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G.993.2
Corrigendum 1
(06/2012)

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

Digital sections and digital line system – Access networks

Very high speed digital subscriber line transceivers 2 (VDSL2)

Corrigendum 1

Recommendation ITU-T G.993.2 (2011) – Corrigendum 1

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Recommendation ITU-T G.993.2

Very high speed digital subscriber line transceivers 2 (VDSL2)

Corrigendum 1

Summary

Corrigendum 1 to Recommendation ITU-T G.993.2 (2011) covers the following functionalities:

- Handshake bits for downstream and full ITU-T G.993.5-friendly operation (corrigendum).
- CIpolicy=2 (corrigendum).
- O-SIGNATURE (corrigendum).
- Annex N (corrigendum).
- Annex O (corrigendum).

History

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FOREWORD

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Very high speed digital subscriber line transceivers 2 (VDSL2)

Corrigendum 1

1) Handshake bits for downstream and full ITU-T G.993.5-friendly operation

12.3.2 ITU-T G.994.1 handshake phase

Change Table 12-7 as follows:

Table 12-7 – VTU-O CL message NPar(2) bit definitions

ITU-T G.994.1 NPar(2) Bit	Definition of NPar(2) bit
All-digital mode	If set to ONE, signifies that the VTU-O supports all-digital mode.
Support of downstream virtual noise	If set to ONE, signifies that the VTU-O supports the use of the downstream virtual noise mechanism.
Lineprobe	Always set to ONE in a VTU-O CL message.
Loop Diagnostic mode	Set to ONE if the VTU-O requests loop diagnostic mode.
Support of PSD shaping in US0	Always set to ONE in a VTU-O CL message.
Support of equalized FEXT UPBO	If set to ONE, signifies that the VTU-O supports equalized FEXT UPBO.
ITU-T G.993.5-friendly ITU-T G.993.2 operation in the downstream direction	If set to ONE, signifies that VTU-O supports Annex N. ~~See Annex L, Table L.12-3~~
Full ITU-T G.993.5-friendly ITU-T G.993.2 operation	If set to ONE, signifies that VTU-O supports Annex O.
Alternative electrical length estimation method	If set to ONE, signifies that the VTU-O supports the Alternative Electrical Length Estimation Method (ELE-M1)

Change Table 12-10 as follows:

Table 12-10 – VTU-O MS message NPar(2) bit definitions

ITU-T G.994.1 NPar(2) Bit	Definition of NPar(2) bit
All-digital mode	Set to ONE if and only if both the last previous CLR and the last previous CL messages have set this bit to ONE. If set to ONE, indicates that both the VTU-O and the VTU-R shall be configured for operation in all-digital mode.
Support of downstream virtual noise	Set to ONE if and only if both the last previous CLR and the last previous CL messages have set this bit to ONE. Indicates that the downstream virtual noise mechanism may be used.

Table 12-10 – VTU-O MS message NPar(2) bit definitions

ITU-T G.994.1 NPar(2) Bit	Definition of NPar(2) bit
Lineprobe	Set to ONE if and only if both the last previous CLR and the last previous CL messages have set this bit to ONE. Indicates that the channel discovery phase of initialization shall include a lineprobe stage.
Loop Diagnostic mode	Set to ONE if either the last previous CLR or the last previous CL message has set this bit to ONE. Indicates that both VTUs shall enter loop diagnostic mode.
Support of PSD shaping in US0	Set to ONE if and only if both the last previous CLR and the last previous CL messages have set this bit to ONE. Indicates that the VTU-R supports PSD shaping in the US0 band.
Support of equalized FEXT UPBO	Set to ONE if and only if both the last previous CLR and the last previous CL messages have set this bit to ONE. Indicates that both the VTU-O and the VTU-R shall use equalized FEXT UPBO.
ITU-T G.993.5-friendly ITU-T G.993.2 operation in the downstream direction	See Table N.2
Full ITU-T G.993.5-friendly ITU-T G.993.2 operation	See Table O.2.
Alternative Electrical Length Estimation Method	Set to ONE if and only if both the last previous CLR and the last previous CL messages have set this bit to ONE. Indicates that both the VTU-O and the VTU-R shall use electrical length estimation method ELE-M1.

Change Table 12-13 as follows:

Table 12-13 – VTU-R CLR message NPar(2) bit definitions

ITU-T G.994.1 NPar(2) Bit	Definition of NPar(2) bit
All-digital mode	If set to ONE, signifies that the VTU-R supports all-digital mode.
Support of downstream virtual noise	If set to ONE, signifies that the VTU-R supports the use of the downstream virtual noise mechanism.
Lineprobe	Set to ONE if the VTU-R requests the inclusion of a lineprobe stage in initialization.
Loop Diagnostic mode	Set to ONE if the VTU-R requests loop diagnostic mode.
Support of PSD shaping in US0	If set to ONE, signifies that the VTU-R supports PSD shaping in the US0 band.
Support of equalized FEXT	If set to ONE, signifies that the VTU-R supports equalized FEXT UPBO.
ITU-T G.993.5-friendly ITU-T G.993.2 operation in the downstream direction	If set to ONE, signifies that the VTU-R supports Annex N. ~~See Table N.3~~
Full ITU-T G.993.5-friendly ITU-T G.993.2 operation	If set to ONE, signifies that VTU-R supports Annex O.

Table 12-13 – VTU-R CLR message NPar(2) bit definitions

ITU-T G.994.1 NPar(2) Bit	Definition of NPar(2) bit
Alternative electrical length estimation method	If set to ONE, signifies that the VTU-R supports the Alternative Electrical Length Estimation Method (ELE-M1)

Change Table 12-16 as follows:

Table 12-16 – VTU-R MS message NPar(2) bit definitions

ITU-T G.994.1 NPar(2) Bit	Definition of NPar(2) bit
All-digital mode	Set to ONE if and only if both the last previous CLR and the last previous CL messages have set this bit to ONE. If set to ONE, indicates that both the VTU-O and the VTU-R shall be configured for operation in all-digital mode.
Support of downstream virtual noise	Set to ONE if and only if both the last previous CLR and the last previous CL messages have set this bit to ONE. Indicates that the downstream virtual noise mechanism may be used.
Lineprobe	Set to ONE if and only if both the last previous CLR and the last previous CL messages have set this bit to ONE. Indicates that the channel discovery phase of initialization shall include a lineprobe stage.
Loop Diagnostic mode	Set to ONE if either the last previous CLR or the last previous CL message has set this bit to ONE. Indicates that both VTUs shall enter loop diagnostic mode.
Support of PSD shaping in US0	Set to ONE if and only if both the last previous CLR and the last previous CL messages have set this bit to ONE. Indicates that the VTU-R shall support PSD shaping in the US0 band.
Support of equalized FEXT	Set to ONE if and only if both the last previous CLR and the last previous CL messages have set this bit to ONE. Indicates that both the VTU-O and the VTU-R shall use equalized FEXT UPBO.
ITU-T G.993.5-friendly ITU-T G.993.2 operation in the downstream direction	See Table N.4
<u>Full ITU-T G.993.5-friendly ITU-T G.993.2 operation</u>	<u>See Table O.4.</u>
Alternative electrical length estimation method	Set to ONE if and only if both the last previous CLR and the last previous CL messages have set this bit to ONE. Indicates that both the VTU-O and the VTU-R shall use ELE-M1.

2)   CIpolicy=2

Change clause 12.3.5.2.1.2 as follows:

12.3.5.2.1.2   O-TPS

• • •

The field "TPS-TC options" shall be coded as follows:

•   Bit 0: The bit shall be set to ONE to enable pre-emption in this bearer, if and only if the bit was set to ONE for this bearer in both O-MSG 1 and R-MSG 2.

•   Bit 1: The bit shall be set to ONE to enable short packets in this bearer, if and only if the bit was set to ONE for this bearer in both O-MSG 1 and R-MSG 2.

For a bearer mapped to an ATM or STM TPS-TC, bits 0 and 1 of the TPS-TC options field are reserved by ITU-T and shall be set to ZERO.

For the upstream bearer channel(s), bits 2-7 shall be set to ZERO.

For the downstream bearer channel(s), bits 2-7 shall be coded as follows:

•   Bit~~s~~ 3-2 contain~~s~~ the selection of the CIpolicy that shall be used in the downstream direction. A value of ~~ZERO~~00_2 indicates that the mandatory CIpolicy shall be used. A value of ~~ONE~~01_2 indicates that the optional CIpolicy 1 (see clause 12.3.7) shall be used. A value of 10_2 indicates that the optional CIpolicy 2 (see clause 12.3.7) shall be used. The CO shall only select optional CIpolicies for which the VTU-R has indicated support (see clause 12.3.5.2.2.1). A value ~~of ONE~~different from 00_2 can only be selected if no more than one bearer channel is active.

•   ~~Bit 3 is reserved by ITU-T and set to ZERO.~~

•   Bit 4 contains the selection of the Re-Initialization Policy that shall be used in the downstream direction for that bearer channel ($RIpolicyds_n$). A value of ZERO indicates that the mandatory Re-Initialization Policy 0 shall be used. A value of ONE indicates that the optional Re-Initialization Policy 1 (see clause 12.1.4) shall be used. The same value shall be indicated for all bearer channels. The CO shall only select optional Re-Initialization Policies for which the VTU-R has indicated support (see clause 12.3.5.2.2.1).

•   Bits 5-7 are reserved by the ITU-T and shall be set to ZERO.

• • •

Change clause 12.3.5.2.2.1 as follows:

12.3.5.2.2.1   R-MSG 2

• • •

The field "TPS-TC options" shall be coded as follows:

•   Bit 0: If the VTU-R supports pre-emption in this bearer (N.3.1.2 of [ITU-T G.992.3]), the bit shall be set to ONE.

•   Bit 1: If the VTU-R supports short packets in this bearer (N.3.1.3 of [ITU-T G.992.3]), the bit shall be set to ONE.

For a bearer mapped to an ATM or STM TPS-TC, bits 0 and 1 shall be set to ZERO at the transmitter and ignored by the receiver.

Bit 2 indicates whether the optional channel initialization policy 1 is supported for that bearer channel. This bit shall be set to ONE to indicate support for this policy.

Bit 3 indicates whether the optional channel initialization policy 2 is supported for that bearer channel. This bit shall be set to ONE to indicate support for this policy is reserved by ITU-T and shall be set to ZERO.

Bit 4 indicates whether the optional Re-Initialization Policy 1 (i.e., $RIpolicyds_n=1$) is supported (see clause 12.1.4) for that bearer channel. This bit shall be set to ONE to indicate support for this policy. This bit shall be set to the same value for all bearer channels.

Bits 5-7 are reserved by ITU-T and shall be set to ZERO.

…

3) O-SIGNATURE

Change clause 12.3.3.2.1.1 as follows:

12.3.3.2.1.1 O-SIGNATURE

Add field #23 to Table 12-21:

Table 12-21 – Description of message O-SIGNATURE

	Field name	Format
23	Reserved for operation according to Annex N	1 byte

Add the following field definition at the end of the clause:

Field #23 is reserved for operation according to Annex N (see clause N.2.2.1a.1.1). This field shall be set to 00_{16} if the selected mode of operation is not according to Annex N, and have a value as defined in Table N.5a otherwise.

4) Annex N

Annex N

ITU-T G.993.5-friendly ITU-T G.993.2 operation in the downstream direction

This annex provides the necessary and sufficient additional requirements for ITU-T G.993.2 operation to allow cancellation of the downstream crosstalk from lines with ITU-T G.993.2 Annex N VTU-Rs into lines with ITU-T G.993.5 VTU-Rs (both connected to ITU-T G.993.5-capable VTU-Os).

This includes:

• Requirements for the ITU-T G.993.2 Annex N VTU-O downstream transmit signals.

• Requirements for the ITU-T G.993.2 Annex N VTU-R downstream receiver to be immune to the ITU-T G.993.2 Annex N VTU-O downstream transmit signals sent by the VTU-O during Initialization and Showtime. The VTU-R shall be immune to the VTU-O sending pilot sequences on the probe tones (as defined in [ITU-T G.993.5]) of the sync symbols during showtime.

A VTU-O supporting operation according to this annex shall also support operation according to [ITU-T G.993.5].

This annex reflects changes to the main body of this Recommendation to allow ITU-T G.993.5-friendly operation of ITU-T G.993.2 in the downstream direction. The clauses below indicate changes to specific clauses of this Recommendation.

NOTE – Simultaneous initialization of a line operating per this annex and a line operating per [ITU-T G.993.5] or per ITU-T G.993.2 Annex O only supports downstream vectoring.

N.1   Power management commands and responses (clause 11.2.3.9)

The same power management commands and responses shall be used as defined in clause 11.2.3.9. The orderly shutdown procedures described in clauses 11.2.3.9.1 and 11.2.3.9.2 shall be modified as defined in this clause.

N.1.1   L3 Request by VTU-R (replaces clause 11.2.3.9.1)

Upon receipt of the L3 Request command, the responding VTU-O shall send either the Grant or Reject response. The proposed link state shall be formatted as 03_{16} for the L3 link state. If any other link state is received, the Reject response shall be sent with the reason code 02_{16}.

The VTU-O may reject a request to move to link state L3 using reason code 01_{16} because it is temporarily busy, or reject it using code 03_{16} because it has local knowledge that the L3 state is not desired at this time.

If the VTU-R receives the Grant response, the VTU-R shall transmit zero power on all subcarriers. The VTU-R shall make no action causing changes to the characteristics of the transmission path. When the VTU-O observes the stopped transmission, it shall also stop transmitting. When the VTU-R observes the stopped transmission, it may perform at its own discretion functions that change the characteristics of the transmission path at its own discretion.

N.1.2   L3 Request by VTU-O (replaces clause 11.2.3.9.2)

Upon receipt of the L3 Request command, the responding VTU-R shall send either the Grant or Reject response. The proposed link state shall be formatted as 03_{16} for the L3 link state. If any other link state is received, the Reject response shall be sent with the reason code 02_{16}.

The VTU-R may reject a request to move to link state L3 using reason code 01_{16} because it is temporarily too busy, or reject it using code 03_{16} because it has local knowledge that the L3 state is not desired at this time.

If the VTU-O receives the Grant response, the VTU-O shall transmit zero power on all subcarriers. The VTU-O shall make no actions causing changes to the characteristics of the transmission path. When the VTU-R observes the stopped transmission, it shall also stop transmitting. When the VTU-O observes the stopped transmission, it may perform at its own discretion functions that change the characteristics of the transmission path at its own discretion.

N.2   Initialization procedure (supplements clause 12.3)

If and only if the ITU-T G.994.1 VTU-O MS message or VTU-R MS message the NPar(2) bit "ITU-T G.993.5-friendly ITU-T G.993.2 operation in the downstream direction" is set to ONE, the VTU-O shall use a modified ITU-T G.993.2 initialization procedure, as defined in this annex.

This initialization procedure is identical to an ITU-T G.993.2 initialization procedure, except for the channel discovery phase and the training phase.

As applicable to the VTU-O, this initialization procedure defines two new signals to be transmitted.

As applicable to the VTU-R, this initialization procedure requires these two new signals to be ignored.

N.2.1 ITU-T G.994.1 handshake phase

N.2.1.1 Handshake – VTU-O

N.2.1.1.1 CL messages (supplements clause 12.3.2.1.1)

Table 12-7 shall be extended with Table N.1 as follows:

Table N.1 – VTU-O CL message NPar(2) bit definitions

ITU-T G.994.1 NPar(2) bit	Definition of NPar(2) bit
ITU-T G.993.5-friendly ITU-T G.993.2 operation in the downstream direction	If set to ONE, indicates the capability of the VTU-O <u>to comply with all requirements of this annex, including</u>: • to send O-P-VECTOR-1 (as defined in [ITU-T G.993.5]) during initialization after O-P-QUIET and before O-P-CHANNEL DISCOVERY 1, and • to send O-P-VECTOR-1-1 (as defined in [ITU-T G.993.5]) during initialization after O-P-SYNCHRO 3 and before O-P-TRAINING 1, and • to send pilot sequences on the probe tones (as defined in [ITU-T G.993.5]) of the sync symbols during showtime. If set to ONE, the ITU-T G.993.5 SPar(2) bit shall also be set to ONE.
~~O-P-VECTOR-1-1 maximum duration~~	~~This field is a 3-bit unsigned integer n, with n=0…7. It represents the maximum duration of O-P-VECTOR-1-1 (see Table N.5) as requested by the VTU-O.~~

N.2.1.1.2 MS messages (supplements clause 12.3.2.1.2)

Table 12-10 shall be extended with Table N.2 as follows:

Table N.2 – VTU-O MS message NPar(2) bit definitions

ITU-T G.994.1 NPar(2) bit	Definition of NPar(2) bit
ITU-T G.993.5-friendly ITU-T G.993.2 operation in the downstream direction	Set to ONE if and only if both the last previous CLR and the last previous CL messages have set this bit to ONE. If set to ONE, indicates <u>that both the VTU-O and VTU-R shall operate in compliance with all requirements of this annex, including</u> that the VTU-O <u>shall</u>: • ~~shall~~ send O-P-VECTOR-1 (as defined in [ITU-T G.993.5]) during initialization after O-P-QUIET and before O-P-CHANNEL DISCOVERY 1, and • ~~shall~~ send O-P-VECTOR-1-1 (as defined in [ITU-T G.993.5]) during initialization after O-P-SYNCHRO 3 and before O-P-TRAINING 1, and • ~~shall~~ send pilot sequences on the probe tones (as defined in [ITU-T G.993.5]) of the sync symbols during showtime. <u>NOTE – If this bit is set to ONE, bits "Full ITU-T G.993.5-friendly ITU-T G.993.2 operation" and "ITU-T G.993.5" are set to ZERO in the VTU-O MS message.</u>
~~O-P-VECTOR-1-1 maximum duration~~	~~This field is a 3-bit unsigned integer n, with n=0…7. It represents the maximum duration of O-P-VECTOR-1-1 (see Table N.5). This field shall be set to the same value in the MS and CL message.~~

N.2.1.2 Handshake – VTU-R

N.2.1.2.1 CLR messages (supplements clause 12.3.2.2.1)

Table 12-13 shall be extended with Table N.3 as follows:

Table N.3 – VTU-R CLR message NPar(2) bit definitions

ITU-T G.994.1 NPar(2) bit	Definition of NPar(2) bit
ITU-T G.993.5-friendly ITU-T G.993.2 operation in the downstream direction	Set to ONE if the VTU-R is <u>compliant with all requirements of this annex, including being</u> immune to a VTU-O • sending O-P-VECTOR-1 (as defined in [ITU-T G.993.5]) after O-P-QUIET and before O-P-CHANNEL DISCOVERY 1, and • sending O-P-VECTOR-1-1 (as defined in [ITU-T G.993.5]) during initialization after O-P-SYNCHRO 3 and before O-P-TRAINING 1, and • sending pilot sequences on the probe tones (as defined in [ITU-T G.993.5]) of the sync symbols during showtime. If set to ONE, the ITU-T G.993.5 SPar(2) bit shall be set to ZERO <u>(see Note)</u>.
~~O-P-VECTOR 1-1 maximum duration~~	~~This field is a 3-bit unsigned integer *n*, with n=0…7. It represents the maximum duration of O-P-VECTOR 1-1 (see Table N.5) as requested by the VTU-R. This field shall be set to ZERO.~~
<u>NOTE – A VTU-R that has ITU-T G.993.5 capability enabled sets this NPar(2) bit to 0.</u>	

N.2.1.2.2 MS messages (supplements clause 12.3.2.2.2)

Table 12-16 shall be extended with Table N.4 as follows:

Table N.4 – VTU-R MS message NPar(2) bit definitions

ITU-T G.994.1 NPar(2) bit	Definition of NPar(2) bit
ITU-T G.993.5 friendly ITU-T G.993.2 operation in the downstream direction	Set to ONE if and only if both the last previous CLR and the last previous CL message have set this bit to ONE. If set to ONE, indicates <u>that both the VTU-O and VTU-R shall operate in compliance with all requirements of this annex, including</u> that the VTU-O shall<u>:</u> • send O-P-VECTOR-1 (as defined in [ITU-T G.993.5]) after O-P-QUIET and before O-P-CHANNEL DISCOVERY 1, and • send O-P-VECTOR-1-1 (as defined in [ITU-T G.993.5]) during initialization after O-P-SYNCHRO 3 and before O-P-TRAINING 1, and • send pilot sequences on the probe tones (as defined in [ITU-T G.993.5]) of the sync symbols during showtime. <u>NOTE – If this bit is set to ONE, bits "Full ITU-T G.993.5-friendly ITU-T G.993.2 operation" and "ITU-T G.993.5" are set to ZERO in the VTU-R MS message.</u>
~~O-P-VECTOR 1-1 maximum duration~~	~~This field is a 3-bit unsigned integer *n*, with n=0…7. It represents the maximum duration of O-P-VECTOR 1-1 (see Table N.5). This field shall be set to the same value in the MS and CL message.~~

N.2.2 Channel discovery phase

#### N.2.2.1 Overview (supplements clause 12.3.3.1)

Figure N.1 replaces Figure 12-6. Figure N.1 highlights the signals added and the signals/messages modified in the ITU-T G.993.2 Channel Discovery phase for operation according to this annex. Non-highlighted signals and messages shall be as defined in the main body of this Recommendation.

The VTU-O shall initiate the start of the channel discovery phase with O-P-QUIET 1 as defined in clause 12.3.3.1.

When in the ITU-T G.994.1 VTU-O MS message or VTU-R MS message the NPar(2) bit "ITU-T G.993.5-friendly ITU-T G.993.2 operation in the downstream direction" is set to ONE, the VTU-O shall use a modified ITU-T G.993.2 initialization procedure, by ~~the~~ insertion of ITU-T G.993.5 O-P-VECTOR 1 of duration no longer than $1\,024 \times 257$ symbols after O-P-QUIET 1.

NOTE – As applicable to the VTU-O, this channel discovery phase is identical to an ITU-T G.993.5 channel discovery phase with all segments x-P-VECTOR y-z set to zero length, except for O-P-VECTOR 1.

After completing the O-P-VECTOR 1 stage, the VTU-O shall start transmitting O-P-CHANNEL DISCOVERY 1 and proceed as defined in clause 12.3.3.1.
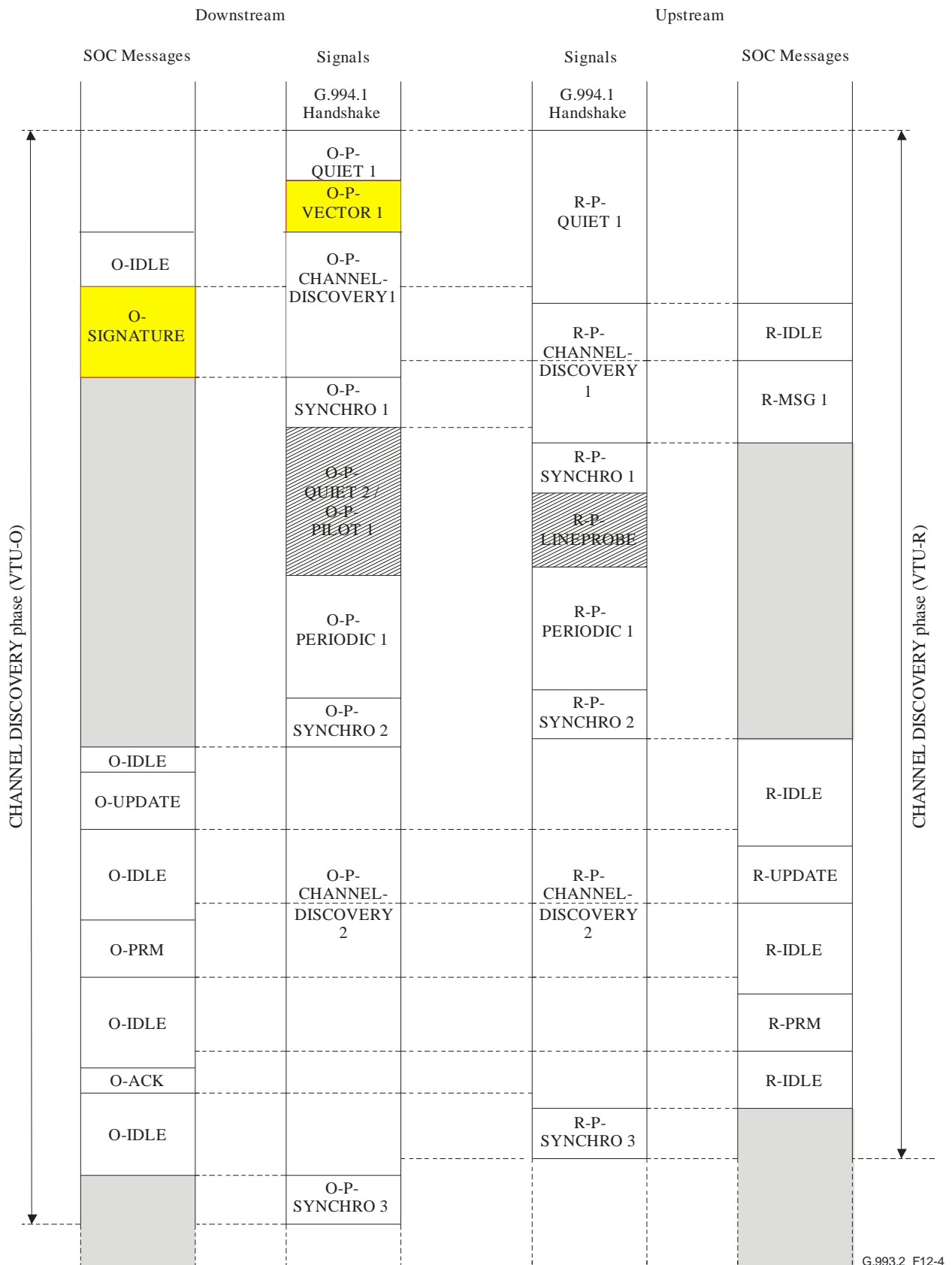
Figure N.1 – Timing diagram for the stages of the channel discovery phase

Table 12-19 shall be extended with Table N.5 as follows:

Table N.5 – VTU-O signals and SOC messages in the channel discovery phase

Signal	Signal type	Signal duration in DMT symbols with CE	SOC messages	SOC state
O-P-VECTOR 1	ITU-T G.993.5	4×257 to $1\ 024 \times 257$	None	Inactive

N.2.2.1a   SOC message exchange during the channel discovery phase (supplements clause 12.3.3.2)

N.2.2.1a.1   VTU-O messages sent during the channel discovery phase (supplements clause 12.3.3.2.1)

N.2.2.1a.1.1   O-SIGNATURE (supplements clause 12.3.3.2.1.1)

Table 12-21 shall be extended with Table N.5a as follows:

Table N.5a – Description of message O-SIGNATURE

	Field name	Format
23	O-P-VECTOR 1-1 maximum duration	1 byte

Add the following definition for field #23 after the definition for field #22:

Field #23 "O-P-VECTOR 1-1 maximum duration" field indicates the maximum duration of the O-P-VECTOR 1-1 signal, as defined in Table N.6. The three LSBs shall represent the value of *n* in the range 0 to 7 and the five MSBs shall be set to 0.

N.2.2.2   Signals transmitted during the channel discovery phase (supplements clause 12.3.3.3)

O-P-VECTOR 1 shall comply ~~to~~with the general requirements for signals transmitted during the channel discovery phase.

N.2.2.2.1 Signals transmitted by the VTU-O

N.2.2.2.1.1   O-P-VECTOR 1 (supplements clause 12.3.3.3.1 between clauses 12.3.3.3.1.1 and 12.3.3.3.1.2)

O-P-VECTOR 1 shall be as defined in [ITU-T G.993.5].

### N.2.2.2.1.2   O-P-SYNCHRO 3 (replaces clause 12.3.3.3.1.9)

O-P-SYNCHRO 3 is a signal that provides an exact time marker for transitions from O-P-CHANNEL DISCOVERY 2 to O-P-VECTOR 1-1 (training phase).

O-P-SYNCHRO 3 shall be identical to O-P-SYNCHRO 1.

N.2.3   Training phase

N.2.3.1   Overview (supplements clause 12.3.4.1)

Figure N.2 replaces Figure 12-8. Figure N.2 highlights the signals added and the signals/messages modified in the ITU-T G.993.2 training phase for operation according to this annex. Non-highlighted signals and messages shall be as defined in the main body of this Recommendation.
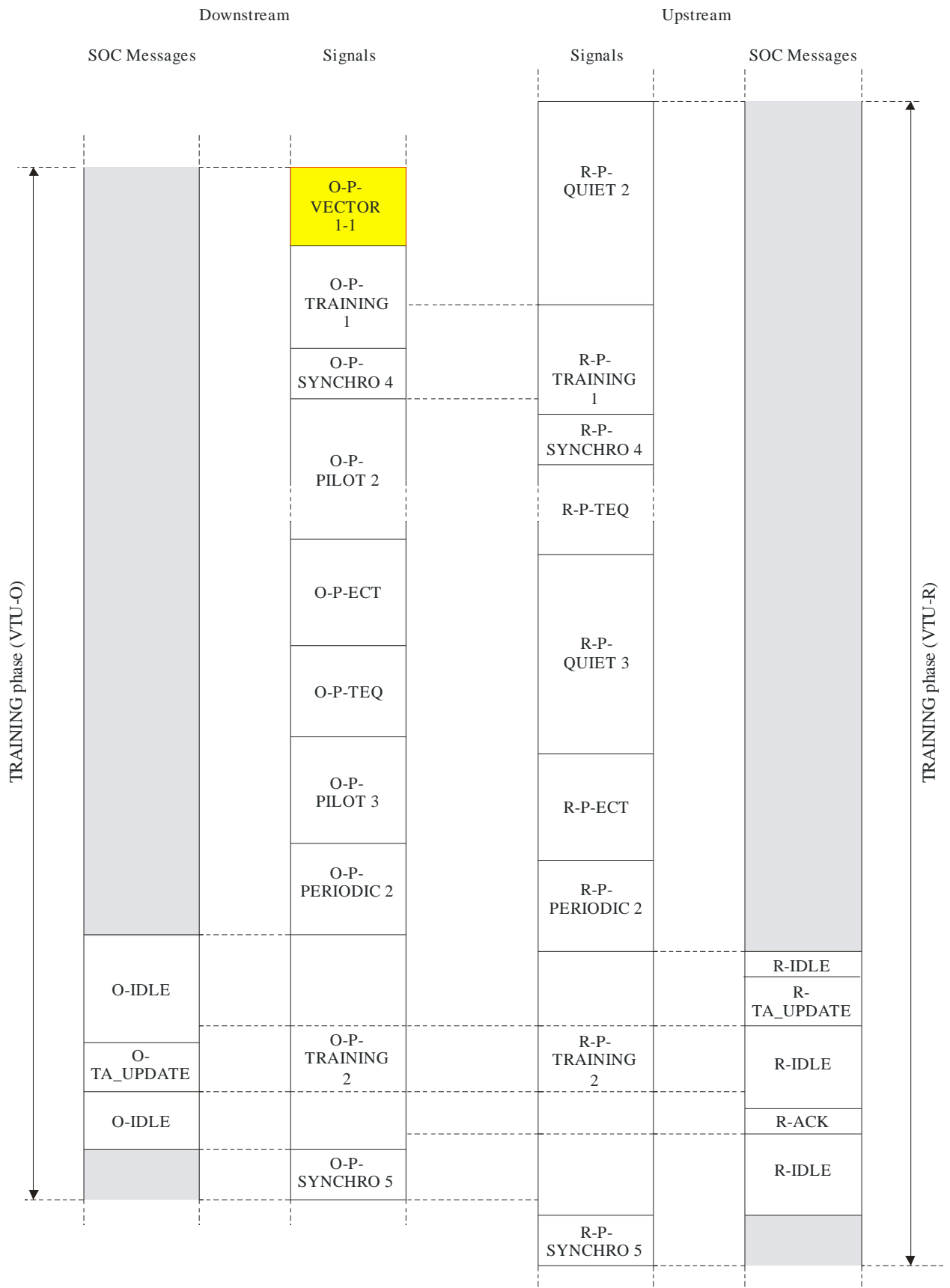
Figure N.2 – Timing diagram for the stages of the training phase

When in the ITU-T G.994.1 VTU-O MS message or VTU-R MS message the NPar(2) bit "ITU-T G.993.5-friendly ITU-T G.993.2 operation in the downstream direction" is set to ONE, at the start of the training phase, the VTU-O shall transmit O-P-VECTOR 1-1, and the VTU-R shall be silent (R-P-QUIET 2). O-P-VECTOR 1-1 shall be followed by O-P-TRAINING 1, while the VTU-R is still silent (R-P-QUIET 2). The remainder of the initialization procedure shall be as defined in clause 12.3.4.1.

NOTE – As applicable to the VTU-O, this training phase is identical to an ITU-T G.993.5 training phase with all segments x-P-VECTOR y-z set to zero length except for O-P-VECTOR 1-1.

Table 12-39 shall be extended with Table N.6 as follows:

Table N.6 – VTU-O signals and SOC messages in the training phase

Signal	Signal type	Signal duration in DMT symbols with CE	SOC messages	SOC state
O-P-VECTOR 1-1	ITU-T G.993.5	4×257 to $(n+1) \times 1024 \times 257$, with $n=0\dots7$ (see Note)	None	Inactive
NOTE – The value of n is communicated to the VTU-R in O-SIGNATURE message during channel discovery phase (see Table N.5a). ~~NOTE – The value of n is communicated to the VTU-R in the G.994.1 phase (see Tables N.1, N.2, N.3, and N.4).~~				

N.2.3.2 Signals transmitted during the training phase (supplements clause 12.3.4.3)

O-P-VECTOR 1-1 shall comply ~~to~~with the general requirements for signals transmitted in the training phase.

N.2.3.2.1 Signals transmitted by the VTU-O

N.2.3.2.1.0 O-P-VECTOR 1-1 (supplements clause 12.3.4.3.1, before clause 12.3.3.3.1.1)

O-P-VECTOR 1-1 shall be as defined in [ITU-T G.993.5].

5) Annex O

Annex O

Full ITU-T G.993.5-friendly ITU-T G.993.2 operation

(This annex forms an integral part of this Recommendation.)

This annex provides the necessary and sufficient additional requirements for ITU-T G.993.2 operation to allow cancellation of the downstream and upstream crosstalk from lines with ITU-T G.993.2 Annex O VTU-Rs into lines with ITU-T G.993.5 VTU-Rs (both connected to ITU-T G.993.5-capable VTU-Os that also support upstream vectoring).

NOTE 1 – These requirements also allow cancellation of the upstream crosstalk from lines with ITU-T G.993.5 VTU-Rs into lines with ITU-T G.993.2 Annex O VTU-Rs (both connected to ITU-T G.993.5-capable VTU-Os).

A VTU-O supporting operation according to this annex shall also support [ITU-T G.993.5] with support of upstream vectoring.

NOTE 2 – Indication of support of ITU-T G.993.5 upstream vectoring in the VTU-O CL message, together with indicating support of ITU-T G.993.2 Annex O, does not imply a requirement for cancellation of

upstream crosstalk from lines with ITU-T G.993.5 VTU-Rs into a line operating according to ITU-T G.993.2 Annex O.

NOTE 3 – A VTU-R supporting operation according to this annex supports all functionality of ITU-T G.993.5 (including change of the upstream pilot sequence), except for the clipped error sample feedback during initialization (support of R-ERROR-FEEDBACK message is not required) and Showtime (support of the backchannel is not required).

This annex reflects changes to the main body of this Recommendation and [ITU-T G.993.5]. The clauses below indicate changes to specific clauses of ITU-T G.993.2 and [ITU-T G.993.5].

O.1 Initialization procedure (supplements clause 12.3 of ITU-T G.993.2)

If and only if the ITU-T G.994.1 VTU-O MS message or VTU-R MS message the NPar(2) bit "Full ITU-T G.993.5-friendly ITU-T G.993.2 operation" is set to ONE, the VTU-O and VTU-R shall use the modified ITU-T G.993.5 initialization procedure, as defined in this annex.

This initialization procedure is identical to an ITU-T G.993.5 initialization procedure, except for the initialization messages R-MSG 1, O_TA-UPDATE, and O-PMS and for the initialization signal R-P-VECTOR 2 (during which the message R-ERROR-FEEDBACK is not transmitted).

O.1.1 ITU-T G.994.1 Handshake phase

O.1.1.1 Handshake – VTU-O

O.1.1.1.1 CL messages (supplements clause 12.3.2.1.1 of ITU-T G.993.2)

Table 12-7 shall be extended with Table O.1 as follows:

Table O.1 – VTU-O CL message NPar(2) bit definitions

ITU-T G.994.1 NPar(2) bit	Definition of NPar(2) bit
Full ITU-T G.993.5-friendly ITU-T G.993.2 operation	If set to ONE, indicates that the VTU-O supports compliance with this annex (full ITU-T G.993.5-friendly ITU-T G.993.2 operation). If set to ONE, both the ITU-T G.993.5 SPar(2) bit and the related "Upstream vectoring" NPar(3) bit shall also be set to ONE.

O.1.1.1.2 MS messages (supplements clause 12.3.2.1.2 of ITU-T G.993.2)

Table 12-10 shall be extended with Table O.2 as follows:

Table O.2 – VTU-O MS message NPar(2) bit definitions

ITU-T G.994.1 NPar(2) bit	Definition of NPar(2) bit
Full ITU-T G.993.5-friendly ITU-T G.993.2 operation	Set to ONE if and only if both the last previous CLR and the last previous CL messages have set this bit to ONE. If set to ONE, both the VTU-O and VTU-R shall operate as defined in this annex. If set to ONE, the "ITU-T G.993.5-friendly ITU-T G.993.2 operation in the downstream direction" (see Annex N) bit shall be set to ZERO. If set to ONE, the "O-P-VECTOR 1-1 maximum duration" (see Annex N) field shall be set to ZERO. NOTE – If set to ONE, the bit "ITU-T G.993.5-friendly ITU-T G.993.2 operation in the downstream direction" (see Annex N) and the bit "ITU-T G.993.5" are both set to ZERO in the VTU-O MS message.

O.1.1.2   Handshake – VTU-R

O.1.1.2.1 CLR messages (supplements clause 12.3.2.2.1 of ITU-T G.993.2)

Table 12-13 shall be extended with Table O.3 as follows:

Table O.3 – VTU-R CLR message NPar(2) bit definitions

ITU-T G.994.1 NPar(2) bit	Definition of NPar(2) bit
Full ITU-T G.993.5-friendly ITU-T G.993.2 operation	If set to ONE, indicates that the VTU-R supports full compliance with this annex (ITU-T G.993.5-friendly ITU-T G.993.2 operation). If set to ONE, the ITU-T G.993.5 SPar(2) bit shall be set to ZERO (see Note).
NOTE – A VTU-R that has ITU-T G.993.5 capability enabled, sets this NPar(2) bit to 0.	

O.1.1.2.2 MS messages (supplements clause 12.3.2.2.2 of ITU-T G.993.2)

Table 12-16 shall be extended with Table O.4 as follows:

Table O.4 – VTU-R MS message NPar(2) bit definitions

ITU-T G.994.1 NPar(2) bit	Definition of NPar(2) bit
Full ITU-T G.993.5 friendly ITU-T G.993.2 operation	Set to ONE if and only if both the last previous CLR and the last previous CL messages have set this bit to ONE. If set to ONE, both the VTU-O and VTU-R shall operate as defined in this annex. If set to ONE, the "ITU-T G.993.5-friendly ITU-T G.993.2 operation in the downstream direction" (see Annex N) bit shall be set to ZERO. If set to ONE, the "O-P-VECTOR 1-1 maximum duration" (see Annex N) field shall be set to ZERO. NOTE – If set to ONE, the bit "ITU-T G.993.5-friendly ITU-T G.993.2 operation in the downstream direction" (see Annex N) and the bit "ITU-T G.993.5" are both set to ZERO in the VTU-R MS message.

O.2   R-MSG1 (supplements clause 10.3.2.2 of [ITU-T G.993.5])

Field #2, "Maximum number of FEXT estimation symbols per super-frame", defines the maximum number ($Kmax$) of symbols in the super-frame for which the VTU-R supports error sample reporting. The field shall be formatted as an unsigned integer with value $Kmax = 0$.

Field #3, "Support of optional backchannel control parameters", indicate the optional values of control parameters supported by the VTU-R. The field shall be formatted as an unsigned integer with value 00_{16}.

O.3   O-TA_UPDATE (supplements clause 10.4.2.1 of [ITU-T G.993.5])

Field #2, "Error report control parameters", defines the control parameters for each of the vectored bands indicated in O-SIGNATURE. The VTU-R shall ignore the error report control parameters.

Field #3, "SOC Repetition Factor", defines the SOC repetition factor, 1/R, as set by the VCE. The field shall be represented as an unsigned integer with value $1/R = 10$.

Field #4, "FEXT estimation symbols per super-frame", defines the number of symbols (K) in the super-frame for which a clipped error sample shall be reported. The field shall be formatted as an unsigned integer with value $K = 0$.

O.4 R-P-VECTOR 2 (replaces clause 10.4.4.5 of [ITU-T G.993.5])

At sync symbol positions, the R-P-VECTOR 2 signal shall contain sync symbols, modulated as defined for the R-P-VECTOR 1 signal. At other symbol positions, the symbols shall be modulated as for the R-P-TRAINING 2 signal, with the extended SOC channel being established.

Transmission of R-P-VECTOR 2 enables the VCE to estimate upstream FEXT channels from the vectored lines into the initializing line, and update the estimates of the upstream FEXT from the initializing lines into the vectored lines.

During the sync symbols, the SOC is in the inactive state. During the other symbols, the SOC is in the active state, and the VTU-R shall transmit the R-IDLE message.

The duration of R-P-VECTOR 2 signal is controlled by the VTU-O. Within 64 symbols after the last symbol of the O-P-SYNCHRO V4 signal, the VTU-R shall end the transmission of the R-P-VECTOR 2 signal.

The R-P-VECTOR 2 signal shall be followed by the R-P-SYNCHRO V2 signal.

NOTE – The R-P-VECTOR 2 signal is identical to the ITU-T G.993.5 R-P-VECTOR 2 signal without extended SOC and with the VTU-R transmitting R-IDLE messages instead of R-ERROR-FEEDBACK messages.

O.5 O-PMS (supplements clause 10.5.2.1 of [ITU-T G.993.5])

Field #2, "Showtime backchannel encapsulation", defines whether the Showtime backchannel is encapsulated into eoc messages or into Layer 2 Ethernet packets. The VTU-R shall ignore this field.

Field #3, "Layer 2 VCE MAC Address", defines the VCE MAC Address to be used by the NT as MAC destination address in case Layer 2 Ethernet encapsulation is used. The VTU-R shall ignore this field.

Field #4, "Layer 2 Line_ID", defines the Line_ID to be used by the NT in case Layer 2 Ethernet encapsulation is used. The VTU-R shall ignore this field.

O.6 eoc messages for backchannel configuration (replaces clause 8.1 of [ITU-T G.993.5])

During Showtime, the VTU-O shall not send a backchannel configuration eoc command.

NOTE – At the start of Showtime, the backchannel is inactive. In absence of activation by the VTU-O through a backchannel configuration eoc command, the backchannel remains inactive throughout Showtime.

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