



INTERNATIONAL TELECOMMUNICATION UNION

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

G.992.2

Amendment 1
(03/2003)

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

Digital sections and digital line system – Access networks

Splitterless asymmetric digital subscriber line
(ADSL) transceivers

Amendment 1: Revised Annex C

ITU-T Recommendation G.992.2 (1999) – Amendment 1

ITU-T G-SERIES RECOMMENDATIONS
TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

INTERNATIONAL TELEPHONE CONNECTIONS AND CIRCUITS	G.100–G.199
GENERAL CHARACTERISTICS COMMON TO ALL ANALOGUE CARRIER-TRANSMISSION SYSTEMS	G.200–G.299
INDIVIDUAL CHARACTERISTICS OF INTERNATIONAL CARRIER TELEPHONE SYSTEMS ON METALLIC LINES	G.300–G.399
GENERAL CHARACTERISTICS OF INTERNATIONAL CARRIER TELEPHONE SYSTEMS ON RADIO-RELAY OR SATELLITE LINKS AND INTERCONNECTION WITH METALLIC LINES	G.400–G.449
COORDINATION OF RADIOTELEPHONY AND LINE TELEPHONY	G.450–G.499
TESTING EQUIPMENTS	G.500–G.599
TRANSMISSION MEDIA CHARACTERISTICS	G.600–G.699
DIGITAL TERMINAL EQUIPMENTS	G.700–G.799
DIGITAL NETWORKS	G.800–G.899
DIGITAL SECTIONS AND DIGITAL LINE SYSTEM	G.900–G.999
General	G.900–G.909
Parameters for optical fibre cable systems	G.910–G.919
Digital sections at hierarchical bit rates based on a bit rate of 2048 kbit/s	G.920–G.929
Digital line transmission systems on cable at non-hierarchical bit rates	G.930–G.939
Digital line systems provided by FDM transmission bearers	G.940–G.949
Digital line systems	G.950–G.959
Digital section and digital transmission systems for customer access to ISDN	G.960–G.969
Optical fibre submarine cable systems	G.970–G.979
Optical line systems for local and access networks	G.980–G.989
Access networks	G.990–G.999
QUALITY OF SERVICE AND PERFORMANCE	G.1000–G.1999
TRANSMISSION MEDIA CHARACTERISTICS	G.6000–G.6999
DIGITAL TERMINAL EQUIPMENTS	G.7000–G.7999
DIGITAL NETWORKS	G.8000–G.8999

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

ITU-T Recommendation G.992.2

Splitterless asymmetric digital subscriber line (ADSL) transceivers

Amendment 1 Revised Annex C

Summary

This Amendment 1 to ITU-T Rec. G.992.2 revises Annex C for improved robustness and extended reach. It includes the changes introduced by G.992.2 (1999) Corrigendum 1 (07/2002).

Source

Amendment 1 to ITU-T Recommendation G.992.2 (1999) was prepared by ITU-T Study Group 15 (2001-2004) and approved under the WTSA Resolution 1 procedure on 16 March 2003.

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.

INTELLECTUAL PROPERTY RIGHTS

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

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

© ITU 2003

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

CONTENTS

	Page
C.1 Scope	1
C.2 Definitions and abbreviations.....	1
C.3 Reference models	2
C.4 Operating modes (new)	6
C.5 ATU interfaces	7
C.6 ATU functional characteristics (pertains to clause 7)	7
C.7 aoc on-line adaptation and reconfiguration (pertains to clause 9).....	14
C.8 In-service performance monitoring and surveillance (pertains to clause 10).....	15
C.9 Initialization.....	16
C.10 Fast retraining (supplements clause 12)	36
C.11 Power management (pertains to clause 13).....	41
 Appendix IV – Example Overlapped PSD Masks for use in a TCM-ISDN crosstalk environment	 41

Copyright International Telecommunication Union/ITU Telecommunication Sector
Provided by IHS Markit under license with ITU-T
No reproduction or networking permitted without license from IHS

ITU-T Recommendation G.992.2

Splitterless asymmetric digital subscriber line (ADSL) transceivers

Amendment 1

Revised Annex C

ADSL above POTS co-existing in the same binder as TCM-ISDN DSL

C.1 Scope

This annex describes those specifications that are unique to an ADSL system co-existing in the same binder as TCM-ISDN as defined in Appendix III/G.961. The subclauses in this annex provide the additions and modifications to the corresponding clauses in the main body. The modifications described in this annex provide a performance improvement over the Splitterless ADSL system specified in main body in an environment co-existing with TCM-ISDN. It is preferred that ADSL system implementing this annex also implements the main body.

This annex defines several optional operating modes or "profiles", negotiable through G.994.1, to allow limited independent control of:

- FEXT and NEXT period transmission in both upstream and downstream directions
- overlapped and non-overlapped spectrum downstream during FEXT and NEXT periods

These new optional profiles (defined in C.4 as Profiles 1 to 6) offer improved robustness and extended reach compared to the previously defined operating modes.

NOTE – References to figures or tables of Appendix IV will be defined when Appendix IV is made available.

C.2 Definitions and abbreviations

C.2.1 Definitions

C.2.1.1 Dual Bitmap: The Dual Bitmap method has dual bit rates under the FEXT and NEXT noise from TCM-ISDN.

C.2.1.2 FEXT Bitmap: Similar to the Dual Bitmap method; however, transmission only occurs during FEXT noise from TCM-ISDN.

C.2.1.3 Hyperframe: Five Superframes structure which synchronized TTR.

C.2.1.4 Bitmap-F_R: ATU-C transmitter bitmap under TCM-ISDN FEXT noise generated at ATU-R.

C.2.1.5 Bitmap-N_R: ATU-C transmitter bitmap under TCM-ISDN NEXT noise generated at ATU-R.

C.2.1.6 Bitmap-F_C: ATU-R transmitter bitmap under TCM-ISDN FEXT noise generated at ATU-C.

C.2.1.7 Bitmap-N_C: ATU-R transmitter bitmap under TCM-ISDN NEXT noise generated at ATU-C.

C.2.1.8 FEXT_R duration: TCM-ISDN FEXT duration at ATU-R estimated by the ATU-C.

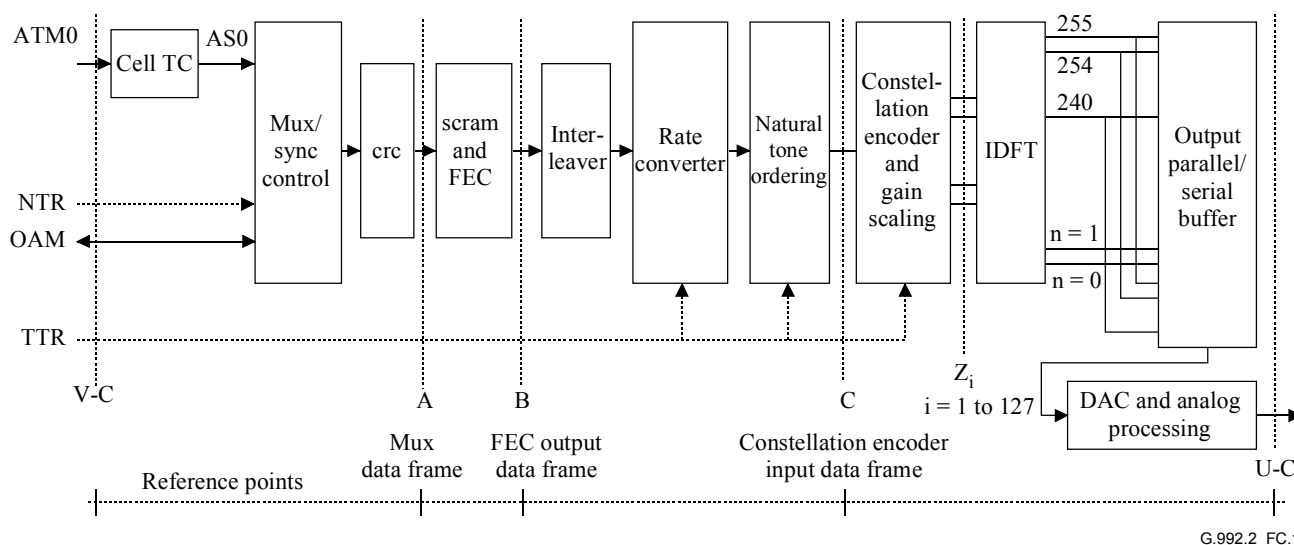
- C.2.1.9 NEXT_R duration:** TCM-ISDN NEXT duration at ATU-R estimated by the ATU-C.
- C.2.1.10 FEXT_C duration:** TCM-ISDN FEXT duration at ATU-C estimated by the ATU-R.
- C.2.1.11 NEXT_C duration:** TCM-SDN NEXT duration at ATU-C estimated by the ATU-R.
- C.2.1.12 FEXT_R symbol:** DMT symbol transmitted by ATU-C during TCM-ISDN FEXT.
- C.2.1.13 NEXT_R symbol:** DMT symbol transmitted by ATU-C during TCM-ISDN NEXT.
- C.2.1.14 FEXT_C symbol:** DMT symbol transmitted by ATU-R during TCM-ISDN FEXT.
- C.2.1.15 NEXT_C symbol:** DMT symbol transmitted by ATU-R during TCM-ISDN NEXT.
- C.2.1.16 N_{SWF}:** Sliding window frame counter.

C.2.2 Abbreviations

TTR	TCM- ISDN Timing Reference
TTR _C	Timing Reference used in ATU-C
TTR _R	Timing Reference used in ATU-R
UI	Unit Interval

C.3 Reference models

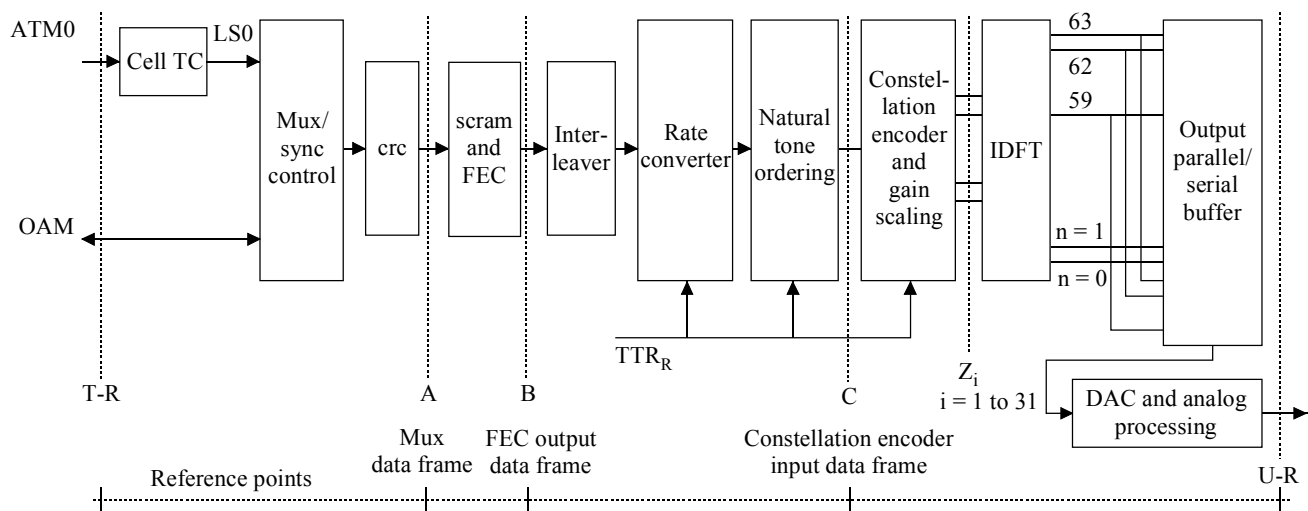
C.3.1 ATU-C transmitter reference model (replaces figure in 4.2)



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

Figure C.1/G.992.2 – ATU-C transmitter reference model for ATM transport

C.3.2 ATU-R transmitter reference model (replaces figure in 4.2)



G.922.2_FC.2

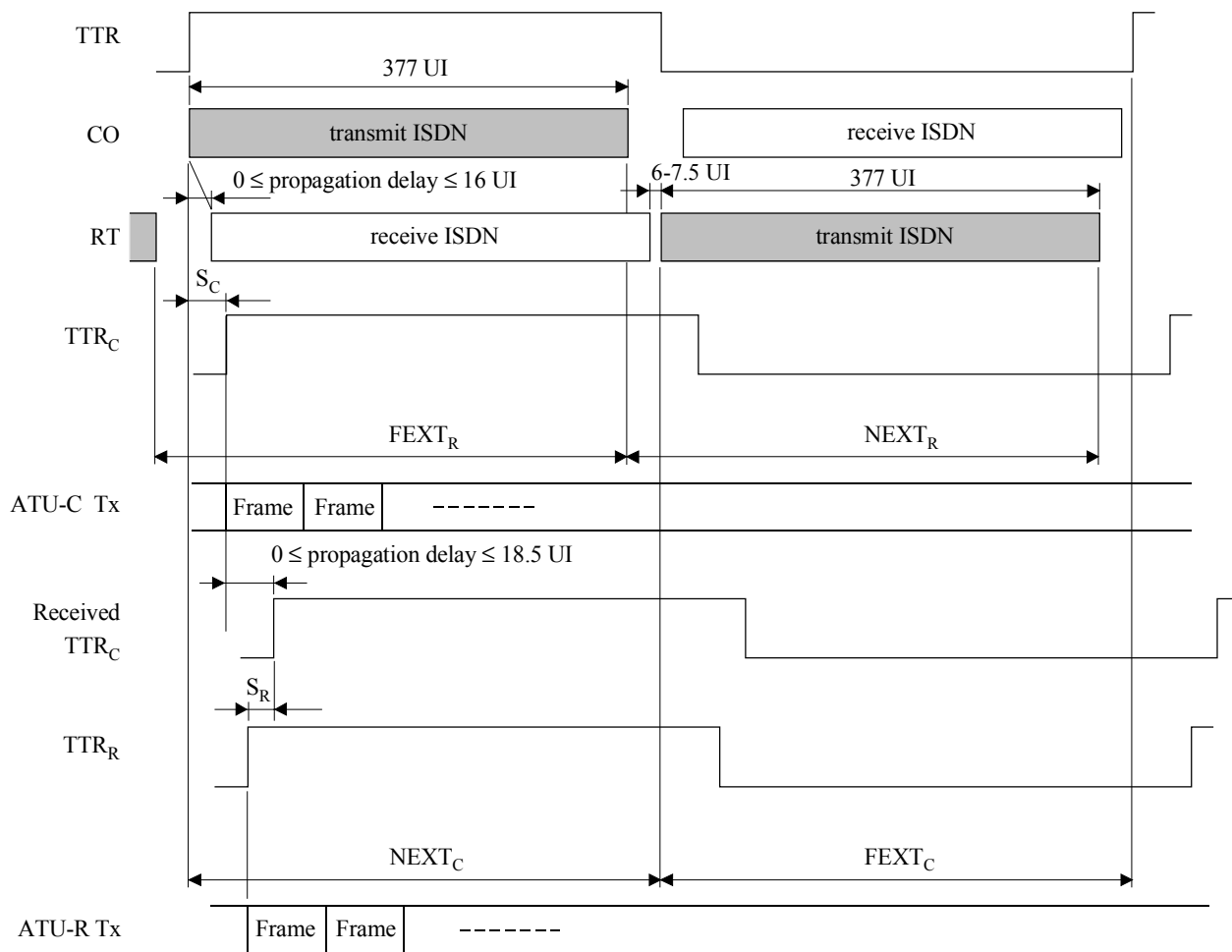
NOTE – The TTR_R shall be generated in the ATU-R from the received TTR_C , and shall be locked to 690 periods of upstream sampling clock (276 kHz).

Figure C.2/G.992.2 – ATU-R transmitter reference model for ATM transport

C.3.3 ATU transmitter timing model (new)

C.3.3.1 TCM-ISDN crosstalk timing model (new)

Figure C.3 shows the timing chart of the crosstalk from TCM-ISDN.



G.992.2_FC.3

1 UI = 3.125 μs

FEXT_R and NEXT_R are estimated by the ATU-C

FEXT_C and NEXT_C are estimated by the ATU-R

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

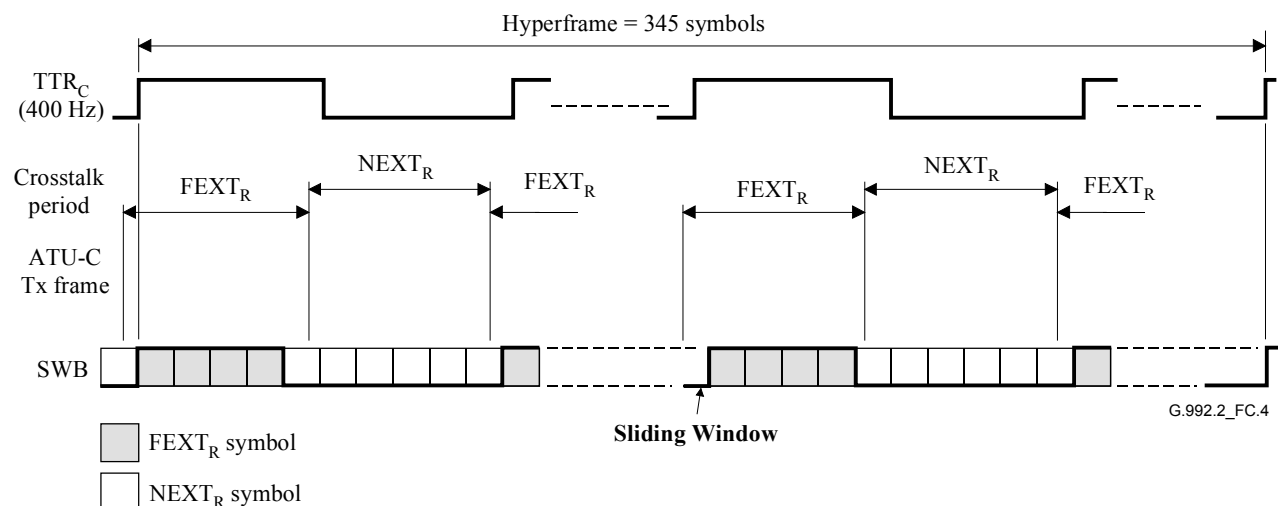
S_R -42 × 0.9058 μs: Offset from received TTR_C to TTR_R

Figure C.3/G.992.2 – Timing chart of the TCM-ISDN cross-talk

The data stream of TCM-ISDN transmitted in a TTR period. The TCM-ISDN CO transmits the symbols in the first half of the TTR period and the TCM-ISDN RT transmits in the second half of the TTR period. The ATU-C receives NEXT noise from ISDN in the first half of the TTR period and FEXT noise from ISDN in the second half of the TTR period. On the other hand, the ATU-R receives FEXT noise from the TCM-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 C.6.2.2 and in C.9, the ATU-C shall estimate the FEXT_R and NEXT_R duration at ATU-R, and ATU-R shall estimate FEXT_C and NEXT_C duration at ATU-C taking propagation delay on the subscriber line into consideration.

C.3.3.2 Sliding Window (new)



The "Sliding Window" operation defines the procedures to transmit symbols under the crosstalk noise environment synchronized to the period of the TTR. The $\text{FEXT}_{\text{C/R}}$ symbol represents the symbol completely inside the $\text{FEXT}_{\text{C/R}}$ duration. The $\text{NEXT}_{\text{C/R}}$ symbol represents the symbol containing any $\text{NEXT}_{\text{C/R}}$ duration. Thus, there are more $\text{NEXT}_{\text{C/R}}$ symbols than $\text{FEXT}_{\text{C/R}}$ symbols.

C.3.3.3 ATU-C symbol synchronization to TTR_C (new)

C.3.3.4 Dual Bitmap switching (new)

The ATU-C shall have the capability to disable Bitmap-N_C and Bitmap-N_R transmission during NEXT_{CR} (see Table 11 i/G.994.1 C.6.7). In this case, the ATU-C shall transmit only the pilot tone as NEXT_R symbol, and ATU-R shall transmit silence as the NEXT_C symbol (see C.5.5 and C.5.7).

During FEXT Bitmap mode, the ATU-C shall transmit only the pilot tone as NEXT_R symbol. As an option, an ATU-C may have the ability to enable or disable Bitmap-N_C independently of Bitmap-N_R. This is controlled by way of the profiles negotiated through G.994.1.

C.3.3.5 Loop timing at ATU-R (new)

The phase relation between received symbol and transmitted symbol of ATU-R at reference point U-R shall meet the phase tolerances as shown in Figure C.5.

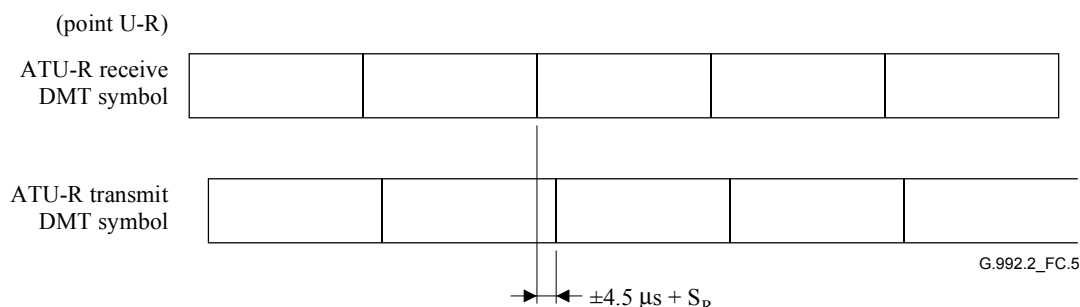


Figure C.5/G.992.2 – Loop timing for ATU-R

C.4x Operating modes (new)

The following profiles are defined to support independent control of FEXT and NEXT bitmaps in the upstream and downstream direction, as well as independent control of the downstream spectrum for each downstream bitmap:

Profile 1

For Profile 1, upstream transmission only uses Bitmap-F_C, and downstream transmission only uses Bitmap-F_R with non-overlapped spectrum.

Profile 2

For Profile 2, upstream transmission uses both Bitmap-F_C and Bitmap-N_C, and downstream transmission uses both Bitmap-F_R and Bitmap-N_R. Non-overlapped spectrum is used with both downstream bitmaps.

Profile 3

For Profile 3, upstream transmission only uses Bitmap-F_C, and downstream transmission only uses Bitmap-F_R with overlapped spectrum. An example of a downstream PSD mask for this operating mode is shown in Figure IV.3.

Profile 4

For Profile 4, upstream transmission uses both Bitmap-F_C and Bitmap-N_C, and downstream transmission uses both Bitmap-F_R and Bitmap-N_R. Overlapped spectrum is used with both downstream bitmaps.

Profile 5

For Profile 5, upstream transmission only uses Bitmap-F_C, and downstream transmission uses both Bitmap-F_R and Bitmap-N_R. Non-overlapped spectrum is used with Bitmap-N_R, and overlapped spectrum is used with Bitmap-F_R. An example of a downstream PSD mask for use with Bitmap-N_R is shown in Figure IV.1 and described in Table IV.1 in Appendix IV. An example of a downstream PSD mask for use with Bitmap-F_R is shown in Figure IV.2 and described in Table IV.2 in Appendix IV.

Profile 6

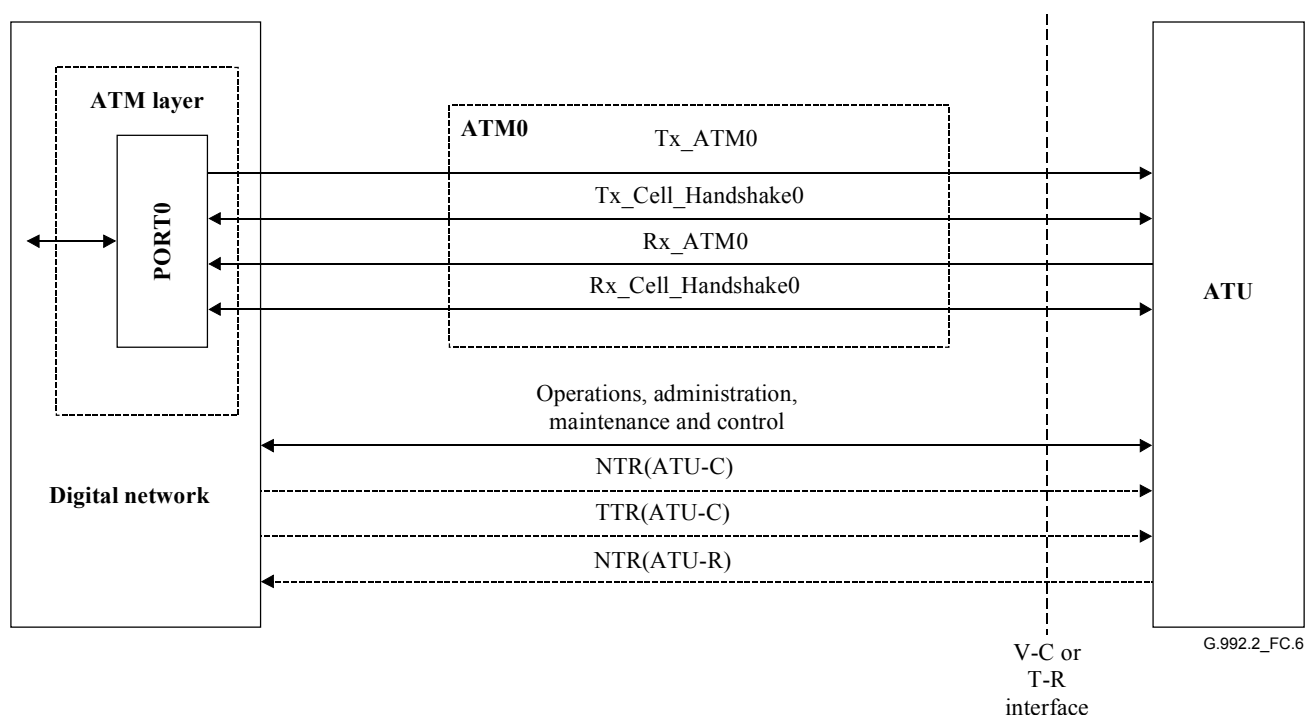
For Profile 6, upstream transmission uses both Bitmap- F_C and Bitmap- N_C , and downstream transmission uses both Bitmap- F_R and Bitmap- N_R . Non-overlapped spectrum is used with Bitmap- N_R , and overlapped spectrum is used with Bitmap- F_R . An example of a downstream PSD mask for use with Bitmap- N_R is shown in Figure IV.1 and described in Table IV.1 in Appendix IV. An example of a downstream PSD mask for use with Bitmap- F_R is shown in Figure IV.2 and described in Table IV.2 in Appendix IV.

Table 11.9.1/G.994.1 contains the code points to support these profiles.

C.45 ATU interfaces

C.54.1 ATM interface for ATM transport (replaces figure in 6.1)

The functional data interface at the ATU for ATM transport are shown in Figure C.6.



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

Figure C.6/G.992.2 – ATU functional interfaces to the ATM layer at the V or T reference point

C.65 ATU functional characteristics (pertains to clause 7)

C.65.1 Payload transfer delay (supplements 7.1.1)

The one-way transfer delay (excluding cell specific functionalities) for payload bits from the V reference point at the central office end (V-C) to the T reference point at remote the end (T-R) shall be as specified in 7.1.1 with an additional 5 ms for transfer delay attributed to the rate converter. The same requirement applies in the opposite direction, from the T-R reference point to the V-C reference point.

The maximum rate converter delay specified in the above text shall not apply to bit rates of 32 kbit/s and 64 kbit/s.

C.65.2 Framing (pertains to 7.3)

C.65.2.1 Superframe structure (supplements 7.3.3.1)

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 7.3.3.1.

C.65.2.2 Hyperframe structure (new)

This annex uses the hyperframe structure shown in Figures C.7 and C.8. Both figures show the phase relationship between the $TTR_{C/R}$ and the hyperframe at the point U-C and U-R. Each hyperframe is composed of five 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 N_{inv} -th superframe, which is generated from a tone-by-tone 180-degree phase reversal of the synchronization symbol (see C.65.3.1) except for the pilot tone. N_{inv} -th is defined as:

$$N_{inv} - th = \begin{cases} 3 \text{ (SPF\#3) for downstream} \\ 0 \text{ (SPF\#0) for upstream} \end{cases}$$

The FEC Output Frame from the interleaver is put into the rate-converter. The bit-level data stream from the rate-converter is extracted according to the size of $Bitmap-F_{R/C}$ and $Bitmap-N_{R/C}$ using the Sliding Window (see C.3.3.2 and C.3.3.4).

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 C.65.6). The hyperframe is composed of 345 DMT symbols, numbered from 0 to 344. Each symbol is assigned as a $FEXT_{R/C}$ or $NEXT_{R/C}$ symbol in a $FEXT_{R/C}$ or $NEXT_{R/C}$ duration (see C.3.3.1). The following numerical formula gives the information which duration N_{dmt} -th DMT symbol belongs to at ATU transmitter.

Downstream data (see Figure C.9):

For ($N_{dmt} = 0, 1, \dots, 344$)

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

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

else then $NEXT_R$ symbol

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

Upstream data (see Figure C.10):

For ($N_{dmt} = 0, 1, \dots, 344$)

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

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

else then $NEXT_C$ symbol

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

Thus, 128 DMT symbols are allocated in the $FEXT_{R/C}$ duration ($FEXT_{C/R}$ symbols), and 217 DMT symbols are allocated in the $NEXT_{R/C}$ duration ($NEXT_{C/R}$ symbols). The symbols are composed of:

$FEXT_{C/R}$ symbol:

- Number of symbols using $Bitmap-F_{R/C}$ = 126
- Number of synch symbols = 1
- Number of inverse synch symbols = 1

NEXT_{C/R} symbol:

- Number of symbols using Bitmap-N_{R/C} = 214
- Number of synch symbols = 3

For modems not using any of the profiles defined in C.4, and modems using Profile 1, during FEXT Bitmap mode, the ATU-C shall transmit only the pilot tone as NEXT_R symbol. For Profile 3, the ATU-C shall not transmit any signal in NEXT_R symbols. The remaining Profiles, i.e. Profiles 2, 4, 5, and 6 use the dual bit map technique.

During FEXT Bitmapping mode, and the ATU-R shall not transmit any signal as NEXT_C symbol.

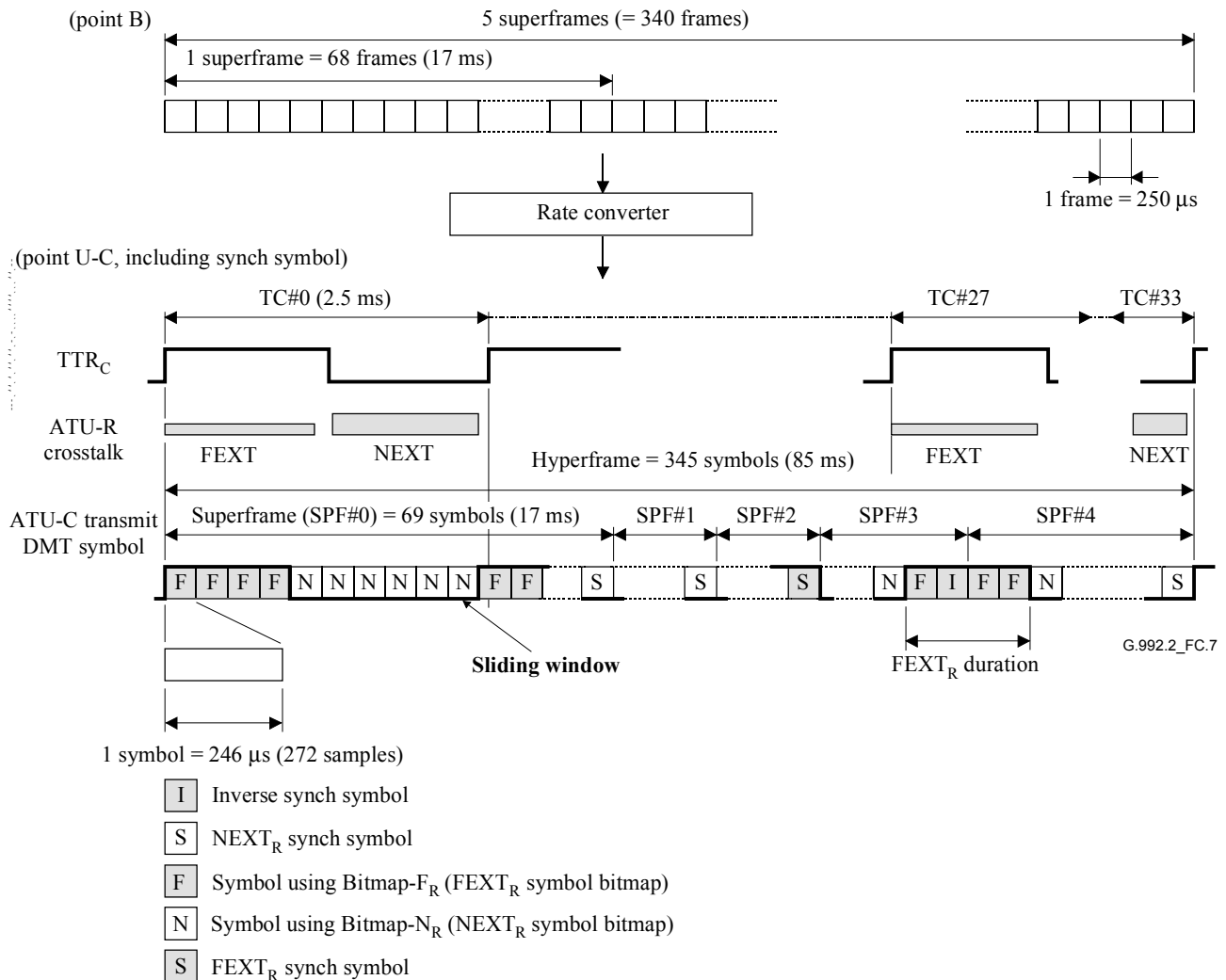


Figure C.7/G.992.2 – Hyperframe structure for downstream