

PERFORMANCE CHARACTERISTICS OF A TRANSPORTABLE TRANSMIT AND RECEIVE STATION OF A-TYPE
FOR JAPAN'S MEDIUM-SCALE BROADCASTING SATELLITE FOR EXPERIMENTAL PURPOSE (BSE)

By

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ABSTRACT

The performance characteristics of a transportable type small-scale earth station of A-type that has been used in the experiments made with the Japan's medium-scale broadcasting satellite for experimental purpose are outlined in this paper. The experiments prove the practicality of establishing a TV broadcasting service on the 14/12 GHz band.

Introduction

Japan's medium-scale broadcasting satellite for experimental purpose (BSE) was launched into its stationary orbit above the equator at long. 110°E in April 1978. It was assigned the frequency bands of 12GHz (for down-link) and 14GHz (up-link) along with the frequency bands for carrying out the satellite broadcasting service agreed on in WARC-ST in June 1971. Using these bands, full-fledged experiments have been conducted so far to assure the feasibility of color TV transmission by the BSE.

The ground terminal facilities available in the BSE system consist of a Main Transmit and Receive Station (MTRS), a Transportable Transmit and Receive Station of A-Type (hereinafter called the TTRS A-Type station), a Transportable Transmit and Receive Station of B-Type (TTRS B-Type), Receive-Only Station, and Simple Receive Equipments.

This paper presents the performance characteristics of the TTRS A-Type station developed in connection with the R&D efforts made on various segments of the BSE system.

Its configuration enables the ease of transportation and reassembly in the field as shown in Figure 1 and also transmission and reception of color TV programs simultaneously by the multiple access scheme shared together with other earth stations, and of engineering service signals. Hence it can be installed anywhere in Japan.

Summary of Design Concepts

The TTRS A-Type station was designed on the basis of the basic BSE design concept (1) (2) calling for the allocation of the transponder's 180MHz band to the five subchannels, i.e. A1, A2, B1, B2, and B3 on the 14GHz (up-link) and 12GHz (down-link) band and for the satellite link parameters yielding the TV weighted S/N ratio at a Japan mainland receive-only station which exceeds 45dB when it features an antenna of 1.6m diameter and a system noise temperature of 600K.

Moreover, its performance relaxed the requirements of small stations including simple receive equipments by permitting them to be designed on the same concepts as are those of the ordinary TV broadcasting service networks.

Owing to the above, the TTRS A-Type station (3) has the features as given below :

- 1) Any one of its five subchannels A1, A2, B1, B2 and B3 is selectable for transmit of telecasts.
- 2) Any one subchannel in each of A and B channels is usable simultaneously for reception of telecasts.
- 3) Transmission and/or reception of voice and data orderwire signals are possible via FM-SCPC orderwire channels in B3 sub-channel.
- 4) The station is small and light, enabling its quick setting up and ease of assembly/disassembly and transportation to or from a site. It offers a stable, permanent operation once it is set up.



Figure 1 Transportable Transmit and Receive Station of A-Type (TTRS A-Type)

Constitution and Performance Results

The TTRS A-Type station consists of two major components, i.e., the 4.5m dia. antenna and the equipment shelter where all the transmit and receive equipments excluding the low noise converter and the antenna control equipment are accommodated.

The high-power amplifier (HPA) employs a 5-cavity klystron of 2KW saturated output power, and covers the 180MHz band-spread over two channels by means of a 3-stop preset tuning mechanism. When transporting the shelter, the only precaution to be taken is to remove the klystron and the traveling wave tube (TWT) of the orderwire HPA for the sake of a safer transit.

The antenna is of a Cassegrain type, and employs an X-Y type mounting. It can be set up easily and pointed at the satellite without precise adjustments, by built-in facilities which also yield transportability to any point in Japan. A hill-climb type step tracking system is employed for automatically tracking the satellite over the range of $\pm 5^\circ$.

When carrying on high-power transmission with this type of small diameter antenna, the wide-angle sidelobe characteristics of the antenna become extremely interfering to other terrestrial networks, preventing effective utilization of the satellite orbit unless the sidelobe power is suppressed. As shown in Figure 2, excellent performance characteristics were obtained by taking various counter-measures such as the adoption of a corrugated horn, optimization of the ratio of diameters of the mainreflector and subreflector, reduction of unnecessary scattering by use of a shaped reflector and a specially shaped tripod of subreflector.

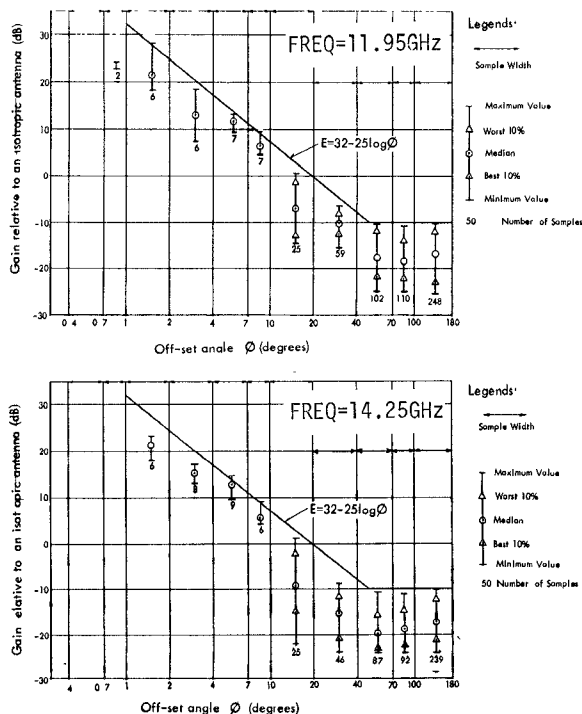


Figure 2 Wide-Angle Radiation Pattern of 4.5m Antenna (TTRS A-Type)

To cope with a parallel-linear polarization operation, a halfwave plate polarizer with rotary joints and a duplexer which consists of a T-junction, a cutoff filter and a corrugated type filter are used in the feed assembly. The corrugated type filter inserted in the receive path of the feed assembly provides the isolation exceeding 110dB between the transmit and receive ports which isolation is necessary when a planar circuit type device is used in the receive front end. The major performance characteristics are listed in Table 1 (4).

The front end of the receiving subsystem adopts the low-noise converter consisting of a planner circuit mounted in the waveguide(5), converts the receive signal into that of the 1.25GHz band, amplifies it, and distributes it to the respective receiving channels. By use of this converter, the receiving system noise performance below 630K and the 180MHz wideband characteristics are obtained together.

The modems for the TV signal and FM-SCPC signals have IF frequencies in the 140MHz band, which are converted to 14GHz signals by the up-converters of the transmit subsystem. In the demodulation of TV signals and FM-SCPC signals, the 1.25GHz receive signals are converted to 140MHz signals by the down-converters of the receive subsystem. The demodulator for FM-SCPC orderwire has a +150 KHz pull-in range and employs the PLL type threshold extension demodulation technique to improve its threshold characteristics.

The performance characteristics of the TTRS A-Type station are summarized in Figures 3 and 4, which show the gain/frequency response and group delay distortion measured through the in-station RF loop and the satellite loop and the TV weighted S/N ratio versus input level, respectively.

The TV picture qualities received at various receive stations and simple receive equipments were confirmed to pass TASO grade 1 (Excellent) and to be better than CCIR broadcasting quality standards.

Table 1 Major Performance Characteristics of 4.5m Antenna

Frequency(GHz)	14.0~14.5	11.7~12.2
Gain (dB)	$54.0+20\log \frac{F(\text{GHz})}{14.25}$	$52.5+20\log \frac{F(\text{GHz})}{11.95}$
VSWR	1.07	1.17
Axial ratio(dB)	21	24
Feed loss(dB)	0.14	0.23
Noise temp.(K)	—	45 ($E=45^\circ$)
Tracking accuracy	Step tracking accuracy Better than $\pm 0.05^\circ$	

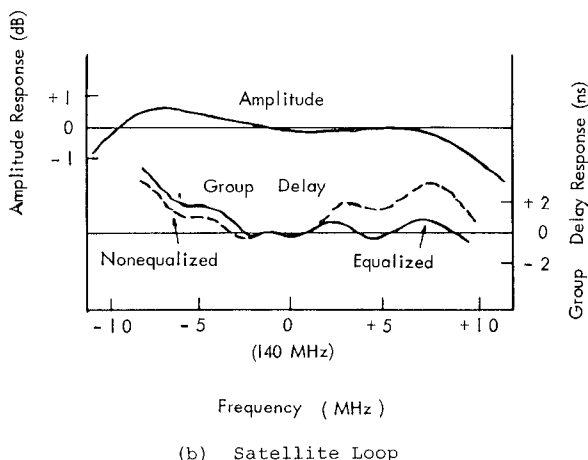
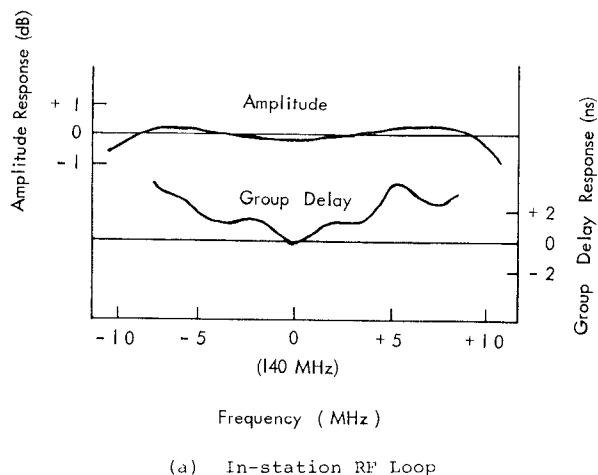


Figure 3 Transmission Characteristics

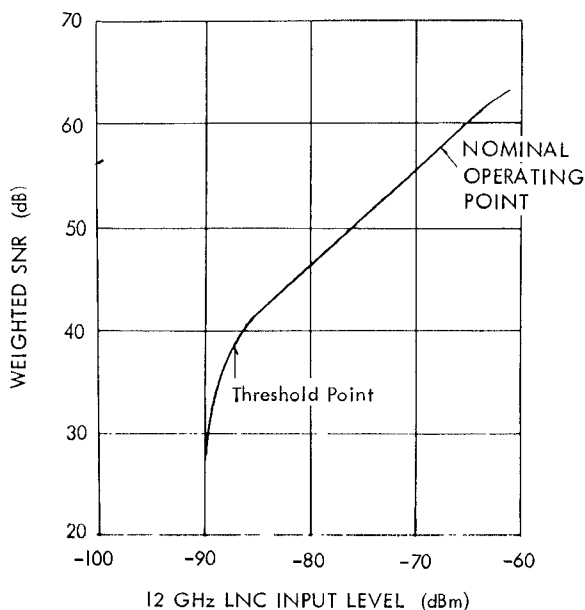


Figure 4 TV Weighted S/N Ratio versus Input Level

Conclusion

The results obtained from the BSE experiments will contribute toward establishing the essential technical standards to be applied to the future satellite broadcasting systems using the 14/12 GHz band and toward developing practical operational techniques (6).

Acknowledgements

The authors express their appreciation to the engineering staff of the NHK's Technical Research Laboratories and of the NHK's Headquarters, Technical Administration & Construction, for all the advices and suggestions extended to them in the development of the above system and related devices.

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