

AD-A080 404

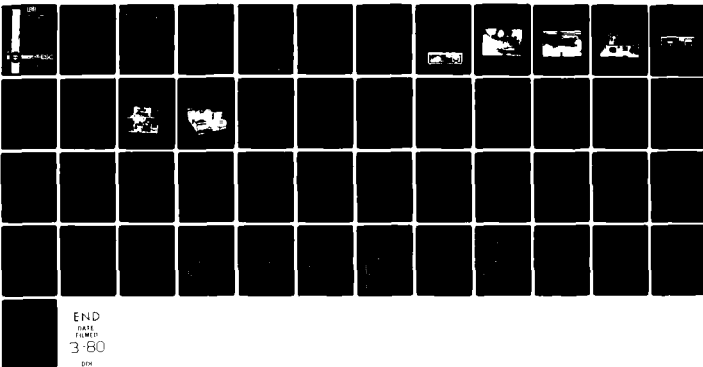
AIR FORCE ENGINEERING AND SERVICES CENTER TYNDALL AF--ETC F/6 3/2  
SOLAR INSOLATION RECORDING SYSTEM (SIRS) REFERENCE MANUAL (U)  
DEC 79 E E STAPLETON, M R MANTZ

UNCLASSIFIED

AFESC/ESL-TR-79-34

NL

1 of 1  
AD-A080 404



END  
DATE  
FILMED  
3-80  
DOW

**2<sup>5</sup> LEVEL II**

ESL-TR-79-34

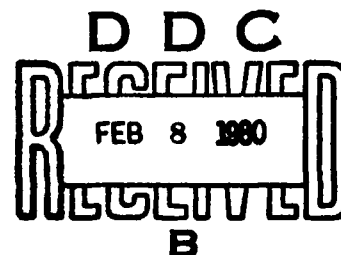
**SOLAR INSOLATION RECORDING SYSTEM  
(SIRS) REFERENCE MANUAL**

**SMSGT EDWARD E. STAPLETON  
1st LT MICHAEL R. MANTZ**

**DECEMBER 1979**

**INTERIM REPORT**

**JANUARY 1977 - DECEMBER 1978**



**APPROVED FOR PUBLIC RELEASE;  
DISTRIBUTION UNLIMITED**



**AFESC**

**ENGINEERING AND SERVICES LABORATORY  
AIR FORCE ENGINEERING AND SERVICES CENTER  
TYNDALL AIR FORCE BASE, FLORIDA 32403**

**80 2 6 026**

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

| REPORT DOCUMENTATION PAGE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                            | READ INSTRUCTIONS<br>BEFORE COMPLETING FORM                                             |                                  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|-----------------------------------------------------------------------------------------|----------------------------------|
| 1. REPORT NUMBER<br>30/ESL-TR-79-34                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 2. GOVT ACCESSION NO.                      | 3. RECIPIENT'S CATALOG NUMBER                                                           |                                  |
| 4. TITLE (and Subtitle)<br>Solar Insolation Recording System (SIRS)<br>Reference Manual                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                            | 5. TYPE OF REPORT & PERIOD COVERED<br>Interim <i>kept</i><br>January 1977-December 1978 | 6. PERFORMING ORG. REPORT NUMBER |
| 7. AUTHOR(s)<br>10/Edward E. Stapleton SMSgt, USAF<br>Michael R. Manta 1st Lt, USAF                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 8. CONTRACT OR GRANT NUMBER(s)<br>In-House |                                                                                         |                                  |
| 9. PERFORMING ORGANIZATION NAME AND ADDRESS<br>HQ AFESC/RDVW<br>Tyndall AFB FL 32403                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                            | 10. PROGRAM ELEMENT, PROJECT, TASK<br>AREA & WORK UNIT NUMBERS<br>64708F, JON 20545006  |                                  |
| 11. CONTROLLING OFFICE NAME AND ADDRESS<br>HQ AFESC/RDVW<br>Tyndall AFB FL 32403                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                            | 12. REPORT DATE<br>December 1979                                                        | 13. NUMBER OF PAGES<br>50        |
| 14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)<br>1256                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                            | 15. SECURITY CLASS. (of this report)<br>UNCLASSIFIED                                    |                                  |
| 16. DISTRIBUTION STATEMENT (of this Report)<br>Approved for public release; distribution unlimited.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                            |                                                                                         |                                  |
| 17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)<br>DDC<br>REF ID: A66111<br>FEB 8 1980<br>B                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                            |                                                                                         |                                  |
| 18. SUPPLEMENTARY NOTES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                            |                                                                                         |                                  |
| 19. KEY WORDS (Continue on reverse side if necessary and identify by block number)<br>Solar Data Recorder<br>Solar Radiation Data Logger<br>Solar Insolation Digital Data Collection System<br>Solar Insolation Recording System<br>Data Acquisition System                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                            |                                                                                         |                                  |
| 20. ABSTRACT (Continue on reverse side if necessary and identify by block number)<br>This manual provides the installation procedures, theory of operation, and maintenance procedures necessary to install, operate, calibrate, maintain and understand the Solar Insolation Recording System (SIRS) which is a micro-computer-based data acquisition system used to collect solar insolation data. Traditionally solar data has been collected in an analog format (strip chart). Large quantities of data were particularly difficult to manipulate. Therefore, to simplify the processing of data, a data acquisition system was designed and built which produced a computer compatible data medium. |                                            |                                                                                         |                                  |

DD FORM 1473  
1 JAN 73

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

394 653

15

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

Block 20 (Concluded)

*cont.* → In the case of SIRS, the data media is digital cassette tapes. These tapes can be read into a larger computer where complex data manipulation/processing can be accomplished. This document strictly addresses the data acquisition system. Data reduction and manipulation will be covered in the final technical report on Solar Radiation Measuring.

↖

UNCLASSIFIED

## PREFACE

This report was prepared by SMSgt Edward E. Stapleton and 1st Lieutenant Michael R. Mantz of the Energy Research Office, Engineering and Services Laboratory, Air Force Engineering and Services Center. The development was conducted by SMSgt Stapleton and 1st Lt Mantz as part of a larger Solar Radiation Measuring effort.

When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto. Any reference to a particular manufacturer of product brand is by no means to be considered an endorsement of that company or product.

This report has been reviewed by the Information Office (OI) and is releasable to the National Technical Information Service (NTIS). At NTIS it will be available to the general public, including foreign nations.

This report has been reviewed and approved for publication.

*Edward E. Stapleton*

EDWARD E. STAPLETON, SMSgt, USAF  
Project Officer

*Gary G. Worley*

GARY G. WORLEY, Maj, USAF  
Chief, Assessment Technology  
and Energy Branch

*Emil C. Frein*

EMIL C. FREIN, Maj, USAF  
Chief, Environics Division

*Joseph S. Pizzuto*

JOSEPH S. PIZZUTO, Col, USAF, BSC  
Director, Engineering and  
Services Laboratory

|                                 |                                                   |
|---------------------------------|---------------------------------------------------|
| ACCESSION for                   |                                                   |
| NTIS                            | White Section <input checked="" type="checkbox"/> |
| DDC                             | Buff Section <input type="checkbox"/>             |
| UNANNOUNCED                     | <input type="checkbox"/>                          |
| JUSTIFICATION _____             |                                                   |
| BY _____                        |                                                   |
| DISTRIBUTION/AVAILABILITY CODES |                                                   |
| Dist.                           | AVAIL. and/or SPECIAL                             |
| A                               | -                                                 |

# TABLE OF CONTENTS

| Section    | Title                                     | Page |
|------------|-------------------------------------------|------|
| I          | INTRODUCTION.....                         | 1    |
|            | Background .....                          | 1    |
|            | Purpose of Manual .....                   | 1    |
| II         | INSTALLATION .....                        | 2    |
| III        | OPERATION .....                           | 5    |
| IV         | CALIBRATION .....                         | 7    |
| V          | MAINTENANCE .....                         | 8    |
| VI         | SYSTEM OVERVIEW .....                     | 9    |
|            | Hardware Overview .....                   | 9    |
|            | Software Overview .....                   | 12   |
| VII        | THEORY OF OPERATION .....                 | 13   |
|            | System Initialization .....               | 13   |
|            | Record/Standby Switch .....               | 13   |
|            | Time/Date Set Switches.....               | 13   |
|            | Time/Date Display .....                   | 14   |
|            | Digital Cassette Recorder Interface ..... | 14   |
|            | Real Time Clock .....                     | 15   |
|            | BIBLIOGRAPHY.....                         | 16   |
| APPENDIX A | SCHEMATICS OF SIRS COMPONENTS.....        | 17   |
| APPENDIX B | I/O SUMMARY .....                         | 21   |
| APPENDIX C | MEMORY MAP .....                          | 23   |
| APPENDIX D | FLOWCHARTS .....                          | 24   |
| APPENDIX E | SOURCE SOFTWARE .....                     | 30   |

# LIST OF FIGURES

| Figure | Title                                                     | Page |
|--------|-----------------------------------------------------------|------|
| 1      | Solar Insolation Recording System (Less Pyranometer)..... | 1    |
| 2      | Weather Station Pyranometer Installation .....            | 2    |
| 3      | Eppley Precision Spectral Pyranometer (Installed) .....   | 3    |
| 4      | SIRS Recording System (In Place) .....                    | 4    |
| 5      | SIRS Front Panel .....                                    | 5    |
| 6      | SIRS Block Diagram .....                                  | 9    |
| 7      | SIRS Recording System .....                               | 10   |
| 8      | Card Cage .....                                           | 11   |

# LIST OF TABLES

| TABLE | Title                                               | Page |
|-------|-----------------------------------------------------|------|
| 1     | Operation of Solar Insolation Radiation System..... | 6    |

## SECTION I

### INTRODUCTION

#### 1.0 BACKGROUND

This interim technical report addresses the Solar Insolation Recording System (SIRS), a piece of hardware developed as a part of a larger effort on Solar Radiation Measuring. This project was undertaken to provide (1) an adequate data base for large scale design of solar energy collectors, (2) to provide correlation between local measurements of solar radiation and regional measurements being taken by National Oceanic and Atmospheric Administration (NOAA) and (3) to determine the applicability of this equipment to current or future Air Weather Services procedures. The hardware/software development began in January 1978 and was completed in April 1978.

The system was initially tested from June 1978 to August 1978. It was installed at Det 9, 12th Weather Squadron, 3rd Weather Wing, Tyndall AFB, Florida on 11 November 1978 for operational testing. Development was initiated by the Air Force Civil Engineering Center and was completed by the Civil and Environmental Engineering Development Office (CEEDO). Since this effort was completed, CEEDO has become the Directorate of Research and Development of the Air Force Engineering and Services Center (AFESC).

#### 2.0 PURPOSE OF MANUAL

This manual provides the user with the installation procedures, theory of operation, and maintenance procedures necessary to install, operate, calibrate, maintain and understand the SIRS, developed and constructed by members of the Energy Research Office of the Air Force Engineering and Services Laboratory (Figure 1). Schematics of SIRS components are presented in Appendix A.

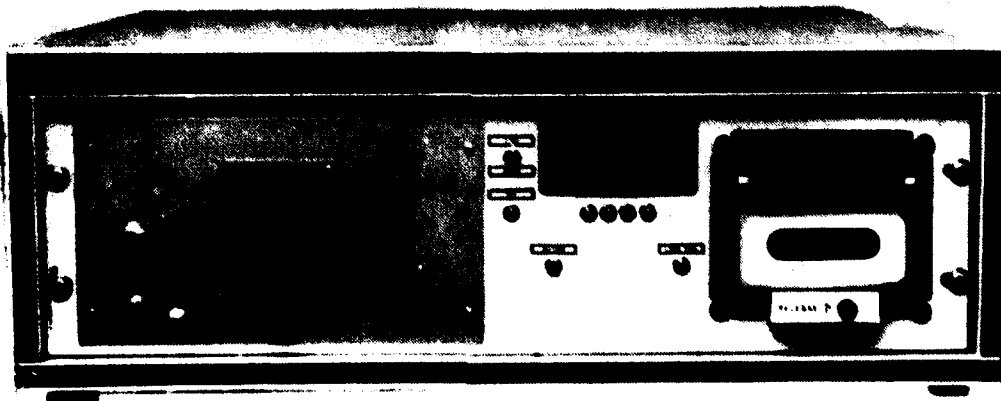


Figure 1. Solar Insolation Recording System  
(Less Pyranometer)

## SECTION 11

### INSTALLATION<sup>1</sup>

The site for an upward-looking pyranometer should be free from any significant obstructions above the plane of the sensing element and, at the same time, should be readily accessible. If practicable, the instrument should be so located that (a) a shadow will not be cast on it at any time (e.g. by radio masts, etc.); (b) it is not close to light-colored walls or other objects likely to reflect sunlight onto it; and (c) it is not exposed to artificial radiation sources.

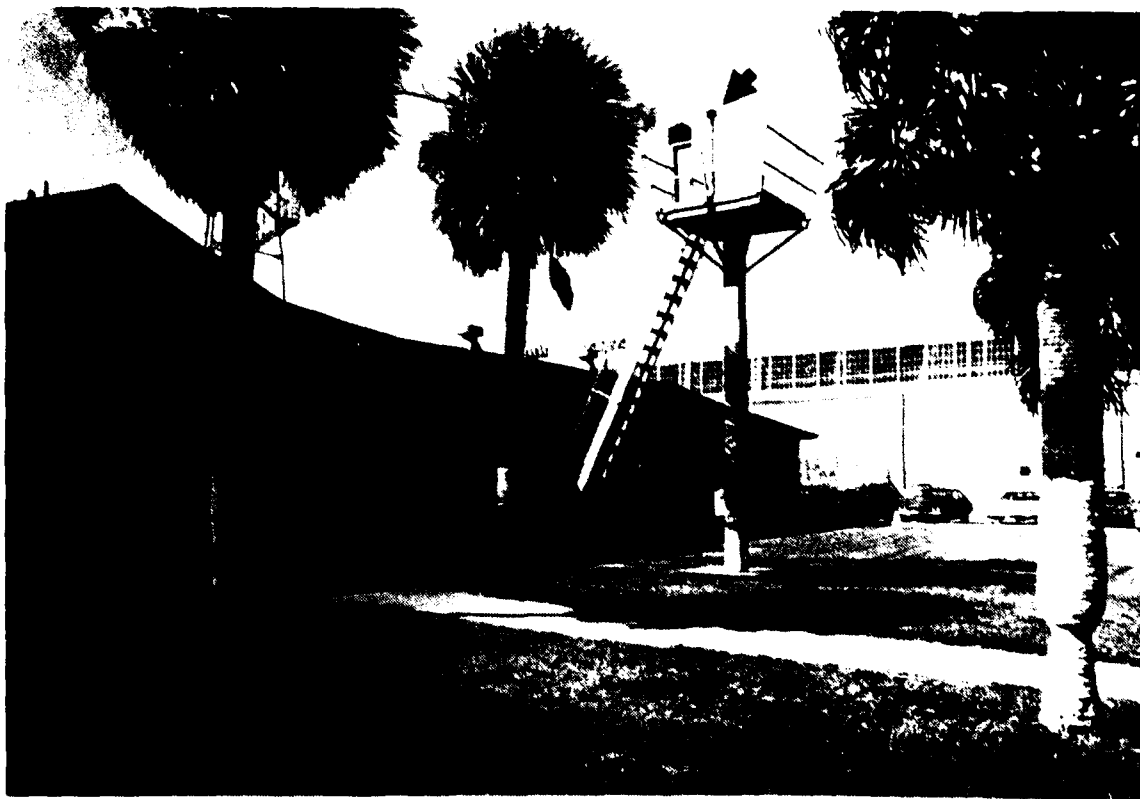


Figure 2. Weather Station Pyranometer Installation

<sup>1</sup> Reference "Eppley Electronic Integrator Instructions, Models 410," Eppley Laboratory, Inc.

At most places, a flat roof provides the best location for mounting the instrument; if such a site cannot be obtained, a rigid stand with a horizontal upper surface some distance from structures or other obstructions should be used.

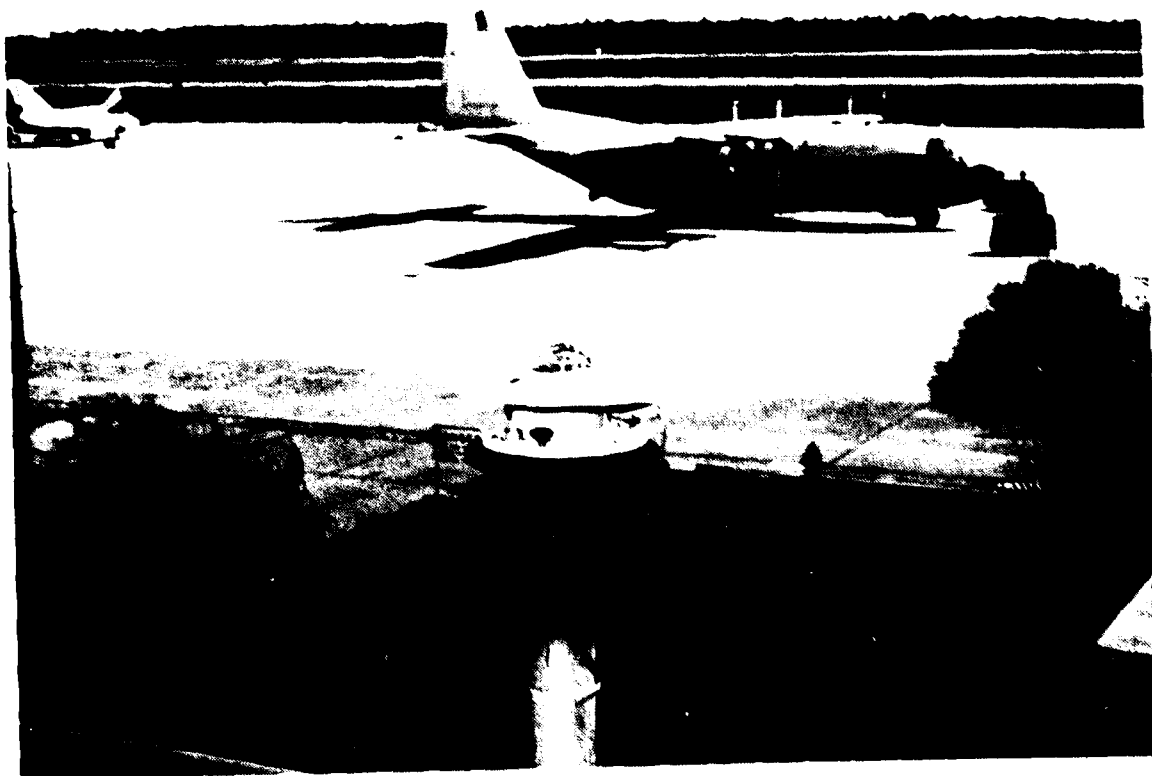


Figure 3. Eppley Precision Spectral  
Pyranometer (Installed)

The pyranometer should be connected to the recorder by a cable of no more than 50 feet in length to prevent generating common-mode voltages.

The integrator recorder requires only a source of 110 VAC, 60 Hz.



Figure 4. SRS Recording System  
(Installed)

## SECTION III

### OPERATION

A self-explanatory checklist is provided in Table 1 for operation of the recording system.

It should be noted that the clock must be reset if even a momentary power failure occurs (due to lightning strikes, etc) since no provision was made for battery backup of the random access memory.

Tapes used may be Datel<sup>®</sup> certified digital cassettes, part number 12123-1 or equivalent. Ten to eleven months of data (at 60-minute intervals) can be recorded on one cassette.

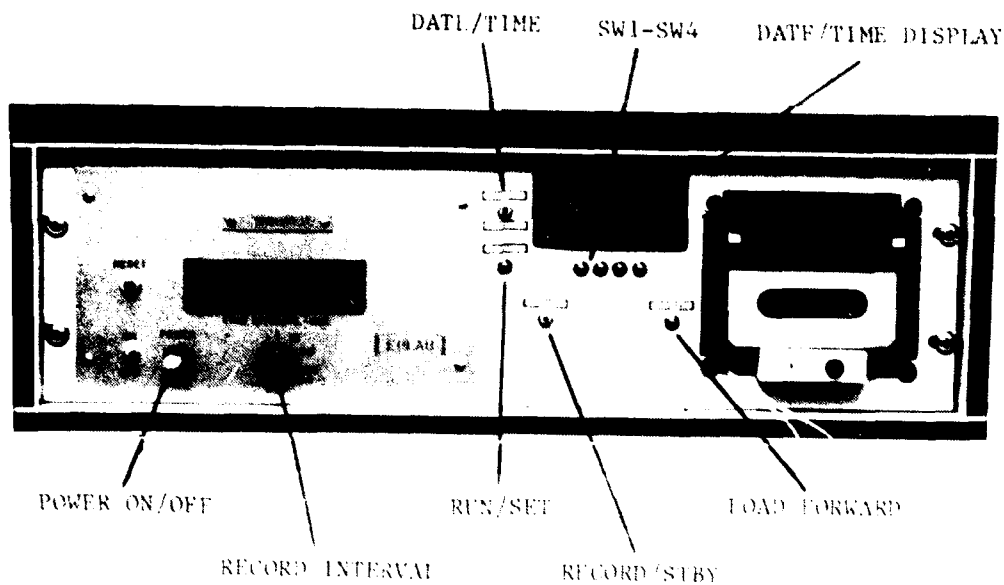


Figure 5. SIRS Front Panel

TABLE 1. OPERATION OF SOLAR INSOLATION  
RECORDING SYSTEM

A. Start Up:

1. Turn on power.
2. Set record interval (1, 10, or 60 minutes).
3. Set "record" switch down.
4. Set "date/time" switch to time.
5. Set time:  
Depress "set" switch while incrementing display using switches under individual digits (24-hour time).
6. Set date/time switch to date.
7. Set Julian date as in step 5 above.  
(8235 = 1978 235th day)
8. Install cassette.
9. Depress load forward until leader is run off.
10. Depress bar on top of recorder so head contacts tape.
11. Set "record" switch up.

B. Changing Tapes:

1. Set record switch down.
2. Depress release button on recorder.
3. Remove tape.
4. Install new tape.
5. Depress load forward until leader is run off.
6. Depress bar on top of recorder so head contacts tape.
7. Set record switch up.

C. Power Failure/Reset:

Set time and date as in A5, A6, and A7.

#### SECTION IV

#### CALIBRATION

The end instrument should be calibrated once a year or prior to being installed if more than a year has elapsed since the last calibration.

The pyranometer (not the recorder) should be sent to:

Solar Radiation Facility  
National Oceanic and Atmospheric Admin  
Environmental Research Laboratories  
Boulder CO 80302  
ATTN: Mr Edwin C. Flowers

Calibration takes approximately three weeks.

The integrator can be calibrated using a 10-millivolt source to adjust the gain and offset.

With a NOAA calibration of  $8.83 \times 10^{-6}$  volts/watt-meter<sup>-2</sup>, the counter is adjusted to produce 359.2 counts/hour with a 10 mV input using the formula:

$$\text{Sensitivity} = \frac{8.83 \times 10^{-6} \text{ V}}{\text{W/m}^2} \times \frac{3.152 \text{ W/m}^2}{\text{Btu/ft}^2 - \text{hour}}$$
$$= 35.92 \text{ Btu/ft}^2\text{-hour/mV}$$

$$10 \text{ mV} = 359.2 \text{ Btu/ft}^2\text{/hour}$$

where the derived constant is  $8.83 \times 10^{-6} \text{ V/Wm}^2$  and

$$1 \text{ Btu/ft}^2\text{-hour} = 3.152481 \text{ W/m}^2$$

## SECTION V

### MAINTENANCE

Pyranometers in continuous operation should be inspected, ideally, at least once per day. At these inspections, the (outer) hemisphere should be wiped clean and dry with a lint-free soft cloth. In desert or arid regions, the hemisphere should be cleaned very gently in order to prevent scratching of the surface. Such abrasive action can alter appreciably the original transmission properties of the material and, hence, the radiometer calibration. If frozen snow, glazed ice, hoar frost or rime is present, an attempt should be made to remove, at least temporarily, the deposit carefully with warmed cloths. In the polar regions, it will be necessary to experiment to discover the best method of keeping pyranometers frost free. It has been found that warm cloths (heated inside the recorder hut and held against the body while travelling between hut and instruments) are sometimes useful. Under some conditions, it is impossible to keep frost off the instruments for any length of time; in such instances, attempts should be made to remove frost at convenient times during the day when the sun is shining.

Should the internal surface of the (outer) hemisphere become coated with moisture, it can be cleaned by careful removal on a dry day, allowing the air to evaporate the moisture and then firmly resecuring the hemisphere. The inside of the hemisphere should not be wiped unless smears are visible. Precautions should be taken to avoid scratching the under-surface of the collar carrying this hemisphere. The external surface of the inner hemisphere can also be cleaned, if necessary, when the outer one is removed. Should moisture be deposited on the inside of the small hemisphere, it can similarly be removed. However, extreme care must be exercised since the thermopile element is now unprotected and could be seriously damaged.

Occasionally, the desiccator installed in the pyranometer case should be inspected. Whenever the silica gel drying agent is pinkish or white in color, it should be replaced. (Silica gel can be rejuvenated by drying in an oven at about 135°C for a few hours, until the original dark blue color reappears).

The circular spirit level of the pyranometer should be inspected at regular intervals.

Other than verification of proper operation, no preventive maintenance is required for the recording equipment.

## SECTION VI

### SYSTEM OVERVIEW

The instrumentation system consists of a pyranometer, an integrator, a single-board microcomputer, a digital cassette recorder, and a front panel which consists of a four-digit display and input switches (Figure 6).

#### SOLAR INSOLATION RECORDING SYSTEM

##### BLOCK DIAGRAM

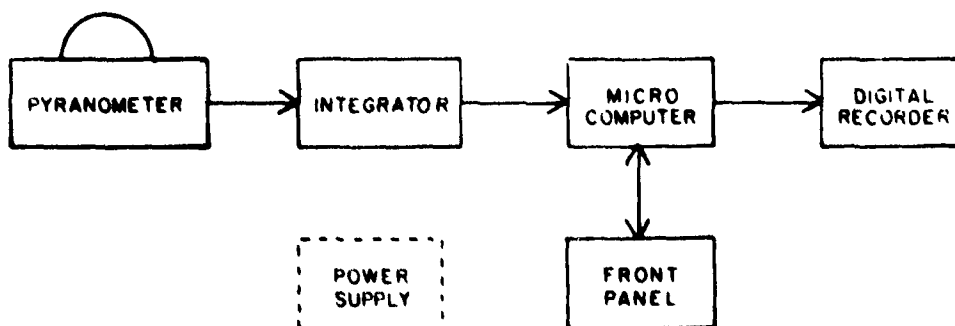


Figure 6. SIRS Block Diagram

### 1.0 HARDWARE OVERVIEW

The pyranometer is an Eppley Laboratory Precision Spectral Pyranometer, Model PSP. The output of the pyranometer thermopile is fed directly to the input of an Eppley Laboratory Electronic Integrator, Model 411, where the low level analog signal from the pyranometer is amplified and converted into a pulse-rate output proportional to the input signal. This output pulse train is counted and totalized to produce the integral of the input signal. The count is displayed on an electronic digital counter which counts in binary coded decimal (BCD). The BCD from the display is also paralleled to connector Pl02 at the rear of the integrator, along with the interval selection switch and integrator reset.

The microcomputer is an Intel Single Board Computer, SBC 80/10, with an Intel SBC 630 power supply. The SBC has an 8080 CPU, system clock, 1K by 8 bit words of read/write memory (RAM), provision for up to 4K by 8

bits of read-only-memory (ROM), 48 parallel input/output (I/O) lines (two groups of three ports, eight lines per port) and a serial communications interface (Figure 3).

The recorder is a Patel<sup>®</sup> 1200 cassette data logger, modified by removing its analog to digital converter and multiplexer cards. It receives and serially records an eight bit parallel output from one of the IBC<sup>®</sup> ports. An interface card converts the 5-volt IBC<sup>®</sup> output to a 12-volt level for the recorder, (TTL CMOS) (Figure 3).

The display consists of four Hewlett Packard 5082-1340 solid state hexadecimal indicators. They have self-contained decoder drivers and latched memory. A positive logic 1-2-4-8 is decoded into 16 states, 0-9 and A-F, for display. It is used to display the Julian date and time.

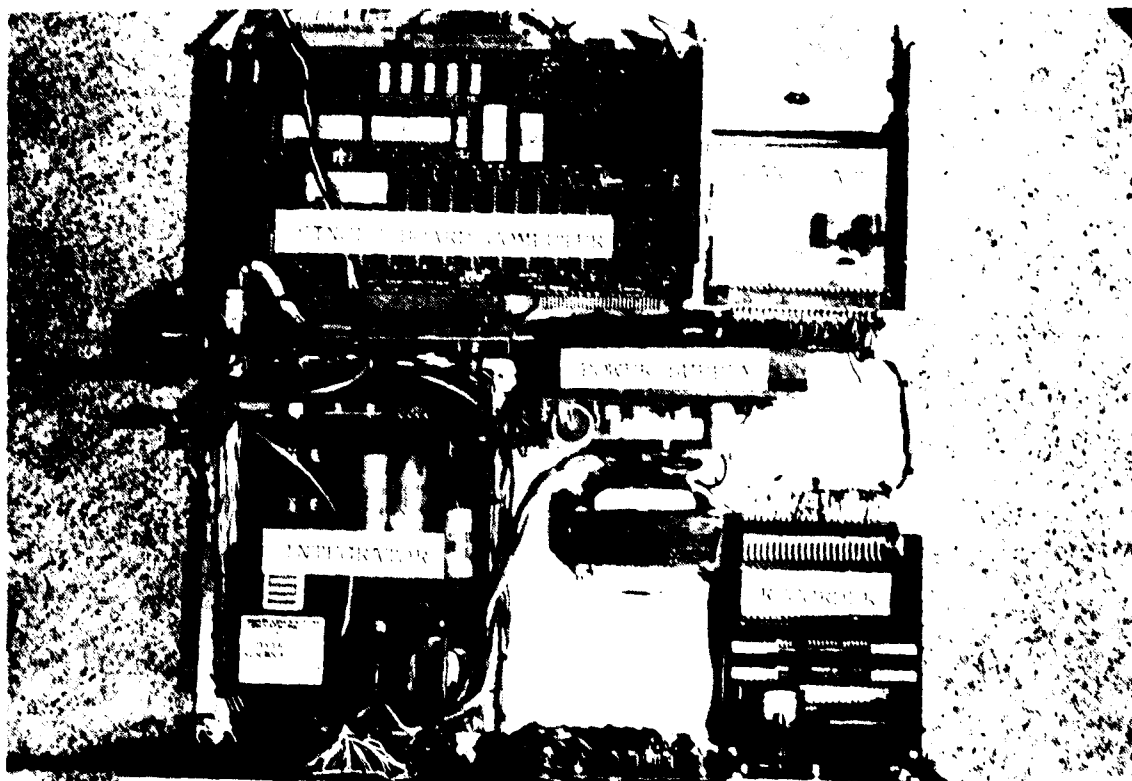


Figure 3. Subsystem layout

The real time interrupt driven clock is a software clock that is incremented by a hardware interrupt synchronized to the 60 cycle line frequency (Figure 8). Switches are provided to set and display the date/time, disable recording during loading of a tape, and load forward new tape off the loader.

Power for everything except the information is supplied by the 500 watt power supply.

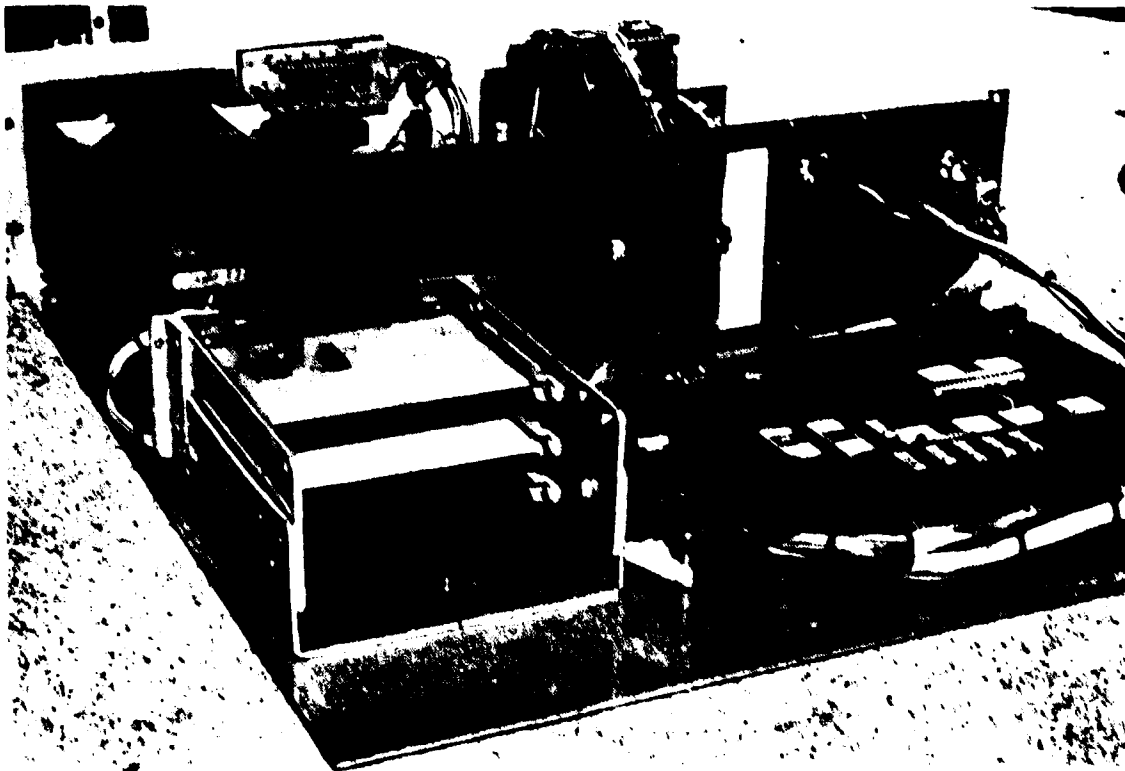


Figure 8. Card cage

## 2.0 SOFTWARE OVERVIEW

After power-up, the program initializes the I/O and selected memory locations and then enters the main loop. The main loop simply calls three subroutines, checks the position of the date/time switch, displays either the date or time, and then jumps to the beginning of the main loop.

The first routine, called STBYCK, senses the record/standby switch position and sends a file gap to the recorder on a transition from "stand-by" to "run." This in turn resets the recorder word counter.

The next routine, RCDTM, checks the time and at seconds = 00 stores the integrator output, resets the integrator, and then records the date, time, data, and interval.

SWCHK scans the front panel switches. If a switch is depressed, SWCHK increments the appropriate counter. If no switch is depressed, the routine is exited.

TIMIT is an interrupt-driven, real-time software clock. An interrupt is generated every sixtieth of a second by a hardware, real-time clock generator. These interrupts temporarily stop the execution of the main program loop. TIMIT updates the time and date counter and then returns control to the main programs.

## SECTION VII

### THEORY OF OPERATION

#### 1.0 SYSTEM INITIALIZATION

System power is applied through the "on-off" switch on the integrator. This causes a power-on reset sequence in the microprocessor, which immediately jumps to PROM memory location 50H where initialization is started. To initialize the I/O ports, (see Appendix B), an initialization word is sent to the appropriate control registers. Group B I/O ports automatically come up with all ports set for "INPUT." Group A I/O ports are set so port 1 is "INPUT" and ports 2 and 3 are "OUTPUT." Memory locations for time, date, and interval are initialized to 00 (See Appendix C.)

An integrator reset and a recorder file gap command are also generated at this time. This is accomplished by strobing bits 5 and 6 of port 2 low, then high. All output ports are active low. The integrator requires an active low for reset; however, the recorder requires active high for all inputs, control and data. The recorder also requires a +12 volt logic level. Since the port output is only +5 volts, an inverting buffer is used to drive all recorder inputs; the output of the buffer is active high at +12 volts.

#### 2.0 RECORD/STANDBY SWITCH

After initialization, the first subroutine called STBYCK checks the setting of the record/standby switch, SW7, (all front panel switches are debounced prior to being applied to a port). The output of the debouncer for SW7 (J102-S) is applied to port 1 bit 6 (J1A-18), where it is checked for 'record' or 'stby.' If 'stby,' a flag is set and the subroutine is exited. The first time this subroutine is called after SW7 is put into the "record" mode, a check is made of the flag. If set, a file gap is generated and the flag reset, which insures only one file gap will be generated for each transition of the switch from standby to record. This allows tapes to be changed and the recorder word counter to be reset without interfering in any way with the other operations. When SW7 is in the standby position it also holds off the recording process in the subroutine RECDAT.

#### 3.0 TIME/DATE SET SWITCHES

SW5 (run/set) is a momentary-on switch that must be held down while incrementing the date or time. It appears at port 1 bit 0 (J1A-21), and is sensed in SWCHK. After the program determines that SW5 is in the "set" position it checks SW6, port 1 bit 1 (J1A-22) for date or time (date = active high, time = low). If SW6 is in the date position, first the date will be displayed and then the four switches (SW 1 through SW 4) will be scanned. The memory location for the digit above a switch will be incremented each time that a switch is depressed and the new number is displayed.

The diagram below depicts the relationship of SW1 through SW4 to the display, input port, and SBC connector J1A.

| Switch | Display Digit | Port 1 | SBC Input |
|--------|---------------|--------|-----------|
| 1      | 1             | Bit 2  | J1A 23    |
| 2      | 2             | Bit 3  | J1A 24    |
| 3      | 3             | Bit 4  | J1A 20    |
| 4      | 4             | Bit 5  | J1A 19    |

If SW6 is in the time position the memory locations for time will be incremented in the same manner as the date, above.

#### 4.0 TIME/DATE DISPLAY

The data inputs of the individual digits of the display are wired in parallel. After data are latched up at the output of port 3, the individual display digit selected for displaying that data is strobed and the data latched into the digits memory where they are retained. The lower four bits of port 3 are used for both the display and the eight bit word sent to the recorder. The "digit latch" and "record" strobes determine which of these responds to, or accepts, the data for input. Port 2 bits 0 through 3 (J1A-4 through J1A-1) make up the display digit latch (strobe) port; outputs are normally held high and strobed low when loading the display.

#### 5.0 DIGITAL CASSETTE RECORDER INTERFACE

The data output from the integrator (P102 pins 1-20) are an active high, six digit, BCD number in the format 1-2-4-8, 10-20-40-80, etc. J102 connects directly to J2A, (group B, ports 4, 5, and 6). Of the four upper bits of port 6 that remained, bits 4, 5, and 6 are used to sense the position of the interval switch on the integrator. P102 pin 22 is grounded when an interval rate of 1-minute is selected (active low) and is routed to J2A, pin 14 (bit 4, port 6). When "seconds = 00" (once each minute), the internal switch is scanned; and if interval equals 1 minute, the data from the integrator are sensed and stored in memory. The integrator then is reset and counting is begun on the next cycle while the date, time data, and interval are recorded.

The recording process consists of accessing the memory location containing the required data, i.e., date, and outputting it to the recorder with a strobe to start recording. The recorder immediately returns a "recorder busy" and holds it high until the data have been converted from parallel to serial and have been put on tape. This "busy bit" is monitored until it returns low, at which time new data are sent to the recorder. This continues until all the data are recorded, after which the program returns to the main loop until the next record time.

Data to the recorder are latched up at J1A 9-16 (port 3 bits 0 through 7). From there it is converted to a 12-volt level before being applied to the recorder input. J1A-6 (port 2, bit 5) is the output for the record strobe, and it, also, is amplified prior to being sent to the recorder.

The "busy-bit" appears at recorder I/O plug, P1A-F, and is changed from active 12 VDC to active 5 VDC before being applied to J1A-17 (port 1 bit 7).

#### 6.0 REAL TIME CLOCK

The main program is interrupted every sixtieth of a second by the output of the interrupt generator, which causes all processing of the main loop to be temporarily suspended while the real time clock is incremented by software in the subroutine TIMIT.

The interrupt generator uses the 5 VAC from the power supply to lock the timing to the line frequency. The 60-Hertz input is clipped and applied to a 7413 Schmitt trigger for shaping before driving a 74121 monostable multivibrator. The "not Q" output is used to drive the SBC interrupt input to the processor (J1A-25). The pulse width of the one shot was selected to be greater than the longest instruction execution time of the processor and less than the time it takes to reach the interrupt enable instruction within TIMIT. This was to prevent the processor from being interrupted more than once by the same pulse.

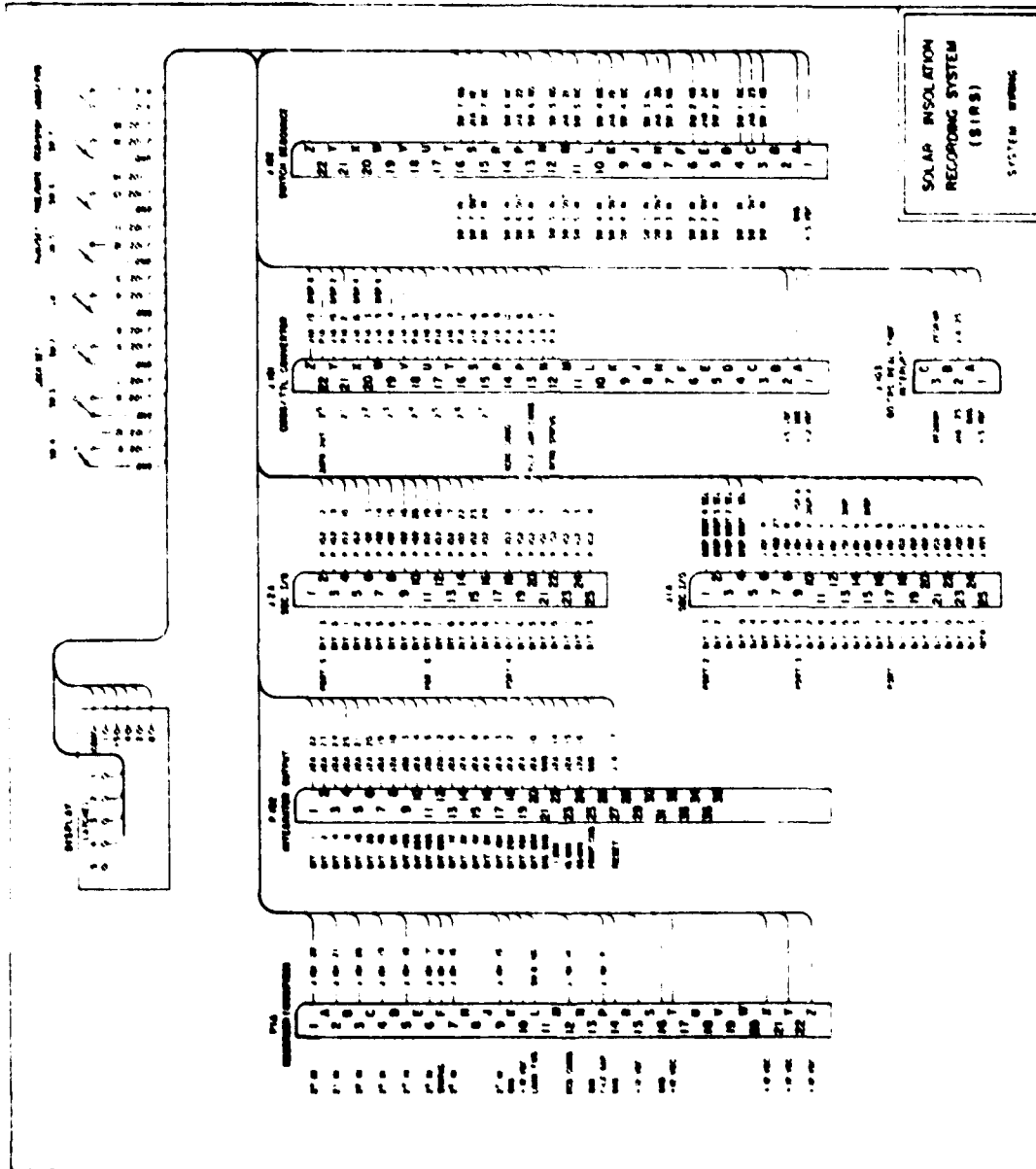
#### 7.0 FLOWCHART AND SOURCE SOFTWARE

Pertinent flowcharts and source software are presented in Appendices D and E, respectively.

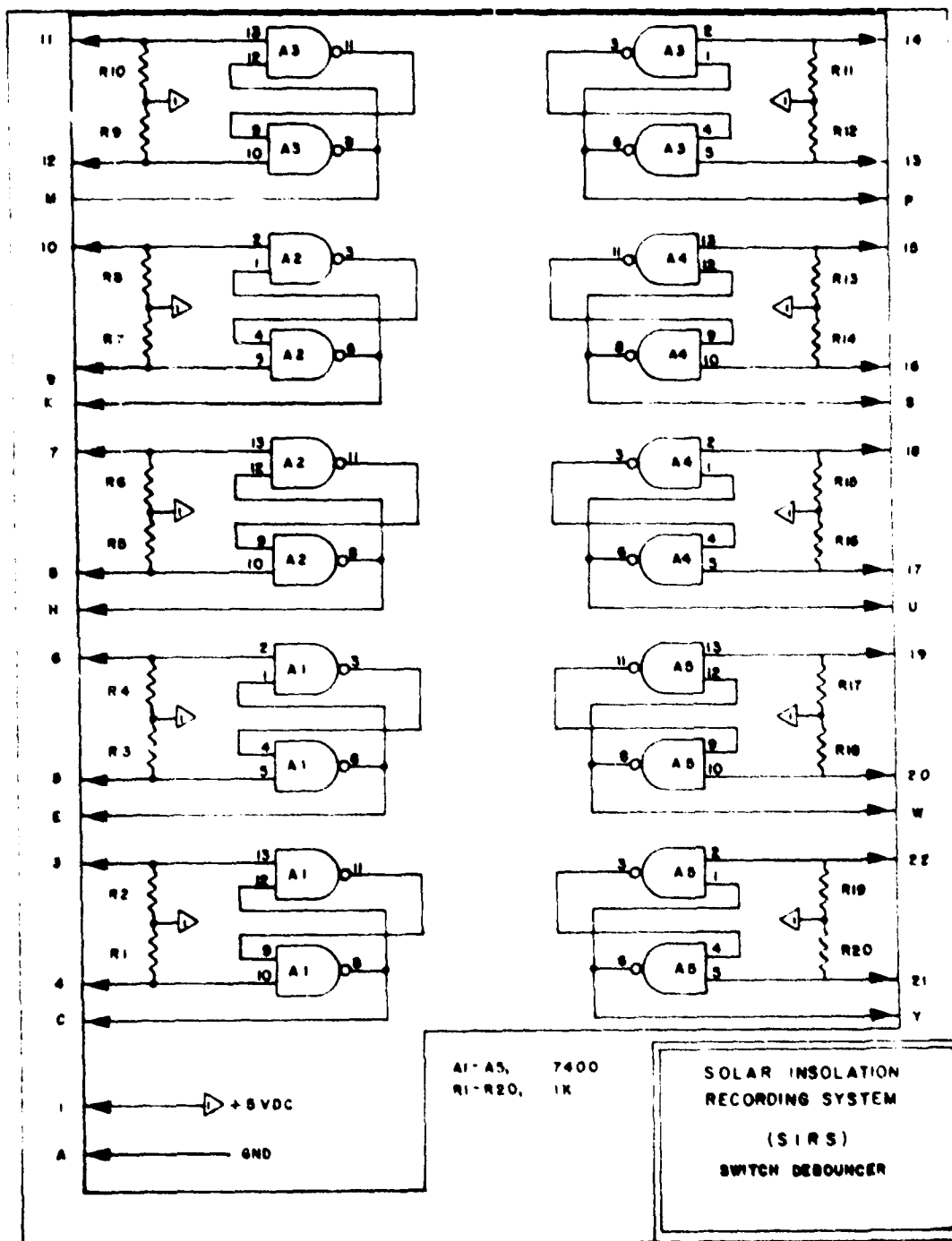
#### BIBLIOGRAPHY

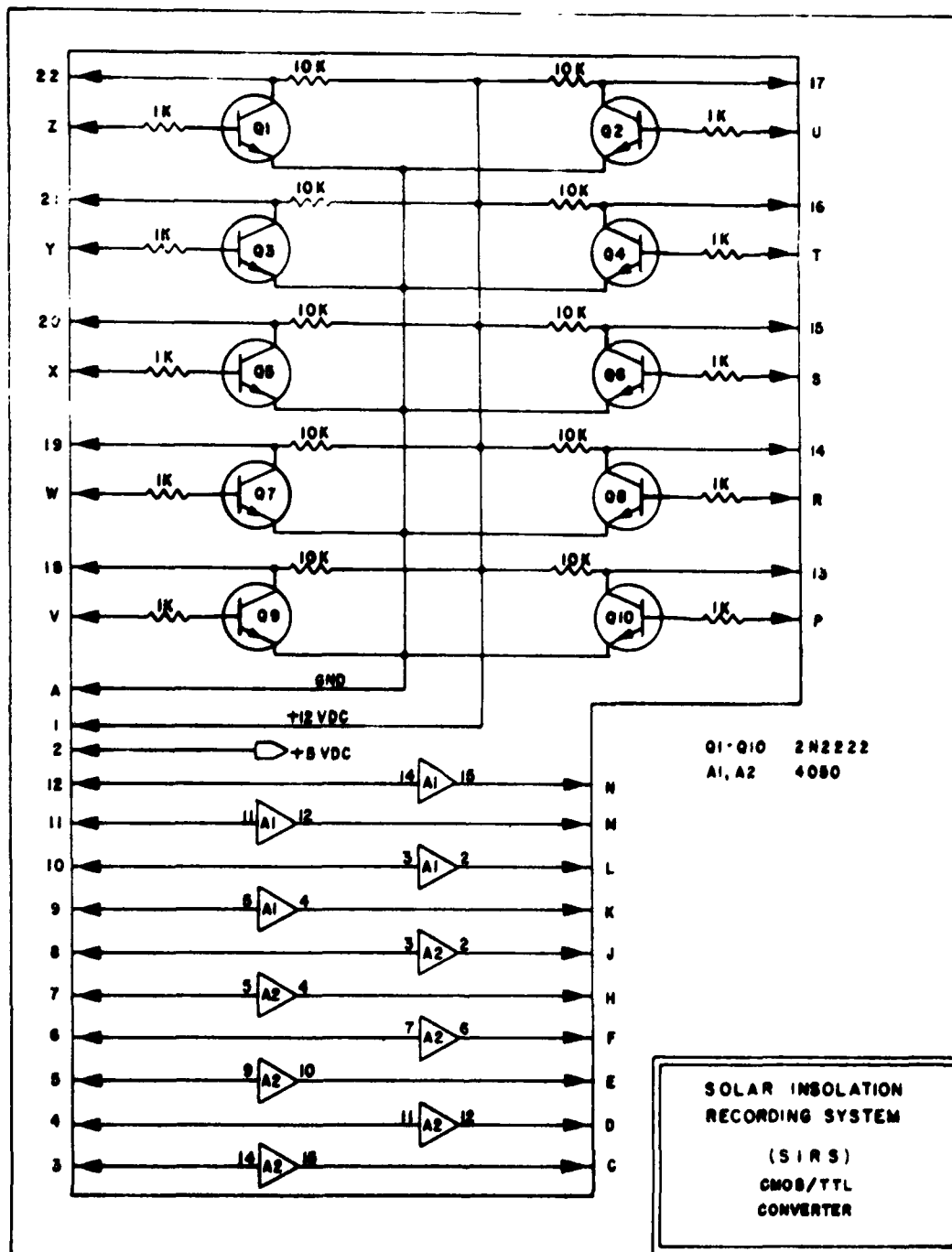
1. SBC 80/10 Single Board Computer Hardware Reference Manual, Intel Corporation, 1976.
2. SBC 630 Power Supply User's Manual, Intel Corporation, 1976.
3. LPS-16 Cassette Data Logger Instruction Manual, Datel Systems, Inc., 1975.
4. "Eppley Electronic Integrator Instructions, Models 410," Eppley Laboratory, Inc.
5. "Instrumentation for the Measurement of the Components of Solar and Terrestrial Radiation," Eppley Laboratory, Inc.

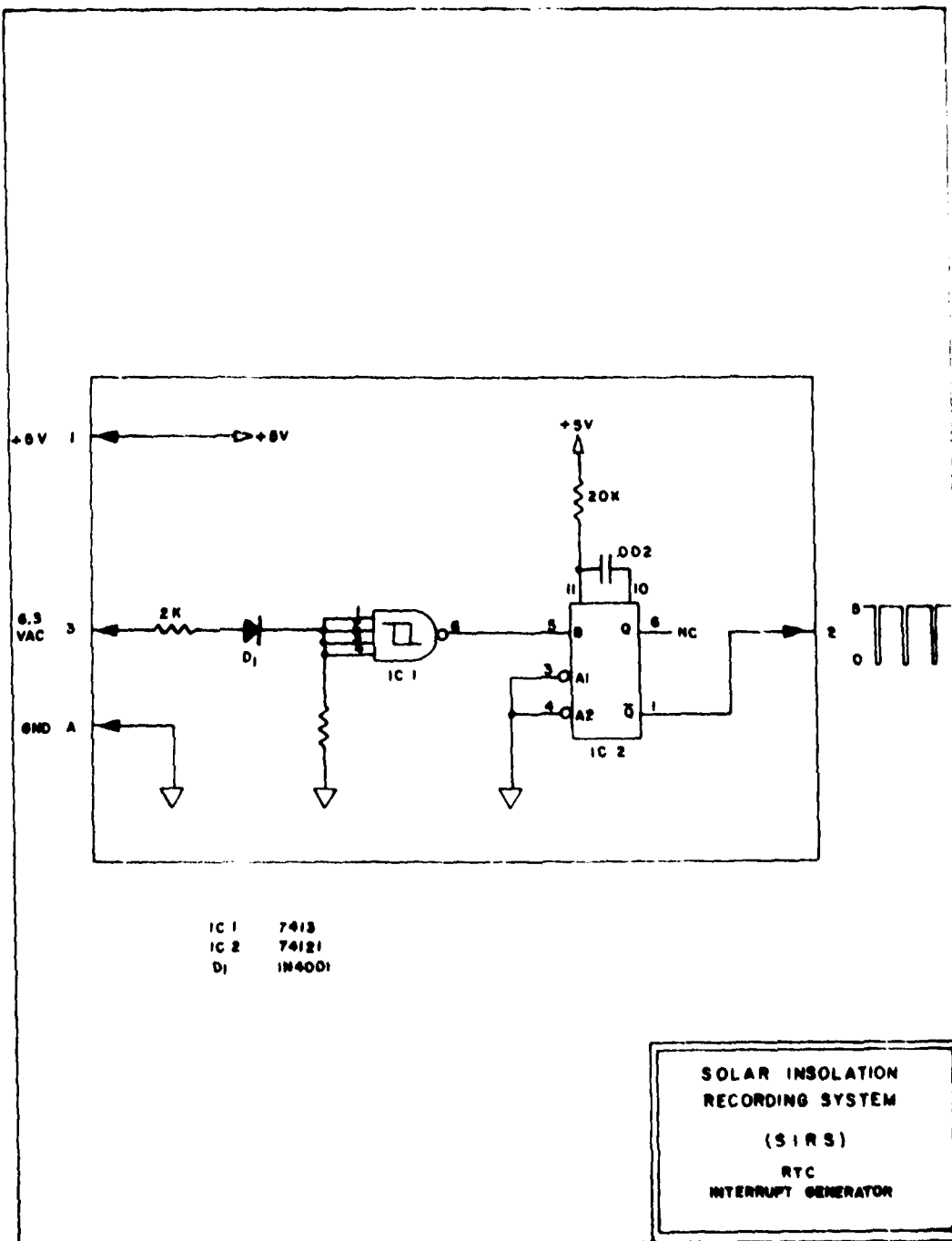
## SCHEMATICS OF SIRS COMPONENTS



THIS PAGE IS BEST QUALITY PRINTING







# APPENDIX B

## I/O SUMMARY

| PORT NAME                        | ADDRESS | BIT | I/O FUNCTION                            |
|----------------------------------|---------|-----|-----------------------------------------|
| Port 1                           | 0E4H    | 0   | - Time/Date Switch                      |
| Group 1, Port A<br>Mode 0 Input  |         | 1   | - Run/Set Switch                        |
|                                  |         | 2   | - MS Digit Switch                       |
|                                  |         | 3   | - 2nd MS Digit Switch                   |
|                                  |         | 4   | - 2nd LS Digit Switch                   |
|                                  |         | 5   | - LS Digit Switch                       |
|                                  |         | 6   | - Record/Standby Switch                 |
|                                  |         | 7   | - Recorder Status Bit<br>(Busy Bit)     |
| Port 2                           | 0E5H    | 0   | - MS Digit Latch                        |
| Group 1, Port B<br>Mode 0 Output |         | 1   | - 2nd MS Digit Latch                    |
|                                  |         | 2   | - 2nd LS Digit Latch                    |
|                                  |         | 3   | - LS Digit Latch                        |
|                                  |         | 4   | - Not Used                              |
|                                  |         | 5   | - File Gap Command                      |
|                                  |         | 6   | - Integrator Reset                      |
|                                  |         | 7   | - Record Command                        |
| Port 3                           | 0E6H    | 0   | - Digit Data 0/Recorder<br>Data 0       |
| Group 1, Port C<br>Mode 0 Output |         | 1   | - Digit Data 1/Recorder<br>Data 1       |
|                                  |         | 2   | - Digit Data 2/Recorder<br>Data 2       |
|                                  |         | 3   | - Digit Data 3/Recorder<br>Data 3       |
|                                  |         | 4   | - Recorder Data 4                       |
|                                  |         | 5   | - Recorder Data 5                       |
|                                  |         | 6   | - Recorder Data 6                       |
|                                  |         | 7   | - Recorder Data 7                       |
| Port 4                           | 0E8H    | 0   | - <u>Integrator</u><br>Integrator Bit 1 |
| Group 2, Port A<br>Mode 0 Output |         | 1   | - Integrator Bit 2                      |
|                                  |         | 2   | - Integrator Bit 4                      |
|                                  |         | 3   | - Integrator Bit 8                      |
|                                  |         | 4   | - Integrator Bit 10                     |
|                                  |         | 5   | - Integrator Bit 20                     |
|                                  |         | 6   | - Integrator Bit 40                     |
|                                  |         | 7   | - Integrator Bit 80                     |

# APPENDIX B continued

| PORT NAME                       | ADDRESS | BIT | I/O FUNCTION         |
|---------------------------------|---------|-----|----------------------|
| Port 5                          | 0E9H    | 0   | - Integrator Bit 100 |
| Group 2, Port B<br>Mode 0 Input |         | 1   | - Integrator Bit 200 |
|                                 |         | 2   | - Integrator Bit 400 |
|                                 |         | 3   | - Integrator Bit 800 |
|                                 |         | 4   | - Integrator Bit 1K  |
|                                 |         | 5   | - Integrator Bit 2K  |
|                                 |         | 6   | - Integrator Bit 4K  |
|                                 |         | 7   | - Integrator Bit 8K  |
| Port 6                          | 0EAH    | 0   | - Integrator Bit 10K |
| Group 2, Port C<br>Mode 0 Input |         | 1   | - Integrator Bit 20K |
|                                 |         | 2   | - Integrator Bit 40K |
|                                 |         | 3   | - Integrator Bit 80K |
|                                 |         | 4   | - 1 minute           |
|                                 |         | 5   | - 10 minutes         |
|                                 |         | 6   | - 60 minutes         |
|                                 |         | 7   | - Not Used           |

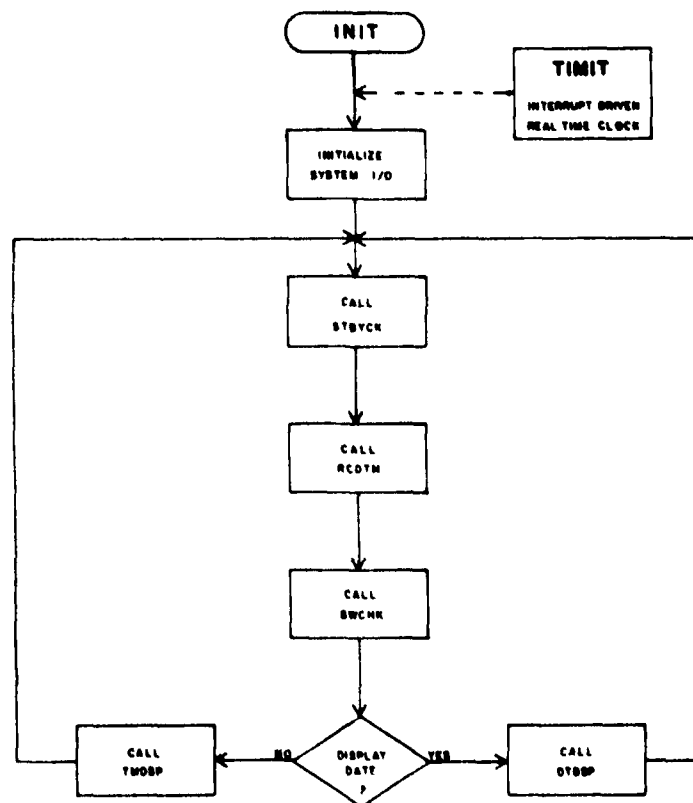
# APPENDIX C

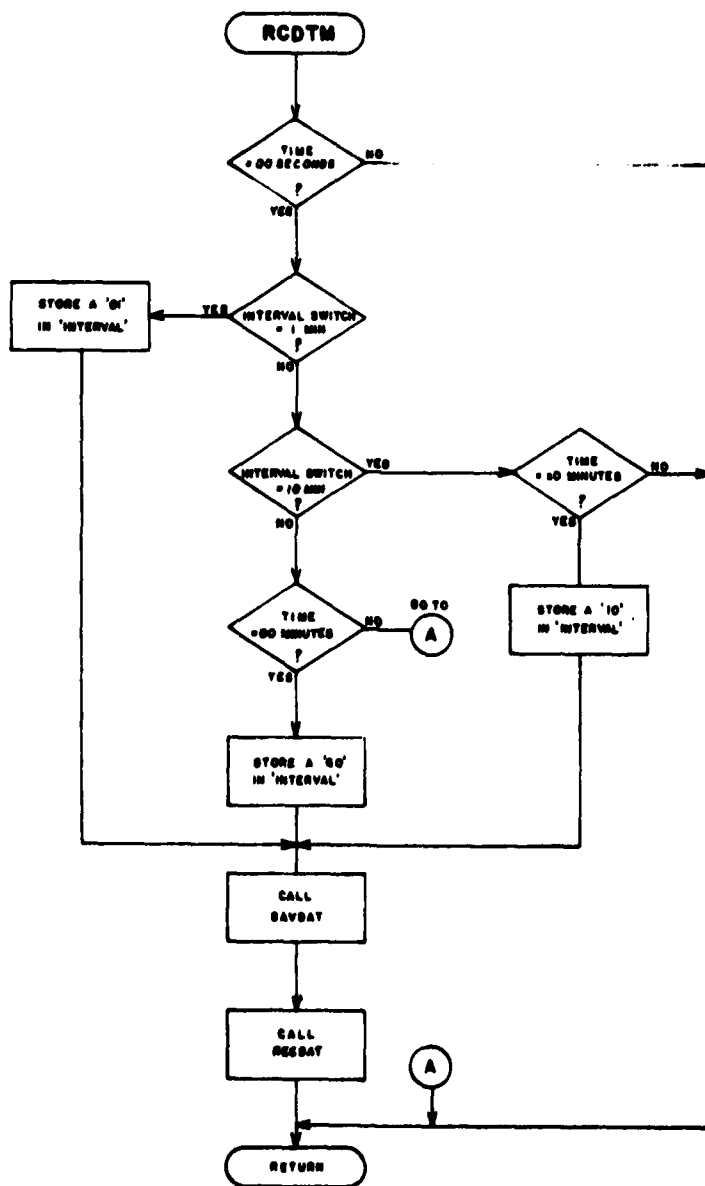
## MEMORY MAP

| ADDRESS (HEX) | LOCATION NAME         |
|---------------|-----------------------|
| 3C00          | TIMER                 |
| 3C01          | SEC                   |
| 3C02          | MIN OR TIME           |
| 3C03          | HRS                   |
| 3C04          | LS DATE OR DATE       |
| 3C05          | MSDATE                |
| 3C06          | LSDATA                |
| 3C07          | DATA                  |
| 3C08          | MSDATA                |
| 3C09          | INTVL (Interval)      |
| 3COA          | Not Used              |
| 3COB          | Not Used              |
| 3COC          | STBYFL (Standby Flag) |

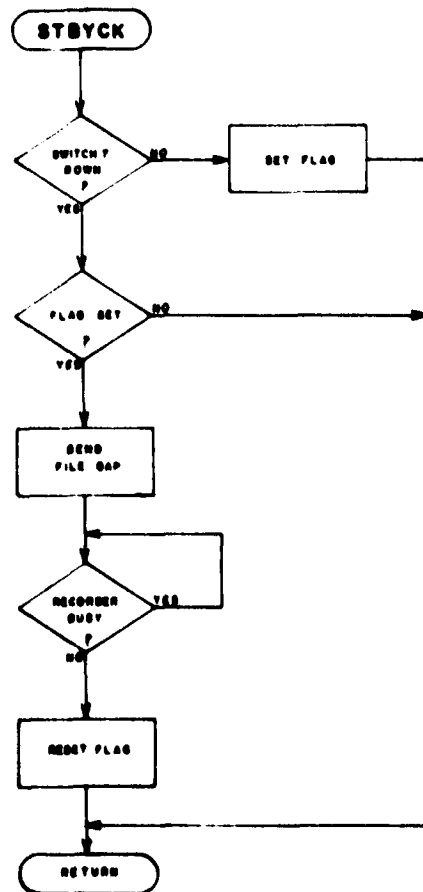
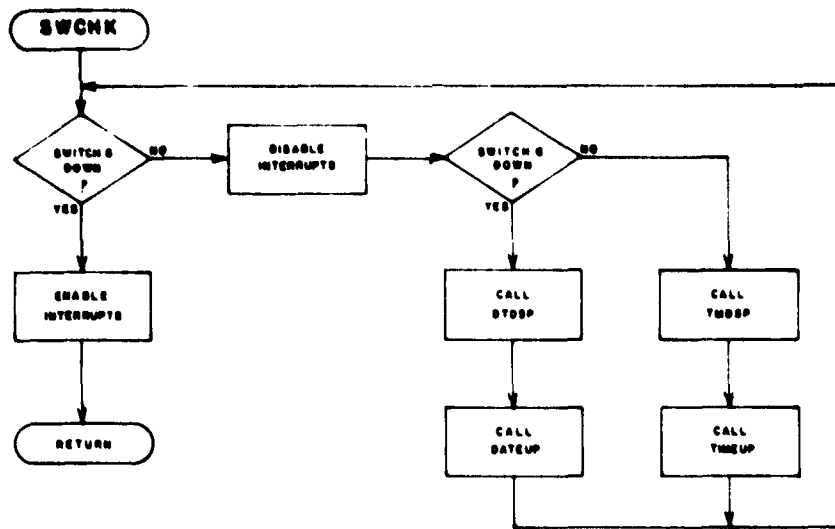
## APPENDIX D

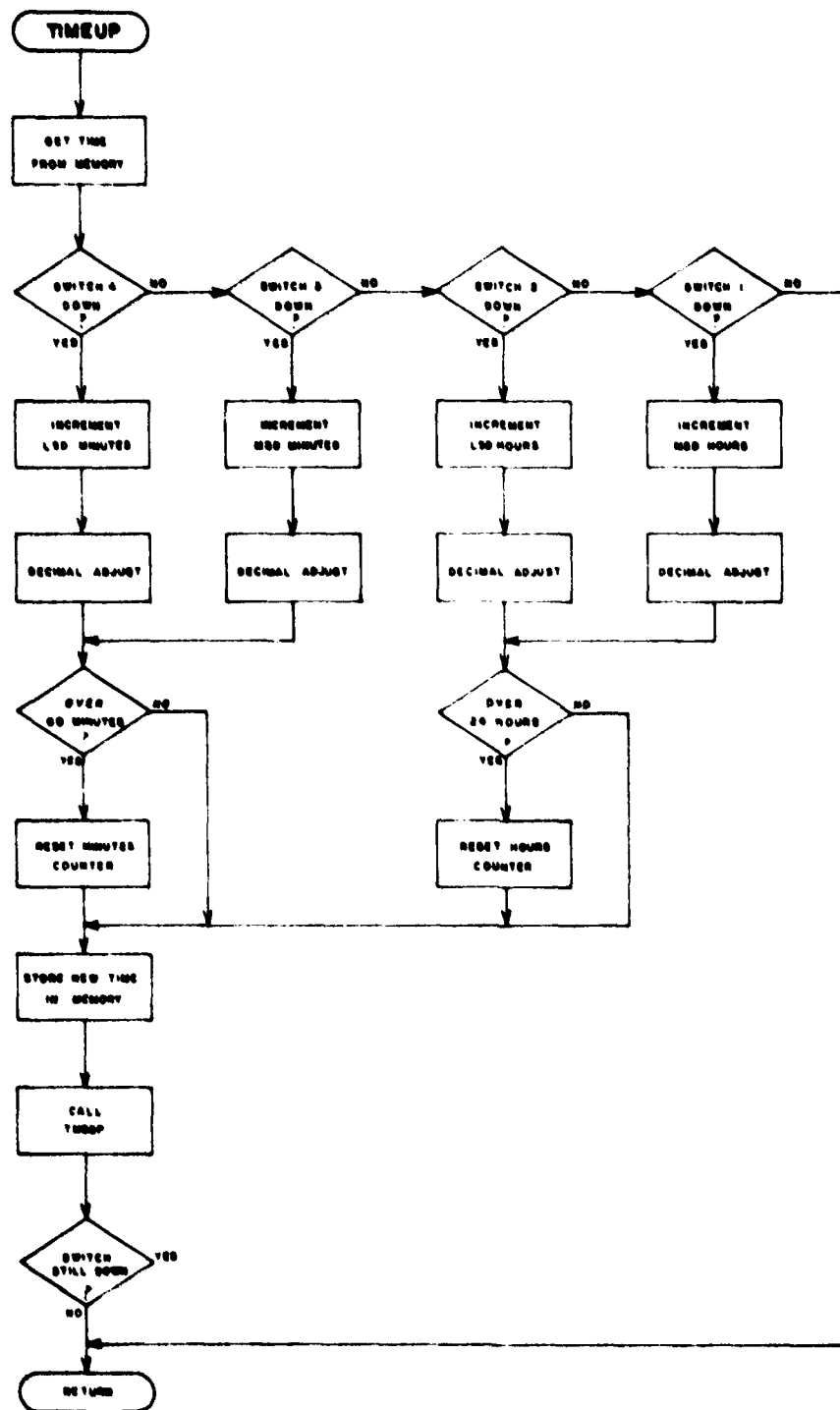
### FLOWCHARTS



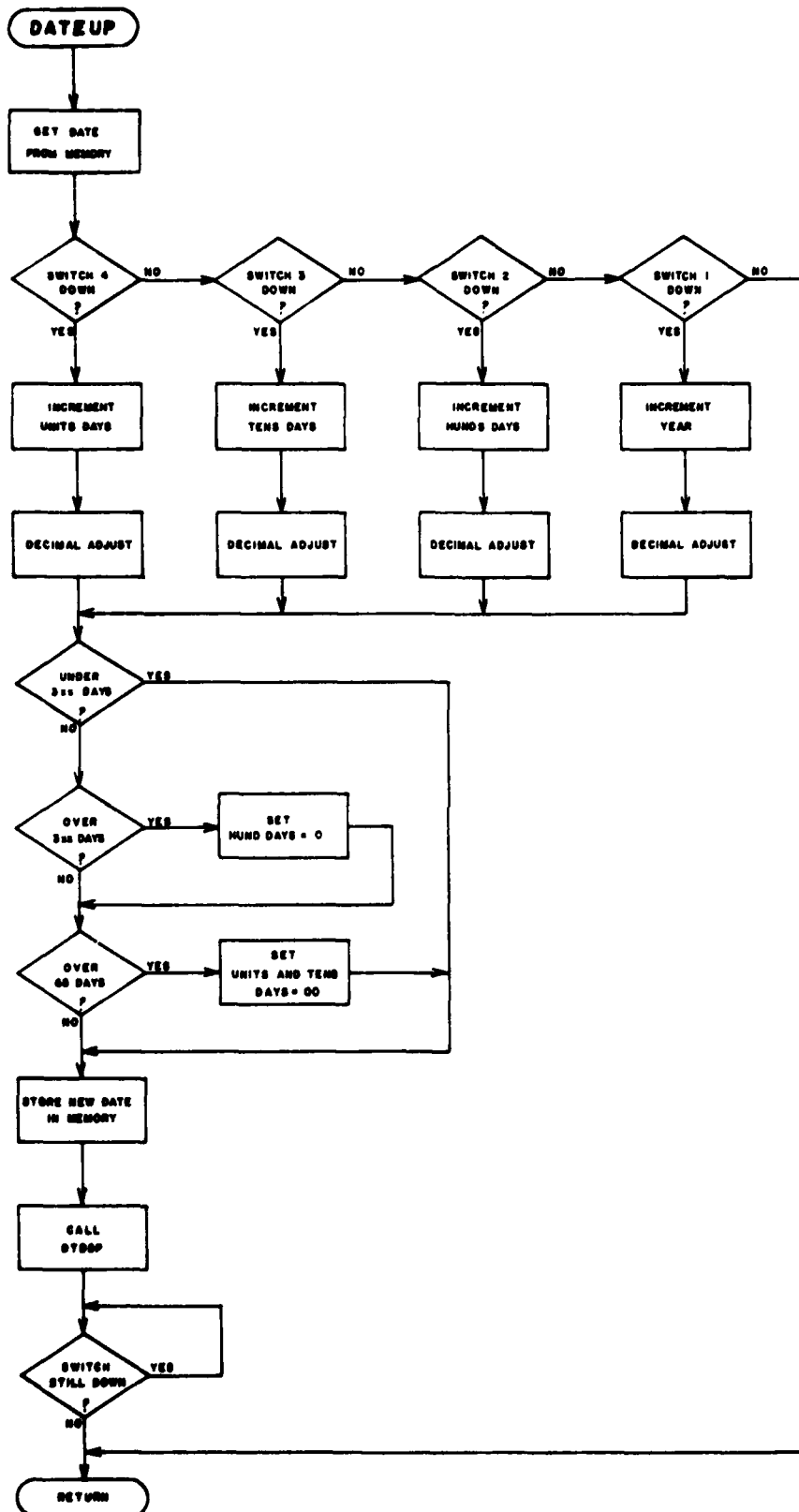








THIS PAGE IS BEST QUALITY FRAGMENT  
FROM COPY PROVIDED TO DDC



APPENDIX E  
SOURCE SOFTWARE

ISIS-11 OBJECT LOCATER V3.0 INVOKED BY

-LOCATE F1 SOLAR LINK CODE(0050H) MAP PRINT( F1 SOLMAP LST) SYMBOLS COLUMNS(3)

SYMBOL TABLE OF MODULE SOLAR

| VALUE | TYPE   | SYMBOL | VALUE | TYPE | SYMBOL | VALUE | TYPE | SYMBOL |
|-------|--------|--------|-------|------|--------|-------|------|--------|
| MOD   | INIT   |        | 3080H | SYN  | INTVL  | 00E4H | SYN  | PORT1  |
| 3034H | SYN    | DATE   | 3082H | SYN  | TIME   | 3080H | SYN  | TIMER  |
| 00E3H | SYN    | PORT2  | 0072H | SYN  | NRIN   | 0080H | SYN  | THERE  |
| 0050H | SYN    | BEGIN  | 3082H | SYN  | MIN    | 00E4H | SYN  | PORT6  |
| MOD   | ACDTH  |        | 0083H | SYN  | AROUND | 0087H | SYN  | NEXT   |
| 3080H | SYN    | INTVL  | 008FH | SYN  | RCRD   | 0097H | SYN  | THERE  |
| 3081H | SYN    | SEC    | 00E3H | SYN  | PORT2  | 308CH | SYN  | STBYFL |
| 008EH | SYN    | ACDTH  | 00E3H | SYN  | STRY   | 00C9H | SYN  | STBYCK |
| MOD   | STBYCK |        | 00E3H | SYN  | PORT2  | 00E3H | SYN  | PORT4  |
| 01C4H | SYN    | PORT1  | 00E7H | SYN  | PORT6  | 00FGH | SYN  | SAVDAT |
| 00D9H | SYN    | SETFLG | 3084H | SYN  | LSDATE | 3082H | SYN  | MIN    |
| 00DFH | SYN    | STRB   | 3081H | SYN  | SEC    | 3080H | SYN  | TIMER  |
| MOD   | SAVDAT |        | 0167H | SYN  | EXIT   | 0166H | SYN  | EXIT2  |
| 3086H | SYN    | DATA   | 0140H | SYN  | LEAP   | 0176H | SYN  | SAVE   |
| 00E3H | SYN    | PORT5  | 0166H | SYN  | DTTN   | 0170H | SYN  | SHCHK  |
| MOD   | TINIT  |        | 01A8H | SYN  | TNDSP  |       |      |        |
| 3083H | SYN    | NR     | 01A7H | SYN  | DTDSP  |       |      |        |
| 3083H | SYN    | MSDATE | 3083H | SYN  | NRS    | 3089H | SYN  | INTVL  |
| 016CH | SYN    | DIVIT  | 3084H | SYN  | LSDATE | 3082H | SYN  | MIN    |
| 0152H | SYN    | JULDT  | 3083H | SYN  | MSDATE | 00E4H | SYN  | PORT1  |
| 0112H | SYN    | TINIT  | 3082H | SYN  | TIME   | 0238H | SYN  | DBON   |
| MOD   | SHCHK  |        | 021EH | SYN  | EXIT1  | 0229H | SYN  | EXIT2  |
| 00E4H | SYN    | PORT1  | 0204H | SYN  | NKT2   | 0212H | SYN  | NKT3   |
| 0197H | SYN    | THERE  | 0238H | SYN  | OVER2  | 01E4H | SYN  | TINEUP |
| MOD   | TNDSP  |        | 00E4H | SYN  | PORT1  | 0204H | SYN  | CHECK  |
| 3082H | SYN    | TIME   | 0299H | SYN  | DBON   | 0278H | SYN  | DTCHK  |
| MOD   | DTDSP  |        | 0253H | SYN  | NKT1   | 0262H | SYN  | NKT2   |
| 3084H | SYN    | DATE   | 0082H | SYN  | D102   | 0084H | SYN  | D103   |
| MOD   | RECDAT |        | 00E3H | SYN  | PORT2  | 00E6H | SYN  | PORT3  |
| 3087H | SYN    | DATA   | 00C2H | SYN  | OUTIT  |       |      |        |
| 3086H | SYN    | LSDATA | 00E3H | SYN  | PORT2  | 00E6H | SYN  | PORT3  |
| 3080H | SYN    | MSDATA | 00E3H | SYN  | PORT2  | 00E6H | SYN  | PORT3  |
| 01A8H | SYN    | RECDAT | 00E3H | SYN  | PORT2  | 00E6H | SYN  | PORT3  |
| MOD   | TINEUP |        | 00E3H | SYN  | PORT2  | 00E6H | SYN  | PORT3  |
| 00E4H | SYN    | PORT1  | 00E3H | SYN  | PORT2  | 00E6H | SYN  | PORT3  |
| 0231H | SYN    | EXIT   | 00E3H | SYN  | PORT2  | 00E6H | SYN  | PORT3  |
| 01F6H | SYN    | NKT1   | 00E3H | SYN  | PORT2  | 00E6H | SYN  | PORT3  |
| 0223H | SYN    | OVER1  | 00E3H | SYN  | PORT2  | 00E6H | SYN  | PORT3  |
| MOD   | DATEUP |        | 00E3H | SYN  | PORT2  | 00E6H | SYN  | PORT3  |
| 3084H | SYN    | DATE   | 00E3H | SYN  | PORT2  | 00E6H | SYN  | PORT3  |
| 0240H | SYN    | DATEUP | 00E3H | SYN  | PORT2  | 00E6H | SYN  | PORT3  |
| 0236H | SYN    | EXIT   | 00E3H | SYN  | PORT2  | 00E6H | SYN  | PORT3  |
| 0271H | SYN    | NKT3   | 00E3H | SYN  | PORT2  | 00E6H | SYN  | PORT3  |
| MOD   | DISPL  |        | 00E3H | SYN  | PORT2  | 00E6H | SYN  | PORT3  |
| 0081H | SYN    | D101   | 00E3H | SYN  | PORT2  | 00E6H | SYN  | PORT3  |
| 0080H | SYN    | D104   | 00E3H | SYN  | PORT2  | 00E6H | SYN  | PORT3  |
| 0291H | SYN    | DISPL  | 00E3H | SYN  | PORT2  | 00E6H | SYN  | PORT3  |
| MOD   | RECORD |        | 00E3H | SYN  | PORT2  | 00E6H | SYN  | PORT3  |
| 00E4H | SYN    | PORT1  | 00E3H | SYN  | PORT2  | 00E6H | SYN  | PORT3  |
| 00E3H | SYN    | RECDAT | 00E3H | SYN  | PORT2  | 00E6H | SYN  | PORT3  |

MEMORY MAP OF MODULE SOLAR  
READ FROM FILE F1: SOLAR.LNK  
WRITTEN TO FILE F1: SOLAR  
MODULE IS NOT A MAIN MODULE

START STOP LENGTH REL NAME

|       |       |       |   |          |
|-------|-------|-------|---|----------|
| 0000H | 0002H | 3H    | A | ABSOLUTE |
| 0030H | 003AH | 3H    | A | ABSOLUTE |
| 0050H | 02E0H | 290H  | B | CODE     |
| 02E0H | 02F0H | 0H    | B | STACK    |
| 02F0H | F6BFH | F3C7H | B | MEMORY   |

| LOC         | OBJ | SEQ | SOURCE STATEMENT                                         |
|-------------|-----|-----|----------------------------------------------------------|
|             |     | 1   | NAME INIT                                                |
|             |     | 2   | EXTRN TINIT, SMCHK, TNDSP, DTDSP, SAVDAT, STBYCK, RCDTM  |
| 3C80        |     | 3   | TIMER EQU 3C80H                                          |
| 3C82        |     | 4   | TIME EQU 3C82H                                           |
| 3C84        |     | 5   | DATE EQU 3C84H                                           |
| 3C89        |     | 6   | INTVL EQU 3C89H                                          |
| 00E4        |     | 7   | PORT1 EQU 00E4H                                          |
| 00E5        |     | 8   | PORT2 EQU 00E5H                                          |
|             |     | 9   | *****                                                    |
|             |     | 10  | MAIN PROGRAM                                             |
|             |     | 11  |                                                          |
|             |     | 12  | PROGRAMMER: STAPLETON                                    |
|             |     | 13  | *****                                                    |
|             |     | 14  | RSEG                                                     |
| 0000        |     | 15  | ORG 0 ; RST 0, GENERATED ON POWER-UP                     |
| 0000 C30000 | C   | 16  | JMP BEGIN                                                |
| 0038        |     | 17  | ORG 38H ; RST 1, GENERATED BY INTERRUPT 1                |
| 0038 C30000 | E   | 18  | JMP TINIT                                                |
|             |     | 19  | CSEG                                                     |
|             |     | 20  | BEGIN:                                                   |
| 0000 3E90   |     | 21  | MVI A, 90H ; SET UP GROUP A, PORT 1, INPUT; 2 & 3 OUTPUT |
| 0002 D3E7   |     | 22  | OUT 0E7H                                                 |
| 0004 21FF3C |     | 23  | LXI H, 3CFFH ; INIT STACK LOCATION                       |
| 0007 F9     |     | 24  | SPHL                                                     |
| 0008 110000 |     | 25  | LXI D, 00H ; INIT DISPLAY                                |
| 0008 210000 |     | 26  | LXI H, 00H ;                                             |
| 000E 22003C |     | 27  | SHLD TIMER ; INIT SEC'S & MSEC'S                         |
| 0011 22023C |     | 28  | SHLD TIME ; INIT MEM TIME                                |
| 0014 22043C |     | 29  | SHLD DATE ; INIT DATE, ALSO                              |
| 0017 22093C |     | 30  | SHLD INTVL ; INIT INTVL                                  |
| 001A 3E60   |     | 31  | MVI A, 60H ; RESET INTEGRATOR, SET FILE GAP HI           |
| 001C D3E5   |     | 32  | OUT PORT2                                                |
| 001E 3E00   |     | 33  | MVI A, 00H ; RETURN RESET LINE HI, SET FILE GAP LO       |
| 0020 D3E5   |     | 34  | OUT PORT2                                                |
|             |     | 35  | MAIN:                                                    |
| 0022 C00000 | E   | 36  | CALL STBYCK                                              |
| 0025 C00000 | E   | 37  | CALL RCDTM                                               |
| 0028 C00000 | E   | 38  | CALL SMCHK                                               |
| 002B 00E4   |     | 39  | IN PORT1                                                 |
| 002D E682   |     | 40  | ANI 02H ; MASK FOR DATE/TIME SWITCH                      |
| 002F C23000 | C   | 41  | JNZ THERE ; SET TO TIME, JUMP OVER 'DISPLAY DATE'        |
| 0032 C00000 | E   | 42  | CALL DTDSP ; SET TO DATE, DISPLAY IT                     |
| 0035 C32200 | C   | 43  | JMP MAIN ; LOOP FOREVER                                  |
|             |     | 44  | THERE:                                                   |
| 0038 C00000 | E   | 45  | CALL TNDSP ; DISPLAY TIME                                |
| 003B C32200 | C   | 46  | JMP MAIN ; LOOP FOREVER                                  |
|             |     | 47  | END                                                      |

| LOC           | OBJ | SEQ | SOURCE STATEMENT                                      |
|---------------|-----|-----|-------------------------------------------------------|
|               |     | 1   | NAME RCDTH                                            |
|               |     | 2   | PUBLIC RCDTH                                          |
|               |     | 3   | EXTRN SAVDAT, RECDAT                                  |
| 3081          |     | 4   | SEC EQU 3081H                                         |
| 3082          |     | 5   | MIN EQU 3082H                                         |
| 3089          |     | 6   | INTVL EQU 3089H                                       |
| 00EA          |     | 7   | PORT6 EQU 0EAH                                        |
|               |     | 8   | *****                                                 |
|               |     | 9   | THIS ROUTINE CHECKS THE TIME AND AT SEC=00            |
|               |     | 10  | RECORDS THE DATA CALLED FOR ELSEWHERE IF THE          |
|               |     | 11  | TIME MATCHES THE INTERVAL OF THE SWITCH ON THE        |
|               |     | 12  | INTEGRATOR.                                           |
|               |     | 13  |                                                       |
|               |     | 14  | REGISTERS: A, B                                       |
|               |     | 15  | MEMORY: INTVL, RCLG, INTVL                            |
|               |     | 16  | STACK SPACE: 2 BYTES                                  |
|               |     | 17  | INPUT PORTS: PORT 6                                   |
|               |     | 18  | OUTPUT PORTS: NONE                                    |
|               |     | 19  | PROGRAMMER: STAPLETON                                 |
|               |     | 20  | *****                                                 |
|               |     | 21  | CSEG                                                  |
|               |     | 22  | RCDTH:                                                |
| 0000 3A013C   |     | 23  | LDA SEC ;GET SECONDS                                  |
| 0003 FE00     |     | 24  | CPI 00H ;SEE IF 00                                    |
| 0005 CA0900 C |     | 25  | JZ THERE ;=00, CHECK INTERVAL SWITCH                  |
| 0008 C9       |     | 26  | RET ;ELSE RETURN                                      |
|               |     | 27  |                                                       |
|               |     | 28  | THERE:                                                |
| 0009 D8EA     |     | 29  | IN PORT6 ;ELSE, SCAN INTERVAL SW ON INTEGRATOR        |
| 000B E610     |     | 30  | ANI 10H ;1 MIN POSITION MASK                          |
| 000D C21500 C |     | 31  | JNZ AROUND ;NOT ONE MIN. PRESS ON                     |
| 0010 3E01     |     | 32  | MVI A, 01 ;1 MIN                                      |
| 0012 C33100 C |     | 33  | JMP RCRD ;THEN START RECORDING                        |
|               |     | 34  | AROUND:                                               |
| 0015 D8EA     |     | 35  | IN PORT6 ;GET ANOTHER COPY OF INTERVAL SW             |
| 0017 E620     |     | 36  | ANI 20H ;MASK FOR 10 MIN INTERVAL                     |
| 0019 C22900 C |     | 37  | JNZ NEXT ;NOT 10 MIN, GO CHECK 60 MINS                |
| 001C 3A023C   |     | 38  | LDA MIN ;GET MINUITS                                  |
| 001F E60F     |     | 39  | ANI 0FH ;MASK OFF TENS                                |
| 0021 FE00     |     | 40  | CPI 00H ;CHECK FOR MINS = X0                          |
| 0023 C0       |     | 41  | RNZ ;NOT = X0, RETURN                                 |
| 0024 3E10     |     | 42  | MVI A, 10H ;PUT A 10 IN ACC FOR STORING IN INTVL      |
| 0026 C33100 C |     | 43  | JMP RCRD ;GO RECORD                                   |
|               |     | 44  | NEXT:                                                 |
| 0029 3A023C   |     | 45  | LDA MIN ;GET TIME                                     |
| 002C FE00     |     | 46  | CPI 00H ;WHEN MINS = 00 TIME TO RECORD                |
| 002E C0       |     | 47  | RNZ                                                   |
| 002F 3E60     |     | 48  | MVI A, 60H                                            |
|               |     | 49  | RCRD:                                                 |
| 0031 32093C   |     | 50  | STA INTVL ;STORE INTERVAL FOR RECORDING               |
| 0034 C00000 E |     | 51  | CALL SAVDAT ;GET DATA, STORE IT, AND RESET INTEGRATOR |
| 0037 C00000 E |     | 52  | CALL RECDAT ;THEN RECORD DATA, DATE, TIME ET ALL      |
| 003A C9       |     | 53  | RET ;THEN RETURN                                      |
|               |     | 54  | END                                                   |

| LOC         | OBJ | SEQ | SOURCE STATEMENT                                 |
|-------------|-----|-----|--------------------------------------------------|
|             |     | 1   | NAME RECDAT                                      |
|             |     | 2   | PUBLIC RECDAT                                    |
|             |     | 3   | EXTRN RECORD                                     |
| 00E4        |     | 4   | PORT1 EQU 0E4H                                   |
| 30B5        |     | 5   | MSDATE EQU 30B5H                                 |
| 30B4        |     | 6   | LSDATE EQU 30B4H                                 |
| 30B3        |     | 7   | HRS EQU 30B3H                                    |
| 30B2        |     | 8   | MIN EQU 30B2H                                    |
| 30B8        |     | 9   | MSDATA EQU 30B8H                                 |
| 30B7        |     | 10  | DATA EQU 30B7H                                   |
| 30B6        |     | 11  | LSDATA EQU 30B6H                                 |
| 30B9        |     | 12  | INTVL EQU 30B9H                                  |
|             |     | 13  | *****                                            |
|             |     | 14  | THIS ROUTINE CHECKS THE RUN/STANDBY SWITCH       |
|             |     | 15  | SETTING THEN RECORDS DATA IN THE PROPER SEQUENCE |
|             |     | 16  | BY LOADING THE DATA INTO THE ACCUM AND CALLING   |
|             |     | 17  | THE RECORD SUBROUTINE.                           |
|             |     | 18  |                                                  |
|             |     | 19  | REGISTERS: A                                     |
|             |     | 20  | MEMORY: NONE                                     |
|             |     | 21  | STACK SPACE: 1 BYTE                              |
|             |     | 22  | INPUT PORTS: PORT 1                              |
|             |     | 23  | OUTPUT PORTS: NONE                               |
|             |     | 24  | PROGRAMMER: STAPLETON                            |
|             |     | 25  | *****                                            |
|             |     | 26  | CSEG                                             |
|             |     | 27  | RECDAT:                                          |
| 0000 08E4   |     | 28  | IN PORT1 ; SW PORT                               |
| 0002 E640   |     | 29  | ANI 40H ; MASK FOR STBY SW                       |
| 0004 C8     |     | 30  | RZ ; IN STBY, RETURN                             |
|             |     | 31  |                                                  |
| 0005 3A853C |     | 32  | LDA MDATE ; ELSE START RECORDING SEQUENCE        |
| 0006 C00000 | E   | 33  | CALL RECORD                                      |
| 0008 3A843C |     | 34  | LDA LDATE                                        |
| 000E C00000 | E   | 35  | CALL RECORD                                      |
| 0011 3A833C |     | 36  | LDA HRS                                          |
| 0014 C00000 | E   | 37  | CALL RECORD                                      |
| 0017 3A823C |     | 38  | LDA MIN                                          |
| 001A C00000 | E   | 39  | CALL RECORD                                      |
| 001D 3A803C |     | 40  | LDA MSDATA                                       |
| 0020 C00000 | E   | 41  | CALL RECORD                                      |
| 0023 3A873C |     | 42  | LDA DATA                                         |
| 0026 C00000 | E   | 43  | CALL RECORD                                      |
| 0029 3A863C |     | 44  | LDA LSDATA                                       |
| 002C C00000 | E   | 45  | CALL RECORD                                      |
| 002F 3A893C |     | 46  | LDA INTVL                                        |
| 0032 C00000 | E   | 47  | CALL RECORD                                      |
| 0035 C9     |     | 48  | RET                                              |
|             |     | 49  | END                                              |

| LOC         | OBJ | SEQ | SOURCE STATEMENT                |
|-------------|-----|-----|---------------------------------|
|             |     | 1   | NAME RECORD                     |
|             |     | 2   | PUBLIC RECORD                   |
| 00E4        |     | 3   | PORT1 EQU 0E4H                  |
| 00E3        |     | 4   | PORT2 EQU 0E3H                  |
| 00E6        |     | 5   | PORT3 EQU 0E6H                  |
|             |     | 6   | *****                           |
|             |     | 7   | RECORD ROUTINE                  |
|             |     | 8   | THIS ROUTINE SENDS ONE          |
|             |     | 9   | BYTE OF DATA TO THE RECORDER.   |
|             |     | 10  | THEN SENDS A 'RECORD' STROBE.   |
|             |     | 11  | DATA MUST BE IN THE ACCUMULATOR |
|             |     | 12  | PRIOR TO CALLING THIS PROGRAM.  |
|             |     | 13  |                                 |
|             |     | 14  | REGISTERS: A                    |
|             |     | 15  | MEMORY: NONE                    |
|             |     | 16  | STACK SPACE: NONE               |
|             |     | 17  | INPUT PORTS: PORT 1             |
|             |     | 18  | OUTPUT PORTS: PORT 2            |
|             |     | 19  | PROGRAMMER: MANTZ               |
|             |     | 20  | *****                           |
|             |     | 21  | CSEG                            |
|             |     | 22  | RECORD:                         |
| 0000 2F     |     | 23  | CMA ; INVERT DATA TO CORRECT    |
| 0001 D3E6   |     | 24  | OUT PORT3                       |
|             |     | 25  |                                 |
|             |     | 26  | STROBE TO START RECORDING       |
|             |     | 27  |                                 |
| 0003 DBE5   |     | 28  | IN PORT2                        |
| 0005 F600   |     | 29  | ORI 00H                         |
| 0007 D3E5   |     | 30  | OUT PORT2                       |
| 0009 E67F   |     | 31  | ANI 7FH                         |
| 000B D3E5   |     | 32  | OUT PORT2                       |
|             |     | 33  |                                 |
|             |     | 34  | MONITOR THE BUSY BIT            |
|             |     | 35  |                                 |
| 000D DBE4   |     | 36  | RECBY: IN PORT1                 |
| 000F E600   |     | 37  | ANI 00H ; MASK BUSY BIT         |
| 0011 C20000 | C   | 38  | JNZ RECBY ; LOOP UNTIL DONE     |
| 0014 C9     |     | 39  | RET ; THEN RETURN               |
|             |     | 40  | END                             |

| LOC           | OBJ | SEQ | SOURCE STATEMENT                                         |
|---------------|-----|-----|----------------------------------------------------------|
|               |     | 1   | NAME STBYCK                                              |
|               |     | 2   | PUBLIC STBYCK                                            |
| 308C          |     | 3   | STBYFL EQU 308CH                                         |
| 00E4          |     | 4   | PORT1 EQU 0E4H                                           |
| 00E5          |     | 5   | PORT2 EQU 0E5H                                           |
|               |     | 6   | *****                                                    |
|               |     | 7   | STANDBY/RUN SWITCH CHECK                                 |
|               |     | 8   |                                                          |
|               |     | 9   | THIS ROUTINE CHECKS THE STATUS OF THE RUN/STANDBY SWITCH |
|               |     | 10  | AND GENERATES A FILE GAP COMMAND UPON THE TRANSITION     |
|               |     | 11  | FROM STANDBY TO RUN THIS IN TURN RESETS THE RECORDER     |
|               |     | 12  | WORD COUNTER                                             |
|               |     | 13  |                                                          |
|               |     | 14  | REGISTERS: A                                             |
|               |     | 15  | MEMORY: STBYFL (STANDBY FLAG = FF IN STBY)               |
|               |     | 16  | STACK SPACE: NONE                                        |
|               |     | 17  | INPUT PORTS: PORTS 1,2                                   |
|               |     | 18  | OUTPUT PORTS: PORT 2                                     |
|               |     | 19  | PROGRAMMER: STAPLETON                                    |
|               |     | 20  | *****                                                    |
|               |     | 21  | CSEG                                                     |
|               |     | 22  | STBYCK:                                                  |
| 0000 D0E4     |     | 23  | IN PORT1 ;STBY/RUN SW INPUT PORT                         |
| 0002 E640     |     | 24  | ANI 40H ;MASK FOR SW                                     |
| 0004 C01000 C |     | 25  | JZ SETFLG ;NOT RUN, SET FLAG                             |
| 0007 308C3C   |     | 26  | LDA STBYFL ;RUN, GET FLAG                                |
| 0009 F600     |     | 27  | ORI 00H ;SEE IF SET                                      |
| 000C C21600 C |     | 28  | JNZ STRB ;IN 'RUN' AND FLAG SET, SEND STROBE             |
| 000F C9       |     | 29  | RET ;OTHERWISE RETURN                                    |
|               |     | 30  | SETFLG:                                                  |
| 0010 3EFF     |     | 31  | MVI A,0FFH ;STANDBY = FF                                 |
| 0012 320C3C   |     | 32  | STA STBYFL ;STORE IT                                     |
| 0015 C9       |     | 33  | RET ;THEN RETURN                                         |
|               |     | 34  | STRB:                                                    |
| 0016 D0E5     |     | 35  | IN PORT2 ;GET COPY OF STROBE PORT                        |
| 0018 F620     |     | 36  | ORI 20H ;SET FILE GAP STROBE HI                          |
| 001A D3E5     |     | 37  | OUT PORT2 ;SEND IT TO RECORDER                           |
| 001C E6DF     |     | 38  | ANI 00FH ;RETURN STROBE LOW                              |
| 001E D3E5     |     | 39  | OUT PORT2 ;SEND IT                                       |
|               |     | 40  | STAY:                                                    |
| 0020 D0E4     |     | 41  | IN PORT1 ;BUSY BIT INPUT PORT                            |
| 0022 E600     |     | 42  | ANI 00H ;BUSY BIT MASK                                   |
| 0024 C22000 C |     | 43  | JNZ STAY ;LOOP HERE UNTIL DONE, THEN                     |
| 0027 3E00     |     | 44  | MVI A,00H ;RESET STROFL TO 00.                           |
| 0029 320C3C   |     | 45  | STA STBYFL ;AND STORE IT                                 |
| 002C C9       |     | 46  | RET ;THEN RETURN                                         |
|               |     | 47  |                                                          |
|               |     | 48  | END                                                      |

| LOC         | OBJ | SEQ | SOURCE STATEMENT                                 |
|-------------|-----|-----|--------------------------------------------------|
|             |     | 1   | NAME SAVDAT                                      |
|             |     | 2   | PUBLIC SAVDAT                                    |
| 3086        |     | 3   | DATA EQU 3086H                                   |
| 08E5        |     | 4   | PORT2 EQU 08E5H                                  |
| 08E8        |     | 5   | PORT4 EQU 08E8H                                  |
| 08E9        |     | 6   | PORT5 EQU 08E9H                                  |
| 08EA        |     | 7   | PORT6 EQU 08EAH                                  |
|             |     | 8   | *****                                            |
|             |     | 9   | SAVE DATA                                        |
|             |     | 10  |                                                  |
|             |     | 11  | THIS ROUTINE READS THE OUTPUT OF THE INTEGRATOR  |
|             |     | 12  | AND STORES IT IN THREE MEMORY LOCATIONS STARTING |
|             |     | 13  | AT DATA. IT ALSO RESETS THE INTEGRATOR TO ZERO.  |
|             |     | 14  |                                                  |
|             |     | 15  | REGISTERS: ACC                                   |
|             |     | 16  | MEMORY: 3 BYTES                                  |
|             |     | 17  | STACK SPACE: NONE                                |
|             |     | 18  | INPUT PORTS: PORTS 2,4,5,6                       |
|             |     | 19  | OUTPUT PORTS: PORT 2                             |
|             |     | 20  | PROGRAMMER: STAPLETON                            |
|             |     | 21  | *****                                            |
|             |     | 22  | CSEG                                             |
|             |     | 23  |                                                  |
| 0000 08E8   |     | 24  | SAVDAT: IN PORT4 ; READ L 5 DIGITS OF INTEGRATOR |
| 0002 32063C |     | 25  | STA DATA ; STORE IT IN MEMORY 'DATA'             |
| 0005 08E9   |     | 26  | IN PORT5                                         |
| 0007 32073C |     | 27  | STA DATA+1                                       |
| 000A 08EA   |     | 28  | IN PORT6                                         |
| 000C E60F   |     | 29  | ANI 0FH ; MASK OFF UPPER BITS                    |
| 000E 32083C |     | 30  | STA DATA+2                                       |
| 0011 08E5   |     | 31  | IN PORT2 ; GET COPY OF PORT 2                    |
| 0013 F640   |     | 32  | ORI 40H ; MASK OFF ALL BUT INTEGR RESET BIT      |
| 0015 D3E5   |     | 33  | OUT PORT2 ; RESET INTEGRATOR                     |
| 0017 E60F   |     | 34  | ANI 0BFH ; SET BIT 7 HI                          |
| 0019 D3E5   |     | 35  | OUT PORT2 ; RETURN INTEGR TO COUNTING            |
| 001B C9     |     | 36  | RET ; RETURN TO CALLING FROM                     |
|             |     | 37  | END                                              |

| LOC         | OBJ | SEQ | SOURCE STATEMENT                                          |
|-------------|-----|-----|-----------------------------------------------------------|
|             |     | 1   | NAME TIMIT                                                |
|             |     | 2   | PUBLIC TIMIT                                              |
| 3085        |     | 3   | MSDATE EQU 3085H ;LO ORDER DIGIT OF YEAR                  |
|             |     | 4   | ; AND HI ORDER DIGIT OF DATE                              |
| 3084        |     | 5   | LSDATE EQU 3084H ;LOW ORDER DIGITS OF DATE                |
| 3083        |     | 6   | HR EQU 3083H ;HOURS                                       |
| 3082        |     | 7   | MIN EQU 3082H ;MINUTES                                    |
| 3081        |     | 8   | SEC EQU 3081H ;SECONDS                                    |
| 3080        |     | 9   | TIMER EQU 3080H ;60THS OF SECONDS                         |
|             |     | 10  | *****                                                     |
|             |     | 11  | INTERRUPT DRIVEN REAL TIME CLOCK                          |
|             |     | 12  |                                                           |
|             |     | 13  | THIS ROUTINE IS A SOFTWARE INTERRUPT                      |
|             |     | 14  | DRIVEN JULIAN DATE CALENDER AND REAL TIME                 |
|             |     | 15  | CLOCK IT IS A BORROWED PROGRAM THAT HAS                   |
|             |     | 16  | BEEN SLIGHTLY MODIFIED. THE ORIGINAL                      |
|             |     | 17  | VERSION CAN BE FOUND IN INSITE, REF. NO. D24,             |
|             |     | 18  | PG. 7-69.                                                 |
|             |     | 19  |                                                           |
|             |     | 20  | REGISTERS: NONE, ALL STATUS SAVED                         |
|             |     | 21  | MEMORY: TIMER, SEC, MIN, HR,                              |
|             |     | 22  | LSDATE,MSDATE                                             |
|             |     | 23  | STACK SPACE: 2 BYTES                                      |
|             |     | 24  | INPUT PORTS: NONE                                         |
|             |     | 25  | OUTPUT PORTS: NONE                                        |
|             |     | 26  | PROGRAMMER: STEVE BECQUER                                 |
|             |     | 27  | *****                                                     |
|             |     | 28  | CSEG                                                      |
|             |     | 29  | TIMIT:                                                    |
| 0000 F5     |     | 30  | PUSH PSH ;SAVE STATUS AND REGISTERS                       |
| 0001 C5     |     | 31  | PUSH B ;OF INTERRUPTED ROUTINE                            |
| 0002 D5     |     | 32  | PUSH D ;                                                  |
| 0003 11803C |     | 33  | LXI D,TIMER ;GET ADDRESS OF TIME COUNTERS (60THS OF SEC). |
| 0006 0660   |     | 34  | MVI B,60H ;SET MODULO TO 60.                              |
| 0008 0E00   |     | 35  | MVI C,0 ;SET STARTING COUNT TO 0.                         |
| 0009 C05900 | C   | 36  | CALL DIVIT ;UPDATE 60THS OF SEC COUNTER.                  |
| 000D 0660   |     | 37  | MVI B,60H ;SET MODULO TO 60.                              |
| 000F C05900 | C   | 38  | CALL DIVIT ;UPDATE SECONDS COUNTER.                       |
| 0012 C05900 | C   | 39  | CALL DIVIT ;UPDATE MINUTES COUNTER.                       |
| 0015 0624   |     | 40  | MVI B,24H ;SET MODULO TO 24.                              |
| 0017 C05900 | C   | 41  | CALL DIVIT ;UPDATE HOURS COUNTER.                         |
| 001A 11853C |     | 42  | LXI D,MSDATE                                              |
| 001D 0600   |     | 43  | MVI B,00H ;SET MODULO 100                                 |
| 001F 1A     |     | 44  | LDAX D ;LOAD COUNT(VRAMSDATE)                             |
| 0020 E60F   |     | 45  | ANI 0FH ;MASK OFF YEAR, LEAVE HD DAYS                     |
| 0022 FE03   |     | 46  | CPI 03H ;3RD DAYS?                                        |
| 0024 C24000 | C   | 47  | JNZ JULDY ;NO, DO INCR LS DATE                            |
| 0027 1A     |     | 48  | LDAX D ;GET ANOTHER COPY OF VRAMSDATE                     |
| 0028 0E01   |     | 49  | MVI C,01H ;START COUNT DAYS FR 001                        |
| 002A E60F   |     | 50  | ANI 0FH ;MASK OFF HD DAYS                                 |
| 002C FE00   |     | 51  | CPI 00 ;1900                                              |
| 002E 070000 |     | 52  | JZ LEPP                                                   |

|               |     |           |        |                                            |
|---------------|-----|-----------|--------|--------------------------------------------|
| 0031 FE28     | 53  | CPI       | 40     | ; 1904                                     |
| 0033 C03800   | 54  | JZ        | LEAP   |                                            |
| 0035 0666     | 55  | MVI       | B, 66H | ; NOT LEAP, RESETS AT 66                   |
| 0038 C34000 C | 56  | JMP       | JULDT  | ; UPDATE DATE                              |
| 0038 0667     | 57  | LEAP: MVI | B, 67H | ; LEAP YEAR RESETS AT 67                   |
| 003D C34000 C | 58  | JMP       | JULDT  |                                            |
|               | 59  | JULDT:    |        |                                            |
| 0040 1B       | 60  | DCX       | D      | ; POINT TO LS DATE                         |
| 0041 C05A00 C | 61  | CALL      | DIVIT  | ; UPDATE LS DATE COUNTER                   |
| 0044 0604     | 62  | MVI       | B, 04H | ; RESETS WHEN MS DATE=4                    |
| 0046 1A       | 63  | LDAK      | D      | ; GET MS DATE                              |
| 0047 3C       | 64  | INR       | A      | ; INCR IT                                  |
| 0048 12       | 65  | STAK      | D      | ; STORE A COPY, AND                        |
| 0049 AB       | 66  | ANA       | B      | ; MASK YEAR WHILE COMPARING TO 4 HD DAYS   |
| 004A 88       | 67  | CMP       | B      | ; ACC = 0 IF 400 DAYS                      |
| 004B C25400 C | 68  | JNZ       | EXIT2  | ; NOT OVER 365 OR 366                      |
| 004E 1A       | 69  | LDAK      | D      | ; DAYS = 400, READY RESET                  |
| 004F E6F0     | 70  | ANI       | 0F0H   | ; RESET HD DAYS, LEAVE YEAR ALONE          |
| 0051 C610     | 71  | ADI       | 10H    | ; ADD 1 TO YEAR                            |
| 0053 12       | 72  | STAK      | D      | ; STORE NEW                                |
|               | 73  | EXIT2:    |        |                                            |
| 0054 D1       | 74  | POP       | D      | ; DUMMY RETURN                             |
|               | 75  | EXIT:     |        |                                            |
| 0055 D1       | 76  | POP       | D      | ; RESTORE REGISTERS                        |
| 0056 C1       | 77  | POP       | B      |                                            |
| 0057 F1       | 78  | POP       | PSW    | ; RESTORE STATUS                           |
| 0058 FB       | 79  | EI        |        | ; ENABLE FURTHER INTERRUPTS                |
| 0059 C9       | 80  | RET       |        | ; RETURN TO INTERRUPTED ROUTINE            |
|               | 81  | DIVIT:    |        | ; VARIABLE MODULO COUNTER                  |
| 005A 1A       | 82  | LDAK      | D      | ; LOAD COUNTER TO BE INCREMENTED INTO ACC. |
| 005B 37       | 83  | STC       |        |                                            |
| 005C 3F       | 84  | CNC       |        | ; CLEAR CARRY BY SETTING IT                |
|               | 85  |           |        | ; AND THEN COMPLEMENTING IT.               |
| 005D 3C       | 86  | INR       | A      | ; INCREMENT COUNT.                         |
| 005E 27       | 87  | DAA       |        | ; DECIMAL ADJUST.                          |
| 005F 08       | 88  | CMP       | B      | ; TEST IF RESET COUNT                      |
|               | 89  |           |        | ; HAS BEEN REACHED.                        |
| 0060 C26400 C | 90  | JNZ       | SAVE   | ; IF NOT REACHED,                          |
|               | 91  |           |        | ; SAVE COUNT AND EXIT.                     |
| 0063 79       | 92  | MOV       | A, C   | ; RESET TO STARTING COUNT.                 |
|               | 93  | SAVE:     |        |                                            |
| 0064 12       | 94  | STAK      | D      | ; RETURN COUNT TO MEMORY.                  |
| 0065 13       | 95  | INX       | D      | ; POINT TO NEXT COUNTER                    |
| 0066 C8       | 96  | RZ        |        | ; IF RESET OCCURED,                        |
|               | 97  |           |        | ; GO UPDATE NEXT COUNTER                   |
| 0067 D1       | 98  | POP       | D      | ; IF NOT, ISSUE A DUMMY RETURN             |
| 0068 C35000 C | 99  | JMP       | EXIT   | ; EXIT DIVIT.                              |
|               | 100 | END       |        |                                            |

| LOC         | OBJ | SEQ | SOURCE STATEMENT                         |
|-------------|-----|-----|------------------------------------------|
|             |     | 1   | NAME SMCHK                               |
|             |     | 2   | PUBLIC SMCHK                             |
|             |     | 3   | EXTRN DATEUP, TIMEUP, DTDSP, TNDSP       |
| 00E4        |     | 4   | PORT1 EQU 0E4H                           |
|             |     | 5   | *****                                    |
|             |     | 6   | SWITCH CHECK                             |
|             |     | 7   | CHECKS FRONT PANEL SWITCHES FOR RUN/SET, |
|             |     | 8   | DATE/TIME CALLS APPROPRIATE ROUTINE      |
|             |     | 9   | REGISTERS: A                             |
|             |     | 10  | MEMORY: NONE                             |
|             |     | 11  | STACK SPACE: 2 BYTES                     |
|             |     | 12  | INPUT PORTS: PORT 1                      |
|             |     | 13  | OUTPUT PORTS: NONE                       |
|             |     | 14  | PROGRAMMER: STAPLETON                    |
|             |     | 15  | *****                                    |
|             |     | 16  | CSEG                                     |
|             |     | 17  |                                          |
| 0000 00E4   |     | 18  | SMCHK: IN PORT1 ; SM INPUT PORT          |
| 0002 E601   |     | 19  | ANI 01H ; MASK FOR RUN/SET, SM-5         |
| 0004 C0000  | C   | 20  | JZ DTTN ; NOT RUN GO SET DATE/TIME       |
| 0007 FB     |     | 21  | EI ; ENABLE INTERRUPT FOR CLOCK          |
| 0008 C9     |     | 22  | RET ; RUN RETURN TO CALLING PROGRAM      |
|             |     | 23  | DTTN:                                    |
| 0009 F3     |     | 24  | DI ; DISABLE INTERRUPTS, STOP CLOCK      |
| 000A 00E4   |     | 25  | IN PORT1 ; GET ANOTHER COPY OF PORT      |
| 000C E602   |     | 26  | ANI 02H ; MASK FOR DATE/TIME             |
| 000E C21A00 | C   | 27  | JNZ THERE ; GO UPDATE TIME               |
| 0011 C0000  | E   | 28  | CALL DTDSP ; DISPLAY DATE                |
| 0014 C0000  | E   | 29  | CALL DATEUP ; UPDATE IT                  |
| 0017 C30000 | C   | 30  | JMP SMCHK ; CHECK SWITCHES UNTIL RUN     |
|             |     | 31  | THERE:                                   |
| 001A C0000  | E   | 32  | CALL TNDSP                               |
| 001D C0000  | E   | 33  | CALL TIMEUP                              |
| 0020 C30000 | C   | 34  | JMP SMCHK                                |
|             |     | 35  | END                                      |

| LOC  | OBJ    | SEQ | SOURCE STATEMENT                               |
|------|--------|-----|------------------------------------------------|
|      |        | 1   | NAME TIMEUP                                    |
|      |        | 2   | PUBLIC TIMEUP                                  |
|      |        | 3   | EXTRN THDSP                                    |
| 3082 |        | 4   | TIME EQU 3082H                                 |
| 00E4 |        | 5   | PORT1 EQU 0E4H                                 |
|      |        | 6   | *****                                          |
|      |        | 7   | TIME UPDATE                                    |
|      |        | 8   | THIS ROUTINE CHECKS THE BUTTONS UNDER THE      |
|      |        | 9   | FRONT PANEL DISPLAY AND INCREMENTS THAT        |
|      |        | 10  | DIGIT EACH TIME THE BUTTON IS DEPRESSED.       |
|      |        | 11  | CALLS THDSP AND DISPLAYS NEW TIME.             |
|      |        | 12  |                                                |
|      |        | 13  | DIG 1   DIG 2   DIG 3   DIG 4                  |
|      |        | 14  | MS HR   LS HR   MS MIN   LS MIN                |
|      |        | 15  | -----                                          |
|      |        | 16  | SW 1   SW 2   SW 3   SW 4                      |
|      |        | 17  |                                                |
|      |        | 18  | REGISTERS:   A, D, E, H, L                     |
|      |        | 19  | MEMORY:   TIME (2 BYTES)                       |
|      |        | 20  | STACK SPACE:   2 BYTES                         |
|      |        | 21  | INPUT PORTS:   PORT 1                          |
|      |        | 22  | OUTPUT PORTS:   NONE                           |
|      |        | 23  | PROGRAMMER:   STAPLETON                        |
|      |        | 24  | *****                                          |
|      |        | 25  | CSEG                                           |
|      |        | 26  | TIMEUP:                                        |
| 0000 | 2F023C | 27  | LJLD   TIME   ; HRS & MINS TO HAL              |
| 0003 | EB     | 28  | XCHG   ; PUT INTO DAE                          |
| 0004 | D0E4   | 29  | IN   PORT1   ; GET COPY OF BUTTON INPUT PORT   |
| 0005 | E620   | 30  | ANI   20H   ; MASK OFF FOR SW-4, LSD MINS      |
| 0009 | CF1200 | 31  | JZ   NXT1   ; NOT THIS BUTTON, PRESS ON        |
| 000B | 7B     | 32  | MOV   A, E   ; BUTTON DOWN, PUT MINS INTO ACC  |
| 000C | C601   | 33  | ADI   01H   ; ADD 1                            |
| 000E | 27     | 34  | DAA   ; DECIMAL ADJUST (WILL INCR NEXT DIGIT)  |
| 000F | C3A00  | 35  | JMP   EXIT1                                    |
| 0012 | D0E4   | 36  | NXT1: IN   PORT1   ; GET ANOTHER COPY OF PORT1 |
| 0014 | E610   | 37  | ANI   10H   ; MASK FOR SW-3, MSD MINS          |
| 0016 | CF2000 | 38  | JZ   NXT2   ; NOT DOWN, PRESS ON               |
| 0019 | 7B     | 39  | MOV   A, E   ; BUTTON DOWN, MOVE MINS INTO ACC |
| 001A | C610   | 40  | ADI   10H   ; INCREMENT MSD MINS BY 1          |
| 001C | 27     | 41  | DAA   ; DECIMAL ADJUST. DISREGARD CARRYOUT     |
| 001D | C3A00  | 42  | JMP   EXIT1   ; NOW EXIT                       |
| 0020 | D0E4   | 43  | NXT2: IN   PORT1                               |
| 0022 | E600   | 44  | ANI   00H   ; MASK FOR SW-2, LSD HRS           |
| 0024 | CF2000 | 45  | JZ   NXT3   ; NOT DOWN                         |
| 0027 | 7B     | 46  | MOV   A, D   ; BUTTON DOWN, MOVE HRS INTO ACC  |
| 0028 | C601   | 47  | ADI   01H   ; ADD 1                            |
| 002A | 27     | 48  | DAA                                            |
| 002B | C34300 | 49  | JMP   EXIT2                                    |
| 002E | D0E4   | 50  | NXT3: IN   PORT1                               |
| 0030 | E604   | 51  | ANI   04H   ; SW-1                             |
| 0032 | C8     | 52  | RZ   ; RET TO CALLING PGM, NO BUTTONS DOWN     |
| 0033 | 7B     | 53  | MOV   A, D                                     |
| 0034 | C610   | 54  | ADI   10H                                      |

|             |   |    |        |        |                                  |
|-------------|---|----|--------|--------|----------------------------------|
| 0036 27     |   | 55 | DAR    |        |                                  |
| 0037 C34500 | C | 56 | JMP    | EXIT2  |                                  |
|             |   | 57 | EXIT1: |        |                                  |
| 0038 FE60   |   | 58 | CPI    | 60H    | ; MODULO 60 MINS                 |
| 003C FA4100 | C | 59 | JN     | OVER1  | ; LESS THAN 60                   |
| 003F 3E00   |   | 60 | MVI    | A, 00H | ; RESET TO 00 IF 60 MINS OR MORE |
| 0041 5F     |   | 61 | OVER1: | MOV    | E, A                             |
| 0042 C34000 | C | 62 | JMP    | EXIT   | ; RETURN MINS TO E REGISTER      |
|             |   | 63 | EXIT2: |        |                                  |
| 0045 FE24   |   | 64 | CPI    | 24H    | ; MODULO 24 HRS                  |
| 0047 FA4000 | C | 65 | JN     | OVER2  | ; LESS THAN 24                   |
| 004A 3E00   |   | 66 | MVI    | A, 00H | ; RESET TO 00 IF 24 OR MORE      |
| 004C 57     |   | 67 | OVER2: | MOV    | D, A                             |
|             |   | 68 |        |        | ; RETURN HRS TO D REGISTER       |
|             |   | 69 | EXIT:  |        |                                  |
| 004D EB     |   | 70 | XCHG   |        | ; PUT TIME IN HAL                |
| 004E 22023C |   | 71 | SHLD   | TIME   | ; PUT TIME IN MEMORY             |
| 0051 C00000 | E | 72 | CALL   | TNDSP  | ; DISPLAY NEW TIME               |
| 0054 D8E4   |   | 73 | DBON:  | IN     | PORT1                            |
| 0056 E63C   |   | 74 | ANI    | 3CH    | ; GET ANOTHER COPY OF PORT 1     |
| 0058 C25400 | C | 75 | JNZ    | DBON   | ; MASK FOR SWITCHES STILL DOWN   |
| 005B C9     |   | 76 | RET    |        | ; WAIT FOR SW TO BE RELEASED     |
|             |   | 77 |        |        | ; RETURN TO CALLING PROGRAM      |
|             |   | 78 | END    |        |                                  |

| LOC           | OBJ | SEQ | SOURCE STATEMENT                                 |
|---------------|-----|-----|--------------------------------------------------|
|               |     | 1   | NONE DATEUP                                      |
|               |     | 2   | PUBLIC DATEUP                                    |
|               |     | 3   | EXTRN DTOSP                                      |
| 3C04          |     | 4   | DATE EQU 3C04H                                   |
| 00E4          |     | 5   | PORT1 EQU 0E4H                                   |
|               |     | 6   | *****                                            |
|               |     | 7   | JULIAN DATE UPDATE                               |
|               |     | 8   | THIS ROUTINE CHECKS THE BUTTONS UNDER THE        |
|               |     | 9   | FRONT PANEL DISPLAY AND INCREMENTS THAT          |
|               |     | 10  | DIGIT EACH TIME THE BUTTON IS DEPRESSED.         |
|               |     | 11  | CALLS DTOSP AND DISPLAYS NEW DATE.               |
|               |     | 12  |                                                  |
|               |     | 13  | NOTE: CONTAINS NO PROVISION FOR MANUALLY SETTING |
|               |     | 14  | 366 DAYS IN LEAP YEAR. ONLY DEC 31 AFFECTED,     |
|               |     | 15  | AND WHO WORKS NEW YEARS EVE?                     |
|               |     | 16  |                                                  |
|               |     | 17  | DIG 1 DIG 2 DIG 3 DIG 4                          |
|               |     | 18  | LS YEAR HD DATE TN DATE UN DATE                  |
|               |     | 19  | -----                                            |
|               |     | 20  | SH 1 SH 2 SH 3 SH 4                              |
|               |     | 21  |                                                  |
|               |     | 22  | REGISTERS: A,D,E,H,L                             |
|               |     | 23  | MEMORY: DATE (2 BYTES)                           |
|               |     | 24  | STACK SPACE: 2 BYTES                             |
|               |     | 25  | INPUT PORTS: PORT 1                              |
|               |     | 26  | OUTPUT PORTS: NONE                               |
|               |     | 27  | PROGRAMMER: STAPLETON                            |
|               |     | 28  | *****                                            |
|               |     | 29  | CSEG                                             |
|               |     | 30  |                                                  |
|               |     | 31  | DATEUP:                                          |
| 0000 2F043C   |     | 32  | LJLD DATE ; JULIAN DATE INTO HML                 |
| 0003 EB       |     | 33  | XCHG ; PUT INTO DE                               |
| 0004 00E4     |     | 34  | IN PORT1 ; GET COPY OF BUTTON INPUT PORT         |
| 0006 E620     |     | 35  | ANI 20H ; MASK OFF FOR SH-4, UNITS DATE          |
| 0009 C01300 C |     | 36  | JZ NKT1 ; NOT THIS BUTTON, PRESS ON              |
| 000B 7B       |     | 37  | MOV A,E ; BUTTON DOWN, PUT LAST 2 OF DATE IN ACC |
| 000C C001     |     | 38  | ADI 01H ; ADD 1                                  |
| 000E 27       |     | 39  | DAA ; DECIMAL ADJUST                             |
| 000F 5F       |     | 40  | MOV E,A ; RETURN IT TO E REGIS                   |
| 0010 C33000 C |     | 41  | JMP DTCHK                                        |
| 0013 00E4     |     | 42  | IN PORT1 ; GET ANOTHER COPY OF PORT 1            |
| 0015 E610     |     | 43  | ANI 10H ; MASK FOR SH-3, TENS DATE               |
| 0017 C02200 C |     | 44  | JZ NKT2 ; NOT THIS BUTTON EITHER                 |
| 001A 7B       |     | 45  | MOV A,E ; BUTTON DOWN, PUT LAST 2 OF DATE IN ACC |
| 001B C610     |     | 46  | ADI 10H ; ADD 1 TO TENS                          |
| 001D 27       |     | 47  | DAA                                              |
| 001E 5F       |     | 48  | MOV E,A                                          |
| 001F C33000 C |     | 49  | JMP DTCHK                                        |

|             |    |        |       |        |                                       |
|-------------|----|--------|-------|--------|---------------------------------------|
| 0022 DBE4   | 50 | ANT2:  | IN    | PORT1  |                                       |
| 0024 E680   | 51 |        | ANI   | 00H    | : MASK FOR SW-2                       |
| 0026 C03100 | 52 |        | JZ    | NXT3   | : NOR THIS BUTTON                     |
| 0029 7A     | 53 |        | MOV   | A, D   | : YEAR & HND'S OF DATE TO ACC         |
| 002A C681   | 54 |        | ADI   | 81H    |                                       |
| 002C 27     | 55 |        | DAA   |        |                                       |
| 002D 57     | 56 |        | MOV   | D, A   |                                       |
| 002E C33800 | 57 |        | JMP   | DTCHK  |                                       |
| 0031 DBE4   | 58 | NXT3:  | IN    | PORT1  |                                       |
| 0033 E684   | 59 |        | ANI   | 04H    | : MASK FOR SW-1                       |
| 0035 C8     | 60 |        | RZ    |        | : NO SW'S DOWN RETURN TO CALLING PRGM |
| 0036 7A     | 61 |        | MOV   | A, D   |                                       |
| 0037 C0310  | 62 |        | ADI   | 10H    |                                       |
| 0039 27     | 63 |        | DAA   |        |                                       |
| 003A 57     | 64 |        | MOV   | D, A   |                                       |
|             | 65 | DTCHK: |       |        |                                       |
| 003B 7A     | 66 |        | MOV   | A, D   | : YR & MSD, DATE TO ACC               |
| 003C E68F   | 67 |        | ANI   | 0FH    | : MASK OFF UPPER BITS (YR)            |
| 003E FEB3   | 68 |        | CPI   | 03H    | : OVER 300 DAYS?                      |
| 0040 F85200 | 69 |        | JN    | EXIT   | : NO, EXIT                            |
| 0043 C04000 | 70 |        | JZ    | CHECK  | : 300, GO SEE IF OVER 365             |
| 0046 7A     | 71 |        | MOV   | A, D   | : OVER 300, GET ANOTHER COPY          |
| 0047 E6F0   | 72 |        | ANI   | 0F0H   | : RESET MSD, DATE TO 00               |
| 0049 57     | 73 |        | MOV   | D, A   | : RETURN IT TO D                      |
| 004A 7B     | 74 | CHECK: | MOV   | A, E   | : GET LAST 2 DIGITS                   |
| 004B FE66   | 75 |        | CPI   | 66H    | : OVER 65? (365 DAYS PER)             |
| 004D F85200 | 76 |        | JN    | EXIT   | : NO, EXIT                            |
| 0050 1E80   | 77 |        | NYI   | E, 00H | : YES, RESET TO 00                    |
|             | 78 |        |       |        |                                       |
|             | 79 | EXIT:  |       |        |                                       |
| 0052 EB     | 80 | XCHG   |       |        | : PUT DATE IN HAL                     |
| 0053 22043C | 81 | SHLD   | DATE  |        | : PUT DATE IN MEMORY                  |
| 0056 C00000 | 82 | CALL   | DTDSP |        | : DISPLAY NEW DATE                    |
| 0059 DBE4   | 83 | DBON:  | IN    | PORT1  | : GET ANOTHER COPY OF PORT 1          |
| 005B E63C   | 84 |        | ANI   | 3CH    | : MASK FOR SWITCHES STILL DOWN        |
| 005D C25900 | 85 |        | JNZ   | DBON   | : WAIT FOR SW TO BE RELEASED          |
| 0060 C9     | 86 |        | RET   |        | : RETURN TO CALLING PROGRAM           |
|             | 87 |        |       |        |                                       |
|             | 88 | END    |       |        |                                       |

| LOC  | OBJ      | SER | SOURCE STATEMENT                             |
|------|----------|-----|----------------------------------------------|
|      |          | 1   | NAME THDSP                                   |
|      |          | 2   | PUBLIC THDSP                                 |
|      |          | 3   | EXTRN DISPL                                  |
| 3082 |          | 4   | TIME EQU 3082H                               |
|      |          | 5   | *****                                        |
|      |          | 6   | DISPLAY TIME                                 |
|      |          | 7   |                                              |
|      |          | 8   | THIS ROUTINE ACCESSES THE TIME MEMORY        |
|      |          | 9   | LOCATIONS AND DISPLAYS THEM IN THE FOLLOWING |
|      |          | 10  | FORMAT:                                      |
|      |          | 11  |                                              |
|      |          | 12  | DIG 1    DIG 2    DIG 3    DIG 4             |
|      |          | 13  | -----                                        |
|      |          | 14  | HR        HR        MIN       MIN            |
|      |          | 15  |                                              |
|      |          | 16  | REGISTERS:    A, D, E, H, L                  |
|      |          | 17  | MEMORY: TIME (2 BYTES)                       |
|      |          | 18  | STACK SPACE: 2BYTES                          |
|      |          | 19  | INPUT PORTS: NONE                            |
|      |          | 20  | OUTPUT PORTS: PORTS 2, 3                     |
|      |          | 21  | PROGRAMMER: M MINTZ                          |
|      |          | 22  | *****                                        |
|      |          | 23  | CSEG                                         |
|      |          | 24  | THDSP:                                       |
| 0000 | 2A823C   | 25  | LHLD TIME ;LOAD H WITH HR, L WITH MIN        |
| 0003 | EB       | 26  | XCHG ;PUT IN DE                              |
| 0004 | C30000 E | 27  | JMP DISPL ;DISPLAY IT                        |
|      |          | 28  |                                              |
|      |          | 29  | END                                          |

| LOC             | OBJ | SEQ | SOURCE STATEMENT                             |
|-----------------|-----|-----|----------------------------------------------|
|                 |     | 1   | NAME DTDSP                                   |
|                 |     | 2   | PUBLIC DTDSP                                 |
|                 |     | 3   | EXTRN DISPL                                  |
| 3084            |     | 4   | DATE EQU 3084H                               |
|                 |     | 5   | *****                                        |
|                 |     | 6   | DISPLAY DATE                                 |
|                 |     | 7   |                                              |
|                 |     | 8   | THIS ROUTINE ACCESSES THE JULIAN DATE MEMORY |
|                 |     | 9   | LOCATIONS AND DISPLAYS THEM IN THE FOLLOWING |
|                 |     | 10  | FORMAT:                                      |
|                 |     | 11  |                                              |
|                 |     | 12  | DIG 1   DIG 2   DIG 3   DIG 4                |
|                 |     | 13  | -----                                        |
|                 |     | 14  | LS YR   DATE   DATE   DATE                   |
|                 |     | 15  |                                              |
|                 |     | 16  | REGISTERS:   A,D,E,H,L                       |
|                 |     | 17  | MEMORY: DATE (2 BYTES)                       |
|                 |     | 18  | STACK SPACE:   2 BYTES                       |
|                 |     | 19  | INPUT PORTS:   NONE                          |
|                 |     | 20  | OUTPUT PORTS:   PORTS 2, 3                   |
|                 |     | 21  | PROGRAMMER:   STAPLETON                      |
|                 |     | 22  | *****                                        |
|                 |     | 23  | CSEG                                         |
|                 |     | 24  | DTDSP:                                       |
| 0000 2A043C     |     | 25  | LHLD   DATE   ;LOAD HLL WITH DATE            |
| 0003 EB         |     | 26  | XCHG   ;PUT IN DE                            |
| 0004 C30000   E |     | 27  | JMP   DISPL   ;DISPLAY IT                    |
|                 |     | 28  |                                              |
|                 |     | 29  | END                                          |

```

47 ;
48 OUT17:
49     CMA      ; INVERT DATA TO PORT
50     OUT      PORT3 ; OUTPUT IT AND LATCH PORT
51 ; STROBE ALL LATCHES HIGH
52     IN      PORT2 ; GET COPY OF LOAD PORT
53     XRI     0FFH ; INVERT UPPER 4 BITS
54     ORI     0FH  ; SET LOWER 4 HIGH
55     CMA      ; INVERT FOR OUT
56     OUT      PORT2 ; HAVEN'T CHANGED UPPER 4 BITS
57 ; STROBE SELECTED DIGIT LOW TO LOAD
58     ANI     0F0H ; ZERO LOWER 4 BITS
59     ORA     8    ; MERGE INVERTED SELECT BITS.
60     OUT      PORT2 ; SEND LOAD CODE
61 ; STROBE ALL LATCHES HIGH
62     ANI     0F0H ; RESET LATCHES
63     OUT      PORT2 ; REESTABLISH HOLD STATE
64     RET
65 ;
66     END

```

0021 2F  
0022 D3E6  
  
0024 08E3  
0026 EEF  
0028 F68F  
002A 2F  
002B D3E3  
  
002D E6F0  
002F 80  
0030 D3E3  
  
0032 E6F0  
0034 D3E3  
0036 C9

| LOC           | OBJ | SEQ | SOURCE STATEMENT                                 |
|---------------|-----|-----|--------------------------------------------------|
|               |     | 1   | NAME DISPL                                       |
|               |     | 2   | PUBLIC DISPL                                     |
| 0001          |     | 3   | DIG1 EQU 01H ;DIGIT 1 ENABLE                     |
| 0002          |     | 4   | DIG2 EQU 02H ;DIGIT 2 ENABLE                     |
| 0004          |     | 5   | DIG3 EQU 04H ;DIGIT 3 ENABLE                     |
| 0006          |     | 6   | DIG4 EQU 06H ;DIGIT 4 ENABLE                     |
| 00E3          |     | 7   | PORT2 EQU 0E3H ;PORT 2 8255 #1                   |
| 00E6          |     | 8   | PORT3 EQU 0E6H ;PORT 3 8255 #1                   |
|               |     | 9   | *****                                            |
|               |     | 10  | DISPLAY ROUTINE                                  |
|               |     | 11  |                                                  |
|               |     | 12  | DISPLAYS CONTENTS OF D&E REGISTERS ALWAYS.       |
|               |     | 13  | 'B' REGISTER CONTAINS DIGIT ENABLE. A '1' IN ANY |
|               |     | 14  | OF THE BITS WILL SELECT THAT DIGIT. THIS PROGRAM |
|               |     | 15  | DOES NOT EFFECT THE HIGH ORDER BYTE OF PORT 2    |
|               |     | 16  |                                                  |
|               |     | 17  | REGISTERS: A,B,D,E,H,L                           |
|               |     | 18  | MEMORY: NONE                                     |
|               |     | 19  | STACK SPACE: 28BYTES                             |
|               |     | 20  | INPUT PORTS: PORT2,PORT3                         |
|               |     | 21  | OUTPUT PORTS: PORT2,PORT3                        |
|               |     | 22  | PROGRAMMER: STAPLETON                            |
|               |     | 23  | *****                                            |
|               |     | 24  | CSEG                                             |
|               |     | 25  | DISPL:                                           |
| 0000 7A       |     | 26  | MOV A,D ;LOAD ACCUM WITH DATA FROM D             |
| 0001 0602     |     | 27  | MVI B,DIG2                                       |
| 0003 CD2100 C |     | 28  | CALL OUTIT ;OUTPUT L.O. BYTE                     |
| 0006 7A       |     | 29  | MOV A,D ;GET ANOTHER COPY                        |
| 0007 0F       |     | 30  | RRC                                              |
| 0008 0F       |     | 31  | RRC                                              |
| 0009 0F       |     | 32  | RRC                                              |
| 000A 0F       |     | 33  | RRC ;MOVE 4 MSB'S TO 4 LSB'S POSITION            |
| 000B 0601     |     | 34  | MVI B,DIG1                                       |
| 000D CD2100 C |     | 35  | CALL OUTIT                                       |
| 0010 7B       |     | 36  | MOV A,E ;GET DATA FROM E                         |
| 0011 0604     |     | 37  | MVI B,DIG4                                       |
| 0013 CD2100 C |     | 38  | CALL OUTIT                                       |
| 0016 7B       |     | 39  | MOV A,E ;GET ANOTHER COPY                        |
| 0017 0F       |     | 40  | RRC                                              |
| 0018 0F       |     | 41  | RRC                                              |
| 0019 0F       |     | 42  | RRC                                              |
| 001A 0F       |     | 43  | RRC                                              |
| 001B 0604     |     | 44  | MVI B,DIG3                                       |
| 001D CD2100 C |     | 45  | CALL OUTIT                                       |
| 0020 C9       |     | 46  | RET                                              |

# INITIAL DISTRIBUTION

|                  |    |
|------------------|----|
| HQ USAF/LEY      | 1  |
| HQ USAF/LEE      | 1  |
| OSAF/MIQ         | 1  |
| HQ AFSC/DE       | 1  |
| HQ AFSC/SD       | 1  |
| HQ USAFA/DE      | 1  |
| HQ USAFA/Library | 1  |
| HQ USAF/RD       | 1  |
| OSAF/ED          | 1  |
| AFOSR/CC         | 1  |
| AUL/LSE          | 1  |
| AFAPL/POE        | 1  |
| OASD/(MRA&L) EES | 1  |
| US ARMY/DAEN-RDM | 1  |
| AFIT Library     | 1  |
| AFIT/DE          | 1  |
| NCEL, Code 25111 | 1  |
| DDC/TCA          | 2  |
| AFESC/DEB        | 2  |
| US ARMY FESA     | 1  |
| AFESC/TST        | 2  |
| AFESC/RDX        | 1  |
| AFESC/RDV        | 1  |
| AFESC/RDVA       | 15 |
| AD/DL            | 1  |
| AFAPL/STINFO     | 2  |
| AFAL/TSR         | 1  |
| AFAPL/POE-1      | 1  |
| DOE/ET-50        | 2  |
| DOE/CS           | 2  |
| DOE/ET           | 2  |