

Start of Transmission from Tokyo Skytree

—Part 2: Transmission Equipment—

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1. Introduction

The transmission equipment at Tokyo Skytree constitutes the largest transmission facility in Japan. The equipment is designed to be more reliable, easier to maintain and operate, and more energy efficient. This part introduces NHK's transmission equipment for television and FM radio.

2. Television transmission equipment

2.1 Overview

The specifications of the television transmission equipment are listed in Table 1, and an overall system diagram is shown in Fig. 1. TV program signals are transmitted from the NHK Broadcasting Center in Shibuya via three routes, comprising two optical lines and a radio link. We use a dual transmitter system (active plus standby) in which the standby transmitter is automatically switched when a fault has occurred in the active transmitter. Each of these transmitters consists of two 5 kW transmitters generating 10 kW of power, resulting in a highly reliable system. If one of the 5 kW transmitters in the active transmitter fails, the other keeps on broadcasting while the live transmitter is switched over to the standby transmitter.

2.2 Ease of maintenance and operation

The television transmission equipment is shown in Photo 1. To prevent operational errors, the transmitter racks for NHK General TV and NHK Educational TV are colored differently.



Photo 1: Television transmission equipment

The transport stream (TS) switch at the stage before the OFDM modulator input can switch signals seamlessly, and the active/standby transmitter output switch system is capable of switching without any output fluctuations because it uses an uninterruptible antenna switching apparatus.

This makes it possible to perform maintenance on either of the transmitters even in the middle of live broadcasting by switching between the active and standby transmitters.

2.3 Power saving

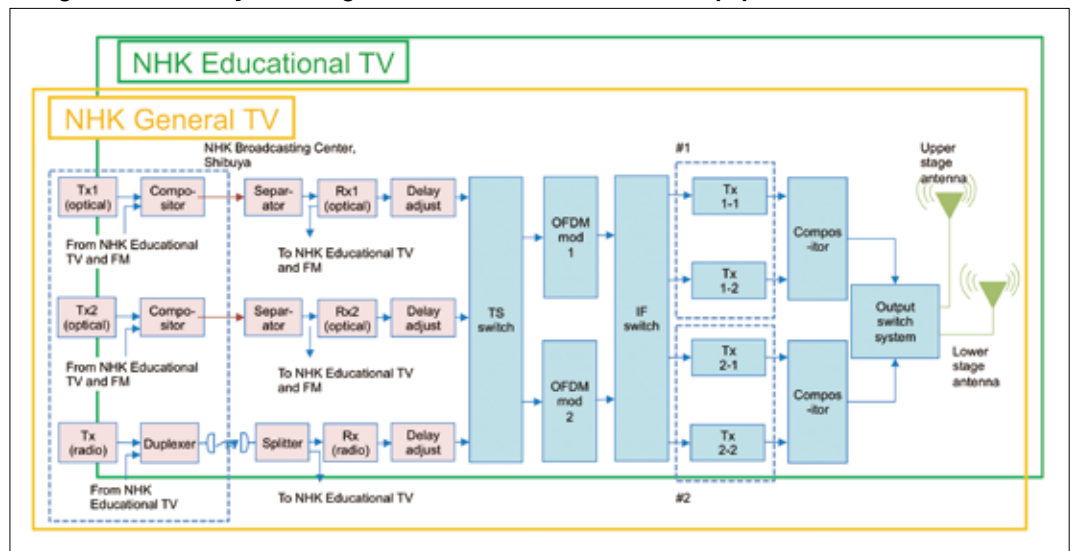
The power amplifiers (PAs) of digital

transmitters generally have poor efficiency (output power/electricity consumption) and higher electricity consumption. However, Skytree's transmitters achieve greater efficiency through the use of a Doherty circuit configuration with gallium nitride (GaN) circuit elements in the PA amplifier devices. Moreover, the circuit that compensates for the intermodulation distortion that occurs when amplifying OFDM signals outperforms a conventional circuit, leading to greater PA efficiency. The combination of these factors has enabled us to improve the PA efficiency to at least 30% (compared with 18% for a conventional PA), resulting in substantially lower electricity consumption.

3. FM transmission equipment

The specifications of the FM transmission equipment are listed in Table 2, and an overall system diagram is shown in Fig. 2. With a configuration similar to that of the television transmission equipment, the device inputs are obtained via three routes, comprising two optical

■ Figure 1: Overall system diagram of television transmission equipment



■ **Table 1: Specifications of television transmission equipment**

Item	Summary
Transmitting channels	NHK General TV: 27 channels NHK Educational TV: 26 channels
Nominal output	10 kW
Transmitter type	Dual system (non-disruptive changeover)
Cooling system	Transmitter PA: Water-cooled
	Other parts: Fan-cooled

■ **Table 2: Specifications of FM transmission equipment**

Item	Summary
Transmission frequency	82.5 MHz
Nominal output	7 kW
Transmitter type	Dual system (non-disruptive changeover)
Cooling system	Fan-cooled (indoor circulation)

■ **Table 3: Specifications of television transmission antenna**

Item	Summary
Antenna type	4L stacked loop antenna with shared space for 20 panels in 4 stages
Directivity	Horizontally directionless, electrical tilt 2°
Main feeder	CX-120D, approx. 250 m × 2

■ **Table 4: Specifications of FM transmission antenna**

Item	Summary
Antenna type	2L stacked loop antenna with 9 panels in 4 stages (shared with J-WAVE)
Directivity	Horizontally directional (suppressed except in westerly direction)
Main feeder	CX-120D, approx. 200 m × 2

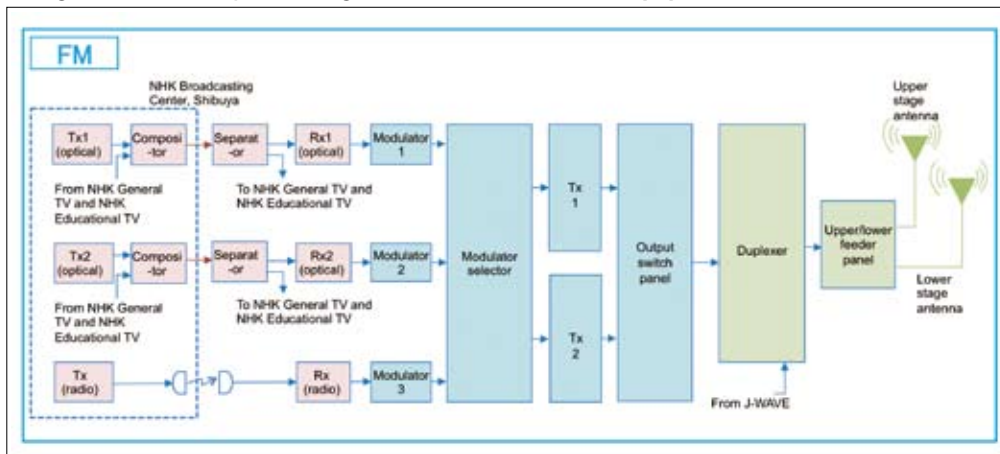
our case, NHK General TV and NHK Educational TV) are arranged alternately. For these two channels, there are a total of 160 antenna elements. With such a large number of elements, we monitor not only the voltage standing wave ratio (VSWR) and DC resistance (DCR), which are normally used for monitoring the antenna characteristics, but also the radiated power of each antenna by attaching sensors to each individual antenna element.

4.2 FM transmission antenna

The specifications of the FM transmission antenna are listed in Table 4, and an exterior view of the antenna is shown in Photo 3.

The FM transmission antenna is a dual wave antenna that is used for J-WAVE (a private broadcaster) and NHK transmissions. Since FM is used for regional broadcasting, the main beam is electrically confined in the horizontal direction to suppress the spillover to other prefectures and to improve the reception environment in regions lying to

■ **Figure 2: Overall system diagram of FM transmission equipment**



lines and a radio link. The audio program signals (AES/EBU format) are input to an FM modulator, which outputs FM-modulated stereo signals at the broadcast frequency. The modulated output signals of the three systems are selected using switches and output to two transmitters. We use a dual transmitter system (active plus standby) in which the standby transmitter is automatically switched when a fault occurs in the active transmitter. An uninterruptible antenna switching apparatus has been introduced to enable switching between the active and standby transmitters without any fluctuations in the output.

4. Antenna equipment

4.1 TV transmission antenna

The specifications of the television transmission antenna are listed in Table 3, and an exterior view of the antenna is

shown in Photo 2.

The TV transmission antenna is attached to the gain tower, a hexagonal column about 140 m tall and 6 m wide at the upper part of Skytree. To reduce as much as possible the height difference between the transmitting antennas so as to avoid differences in the coverage areas of seven different channels (including private broadcasters' channels), a space-sharing system is used whereby the antenna elements of two channels (in



Photo 2: TV transmission antenna

the west.

5. Conclusion

We have introduced NHK's transmission equipments in Tokyo Skytree. By actively incorporating new technologies to produce equipment that is highly reliable and efficient, we will work to maintain and manage this facility so as to provide viewers and listeners with a stable service for many years to come.



Photo 3: FM transmission antenna