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Presentation 5

Digital Broadcasting Facilities and System

Part 2 : Transmission System and Hardware

October 15th, 2004

Digital Broadcasting Expert Group (DiBEG)

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   - -Peripheral
4. Antenna for Digital Broadcasting in Tokyo Tower

1.Comparison of Analog System and Digital System

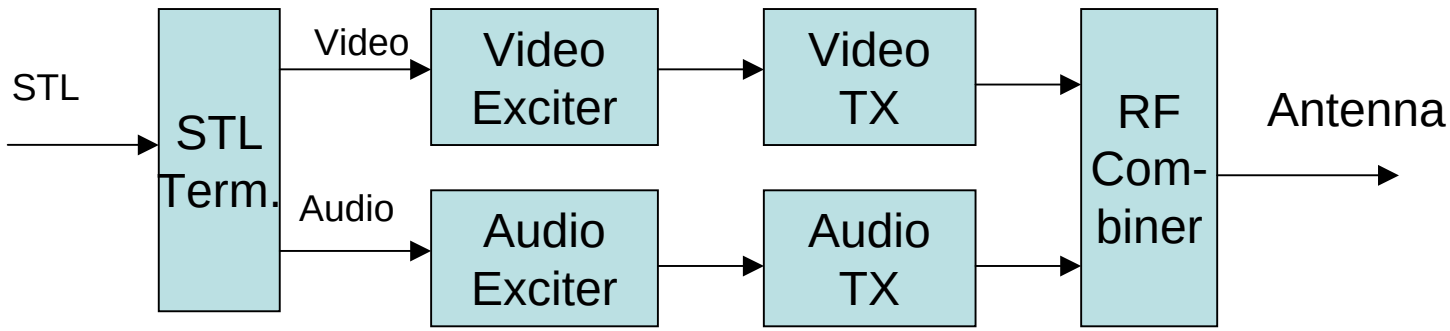
(1) Differences of Transmitter Composition

(2) Differences of Specifications

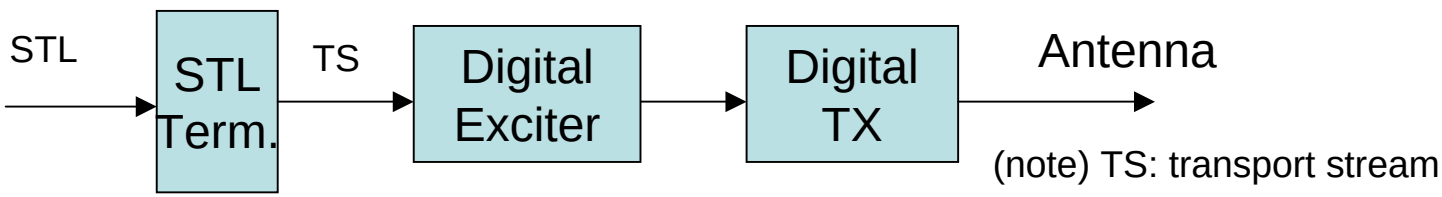
1. Comparison of Analog system and Digital System(1/)

（1）Differences of Transmitter Composition

Transmitter composition is quite different.



(a) Analog High Power Transmitter block-diagram



(b) Digital High Power Transmitter block-diagram

(2) Differences of Specification

(a) Required transmitting Power

minimum required signal field strength of digital system is about 1/10 of analog system.(In Japan, 70dBuV/m for analog T V, 60dBuv/m for digital TV)

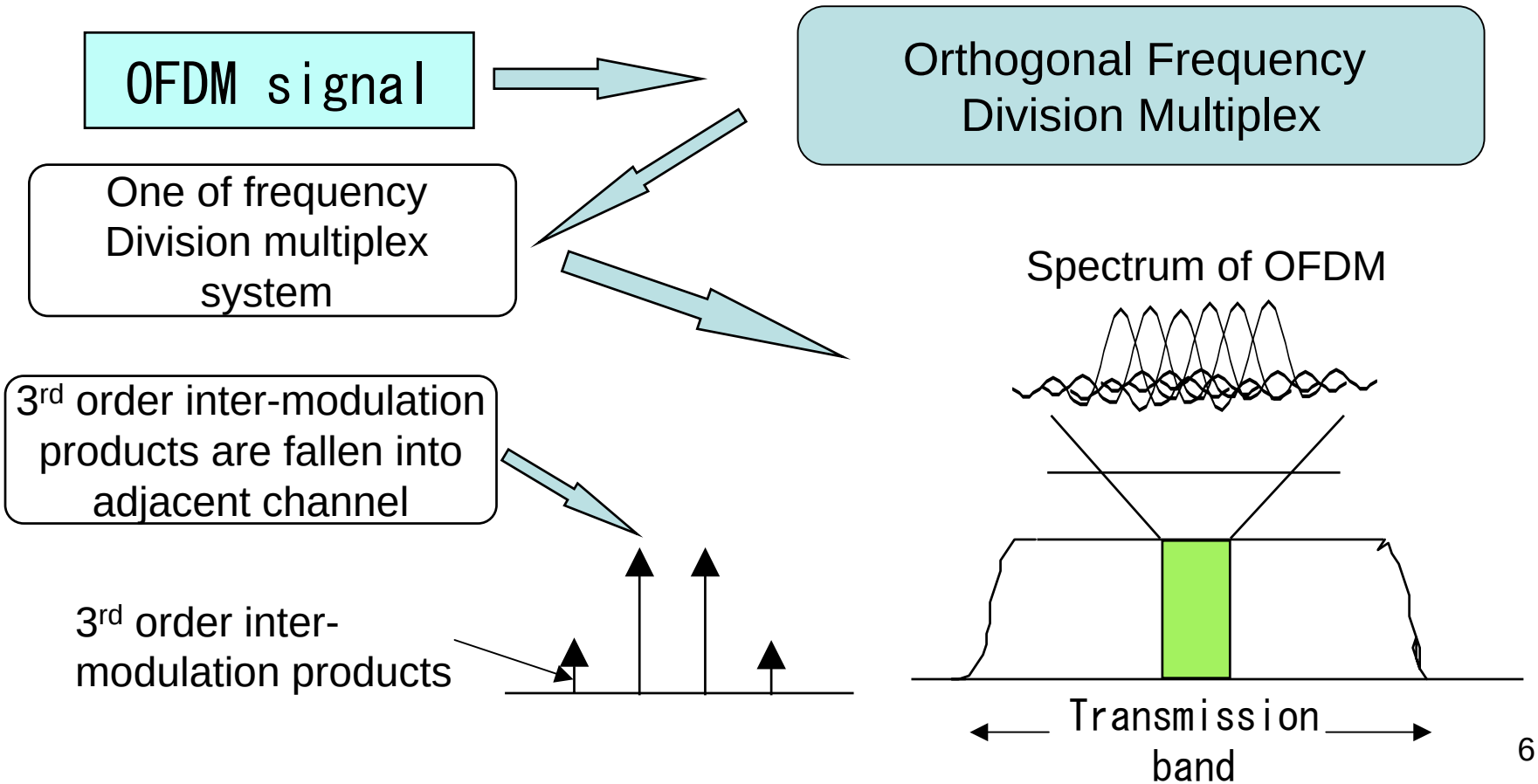
Tokyo area key station: Analog system; 50kW VHF
Digital system ; 10kW UHF

(b) Frequency difference

Frequency difference is critical for digital SFN network system

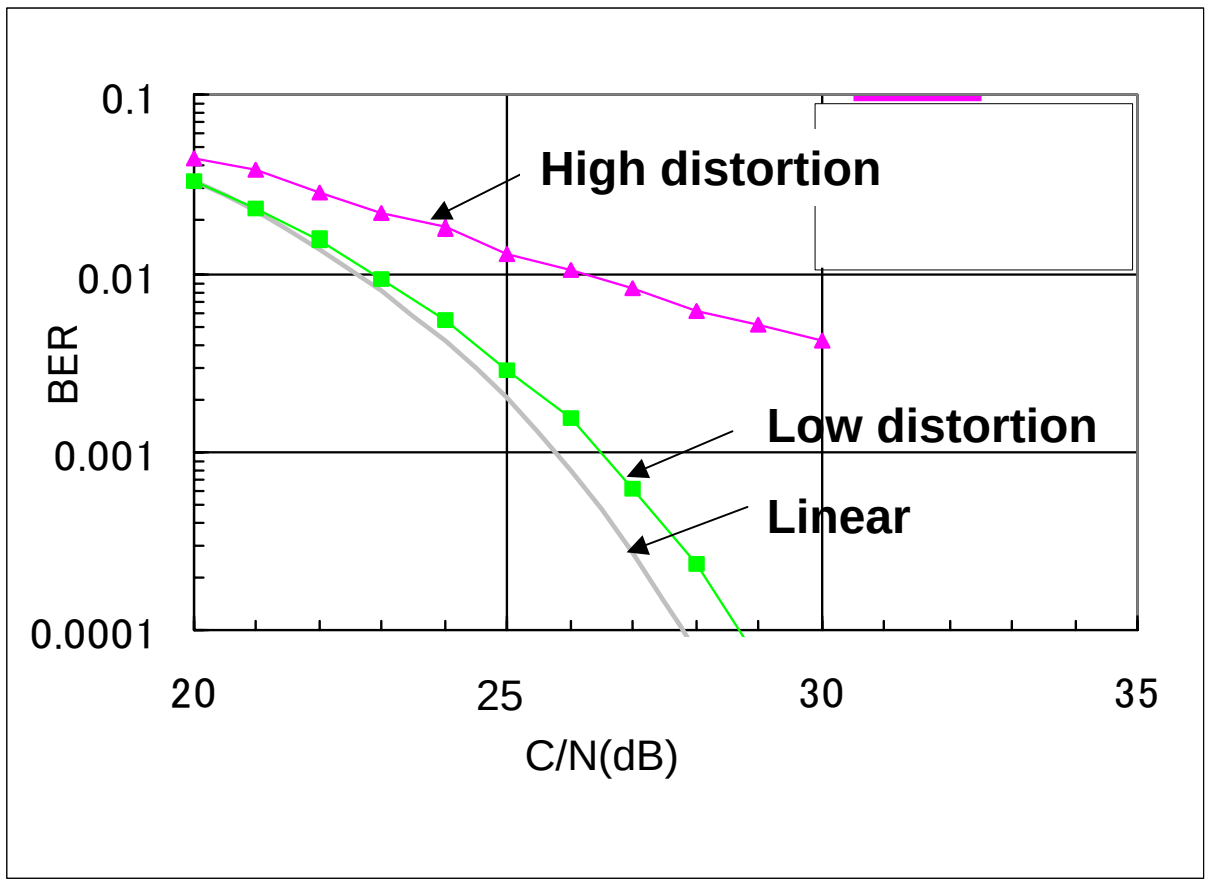
(c) Non-linear distortion

In digital system Non-linear distortion of transmitter causes the inter-modulation products, and these products are fallen into the adjacent sub-channels. Therefore signal quality is degraded by the Inter-carrier interference.

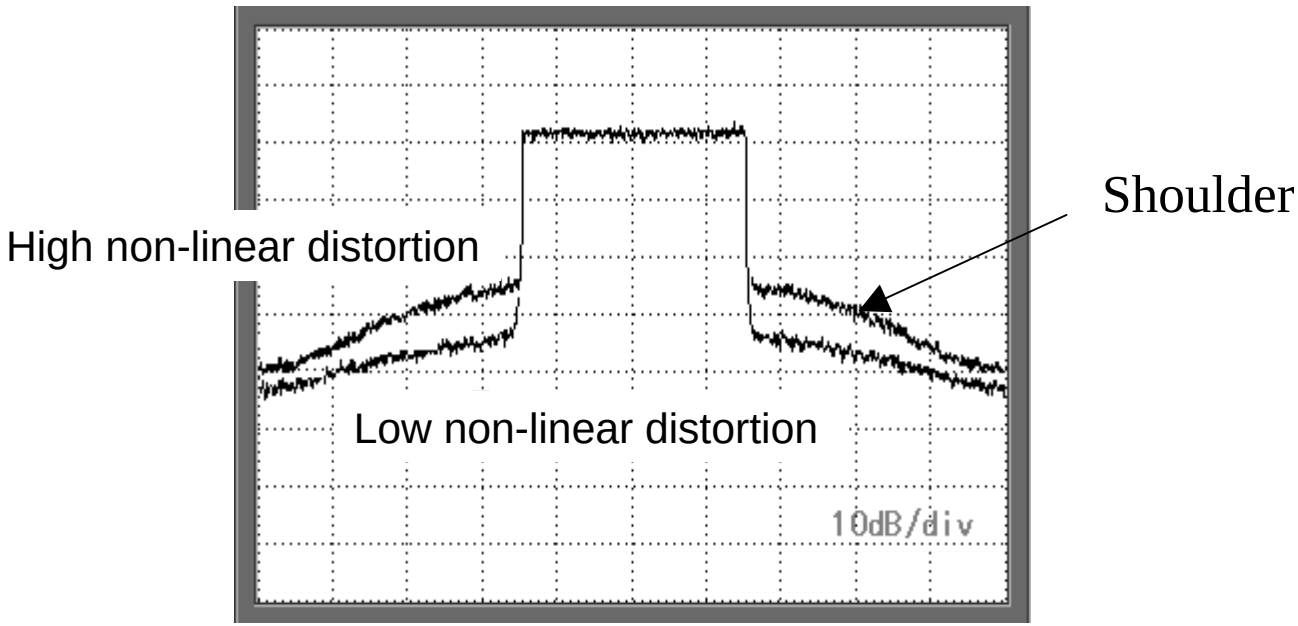


Signal degradation caused by non-linear distortion

Inter-modulation products are fallen into adjacent sub-channels. These products behave as thermal noise, therefore BER characteristics are degraded.



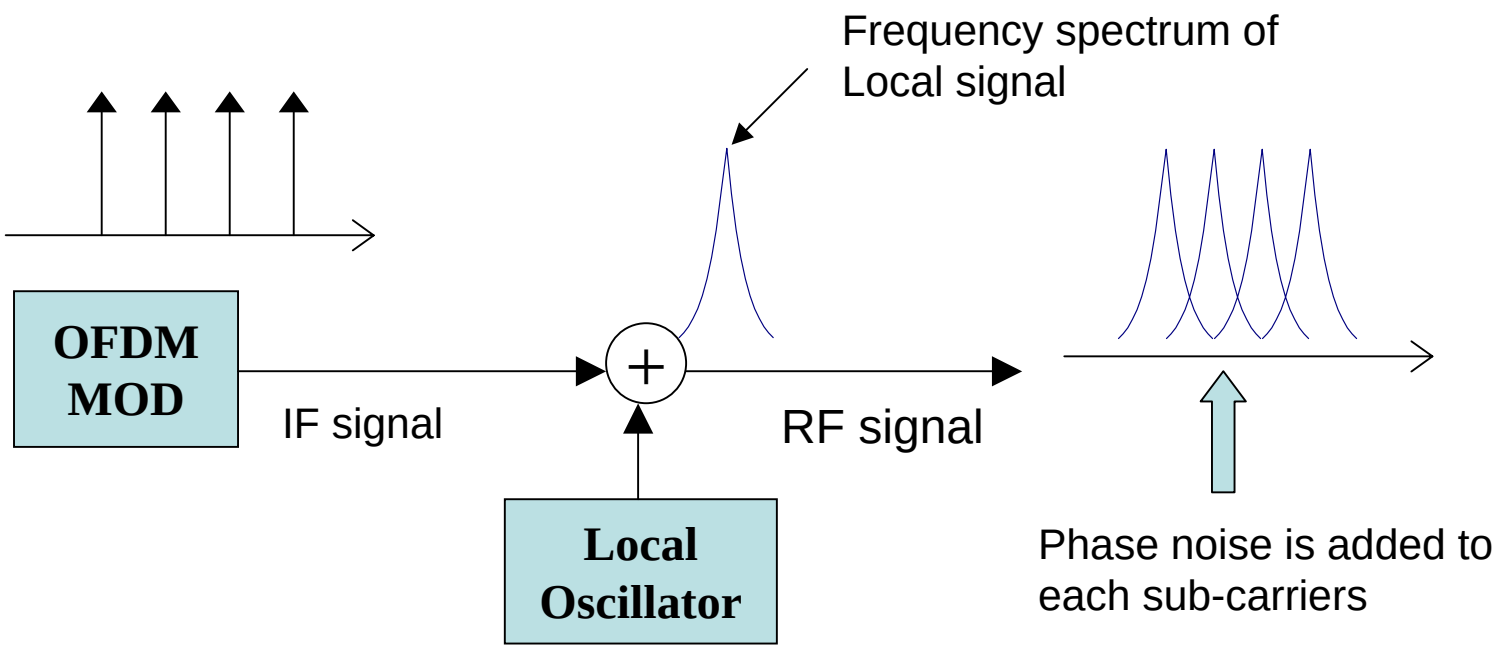
An example of output spectrum



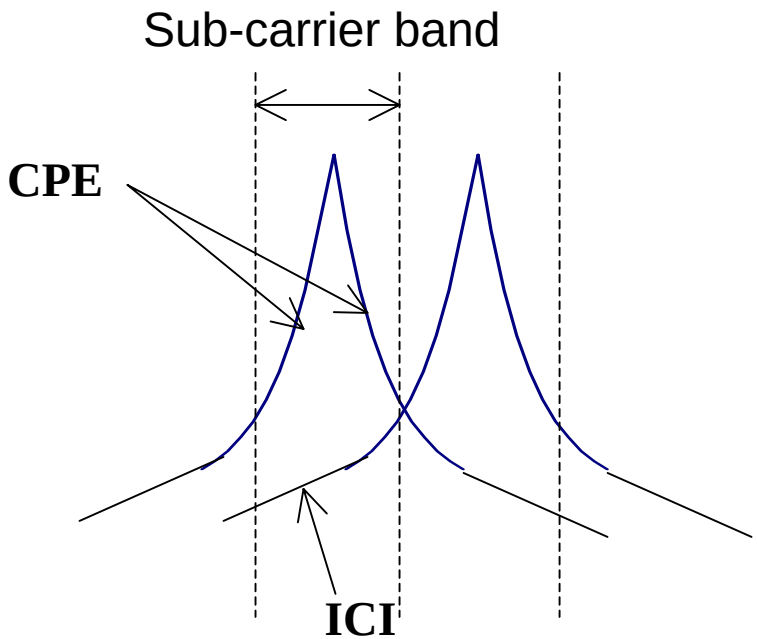
The 3rd-order inter-modulation products appeared on the outside of signal bandwidth. These products are coaled “Shoulder”, and used for measurement parameter of transmitter

(d) Phase Noise

The phase noise is mainly generated from local oscillator, and is added to each sub-carriers of OFDM signal(See below)



The Influences of Phase Noise



CPE: **Common Phase Error. The in-band components of Phase Noise. This causes circular shift of signal constellation. As a result, causes the C/N degradation.**

ICI: **Inter-Carrier Interference. The out-band components of Phase Noise. This components behave as a thermal noise. As a result, causes the C/N degradation**.

2.Outline of Digital Transmission Network

(1) An image of transmission network Chain

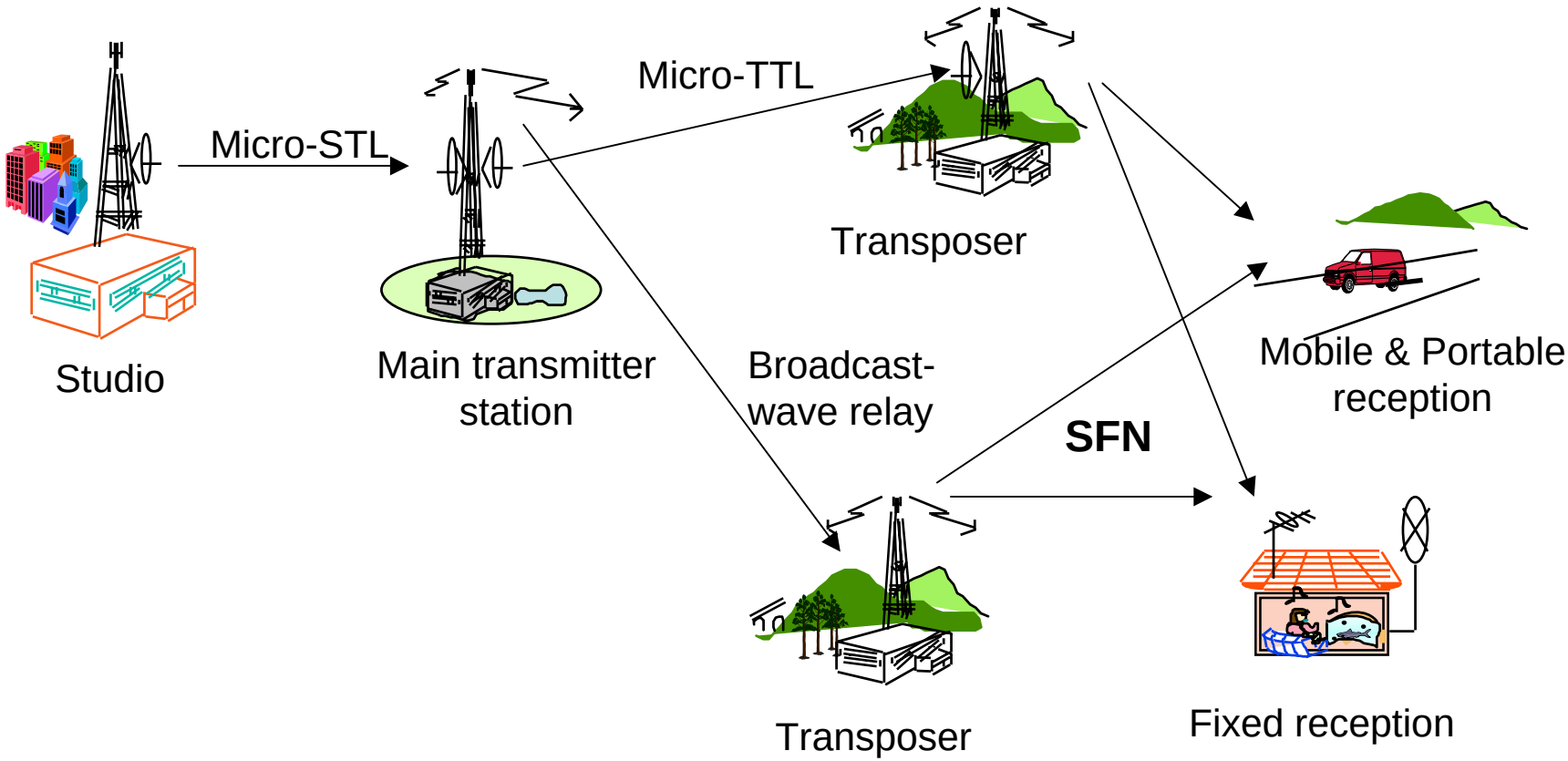
(2) Key factors for transmission network design

(a) Key factor #1: Equivalent C/N

- Cliff effect
- Link budget
- Degradation factors of transmission network
- New technologies for the improvement of C/N degradation

(b) Network Synchronization

(1) An Image of transmission network chain



(2) Key Factors of Digital Transmission Network Design

(a) Key Factor #1 :Equivalent C/N

Keep required Equivalent C/N ratio at the receiver front end

-In the digital system, "cliff effect" shall be considered

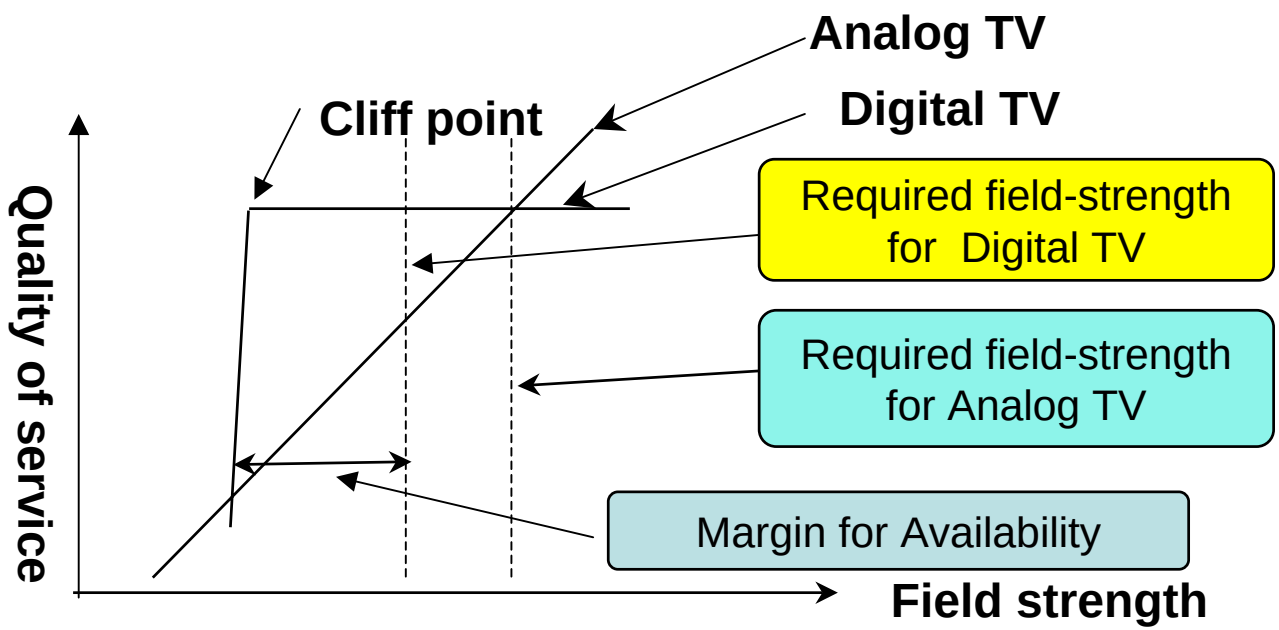
-Carefully design the network link budget

-Consider the degradation factors of transmission chain

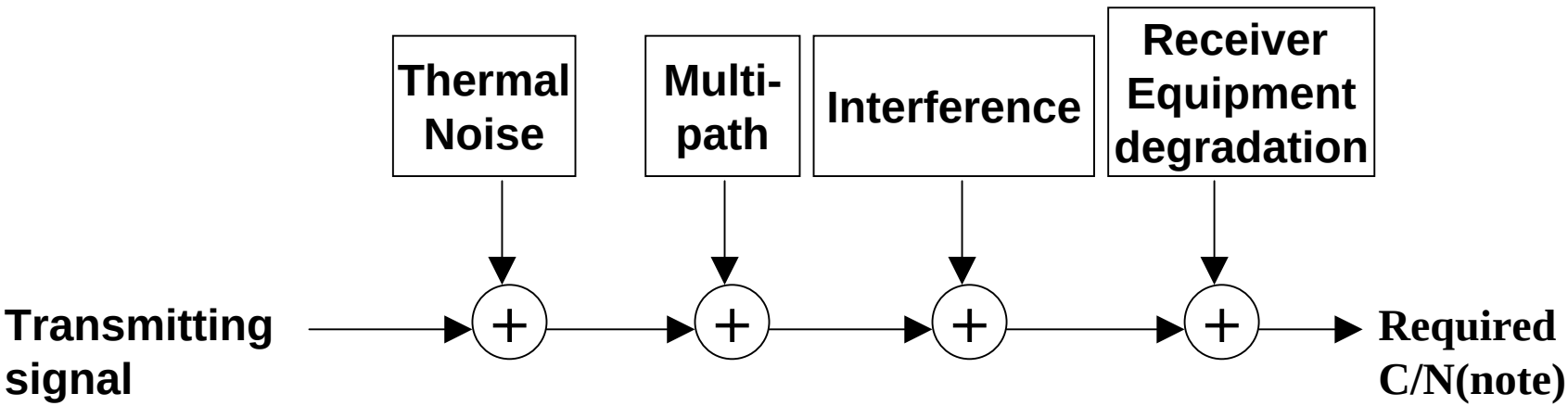
-To improve the equivalent C/N of network, several new technologies are proposed and on developped.

[1] “Cliff Effect”

In digital system, Quality of service is not proportional to input signal strength. At the lower level of cliff point, the fatal disturbances will happen, such as large block noise, moving picture frozen, and picture black out.

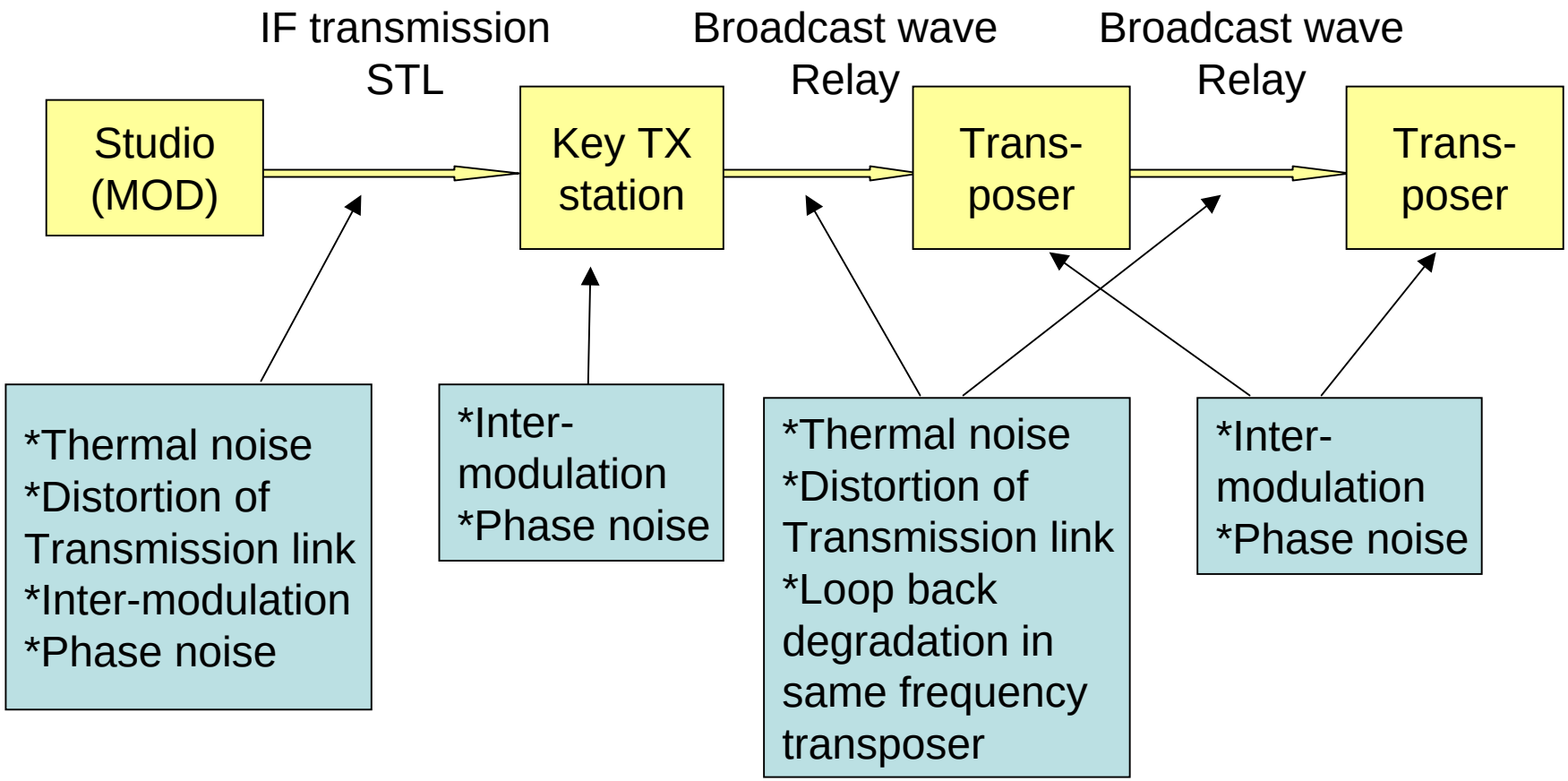


[2] Link budget model for Terrestrial Digital Broadcasting



(note) required C/N depends on transmission parameters

[3] The causes of signal degradation in transmission network



[4] New Technologies for the Improvement of C/N Degradation

(1) Improvement of transmitter non-linear distortion

-Feedback Pre-distortion correction technologies; adopted for high power transmitter

- Feed forward type amplifier; mainly adopted for middle power multi-channel power amplifier used as trans-poser

(2) Improvement of transmission distortion

-Multi-path canceller; especially compensate the multi-path distortion on transmission link.

-Coupling loop interference(CLI) canceller; compensate the coupling loop between TX antenna and RX antenna in SFN

-**Diversity receiving technology**; Improve the degradation caused by fading. This technology is useful not only transmission network but also mobile reception.

(b) Key factor #2 :Network Transmission Timing Synchronization

For SFN(Single Frequency Network), at the receiving point, time difference of plural (two or more) transmitter signal should be within guard interval length. Therefore, the transmission timing management is very important factor.

Example ; TS tratnsmission network Synchronization

-Detect header of OFDM frame which is multiplexed in TS signal from Studio.

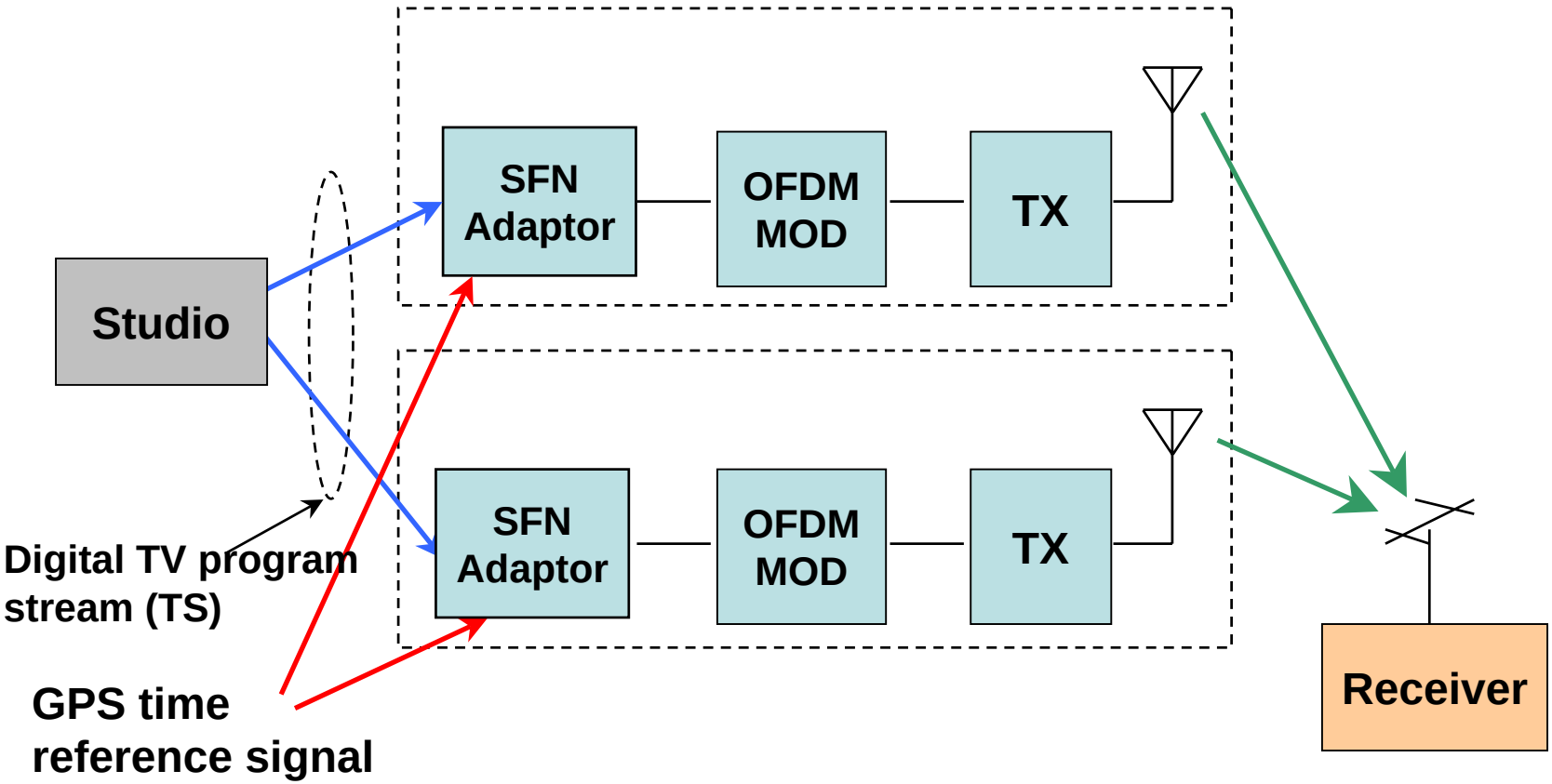
-Adjust the transmission timing of OFDM frame header according to the control information written in information packet.

-Network management system is defined in ARIB STD-B31

See next page

(note) Synchronization technology of If transmission network and broadcast wave relay network is now on studying. In near future, will be standardized.

Network Synchronization for TS transmission system



3. Examples of Transmission System and Hardware

For digital terrestrial broadcasting, many equipment have been already provided and now are in operation. In this section, examples of transmission equipment are intgrodued.

(1)High Power Digital Transmitter System

(2)Micro-wave Links of Digital Terrestrial Broadcasting

(3)Trans-poser of Digital Terrestrial Broadcasting and new technology

(4)Peripheral

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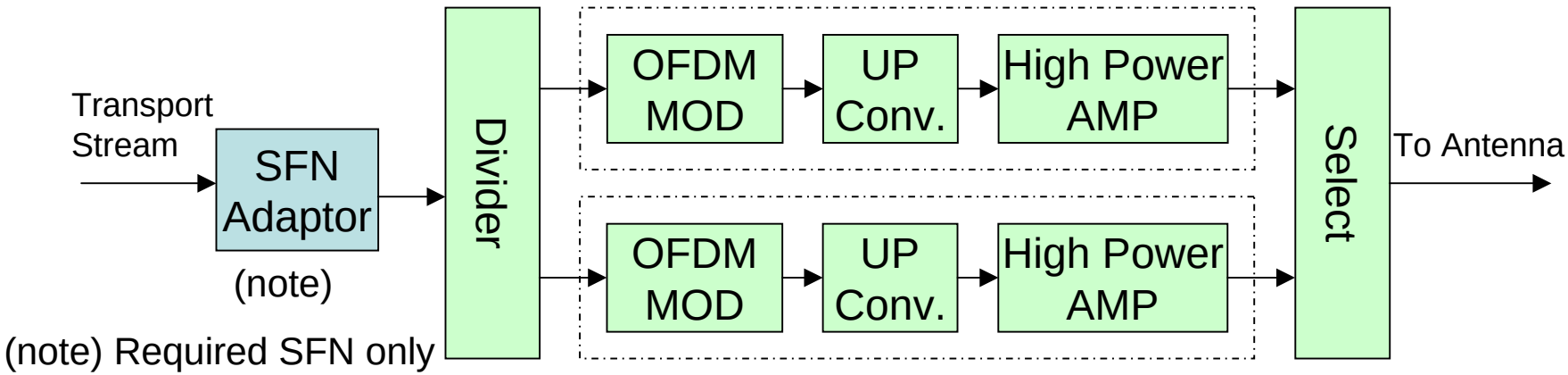
(1) High Power Digital Transmitter system

(a) An Example of Conceptual block diagram (Full redundant system)



(note) Required SFN only

(b) Power Line-up in Japan

Area	Digital TX	Analog TX	note
Tokyo	UHF 10 kW	VHF 50 kW	wide area key station
Osaka	UHF 3 kW	VHF 10 kW	same as above
Nagoya	UHF 3 kW	VHF 10kW	same as above

(c) Examples of Hardware; see following pages

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Examples of High Power Digital Transmitter (Toshiba)

10 kW digital Transmitter(2/3 type)

3 kW digital transmitter rack

1 kW digital transmitter rack

Output power series;

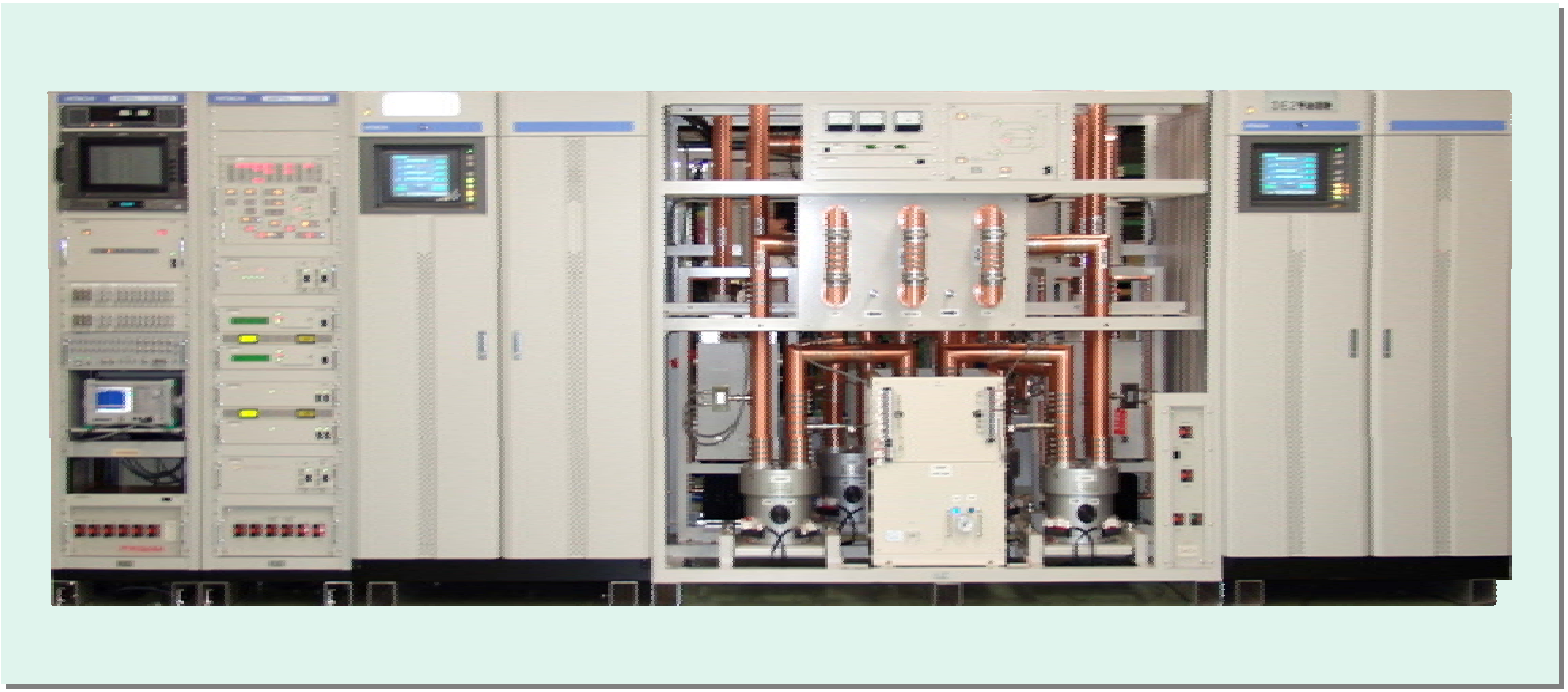
-10kW(2/3) type; for Kanto area
-3kW dual type; for Kansai and Chukyo
-1kW dual type; for medium cover area

Feature;

-Any of cooling type (water or air)
-Equipped high performance non-linear distortion compensator

Examples of High Power Digital Transmitter (Hitachi Kokusai Electric)

3kW dual system



- 3kW digital Transmitter with water cooling system
  Air cooling type is also available
- Built-in latest adaptive pre-distortion technology
- Transmission Frequency is 1 channel within UHF band

Examples of High Power Digital Transmitter of Digital Terrestrial Broadcasting (Mitsubishi Electric)

IS-6000Series

1.Feature

✧High performance Output Power Signal C/N and IM
✧High power amplifier ratio
✧Self daignosis and remote monitoring

2.Main Specifications

Output Signal Power	1kW,500W,300W,100W
Output Signal Frequency Range	UHF(470MHz～770MHz)
Input Signal	・DVB-ASI ・IF(37.15MHz)
Distortion Reduction	Adaptive Digital Pre Distortion
IM(Intermoduration)	Max -50dB
Input Power	AC 200V-3 ϕ (50Hz/60Hz)
Power Consumption	Max 9kW (air cooling)
Size	800(W)×1950(H)×1200(D)mm
Weight	600kg

3.Achievements

✧First product is delivered to the customer

Examples of Digital Transmitter (NEC)

Features

1) **Both liquid cooling / air cooling available**
2) **Compact size / Minimized footprint**
3) **Adaptive Digital Corrector to maintain optimal signal quality**
4) **Color LCD to monitor detailed parameters**

3kW Air Cooled
UHF Digital TV Transmitter
(in operation at Osaka & Nagoya stations)

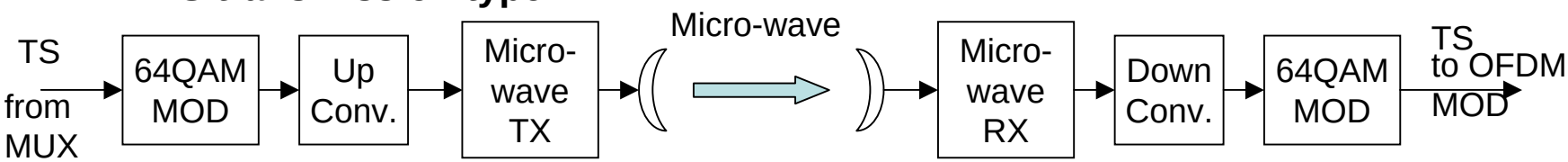
10kW Water Cooled
UHF Digital TV Transmitter
(in operation at Tokyo station)

(2) Micro-wave Transmission Link

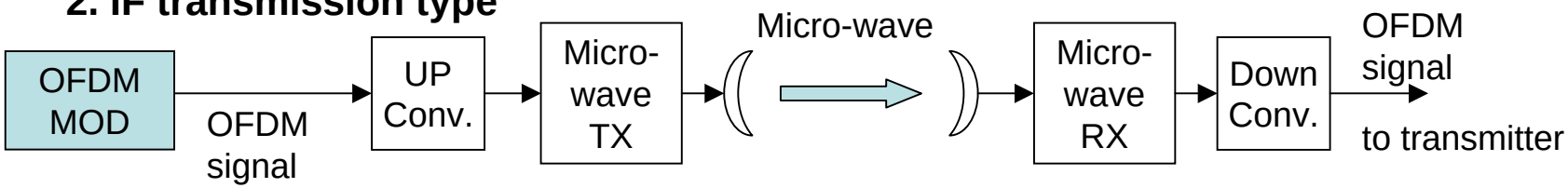
(a) STL(studio transmitter link) and TTL(transmitter transmitter link)

2 transmission types described below are available(can be applied to fiber transmission

1. TS transmission type



2. IF transmission type



(b) FPU(Field Pick Up)

Field Pick Up is the outside program transmission system for news gathering and sports relay system, etc. Recently, digital modulation system such as single carrier QAM and OFDM are introduced.

(c) Examples of Hardware; see following pages

Examples of Microwave STL/TTL (Toshiba)

TS STL/TTL TX TS STL/TTL RX

-Dual type, seamless switching

-DVB-ASI digital interface

-Equipped automatic multi-path equalizer

IF TTL TX/RX

-Dual type, TX/RX are installed in 1 rack

-OFDM IF signal interface

-Phase noise compensation technology with pilot signal

Examples of Digital Studio to Transmitter Link for TS Signal Transmission

(Hitachi Kokusai Electric)

2 channels dual system

・Seamless SHF Output Signal Switching

・DVB-ASI Digital Signal Interface

・High-performance automatic equalizer diminishes multi-path distortion

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Examples of Digital STL (NEC)

STL Transmitter

STL Receiver

Features

1) **Ready for three different frequency bands**

7GHz/2.0W
10GHz/2.0W
13GHz/0.5W

2) **HEMT employed at LNA stage to reduce NF**
NF=3db typical for all bands

3) **Test signal (PN pattern) incorporated in digital modulator to measure BER**

4) **4 channels of telephonic signal accommodated**

5) **64QAM / HPA can be separated max. 200m (with 5D-2W) without degradation**

Digital Microwave Link

Digital / Analog in single FPU
that supports three modes

PF-503 TX-H

PP-57

PF-503 RX-H

Ikegami FPU (PF-503/PP-57) makes it possible to select HDTV and SDTV by built-in Encoder Board.

PF-503 supports 3 mode transmission including analog mode.
①QAM (Single Carrier) ②QAM-OFDM (Multi Carrier) ③Analog (FM)

PF-57(QAM-OFDM) is suitable for wireless camera system in both SDTV and HDTV.

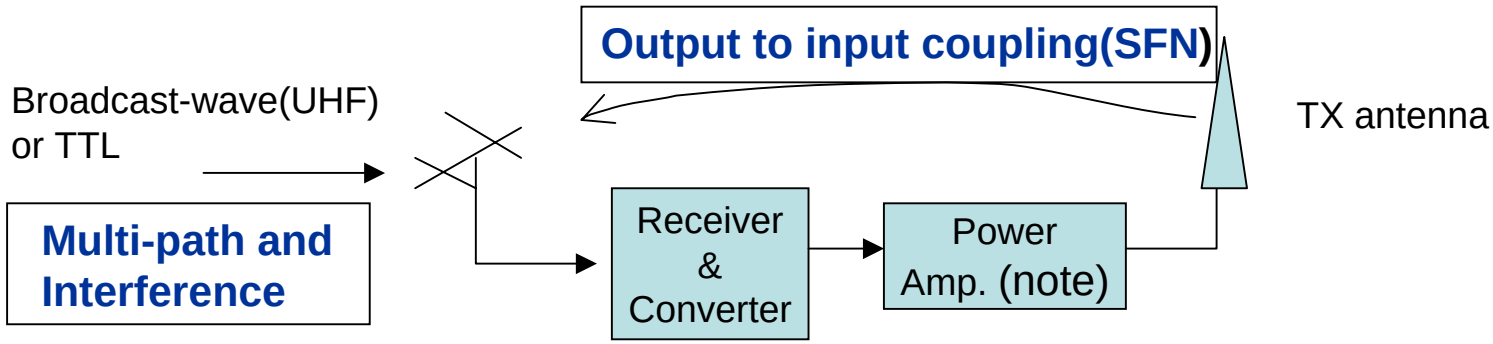
Examples of Micro-wave Transmission Link （Hitachi Kokusai Electric)

・Switch Selectable among analog FM, digital single carrier QAM and digital multi-carrier OFDM

・Video and audio signals transmissible in HDTV or SDTV

(3) Transposer of Digital Terrestrial Broadcasting And new technology

(a) Conceptual Block diagram



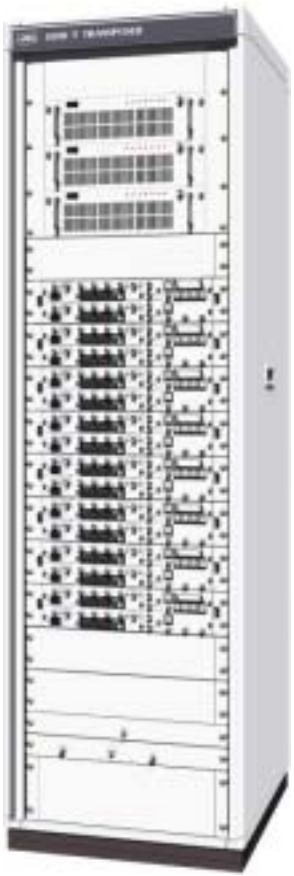
(note) to save the cost, common amplifier is expected

(b) Key factors of digital terrestrial transposer

1. **To reduce the cost, common wideband amplifier for plural channel is expected**
2. **In some cases, degradation caused on transmission link should be improved (Multi-path, interference canceller, diversity reception, etc)**
3. **For SFN, receiving and transmitting frequency is same, coupling of input and output should be decreased (coupling loop canceller)**

(c) Examples of Hardware; see following pages

Examples of Digital transposer (JRC)



Digital transposer

-Adopting a Multi channel common amplifier

-Output power of 10W on 8 channels

(Suitable for the Tokyo area)

50W power amplifier

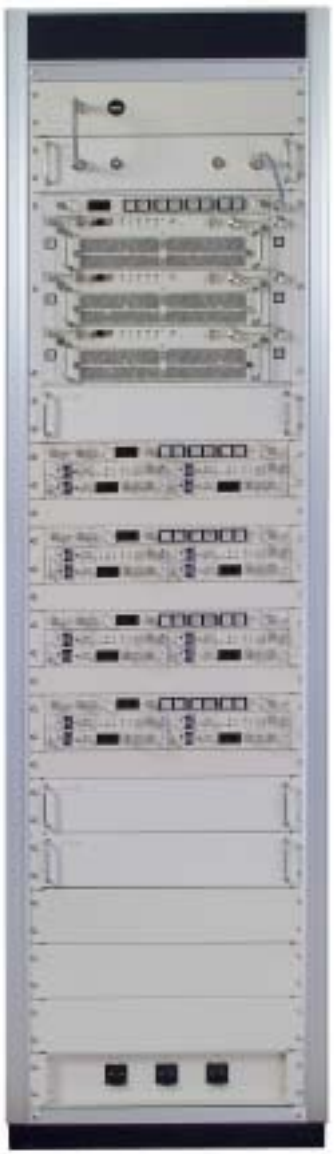
-MCPA (Multi Channel Power Amplifier)

-Feed-forward distortion compensation amplifier

Receiver

-In-use and / or standby receiver and change-over switch

Examples of Transposer of Digital Terrestrial Broadcasting(Mitsubishi Electric)



IS-3000Series

1.Feature

✧Low distortion output power by feed forward compensation
✧Wide frequency range MCPA(Multi Channel Power Amplifier)
✧Easy maintenance and Compact Size

2.Main Specifications

Input Signal form	・UHF（470MHz～770MHz） ・DVB-ASI or IF（37.15MHz）
Output Signal form	UHF(470MHz～770MHz)
Output Signal Power	50W、30W、10W、3W、1W、0.3W、0.1W
IM(Intermoduration)	Max -50dB
Spurious	MAX -60dBc
Input Power	AC 100V/200V(50Hz/60Hz)
Size	570(W)×1900(H)×630(D)mm

3.Achievements

✧Several products are inspected on site and in the factory

Examples of Digital Transposer (NEC)

30W x 3-channels common amplification System

Features

1) Excellent IM (less than -50dB) using Feed-forward technology.

2) MCPA (Multi Channel Power Amplifier) is available.

   No required of Channel combiner, especially, in the case of adjacent channel transmitting.

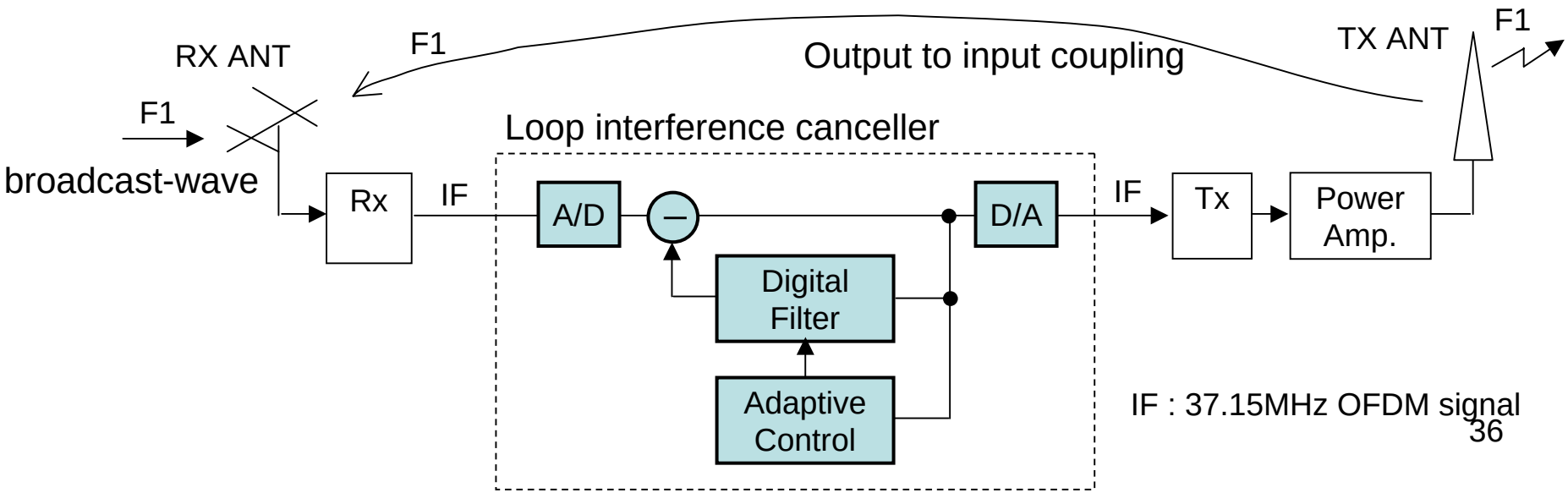
3) END (Equivalent Noise Degradation) improving equipment for on air receiving system is provided.

   - Loop canceller
   - Diversity receiver
   - Noise reduction (Re-mapping) Equipment.

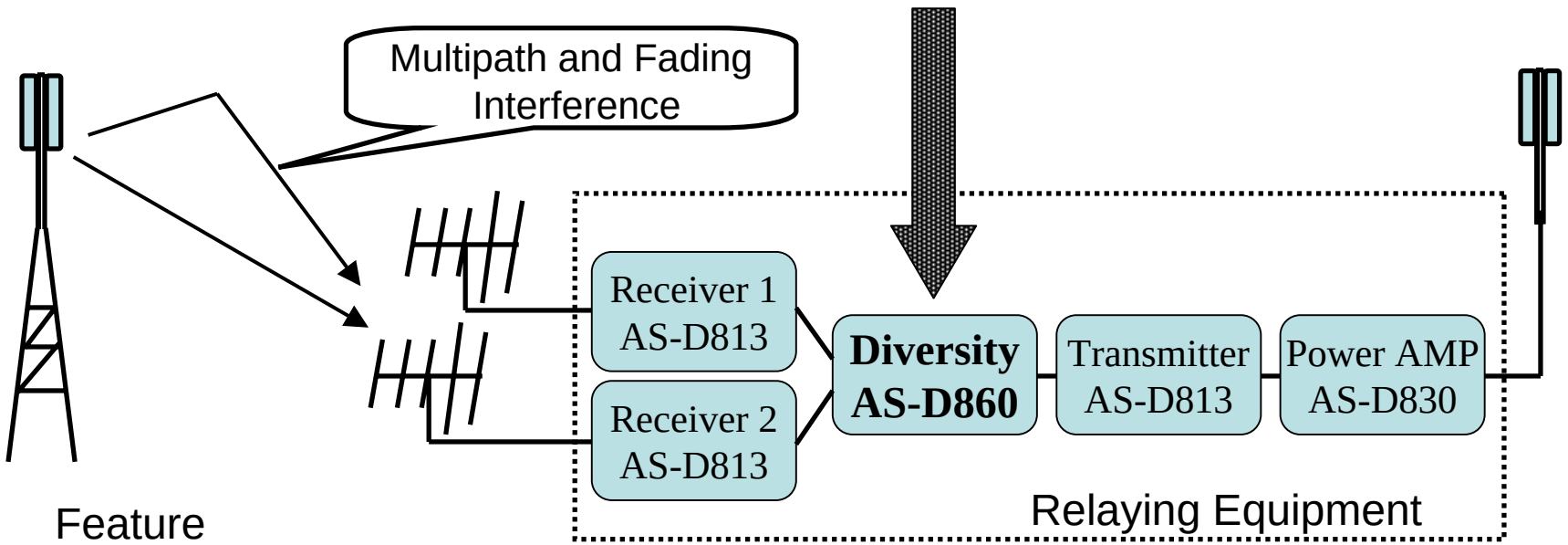
Examples of New Technologies (JRC)

Loop interference canceller for SFN (Single Frequency Network)

-Economical SFN by the broadcast-wave can be realized



Signal quality compensate equipment for Terrestrial Digital Broadcasting Relay Station MODEL AS-D860 (Panasonic).



Feature

★ Signal quality degradation by the multipath and fading is compensated.

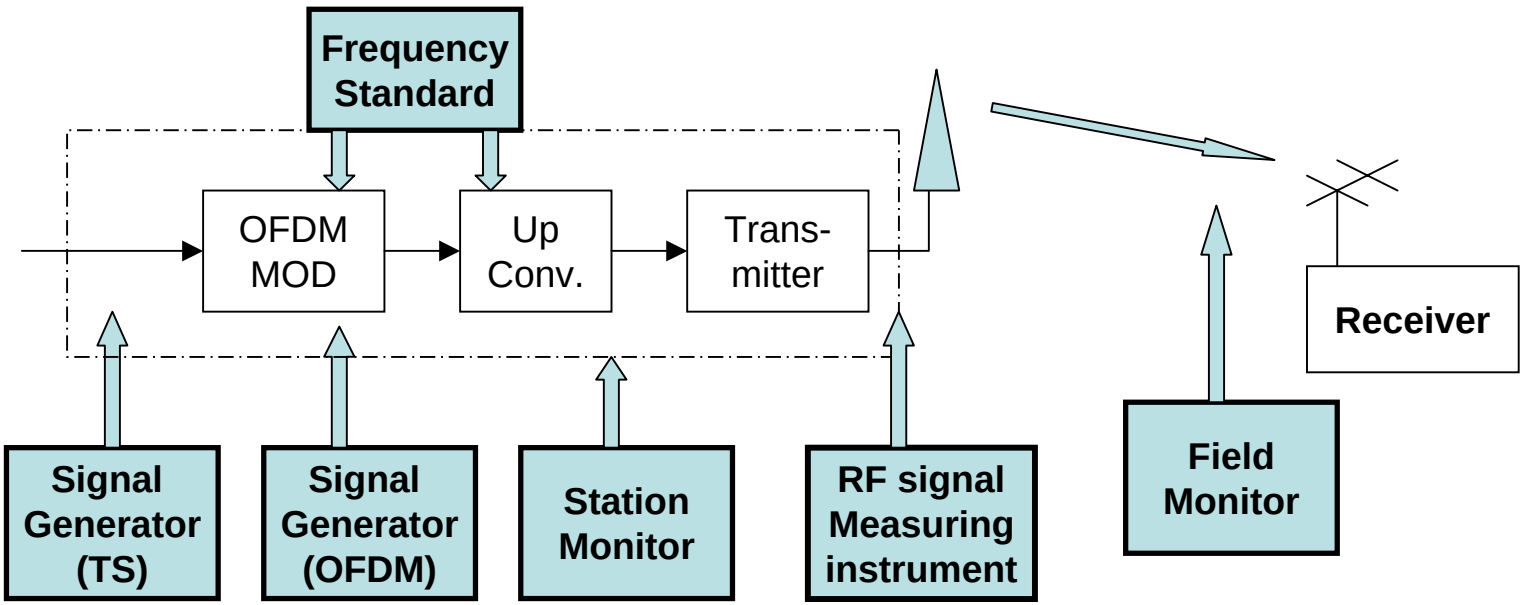
★ Adopted to maximum-ratio-combined method.

★ Miniaturization Size : 480mm(W)×400mm(D)×50mm（H)

(4) Peripherals

(a) Peripherals for digital transmitter system

Peripherals for digital transmitting system are quite different from the ones for analog system. Many types of peripherals for digital have been developed and commercialized



(b) Examples of Hardware; see following pages

OFDM FIELD ANALYZER

MODEL 5287 (NITSUKI)

Various measurement function enables predicting recieving obstacle in the field.

* **Equipped with built-in very low noise UHF all channel down converter.**
* **Output MPEG2-TS from demodulated OFDM signal.**
* **Measured results are displayed on LCD and can be stored in memory card.**
* **Displays transmission parameters at each hierarchical level, according to TMCC information.**
* **In case measured value exceed normal range, alarm signal will be issued.**

(Japan Communication Equipment Co.,Ltd. ”Nitsuki”)

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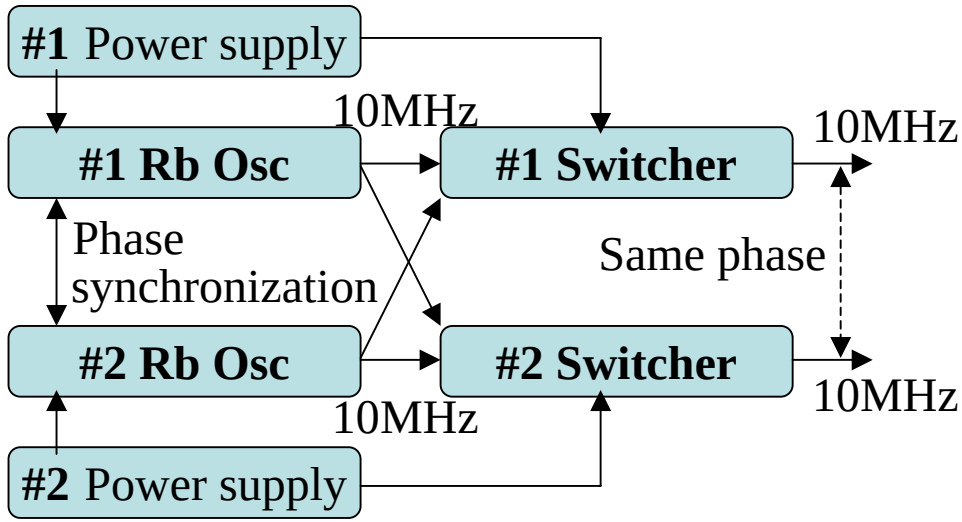
SYNCHRONIZED REFERENCE SIGNAL GENERATOR

MODEL3275 (NITSUKI)



∗ High accuracy 10MHz reference signal generator using the Rubidium resonance frequency.

∗ Synchronized two Rb oscillator(main/back up) enables switching without phase jump.

∗ Main/Back up system consists Plug-in unit, can be extract/insert during operation without any affection to the other system.

(Japan Communication Equipment Co.,Ltd. ”Nitsuki”)

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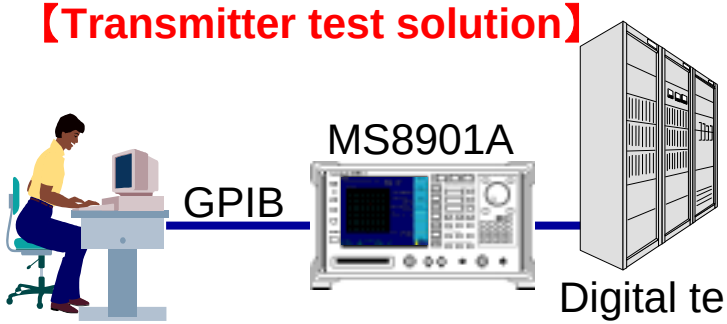
Introduction of measuring instrument for digital broadcasting

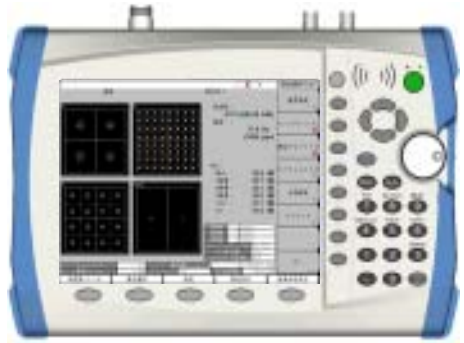
MS8901A(Anritsu) Digital Broadcast Signal Analyzer

This is a digital broadcasting signal analyzer that makes the base of high performance Spectrum Analyzer (9kHz~3GHz). Using High-speed DSP , and you will be able to do some diverse measuring functions by installing the measurement software.

【Transmitter test solution】



MS8911A(Anritsu) Digital Broadcast Field Analyzer



MS8911A is a suitable and optimal measuring instrument for Digital Broadcasting Signal Wave (ISDB-T). This has the most advanced ultra-portable spectrum analyzer on the market, featuring unparalleled performance and size at a modest price.

【Field measurement solution】

No.MC-X2DBA1173-00

Anritsu

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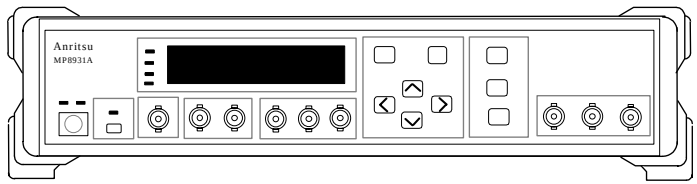
Introduction of measuring instrument for digital broadcasting

MG8940A(Anritsu) Digital Broadcast Signal Generator

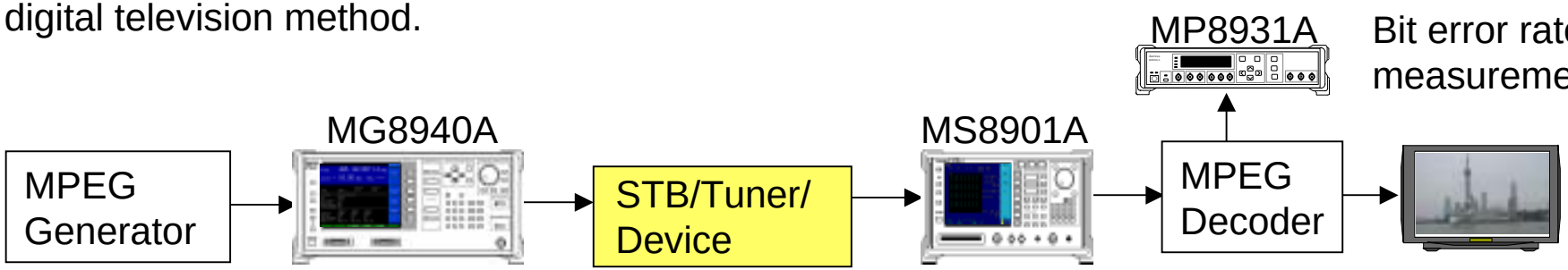
This is a digital broadcasting Signal Generator that makes the base of high performance Signal Generator(250kHz-3GHz). If you install ISDB-T transmission and code Unit in MG8940A, It can generate signal that is a high accuracy and based on the ISDB-T terrestrial digital television method.

MP8931A(Anritsu) Bit Error Rate Tester



MP8931A is the general-purpose Bit Error Rate Tester which can be used in various fields deal with digital data, such as digital broadcasting, mobile communications and digital circuit.

【Receiver evaluation system】



Evaluate analog performance quantitatively with MER

No.MC-X2DBA1173-00

Anritsu

4. Digital TV Broadband Antenna Implemented on the Tokyo Tower

Digital terrestrial TV broadcasting started in UHF-Band. Analog TV in Tokyo area operate in VHF band. Therefore, Digital TV antenna is installed separately.

Antenna should be installed on very narrow space of Tokyo Tower, even though many channel transmission should be required.

From this reason, Broadband antenna system for common use of plural channel were adopted.

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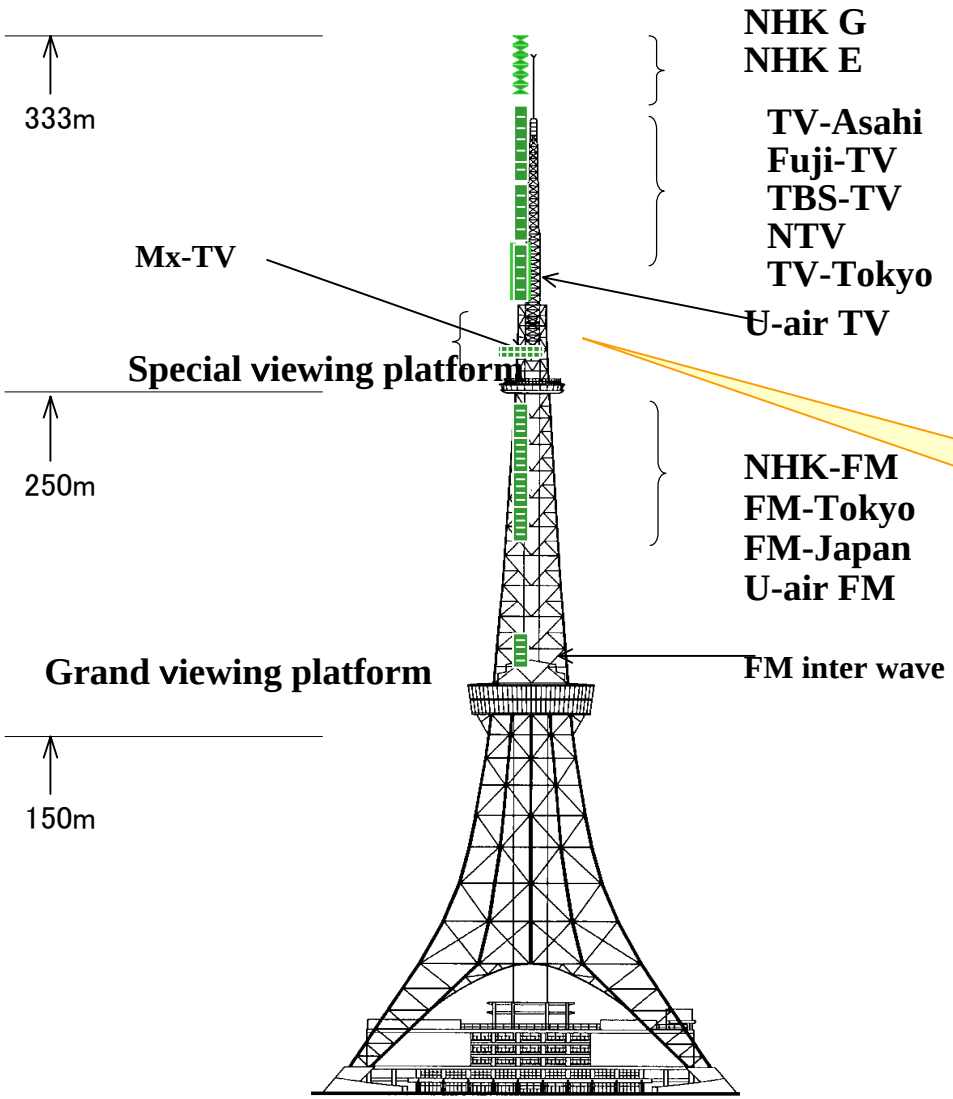
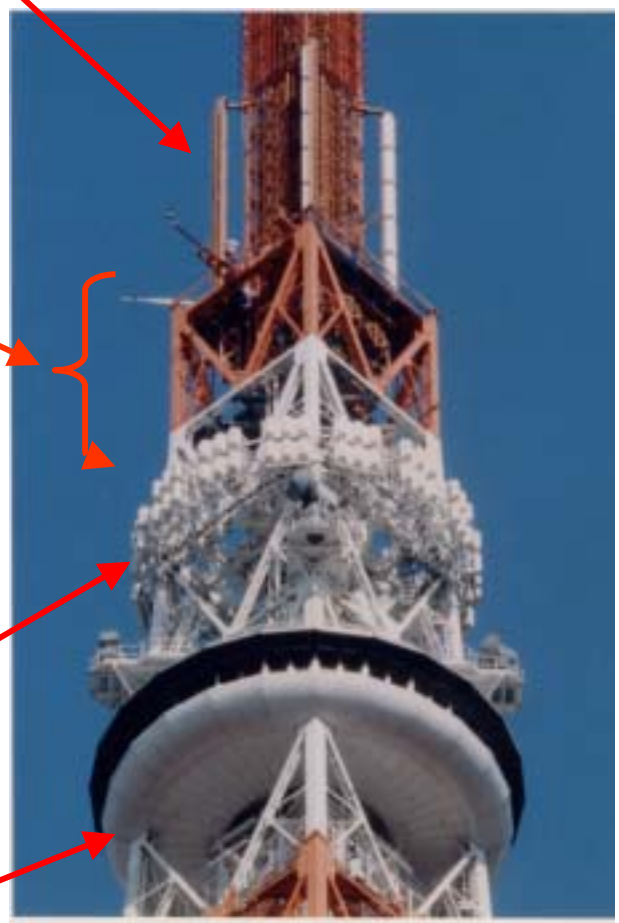
TV Broadcasting Antennas Installed on the Tokyo Tower



- A number of analogue TV broadcasting antennas are already installed on the Tokyo Tower, leaving only a limited space for mounting of digital broadcasting antennas

Digital TV antennas to be mounted here

Mounting Space for Digital TV Antennas on the Tokyo Tower



- The mounting space for the digital TV antennas is limited to a small space of 6 meters in width and 12 meters in height on the tower structure.
- A pattern synthesis technology is required to realize an omnidirectional radiation pattern using such a difficult space for mounting

Thank you!
For your attention

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