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CASDAC SYSTEM
- ON-SITE MULTIPLEXER -
USER'S GUIDE

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日本原子力研究所
Japan Atomic Energy Research Institute

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- On-site Multiplexer -
User's Guide

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The CASDAC (Containment And Surveillance Data Authenticated Communication) system has been developed by JAERI for nuclear safeguards and physical protection of nuclear material. This system is a remote monitoring system for continual verification of security and safeguards status of nuclear material.

The CASDAC system consists of two subsystems, one of them is a Grand Command Center (GCC) subsystem and the other is a facility subsystem.

This report describes the outline and usage of the On-Site Multiplexer (OSM), which controls all other equipments in a facility subsystem and communicates with the GCC. This work has been carried out in the framework of Japan Support Programme for Agency Safeguards (JASPAS) as a project, JA-1.

Keywords : CASDAC, Safeguards, Physical Protection, System, Verification, C/S (Containment/Surveillance), OSM

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CASDACシステム
－オンサイト・マルチプレクサ－
使用者の手引き

日本原子力研究所東海研究所燃料安全工学部
山本　洋一・小山　謹二

（1993年2月15日受理）

CASDAC（封じ込め／監視データ認証通信）システムは，保障措置及び核物質防護の一環として日本原子力研究所が開発した。このシステムはRECOVERシステムとTRANSEAVERシステムを基に，改良RECOVERシステムとして設計，製作された，核物質の保全状況及び保障措置状況の検認を行うための遠隔監視システムである。

本システムは，2つのサブシステムからなり，1つは中央監視センター（GCC），他の1つは施設サブシステムである。

本報告書は，施設サブシステムを構成している機器類を統括・制御し，かつ中央監視センターとの通信を行っているオンサイト・マルチプレクサ（OSM）について，その概要及び使用方法についてまとめたものである。なお，本研究は日本国のIAEA保障措置支援計画の一環としてプロジェクトJA－1として実施したものである。

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1. Outline of CASDAC System

The CASDAC (Containment and Surveillance Data Authenticated Communication) system [1] is a secure and reliable communication system which continually monitors any changes in the status of containment and surveillance sensors and the status of integrity and health of the system itself.

Communication data must be secure and reliable, therefore all the data on public telephone line network are encrypted to prevent falsification and tapping by unauthorized persons, and the high level data link control (HDLC) procedures are adopted to detect tampering with the data or unauthorized polling trial through public telephone line. The system configuration is shown in Fig. 1.

The system is designed to realize requirements of secure communication, very low false alarm rates and of unattended operation of the facility subsystem. Together with these requirements, cost performance, easy maintenance and transportability of software system including the application programs are also important factors considered.

The system is divided into two subsystems, one is the Grand Command Center (GCC) system and the other is the facility subsystem including containment and surveillance sensor (C/S) system. The communication between two subsystems is controlled by means of a tamper resistant and secure way through the international public telephone line network.

The GCC system consists of two engineering workstations with graphic terminals and two communication control equipments (CCE).

The facility subsystem consists of: 1) The On-Site Multiplexer (OSM) composed of a personal computer, a modem, two HDLC boards, and a monitoring unit adapter (MU-ADP) which is designed for this system specially to make communication available between OSM and MUs (up to 30 MUs), 2) A set of the Monitoring Units (MU), which can monitor up to 8 bits binary (on/off) signals from C/S sensor, 3) The Data Terminal Equipment (DTE) for making message communication available between the GCC and the facility subsystem by a classified and secure way, which also consists of a personal computer with 40 M bytes hard-disk and a HDLC board, and 4) The Multiplexer Unit (MXU) which can link with computer controlled devices such as the global positioning system (GPS) and the satellite communication control equipments.

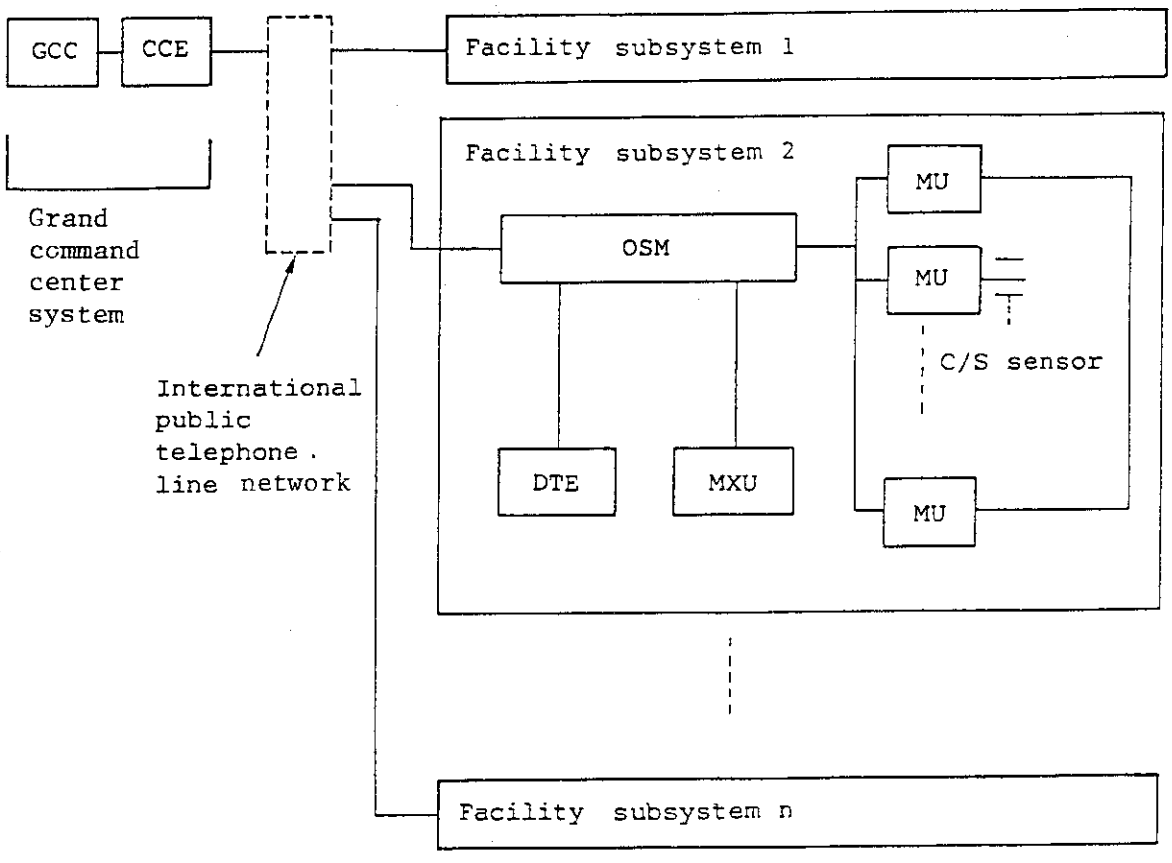


Fig. 1 Configuration of CASDAC System

2. Outline of On-site Multiplexer (OSM)

The OSM is the highest level computer based device within a facility subsystem in order to control all other devices of it according to preset instructions stored internally and instructions from the GCC.

The OSM monitors continually containment and surveillance (C/S) sensor status. If a sensor detects some failures or a tampered signal, the OSM sends the monitored information to the GCC placed in the monitoring center of CASDAC System. It also transmits monitoring data stored in it when it is requested by a demand call from the GCC. In addition, the OSM intervenes between the Data Terminal Equipment (DTE) or the Multiplexer Unit (MXU) and the GCC in order to control data communications between them.

The principal functions of the OSM are collection of status data from the MUs, and the MXU, transmission of these data and state-of-health data to the GCC, and message transfer between the GCC and the DTE. The data transmission to the GCC is initiated by either the request from the GCC or the function of automatic poll of the OSM triggered by an alert signal which is aroused internally by monitoring the status signals.

The MU data is collected at programmable time intervals with a random variation of the order of polling sequence through a party line network. One OSM can monitor up to 30 MUs by three party lines (10 MUs for each party line).

The OSM initiates an MU polling by sending a polling inquiry consisting of 7 bytes followed by random number. The inquiry identifies the MU, and the random number is used for encryption of a response from the MU. While the encryption key stored in the MU will not change until the next re-initialization instructed by the OSM, the random number is changed by the OSM for every poll. The response from the MU consists of the identification of itself, state-of-health information, and the present and past history of sensor status information.

In addition to this information, the response from the MU contains the number of responses given by the MU as a reply to polling request. The number is used to detect any unauthorized poll of the MU: if this number is different from the number recorded in the OSM, it is assumed that a third party has performed unauthorized polling of the MU signaling and that an attempt has been made to breach the security of the system; such a poll mismatch is a condition for system alert. The same function to the detection of unauthorized polls is also facilitated in the communication between the OSM and the GCC.

The OSM is the most important node for unattended use of the facility subsystem, therefore the security of the OSM must be maintained in a high level. The OSM is protected by a secure cover and is capable of encrypting and decrypting all of the communication data between the OSM and the CCE. The OSM is equipped with self-check capabilities and it reports its state-of-health to the GCC, and with the function of automatic poll of the GCC when an alert is recognized by the OSM.

Major functions of OSM are as follows:

1) Communication with the CCE (and GCC)
2) Communication with the MU
3) Communication with the DTE
4) Communication with the MXU
5) Tamper detection and fault recovery
6) Encoding and decoding communication data
7) Self diagnosis and line test

3. Hardware Structure

The OSM is a desk side type equipment installed within a casing of about 600(W) x 600(D) x 525(H) mm in size. Figure 2 shows the sketch drawing of the OSM.

The front door is equipped with an open/close sensor switches for protection against tampers. In addition, no set screws are exposed to outside, except for those fixing the front door, which disables the casing from being disassembled without removing the front door.

The OSM is composed of a sub-rack installation type 16-bit factory computer (FC-9801 V2), modem, MU-ADP and cooling fan, door open/close switches, and connectors for line connection. Fig. 3 shows the hardware block diagram of the facility subsystem. The general specifications of the OSM are given in Table 1.

Table 1. General Specifications of OSM

Item		Specifications
Supply voltage		100 VAC ± 10% (50/60 Hz)
Power consumption		Max. 160 W
Environmental conditions	Temp.	0 to 40°C
	Humidity	30 to 80%
Weight		Approx. 65 kg
Outside dimensions		600(W) x 600(D) x 525(H) mm

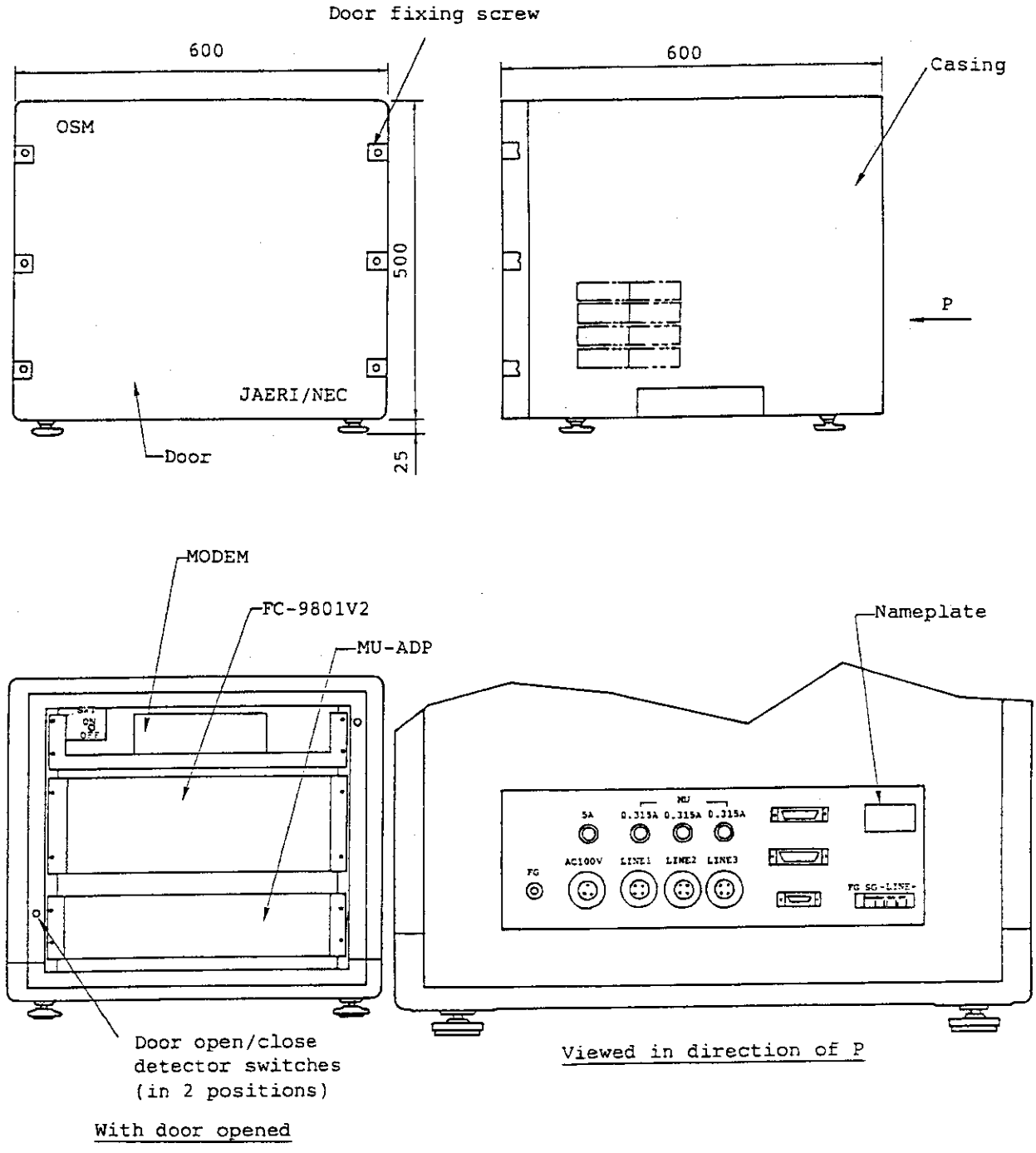


Fig. 2 Sketch Drawing of OSM

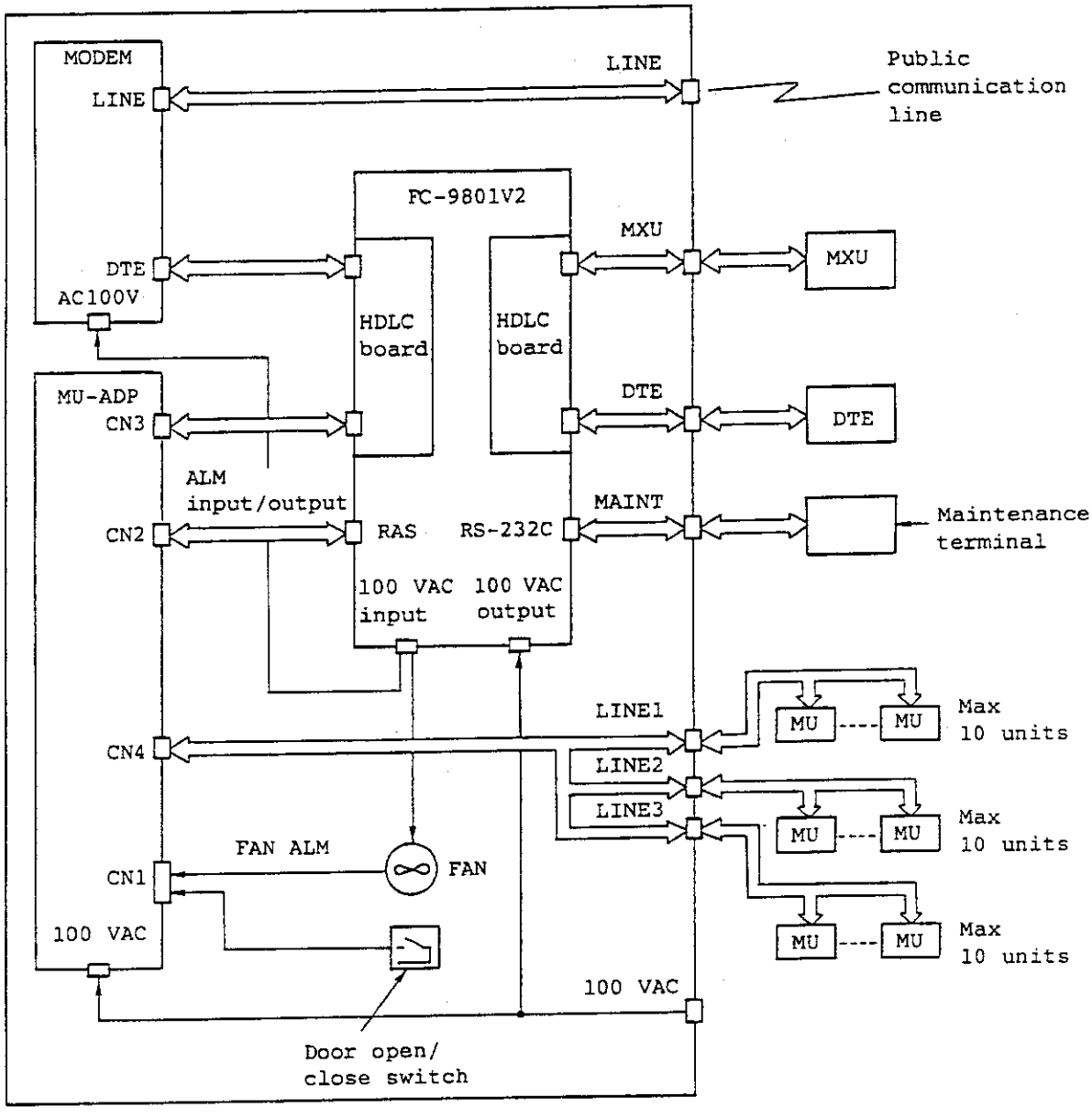


Fig. 3 Hardware Block Diagram of Facility Subsystem

4. Data Communication

The OSM is a key node to control data communication within CASDAC system. Therefore, it has to manage data communication with GCC through the international public telephone line network, and also with MUs, DTE and MXU within a facility subsystem. On the data communication the GCC is assigned as a master system, the OSM as a slave system, and the others: MU, DTE and MXU as peripheral units of the OSM.

The data transmission to the GCC is initiated either by the request from the GCC or by the automatic poll from the OSM triggered by an alert signal which is aroused internally by monitoring the status signals or triggered by a request to send message (or data) to the GCC from DTE (or MXU).

4.1 Communication with GCC (through CCE)

The OSM has a modem with NCU (Network Control Unit) capable of automatic calling and receiving, which links the OSM to the GCC via the public telephone line network.

For receiving commands and message data from the GCC, the OSM is always ready for them. When it receives a test packet for communication line test from the GCC, it is returned directly to the GCC without any modification.

The OSM calls automatically the GCC if an alert signal is aroused from status data monitored by it, and a request to send data is transmitted by the DTE or MXU. If the OSM is in a mode of communication line test, it transmits automatically a test packet to the CCE and checks contents of the packet that is returned from the CCE.

The data which are sending out to or receiving from the GCC are summarized in Table 2 with corresponding conditions for sending out or receiving them.

The specifications of the telephone line interface are summarized in Table 3.

Table 2. Data to be Sent/Received and Calling/Receiving Conditions

Data To be Sent	Data To be Received	Calling Condition	Receiving condition
OSM data MU status OSM status Tamper status AC power failure MU communication error MU-ADP error MXU communication error DTE communication error		1) Alert from monitored status 2) Recovery from AC power failure 3) MU-ADP error 4) MXU communication error 5) As a response	
Message data MXU data		When receiving a request to send message from DTE or MXU	
	Message data		Always
	MXU data		Always
Test packet		When the OSM enters the test mode or receive a test packet	
	Test packet		Always
	GCC command (Note 1)		Always

Note 1: The GCC commands denote the OSM initialize request (including the GCC's telephone number), MU initialize request, request to send MXU data, send data inquiry and other commands.

Table 3. Telephone Line Interface

Item	Specifications
Communication line	Telephone type public communication line
Line side input/ output resistance	600 ohms, balanced
Communication type	2-wire full duplex communication
Modulation type	QAM (AM, PM) type modulation (4-phase, 4-amplitude)
Dialing signal	DP 10 pps/20 pps, PB
Transmission rates	2,400 bps
Transmission control procedure	HDLC-ABM
Code error detection	CRC-CCITT ($X^{16} + X^{12} + X^5 + 1$)
Code type	NRZ

4.2 Communication with MU

The OSM has three ports for connection with MUs and each of them allows multi-drop connection up to 10 MUs, 30 MUs in all.

An MU is assigned as slave unit of the OSM and polled by it's own station number. The time periods needed to complete a set of data transmission are about 15 seconds from the beginning of the demand call to the end of the communication. Polling rates of an MU depend on the number of MUs connected and the order of polling that is assigned randomly within a series of pollings.

The OSM monitors the MU status (C/S sensor data, MU status data, etc.) obtained by polling each MU. If the OSM detects some changes in the status information, it calls the GCC and reports all status information which have been monitored by itself and MUs.

Table 4 shows the specifications of MU communication interface.

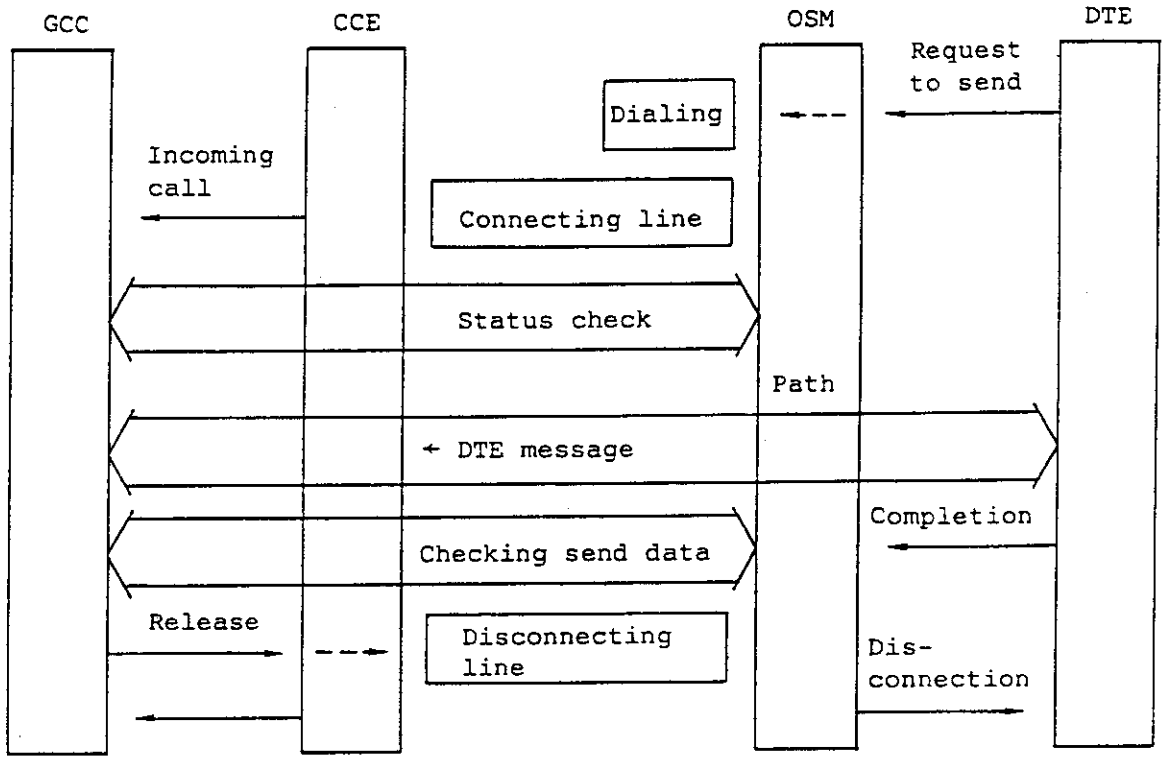
4.3 Communication with DTE

The OSM opens the communication channel between the GCC and the DTE and transfers messages between them as shown in Figure 4.

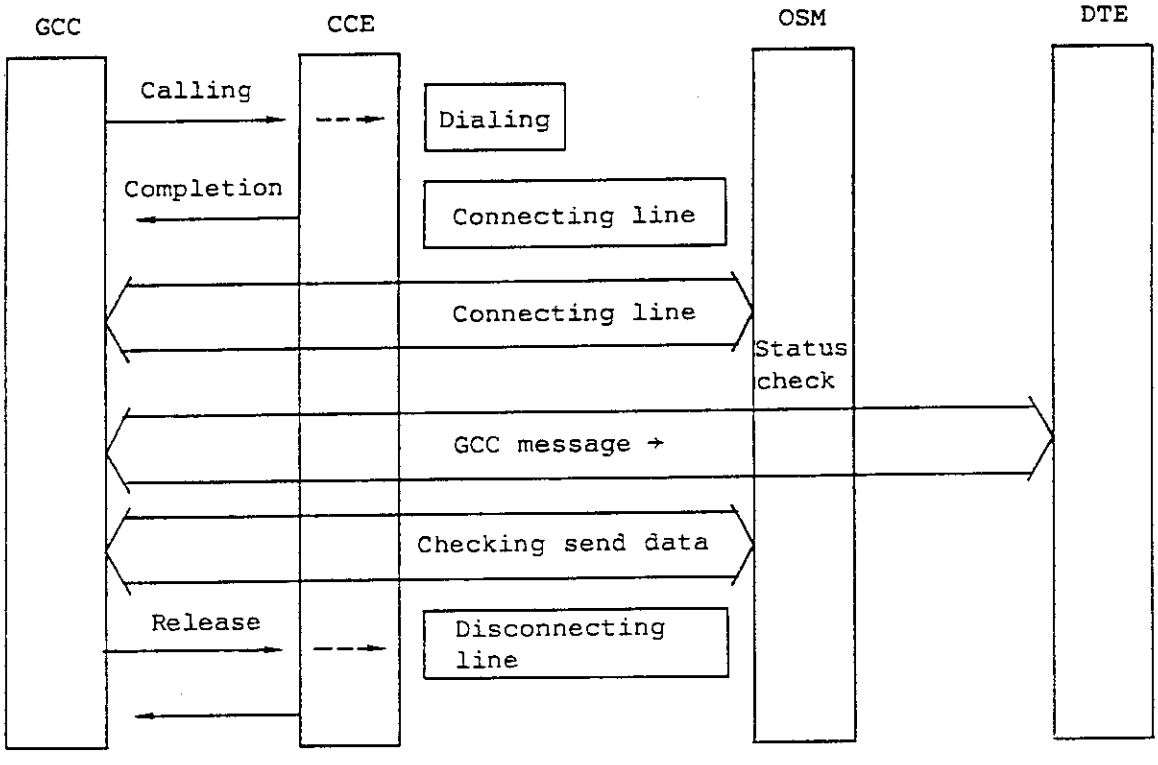
When the OSM receives a request to send a message from the DTE, it calls the GCC by auto-dialing and connects the line, checks and adjusts the current status both the GCC and the OSM in order to open the communication channel, then transfers a message from the DTE to the GCC.

Likewise, when the OSM receives a request to send a message from the GCC, it transfers GCC's message data to the DTE.

Fig. 4 shows outline of the sequence of message transfer between them. And the specifications of DTE communication line interface are summarized in Table 5.



(a) DTE --> GCC



(b) GCC --> DTE

Fig. 4 Outline of Message Transfer between DTE and GCC

Table 4. MU Communication Line Interface

Item	Specifications
Signal standard	0 - 5 V interface
Communication type	Half duplex
Synchronization	Asynchronous
Communication speed	300 bps
Transmission control procedure	Special
Data type	Downward: Humming code (7 bits) + parity (1 bit) Upward: JIS 8
Stop bit	2 bits
Code error detection	Odd parity, BCC (upward)

Table 5. DTE Communication Line Interface

Item	Specifications
Electric & physical standard	CCITT X. 21
Communication type	Full duplex
Communication speed	48 Kbps
Transmission control procedure	HDLC-ABM
Code error detection	CRC-CCITT ($X^{16} + X^{12} + X^5 + 1$)

4.4 Communication with MXU

The OSM opens the communication channel between the GCC and the MXU and transfers MXU data between them as same as the message transfer between the DTE and the GCC.

Fig. 5 shows outline of the sequence of data transfer between the MXU and the GCC. The specifications of MXU communication line interface are given in Table 6.

4.5 Communication with Maintenance Terminal

The OSM has another communication port for the maintenance terminal that can test and check the OSM's functions of communication with MUs or the GCC at facility site without linkage with GCC.

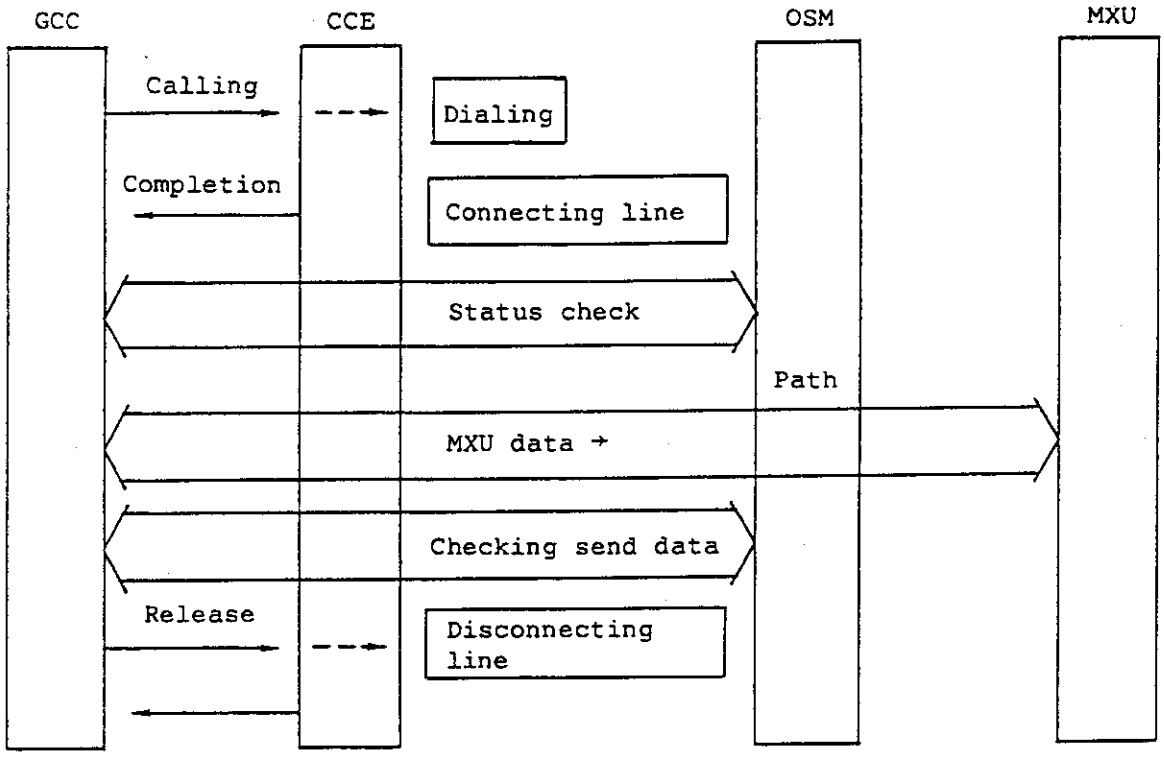
The maintenance terminal has following two functions:

1) Verify the connection between the OSM and MUs
   Dump current MU status data stored in the OSM on CRT display, which are automatically updated by every polling of MU from the OSM, in order to confirm the setup conditions concerning the connection of MUs with the OSM including communication between them.

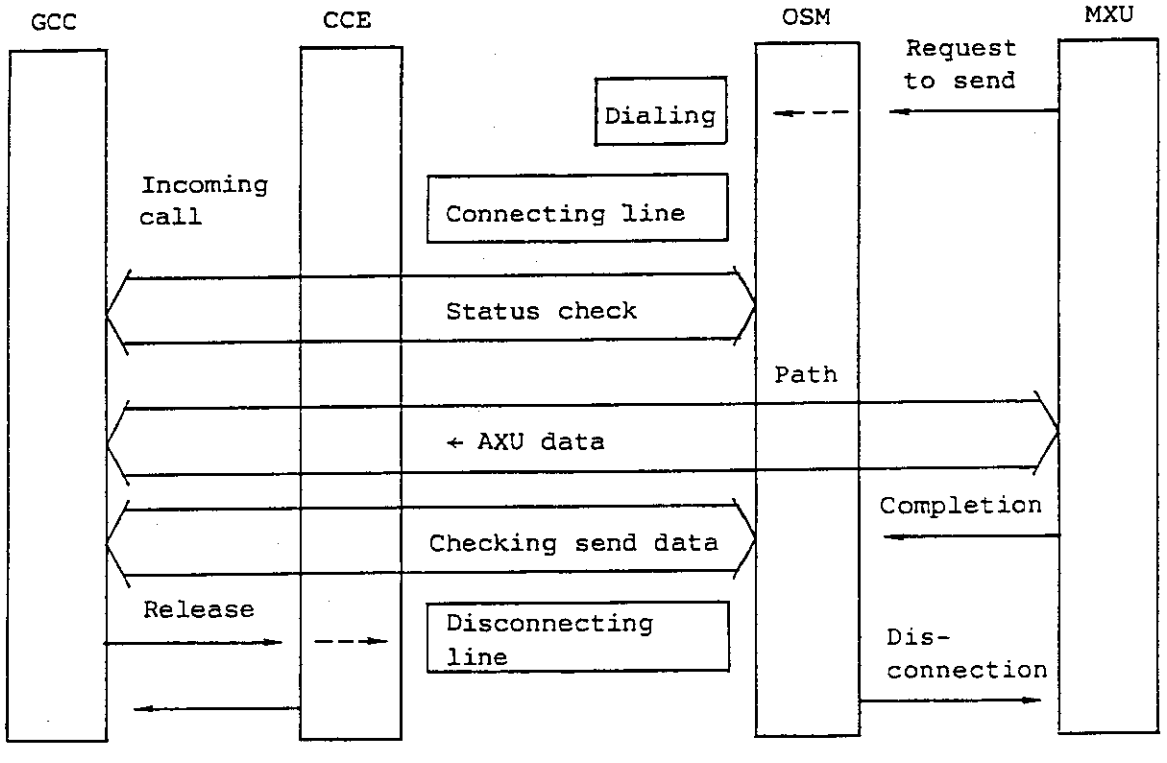
2) Verify the connection between the OSM and the GCC
   Test the communication line between the OSM and the GCC via international telephone line network. In this test mode, an OSM sends a test packet with 128 bytes message out to the communication control equipment (CCE) of the GCC, and the CCE sends immediately the test packet back to the OSM without any modification of the contents of message, then the OSM verifies the linkage between them by comparing the both messages.

Where, the DTE is temporally used as the maintenance terminal that is linked with the OSM through RS-232C ports of the DTE and the OSM. The parameters that must be set for the maintenance terminal are described in Appendix: "How to Check Set-up Conditions".

The specifications of the maintenance terminal communication line interface are summarized in Table 7.



(a) Polling from GCC



(b) Calling from OSM

Fig. 5 Outline of Data Transfer between MXU and GCC

Table 6. MXU Communication Line Interface

Item	Specifications
Electric & physical standard	CCITT V. 24/28
Communication type	Full duplex
Communication speed	9.6 Kbps
Transmission control procedure	HDLC-ABM
Code error detection	CRC-CCITT ($X^{16} + X^{12} + X^5 + 1$)

Table 7. Maintenance Port Communication Line Interface

Item	Specifications
Electric & physical standard	CCITT V. 24/28
Communication type	Full duplex
Synchronization	Asynchronous
Communication speed	2,400 bps
Transmission control procedure	Non-procedure
Data type	8-bit data, no parity
Stop bit	1 bit
Code error detection	Non

5. Operation

5.1 Initial Setting of Hardware Switches

The OSM is composed of a 16-bit computer, MU-ADP board and a MODEM. The computer(FC-9801V2) is expanded its functions by installing a 1.2 M-byte RAM board with auto-start function and two HDLC communication boards into the extension bus slots. The MU-ADP board with 16-bit CPU enables the OSM to hold communication lines with MUs and to supply DC power to MUs.

Each unit or board has switches to set its operation mode properly. The parameters which must be selected by these switches have been properly set before delivery. Therefore, users need not any change of the settings but the OSM address on the MU-ADP board and some parameters of MODEM so as to meet the signal conditions of telephone line to be connected. Table 8 shows the parameters which have been set before delivery.

Fig. 6 shows the location of HDLC-1, -2, RAM and RAS input boards mounted from back side into the central processing unit FC-9801V2 of the OSM.

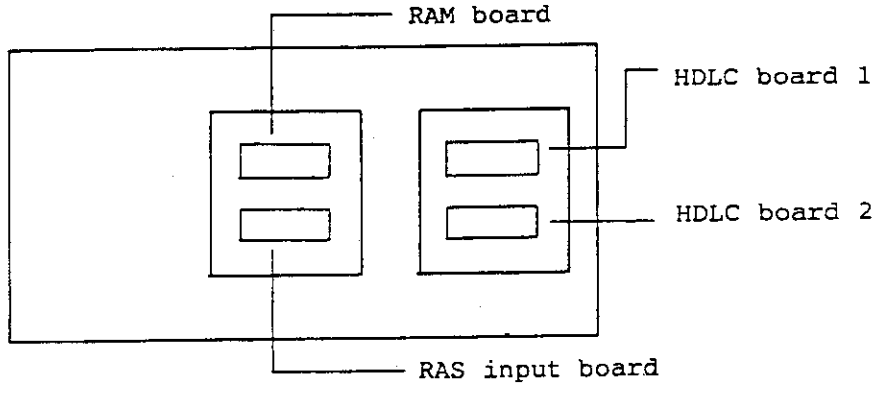


Fig. 6 Board Layout in OSM Central Processing Unit

Arrangement of MODEM and MU-ADP board in the OSM is shown in Figure 2. The location where the switches are mounted on HDLC, RAM and MU-ADP boards is shown on the figures 7, 8 and 9 respectively.

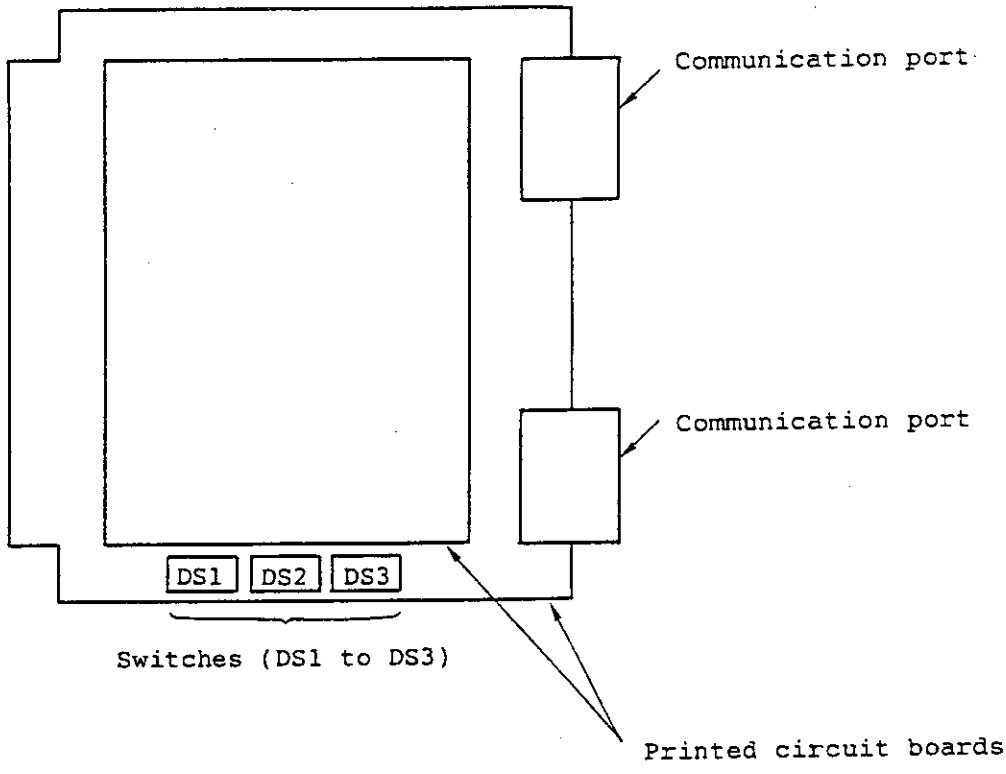


Fig. 7 Switch Layout on HDLC Board

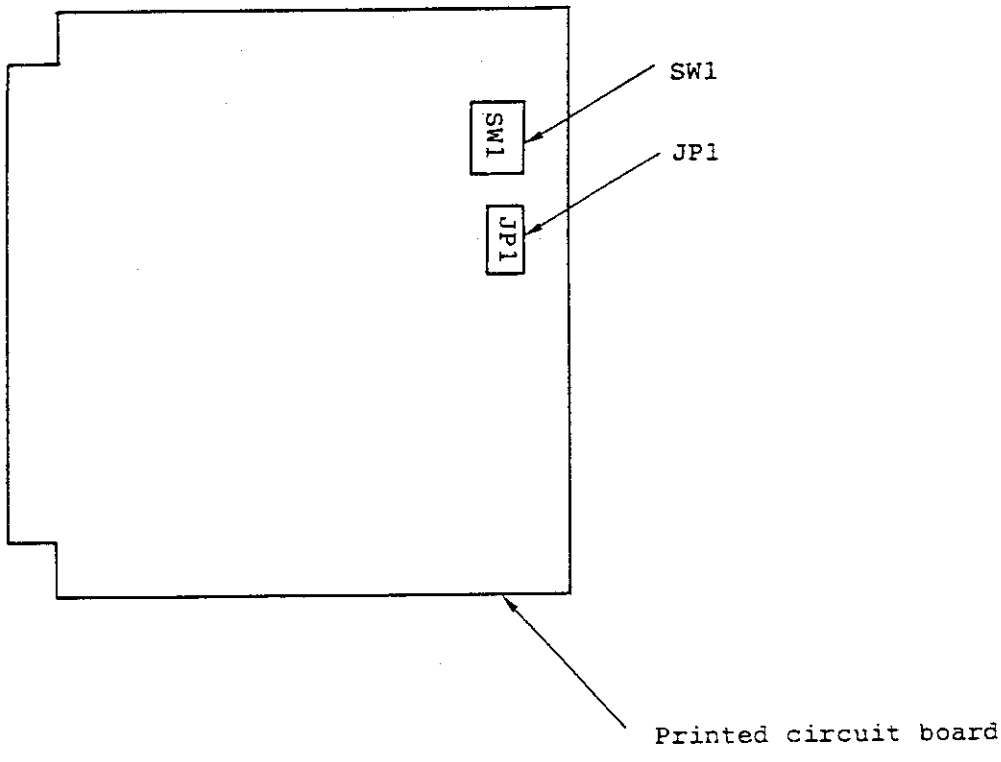


Fig. 8 Switch Layout on RAM Board

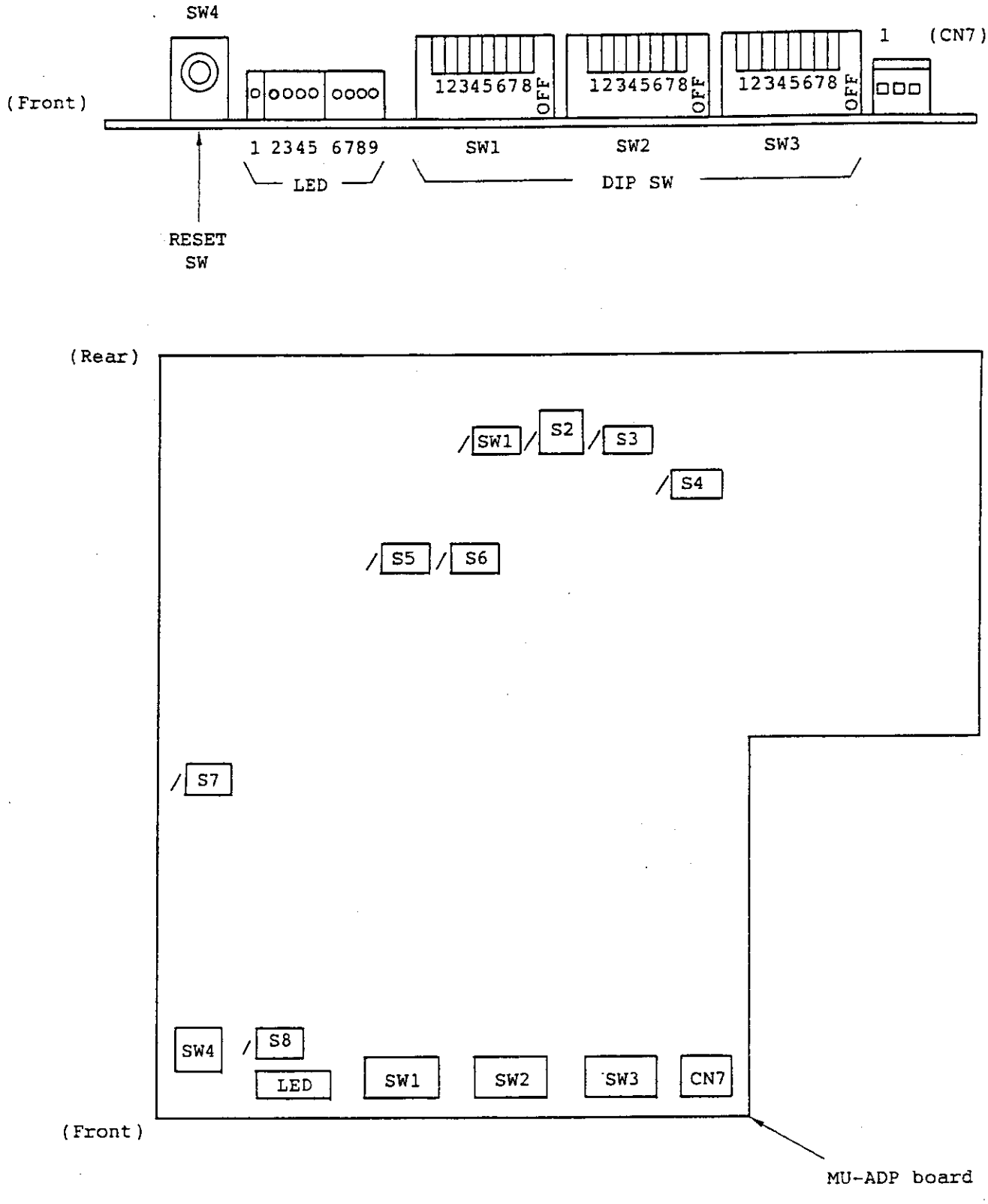


Fig. 9 Switch Layout on MU - ADP

Table 8. Parameter List for Setting

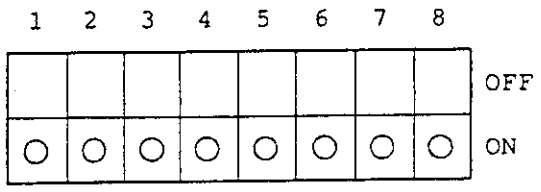
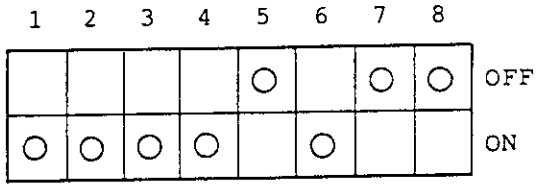
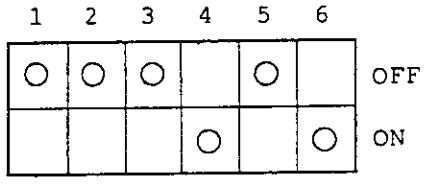
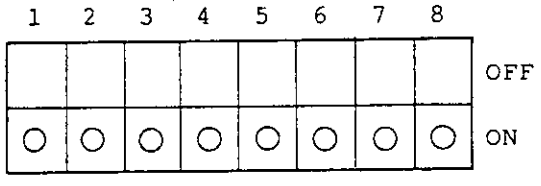
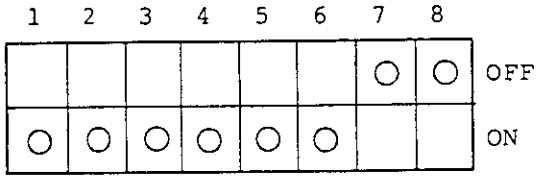
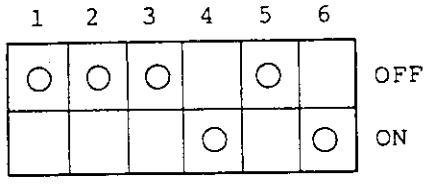
Unit Name	Switch	Setting	Remarks
HDLC board 1 [DTE side MXU side]	DS1		
	DS2		
	DS3		
HDLC board 2 MU-ADP side [CCE side]	DS1		
	DS2		
	DS3		
RAMDISK	JP1	Close	

Table 8. Parameter List for Setting (Continued)

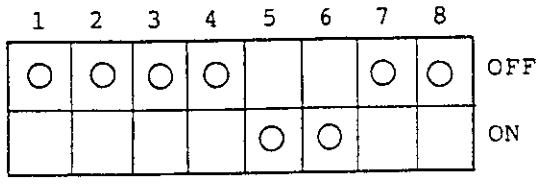
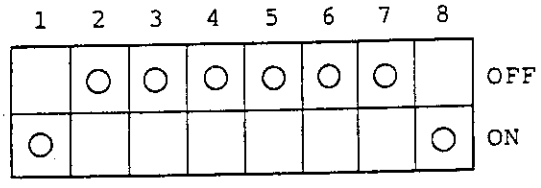
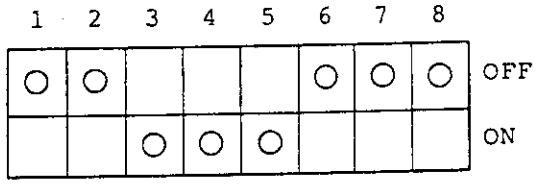
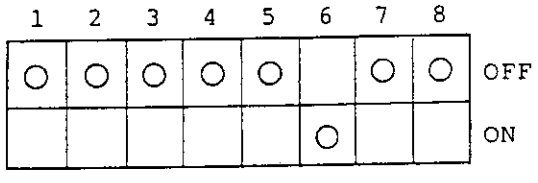
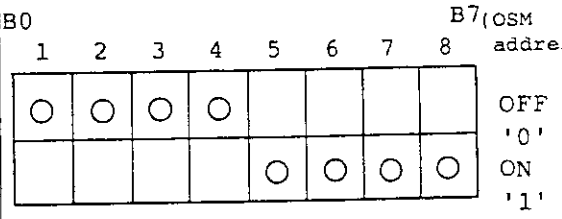
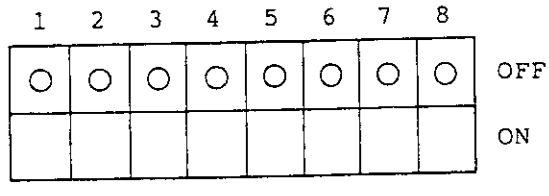
Unit Name	Switch	Setting	Remarks
RAMDISK	SW1		
FC9801V2	SW1		FC9801V2 Mounted on unit front panel.
	SW2		FC9801V2 Mounted on unit front panel.
	SW3		FC9801V2 Mounted on unit front panel.
MU ADP	SW1		Example of OSM address: "OFH"
	SW2		Spare

Table 8. Parameter List for Setting (Continued)

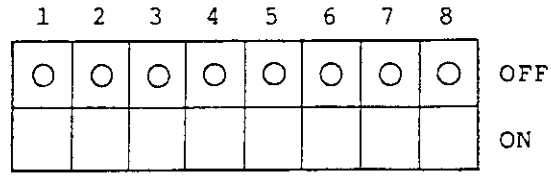
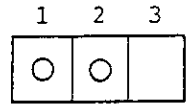
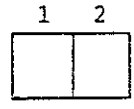
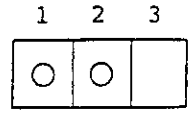
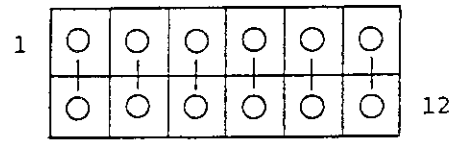
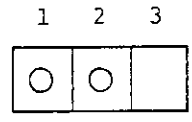
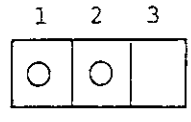
Unit Name	Switch	Setting	Remarks
MU ADP	SW3		Spare
	S1		1 - 2 close
	S2		1 - 2 open
	S3		1 - 2 close
	S4		1 - 2, 3 - 4, 5 - 6, 7 - 8, 9 - 10, and 11 - 12 close
	S5		1 - 2 close
	S6		1 - 2 close

Table 8. Parameter List for Setting (Continued)

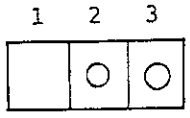
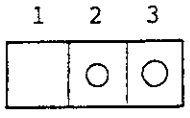
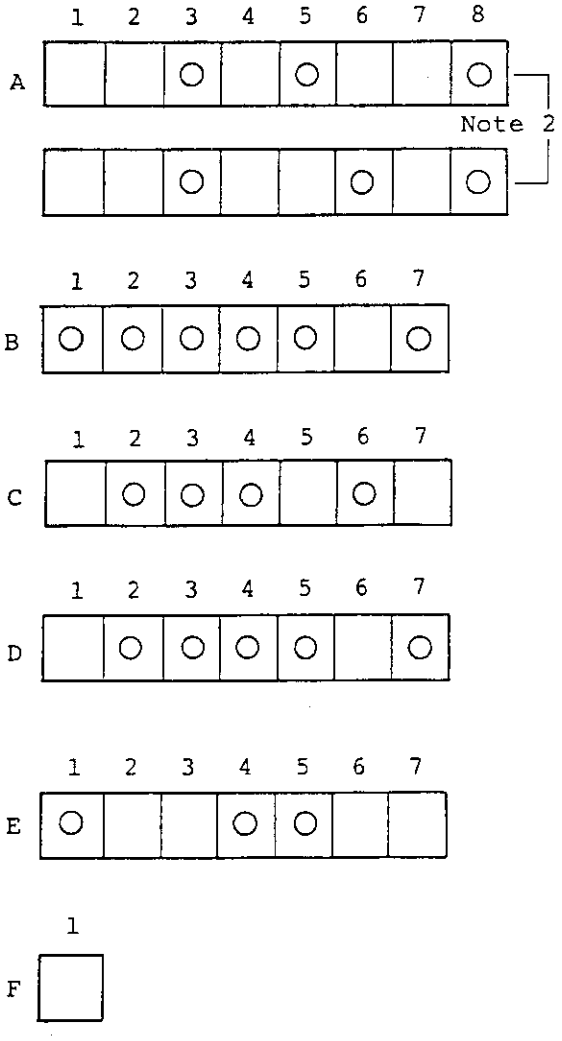
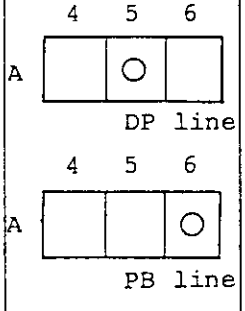
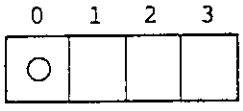
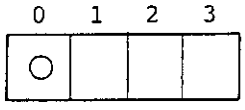
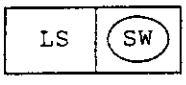
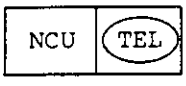
Unit Name	Switch	Setting	Remarks
MU-ADP	S7		2 - 3 close
	S8		1 - 2 close
MODEM (internal switch)	JP		o ... close Note 1: Refer to the DATAX SP242AA operation manual. Note 2: Change A setting in accordance with line type. 

Table 8. Parameter List for Setting (Continued)

Unit Name	Switch	Setting	Remarks
MODEM (internal switch)	RA		
	TA		
	S LEV ADJ	8 dB	
	SL/SW		O...ON
	NCU/ TEL		O...ON
MODEM (switch on front penel)	AA/MA/ MM	AA	
	AL/DL	NOR	
	RDL	NOR	
	ST	NOR	
	24/12 DTE 24		
	SYN/ ASYN	SYN	
MODEM (switch on rear panel)	TEL/ NOR	NOR	

5.2 Cable Connection

Fig. 10 shows the cable connection diagram inside the OSM by means of connection of FC-9801V2 computer with MODEM, MU-ADP and connectors arranged on the rear panel of OSM together.

The cable connection of the OSM with the other units and lines: MUs, DTE, MXU, telephone line and etc. is shown in Fig. 11. Brief instructions and conditions for the connection are summarized in follows:

(1) GND line connection (1 in Fig. 11)

Connect the grounding wire to the FG terminal.

(2) Power cable connection (2 in Fig. 11)

Connect the power cable "C32-2002276-301" supplied with the unit to the wall socket. Notice: 100 VAC ± 10% (50/60 Hz)

(3) MU connection (3 in Fig. 11)

Connect an MU with either LINE 1, 2 or 3 terminals through the connector plugs "CN-1604RP" mounted on the rear panel of OSM. Table 9 shows the pin assignment and line definition of the terminal LINE 1 to 3.

1) Connection via C/S sensor

Connect in accordance with the specification mentioned above.

2) Connection via sensor simulator

As shown in Fig. 12, connect a set of cables between one of the LINE 1 to 3 terminals and the OSM terminals on the sensor simulator. The OSM terminal on the sensor simulator is a kind of screw tightening type.

Peel off the sheath of cables by 10 mm. Insert wires into the terminal holes and tighten the screws. Use wires "AWG26" to "AWG14".

Connect the sensor simulator and MU with the flat cable supplied with the sensor simulator.

(4) DTE connection (4 in Fig. 11)

Connect the attached cable "LCBL2" to the 15-pin connector on the HDLC board mounted in the extension bus slot of the DTE.

The cable has both 15-pin connectors (plugs) which are connected straight.

(5) MXU connection (5 in Fig. 11)

Connect the attached cable "C32-9541601-301" to the MXU.
The cable has both 25-pin connectors (plugs) which are connected straight.

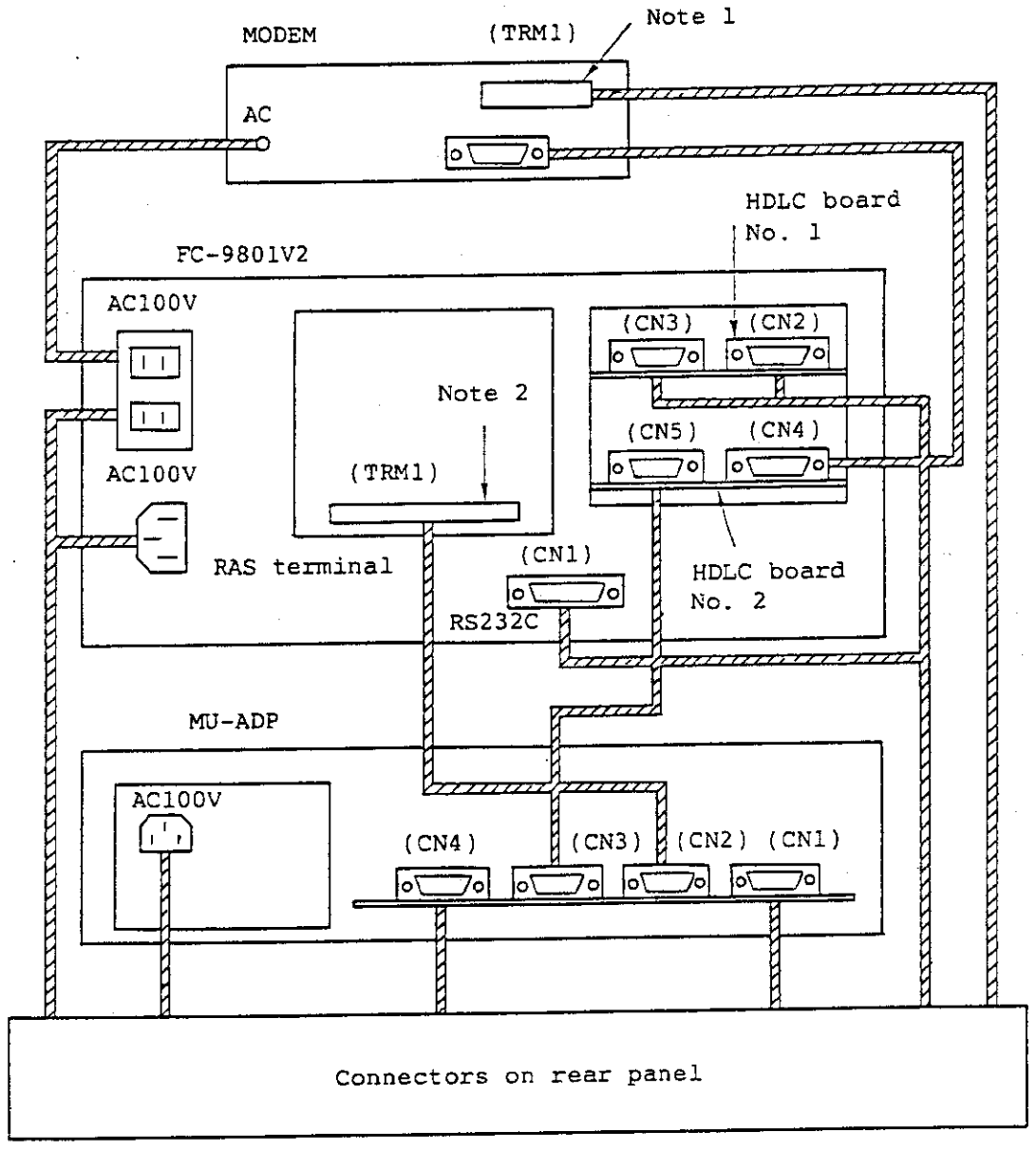
(6) Connection to maintenance terminal (6 in Fig. 11)

Connect the attached cable "C32-9541601-301" to the maintenance terminal.

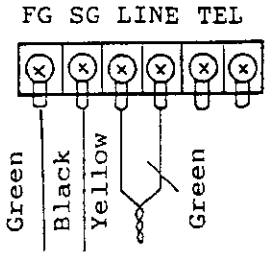
The cable has both 25-pin connectors (plugs) which are connected straight.

(7) Connection to telephone line (7 in Fig. 11)

Connect the telephone line to the LINE terminal (with an M3 screw).



Note 1 Connection with modem TRM1



Note 2 Connection with FC-9801V2 TRM1 (RAS terminal)

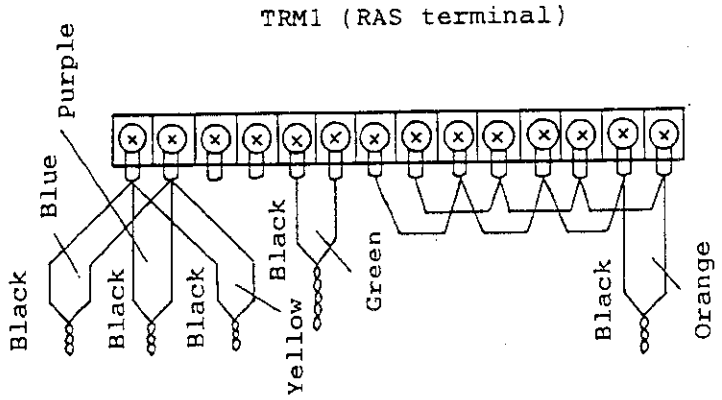


Fig. 10 OSM Internal Connection Deagram

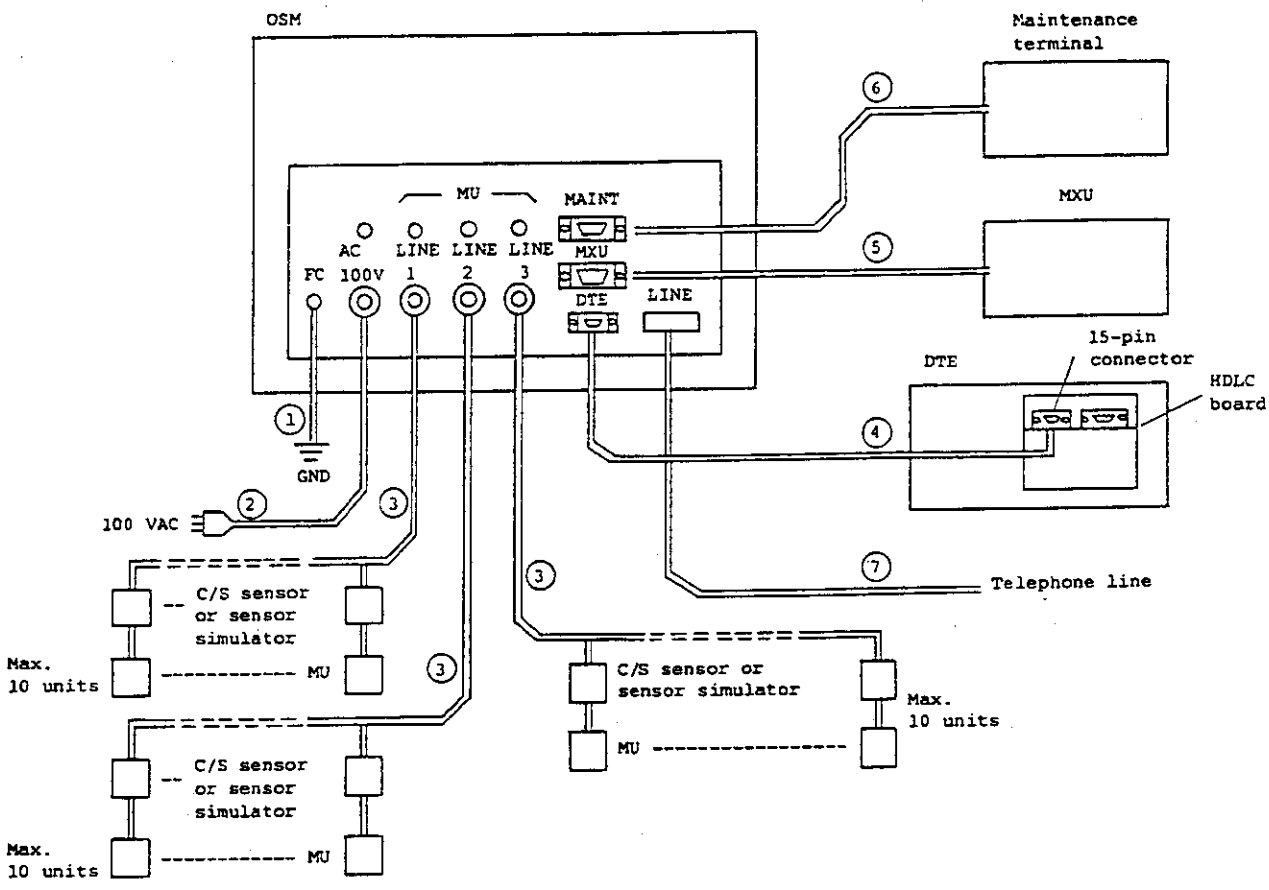


Fig. 11 OSM Connection Diagram with the Other Units

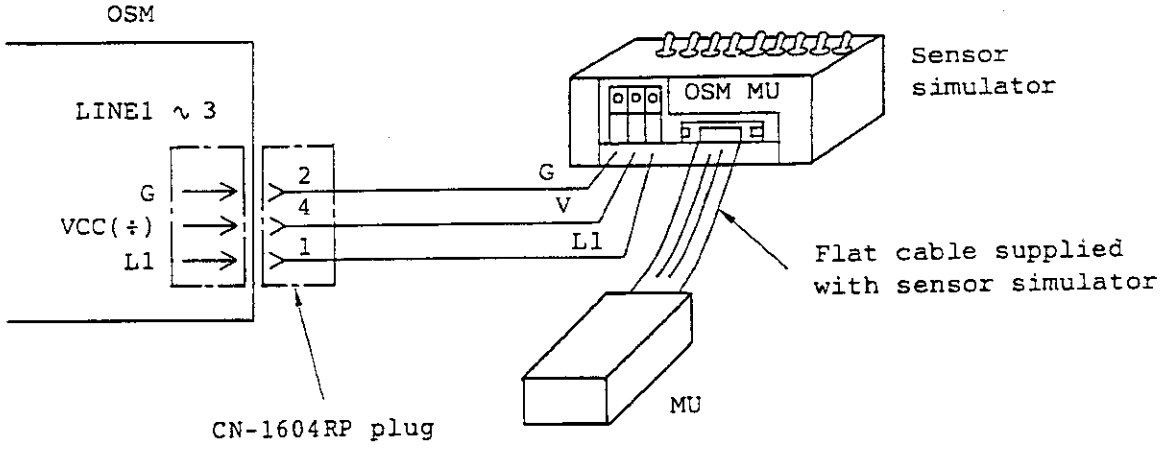


Fig. 12 OSM Connection with Sensor Simulator and MU

Table 9. Pin Assignment and Line Definition of MU Terminal

Line	Pin No.	ID
Communication line	1	L1
Ground line	2	G
Power supply to MU	4	Vcc(+)

Notes: See "- Monitoring Unit - User's Guide" of CASDAC System.

Signal specification of communication line: L1

Signal level	Assignment of data
High	0
Low	1

Margins of Input/Output Signal Level

Item	Specification
High Level Output	4.8 to 5.0 Volts
Low Level Output	0.0 to 0.05 Volts
High Level Input	3.45 to 5.0 Volts
Low Level Input	0.0 to 2.75 Volts

5.3 Starting System

Prior to starting the system, switch parameters on the following PC boards and units must be set properly as mentioned in Para. 5.1 and it must also be confirmed that the line voltage to be supplied is in 100 VAC ± 10% (50/60 Hz).

(i) HDLC board
(ii) RAM board
(iii) FC-9801V2 — See Table 8 for setting parameters.
(iv) Modem — Except Modem and MU-ADP, all parameters
(v) MU-ADP — have been set properly in the factory.

Start the OSM system in accordance with the following steps:

(1) Remove the cover, and connect the floppy disk drive unit (hereinafter referred to as FD unit), CRT, and keyboard to the FC-9801V2 (central processing unit of the OSM).

(2) Set the system disk of the OSM into the drive 1 of the FD unit.

(3) Turn on power switch of FC-9801V2.

(4) When the system has started, it initializes the RAM board automatically by FORMAT command.

(5) After initialization of the RAM board, the OSM system program is loaded from the floppy disk to the RAM board.

(6) Disconnect the FD unit, CRT and keyboard from the FC-9801V2, press the reset button, then the system is now ready to start.

Note 1: Check the switch SW-1 beside the Modem is at the "ON" position, otherwise the tamper protection function concerning the door open does not work properly. (See Fig. 2)

Note 2: SW4 on MU-ADP (front side of it as shown in Fig. 9) must be pushed down in order to reset and start the MU-ADP board again before closed the cover, when the OSM port address is modified by the SW1.

(7) Attach and close the door, then, the system starts automatically.

6. Maintenance

The OSM has been designed as a system that does not require any maintenance service, except exchanging a battery cell on the MU-ADP board or in FC-9801V2 computer.

All the functional units of the OSM are mounted into a rigid frame with covers which consist of a front cover, a rear cover and a cover for top and both sides. The bottom side of cover has been fixed to the frame tightly so as not to remove from the frame unless the frame is dismantled.

The cover must be opened in order to exchange the battery cell or to start the system up as mentioned previous paragraph.

(1) How to remove the cover (See Fig. 13)

1) Remove the front cover by removing sixes screws on it.
2) Pull out the cover for top and both sides horizontally after removing sevens screws.
3) Then, the rear cover can remove from the frame by removing two screws.

(2) Exchange of the battery cell on the MU-ADP (See Fig. 14)

1) First turn the power of MU-ADP off after remove the front cover of the OSM.
2) Remove the front panel of MU-ADP by removing a screw on each corner of the panel.
3) Loose the two screws to fix the fixing bar plate of the battery cell, turn the bar plate clockwise, then pull the battery cell out horizontally.
4) Take off a pair of lead wires by plug socket.
5) Exchange the battery cell. Where, the red color wire must connect with plus (+) electrode and the black color wire with minus (-).
6) Take reverse procedures from 3) to 2) for setting up.
7) Finally turn the power switch on.

6.1 Procedure for Recovery

All data which are collected and stored in the OSM must be secure and reliable. The status of C/S measures applied and the integrity and health of the facility subsystem are monitored by the GCC in order to assure the data collected by the OSM. Although, it is necessary to protect the data against tampering directly with the OSM and AC power line, there is no way

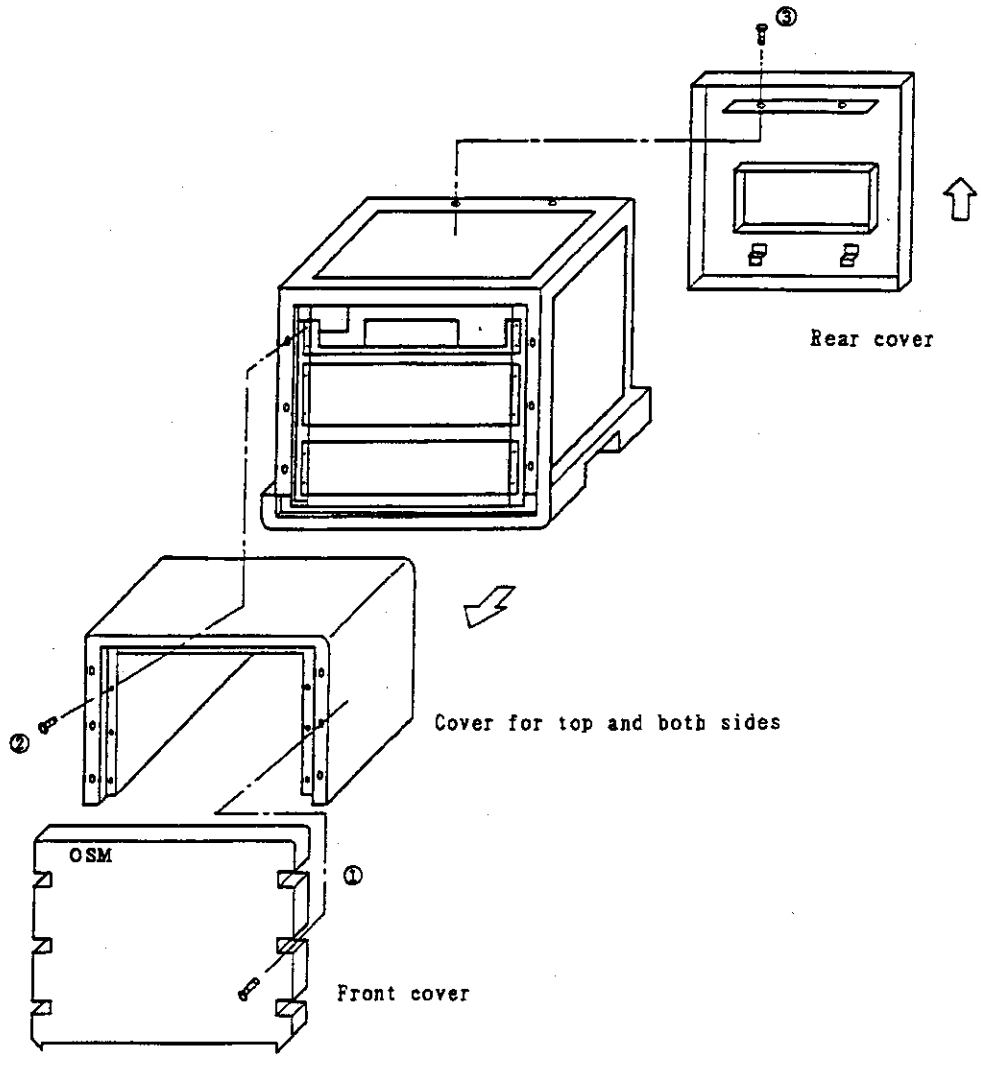


Fig. 13 Procedures for Removal of Covers

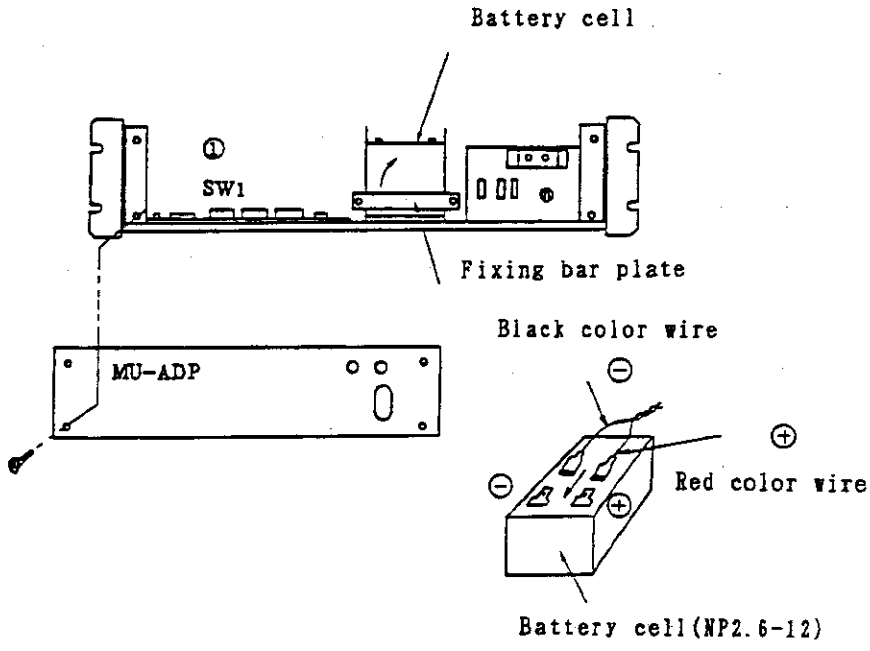


Fig. 14 Exchange of Battery Cell of MU－ADP

to guard them physically.

AS mentioned before, the steal covers of the OSM can not be opened, unless the front cover monitored by open/close sensor switches is removed. Tampering with the OSM is detected by these switches. Leakage and diversion of the data, which must be guarded for security, are protected by erasing them from memory completely when the front cover is opened.

The follows are outline of the procedures to be taken by the OSM at occasions when some interventions including AC power failure are occurred (i.e., tamper detection), and procedures to be taken for recovering.

- If the front cover is opened, the OSM stops all processing and erases the data stored in the memory (i.e., the random number data for encoding, CCE telephone number, MU data, etc. except the program).

- To restart the OSM, the program and data must be loaded from the OSM system disk.

- In case of AC power failure, since power is not supplied to the central processing unit of the OSM and modem, the OSM can not maintain communication with the CCE, DTE and MXU. However, the MU-ADP board is backed up by battery power supply and carries on communication with the MU and tamper detection for an hour.

- If AC power failure continues beyond an hour, the MU-ADP stops its operation and the OSM enters into "asleep mode", but the memory backup function saves and keeps the status data of MUs and the data concerning tampering up to 72 hours.

- If AC power is restored within 72 hours, the OSM restarts automatically and informs the GCC of the occurrence of AC power failure.

These procedures are summarized in Table 10.

References

1. Y. YAMAMOTO and K. KOYAMA: "Upgraded RECOVER System - CASDAC System -", JAERI-M 92-026, JASPAS 91-2 (1992).

Table 10. Procedures in Case of Failure

No.	Cause		Processing of OSM Central Processing Unit	Processing of MU-ADP
1	Door open.		Deletes data (except for program).	Deletes data.
2	AC power failure	Within 1 hr.	Stops.	. Continues communication with MU, accumulates MU data. . Detects tamper.
		Within 72 hrs. over 1 hr.	Stops.	. Saves MU data. . Saves tamper data.
3	MU-ADP power and Hardware failure		Reports the failure to GCC.	Stops.
4	CPU alarm in OSM		Stops.	. Continues communication with MU, accumulates MU data. . Detects tamper.
5	Modem failure		Stops communication with GCC only.	Normal processing

A self diagnosis function is prepared in the software system and works when AC power is turned on. The function checks RAM memory of the OSM by means of read-after-write check and ROM of the MU-ADP by check-sum before the system program is loaded into the system.

Notes: If an error occurs in the central processing unit of the OSM, MU-ADP or modem, the OSM must be recovered its operation in accordance with the procedures shown in Table 11.

Table 11. Procedures for Recovery

No.	Cause		Recovery Procedures	Operation after Recovery	Remarks
1	Door opens.		Close door.	Start from initialization	(Note 1)
2	AC power failure	Within 72 hrs.	Power ON	Self Restart and Reports to GCC	
		Over 72 hrs.	Power ON	Start from initialization	(Note 1)
3	MU-ADP power and hardware failures		Check and maintenance of MU-ADP central processing unit	Start from initialization	(Note 1)
4	CPU alarm in OSM		Check and maintenance of OSM central processing unit	Start from initialization	(Note 1)
5	Modem failure		Check and maintenance of modem	Start from initialization	(Note 1)

Note 1: "Start from initialization" means connecting an external floppy disk drive unit to the central processing unit of the OSM, loading the program, random number data and CCE telephone number, then starting operation.

Appendix: How to Check Set-up Conditions

The OSM has functions to verify the internal status of the OSM and the status of communication between the OSM and other equipments which are stored in the RAM of the OSM. These functions are only available when the MAINT port on the back panel of the OSM is active and the Maintenance Terminal has been properly set.

The Maintenance Terminal has following two test functions:

1) Verify the connection between the OSM and MUs
   Dump current MU status data stored in the OSM on CRT display, which are automatically updated by every polling of MU from the OSM, in order to confirm the setup conditions concerning the connection of MUs with the OSM and the communication lines between the OSM and MUs.

2) Verify the connection between the OSM and the GCC
   Test the communication line and protocol between the OSM and the GCC via international telephone line network through the Modems by means of loop-back test.

   In this mode, an OSM sends a test packet with 128 bytes message out to the communication control equipment (CCE) of the GCC, the CCE sends immediately the test packet back to the OSM without any modification of the contents of message, and then the Maintenance Terminal verify the linkage between them by comparing the both messages.

A) Setting up the Maintenance Terminal

The DTE is temporally used as the Maintenance Terminal in order to make it possible to test and check the communication functions of the OSM with MUs or the GCC at facility site without linkage with GCC. The Maintenance Terminal must be linked with the OSM through RS-232C ports instead of the port of HDLC board of the DTE, PC-9801VM11 as shown in Fig. 11.

The memory switch parameters for the Maintenance Terminal which must be set by SWITCH command of MS-DOS are summarized in Table A-1.

Table A－1. Memory Switch Parameters Setting

RS232C-0	Baud rate	2400 bps
	Character length	8 bits
	Parity check	No parity
	Stop bit length	1 bit
	X parameter	None
Printer	24-dot type ANK/KANJI = 1/2	
Memory size	512 K bytes	
Screen display attribute	White	
Numeric data processor	None	
Boot device	Standard	
Numeric data processor 2	None	

The parameters for the Maintenance Terminal which must be set by hardware switch of SW2 on the front panel of PC-9801VM11 are slightly different from those for the DTE as follows:

SW2	1	2	3	4	5	6	7	8
DTE	off	off	on	on	on	off	off	on
M.Term.	off	on	off	off	off	on	off	off

The specifications of the maintenance terminal communication line interface are summarized in Table 7.

B) Commands

There are following four commands available to perform the test functions that the Maintenance Terminal has.

No.	Command	Function
1	D:STATUS	Dump all the status data stored in the OSM RAM on the CRT display.
2	T:S	Start the loop-back test between the OSM and the GCC, the test is repeated until the end of test command is typed in.
3	T:E	End of test command to terminate the communication test.
4	D:TEST	Dump the results of the loop-back test on the CRT display by the following format: For normal end; GD nn nn where "nn nn" is the number(in HEX) of the test repeated successfully. For abnormal end; NG mm mm where "mm mm" is the number of the test repeated successfully until an abnormal situation is detected.

C) Start up The Maintenance Terminal

c-1) After setup all the parameters mentioned above properly, push down the reset button on the front panel of PC-9801VM11, then the terminal becomes ready for BASIC mode operation.

c-2) Press the "RETURN" (or "ENTER") key, the operation mode is changed from BASIC to the Terminal mode as shown in Fig. A-1.

c-3) Press the F-7 (Function key 7), the parameter for communication mode is changed from HALF to FULL duplex mode, this change should be confirmed at bottom right on the CRT screen.

Now the Maintenance Terminal is ready to start to check the status of the OSM or to test the communication line between the OSM and the GCC.

D) Communication Test

The Maintenance Terminal may now be in the terminal mode and is ready to type in "1234" that is assigned as a pass word tentatively.

For making the test of communication line, the pass word should be typed in properly at the first, then as follows:

d-1) T:S ; for starting the communication test
d-2) T:E ; for terminating the test
d-3) D:TEST ; for dumping the results of the test on the CRT display

Fig. A-2 shows a sample profile of test procedures and response.

E) Check and Confirm OSM Status

The OSM has some other communication channels such as with MUs, MU-ADP, DTE and MXU. All the status data to be sent them out to the GCC which consist of data monitored by MU and OSM, and current status of those communication channels can be dumped on the CRT display by using the command "D:STATUS" as following procedure of typing:

e-1) Pass word ; for starting the program
e-2) D:STATUS ; for dumping the current status stored in the OSM

Fig. A-3 shows a sample profile of test procedures and response, and the structure of dumped status data is shown in the Fig. A-4.

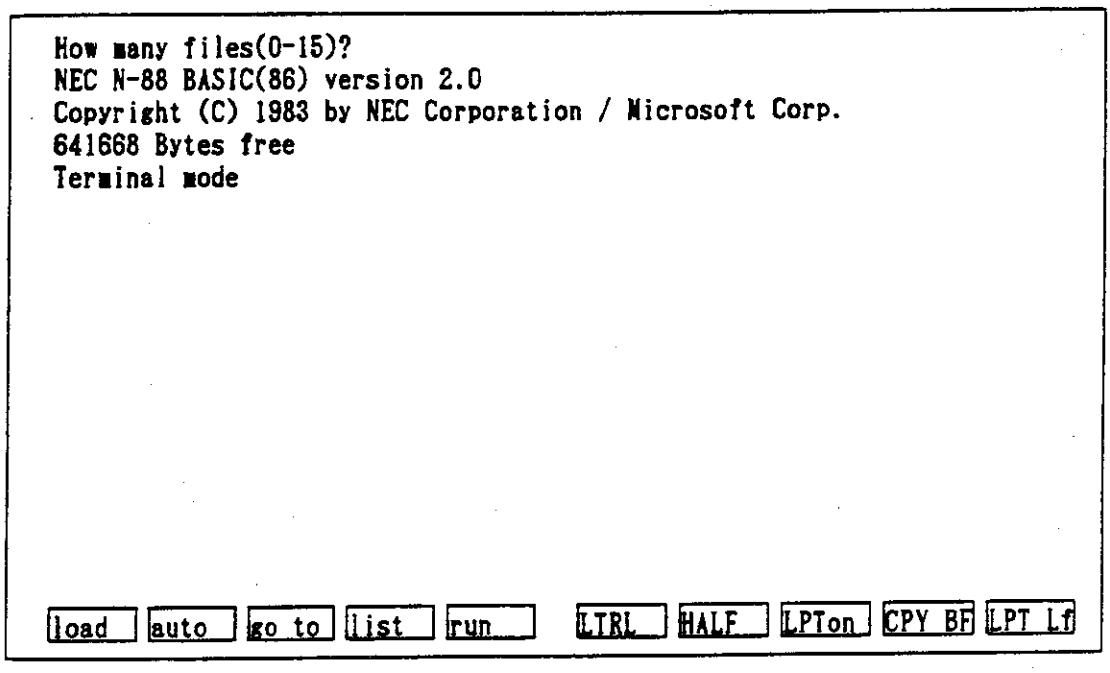


Fig. A－1 Initial Screen in Terminal Mode

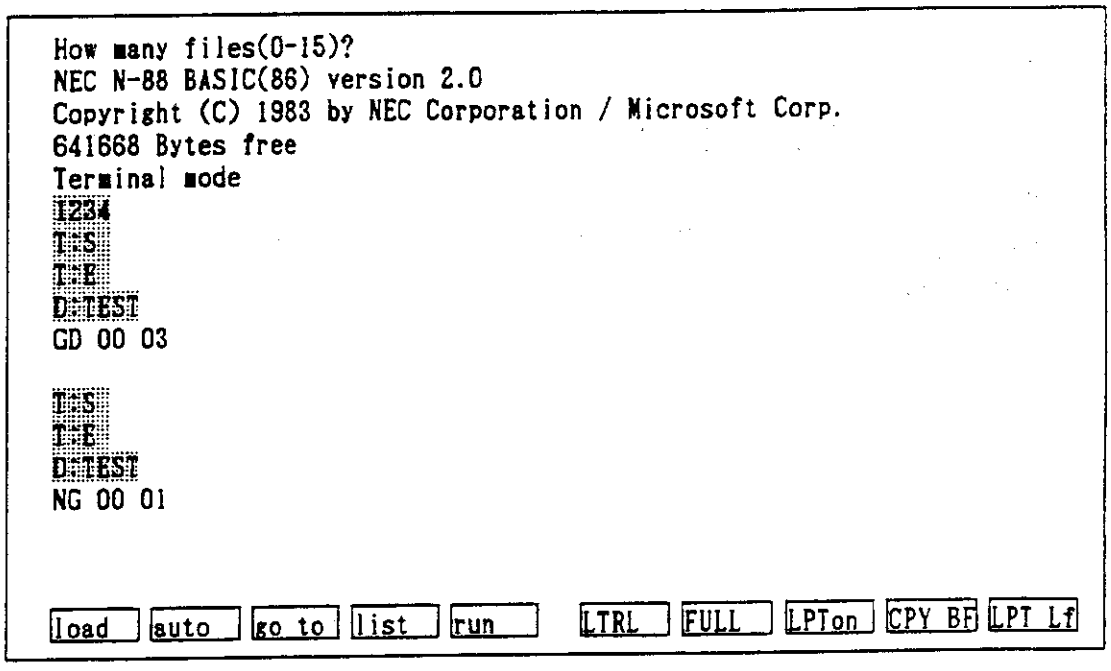


Fig. A－2 Profile of Communication Test on CRT Display

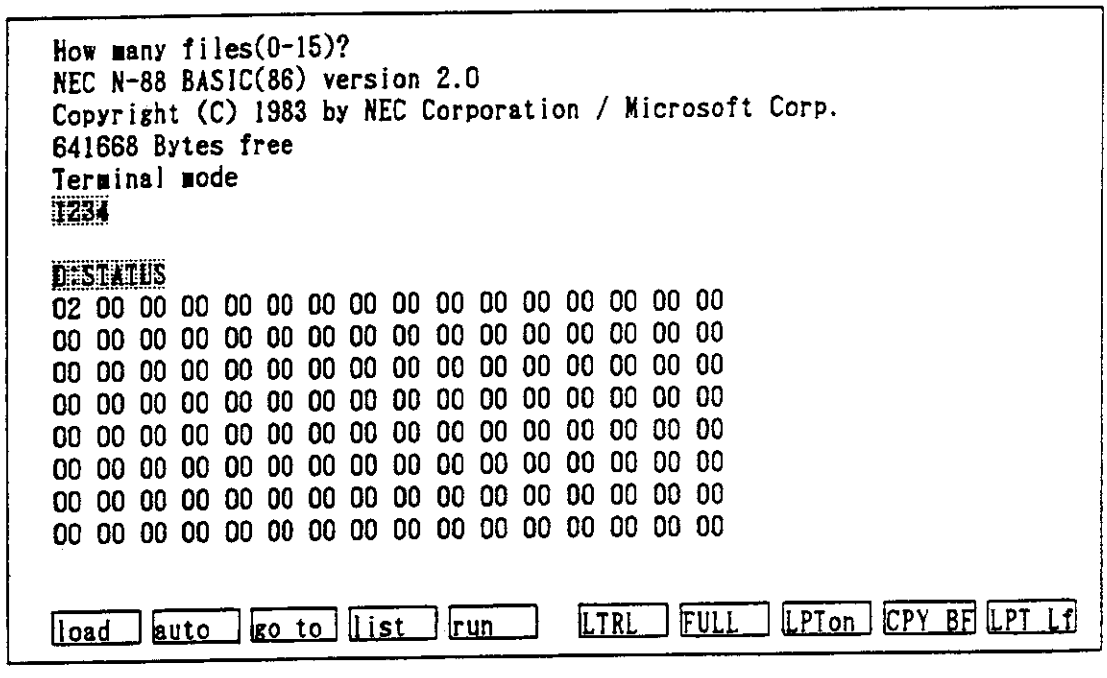


Fig. A－3 Profile of Current Status Dump of OSM on CRT Display

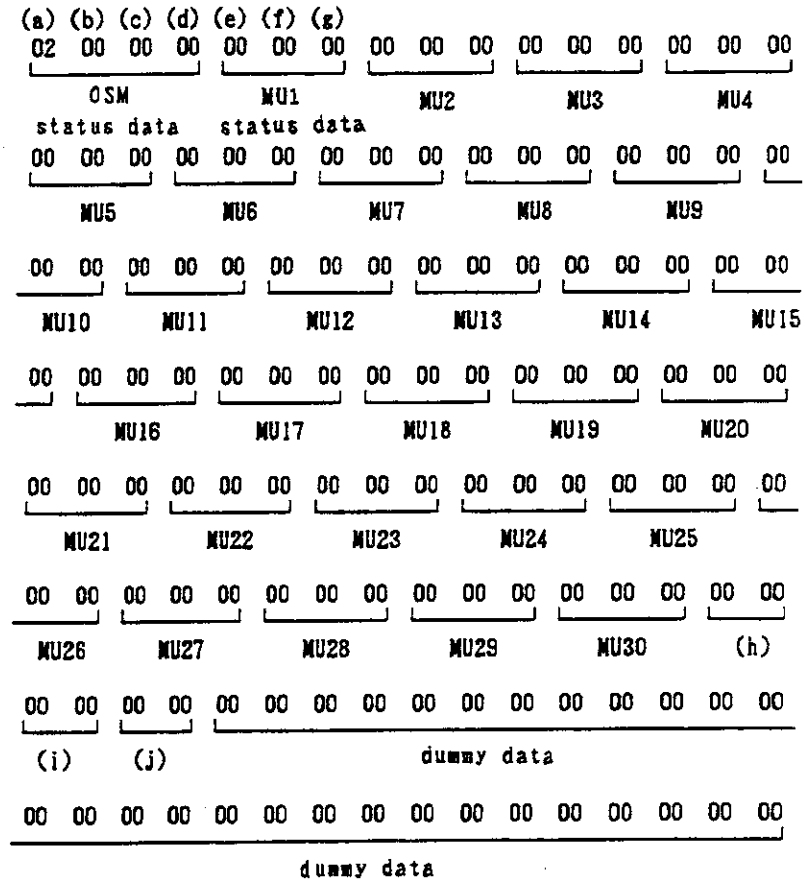


Fig. A – 4 Structure of Dumped Status Data on Maintenance Terminal