# General Disclaimer

## One or more of the Following Statements may affect this Document

- This document has been reproduced from the best copy furnished by the organizational source. It is being released in the interest of making available as much information as possible.

- This document may contain data, which exceeds the sheet parameters. It was furnished in this condition by the organizational source and is the best copy available.

- This document may contain tone-on-tone or color graphs, charts and/or pictures, which have been reproduced in black and white.

- This document is paginated as submitted by the original source.

- Portions of this document are not fully legible due to the historical nature of some of the material. However, it is the best reproduction available from the original submission.

DOE/NASA CONTRACTOR REPORT

DOE/NASA CR-150581

OPERATIONS MANUAL: ON-SITE MONITOR (OSM), SOLAR
HEATING AND COOLING SYSTEMS

Prepared by

IBM Federal Systems Division
Space Systems Division
Huntsville, Alabama 35805

Under Contract NAS8-32036 with

National Aeronautics and Space Administration
George C. Marshall Space Flight Center, Alabama 35812

for the U. S. Department of Energy

# U.S. Department of Energy

Solar Energy
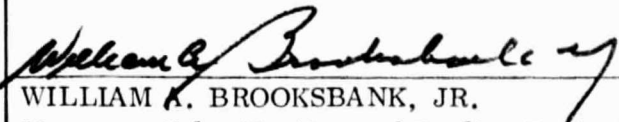
| 1. REPORT NO.<br>DOE/NASA CR-150581 | 2. GOVERNMENT ACCESSION NO. | 3. RECIPIENT'S CATALOG NO. |
|---|---|---|
| 4. TITLE AND SUBTITLE<br>Operations Manual: On Site Monitor (OSM), Solar Heating and Cooling Systems | | 5. REPORT DATE<br>October 17, 1977 |
| | | 6. PERFORMING ORGANIZATION CODE |
| 7. AUTHOR(S) | | 8. PERFORMING ORGANIZATION REPORT #<br>IBM No. 7934365 |
| 9. PERFORMING ORGANIZATION NAME AND ADDRESS<br>IBM Federal Systems Division<br>Space Systems<br>Huntsville, Alabama 35805 | | 10. WORK UNIT NO. |
| | | 11. CONTRACT OR GRANT NO.<br>Contract NAS8-32036 |
| 12. SPONSORING AGENCY NAME AND ADDRESS<br>National Aeronautics and Space Administration<br>Washington, D. C. 20546 | | 13. TYPE OF REPORT & PERIOD COVERED<br>Contractor Report |
| | | 14. SPONSORING AGENCY CODE |

15. SUPPLEMENTARY NOTES

This work was done under the technical management of Mr. Earle G. Harris, George C. Marshall Space Flight Center.

16. ABSTRACT

The On-Site Monitor (OSM) is a portable device which, when connected to a Solar System Site Data Acquisition Subsystem (SDAS), will allow readouts of clock and sensor data in voltage or engineering units at instrumented solar heating and cooling sites.

This report gives an overview of the OSM and provides the operating instructions for proper operation of the unit.

| 17. KEY WORDS | | 18. DISTRIBUTION STATEMENT<br>Unclassified-Unlimited<br><br>WILLIAM A. BROOKSBANK, JR.<br>Manager, Solar Heating and Cooling Project Ofc | |
|---|---|---|---|
| 19. SECURITY CLASSIF. (of this report)<br>Unclassified | 20. SECURITY CLASSIF. (of this page)<br>Unclassified | 21. NO. OF PAGES<br>15 | 22. PRICE<br>NTIS |

# TABLE OF CONTENTS

iii

## ABBREVIATIONS

| | |
|------|-------------------------------------------|
| ABB  | Abbreviations                             |
| BTU  | British Thermal Unit                      |
| CFM  | Cubic Feet Per Minute                     |
| CNT  | Count (Bits)                              |
| DEG  | Degrees (Azimuth)                         |
| DEGF | Degrees Fahrenheit                        |
| DT   | Differential Temperature                  |
| F    | Fahrenheit, Degrees                       |
| $FT^2$ | Square Foot                             |
| FPM  | Feet Per Minute                           |
| GPM  | Gallons Per Minute                        |
| I/O  | Input/Output                              |
| IPCL | Instrumentation Program and Components List |
| KFPM | Thousand Feet Per Minute                  |
| K/H  | Kilometers/Per Hour                       |
| KW   | Kilowatt                                  |
| LED  | Light Emitting Diode                      |
| LGLY | Langley                                   |
| MPH  | Miles Per Hour                            |
| MV   | Millivolt                                 |
| N/A  | Not Applicable                            |
| OFST | Offset                                    |
| OSM  | On-Site Monitor                           |
| PER  | Percent                                   |
| P/N  | Part Number                               |
| PROM | Programmable Read Only Memory             |
| RTC  | Real Time Clock                           |
| SCFM | Summarized Flow in Cubic Feet Per Minute  |
| SDAS | Site Data Acquisition Subsystem           |
| V    | Volt                                      |
| VAC  | Volts Alternating Current                 |

## 1.0  INTRODUCTION

This manual gives an overview of the operation of the On-Site Monitor (OSM) and provides the operating instructions for properly operating the OSM.  The latest revisions to this document are indicated by a line to the right of the changed paragraph.

## 2.0  OPERATIONS OVERVIEW

The OSM is a portable device which can be easily connected to a Site Data Acquisition Subsystem (SDAS) to allow readouts of clock and sensor data in voltage or engineering units at instrumented solar heating and cooling sites.

## 2.1  OSM LAYOUT

The OSM layout is shown in Figure 2-1 and the front panel layout is shown in Figure 2-2.  The major components of the OSM include:

o    A main housing assembly which includes the front and rear panel assemblies, chassis, card cage, and cable holder.

o    A power supply assembly

o    The following card assemblies:

   -    Microprocessor card (P/N 7932921)
   -    PROM card (P/N 7932941)
   -    I/O card (P/N 7934041)
   -    Backpanel
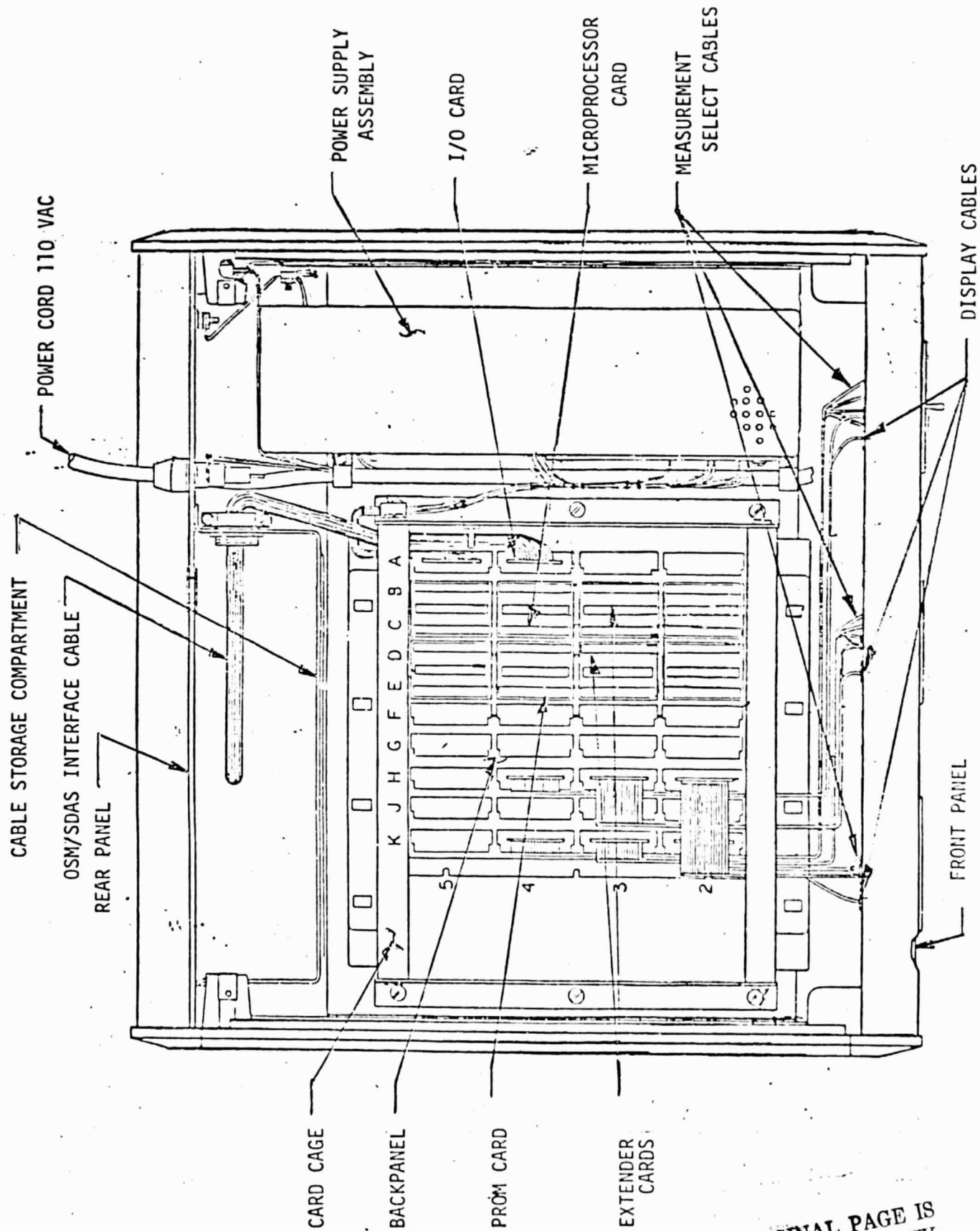   -    Extender Cards (2) (P/N 7934061)

POWER CORD 110 VAC

POWER SUPPLY ASSEMBLY

I/O CARD

MICROPROCESSOR CARD

MEASUREMENT SELECT CABLES

DISPLAY CABLES

CABLE STORAGE COMPARTMENT

OSM/SDAS INTERFACE CABLE

REAR PANEL

K J H G F E D C B A

5

4

3

2

FRONT PANEL

CARD CAGE

BACKPANEL

PROM CARD

EXTENDER CARDS

Figure 2-1    OSM PHYSICAL LAYOUT (TOP VIEW)

3

Figure 2-2 OSM FRONT PANEL LAYOUT

4

*Figure 2-3. OSM Card and Cable Mounting Schematic.*

ORIGINAL PAGE IS
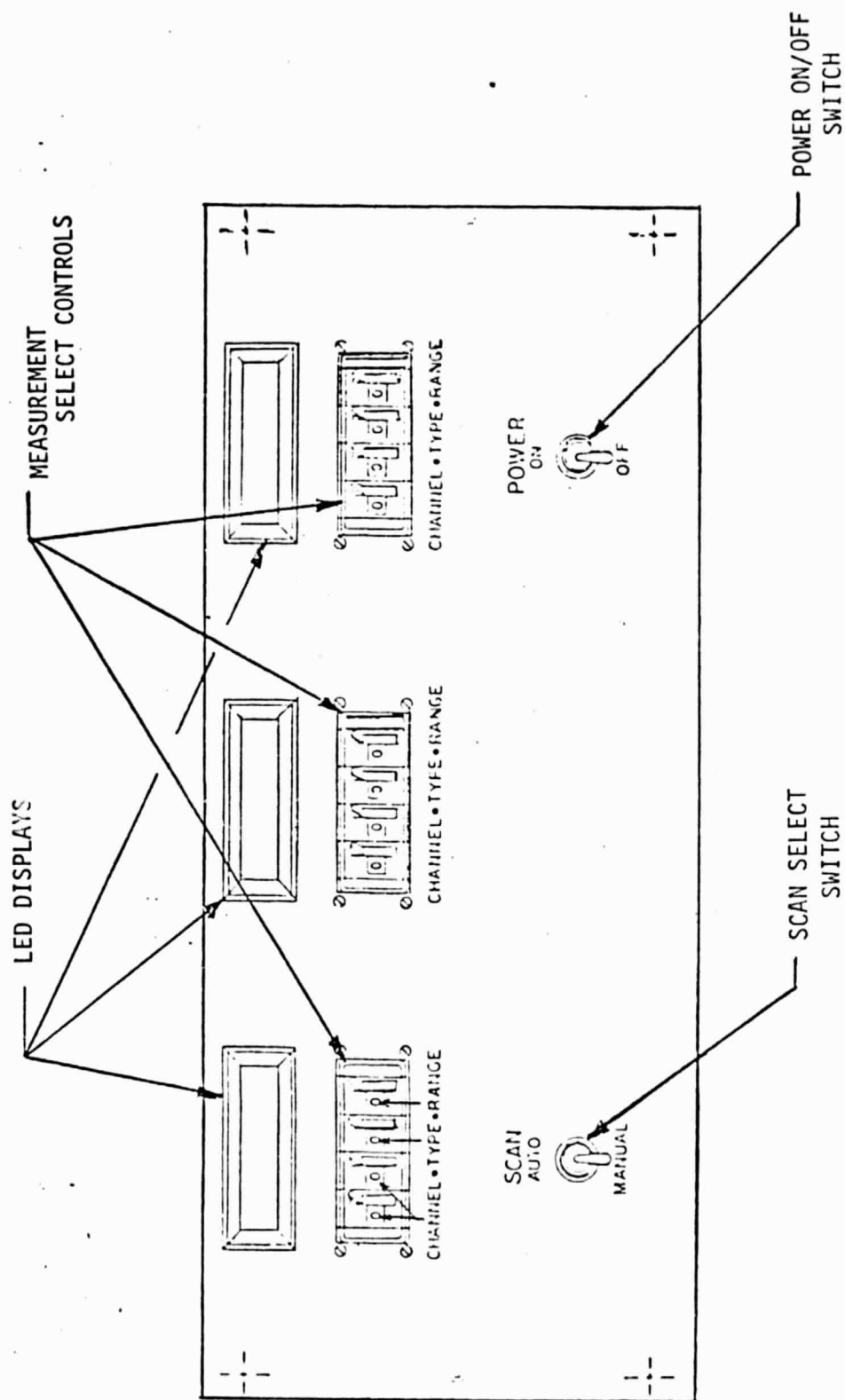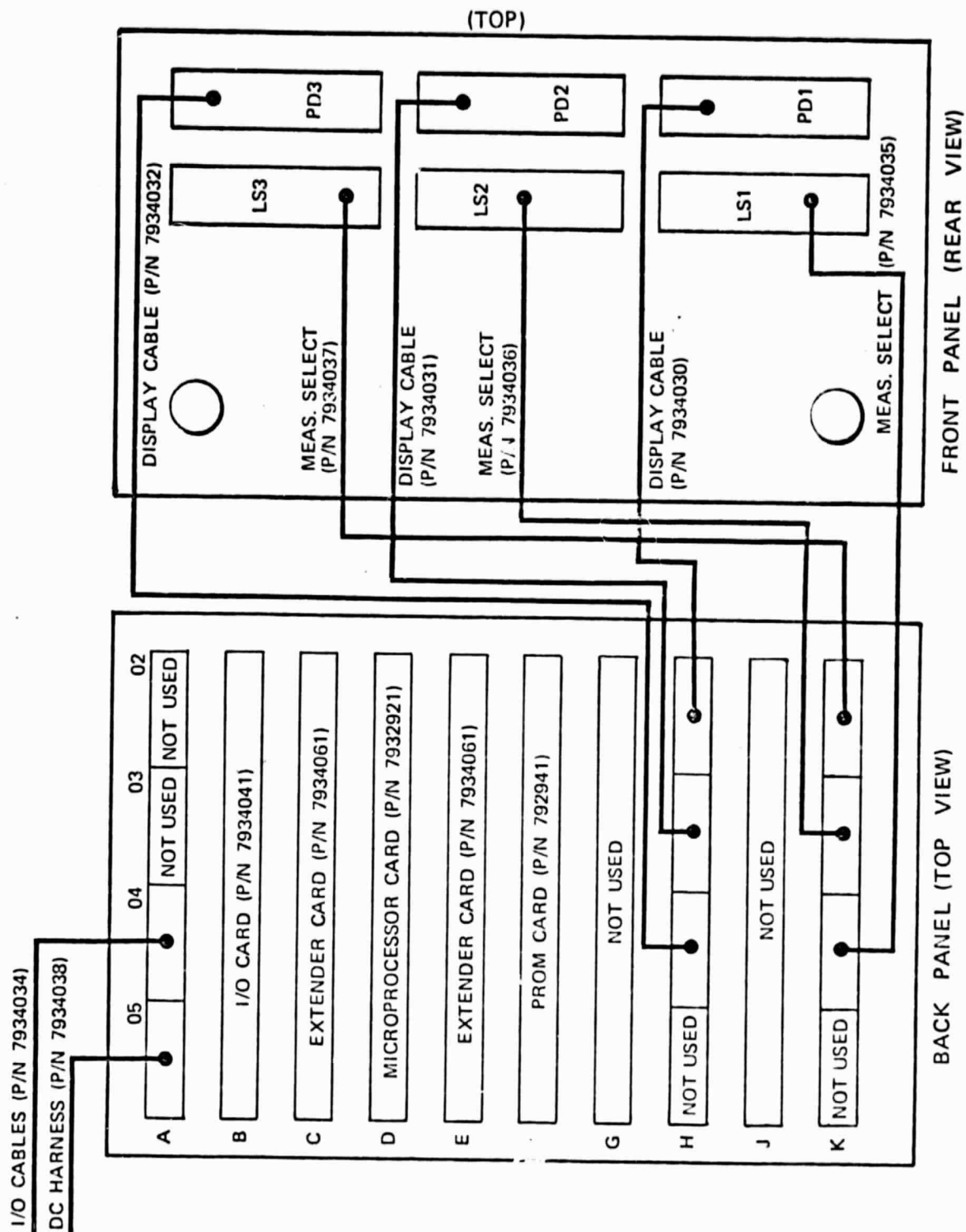OF POOR QUALITY

NOTE: CARDS SHOULD BE MOUNTED WITH COMPONET SIDE FACING AWAY FROM POWER SUPPLY.
THE CONNECTORS WHICH INCLUDE PART NUMBERS AND SERIAL NUMBERS ARE THE BOTTOM OF THE CARD.

5

- The following cable assemblies:

    - Display Cables (3)  (P/N 7934035, 7934036, 7934037)
    - OSM/SDAS Interface Cable (P/N 7934034)
    - Measurement Select Cables (3)  (P/N 7934030, 7934031, 7934032)

Figure 2-3 gives a more detailed schematic of how the card and cable assemblies are plugged or connected into the OSM back panel and front panel.

## 2.2  CONTROLS AND DISPLAYS

The front panel (Figure 2-2) includes three sets of displays and controls which allow three channels/measurements to be displayed simultaneously.  There are three sets of LED displays which provide three digit display with decimals and three corresponding measurement select controls to select the channel, measurement type and measurement range to be displayed.  The channel (0 to 99) is selected by the first and second switch from the left, the measurement type (0 to 9) by the third switch from the left and the measurement range (0 to 9) by the fourth switch from the left.  Table 2-1 gives the OSM measurement selection matrix for use in selecting measurement data to be displayed.  The measurement type is 0-9 on the left side of the chart and the measurement range is 0-9 listed at the top of the chart. For example, a setting of $\boxed{4}\boxed{5}\boxed{0}\boxed{3}$ on the measurement select control gives channel 45, the 0 indicates a temperature measurement, and the 3 indicates a measurement range of $30^{\circ}$ to $450^{\circ}$F.  The type 9 measurements include voltage, bit count, and real-time clock readings for test and raw data evaluation.  All other measurement types are in the engineering units shown.  The blank portions on the matrix indicate that these type/range values are not presently programmed.  A "Site Personalization Table" will be developed for each SDAS site to aid in the selection of channel, measurement, and range switches to aid data evaluation.

The power "ON/OFF" switch controls primary power to the OSM.  The "SCAN" switch has three positions or modes: "AUTO", "NULL" and "MANUAL".  The "NULL" position is the middle switch position and is used while data is being

6

TABLE 2-1. OSM MEASUREMENT SELECTION MATRIX

| TYPE | FORMULA | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | TEMPERATURE | -20 120 F | 30 160 F | 30 230 F | 30 450 F | | | | | | | |
| 1 | DELTA TEMP | 0 50 F | 0 80 F | 0 100 F | | | | | | | | |
| 2 | INSOLATION | 0 330 BTU | 0 350 BTU | 0 360 BTU | 0 370 BTU | 0 380 BTU | 0 390 BTU | 0 400 BTU | 0 410 BTU | 0 420 BTU | 0 435 BTU | Values given are for 0-12 mv full scale range. Select range to nearest 5 BTU. |
| 3 | WIND/HUMIDITY | 360 DEG | 100 MPH | 161 K/H | 0 100 % | | | | | | | All values are normalized to 0-50 mv full scale range |
| 4 | ELECTRIC PWR | .5 KW | 1 KW | 1.5 KW | 3 KW | 4 KW | 5 KW | 10 KW | 20 KW | 40 KW | 160 KW | |
| 5 | LIQUID FLOW (0-10 mv Range) | 0 3 GPM | 0 5 GPM | 0 6 GPM | 0 7 GPM | 0 10 GPM | 0 12 GPM | 0 15 GPM | 0 20 GPM | 0 25 GPM | 0 30 GPM | All values are for 0-10 mv full scale range. |
| 6 | LIQUID FLOW (0-10 mv Range) | 0 40 GPM | 0 70 GPM | 0 100 GPM | 0 120 GPM | 0 150 GPM | 0 175 GPM | 0 200 GPM | 0 350 GPM | 0 600 GPM | 0 1000 GPM | |
| 7 | LIQUID FLOW (0-30 mv Range) | 0 7 GPM | 0 10 GPM | 0 12 GPM | 0 15 GPM | 0 20 GPM | 0 25 GPM | 0 40 GPM | 0 70 GPM | 0 100 GPM | 0 200 GPM | Values given are for 0-30 mv full scale range |
| 8 | AIR FLOW | 0 300 FPM | 0 1250 FPM | 0 2.50 KFPM | 0 6.00 KFPM | 100 | | | | | | KFPM values given in thousands feet per minute |
| 9 | TEST SCALES/ NATURAL GAS | 100 mv | 5 V | 256 CNT | 1023 CNT | MV OFST | 5 V OFST | RTC 1-3 | RTC 4-6 | RTC 7-9 | | Natural gas engineering unit values must be calculated. |

evaluated or when no data updates are required. The "AUTO" position automatically requests and displays updated data approximately once every two seconds. The "MANUAL" position is a momentary position and is used to request one scan of data which provides for storage of all SDAS data channels for leisurely analysis of the collected data frame.

## 2.3 DESCRIPTION OF OPERATION

Once the OSM is connected to the SDAS by attaching the OSM/SDAS interface cable to the SDAS and powered on, data collection and display by the OSM operator is enabled. Activiation of the scan switch causes the SDAS to read all sensor channels and transmit the collected data to the OSM. In order to display the desired measurement now stored in the OSM, the operator next enters the assigned measurement number, the type of measurement (temperature, flow, etc.) and the measurement scale into the appropriate measurement select controls. Display of any desired measurement collected in the same scan can be accomplished by selecting another channel and the appropriate conversion formula. An updated scan will occur whenever the scan switch is again depressed to "MANUAL" and released or every two seconds when in the "AUTO" position.

## 3.0 INITIAL INSPECTION

Prior to applying prime power to the OSM, the OSM top cover should be removed by removing the two cover retainer screws. All internal cables and cards (See Figure 2-3) should be inspected to insure that they are secure and properly seated. The OSM/SDAS interface cable should be removed from the cable storage compartment and inserted into the cable holder slot on the rear panel. The top cover should then be replaced and secured.

## 4.0 CABLE CONNECTIONS

With the OSM power "ON/OFF" switch in the "OFF" position, the OSM three prong power cord should be connected to a standard 115 VAC outlet. The OSM/SDAS interface cable should then be securely connected to the J106 37 pin connector on the SDAS.

## 5.0  OSM OPERATION

The following procedures will allow proper start-up and operation of the OSM:

o   Place the power "ON/OFF" switch to the "ON" position.

o   Momentarily depress the "SCAN" switch to the "MANUAL" position.

o   Place the "SCAN" switch to the "AUTO" position and select "98" with
    the "TYPE" and "RANGE" switches respectively using one of the three
    groups of measurement select control switches.  This will display
    the SDAS real-time clock reading.  If the SDAS and OSM are operating
    properly, the LED display value will increment (by one) approximately
    every two seconds.  It should be noted that the OSM program ignores
    the channel selected when formula code "98" is selected and that the
    real-time clock readings will not be updated during SDAS recorder
    operation, when the SDAS is in telephone communications contact with
    the CDPS, or while the "SCAN" switch is left in the "NULL" position.

The Site Instrumentation Program (IP) Document should be used to identify the
measurements, measurement ranges, scaling factors, and air flow cross-sectional
area in square feet for conversions to CFM.  Scaling factors for the measure-
ment ranges and conversion to volts (XX91) or millivolts (XX90) listed in Table
2-1 are pre-programmed into the OSM.  For an accurate representation of measure-
ments with scaling factors not programmed into the OSM, the operator should
calculate the engineering units value using the following procedure.

o   Set OSM display select switches to XX93 (where XX is the channel
    number of measurement to be read).  This will cause the OSM to
    display the digital count value of the selected measurement.

o   Use Table 5-1 to determine the conversion formula for the measure-
    ment parameter listed in the IP document for the selected channel.

TABLE 5-1. PARAMETER CONVERSION FORMULAS

| CODE | PARAMETER | UNITS | ABB | CONVERSION TYPE |
|---|---|---|---|---|
| D | WIND DIRECTION | DEGREES - AZIMUTH | DEG | LINEAR (L) |
| EP | ELECTRICAL POWER | KILOWATTS | KW | LINEAR (L) |
| F | FLOWRATE (NATURAL GAS) | FEET$^3$/MINUTE | SCFM | LINEAR (L) |
| I | SOLAR FLUX | BTU PER FT$^2$ PER HR | BTU/FT$^2$ - HR | LINEAR (L) |
| RH | HUMIDITY | PERCENT | PER | LINEAR (L) |
| SP | SPARE | N/A | N/A | - |
| T | TEMPERATURE | DEGREES FAHRENHEIT | DEGF | LINEAR (L) OR OFFSET LINEAR (OL) |
| TD | DIFFERENTIAL TEMP. | DEGREES FAHRENHEIT | DEGF/DT | LINEAR (L) |
| W | FLOWRATE (LIQUID/AIR) | GALLONS PER MINUTE FEET PER MINUTE | GPM FPM | SQUARE ROOT (R) THIRD ORDER (T) * |
| V | WIND SPEED | MILES PER HOUR KILOMETERS PER HOUR | MPH K/H | LINEAR (L) |

X = Digital Counts Value of Measurement in Base 10 [Read from OSM (XX93) Selection]

C = Coefficient or Scale Factor (Given in the Site IPCL)

L = C (X)

OL = C(X) $\pm$ (Offset)

R = $\sqrt{C(X)}$

T = $C_0 + C_1X + C_2X^2 + C_3X^3$ (Notice that $C_0$ will usually equal zero, therefore, only $C_1$ through $C_3$ are given in the Site IPCL. * FPM times cross-sectional area = CFM

- Plug into the equation the scale factor or coefficient (C) from the IP document and the digital value (X) displayed on the OSM to determine the correct value in engineering units.

The "SCAN" switch should be placed in the "AUTO" position to update and display the selected parameters approximately once every two seconds. The "SCAN" switch should be momentarily depressed to the "MANUAL" position and released to the neutral position to obtain and store a scan of data (all channels). This feature allows correlating different measurement channels to a common interval of time. Therefore, any measurement sampled may be displayed by selecting the proper measurement select control setting.

## 6.0 ERROR CONDITIONS

The following gives an overview of possible error displays and the procedures to be followed for error correction.

- A display of -188.8 (Range Type or Formula Select Error) indicates that a non-programmed switch code selection has been made. Consult the "OSM Measurement Selection Matrix" for proper switch settings. A display of -190.9 (OSM Buffer Overflow Error) or -191.9 (Zero Bytes Transfer Error) are indications that some error has occurred during transfer of SDAS data to OSM. When operating in "MANUAL SCAN", switch set-up should be reverified for valid selection and "Manual" scan action repeated. If error indication persists in "AUTO" scan, some fault exists between SDAS and OSM data transfers, and the IBM representative designated below should be contacted.

- If the OSM does not display proper readings or the real-time clock reading does not operate, and the inspection and operating procedures described in Sections 3.0, 4.0 and 5.0 have been properly implemented, the following procedures should be taken:

11

1.  Assure that the SDAS is operating properly by monitoring tape write operations (The SDAS will write to tape approximately once each half hour for a 48-channel SDAS).

2.  Assure that the OSM/SDAS interface cable is properly attached to SDAS J106 connector.

3.  Depress the "SCAN" switch to the "MANUAL" position and then lock into the "AUTO" position and monitor for increments in real time clock value.

4.  If SDAS clock readings still do not increment, remove power, disconnect cables and contact the following IBM representative to request maintenance assistance:

> J. E. Sleigh
> Telephone:  (205) 837-4000, Ext. 2255
>
> or
>
> R. E. Day
> Telephone:  (205) 837-4000, Ext. 2250