5 ELEMENT CAVITY BACKED SPIRAL ARRAY ANTENNA FOR LAND MOBILE SATELLITE COMMUNICATIONS

Akio KURAMOTO Yasunori YOSHINO Masaki MORITA Nobuhiro ENDO
MICROWAVE & SATELLITE COMMUNICATIONS DIV. NEC Corporation
4035 Ikebe-cho Midori-ku Yokohama 226, JAPAN

INTRODUCTION

The land mobile satellite communications are now planned all over the world and partly demonstrated by INMARSAT. In order to implement to the voice communications via geostationary satellite, G/T of -16～-12dB/K is required to the mobile terminals. This paper presents the design and the characteristics of a newly developed 5 element one dimensional array antenna which achieves the high G/T of-12dB/K, applicable for INMARSAT-M system.

DESIGN & CONSTRUCTION

As the mobile terminals applied to the vehicle, one dimensional array antenna is convenient to implement a low profile and a simple satellite tracking system. The developed array antenna shown in Fig 1, is constructed with 5 cavity backed spiral elements which has a good axial ratio characteristics in wide frequency band and it can achieve 200mm height. The element construction is shown in Fig.2. The spiral element is matched by the skirt. This array antenna forms a fan beam with 76° ×18° beam width, wide in elevation plane and narrow in azimuth plane and it makes the satellite tracking in only azimuth plane possible. As the satellite tracking system, the combination of the open loop control and the closed loop control is adopted. For the open loop control, the anguler rate sensor is used to direct the antenna to the satellite at the signal outage, when the antenna is shadowed. On the other hand, the beam dithering method in azimuth plane is adopted to overcome the high rate vehicle's turn, as the closed loop control. Fig.3 shows the block diagram of the antenna feed, and it includes 1 bit loaded-line type phase shifter to dither the beam in high frequency.

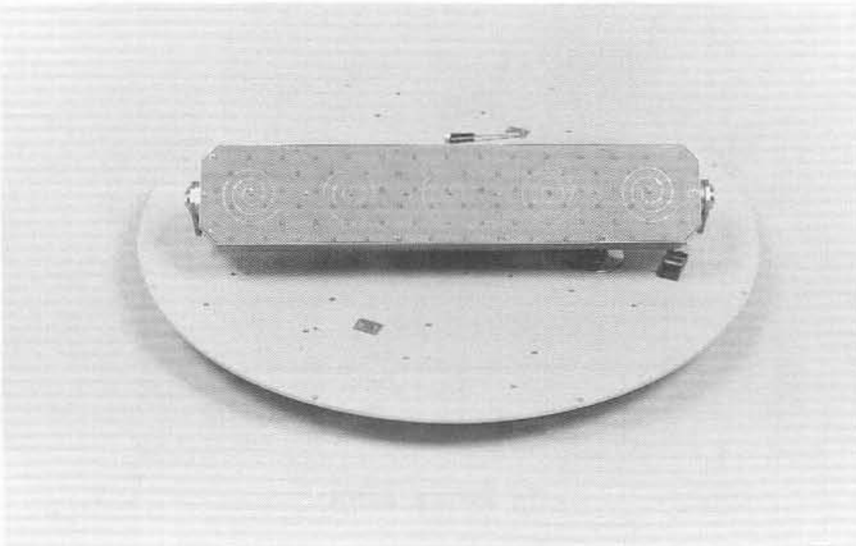

Fig.1 5 Element Cavity Backed Spiral Antenna

CHARACTERISTICS

As this array applies the 5 element cavity backed spiral antenna, the broad frequency band characteristics of the axial ratio less than 1.8dB and the return loss less than 18dB can be obtained as shown in Fig.4. The antenna pattern characteristics in azimuth plane and elevation plane are shown in Fig.5 and Fig.6. The sidelobe levels in azimuth are suppressed less than -15dB by the aperture distribution control in Fig.3. The offset angle between two dithered patterns is set at 3° to get enough tracking error, and to minimize the gain degradation of 0.2dB at crossover point from the beam peak. The gain and the antenna noise temperature characteristics at the typical elevation setting angle of the array antenna are shown in Table 1. It shows that this antenna system satisfies the G/T of -12dB/K, all elevation angles above 5° by 5 different settings. The tracking accuracies in the open and the closed loop mode are shown in Table 2. The tracking accuracies in both closed loop control and open loop control are less than ±5° at the vehicle turning rate of 20 ° /s.

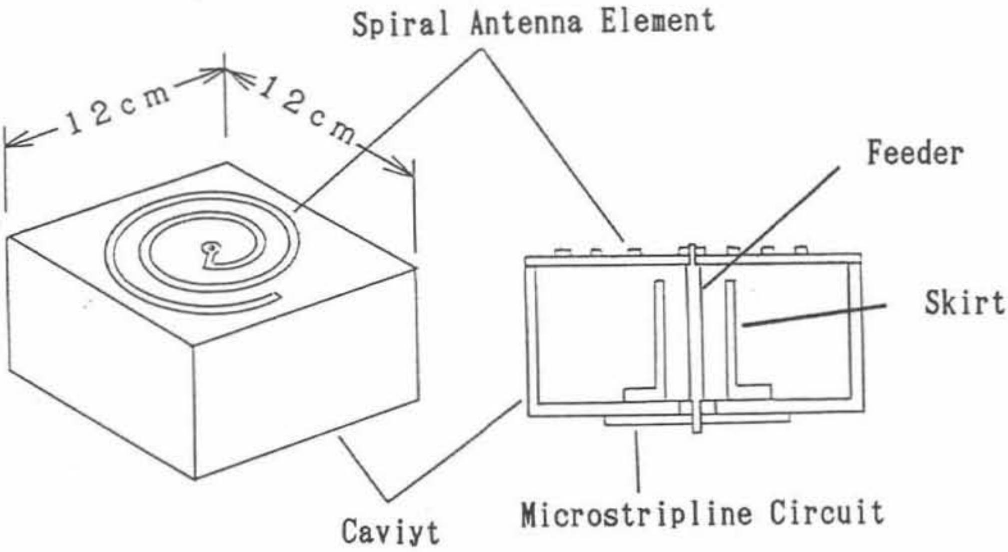

Fig.2 Construction of Cavity Backed Spiral Antenna

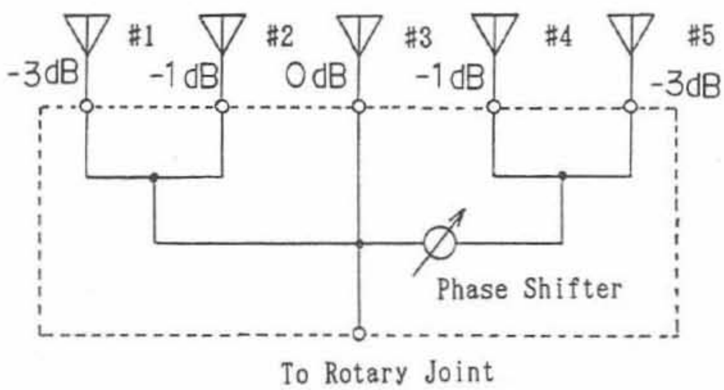

Fig.3 Block Diagram of Antenna

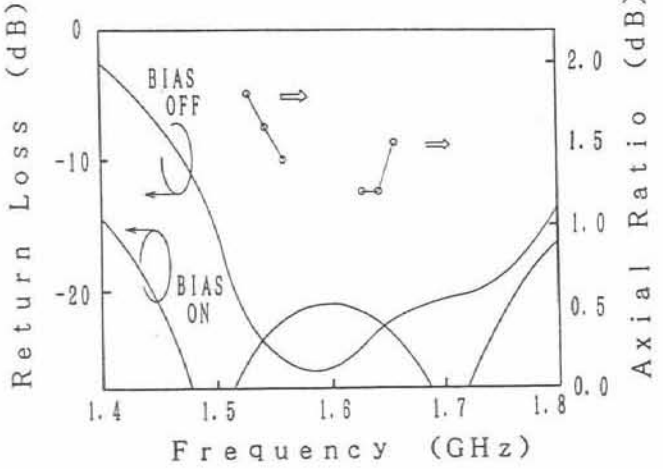

Fig.4 Return Loss & Axial Ratio of One Dimensional Array

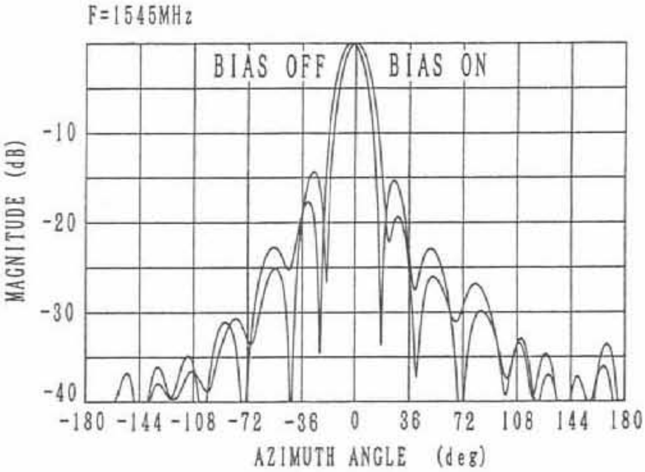

Fig.5 Azimuth Pattern of One Dimensional Array

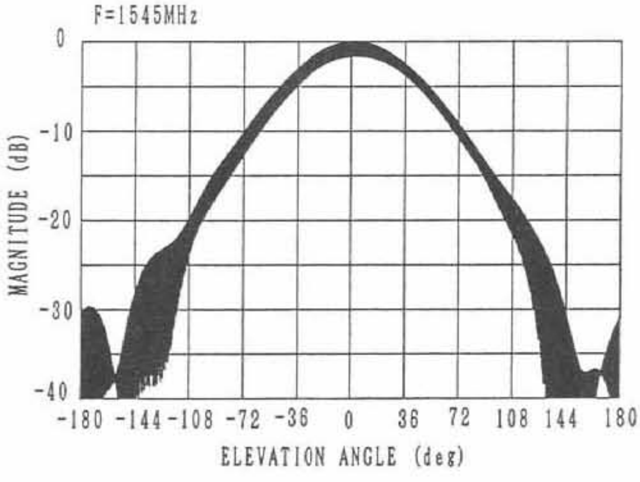

Fig.6 Elevation Pattern of One Dimensional Array Measured by Rotating Linearly Polarized Antenna

CONCLUSION

The cavity backed spiral array antenna for land mobile voice communications is developed. And it can satisfy the high G/T of -12dB/K and achieves a low profile of 200mm height. Furthermore, simple tracking system can be confirmed to be suit able to the vehicle.

REFERENCES

[1] A.Kuramoto et al.,IEEE AP-S Symposium,Syracuce,New York,1988
[2] H.Nakano et al.,IECE,Vol.J66-B,No.11,1983

Table 1 G/T versus Elevation Angle
(Noise Temperature of LNA & Duplexer ; 192K)

Elevation Set Angle (deg)	Elevation Coverage (deg)	Minimum Gain (dBic)	Antenna Noise Temp.(K)	System G/T (dB/K)
15.0	5.0～25.0	12.7	98.9	min. -11.9
30.0	15.0～45.0	12.9	88.0	min. -11.6
45.0	35.0～60.0	13.2	80.5	min. -11.5
60.0	45.0～70.0	12.9	69.5	min. -11.3
75.0	60.0～90.0	12.7	71.7	min. -11.5

Table 2 Tracking Accuracy
(Turning Rate ; 20° /s)

Mode	Tracking Accuracy
Closed loop	±1° r.m.s.
Open loop	±5° within 30 sec.