ARIB STD-B13
Version 2.1-E1

ENGLISH TRANSLATION

# 800MHZ-BAND OFDM TRANSMISSION SYSTEM FOR TELEVISION PROGRAM CONTRIBUTION

# ARIB STANDARD

ARIB STD-B13 Version 2.1


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Association of Radio Industries and Businesses

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# Preface

ARIB (Association of Radio Industries and Businesses) establishes the "ARIB Standards" for the basic technical conditions of standard specifications related to variety of radio communication equipments, broadcasting transmission equipments, and its reception equipments using radio wave with the participation of radio communication equipment manufacturers, broadcasting equipment manufacturers, electric communication companies, service providers and other users.

"ARIB Standards" are nongovernmental standards established by combining governmental technical standards established for the purpose of effective use of frequency and to avoid interference of other users, and nongovernmental optional standards established for convenience for radio communication equipment manufacturers, broadcasting equipment manufacturers, electric communication companies, service providers and users, in order to secure appropriate quality and compatibility of radio communication equipment and broadcast equipment, etc.

This standard is established for “800MHz-Band OFDM Transmission System for Television Program Contribution” by the approval of the standardization committee, participated by radio communication equipment manufacturers, broadcast equipment manufacturers, electric communication companies, service providers and users irrespectively, to secure impartiality and clearness.

We hope that this standard will be put to practical use actively by radio communication equipment manufacturers, broadcast equipment manufacturers, electric communication companies, service providers, users, and so on.

Notice:

This standard does not describe industrial proprietary rights mandatory to this standard. However, the right proprietor of the industrial proprietary rights has expressed that "Industrial proprietary rights related to this standard, listed in the annexed table below, are possessed by the applicator shown in the list. However, execution of the right listed in the annexed table below is permitted indiscriminately, without exclusion, under appropriate condition, to the user of this standard. In the case when the user of this standard possesses the mandatory industrial proprietary rights for all or part of the contents specified in this standard, and when he asserts his rights, it is not applied."

Annexed table

(Selection of Option 2)

| Patent applicant | Name of invention | Patent number | Remarks |
|---|---|---|---|
| Japan Broadcasting Corporation (NHK)* | Coded modulation device and demodulation device | Patent No. 2883238 | Japan |

* Valid for the revised parts of ARIB STD-B13 Version 2.0.

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# Chapter 1 General Matters

## 1.1. Purpose

This standard specifies the digital radio transmission system using OFDM (Orthogonal Frequency Division Multiplexing) modulation in the 800 MHz band, so that this system may be used to ensure the smooth contribution of television programs.

## 1.2. Scope

This standard applies to the 800 MHz band OFDM digital transmission system used by mobile links for television program contributions.

Table 1.1 shows the 800 MHz band channels used by the digital radio transmission system to which this standard applies as well as the modulation mode that complies with Article 4-2 of the Regulations for Enforcement of the Radio Law.

**Table 1.1 800 MHz Band Channels and the Modulation Mode to which This Standard is Applicable**

| Channel | Frequency band | Modulation Mode |
|---|---|---|
| 1 ch | 770 MHz to 779 MHz | X7W |
| 2 ch | 779 MHz to 788 MHz | |
| 3 ch | 788 MHz to 797 MHz | |
| 4 ch | 797 MHz to 806 MHz | |

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# Chapter 2 800 MHz Band OFDM System

## 2.1 Transmission Parameters

Table 2.1 shows the transmission parameters for OFDM digital transmission system.

**Table 2.1 Transmission Parameters**

| Item | Specification | | |
|---|---|---|---|
| Occupied bandwidth [MHz] | 8.5 | | |
| Number of carriers | 544 | | |
| Carrier spacing [kHz] | 15.625 | | |
| Carrier modulation | DQPSK | | |
| Number of FFT points | 1024 | | |
| FFT sampling frequency [MHz] | 16.0 | | |
| Effective symbol duration [μs] | 64.0 | | |
| Guard interval length [μs] | 3.0 | 6.0 | 12.0 |
| Total symbol duration [μs] | 67.0 | 70.0 | 76.0 |
| Total number of symbols in a frame | 900 | | |
| Number of synchronizing symbols within a frame | 6 | | |
| Frame period [ms] | 60.3 | 63.0 | 68.4 |
| Transmission bit rate (Gross) [M bit/s] *1 | 16.130547 | 15.439238 | 14.220351 |

*1: Rounded at the seventh decimal

## 2.2 Input/Output Connector

The connector to interface with the devices such as compression encoder shall be BNC.

## 2.3 Spectral Mask

The spectral mask is shown in Fig. 2.1.

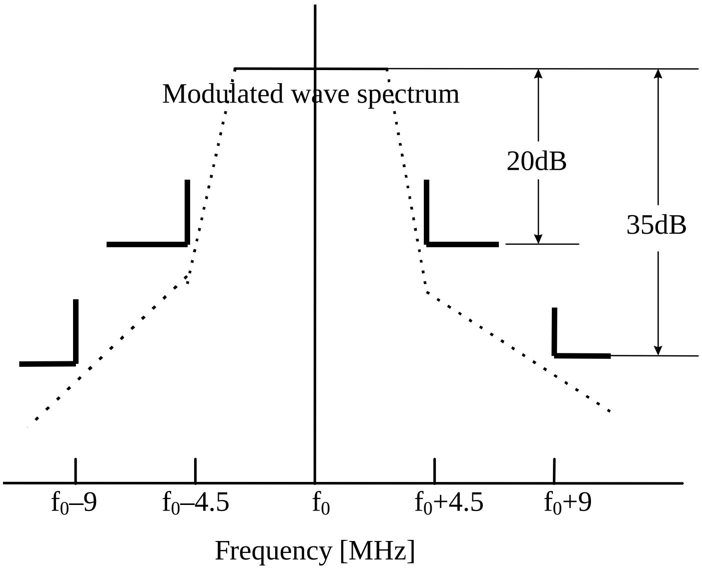


**Fig. 2.1 Spectral Mask**

## 2.4 Polarization

Either circular or linear polarization shall be used.

## 2.5 Transmission Equipment Tolerances

The transmission equipment tolerances shall be as follows, according to the Ordinance Regulating Radio Equipment.

### 2.5.1 Occupied Bandwidth (Ministerial Ordinance)

The occupied bandwidth shall be 8.5 MHz or lower.

### 2.5.2 Frequency Tolerance (Ministerial Ordinance)

The transmission frequency tolerance shall be $1.5 \times 10^{-6}$ or lower.

### 2.5.3 Radiated Power (Ministerial Ordinance)

The radiated transmitting power shall be 5 W or lower.

### 2.5.4 Spurious Emission or Unwanted Emisson Intensity (Ministerial Ordinance)

#### 2.5.4.1 Specification applied after December 1, 2005

| Spurious Emission Intensity in area outside band | Unwanted Emission Intensity in spurious area |
| --- | --- |
| 25 μW or lower | 25 μW or lower |

This specification meets the requirements specified in attached table 3-2(1) of the Ordinance Regulating Radio Equipment.

Please note that there are interim measures in this specification. (Depend on the Ordinance Regulating Radio Equipment (No.119 of the administration ministerial ordinance on august 9, 2005) additional clause.)

#### 2.5.4.2 Specification applied before November 30, 2005

The spurious emission intensity shall be 25 μW or lower.

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# Chapter 3 Manufacturers Compatibility Specifications

## 3.1 Block Diagram

Fig. 3.1 shows the digital FPU in block diagram form.

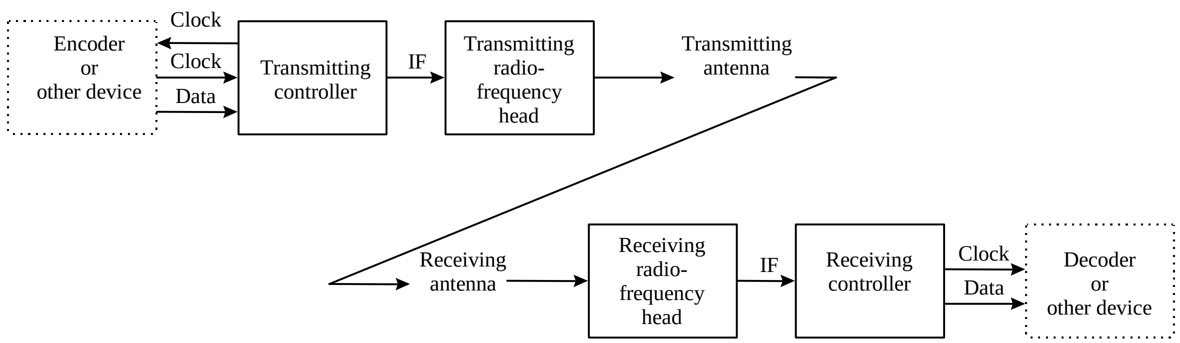



**Fig. 3.1 Block Diagram of the Digital FPU**

## 3.2 Interface of digital FPU transmitter/receiver

The interface with devices such as the encoder/decoder is specified below. The “Serial Interface for Separate-Cable Transmission of Data and Clock for Television Program Contribution ARIB Standard ARIB STD-B18” shall be applied.

### 3.2.1 Electrical Characteristics of the Transmitting End

(1) Output impedance

Output impedance shall be 75Ω unbalanced. The return loss shall be 15 dB or higher in the range of 1/50 to 1 times band of the transmission clock frequency.

(2) Signal level

The peak output signal level shall be within 800 mVpp±10% with AC coupling.

(3) Timing for Data rising and falling

The timing for the data rising and falling specified between the signal level of 20% and 80% shall be 25% or less of the clock cycle. However, if the clock frequency is 12.5 MHz or lower, the timing for the data rising and falling shall be within 20 nsec or less.

(4) Clock duty

The clock duty shall be 30 to 70%.

(5) Clock jitter

The clock rising jitter shall be within 7% pp of the clock cycle. However, if the clock frequency is 140 MHz or higher, the clock rising jitter shall be within 0.5 nsec pp.

(6) Clock and data timing

The data and clock timing is shown in Fig. 3.2. The rising time of the clock is specified to be when the 50% value of the signal level is located at the center of the data signal transition point, and the timing shall be within ±10% of the clock cycle. However, if the clock frequency is 100 MHz or higher, the timing shall be within ±1 nsec.

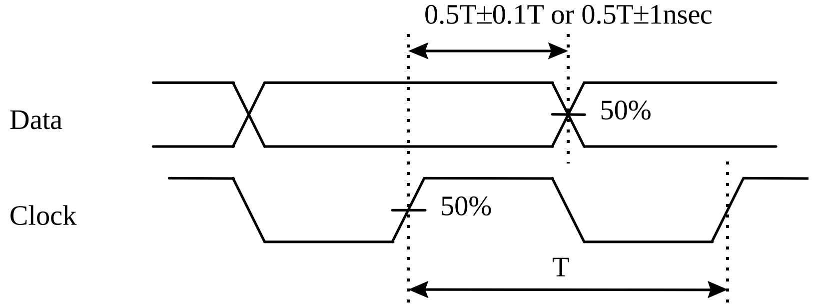



**Fig. 3.2 Clock and Data Timing**

(7) Transmission band

The transmission band shall be in the range of 1/50 to 1 times of the clock frequency.

### 3.2.2 Electrical Characteristics of the Receiving End

(1) Input impedance

The input impedance shall be 75Ω unbalanced. The return loss shall be 15 dB or higher in the range of 1/50 to 1 times band of the transmission clock frequency.

(2) Receiver sensitivity

Signal reception shall be enabled without an equalizer at a maximum transmission distance of 10 m.

(3) Interference cancellation

Reception of the signal at a peak level of 800 mVpp±10% shall be enabled, even in the presence of the disturbing signal, with a ±2.5 V dc component and/or a 2.5 Vpp power supply frequency component.

(4) Delay time difference between the data and clock

Normal operation shall be achieved even if the clock and data timing defined in §3.2.1 (6) fluctuate ±25% of the clock cycle based on the difference in cable lengths between the data and clock signals and so on.

### 3.2.3 Connector and Cable

(1) Connector type

75Ω BNC

(2) Cable type

75Ω coaxial cable 5C-2V (Cable with 5C-2V or equivalent characteristics such as 5C-FB and BS-CX)

(3) Cable length

The cable length shall be a maximum of 10 m.

### 3.2.4 Connection Method

The connection between the encoder and the transmitting controller or the decoder and the receiving controller is as shown in Fig. 3.1.

The transmitting controller shall include the master clock. The clock supplied from the encoder to the transmitting controller shall have the same frequency as that supplied from the transmitting controller to the encoder.

The clock supplied from the transmitting controller to the encoder shall meet the specifications mentioned in §3.2.1 (1) to (5) and the frequency stability shall be 20 ppm or lower.

## 3.3 Transmitting Controller

Fig. 3.3 shows the transmitting controller in block diagram form.

The specifications for each part of the transmitting controller are provided below:

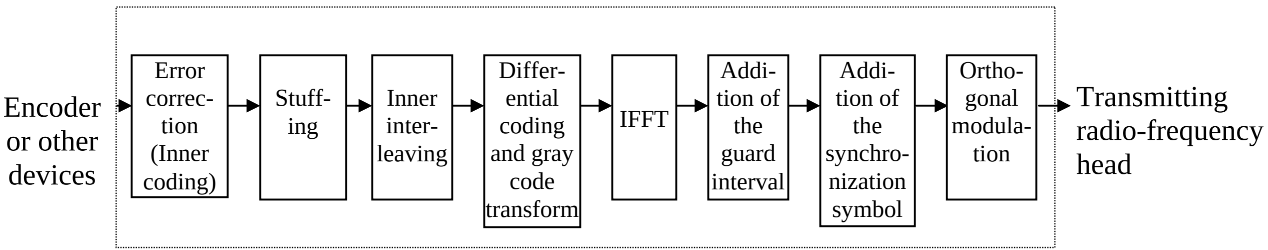



**Fig. 3.3 Block Diagram of the Transmitting Controller**

### 3.3.1 Interface

(1) Connecting point with devices such as an encoder

Devices such as an encoder shall include energy dispersal, outer coding (error correction) and outer interleaving.

(2) Data bit rate

The bit rate shown in Table 3.1 shall be used for connection with devices such as the encoder.

One of the three stuffing modes shall be used for the guard intervals of 6 μs and 12 μs. These stuffing modes have the following characteristics:

- If it is important to ease repairs from devices previously used, stuffing modes I or III may be optimal depending on the manufacturer's circuit design.

- If compatibility among manufacturers is important, stuffing mode II shall be used.

**Table 3.1 Bit Rates for Connection with the Encoder**

| Bit rate after outer coding (DR) (Mbit/s) *[1] | | | Inner coding rate (CR) | | | | |
|---|---|---|---|---|---|---|---|
| | | | 1/2 | 2/3 | 3/4 | 7/8 | None |
| Guard Interval length μs | 3.0 | | 8.000000 | 10.666666 | 12.000000 | 14.000000 | 16.000000 |
| | 6.0 | Stuffing mode I | 7.500000 | 10.000000 | 11.250000 | 13.125000 | 15.000000 |
| | | Stuffing mode II | 7.657143 | 10.209524 | 11.485714 | 13.400000 | 15.314286 |
| | | Stuffing mode III | 7.719619 | 10.292825 | 11.579429 | 13.509333 | 15.439238 |
| | 12.0 | Stuffing mode I | 7.000000 | 9.333333 | 10.500000 | 12.250000 | 14.000000 |
| | | Stuffing mode II | 7.052632 | 9.403509 | 10.578947 | 12.342105 | 14.105263 |
| | | Stuffing mode III | 7.110175 | 9.480234 | 10.665263 | 12.442807 | 14.220351 |

*1: Rounded at the seventh decimal

*1) The bit rate after outer coding is calculated as follows.

$$DR = R \times CR$$

R : Bit rate without convolution (M bit/s)
CR : Inner coding rate

### 3.3.2 Error Correction Coding (Inner Coding)

The convolutional code shall be used as the inner code.

One or multiple coding modes shall be available - there are five coding mode options; namely coding rates of 1/2, 2/3, 3/4 and 7/8 and no coding. The constraint length of the convolutional code shall be 7 and the coding rate shall be 1/2; changeable using punctured convolutional coding.

The specifications for converting one-bit serial to two-bit parallel data (hereafter referred to as the paired data) as performed in the error correction coding are provided below.

(1) When not using convolution coding

When not using convolution coding, one-bit serial data shall be converted to two-bit paired data, as shown in Fig. 3.4:

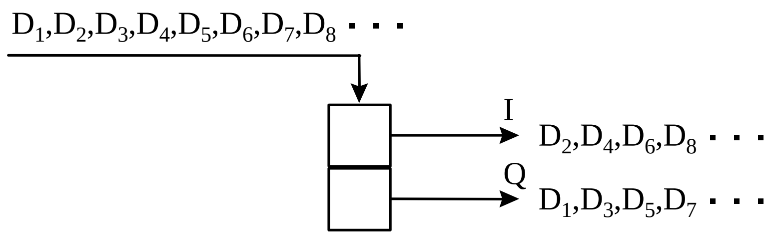



**Fig. 3.4 Serial-to-Parallel Conversion When Not Using Convolution Coding**

(2) When using convolution coding

The convolution encoder is shown in Fig. 3.5.

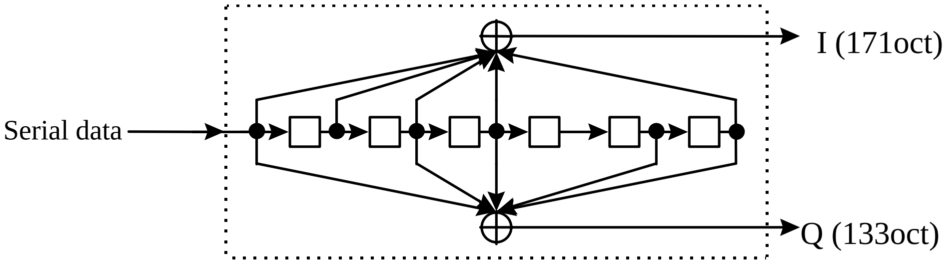



**Fig. 3.5 Convolution Encoder**

(3) Convolution coding and punctured convolutional coding

Convolution coding and punctured convolutional coding is shown in Table 3.2.

**Table 3.2 Convolution Coding**

| Coding rate | Punctured pattern (0: Deleted code word) |
|---|---|
| 1/2 | I : 1<br>Q : 1 |
| 2/3 | I : 1 0<br>Q : 1 1 |
| 3/4 | I : 1 0 1<br>Q : 1 1 0 |
| 7/8 | I : 1 0 0 0 1 0 1<br>Q : 1 1 1 1 0 1 0 |

### 3.3.3 Stuffing

When connecting to the encoder, stuffing shall be performed to offset the difference between the bit rate after inner coding and the transmission bit rate (gross). After adding an inner code to the information bit stream from the encoder, stuffing data shall be added to the trailing part to obtain the transmission bit stream. Although no specifications for stuffing data are required in view of manufacturers compatibility, here, zero (0) should be added for stuffing data.

### 3.3.4 Inner Interleave

To utilize the frequency and time dispersion effects of OFDM, bit interleaving within each OFDM frame shall be performed with two-bit paired data, as shown in Fig. 3.6. Although no inner interleaving can be used for the low delay mode, no specifications for this mode are provided here.

Single frame data (964, 800 bits) shall be consecutively written in the line direction, beginning from the start point of the inner interleaving matrix (one line and row respectively) as shown in Fig. 3.6, with the paired data output from the error correction encoder.

Since the inner interleaving matrix size is 972, 672 bits (544 × 2 × 894), an excess of data cannot be written into the matrix. However, no specifications for the portion of no data (7,872 bits) are provided here.

The data in the inner interleaving matrix shall be consecutively read out in the row direction, beginning from the start point of the inner interleaving matrix, as shown in Fig. 3.6.

The paired read out data are sequentially divided into units of 544 effective carriers to form data symbols. Data symbols 1 to 894, read out from the inner interleaving matrix, are assigned to the 7th to 900th OFDM symbol in the OFDM frame respectively.

The paired data in each symbol are assigned to the carrier number, 1 to 544, in order of the data read out from the inner interleaving matrix.

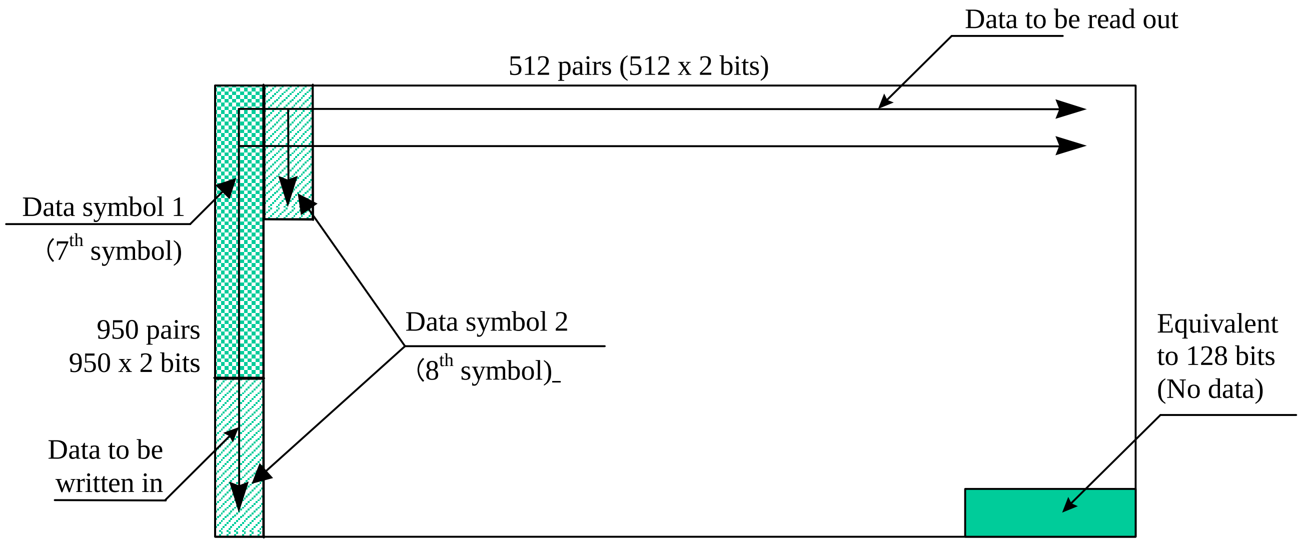



**Fig. 3.6 Inner Interleaving Matrix**

The aforementioned interleaving and convolution interleaving methods can also be switched, optionally. More detailed information on the convolution interleaving method is given below.

The convolution interleaving method involves supplying post-stuffing paired data, one by one, to each path of the 102 paths; and each is blocked with a 233-bit delay, to ensure that the "n"th path has a delay of (n-1) blocks.

(1) Convolution interleaving

The block diagram of the convolution interleaving is shown in Fig. 3.7:

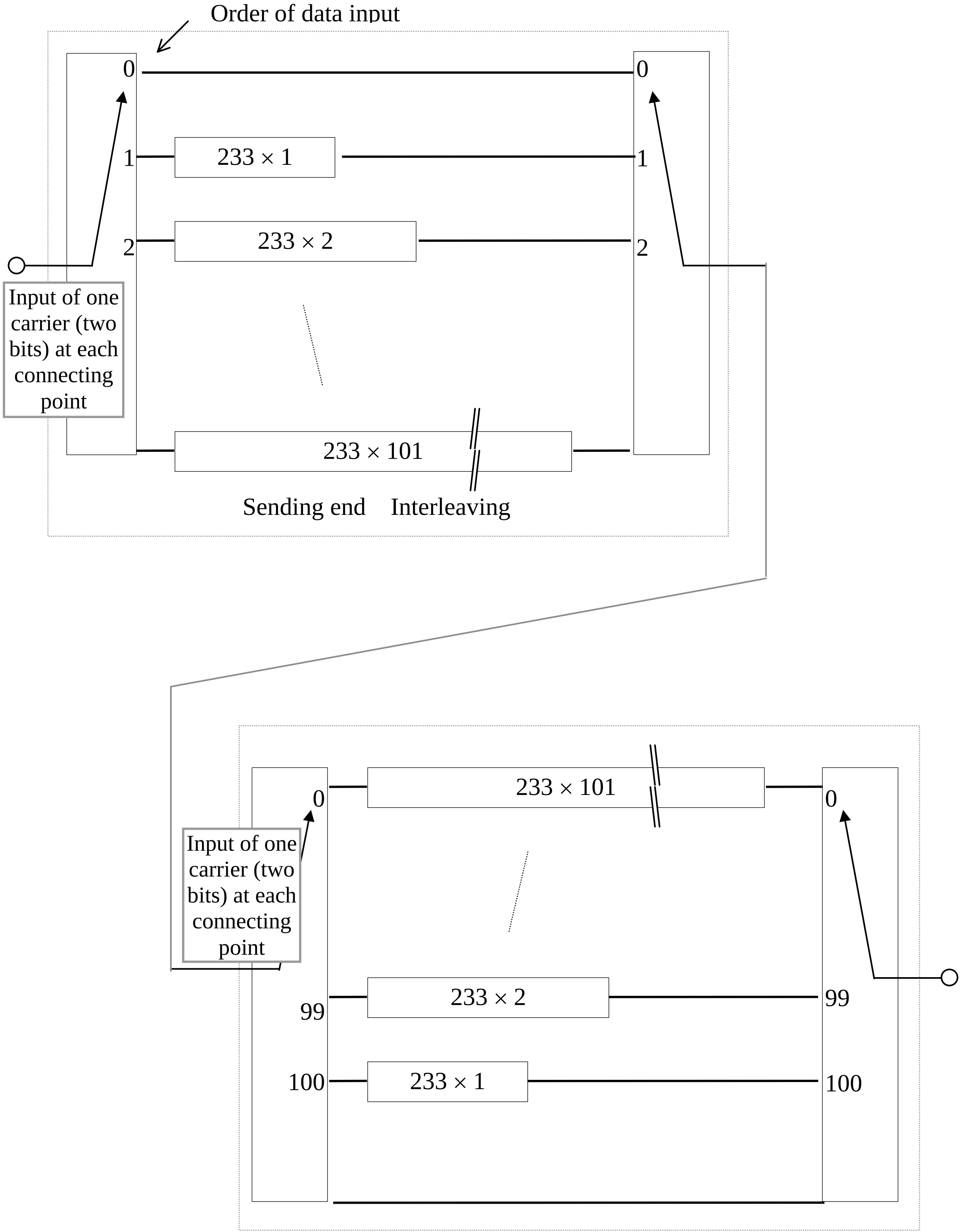



**Fig. 3.7 Block Diagram of the Convolution Interleaving**

(2) Data distribution

Data are distributed as shown in Fig. 3.8.

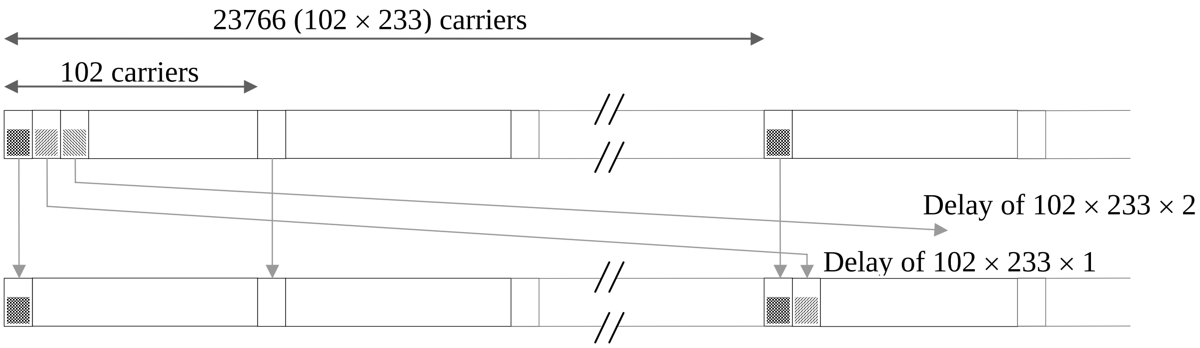



**Fig. 3.8 Data Distribution**

### 3.3.5 Differential Coding and Gray Code Transform

The OFDM carrier is DQPSK (Differential Quadrature Phase Shift Keying) modulated.

Differential coding and gray code transform, as shown in Table 3.3, shall be performed based on the differential reference symbol (the 6th symbol of the synchronization symbol – see §3.3.8 (5)). Each paired piece of data, differentially coded and the gray code converted maps on the complex phase plane (I and Q axes) for each carrier, as shown in Fig. 3.9. The mapped phase data is input into IFFT as data on the frequency domain.

(1) Differential conversion (after gray code transform)

Gray code transform and differential conversion are shown in Table 3.3.

**Table 3.3 Differential Conversion and Gray Code Transform**

| Input data | | Previously input data | | Output data | |
|---|---|---|---|---|---|
| I | Q | I | Q | I | Q |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 0 | 0 | 1 |
| 1 | 0 | 0 | 0 | 1 | 0 |
| 1 | 1 | 0 | 0 | 1 | 1 |
| 0 | 0 | 0 | 1 | 0 | 1 |
| 0 | 1 | 0 | 1 | 1 | 1 |
| 1 | 0 | 0 | 1 | 0 | 0 |
| 1 | 1 | 0 | 1 | 1 | 0 |
| 0 | 0 | 1 | 0 | 1 | 0 |
| 0 | 1 | 1 | 0 | 0 | 0 |
| 1 | 0 | 1 | 0 | 1 | 1 |
| 1 | 1 | 1 | 0 | 0 | 1 |
| 0 | 0 | 1 | 1 | 1 | 1 |
| 0 | 1 | 1 | 1 | 1 | 0 |
| 1 | 0 | 1 | 1 | 0 | 1 |
| 1 | 1 | 1 | 1 | 0 | 0 |

(2) Mapping (In the 800 MHz band transmit frequencies)

Paired data mapping on the complex phase plane is shown in Fig. 3.9.

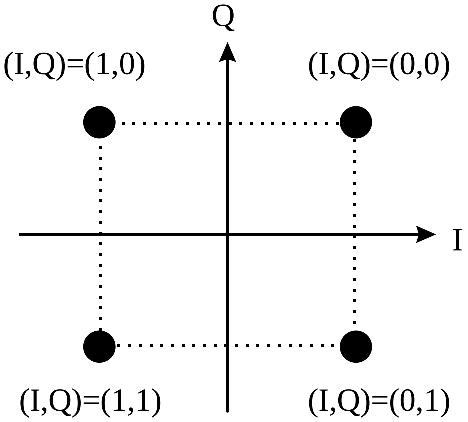
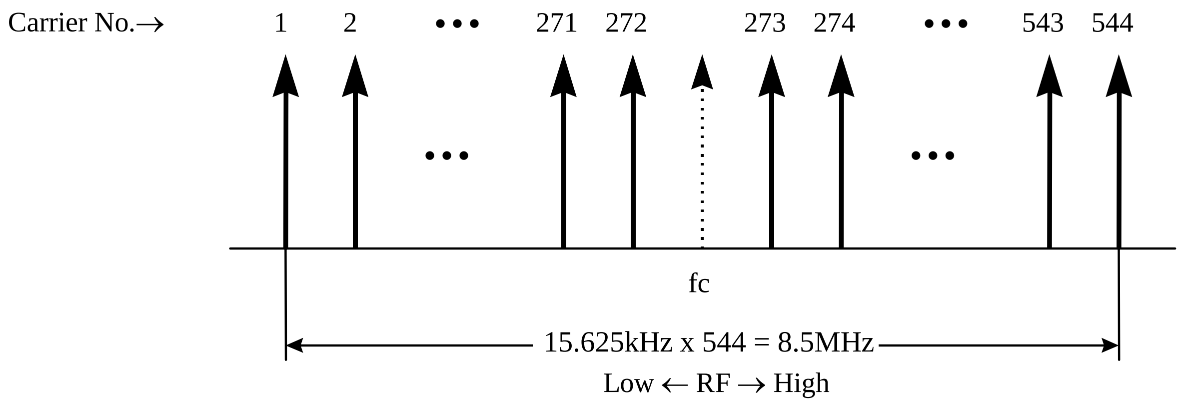



**Fig. 3.9 Mapping**

### 3.3.6 IFFT (Inverse Fast Fourier Transform)

IFFT shall be used to convert the input data on the frequency domain to that on the time domain.

The mapping between the carrier No. and the RF signal is shown in Fig. 3.10. The carrier modulated by the paired data (carrier No. 1) corresponds to the lowest frequency RF carrier and that modulated by the paired data (carrier No. 544) corresponds to the highest frequency RF carrier.




fc: Center transmission and reception frequency
RF: Transmission and reception frequencies (Range)

**Fig. 3.10 Carrier Assignment**

### 3.3.7 Addition of the Guard Interval

A 24-sample (1.5 μs) data shall be cyclically added before and after the 1024-sample IFFT data output to form the guard interval in case of adding 3μs guard interval.

### 3.3.8 Addition of the Synchronization Symbol

The null symbol (the 1st symbol) and the synchronization reference symbols (the 2nd and 3rd symbol) shall be added as synchronization symbol to form an OFDM frame, as shown in Fig. 3.11.

No specifications are provided here for the guard interval of the synchronization symbol since the signal is ignored during frame synchronization.

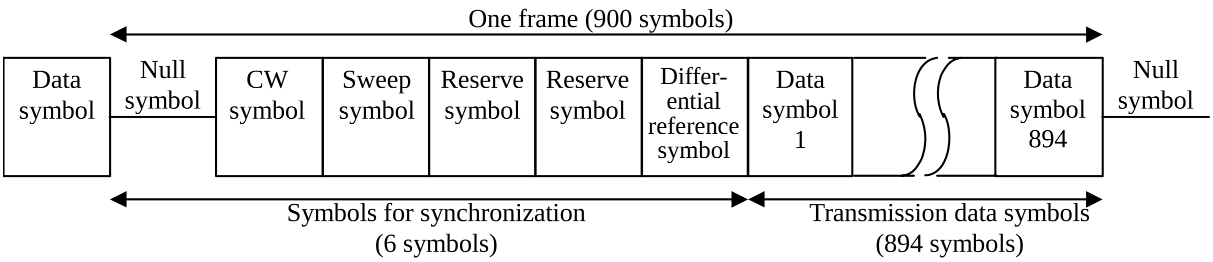



**Fig. 3.11 OFDM Frame Structure**

(1) Null symbol

The null symbol means that the output power of the symbol is zero.

(2) CW symbol*

The CW symbol is used to output the center frequency of the channel. The signal level should preferably be equivalent to the mean power of the data symbol.

(3) Sweep symbol*

The sweep symbol is a signal used to continuously sweep carrier frequencies from lowest to highest on the RF output spectrum. The signal level should preferably be equivalent to the mean power of the data symbol.

The specifications for the sweep signal during the effective symbol are provided below.

Sweep start frequency: $fs = fc - 4.25$ (MHz)

Step frequency interval: $\Delta f = W/1024$ (MHz)

Step time interval: $\Delta t = 62.5$ (nsec)

Here,

fc: Center RF frequency

$W = 8.5$ (MHz)

*) The waveform of the CW symbol and the sweep symbol shall comply with one of the two methods (hereafter referred to as the “Method A” and “Method B”) as shown in Fig. 3.12. Method A shall be used if manufacturers compatibility is required.

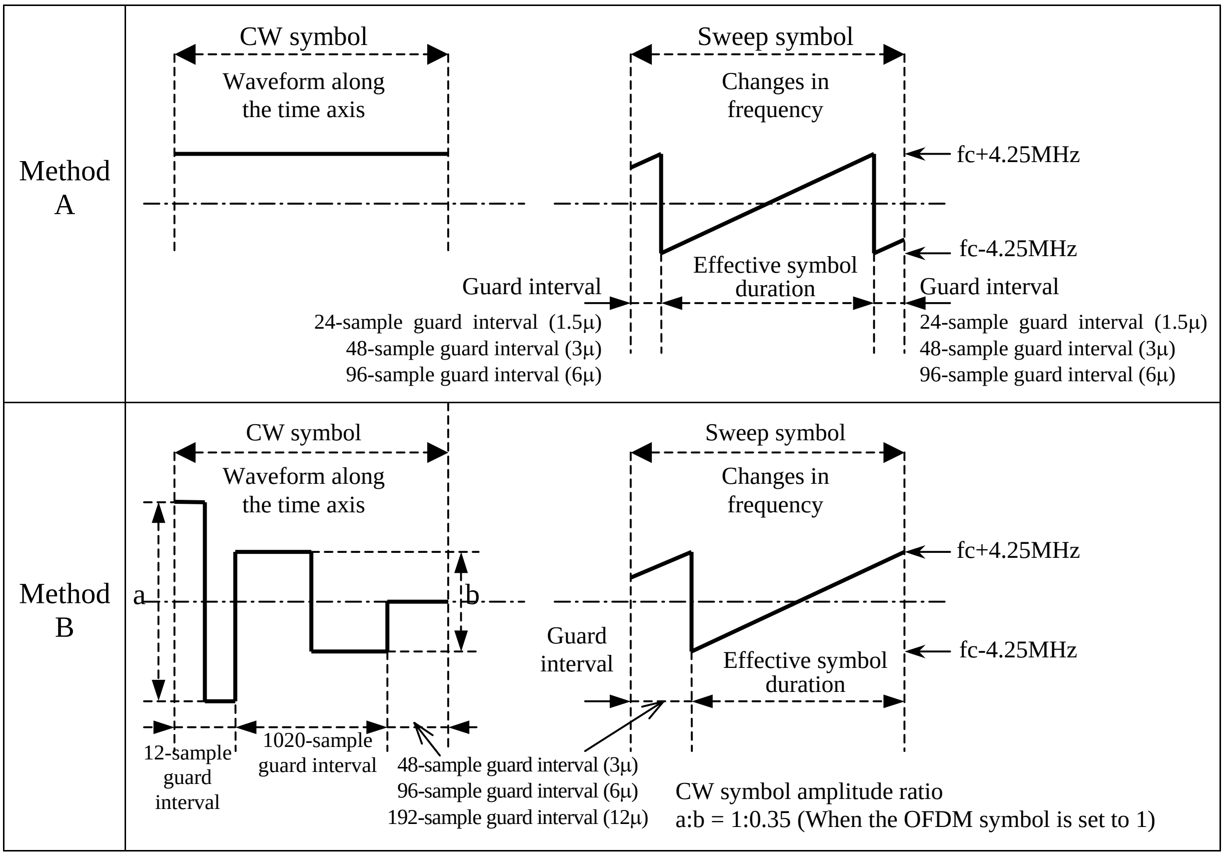



**Fig. 3.12 CW/Sweep Symbol Signal Waveform**

(4) Reserve symbol

Two symbols are reserved for the future. To use these reserve symbols for the purpose of transmission, control data and so on, the reserve symbol will be placed after the differential reference symbol.

Although no specifications for the reserve symbol are required in view of manufacturers' compatibility, the specifications for the differential reference symbol provided below shall also apply to the reserve symbol, here.

(5) Differential reference symbol

The differential reference symbol serves as the reference for differential coding. The symbol is inserted after inner interleaving and placed immediately before the data symbol for differential conversion.

For differential coding, only the differential between symbols has meaning, unlike the starting point of the symbol. Although no specifications for the differential reference symbol are generally required in view of manufacturers' compatibility, the following specifications are applied here to provide some guidance for device manufacturing.

In consideration of moderate randomizing by differential conversion, (0, 0), (1, 0), (0, 1) and (1, 1) shall be repeatedly used in order of carrier No. for the paired data (I, Q).

### 3.3.9 Orthogonal Modulation

The center frequency of IF signal shall be 130 MHz. The IF signal shall be obtained by orthogonally modulating the OFDM baseband signal with the IF center frequency carrier.

### 3.3.10 Clock Stability

The frequency stability of the clock used inside the modulator and demodulator shall be 20 ppm or lower.

## 3.4 Transmission Equipment

The specifications for transmission equipment are provided below.

### 3.4.1 Transmission Parameters

The transmission parameters are shown in Table 3.4.

**Table 3.4 Transmission Parameters**

| Item | | | Specification | | | | |
|---|---|---|---|---|---|---|---|
| Occupied bandwidth | | | 8.5 MHz | | | | |
| Number of carriers | | | 544 | | | | |
| Carrier spacing | | | 15.625 kHz | | | | |
| Carrier modulation | | | DQPSK | | | | |
| Number of FFT points | | | 1024 | | | | |
| FFT sampling frequency | | | 16.0 MHz | | | | |
| Effective symbol duration | | | 64.0 μs | | | | |
| Guard interval length | | | 3.0 μs/6.0 μs/12 μs | | | | |
| Total symbol duration | | | 67.0 μs/70.0 μs/76.0 μs | | | | |
| Total number of symbols in a frame | | | 900 | | | | |
| Number of synchronizing symbols within a frame | | | 6 | | | | |
| Frame period | | | 60.3 ms/63.0 ms/68.4 ms | | | | |
| Transmission bit rate (Gross) | | | 16.130547 Mbit/s/15.439238 Mbit/s/14.220351 Mbit/s | | | | |
| Interleaving method | Outer interleaving | | Convolution byte interleaving | | | | |
| | Inner interleaving | | Block bit interleaving | | | | |
| Error correction method | Outer code | | RS (204, 188) | | | | |
| | Inner code | | Convolution (1/2) | Convolution (2/3) | Convolution (3/4) | Convolution (7/8) | No convolution |
| Bit rate after outer coding (Mbit/s) *1 | | | | | | | |
| Guard Interval length μs | 3.0 | | 8.000000 | 10.666666 | 12.000000 | 14.000000 | 16.000000 |
| | 6.0 | Stuffing mode I | 7.500000 | 10.000000 | 11.250000 | 13.125000 | 15.000000 |
| | | Stuffing mode II | 7.657143 | 10.209524 | 11.485714 | 13.400000 | 15.314286 |
| | | Stuffing mode III | 7.719619 | 10.292825 | 11.579429 | 13.509333 | 15.439238 |
| | 12.0 | Stuffing mode I | 7.000000 | 9.333333 | 10.500000 | 12.250000 | 14.000000 |
| | | Stuffing mode II | 7.052632 | 9.403509 | 10.578947 | 12.342105 | 14.105263 |
| | | Stuffing mode III | 7.110175 | 9.480234 | 10.665263 | 12.442807 | 14.220351 |

*1: Rounded at the seventh decimal place

### 3.4.2 Spectral Mask

The spectral mask of the modulated wave is shown in Fig. 3.13.

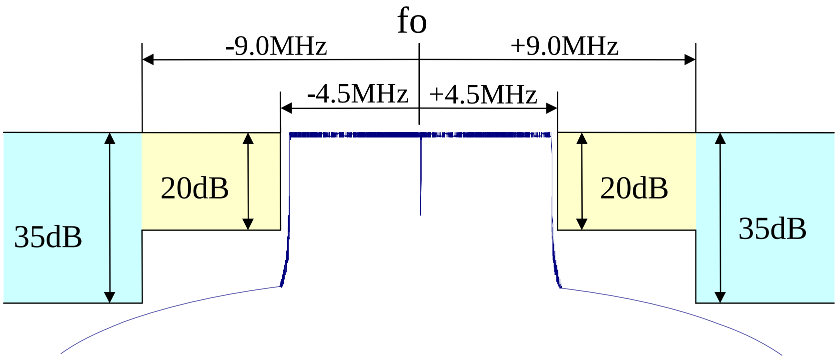



**Fig. 3.13 Spectral Mask**

### 3.4.3 Polarization

Either the circular or linear polarization shall be used.

### 3.4.4 Transmission Equipment Tolerance

The transmission equipment tolerance shall be as follows, according to the Ordinance Regulating Radio Equipment.

(1) Occupied bandwidth

The occupied bandwidth shall be 8.5 MHz or lower.

(2) Frequency Tolerance

The transmission frequency tolerance shall be $1.5 \times 10^{-6}$ or lower.

(3) Radiated power

The radiated power shall be 5 W or lower.

(4) Spurious emission or Unwanted Emisson intensity

(a) Specification applied after December 1, 2005

| Spurious Emission Intensity in area outside band | Unwanted Emission Intensity in spurious area |
|---|---|
| 25 µW or lower | 25 µW or lower |

This specification meets the requirements specified in attached table 3-2(1) of the Ordinance Regulating Radio Equipment.

Please note that there are interim measures in this specification. (Depend on the Ordinance Regulating Radio Equipment (No.119 of the administration ministerial ordinance on august 9, 2005) additional clause.)

(b) Specification applied before November 30, 2005

| |
|---|
| The spurious emission intensity shall be 25 μW or lower. |
| (ARIB STD-B13 Version 2.0) |

## Appendix 1 General information on the OFDM system

The OFDM (Orthogonal Frequency Division Multiplexing) modulation is one of the multi-carrier modulation systems, which use multiple carriers to distribute digital data on the frequency domain for transmission. OFDM modulation is particularly characterized by the fact that since the carrier frequency interval is equal to the reciprocal value of the modulated symbol duration, data transmitted by each carrier are respectively orthogonal; hence inter-carrier interference can be avoided during data transmission.

Since the OFDM system involves simultaneous transmission of multiple modulated carriers, its transmission spectrum resembles a rectangular shape, as shown in Fig. 1. Since the data is mapped to multiple carriers for transmission, some multiple path errors can be corrected using the remaining correct data demodulated from the remaining carriers; while multiple path influences can generally be disregarded.

When an OFDM system using multiple carriers is compared with a single carrier digital modulation under certain transmission bandwidth and capacity conditions, the transmission bit rate per carrier is lower and the modulated symbol duration increases in proportion to the number of carriers. Digital modulation generally suffers from inter-symbol interference when the desired wave is adversely affected by delayed waves. This is due to multiple paths on the transmission link (the symbol to be demodulated overlaps that preceding.) However, since OFDM modulation has a longer symbol duration than single carrier modulation, it suffers less from signal degradation caused by the delayed waves.

The waveform of the transmission signal along the time domain resembles the noise signal, as shown in Fig. 2. The OFDM transmission symbol comprises an effective symbol duration equal to the modulated symbol duration and a guard interval (with part of the waveform cyclically added) as shown in Fig. 2. If the delay time of the delayed waves generated by the multiple paths is shorter than the guard interval, inter-symbol interference can be reduced accordingly to exclude the part of the guard interval which is overlapped by the preceding symbol.

Since mobile transmission involves frequent changes in link conditions, the amplitude and phase of the transmitted signal are susceptible to multiple path fading with temporal and frequency changes. However, OFDM modulation is resistant to multiple path fading because the data is distributed over multiple carriers, the modulated symbol is long and a guard interval is added. Therefore, OFDM modulation is suitable for mobile transmission.

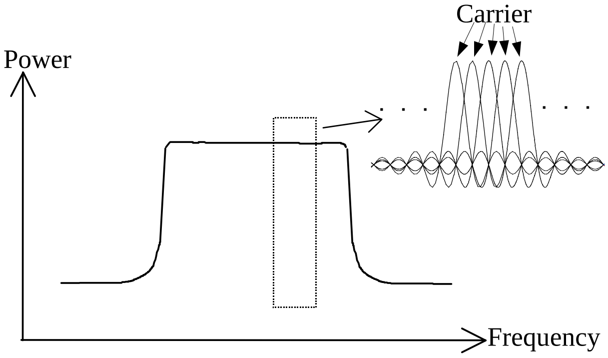



**Fig. 1 Transmission Spectrum**

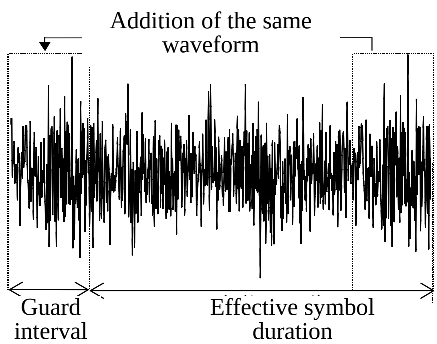



**Fig. 2 Waveform of the Transmission Signal along the Time Axis**

800MHz-BAND OFDM TRANSMISSION SYSTEM
FOR TELEVISION PROGRAM CONTRIBUTION

ARIB STANDARD

ARIB STD-B13 Version 2.1-E1
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