Construction of Transmission Network on Terrestrial Digital Broadcasting

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1. Feature of Digital Broadcasting
Feature of Digital Broadcasting

1. High Quality Video
   High-definition video or multi-channel Standard-definition video

2. High Quality Audio
   5.1ch surround audio or multi-lingual audio

3. Available for additional information
   Data broadcasting, etc.

4. Available for Single Frequency Network
   Effective utilization of broadcasting frequency

5. Available for Mobile Broadcasting
   Easy reception in bad condition of multi-path interference, fading, etc.
Analog broadcasting

**Single Frequency Network (SFN)**

- $f_1$
- $f_4$

**Multi Frequency Network (MFN)**

- $f_2$
- $f_3$
- $f_5$
- $f_6$

**Double Frequency Network (DFN)**

- $f_1$
- $f_2$

2. Transmission Network
Transmission network system

Classification of network system

- TS transmission
- Micro-wave/fiber link
  - IF transmission
  - Micro-wave
    - Broadcast wave relay
## Comparison of network system

<table>
<thead>
<tr>
<th>Network type</th>
<th>Infra &amp; maintenance cost</th>
<th>Signal quality</th>
<th>SFN timing adjustment</th>
<th>Save microwave frequency resource</th>
</tr>
</thead>
<tbody>
<tr>
<td>TS transmission-microwave/fiber</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>IF transmission-micro wave/fiber</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Broadcast-wave relay station</td>
<td>1</td>
<td>3</td>
<td>2 (note1)</td>
<td>1 (note2)</td>
</tr>
</tbody>
</table>

(note1) for Broadcast wave relay system, the range of transmission timing is limited.

(note2) Broadcast wave relay system does not need micro wave frequency.
Classification by Transmission measures

1. TS transmission system by micro wave link

2. TS transmission system by fiber link
Classification by Transmission measures

3. IF transmission system by micro wave link

4. Broadcast wave relay system
3. Technology for Single Frequency Network
Technical Requirements for SFN

SFN : Area cover method by transmitting the same signal in the same frequency from multiple TX’s

- Synchronization of Frequency
  Signal frequencies from each transmitting stations are identical

- Synchronization of Timing
  Signal timings from each transmitting stations are identical

- Synchronization of Signal
  Signal itself from each transmitting stations are identical

- Synchronization of Modulation mode
  Signal modulation modes from each transmitting stations are identical
Modulation mode and transmitting timing are set by the control signal inserted in TS signal.

Transmitting frequency and timing are synchronized referring to GPS signal.

Control signal for synchronization is inserted referring to GPS signal.

Same TS signals are distributed to each station.

Signal timings from TX A and TX B in overlap area should be synchronized.

Transmitting frequency and timing are synchronized referring to GPS signal.
MIP (Megaframe Initialization Packet) is multiplexed into Broadcast TS at SFN adaptor. Broadcasting network control information is included in MIP, and are used for transmission network control at transmitter station.

Adjustment of Transmission Timing

If all transmitter output should be adjusted to maximum_delay, TX output is delayed to this point.
4. Equipments for Digital Broadcasting Network
### Technical Requirements of Equipments

Technical requirements of equipments for reliable operation of broadcasting network in terrestrial digital broadcasting are as follows;

- **Low Inter-Modulation (IM)/High C/N ratio**
  High C/N signal contributes the stable receiving in severe conditions, such as urban area or mobile reception

- **Stability of Output Power of Transmitter**
  Fluctuation of output power causes the receiving disturbance especially in SFN overlap area

- **High Redundancy**
  High redundancy is required for uninterrupted operation

- **Space saving**
  Digital and analog simulcast is necessary in transition stage and space factor of the transmitter is important
8000 Series Transmitter

Key technology

The 8000-series transmitters have been developed with the latest technologies and high reliability.

◆ Applicable to a variety of standards: DVB-T/H, ATSC, ISDB-T/ISDB-T\*1, Chinese standard, NTSC, PAL and SECAM models are available.
◆ The latest LD-MOS FET chips are employed.
◆ All-band transmitter.
  The exciter and the power amplifiers can cover all the UHF band from 470 to 862 MHz.
◆ The 8000-series are digital-ready; and the analog models can be easily modified to digital.

*1: Brazilian digital TV standard

System diagram of the Digital transmitter........Dual Exciter
8000 Series Transmitter

Features

We always put our highest priority on the “Reliability” in the design, development and manufacturing to keep our customers rest assured of the operation 24/7.

◆ Simple and rigid connections

➢ Hot-swappable power amplifiers

With its spring shutting the liquid coupler, the power amplifiers can be inserted or extracted even during the operation.

◆ Robust operation under rough conditions

➢ The power supply operates normally within +/-15% voltage fluctuations.
➢ The transmitter can operate normally even with the reflection of VSWR of 1.3.

◆ Preventive design

➢ Transmitter protection:

When the controller of the transmitter detects any abnormality in the RF output, reflection, liquid status (temperature, flow shortage, pressure and/or quantity), it automatically shuts down the system to protect the system.

➢ The power amplifier protection:

When the power amplifier detects abnormal RF output, reflection and/or temperature, it shuts down the unit automatically to protect themselves.

◆ Operability

➢ Emergency-start switch

With the emergency-start switch equipped at the MCCB panel of the transmitter cabinet, it is possible to re-start manually even when the transmitter controller is damaged.
Liquid-Cooling system

The coolant from the pump rack is fed into the transmitter, divided into several flows and sent to the shelves of the power amplifiers.

The coolant cools power amplifiers while flowing through cold plates and then is sent back through the pipe to the heat exchanger.

Block Diagram of Cooling System
**Feature**

The exciter consists of a signal modulator, a frequency converter and a signal compensator. The non-linear distortion compensation improves the equivalent C/N value, since it serves to suppress intermodulation in the power amplifier.

**Expanded bandwidth**

The exciter can set to any output frequency in all the UHF TV channel (from 470MHz to 862MHz) by means of the synthesizer system.

**Non-linear distortions compensation**

The exciter incorporates distortion compensators to allow adaptive compensation of non-linear distortions.

**Pre-distortion system**

The feedback type pre-distortion system automatically compensates for a non-linear distortion caused by the power amplifier. Since this feature keeps watching the variations in characteristics of the power amplifier, the operation remains stable irrespective of fluctuations in input and output levels and environmental factors including the ambient temperature.
Principle of Non-linear Compensation

Input-Output characteristics

Back-off

Without compensation

With compensation

IM ->

Input power

Output Power

IM

-10dB

-30dB

-50dB
Principle of Non-linear Compensation

Power Amplifier

Pre-distorter

Input

Output

Creates the distortion which curve is inverse to that of PA and cancels
Example of Non-linear Compensation

Non-linear compensator is effective to reduce the IM

Amplifier IM-27dB

Improved by the compensator IM-50dB
TS-TTL

4ch/active-standby system in 1 rack

Ratings

- Signal Input
  Broadcast TS (DVB-ASI)

- Output Power
  0.5W, 1W, 2W, 4W

- Output Frequency
  B,C,D,M,N,E,F,G band
IF-TTL

8ch/active-standby system in 1 rack

**Ratings**

- **Signal Input**: IF (Center Frequency 37.15MHz) OFDM Signal
- **Output Power**: 0.1W, 0.5W, 2W (OFDM Average power)
- **Output Frequency**: B,C,D,E,F,G band (9MHz)
Optical Link

TS signal can be transmitted via optical fiber

Ratings

- Signal Input: DVB-ASI
- Output Wave Length: 1.5um band
- Output Power: +6dBm
- Transmission Bit rate: 33.464Mbps
Transposser for Relay Station

10W/active-standby system

Ratings

- Input Frequency: Broadcast Wave, Specific Channel in UHF band
- Output Frequency: Specific Channel in UHF band
- Output Power: 10W
Coupling Loop Interference

Improvement of coupling between TX antenna and RX antenna

- Directivity of TX Antenna
- Directivity of RX Antenna
- Separation between TX and RX

Coupling Loop Interference at SFN Broadcast Wave Relay Station

Coupling = \frac{P_o}{P_r}
Principle of CLI Canceller

Coupling Loop Interference

Re-ceiver

CLI Canceller

Error Signal Creation

Interference Detection

Trans-mitter
5. Japanese Experiences for Terrestrial Digital Broadcasting
Changeover from Analog to Digital

- **Terrestrial Analog Broadcasting**
  - Start of Terrestrial Digital Broadcasting: 2003/12/1
  - Close of Terrestrial Analog Broadcasting: 2011/7/24

- **BS Digital Broadcasting**

- **CS Digital Broadcasting**

- **Terrestrial Digital Broadcasting**
Start of DTTB

Start date in the seat of the prefectural government

- By Dec. 2004
- By Dec. 2005
- By Dec. 2006
# Amount of digital receivers shipment

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<tr>
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<th>Tuner</th>
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<th>TV (PDP)</th>
<th>TV (LCD)</th>
<th>STB</th>
<th>Recorder</th>
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<td>4340</td>
<td>4356</td>
<td>802</td>
<td>24998</td>
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</tbody>
</table>

1 Seg receiver total (~'07/7) 11774
Example of transmission network (1)

- 菖蒲久喜FX
- 加波山FX
- 東京タワー
- 水戸送信所
- 日立神峰FX
- 日立

Legend:
- 10Wサテ
- 3Wサテ
- 300W送信機
- IF伝送
- TS伝送
Example of transmission network (2)