# EXPERIMENT PLAN FOR EXPERIMENTAL COMMUNICATIONS SATELLITE (ECS)

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## ABSTRACT

We will present the experimental schemes, for satellite communication experiments in the millimeter-wave range with the Japanese Experimental Communication Satellite (ECS), as well as configurations and characteristics of the overal system including spacecraft and ground facilities.

## Introduction

The Japanese Experimental Communication Satellite (ECS) will be launched in February 1979 from Tanegashima Space Center by a N-Rocket of the National Space Developement Agency of Japan, and located at 145° E longitude in the geostationary orbit (Fig. 1).

ECS is a spin stabilized spacecraft weighing about 130 kg in orbit, and has a composite type transponder of C-band (6/4 GHz) and K-band (35/32 GHz), the bandwidth of which can be selected to be any one of 10 MHz, 40 MHz and 120 MHz by command as shown in Fig. 2. The nominal life time is about one year.

The ECS project was initiated around 1976 by the Ministry of Posts and Telecommunication (MOPT), and the experimental programme has been promoted by Radio Research Laboratories (RRL) of MOPT in co-operation with Nippon Telegragh and Telephone public corporation and Kokusai Denshin Denwa Co., Ltd.

The ECS experiment is mainly intended to investigate orbit- and frequency-utilizations in the micro-wave range and possibilities of satellite communications in the millimeter-wave range. So, the stress of the experiment is going to be placed especially on site-diversity communication experiments, and on propagation experiments in the millimeter-wave range and cooperative experiments in the micro-wave range with the Medium capacity Communications Satellite for Experimental Purpose (CS), concerning effective utilization of the geostationary orbit.

## Link Budget

An estimated link budget is shown in Table 1, which allows us to communicate with some margin one channel FM-TV, about 500 channels of FDM-FM telephone or 60 Mbps PCM-PSK/TDMA signal.

## Ground Stations

Fig. 3 shows configurations of the ECS experimental system and Fig. 4 the block diagram.

## Experimental Items

ECS experiments will be classified in 6 categories which are listed with sub-items as follows:

(1) Basic measurements and experiments
  a. On-bord equipment characteristics
  b. Characteristics of millimeter-wave earth stations
  c. Signal transmission characteristics
(2) Interference experiments with other Communication link
  a. With CS micro-wave link
  b. With imaginated-satellite K-band link
(3) Propagation experiments
  a. Precipitation characteristics — measurements and statistical analysis
  b. Millimeter-wave rain attenuation and depolarization
  c. Site-diversity gain with main- and sub-stations
  d. Rain scattering interference at 35 GHz
  e. Scintillation characteristics
(4) Site-diversity communication experiments with PCM-PSK/TDMA signal of 60 or 30 Mbps

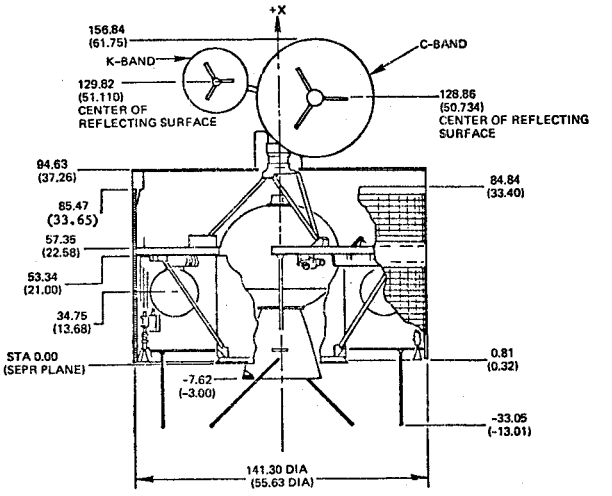


Figure 1: ECS Profile

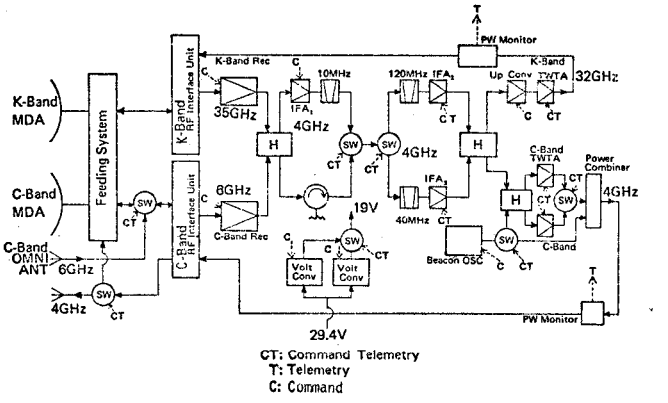


Figure 2: Schematic Diagram of ECS Transponder



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(5) Other experiments for developement of millimeter-wave satellite communication
  a. Operation techniques
  b. Communication experiments
  c. Developements of millimeter-wave communication apparatus
  d. Standard time transmission experiments
(6) Experiments of operation and control techniques for satellite
  a. Developments of automatic operation and control system which is commonly used for geostational and moving satellites
  b. Acquisitions of operation and control techniques
  c. Methods of spacecraft control
  d. Applications of operation and control techniques

(5)-b is are formed of four sub-items;
  1) Quality improvements of speech signal received through the satellite communication link by SPAC (Speech Processing system by use of Autocorrelation Cooefficients), developed in RRL
  2) Transmission experiments of digitalized color TV signal
  3) Basic experiments for adoption of error correction codes
  4) High speed facsimile transmission experiments

(5)-a includes experiments on the sun-interference reduction and frequency diversity by use of site-diversity switching techniques. The frequency diversity experiment is made with the cross-strapped transponder for C- and K-band.

ECS control is going to be automatically made by common use of the system for moving satellites such as Ionospheric Sounding Satellite in Japan (ISS).


## Acknowledgement

The authors wish to acknowlege Dr. Ishida and experts of the study group on ECS experimental plan in RRL, and of ECS-Working Group for their useful discussions and examinations.


## References


(1) N. Fugono et al., Proc. 12th ISTS, Tokyo, May, 1977.
(2) J. Tabata et al., the same as the above.


Table 1: ECS Link Budget

ECS UP-LINK BUDGET

| Terms | Unit | Ka-Band | | C-Band | | Remarks |
|---|---|---|---|---|---|---|
| Earth Station | | | | | | |
| Antenna Dia. | mφ | 10 | | 10 | | |
| Tx. Freq. | GHz | 34.83 | | 6.305 | | |
| Tx. Power | dBm | 54.8 | | 54.7 | | 300W |
| Circuit Comb. Loss | dB | } -1.0 | | -4.0 | | |
| Feeder Loss | dB | | | | | |
| Track Error Loss | dB | -0.3 | | -0.2 | | |
| Antenna Gain | dB | 67.0 | | 53.5 | | Includ. feeder loss |
| EIRP | dBm | 120.5 | | 104.0 | | |
| Path Loss | dB | -214.7 | | -200.0 | | EL=48° |
| Atomospheric Loss | dB | -1.0 | | -0.2 | | |
| Satellite | | | | | | |
| Antenna Gain | dB | 33.0 | | 22.0 | | Spec. |
| Point. Error Loss | dB | -1.0 | | -0.5 | | |
| Receiving Power | dBm | -63.2 | | -74.7 | | (FM; @=10.95, $=5.1) |
| Receiving NF | dB | 13.0 | 10.7@ | 9.0 | 5.3$ | Spec. \| PFM Data |
| Receiving Noise Temp. | dBK | 37.4 | 35.1 | 33.4 | 29.8 | T=275K, Ant. Noise Temp.=300K |
| G/T | dB/K | -5.4 | -3.1 | -11.9 | -8.3 | |
| $(C/T)_{up}$ | dBm/K | -100.6 | -98.3 | -108.1 | -104.5 | |
| $(C/N_o)_{up}$ | dBHz | 98.0 | 100.3 | 90.5 | 94.1 | |

ECS DOWN LINK BUDGET

| | | | | | | |
|---|---|---|---|---|---|---|
| Satellite | | | | | | |
| Tx. Freq. | GHz | 31.65 | | 4.08 | | (FM; @=35.1, $=36.7) |
| Tx. Power | dBm | 32.5 | 34.2@ | 34.2 | 36.6$ | Spec. \| PFM Data |
| Antenna Gain | dB | 32.0 | | 19.0 | | Spec. |
| Point. Error Loss | dB | -0.8 | | -0.5 | | |
| EIRP | dBm | 63.7 | 65.4 | 52.7 | 55.1 | |
| Path Loss | dB | -213.9 | | -196.1 | | EL=48° |
| Atomospheric Loss | dB | -1.0 | | -0.2 | | |
| Earth Station | | | | | | |
| Antenna Dia. | mφ | 10 | | 26 | | |
| Antenna Gain | dB | 66.0 | | 58.5 | | Includ. Feeder Loss |
| Track. Error Loss | dB | -0.3 | | -0.1 | | |
| Receiving Power | dBm | -85.5 | -83.8 | -85.2 | -82.8 | |
| Antenna Noise Temp. | K | 150 | | 50 | | Spec. |
| LNA Noise Temp. | K | 165* | | 30 | | Spec. *Sub-ST.=190K |
| Receiving Noise Temp. | dBK | 25.0# | | 19.0 | | #Sub-ST.= 25.3 |
| G/T | dB/K | 42.7 | | 39.4 | | |
| $(C/T)_{down}$ | dBm/K | -110.5 | -108.8 | -104.2 | -101.8 | |
| $(C/N_o)_{down}$ | dBHz | 88.1 | 89.8 | 94.4 | 96.8 | |

| | | | | | |
|---|---|---|---|---|---|
| Total $C/N_o$ | K/K Mode | dBHz | 87.7 | 89.4 | |
| | K/C Mode | dBHz | 92.8 | 95.2 | Spec. \| PFM Data |
| | C/K Mode | dBHz | 86.1 | 88.4 | |
| | C/C Mode | dBHz | 89.0 | 92.2 | |

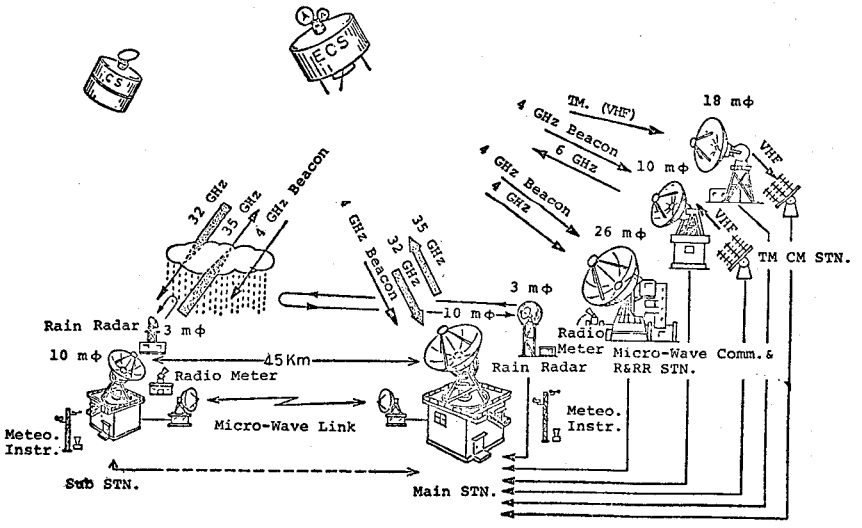


Figure 3: Configurations of ECS Experimental System

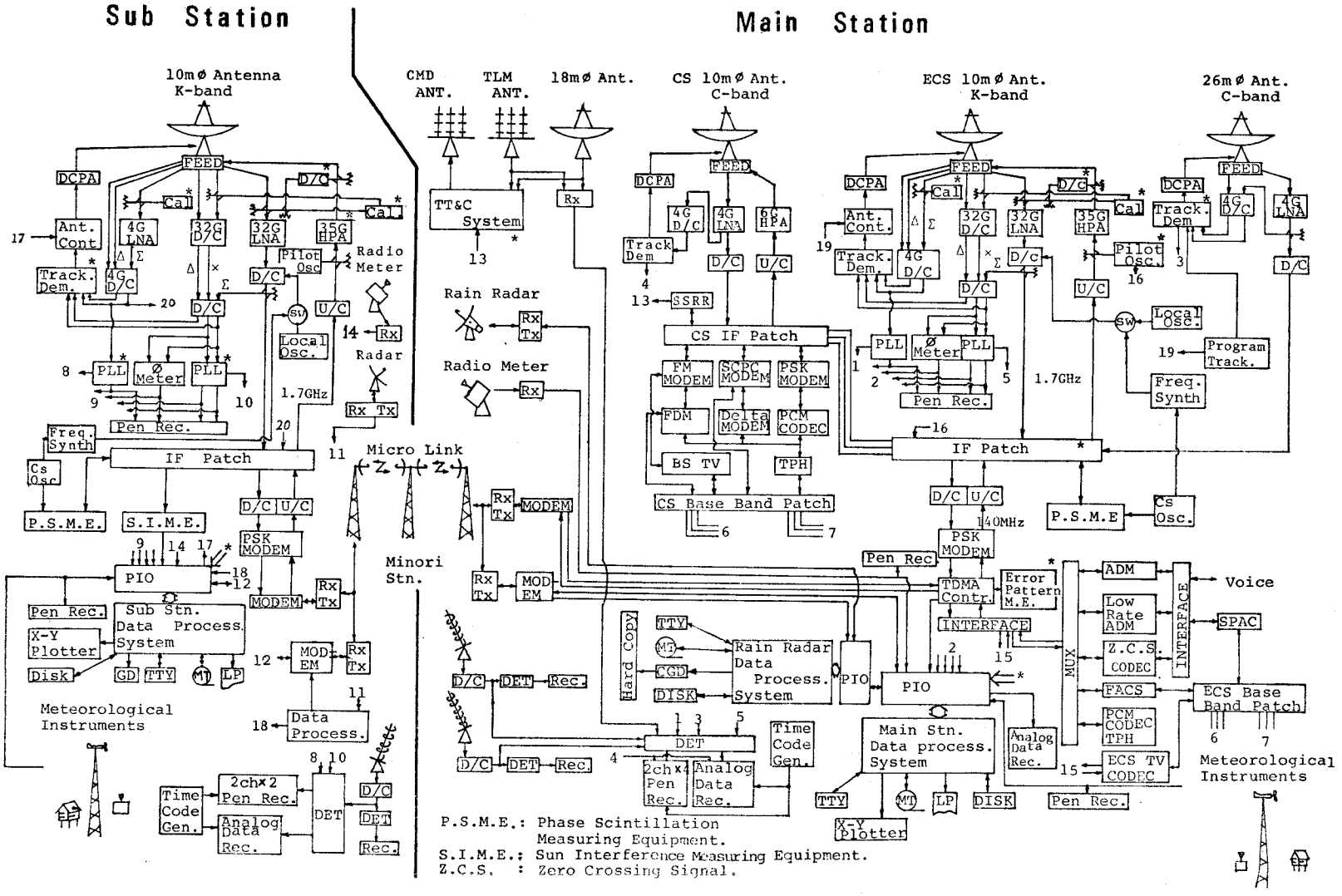


Figure 4: System Block Diagram of ECS Experiments