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OF ITU

G.992.1

Annex H
(10/2000)

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

Digital sections and digital line system – Access networks

Asymmetric digital subscriber line (ADSL) transceivers

Annex H: Specific requirements for a synchronized symmetrical DSL (SSDSL) system operating in the same cable binder as ISDN as defined in ITU-T G.961 Appendix III

ITU-T Recommendation G.992.1 – Annex H

(Formerly CCITT Recommendation)

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ITU-T Recommendation G.992.1

Asymmetric digital subscriber line (ADSL) transceivers

ANNEX H

Specific requirements for a synchronized symmetrical DSL (SSDSL) system operating in the same cable binder as ISDN as defined in ITU-T G.961 Appendix III

Summary

This annex describes those specifications that are unique to Synchronized Symmetrical Digital Subscriber Line (SSDLS) transceivers for use in the same cable binder as TCM-ISDN defined in ITU-T G.961 Appendix III. The SSDSL transmission method allows symmetric data rates in the range of 192 kbit/s to 1.6 Mbit/s with 32 kbit/s granularity using a scheme synchronized with TCM-ISDN.

Source

Annex H to ITU-T Recommendation G.992.1 was prepared by ITU-T Study Group 15 (1997-2000) and approved by the World Telecommunication Standardization Assembly (Montreal, 27 September – 6 October 2000).

FOREWORD

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

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

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

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

NOTE

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

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As of the date of approval of this Recommendation, ITU had received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

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Asymmetrical digital subscriber line (ADSL) transceivers

ANNEX H

Specific requirements for a synchronized symmetrical DSL (SSDSL) system operating in the same cable binder as ISDN as defined in ITU-T G.961 Appendix III

H.1 Scope

This annex describes those specifications that are unique to Synchronized Symmetrical Digital Subscriber Line (SSDSL) transceivers for use in the same cable binder as TCM-ISDN defined in ITU-T G.961 Appendix III. This SSDSL transmission method allows symmetric data rates in the range of 192 kbit/s to 1.6 Mbit/s with 32 kbit/s granularity using a scheme synchronized with TCM-ISDN. 1.544 Mbit/s STM data transport capability is optionally supported.

SSDSL transceivers can provide digital data service on the same twisted pair with voiceband services (including POTS and voiceband data services). The SSDSL transmission scheme occupies a frequency band above the voiceband, and may be separated from it by filtering. Optionally when POTS service and filtering are not utilized, frequencies below 26 kHz including the voiceband may be used in the EFT mode.

The clauses in this annex provide supplementary and replacement material to the clauses in the main body. The nature of the material is parenthetically indicated in the clause heading.

H.2 Definitions

This annex defines the following terms:

H.2.1 SSDSL: Synchronized Symmetrical DSL.

H.2.2 ADSL Frequency band Transmission (AFT): A mode which indicates usage of tones #6 and above for data transmission.

H.2.3 Expanded Frequency band Transmission (EFT): A mode which also allows usage of tones #1 to #5 for data transmission.

H.2.4 TTR: TCM-ISDN Timing Reference.

H.2.5 $\mathbf{TTR_C}$: Timing reference used in ATU-C.

H.2.6 $\mathbf{TTR_R}$: Timing reference used in ATU-R.

H.2.7 Hyperframe: 5 Superframes structure which synchronizes TTR.

H.2.8 Bitmap-$\mathbf{H_R}$: ATU-C transmitter bitmap.

H.2.9 Bitmap-$\mathbf{H_C}$: ATU-R transmitter bitmap.

H.2.10 $\mathbf{FEXT_R}$ duration: TCM-ISDN FEXT duration at ATU-R estimated by the ATU-C.

H.2.11 $\mathbf{NEXT_R}$ duration: TCM-ISDN NEXT duration at ATU-R estimated by the ATU-C.

H.2.12 $\mathbf{FEXT_C}$ duration: TCM-ISDN FEXT duration at ATU-C estimated by the ATU-R.

H.2.13 $\mathbf{NEXT_C}$ duration: TCM-ISDN NEXT duration at ATU-C estimated by the ATU-R.

H.2.14 $\mathbf{FEXT_R}$ symbol: DMT symbol transmitted by ATU-C during TCM-ISDN FEXT.

H.2.15 NEXT$_R$ symbol: DMT symbol transmitted by ATU-C during TCM-ISDN NEXT.

H.2.16 FEXT$_C$ symbol: DMT symbol transmitted by ATU-R during TCM-ISDN FEXT.

H.2.17 NEXT$_C$ symbol: DMT symbol transmitted by ATU-R during TCM-ISDN NEXT.

H.2.18 UI: Unit Interval.

H.2.19 N$_{SWF}$: Sliding Window Frame counter.

H.2.20 Subframe: 10 consecutive DMT symbols (except for sync symbols) according to TTR timing.

H.2.21 TCM: Time compression multiplex.

H.2.22 ATU-C: ADSL transceiver unit at the central office end.

H.2.23 ATU-R: ADSL transceiver unit at the remote terminal end.

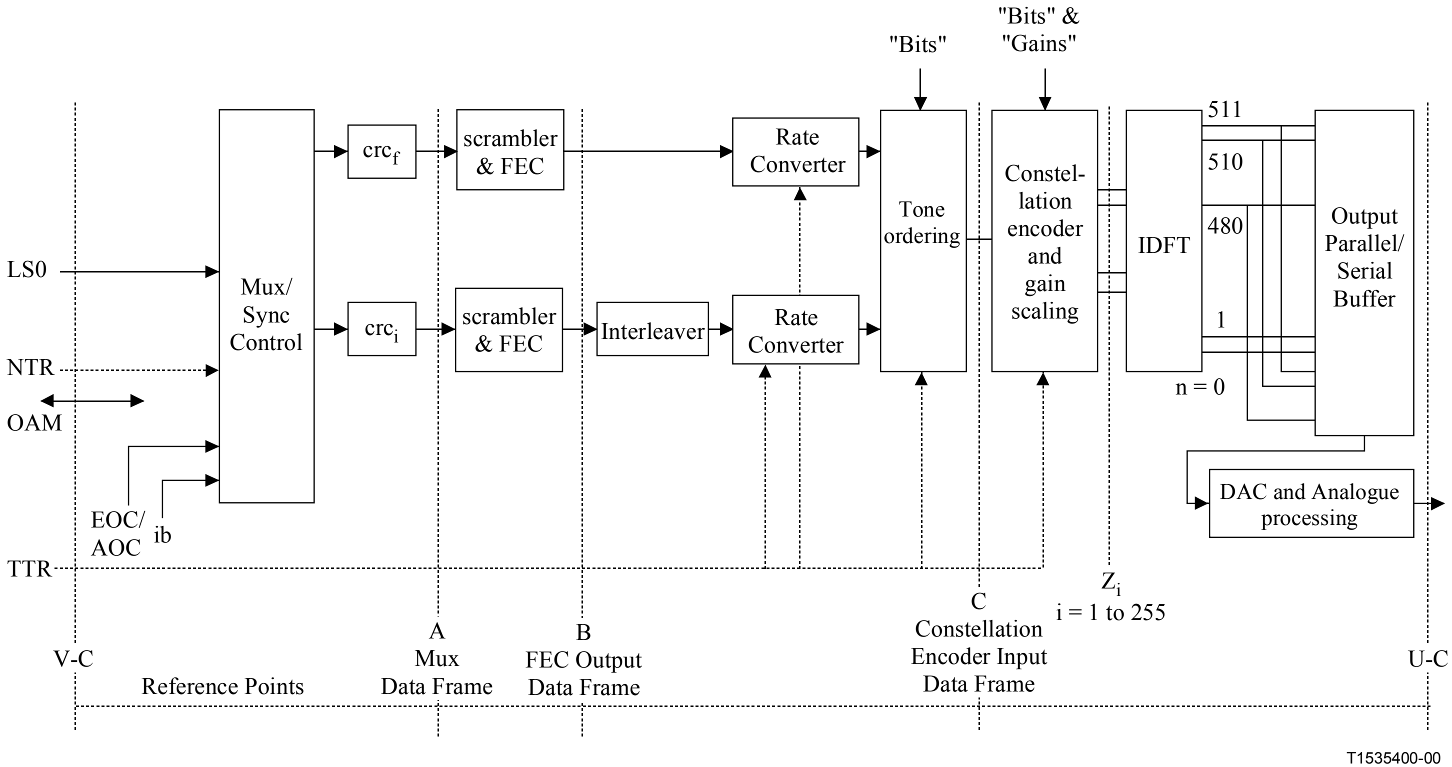
H.3 Reference Models

H.3.1 System reference model

For system reference model, see 1.1 with splitter and POTS service being optionally disabled in EFT mode.

H.3.2 ATU-C transmitter reference model (replaces figures in 5.1)

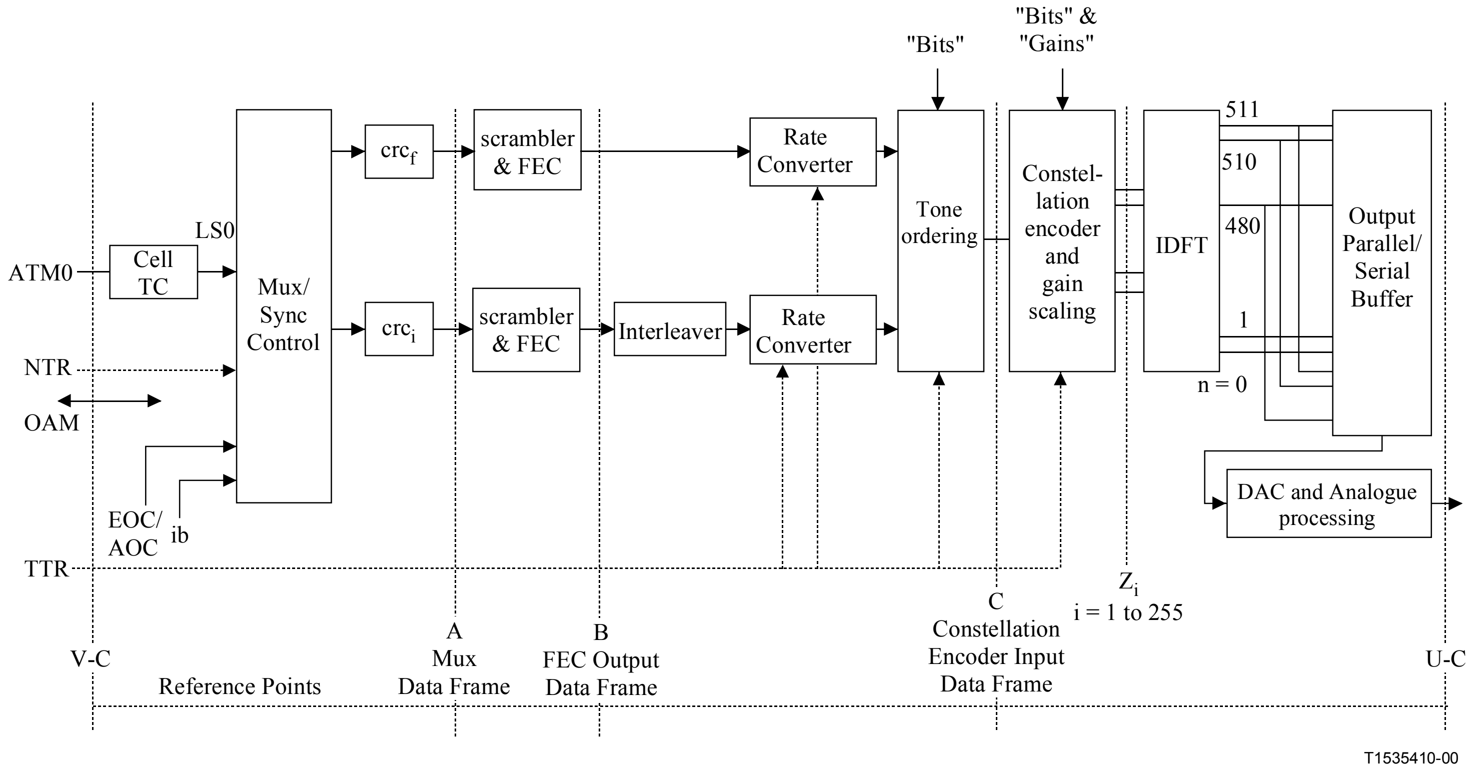
See Figures H.1 and H.2.



NOTE 1 – The TTR may be generated in ATU-C without being provided from the TCM-ISDN clock.

NOTE 2 – Support for fast path is optional.

Figure H.1/G.992.1 – ATU-C transmitter reference model for STM transport



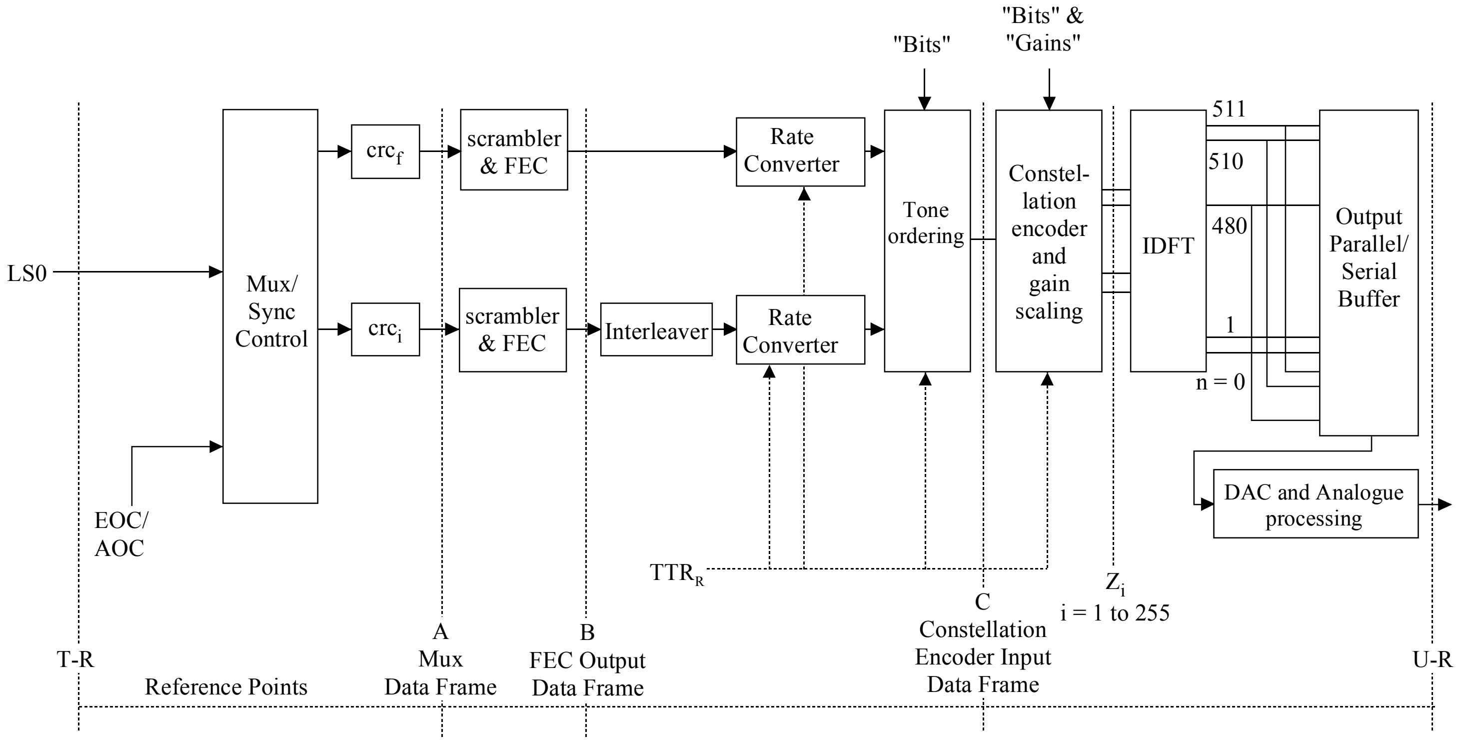
NOTE 1 – The TTR may be generated in ATU-C without being provided from the TCM-ISDN clock.

NOTE 2 – Support for fast path is optional.

Figure H.2/G.992.1 – ATU-C transmitter reference model for ATM transport

H.3.3 ATU-R transmitter reference model (replaces figures in 5.2)

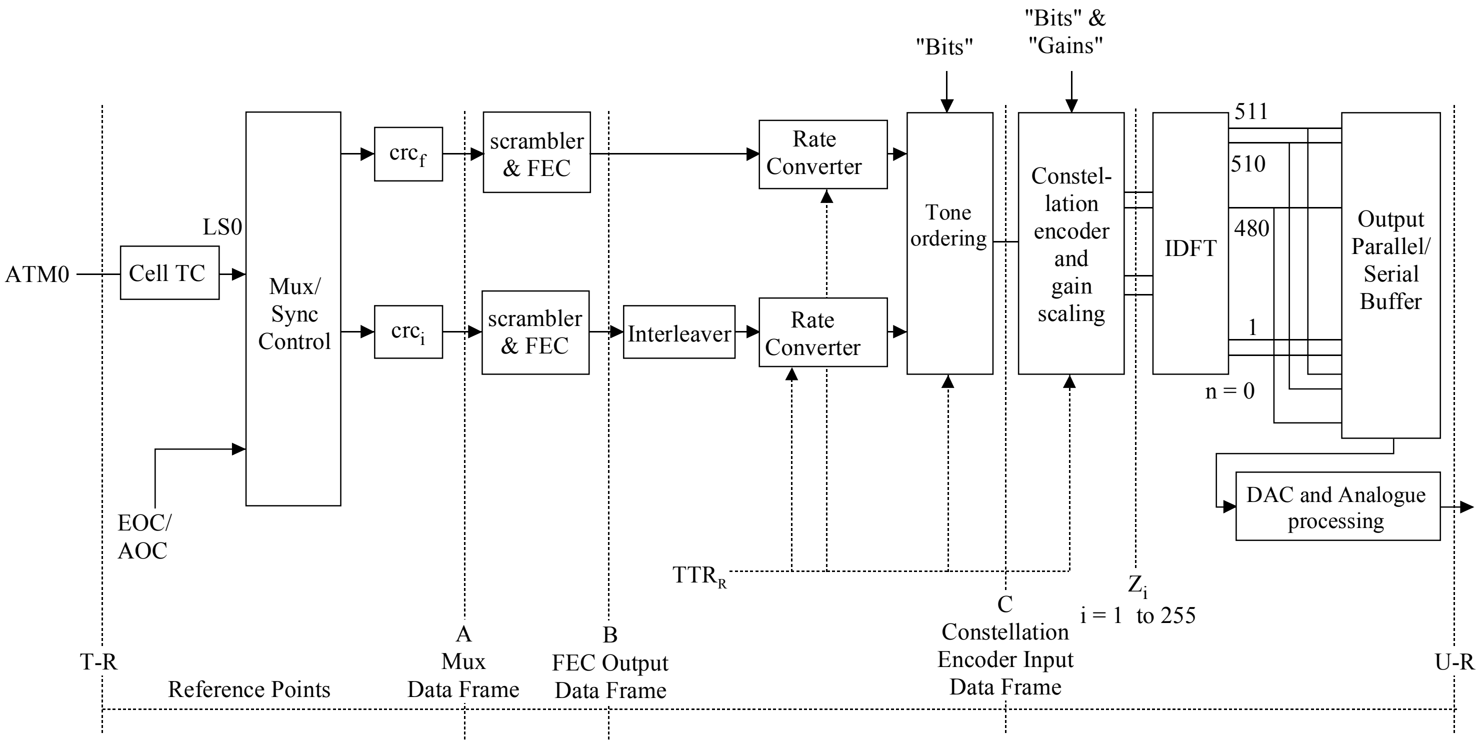
See Figures H.3 and H.4.



NOTE 1 – The TTR_R shall be generated in ATU-R from the received TTR_C signal, and it is locked to 690 periods of upstream sampling clock (276 kHz).

NOTE 2 – Support for fast path is optional.

Figure H.3/G.992.1 – ATU-R transmitter reference model for STM transport



NOTE 1 – The TTR_R shall be generated in ATU-R from the received TTR_C signal, and it is locked to 690 periods of upstream sampling clock (276 kHz).

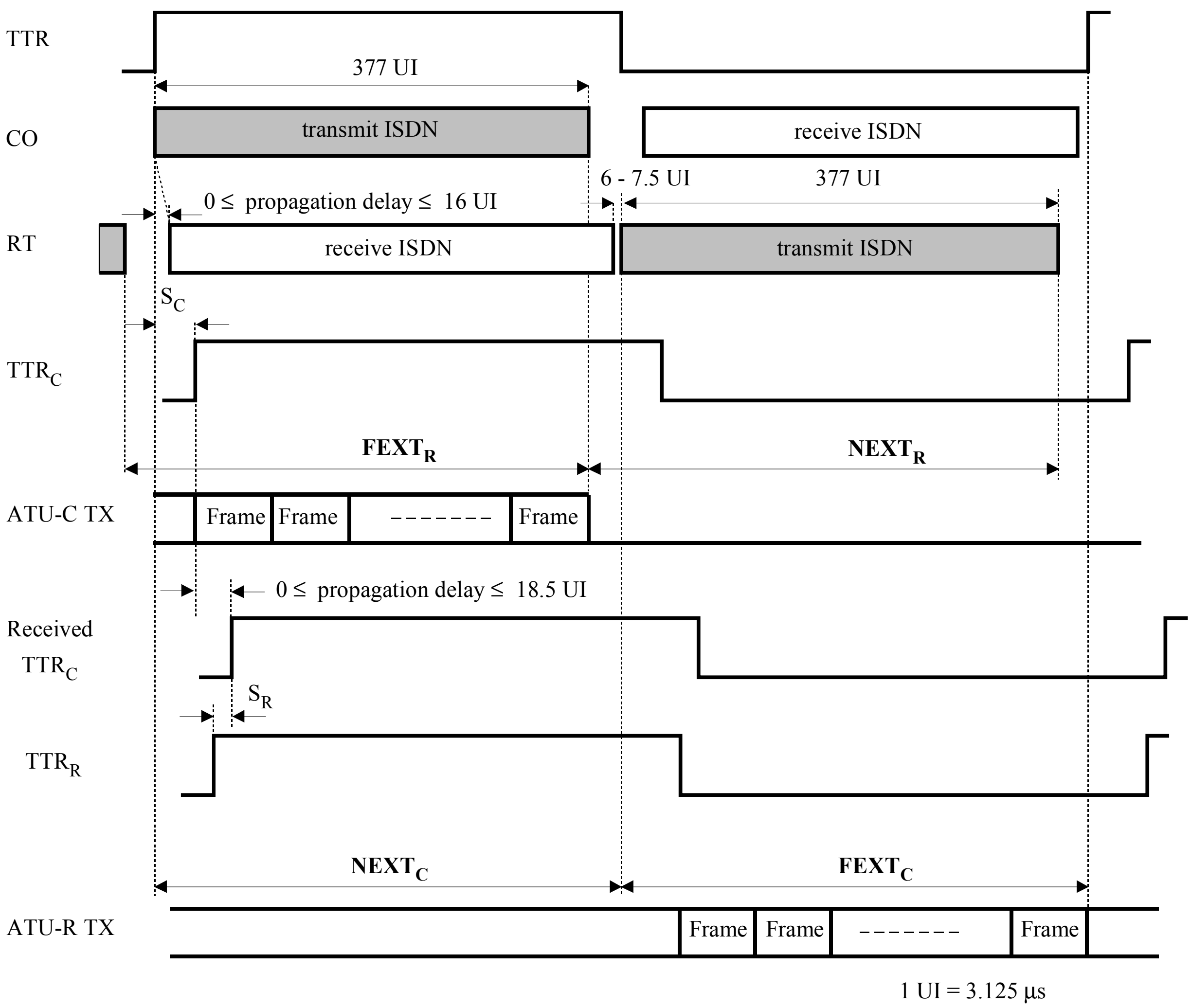
NOTE 2 – Support for fast path is optional.

Figure H.4/G.992.1 – ATU-R transmitter reference model for ATM transport

H.3.4 ATU-C/R transmitter timing model (replacement for 5.3)

H.3.4.1 TCM-ISDN cross-talk timing model (new)

Figure H.5 shows the timing chart of the cross-talk from TCM-ISDN.



$FEXT_R$ and $NEXT_R$ are estimated by ATU-C

$FEXT_C$ and $NEXT_C$ are estimated by ATU-R

T1535440-00

TTR	TCM-ISDN Timing reference
TTR_C	Timing reference used in ATU-C
Received TTR_C	Received TTR_C at ATU-R
TTR_R	Timing reference used in ATU-R
S_C	55×0.9058 µs: Offset from TTR to TTR_C
S_R	-42×0.9058 µs: Offset from received TTR_C to TTR_R

Figure H.5/G.992.1 – Timing chart of the TCM-ISDN cross-talk

The data stream of TCM-ISDN is transmitted in TTR period. CO transmits the stream in the first half of the TTR period and RT transmits in the second half of the TTR period. ATU-C receives NEXT noise from the ISDN in the first half of the TTR period and FEXT noise from the ISDN in the second half of the TCM-ISDN period. On the other hand, ATU-R receives FEXT noise from the ISDN in the first half of the TTR period and NEXT noise from the ISDN in the second half of the TTR period.

As defined in H.8.6.2 and H.8.7.1, the ATU-C shall estimate the $FEXT_R$ and $NEXT_R$ duration at ATU-R, and the ATU-R shall estimate $FEXT_C$ and $NEXT_C$ duration at ATU-C taking propagation delay on the subscriber line into consideration.

The ATU-C shall transmit any symbols by synchronizing with the TTR_C. The ATU-R shall transmit any symbols synchronizing with the TTR_R generated from received TTR_C.

H.3.4.2 Sliding window (new)

Figure H.6 shows the timing chart of the transmission for the Annex H downstream at ATU-C.

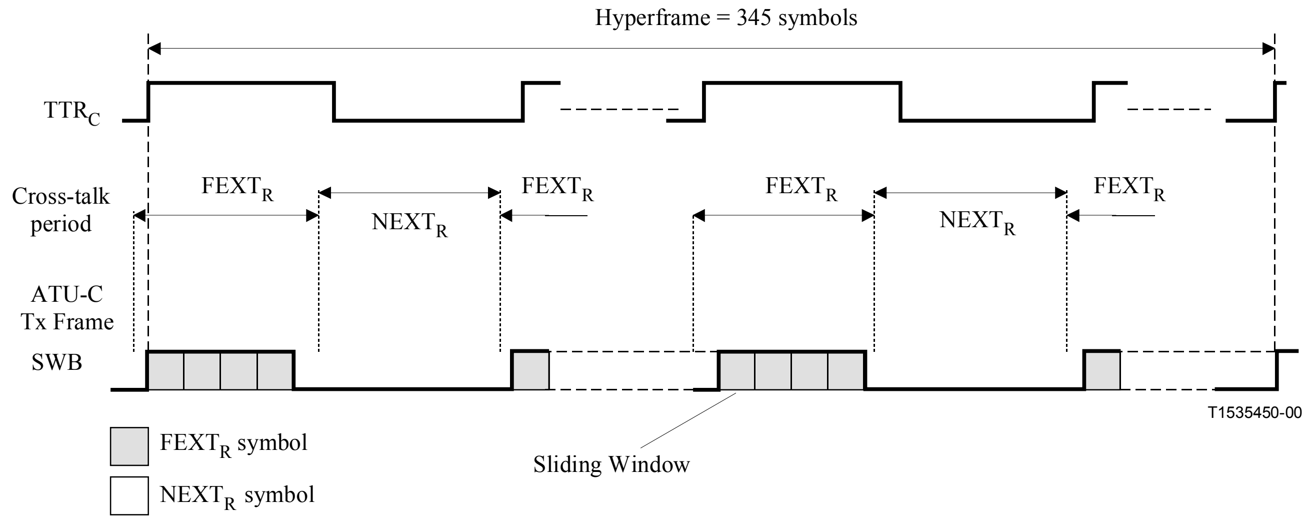


Figure H.6/G.992.1 – Sliding window for downstream symbols

The Sliding Window defines the transmission symbols under the cross-talk noise environment synchronized to the period of TTR. The $FEXT_{C/R}$ symbol represents the symbol completely inside the $FEXT_{C/R}$ duration. No signal including pilot tone is transmitted in the whole period of $NEXT_{R/C}$ duration.

The ATU-C decides $FEXT_R$ symbols according to the sliding window and transmits it with the Bitmap-H_R. Similarly, the ATU-R decides $FEXT_C$ symbols and transmits it with the Bitmap-H_C. Although the phase of the sliding window is asynchronous with $TTR_{C/R}$, the pattern is fixed to the 345 frames of the hyperframe.

H.3.4.3 ATU-C symbol synchronization to TTR (new)

345 symbols are 34 cycles with cyclic prefix of TTR_C (or 32 cycles of TTR_C without cyclic prefix). This implies a PLL lock at the ATU-R.

H.3.4.4 Loop timing at ATU-R (new)

The phase relation between received symbol and transmitted symbol of ATU-R at the reference point U-R shall meet the phase tolerances as shown in Figure H.7.

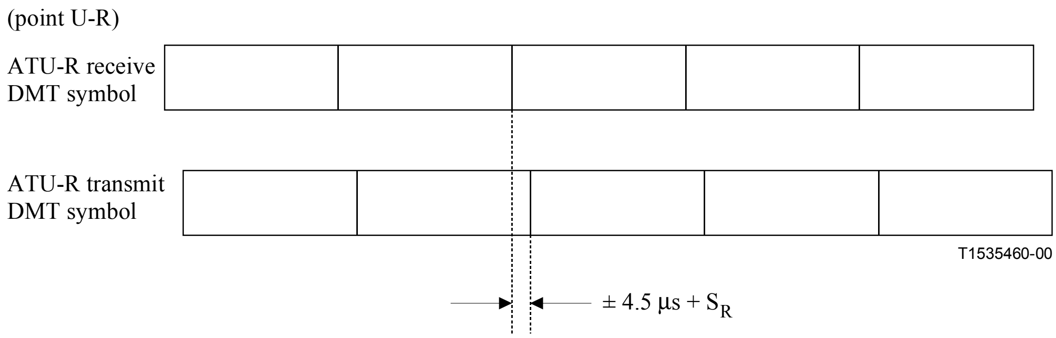


Figure H.7/G.992.1 – Loop timing for ATU-R

H.4 Transport capacity (supplements clause 6)

Only the bearer channel LS0 is used for both downstream and upstream transport. Therefore, only single latency is available. Support for fast path is optional.

H.4.1 Transport of STM data (supplements 6.1)

An SSDSL system transporting STM shall support a duplex bearer channel LS0. Bearer channel LS0 shall support all integer multiples of 32 kbit/s from 192 kbit/s to 1.6 Mbit/s.

Support for integer multiples beyond those required above is optional.

1.544 Mbit/s STM data rate is optionally supported with the frame mode specified in H.5.3.4.

H.4.2 Transport of ATM data (supplements 6.2)

An SSDSL system transporting ATM shall support a single latency mode at all integer multiples of 32 kbit/s from 192 kbit/s to 1.6 Mbit/s for both downstream and upstream.

ATM data shall be mapped to bearer channel LS0 in both downstream and upstream directions.

Support for integer multiples beyond those required above is optional.

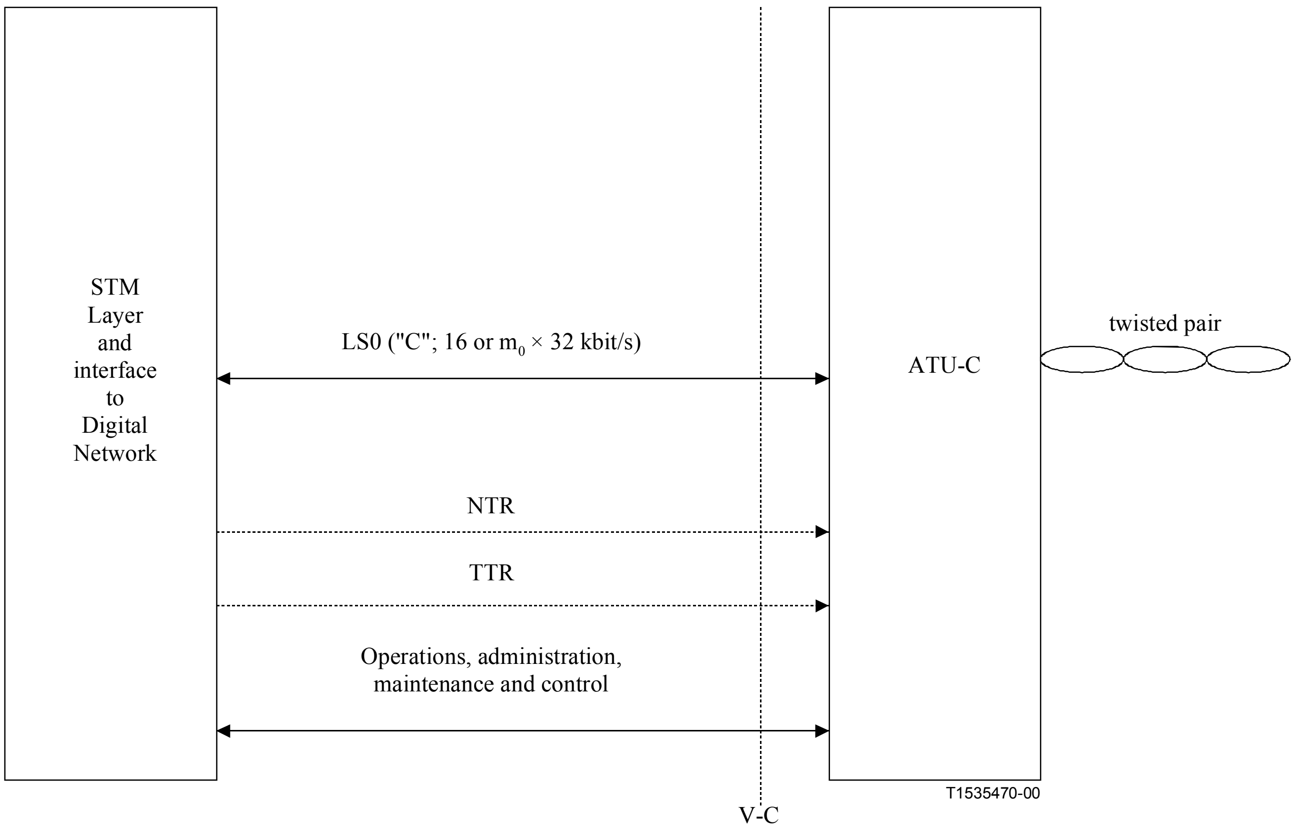
H.5 ATU-C functional characteristics (supplements clause 7)

Only framing structure 3 in Table 7-1 (Reduced overhead with merged fast and sync byte) is used for this annex. The ATU-C shall not transmit any signal including pilot tone in $NEXT_R$ duration.

H.5.1 STM transmission protocol specific functionality (pertains to 7.1)

H.5.1.1 ATU-C input and output V interface for STM transport (supplements 7.1.1)

See Figure H.8.



NOTE – TTR may be generated in the ATU-C without being provided from the V-C Reference point.

Figure H.8/G.992.1 – ATU-C functional interfaces for STM transport at the V-C reference point

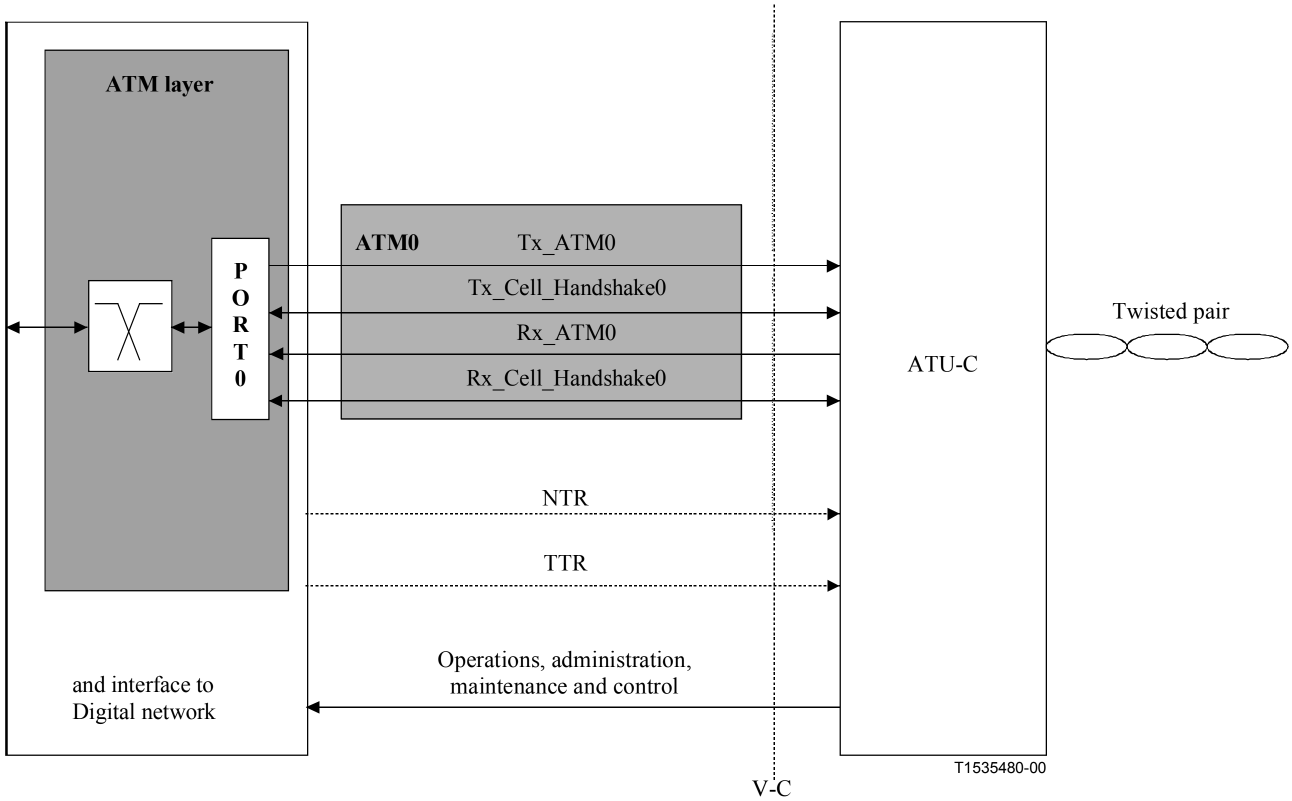
H.5.1.2 Payload transfer delay (replaces 7.1.4)

Since Annex H uses a rate converter with single latency, the maximum payload transfer delay is longer than the value specified in 7.1.4. The additional one-way transfer delay due to the rate converters shall be less than 5 ms. When optional fast path is selected, additional one-way delay shall be less than 1.7 ms.

H.5.2 ATM transmission protocol specific functionalities (pertains to 7.2)

H.5.2.1 ATU-C input and output V interface for ATM transport (supplements 7.2.1)

See Figure H.9.



NOTE – TTR may be generated in the ATU-C without being provided from the V-C Reference point.

Figure H.9/G.992.1 – ATU-C functional interfaces to the ATM layer at the V-C reference point

H.5.2.2 Payload transfer delay (replaces 7.2.2)

Since Annex H uses a rate converter with single latency, the maximum payload transfer delay is longer than the value specified in 7.2.2. The additional one-way transfer delay due to the rate converters shall be less than 5 ms. When optional fast path is selected, additional one-way delay shall be less than 1.7 ms.

H.5.3 Framing (pertains to 7.4)

H.5.3.1 Superframe structure (supplements 7.4.1.1)

Since the rate converter reorders the user data and overhead bit-level data to create hyperframes, the input data frames to the constellation encoder are different than those defined in 7.4.1.1.

H.5.3.2 Hyperframe structure (replaces 7.4.1.3)

Annex H uses the hyperframe structure shown in Figure H.10. Figure H.10 shows the phase relationship between the TTR_C and the hyperframe at the point U-C. Each hyperframe is composed of 5 superframes, which are numbered from 0 to 4. In order to indicate the boundary of the hyperframe, the inverse synch symbol is used for the 4th superframe (SPF #3), which is generated from a tone-by-tone 180 degree phase reversal of the synchronization symbol (see H.5.5.1) except for the pilot tone.

The bit-level data stream from the rate-converter is extracted according to the size of Bitmap-H_R using the Sliding Window (see H.3.4.2).

In order to make the bit rate to be a multiple of 32 kbit/s, the dummy bits are inserted at the end of hyperframe by the rate converter (see H.5.4.2). The hyperframe is composed of 345 DMT symbols, numbered from 0 to 344. Each symbol is assigned as $FEXT_R$ or $NEXT_R$ symbol in a $FEXT_R$ or $NEXT_R$ duration (see H.2), and the following numerical formula gives the information which duration N_{dmt}-th DMT symbol belongs to at ATU-C transmitter (see Figure H.11).

For $N_{dmt} = 0, 1, \ldots 344$

$S = 272 \times N_{dmt} \bmod 2760$

if { $(S + 271 < a)$ or $(S > a + b)$ } then $FEXT_R$ symbol

else then $NEXT_R$ symbol

where $a = 1243$, $b = 1461$

Thus, 128 DMT symbols are allocated in the $FEXT_R$ duration, and 217 DMT symbols are allocated in the $NEXT_R$ duration. The symbols are composed of:

$FEXT_R$ symbol:

Number of symbol using Bitmap-H_R	= 126
Number of synch symbol	= 1
Number of inverse synch symbol	= 1

The ATU-C shall not transmit any signal in $NEXT_R$ duration.

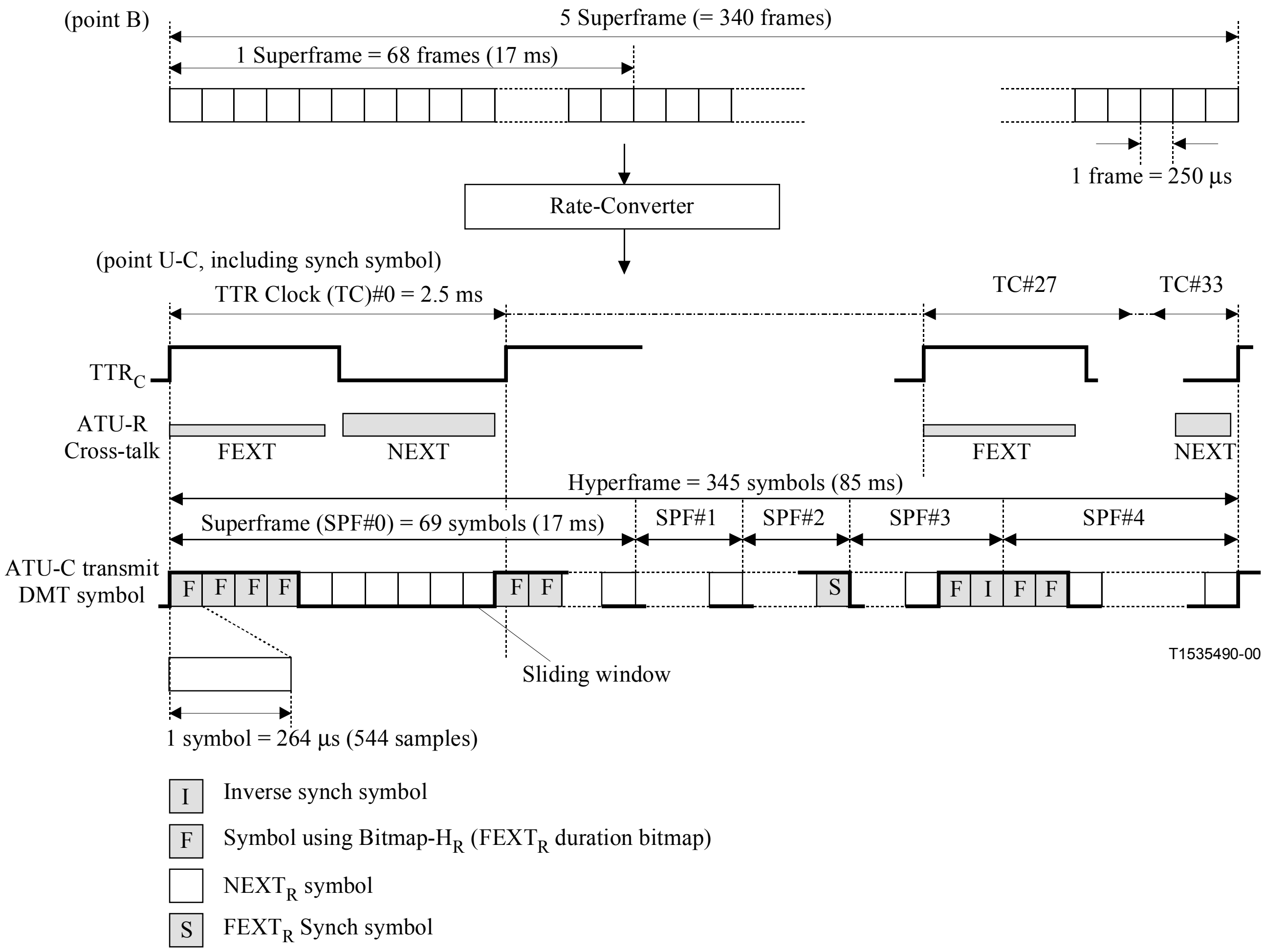


Figure H.10/G.992.1 – Hyperframe structure for downstream

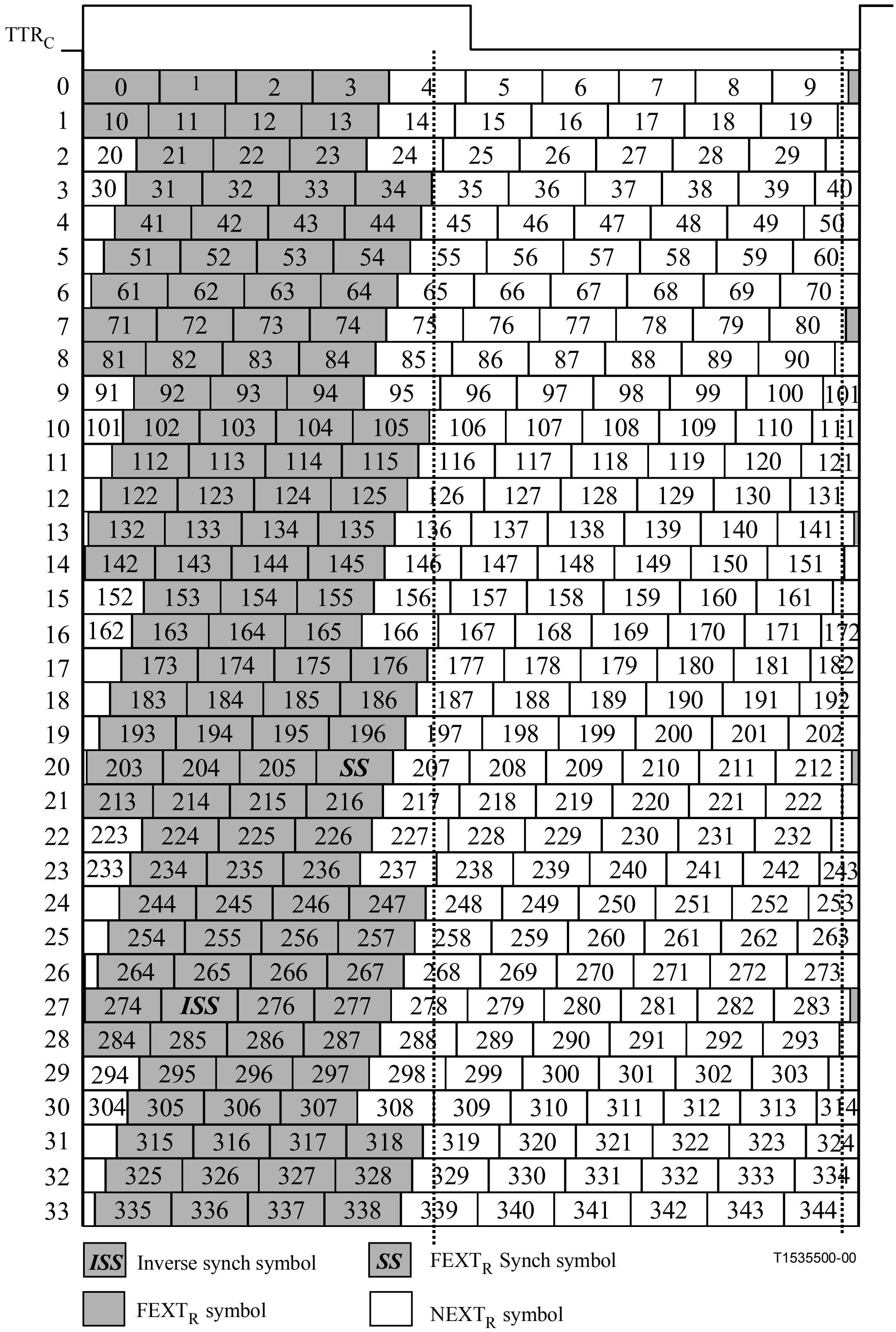


Figure H.11/G.992.1 – Symbol pattern in a hyperframe with cyclic prefix – Downstream

H.5.3.3 Subframe structure (replaces 7.4.1.4)

A subframe is 10 consecutive DMT symbols (except for those noted in Table H.1). The 34 subframes form a hyperframe.

Table H.1/G.992.1 – Subframe (downstream)

Subframe No.	DMT symbol No.	Note
0	0-9	
1	10-19	
2	20-29	
3	30-39	
4	40-49	
5	50-59	
6	60-70	11 DMT symbols for this subframe
7	71-80	
8	81-90	
9	91-100	
10	101-110	
11	111-120	
12	121-130	
13	131-141	11 DMT symbols for this subframe
14	142-151	
15	152-161	
16	162-171	
17	172-181	
18	182-191	
19	192-201	
20	202-212	#206 is Synch Symbol
21	213-222	
22	223-232	
23	233-242	
24	243-252	
25	253-262	
26	263-272	
27	273-283	#275 is Inverse Synch Symbol
28	284-293	
29	294-303	
30	304-313	
31	314-323	
32	324-333	
33	334-344	11 DMT symbols for this subframe

H.5.3.4 Framing for 1.544 Mbit/s STM data mode (new)

A special framing mode is optionally specified to support symmetric 1.544 Mbit/s STM data rate, which is not a multiple of 32 kbit/s, as below. This framing mode shall be selected during handshake process as specified in H.8.2 and H.8.3. See Table H.2.

Table H.2/G.992.1 – Overhead functions for framing modes for 1.544 Mbit/s STM data support

Frame Number	1.544 Mbit/s STM data Overhead mode	
	(Fast buffer only) Fast byte format	**(Interleaved buffer only) Sync byte format**
0	Fast CRC	Interleaved CRC
1	IB0-7	IB0-7
34	IB8-15	IB8-15
35	IB16-23	IB16-23
8n + 4, 8n + 5 with n = 0…7, 64	Remainder 8 kbit/s of LS0	Remainder 8 kbit/s of LS0
65	Dummy byte	Dummy byte
4n + 2, 4n + 3 with n = 0…16, n ≠ 8	EOC or sync (Note)	EOC or sync (Note)
8n, 8n + 1 with n = 1…7	AOC	AOC
NOTE – In the reduced overhead mode, only the "no synchronization action" code shall be used.		

H.5.4 Bitmapping and rate conversion (replaces 7.15)

H.5.4.1 Bitmapping (new)

Data transmission is only allowed by $FEXT_R$ symbols using Bitmap-H_R, which is synchronized with the sliding window pattern of $NEXT_R$/$FEXT_R$ symbols.

H.5.4.2 Rate converter (new)

The rate converter buffering changes the data frame boundaries between the reference points B and C according to Bitmap-H_R and the Sliding Window. The rate converter has to be prepared for each interleaved path and fast path independently. The relation of data amount at the reference points B and C shall be calculated with the following formulae.

For the interleaved path,

t_R is selected so that:

$$126\left[\frac{symbol}{hyperframe}\right]\times\left(f_R-1\right)\left[\frac{bit}{symbol}\right]<340\left[\frac{frame}{hyperframe}\right]\times t_R\left[\frac{bit}{frame}\right]\leq 126\left[\frac{symbol}{hyperframe}\right]\times f_R\left[\frac{bit}{symbol}\right]$$

where:

t_R is the number of payload- and overhead-bits in one frame at the reference point B; and

f_R is the number of payload- and overhead-bits in one $FEXT_R$ symbol at the reference point C.

The rate converter inserts dummy bits at the end of the hyperframe to ensure the bits per hyperframe are equivalent at the reference points B and C.

$$\#dummy_R\left[\frac{bit}{hyperframe}\right] = 126\left[\frac{symbol}{hyperframe}\right]\times f_R\left[\frac{bit}{symbol}\right] - 340\left[\frac{frame}{hyperframe}\right]\times t_R\left[\frac{bit}{frame}\right]$$

For the fast path,

t_R is selected so that:

$$3\left[\frac{symbol}{subframe}\right]\times(f_R - 1)\left[\frac{bit}{symbol}\right] < 10\left[\frac{frame}{subframe}\right]\times t_R\left[\frac{bit}{frame}\right] \leq 3\left[\frac{symbol}{subframe}\right]\times f_R\left[\frac{bit}{symbol}\right]$$

The rate converter inserts dummy bits at the end of the subframe to ensure the bits per subframe are equivalent at the reference points B and C.

For the subframe containing 3 $FEXT_R$ symbols except for synch symbols:

$\#dummy_{R3}\left[\frac{bit}{subframe}\right] = 3\left[\frac{symbol}{subframe}\right]\times f_R\left[\frac{bit}{symbol}\right] - 10\left[\frac{frame}{subframe}\right]\times t_R\left[\frac{bit}{frame}\right]$ at the end of subframe.

For the subframe containing 4 $FEXT_R$ symbols except for synch symbols:

$\#dummy_{SR}\left[\frac{bit}{symbol}\right] = f_R\left[\frac{bit}{symbol}\right] - 10\left[\frac{frame}{subframe}\right]\times t_R\left[\frac{bit}{frame}\right] / 4\left[\frac{symbol}{subframe}\right]$ at the end of each $FEXT_R$ symbol.

At the receiver, the inserted dummy bits shall be removed.

The receiver shall determine Bitmap-H_R so that the number of dummy bits is less than 126 in initialization sequence.

NOTE – In the case of 1.544 Mbit/s STM data mode, the formulae described above shall be also applied because t_R is the number of payload- and overhead-bits in one frame.

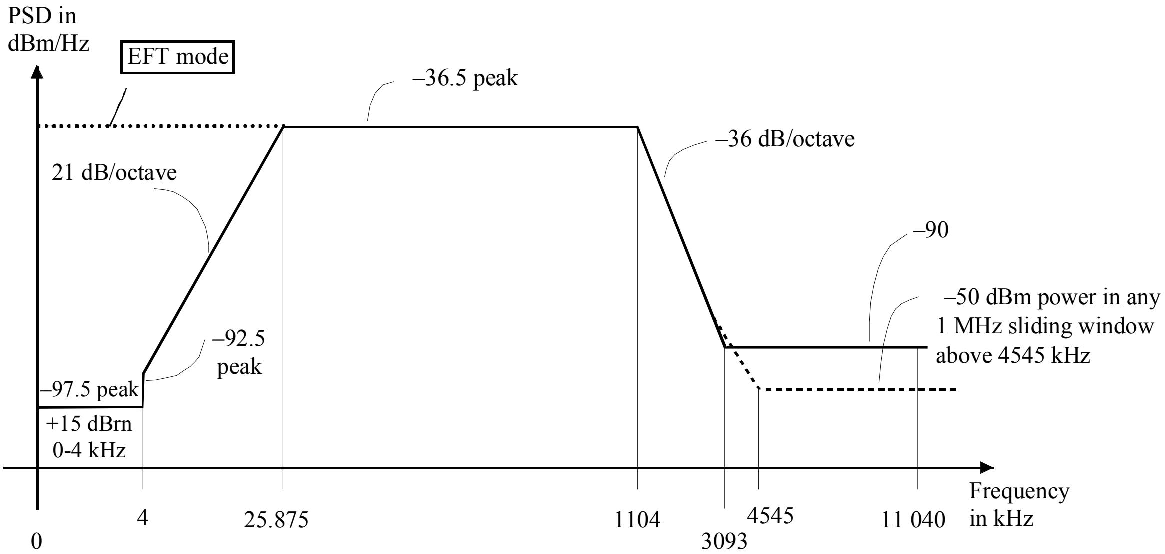
H.5.5 Modulation (pertains to 7.11)

H.5.5.1 Inverse synchronization symbol (replaces 7.11.4)

Except for the pilot tone, Inverse synchronization symbol shall be generated from a tone-by-tone 180 degree phase reversal of Synchronization symbol (i.e. + maps to –, and – maps to +, for each of the 4-QAM signal constellation).

H.5.6 ATU-C downstream transmit spectral mask (replaces 7.14)

Figure H.12 shows the spectral mask for the transmit signal.



Frequency band f (kHz)	Equation for line (dBm/Hz)	
	AFT mode	EFT mode
$0 < f < 4$	–97.5, with max power in the in 0-4 kHz band of +15 dBrn	–36.5
$4 < f < 25.875$	$-92.5 + 21 \times \log_2 (f/4)$	–36.5
$25.875 < f < 1104$	–36.5	
$1104 < f < 3093$	$-36.5 - 36 \times \log_2 (f/1104)$	
$3093 < f < 4545$	–90 peak, with max power in the $[f, f + 1 \text{ MHz}]$ window of $(-36.5 - 36 \times \log_2 (f/1104) + 60)$ dBm	
$4545 < f < 11040$	–90 peak, with max power in the $[f, f + 1 \text{ MHz}]$ window of –50 dBm	

NOTE 1 – All PSD measurements are in 100 Ω; the POTS band total power measurement for AFT mode is in 600 Ω.

NOTE 2 – The breakpoint frequencies and PSD values are exact; the indicated slopes are approximate.

NOTE 3 – The peak PSD shall be measured with a 10 kHz resolution bandwidth.

NOTE 4 – The power in a 1 MHz sliding window is measured in a 1 MHz bandwidth, starting at the measurement frequency.

NOTE 5 – All PSD and power measurements shall be made using only the whole period of the $FEXT_R$ duration at the U-C interface (see H.3.1).

T1535510-00

Figure H.12/G.992.1 – ATU-C transmitter PSD mask

H.6 ATU-R functional characteristics (supplements clause 8)

Only framing structure 3 in Table 7-1 (Reduced overhead with merged fast and sync byte) is used for this annex. The ATU-R shall not transmit any signal in $NEXT_C$ duration.

H.6.1 STM transmission protocols specific functionalities (pertains to 8.1)

H.6.1.1 ATU-R input and output T interface for STM transport (replaces figure in 8.1.1)

See Figure 8.1 with only LS0 available.

H.6.2 ATM transmission protocols specific functionalities (pertains to 8.2)

H.6.2.1 ATU-R input and output T interface for ATM transport (replaces figure in 8.2.1)

See Figure 8.2 with only ATM0 available.

H.6.3 Framing (pertains to 8.4)

H.6.3.1 Superframe structure (replaces 8.4.1.1)

The superframe structure of ATU-R transmitter is identical to that of ATU-C transmitter, as specified in H.5.3.1.

H.6.3.2 Hyperframe structure (replaces 8.4.1.3)

The hyperframe structure of ATU-R transmitter is functionally similar to that of ATU-C transmitter, except that the inverse synch symbol is used in the 1st superframe (SPF #0) (see Figure H.13). The hyperframe is composed of 345 DMT symbols, numbered from 0 to 344. Each symbol is under $FEXT_C$ or $NEXT_C$ duration (see H.2), and the following numerical formula gives the information which duration N_{dmt}-th DMT symbol belongs to at ATU-R transmitter (see Figure H.14).

For $N_{dmt} = 0, 1, \ldots, 344$

$S = 272 \times N_{dmt} \bmod 2760$

if { (S > a) and (S + 271 < a + b) } then $FEXT_C$ symbol

else then $NEXT_C$ symbol

where a = 1315, b = 1293

128 DMT symbols are allocated in the $FEXT_C$ duration, and 217 DMT symbols are allocated in the $NEXT_C$ duration. The symbols are composed of:

$FEXT_C$ symbol:

Number of symbol using Bitmap-H_C	= 126
Number of synch symbol	= 1
Number of inverse synch symbol	= 1

The ATU-R shall not transmit any signal in $NEXT_C$ duration.

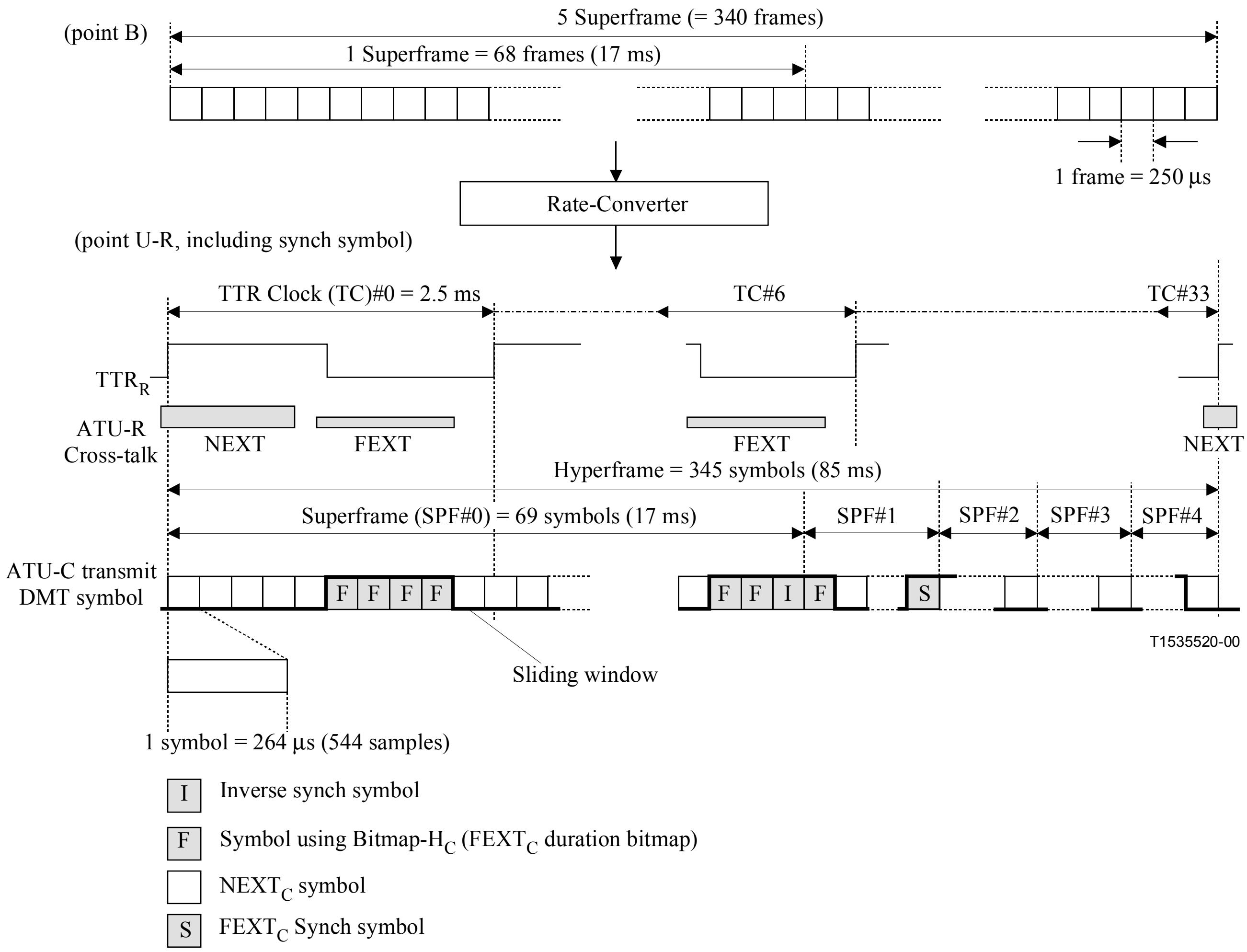


Figure H.13/G.992.1 – Hyperframe structure for upstream

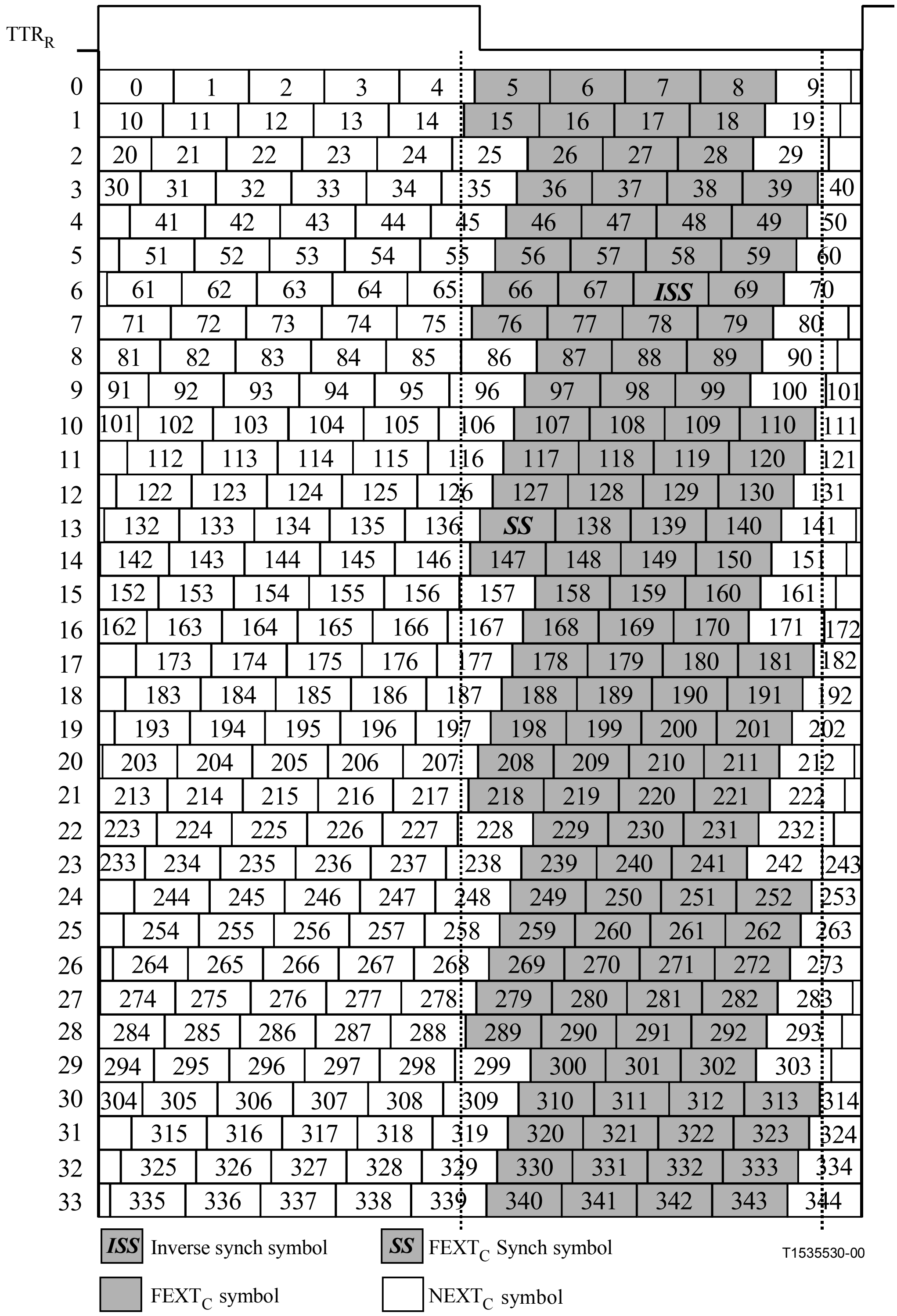


Figure H.14/G.992.1 – Symbol pattern in a hyperframe with cyclic prefix – upstream

H.6.3.3 Subframe structure (replaces 8.4.1.4)

A subframe is 10 consecutive DMT symbols (except for those noted in Table H.3). The 34 subframes form a hyperframe.

Table H.3/G.992.1 – Subframe (upstream)

Subframe No.	DMT symbol No.	Note
0	0-9	
1	10-19	
2	20-29	
3	30-39	
4	40-49	
5	50-59	
6	60-70	#68 is Inverse Synch Symbol
7	71-80	
8	81-90	
9	91-100	
10	101-110	
11	111-120	
12	121-130	
13	131-141	#137 is Synch Symbol
14	142-151	
15	152-161	
16	162-171	
17	172-181	
18	182-191	
19	192-201	
20	202-212	11 DMT symbols for this subframe
21	213-222	
22	223-232	
23	233-242	
24	243-252	
25	253-262	
26	263-272	
27	273-283	11 DMT symbols for this subframe
28	284-293	
29	294-303	
30	304-313	
31	314-323	
32	324-333	
33	334-344	11 DMT symbols for this subframe

H.6.3.4 Framing for 1.544 Mbit/s STM data mode (new)

A special framing mode is optionally specified to support symmetric 1.544 Mbit/s STM data rate, which is not a multiple of 32 kbit/s, as Table H.2. This framing mode shall be selected during handshake process as specified in H.8.2 and H.8.3.

H.6.4 Bitmapping and rate conversion (replaces 8.15)

H.6.4.1 Bitmapping (new)

Data transmission is only allowed by $FEXT_C$ symbols using Bitmap-H_C, which is synchronized with the sliding window pattern of $NEXT_C$/$FEXT_C$ symbols.

H.6.4.2 Rate converter (new)

The rate converter buffering changes the data frame boundaries between the reference points B and C according to Bitmap-H_C and the Sliding Window. The rate converter has to be prepared for each interleaved path and fast path independently. The relation of data amount at the reference points B and C shall be calculated with the following formulae.

For the interleaved path,

t_C is selected so that:

$$126\left[\frac{symbol}{hyperframe}\right]\times(f_C-1)\left[\frac{bit}{symbol}\right]<340\left[\frac{frame}{hyperframe}\right]\times t_C\left[\frac{bit}{frame}\right]\leq 126\left[\frac{symbol}{hyperframe}\right]\times f_C\left[\frac{bit}{symbol}\right]$$

where:

- t_C is the number of payload- and overhead-bits in one frame at the reference point B; and
- f_C is the number of payload- and overhead-bits in one $FEXT_C$ symbol at the reference point C.

The rate converter inserts dummy bits at the end of the hyperframe to ensure the bits per hyperframe are equivalent at the reference points B and C.

$$\#dummy_C\left[\frac{bit}{hyperframe}\right]=126\left[\frac{symbol}{hyperframe}\right]\times f_C\left[\frac{bit}{symbol}\right]-340\left[\frac{frame}{hyperframe}\right]\times t_C\left[\frac{bit}{frame}\right]$$

For the fast path,

t_C is selected so that:

$$3\left[\frac{symbol}{subframe}\right]\times(f_C-1)\left[\frac{bit}{symbol}\right]<10\left[\frac{frame}{subframe}\right]\times t_C\left[\frac{bit}{frame}\right]\leq 3\left[\frac{symbol}{subframe}\right]\times f_C\left[\frac{bit}{symbol}\right]$$

The rate converter inserts dummy bits at the end of the subframe to ensure the bits per subframe are equivalent at the reference points B and C.

For the subframe containing 3 $FEXT_C$ symbols except for synch symbols:

$$\#dummy_{C3}\left[\frac{bit}{subframe}\right]=3\left[\frac{symbol}{subframe}\right]\times f_C\left[\frac{bit}{symbol}\right]-10\left[\frac{frame}{subframe}\right]\times t_C\left[\frac{bit}{frame}\right]$$ at the end of subframe.

For the subframe containing 4 $FEXT_C$ symbols except for synch symbols:

$$\#dummy_{SC}\left[\frac{bit}{symbol}\right]=f_C\left[\frac{bit}{symbol}\right]-10\left[\frac{frame}{subframe}\right]\times t_C\left[\frac{bit}{frame}\right]/4\left[\frac{symbol}{subframe}\right]$$ at the end of each $FEXT_C$ symbol.

At the receiver, the inserted dummy bits shall be removed.

The receiver shall determine Bitmap-H_C so that the number of dummy bits is less than 126 in initialization sequence.

NOTE – In the case of 1.544 Mbit/s STM data mode, the formulae described above shall be also applied because t_C is the number of payload- and overhead-bits in one frame.

H.6.5 Modulation (pertains to 8.11)

H.6.5.1 Maximum number of carriers for upstream signal (new)

Upstream signal allows for a maximum of 255 carriers (at frequencies $n\Delta f$, n = 1 to 255) to be used.

H.6.5.2 Inverse synchronization symbol (replaces 8.11.4)

Inverse synchronization symbol shall be generated from a tone-by-tone 180 degree phase reversal of synchronization symbol (i.e. + maps to –, and – maps to +, for each of the 4-QAM signal constellation).

H.6.5.3 Gain scaling in synchronization symbol (new)

At initialization time, the sync symbol reference transmit PSD level shall be set at the nominal PSD level +10 log (g_{sync}^2) dBm/Hz, with g_{sync}^2 defined as the average g_i^2 value over the used (i.e. $b_i>0$) subcarriers in the NEXT or FEXT bitmap, whichever results in the highest average gain. The sync symbol reference transmit PSD shall not be updated with used subcarrier gain changes during SHOWTIME.

H.6.6 ATU-R upstream transmit spectral mask (supplements 8.14)

The upstream spectral mask is the same as the downstream transmit spectral mask in H.5.6.

All PSD and power measurements shall be made using only the whole period of the $FEXT_C$ duration at the U-R interface.

H.7 EOC operations and maintenance (pertains to clause 9)

H.7.1 ADSL line related primitives (supplements 9.3.1)

H.7.1.1 ADSL line related near-end defects (supplements 9.3.1.3)

Two near-end defects are further defined:

- *Loss-of-signal (LOS)*: The ADSL power shall be measured only in the $FEXT_C$ duration at ATU-C, or only in the $FEXT_R$ duration at ATU-R.
- *Severely errored frame (SEF)*: A SEF defect occurs when the content of two consecutively received ADSL synchronization symbols in the $FEXT_C$ duration at ATU-C, or in the $FEXT_R$ duration at ATU-R, does not correlate with the expected content over a subset of the tones. An SEF defect terminates when the content of two consecutively received ADSL synchronization symbols in the $FEXT_C$ duration at ATU-C, or in the $FEXT_R$ duration at ATU-R, correlate with the expected contents over the same subset. The correlation method, the selected subset of tones, and the threshold for declaring these defect conditions are implementation discretionary.

H.7.1.2 ADSL line related far-end defects (supplements 9.3.1.4)

Loss-of-signal is further defined:

- *Loss-of-signal (LOS)*: The ADSL power shall be measured only in the $FEXT_C$ duration at ATU-C, or only in the $FEXT_R$ duration at ATU-R.

H.7.2 Test Parameters (supplements 9.5)

H.7.2.1 Near-end test parameters (supplements 9.5.1)

The near-end primitives are further defined:

- *Attenuation (ATN)*: The received signal power shall be measured only in the $FEXT_C$ duration at ATU-C, or only in the $FEXT_R$ duration at ATU-R.
- *Signal-to-Noise ratio (SNR) margin*: During FEXT Bitmap mode, this primitive represents the snr margin in the $FEXT_C$ duration at ATU-C, or in the $FEXT_R$ duration at ATU-R.

H.7.2.2 Far-end test parameters (supplements 9.5.2)

The far-end primitives are further defined:

- *Attenuation (ATN)*: The received signal power shall be measured only in the $FEXT_C$ duration at ATU-C, or only in the $FEXT_R$ duration at ATU-R.
- *Signal-to-Noise ratio SNR margin*: During FEXT Bitmap mode, this primitive represents the snr margin in the $FEXT_C$ duration at ATU-C, or in the $FEXT_R$ duration at ATU-R.

H.8 Initialization

H.8.1 Initialization with hyperframe (replaces 10.1.5)

The training and the exchange of messages between ATU-C and ATU-R should be performed in $FEXT_C$ and $FEXT_R$. The DMT symbol has two symbol rates: one is 4.3125 kbaud for the symbol without a cyclic prefix, and the other is $4 \times 69/68$ kbaud for the symbol with a cyclic prefix. 32 times of the TTR has the same period as 345 times of the 4.3125 kbaud, and 34 times of the TTR is the same as 345 times of $4 \times 69/68$ kHz. No signal including pilot tone and A_{48} are transmitted in $NEXT_{R/C}$ duration.

The ATU-C begins transmitting C-PILOT1 at the beginning of the hyperframe without cyclic prefix. The ATU-C informs the phase of the TTR to ATU-R during C-PILOT1. The ATU-R begins transmitting R-PCALC at the beginning of the hyperframe without cyclic prefix. The ATU-R performs the training of any receiver equalizer using this phase information of the TTR.

From C-PILOT1 to C-SEGUE1, the following numerical formula gives the information which duration N_{dmt}-th DMT symbol belongs to at ATU-R (see Figure H.15).

For $N_{dmt} = 0, 1, \ldots, 344$

$S = 256 \times N_{dmt} \bmod 2760$

if { (S + 255 < a) or (S > a + b) } then $FEXT_R$ symbols

else then $NEXT_R$ symbols

where a = 1243, b = 1461

In order to enter C-RATES1 at the beginning of the hyperframe with cyclic prefix, the number of symbols from C-PILOT1 to C-SEGUE1 shall be a multiple of 345 DMT symbols.

From R-PCALC to R-SEGUE1, the following numerical formula gives the information which duration N_{dmt}-th symbol belongs to at ATU-C (see Figure H.16).

For $N_{dmt} = 0, 1, \ldots, 344$

$S = 256 \times N_{dmt} \bmod 2760$

if { (S > a) and (S + 255 < a + b) } then $FEXT_C$ symbols

else then $NEXT_C$ symbols

where $a = 1315$, $b = 1293$

From C-RATES1 to C-SEGUE3, the number of symbols is a multiple of 345 DMT symbols. The following numerical formula gives the information which duration N_{dmt}-th DMT symbol belongs to. ATU-C transmits the message data in $FEXT_R$ symbols (see Figure H.11).

For $N_{dmt} = 0, 1, ..., 344$

$S = 272 \times N_{dmt} \bmod 2760$

if { $(S + 271 < a)$ or $(S > a + b)$ } then $FEXT_R$ symbols

else then $NEXT_R$ symbols

where $a = 1243$, $b = 1461$

The ATU-R enters R-REVERB3 at the beginning of the hyperframe with cyclic prefix, which is extracted from received signal. From R-REVERB3 to R-SEGUE5, the number of symbols is a multiple of 345 DMT symbols. The following numerical formula gives the information which duration N_{dmt}-th DMT symbol belongs to. ATU-R transmits the message data in $FEXT_C$ symbols (see Figure H.14).

For $N_{dmt} = 0, 1, ... 344$

$S = 272 \times N_{dmt} \bmod 2760$

if { $(S > a)$ and $(S + 271 < a + b)$ } then $FEXT_C$ symbols

else then $NEXT_C$ symbols

where $a = 1315$, $b = 1293$

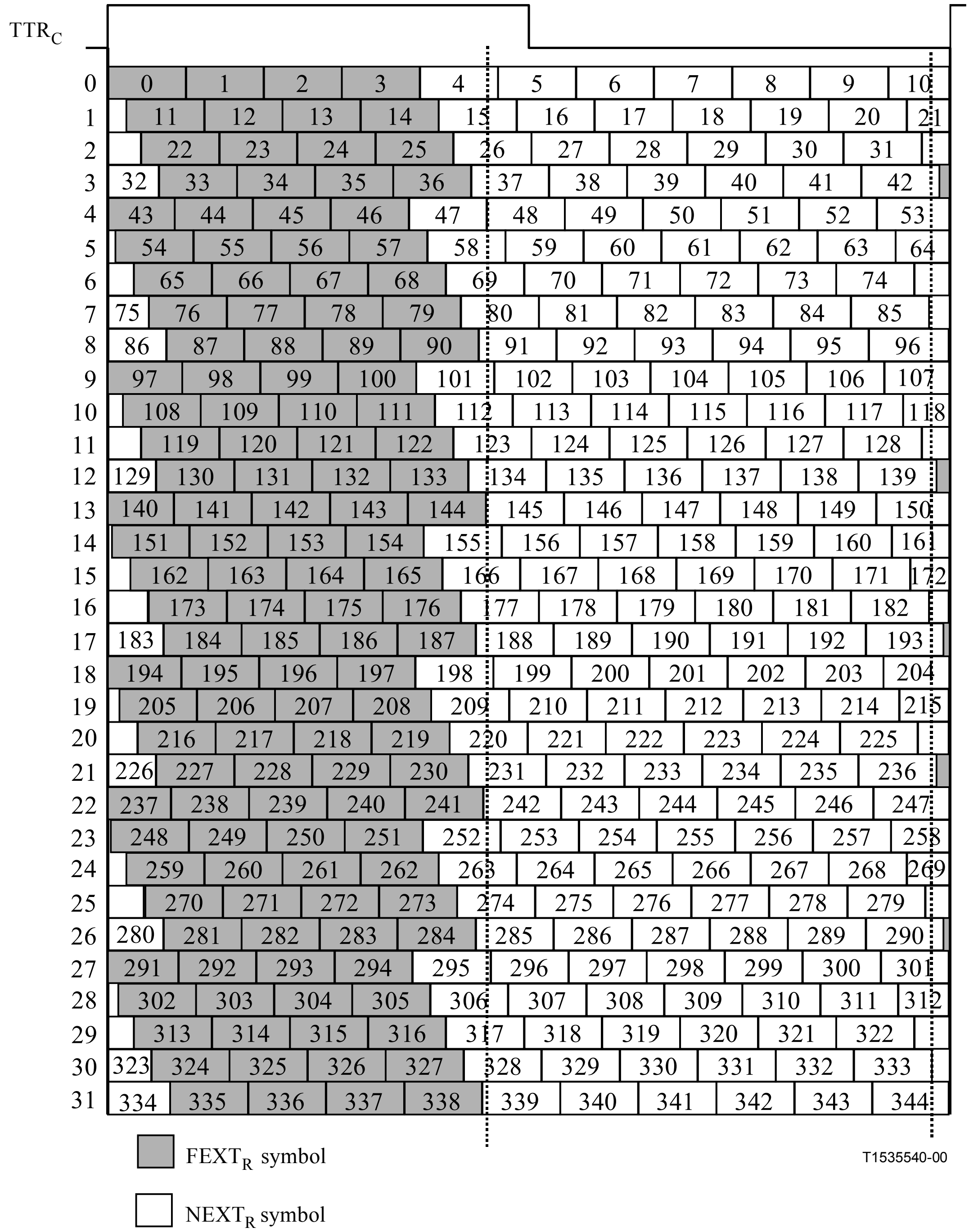


Figure H.15/G.992.1 – Symbol pattern in a hyperframe without cyclic prefix – Downstream

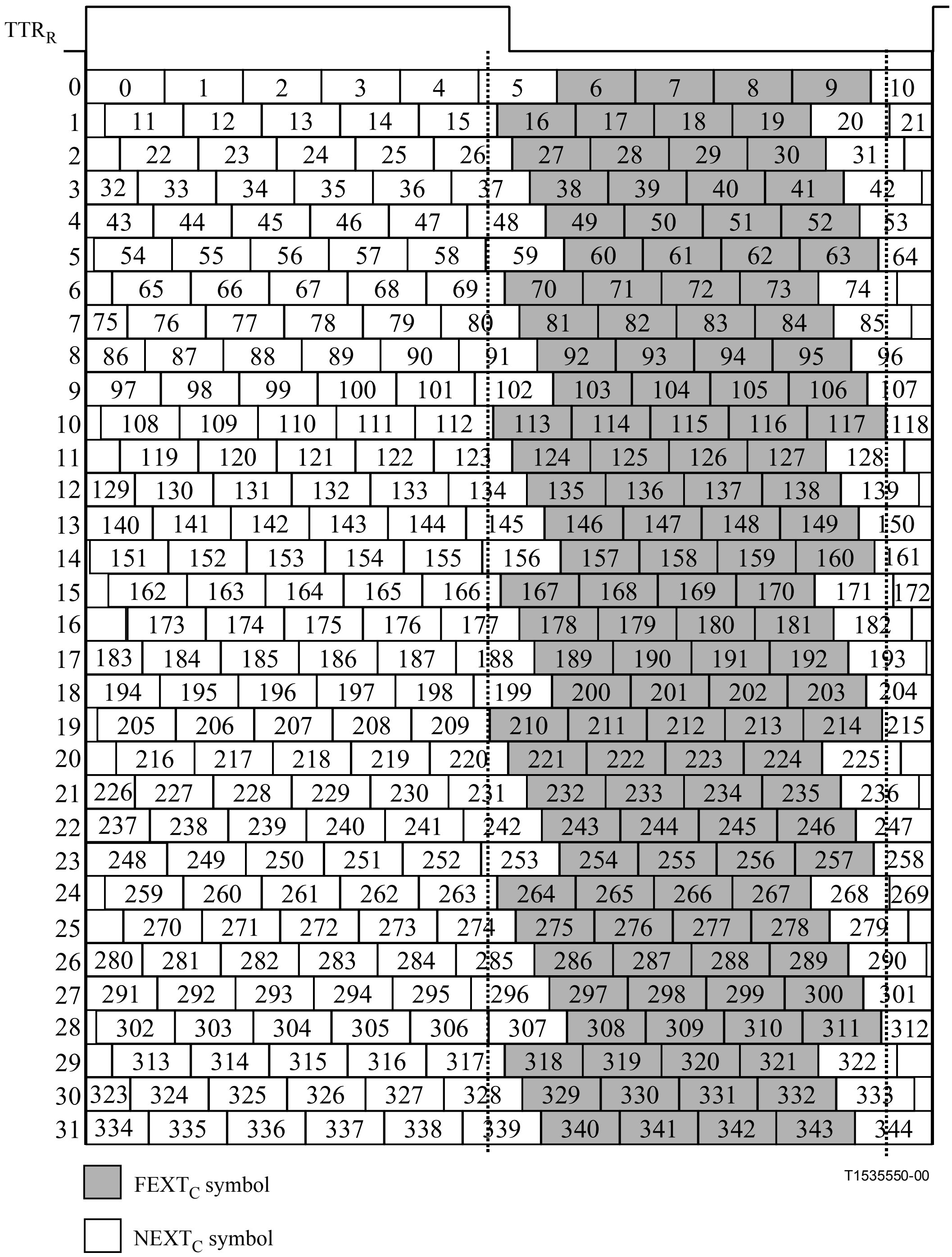


Figure H.16/G.992.1 – Symbol pattern in a hyperframe without cyclic prefix – Upstream

H.8.2 Handshake – ATU-C (supplements 10.2)

H.8.2.1 CL messages (supplements 10.2.1)

See Table H.4.

Table H.4/G.992.1 – ATU-C CL message NPar(2) bit definitions for Annex H

NPar(2) bit	Definition
EFT	If set to ONE, signifies that the ATU-C is capable of transmitting and receiving data on tones #1-#5 with low frequency expanded PSD.
Fast path	If set to ONE, signifies that the ATU-C is capable of using fast path.
1.544 Mbit/s	If set to ONE, signifies that the ATU-C is capable of the optional 1.544 Mbit/s STM data transmission mode.

H.8.2.2 MS messages (supplements 10.2.2)

See Table H.5.

Table H.5/G.992.1 – ATU-C MS message NPar(2) bit definitions for Annex H

NPar(2) bit	Definition
EFT	If set to ONE, signifies that both ATU-C and ATU-R are allowed to transmit and receive data on tones #1-#5 with low frequency expanded PSD.
Fast path	If set to ONE, signifies that both upstream and downstream shall use fast path.
1.544 Mbit/s	If set to ONE, signifies that symmetric 1.544 Mbit/s STM data transmission mode shall be selected.

H.8.3 Handshake – ATU-R (supplements 10.3)

H.8.3.1 CLR messages (supplements 10.3.1)

See Table H.6.

Table H.6/G.992.1 – ATU-R CLR message NPar(2) bit definitions for Annex H

NPar(2) bit	Definition
EFT	If set to ONE, signifies that the ATU-R is capable of transmitting and receiving data on tones #1-#5 with low frequency expanded PSD.
Fast path	If set to ONE, signifies that the ATU-R is capable of using fast path.
1.544 Mbit/s	If set to ONE, signifies that the ATU-R is capable of the optional 1.544 Mbit/s STM data transmission mode.

H.8.3.2 MS messages (supplements 10.3.2)

See Table H.7.

Table H.7/G.992.1 – ATU-R MS message NPar(2) bit definitions for Annex H

NPar(2) bit	Definition
EFT	If set to ONE, signifies that both ATU-C and ATU-R are allowed to transmit and receive data on tones #1-#5 with low frequency expanded PSD.
Fast path	If set to ONE, signifies that both upstream and downstream shall use fast path.
1.544 Mbit/s	If set to ONE, signifies that symmetric 1.544 Mbit/s STM data transmission mode shall be selected.

H.8.4 Transceiver training – ATU-C (supplements 10.4)

ATU-C shall transmit signals only during $FEXT_R$ symbol period, and transmit no signals including pilot tone during $NEXT_R$ symbol period. The duration of each state is defined in Figure H.18.

H.8.4.1 C-QUIET2 (supplements 10.4.1)

For EFT mode, L1-to-L2 capacitance (H.10.1) at the transceiver input shall be switched during C-QUIET2.

H.8.4.2 C-PILOT1 (supplements 10.4.2)

The ATU-C shall start the N_{SWF} (sliding window frame) counter from 0 immediately after entering C-PILOT1, and increment the N_{SWF} counter modulo 345 after transmission of each DMT symbol. According to the sliding window function and this counter, the ATU-C decides to transmit all of the subsequent symbols in $FEXT_R$ symbols (for example, see Figure H.11 and Figure H.15).

C-PILOT1 has two subcarriers.

The first carrier is the pilot tone as a single frequency sinusoid $f_{\text{C-PILOT1}}$ = 276 kHz ($n_{\text{C-PILOT1}}$ = 64) (see 10.4.2).

The second carrier (A_{48}) is used to transmit $NEXT_R/FEXT_R$ information. Since this annex does not transmit any signal during $NEXT_R$ symbol period, the 48th carrier with 2-bit constellation shall be encoded during $FEXT_R$ symbol period as follows:

(+ , –); indicates the first and the last symbol in consecutive $FEXT_R$ symbols.

(+ , +); indicates the other symbols in consecutive $FEXT_R$ symbols.

H.8.4.3 C-PCALC (new)

C-PCALC is a signal that allows the ATU-R receiver to calculate the upstream power cut-back level. C-PCALC contains the 7-18th subcarriers and the 64th pilot carrier.

The data pattern used in C-PCALC shall be the subset of pseudo-random downstream sequence (PRD), d_n for n = 15 to 38, defined in 7.11.3. The two bits pairs ($d_{2\times i+1}$ and $d_{2\times i+2}$) shall be used to define the X_i and Y_i for i = 7 to 18 as defined in Table 7-13. The PRD shall be re-initialized for each symbol, so each symbol of C-PCALC is identical. The transmit power of C-PCALC is –40 dBm/Hz in $FEXT_R$ duration.

H.8.4.4 ATU-C power cut-back (new)

The nominal transmit PSD for C-REVERB1 is –40 dBm/Hz (i.e. –3.65 dBm total transmit power in any 4.3125 kHz wide sliding window over the used passband) in $FEXT_R$ duration. If, however, the total upstream power measured on subcarriers 7-18 during R-PCALC is greater than 1 dBm, then the PSD for C-REVERB1 and all subsequent downstream signals shall be reduced to a level of $-40 -2n_{PCB}$ dBm/Hz with $n_{PCB} = 0$ to 6 as shown in following Table H.8.

Table H.8/G.992.1 – Power cut-back: downstream PSD as a function of upstream received power

Upstream received power (dBm) <	1	2	3	4	5	6	7
Max downstream PSD (dBm/Hz)	–40	–42	–44	–46	–48	–50	–52

This chosen level shall become the reference level for all subsequent gain calculations.

H.8.5 Transceiver training – ATU-R (supplements 10.5)

ATU-R shall transmit signals only during $FEXT_C$ symbol period, and transmit no signals during $NEXT_C$ symbol period. The duration of each state is defined in Figure H.18.

H.8.5.1 R-QUIET2 (supplements 10.5.1)

During the transmission of R-QUIET2, the ATU-R enters R-PCALC after it completes timing recovery and hyperframe synchronization from C-PILOT1.

For EFT mode, L1-to-L2 capacitance (H.10.1) at the transceiver input shall be switched during R-QUIET2.

H.8.5.2 R-PCALC (new)

R-PCALC is the same signal as C-PCALC except that the 64th pilot carrier shall not be transmitted.

ATU-R shall start transmission of R-PCALC with the beginning of hyperframe.

H.8.5.3 R-REVERB1 (supplements 10.5.2)

The data pattern for the pseudo-random upstream sequence (PRU) is replaced by formula (10.1) in 10.4.5. The same formula (10.1) is used as the PRU for the subsequent R-REVERB and R-SEGUE.

H.8.5.4 ATU-R Power Cut-back (new)

The power cut-back for R-REVERB1 and all subsequent upstream signals is calculated during C-PCALC as same as ATU-C power cut-back (see H.8.4.4).

H.8.5.5 R-REVERB2 (supplements 10.5.5)

After ATU-R detects C-SEGUE1, the ATU-R enters R-SEGUE1. The duration of R-REVERB2 is 3781 DMT symbols.

H.8.6 Channel analysis (ATU-C) (supplements 10.6)

ATU-C shall transmit signals only during $FEXT_R$ symbol period, and transmit no signals including pilot tone during $NEXT_R$ symbol period. The duration of each state is defined in Figure H.18.

H.8.6.1 C-MSG1 (pertains to 10.6.4)

H.8.6.1.1 Overlapped Spectrum option – Bit 16 (replaces 10.6.4.3)

m_{16} is reserved for future use.

H.8.6.2 C-MEDLEY (supplements 10.6.6)

Basically, the definition of C-MEDLEY is the same as 10.6.6, except for the duration of the SNR estimation at ATU-R for the downstream. With the periodical noise of TCM-ISDN, SNR also changes in the same cycle, as shown in Figure H.17. The ATU-C transmits the signal only in $FEXT_R$ symbols, and the ATU-R estimates SNR only from the received $FEXT_R$ symbols, as defined in Figure H.11.

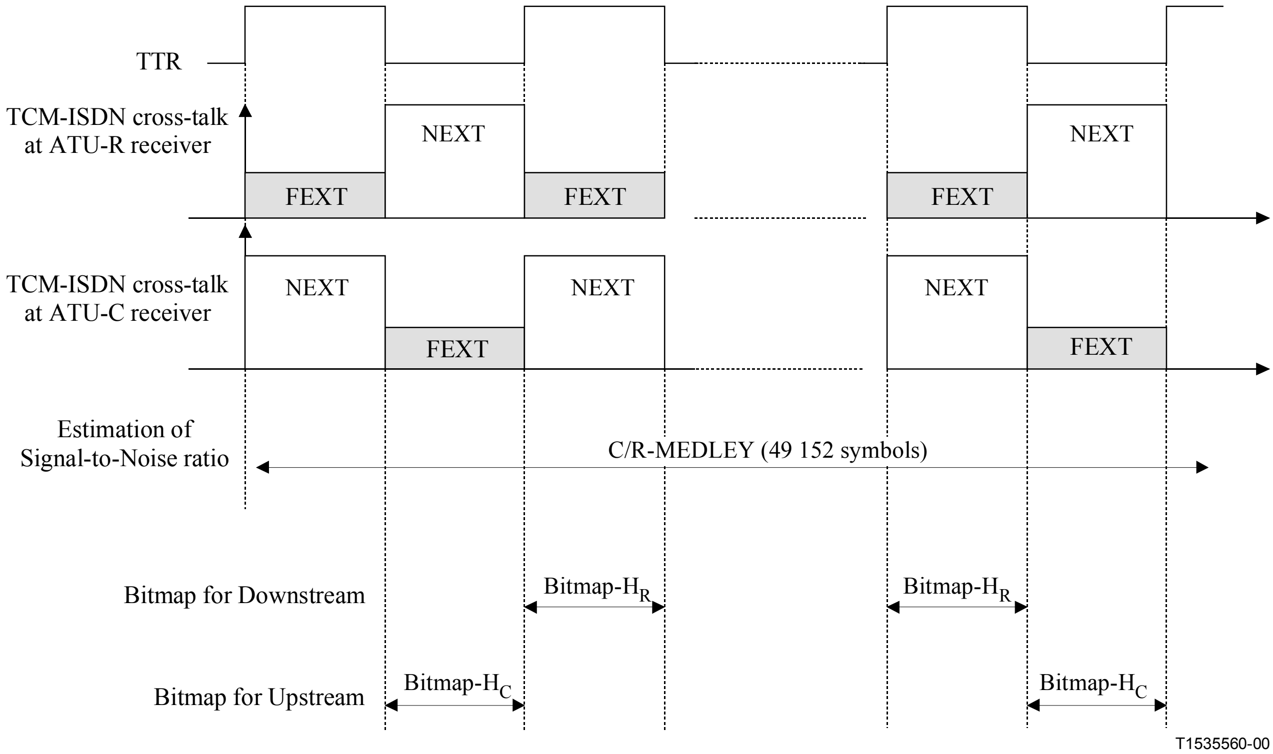


Figure H.17/G.992.1 – Estimation of periodic Signal-to-Noise ratio

H.8.7 Channel analysis (ATU-R) (supplements 10.7)

ATU-R shall transmit signals only in the whole period of $FEXT_C$ duration, and transmit no signals in the whole period of $NEXT_C$ duration. The duration of each state is defined in Figure H.18.

H.8.7.1 R-MEDLEY (supplements 10.7.8)

ATU-R shall not transmit signals in $NEXT_C$ duration. The data to be transmitted are derived from the pseudo-random sequence PRU defined in H.8.5.3. Basically, the definition of R-MEDLEY is the same as 10.7.8, except for the duration of the SNR estimation at ATU-C for the upstream. With the periodical noise of TCM-ISDN, SNR also changes in the same cycle. ATU-R shall transmit the signal only in $FEXT_C$ symbols, and ATU-C shall estimate two SNRs from the received $FEXT_C$ symbols, as defined in Figure H.14.

H.8.8 Exchange – ATU-C (supplements 10.8)

ATU-C shall transmit signals only in the whole period of $FEXT_R$ duration, and shall not transmit signals including pilot tone in the whole period of $NEXT_R$ duration. The duration of each state is defined in Figure H.19.

H.8.8.1 C-MSG2 (supplements 10.8.9)

$N_{1C\text{-}MSG2} = 43$

$N_{2C\text{-}MSG2} = 91$

C-MSG2 transmits a 32-bit message signal to the ATU-R. The message components for C-MSG2 are the same as R-MSG2 which are defined in Table 10-18.

The bits of which suffix i is 0 to 11, represent the maximum number of bits per frame defined at the reference point B.

H.8.8.1.1 Total number of bits per symbol supported (replaces 10.8.9.3)

The total number of bits per symbol supported is not defined. However, the total number of bits per frame supported is defined in H.8.8.1.2.

H.8.8.1.2 Total number of bits per frame supported (new)

The maximum number of bits per frame is defined at the reference point B. It is calculated from the $FEXT_C$ upstream channel performance (e.g. if the maximum number of bits that can be supported in $FEXT_C$ symbols is 170, {Total number of bits per frame supported} = 170 × 126 / 340 = 63).

The number of frames per hyperframe is 340. The number of $FEXT_C$ symbols per hyperframe is 126.

H.8.8.2 C-RATES2 (supplements 10.8.11)

NOTE – Upstream rate and downstream rate may differ.

H.8.8.3 C-B&G (replaces 10.8.13)

C-B&G shall be used to transmit to the ATU-R the bits and gains information, $\{b_1, g_1, b_2, g_2, \ldots b_{255}, g_{255}\}$, that are to be used on the upstream carriers. b_i indicates the number of bits to be coded by ATU-R transmitter onto the i th upstream carrier in $FEXT_C$ symbols; g_i indicates the scale factor, relative to the gain that was used for that carrier during the transmission of R-MEDLEY, that shall be applied to the i th upstream carrier in $FEXT_C$ symbols. Because no bits or energy will be transmitted at DC or one-half the sampling rate, b_0, g_0, b_{256}, and g_{256} are all presumed to be zero and shall not be transmitted. The C-B&G information shall be mapped in a 4080-bit (510-byte) message m defined by:

$$m = \{m_{4079}, m_{4078}, \ldots, m_1, m_0\} = \{ g_{255}, b_{255}, \ldots, g_1, b_1\}, \qquad \text{(H.10.9)}$$

with the MSB of b_i and g_i in the higher m index and m_0 being transmitted first. The message m shall be transmitted in 510 symbols, using the transmission method as described in 10.8.9.

H.8.9 Exchange – ATU-R (supplements 10.9)

ATU-R shall transmit signals only in the whole period of $FEXT_C$ duration, and shall not transmit signals in the whole period of $NEXT_C$ duration. The duration of each state is defined in Figure H.19.

H.8.9.1 R-MSG-RA (supplements 10.9.2)

Table 10-15 shall be used for R-MSG-RA.

H.8.9.1.1 Total number of bits supported (B_{max}) (replaces 10.9.2.8)

This parameter shall be defined as in R-MSG2, see H.8.9.2.

H.8.9.2 R-MSG2 (supplements 10.9.8)

$N_{1R\text{-}MSG2} = 10$

$N_{2R\text{-}MSG2} = 20$

H.8.9.2.1 Total number of bits per symbol supported (supplements 10.9.8.3)

Total number of bits per symbol supported is not defined. On the other hand, that per frame is defined in H.8.9.2.2.

H.8.9.2.2 Total number of bits per frame supported (new)

The maximum number of bits per frame is defined at the reference point B. It is calculated from the $FEXT_R$ downstream channel performance (e.g. if the maximum number of bits that can be supported in $FEXT_R$ symbols is 170, {Total number of bits per frame supported} = $170 \times 126 / 340 = 63$).

The number of frames per hyperframe is 340. The number of $FEXT_R$ symbols per hyperframe is 126. See Figure H.18.

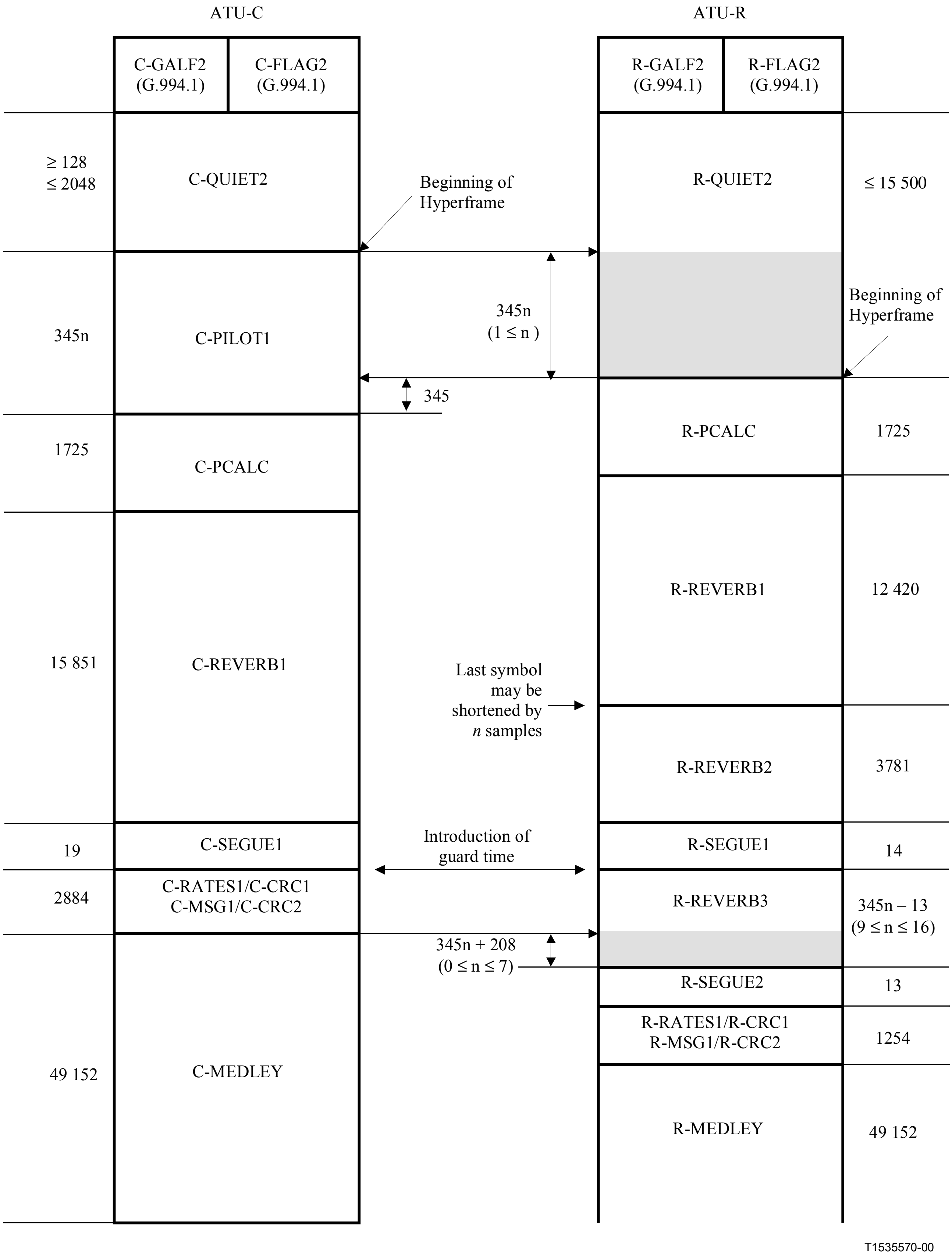
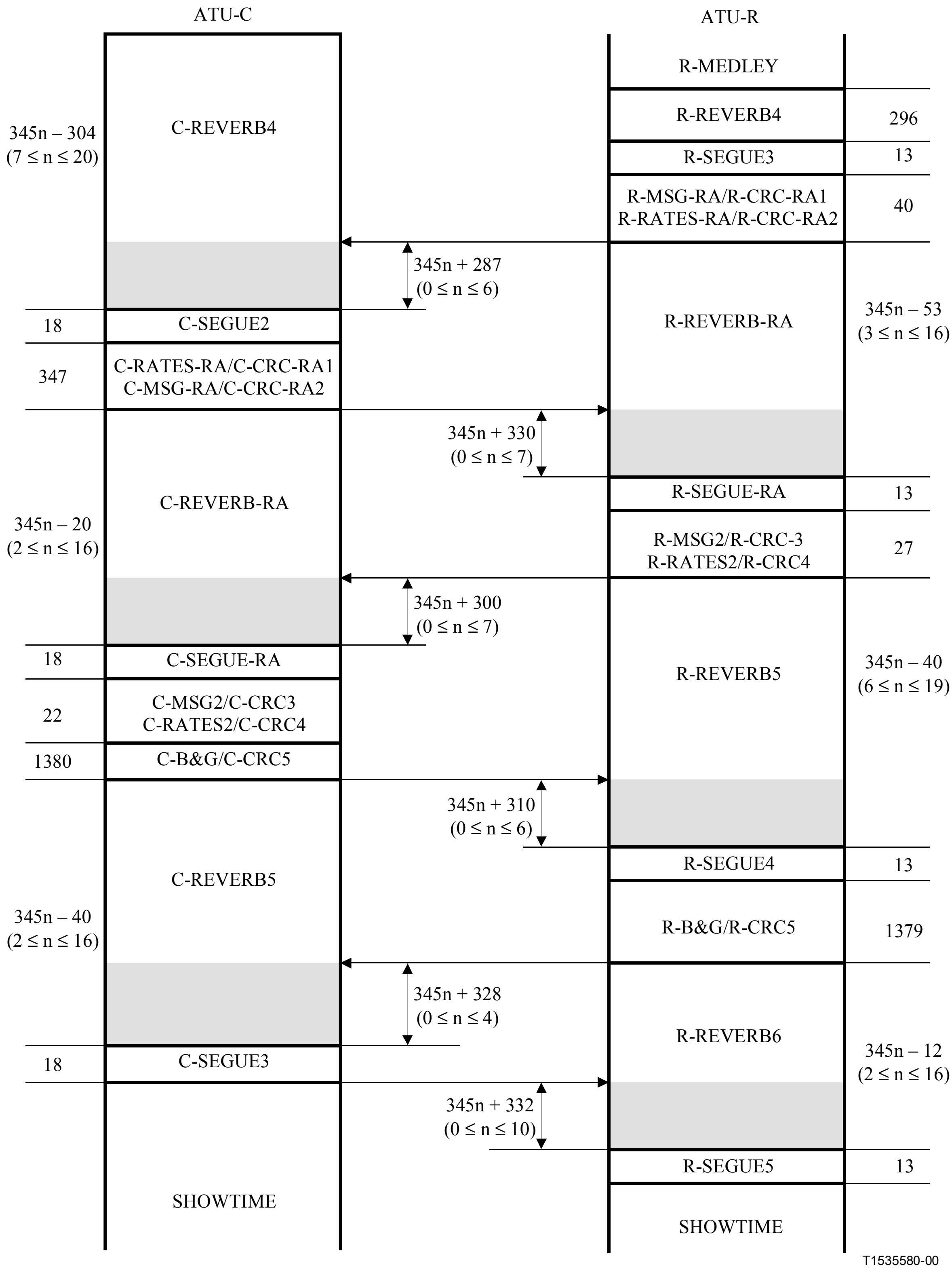


Figure H.18/G.992.1 – Timing diagram of the initialization sequence (*part 1*)



NOTE – The ATU-C shall transmit in the whole period of the $FEXT_R$ duration, and shall not transmit in the whole period of the $NEXT_R$ duration. The ATU-R shall transmit in the whole period of the $FEXT_C$ duration, and shall not transmit in the whole period of the $NEXT_C$ duration.

Figure H.19/G.992.1 – Timing diagram of the initialization sequence *(part 2)*

H.9 AOC on-line adaptation and reconfiguration (pertains to clause 11)

H.9.1 Bit swap acknowledge (supplements 11.2.5)

The bit swap superframe counter number shall only indicate the last superframe (SPF #4) of a hyperframe.

The new bit and/or transmit power table(s) shall then take effect starting from the first frame (frame 0) of SPF #0 of a hyperframe.

If the bit swap superframe counter number contained in the received bit swap acknowledge message does not indicate SPF #4, then the new table(s) shall take effect starting from frame 0 of SPF #0 of the next hyperframe.

H.10 Electrical characteristic (new)

H.10.1 L1-to-L2 capacitance (new)

For AFT mode, the L1-to-L2 capacitance at the transceiver input is identical to E.4.2.6.1.

For EFT mode, the L1-to-L2 capacitance at the transceiver input shall be 1µF ±10% (DC-30Hz). As for ATU-C, the capacitance shall be switched during C-QUIET2. From C-SILENT1 (11.1/G.994.1) to the switching, the capacitance shall be identical to E.4.2.6.1. As for ATU-R, the capacitance shall be switched during R-QUIET2. From R-SILENT0 (11.1/G.994.1) to the switching, the capacitance shall be identical to E.4.2.6.1.

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