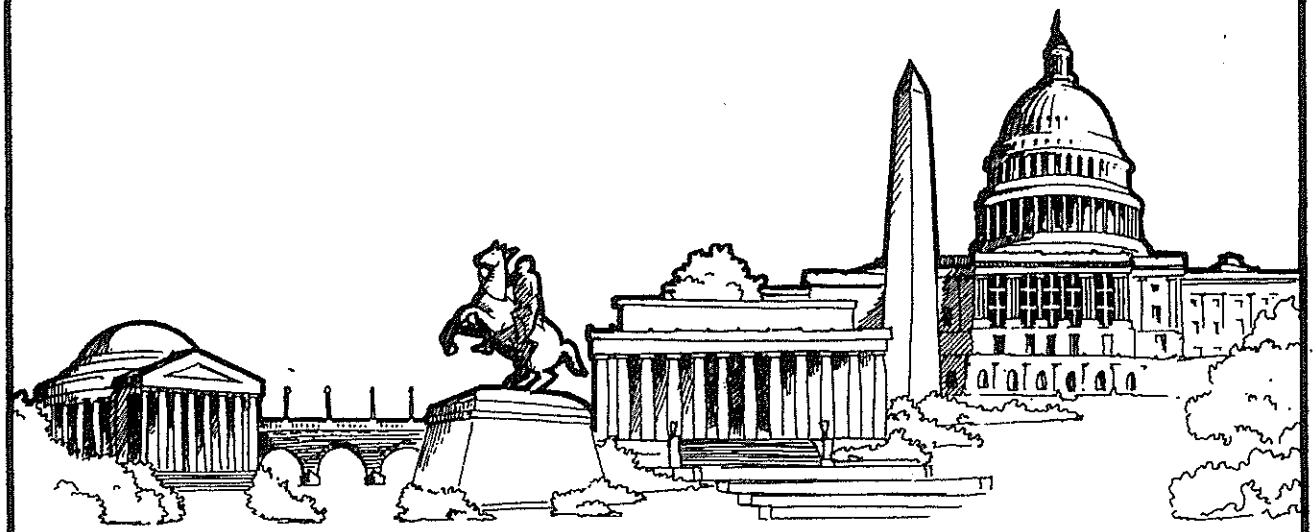
TECHNOLOGY GROWTH FOR THE 80's



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14/12 GHz BAND MOBILE-TYPE EARTH STATION FOR JAPANESE BROADCASTING SATELLITE COMMUNICATION

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Abstract

This report describes function and performance of mobile-type earth station system and subsystems, designed for using higher carrier frequencies, and station construction for mobile use.

Introduction

The mobile-type earth station is designed to be as compact and lightweight as possible so that it can travel everywhere in the mainland of country, and can easily access the satellite. The appearance of the mobile-type earth station is shown in Photo 1.

The station can transmit one TV channel and two order-wire channels in the 14 GHz band, as well as receive two TV channels and three order-wire channels in the 12 GHz band. Table 1 lists the overall performance [1] of the mobile-type earth station.

System Configuration

A block diagram of the mobile-type earth station is shown in Fig. 1. The TV video signal with associated audio signal in the transmit system is frequency-modulated at 140 MHz. The 140 MHz signal is up-converted into a 14 GHz band signal, which is amplified by a 2 kW klystron tube high power amplifier to be fed to an 2.5 mϕ antenna. The order-wire signals are frequency-modulated at 140 MHz. The outputs of two order-wire modulators are combined and up-converted into 14 GHz band signal which is amplified by a 100 W TWT amplifier and combined with the TV signal at a 10 dB coupler. The order-wire modulator for CH 1, 3 and 4 can be switched to one of the preassigned channels.

In the receiving system, the 12 GHz signal from the antenna is down converted to a 1.25 GHz IF signal by a low noise frequency converter [2] [3] [4]. After being branched, two TV signals are down-converted to the 140 MHz IF signals. Each TV down converter can be switched to one of the preassigned channels. The 140 MHz IF signals are demodulated into TV video and associated audio signals.

The 1.25 GHz IF signal is also applied to a order-wire down converter and translated into the 140 MHz IF signal. Three 140 MHz/ 10.7 MHz down converters are provided for CH 1, CH 2 and CH 3 and 4 order-wire signals. The down converter for CH 3 and 4 can be switched. The 10.7 MHz signals are demodulated into order-wire baseband.

An equipment layout of the mobile-type earth station is shown in Fig. 2. The antenna and receiving low noise frequency converter are mounted at the rear of the vehicle. All other equipments are accommodated in the van. The following consideration is given to this mobile-type earth station.

(1) The required e.i.r.p and receive noise temperature can be obtained with the 2.5 mϕ antenna.

(2) Since RF frequencies in use are high and the antenna beam width is very narrow, the vehicle strength and stability are increased so as to minimize the pointing error.

(3) The antenna is designed to reduce radiation side lobe level.

(4) Each equipment is designed to be compact, lightweight and shockproof, and for low-power consumption.

(5) The station can be operated by a few persons in a short time.

An overall system carrier-to-themalnoise ratio (C/N) of 21.5 dB is obtained for the Japanese mainland by this mobile station. To obtain the e.i.r.p. (effective isotropically radiated power) of 79 dBW, with as small an antenna as 2.5 mϕ, a newly-developed 2 kW klystron tube high-power amplifier is used. This earth station e.i.r.p. overcomes the 3 dB rain attenuation and keeps total receiving signal-to-noise ratio of 45 dB for receive-only earth station having 4.5 mϕ antenna at any place in Japan.

Newly Developed Subsystem

1) Antenna

The antenna is a cassegrain type, which can be mounted on a vehicle. The antenna is designed giving particular consideration to the low level side lobe characteristic.

A cassegrain antenna with a shaped refrector is adopted and also a shield with a microwave absorber is used around the periphery of the main reflector to meet the standard pattern ($32 - 25\log\theta$) recommended by CCIR. The measured sidelobe pattern and antenna noise temperture are shown in Fig. 3 and Fig. 4, respectively.

BSE (Medium-scale Broadcasting Satellite for Experimental Purpose) uses linear polarization, where transmit and receive signal polarization are parallel to each other. The orthomode transducer and polarizer using a $0/\pi$ phase shifter [5] are developed instead of conventional diplexing filter.

When the vehicle is driven from point to point, the antenna is kept vertical on the vehicle. Such main reflector portions that extend over the width of the vehicle are divided into 2 or 3 pieces so they can be stowed separately.

2) Low Noise Converter

The 12 GHz low-noise down converter of a 4.5 dB noise figure is used on the front end of the receiver because of the small-diameter antenna. To achieve such a low-noise figure, a recently-developed planar circuit mixer, mounted in a waveguide, is employed. A low noise GaAs FET (2SK-85), manufactured by NEC, is used for the 1.25 GHz pre-amplifier, obtaining an excellent overall noise figure shown in Fig. 5.

3) High Power Amplifier

The 2 kW kylstron tube which has been developed through joint research with NHK's Technical Research Laboratory and NEC Electron Device Division, has a tuning range of 14 ~ 14.5 GHz. The preset mechanism is provided which can be turned to any one of three assigned channels in the band.

Conclusions

After being supplied to NHK in March 1977, this system has been used for many experiments.

A system G/T of 20.8 dB/°K and e.i.r.p of 79.5 dBW with a 2.5 mϕ antenna was achieved, yielding a video signal-to-noise ratio of more than sufficient quality for Japanese mainland.

Acknowledgement

The authors wish to express their sincere gratitude to those concerned in the NHK Headquarters of Technical Administration & Construction, and the Technical Research Laboratories for their continued cooperation and guidance.

References

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(5) I. Sato, S. Tamagawa and M. Iida, "0/π Radian Polarizer," Nat. Conv. Rec., IECE Japan, Optics and Radio Waves, 191, Oct. 1976.

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Table 1 Overall Performance

Frequency range:	TX:	14.25 ~ 14.43 GHz
	RX:	11.95 ~ 12.13 GHz
EIRP:	TV:	79.5 dBW
	OW:	54.5 dBW
G/T:	20.8 dB/°K	
Receive noise temperature:	less than 600°K	
Antenna characteristics		
Gain (TX/RX):	50.0/48.6 dB	
Noise temperature (Elevation 40°):	30K	
Side lobe characteristics:	Fig. 3	
Movable range	AZ:	−45° ~ +45°
	EL:	−5° ~ +50°
C/N:	21.5 dB	
Video S/N:	52.6 dB	
Power Consumption:	15KVA	
Vehicle specification		
Dimensions:	8.95 m (L) x 2.46 m (W) x 3.4 m (H)	
Weight:	13,960 Kg	

Photo. 1 Mobile-Type Earth Station

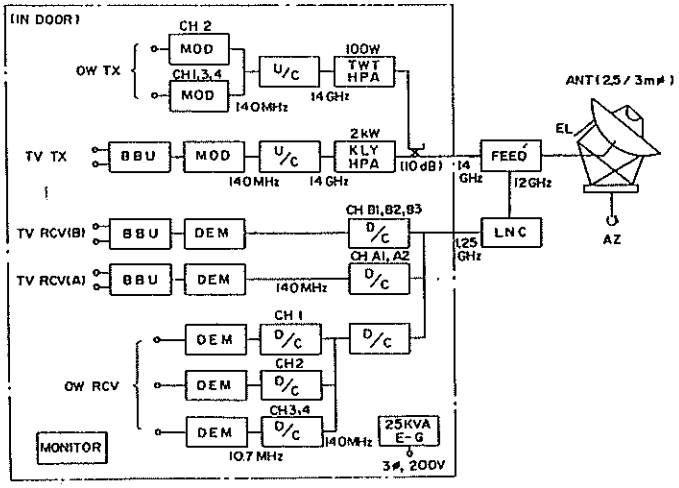
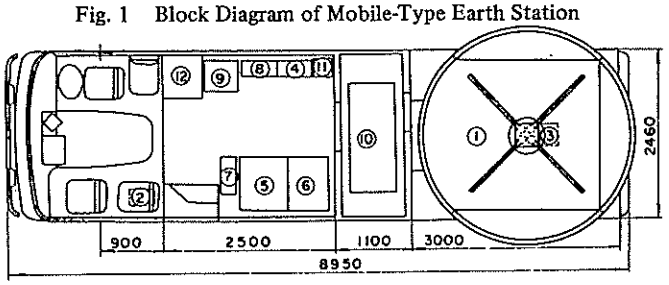


Fig. 1 Block Diagram of Mobile-Type Earth Station



No.	Equipment	No.	Equipment
1	Antenna	7	TV Transmitter
2	Dehydrator	8	OW Transmitter Receiver
3	12 GHz Low Noise Converter	9	Monitor
4	TV Receiver	10	Engine Generator
5	14 GHz 2 kW HPA	11	Power Distribution Board
6	14 GHz 100 W PA	12	Air Conditioner

Fig. 2 Equipment Layout of Mobile-Type Earth Station

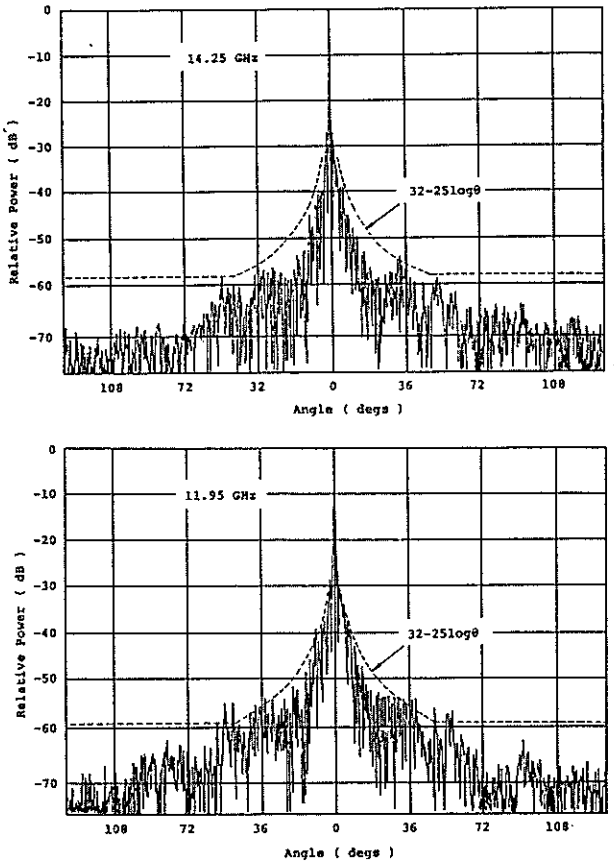


Fig. 3 Antenna Radiation Pattern

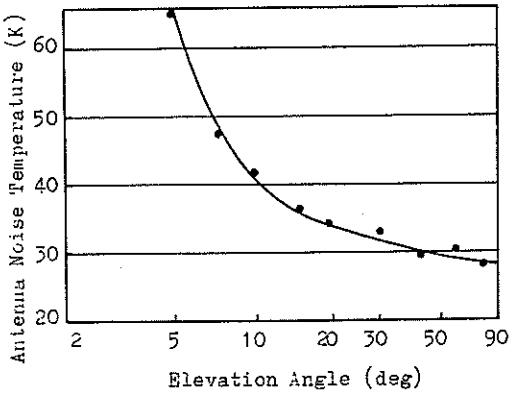


Fig. 4 Antenna noise temperature.

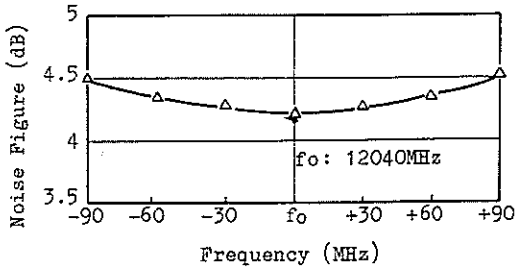


Fig.5 Noise figure characteristic of LNC.