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OF ITU

# G.989.1

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

Digital sections and digital line system – Optical line systems for local and access networks

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## Phoneline networking transceivers – Foundation

ITU-T Recommendation G.989.1

(Formerly CCITT Recommendation)

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ITU-T G-SERIES RECOMMENDATIONS

**TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS**



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**ITU-T Recommendation G.989.1**

# Phoneline networking transceivers – Foundation


**Summary**

This Recommendation specifies the basic characteristics of devices designed for the transmission of data over in-premises phoneline networks. These devices are intended to be compatible with existing telephony devices on the in-premises phoneline network. Additionally, the Recommendation provides for spectrum notching for compatibility with Amateur Radio services.

This Recommendation defines:

- the system reference model for these devices;
- the PSD mask;
- the line signal frame format;
- the media access protocol;
- basic electrical characteristics.



**Source**

ITU-T Recommendation G.989.1 was prepared by ITU-T Study Group 15 (2001-2004) and approved under the WTSA Resolution 1 procedure on 9 February 2001.

## FOREWORD

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**ITU-T Recommendation G.989.1**

# Phoneline networking transceivers – Foundation

## 1 Scope

This Recommendation specifies the basic characteristics of devices designed for the transmission of data over in-premises phoneline networks.

The Recommendation defines:

- the system reference model for in-premises phoneline networking transceivers;
- the power spectral density (PSD) mask;
- the line signal frame format;
- the media access protocol;
- basic electrical characteristics.

These devices are intended to be compatible with other devices sharing the in-premises phoneline network, e.g.:

- PSTN telephony services;
- voiceband data services, e.g. V.90;
- ISDN basic rate services;
- G.992.x ADSL services.

Additionally, the Recommendation provides for spectrum notching for compatibility with Amateur radio services.

These devices can be used for in-premises distribution of data provided from wide area access networks such as:

- voiceband data services, e.g. V.90;
- ISDN;
- xDSL services (e.g. ADSL, SHDSL, VDSL, Cable modems J.112).

The use of isolation filters between in-premises networks and wide area access networks is addressed in clause 4.

## 2 Definitions

This Recommendation defines the following terms:

**2.1 backoff level**: An integer value in the range 0-15 used in collision resolution to determine which of the originally colliding stations will transmit.

**2.2 backoff signal**: A symbol sequence that active transmitters can transmit during the three Signal Slots which follow a collision.

**2.3 isolation function**: A device which provides spectral isolation between the in-premises wiring and the access network, such as a filter, gateway etc.

**2.4 station**: A G.989.1 transceiver.

**2.5 TX PRI**: Priority value for the frame ready for transmission at a station determined by the link layer.

## 3 Abbreviations

This Recommendation uses the following abbreviations:

| | |
|---|---|
| ADSL | Asymmetrical Digital Subscriber Line |
| AP | Access Point |
| BL | Backoff Level |
| CP | Customer Premises |
| CR | Collision Resolution |
| CS | Carrier Sense |
| CSMA/CD | Carrier Sense Multiple Access/Collision Detection |
| DF | Data Frame |
| DSL | Digital Subscriber Line |
| EOF | End-Of-Frame delimiter |
| FT | Frame Type |
| IF | Isolation Function |
| IFG | Inter-Frame Gap |
| ISDN | Integrated Services Digital Network |
| MAC | Media Access Control |
| MAP | Media Access Protocol |
| MBL | Maximum Backoff Level |
| NI | Network Interface |
| NID | Network Interface Device |
| OSI | Open Systems Interconnection (ITU-T X.200 (1994) \| ISO/IEC 7498-1:1994) |
| PHY | Physical Layer |
| PNT | Phoneline Networking Transceiver |
| PRI | Priority value |
| PSD | Power Spectral Density |
| PSTN | Public Switched Telephone Network |
| QoS | Quality of Service |
| RFI | Radio Frequency Interference |
| SHDSL | Single pair High speed Digital Subscriber Line |
| TX | Transmitter |
| VDSL | Very high speed Digital Subscriber Line |
| xDSL | a collective term referring to any of the various types of DSL technologies |

## 4 System reference model for phoneline networking transceivers

The system reference model for in-premises phoneline networking transceivers (PNT) is shown in Figure 1. The reference model includes physical layer (PHY) and media access control (MAC) functionality between the phoneline interface and a host interface. The primary interface is the wire-side electrical and logical interface (W1) between a PNT station and the phone wire. Typically the in-premises wiring is connected to the access network. An isolation function (IF) separates the in-premises wiring from the access network.

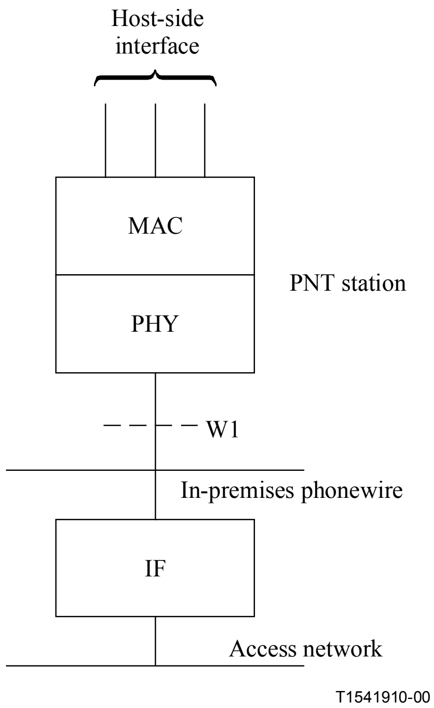



**Figure 1/G.989.1 – Basic reference model**

A functionally oriented view of the reference model is shown in Figure 2:

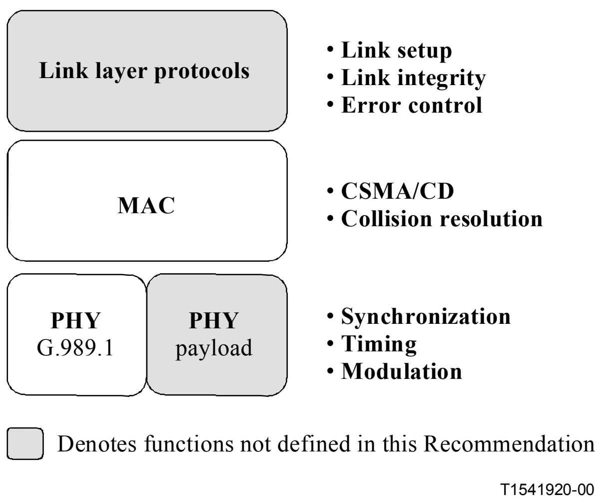



**Figure 2/G.989.1 – Functional view of reference model**

The PNT system implements a shared-medium single-segment network. All stations on a segment are logically connected to the same shared channel on the phoneline.

Multiple network segments and other network links can be connected through OSI network layer 2 (L2 or data link) or layer 3 (L3 or network) relays. (See ITU-T X.200 (1994) | ISO/IEC 7498-1:1994).

In Figure 3, a layer 3 router/gateway is shown which interconnects a wide-area network link to the in-premises network. Such a wide-area link might be provided via subscriber line (voiceband modem, e.g. V.90, Basic rate ISDN, ADSL, cable modem, VDSL) or wireless link. Also shown is an L2 bridge which interconnects the first in-premises network segment with other network segments such as a PNT network.

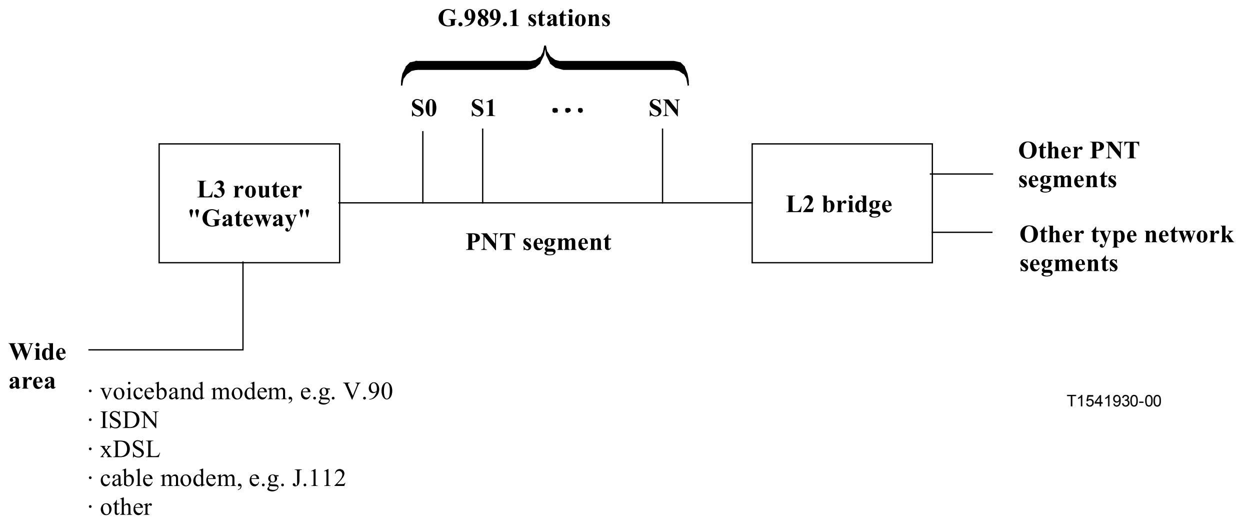



**Figure 3/G.989.1 – Wide area network interworking**

Phoneline networking transceivers are intended to work over existing in-premises wiring. The topologies supported are arbitrary combinations of star, tree and multi-point bus wiring as illustrated in Figure 4. Within a topology, each wiring segment may have one or more access points (AP), and variable length extension wiring to the attached POTS or PNT device.

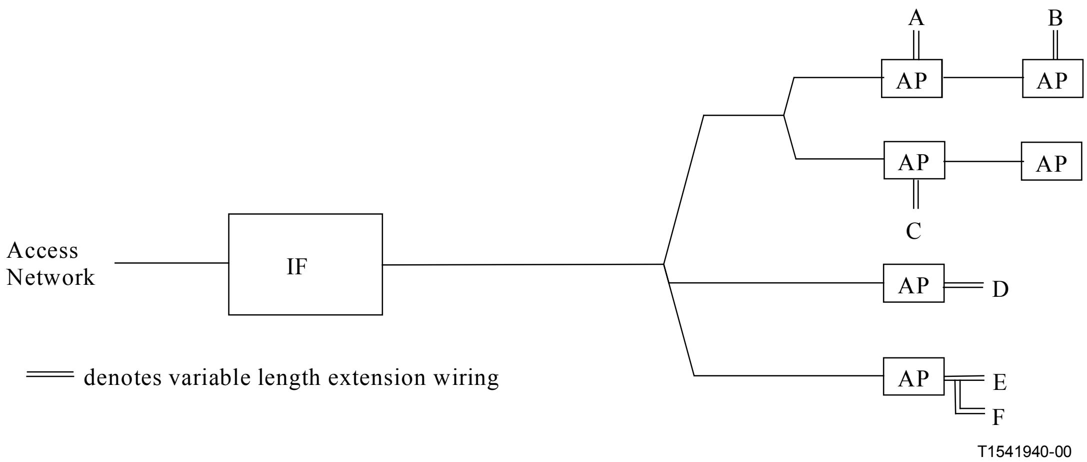



**Figure 4/G.989.1 – Network topology examples**

In Figure 4, stations A and B are on one wiring segment with station B tandemed to station A; station C is on a second unterminated wiring segment; station D is at the end of a direct wiring segment from the access network; and stations E and F share a single access point (AP) via a two-outlet adapter. Many other topologies are possible. Other phoneline based devices may be co-located with the G.989.1-based stations and connected to the same access points. These may include analogue telephone sets, possibly with an optional low-pass filter in series with each telephone set. These devices are outside the scope of this Recommendation.

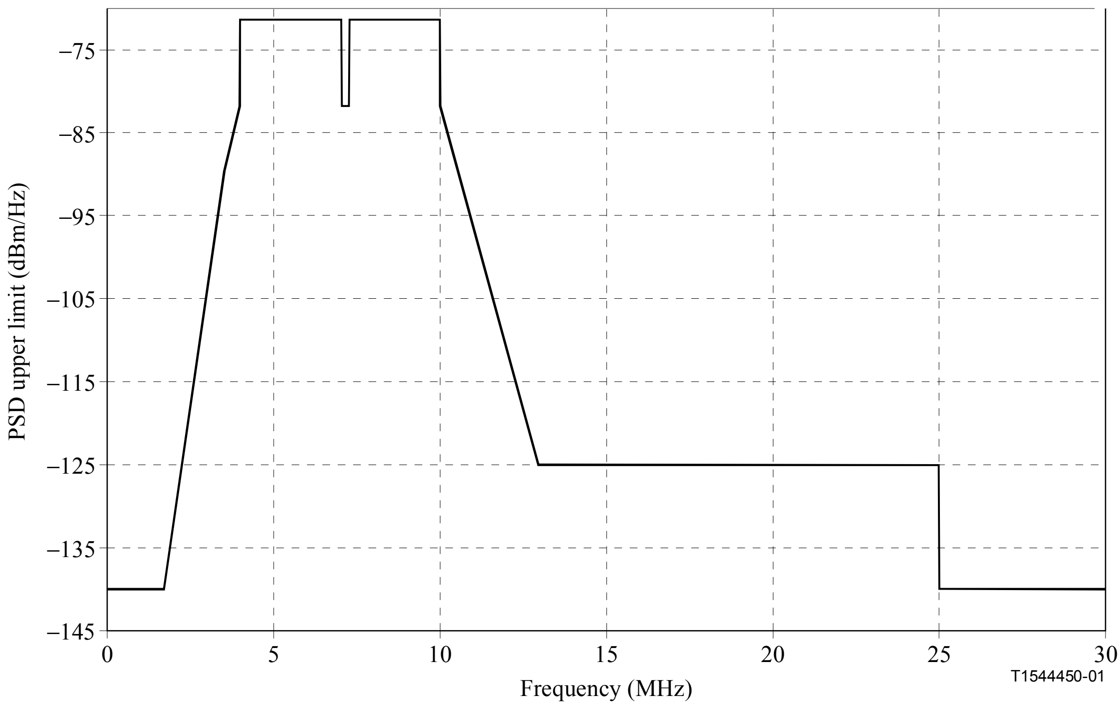
An isolation function (IF) shall be implemented when necessary to prevent interference between PNT devices operating on in-premises wiring and access network technologies that use an overlapping frequency spectrum, e.g. VDSL.

An isolation function (IF) may provide:

- spectral isolation with wide area network access technologies;
- known termination impedance;
- additional lightning and over-voltage suppression.

## 5 Power spectral density

The transmit PSD mask is given in Figure 5. A G.989.1 transceiver shall be constrained by the upper bound as depicted in Figure 5 with the measurement made across a 100 Ω load across the two-wire interface W1 at the transmitter.




| Frequency (MHz) | PSD limit (dBm/Hz) |
|---|---|
| 0.015 < f ≤ 1.7 | –140 |
| 1.7 < f ≤ 3.5 | –140 + (f – 1.7)*50.0/1.8 |
| 3.5 < f ≤ 4.0 | –90 + (f – 3.5)*17.0 |
| 4.0 < f < 7.0 | –71.5 |
| 7.0 ≤ f ≤ 7.3 | –81.5 |
| 7.3 < f < 10.0 | –71.5 |
| 10.0 ≤ f < 13.0 | –81.5 – (f –10.0)*43.5/3.0 |
| 13.0 ≤ f < 25.0 | –125 |
| 25.0 ≤ f < 30.0 | –140 |

**Figure 5/G.989.1 – PSD mask**

Maximum-length frames and minimum inter-frame gaps (IFGs) are assumed. Since most of the frame data can be expected to be randomized by a data scrambler, these assumptions allow the burst transmissions to be treated as a single continuous data stream for the purpose of defining the PSD mask.

The 10 dB notches at 4.0, 7.0 and 10.0 MHz are designed to reduce RFI egress in the radio amateur bands.

The resolution bandwidth used to make this measurement shall be 10 kHz for frequencies between 2.0 and 30.0 MHz and 3 kHz for frequencies between 0.015 and 2.0 MHz. An averaging window of 213 seconds shall be used, and 1500-octet frames separated by an IFG duration of silence shall be assumed. A total of 50 kHz of possibly non-contiguous bands may exceed the limit line under 2.0 MHz, with no sub-band greater than 20 dB above the limit line. A total of 100 kHz of possibly non-contiguous bands may exceed the limit line between 13.0 and 30.0 MHz, with no sub-band greater than 20 dB above the limit line.

### 5.1 Peak-to-average ratio assumptions

To meet national conducted emissions regulations, the transmitted power averaged over a short window must be constrained. In addition, the desire to avoid audible interference in telephones leads to limits on peak transmitted power. Therefore, a viable constellation scaling is one that sets the outer points to approximately the same amplitude and allows the average power to decrease with increasing constellation size.

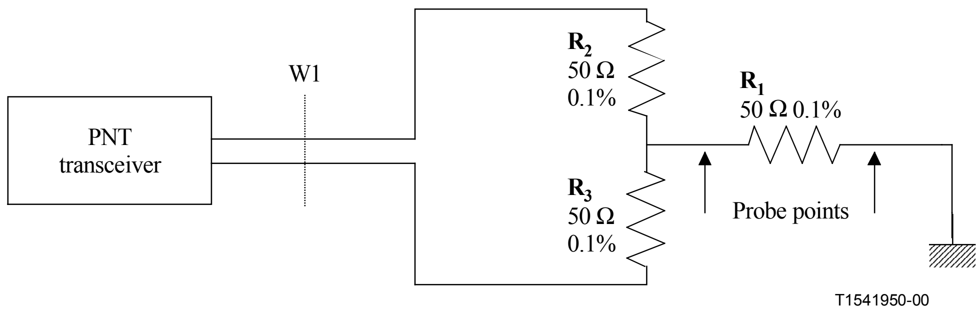
The following assumptions are made:

- the peak-to-average ratio at the wire interface of a transmitting device is less than 9.5 dB for the choice of constellation that yields the highest average transmitted power;
- the ratio of the maximum value of the short-term average power over a 2-µsec sliding window to the average power, as defined in clause 5 above, is less than 2.7 dB for the same constellation choice.

## 6 Electrical characteristics

### 6.1 Longitudinal voltage

The transmitter shall limit the longitudinal voltage emitted from the W1 interface such that the level measured across $R_1$ in Figure 6 does not exceed −55 dBVrms in the band extending from 0.1 to 30 MHz.




NOTE – The specified value of no more than –55 dBVrms considers that the measurement across resistor $R_1$ measures 2/3 of the actual longitudinal voltage. Therefore, when performing a measurement of this parameter, in order to ensure meaningful results, the resistance values of $R_1$, $R_2$ and $R_3$ as depicted in this figure must be well matched and the values of the resistors must be within 0.1% of the values specified here.

**Figure 6/G.989.1 – Longitudinal output voltage measurement method**

## 6.2 Longitudinal balance

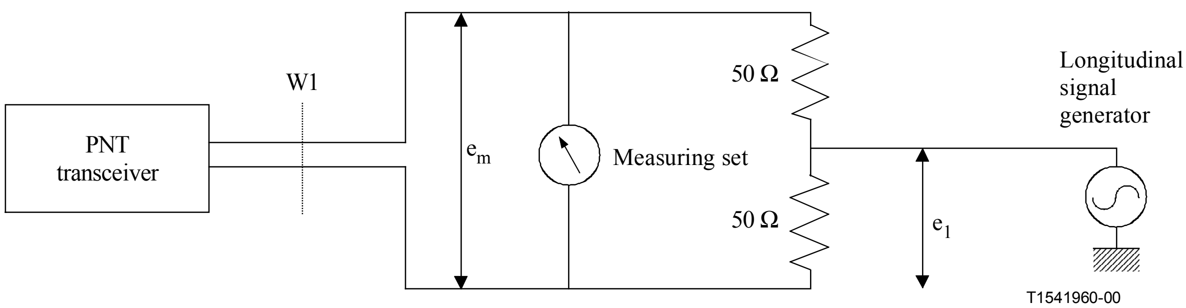
Longitudinal balance at the W1 interface shall be greater than 35 dB over the frequency range 0.1 MHz to 30 MHz. The measurement of the longitudinal balance shall be performed assuming a non-transmitting PNT transceiver as shown in Figure 7. Longitudinal balance is given by the equation:

$$L_{Bal} = 20 \log \left| \frac{e_l}{e_m} \right| \text{dB} \qquad (1)$$

where:

$e_l$ the applied longitudinal voltage (referenced to the building or green wire ground of the PNT transceiver);

$e_m$ the resultant metallic voltage appearing across a terminating resistor.




NOTE – When performing the measurement of this parameter, in order to ensure meaningful results, resistance values must be within 0.1% of the values specified here.

The longitudinal signal generator is a voltage source that is required to output a variable-frequency sine wave.

**Figure 7/G.989.1 – Longitudinal balance measurement method**

NOTE – The balance requirements should be met in the presence of the dc bias conditions for which the G.989.1 device is intended to operate.

## 7 Framing

The G.989.1 frame format is given in Figure 8. This consists of a preamble and frame type (FT) field, the PNT header and payload, and a trailer (EOF). Each of the fields, except the PNT header and payload, is a fixed sequence for each transmission. A minimum silence gap, referred to as the inter-frame gap (IFG), follows every frame. The preamble, FT, EOF, and IFG are defined in this Recommendation. The PNT header, and payload, are for further study.

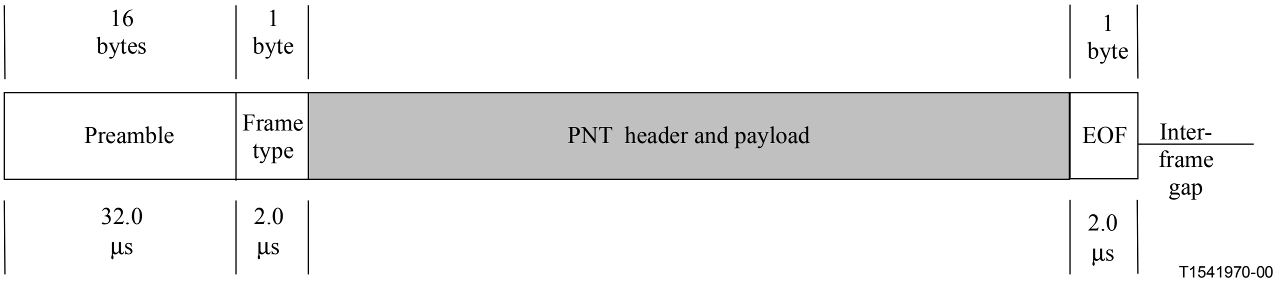



**Figure 8/G.989.1 – Basic frame format**

Figure 9 indicates that preamble, FT, and EOF generation is logically distinct from the PNT header and payload generation. This allows different framing, modulation, and synchronization methods for the PNT header and payload (as indicated by the information in the Frame Type field).

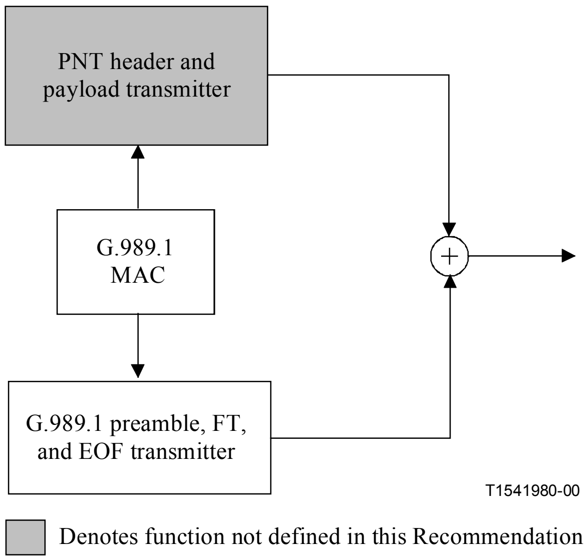



**Figure 9/G.989.1 – Basic structure of a G.989.1 transmitter**

### 7.1 Preamble

The preamble is a fixed sequence known by every burst receiver using the same frequency band on the wire. The preamble shall consist of the bit sequence 0xFC483084, repeated 4 times, with bits transmitted most significant octet first, least significant bit first and mapped according to Figure 10.

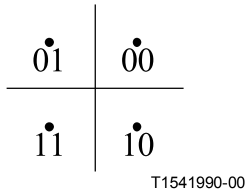



**Figure 10/G.989.1 – Preamble symbol map**

The symbol values are shown with bits ordered such that the right-most bit is the first bit received from the preamble generator.

The resulting length-64 sequence of 4-point symbols is interspersed with symbols of zero amplitude to produce a length-128 sequence that is transmitted using quadrature amplitude modulation with a symbol interval of 0.25 μs, a carrier frequency of 7.0 MHz. Transmit filtering sufficient to meet the PSD mask defined in clause 5 is applied.

### 7.2 Frame type (FT)

The frame type (FT) field is an 8-bit field that is set to a known value by the transmitter. It is encoded into 4 symbols according to the diagram in the previous clause, then interspersed with 4 symbols of zero amplitude, and it is quadrature amplitude modulated with a carrier frequency of 7.0 MHz. The receiver decodes this field and discards the frame if it is not a known value.

The frame type is intended to provide flexibility for defining other frame formats and modulators in future versions of this Recommendation. For G.989.1 the value of FT shall be as defined in Table 1:

**Table 1/G.989.1 – Frame type allocation**

| FT | Usage |
|---|---|
| 0 | Reserved for the installed base of existing PNT devices |
| 1-127 | Reserved for use by the ITU-T |
| 128-255 | Reserved for prototyping and Non-standard facilities |

### 7.3 End-of-frame delimiter (EOF)

The end-of-frame delimiter (EOF) is the first eight symbols of the length-128 preamble, quadrature amplitude modulated with a carrier frequency of 7.0 MHz and an initial phase of $2\pi\tau \times 7.0 + \phi$, where $\tau$ is the offset from the last symbol of the FT field in microseconds and $\phi$ is the initial phase of the modulator (at the start of the burst).

### 7.4 Maximum frame size

All G.989.1 stations shall transmit and receive frames with a total duration on the phoneline network not to exceed 3122 μs for FT = 0 or 1.

### 7.5 Inter-frame gap

The minimum inter-frame gap shall be 29 μs.

## 8 Medium access protocol

This clause describes the medium access protocol that shares media access between users of the spectrum by a distributed CSMA/CD protocol. Each station on a G.989.1 network segment executes the media access protocol (MAP) to coordinate access to the shared media.

The CSMA/CD media access procedure is the means by which two or more stations share the common transmission channel. To transmit, a station waits (defers) for a quiet period on the channel (that is, no other station is transmitting) and then sends the intended message in accordance with the appropriate physical-layer specification. To support more than one quality of service (QoS), the transmission deferral is ordered by eight priority levels, implementing absolute priority among the stations contending for access. If, after initiating a transmission, the message collides with that of another station, then each transmitting station ceases transmission and resolves the collision by choosing a Backoff Level, deferring to other stations that have chosen a lower Backoff Level.

### 8.1 Priority access

The G.989.1 system can be used for carrying multiple types of data, including media streams such as voice, streaming audio, and video. To reduce the latency variation in these streams, a priority mechanism is defined to allow higher layers to label outgoing frames with priority value (PRI), and guarantee that those frames will have preferential access to the channel over lower priority frames. This access priority method is to delay transmissions to a time slot beyond the minimum inter-frame gap, based on the priority level of the frame waiting to be transmitted. (See Figure 11.)

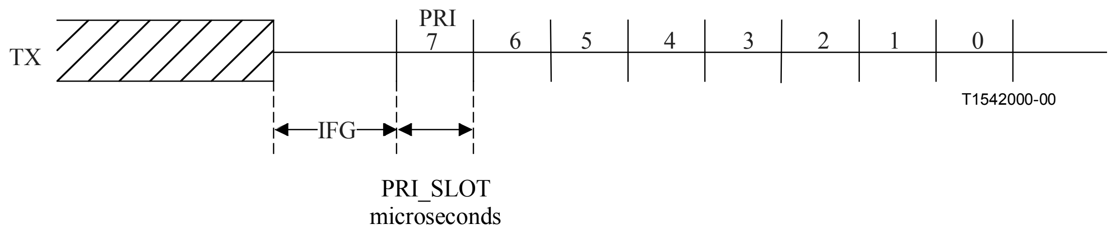



**Figure 11/G.989.1 – Priority slots**

Slots are numbered in decreasing priority, with the highest priority starting at level 7. Higher priority transmissions commence transmission in earlier slots and acquire the channel without contending with the lower priority traffic. A station's priority slot is based on the higher layer priority number associated with the frame ready for transmission (TX_PRI), as determined by the data link layer. Those transmissions without a specified priority use a default TX_PRI value of 2 ("best effort"). The station uses any slot whose number is less than or equal to TX_PRI, normally the slot numbered exactly TX_PRI. After priority slot 0 there are no more priority slots, and any station with traffic at any priority level can contend on a first-come, first-served basis. All collisions after priority slot 0 are considered to happen at PRI = 0.

The priority slot width is 21.0 μs.

Stations waiting for transmission shall monitor carrier sense (CS), and defer from using the media if CS was true prior to the start of the station's priority slot, or if beyond priority slot 0, the station shall defer if CS was true. Any station ready to transmit at the start of its priority slot shall transmit if CS was false prior to the start of its priority slot, without deferring if CS was asserted prior to the start of transmission.

In the example shown in Figure 12, a high priority transmission begins transmitting at a designating time instead of contending with lower priority traffic.

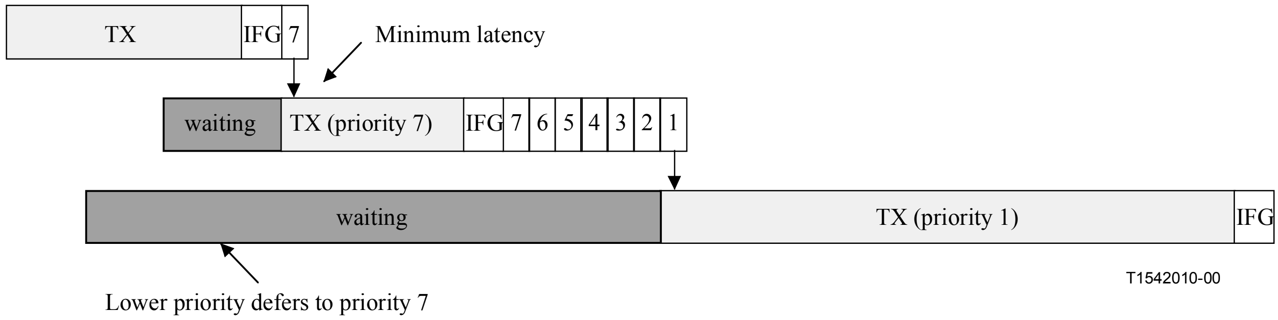



**Figure 12/G.989.1 – Example of priority access**

The slot timer is restarted if another transmission acquires the channel while a station is waiting at a lower priority.

## 8.2 Priority mapping

The TX_PRI value is the priority used to schedule transmission and is the value present in the PRI field of the frame header. The TX_PRI value is determined by a higher layer, and the method of priority labelling is outside the scope of this Recommendation.

There may be a mapping between media access (MAC) layer priorities and the link layer (LL) priority values as delivered to the link layer by the network layer. The definition of any additional mapping of priorities that may occur between the link and MAC layers is for further study.

In general, the network layer or application layer will determine what the policy is used to map traffic onto LL priorities.

## 8.3 Collision detection

Two or more stations may begin transmitting in the same priority slot following the IFG period or may begin transmitting at the same time after priority slot 0. A collision occurs when two or more stations have waiting frames (in this context, defined as an active station) and attempt to access the channel by transmitting a preamble and header. The priority level of a collision can be inferred from the priority slot where the collision occurs. Generally, collisions are between frames at the same priority level, but it is possible for collisions to occur between transmissions at different priority levels.

All stations monitor the channel to detect the colliding transmissions of other stations. Passive stations can detect collisions by observing the length of transmission fragment.

A station detecting a collision should cease transmission no later than 70.0 μs after the beginning of the frame as measured at the W1 interface. The minimum size of a valid (non-colliding) frame is 92.5 μs, to account for time skews between stations' transmissions. Transmissions that are too short or too long are recognized as collisions between other stations.

## 8.4 Collision resolution

In order to resolve collision, a distributed collision resolution (CR) algorithm is employed which results in stations becoming ordered into backoff levels. The backoff levels indicate the order of which the originally colliding stations will transmit. The desired outcome is for only one station to be at backoff level 0, enabling it to acquire the channel. After the winning station completes its transmission, all stations reduce their backoff level by one if it is greater than zero, and the new station(s) at backoff level 0 attempt transmission. All stations, even those with no frame to transmit, monitor the activity on the medium to keep track of the maximum backoff level. By monitoring the maximum backoff level, the collision resolution cycle is closed, so that stations that did not collide are not allowed to contend for access to the medium until all stations that collided have transmitted one frame successfully or have forgone the right to transmit their waiting frame.

Using this process all stations that were contending for access in the initial collision gain access to the wire and the collision resolution cycle is ended. This results in access latency being tightly bounded.

Each station maintains eight backoff level (BL) counters, one for each priority, and eight maximum backoff level (MBL) counters. The BL and MBL counters are initialized to 0 and saturate at 15.

### 8.4.1 Selection of backoff level by signalling

After a collision and an IFG, three special signal slots (S0…S2) are present before the normal sequence of priority slots (contention slots) occurs. See Figure 13. Signal slots are used to set/determine the backoff level counters. Signal slots only occur after collisions and do not follow successful transmissions. The width of the signal slot is 32.0 μs.

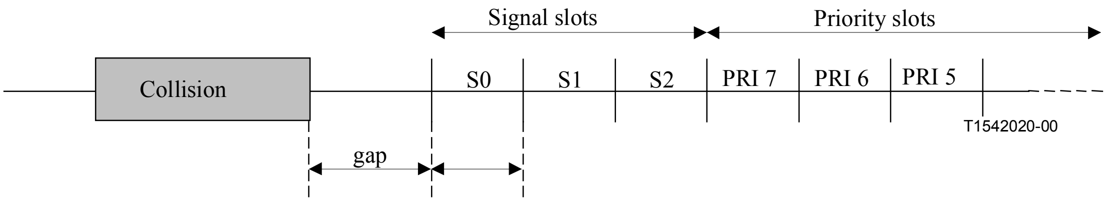



**Figure 13/G.989.1 – Signal slots**

Each active station in the collision resolution period pseudo-randomly chooses one of the signal slots, and transmits a backoff signal. The backoff signal is a symbol sequence consisting of the first 32 of the 128 symbols of the preamble sequence followed by the 8-symbol EOF sequence. These are modulated on a 7.0 MHz carrier and the result is filtered to meet the PSD defined in clause 5. More than one station can transmit a backoff signal in the same signal slot. The active stations transmit backoff signals to indicate ordering information that determines the new backoff levels to be used.

All stations (even non-active stations) monitor collision events and the signal slots to compute the backoff level. If an active station sees a backoff signal in a slot prior to the one it chose, it increases its backoff level. Those stations at backoff level 0 (ones that are actively contending) that did not receive backoff signals prior to the one chosen remain at backoff level 0 and contend for transmission in the priority slot that immediately follows the backoff signal sequence. The priority slot number equals the priority of the waiting frame (TX_PRI). Eventually, only one station remains at backoff level 0 and successfully gains access to the channel. Note that stations with higher-priority waiting frames may pre-empt the collision resolution by transmitting in a priority slot earlier than the one in which the previous collision occurred.

The MBL counter is incremented for each backoff signal seen and decremented when a successful transmission occurs. The MBL for every station is non-zero whenever a collision resolution cycle is in progress. When a station first becomes active, BL is initialized to the contents of MBL. This ensures that all currently active stations gain access to the channel before stations can re-enter the waiting queue.

## APPENDIX I

## Bibliography


- ITU-T G.992.1 (1999), *Asymmetrical digital subscriber line (ADSL) transceivers*.
- ITU-T G.992.2 (1999), *Splitterless asymmetric digital subscriber line (ADSL) transceivers*.
- ITU-T J.112 (1998), *Transmission systems for interactive cable television services*.
- ITU-T V.90 (1998), *A digital modem and analogue modem pair for use on the Public Switched Telephone Network (PSTN) at data signalling rates of up to 56 000 bit/s downstream and up to 33 600 bit/s upstream*.
- ITU-T X.200 (1994) | ISO/IEC 7498-1:1994, *Information technology – Open Systems Interconnection – Basic Reference Model: The Basic Model*.
- IEEE 802.3 (2000), *Information technology – LAN/MAN – Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications*.
- ETSI TS 101 270-1 (1999), *Transmission and Multiplexing (TM); Access transmission systems on metallic access cables; Very high speed Digital Subscriber Line (VDSL); Part 1: Functional requirements*.

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