be set to 000₂.

7.1.2.3.2.2.18 Connection management (CNN_MNGMT)

See clause 7.1.2.3.2.2.18 of [ITU-T G.9960].

7.1.2.3.2.2.19 Bandwidth reservation update request (BRURQ)

See clause 7.1.2.3.2.2.19 of [ITU-T G.9960].

7.1.2.3.2.2.20 Start segment sequence number (START_SSN)

See clause 7.1.2.3.2.2.20 of [ITU-T G.9960].

7.1.2.3.2.2.21 Current TS (CURRTS)

See clause 7.1.2.3.2.2.21 of [ITU-T G.9960].

7.1.2.3.2.2.22 Request for bidirectional transmission (BTXRQ)

See clause 7.1.2.3.2.2.22 of [ITU-T G.9960].

7.1.2.3.2.2.23 Number of Mc-ACK slots (NUM_MCACK_SLOTS)

See clause 7.1.2.3.2.2.23 of [ITU-T G.9960].

7.1.2.3.2.2.24 MIMO indication (MIMO_IND)

The MIMO_IND field indicates a MIMO transmission with the payload created as 2 spatial streams intended for ITU-T G.9963 receivers (i.e., case "4a" in Table 7-1). This requires at least one additional channel estimation (ACE) symbol after the PHY-frame header (PFH).

It is a 1-bit field. It shall be set to one for case "4a" in Table 7-1. It shall be set to zero for all other applicable cases (i.e., cases "4b", "5" and "6" in Table 7-1).

7.1.2.3.2.2.25 Advised window size (ADVISED_WIN_SIZE)

See clause 7.1.2.3.2.2.24 of [ITU-T G.9960].

7.1.2.3.2.3 ACK PHY-frame type specific fields

Table 7-4 lists the PHY-frame header fields specific to the core part of the PHY-frame header of the ACK frame type.

Table 7-4 – ACK PHY frame type specific fields

Field	Octet	Bits	Description	Reference
FLCTRL_CONN	0	[0]	Flow control connection flag	Clause 7.1.2.3.2.3.1 of [ITU-T G.9960]
FLCTRLT		[1]	Flow control type	Clause 7.1.2.3.2.3.2 of [ITU-T G.9960]
FLCTRL		[6:2]	Flow control	Clause 7.1.2.3.2.3.3 of [ITU-T G.9960]
FLCTRL_EXT		[7]	Flow control extension	Clause 7.1.2.3.2.3.11 of [ITU-T G.9960]
RXRST_DATA	1	[0]	Data RX reset flag	Clause 7.1.2.3.2.3.5 of [ITU-T G.9960]
RXRST_MNGMT		[1]	Management RX reset flag	Clause 7.1.2.3.2.3.6 of [ITU-T G.9960]
BAD_BURST		[2]	Bad burst indication	Clause 7.1.2.3.2.3.7 of [ITU-T G.9960]
BTXRQ		[3]	Request for bidirectional transmission	Clause 7.1.2.3.2.3.4 of [ITU-T G.9960]
EXTACKRQ		[4]	Request for extended acknowledgement	Clause 7.1.2.3.2.3.10 of [ITU-T G.9960]
Reserved		[7:5]	Reserved	Reserved by ITU-T (Note 2)
ACK_CE_CTRL/RX_CONN_WIN_SIZE	2	[7:0]	ACK channel estimation control/Receiver window size for the connection (Note 1)	Clause 7.1.2.3.2.3.1
ACKDATA/MCACK_D	3 to 14	[90:0]	Acknowledgement data and Mc-ACK descriptor	Clause 7.1.2.3.2.3.9 of [ITU-T G.9960]
Reserved		[95:91]	Reserved	Reserved by ITU-T (Note 2)

NOTE 1 – This field is interpreted as RX_CONN_WIN_SIZE only when the ACK frame is sent as a reply for MSG frame requesting setup or reset of either a data or a management connection (i.e., when CNN_MNGMT in the MSG frame for connection setup is 0101₂ ~~or~~ 0001₂, 0011₂ or 0111₂).

NOTE 2 – Bits that are reserved by ITU-T shall be set to zero by the transmitter and ignored by the receiver.

7.1.2.3.2.3.1 ACK channel estimation control/Receiver window size for the connection (ACK_CE_CTRL/RX_CONN_WIN_SIZE)

In case of an ACK frame sent in response to a MSG frame requesting setup of a data or management connection with acknowledgements (i.e., when CNN_MNGMT in the MSG frame for connection setup is 0101₂ ~~or~~ 0001₂, 0011₂ or 0111₂ see Table 7-17 of [ITU-T G.9960]), this parameter is called RX_CONN_WIN_SIZE and the value of this parameter shall indicate the maximum

acknowledge window size (i.e., ACK_RX_CONF_WINDOW_SIZE in clause 8.9.4.3 in [ITU-T G.9961]) that the receiver can support for the connection being setup. The maximum acknowledge window size shall be 8 times the value of (RX_CONN_WIN_SIZE+1) LPDUs. The valid values for the maximum acknowledge window size shall be 8, 16, 24 ... 1024 LPDUs. The indicated value of maximum acknowledge window size shall be less than or equal to ACK_MAX_WINDOW_SIZE (1024 for data connections, 32 for management connections – see clause 8.9.4.1 in [ITU-T G.9961]).

For all other ACK frames, this field is called, ACK_CE_CTRL and is used for channel estimation control. It is an 8-bit field that consists of the ACK_CE_CTRL_TYPE, the RUNTIME_BAT_ID/RUNTIME_BMAT_ID and the RUNTIME_BMAT_ID fields as shown in Table 7-5.

Table 7-5 – Interpretation of the ACK_CE_CTRL field

Field	Octet	Bits
ACK_CE_CTRL_TYPE	0	[1:0]
RUNTIME_BAT_ID/RUNTIME_BMAT_ID		[6:2]
BMAT_ID_IND		[7]

7.1.2.3.2.3.1.1 ACK channel estimation control type (ACK_CE_CTRL_TYPE)

When BMAT_ID_IND equals 0, ACK_CE_CTRL_TYPE shall be coded as shown in Table 7-25 of [ITU-T G.9960] as specified in clause 7.1.2.3.2.3.8 of [ITU-T G.9960].

When BMAT_ID_IND equals 1, ACK_CE_CTRL_TYPE shall be coded as shown in Table 7-6.

Table 7-6 – ACK_CE_CTRL_TYPE field values when BMAT_ID_IND = 1

ACK_CE_CTRL_TYPE value (b ₁ b ₀)	Interpretation
00	No ACK_CE_CTRL information is transmitted
01	RUNTIME_BMAT_ID is invalid
10	Request PROBE frame transmission.
11	Reserved by ITU-T

If the BMAT_ID_IND field equals 1 and the ACK_CE_CTRL_TYPE field is set to 01₂, the runtime BMAT associated with the RUNTIME_BMAT_ID shall not be used for transmission, as specified in clause 8.11.1.5.

If the BMAT_ID_IND field equals 1 and the ACK_CE_CTRL_TYPE field is set to 10₂, transmission of a 2 SS channel estimation PROBE frame is requested.

Otherwise, the ACK_CE_CTRL_TYPE field shall be set to 00₂.

7.1.2.3.2.3.1.2 Runtime BAT_ID (RUNTIME_BAT_ID)/Runtime BMAT ID (RUNTIME_BMAT_ID)

When this field is interpreted as RUNTIME_BAT_ID (i.e., when BMAT_ID_IND = 0), see clause 7.1.2.3.2.3.8.2 of [ITU-T G.9960].

When this field is interpreted as RUNTIME_BMAT_ID (i.e., when BMAT_ID_IND = 1), the following applies.

If the ACK_CE_CTRL_TYPE field is set to 01₂, this field shall contain a RUNTIME_BMAT_ID (see Table 7-3). Otherwise, it shall be set to 00000₂.

7.1.2.3.2.3.1.3 BMAT_ID indication (BMAT_ID_IND)

If the BMAT_ID_IND field is set to 0, the interpretation of the other subfields in the ACK_CE_CTRL shall be as described in [ITU-T G.9960].

If the BMAT_ID_IND field is set to 1, the interpretation of the other subfields in the ACK_CE_CTRL shall be as described in this Recommendation.

7.1.2.3.2.4 RTS PHY-frame type specific fields

See clause 7.1.2.3.2.4 of [ITU-T G.9960].

7.1.2.3.2.5 CTS PHY-frame type specific fields

See clause 7.1.2.3.2.5 of [ITU-T G.9960].

7.1.2.3.2.6 CTMG PHY-frame type specific fields

See clause 7.1.2.3.2.6 of [ITU-T G.9960].

7.1.2.3.2.7 PROBE PHY-frame type specific fields

The PROBE PHY-frame type specific field is composed of a common part and a variable part. The common part contains fields that are common for all PROBE PHY-frame types (PRBTYPEs). The variable part contains fields that are specific to each PRBTYPE.

The fields of the common part of the PROBE PHY-frame specific field are defined in Table 7-7.

Table 7-7 – PROBE PHY-frame type specific fields

Field	Octet	Bits	Description	Reference
				Common part
PRB_DUR	0 and 1	[15:0]	Duration for PROBE frame	Clause 7.1.2.3.2.7.1.1
PRBTYPE	2	[3:0]	PROBE frame type	Clause 7.1.2.3.2.7.1.2
PRBSYM		[7:4]	Probe symbols	Clause 7.1.2.3.2.7.1.3
~~APSD~~ ~~CA~~ ~~PSD~~ ~~M~~ ~~AX~~ -P	3	[4:0]	~~Actual PSD ceiling~~ ~~APSD~~ ~~MAX~~ of PROBE frame	Clause 7.1.2.3.2.7.1.4
PRBGI		[7:5]	Probe symbol guard interval	Clause 7.1.2.3.2.7.1.5
CURRTS	4	[6:0]	Current TS	Clause 7.1.2.3.2.7.1.6
MIMO_IND		[7]	MIMO indication	Clause 7.1.2.3.2.7.1.7
Reserved	5	[7:0]	Reserved by ITU-T (Note)	
				Variable part
PFTSF	6 to 14	[71:0]	PROBE frame type specific field	Clause 7.1.2.3.2.7.2
NOTE – Bits that are reserved by ITU-T shall be set to zero by the transmitter and ignored by the receiver.				

7.1.2.3.2.7.1 Common part fields

7.1.2.3.2.7.1.1 Duration for PROBE frame (PRB_DUR)

See clause 7.1.2.3.2.7.1.1 of [ITU-T G.9960].

7.1.2.3.2.7.1.2 PROBE frame type (PRBTYPE)

The PRBTYPE field shall contain the type of the PROBE frame. It is a 4-bit field that shall be coded as shown in Table 7-8.

Table 7-8 – PRBTYPE field values

PRBTYPE value (b₃b₂b₁b₀)	Interpretation	Reference	MIMO_IND
0000	Silent PROBE frame – a PHY frame in which the probe symbols composing the payload shall all be silent symbols, as specified in clause 7.1.3.7.	Clause 7.1.2.3.2.7.2.1	0
0001	1 SS channel estimation PROBE frame – a PHY frame in which the probe symbols composing the payload shall all be 1 SS channel estimation probe symbols, as specified in clause 7.1.3.7.	Clause 7.1.2.3.2.7.2.2	0
0010 to 0111	Reserved by ITU-T.		Reserved
1000	2 SS channel estimation PROBE frame – a PHY frame in which the probe symbols composing the payload shall all be 2 SS channel estimation probe symbols, as specified in clause 7.1.3.7.	Clause 7.1.2.3.2.7.2.3	1
1001 to 1111	Reserved by ITU-T.		Reserved

7.1.2.3.2.7.1.3 Probe symbols (PRBSYM)

See clause 7.1.2.3.2.7.1.3 of [ITU-T G.9960].

7.1.2.3.2.7.1.4 ~~Actual PSD ceiling~~Maximum Actual PSD of PROBE frame (APSD~~C~~ MAX-P)

See clause 7.1.2.3.2.7.1.4 of [ITU-T G.9960].

7.1.2.3.2.7.1.5 PROBE symbol guard interval (PRBGI)

See clause 7.1.2.3.2.7.1.5 of [ITU-T G.9960].

7.1.2.3.2.7.1.6 Current TS (CURRTS)

See clause 7.1.2.3.2.7.6 of [ITU-T G.9960].

7.1.2.3.2.7.1.7 MIMO indication (MIMO_IND)

See clause 7.1.2.3.2.2.24.

7.1.2.3.2.7.2 PROBE frame type specific fields

7.1.2.3.2.7.2.1 Silent PROBE frame specific fields

See clause 7.1.2.3.2.7.2.1 of [ITU-T G.9960].

7.1.2.3.2.7.2.2 1 SS channel estimation PROBE frame specific fields

See clause 7.1.2.3.2.7.2.2 of [ITU-T G.9960].

7.1.2.3.2.7.2.3 2 SS channel estimation PROBE frame specific fields

The fields of the specific part of the 2 SS channel estimation PROBE frame are defined in Table 7-9.

Table 7-9 – 2 SS channel estimation PROBE frame specific field values

Field	Octet	Bits	Description	Reference
PRB_BMAT_ID	0	[4:0]	BMAT_ID used to generate the PROBE	Clause 7.1.2.3.2.7.2.3.1
ACE_SYM	0	[7:5]	Number of ACE symbols	Clause 7.1.2.3.2.7.2.3.2
NUM_SILENT_SYM	1	[5:0]	Number of silent symbols	Clause 7.1.2.3.2.7.2.3.3
Reserved	1	[7:6]	Reserved by ITU-T (Note)	
Reserved	2 to 8	[55:0]	Reserved by ITU-T (Note)	
NOTE – Bits that are reserved by ITU-T shall be set to zero by the transmitter and ignored by the receiver.				

7.1.2.3.2.7.2.3.1 PROBE frame BMAT_ID (PRB_BMAT_ID)

This field indicates the BMAT_ID (predefined or runtime) whose mapping allocation table (MAT) is used in the Tx port mapper to generate this 2 SS channel estimation PROBE frame. The bit allocation tables (BATs) associated with the BMAT_ID are only relevant to infer the Tx port mapping (TPMs) used per sub-carrier (see Table 8-27) for 2 SS channel estimation probe symbol generation (see clause 7.1.4.2.4.3). Therefore, if the PRB_BMAT_ID conveys a predefined BMAT_ID, the valid values for channel estimation shall be 3, 7 and 11.

NOTE – The PRB_BMAT_ID field allows transmitting PROBES using the precoding parameters associated with a given runtime BMAT_ID.

7.1.2.3.2.7.2.3.2 ACE symbols (ACE_SYM)

See clause 7.1.2.3.2.2.17 of [ITU-T G.9960].

If MIMO_IND is set to one, ACE_SYM shall not be set to 000₂.

7.1.2.3.2.7.2.3.3 Number of silent symbols (NUM_SILENT_SYM)

This field indicates the number of silent symbols that shall be transmitted instead of probe symbols at the end of the 2 SS channel estimation PROBE frame. The valid range is from 0 (no silent symbol) to 63 (63 silent symbols). NUM_SILENT_SYM shall be less than or equal to PRBSYM. First (PRBSYM – NUM_SILENT_SYM) symbols of the 2 SS channel estimation PROBE frame are normal (non-silent) probe symbols.

7.1.2.3.2.8 ACKRQ PHY frame type specific fields

See clause 7.1.2.3.2.8 of [ITU-T G.9960].

7.1.2.3.2.9 BMSG PHY-frame type specific fields

Table 7-10 lists the fields specific to the core part of the PHY-frame header of the BMSG frame type.

Table 7-10 – BMSG PHY-frame type specific fields – core part

Field	Octet	Bits	Description	Reference
BMSG_DUR	0 and 1	[15:0]	Duration for BMSG frame	Clause 7.1.2.3.2.9.1
BLKSZ	2	[1:0]	Block size of FEC codeword for BMSG frame payload	Clause 7.1.2.3.2.9.2
FEC_RATE		[4:2]	FEC coding rate for BMSG frame payload	Clause 7.1.2.3.2.9.3

Table 7-10 – BMSG PHY-frame type specific fields – core part

Field	Octet	Bits	Description	Reference
REP		[7:5]	Number of repetitions used for encoding the BMSG frame payload	Clause 7.1.2.3.2.9.4
FCF	3	[2:0]	FEC concatenation factor	Clause 7.1.2.3.2.9.5
SI		[6:3]	Scrambler initialization	Clause 7.1.2.3.2.9.6
MDET		[7]	Master is detected	Clause 7.1.2.3.2.9.7
BAT_ID/ BMAT_ID	4	[4:0]	Bit allocation table identifier/Bit allocation and Tx port mapping allocation table identifier for MIMO	Clause 7.1.2.3.2.9.8
BNDPL/GRP_ID		[7:5]	Bandplan identifier/sub-carrier grouping identifier	Clause 7.1.2.3.2.9.9
GI_ID	5	[2:0]	Guard interval identifier	Clause 7.1.2.3.2.9.10
APSD <u>MAX</u> ~~C-M~~		[7:3]	<u>Actual PSD ceiling</u> ~~APSD_MAX~~ of BMSG frame	Clause 7.1.2.3.2.9.11
CONNECTION_ID	6	[7:0]	Connection identifier	Clause 7.1.2.3.2.9.12
RPRQ	7	[1:0]	Reply required	Clause 7.1.2.3.2.9.13
BRSTCnt		[3:2]	Burst frame count	Clause 7.1.2.3.2.9.14
BEF		[4]	Burst end flag	Clause 7.1.2.3.2.9.15
AIFG_IND		[5]	AIFG indication	Clause 7.1.2.3.2.9.16
MIMO_IND		[6]	MIMO indication	Clause 7.1.2.3.2.9.25
<u>EXTACKGR</u> ~~Reserved~~		[7]	<u>Extended ACK granted</u> ~~Reserved~~	<u>Clause 7.1.2.3.2.9.26</u> ~~Reserved by ITU-T (Note 1)~~
ACE_SYM	8	[2:0]	Number of ACE symbols	Clause 7.1.2.3.2.9.17
CNN_MNGMT		[6:3]	Connection management	Clause 7.1.2.3.2.9.18
<u>Reserved</u> ~~EXTACKGR~~		[7]	<u>Reserved</u> ~~Extended ACK granted~~	<u>Reserved by ITU-T (Note 1)</u> ~~Clause 7.1.2.3.2.9.26~~
BRURQ	9 and 10	[15:0]	Bandwidth reservation update request	Clause 7.1.2.3.2.9.19 (Note 2)
START_SSN	9 and 10	[15:0]	Start segment sequence number	Clause 7.1.2.3.2.9.20 (Note 3)
CURRTS	11	[6:0]	Current TS	Clause 7.1.2.3.2.9.21
Reserved		[7]	Reserved	Reserved by ITU-T (Note 1)
Reserved	12 and 13	[0]	Reserved	Reserved by ITU-T (Note 1)
BTXGL		[8:1]	Bidirectional transmission grant length	Clause 7.1.2.3.2.9.22
BTXEF		[9]	Bidirectional transmission end flag	Clause 7.1.2.3.2.9.23
Reserved		[15:10]	Reserved	Reserved by ITU-T (Note 1)

Table 7-10 – BMSG PHY-frame type specific fields – core part

Field	Octet	Bits	Description	Reference
ACK_CE_CTRL	14	[7:0]	ACK channel estimation control	Clause 7.1.2.3.2.9.24
NOTE 1 – Bits that are reserved by ITU-T shall be set to zero by the transmitter and ignored by the receiver. NOTE 2 – The BRURQ field is defined when the START_SSN field is not defined. NOTE 3 – The START_SSN field is defined only when CNN_MNGMT = 0001, CNN_MNGMT = 0011, CNN_MNGMT = 0101 or CNN_MNGMT = 0111. Otherwise the meaning of this field is BRURQ.				

The PHY-frame header fields specific to the extended part of the header of the BMSG frame type are listed in Table 7-54 of [ITU-T G.9960].

7.1.2.3.2.9.1 Duration for BMSG frame (BMSG_DUR)

See clause 7.1.2.3.2.9.1 of [ITU-T G.9960].

7.1.2.3.2.9.2 Block size (BLKSZ)

See clause 7.1.2.3.2.9.2 of [ITU-T G.9960].

7.1.2.3.2.9.3 FEC coding rate (FEC_RATE)

See clause 7.1.2.3.2.9.3 of [ITU-T G.9960].

7.1.2.3.2.9.4 Repetitions (REP)

See clause 7.1.2.3.2.9.4 of [ITU-T G.9960].

7.1.2.3.2.9.5 FEC concatenation factor (FCF)

See clause 7.1.2.3.2.9.5 of [ITU-T G.9960].

7.1.2.3.2.9.6 Scrambler initialization (SI)

See clause 7.1.2.3.2.9.6 of [ITU-T G.9960].

7.1.2.3.2.9.7 Master is detected indication (MDET)

See clause 7.1.2.3.2.9.7 of [ITU-T G.9960].

7.1.2.3.2.9.8 BAT_ID/BMAT_ID

See clause 7.1.2.3.2.2.8.

7.1.2.3.2.9.9 Bandplan identifier/sub-carrier grouping identifier (BNDPL/GRP_ID)

See clause 7.1.2.3.2.2.9.

7.1.2.3.2.9.10 Guard interval identifier (GI_ID)

See clause 7.1.2.3.2.9.10 of [ITU-T G.9960].

7.1.2.3.2.9.11 ~~Actual PSD ceiling~~Maximum Actual PSD of BMSG frame (APSD_{C_MAX} -M)

See clause 7.1.2.3.2.9.11 of [ITU-T G.9960].

7.1.2.3.2.9.12 Connection identifier (CONNECTION_ID)

See clause 7.1.2.3.2.9.12 of [ITU-T G.9960].

7.1.2.3.2.9.13 Reply required (RPRQ)

See clause 7.1.2.3.2.9.13 of [ITU-T G.9960].

7.1.2.3.2.9.14 Burst frame count (BRSTCnt)

See clause 7.1.2.3.2.9.14 of [ITU-T G.9960].

7.1.2.3.2.9.15 Burst end flag (BEF)

See clause 7.1.2.3.2.9.15 of [ITU-T G.9960].

7.1.2.3.2.9.16 AIFG indication (AIFG_IND)

See clause 7.1.2.3.2.9.16 of [ITU-T G.9960].

7.1.2.3.2.9.17 ACE symbols (ACE_SYM)

See clause 7.1.2.3.2.9.17 of [ITU-T G.9960].

7.1.2.3.2.9.18 Connection management (CNN_MNGMT)

See clause 7.1.2.3.2.9.18 of [ITU-T G.9960].

7.1.2.3.2.9.19 Bandwidth reservation update request (BRURQ)

See clause 7.1.2.3.2.9.19 of [ITU-T G.9960].

7.1.2.3.2.9.20 Start segment sequence number (START_SSN)

See clause 7.1.2.3.2.9.20 of [ITU-T G.9960].

7.1.2.3.2.9.21 Current TS (CURRTS)

See clause 7.1.2.3.2.9.21 of [ITU-T G.9960].

7.1.2.3.2.9.22 Bidirectional transmission grant length (BTXGL)

See clause 7.1.2.3.2.9.22 of [ITU-T G.9960].

7.1.2.3.2.9.23 Bidirectional transmission end flag (BTXEF)

See clause 7.1.2.3.2.9.23 of [ITU-T G.9960].

7.1.2.3.2.9.24 ACK channel estimation control (ACK_CE_CTRL)

The interpretation of this field shall be as specified for the ACK_CE_CTRL field of the ACK frame in clause 7.1.2.3.2.3.1.

7.1.2.3.2.9.25 MIMO indication (MIMO_IND)

See clause 7.1.2.3.2.2.24.

7.1.2.3.2.9.26 Extended ACK Granted (EXTACKGR)

See clause 7.1.2.3.2.9.25 of [ITU-T G.9960].

7.1.2.3.2.10 BACK PHY-frame type specific fields

Table 7-11 lists the fields specific to the core part of the PHY-frame header of the BACK frame type.

Table 7-11 – BACK PHY-frame type specific fields – core part

Field	Octet	Bits	Description	Reference
BACK_DUR	0 and 1	[15:0]	Duration for BACK frame	Clause 7.1.2.3.2.10.1
BLKSZ	2	[1:0]	Block size of FEC codeword for BACK frame payload	Clause 7.1.2.3.2.10.2
FEC_RATE		[4:2]	FEC coding rate for BACK frame payload	Clause 7.1.2.3.2.10.3
REP		[7:5]	Number of repetitions used for encoding the BACK frame payload	Clause 7.1.2.3.2.10.4
FCF	3	[2:0]	FEC concatenation factor	Clause 7.1.2.3.2.10.5
SI		[6:3]	Scrambler initialization	Clause 7.1.2.3.2.10.6
MDET		[7]	Master is detected	Clause 7.1.2.3.2.10.7
BAT_ID/BMAT_ID	4	[4:0]	Bit allocation table identifier/Bit allocation and Tx port mapping allocation table identifier for MIMO	Clause 7.1.2.3.2.10.8
BNDPL/GRP_ID		[7:5]	Bandplan identifier/sub-carrier grouping identifier	Clause 7.1.2.3.2.10.9
GI_ID	5	[2:0]	Guard interval identifier	Clause 7.1.2.3.2.10.10
<u>APSD</u> <u>CAPSD_MAX</u> -M		[7:3]	<u>Actual PSD ceiling</u> <u>APSD_MAX</u> of BACK frame	Clause 7.1.2.3.2.10.11
CONNECTION_ID	6	[7:0]	Connection identifier	Clause 7.1.2.3.2.10.12
RPRQ	7	[1:0]	Reply required	Clause 7.1.2.3.2.10.13
BRSTCnt		[3:2]	Burst frame count	Clause 7.1.2.3.2.10.14
BEF		[4]	Burst end flag	Clause 7.1.2.3.2.10.15
AIFG_IND		[5]	AIFG indication	Clause 7.1.2.3.2.10.16
MIMO_IND		[6]	MIMO indication	Clause 7.1.2.3.2.10.21
Reserved		[7]	Reserved	Reserved by ITU-T (Note)
ACE_SYM	8	[2:0]	Number of ACE symbols	Clause 7.1.2.3.2.10.17
CNN_MNGMT		[6:3]	Connection management	Clause 7.1.2.3.2.10.18
Reserved		[7]	Reserved	Reserved by ITU-T (Note)
BTXRL	9	[7:0]	Bidirectional transmission request length	Clause 7.1.2.3.2.10.19
ACK_CE_CTRL	10	[7:0]	ACK channel estimation control	Clause 7.1.2.3.2.10.20
Reserved	11 to 14	[31:0]	Reserved	Reserved by ITU-T (Note)

NOTE – Bits that are reserved by ITU-T shall be set to zero by the transmitter and ignored by the receiver.

The PHY-frame header fields specific to the extended part of the header of the BACK frame type are listed in Table 7-54 of [ITU-T G.9960].

7.1.2.3.2.10.1 Duration for BACK frame (BACK_DUR)

See clause 7.1.2.3.2.10.1 of [ITU-T G.9960].

7.1.2.3.2.10.2 Block size (BLKSZ)

See clause 7.1.2.3.2.10.2 of [ITU-T G.9960].

7.1.2.3.2.10.3 FEC coding rate (FEC_RATE)

See clause 7.1.2.3.2.10.3 of [ITU-T G.9960].

7.1.2.3.2.10.4 Repetitions (REP)

See clause 7.1.2.3.2.10.4 of [ITU-T G.9960].

7.1.2.3.2.10.5 FEC concatenation factor (FCF)

See clause 7.1.2.3.2.10.5 of [ITU-T G.9960].

7.1.2.3.2.10.6 Scrambler initialization (SI)

See clause 7.1.2.3.2.10.6 of [ITU-T G.9960].

7.1.2.3.2.10.7 Master is detected indication (MDET)

See clause 7.1.2.3.2.10.7 of [ITU-T G.9960].

7.1.2.3.2.10.8 BAT_ID/BMAT_ID

See clause 7.1.2.3.2.2.8.

7.1.2.3.2.10.9 Bandplan identifier/sub-carrier grouping identifier (BNDPL/GRP_ID)

See clause 7.1.2.3.2.2.9.

7.1.2.3.2.10.10 Guard interval identifier (GI_ID)

See clause 7.1.2.3.2.10.10 of [ITU-T G.9960].

7.1.2.3.2.10.11 Maximum Actual PSD ceiling of BACK frame (APSDC MAX-M)

See clause 7.1.2.3.2.10.11 of [ITU-T G.9960].

7.1.2.3.2.10.12 Connection identifier (CONNECTION_ID)

See clause 7.1.2.3.2.10.12 of [ITU-T G.9960].

7.1.2.3.2.10.13 Reply required (RPRQ)

See clause 7.1.2.3.2.10.13 of [ITU-T G.9960].

7.1.2.3.2.10.14 Burst frame count (BRSTCnt)

See clause 7.1.2.3.2.10.14 of [ITU-T G.9960].

7.1.2.3.2.10.15 Burst end flag (BEF)

See clause 7.1.2.3.2.10.15 of [ITU-T G.9960].

7.1.2.3.2.10.16 AIFG indication (AIFG_IND)

See clause 7.1.2.3.2.10.16 of [ITU-T G.9960].

7.1.2.3.2.10.17 ACE symbols (ACE_SYM)

See clause 7.1.2.3.2.10.17 of [ITU-T G.9960].

7.1.2.3.2.10.18 Connection management (CNN_MNGMT)

See clause 7.1.2.3.2.10.18 of [ITU-T G.9960].

7.1.2.3.2.10.19 Bidirectional transmission request length (BTXRL)

See clause 7.1.2.3.2.10.19 of [ITU-T G.9960].

7.1.2.3.2.10.20 ACK channel estimation control (ACK_CE_CTRL)

The interpretation of this field shall be as specified for the ACK_CE_CTRL field of the ACK frame in clause 7.1.2.3.2.3.1.

7.1.2.3.2.10.21 MIMO indication (MIMO_IND)

See clause 7.1.2.3.2.2.24.

7.1.2.3.2.11 ACTMG PHY-frame type specific fields

See clause 7.1.2.3.2.11 of [ITU-T G.9960].

7.1.2.3.2.12 Reserved

Reserved by ITU-T.

7.1.2.3.2.13 Reserved

Reserved by ITU-T.

7.1.2.3.2.14 Reserved

Reserved by ITU-T.

7.1.2.3.2.15 Reserved

Reserved by ITU-T.

7.1.2.3.2.16 FTE PHY-frame type specific fields

See clause 7.1.2.3.2.16 of [ITU-T G.9960].

7.1.2.3.3 Extended header fields

See clause 7.1.2.3.3 of [ITU-T G.9960].

7.1.3 Physical medium attachment (PMA) sublayer

The functional model of the PMA is presented in Figure 7-4. It is intended to describe in more detail the PMA functional block presented in Figure 7-1.

In the transmit direction, the incoming PHY frame (except for the preamble and the channel estimation symbols) at the α -reference point has a format as defined in clause 7.1.2. Both the header bits and the payload bits of the incoming frame are scrambled as described in clause 7.1.3.1. The header bits of the incoming frame are encoded as described in clause 7.1.3.4. The payload bits are encoded, as described in clause 7.1.3.3. The parameters of the payload encoder are controlled by the PHY management entity.

After encoding, the payload is parsed into multiple spatial streams as described in clause 7.1.3.5. The header and payload are then each segmented into an integer number of symbol frames as described in clause 7.1.3.6. The obtained symbol frames of the header and the payload are submitted to the PMD (at the δ -reference point) for modulation and transmission over the medium.