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SOLAR RADIO DATA ACQUISITION AND COMMUNICATION SYSTEM (SORDACS) OF TOYOKAWA OBSERVATORY

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Abstract

Solar Radio Data Acquisition and Communication System (SORDACS) is described on input data, hardware, software and operation. The SORDAC system, presently handles data of the full-automatic radiopolarimeters, is designed to be able to treat data of the λ 8-cm and 3-cm radioheliographs systematically. The system is characterized in automatic operation to minimize the load of observers and in very high speed of data transmission at 48 kilobaud. It is also featured by a variety of backup subsystems to obtain full coverage of data as complete as possible. Examples are shown for the latest data.

1. Introduction

Solar patrol observations with radiopolarimeters in microwave frequencies at 9.4, 3.75, 2, and 1 GHz have been carried out at Toyokawa Observatory since 1951 for the oldest one at 3.75 GHz. In 1975 the λ 8-cm radioheliograph was completed and since then it has been possible to obtain one- and two-dimensional solar radio maps both at 8 cm and 3 cm in intensity (I component of the Stokes parameters) and in polarization (V). Data acquisition and data processing of the λ 8-cm radioheliograph had been performed by a NOVA 1200 minicomputer system, which constitutes an image processing subsystem of the λ 8-cm radioheliograph system. Solar patrol data, on the other hand, of radiopolarimeters were processed mostly manually. In other words, data recorded on a roll-type paper chart are read by visual estimation, which are then reduced to three-hourly and daily values of solar flux after appropriate corrections. These values are tabulated monthly as a Monthly Report of Toyokawa Observatory. These manual procedures are very laborious and time-consuming task, particularly to obtain burst parameters and profiles.

Recently new full-automatic radiopolarimeters have been constructed and have almost replaced the old ones (Torii et al., 1979). The computer system of the Research Institute, on the other hand, has also been replaced by a new system of ACOS 600 of NEC, which has much higher performance and larger capacity, as well as more diverse and interactive peripherals, than the old system (Enome, 1978).

In these situations, it was felt indispensable to improve the performance of the minicomputer system to link all the observational instruments as closely as possible to the new host computer of the Institute. The SORDAC system is designed along these ideas. It is also considered to have capabilities of automatic operations as far as possible to reduce the burden of observers.

2. Input data to SORDACS

Two kinds of data are treated in SORDACS. One is the outputs of the full-automatic radiopolarimeters and the other is the outputs of λ 8-cm and 3-cm radioheliographs.

The antennas of the full-automatic radiopolarimeters are placed on a mound north-west of the λ 3-cm radioheliograph (Torii et al., 1979). They are now in the final stage of the parallel run with the old radiopolarimeters to check the continuity of data over the transition of the observational instruments. The sampling rate of each data is 10 Hz to be able to follow the rapid time variation of intensity during bursts. The accuracy of analog/digital conversion(A/D) is sign plus 11 bits. The information on the status of the receivers is represented by 4 bits, which is also taken at the same rate with the data. These two kinds of information are put together to form one word of 16 bits. The outputs of the full-automatic radiopolarimeters consist of 8-channel data, which correspond to two polarizations (I and V components) for four-frequency data, and 4-channel data on the temperature of the reference load of the Dicke switch of four sets of receivers. The latter four data are sampled once a minute.

Data sampling is carried out from sunrise to sunset for about fourteen hours a day in summer. In this case the sampled data amount to about 4 megawords. When this amount of data is filed on 800-BPI, 9-track, 2400-ft magnetic tape, it requires almost one reel of tape a day including interrecord gaps.

General view of two sets of radioheliographs at 8 cm and 3 cm are shown in Fig. 1 and 2. Each set is composed of 32 + 2 elements on the

Fig. 1 A view of 8-cm radioheliograph.

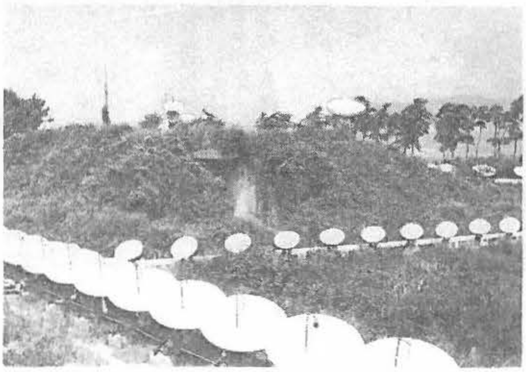

Fig. 2 A view of 3-cm radioheliograph.

East-West array and 16 elements for 3 cm and 16 + 1 elements for 8 cm on the North-South array (Tanaka et al., 1970, Ishiguro et al., 1975). It is possible to conduct observations on several modes by different combination of arrays. The highest sampling rate is 100 Hz each for two channels (I and V) to obtain one map in 40 seconds. As the λ 8-cm radioheliograph is to be operated for four hours around local noon, about 0300 UT, largest data output is 3 megawords a day and this also requires one reel of magnetic tape a day.

3. Hardware system

The SORDACS is divided into two subsystems. One is composed of a minicomputer(NOVA 1200) and a variety of peripherals with a communication processor and an analog/digital processor (Fig. 3), and the other

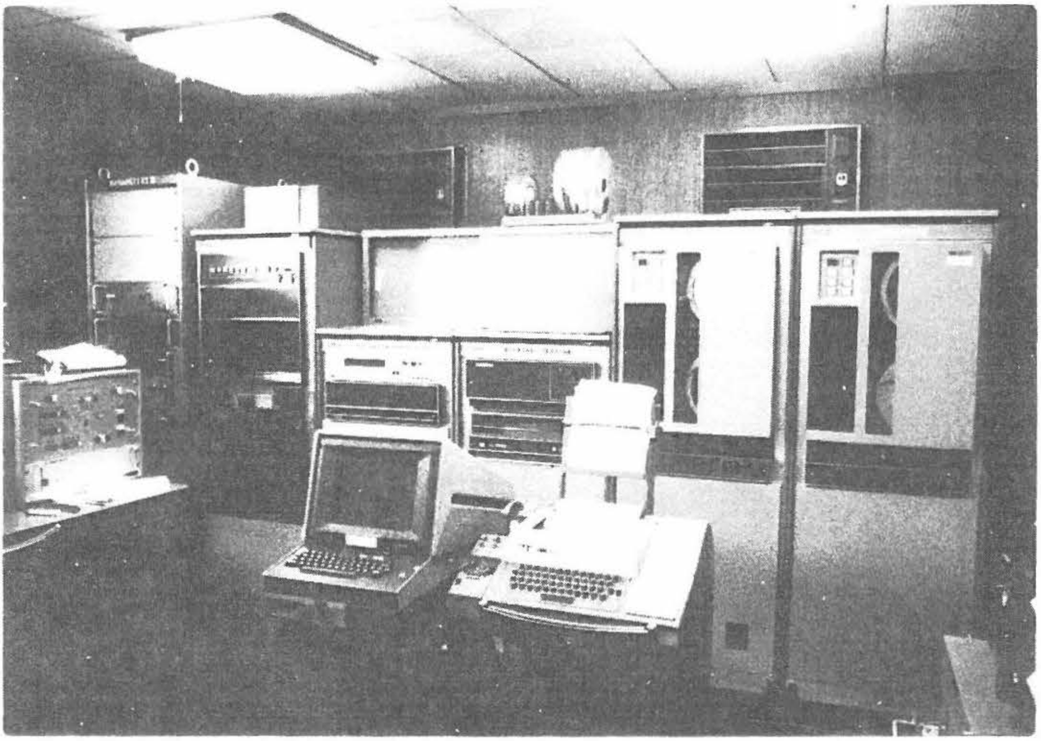

Fig. 3 The minicomputer subsystem of SORDACS.

consists of the host computer (Fig. 4), which is put to multiple use.

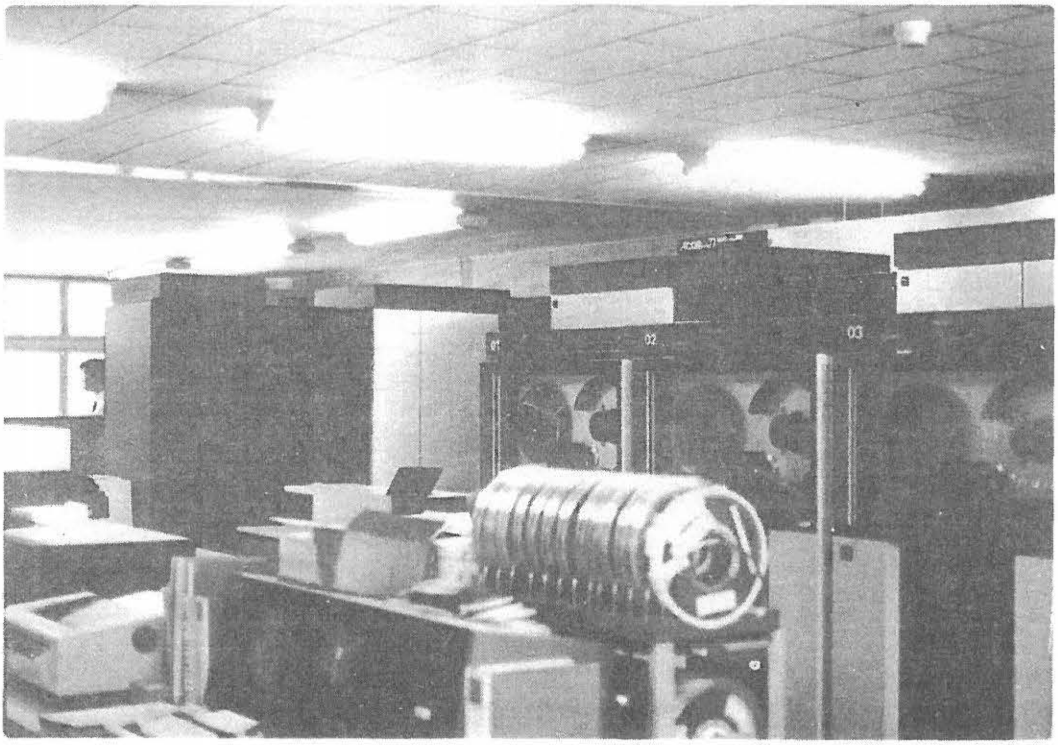

Fig. 4 The host computer.

The block diagram of the minicomputer subsystem is shown in Fig. 5. This minicomputer subsystem has following characteristics:

1) it utilizes two independent micro-processors with 1-kiloword random access memory(RAM) for analog/digital conversion and for communication control respectively to reduce the load of the central processing unit (CPU) of the minicomputer,

2) it transfers data to the host computer through a high-speed data transmission line at 48 kilobaud,

3) the automatic power sequence controller turns on and off the power switches of the minicomputer subsystem, which enable us unmanned operation of the minicomputer subsystem.

The host computer has large main memory of 768 kilobytes and auxiliary memory of disk file of 400 megabytes with diverse peripherals, among which are graphic terminals for three-dimensional color display and of storage-type display. It is also equipped with several character

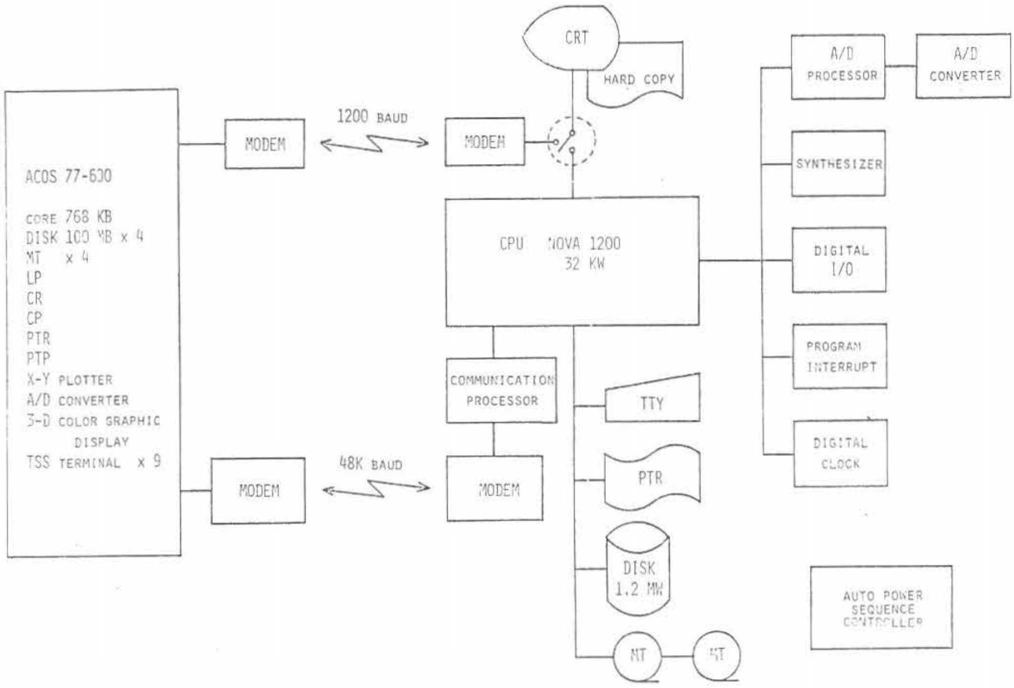

Fig. 5 A block diagram of SORDACS.

and graphic TSS terminals, by which we can edit programs, submit monitoring programs and data processing programs, and can conduct man-machine interactive processings. The cathode ray tube display of the minicomputer subsystem can be switched to a TSS terminal of the host computer to monitor processed data or to submit processing programs.

4. Software

1) *The Minicomputer Subsystem*

The minicomputer subsystem manages control of the λ 8-cm radioheliograph and handling of data of the radioheliographs and the full-automatic radiopolarimeters. The latter includes sampling, editing, transfer to magnetic tape and transfer to the host computer, of data. The control of the λ 8-cm radioheliograph has been described elsewhere (Ishiguro et al., 1975).

A program is run on the A/D processor to sample data of the radioheliographs and the full-automatic radiopolarimeters. The sampling rate for the full-automatic radiopolarimeters is 10 Hz, and that for the radioheliographs is time-dependent variable and is controlled by the synthesizer. Sampled data are transferred to the minicomputer, where 12-bit data and 4-bit information on status of the receivers are packed into one word, and thus arranged data are grouped into blocks according to channel number. One block is composed of 128 words, 112 words of which are for the data, 15 words are for the header and one word for the terminator. In the header are written the channel number, the sampled time of the first data of the block to the accuracy of 10 msec, etc. Transfer to magnetic tape or to communication processor is done in the unit of block.

Four kinds of data are dealt with in the same blocking format, which are 4 channel data of the radioheliographs, 8 channel data of the full-automatic radiopolarimeters, the angular position information on the rotary phase shifters and the temperature of the receiver components.

Data transmission is controlled by the front-end communication processor, as the transmission speed is as high as 48 kilobaud. A monitoring program checks the status of data transmission line by the command submitted from the teletype of the minicomputer subsystem. If the line is in the normal state, an on-line program is run on the host computer to receive the transmitted data, and the monitoring program connects the line to the on-line program to start the data transmission. When the host computer is too busy to accept data, data transmission is held and the data are stored temporarily on the disk of the minicomputer subsystem until the host computer is free to receive the data. If the host computer goes out of order, the transmission line is closed and data are stored on the disk of the minicomputer subsystem. When the host computer becomes normal, transmission of data is restarted by the command for the real-time data and also for the temporarily stored data on the disk files. Those data, which were sampled and written on magnetic tape when the host computer was not switched on, are rewound and transmitted to the host computer with the real-time data.

2) *The Host Computer System*

The on-line program on the host computer handles data reception from the minicomputer and storing of data separately according to the channel number. The on-line program writes the status of each channel on the control area in the disk files every 5 minutes. The observer can refer to the present status through a separate monitoring program. It is also possible to obtain the latest information on the status of the receivers and the mode of observation by reading the latest block of the data.

5. Operation

Since the full-automatic radiopolarimeters are almost free from manual operations, the minicomputer subsystem of SORDACS is designed to have capability to conduct unmanned operation.

In the morning firstly the air conditioner is powered on and the room temperature is gradually stabilized and controlled. The automatic power sequence controller then turns on the minicomputer subsystem, and the program is automatically run. After the warming-up of the disk drive the Real-Time Disk Operating System is started and after a table is arranged to control the λ 8-cm radioheliograph, data sampling is brought to start. When the host computer is open, which is powered on regularly at 0830 in the morning, the magnetic tape transport is switched to the other one by the command from the teletype, and data transfer to the host computer is initiated. On the released magnetic tape are the data files, which were recorded in the previous evening after the termination of data transfer and in the morning before the commencement of data transfer. These data files are rewound and transferred on the same line with the real-time data. The played-back tape reel is dismounted from the transport, and a new tape reel is mounted for the radioheliograph data. The status of data sampling and transfer can be quickly looked through a monitoring program, which is run on the host computer from the TSS terminal switched from the console CRT of the minicomputer. Partial files of the data of the full-automatic radiopolarimeters are put together to obtain a complete one-day file, which is then transferred on magnetic tape of the host computer. This tape is saved when an interesting event is recorded. Before the host computer is closed, data transfer to it is terminated and the transferred data are saved on the pre-assigned file. After the observing hut is closed at 1700 in the evening, data sampling of the full-automatic radiopolarimeters is continued until sunset. The program is terminated after preparation is made for the run in the next morning and the automatic power sequence controller switches off the minicomputer subsystem, and then the air conditioner is turned off.

The SORDACS is also characterized by the capability of multiple back-up functions. When the host computer is down or is off, the data files, always written on magnetic tape of the minicomputer subsystem, can be processed later on the host computer to obtain a complete one-day file. When a trouble gives to rise during the real-time data transfer on the line or on the host computer, data can be temporarily saved on the disk of the minicomputer subsystem for the later recovery. There are also an analog recording system and off-line analog/digital converter with a paper tape punch system to recover data when the mini-computer subsystem is out of order.

6. Examples of data

To obtain a quick look of data profiles of one day, ten-second average data are plotted on a sheet of paper of 10 x 14 inch as shown in Fig. 6. This plot is processed every day on the XY plotter of the host computer system.

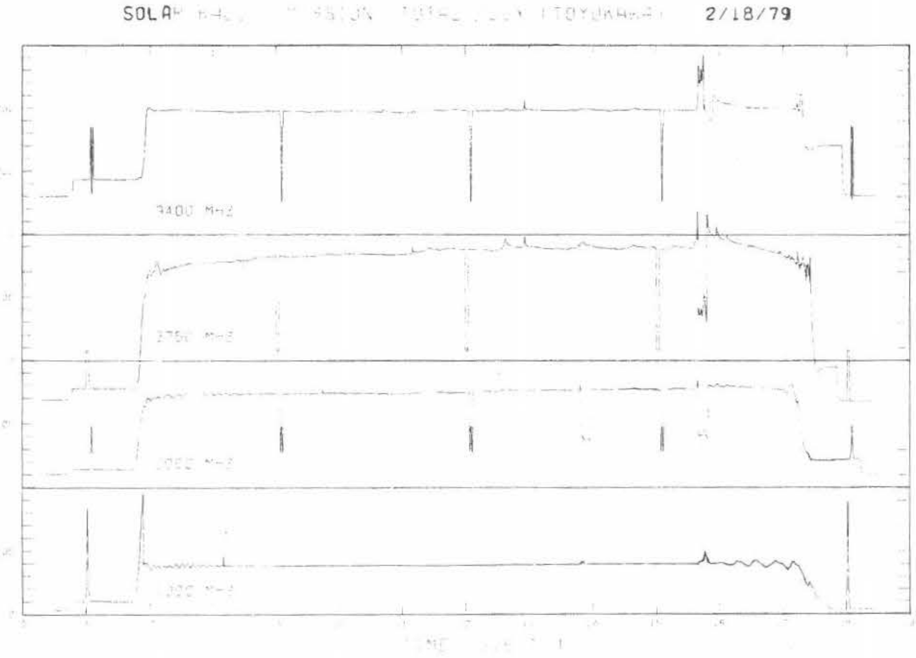

Fig. 6 10-second averaged one-day data of the full-automatic radio-polarimeters on February 18, 1979.

Another quick look of burst profiles is shown in Fig. 7.

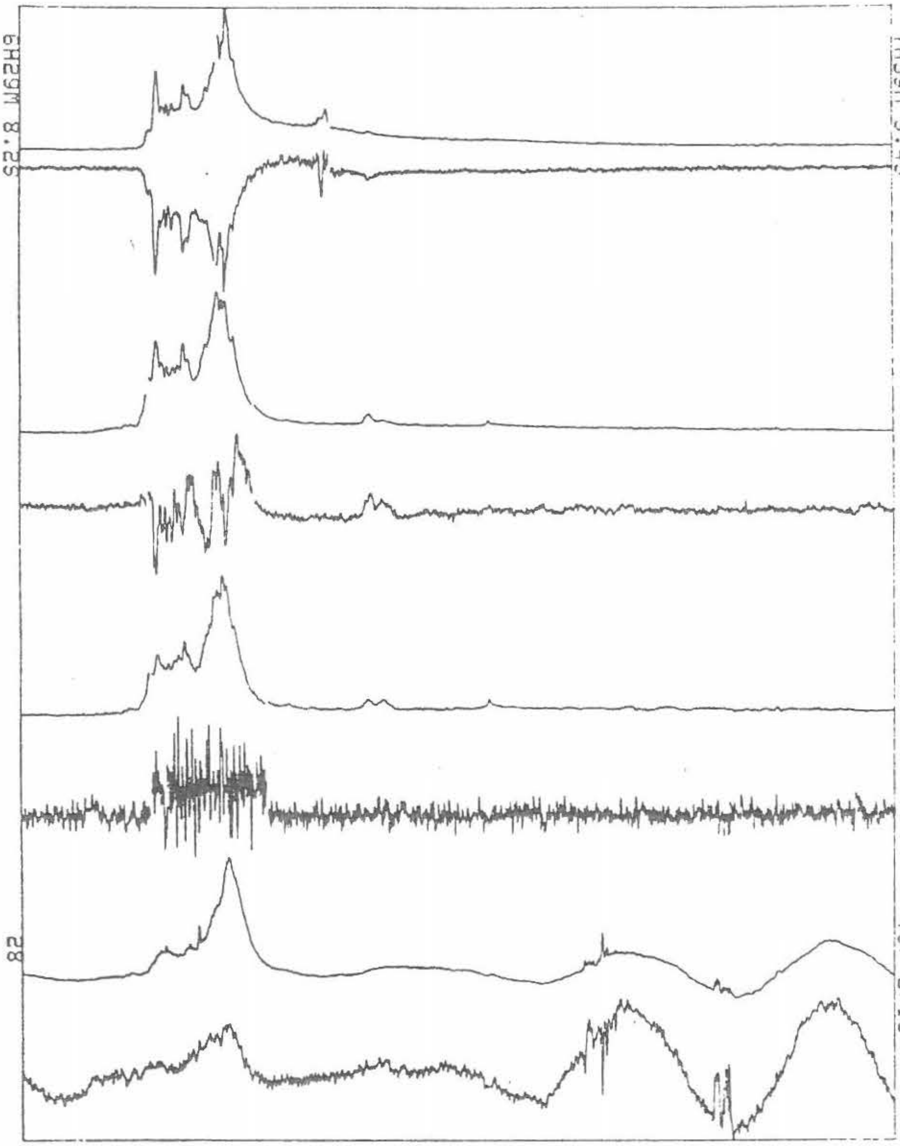

Fig. 7 Burst time profiles observed by the full-automatic radio-polarimeters on February 18, 1979. 8 channel data are from top to bottom 9.4 GHz intensity(I) and polarization(V), 3.75 GHz I and V, 2 GHz I and V, and 1 GHz I and V. Vertical peak-to-peak interval is same for each channel. Receiver gain attenuation, which is seen in Fig. 6, is recovered to obtain original profiles. Maximum time at 3.75 GHz is 0645 UT.

7. Acknowledgement

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