

Japanese Aerospace Literature

This month: *Spacecraft/Satellite Equipment and Instruments*

A89-38366 Development of electrophoresis equipment for SFU (Space Flyer Unit). NOBORU HAMANO, KENJI MITANI, KUNIYOSHI TSUBOUCHI, YUSUKE TAKAGI, TSUTOMU OKUSAWA et al., *Proceedings of the 16th International Symposium on Space Technology and Science*, Sapporo, Japan, May 22-27, 1988, Vol. 2 (A89-38031 16-12). Tokyo, AGNE Publishing, Inc., 1988, pp. 2459-2464. Research supported by the Ministry of International Trade and Industry.

Results obtained during conceptual studies of electrophoresis equipment for a space flyer unit are presented. The thermal and fluid mechanical characteristics of the separation chambers were analyzed. Areas of further development include: (1) the determination of a detailed specification of the system based on the thorough interaction between main investigators and the equipment developer, and (2) the establishment of a sterilization method suitable for the equipment aboard the SFU.

A89-38325 Data acquisition system for solar occultation experiment of Japanese spacecraft 'SUISEI'. ZEN-ICHI YAMAMOTO, TOMONAO HAYASHI, TOSHIMITSU NISHIMURA, HARUTO HIROSAWA, TADASHI TAKANO et al., *Proceedings of the 16th International Symposium on Space Technology and Science*, Sapporo, Japan, May 22-27, 1988, Vol. 2 (A89-38031 16-12). Tokyo, AGNE Publishing, Inc., 1988, pp. 2173-2177.

The Japanese Halley's comet probe PLANET-A was launched successfully in August, 1985 and was named 'SUISEI'. SUISEI was occulted by the sun on July 17-18, 1987. Utilizing this phenomenon, a radio scientific solar occultation experiment has been performed to get some information about the solar wind. The experiment was done from July 1 to October 12 by transmitting an unmodulated carrier signal from SUISEI receiving it by an open-loop receiver at the Usuda Deep Space Center. In this paper, the signal receiving system, the data recording system, the noise temperature monitoring system, and the data analysis system used for this radio scientific solar occultation experiment are described.

A89-38192 The ground test facilities of space robotics technology. YASUO SHINOMIYA, SHIN-ICHIROU NISHIDA, HIROMICHI KAWAUCHI, MASAKI TANAKA, TSUYOSHI KOSUGI et al., *Proceedings of the 16th International Symposium on Space Technology and Science*, Sapporo, Japan, May 22-27, 1988, Vol. 1 (A89-38031 16-12). Tokyo, AGNE Publishing, Inc., 1988, pp. 1231-1236.

The development of Japanese ground test facilities for a system of teleoperation/telepresence control is discussed. The current state of teleoperation/telepresence technology is assessed. A hybrid position/force control system is proposed to reduce the effect of time delay in manipulator operation. Preliminary results are presented from tests using the facilities.

A89-38184 Pointing and microgravity technology for space activities in the 1990s. YOSHIHARU SHIMAMOTO, HITOSHI SUGIURA, and KEIJI GOMA, *Proceedings of the 16th International Symposium on Space Technology and Science*, Sapporo, Japan, May 22-27, 1988, Vol. 1 (A89-38031 16-12). Tokyo, AGNE Publishing, Inc., 1988, pp. 1181-1186.

The development of pointing and microgravity technology for future spacecraft is discussed in relation to spacecraft dynamics and control. Current trends in pointing and microgravity research are reviewed. Consideration is given to the development of actuator hardware for the Engineering Test Satellite 6, including large antenna acquisition tracking and pointing, laser beam accurate pointing, and a vibration isolation system for microgravity research.

A89-38164 LSI implemented on board equipment for controlling communications subsystem. ATSUSHI WAKATSUKI and TOMOYUKI IZUMISAWA, *Proceedings of the 16th International Symposium on Space Technology and Science*, Sapporo, Japan, May 22-27, 1988, Vol. 1 (A89-38031 16-12). Tokyo, AGNE Publishing, Inc., 1988, pp. 1043-1048.

A communications system supervisory and control equipment is presented for use on a multibeam high capacity communications satellite. Four types of LSIs were developed to achieve compactness, light weight, and low power consumption of the communications subsystem. The communications subsystem equipment and the LSIs are described. Results from tests of the equipment show that they are sufficiently reliable for use in the space environment.

A89-38160 'Ginga' Electrical Power Subsystem (EPS) and its flight result. AKIO USHIROKAWA, FUMIYOSHI MAKINO, KEIJI TAKAHASHI, MASAHIKO KOUBATA, TSUYOSHI OKAZAKI et al., *Proceedings of the 16th International Symposium on Space Technology and Science*, Sapporo, Japan, May 22-27, 1988, Vol. 1 (A89-38031 16-12). Tokyo, AGNE Publishing, Inc., 1988, pp. 999-1010.

The characteristics of the electrical power subsystem of the Ginga scientific satellite are outlined. The Ginga satellite was launched in February, 1987, and has two 19 ampere-hour batteries and solar array paddles which generate more than 449.6 W. The aspects of the electrical power subsystem considered include the solar array power, the operating point of over-voltage control, the operating points of heater control, the charge current limit values, and the battery end of discharge voltage. The components of the subsystem are described and results are presented from tests of the subsystem in flight.

A89-38159 Design and performance of multi-port amplifier. KAZUICHI YAMAMOTO and MASAYOSHI TANAKA, *Proceedings of the 16th International Symposium on Space Technology and Science*, Sapporo, Japan, May 22-27, 1988, Vol. 1 (A89-38031 16-12). Tokyo, AGNE Publishing, Inc., 1988, pp. 993-998.

Consideration is given to the possible use of a multiport amplifier, consisting of an array of high power amplifiers, for use in a multibeam mobile satellite communications system. A multiport amplifier analytical model is presented, and the ways in which high power amplifier failures and variations of the characteristics of the high power amplifiers influence the performance of the multiport amplifier are investigated. A technique for arranging high power amplifiers is proposed, which decreases the leakage power output to other ports without decreasing output power.

A89-38147 Development of space cryocoolers. MASAKUNI KAWADA, ISAO KUDO, KAZUO MACHIDA, and SHUNSUKE HOSOKAWA, *Proceedings of the 16th International Symposium on Space Technology and Science*, Sapporo, Japan, May 22-27, 1988, Vol. 1 (A89-38031 16-12). Tokyo, AGNE Publishing, Inc., 1988, pp. 911-919. 9 Refs.

This paper describes the development of the small cryocoolers for space use. Three kinds of the cryocooler were developed and tested. The design goal of every cryocooler involved in this paper is few watts class of cooling capacity at temperature of 80 K, with long lifetime potential. Structural features of the cryocoolers are described, and the test results are presented.

A89-38311 Up-to-date communications system for Japanese scientific spacecraft. TOMONAO HAYASHI, TADASHI TAKANO, KOJI YOKOYAMA, KOZABURO INOUE, SHINICHI OTANI et al., *Proceedings of the 16th International Symposium on Space Technology and Science*, Sapporo, Japan, May 22-27, 1988, Vol. 2 (A89-38031 16-12). Tokyo, AGNE Publishing, Inc., 1988, pp. 2077-2083.

The Institute of Space and Astronautical Science (ISAS) has a plan to develop a lunar explorer and an interplanetary spacecraft, as well as near earth orbit satellites to perform various missions. In order to realize this plan, ISAS has been developing an onboard S-band transponder, S-band transmitter, S-band receiver, and X-band transmitter for the newly developing X-band communications system. This paper presents an outline of the communications system and the corresponding onboard hardware.

A89-38297 Research and development of millimeter-wave transponder for personal satellite communications. ISAO IZUMI, AKIHIKO INOUE, MASAYUKI ISHIZAKI, NOBUO ISHIZU, and YUICHI OTSU, *Proceedings of the 16th International Symposium on Space Technology and Science*, Sapporo, Japan, May 22-27, 1988, Vol. 2 (A89-38031 16-12). Tokyo, AGNE Publishing, Inc., 1988, pp. 1975-1980.

This paper describes key technology development for the millimeter-wave transponder used in personal satellite communications. A basic concept and key parameters of the transponder equipment are described along with a technological development theme and its major performance requirements.

A89-38296 Plan of advanced satellite communications experiment using ETS-VI. TADASHI SHIOMI, YOSHIKI SUZUKI, SHIGERU OKUBO, MASAHIKI SHIMADA, MOTOKAZU SHIKATANI et al., *Proceedings of the 16th International Symposium on Space Technology and Science*, Sapporo, Japan, May 22-27, 1988, Vol. 2 (A89-38031 16-12). Tokyo, AGNE Publishing, Inc., 1988, pp. 1963-1974. 5 Refs.

Communications Research Laboratory (CRL) has been developing three advanced satellite communication payloads for Japan's Engineering Test Satellite-VI (ETS-VI), which is to be launched in 1992. CRL's three experimental systems are: (1) an S-band intersatellite tracking and data relay system with a phased-array multibeam antenna; (2) a millimeter-wave intersatellite and personal satellite communications system; and (3) an optical intersatellite communications system. Communication experiments between ETS-VI and low earth orbit satellites and earth stations are planned.

A89-38276 Remote manipulator system of Japanese Experiment Module. KOJI YAMAWAKI, KESATOSHI KURAOKA, TAMIJIRO SUMI, RYO OKAMURA, and JUNICHI KATO, *Proceedings of the 16th International Symposium on Space Technology and Science*, Sapporo, Japan, May 22-27, 1988, Vol. 2 (A89-38031 16-12). Tokyo, AGNE Publishing, Inc., 1988, pp. 1825-1829. 6 Refs.

This paper presents an overview of the current development status of the remote manipulator system of the Japanese Experiment Module (JEM). The manipulator system is mainly characterized by a combination of a 10-m main arm and a 2-m small arm that can be attached on orbit to the main arm and used for tasks requiring dexterity. While basic control of the main arm is executed automatically, the small arm is principally teleoperated by a master-slave bilateral control system. Visual information to the operator is provided by TV system beside a window of the pressurized JEM module.

A89-38275 Development of equipment exchange unit for Japanese Experiment Module of Space Station. GAKUMEI HATTORI, HIROSHI ITOH, FUMIAKI SANO, HISAO KOJIMA, YOSHITERU YAMAMOTO et al., *Proceedings of the 16th International Symposium on Space Technology and Science*, Sapporo, Japan, May 22-27, 1988, Vol. 2 (A89-38031 16-12). Tokyo, AGNE Publishing, Inc., 1988, pp. 1819-1824.

The equipment exchange unit (EEU) which is projected to be attached to the exposed facility (EF) of the Space Station JEM is described. The EEU will provide a simple means for the automatic exchange of experimental payloads, accommodate up to 10 payloads, and reduce crew experiment time and EVA time. Tests have validated such aspects of the EEU functional requirements as the ability to connect and disconnect in a rapid single operation all of the utility interfaces (power and fluids) between the EF and the payloads.

A89-38274 Demonstration of performance of JEM exposed facility using a free flyer (SFU). NORIO SAITO, MASAO HATADA, KATSUYOSHI ARAI, TOSHIO KATOH, and MIKIO MORIOKA, *Proceedings of the 16th International Symposium on Space Technology and Science*, Sapporo, Japan, May 22-27, 1988, Vol. 2 (A89-38031 16-12). Tokyo, AGNE Publishing, Inc., 1988, pp. 1813-1817.

EFFU (Exposed Facility Flyer Unit) which is mounted on 'SFU' (Space Flyer Unit) will be launched in early 1993 by the H-II launch vehicle and retrieved in June, 1993 by the Space Shuttle. The EFFU main purposes are to demonstrate the design capabilities of the Exposed Facility, attaching the Japanese Experiment Module (JEM) to the Space Station, and the development technologies for the common experiment equipments in space, e.g., the vapor crystal growth apparatus. The EFFU is composed of the Exposed Facility Section (EFS) and experiment equipment. The EFS is equipped with EEU (Equipment Exchange Unit) and an active thermal loop for the thermal control system.

A89-38247 On the tether technology realizing a microgravity laboratory deployed in the proximity of the large mother spaceship. SHOICHI YOSHIMURA and TATSUO YAMANAKA, *Proceedings of the 16th International Symposium on Space Technology and Science*, Sapporo, Japan, May 22-27, 1988, Vol. 2 (A89-38031 16-12). Tokyo, AGNE Publishing, Inc., 1988, pp. 1621-1626. 5 Refs.

A study has been carried out on the tether technology realizing the microgravity environment (0.0001-0.0001 G) in a tethered small satellite deployed in the proximity of a large mother spaceship. Cutting off or at least attenuating the propagation of the g-jitters from the mother spaceship, the tether would provide the microgravity environment inside the tethered satellite. Numerical simulations of the tether system dynamics with and without control are now being carried out.

A89-38244 System design of the Application Technology Platform. MASAMI IKEUCHI, RYOICHI IMAI, NORIKAZU HARA, and MASANARI HOMMA, *Proceedings of the 16th International Symposium on Space Technology and Science*, Sapporo, Japan, May 22-27, 1988, Vol. 2 (A89-38031 16-12). Tokyo, AGNE Publishing, Inc., 1988, pp. 1597-1602.

The system design of the Application Technology Platform (ATP), a Space Station coorbiting platform to be launched in 1995 using the H-II launch vehicle is discussed. The Mission Module, Resource Module, and Propulsion Module of the ATP upper level are described, along with the Orbital Replaceable Unit (of the lower level) which contains the equipment necessary for the in-orbit exchange of materials. The design includes such advanced technologies as an autonomous rendezvous-docking two-phase fluid-loop thermal control system, a retractable solar array, and a fiber optics data bus.

A89-38242 System design and advanced technologies of Engineering Test Satellite-VI. KUNIO NAKAMARU, HIDEHIKO MITSUMA, TSUGUHIKO KATAGI, and HIROSHI KITAHARA, *Proceedings of the 16th International Symposium on Space Technology and Science*, Sapporo, Japan, May 22-27, 1988, Vol. 2 (A89-38031 16-12). Tokyo, AGNE Publishing, Inc., 1988, pp. 1579-1590. 16 Refs.

The features of the Japanese Engineering Test Satellite-VI (ETS-VI), designed to perform communications experiments and satellite bus experiments and to employ the H-II launch vehicle, are described. The ETS-VI system consists of an antenna module, a mission module, a bus module, an apogee kick engine module, and a solar array. The bus module consists of a reaction control subsystem, an ion engine subsystem, an attitude control subsystem, and the electronics associated with the housekeeping functions.

A89-38226 EMC design for on-board communications equipment. KAZUYASU OKADA and MASAYOSHI TANAKA, *Proceedings of the 16th International Symposium on Space Technology and Science*, Sapporo, Japan, May 22-27, 1988, Vol. 2 (A89-38031 16-12). Tokyo, AGNE Publishing, Inc., 1988, pp. 1457-1462.

Models for the estimation of electromagnetic interference environments in communications satellites are discussed. The dominant factors causing EMI are classified into interference caused by conducted emission and interference caused by radiated emission. A method for determining the voltage fluctuations due to turn-on transients has been experimentally validated. A means of evaluating cable shield effectiveness is also considered.

A89-38146 Cryogenic system of He II cooled infrared telescope onboard SFU. MASAHIRO MURAKAMI, GENSHIRO FUJII, and MAKOTO KYOYA, *Proceedings of the 16th International Symposium on Space Technology and Science*, Sapporo, Japan, May 22-27, 1988, Vol. 1 (A89-38031 16-12). Tokyo, AGNE Publishing, Inc., 1988, pp. 905-910. 7 Refs.

An infrared telescope (IRTS) is planned to be launched in 1993, which will be accommodated to the Space Flyer Unit (SFU). It is cooled down to 1.8 K by 100 l of stored superfluid helium. The cooled-mission lifetime is requested to be longer than several weeks. Minimization of heat leak to the lowest temperature level is one of the primary design points for the maximum lifetime. The liquid cryogen management in the zero-g situation is another key item. The ground operation at the launching site should also be well planned, especially in liquid helium treatment.

A89-35866 Spectral indices for vegetation and rock type discrimination using the optical sensor of the Japanese ERS-1. YASUSHI YAMAGUCHI, *Proceedings of the 6th Thematic Conference on Remote Sensing for Exploration Geology*, Houston, TX, May 16-19, 1988, Vol. 1 (A89-35851 14-43). Ann Arbor, MI, Environmental Research Institute of Michigan, 1988, pp. 159-168. 10 Refs.

Spectral indices for vegetation and rock type discrimination have been developed for optical sensor data from the planned Japanese Resources Satellite, ERS-1. Simulations of sensor response patterns from reflectance data and a linear spectral mixing model in a single picture are used to obtain equations for estimating the proportion of vegetation and clay and/or carbonate minerals within a pixel. In addition, a perpendicular vegetation index, a total absorption index, an alunite index, and a calcite index are presented.

A89-29673 IDR digital modem terminal equipment. S. OTANI and Y. GOTO, *International Journal of Satellite Communications* (ISSN 0737-2884), Vol. 6, Oct.-Dec. 1988, pp. 475-486.

Intermediate data rate (IDR) digital modulator and demodulator equipment and the IDR digital modem terminal are described. The design objectives of the IDR digital modem equipment are considered, including multiple user data rates, multidestination operation, forward error correction, frequency agility, IF output level control, terrestrial interface, engineering service circuits, and buffering. The equipment configurations are illustrated and the 1:N redundancy switch-over and monitor and control units of the modem terminal are examined.

A89-29325 Development of a spectroscopically resolved multi-channel image camera for a sounding rocket and satellite. TOSHIKI YOKOTA, SUSUMU SASAKI, NOBUKI KAWASHIMA, MASAYUKI HOSHI, and SHINRIKI TEII, *Review of Scientific Instruments* (ISSN 0034-6748), Vol. 59, Oct. 1988, pp. 2232-2234. Research supported by the University of Tokyo.

An onboard model of a TV camera to detect spectroscopically resolved images has been developed. It has been able to detect several spectral pictures at the same time by using only one camera with no restriction against spectral selection between each picture. The wavelength of each picture has been selected electronically. The number of spectroscopically resolved pictures is dependent only on the memory size of the computer. This camera is equivalent to a standard TV camera in which 117 bandpass filters are installed. This camera does not cause a time difference between each picture and is able to display the physical parameters by numerical calculations and can change the spectral range even after launch. The principal purpose of this model is to assist in investigating the dynamic structure of the aurora and the atmospheric composition of planets.

A89-26395 Communication satellite and related advanced technologies in Japan. KIYOSHI TAKAHARA, Commercial opportunities in space; Symposium, Taipei, Republic of China, Apr. 19-24, 1987, Technical Papers (A89-26376 09-12). Washington, DC, American Institute of Aeronautics and Astronautics, Inc., 1988, pp. 333-347.

Satellite communications research in Japan is examined, focusing on the development of a high power communications satellite called the Super Bird. The Super Bird uplink frequencies are 14.0-14.4 GHz in the Ku band and 27.5 and 29.25 GHz in the Ka band with downlink frequencies of 12.35-12.75 GHz and 17.7-19.45 GHz for the Ku and Ka bands, respectively. The Ku band has 19 operating channels, while the Ka band has 10. The antenna coverage for both bands includes all of Japan. The service planning, configuration, and fundamental features of the Super Bird are described. Also, the possible development of a multibeam satellite communication system is considered.

A89-25488 Observation of surface charging on Engineering Test Satellite V of Japan. HIRONOBU NISHIMOTO, HARUHISA FUJII, and TOSHIO ABE, AIAA Paper 89-0613 presented at the AIAA 27th Aerospace Sciences Meeting, Reno, NV, Jan. 9-12, 1989. 7 pp. 11 Refs.

A potential monitor (POM) was developed and was installed on geostationary Engineering Test Satellite V of Japan launched on August 27, 1987. The POM can measure the surface potentials of insulating material samples which get charged in the space environment. Three kinds of thermal control materials were used as the samples. The following observational results were obtained: (1) the charging potentials increased negatively in the shadow of antenna or shunt of solar array paddle, (2) the potentials gradually increased for one year, and (3) the potentials changed periodically with the temperature of the sensing part of the POM.

A89-17772 Experimental optical navigation and guidance for Muses-A. T. NISHIMURA, K. NINOMIYA, T. ICHIKAWA, K. NOGUCHI, T. NAMERA et al., IAF Paper 88-329 presented at the IAF 39th International Astronautical Congress, Bangalore, India, Oct. 8-15, 1988. 9 pp.

To establish the high accuracy optical navigation technologies for the future deep space scientific programs, an optical navigation and guidance experiment is planned for the lunar swingby orbit spacecraft (Muses-A). For the purpose of this experiment, a solid state optical navigation sensor (ONS) is developed to detect the moon and stars to determine the moon's direction in the inertial frame with an accuracy of better than one arc-minute. According to the numerical simulation, the ONS data contribute well to enhance the orbit determination capability of the radiometric tracking system.

A88-55419 Transponder hopping RF equipment for Dyanet (Dynamic Channel Assigning and Routing Satellite Aided Digital Network). Y. UMEMA, T. SAITO, Y. FUKUYO, and T. INOUE, IAF Paper 88-430 presented at the IAF 39th International Astronautical Congress, Bangalore, India, Oct. 8-15, 1988. 9 pp. 8 Refs.

This paper proposes 30/20 GHz compact and high-performance RF equipment developed to realize the Dynamic Channel Assigning and Routing Satellite Aided Digital Network (Dyanet). The configuration of the transponder-hopping RF equipment is briefly described. The configuration and performance characteristics of high-power amplifiers and up and down converters are described in detail.

A88-54686 High voltage power supply with integrated photovoltaic cell array. HITOSHI SEKITA, MASASHI HASHIMOTO, TOMONAO HAYASHI, HIROSHI INAGAKI, JUN TAJIKA et al., IN: PESC '88 - Annual IEEE Power Electronics Specialists Conference, 19th, Kyoto, Japan, Apr. 11-14, 1988, Record. Vol. 1 (A88-54677 24-33). New York, Institute of Electrical and Electronics Engineers, 1988, pp. 173-179.

A high-voltage power supply developed for satellite-borne instruments is presented. The principle of operation is described. The structure of the boosting transformer is examined; it consists of a photovoltaic-cell array and a light-emitting-diode array. The transformer efficiency and stability are discussed.

A88-53214 Small Vuilleumier cooler (for spacecraft applications). HIDETO YOSHIMURA and MASAKUNI KAWADA, IN: Advances in cryogenic engineering. Vol. 33 - Proceedings of the Cryogenic Engineering Conference, Saint Charles, IL, June 14-18, 1987 (A88-53176 23-31). New York, Plenum Press, 1988, pp. 837-844. 5 Refs.

This paper describes the principal design features of a small (6 lb) feasibility model of a Vuilleumier cooler designed for space applications, together with the results of performance tests. The cooler model provided 1.8 W cooling capacity at 80 K, with no-load temperature of 52 K, cool-down time of 28 min, and 130 W of heater input power. A calculation method was developed for computing thermal performance of Vuilleumier cooler to guide the design of a spaceborne model. The computed values were in good agreement with measurements obtained with the feasibility model.

A88-49838 Grazing incidence optics for the X-ray astronomy mission SXO. YASUO TANAKA and FUMIYOSHI MAKINO, IN: Grazing incidence optics for astronomical and laboratory applications; Proceedings of the Meeting, San Diego, CA, Aug. 17-19, 1987 (A88-49826 21-74). Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1988, pp. 242-244. 5 Refs.

Following three X-ray astronomical satellites, Hakucho (1979), Tenma (1983), and Ginga (1987), the Japanese X-ray astronomers are planning an X-ray telescope mission called SXO in the early 1990's. The main project is X-ray spectroscopy with E/Delta E greater than 20 at 6 keV and with spatial resolution of about 1 arc min. A thin foil mirror is considered to cover the energy range up to 10 keV with high throughput. A position sensitive gas scintillation proportional counter and some types of solid state detector are studied as the focal plane instruments.

A88-49241 Research and development activities of optical ISLs in Japan. KOJI YASUKAWA, KEN'ICHI ARAKI, KANSHIRO KASHIKI, and TADASHI ARUGA, *International Journal of Satellite Communications* (ISSN 0737-2884), Vol. 6, Apr.-June 1988, pp. 141-152. 46 Refs.

The current state of research and development activities of optical intersatellite links (ISLs) and related optical devices in Japan, including semiconductor laser diodes, photodiodes, CCDs and modulation/demodulation techniques, is described. Subjects for further research on optical devices and communications are summarized. An optical communication experiment which uses the communications system on board the Engineering Test Satellite-VI to be launched in Japan in 1992, is outlined.

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