International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

G.9902

Amendment 1

(03/2013)

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

Access networks – In premises networks

Narrowband orthogonal frequency division multiplexing power line communication transceivers for ITU-T G.hnem networks

Amendment 1

Recommendation ITU-T G.9902 (2012) – Amendment 1

International Telecommunication Union

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Recommendation ITU-T G.9902

Narrowband orthogonal frequency division multiplexing power line communication transceivers for ITU-T G.hnem networks

Amendment 1

Summary

Amendment 1 to Recommendation ITU-T G.9902 (2012) contains:

- various clarifications and corrections
- the support for an annex with an ARIB bandplan for the Japan region.

History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T G.9902	2012-10-29	15
1.1	ITU-T G.9902 (2012) Amd. 1	2013-03-16	15

FOREWORD

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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, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

Recommendation ITU-T G.9902

Narrowband orthogonal frequency division multiplexing power line communication transceivers for ITU-T G.hnem networks

Amendment 1

NOTE – Any modifications introduced by this amendment are shown with revision marks. Unchanged text is replaced by ellipses (…). Some parts of the unchanged text (clause numbers, etc.) may be kept to indicate the correct insertion points.

• • •

1) Changes to clauses 8.3.5 and 8.4.2.7

Make the changes indicated below for clauses 8.3.5 and 8.4.2.7.

8.3.5 Channel interleaver

The channel interleaver interleaves a block of B_I bits (see clause 8.3.3, clause 8.3.4), based on the number of subcarriers per symbol frame that are loaded bits multiplied by *k*, which stands for modulation used (*k* = 1 for 1-bit modulation, *k* = 2 for 2-bit modulation, etc.), denoted in this section by *m*. For the payload, these subcarriers are those identified in the TM field of the PFH, except the subcarriers from the PMSC, RMSC (unless BAT type 0 is used), and PSC sets. For the PFH, these are all subcarriers from the RMSC set and all subcarriers from the SSC set, except those from the PSC set (see clause 8.4.2.1, clause 8.4.2.2, clause 8.4.2.5).

For the payload encoder $B_I = B_0$, for the PFH encoder $B_I = NS_I \times k_H$. The interleaver is only defined for values of B_I that are multiples of *m*, i.e., $n = B_I / m$ is an integer. The B0I input bits shall be written into the permutation matrix with *n* rows and *m* columns. The insertion of the bits into the matrix shall be performed using the equations below:

~~$q = floor(p/(k \times m))$~~

~~$r = mod(p,k \times m)$~~

~~$i = floor(r,k)$~~

~~$j = k \times q + mod(r,k)$~~

$j = floor(p/m)$

$i = mod(p, m)$

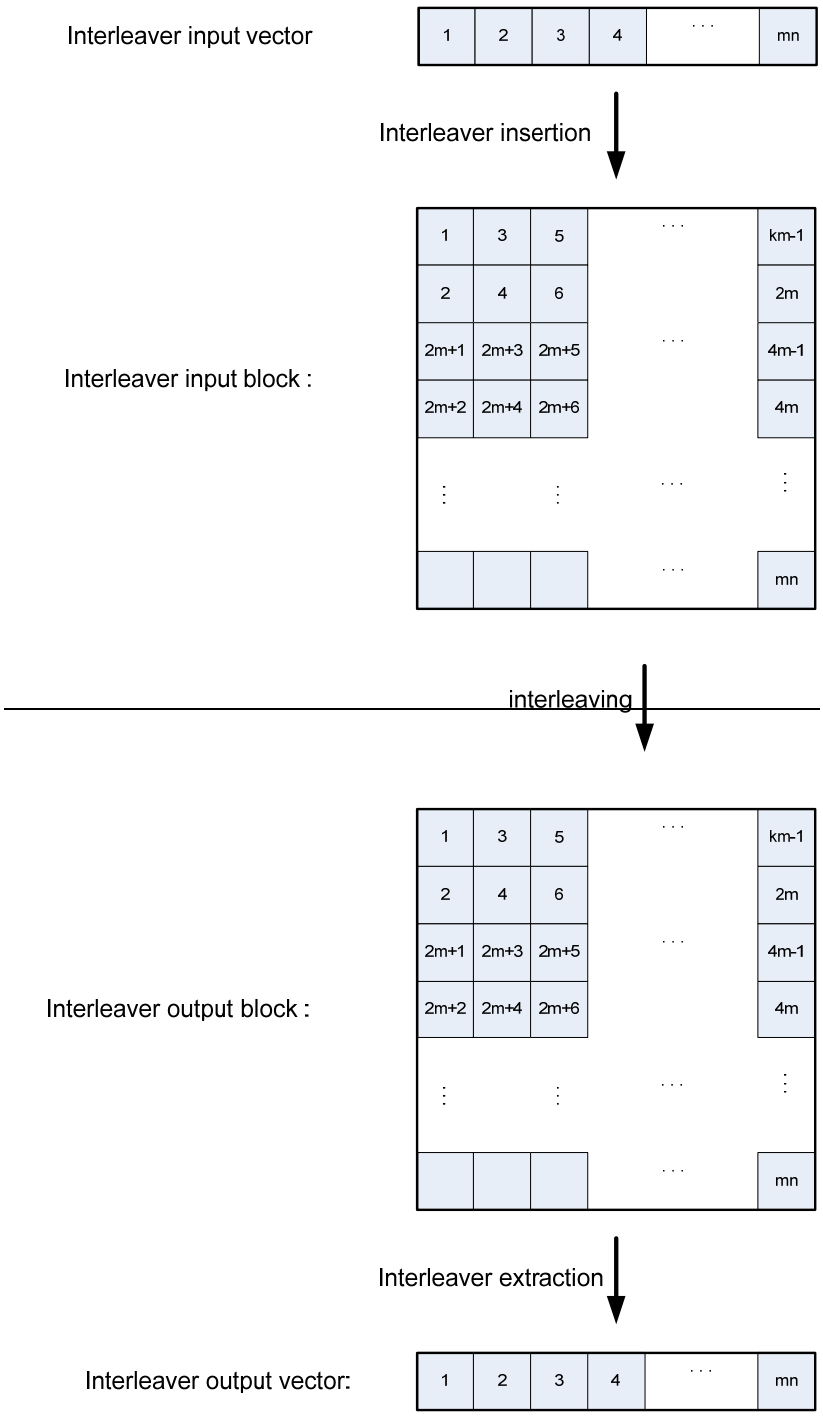
where:

p is the sequential number of the bit in the input sequence (input vector), in the range from 0 to BI-1

~~*k* is the modulation used (k=1 for 1-bit modulation, k=2 for 2-bit modulation, etc.)~~

i is the index of the column and j is the index of the row in the permutation matrix in the range from 0 to m-1 and from 0 to n-1, respectively (m columns by n rows).

Figure 8-14 shows the insertion of the bits into a matrix ~~when the equations are used with *k*=2~~. Each box in the Figure 8-14 represents a bit. The number in the box indicates the position of the bit in the input bit sequence (input vector) and in the output bit sequence (output vector), respectively.


Interleaver input vector
1
2
3
4
mn
Interleaver insertion
Interleaver input block :
1
3
5
km-1
2
4
6
2m
2m+1
2m+3
2m+5
4m-1
2m+2
2m+4
2m+6
4m
mn
interleaving
Interleaver output block :
1
3
5
km-1
2
4
6
2m
2m+1
2m+3
2m+5
4m-1
2m+2
2m+4
2m+6
4m
mn
Interleaver extraction
Interleaver output vector:
1
2
3
4
mn

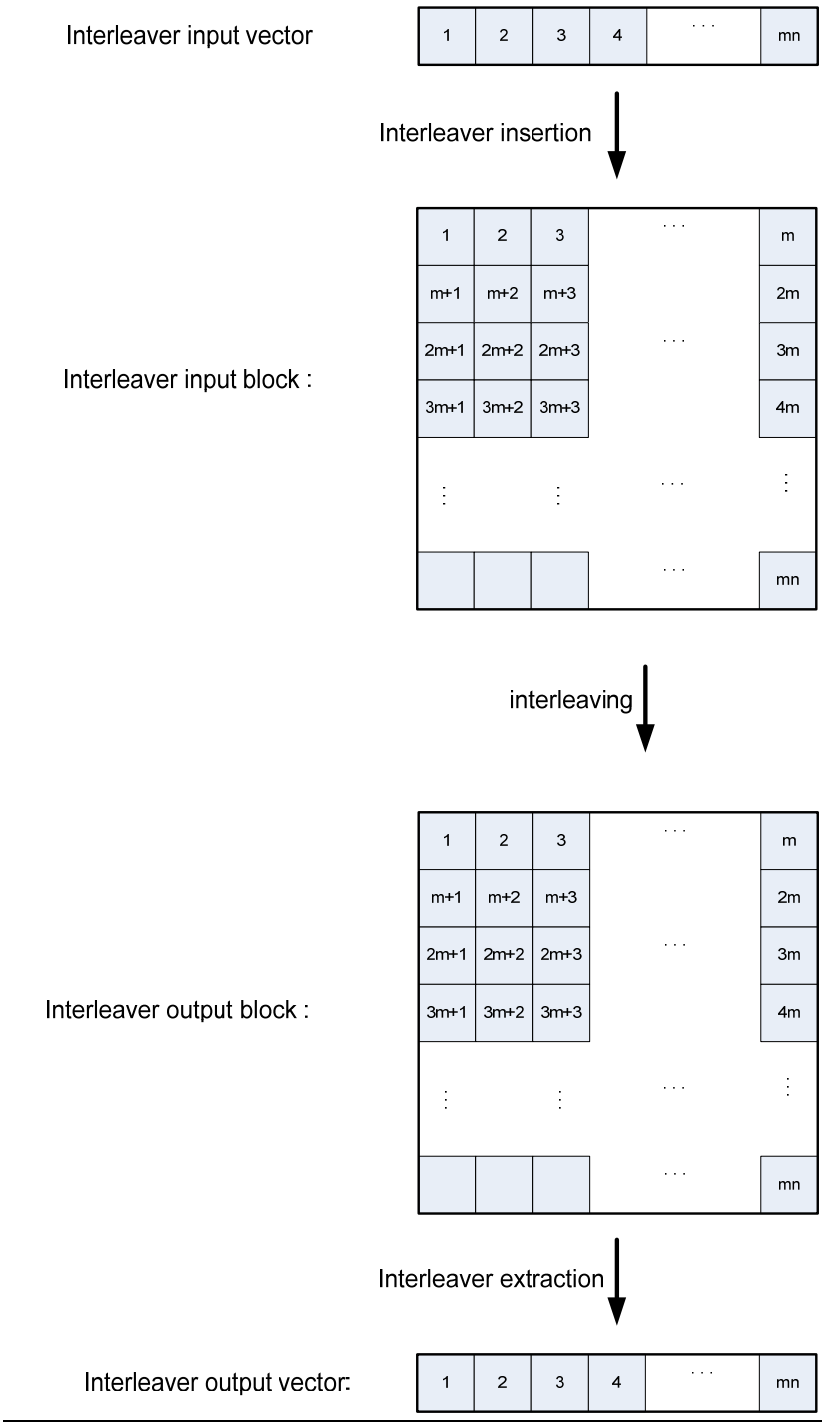


Figure 8-14 – Order of writing in and reading out of the permutation matrix

The entries of the $n \times m$ matrix shall be permuted. The relation between input and output bit indices shall be determined from the following equations: for the bit with the original position (i, j), where $i = 0,1,..., m-1$ and $j = 0,1,..., n-1$, the interleaved bit position (I, J) shall be:

$$J = (j \times n\_j + i \times n\_i) \bmod n$$

$$I = (i \times m\_i + J \times m\_j) \bmod m$$

where m_i, m_j, n_i, and n_j are selected based on the values of m and n, under the constraint that

$$m\_i, m\_j, n\_i, n\_j > 2$$

$$\mathrm{GCD}(m\_i,m) = \mathrm{GCD}(m\_j,m) = \mathrm{GCD}(n\_i,n) = \mathrm{GCD}(n\_j,n) = 1$$

where GCD stands for the greatest common divisor.

The values of *n_i*, *n_j* and *m_i*, *m_j* shall be computed as follows: For a given value of *n*, all the co-prime numbers of *n* except numbers 1 and 2 shall be sorted in ascending order; then, *n_i* shall be the first co-prime element above *n*/2 in that co-prime number set, and *n_j* shall be the next element to *n_i*. In case there are not enough co-prime numbers to satisfy the rule, all the existing co-primes (including 1 and 2) should be used to form a set, *n_i* should be the second number in the set, while *n_j* should be the third number. In case there are only two numbers in a set, *n_i* should be the first number and *n_j* should be the second number. Same steps shall be applied to compute *m_i* and *m_j*, for a given value of *m*.

The following is an example for co-prime selection for $n = 8$, $m = 10$:

- Since $n = 8$, the co-prime numbers for 8 except 1 and 2 are: 3, 5, 7.

  The first co-prime number above $n/2$ is 5, so $n\_i = 5$; and the next co-prime is 7, so $n\_j = 7$.
- Since m = 10, the co-prime numbers for 10 except 1 and 2 are: 3, 7, 9.

  The first co-prime number above $m/2$ is 7, so $m\_i = 7$; and the next is 9, so $m\_j = 9$.

After permutation, bits shall be extracted from the permutation matrix in the same order that they were written into the matrix. An example ~~for 2-bit modulation (k=2)~~ is given in Figure 8-14.

• • •

8.4.2.7 Modulation of pilot subcarriers

Pilot subcarriers shall be modulated with 2-bit modulation where the bits shall be generated using an LFSR initialized with all ones at the beginning of the PFH, prior to the transmission of the first PSC. The generation polynomial shall be as defined in clause 8.4.2.6.

The modulation of the PSC shall start from the first PFH symbol; each subcarrier from the PSC set (in ascending order) shall be modulated with the two bits which are the LSBs of the LFSR, d_0, and d_1 (as presented in Figure 8-17), using the 2-bits constellation mapping defined in clause 8.4.3.

• • •

2) New Annex E

Add the following new annex.

Annex E

Regional requirements for Japan

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

E.1 Introduction

Clause A.1.3 of [ITU-T G.9901] defines the parameters and requirements for the ARIB bandplan. The requirements for the ARIB regional annex shall follow the FCC requirements, with the modifications given below.

E.2 Physical layer (PHY) specification

The PHY specification shall be in accordance with the bandplan specification defined by clause A.1.3 of [ITU-T G.9901] and clause 8 of this Recommendation.

E.3 Data link layer (DLL) specification

The DLL specification shall be in accordance with clause 9 of this Recommendation, with the following changes:

- IFG_MIN shall be set to 25 ms except for retransmissions where IFG_MIN shall remain unchanged;
- The maximum number of re-transmissions (MaxRetransmissions) shall be limited to being less than or equal to 7.

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