IEEE P802.11  
Wireless LANs

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| |  |  |  |  |  | | --- | --- | --- | --- | --- | | CC35 Scrambler | | | | | | Date: 2021-07-08 | | | | | | Author(s): | | | | | | Name | Affiliation | Address | Phone | email | | Youhan Kim | Qualcomm |  |  | [youhank@qti.qualcomm.com](mailto:youhank@qti.qualcomm.com) | |  |  |  |  |  | |  |  |  |  |  | |  |  |  |  |  | |  |  |  |  |  | |  |  |  |  |  | |

Abstract

This submission proposes resolutions for the following comments from comment collection on P802.11-REVme D0.0:

602

NOTE – Set the Track Changes Viewing Option in the MS Word to “All Markup” to clearly see the proposed text edits.

**Revision History:**

R0: Initial version.

R1: Incorporated offline feedback from Mark Rison.

R2: Updated Table 19-1, 21-1 and 27-1.

R3: Updated during teleconference on 7/26/2021.

# CID 602

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **CID** | **Clause** | **Page.Line** | **Comment** | **Proposed Change** |
| 602 | 17.3.5.5 | 2907.3 | Scrambler currently has two modes of operation - one when CH\_BANDWIDTH\_IN\_NON\_HT is present and another when it is not present.  This sometimes causes confusion to readers on which mode to use in which situations.  Note that the functionality of the scrambler can be maintained w/o breaking any interop issues w/ existing devices even if we consolidate the scrambler mode to only one - the one used when CH\_BANDWIDTH\_IN\_NON\_HT is present. | Consolidate the scrambler operation mode to one.  More details on the text changes will be provided by the commenter during comment resolution. |

**Discussion**

There are currently two ways to initialize the data scrambler.

Method 1:

|  |
| --- |
|  |

Method 2:

|  |
| --- |
|  |

Method 2 is used when there is need to control the specific value of the first 7 bits of the scrambling sequence, such as

* Transmitting a non-HT or non-HT duplicate PPDU using the bandwidth signaling TA
  + Some bits within the first 7 bits of the scrambling sequence indicates the bandwidth of the PPDU
* Transmitting a CTS frame in a non-HT or non-HT duplicate PPDU in response to an MU-RTS
  + The first 7 bits of the scrambling sequence in the CTS must be the same as that used in the MU-RTS

Method 1 is used in other cases – where the first 7 bits of the scrambling sequence is randomly selected.

The reason for the two methods is because:

* Only method 1 existed initially.
* Then in VHT, bandwidth signaling TA was introduced, which required a practical way to control the first 7 bits of the scrambling sequence. Method 1 does not offer a practical method to do so, hence method 2 was introduced.

Note that from a receiver point of view, there is no difference in the receive processing regardless of whether the transmitter has used method 1 or 2 to generate the scrambling sequence. This is because there is always a one-to-one mapping between sequences generated by method 1 and method 2. For example, the following scrambling sequence can be generated by either method 1 (using all 1s initial state) or method 2 (using integer 112 (which corresponds to binary 1110000 with the LSB ‘0’ transmitted first) as the first 7 bits of the scrambing sequence):

00001110 11110010 11001001 00000010 00100110 00101110 10110110 00001100 11010100 11100111 10110100 00101010 11111010 01010001 10111000 1111111

There is even the following NOTE in REVme D0.1 (P3096L61) which explicitly states that it does not matter to receivers on which method the transmitter has used to generate the scrambling sequence. In this NOTE, “CH\_BANDWIDTH\_IN\_NON\_HT not present” corresponds to method 1 and “CH\_BANDWIDTH\_IN\_NON\_HT present” corresponds to method 2.

|  |
| --- |
| NOTE 3—The receiving PHY cannot determine whether the TXVECTOR parameter CH\_BANDWIDTH\_IN\_NON\_HT was present, but it does not matter since descrambling the DATA field is the same either way. |

Hence, there is no reason to keep two different methods for generating the scrambling sequence in the standard – receivers do not care which method was used at the transmitter, and it only makes reading the standard more complex. Thus, the proposed resolution in this document updates the scrambling sequence generation for PHYs operating in 2.4, 5 and 6 GHz (11a/g/n/ac/ax) to method 2.

Note that the proposed resolution does not change the way the scrambling sequence generation is described for mmWave or S1G PHYs.

While reviewing this comment, the author also noticed that the description for SCRAMBLER\_INITIAL\_VALUE introduced by 11ax should be improved. The SCRAMBLER\_INITIAL\_VALUE was introduced to ensure that the CTS transmission in response to an MU-RTS uses the same first 7-bits for the scrambling sequence. However, the scrambler description in Clause 17 does not describe how the SCRAMBLER\_INITIAL\_VALUE is used to generate the scrambling sequence. Hence, the proposed resolution also improves the description/behavior for the SCRAMBLER\_INITIAL\_VALUE.

**Proposed Resolution: CID 602**

**Revised**.

**Note to Commenter:**

The proposed text update consolidates the scrambler operation into a single method.

**Instruction to Editor:**

Implement the proposed text updates for CID 602 in <https://mentor.ieee.org/802.11/dcn/21/11-21-1040-03-000m-cc35-scrambler.docx>

**Proposed Text Updates: CID 602**

* TXVECTOR parameters
* General

*Instruction to Editor: Update Table 17-1 at REVme D0.1 P3081L18 as shown below:*

|  |  |  |
| --- | --- | --- |
| * TXVECTOR parameters | | |
| Parameter | Associated primitive | Value |
| … | | |
| DYN\_BANDWIDTH \_IN\_NON\_HT | PHY-TXSTART.request  (TXVECTOR) | If present, Static or Dynamic |
| SCRAMBLER\_INITIAL\_VALUE | PHY-TXSTART.request  (TXVECTOR) | If present, an integer in the range 1-127. |
| SCRAMBLER\_RESET | PHY-TXSTART.request (TXVECTOR) | Indicates whether the scrambler is reset before the start of the PPDU  Enumerated Type:  RESET\_SCRAMBLER: The scrambler is reset  NO\_SCRAMBLER\_RESET: The scrambler is not reset. |

*Instruction to Editor: Add the following subclause at REVme D0.1 P3082L24:*

17.2.2.8a TXVECTOR SCRAMBLER\_INITIAL\_VALUE

If present, SCRAMBLER\_INITIAL\_VALUE is an integer in the range 1-127 and is used as the first 7 bits of the scrambling sequence (the first 7 bits transmitted in the SERVICE field after scrambling).

17.2.3 RXVECTOR parameters

17.2.3.1 General

*Instruction to Editor: Update Table 17-2 at REVme D0.1 P3083L22 as shown below:*

|  |  |  |
| --- | --- | --- |
| * RXVECTOR parameters | | |
| Parameter | Associated primitive | Value |
| … | | |
| DYN\_BANDWIDTH \_IN\_NON\_HT | PHY-RXSTART.request  (RXVECTOR) | If present, Static or Dynamic |
| SCRAMBLER\_INITIAL\_VALUE | PHY-RXSTART.request  (RXVECTOR) | If present, an integer in the range 1-127. |
| NOTE—Parameter is present only when dot11RadioMeasurementActivated is true. | | |

*Instruction to Editor: Add the following subclause at REVme D0.1 P3084L24:*

17.2.3.8a RXVECTOR SCRAMBLER\_INITIAL\_VALUE

SCRAMBLER\_INITIAL\_VALUE is present in an HE STA, and is the integer representation of the first 7 bits of the scrambling sequence (the first 7 bits received in the SERVICE field prior to descrambling), with the first bit of the scrambling sequence being the LSB of SCRAMBLER\_INITIAL\_VALUE.

SCRAMBLER\_INITIAL\_VALUE is not present in a non-HE STA.

17.3.2.2 Overview of the PPDU encoding process

*Instruction to Editor: Update REVme D0.1 P3086L57 as shown below:*

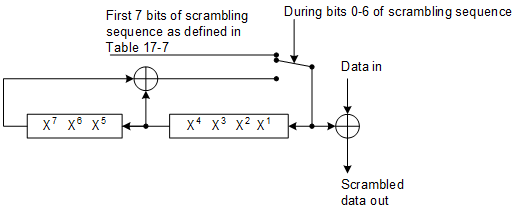
1. Generate the scrambling sequence as defined in 17.3.5.5, and XOR the scrambling sequence with the extended string of data bits.

*Instruction to Editor: Update 17.3.5.5 at REVme D0.1 P3095L53 as shown below:*

* PHY DATA scrambler and descrambler

The DATA field, composed of SERVICE, PSDU, tail, and pad parts, shall be scrambled with a length-127 PPDU-synchronous scrambler. The octets of the PSDU are placed in the transmit serial bit stream, bit 0 first and bit 7 last. The PPDU synchronous scrambler uses the generator polynomial *S(x)* as follows and is illustrated in Figure 17-7:

 (17-14)



**Figure 17-7 – Data scrambler**



NOTE 1—The 127-bit sequence generated repeatedly by the scrambler is (leftmost used first) 00001110 11110010 11001001 00000010 00100110 00101110 10110110 00001100 11010100 11100111 10110100 00101010 11111010 01010001 10111000 1111111, when the when the TXVECTOR parameter SCRAMBLER\_INITIAL\_VALUE is is present and has the value 112 (1110000 in binary representation).

The same scrambler is used to scramble transmit data and to descramble receive data. The first 7 bits of the scrambling sequence shall be set as shown in Table 17-7. The scrambler shall generate the scrambling sequence as shown in Figure 17-7.

If the TXVECTOR parameter SCRAMBLER\_RESET is set to RESET\_SCRAMBLER and dot11MACPrivacyActivated is true, the bits corresponding to pseudorandom integer within the first 7 bits of the scrambling sequence (see Table 17-7) shall be set to a nonzero random value not based on the scrambler value at the end of the last transmitted PPDU.

During reception by a VHT STA, RXVECTOR parameter CH\_BANDWIDTH\_IN\_NON\_HT shall be determined from selected bits in the scrambling sequence as shown in Table 17-7 and Table 17-9. During reception by a VHT STA, the RXVECTOR parameter DYN\_BANDWIDTH\_IN\_NON\_HT shall be set to selected bits in the scrambling sequence as shown in Table 17-7. The fields shall be interpreted as being sent LSB-first.

During reception, an HE STA shall generate the RXVECTOR parameter SCRAMBLER\_INITIAL\_VALUE as the integer representation of the first 7 bits of the scrambling sequence, with the first bit of the scrambling sequence being the LSB of SCRAMBLER\_INITIAL\_VALUE.

NOTE 2 – An HE STA is also a VHT STA. Hence, an HE STA generates RXVECTOR parameter SCRAMBLER\_INITIAL\_VALUE as well as RXVECTOR parameters CH\_BANDWIDTH\_IN\_NON\_HT and DYN\_BANDWIDTH\_IN\_NON\_HT when receiving a non-HT or non-HT duplicate PPDU.

A non-HE STA does not generate the RXVECTOR parameter SCRAMBLER\_INITIAL\_VALUE.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| * Contents of the first 7 bits of the scrambling sequence | | | | |
| Parameter | Condition | First 7 bits of scrambling sequence | | |
| **B0 B3** | **B4** | **B5 B6** |
| Transmit order | | |
| TXVECTOR | CH\_BANDWIDTH\_IN\_NON\_HT is present and DYN\_BANDWIDTH\_IN\_NON\_HT is not present in TXVECTOR | 5-bit pseudorandom nonzero integer if CH\_BANDWIDTH\_IN\_NON\_HT equals CBW20 and a 5-bit pseudorandom integer otherwise | | CH\_BANDWIDTH\_IN\_NON\_HT |
| TXVECTOR | CH\_BANDWIDTH\_IN\_NON\_HT is present and DYN\_BANDWIDTH\_IN\_NON\_HT is present in TXVECTOR | 4-bit pseudorandom nonzero integer if CH\_BANDWIDTH\_IN\_NON\_HT equals CBW20 and DYN\_BANDWIDTH\_IN\_NON\_HT equals Static, and a 4-bit pseudorandom integer otherwise | DYN\_BANDWIDTH\_IN\_NON\_HT |
| TXVECTOR | SCRAMBLER\_INITIAL\_VALUE is present | SCRAMBLER\_INITIAL\_VALUE | | |
| TXVECTOR | CH\_BANDWIDTH\_IN\_NON\_HT and SCRAMBLER\_INITIAL\_VALUE are not present | 7-bit pseudorandom nonzero integer | | |
| RXVECTOR | VHT STA | — | DYN\_BANDWIDTH\_IN\_NON\_HT | CH\_BANDWIDTH\_IN\_NON\_HT\_INDICATOR  (see Table 17-9 (RXVECTOR parameter CH\_BANDWIDTH\_IN\_NON\_HT values)) |
| RXVECTOR | HE STA | SCRAMBLER\_INITIAL\_VALUE | | |
| The encoding of CH\_BANDWIDTH\_IN\_NON\_HT is shown in Table 17-8 and Table 17-9 for TXVECTOR and RXVECTOR, respectively. The encoding of DYN\_BANDWIDTH\_IN\_NON\_HT is shown in Table 17-10.  CH\_BANDWIDTH\_IN\_NON\_HT and SCRAMBLER\_INITIAL\_VALUE are transmitted LSB first. For example, if CH\_BANDWIDTH\_IN\_NON\_HT is CBW80 (whose numerical value is 2), then B5=0 and B6=1.  NOTE – SCRAMBLER\_INITIAL\_VALUE is present in PPDUs carrying an MU-RTS Trigger frame and PPDUs carrying a CTS frame response to an MU-RTS Trigger frame. Also, CH\_BANDWIDTH\_IN\_NON\_HT and DYN\_BANDWIDTH\_IN\_NON\_HT are used when a bandwidth signaling TA is used. But the bandwidth signaling TA is not used in an MU-RTS Trigger frame or a CTS frame response to an MU-RTS Trigger frame (see 26.2.6.3). Hence, TXVECTOR parameters CH\_BANDWIDTH\_IN\_NON\_HT and DYN\_BANDWIDTH\_IN\_NON\_HT and TXVECTOR parameter SCRAMBLER\_INITIAL\_VALUE are not both present in a given PPDU. | | | | |

|  |  |
| --- | --- |
| * TXVECTOR parameter CH\_BANDWIDTH\_IN\_NON\_HT values | |
| Enumerated value | Value |
| CBW20 | 0 |
| CBW40 | 1 |
| CBW80 | 2 |
| CBW160 or CBW80+80 | 3 |

|  |  |  |
| --- | --- | --- |
| * RXVECTOR parameter CH\_BANDWIDTH\_IN\_NON\_HT values | | |
| CH\_BANDWIDTH\_IN\_NON\_HT\_INDICATOR field of first 7 bits of scrambling sequence | dot11CurrentChannelCenterFrequencyIndex1 | RXVECTOR parameter CH\_BANDWIDTH\_IN\_NON\_HT |
| 0 | 0 | CBW20 |
| 1 | 0 | CBW40 |
| 2 | 0 | CBW80 |
| 3 | 0 | CBW160 |
| 3 | 1 to 200 | CBW80+80 |

|  |  |
| --- | --- |
| * DYN\_BANDWIDTH\_IN\_NON\_HT values | |
| Enumerated value | Value |
| Static | 0 |
| Dynamic | 1 |

NOTE 3—The receiving PHY in a VHT STA cannot determine whether the CH\_BANDWIDTH\_IN\_NON\_HT and DYN\_BANDWIDTH\_IN\_NON\_HT parameters were present in the TXVECTOR of the transmitting PHY; therefore, the receiving PHY in a VHT STA always includes values for the CH\_BANDWIDTH\_IN\_NON\_HT and DYN\_BANDWIDTH\_IN\_NON\_HT parameters in the RXVECTOR if the PPDU is a non-HT PPDU. It is the responsibility of the MAC to determine the validity of the RXVECTOR parameters CH\_BANDWIDTH\_IN\_NON\_HT and DYN\_BANDWIDTH\_IN\_NON\_HT.

NOTE 4—The receiving PHY in an HE STA cannot determine whether the CH\_BANDWIDTH\_IN\_NON\_HT, DYN\_BANDWIDTH\_IN\_NON\_HT or SCRAMBLER\_INITIAL\_VALUE parameters were present in the TXVECTOR of the transmitting PHY; therefore, the receiving PHY in an HE STA always includes values for the CH\_BANDWIDTH\_IN\_NON\_HT, DYN\_BANDWIDTH\_IN\_NON\_HT and SCRAMBLER\_INITIAL\_VALUE parameters in the RXVECTOR if the PPDU is a non-HT PPDU. It is the responsibility of the MAC to determine the validity of the RXVECTOR parameters CH\_BANDWIDTH\_IN\_NON\_HT, DYN\_BANDWIDTH\_IN\_NON\_HT and SCRAMBLER\_INITIAL\_VALUE.

NOTE 5—The receiving PHY cannot determine whether the TXVECTOR parameters CH\_BANDWIDTH\_IN\_NON\_HT, DYN\_BANDWIDTH\_IN\_NON\_HT or SCRAMBLER\_INITIAL\_VALUE were present, but it does not matter since descrambling the DATA field is the same either way.

The seven LSBs of the SERVICE field shall be set to all 0s prior to scrambling to enable estimation of the initial state of the scrambler in the receiver.

An example of the scrambler output is illustrated in I.1.5.2 (Scrambling the BCC example) with the TXVECTOR parameter SCRAMBLER\_INITIAL\_VALUE present.

**18.2 PHY-specific service parameter list**

*Instruction to Editor: Add a row for SCRAMBLER\_INITIAL\_VALUE at the end of Table 18-1 at REVme D0.1 P3130L46 as shown below:*

|  |  |
| --- | --- |
| Table 18-1 – TXVECTOR parameters | |
| Parameter | Value |
| … | |
| SCRAMBLER\_INITIAL\_VALUE | If present, an integer in the range 1-127. See 17.3.5.5. |

*Instruction to Editor: Add a row for SCRAMBLER\_INITIAL\_VALUE at the end of Table 18-3 at REVme D0.1 P3131L65 as shown below:*

|  |  |
| --- | --- |
| Table 18-3 – RXVECTOR parameters | |
| Parameter | Value |
| … | |
| SCRAMBLER\_INITIAL\_VALUE | If present, an integer in the range 1-127. See 17.3.5.5. |

**19.2.2 TXVECTOR and RXVECTOR parameters**

*Instruction to Editor: Add a row for SCRAMBLER\_INITIAL\_VALUE in Table 19-1 as shown below:*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Table 19-1 – TXVECTOR and RXVECTOR parameters | | | | |
| Parameter | Condition | Value | TXVECTOR | RXVECTOR |
| … | | | | |
| SCRAMBLER\_INITIAL\_VALUE | FORMAT is HT\_MF or HT\_GF, and the STA is an HE STA | The first 7 bits of the scrambling sequence (the first 7 bits in the SERVICE field prior to descrambling), with the first bit of the scrambling sequence being the LSB of SCRAMBLER\_INITIAL\_VALUE. | N | Y |
| FORMAT is HT\_MF or HT\_GF, and the STA is not an HE STA | Not present | N | N |
| Otherwise | See corresponding entry in Table 17-1 and 17.2.2.8a, Table 17-2 and 17.2.3.8a, Table 18-1 and 17.2.2.8a or Table 18-3 and 17.2.3.8a. | | |

**19.3.4 Overview of the PPDU encoding process**

*Instruction to Editor: Update REVme D0.1 P3160L41 as shown below:*

f) Generate a scrambling sequence, and  
exclusive-OR (XOR) it with the string of data bits as described in 19.3.11.3.

*Instruction to Editor: Update REVme D0.1 P3186L28 as shown below:*

**19.3.11.3 Scrambler**

The data field shall be scrambled by the scrambler defined in 17.3.5.5. The Clause 17 TXVECTOR parameters CH\_BANDWIDTH\_IN\_NON\_HT, DYN\_BANDWIDTH\_IN\_NON\_HT and SCRAMBLER\_INITIAL\_VALUE are not present in an HT PPDU; therefore, the first 7 bits of the scrambling sequence are set to a 7-bit pseudorandom nonzero integer.

**21.2.2 TXVECTOR and RXVECTOR parameters**

*Instruction to Editor: Add a row for SCRAMBLER\_INITIAL\_VALUE in Table 21-1 as shown below:*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Table 21-1 – TXVECTOR and RXVECTOR parameters | | | | |
| Parameter | Condition | Value | TXVECTOR | RXVECTOR |
| … | | | | |
| SCRAMBLER\_INITIAL\_VALUE | FORMAT is VHT, GROUP\_ID is neither 0 nor 63, and STA is an HE STA | The first 7 bits of the scrambling sequence (the first 7 bits in the SERVICE field prior to descrambling), with the first bit of the scrambling sequence being the LSB of SCRAMBLER\_INITIAL\_VALUE. | N | Y |
| FORMAT is VHT and GROUP\_ID is 0 or 63 | Not present | N | N |
| FORMAT is VHT and STA is not an HE STA | Not present | N | N |
| Otherwise | See corresponding entry in Table 19-1. | | |

*Instruction to Editor: Update REVme D0.1 P3361L57 as shown below:*

**21.3.10.4 Scrambler**

The SERVICE, PSDU, and PHY pad parts of the Data field shall be scrambled by the scrambler defined in 17.3.5.5. The Clause 17 TXVECTOR parameters CH\_BANDWIDTH\_IN\_NON\_HT, DYN\_BANDWIDTH\_IN\_NON\_HT and SCRAMBLER\_INITIAL\_VALUE are not present; therefore, the first 7 bits of the scrambling sequence are set to a 7-bit pseudorandom nonzero integer. Different users in a VHT MU PPDU may use different pseudorandom nonzero seeds.

26.2.6.3 CTS frame response to an MU-RTS Trigger frame

*Instruction to Editor: Update REVme D0.1 P3742L40 as shown below:*

NOTE 3 — A bandwidth signaling TA is not used in an MU-RTS Trigger frame or a CTS frame response to an MU-RTS Trigger frame (see 9.3.1.22 (Trigger frame format) and 9.3.1.3 (CTS frame format)). As a result, the TXVECTOR parameter CH\_BANDWIDTH\_IN\_NON\_HT is not present when transmitting an MU-RTS Trigger frame or CTS frame response to an MU-RTS Trigger frame.

(#24287)

*Instruction to Editor: Update REVme D0.1 P3971L10 as shown below:*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| * TXVECTOR and RXVECTOR parameters | | | | |
| Parameter | Condition | Value | TXVECTOR | RXVECTOR |
| … | | | | |
| SCRAMBLER\_INITIAL\_VALUE |  |  |  |  |
| FORMAT is HE\_SU or HE\_ER\_SU | The first 7 bits of the scrambling sequence (the value of the Scrambler Initialization field prior to descrambling), with the first bit of the scrambling sequence being the LSB of SCRAMBLER\_INITIAL\_VALUE. | N | Y |
| FORMAT is HE\_MU or  HE\_TB | Not present | N | N |
|  |  |  |  |
|  |  |  |  |
| Otherwise | See corresponding entry in Table 21-1. | | |

*Instruction to Editor: Update REVme D0.1 P4034L28 as shown below:*

**27.3.12.4 Scrambler**

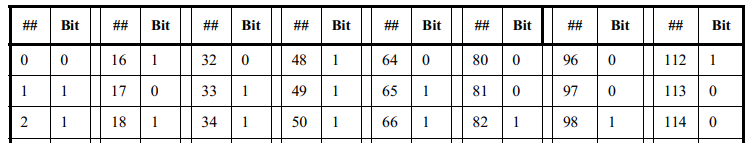
The SERVICE field, PSDU, and pre-FEC PHY padding of the Data field shall be scrambled by the scrambler defined in 17.3.5.5. The Clause 17 TXVECTOR parameters CH\_BANDWIDTH\_IN\_NON\_HT, DYN\_BANDWIDTH\_IN\_NON\_HT and SCRAMBLER\_INITIAL\_VALUE are not present; therefore, the first 7 bits of the scrambling sequence are set to a 7-bit nonzero pseudorandom integer. A different nonzero pseudorandom value may be used for each user in an HE MU PPDU.

*Instruction to Editor: Update REVme D0.1 P5053L22 as shown below:*

**I.1.5.2 Scrambling the BCC example**

The 864 bits are scrambled by the scrambler defined in 17.3.5.5. The TXVECTOR parameter SCRAMBLER\_INITIAL\_VALUE is 54 . The generated scrambling sequence is given in Table I-14.

**Table I-14—Scrambling sequence for TXVECTOR parameter SCRAMBLER\_INITIAL\_VALUE equal to 54**



[End of File]