INTELSAT STANDARD-A EARTH STATION ANTENNA FEATURING 800-MHz BANDWIDTH AND DEPOLARIZATION COMPENSATION CAPABILITY

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1. INTRODUCTION

The third INTELSAT Standard-A earth station antenna (YA-3) with 800-MHz bandwidth in the 6- and 4-GHz bands was constructed in November 1984 at KDD Yamaguchi earth station. Presented here is the design method, system configuration and depolarization compensation network of the antenna system as well as the measured antenna performance.

2. BASIC DESIGN OF ANTENNA

Effort has been made in designing to effect good performance over the entire bandwidth allocated to the fixed satellite service at the 1979 WARC. The antenna is of a Cassegrain type with a main reflector of 34 meters in diameter fed by the four beam-waveguide reflectors in the wide frequency range of 5,850 - 6,725 MHz and 3,400 - 4,200 MHz.[1] A new corrugated horn is used as the primary radiator, the impedance matching section of which is designed to suppress the resonance due to the TM_{11} mode excited at around 3,440 MHz. The surface of main- and sub-reflectors as well as of the four beam-waveguide reflectors were shaped to obtain uniform illumination and to suppress the spill-over from each reflector edge over the wide frequency range.

3. DEVELOPMENT OF WIDEBAND FEED

Design of the feed strongly influences the characteristics of wide band antenna system.[2] Figure 1 shows the block-diagram of the feed assembly including depolarization compensation network. The RF depolarization compensation circuit consists of two rotatable polarizers. The extremely low axial ratio of the feed as shown in Figure 2 should be noted. The tracking error signal is picked up by a higher mode coupler and then superimposed over the reference beacon signal to give the same phase difference.

4. MEASURED ANTENNA PERFORMANCES

Overall antenna performance was measured by using a bore-sight facility capable to transmit any frequencies with arbitrary polarization over the 800-MHz bandwidth in the 6- and 4-GHz bands.

Three radio stars, CAS-A, TAU-A, CYG-A, were used to obtain the antenna gain, the measured results being shown in Figure 3. The CCIR Rep. 390-4 was refered to for evaluating the measured data. The mesured results using three radio stars show a good agreement. No specific deterioration of antenna efficiency can be found even at the band edge frequencies.

Figure 4 shows the elevation angle dependence of G/T at 3.4 and 4.0 GHz obtained from radiometric measurements of TAU-A.

The G/T in this case includes the contribution from LNA which covers the 800-MHz bandwidth with noise temperature of lower than 50 K.

Typical examples of wide-angle radiation pattern are shown in Figure 5. The side-lobe performance is much better than the reference radiation diagram of CCIR Rec. 465-1 even for the side-lobe peaks. Similar outstanding radiation characteristics were found at other frequencies in both co- and cross-polarizations. Also shown in Figure 2 is the overall antenna system axial ratio which is lower than 0.4 and 0.35 dB over the extended 6- and 4-GHz bands, respectively.

5. DEPOLARIZATION COMPENSATION NETWORK

Being 9 and 6 degrees of elevation angle for INTELSAT satellites at Yamaguchi earth station, depolarization compensation is required to maintain satisfactory dual polarization operation.

In the 6- and 4-GHz bands, differential phase shift (DPS) of propagation media may be the dominating cause of the depolarization and differential attenuation could be negligeble. The principle of compensation employed here is based upon the fact that the restoration of orthogonality between two polarizations can be achieved by artificially giving the same amount of DPS in the orthogonal direction to the rain-induced DPS. The rotatable 90- and 180-degrees polarizers can convert any incident elliptically polarized signals into linearly polarized signals at the desired ports of the OMT. Depolarization induced in up- and down-links can be compensated by detecting the phase and amplitude information contained in the looped back pilot signals (pilot mode). In the meantime, the up-link depolarization can be predicted from the statistical relationship with down-link depolarization, upon which correlation (or prediction) mode control is based.[3] The compensation network is composed of four polarizers, a pilot transmitter, a pilot receiver and a polarizer control circuit. Micro-processors are provided for the correlation mode operation.

The capability of depolarization compensation network was examined by using an INTELSAT satellite. Figure 6 shows an event recorded in June 1984 in the pilot mode. The XPD degraded down to 15-20 dB was recovered to 35-40 dB. The correlation mode gave a satisfactory result, however, further studies may be required to find a better correlation coefficient.

6. CONCLUSION

The measured results of the new YA-3 antenna showed satisfactory radiation characteristics over the wide frequency range of 875-MHz and 800-MHz in the 6- and 4-GHz bands, respectively. The pilot based depolarization compensation network proved to be operationally feasible. The antenna system was put into service from February 1985.

REFERENCES

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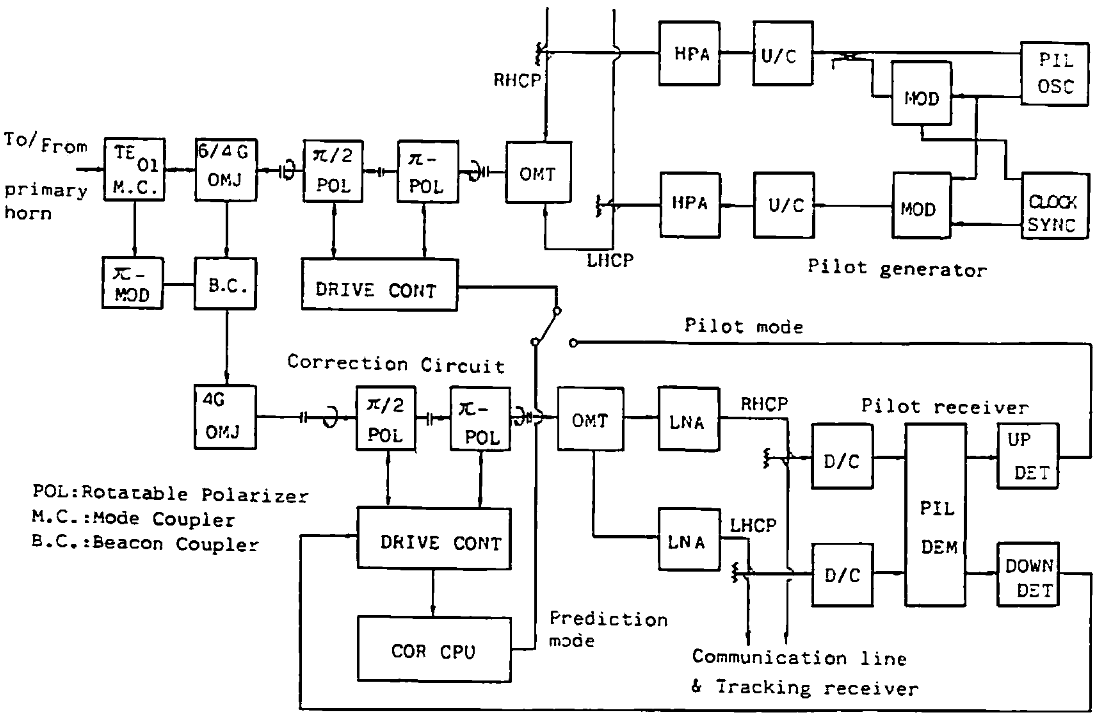

Fig. 1 Block-diagram of depolarization compensation network at Yamaguchi NO.3 earth station

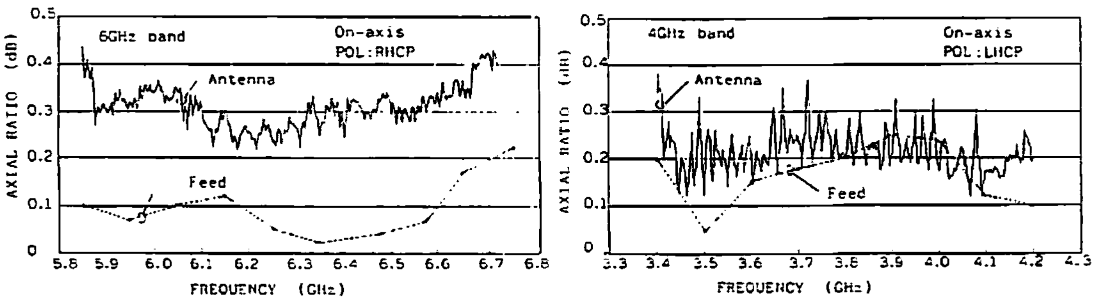

Fig. 2 Measured axial ratio of YA-3 antenna

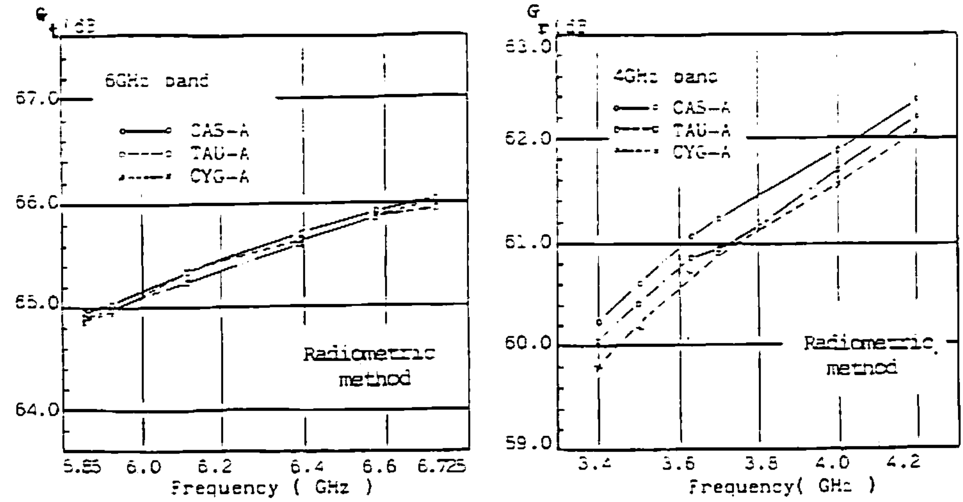

Fig. 3 Measured antenna gain of YA-3

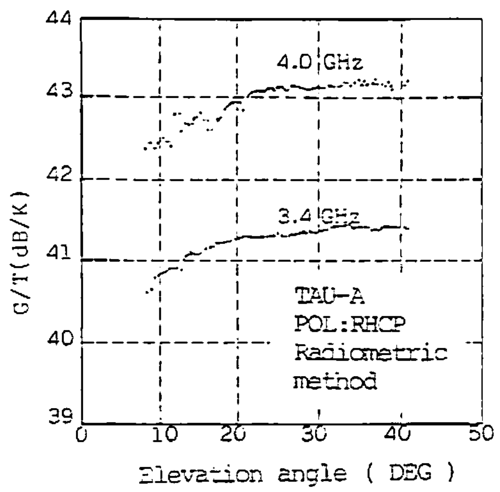

Fig. 4 G/T of YA-3 antenna

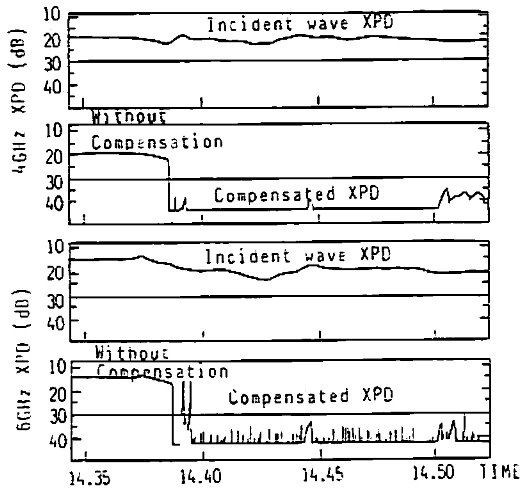

Fig. 6 Depolarization compensation

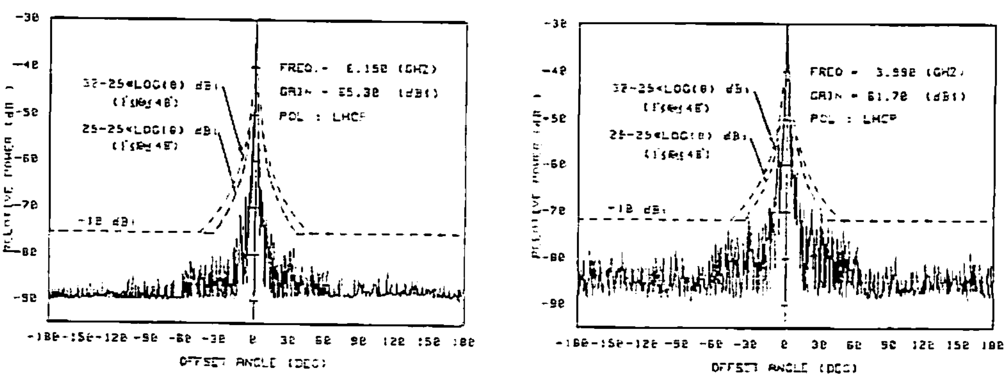

Fig. 5 Measured radiation pattern of YA-3 antenna