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**A HYBRID SPACE HEATING/COOLING SYSTEM WITH
TROMBE WALL, UNDERGROUND VENTING, AND ASSISTED HEAT PUMP**

by

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June 22, 1983

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Appropriate Technologies Small Grants Program

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A HYBRID SPACE HEATING/COOLING SYSTEM

SUMMARY

Our goal was to design and monitor a hybrid solar system/ground loop which automatically assists the standard, thermostatically controlled home heating/cooling system. The input from the homeowner was limited to normal thermostat operations. During the course of the project it was determined that to effectively gather data and control the various component interactions, a micro-computer based control system would be required. The choice of a micro-computer based control system would also allow the HVAC system to be optimised by simple changes to software. This flexibility in an untested concept helped us to achieve optimum system performance.

Control ranged from direct solar heating and direct ground loop cooling modes, to assistance of the heat pump by both solar space and ground loop. Sensors were strategically placed to provide data on response of the Trombe wall (surface, 4" deep, 8" deep), and the ground loop (inlet, 3/4 length, outlet).

Micro-computer hardware and computer programs were developed to make cost effective decisions between the various modes of operation. Although recent advances in micro-computer hardware make similar control systems more readily achievable utilizing standard components, attention to the decision making criteria will always be required.

The ground loop was found to resist fluctuations in temperature and quickly recover from minor temperature variations caused by air flow through the loop. System performance is most sensitive to volume of air flow through the ground loop, and

A HYBRID SPACE HEATING/COOLING SYSTEM

design emphasis should primarily be placed on air flow requirements.

The use of a Trombe wall to supply heat to the heat pump excluded subsequent direct use of the solar space. The additional benefit supplied to the heat pump did not justify the additional effort required to tie the systems together. Our final conclusion includes a recommendation for a separate Trombe wall with manual or automatic controls and two separate ground loops. A closed system ground loop is felt to offer the best interior cooling assistance, when integrated into the inside circulation system, while a passive open system ground loop is felt to provide the most cost effective assistance to the outside unit of a heat pump or the interior shell of a double wall structure.

INTRODUCTION

OBJECT OF RESEARCH

The research reported herein was initiated to experimentally determine the performance of a Hybrid Space Heating/Cooling system. During the design of the Shirley home, two Heat Pump based mechanical systems were considered. A liquid based solar assisted heat pump was quickly eliminated after preliminary pricing, and it was felt that possibly a cost effective air based solar assisted heat pump system could be developed. The 3 ton heat pump system was sized to provide 100% of the homes heating/cooling and the 200 SF Trombe Wall was estimated to provide up to 30% of the estimated heating load for the residence, assuming optimal conditions. Due to the lack of available design information for ground tubes, the "loop" was sized to provide a cross-sectional area equal to the area of the heat pump outdoor coil fan, approximately 3 SF.

The Shirley residence (see figures 1-4) is located in Columbia, South Carolina, latitude 34 degrees, longitude 81 degrees 1 minute. The house was designed with energy conservation and passive solar energy considerations as well as the Hybrid/active systems primarily analyzed herein. The residence contains approximately 2350 SF of heated floor space and 3000 SF of total floor space. The house is oriented with the long axis facing South 10 degrees West with overhang and double glazing designed to maximize heat gain on the southern exposure while minimizing heat gain/loss on all other exposures. The two story structure is placed on a sloping lot with the lower level

bermed to a depth of approximately 6 ft on the north wall and transitioning from 6 ft to 3 ft on the west wall and from 6 ft to 4 ft on the east garage wall. The building envelope is insulated as follows: Basement floor averages R8, Basement level walls average R12, First floor walls R17, First floor ceiling R30. The lot does suffer some shading from Southern Pines which has tended to reduce the direct radiation on the Trombe Wall in the mornings and late afternoons, the estimate for shading penalty is set at 35 percent.

SCOPE OF INVESTIGATION

The research program consisted of the following phases:

- 1) Design and Construction of the Micro-processor based mechanical control/monitoring system and the placement of sensor devices.
- 2) Monitoring and optimization of the mechanical system.
- 3) Analysis of the recorded data.

DESCRIPTION OF HEATING/COOLING SYSTEM

SYSTEM COMPONENTS

The mechanical system can be separated into four separate units for purposes of discussion: 1) Ground Loop, 2) Trombe Wall(Solar Space), 3) Heat Pump, and 4) Control and Monitoring system.

The design of the ground loop (see figure 5) required little additional excavation during the construction of the structure, the loop simply wraps around the structure at the foundation level separated from the structure by a distance of 12 inches. The Ground Loop inlet is located at the southeast corner of the structure. A Venturi fan with a 12 inch blade and a 1/4 hp motor rated at 1430 CFM free air was provided to circulate the air through the ground loop. A motorized damper placed immediately in front of the fan insures a positive seal when the loop is not operating. The initial 30 feet of the loop running from the southeast corner to the northeast corner is made up of an open channel with a cross section of 3 SF (see figure 5). At the northeast corner a 90 degree turn leads into a section of loop designed as 12" concrete blocks stacked in a pyramid fashion creating 3 SF of opening for an air channel (see figure 5). This arrangement runs 60 feet from the northeast corner to the northwest corner then through a 90 degree junction box with a deflector and continues on 30 feet to the southwest corner of the structure through another 90 degree junction box and exiting into the Solar Space. The average mid-depth of the loop is

approximately 5 feet below the ground surface over the entire 120 foot loop. The "loop" continues through the Solar Space for 25 feet and exits through the Solar Space Outlet, a motorized damper which exhausts air flow to the outside coils of the Heat Pump system.

The Solar Space (see figure 6) consists of a 200 SF 12" concrete block wall which is fully grouted and functions as a structural wall for 25' along the south side of the basement. The wall has a 32" overhang computed to eliminate any direct sunlight during the summer months, but effectively reducing the solar wall height to 6.25'. The design called for the placing of the inside unit and supply and return ductwork in the Solar Space with insulation on the inside of the duct. The outside was painted to match the wall, to provide quick heatup in the morning sun and therefore early useful temperatures for the structure. The ductwork occupies the upper 2' of the Solar Space and projects 22" out from the wall, effectively utilizing 1.5' of the upper 2' for solar collection during the winter months, while remaining shaded during the summer months. The effective maximum collector area was 187.5 SF. The entire wall, ductwork, and air handler unit were painted with Sherwin Williams Metalatex Black (#B42B3) with an absorptance of approximately 0.90. The entire wall was double glazed with the inside glazing consisting of 3/16" low-iron glass at a distance of approximately 28" from the solar wall and the outside glazing consisting of 0.025" Kalwall Sun-Lite Premium II (fiberglass reinforced plastic) located at approximately 32" from the wall surface. The total transmittance, at normal incidence, for this system was

calculated to be 0.78. The Ground Loop enters on the west end and a motorized damper allows air flow to leave at the east end of the wall, exiting to the outside unit of the Heat Pump. Two motorized dampers were provided in the return duct, one at the west end of the Solar Space, the other at the east end of the Solar Space. These dampers are opened simultaneously to pull return air through the Solar Space, or to allow ground loop air to flow directly into the house, with the return air being exhausted outside the Solar Space. The Ground Loop damper and Solar Space outlet damper must also be open to effect this mode.

The "3 Ton" Heat Pump system consists of an un-modified YORK Champion split-system high efficiency Heat Pump, model CHPI36/CHPO36. The heat pump is rated at 22,000 BTUH for heating at the Columbia, South Carolina design temperature of 20F, assuming 70F return air. The heat pump is rated at 32,800 BTUH for total cooling capacity at the Columbia, South Carolina design temperature of 95F dry bulb, assuming a 72F indoor design temperature. The inside unit blower is rated at 1200 CFM, and the outside unit blower is rated at 2440 CFM for a dry coil.

The Control/Data-Acquisition System consists of two micro-computer based units which interact in a master/slave arrangement during programing, initialization, and a receive/broadcast arrangement for data-acquisition. During programming and initialization, an Intertec Superbrain QD micro-computer system is used to develop and download assembly language programs for use in the Control unit. During data-acquisition, this micro-computer system becomes the receiver of data broadcast at 10

second intervals from the Control unit, recording data on floppy diskettes according to its operating program. All data-acquisition and analysis software (see appendix) was written in PL/1 due to the ease of creation and modification. Communications between the two micro-computer systems is provided via an RS232-C serial link at 1200 baud using software handshaking. The Control Unit is a custom creation, based on a Miller Technology M-80 Microcomputer, consisting of a single board Z80 based micro-computer system with 2K bytes of RAM and a separate power supply board. Custom Analog to Digital(A/D) hardware and output control hardware were designed and built to perform the interfacing to the "Real World". The A/D board uses a National Semiconductor ADC0816 8-bit Analog-to-Digital converter chip which multiplexes 16 analog inputs. The Output control section consists primarily of 24 volt relays to control the system dampers and to interface to the Heat Pump thermostat for control. All inputs and outputs are memory mapped. The system is designed so that removal of power from the micro-computer control system causes a reversion back to the normal heat pump thermostat control system.

INPUTS AND OUTPUTS

The Control System inputs (see figures 6-8) are provided by 16 multiplexed analog inputs (I0-I15) and one additional Direct Memory Access input (I16).

The inputs are:

- I0 - Thermister, Solar Wall surface temperature.
- I1 - Thermister, Solar Wall 4" depth temperature.

- I2 - Thermister, Solar Wall 8" depth temperature.
- I3 - Photo-Resistor, Day/Night sensor.
- I4 - Thermistor, Solar Space temperature at 4 ft. height.
- I5 - Thermister, Ambient temperature at Ground Loop inlet.
- I6 - Thermister, Ground Loop Outlet temperature.
- I7 - Thermister, Solar Space Outlet temperature at 1 ft. height.
- I8 - Thermister, HP outside coil air temp. / Ground temp.
- I9 - Thermister, Inside return air temperature.
- I10 - Relay, Thermostat mode (Heating/Cooling).
- I11 - Relay, Thermostat state (on/off).
- I12 - DPDT Switch, Software override switch #4 (Disable Heat Pump).
- I13 - DPDT Switch, Software override switch #3 (Inside Fan on/off).
- I14 - DPDT Switch, Software override switch #2 (Return Dampers).
- I15 - DPDT Switch, Software override switch #1 (Ground Loop Fan).
- I16 - Display Switches, 4 bit input to memory reading.
 - Switch 4 - Down = Cooling, Up = Heating.
 - Switch 3 - Down = Auto, Up = Manual(affects Sw 2, Sw 1).
 - Switch 2 - Down = off, Up = on (relay 5).
 - Switch 1 - Down = off, Up = on (relay 6).

The Control System Outputs (see figures 6-8) are provided by six 24 volt relay outputs:

- 01 - Relays, cascaded 24 volt relay into a 120 volt relay to control Fan and Damper at Ground Loop Entrance, Damper at Solar Space Outlet to Heat Pump (on / off & open / closed).
- 02 - Relay, controls Dampers in Heating Systems Return in Solar Space (open / closed).
- 03 - Relay, controls thermostat output to Air Handler Fan (Enable/Don't Care, inside circulation fan).

04 - Relay, controls thermostat output for Heat Pump Control (Disable / Enable Heat Pump operation).

05 - Not used.

06 - Not used.

Additionally, an override switch was provided which places the system in either a manual mode for testing or an automatic mode for software operation. In the manual mode, 4 additional switches similar to I12 - I15 described above control relay outputs 1 through 4.

CONTROL SOFTWARE

The control software consists of approximately 2K bytes of Z80 Assembler code (see appendix). The control algorithm is essentially a simple loop which performs the control functions approximately 2.1 times per second and transmits down the communication link the 21st evaluation, on a 10 second interval. The display count is then incremented indicating that the unit is functioning and there is a 14 hundredths of a second delay loop after the display update to insure a constant cycle of 10 seconds.

The primary subroutine used to control the system, SCYCLE, and its functional approach are described. The System Cycle routine first calls UPREADS which updates all of the A/D readings and insures that a consistent snapshot of the system is acquired. (This technique eliminates any drift in the readings which typically occur when taking multiple readings of the same sensor for several different evaluations.) Using the fixed A/D readings the UPDAY routine updates the DAY/NIGHT values. The UPSFSW

routine then updates the SOFTWARE SWITCH values, the UPDMS routine updates the MODE and STATE values, and the various MODE VALUES are calculated by EVAL. The HEAT PUMP is now either disabled or enabled by CTRLHP, the CONTROL routine is activated to determine if manual override is in effect or mode change has occurred, and the RELAYS are updated by UPREL as required.

The logical control of the system is centered in the routines EVAL and CONTROL. EVAL computes the values of the seven modes possible for the system, and "programs" the action to be taken should the thermostat call for heating or cooling. EVAL first calls VALMS which computes the numeric values for the seven modes based on the current A/D readings. The numeric temperature values for the non-linear thermistor readings are computed using a table look-up with interpolation to the nearest 1/10th degree Centigrade.

Each mode has a simple numeric value based on addition, subtraction, multiplication, and division, and the choice between modes is based on the computed value and the order of evaluation. Specifically, the modes are checked in ascending order and the first heating/cooling mode with a positive value is selected. The seven modes are:

MODE0 - (see figure 9) Heating by circulating house air through the Sun Space with Heat Pump DISABLED. (The value for MODE0 is defined as the difference between the Solar Space Temperature and the Inside Temperature of the house less a constant of 2.0 degrees Centigrade.) The constant provides a "deadband" between this mode and MODE1.

MODE1 - (see figure 10) Heating by circulating house air

through the Solar Space with the Heat Pump ENABLED. (The value for MODE1 is defined as the difference between the Solar Space Temperature and the Inside Temperature of the house.) Should the Solar Space temperature drop to within 2.0 degrees of the inside temperature the Heat Pump is enabled. This mode is provided to insure that a lockout of the heat pump with subsequent heat loss exceeding heat gain does not occur.

MODE2 - (see figure 11) Heating by circulating outside air through the Ground Loop, through the Solar Space, and through the outside coil of the Heat Pump. This circulation pattern serves to assist the Heat Pump by tempering part of the air used by the Heat Pump. This mode is enabled only when the DAY/NIGHT sensor indicates NIGHT. This definition insures that the direct modes, MODE0 and MODE1, will have a chance to operate and provide maximum benefit through direct heating. (The value of MODE2 is defined as the difference between the Solar Space Outlet to the Heat Pump and the Ambient Temperature less a constant of 10.0 degrees Centigrade.) The 10.0 degree constant was empirically determined by measuring the current draw of the Ground Loop fan and Damper (1.8 Amps) and establishing the volume of air delivered to the Heat Pump by the fan (~660 CFM). This information along with the performance data of the YORK Heat Pump (see figure 15) was used to determine the necessary temperature differential for operation of the Ground Loop with "payback". This Balance Point temperature was determined to be 2.65 degrees Centigrade if 100% of the required air is provided. Since the Ground Loop fan only provided 27% of the HP outside fan (2440

CFM), the Balance Point temperature was factored up accordingly, establishing a required constant of 10.0 degrees Centigrade for operation. This is a severe criteria but insures that when the Ground Loop operates, a positive Return On Investment for the current used is achieved.

MODE3 - This is a currently unused heating mode provided for expansion purposes.

MODE4 - (see figure 12) Cooling provided by the circulation of outside air through the Ground Loop and directly into the house. (The value of MODE4 is defined as the difference between the Inside Temperature and the Ground Loop Outlet less a constant of 2.0 degrees Centigrade.) This mode is enabled only when the Ambient Temperature is less than 21.0 degrees Centigrade.

MODE5 - (see figure 13) Cooling provided by the circulation of outside air through the Ground Loop, through the shaded Solar Space, and across the outside coils of the Heat Pump. (The value of MODE5 is defined as the difference between the Ambient Temperature and the Ground Loop Outlet temperature less a constant of 10.0 degrees Centigrade.)

MODE6 - This is a currently unused cooling mode provided for expansion purposes.

MODE7 - (see figure 14) This is the default mode of heating/cooling with only the Heat Pump in operation and is selected only if all other modes fail to produce a non-zero, positive value.

The EVALuation routine determines if the system is calling for heating or cooling (If Cooling is required, EVAL skips over the first four mode values.) and then locates the first value

which is greater than zero. This mode is used to "program" the system for response when the thermostat calls for action. This evaluation takes place approximately 2.1 times per second continuously. To prevent "toggling" between any modes, the system is provided with a timeout mechanism which allows the system to move to a mode with a larger mode number, but forces a time delay when the system tries to move to a mode of lower value. The delay is approximately 13 minutes of operation.

The CTRLHP routine is the only routine which operates continuously in "Real-Time". This routine serves to predetermine the status of the Heat Pump when the thermostat next calls for Heating/Cooling and enable or disable its operation. This serves to eliminate the unnecessary strain induced by providing a power surge to the Heat Pump which is subsequently powered off within 1.0 second by the selection of a direct heating/cooling mode.

The CONTROL routine next determines if the State of the system is on or off. If the system is on, CONTROL checks and sets the appropriate action as determined by EVAL, and by checking certain conditions and blocking the "toggling" from one mode to another, and by resetting the "system" to all off (shutdown) when the system thermostat no longer requires action.

Finally the UPREL routine executes the current software settings of the relays if the system is on and the software switches are set to auto, or UPREL will immediately execute the current manual setting of a software switch.

CALIBRATION OF SYSTEM

Calibration of the system initiated with the initial establishment of the A/D conversion routine delay, and still continues as more information points to improvements.

The first calibration was required when it was noticed that multiple A/D readings of known different temperatures were reporting the same value. The solution required a 1/100th second delay when the A/D port was selected and a 1/100th second delay at the End Of Conversion flag following the A/D reading. These delays insured that first the address and then the latched tri-state output data provided by the ADC0816 were stable on the M80 bus.

The temperature look-up table was established at 10 degree Centigrade increments by comparing a given input thermistor reading to the known temperature established by thermometer. The control program table was adjusted to reflect the proper thermistor reading at the known temperature, and the calibrated value was dated.

The photo-resistor, DAY/NIGHT sensor, was calibrated by determining the A/D reading at the desired time of day. The current setting toggles at dusk. (Due to the lack of early morning and late afternoon direct radiation this setting may soon be reset, extending the NIGHT reading.)

The calibration of the control unit required determining the values of A/D readings on the DPDT software override switches which represented ON/AUTO/OFF positions. Additional input values for the SPST switches located below the display unit were established which represent ON/OFF positions.

During the system implementation, the original procedure for mode evaluation was to determine each A/D reading as needed during the evaluation of each mode. It was noticed that during the mode evaluations that any given sensor might report different values when read at different conversions within the same evaluation cycle causing inconsistent mode comparisons. The solution to this problem was to establish a snapshot of the system by reading all of the sensors at one time and then evaluation all of the modes using the consistent data.

A major problem arose when the heat pump first went into its defrost mode. This input appeared to the control system as a call for cooling, and in February the system decided to disable the heat pump and provide outside air directly into the house. Once the control unit disabled the Heat pump, the defrost cycle was disabled and the control unit recognized the heating mode once more. This cycling continued for about 45 seconds until the problem was identified and the control unit disabled. The solution was to use one of the then unused switches under the display on the Control Unit to set manually the desired mode, HEATING or COOLING. When the Heat Pump indicates a mode other than the switch setting, the control unit assumes the defrost cycle and remains passive.

Another calibration was required to establish a constant time interval for transmission of data to the monitoring unit. Simple timing delays were implemented to insure a constant transmission cycle of 10 seconds.

Another major problem occurred when the temperature was at a

point where the system could toggle from one mode to another and back again. Toggling occurred during interpolation of temperature values when system resolution causes two successive A/D readings to be different. Toggling also occurs when a reduction of temperature is caused by system cooling. When cold air flow is introduced a mode change may occur and air flow stops, the subsequent warming of the sensor causes the mode to toggle back. The solution to this problem was to allow the first mode change to occur, but to prevent the toggling back. This scheme was implemented by allowing modes of increasing value to occur freely but to lock-out for approximately 13 minutes the return to a lower mode.

Once the current required to drive the ground loop fan had been determined and the performance of the loop was established, the break-even point from an energy standpoint for running the ground loop was calculated. This temperature difference was determined to be approximately 10 degrees Centigrade and the modes involving the ground loop were appropriately calibrated.

During the early calibration of the system the Ambient temperature sensor was initially placed at the mid-depth elevation of the structure, as is the Inside temperature sensor. Later it was decided that since the performance of the Ground Loop was of considerable importance, the Ambient sensor was moved to the Inlet of the Ground Loop, at an elevation approximately 2 feet from the slab, or approximately 6 feet lower than its initial placement. The current placement allows both the inlet and outlet air temperatures of the loop air to easily be determined, while still representing Ambient conditions.

Another loop problem arose when the original relay was exposed to moist conditions for a few months. The relay stuck in the on condition and required replacement. The replacement relay was of the sealed variety and has operated satisfactorily until recently. The switching of 120 VAC tends to cause pitting of the contacts over time and the relay has recently required filing of these contacts. A future electronic relay may resolve this minor maintenance problem.

After the system was operational, it was noticed that the house would occasionally overheat during the daytime. Analysis determined that a natural circulation loop had developed between the lower level inlet registers and the upper level inlet registers. A partial solution to this problem was to install a gravity damper in the upper level supply trunk prior to the registers.

In August of 1982, the ADC0816 chip failed and required replacement. An ADC0817 chip was substituted while a replacement was ordered. The ADC0817 chip is still functioning satisfactorily at this writing, implying that 7-bit or 8-bit resolution would be satisfactory for this application over the temperature ranges involved.

During the calibration of the Cooling modes, it was determined that a situation could arise whereby outside air could be cooler than the inside air but insufficient to cool the structure to a comfortable temperature. Additionally, a situation was envisioned where a simple temperature difference would not suffice. This condition could occur when the structure

had additional load, such as solar, causing the inside temperature to increase, while the ambient air temperature was also rising but remaining below the threshold that would allow the heat pump system to intervene. To mitigate this problem an absolute temperature point which would enable the direct cooling mode was implemented. The temperature chosen was 21.0 degrees Centigrade and direct cooling is possible only when the Ambient temperature is below this value.

During the analysis of data it was determined that the ground loop outlet sensor had been influenced during the summer months due to its proximity to the ground surface. The initial placement had the sensor placed in the concrete box which terminated the ground loop prior to inlet to the solar space, at a depth of approximately 2 feet below the surface. The box, however, was covered by only a thin layer of soil and could therefore be subjected to considerable direct radiation during summer months. The current placement is approximately 6 feet into the ground loop and at a depth below ground surface of approximately 4 feet, consisting of soil and the concrete block which constitutes the loop.

Finally, during late spring and early fall, it is often undesirable for the solar space to heatup. A large piece of metal with both a dark and light side was placed on the floor of the solar space. When this absorber/reflector exposes its dark horizontal surface, the solar space has an earlier heatup and a greater total absorber area. When this heat is not desirable, the white side is exposed as a vertical reflector which significantly reduces the heat buildup.

ACQUISITION OF DATA

The data collection for the SYSTEM began February 8, 1982 and continues to this date. The period which this report covers is the time from 02/08/82 to 05/21/83. Usually two or three days of data were gathered each month. An attempt was then made to select the best day of recorded data each month which represented clear weather. The choice of clear days allowed the system a chance to illustrate best performance by removing noisy data, and hence providing an upper bound on the net savings. The data acquisition continued from February until October when the SYSTEM was retuned for optimum cooling performance. Data acquisition continued until November when the first versions of the PLOT program were operational and preliminary analysis of the data began.

Data analysis caused movement of some sensors in the Ground Loop to occur. Analysis continued in January of 1983 with the movement of the sensor from the outside Heat Pump coil to the NorthWest corner of the structure and inside the Ground Loop. This sensor had been used to establish the delta-T across the loop by providing useful Temperature delivered to the Heat Pump, as measured from the Inlet Temperature. This information with other data provided by the Heat Pump manufacturer had previously allowed the breakeven point for the Ground Loop to be determined. This sensor currently measures the ground temperature at the 3/4 point in the ground loop.

Additionally, preliminary analysis mandated the movement of the Ground Loop outlet sensor, avoiding the future effects of direct radiation which affected early sensor placement. Data

acquisition continues on a random basis in this new configuration.

ANALYSIS OF DATA

The analysis of data which follows consists of a presentation of selected dates of recorded data and associated observations and conclusions which were drawn from the data.

The plots of the data represent the significant data recorded during the testing period. Following is a description of the graph data from left to right:

- Relay output values.
4321 (position)
x___ Relay #4, Enable=1/Disable=0 Heat Pump
_x___ Relay #3, Turns on=1/off=0 inside circulation fan
__x___ Relay #2, Opens=1/Closes=0 dampers in Return Duct
___x___ Relay #1, Turns on=1/off=0 Ground Loop fan

M# - Mode & State indicators.
x_ Mode, either (H)eating, (C)ooling, or (D)efrost
_x State, either 0 = off or 1 = on

P - Photo-resistor indicator, (D)ay or (N)ight

HH:MM - Time of Day (hours:minutes)

PLOT LEGEND

* Photo-resistor relative value

M Heat Pump temperature at condensor coil or Ground temperature (04/30/83 and subsequent data)

A Ambient temperature

G Ground Loop outlet temperature

X Solar Space Outlet temperature

8 Solar wall temperature at 8 inch depth

4 Solar wall temperature at 4 inch depth

0 Solar wall temperature at 0 inch depth (surface)

+ Solar Space Air temperature at mid-depth

I Inside temperature

The analysis which follows describes the performance of the system for selected days and represents the typical system behavior for various times throughout the 1982 year.

02/11/82

As can be seen from the plots in the Appendix, several interesting features will be present in all graphs. First one should note the shading which occurred. This shading is best illustrated during the winter months by the plot of the surface wall temperature. This sensor consisted of a thermister placed directly on the surface of the solar wall and exposed to direct solar radiation. Next it can be observed that the Photo-resister was designed to be insensitive to shading, due to its field of view, and measures primarily diffuse radiation. Additionally, one should note that the 4" depth peak temperature lags the surface peak temperature by approximately 30 min. The 8" depth peak temperature value typically lagged the 4" depth peak temperature by approximately 45 min and would hold its maximum value for around 4 hrs. Additionally, one should note that the inside temperature was increased due to "passive heating" as described earlier. Specific data for 2/11/83 are: Wall surface temperature peaks at approximately 104F at 2:08 PM. Solar Space contributed to house heating for approximately 6 hrs. System recognized contribution for approximately 5 hrs. (Difference due to passive heating.) Ambient temperature peaked at 64F at 4:00PM. Duration of day was approximately 9 hrs. For all subsequent days, only summary data and notable differences will be listed.

02/13/82

Surface temperature peaked at 2:12PM at 99F. 4" temperature peaked at 80F. 8" temperature peaked at 75F. Maximum inside temperature achieved was 75F. Solar contributed for approximately 6.63 hrs. Solar System contribution duration was 5.52 hrs. Ambient temperature peaked at 4:13PM at 57F. Solar Space temperature peaked at 89F at 1:10PM. Duration of day was approximately 10 hrs. Minimum wall surface temperature was 57F at 6:40AM. Minimum Ambient temperature was 28F at 6:40AM. Minimum Solar Space temperature was 53F at 6:40AM. System was in Ground Loop assist mode to Heat Pump for approximately 8.95 hrs. Duration of night was 13.9 hrs.

03/08/83 - 03/09/82

It should be noted that the higher sun angles were allowing earlier morning heatup by reduction of shading. Daytime data reported is for 03/09/82 while nighttime values are for the evening of 03/08/82 - 03/09/82. Surface temperature of Solar Wall peaked at 12:40PM at 100F. 4" depth Solar Wall temperature peaked at 84F. 8" depth Solar Wall temperature peaked at 80F. Maximum inside temperature achieved was 77F. Solar contributed for approximately 10.22 hrs. Solar System contributed for approximately 9.18 hrs. Ambient temperature peaked at 3:13PM at 62F. Solar Space temperature peaked at 94F at 1:10PM. Duration of day was approximately 11.15 hrs. Minimum wall surface temperature was 56F at 6:43AM. Minimum Ambient temperature was 26F at 6:19AM. Minimum Solar Space temperature was 52F at 5:33AM. System was in Ground Loop assist mode to Heat Pump for approximately 11.83 hrs. Duration of night was 12.87 hrs.

04/07/82

Again, it should be noted that the higher sun angles were causing earliest morning heatup by reduction of shading. Solar radiation no longer directly strikes the surface temperature sensor. The temperature of the air in the solar space exceeds the temperature on the surface of the solar wall. Surface temperature of Solar Wall peaked at 1:23PM at 87F, 4" depth Solar Wall temperature peaked at 1:38PM at 81F, and 8" depth Solar Wall temperature peaked at 1:54PM at 77F. Maximum inside temperature achieved was 77F. Solar contributed for approximately 8.75 hrs. Solar System contributed for approximately 8.25 hrs. Ambient temperature peaked at 5:14PM at 65F. Solar Space temperature peaked at 91F at 1:08PM. Duration of day was approximately 11.68 hrs. Minimum wall surface temperature was 62F at 6:24AM. Minimum Ambient temperature was 27F at 4:56AM. Minimum Solar Space temperature was 55F at 5:40AM. System was in Ground Loop assist mode to Heat Pump for approximately 6.67 hrs. (Note: recording period was not a full 24 hours.) Duration of night was 12.32 hrs.

05/14/82

Cooling mode was entered, and the wall was mostly shaded. Note that solar contribution did interfere with cooling. (This problem has been corrected by the addition of a reflector used in the late spring and early fall. Surface temperature of Solar Wall peaked at 2:10PM at 89F. 4" depth Solar Wall temperature peaked at 86F, 8" depth Solar Wall temperature peaked at 83F. Maximum inside temperature achieved was 82F. Ground cooling did

not contribute to the system at all. Ambient temperature peaked at 4:08PM at 86F. Solar Space temperature peaked at 93F at 3:25PM. Duration of day was approximately 12.5 hrs. Minimum wall surface temperature was 75F at 6:35AM. Minimum Ambient temperature was 63F at 6:35AM. Minimum Solar Space temperature was 73F at 5:34AM. System was never in mode of Ground Loop to assist Heat Pump. Duration of night was 11.5 hrs.

06/15/82

All solar space temperatures approximated ambient conditions. Maximum inside temperature achieved was 76F. Ambient temperature peaked at 2:40PM at 84F. Solar Space temperature peaked at 86F at 3:24PM. Duration of day was approximately 12.6 hrs. Minimum ambient temperature was 72F at 1:44AM. Minimum Solar Space temperature was 75F at 00:12AM. System was never in mode of Ground Loop assist to Heat Pump. Duration of night was 11.4 hrs.

07/27/82

Maximum inside temperature achieved was 77F. Ambient temperature peaked at 12:48PM at 87F. Solar Space temperature peaked at 86F at 1:23PM. Duration of day was approximately 12.3 hrs. Minimum Ambient temperature was 76F at 5:58AM. Minimum Solar Space temperature was 76F at 6:50AM. System was never in mode of Ground Loop assist to Heat Pump. Duration of night was 11.7 hrs.

08/20/82

Maximum inside temperature achieved was 77F. Ambient temperature peaked at 2:00PM at 85F. Solar Space temperature peaked at 97F at 2:08PM. Duration of day was approximately 12.08

hrs. Minimum wall surface temperature was 78F at 5:23AM. Minimum ambient temperature was 72F at 5:58AM. Minimum solar space temperature was 76F at 3:58AM. System was never in mode of Ground Loop assist to Heat Pump. Duration of night was 11.92 hrs.

04/30/83

It should be noted that this and subsequent data reflects revised sensor placement. System in direct cooling mode for 28.22 hrs. The relative humidity increased from approximately 55% to 70% during this run. This date provides typical data for cooling mode analysis. The inside temperature tended to rise on 5/01/83 along with the ambient temperature rise, indicating a failure of the system to satisfy the cooling load requirement. Ground temperature did increase by 4F from 62F to 66F over the 28.22 hour runtime. Daytime data reported is for 04/30/83-05/01/83 while nighttime values are for morning/evening of 04/30/83-05/01/83. Maximum inside temperature achieved was 79F at run termination, indicating a 2F rise from the starting temperature of 77F. Ambient temperature peaked at 2:42PM at 82F. Solar Space temperature peaked at 77F at 1:04PM. Duration of day was approximately 11.35 hrs. Minimum Ambient temperature was 65F at 6:04AM. Minimum Solar Space temperature was 68F at 2:45AM. System was in Ground Loop assist mode to Heat Pump for approximately 28.22 hrs. Duration of night was 12.65 hrs.

5/20/83-5/21/83

Again this date provides typical data for the system in the direct cooling mode. Relative humidity increased from the normal

50% - 60% to approximately 70% during this run. Minimum inside temperature occurred at 00:27AM at 75F. Maximum inside temperature occurred at 4:56PM at 80F. Ambient temperature peaked at 4:09PM at 84F. Minimum ambient temperature occurred at 3:38AM at 69F. The ground temperature started at approximately 68F and increased 3F over a 10.07 hour runtime.

CONCLUSIONS

Based on the test data reported herein, the following observations are made:

1) The ground loop used in this system only assisted the heat pump in the heating/cooling mode when the computer control system determined that the cost of operation of the ground loop would be overcome. This constraint assured that the loop would be utilized only in a cost effective manner. The analyzed system provided approximately 33% of the air required by the outside coil of the heat pump. Due to insufficient volume, a temperature differential of 10C (18F) was required for cost effective operation during the heat pump assist mode. The conditions required for operation of the system in the heat pump heating assist mode therefore occurred only when the ambient temperature approached freezing. Had the volume supplied been 100% of demand, a required temperature differential of 3C (5.4F) would have been adequate for cost effective operation during the heat pump assist mode. The system has not yet been observed to assist the heat pump in the cooling mode. The lack of operation of the heat pump cooling assist mode is attributed to the large temperature differential required by the insufficient air volumes and the high efficiency of the heat pump in the cooling mode. The primary temperature variations noted in the ground loop were caused by annual variation in ground temperature and were only temporarily influenced by airflow through the loop.

2) The ground loop supplied approximately 50% of the required CFM for the inside circulation system of the structure.

Since the volume of air supplied to the structure was inadequate, the loop did not always meet the cooling load of the structure even though the temperature conditions were optimum. Additionally, during some days of operation of the direct cooling mode, the relative humidity has been observed to rise from the normal of approximately 55% to as high as 70% .

3) The system of ducts contained within the heated space of the Trombe wall system performed as expected and can be designed to effectively control temperature swings within the living space. The estimated optimal thickness for a Trombe wall in a system of this type is 6". The control system for heating MODE0 (direct solar heating) and heating MODE1 (direct solar heating with heat pump heating) could be implemented utilizing a two stage thermostat assuming the thermostat had a temperature sensor for the first stage. This type of design would eliminate the need for a micro-computer control system for these modes. The presence of metal in the solar space allowed quick heatup once sunlight had access to the Solar Space and would have provided earlier morning heat were it not for shading.

4) Computerized control of HVAC systems for light commercial and residential structures is now feasible using standard off the shelf hardware such as the TIMEX SINCLAIR ZX81, COMMODORE VIC 20, or other low cost micro-computers in conjunction with standard or custom A/D and D/A interfaces. Although the hardware used in this project was of custom design and construction, today this system could be implemented using standard interfaces. Systems of this type will allow both sophisticated optimizing control and cost effective design to be easily achieved.

RECOMMENDATIONS

Based on the analysis of data herein and the experience of the authors in the design of this system, several design recommendations are given:

Ground loops which supply air to a closed system should be sized to provide 100% of the rated CFM supplied by the heat pump system. This volume of air will be required if the loop is to meet all loads on the structure, when temperature conditions call for utilization. In a cooling mode, a closed loop powered system will provide at least two additional benefits. First, a lower temperature inside return air will usually be supplied to the loop inlet. This reduced temperature can be significant in hot summer months. Second, potential humidity problems would be eliminated. Although humidity has not been a problem on this project, high humidity air (relative humidity of 70% or more) delivered to the interior of the structure has presented marginally comfortable conditions on some days during the direct cooling mode. The normal summertime relative humidity values utilizing only the heat pump run 50% to 60% .

Open ground loops which supply air to the exterior coils of a heat pump or which cool a structure by convection and conduction through the exterior walls should be designed in such a way that the flow through the loop is induced by passive means, if possible. A powered ground loop can assist a standard Air-to-Air heat pump system in a cost effective manner if the winter season typically experiences many days with the ambient temperature near freezing. A powered ground loop could be cost effective at a temperature differential of approximately 3C

(5.4F) assuming 100% of air flow is provided.

It is felt that a better design would use a closed loop return air system utilizing a basement wall or sub-floor slab as the thermal mass with power being derived from the circulation fan of the structures' HVAC system. A separate open ground loop should also be utilized to assist the outside coil of the heat pump with air flow being induced by the vacuum created by the fan on the outside unit. Another form of outside cooling only loop could utilize passive airflow around the internal shell of a hollow wall structure.

Specific recommendations for the design of an outside loop includes the use of a loop cross-sectional area equal to or greater than the outside coil area, for heat pump assistance. For the loop reported herein, and at the airflow reported, a length of 90' instead of 120' could have been utilized. It is suggested that if the loop is wrapped around the structure that a separation distance of at least 6' be utilized to insure minimum impact on the ground temperature profile surrounding the structure. For inside loops, the maximum available surface area should be utilized to minimize temporary variations in loop temperature. Additionally, in both loop designs, frictional losses should be considered more important than heat transfer characteristics of the materials involved.

A 12" Trombe wall is an effective tool for moderating excessive peak temperatures. For a design where high residual temperatures would contribute to a longer carry over into the night, an optimal thickness of approximately 6" should be used.

A Trombe wall system should be designed as a separate system with no interaction with ground loops. A two stage thermostat in conjunction with duct and dampers enclosed in a Solar Space can be a cost effective way of controlling temperature swings and eliminating distribution problems normally associated with a totally passive Trombe wall systems. In systems where supply ducts are designed inside the Trombe wall environment, analysis should consider potential convective loops.

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REFERENCES

NUMBER	TITLE
1	<u>Solar Energy Thermal Processes</u>
by J. A. Duffie and W. A. Beckman
John Wiley & Sons, 1974
2	<u>Solar Heating Design By The f-Chart Method</u>
by W. A. Beckman, S. A. Klein, J. A. Duffie
John Wiley & Sons, 1977
3	<u>Technical Notes On Brick Construction,</u>
<u>Set 43A-43B, Passive Solar Heating With</u>
<u>Brick Masonry</u>
by Brick Institute of America, 1979
4	<u>The Passive Solar Energy Book</u>
<u>Expanded Professional Edition</u>
by Edward Mazria
Rodale Press, 1979
5	<u>M-80 Single Board Microcomputer Instruction</u>
<u>Manual</u>
Miller Technology, 1980
6	<u>Application Data Split-System Heat Pump</u>
<u>Champion Indoor Evap-Blower</u>
Form 515.21-AD2 coded 979
York Division Borg-Warner

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SITE PLAN		
SCALE - AS SHOWN	SHIRLEY HOME	DRAWN BY JWS
DATE		
S.C. SOLAR ENERGY GROUP		
36	FIGURE 1

SHIRLEY HOME		
DATE 7-8-79	APPROVED BY:	DESIGNED BY JWSMAS
S.C. SOLAR ENERGY GROUP		
37	FIGURE 2

DOORS	
①	3068
②	2868
③	2468
④	2068
⑤	

FIRST FLOOR PLAN

SHIRLEY HOME

AS SHOWN 7-7-79

S.C. SOLAR ENERGY GRO

38 Figure 3

SOUTH ELEVATION

NORTH ELEVATION

0 4 8 12
FEET

SHIRLEY HOME

DATE: 7-8-79 DRAWN BY: JWS-MAS

S.C. SOLAR ENERGY GROUP

SHIRLEY HOME		
SCALE: AS SHOWN	APPROVED BY:	DESIGNED BY JWSMAS
DATE:		
S.C. SOLAR ENERGY GROUP		
40		FIGURE 4A

① View of Ground Loop Looking East At Deflector On NW Corner

② View Of Ground Loop On North Side Looking East

③ View Of Ground Loop On NE Corner Looking South

⑤ Ground Loop Looking North

④ Ground Loop Looking South

GROUND LOOP AND DETAILS

FIGURE 5

BASEMENT FLOOR PLAN

○ INPUT

No. DESCRIPTION

- 0 - Solar Wall Surface Temperature @ 3' Height
- 1 - Solar Wall 4" Depth Temperature @ 3' Height
- 2 - Solar Wall 8" Depth Temperature @ 3' Height
- 3 - Photo-Resistor Sunlight Sensor @ 4' Height
- 4 - Solar Space Temperature @ 5' Height
- 5 - Ambient Temperature (Loop Inlet) @ 2' Height
- 6 - Loop Outlet & Solar Space Inlet Temperature @ 1' Height
- 7 - Solar Space Outlet Temperature To Heat Pump @ 1' Height
- 8 - HP Coil Air Temperature (Actual Mixed Inlet Temperature / * Ground Temp. After January 1983)
- 9 - Inside Temperature @ 8' Height (Return Air)
- 10 - Thermostat Mode (Heating Or Cooling)
- 11 - Thermostat State (On Or Off)

□ OUTPUT

No. DESCRIPTION

- 1 - Fan And Damper No. 4 @ Loop Entrance And Damper No. 3 @ Heat Pump (Open)
- 2 - Damper No. 1 And No. 2 In Return In Solar Space (Open)
- 3 - Open
- 4 - Open
- 5 - Air Handler Fan (Enable Inside Circulation Fan)
- 6 - Heat Pump Control (Disable Heat Pump)

CONTROL SYSTEM

FIGURE 6

① Exterior View Showing Solar Space and Heat Pump

② View of Control System

③ Interior View of Solar Space Looking West - Shows Damper (No. 2) At Air Handler

④ Interior View of Solar Space Showing Outlet To Heat Pump And Sensors

⑤ Interior View Of Solar Space Showing Outlet To Heat Pump, Damper (No.3) And Outlet Sensor (No.7)

⑥ View of Ground Loop Air Inlet

⑦ View Of Air Inlet, Fan And Ambient Temperature Sensor (No. 5)

CONTROL SYSTEM DETAILS

FIGURE 6A

FIGURE 7

THERMOSTAT INTERFACE

FIGURE 8

ELEVATION
(SECTION A-A, SEE FIG. 6)

PLAN

HEATING RETURN AIR
USING ONLY SOLAR SPACE

(MODE 0)

FIGURE 9

ELEVATION
(SECTION A-A, SEE FIG.6)

PLAN

HEATING RETURN AIR USING SOLAR SPACE AND HEAT PUMP

(MODE I)

FIGURE 10

HEATING RETURN AIR USING HEAT PUMP AND GROUND LOOP ASSIST

(MODE 2)

FIGURE 11

ELEVATION

PLAN

COOLING RETURN AIR
USING HEAT PUMP AND GROUND LOOP ASSIST

(MODE 5)

FIGURE 13

ELEVATION

PLAN

HEATING / COOLING RETURN AIR
USING HEAT PUMP ONLY
 (MODE 7)

FIGURE 14

HEAT PUMP DATA
HEATING PERFORMANCE DATA
(YORK CHP036 / CHP136)

FIGURE 15

HEAT PUMP DATA
COOLING PERFORMANCE DATA
 (YORK CHP036 / CHP136)

FIGURE 15A

APPENDIX

ITEM	PAGE
DOWNLOAD assembly language communications program ...	58
SYSTEM assembly language control program	65
RECORD PL/1 language data acquisition program	91
PLAYBACK PL/1 language data display program	98
PLOT PL/1 language graphics plot program	100
List of Recorded Data	104
Data Plots	105

```

1: ;*****
2: ;          DOWNLOAD VERSION 2.2      01/25/82
3: ;*****
4: ;
5: ; THE DOWNLOAD PROGRAM READS INPUT FILE X.COM AND
6: ; TRANSFERS THE FILE TO MEMORY.  UPON COMPLETION OF
7: ; THE TRANSFER, THE PROGRAM INITIATES COMMUNICATIONS
8: ; BETWEEN THE KEYBOARD AND THE M80.  ALL SUBSEQUENT
9: ; FUNCTIONS INTERACT WITH THE M80, COMPUTER, OR PRINTER.
10: ; THE COMMUNICATION IS THROUGH THE MAIN PORT AND
11: ; THE COMPUTER WILL DOWNLOAD THE TRANSFERED DATA
12: ; TO THE MAIN PORT ON COMMAND.
13: ; SOFTWARE BY JEFF W. SHIRLEY
14: ;
15: ;          DOWNLOAD X.COM
16: ;
17: ;*****
18:
19:      ORG          100H
20:  BDOS      EQU      0005H      ;DOS ENTRY POINT
21:  CONIN     EQU      1          ;CONSOLE INPUT FUNCTION
22:  CONOUT    EQU      2          ;CONSOLE OUTPUT FUNCTION
23:  LISTF     EQU      5          ;LIST OUTPUT FUNCTION
24:  PRINTF    EQU      9          ;BUFFER PRINT ENTRY
25:  CONST     EQU      11         ;CONSOLE STATUS FUNCTION
26:  OPENF     EQU      15         ;FILE OPEN
27:  READF     EQU      20         ;READ FUNCTION
28:  M80MEM    EQU      1000H      ;STARTING M80 MEMORY LOCATION
29:  STMEM     EQU      4100H      ;STARTING MEMORY LOCATION
30:           ;IN HOST TO STORE COM FILE
31:  OFFSET    EQU      0F00H      ;OFFSET IN COM FILE TO
32:           ;START OF PROGRAM
33:  STM80     EQU      STMEM+OFFSET ;STARTING MEMORY LOCATION
34:           ;IN HOST TO TRANSFER TO M80
35:  NBYTES    EQU      07FFH      ;NUMBER OF BYTES TO TRANSFER
36:  ENDM80    EQU      STM80+NBYTES ;ENDING MEMORY LOCATION IN
37:           ;HOST TO TRANSFER TO M80
38:
39: ;          ASCII CHARACTERS
40:  CR        EQU      0DH        ;CARRIAGE RETURN
41:  LF        EQU      0AH        ;LINE FEED
42:
43: ;          FILE CONTROL BLOCK DEFINITIONS
44:  FCB        EQU      5CH        ;FILE CONTROL BLOCK ADDRESS
45:  FCBCR     EQU      FCB+32     ;CURRENT (NEXT) RECORD NUMBER (0 TO 128)
46:  BUFF      EQU      80H        ;INPUT DISK BUFFER ADDRESS
47:
48: ;*****
49: ;          BEGIN EXECUTABLE CODE
50: ;*****
51:
52:      LXI      D,SIGNON
53:      CALL     ERR
54: ;          SET UP STACK
55:      LXI      H,00             ;LD REG PAIR HL IMMEDIATE WITH 0
56:      DAD      SP               ;DBL REG ADD SP TO HL REG
57: ;          ENTRY STACK POINTER IN HL FROM THE CCP
58:      SHLD     OLDSP            ;STORE HL DIRECT TO OLDSP
59: ;          SET SP TO LOCAL STACK AREA (RESTORED AT FINIS)
60:      LXI      SP,STKTOP

```

```

61: ; READ AND PRINT SUCCESSIVE BUFFERS
62: CALL SETUP ;SET UP INPUT FILE
63: CPI 255 ;255 IF FILE NOT PRESENT
64: JNZ OPENOK ;SKIP IF OPEN IS OK
65: ;
66: ; FILE NOT THERE, GIVE ERROR MESSAGE AND RETURN
67: LXI D,OPNMSG
68: CALL ERR
69: JMP FINIS ;TO RETURN
70:
71: OPENOK: ;OPEN OPERATION OK, SET BUFFER INDEX TO END
72: MVI A,128
73: STA IBP ;SET BUFFER POINTER TO 128
74: ; INITIALIZE STARTING MEMORY TRANSFER LOCATION
75: LXI H,STMEM
76: SHLD MEMLOC
77:
78: MAINLOOP:
79: ; CHECK FOR BREAK KEY
80: CALL CONINP ;CHECK CONSOLE STATUS
81: ; A = 0FFH CHARACTER READY, A = 00H NO CHARACTER READY
82: ; ACCUM LAST BIT = 1 IF CHARACTER READY
83: RRC ;ROTATE ACCUM RIGHT, INTO CARRY
84: JC FINIS ;TERMINATE FILE TO MEMORY TRANSFER
85:
86: CALL GNB ;RETURNS CHARACTER IN ACCUM
87: JC FINIS ;CARRY SET BY GNB IF END FILE
88:
89: ; TRANSFER BYTE TO MEMORY
90: CALL STOREBYTE
91: JMP MAINLOOP
92:
93: FINIS: ;BEGIN M80 COMMUNICATIONS
94: CALL CRLF
95: LXI D,SIGNON2
96: CALL ERR
97: LXI D,SIGNON3
98: CALL ERR
99: LXI D,SIGNON4
100: CALL ERR
101: CALL CRLF
102: MVI A,'R'
103: CALL OUTMP ;RESET M80
104:
105: MLOOP: ;M80 I/O LOOP
106:
107: ; CHECK FOR KEYBOARD INPUT
108: MVI C,06 ;DIRECT CONSOLE I/O
109: MVI E,0FFH ;INPUT MODE
110: CALL BDOS ;GET CONSOLE STATUS
111: CPI 00 ;ZERO IF NO INPUT
112: JZ CKINP ;NO OUTPUT, CHECK FOR INPUT FROM PORT
113:
114: ; CONSOLE INPUT, CLEAR HIGH BIT
115: ANI 7FH ;CLEAR HIGH BIT
116: ; OUTPUT TO MAIN PORT INPUT FROM KEYBOARD
117: CPI 04H ;CHECK FOR CONTROL D (DOWNLOAD)
118: JNZ CK2 ;CHECK #2
119:
120: CALL DNLD ;DOWN-LOAD M80

```



```

121:      JMP      CKINP
122:
123:  CK2:  CPI      11H      ;CHECK FOR CONTROL Q (QUIT)
124:      JZ        EXIT      ;NORMAL EXIT
125:
126:      CPI      10H      ;CHECK FOR CONTROL P (PRINT TOGGLE)
127:      JNZ       CK3      ;EXIT CHECKS
128:
129:      CALL     TGLIO     ;TOGGLE I/O SWITCH
130:      JMP      CKINP
131:
132:  CK3:  ;END CHECKS, OUTPUT CHARACTER TO M80
133:      CALL     OUTMP     ;OUTPUT DATA TO MAIN PORT
134:
135:  CKINP:;NOW CHECK FOR MAIN PORT INPUT DATA
136:      IN       59H      ;CHECK FOR INPUT FROM MAIN PORT
137:      ANI      02H
138:      JZ        MLOOP    ;CONTINUE MAIN LOOP
139:
140:      MVI      C,03H    ;CP/M READER INPUT FUNCTION (MAIN PORT)
141:      CALL     BDOS      ;GET CHARACTER
142:      MOV      E,A      ;PLACE CHARACTER FOR I/O
143:      CPI      04      ;CHECK FOR COMMUNICATIONS CHARACTERS
144:      JC        MLOOP    ;NON-PRINTING CHARACTERS, RESTART LOOP
145:
146:      CALL     PCHAR     ;OUTPUT MAIN PORT INPUT DATA TO CRT
147:      LDA      IOSWH    ;LOAD I/O SWITCH
148:      CPI      00      ;NO PRINT = 0
149:      JZ        MLOOP    ;CONTINUE
150:
151:      MVI      C,LISTF   ;PRINTER FUNCTION
152:      CALL     BDOS      ;PRINT CHARACTER
153:      JMP      MLOOP     ;REPEAT I/O CYCLE
154:
155: ;*****
156: ;      NORMAL EXIT
157: ;*****
158:
159: EXIT:  LHLD     OLDSP    ;LOAD H AND L DIRECT
160:      SPHL      ;MOVE H & L TO SP
161: ;      STACK POINTER CONTAINS CCP'S STACK LOCATION
162:      RET       ;TO THE CCP
163:
164: OLDSP: DS      2        ;ENTRY SP VALUE FROM CCP
165:
166: ;*****
167: ;      OPEN THE FILE FOR INPUT
168: ;*****
169:
170: SETUP: XRA      A      ;ZERO TO ACCUM
171:      STA      FCBCR    ;CLEAR CURRENT RECORD
172:      LXI      D,FCB
173:      MVI      C,OPENF  ;FUNCTION #15
174:      CALL     BDOS
175: ;      255 IN ACCUM IF OPEN ERROR
176:      RET
177:
178: ;*****
179: ;      PRINT ERROR MESSAGE
180: ;      D,E ADDRESSES MESSAGE ENDING WITH "$"

```

```

181: ;*****
182:
183: ERR:      MVI      C,PRINTF;PRINT BUFFER, FUNCTION #9
184:          CALL      BDOS
185:          RET
186:
187: ;*****
188: ;      GET NEXT BYTE
189: ;*****
190:
191: GNB:      LDA      IBP      ;LDA WITH INPUT BUFFER POINTER
192:          CPI      128      ;COMPARE IMMEDIATE A WITH 128
193: ;      CHECK TO DETERMINE IF NEW RECORD NEEDS TO BE READ
194:          JNZ      G0
195:
196: ;      READ ANOTHER BUFFER
197:          CALL      DISKR
198:          ORA      A      ;ZERO VALUE IF READ OK
199:          JZ       G0      ;FOR ANOTHER BYTE
200:
201: ;      END OF DATA, RETURN WITH CARRY SET FOR EOF
202:          STC      ;SET CARRY FLAG TO 1
203:          JMP      EXITGNB
204:
205: G0:      ;READ THE BYTE AT BUFF+REG A
206:          MOV      E,A      ;LOW BYTE OF BUFFER INDEX
207:          MVI      D,0      ;DOUBLE PRECISION INDEX TO DE
208:          INR      A      ;INDEX=INDEX+1
209:          STA      IBP      ;BACK TO MEMORY
210: ;      POINTER IS INCREMENTED
211: ;      SAVE THE CURRENT FILE ADDRESS
212:          LXI      H,BUFF  ;LD HL IMMEDIATE WITH BUFF ADDRESS
213:          DAD      D      ;DBL REG ADD DE TO HL
214: ;      ABSOLUTE CHARACTER ADDRESS IS IN HL
215:          MOV      A,M      ;MOVE MEMORY TO ACC, ADDRESS IN HL
216: ;      BYTE IS IN THE ACCUMULATOR
217:          ORA      A      ;RESET CARRY BIT
218: EXITGNB: ;FUNCTION COMPLETE
219:          RET
220:
221: IBP:      DS      1      ;INPUT BUFFER POINTER (8 BIT COUNTER)
222:
223: ;*****
224: ;      READ DISK FILE RECORD
225: ;*****
226:
227: DISKR:    PUSH H! PUSH D! PUSH B
228:          LXI      D,FCB
229:          MVI      C,READF ;FUNCTION #20
230:          CALL      BDOS
231:          POP B! POP D! POP H
232:          RET
233:
234: ;*****
235: ;      PERFORM CARRIAGE RETURN AND LINE FEED ON CONSOLE
236: ;*****
237:
238: CRLF:     MVI      A,CR
239:          CALL      PCHAR
240:          MVI      A,LF

```

```

241:          CALL    PCHAR
242:          RET
243:
244: ;*****
245: ;          CHECK CONSOLE INPUT STATUS
246: ;          ANY INPUT, ACCUM = 0FFH
247: ;          NO INPUT, ACCUM = 00H
248: ;*****
249:
250: CONINP: PUSH H! PUSH D! PUSH B; ENVIRONMENT SAVED
251:          MVI      C,CONST ;FUNCTION #11
252:          CALL     BDOS
253:          POP B! POP D! POP H; ENVIRONMENT RESTORED
254:          RET
255:
256: ;*****
257: ;          OUTPUT A CHARACTER TO THE CONSOLE
258: ;*****
259:
260: PCHAR:  PUSH H! PUSH D! PUSH B; SAVED
261:          MVI      C,CONOUT ;FUNCTION #2
262:          MOV      E,A
263:          CALL     BDOS
264:          POP B! POP D! POP H; RESTORED
265:          RET
266:
267: ;*****
268: ;          TRANSFER A BYTE TO MEMORY
269: ;*****
270:
271: STOREBYTE:
272:          PUSH     H          ;SAVE HL
273:          LHLD     MEMLOC    ;LOAD CURRENT VALUE OF POINTER
274:          MOV      M,A       ;TRANSFER ACCUM TO MEMORY
275:          INX      H         ;INCREMENT POINTER
276:          SHLD     MEMLOC    ;STORE INCREMENTED POINTER
277:          POP      H         ;RESTORE HL
278:          RET
279:
280: MEMLOC:  DS       2          ;MEMORY POINTER TO STORE CURRENT BYTE
281:
282: ;*****
283: ;          COMPARE HL TO DE, ACC LOST AND FLAGS SET
284: ;*****
285:
286: CHLDE:  MOV      A,D
287:          CMP      H
288:          JNZ      ECMP
289:          MOV      A,E
290:          CMP      L
291:          ECMP:  RET
292:
293: ;*****
294: ;          DOWN-LOAD M80 (SEE M80 MANUAL P.46)
295: ;*****
296:
297: DNLD:   MVI      A,02H      ;CONTROL B
298:          CALL     OUTMP      ;SEND TO MAIN PORT
299:          LP1:    IN         59H      ;CHECK MAIN PORT STATUS
300:          ANI      02H

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301:      JZ      LP1
302:
303:      IN       5BH      ;READ CHAR
304:      LXI      D,DWNMSG
305:      CALL     ERR
306:      LXI      H,NBYTES;NUMBER OF BYTES TO DOWNLOAD
307:      MOV      A,H      ;HIGH BYTE OF (NUMBER OF BYTES)
308:      CALL     OUTMP    ;DOWNLOAD BYTE
309:      MOV      A,L      ;LOW BYTE OF (NUMBER OF BYTES)
310:      CALL     OUTMP    ;DOWNLOAD BYTE
311:      LXI      H,M80MEM;STARTING M80 MEMORY LOCATION
312:      MOV      A,H      ;HIGH BYTE OF (START ADDRESS)
313:      CALL     OUTMP    ;DOWNLOAD BYTE
314:      MOV      A,L      ;LOW BYTE OF (START ADDRESS)
315:      CALL     OUTMP    ;DOWNLOAD BYTE
316:      LXI      H,STM80 ;STARTING HOST MEMORY LOCATION
317:      LXI      D,ENDM80;ENDING HOST MEMORY LOCATION
318:      SDLP:    ;LOOP TO TRANSFER BLOCK OF MEMORY
319:      MOV      A,M      ;GET BYTE FROM MEMORY
320:      CALL     OUTMP    ;DOWNLOAD BYTE
321:      INX      H        ;INCREMENT COUNTER
322:      CALL     CHLDE    ;COMPARE HL TO DE, FLAGS SET
323:      JNZ      SDLP
324:
325:      RET                      ;RETURN WHEN TRANSFER COMPLETE
326:
327:      ;*****
328:      ;      OUTPUT DATA TO MAIN PORT
329:      ;*****
330:
331:      OUTMP:   PUSH     PSW      ;SAVE DATA
332:      CALL     MPSTAT   ;CHECK MAIN PORT OUTPUT STATUS
333:      POP      PSW      ;RECALL DATA
334:      OUT      5BH      ;OUTPUT DATA TO MAIN PORT
335:      RET
336:
337:      ;*****
338:      ;      CHECK MAIN PORT OUTPUT STATUS (HOLDS HERE UNTIL CLEAR)
339:      ;*****
340:
341:      MPSTAT:  IN       5BH      ;CHECK MAIN PORT STATUS
342:      ANI      01H
343:      JZ      MPSTAT   ;INFINITE LOOP UNTIL CLEAR
344:      RET
345:
346:      ;*****
347:      ;      TOGGLE I/O SWITCH
348:      ;*****
349:
350:      TGLIO:   PUSH     PSW
351:      LDA      IOSWH    ;GET SWITCH
352:      CPI      00      ;CHECK FOR 00 = NO PRINT
353:      JZ      TGL1
354:
355:      MVI      A,00     ;NOT ZERO, MAKE ZERO
356:      STA      IOSWH
357:      JMP      TGL2
358:
359:      TGL1:    MVI      A,01     ;ZERO, MAKE ONE
360:      STA      IOSWH

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361:    TGL2: POP      PSW
362:          RET
363:
364: IOSWH:  DB        00      ;I/O SWITCH USED TO CONTROL PRINTING
365:
366: ;          FIXED MESSAGE AREA
367: SIGNON: DB        CR,LF,'DOWNLOAD - VERSION 2.2$'
368: SIGNON2:DB        CR,LF,'CONTROL D - DOWNLOAD FILE$'
369: SIGNON3:DB        CR,LF,'CONTROL Q - QUIT$'
370: SIGNON4:DB        CR,LF,'CONTROL P - TOGGLE PRINT$'
371: OPNMSG: DB        CR,LF,'** NO INPUT FILE **$'
372: DWNMSG: DB        'DOWN-LOADING M80 PROGRAM',CR,LF,'$'
373:
374: ;          STACK AREA
375: DS        32      ;RESERVE 16 LEVEL STACK
376: STKTOP:
377:
378:          END      100H

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1: *****
2: ;
3: ;      SYSTEM.ASM      VERSION 3.3      10/31/82
4: ;
5: ;      SYSTEM IS A CONTROL PROGRAM WHICH INTERACTS WITH A
6: ;      SPLIT SYSTEM YORK HEAT PUMP (CHPI36, CHPO36), TO
7: ;      ASSIST WITH EITHER HEATING OR COOLING.  THE MODE IS
8: ;      SELECTABLE, ALONG WITH 6 OTHER MANUAL OR AUTOMATIC
9: ;      CONTROLS.  THE PROGRAM HAS COMPLETE CONTROL OF
10: ;      DECISIONS CONCERNING THE OPERATION OF THE "SYSTEM"
11: ;      AND BASES DECISIONS ON VARIOUS A/D SENSOR READINGS.
12: ;      THE ONLY REQUIRED USER INPUT IS THE DESIRED
13: ;      TEMPERATURE SETTING FOR THE HOUSE HEAT PUMP SYSTEM,
14: ;      AND THE DESIRED MODE (HEATING/COOLING).  THE PROGRAM
15: ;      THEN CONTROLS THE INTERACTION OF THE HEAT PUMP,
16: ;      THE SOLAR SPACE, AND THE GROUND LOOP TO PROVIDE
17: ;      THE OPTIMUM "HEATING/COOLING SYSTEM" PERFORMANCE.
18: ;      SOFTWARE BY STEVE STEVENS & JEFF W. SHIRLEY
19: ;
20: ; *****
21: ;      ORG      1000H      ;LOAD POINT FOR M80 MICRO
22: ; *****
23: ;      MAIN CONTROL LOOP
24: ; *****
25: ;
26: ;      JUMP TABLE, "START" OF PROGRAM AT 1009H
27: ;      JMP      TPCAL      ;RST 1 JUMPS HERE, 1 BYTE CALL TO TPCAL
28: ;      JMP      PRA        ;RST 6 JUMPS HERE, 1 BYTE CALL TO PRA
29: ;      JMP      PRLN        ;RST 7 JUMPS HERE, 1 BYTE CALL TO PRLN
30: ; ***** START OF EXECUTABLE PROGRAM (M80 MONITOR 'G 1009')
31: START: LXI      SP,17FFH;M80 STACK REGISTERS (TOP OF MEMORY)
32: ;      CALL     RESETRL    ;RESET RELAYS TO INITIAL STATE
33: ;      LXI      H,DISPC    ;POINT TO DISPLAY COUNT VARIABLE
34: ;      CALL     ZEROM      ;ZERO MEMORY LOCATION MEM(HL)
35: ;      XRA      A          ;(A)=0
36: ;      STA      PCTRLM     ;INITIALIZE PREVIOUS CONTROL MODE#
37: ;      BEGIN MAIN LOOP
38: MLOOP: XRA      A          ;ZERO (A)
39: ;      REPEAT CONTROL SEQUENCE BEFORE PRINTING
40: SLOOP: PUSH     PSW        ;SAVE (A)
41: ;      CALL     SCYCLE     ;CALL SYSTEM CYCLE EVALUATION ROUTINE
42: ;      POP      PSW        ;RECALL COUNT
43: ;      INR      A          ;INCREMENT COUNT
44: ;      CPI      21         ;MAXIMUM # OF LOOPS
45: ;      JNZ      SLOOP      ;NOT MAXIMUM, REPEAT
46: ;
47: ;      CALL     PRTV        ;CALL PRINT ROUTINE
48: ;      CALL     UPDISP     ;UPDATE DISPLAY
49: ;      ADJUST TOTAL DELAY TO 10 SEC PER PRINTING SEQUENCE
50: ;      MVI      A,14       ;DELAY VALUE IN HUNDRETHS OF A SECOND
51: ;      CALL     DELAY      ;MAXIMUM DELAY = 255 HUNDRETHS
52: ;      JMP      MLOOP
53: ;
54: ; *****
55: ;      SYSTEM CYCLE ROUTINE (1/19/82 JWS)
56: ; *****
57: ;
58: SCYCLE: CALL     UPREADS    ;UPDATE A/D READINGS
59: ;      CALL     UPDAY      ;UPDATE DAY/NIGHT VALUES
60: ;      CALL     UPSFSW     ;UPDATE SOFTWARE SWITCH VALUES

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61:      CALL      UPDMS      ;UPDATE MODE AND STATE VALUES
62:      CALL      EVAL      ;EVALUATE MODES
63:      CALL      CTRLHP     ;DISABLE/ENABLE HEAT PUMP
64:      CALL      CONTROL    ;EXECUTION FLAG, 0=MANUAL, 1=PROGRAM
65:      CALL      UPREL      ;READ PROGRAM RELAYS & SET RELAYS
66:      RET
67:
68: ;*****
69: ;      SET CONTROL VARIABLE TO ENABLE RELAYS (1/19/82 JWS)
70: ;      CONTROL WILL ALLOW THE MODE# & MODE OF OPERATION OF
71: ;      THE HEATING SYSTEM TO CHANGE, AS LONG AS THE CHANGE
72: ;      CAUSES THE MODE# TO INCREASE, ANY ATTEMPT TO TOGGLE
73: ;      OR RETURN TO A LOWER MODE# IS BLOCKED, UNTIL A
74: ;      SPECIFIED COUNT IS REACHED.
75: ;      INPUTS: NONE
76: ;      OUTPUTS: (D) - 00=MANUAL ONLY, 01=PROGRAMMED/MANUAL
77: ;*****
78:
79: CONTROL:LDA      STATE      ;GET CURRENT STATE
80:      MOV      D,A          ;SAVE (STATE) VARIABLE
81:      CPI      00          ;CHECK FOR OFF STATE
82:      JNZ      CONTRL2      ;STATE ON, CONTINUE
83:
84: ;      STATE OFF, CHECK FOR CHANGE OF STATE TO OFF
85:      LDA      PSTATE      ;GET PREVIOUS STATE
86:      CPI      01          ;PREVIOUS STATE ON?
87:      JNZ      CONTRL2      ;NO, CONTINUE
88:
89: ;      PREVIOUS STATE WAS ON, RESET RELAYS, MODE#
90:      CALL      RESETRL     ;RESET RELAYS TO OFF POSITION
91:      XRA      A           ;ZERO (A)
92:      STA      PCTRLM      ;RESET PREVIOUS CONTROL MODE#
93:      CALL      RESETTM     ;RESET TIMER COUNT
94: ;      UPDATE STATE
95: CONTRL2:MOV      A,D        ;GET CURRENT STATE
96:      STA      PSTATE      ;PREVIOUS STATE = CURRENT STATE
97:      CPI      00          ;CHECK FOR OFF STATE
98:      JZ       CONTRLX      ;STATE OFF, EXIT
99:
100: ;      STATE ON, CHECK PREVIOUS CONTROL MODE
101:      LXI      H,PCTRLM     ;PREVIOUS CONTROL MODE ADDRESS
102:      LDA      CTRLM        ;GET CURRENT MODE#
103:      CMP      M            ;COMPARE THEM
104:      JNC      CONTRL5      ;CURRENT MODE# EQUAL OR LARGER, EXIT
105:
106: ;      CURRENT MODE# SMALLER, BLOCK EXECUTION,
107: ;      UNLESS TIMER COUNT HAS BEEN REACHED
108:      LHLD     TIMER        ;GET DELAY VALUE
109:      DCX      H            ;DECREASE COUNT
110:      SHLD     TIMER        ;STORE UPDATED TIMER
111:      MOV      A,H          ;RECALL HIGH BYTE
112:      ADD      L            ;ADD LOW BYTE
113:      JC       CONTRL3      ;CHECK FOR ZERO WITH CARRY
114:
115:      JZ       CONTRL4      ;COUNT REACHED, UNLOCK MODE
116:
117: ;      DON'T UPDATE PREVIOUS MODE#
118: CONTRL3:XRA      A          ;MANUAL CONTROL ONLY
119:      MOV      D,A          ;CONTROL VARIABLE = 0
120:      JMP      CONTRLX      ;EXIT

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121:
122: ;      UNLOCK CURRENT HIGH MODE #, ALLOWING RESELECTION
123: CONTRL4:CALL    RESETTM ;RESET TIMER COUNT
124: ;      UPDATE PREVIOUS CONTROL MODE
125: CONTRL5:LDA      CTRLM    ;GET CURRENT MODE#
126:          STA      PCTRLM  ;PREVIOUS MODE# = CURRENT MODE#
127: CONTRLX:RET
128:
129: PSTATE: DB      000      ;PREVIOUS STATE
130: PCTRLM: DB      000      ;PREVIOUS CONTROL MODE
131: TIMER:  DW      0000     ;TIMER COUNT TO ENABLE 'LOWER' MODE
132:
133: ;*****
134: ;      RESET TIMER COUNT (1/19/82 JWS)
135: ;      DELAY COUNT - APPROXIMATELY 5-10 MIN.
136: ;*****
137:
138: RESETTM:LXI      H,2000   ;DELAY COUNT FOR MODE LOCK
139:          SHLD     TIMER   ;RESET DELAY COUNT
140:          RET
141:
142: ;*****
143: ;      EVALUATE MODES ROUTINE (12/28/81 JWS)
144: ;      INPUT: NONE
145: ;      OUTPUTS: LOCAL VARIABLES UPDATED, (MODE#)
146: ;      (PREL#) VALUES ARE SET FOR EXECUTION
147: ;*****
148:
149: EVAL:   CALL      VALMS    ;EVALUATE ALL MODES
150: ;      SELECT 1ST POSITIVE MODE IN SEQUENCE
151:          CALL      ZEROPR  ;ZERO PROGRAM RELAYS
152:          LXI      D,SZERO  ;(+000.0) FOR COMPARISONS
153:          LDA      MODE     ;RECALL SYSTEM MODE (H/C)
154:          CPI      'C'      ;CHECK FOR COOLING
155:          JZ       EVAL4    ;SKIP HEATING MODES
156:
157: ;      CHECK FOR DEFROST CYCLE ON HEAT PUMP
158:          CPI      'D'      ;CHECK FOR DEFROST CYCLE
159:          JZ       EVAL7    ;USE DEFAULT STATE, SYSTEM OFF
160:
161: ;      HEATING MODES
162: EVAL0:  LXI      H,SMODE0  ;ADDRESS OF SIGNED MODE0 VALUE
163:          CALL      CMPBS    ;COMPARE MODE VALUE TO ZERO
164:          JNC      EVAL1    ;MODE0<=0, CHECK MODE1
165:
166: ;      MODE0 SELECTED, PROGRAM RELAYS
167:          MVI      A,01     ;ON VALUE
168:          STA      PREL2    ;OPEN DAMPERS IN RETURN
169:          STA      PREL5    ;TURN ON INSIDE CIRCULATION FAN
170:          STA      PREL6    ;DISABLE HEAT PUMP
171:          XRA      A        ;MODE SELECTED FLAG
172:          JMP      EVALEX   ;EXIT
173:
174: EVAL1:  LXI      H,SMODE1  ;ADDRESS OF MODE1 VALUE
175:          CALL      CMPBS    ;COMPARE MODE VALUE TO ZERO
176:          JNC      EVAL2    ;MODE1<=0, CHECK MODE2
177:
178: ;      MODE1 SELECTED, PROGRAM RELAYS
179:          MVI      A,01     ;FLAG & ON VALUE
180:          STA      PREL2    ;OPEN DAMPERS IN RETURN

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181:      JMP      EVALEX   ;EXIT
182:
183: EVAL2:  LDA      DAYN    ;GET DAY/NIGHT FLAG
184:      CPI      'D'      ;IS IT DAY?
185:      JZ       EVAL3     ;YES, SKIP MODE2
186:
187: ;      NIGHT, EVALUATE MODE2
188:      LXI      H,SMODE2;ADDRESS OF MODE2 VALUE
189:      CALL     CMPBS     ;COMPARE MODE VALUE TO ZERO
190:      JNC      EVAL3     ;MODE2<=0, CHECK MODE3
191:
192: ;      MODE2 SELECTED, PROGRAM RELAYS
193:      MVI      A,01      ;ON VALUE
194:      STA      PREL1     ;TURN ON GROUND LOOP FAN
195:      MVI      A,02      ;MODE VALUE FLAG
196:      JMP      EVALEX   ;EXIT
197:
198: EVAL3:  LXI      H,SMODE3;ADDRESS OF MODE3 VALUE
199:      CALL     CMPBS     ;COMPARE MODE VALUE TO ZERO
200:      JNC      EVAL7     ;MODE3<=0, SELECT MODE7
201:
202: ;      MODE3 SELECTED, PROGRAM RELAYS
203:      MVI      A,01      ;ON VALUE
204:      STA      PREL1     ;TURN ON GROUND LOOP FAN
205:      MVI      A,03      ;MODE VALUE FLAG
206:      JMP      EVALEX   ;EXIT
207:
208: ;      COOLING MODES
209: EVAL4:  LXI      H,SMODE4;ADDRESS OF MODE4 VALUE
210:      CALL     CMPBS     ;COMPARE MODE VALUE TO ZERO
211:      JNC      EVAL5     ;MODE4<=0, CHECK MODE5
212:
213: ;      MODE4 SELECTED, PROGRAM RELAYS
214:      MVI      A,01      ;ON VALUE
215:      STA      PREL1     ;TURN ON GROUND LOOP FAN
216:      STA      PREL2     ;OPEN DAMPERS IN RETURN
217:      STA      PREL5     ;TURN ON INSIDE CIRCULATION FAN
218:      STA      PREL6     ;DISABLE HEAT PUMP
219:      MVI      A,04      ;MODE VALUE FLAG
220:      JMP      EVALEX   ;EXIT
221:
222: EVAL5:  LXI      H,SMODE5;ADDRESS OF MODE5 VALUE
223:      CALL     CMPBS     ;COMPARE MODE VALUE TO ZERO
224:      JNC      EVAL6     ;MODE5<=0, CHECK MODE6
225:
226: ;      MODE5 SELECTED, PROGRAM RELAYS
227:      MVI      A,01      ;ON VALUE
228:      STA      PREL1     ;TURN ON GROUND LOOP FAN
229:      MVI      A,05      ;MODE VALUE FLAG
230:      JMP      EVALEX   ;EXIT
231:
232: EVAL6:  LXI      H,SMODE6;ADDRESS OF MODE6 VALUE
233:      CALL     CMPBS     ;COMPARE MODE VALUE TO ZERO
234:      JNC      EVAL7     ;MODE6<=0, SELECT MODE7
235:
236: ;      MODE6 SELECTED, PROGRAM RELAYS
237:      MVI      A,01      ;ON VALUE
238:      STA      PREL1     ;TURN ON GROUND LOOP FAN
239:      MVI      A,06      ;MODE VALUE FLAG
240:      JMP      EVALEX   ;EXIT

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241:
242: EVAL7:  ;MODE7 DEFAULT MODE, (HEAT PUMP SYSTEM ONLY)
243: CALL    ZEROPR  ;ZERO PROGRAMED RELAYS
244: MVI     A,07     ;MODE FLAG VALUE
245: EVALEX: STA     CTRLM ;SET MODE SELECTED FLAG
246: RET
247:
248: CTRLM:  DB      00      ;NUMBER OF MODE SELECTED
249:
250: ;*****
251: ;      ZERO PROGRAM RELAYS (1/14/82 JWS)
252: ;*****
253:
254: ZEROPR: XRA      A      ;ZERO (A), OFF VALUE
255: STA     PREL1    ;GROUND LOOP FAN OFF
256: STA     PREL2    ;CLOSE DAMPERS IN RETURN
257: STA     PREL3    ;TURN OFF OPEN RELAY
258: STA     PREL4    ;TURN OFF OPEN RELAY
259: STA     PREL5    ;CIRCULATION FAN TO AUTO
260: STA     PREL6    ;ENABLE HEAT PUMP
261: RET
262:
263: ;*****
264: ;      COMPUTE MODE VALUES ROUTINE (1/17/82 JWS)
265: ;*****
266:
267: VALMS:  ;COMPUTE VALUES FOR ALL MODES
268: ;      COMPUTE VALUE FOR MODE0 ROUTINE (1/12/82 JWS)
269: ;      DIRECT SOLAR HEATING WITHOUT HEAT PUMP
270: VALM0: LDA      R04     ;GET SOLAR SPACE A/D READING
271: RST     1             ;CALL TPCAL & COMPUTE SOLAR SPACE TEMP.
272: LXI     D,SMODE0;ADDRESS OF RESULT
273: XCHG
274: CALL    MOVS        ;MOVE (STTP) TO (SMODE0)
275: XCHG        ;SAVE (SMODE0) ADDRESS
276: LDA      R09        ;GET INSIDE A/D READING
277: RST     1             ;CALL TPCAL & COMPUTE INSIDE TEMP.
278: XCHG        ;ADDRESS OF (SMODE0) TO (HL)
279: CALL    SUBS        ;MODE0=S.S.TEMP.-INSIDE TEMP.
280: LXI     D,SC0       ;LOAD ADDRESS OF CONSTANT
281: CALL    SUBS        ;MODE0=(S.S.TEMP-INSIDE TEMP.)-C0
282: ;      COMPUTE VALUE FOR MODE1 ROUTINE (12/28/81 JWS)
283: ;      DIRECT SOLAR HEATING WITH HEAT PUMP
284: VALM1: LDA      R04     ;GET SOLAR SPACE A/D READING
285: RST     1             ;CALL TPCAL & COMPUTE SOLAR SPACE TEMP.
286: LXI     D,SMODE1;ADDRESS OF RESULT
287: XCHG
288: CALL    MOVS        ;MOVE (STTP) TO (SMODE1)
289: XCHG        ;SAVE (SMODE1) ADDRESS
290: LDA      R09        ;GET INSIDE A/D READING
291: RST     1             ;CALL TPCAL & COMPUTE INSIDE TEMP.
292: XCHG        ;ADDRESS OF (SMODE1) TO (HL)
293: CALL    SUBS        ;MODE0=S.S.TEMP.-INSIDE TEMP.
294: ;      COMPUTE VALUE FOR MODE2 ROUTINE (1/12/82 JWS)
295: ;      GROUND LOOP ASSIST HEAT PUMP HEATING
296: VALM2: LDA      R07     ;SOLAR SPACE OUTLET TEMP. TO HEAT PUMP
297: RST     1             ;CALL TPCAL & COMPUTE SOLAR SPACE TEMP.
298: LXI     D,SMODE2;ADDRESS OF RESULT
299: XCHG        ;MOVE ADDRESS OF (TTP) TO (DE)
300: CALL    MOVS        ;MOVE (TTP) TO (MODE2)

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301:      XCHG
302:      LDA      R05      ;AMBIENT TEMPERATURE SENSOR #05
303:      RST      1        ;CALL TPCAL & COMPUTE OUTSIDE TEMP.
304:      XCHG      ;ADDRESS OF (MODE2) TO (HL)
305:      CALL      SUBS      ;MODE2=S.S.TEMP.-OUTSIDE TEMP.
306:      LXI      D,SC2     ;CONSTANT ADDRESS
307:      CALL      SUBS      ;MODE2=(S.S.TEMP.-OUTSIDE TEMP.)-C2
308:      ;      COMPUTE VALUE FOR MODE3 ROUTINE (1/14/82 JWS)
309:      ;      PRE-HEAT GROUND LOOP (FREE MODE)
310: VALM3: LXI      H,SMODE3;ADDRESS OF MODE3 VARIABLE
311:      CALL      ZEROM     ;ZERO MODE VALUE
312:      ;      COOLING MODES
313:      ;      COMPUTE VALUE FOR MODE4 ROUTINE (10/03/82 JWS)
314:      ;      DIRECT GROUND LOOP COOLING WITHOUT HEAT PUMP
315: VALM4: ;CHECK FOR AMBIENT LESS THAN A SPECIFIED MAXIMUM FOR
316:      ;DIRECT COOLING
317:      LXI      D,SM40N   ;ADDRESS OF CONSTANT
318:      LDA      R05      ;GET AMBIENT A/D READING
319:      RST      1        ;CALL TPCAL & COMPUTE AMBIENT TEMP.
320:      XCHG      ;ADDRESS OF (SM40N) TO (HL)
321:      CALL      CMPBS     ;COMPARE MEM(DE) & MEM(HL)
322:      JNC      VALM5     ;CHECK TEMP (<= AMBIENT, CHECK MODE5
323:
324:      ;      AMBIENT < CHECK TEMP, MODE4 ALLOWED, COMPUTE VALUE
325:      LDA      R09      ;GET INSIDE A/D READING
326:      RST      1        ;CALL TPCAL & COMPUTE INSIDE TEMP.
327:      LXI      D,SMODE4;ADDRESS OF RESULT
328:      XCHG
329:      CALL      MOVS      ;MOVE (STTP) TO (SMODE4)
330:      XCHG      ;SAVE (SMODE4) ADDRESS
331:      LDA      R06      ;GET GROUND LOOP OUTLET A/D READING
332:      RST      1        ;CALL TPCAL & COMPUTE 'INSIDE' TEMP.
333:      XCHG      ;ADDRESS OF (SMODE4) TO (HL)
334:      CALL      SUBS      ;MODE4=INSIDE TEMP.-G.L.TEMP.
335:      LXI      D,SC4     ;LOAD ADDRESS OF CONSTANT
336:      CALL      SUBS      ;MODE4=(INSIDE TEMP.-G.L.TEMP.)-C4
337:      ;      COMPUTE VALUE FOR MODE5 ROUTINE (05/03/82 JWS)
338:      ;      GROUND LOOP ASSIST HEAT PUMP COOLING
339: VALM5: LDA      R05      ;GET AMBIENT A/D READING
340:      RST      1        ;CALL TPCAL & COMPUTE AMBIENT TEMP.
341:      LXI      D,SMODE5;ADDRESS OF RESULT
342:      XCHG
343:      CALL      MOVS      ;MOVE (STTP) TO (SMODE5)
344:      XCHG      ;SAVE (SMODE5) ADDRESS
345:      LDA      R06      ;GET LOOP OUTLET & S.S. INLET A/D READING
346:      RST      1        ;CALL TPCAL & COMPUTE 'INPUT' TEMP.
347:      XCHG      ;ADDRESS OF (SMODE5) TO (HL)
348:      CALL      SUBS      ;MODE5=AMBIENT TEMP.-S.S.I.TEMP.
349:      LXI      D,SC5     ;LOAD ADDRESS OF CONSTANT
350:      CALL      SUBS      ;MODE5=(AMBIENT TEMP.-S.S.I.TEMP.)-C5
351:      ;      COMPUTE VALUE FOR MODE6 ROUTINE (1/14/82 JWS)
352:      ;      PRE-COOL GROUND LOOP (FREE MODE)
353: VALM6: LXI      H,SMODE6;ADDRESS OF MODE6 VARIABLE
354:      CALL      ZEROM     ;ZERO MODE VALUE
355:      ;      COMPUTE VALUE FOR MODE7 ROUTINE (1/14/82 JWS)
356:      ;      HEAT PUMP SYSTEM ONLY (DEFAULT)
357: VALM7: LXI      H,SMODE7;ADDRESS OF MODE7 VARIABLE
358:      LXI      D,SC7     ;ADDRESS OF CONSTANT
359:      CALL      MOVS      ;MOVE (C7) TO (MODE7)
360:      RET

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361:
362: SMODE0: DB      00      ;SIGN OF MODE0
363: MODE0:  DW      0000    ;MODE0 VARIABLE
364: SMODE1: DB      00      ;SIGN OF MODE1
365: MODE1:  DW      0000    ;MODE1 VARIABLE
366: SMODE2: DB      00      ;SIGN OF MODE2
367: MODE2:  DW      0000    ;MODE2 VARIABLE
368: SMODE3: DB      00      ;SIGN OF MODE3
369: MODE3:  DW      0000    ;MODE3 VARIABLE
370: SMODE4: DB      00      ;SIGN OF MODE4
371: MODE4:  DW      0000    ;MODE4 VARIABLE
372: SMODE5: DB      00      ;SIGN OF MODE5
373: MODE5:  DW      0000    ;MODE5 VARIABLE
374: SMODE6: DB      00      ;SIGN OF MODE6
375: MODE6:  DW      0000    ;MODE6 VARIABLE
376: SMODE7: DB      00      ;SIGN OF MODE7
377: MODE7:  DW      0000    ;MODE7 VARIABLE
378: SC0:    DB      00      ;SIGN OF CONSTANT
379: C0:      DB      00H     ;BCD CONSTANT
380:          DB      20H     ;BCD CONSTANT (+002.0) 01/31/82 JWS
381: SC2:    DB      00      ;SIGN OF BCD CONSTANT
382: C2:      DB      01H     ;BCD CONSTANT
383:          DB      00H     ;BCD CONSTANT (+010.0) 01/31/82 JWS
384: SC4:    DB      00      ;SIGN OF CONSTANT
385: C4:      DB      00H     ;BCD CONSTANT
386:          DB      20H     ;BCD CONSTANT (+002.0) 10/02/82 JWS
387: SC5:    DB      00      ;SIGN OF CONSTANT
388: C5:      DB      01H     ;BCD CONSTANT
389:          DB      00H     ;BCD CONSTANT (+010.0) 05/03/82 JWS
390: SC7:    DB      00      ;SIGN OF CONSTANT
391: C7:      DB      00H     ;BCD CONSTANT
392:          DB      10H     ;BCD CONSTANT (+001.0) 1/14/82 JWS
393: SM40N:  DB      00H     ;SIGN OF CONSTANT
394: M40N:    DB      02H     ;BCD CONSTANT
395:          DB      10H     ;BCD CONSTANT (+021.0) 10/31/82 JWS
396:
397: ;*****
398: ;      PRINT ROUTINE      (12/28/81 SS & JWS)
399: ;*****
400:
401: ;      TRANSMIT SYNCHRONIZATION CHARACTERS
402: PRTV:    MVI      A,01     ;SOH - ASCII START OF HEADER (COMMUNICATIONS)
403:          RST      5        ;CALL XMTR & TRANSMIT (A)
404:          MVI      A,02     ;STX - ASCII START OF TEXT (COMMUNICATIONS)
405:          RST      5        ;CALL XMTR & TRANSMIT (A)
406:          CALL     CRLF
407: ;      DISPLAY VARIABLE COUNT
408:          LXI      H,DISPC  ;ADDRESS OF DISPLAY COUNT
409:          MOV      A,M       ;GET HIGH BYTE
410:          RST      6        ;PRINT (A) AS TWO HEX DIGITS
411:          INX      H        ;POINT TO 2ND BYTE
412:          MOV      A,M
413:          RST      6        ;PRINT (A) AS TWO HEX DIGITS
414:          INX      H        ;POINT TO LOW BYTE
415:          MOV      A,M       ;GET LOW BYTE
416:          RST      6        ;PRINT (A) AS TWO HEX DIGITS
417:          MVI      A,' '
418:          RST      5        ;CALL XMTR & TRANSMIT (A)
419:          RST      5        ;CALL XMTR & TRANSMIT (A)
420:          RST      5        ;CALL XMTR & TRANSMIT (A)

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421: ; DAY/NIGHT SENSOR
422: LDA DAYN ;GET DAY/NIGHT FLAG
423: RST 5 ;CALL XMTR & TRANSMIT (A)
424: MVI A,'=' ;ASCII EQUALS CHARACTER
425: RST 5 ;CALL XMTR & TRANSMIT (A)
426: LDA R03 ;DAY/NIGHT SENSOR A/D VALUE
427: RST 6 ;CALL PRA
428: MVI A,' '
429: RST 5 ;CALL XMTR & TRANSMIT (A)
430: ; MODE SENSOR
431: MVI A,'M'
432: RST 5 ;CALL XMTR & TRANSMIT (A)
433: MVI A,'=' ;ASCII EQUALS CHARACTER
434: RST 5 ;CALL XMTR & TRANSMIT (A)
435: LDA MODE ;MODE VARIABLE
436: RST 5 ;CALL XMTR & TRANSMIT (A)
437: MVI A,' '
438: RST 5 ;CALL XMTR & TRANSMIT (A)
439: ; STATE SENSOR
440: MVI A,'S'
441: RST 5 ;CALL XMTR & TRANSMIT (A)
442: MVI A,'=' ;ASCII EQUALS CHARACTER
443: RST 5 ;CALL XMTR & TRANSMIT (A)
444: LDA STATE ;STATE VARIABLE
445: RST 7 ;CALL PRLN & TRANSMIT LOWER NIBBLE OF (A)
446: MVI A,' '
447: RST 5 ;CALL XMTR & TRANSMIT (A)
448: ; SOFTWARE SWITCHES
449: LDA SFSW4 ;SOFTWARE SWITCH #4
450: RST 7 ;CALL PRLN & TRANSMIT LOWER NIBBLE OF (A)
451: LDA SFSW3
452: RST 7 ;CALL PRLN & TRANSMIT LOWER NIBBLE OF (A)
453: LDA SFSW6
454: RST 7 ;CALL PRLN & TRANSMIT LOWER NIBBLE OF (A)
455: LDA SFSW5
456: RST 7 ;CALL PRLN & TRANSMIT LOWER NIBBLE OF (A)
457: LDA SFSW2 ;SOFTWARE SWITCH #2
458: RST 7 ;CALL PRLN & TRANSMIT LOWER NIBBLE OF (A)
459: LDA SFSW1
460: RST 7 ;CALL PRLN & TRANSMIT LOWER NIBBLE OF (A)
461: MVI A,'+'
462: RST 5 ;CALL XMTR & TRANSMIT (A)
463: ; PROGRAMMED RELAY POSITIONS
464: LDA PREL6 ;PROGRAMMED RELAY POSITION, RELAY #6
465: RST 7 ;CALL PRLN & TRANSMIT LOWER NIBBLE OF (A)
466: LDA PREL5
467: RST 7 ;CALL PRLN & TRANSMIT LOWER NIBBLE OF (A)
468: LDA PREL4
469: RST 7 ;CALL PRLN & TRANSMIT LOWER NIBBLE OF (A)
470: LDA PREL3
471: RST 7 ;CALL PRLN & TRANSMIT LOWER NIBBLE OF (A)
472: LDA PREL2
473: RST 7 ;CALL PRLN & TRANSMIT LOWER NIBBLE OF (A)
474: LDA PREL1
475: RST 7 ;CALL PRLN & TRANSMIT LOWER NIBBLE OF (A)
476: MVI A,'=' ;ASCII EQUALS CHARACTER
477: RST 5 ;CALL XMTR & TRANSMIT (A)
478: ; GET RELAY BYTE SETTING
479: LDA RELSTAT ;RELAY BYTE VARIABLE
480: RST 6 ;CALL PRA

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481:      MVI      A,' '
482:      RST      5          ;CALL XMTR & TRANSMIT (A)
483: ;      READ TEMPERATURE SENSORS (0-2)
484:      XRA      A          ; (A)=0
485:      CALL     CPBCD
486:      CALL     CPBCD
487:      CALL     CPBCD
488:      CALL     CRLF
489: ;      READ TEMPERATURE SENSORS (4-9)
490:      MVI      A,04
491:      CALL     CPBCD
492:      CALL     CPBCD
493:      CALL     CPBCD
494:      CALL     CPBCD
495:      CALL     CPBCD
496:      CALL     CPBCD
497:      CALL     CRLF
498: ;      MODES EVALUATION
499:      XRA      A          ; (A)=0
500:      LXI      H,SMODE0;HEATING (SOLAR) DIRECT (HP+LOOP=OFF)
501:      CALL     PRMODE ;PRINT MODE VALUE
502:      LXI      H,SMODE1;HEATING (HP+SOLAR) DIRECT (LOOP=OFF)
503:      CALL     PRMODE ;PRINT MODE VALUE
504:      LXI      H,SMODE2;HEATING (HP) GROUND + SOLAR ASSIST
505:      CALL     PRMODE ;PRINT MODE VALUE
506:      LXI      H,SMODE3;HEATING (FREE MODE)
507:      CALL     PRMODE ;PRINT MODE VALUE
508:      LXI      H,SMODE4;COOLING GROUND DIRECT
509:      CALL     PRMODE ;PRINT MODE VALUE
510:      LXI      H,SMODE5;COOLING GROUND ASSIST HEAT PUMP
511:      CALL     PRMODE ;PRINT MODE VALUE
512:      LXI      H,SMODE6;COOLING (FREE MODE)
513:      CALL     PRMODE ;PRINT MODE VALUE
514:      MVI      A,'C'
515:      RST      5          ;CALL XMTR & TRANSMIT (A)
516:      MVI      A,'='      ;ASCII EQUALS CHARACTER
517:      RST      5          ;CALL XMTR & TRANSMIT (A)
518:      LXI      H,CTRLM ;MODE TO BE USED
519:      MOV      A,M
520:      RST      7          ;CALL PRLN & TRANSMIT LOWER NIBBLE OF (A)
521:      MVI      A,' '
522:      RST      5          ;CALL XMTR & TRANSMIT (A)
523:      MVI      A,'P'
524:      RST      5          ;CALL XMTR & TRANSMIT (A)
525:      MVI      A,'='      ;ASCII EQUALS CHARACTER
526:      RST      5          ;CALL XMTR & TRANSMIT (A)
527:      LXI      H,PCTRLM;PREVIOUS MODE#
528:      MOV      A,M
529:      RST      7          ;CALL PRLN & TRANSMIT LOWER NIBBLE OF (A)
530:      CALL     CRLF
531: ;      TRANSMIT SYNCHRONIZATION CHARACTER
532:      MVI      A,03      ;ETX - ASCII END OF TEXT (COMMUNICATIONS)
533:      RST      5          ;CALL XMTR & TRANSMIT (A)
534:      RET
535:
536: *****
537: ;
538: ;      SUBS.LIB          VERSION 1.9          1/28/82
539: ;
540: ;      SUBS IS A COLLECTION OF CONTROL SUBROUTINES USED TO

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541: ; INTERACT WITH THE HARDWARE COMPONENTS OF THE "SYSTEM"
542: ; SOFTWARE BY STEVE STEVENS & JEFF W. SHIRLEY
543: ;
544: ;*****
545:
546: ;*****
547: ; M80 USER ROUTINES, P.50 M80 MANUAL
548: ;*****
549:
550: CRLF EQU 02C3H ;TRANSMIT CR AND LF
551: HXASC EQU 02D2H ;CONVERT BINARY IN (A) TO ASCII IN (DE)
552: XMTR EQU 0269H ;TRANSMIT DATA IN (A)
553: WAIT EQU 02A4H ;WAIT LOOP, DELAY VALUE IN (HL)
554:
555: ;*****
556: ; UPDATE A/D READINGS (12/30/81 JWS)
557: ; INPUT: NONE
558: ; OUTPUTS: UPDATES LOCAL VARIABLES (R##)
559: ;*****
560:
561: UPREADS:XRA A ;STARTING SENSOR #
562: UPRDS1: MOV B,A ;SAVE SENSOR #
563: CALL GETRAD ;COMPUTE SENSOR VARIABLE ADDRESS
564: CALL CONAD ;GET A/D READING
565: MOV M,A ;STORE A/D READING TO (R##)
566: MOV A,B ;RECALL SENSOR #
567: INR A ;POINT TO NEXT
568: CPI 16 ;MAX + 1
569: JNZ UPRDS1 ;CONTINUE READING
570:
571: CALL DISPRSW ;READ DISPLAY SWITCHES
572: STA R16 ;STORE READING TO VARIABLE (R16)
573: RET
574:
575: ; DATA MUST BE CONTINUOUS BLOCK, OFFSETS TO ADDRESS
576: ; (R00) ARE USED TO ACCESS THE VARIABLES
577: R00: DB 00 ;SOLAR WALL SURFACE TEMPERATURE
578: R01: DB 00 ;SOLAR WALL 4" DEPTH TEMPERATURE
579: R02: DB 00 ;SOLAR WALL 8" DEPTH TEMPERATURE
580: R03: DB 00 ;PHOTO-RESISTOR SUNLIGHT SENSOR
581: R04: DB 00 ;SOLAR SPACE TEMPERATURE
582: R05: DB 00 ;AMBIENT TEMPERATURE
583: R06: DB 00 ;LOOP OUTLET & SOLAR SPACE INLET TEMP.
584: R07: DB 00 ;SOLAR SPACE OUTLET TEMP. TO HEAT PUMP
585: R08: DB 00 ;GROUND TEMPERATURE (PORTABLE SENSOR)
586: R09: DB 00 ;INSIDE TEMPERATURE
587: R10: DB 00 ;THERMOSTAT MODE
588: R11: DB 00 ;THERMOSTAT STATE
589: R12: DB 00 ;SOFTWARE SWITCH #4
590: R13: DB 00 ;SOFTWARE SWITCH #3
591: R14: DB 00 ;SOFTWARE SWITCH #2
592: R15: DB 00 ;SOFTWARE SWITCH #1
593: R16: DB 00 ;DISPLAY SWITCH READING
594:
595: ;*****
596: ; GET READING ADDRESS ROUTINE (12/30/81 JWS)
597: ; INPUT: (A) - A/D SENSOR #
598: ; OUTPUT: (HL) - ADDRESS OF VARIABLE (R##) TO ACCESS
599: ;*****
600:

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601: GETRAD: PUSH    PSW        ;SAVE SENSOR #
602:          LXI      H,R00     ;LOAD STARTING A/D SENSOR ADDRESS
603:          ADD      L         ;COMPUTE LOW BYTE ADDRESS
604:          MOV      L,A        ;STORE LOW BYTE OF ADDRESS
605:          JNC      RADEX      ;NO CARRY, EXIT
606:
607:          INR       H          ;CARRY, INCREMENT (H)
608: RADEX:  POP      PSW        ;RESTORE SENSOR #
609:          RET
610:
611: ;*****
612: ;      UPDATE DAY/NIGHT VALUES ROUTINE (1/2/82 SS & JWS)
613: ;*****
614: DAYVAL EQU      20H          ;DAY VALUE UPPER LIMIT (1/2/82 JWS)
615: ;*****
616:
617: UPDAY:  LDA      R03          ;DAY/NIGHT PHOTO CELL A/D READING
618:          CPI      DAYVAL      ;DAY VALUE UPPER LIMIT
619:          JC       UPDAY1      ;VALUE < DAYVAL
620:
621:          MVI      A,'N'       ;ITS NIGHT
622:          JMP      UPDAY2
623:
624: UPDAY1: MVI      A,'D'        ;ITS DAY
625: UPDAY2: STA      DAYN
626:          RET
627:
628: DAYN:   DB       044H        ;DAY='D', NIGHT='N'
629:
630: ;*****
631: ;      UPDATE THERMOSTAT MODE AND STATE (12/26/81 SS & JWS)
632: ;*****
633: ;      MODE AND STATE EQUATES AND VALUES
634: ;      ACTUAL READINGS: MODE - 0F=COOLING, FF=HEATING,
635: ;      STATE - FF=OFF, 0E=ON (12/26/81 JWS)
636: MIDVAL EQU      088H        ;ON/OFF LIMIT VALUE
637: ;*****
638:
639: UPDMS:  LDA      R10          ;MODE A/D READING
640:          CPI      MIDVAL
641:          JC       UPDMS1
642:
643:          MVI      A,'H'       ;(A) >= MIDVAL, HEATING MODE
644:          JMP      UPDMS2
645:
646: UPDMS1: MVI      A,'C'        ;(A) < MIDVAL, COOLING MODE
647: UPDMS2: STA      MODE
648:          MOV      B,A         ;SAVE A/D READING MODE
649:          LDA      SMODE       ;RECALL SOFTWARE MODE
650:          CMP      B           ;SAME MODE?
651:          JZ       UPDMS3      ;YES, CONTINUE
652:
653: ;      MODES NOT SAME, DEFROST MODE
654:          MVI      A,'D'       ;DEFROST
655:          STA      MODE        ;DEFROST MODE
656: UPDMS3: LDA      R11          ;STATE A/D READING
657:          CPI      MIDVAL
658:          JC       UPDMS4
659:
660:          XRA      A           ;(A) >= MIDVAL, SYSTEM OFF

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661:      JMP      UPDMS5
662:
663: UPDMS4: MVI      A,01      ;(A) < MIDVAL, SYSTEM ON
664: UPDMS5: STA      STATE
665:      RET
666:
667: MODE:   DB       048H      ;HEATING='H', COOLING='C', DEFROST='D'
668: STATE:  DB       00        ;0=OFF, 1=ON
669:
670: ;*****
671: ;      CONVERT A/D CHANNEL (11/24/81 SS)
672: ;      INPUT: (A) - CHANNEL TO CONVERT. (0-F)
673: ;      OUTPUT: (A) CONVERTED VALUE FROM A/D CHANNEL SELECTED
674: ;*****
675: ;      A/D ADDRESSES
676: ADPTS   EQU      3400H      ;A/D PORT SELECT
677: ADSCON  EQU      3800H      ;START A/D CONVERSION
678: ADECON  EQU      3000H      ;END OF A/D CONVERSION FLAG
679: ADPORT  EQU      3C00H      ;A/D DATA PORT
680: ;*****
681:
682: CONAD:  PUSH     H
683:      STA      ADPTS      ;SELECT A/D PORT
684: ;      WAIT FOR ADDRESS TO STABILIZE ON BUS
685:      MVI      A,01      ;LOAD DELAY VALUE = 0.01 SEC.
686:      CALL     DELAY
687:      STA      ADSCON      ;START CONVERSION
688: CKEOC:  LDA      ADECON      ;END OF CONVERSION?
689:      ANI      01
690:      JNZ      CKEOC      ;NOT YET
691:
692: ;      WAIT FOR DATA TO STABILIZE ON BUS
693:      MVI      A,01      ;LOAD DELAY VALUE = 0.01 SEC.
694:      CALL     DELAY
695:      LDA      ADPORT      ;READ A/D PORT
696:      POP      H
697:      RET
698:
699: ;*****
700: ;      UPDATE SOFTWARE SWITCH POSITIONS (1/2/82 SS & JWS)
701: ;      INPUTS: NONE
702: ;      OUTPUTS: LOCAL VARIABLES ARE UPDATED
703: ;      REGISTERS CHANGED
704: ;*****
705:
706: UPSFSW: LDA      R15      ;A/D READING SWITCH #1
707:      CALL     SWSPT      ;RETURN STATE OF SWITCH
708:      STA      SFSW1      ;SAVE STATE OF SWITCH 1
709:      LDA      R14      ;A/D READING SWITCH #2
710:      CALL     SWSPT      ;RETURN STATE OF SWITCH
711:      STA      SFSW2      ;SAVE STATE OF SWITCH 2
712:      LDA      R13      ;A/D READING SWITCH #3
713:      CALL     SWSPT      ;RETURN STATE OF SWITCH
714:      STA      SFSW3      ;SAVE STATE OF SWITCH 3
715:      LDA      R12      ;A/D READING SWITCH #4
716:      CALL     SWSPT      ;RETURN STATE OF SWITCH
717:      STA      SFSW4      ;SAVE STATE OF SWITCH 4
718: ;      READ DISPLAY SWITCH SETTINGS, SET SOFTWARE SWITCHES
719: ;      SWITCH 8 - DOWN=COOLING, UP=HEATING
720: ;      SWITCH 4 - DOWN=AUTO, UP=MANUAL

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721: ; SWITCH 2 - DOWN=OFF, UP=ON (SFSW5)
722: ; SWITCH 1 - DOWN=OFF, UP=ON (SFSW6)
723: MVI A,'H' ;ASSUME HEATING MODE
724: STA SMODE ;SOFTWARE MODE
725: MVI A,02 ;ASSUME SWITCHES ARE AUTO
726: STA SFSW5 ;SOFTWARE SWITCH #5
727: STA SFSW6
728: LDA R16 ;DISPLAY SWITCHES VALUE
729: MOV B,A ;SAVE DATA
730: ; CHECK DISPLAY SWITCH 8 (X000)
731: ANI 008H ;CHECK FOR HEATING MODE
732: CPI 00 ;SWITCH 8 DOWN?
733: JNZ DSW50 ;NO, HEATING MODE CONTINUE
734:
735: ; COOLING MODE SET SOFTWARE FLAG
736: MVI A,'C'
737: STA SMODE ;STORE SOFTWARE MODE
738: ; CHECK DISPLAY SWITCH 4 (0X00)
739: DSW50: MOV A,B ;RESTORE DATA
740: ANI 004H ;CHECK FOR MANUAL MODE
741: CPI 00 ;SWITCH 4 DOWN?
742: JZ DSWSEX ;YES, EXIT
743:
744: ; MANUAL MODE SELECTED
745: ; CHECK DISPLAY SWITCH 2 (00X0)
746: MVI A,01
747: STA SFSW5 ;SOFTWARE SWITCH 2 ON
748: MOV A,B ;RESTORE DATA
749: ANI 002H ;CHECK FOR SWITCH 2 UP
750: CPI 00 ;SWITCH 2 DOWN?
751: JNZ DSW51 ;NO, CHECK SWITCH 1
752:
753: ; DISPLAY SWITCH 2 (00X0) IS OFF
754: XRA A ;(A)=0
755: STA SFSW5 ;SOFTWARE SWITCH #5 OFF
756: ; CHECK DISPLAY SWITCH 1 (000X) SETTING
757: DSW51: MVI A,01
758: STA SFSW6 ;ASSUME SWITCH #6 ON
759: MOV A,B ;RESTORE DATA
760: ANI 001H ;CHECK FOR SWITCH 1 UP
761: CPI 00 ;SWITCH 1 DOWN?
762: JNZ DSWSEX ;NO, SWITCH 1 UP, EXIT
763:
764: ; DISPLAY SWITCH 1 (000X) IS OFF
765: XRA A
766: STA SFSW6 ;SWITCH #6 IS OFF
767: DSWSEX: RET
768:
769: ; LOCAL VARIABLES FOR SOFTWARE SWITCHES
770: ; 0=OFF, 1=ON, 2=AUTO
771: SFSW1: DB 00 ;SWITCH 1 = RELAY 1
772: SFSW2: DB 00 ;SWITCH 2 = RELAY 2
773: SFSW3: DB 00 ;SWITCH 3 = RELAY 5
774: SFSW4: DB 00 ;SWITCH 4 = RELAY 6
775: SFSW5: DB 00 ;SWITCH 5 = RELAY 3
776: SFSW6: DB 00 ;SWITCH 6 = RELAY 4
777: SMODE: DB 00 ;SOFTWARE HEATING/COOLING MODE
778:
779: ;*****
780: ; RETURN SOFTWARE SWITCH POSITION.

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781: ; INPUT: (A) - READING OF SWITCH TO CHECK. (R15=1-R12=4)
782: ; OUTPUT: (A) - 0=OFF, 1=ON, 2=AUTO
783: ;*****
784: ; SOFTWARE SWITCH POSITION EQUATES AND VALUES
785: ; ACTUAL READINGS: 10=ON, 2A=OFF, FF=AUTO (12/24/81 JWS)
786: ; MID-POINTS BETWEEN READINGS SELECTED AS CUT-OFF POINTS
787: SWSON EQU 01DH ;00 - 1C IS ON
788: SWSOFF EQU 095H ;1D - 94 IS OFF
789: SWSAUTO EQU 0FFH ;95 - FF IS AUTO
790: ;*****
791:
792: SWSPT: PUSH B
793: CPI SWSON
794: MVI B,01
795: JC SWSPTE ;SWITCH IS ON
796:
797: CPI SWSOFF
798: MVI B,00
799: JC SWSPTE ;SWITCH IS OFF
800:
801: MVI B,02 ;SWITCH IS AUTO
802: SWSPTE: MOV A,B
803: POP B
804: RET
805:
806: ;*****
807: ; READ DISPLAY INPUT SWITCHES (1/2/82 SS & JWS)
808: ; INPUT: NONE
809: ; OUTPUT: (A) - SETTING OF DISPLAY SWITCHES
810: ;*****
811: DISPSW EQU 2C00H ;ADDRESS OF DISPLAY CONTROL SWITCH
812: ;*****
813:
814: DISPRSW:LDA DISPSW ;READ DISPLAY SWITCH SETTING
815: ANI 0FH ;CLEAR UPPER NIBBLE
816: RET
817:
818: ;*****
819: ; CONTROL HEAT PUMP ROUTINE (12/28/81 JWS)
820: ; DISABLE/ENABLE HEAT PUMP (RELAY #6)
821: ;*****
822:
823: CTRLHP: LDA PREL6 ;RELAY #6 CONTROL VARIABLE
824: MOV C,A
825: LDA SFSW4 ;SOFTWARE SWITCH #4
826: MVI B,RELAY6;RELAY #6 BIT PATTERN
827: MVI D,01 ;PROGRAM/MANUAL EXECUTION CODE
828: CALL UPRELS ;TURN (ON/OFF) RELAY #6
829: RET
830:
831: ;*****
832: ; UPDATE RELAY POSITION (12/01/81 SS & JWS)
833: ; INPUT: (D) - EXECUTION FLAG, 0=MANUAL, 1=PROGRAM/MANUAL
834: ; OUTPUT: SET RELAY USING (PREL) VALUE IF SWITCH IS AUTO,
835: ; OR SET RELAY USING MANUAL SWITCH SETTING
836: ;*****
837: ; RELAY EQUATES
838: RELAY1 EQU 01H ;FAN @ GROUND LOOP ENTRANCE & DAMPER #3
839: RELAY2 EQU 02H ;DAMPERS #1, #2 (RETURN IN SOLAR SPACE)
840: RELAY3 EQU 04H ;OPEN

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841: RELAY4 EQU 08H ;OPEN
842: RELAY5 EQU 10H ;AIR HANDLER FAN CONTROL (INSIDE)
843: RELAY6 EQU 20H ;THERMOSTAT CONTROL (ENABLE HEAT PUMP)
844: RELCTLN EQU 2400H ;ADDRESS OF RELAY CONTROL PORT
845: ;*****
846:
847: UPREL: LDA PREL1 ;LOAD PROGRAM CONTROL SETTING
848: MOV C,A ;STORE PROGRAM CONTROL SETTING
849: LDA SFSW1 ;LOAD SOFTWARE SWITCH #1 SETTING
850: MVI B,RELAY1;LOAD RELAY #1
851: CALL UPRELS ;SET RELAY
852: LDA PREL2
853: MOV C,A
854: LDA SFSW2 ;SWITCH #2
855: MVI B,RELAY2;RELAY #2
856: CALL UPRELS
857: LDA PREL3
858: MOV C,A
859: LDA SFSW5 ;SWITCH #5
860: MVI B,RELAY3;RELAY #3
861: CALL UPRELS
862: LDA PREL4
863: MOV C,A
864: LDA SFSW6 ;SWITCH #6
865: MVI B,RELAY4;RELAY #4
866: CALL UPRELS
867: LDA PREL5
868: MOV C,A
869: LDA SFSW3 ;SWITCH #3
870: MVI B,RELAY5;RELAY #5
871: CALL UPRELS
872: LDA PREL6
873: MOV C,A
874: LDA SFSW4 ;SWITCH #4
875: MVI B,RELAY6;RELAY #6
876: CALL UPRELS
877: RET
878:
879: ; PROGRAMED RELAY POSITION VARIABLES
880: ; 0=OFF, 1=ON
881: PREL1: DB 00 ;RELAY 1
882: PREL2: DB 00 ;RELAY 2
883: PREL3: DB 00 ;RELAY 3
884: PREL4: DB 00 ;RELAY 4
885: PREL5: DB 00 ;RELAY 5
886: PREL6: DB 00 ;RELAY 6
887: RELSTAT:DB 00 ;INITIALIZED RELAY OUTPUT VARIABLE
888:
889: ;*****
890: ; RELAY SUBROUTINE (12/1/81 SS)
891: ; INPUTS:
892: ; (A) - 0=OFF, 1=ON, 2=AUTO (SOFTWARE SWITCH SETTING)
893: ; (B) - RELAY CODE (BIT TO SET IN RELAY PORT)
894: ; (C) - 0=OFF, 1=ON (PROGRAMMED POSITION)
895: ; (D) - 0=MANUAL ONLY, 1=PROGRAM/MANUAL (EXECUTION FLAG)
896: ; OUTPUT: SELECTED RELAY TURNED (ON/OFF)
897: ;*****
898:
899: UPRELS: CPI 02 ;CHECK FOR SOFTWARE SWITCH = AUTO
900: JNZ UPRSE ;NO, OVER RIDE PROGRAM, SET RELAY

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901:
902: ; SOFTWARE SWITCH IS IN AUTO POSITION
903: MOV A,D ;GET EXECUTION FLAG
904: CPI 00 ;CHECK FOR MANUAL ONLY
905: JZ UPEND ;EXECUTE MANUAL SETTINGS ONLY, EXIT
906:
907: MOV A,C ;USE PROGRAMMED POSITION TO SET RELAY
908: UPRS2: CPI 00 ;IS THE RELAY OFF?
909: JNZ UPRS3 ;NO, ITS ON
910:
911: MOV A,B ;YES, ITS OFF
912: CALL RELAYOF ;CUT THE RELAY OFF
913: JMP UPEND
914:
915: UPRS3: MOV A,B
916: CALL RELAYON ;CUT THE RELAY ON
917: UPEND: RET
918:
919: ;*****
920: ; RELAY (ON) ROUTINE (12/23/81 SS & JWS)
921: ; INPUT: (A) - RELAY CODE, BIT(S) TO SET IN RELAY PORT
922: ; OUTPUT: UPDATE (RELSTAT) VARIABLE & SET RELAYS
923: ;*****
924:
925: RELAYON: PUSH H ;SAVE REGISTERS
926: PUSH PSW ;SAVE RELAY CODE
927: LXI H,RELSTAT
928: ANA M ;CHECK STATE
929: JNZ RELONEX ;RELAY(S) ON, EXIT
930:
931: ; RELAY(S) OFF, CUT IT/(THEM) ON
932: POP PSW ;RESTORE (A)
933: PUSH PSW
934: ORA M ;SET RELAY(S)
935: MOV M,A ;UPDATE RELAY STATE (RELSTAT)
936: STA RELCTLN ;SET RELAYS, WRITE TO PORT
937: RELONEX: POP PSW
938: POP H
939: RET
940:
941: ;*****
942: ; RELAY (OFF) ROUTINE (12/23/81 SS & JWS)
943: ; INPUT: (A) - RELAY CODE, BIT(S) TO SET IN RELAY PORT
944: ; OUTPUT: UPDATE (RELSTAT) VARIABLE & SET RELAYS
945: ;*****
946:
947: RELAYOF: PUSH H
948: PUSH PSW
949: LXI H,RELSTAT
950: ANA M ;CHECK STATE
951: JZ RELOFEX ;RELAY(S) OFF, EXIT
952:
953: ; RELAY(S) ON, CUT IT/(THEM) OFF
954: POP PSW ;RESTORE (A)
955: PUSH PSW
956: XRA M ;CLEAR FLAG
957: MOV M,A ;STORE NEW STATE
958: STA RELCTLN ;SET RELAY(S), WRITE TO PORT
959: RELOFEX: POP PSW
960: POP H

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961:          RET
962:
963: ;*****
964: ;      UPDATE 3-BYTE COUNTER AND DISPLAY LOW BYTE (1/3/82 JWS)
965: ;*****
966:
967: UPDISP: LXI      H,DISPC+2;DISPLAY VARIABLE VALUE, LOW BYTE
968:          MVI      A,01      ;INCREMENT
969:          ADD       M         ;UPDATE COUNTER
970:          MOV       M,A       ;STORE BYTE
971:          CALL      DISPLAY   ;DISPLAY COUNT
972:          DCX       H         ;POINT TO BYTE 2
973:          MVI      A,00      ;NOTE: **DON'T CHANGE FLAGS**
974:          ADC       M         ;ADD CARRY ONLY
975:          MOV       M,A       ;UPDATE BYTE 2
976:          DCX       H         ;POINT TO HIGH BYTE
977:          MVI      A,00      ;FLAGS UNCHANGED
978:          ADC       M         ;ADD CARRY TO HIGH BYTE
979:          MOV       M,A       ;STORE HIGH BYTE
980:          RET
981:
982: DISPC:  DW       0000      ;DISPLAY COUNT VARIABLE
983:          DB        00      ;DISPLAY COUNT VARIABLE, LOW BYTE
984:
985: ;*****
986: ;      OUTPUT (A) TO DISPLAY (11/24/81 SS & JWS)
987: ;      INPUT: (A) - HEX DATA TO BE DISPLAYED
988: ;      OUTPUT: ALL REGISTERS PRESERVED
989: ;*****
990: DISCNTL EQU      2800H     ;ADDRESS OF DISPLAY CONTROL PORT
991: ;*****
992:
993: DISPLAY:STA      DISCNTL ;WRITE HEX DATA TO DISPLAY
994:          RET
995:
996: ;*****
997: ;      RESET RELAYS TO INITIAL VALUES (ALL OFF OR PASSIVE)
998: ;      (12/30/81 JWS)
999: ;*****
1000:
1001: RESCTRL:XRA      A         ;ZERO ACCUMULATOR
1002:          STA      RELSTAT ;INITIALIZE RELAY OUTPUTS
1003:          STA      RELCTLN ;INITIALIZE RELAY PORT
1004:          RET
1005:
1006: ;*****
1007: ;      CONVERT AND TRANSMIT SENSOR OUTPUT & BCD TEMPERATURE
1008: ;      (12/30/81 JWS)
1009: ;      INPUT: (A) - SENSOR #
1010: ;      OUTPUTS: (A) - SENSOR # + 1, SENSOR VALUES TRANSMITED
1011: ;*****
1012:
1013: CPBCD:  PUSH     PSW       ;SAVE SENSOR #
1014:          MVI      A,'T'
1015:          RST      5        ;CALL XMTR & TRANSMIT (A)
1016:          POP      PSW       ;RESTORE (A)
1017:          PUSH     PSW
1018:          CALL      GETRAD   ;(HL) = ADDRESS OF A/D READING (R##)
1019:          RST      7        ;CALL PRN & TRANSMIT LOWER NIBBLE OF (A)
1020:          MVI      A,'='

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1021:      RST      5      ;CALL XMTR & TRANSMIT (A)
1022:      MOV      A,M      ;(A) = (R##)
1023:      RST      1      ;CALL TPCAL & CONVERT A/D TO BCD TEMP.
1024:      RST      6      ;CALL PRA & TRANSMIT (A)
1025:      MVI      A,'='
1026:      RST      5      ;CALL XMTR & TRANSMIT (A)
1027:      CALL     PBCD      ;TRANSMIT BCD TEMPERATURE
1028:      POP      PSW      ;RECALL SENSOR #
1029:      INR      A      ;INCREMENT SENSOR #
1030:      RET
1031:
1032: ;*****
1033: ;      TRANSMIT TWO BYTE BCD NUMBERS IN THE FORM: -XXX.X
1034: ;      MEM(HL) IS BYTE TO BE PRINTED, SIGN = (+/-)
1035: ;      (12/30/81 JWS)
1036: ;*****
1037:
1038: PBCD:      MOV      A,M      ;GET SIGN OF NUMBER
1039:      CPI      00      ;CHECK FOR POSITIVE
1040:      MVI      A,'+'
1041:      JZ       PBCD1      ;NUMBER POSITIVE
1042:
1043:      MVI      A,'-'      ;NUMBER NEGATIVE
1044: PBCD1:      RST      5      ;TRANSMIT SIGN
1045:      INX      H      ;POINT TO BCD #
1046:      MOV      A,M      ;GET 1ST BYTE
1047:      RST      6      ;CALL PRA & TRANSMIT (A)
1048:      INX      H      ;POINT TO NEXT BYTE
1049:      MOV      A,M      ;GET 2ND BYTE
1050:      CALL     HXASC      ;CONVERT 2ND BYTE TO 2 BCD DIGITS
1051:      MOV      A,D
1052:      RST      5      ;TRANSMIT ONE'S DIGIT
1053:      MVI      A,'.'
1054:      RST      5      ;TRANSMIT DECIMAL
1055:      MOV      A,E
1056:      RST      5      ;TRANSMIT 1/10THS DIGIT
1057:      MVI      A,' '
1058:      RST      5      ;CALL XMTR & TRANSMIT (A)
1059:      RET
1060:
1061: ;*****
1062: ;      PRINT MODE ROUTINE (1/16/82 JWS)
1063: ;*****
1064:
1065: PRTMODE: PUSH     PSW      ;SAVE DATA (A)
1066:      MVI      A,'M'      ;'MODE' FLAG
1067:      RST      5      ;CALL XMTR & TRANSMIT (A)
1068:      POP      PSW      ;RESTORE (A)
1069:      PUSH     PSW      ;SAVE (A)
1070:      RST      7      ;CALL PRLN & TRANSMIT LOWER NIBBLE OF (A)
1071:      MVI      A,'='      ;ASCII EQUALS CHARACTER
1072:      RST      5      ;CALL XMTR & TRANSMIT (A)
1073:      CALL     PBCD      ;PRINT BCD VALUE
1074:      POP      PSW
1075:      INR      A      ;INCREMENT A
1076:      RET
1077:
1078: ;*****
1079: ;      CONVERT (A) TO ASCII IN (DE) AND TRANSMIT
1080: ;      UPPER NIBBLE (D) AND LOWER NIBBLE (E)

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1081: ;*****
1082:
1083: PRA:    CALL    HXASC    ;CONVERT BINARY (A) TO HEX (DE)
1084:        MOV     A,D
1085:        RST     5        ;CALL XMTR & TRANSMIT (A)
1086:        MOV     A,E
1087:        RST     5        ;CALL XMTR & TRANSMIT (A)
1088:        RET
1089:
1090: ;*****
1091: ;        CONVERT TO ASCII AND TRANSMIT LOWER NIBBLE OF (A)
1092: ;*****
1093:
1094: PRLN:    CALL    HXASC    ;CONVERT BINARY (A) TO HEX (DE)
1095:        MOV     A,E
1096:        RST     5        ;CALL XMTR & TRANSMIT (A)
1097:        RET
1098:
1099: ;*****
1100: ;
1101: ;        MATH.LIB          VERSION 2.5      2/23/82
1102: ;
1103: ;        MATH IS A COLLECTION OF MATH AND UTILITY SUBROUTINES
1104: ;        USED IN THE "SYSTEM".
1105: ;        SOFTWARE BY STEVE STEVENS & JEFF W. SHIRLEY
1106: ;
1107: ;*****
1108:
1109: ;*****
1110: ;        TIME DELAY ROUTINE (1/31/82 JWS)
1111: ;*****
1112:
1113: DELAY:    LXI     H,587    ;LOAD DELAY VALUE = 0.01 SEC.
1114:        CALL    WAIT    ;M80 WAIT LOOP
1115:        DCR     A        ;DECREASE # OF HUNDRETHS
1116:        JNZ     DELAY    ;CONTINUE LOOPING
1117:        RET
1118:
1119: ;*****
1120: ;        SIGNED BINARY COMPARE ROUTINE (1/31/82 JWS)
1121: ;        INPUT: #S IN MEM(DE) & MEM(HL)
1122: ;        OUTPUT: MEM(HL)=MEM(DE) - ZERO FLAG SET
1123: ;                MEM(HL)>MEM(DE) - CARRY FLAG SET
1124: ;                MEM(HL)<MEM(DE) - CARRY FLAG CLEAR
1125: ;*****
1126:
1127: CMPBS:    XCHG                ;-=1 & +=0, REVERSE OF #S
1128:        LDAX    D        ;SIGN OF MEM(DE)
1129:        CMP     M        ;SIGN OF MEM(HL)
1130:        XCHG
1131:        JNZ     CMPBSE    ;SIGNS DIFFERENT, FLAGS SET, EXIT
1132:
1133:        INX     H
1134:        INX     D
1135:        CALL    CMPB      ;SIGNS THE SAME, CHECK NUMBER
1136:        DCX     D
1137:        DCX     H
1138: CMPBSE:    RET
1139:
1140: ;*****

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1141: ;      BINARY COMPARE ROUTINE COMPARE MEM(HL) WITH MEM(DE)
1142: ;      INPUT: #S IN MEM(DE) & MEM(HL) (1/31/82 JWS)
1143: ;      OUTPUT: MEM(HL)=MEM(DE) - ZERO FLAG SET
1144: ;      MEM(HL)>MEM(DE) - CARRY FLAG SET
1145: ;      MEM(HL)<=MEM(DE) - CARRY FLAG CLEAR
1146: ;*****
1147:
1148: CMPB: LDAX    D      ;GET MEM(DE) HIGH BYTE
1149:      CMP      M      ;COMPARE MEM(HL) HIGH BYTE
1150:      JNZ      CMPBE   ;IF NOT ZERO, FLAGS SET, EXIT
1151:
1152: ;      HIGH BYTES EQUAL, CHECK LOW BYTES
1153:      INX      H      ;POINT TO LOW BYTE
1154:      INX      D
1155:      LDAX    D      ;GET MEM(DE) LOW BYTE
1156:      CMP      M      ;COMPARE MEM(HL) LOW BYTE
1157:      DCX      H      ;RESTORE POINTERS TO HIGH BYTES
1158:      DCX      D
1159: CMPBE: RET          ;FLAGS SET, EXIT
1160:
1161: ;*****
1162: ;      ZERO MEMORY, MEM(HL)=+000.0 (1/31/82 JWS)
1163: ;*****
1164:
1165: ZEROM: LXI      D,SZERO ;ADDRESS OF ZERO VALUE
1166: ;      ENTRY INTO SUBROUTINE (MOVS)
1167:
1168: ;*****
1169: ;      MOVE SIGNED NUMBERS, MOVES THREE BYTES OF STORAGE
1170: ;      INPUTS: MEM(HL) - DESTINATION, MEM(DE) - SOURCE
1171: ;      OUTPUT: +MEM(HL)=+MEM(DE)
1172: ;*****
1173:
1174: MOVS:  PUSH     PSW      ;SAVE (A)
1175:      LDAX     D      ;LOAD SIGN BYTE
1176:      MOV      M,A      ;STORE SIGN BYTE IN MEM(HL)
1177:      INX      D
1178:      INX      H
1179:      CALL     MOVMM     ;MOVE TWO BYTE #S
1180:      DCX      H
1181:      DCX      D
1182:      POP      PSW
1183:      RET
1184:
1185: ;*****
1186: ;      MOVE TWO BYTES, MEM(DE) MOVED TO MEM(HL) (12/5/81 SS)
1187: ;*****
1188:
1189: MOVMM:  PUSH     PSW
1190:      LDAX     D      ;LOAD FIRST BYTE FROM MEM(DE)
1191:      MOV      M,A      ;MOVE TO MEM(HL)
1192:      INX      D
1193:      INX      H
1194:      LDAX     D
1195:      MOV      M,A      ;MOVE SECOND BYTE
1196:      DCX      D
1197:      DCX      H
1198:      POP      PSW
1199:      RET
1200:

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1201: ;*****
1202: ;      CONVERT (A) TO A VALID BCD NUMBER (##) (12/15/81 SS)
1203: ;      BINARY VALUE OF 063H = 99D IS LIMIT, WRAPING OCCURS
1204: ;*****
1205:
1206: BCD:   CPI      00      ;CHECK FOR ZERO
1207:       JZ        BCDE2   ;ZERO IS A VALID BCD NUMBER
1208:
1209:       PUSH     B        ;SAVE REGISTER (B) DATA
1210:       MOV      B,A      ;SAVE BINARY VALUE
1211:       XRA      A        ;ZERO BCD #
1212: BCDLP: ADI      01      ;INCREMENT BCD #
1213:       DAA      ;CONVERT (A) TO PACKED BCD NUMBER
1214:       MOV      C,A      ;SAVE BCD #
1215:       MOV      A,B      ;RECALL BINARY VALUE
1216:       SBI      01      ;DECREMENT BINARY VALUE
1217:       JZ        BCDE1   ;IS BINARY VALUE ZERO?
1218:
1219:       MOV      B,A      ;NO, SAVE CURRENT BINARY VALUE
1220:       MOV      A,C      ;RECALL CURRENT BCD #
1221:       JMP      BCDLP    ;REPEAT LOOP
1222:
1223: BCDE1: MOV      A,C      ;RECALL PACKED BCD #
1224:       POP      B        ;RESTORE (B)
1225: BCDE2: RET
1226:
1227: ;*****
1228: ;      BCD ADDITION ROUTINE - MEM(HL)=MEM(HL)+MEM(DE)
1229: ;      TWO BYTE ADDITION USING MEMORY POINTERS (DE) & (HL)
1230: ;      GENERAL FORM OF BCD NUMBERS: ###.# (ABSOLUTE VALUES)
1231: ;      (12/05/81 SS)
1232: ;*****
1233:
1234: ADDM:  PUSH     PSW
1235:       INX      D        ;INCREMENT (DE)
1236:       INX      H
1237:       LDAX    D        ;LOAD (A) INDIRECT USING ADDRESS (DE)
1238:       ADD     M        ;ADD BYTE ADDRESSED BY (HL) TO (A)
1239:       DAA      ;CONVERT (A) TO PACKED BCD NUMBER
1240:       MOV     M,A
1241:       DCX     D        ;DECREMENT (DE)
1242:       DCX     H
1243:       LDAX    D
1244:       ADC     M        ;ADD BYTE ADDRESS (HL) & CARRY TO (A)
1245:       DAA      ;CONVERT (A) TO PACKED BCD NUMBER
1246:       MOV     M,A
1247:       POP     PSW
1248:       RET
1249:
1250: ;*****
1251: ;      SUBTRACT SIGNED BCD NUMBERS (1/31/82 JWS)
1252: ;      INPUT: SIGNED #S IN MEM(DE) & MEM(HL)
1253: ;      OUTPUTS: +MEM(HL)=+MEM(HL)-MEM(DE)
1254: ;*****
1255:
1256: SUBS:  PUSH     PSW      ;SAVE (A)
1257:       LDAX    D        ;GET SIGN BYTE
1258:       CMP     M
1259:       INX     H        ;POINT TO #
1260:       INX     D

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1261:      JZ      SUBS1      ;NORMAL SUB.
1262:
1263: ;      RESULT WILL BE THE DEFAULT SIGN OF MEM(HL)
1264:      CALL     ADDM      ;SIGNS WILL BE THE SAME ADD
1265:      JMP      SUBSE
1266:
1267: SUBS1:  PUSH    H
1268:      PUSH    D
1269:      CALL    CMPB
1270:      JC      SUBS2      ;MEM(HL) > MEM(DE)
1271:
1272:      XCHG
1273:      LXI     H, TEMP0
1274:      CALL    MOVM      ;MOVE MEM(HL) TO TEMP0
1275:      POP     H          ;RESTORE MEM(DE) POINTER
1276:      PUSH    H          ;RE-SAVE (HL)
1277:      XCHG
1278:      CALL    MOVM      ;MEM(HL)=MEM(DE)
1279:      LXI     D, TEMP0   ;CURRENT LOCATION OF MEM(HL)
1280:      DCX     H          ;SET SIGN TO NEGATIVE
1281:      MVI     A, 01
1282:      MOV     M, A        ;STORE NEGATIVE SIGN
1283:      INX     H          ;POINT BACK TO #
1284: SUBS2:  CALL    SUBM
1285:      POP     D
1286:      POP     H
1287: SUBSE:  DCX     H          ;POINT TO SIGN BYTE
1288:      DCX     D
1289:      POP     PSW        ;RESTORE (A)
1290:      RET
1291:
1292: ;*****
1293: ;      BCD SUBTRACTION ROUTINE - MEM(HL)=MEM(HL)-MEM(DE)
1294: ;      TWO BYTE SUBTRACTION USING MEMORY POINTERS (DE) & (HL)
1295: ;      GENERAL FORM OF BCD NUMBERS: ###.# (MEM(HL) > MEM(DE))
1296: ;      (12/05/81 SS)
1297: ;*****
1298:
1299: SUBM:   PUSH    B          ;SAVE (BC)
1300:      MOV     B, A
1301:      XCHG                    ;EXCHANGE (HL) & (DE)
1302:      INX     D
1303:      INX     H
1304:      LDAX    D          ;LOAD (A) INDIRECT USING POINTER (DE)
1305:      SUB     M          ;SUBTRACT MEM(HL) FROM (A)
1306:      DAA                    ;CONVERT (A) TO PACKED BCD NUMBER
1307:      STAX    D
1308:      DCX     H
1309:      DCX     D
1310:      LDAX    D
1311:      SBB     M          ;SUBTRACT MEM(HL) WITH BORROW FROM (A)
1312:      DAA                    ;CONVERT (A) TO PACKED BCD NUMBER
1313:      STAX    D
1314:      MOV     A, B
1315:      POP     B
1316:      XCHG
1317:      RET
1318:
1319: ;*****
1320: ;      SHIFT MEM(HL) ONE NIBBLE TO THE LEFT (BCD MULT. BY 10)

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1321: ; INPUT: MEM(HL) - GENERAL FORMS 00##, 0##0
1322: ; OUTPUT: MEM(HL) - GENERAL FORMS 0##0, ##00
1323: ; (12/05/81 SS)
1324: ;*****
1325:
1326: SHLM: PUSH PSW
1327: PUSH B
1328: MOV A,M ;LOAD LEFT BYTE
1329: INX H
1330: MOV B,M ;LOAD RIGHT BYTE
1331: RLC ;ROTATE (A) LEFT THROUGH CARRY
1332: RLC ;ROTATE (A) LEFT THROUGH CARRY
1333: RLC ;ROTATE (A) LEFT THROUGH CARRY
1334: RLC ;ROTATE (A) LEFT THROUGH CARRY
1335: ANI 0F0H
1336: MOV C,A ;SAVE
1337: MOV A,B
1338: RRC ;ROTATE (A) RIGHT THROUGH CARRY
1339: RRC ;ROTATE (A) RIGHT THROUGH CARRY
1340: RRC ;ROTATE (A) RIGHT THROUGH CARRY
1341: RRC ;ROTATE (A) RIGHT THROUGH CARRY
1342: ANI 0FH
1343: ADD C ;LEFT BYTE COMPLETE
1344: MOV C,A ;STORE
1345: MOV A,M ;LOAD RIGHT BYTE AGAIN
1346: RLC ;ROTATE (A) LEFT THROUGH CARRY
1347: RLC ;ROTATE (A) LEFT THROUGH CARRY
1348: RLC ;ROTATE (A) LEFT THROUGH CARRY
1349: RLC ;ROTATE (A) LEFT THROUGH CARRY
1350: ANI 0F0H ;RIGHT BYTE COMPLETE
1351: MOV M,A ;STORE RIGHT BYTE IN MEMORY
1352: DCX H
1353: MOV M,C ;STORE LEFT BYTE IN MEMORY
1354: POP B
1355: POP PSW
1356: RET
1357:
1358: ;*****
1359: ; BCD DIVISION ROUTINE - MEM(HL)=MEM(HL)/MEM(DE)
1360: ; TWO BYTE DIVISION USING MEMORY POINTERS (DE) & (HL)
1361: ; GENERAL FORM OF BCD NUMBERS: ###.# (12/05/81 SS)
1362: ;*****
1363:
1364: DIVM: PUSH PSW
1365: XRA A ;(A)=0
1366: STA TEMP0 ;ZERO COUNT
1367: STA TEMP0+1
1368: CALL SHLM ;SHIFT (HL) TO THE LEFT (MULT. BY 10)
1369: DIVL: CALL SUBM ;BCD SUBTRACTION ROUTINE
1370: JC DIVE ;AFTER SUB. IF THE RESULT IS NEG, END
1371:
1372: PUSH H
1373: PUSH D
1374: LXI D,PONE ;LOAD ADDRESS OF A CONSTANT (.1)
1375: LXI H,TEMP0 ;LOAD ADDRESS OF COUNT
1376: CALL ADDM ;BCD ADDITION ROUTINE
1377: POP D
1378: POP H
1379: JMP DIVL
1380:

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1381: DIVE:   LXI      D,TEMP0
1382:         CALL     MOVN      ;MOVE ANSWER INTO (HL)
1383:         POP      PSW
1384:         RET
1385:
1386: ;*****
1387: ;      CONVERT A/D READING TO A VALID CENTIGRADE TEMPERATURE
1388: ;      INPUT: (A) - A/D READING VALUE (1/31/82 SS & JWS)
1389: ;      OUTPUT: (STTP) - CENTIGRADE TEMPERATURE, FORM -###.#
1390: ;      (STTP) ADDRESS IS IN (HL), OTHER REGISTERS PRESERVED
1391: ;*****
1392:
1393: TPCAL:  PUSH     B
1394:         PUSH     D
1395:         PUSH     PSW      ;SAVE A/D READING
1396:         LXI      H,STTP   ;TTP = CENTIGRADE TEMPERATURE ON EXIT
1397:         CALL     ZEROM    ;STORE ZEROS IN TTP
1398:         LXI      H,STEMP2
1399:         CALL     ZEROM    ;ZERO TEMP2
1400:         LXI      D,TEN    ;TABLE INCREMENT
1401:         LXI      H,TTPT   ;TEMPERATURE TABLE STARTING ADDRESS
1402:
1403: ;      LOOP TO FIND TABLE VALUES WHICH BOUND READING
1404: TPCL:   CMP      M          ;COMPARE (A) WITH TABLE VALUE (HL)
1405:         JZ       TPCL3     ; (A) = (HL)
1406:
1407:         JNC      TPCFD     ; (A) > (HL)
1408:
1409:         CALL     ATTP      ;ADD 10 TO TTP
1410:         INX      H         ;POINT TO NEXT ENTRY IN TABLE
1411:         JMP      TPCL
1412:
1413: ;      READING (A) IS GREATER THAN CURRENT TABLE VALUE,
1414: ;      BACK-UP TO PREVIOUS TABLE VALUE BEFORE INTERPOLATION
1415: TPCFD:  MOV      B,M        ;STORE (B) CURRENT TABLE VALUE
1416:         DCX      H         ;POINT TO PREVIOUS LARGER TABLE VALUE
1417:         MOV      C,M        ;STORE (C) CURRENT TABLE VALUE
1418:         MOV      A,C        ;MOVE TO (A) LARGER TABLE VALUE
1419:         SUB      B          ;DIFFERENCE BETWEEN TABLE ENTRIES IN (A)
1420:         CALL     BCD        ;CONVERT (A) TO BCD, FORM ##
1421:         STA      TEMP2+1    ;BCD NUMBER FORM 00#.#
1422:         LXI      H,STTP     ;POINT TO TTP
1423:         LXI      D,STEN     ;BCD VALUE 10 BASE TEN
1424:         CALL     SUBS       ;BCD SUBTRACTION ROUTINE
1425:         LXI      H,STEMP1
1426:         CALL     MOVS       ;PUT A 10 IN TEMP1
1427:         LXI      H,TEMP2    ;LOAD ADDRESS
1428:         CALL     SHLM       ;TEMP2 = 0##.0
1429:         LXI      D,TEMP2
1430:         LXI      H,TEMP1    ;TEMP1 = TEMPERATURE INCREMENT
1431:         CALL     DIVM       ;010.0 / TABLE DIFFERENCE
1432:         LXI      D,TEMP1    ;INCREMENT BETWEEN TABLE VALUES
1433:         POP      PSW        ;RECALL A/D READING
1434:         PUSH     PSW        ;SAVE A/D READING
1435: ;      LOOP TO REFINE MATCH WITH A/D READING BETWEEN
1436: ;      TWO TABLE VALUES BY STARTING WITH LARGER AND
1437: ;      DECREMENTING BYTE WHILE INCREMENTING TTP UNTIL
1438: ;      LARGER TABLE VALUE (BYTE) EQUALS A/D READING
1439: TPCL2:  CMP      C          ;COMPARE CURRENT VALUE (C) WITH (A)
1440:         JZ       TPCL3     ;A/D READING (A) = (C)

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1441:
1442:      CALL      ATTP      ;INCREMENT TEMPERATURE (RESULT)
1443:      DCR       C         ;DECREMENT (C) CURRENT VALUE
1444:      JMP       TPCL2
1445:
1446: ;      A/D READING MATCHES CALCULATED VALUE
1447: TPCL3: LXI      H,STTP    ;POINT TO (####.# = +TTP)
1448:      LXI      D,ST50     ;POINT TO (+050.0 = +T50)
1449: ;      COMPUTE CENTIGRADE TEMPERATURE (TTP) = BCD READING - 50
1450:      CALL     SUBS      ;SUBTRACT SIGNED NUMBERS
1451: TPCL4: POP      PSW      ;RESTORE A/D READING
1452:      POP      D
1453:      POP      B
1454:      RET
1455:
1456: ;*****
1457: ;      ADD THE NUMBER IN MEM(DE) TO TTP (TEMPERATURE RESULT)
1458: ;      GENERAL FORM OF BCD NUMBERS: ###.# (12/05/81 SS)
1459: ;*****
1460:
1461: ATTP:  PUSH     H
1462:      LXI      H,TTP
1463:      CALL     ADDM      ;BCD ADDITION ROUTINE
1464:      POP      H
1465:      RET
1466:
1467: ;*****
1468: ;      TEMPERATURE TABLE, EACH BYTE REPRESENTS A
1469: ;      10 DEGREE CENTIGRADE TEMPERATURE INCREMENT
1470: ;*****
1471: ZEROVAL EQU    0C7H      ;DEFINE ZERO VALUE READING
1472: ;*****
1473:
1474: ;      INITIAL VALUE MUST BE LARGEST READING POSSIBLE
1475: TTPT:  DB      0FFH      ;TEMP -50 C
1476:      DB      0FEH      ;TEMP -40 C
1477:      DB      0F7H      ;TEMP -30 C
1478:      DB      0E8H      ;TEMP -20 C
1479:      DB      0DEH      ;TEMP -10 C  1/11/82 JWS
1480:      DB      0C7H      ;TEMP  0 C  12/06/81 JWS
1481:      DB      0B3H      ;TEMP  10 C 12/06/81 JWS
1482:      DB      09CH      ;TEMP  20 C 12/05/81 JWS
1483:      DB      07BH      ;TEMP  30 C  2/22/82 JWS
1484:      DB      064H      ;TEMP  40 C  2/22/82 JWS
1485:      DB      04FH      ;TEMP  50 C  2/22/82 JWS
1486:      DB      040H      ;TEMP  60 C
1487:      DB      034H      ;TEMP  70 C
1488:      DB      02CH      ;TEMP  80 C
1489:      DB      022H      ;TEMP  90 C
1490:      DB      01DH      ;TEMP 100 C
1491:      DB      01CH      ;TEMP 110 C
1492:      DB      01BH      ;TEMP 120 C
1493:      DB      01AH      ;TEMP 130 C
1494:      DB      019H      ;TEMP 140 C
1495:      DB      018H      ;TEMP 150 C
1496:      DB      017H      ;TEMP 160 C
1497:      DB      016H      ;TEMP 170 C
1498:      DB      016H      ;TEMP 180 C
1499:      DB      015H      ;TEMP 190 C
1500:      DB      015H      ;TEMP 200 C

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1501:      DB      014H      ;TEMP 210 C
1502:      DB      014H      ;TEMP 220 C
1503:      DB      013H      ;TEMP 230 C
1504:      DB      013H      ;TEMP 240 C
1505:      DB      012H      ;TEMP 250 C
1506:      DB      011H      ;TEMP 260 C
1507:      DB      011H      ;TEMP 270 C
1508:      DB      010H      ;TEMP 280 C
1509:      DB      00FH      ;TEMP 290 C
1510:      DB      000H      ;TEMP 300 C
1511:
1512: ;*****
1513: ;      COMMON VARIABLES & CONSTANTS
1514: ;*****
1515:
1516: STEMP0: DB      00      ;SIGN BYTE TEMP0
1517: TEMP0:  DW      0000     ;TEMPORARY VARIABLE 0
1518: STEMP1: DB      00      ;SIGN OF TEMP1
1519: TEMP1:  DW      0000
1520: STEMP2: DB      00      ;SIGN OF TEMP2
1521: TEMP2:  DW      0000
1522: SZERO:  DB      00      ;SIGN OF CONSTANT ZERO
1523: ZERO:   DW      000     ;CONSTANT ZERO0
1524: SPONE:  DB      00      ;SIGN OF '+000.1'
1525: PONE:   DB      00      ;VARIABLE 'POINT ONE', BYTE ONE
1526:         DB      01      ;VARIABLE 'POINT ONE', BYTE TWO
1527: STEN:   DB      00      ;SIGN OF CONSTANT '+010.0'
1528: TEN:    DB      01      ;BCD VALUE 10 BASE TEN
1529:         DB      00      ;VARIABLE TEN BYTE TWO
1530: ST50:   DB      00      ;BCD VALUE '+050.0' SIGN BYTE
1531: T50:    DB      05      ;BCD VALUE +50 BYTE ONE
1532:         DB      00      ;VARIABLE 'T50', BYTE TWO
1533: STTP:   DB      00      ;SIGN OF TTP TEMPERATURE, (+=0, -=1)
1534: TTP:    DW      0000     ;TTP = RESULTING CENTIGRADE TEMPERATURE
1535:
1536:      END      0100H

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1: RECORD:
2:     PROCEDURE OPTIONS(MAIN);
3:
4:     /* THIS PROGRAM "RECORDS" SELECTED M80 DATA ON DISK FOR
5:        SUBSEQUENT ANALYSIS, AND DISPLAYS ALL OUTPUT M80 DATA
6:        ON THE CONSOLE WHILE OPERATING. */
7:     /* SOFTWARE BY STEVE STEVENS & JEFF W. SHIRLEY */
8:     /* RECORD      VERSION 2.3      01/01/83 */
9:
10:    %INCLUDE 'A:DIOMOD.DCL';
11:    %REPLACE TRUE BY '1'B,
12:            FALSE BY '0'B;
13:    DECLARE PT1 POINTER;
14:    DECLARE 1 INB BASED (PT1),
15:            2 COUNT CHAR(6), 2 FILLERA CHAR(3),
16:            2 DAY_NIGHT CHAR(1), 2 FILLERB CHAR(1),
17:            2 SOLAR_RADIATION CHAR(2), 2 FILLERC CHAR(3),
18:            2 MODE CHAR(1), 2 FILLERD CHAR(3),
19:            2 STATE CHAR(1), 2 FILLERE CHAR(1),
20:            2 MSWITCHES CHAR(6), 2 FILLERF CHAR(1),
21:            2 SSWITCHES CHAR(6), 2 FILLERG CHAR(1),
22:            2 RELAYS CHAR(2), 2 FILLERH CHAR(7),
23:            2 SOLAR_WALL_SURFACE_TEMP CHAR(6), 2 FILLERI CHAR(7),
24:            2 SOLAR_WALL_4INCH_TEMP CHAR(6), 2 FILLERJ CHAR(7),
25:            2 SOLAR_WALL_8INCH_TEMP CHAR(6), 2 FILLERK CHAR(9),
26:            2 SOLAR_SPACE_TEMP CHAR(6), 2 FILLERL CHAR(7),
27:            2 AMBIENT_TEMP CHAR(6), 2 FILLERM CHAR(7),
28:            2 LOOP_OUTLET_TEMP CHAR(6), 2 FILLERN CHAR(7),
29:            2 SOLAR_SPACE_OUTLET_TEMP CHAR(6), 2 FILLERO CHAR(7),
30:            2 GROUND_TEMP CHAR(6), 2 FILLERP CHAR(7),
31:            2 INSIDE_TEMP CHAR(6), 2 FILLERQ CHAR(6),
32:            2 MODE0 CHAR(6), 2 FILLERR CHAR(4),
33:            2 MODE1 CHAR(6), 2 FILLERS CHAR(4),
34:            2 MODE2 CHAR(6), 2 FILLERT CHAR(4),
35:            2 MODE3 CHAR(6), 2 FILLERU CHAR(4),
36:            2 MODE4 CHAR(6), 2 FILLERV CHAR(4),
37:            2 MODE5 CHAR(6), 2 FILLERW CHAR(4),
38:            2 MODE6 CHAR(6), 2 FILLERX CHAR(3),
39:            2 CURRENT_MODE CHAR(1), 2 FILLERY CHAR(3),
40:            2 PREVIOUS_MODE CHAR(1);
41:    DECLARE 1 M80FS,
42:            2 TIME CHAR(8),
43:            2 DATE CHAR(8),
44:            2 COUNT CHAR(6),
45:            2 DAY_NIGHT CHAR(1),
46:            2 SOLAR_RADIATION CHAR(2),
47:            2 MODE CHAR(1),
48:            2 STATE CHAR(1),
49:            2 MSWITCHES CHAR(6),
50:            2 SSWITCHES CHAR(6),
51:            2 RELAYS CHAR(2),
52:            2 SOLAR_WALL_SURFACE_TEMP CHAR(6),
53:            2 SOLAR_WALL_4INCH_TEMP CHAR(6),
54:            2 SOLAR_WALL_8INCH_TEMP CHAR(6),
55:            2 SOLAR_SPACE_TEMP CHAR(6),
56:            2 AMBIENT_TEMP CHAR(6),
57:            2 LOOP_OUTLET_TEMP CHAR(6),
58:            2 SOLAR_SPACE_OUTLET_TEMP CHAR(6),
59:            2 GROUND_TEMP CHAR(6),
60:            2 INSIDE_TEMP CHAR(6),

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61:         2 CURRENT_MODE CHAR(1),
62:         2 PREVIOUS_MODE CHAR(1);
63:     DECLARE INBUFF(254) CHAR(1),
64:         (FLAG1, FLAG2, STORE_FLAG) BIT(1),
65:         (I, J, CTS0, CTS1, II, TP) FIXED;
66:     DECLARE M80F FILE;
67:     DECLARE PRELAYS CHAR(2), MAXCOUNT FIXED BINARY(7);
68: /* INITIALIZE */
69:     PUT PAGE;
70:     CALL SET_TIME(2, 30); /* SET TIME ON ROW 2, COLUMN 30 */
71:     CALL SET_DATE(4, 30); /* SET DATE ON ROW 4, COLUMN 30 */
72:     J = 0;
73:     CTS0 = 0;
74:     CTS1 = 0;
75:     PRELAYS = '00';
76:     MAXCOUNT = 90;
77:     OPEN FILE (M80F) SEQUENTIAL OUTPUT RECORD TITLE('$1.$1');
78:     PUT PAGE SKIP(0) EDIT(' ***** SYNCHRONIZING WITH M80 ',
79:         'OUTPUT DATA *****')(COLUMN(16), A, A);
80:     CALL CONOUT(ASCII(07)); /* RING BELL */
81:     CALL CONOUT(ASCII(01)); /* HOME CURSOR */
82:     FLAG1 = TRUE;
83:     PT1 = ADDR(INBUFF(1)); /* INB STRUCTURE = INBUFF ARRAY */
84: /* MAIN CONTROL LOOP */
85:     DO WHILE (FLAG1);
86:         IF (RDSTAT()) THEN /* CONTROL Q TO QUIT */
87:             IF RANK(CONINP()) = 17 THEN GOTO EXIT;
88:         FLAG2 = TRUE;
89: /* CHECK FOR DATA FROM M80 */
90:         DO WHILE (FLAG2);
91:             IF (RDSTAT()) THEN /* CONTROL Q TO QUIT */
92:                 IF RANK(CONINP()) = 17 THEN GOTO EXIT;
93:             IF (RANK(RDRDR()) = 01) THEN /* START OF HEADER */
94:                 IF (RANK(RDRDR()) = 02) THEN /* START OF TEXT */
95: /* STORE ALL DATA FROM M80 */
96:                     DO;
97:                         I = 1;
98:                         INBUFF(I) = RDRDR();
99:                         INBUFF(I) = RDRDR(); /* READ CR, LF AND DISCARD */
100:                     DO WHILE (FLAG2);
101:                         INBUFF(I) = RDRDR();
102:                         /* END OF TEXT */
103:                         IF RANK(INBUFF(I)) = 03 THEN FLAG2 = FALSE;
104:                         I = I + 1;
105:                         IF (RDSTAT()) THEN /* CONTROL Q TO QUIT */
106:                             IF RANK(CONINP()) = 17 THEN GOTO EXIT;
107:                     END;
108:                 END;
109:             END;
110: /* TRANSFER SELECTED DATA TO STRUCTURE M80FS FOR OUTPUT */
111:             M80FS.COUNT = INB.COUNT;
112:             M80FS.DAY_NIGHT = INB.DAY_NIGHT;
113:             M80FS.SOLAR_RADIATION = INB.SOLAR_RADIATION;
114:             M80FS.MODE = INB.MODE;
115:             M80FS.STATE = INB.STATE;
116:             M80FS.MSWITCHES = INB.MSWITCHES;
117:             M80FS.SSWITCHES = INB.SSWITCHES;
118:             M80FS.RELAYS = INB.RELAYS;
119:             M80FS.SOLAR_WALL_SURFACE_TEMP =
120:                 INB.SOLAR_WALL_SURFACE_TEMP;

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121:      M80FS.SOLAR_WALL_4INCH_TEMP =
122:      INB.SOLAR_WALL_4INCH_TEMP;
123:      M80FS.SOLAR_WALL_8INCH_TEMP =
124:      INB.SOLAR_WALL_8INCH_TEMP;
125:      M80FS.SOLAR_SPACE_TEMP = INB.SOLAR_SPACE_TEMP;
126:      M80FS.AMBIENT_TEMP = INB.AMBIENT_TEMP;
127:      M80FS.LOOP_OUTLET_TEMP = INB.LOOP_OUTLET_TEMP;
128:      M80FS.SOLAR_SPACE_OUTLET_TEMP =
129:      INB.SOLAR_SPACE_OUTLET_TEMP;
130:      M80FS.GROUND_TEMP = INB.GROUND_TEMP;
131:      M80FS.INSIDE_TEMP = INB.INSIDE_TEMP;
132:      M80FS.CURRENT_MODE = INB.CURRENT_MODE;
133:      M80FS.PREVIOUS_MODE = INB.PREVIOUS_MODE;
134:      M80FS.TIME = TIME();          /* GET SYSTEM TIME */
135:      CALL GET_DATE(M80FS.DATE);    /* GET SYSTEM DATE */
136:      STORE_FLAG = FALSE;
137:      IF M80FS.STATE = '0' THEN
138: /* HEATING/COOLING SYSTEM IS OFF */
139:      DO;
140:          CTS1 = 0;
141:          IF CTS0 = MAXCOUNT THEN CTS0 = 0;
142:          IF CTS0 = 0 THEN STORE_FLAG = TRUE;
143:          CTS0 = CTS0 + 1;
144:      END;
145:      IF M80FS.STATE = '1' THEN
146: /* HEATING/COOLING SYSTEM IS ON */
147:      DO;
148:          CTS0 = 0;
149:          IF CTS1 = MAXCOUNT THEN CTS1 = 0;
150:          IF (PRELAYS ^= M80FS.RELAYS) THEN CTS1 = 0;
151:          IF (CTS1 = 0) THEN STORE_FLAG = TRUE;
152:          CTS1 = CTS1 + 1;
153:      END;
154:      IF STORE_FLAG THEN
155: /* STORE FLAG SET, OUTPUT TO DISK STRUCTURE M80FS */
156:      DO;
157:          WRITE FILE(M80F) FROM (M80FS);
158:          J = J + 1;
159:      END;
160:      PRELAYS = M80FS.RELAYS; /* UPDATE PREVIOUS RELAYS VALUE */
161: /* UPDATE SCREEN */
162:      PUT SKIP(0) LIST (' ***** M80 CONTROL SUMMARY ***** ',
163:          ' TIME = ', M80FS.TIME, ' DATE = ', M80FS.DATE);
164:      PUT SKIP EDIT (' (D=DAY/N=NIGHT) PHOTO-RESISTOR INDICATES'
165:          ', ' = ', M80FS.DAY_NIGHT)(A);
166:      PUT SKIP EDIT (' SOLAR RADIATION READING'
167:          ', ' = ', M80FS.SOLAR_RADIATION)(A);
168:      PUT SKIP EDIT (' (H=HEATING, C=COOLING, '
169:          ', ' D=DEFROST) MODE = ', M80FS.MODE)(A);
170:      PUT SKIP EDIT (' (0=OFF, 1=ON) STATE',
171:          ' = ', M80FS.STATE)(A);
172:      PUT SKIP EDIT (' MANUAL SWITCHES',
173:          ' = ', M80FS.MSWITCHES, ' SOFTWARE SWITCHES = ',
174:          M80FS.SSWITCHES)(A);
175:      PUT SKIP EDIT (' RELAY OUTPUTS',
176:          ' = ', M80FS.RELAYS)(A);
177:      PUT SKIP EDIT (' SOLAR WALL TEMPERATURE AT ',
178:          ' SURFACE = ', M80FS.SOLAR_WALL_SURFACE_TEMP, ' C')(A);
179:      PUT SKIP EDIT (' SOLAR WALL TEMPERATURE AT ',
180:          ' 4-INCH DEPTH = ', M80FS.SOLAR_WALL_4INCH_TEMP, ' C')(A);

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181: PUT SKIP EDIT (' SOLAR WALL TEMPERATURE AT ',
182: ' 8-INCH DEPTH = ', M80FS.SOLAR_WALL_8INCH_TEMP, ' C')(A);
183: PUT SKIP EDIT (' SOLAR SPACE TEMPERATURE',
184: ' = ', M80FS.SOLAR_SPACE_TEMP, ' C')(A);
185: PUT SKIP EDIT (' AMBIENT TEMPERATURE',
186: ' = ', M80FS.AMBIENT_TEMP, ' C')(A);
187: PUT SKIP EDIT (' GROUND LOOP OUTLET TEMPERATURE',
188: ' = ', M80FS.LOOP_OUTLET_TEMP, ' C')(A);
189: PUT SKIP EDIT (' SOLAR SPACE OUTLET TEMPERATURE',
190: ' = ', M80FS.SOLAR_SPACE_OUTLET_TEMP, ' C')(A);
191: PUT SKIP EDIT (' GROUND TEMPERATURE AT NW',
192: ' FOUNDATION = ', M80FS.GROUND_TEMP, ' C')(A);
193: PUT SKIP EDIT (' INSIDE TEMPERATURE',
194: ' = ', M80FS.INSIDE_TEMP, ' C')(A);
195: PUT SKIP EDIT (' CURRENT MODE = ',
196: M80FS.CURRENT_MODE, ' PREVIOUS MODE = ',
197: M80FS.PREVIOUS_MODE)(COLUMN(29), A, A, A, A);
198: PUT SKIP;
199: /* ORIGINAL DATA FROM M80 */
200: PUT SKIP EDIT((INBUFF(II) DO II = 1 TO 249)) (A(1));
201: PUT SKIP LIST (J, ' RECORDS STORED');
202: PUT LIST(' ', ' RECORD COUNTDOWN = ', MAXCOUNT - CTS0 - CTS1);
203: CALL CONOUT(ASCII(01)); /* HOME CURSOR */
204: IF (RDSTAT()) THEN /* CONTROL Q TO QUIT */
205: IF RANK(CONINP()) = 17 THEN FLAG1 = FALSE;
206: END; /* END OF FLAG1 LOOP */
207: POSITION:
208: PROCEDURE(ROW, COLUMN); /* ABSOLUTE CURSOR ADDRESSING */
209: DECLARE (ROW, COLUMN) FIXED BINARY(7);
210: PUT SKIP(0); /* SYNCHRONIZE OUTPUT */
211: CALL CONOUT(ASCII(27)); /* OUTPUT TO CONSOLE 'ESC' */
212: CALL CONOUT(ASCII(89)); /* OUTPUT TO CONSOLE 'Y' */
213: CALL CONOUT(ASCII(31+ROW)); /* MOVE TO ROW POSITION */
214: CALL CONOUT(ASCII(31+COLUMN)); /* MOVE TO COLUMN POSITION */
215: END POSITION; /* CURSOR POSITIONED, EXIT */
216: SET_TIME:
217: PROCEDURE(ROW, COLUMN); /* SET SYSTEM TIME */
218: /* THIS PROCEDURE REQUESTS THE CURRENT TIME FROM THE CONSOLE.
219: THE INPUT TIME IS VALIDATED AND STORED IN THE 'CLOCK'
220: MEMORY LOCATIONS OF THE INTERTEC SUPERBRAIN. THE ROUTINE
221: CAN REQUEST THE TIME FROM MOST POSITIONS OF THE CONSOLE
222: WITH THE PROGRAMMING LIMITS GIVEN BELOW. */
223: DECLARE INPUT_TIME CHAR(8), (CPT1, CPT2) POINTER;
224: DECLARE 1 TIME BASED (CPT1),
225: 2 HOURS CHAR(2),
226: 2 COLON1 CHAR(1),
227: 2 MINUTES CHAR(2),
228: 2 COLON2 CHAR(1),
229: 2 SECONDS CHAR(2);
230: DECLARE SYSTEM_TIME CHAR(8) BASED (CPT2);
231: DECLARE (HRS, MIN, SEC, ROW, COLUMN) FIXED BINARY(7);
232: DECLARE NUMBERS STATIC CHAR(10) INITIAL('0123456789');
233: DECLARE COLON STATIC CHAR(1) INITIAL(':'), NOEXIT BIT(1);
234: IF ROW < 1 ! ROW > 23 ! COLUMN < 5 ! COLUMN > 47 THEN STOP;
235: CPT1 = ADDR(INPUT_TIME);
236: UNSPEC(CPT2) = '0042'B4; /* POINT TO TIME IN INTERTEC */
237: CALL ERASE_LINE(ROW+1, 1);
238: NOEXIT='1'B;
239: DO WHILE (NOEXIT);
240: CALL ERASE_LINE(ROW, 1);

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241:      CALL POSITION(ROW,COLUMN);
242:      PUT EDIT('WHAT TIME IS IT?  HH:MM:SS')(A);
243:      CALL POSITION(ROW,COLUMN+18);
244:      GET LIST(INPUT_TIME);
245:      IF VERIFY(HOURS,NUMBERS) = 0 & VERIFY(MINUTES,NUMBERS) = 0
246:        & VERIFY(SECONDS,NUMBERS) = 0 THEN
247:        DO;
248:          HRS = HOURS;
249:          MIN = MINUTES;
250:          SEC = SECONDS;
251:          IF HRS < 24 & MIN < 60 & SEC < 60 THEN
252:            DO;
253:              NOEXIT = '0'B;
254:              COLON1 = COLON;
255:              COLON2 = COLON;
256:            END;
257:          END;
258:          IF NOEXIT = '1'B THEN
259:            DO;
260:              CALL POSITION(ROW+1,COLUMN-4);
261:              PUT EDIT(ASCII(131),' INVALID FORMAT, PLEASE ',
262:                'RE-ENTER ',ASCII(130),ASCII(07))(A);
263:            END;
264:          END;
265:          SYSTEM_TIME = INPUT_TIME;          /* ASSIGN CURRENT TIME */
266:          END SET_TIME;
267:  TIME:
268:    PROCEDURE RETURNS(CHARACTER(8));          /* GET SYSTEM TIME */
269:    /* THIS PROCEDURE READS MEMORY LOCATIONS (42-4A)HEX IN THE
270:      INTERTEC SUPERBRAIN TO RECALL THE CURRENT TIME.  THE
271:      TIME IS STORED AS 'HH:MM:SS' IN CHARACTER FORMAT.  THIS
272:      PROCEDURE RETURNS THE 'TIME' CHARACTER STRING VARIABLE. */
273:    DECLARE CPT POINTER, TIME CHAR(8) BASED (CPT);
274:    UNSPEC(CPT) = '0042'B4; /* POINT TO TIME IN INTERTEC */
275:    RETURN(TIME); /* RETURN TIME */
276:  END TIME;
277:  GET_DATE:
278:    PROCEDURE(ANSWER); /* GET INTERTEC SYSTEM DATE */
279:    DECLARE ANSWER CHARACTER(8);
280:    ANSWER = DATE(); /* INITIALIZE USING DATE FUNCTION */
281:    SUBSTR(ANSWER,7,2) = SUBSTR(ANSWER,1,2); /* TRANSFER YY */
282:    SUBSTR(ANSWER,1,2) = SUBSTR(ANSWER,3,2); /* TRANSFER MM */
283:    SUBSTR(ANSWER,4,2) = SUBSTR(ANSWER,5,2); /* TRANSFER DD */
284:    SUBSTR(ANSWER,3,1) = '/';
285:    SUBSTR(ANSWER,6,1) = '/';
286:  END GET_DATE; /* DATE ASSIGNED, EXIT */
287:  DATE:
288:    PROCEDURE RETURNS(CHARACTER(6));
289:    /* THIS PROCEDURE READS MEMORY LOCATIONS (4B-4D)HEX IN THE
290:      INTERTEC SUPERBRAIN TO RECALL THE CURRENT DATE.  THE
291:      DATE IS STORED AS 'MMDDYY' IN PACKED BCD FORMAT.  THIS
292:      PROCEDURE RETURNS THE DATE IN A CHARACTER STRING IN THE
293:      STANDARD PL/1 FORMAT: 'YYMMDD'. */
294:    DECLARE (CP0,CP1) POINTER, STRING CHAR(11),
295:      SYSTEM_DATE CHAR(3) BASED (CP0),
296:      (DATE1 CHAR(6), DATE2 CHAR(4), DATE3 FIXED DEC(8,0))
297:      BASED (CP1);
298:    UNSPEC(CP0) = '004B'B4; /* POINT TO DATE IN INTERTEC */
299:    CP1 = ADDR(STRING); /* 'OVERLAY' STRING = DATE, DATE1, DATE2 */
300:    DATE1 = SYSTEM_DATE; /* READ SYSTEM DATE */

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301: SUBSTR(DATE1,4,1) = ASCII(00); /* SET SIGN BYTE IN DATE2 */
302: STRING = DATE2; /* CONVERT DATE2 TO CHARACTER DATA */
303: SUBSTR(STRING,1,2) = SUBSTR(STRING,6,2); /* TRANSFER YY */
304: SUBSTR(STRING,3,2) = SUBSTR(STRING,10,2); /* TRANSFER MM */
305: SUBSTR(STRING,5,2) = SUBSTR(STRING,8,2); /* TRANSFER DD */
306: RETURN(STRING); /* RETURN ASSIGNED DATE */
307: END DATE;
308: SET_DATE:
309: PROCEDURE(ROW,COLUMN); /* SET SYSTEM DATE */
310: /* THIS PROCEDURE REQUESTS THE CURRENT DATE FROM THE CONSOLE.
311: THE INPUT DATE IS VALIDATED AND STORED IN THE 'DATE'
312: MEMORY LOCATIONS OF THE INTERTEC SUPERBRAIN. THE ROUTINE
313: CAN REQUEST THE DATE FROM MOST POSITIONS OF THE CONSOLE
314: WITH THE PROGRAMMING LIMITS GIVEN BELOW. */
315: DECLARE INPUT_DATE CHAR(8), (CP0,CP1) POINTER;
316: DECLARE 1 DATE BASED (CP0),
317: 2 MONTH CHAR(2),
318: 2 SLASH1 CHAR(1),
319: 2 DAY CHAR(2),
320: 2 SLASH2 CHAR(1),
321: 2 YEAR CHAR(2);
322: DECLARE SYSTEM_DATE CHAR(3) BASED (CP1);
323: DECLARE DATE1 CHAR(3) BASED (CP0);
324: DECLARE DATE2 FIXED DECIMAL(15,0) BASED (CP0);
325: DECLARE (MO,DY,YR,ROW,COLUMN) FIXED BINARY(7);
326: DECLARE NUMBERS STATIC CHAR(10) INITIAL('0123456789');
327: DECLARE NOEXIT BIT(1);
328: IF ROW < 1 ! ROW > 23 ! COLUMN < 5 ! COLUMN > 47 THEN STOP;
329: CP0 = ADDR(INPUT_DATE);
330: UNSPEC(CP1) = '004B'B4; /* POINT TO DATE IN INTERTEC */
331: CALL ERASE_LINE(ROW+1,1);
332: NOEXIT='1'B;
333: DO WHILE (NOEXIT);
334: CALL ERASE_LINE(ROW,1);
335: CALL POSITION(ROW,COLUMN);
336: PUT EDIT('WHAT DATE IS IT? MM/DD/YY')(A);
337: CALL POSITION(ROW,COLUMN+18);
338: GET LIST(INPUT_DATE);
339: IF VERIFY(MONTH,NUMBERS) = 0 & VERIFY(DAY,NUMBERS) = 0
340: & VERIFY(YEAR,NUMBERS) = 0 THEN
341: DO;
342: MO = MONTH;
343: DY = DAY;
344: YR = YEAR;
345: IF MO > 0 & MO < 13 & DY > 0 & DY < 32 THEN
346: DO;
347: NOEXIT = '0'B;
348: IF (MO = 4 ! MO = 6 ! MO = 9 ! MO = 11) & DY > 30 THEN
349: NOEXIT = '1'B;
350: IF MO = 2 THEN
351: IF MOD(YR,4) = 0 THEN
352: IF DY > 29 THEN
353: NOEXIT = '1'B;
354: ELSE;
355: ELSE
356: IF DY > 28 THEN
357: NOEXIT = '1'B;
358: END;
359: END;
360: IF NOEXIT = '1'B THEN

```

```

361:         DO;
362:             CALL POSITION(ROW+1,COLUMN-4);
363:             PUT EDIT(ASCII(131),' INVALID FORMAT, PLEASE ',
364:                 'RE-ENTER ',ASCII(130),ASCII(07))(A);
365:         END;
366:     ELSE
367:         DATE2 = DECIMAL(YR) * 10000 + DECIMAL(DY) * 100 +
368:             DECIMAL(MO);
369:     END;
370:     SYSTEM_DATE = DATE1;    /* ASSIGN CURRENT DATE */
371:     END SET_DATE;
372: ERASE_LINE:
373:     PROCEDURE(ROW,COLUMN); /* ERASE FROM CURSOR TO END OF LINE */
374:     DECLARE (ROW,COLUMN) FIXED BINARY(7);
375:     CALL POSITION(ROW,COLUMN); /* POSITION TO ROW, COLUMN */
376:     CALL CONOUT(ASCII(27)); /* OUTPUT TO CONSOLE 'ESC' */
377:     CALL CONOUT(ASCII(126)); /* OUTPUT TO CONSOLE '~' */
378:     CALL CONOUT(ASCII(75)); /* OUTPUT TO CONSOLE 'K' */
379:     END ERASE_LINE; /* CURSOR TO END ERASED, EXIT */
380: EXIT: CLOSE FILE(M80F);
381:     END RECORD;

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```

1:  PLAYBACK:
2:      PROCEDURE OPTIONS(MAIN);
3:
4:      /* PLAYBACK      VERSION 1.0      05/05/82 JWS */
5:      /* THIS PROGRAM READS OR "PLAYS BACK" THE DATA RECORDED ON
6:      DISK BY THE "RECORD" PROGRAM FOR SUBSEQUENT ANALYSIS.
7:      THE DATA READ IS DISPLAYED ON THE CRT, BLOCK BY BLOCK. */
8:
9:      %INCLUDE 'A:DIOMOD.DCL';
10:     %REPLACE TRUE BY '1'B,
11:           FALSE BY '0'B;
12:     DECLARE 1 M80FS,
13:           2 TIME CHAR(8),
14:           2 DATE CHAR(8),
15:           2 COUNT CHAR(6),
16:           2 DAY_NIGHT CHAR(1),
17:           2 SOLAR_RADIATION CHAR(2),
18:           2 MODE CHAR(1),
19:           2 STATE CHAR(1),
20:           2 MSWITCHES CHAR(6),
21:           2 SSWITCHES CHAR(6),
22:           2 RELAYS CHAR(2),
23:           2 SOLAR_WALL_SURFACE_TEMP CHAR(6),
24:           2 SOLAR_WALL_4INCH_TEMP CHAR(6),
25:           2 SOLAR_WALL_8INCH_TEMP CHAR(6),
26:           2 SOLAR_SPACE_TEMP CHAR(6),
27:           2 AMBIENT_TEMP CHAR(6),
28:           2 LOOP_OUTLET_TEMP CHAR(6),
29:           2 SOLAR_SPACE_OUTLET_TEMP CHAR(6),
30:           2 GROUND_TEMP CHAR(6),
31:           2 INSIDE_TEMP CHAR(6),
32:           2 CURRENT_MODE CHAR(1),
33:           2 PREVIOUS_MODE CHAR(1);
34:     DECLARE
35:           (FLAG1, FLAG2, STORE_FLAG) BIT(1),
36:           (I, J, CTS0, CTS1, II, TP) FIXED;
37:     DECLARE M80F FILE;
38:     DECLARE PRELAYS CHAR(2), MAXCOUNT FIXED BINARY(7);
39:     /* INITIALIZE */
40:     PUT PAGE;
41:     J = 0;
42:     CTS0 = 0;
43:     CTS1 = 0;
44:     PRELAYS = '00';
45:     MAXCOUNT = 90;
46:     OPEN FILE (M80F) SEQUENTIAL INPUT RECORD TITLE('1.1');
47:     FLAG1 = TRUE;
48:     /* MAIN CONTROL LOOP */
49:     DO WHILE (FLAG1);
50:         IF (RDSTAT()) THEN /* CONTROL Q TO QUIT */
51:             IF RANK(CONINP()) = 17 THEN GOTO EXIT;
52:             READ FILE(M80F) INTO (M80FS);
53:             J = J + 1;
54:             PRELAYS = M80FS.RELAYS; /* UPDATE PREVIOUS RELAYS VALUE */
55:     /* UPDATE SCREEN */
56:     PUT SKIP(0) LIST (' ***** M80 CONTROL SUMMARY ***** ',
57:           ' TIME = ', M80FS.TIME, ' DATE = ', M80FS.DATE);
58:     PUT SKIP EDIT (' (D=DAY/N=NIGHT) PHOTO-RESISTOR INDICATES'
59:           ', ' = ', M80FS.DAY_NIGHT(A);
60:     PUT SKIP EDIT ('          95          SOLAR RADIATION READING'

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61:      , ' = ', M80FS.SOLAR_RADIATION) (A);
62:      PUT SKIP EDIT ( ' (H=HEATING, C=COOLING, '
63:      , ' D=DEFROST) MODE = ', M80FS.MODE) (A);
64:      PUT SKIP EDIT ( ' (0=OFF, 1=ON) STATE',
65:      ' = ', M80FS.STATE) (A);
66:      PUT SKIP EDIT ( ' MANUAL SWITCHES',
67:      ' = ', M80FS.MSWITCHES, ' SOFTWARE SWITCHES = ',
68:      M80FS.SSWITCHES) (A);
69:      PUT SKIP EDIT ( ' RELAY OUTPUTS',
70:      ' = ', M80FS.RELAYS) (A);
71:      PUT SKIP EDIT ( ' SOLAR WALL TEMPERATURE AT ',
72:      ' SURFACE = ', M80FS.SOLAR_WALL_SURFACE_TEMP, ' C') (A);
73:      PUT SKIP EDIT ( ' SOLAR WALL TEMPERATURE AT ',
74:      ' 4-INCH DEPTH = ', M80FS.SOLAR_WALL_4INCH_TEMP, ' C') (A);
75:      PUT SKIP EDIT ( ' SOLAR WALL TEMPERATURE AT ',
76:      ' 8-INCH DEPTH = ', M80FS.SOLAR_WALL_8INCH_TEMP, ' C') (A);
77:      PUT SKIP EDIT ( ' SOLAR SPACE TEMPERATURE',
78:      ' = ', M80FS.SOLAR_SPACE_TEMP, ' C') (A);
79:      PUT SKIP EDIT ( ' AMBIENT TEMPERATURE',
80:      ' = ', M80FS.AMBIENT_TEMP, ' C') (A);
81:      PUT SKIP EDIT ( ' GROUND LOOP OUTLET TEMPERATURE',
82:      ' = ', M80FS.LOOP_OUTLET_TEMP, ' C') (A);
83:      PUT SKIP EDIT ( ' SOLAR SPACE OUTLET TEMPERATURE',
84:      ' = ', M80FS.SOLAR_SPACE_OUTLET_TEMP, ' C') (A);
85:      PUT SKIP EDIT ( ' HEAT PUMP OUTSIDE COIL ',
86:      ' TEMPERATURE = ', M80FS.GROUND_TEMP, ' C') (A);
87:      PUT SKIP EDIT ( ' INSIDE TEMPERATURE',
88:      ' = ', M80FS.INSIDE_TEMP, ' C') (A);
89:      PUT SKIP EDIT ( ' CURRENT MODE = ',
90:      M80FS.CURRENT_MODE, ' PREVIOUS MODE = ',
91:      M80FS.PREVIOUS_MODE) (COLUMN(29), A, A, A, A);
92:      PUT SKIP;
93:      PUT SKIP LIST (J, ' RECORDS READ');
94:      (PUT SKIP(2) LIST('SPACE BAR = CONTINUE / "CTRL Q" = QUIT');
95:      IF RANK(CONINP()) = 17 THEN FLAG1 = FALSE;
96:      CALL CONOUT(ASCII(01)); /* HOME CURSOR */
97:      END; /* END OF FLAG1 LOOP */
98:      EXIT: STOP;
99:      END PLAYBACK;

```



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1:  PLOT:
2:      PROCEDURE OPTIONS(MAIN);
3:
4:      /* THIS PROGRAM READS AND "PLOTS" THE DATA RECORDED ON
5:         DISK BY THE "RECORD" PROGRAM.  THE DATA IS PLOTTED AT
6:         17CPI AND AT 8LPI ON AN OKIDATA MICROLINE 84. */
7:      /* EXECUTION: PLOT "FILENAME" */
8:      /* PLOT VERSION 3.2      05/01/83 JWS */
9:
10:     DECLARE 1 M80FILES,
11:         2 TIME CHARACTER(8),
12:         2 DATE CHARACTER(8),
13:         2 COUNT CHARACTER(6),
14:         2 DAY_NIGHT CHARACTER(1),
15:         2 SOLAR_RADIATION CHARACTER(2),
16:         2 MODE CHARACTER(1),
17:         2 STATE CHARACTER(1),
18:         2 MSWITCHES CHARACTER(6),
19:         2 SSWITCHES CHARACTER(6),
20:         2 RELAYS CHARACTER(2),
21:         2 SOLAR_WALL_SURFACE_TEMP CHARACTER(6),
22:         2 SOLAR_WALL_4INCH_TEMP CHARACTER(6),
23:         2 SOLAR_WALL_8INCH_TEMP CHARACTER(6),
24:         2 SOLAR_SPACE_TEMP CHARACTER(6),
25:         2 AMBIENT_TEMP CHARACTER(6),
26:         2 LOOP_OUTLET_TEMP CHARACTER(6),
27:         2 SOLAR_SPACE_OUTLET_TEMP CHARACTER(6),
28:         2 GROUND_TEMP CHARACTER(6),
29:         2 INSIDE_TEMP CHARACTER(6),
30:         2 CURRENT_MODE CHARACTER(1),
31:         2 PREVIOUS_MODE CHARACTER(1);
32:
33:     DECLARE POUT POINTER;
34:     DECLARE 1 M80PRINTS BASED (POUT),
35:         2 FILLER0 CHARACTER(3),
36:         2 SSWITCH CHARACTER(4),
37:         2 FILLER1 CHARACTER(1),
38:         2 PMODE CHARACTER(1),
39:         2 PSTATE CHARACTER(1),
40:         2 FILLER2 CHARACTER(1),
41:         2 D_N CHARACTER(1),
42:         2 FILLER3 CHARACTER(1),
43:         2 PTIME CHARACTER(5),
44:         2 GRAPH(118) CHARACTER(1);
45:
46:     DECLARE ISTART FIXED BINARY(7);
47:     DECLARE (I) FIXED BINARY(15);
48:     DECLARE (M80FILE,LST) FILE;
49:     DECLARE MOUT(138) CHARACTER(1);
50:     DECLARE CHECK FIXED BINARY(7);
51:     DECLARE PREVIOUS_TIME CHARACTER(5);
52:     DECLARE WRLST ENTRY(CHARACTER(1));
53:
54: ON ERROR
55:     BEGIN;
56:     PUT FILE(LST) PAGE;
57:     CALL WRLST(ASCII(30)); /* (RS) - SELECT 10CPI, ML84 */
58:     CALL WRLST(ASCII(27)); /* (ESC,6) - SELECT 6LPI */
59:     CALL WRLST(ASCII(54)); /* (ESC,6) - SELECT 6LPI */
60:     CALL WRLST(ASCII(27)); /* SELECT 66 LINES */

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61:      CALL WRLST('F'); /* (ESC,F,6,6) */
62:      CALL WRLST('6'); /* 66 LINES */
63:      CALL WRLST('6'); /* SELECTED */
64:      CALL WRLST(ASCII(27)); /* SET TOP OF FORM */
65:      CALL WRLST(ASCII(53)); /* TOP SELECTED */
66:      PUT FILE(LST) SKIP(0);
67:      STOP;
68:      END;
69:
70:  ON ENDFILE(M80FILE)
71:      BEGIN;
72:      PUT FILE(LST) PAGE;
73:      CALL WRLST(ASCII(30)); /* (RS) - SELECT 10CPI, ML84 */
74:      CALL WRLST(ASCII(27)); /* (ESC,6) - SELECT 6LPI */
75:      CALL WRLST(ASCII(54)); /* (ESC,6) - SELECT 6LPI */
76:      CALL WRLST(ASCII(27)); /* SELECT 66 LINES */
77:      CALL WRLST('F'); /* (ESC,F,6,6) */
78:      CALL WRLST('6'); /* 66 LINES */
79:      CALL WRLST('6'); /* SELECTED */
80:      CALL WRLST(ASCII(27)); /* SET TOP OF FORM */
81:      CALL WRLST(ASCII(53)); /* TOP SELECTED */
82:      PUT FILE(LST) SKIP(0);
83:      STOP;
84:      END;
85:
86:  /* INITIALIZE */
87:      POUT = ADDR(MOUT);
88:      OPEN FILE(M80FILE) SEQUENTIAL INPUT RECORD TITLE('$1.$1');
89:      OPEN FILE(LST) PRINT LINESIZE(138) PAGESIZE(82)
90:          ENV(B(256)) TITLE('$LST');
91:      CALL WRLST(ASCII(29)); /* (GS) = 17CPI, ML84 */
92:      CALL WRLST(ASCII(27)); /* (ESC,8) - SELECT 8LPI */
93:      CALL WRLST(ASCII(56)); /* (ESC,8) - SELECT 8LPI */
94:      CALL WRLST(ASCII(27)); /* SELECT 88 LINES */
95:      CALL WRLST('F'); /* (ESC,F,8,8) */
96:      CALL WRLST('8'); /* 88 LINES */
97:      CALL WRLST('8'); /* SELECTED */
98:      CALL WRLST(ASCII(27)); /* SET TOP OF FORM */
99:      CALL WRLST(ASCII(53)); /* TOP SELECTED */
100:      PREVIOUS_TIME = '00:00';
101:      PTIME = '00:00';
102:      CHECK = 0;
103:      ISTART = 0; /* DISABLE PAGE FEEDS */
104:      PUT PAGE; /* CLEAR CRT */
105:  /* MAIN CONTROL LOOP */
106:  START:
107:      PREVIOUS_TIME = PTIME;
108:      DO I = 1 TO 138;
109:          MOUT(I) = ' ';
110:      END;
111:      READ FILE(M80FILE) INTO (M80FILES);
112:      IF SUBSTR(TIME,1,2) = '00' &
113:          SUBSTR(PREVIOUS_TIME,1,2) ~= '00' THEN CHECK = 0;
114:      IF CHECK = 0 THEN /* PRINT HEADER */
115:          DO;
116:              CALL HEADING; /* CREATE HEADING */
117:              IF ISTART ~= 0 THEN PUT FILE(LST) PAGE;
118:              PUT FILE(LST) EDIT((MOUT(I) DO I = 1 TO 138))
119:                  (A(1));
120:              ISTART = 1; /* ENABLE PAGE FEEDS */

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121:         DO I = 1 TO 138;
122:             MOUT(I) = ' ';
123:         END;
124:         CHECK = 1;
125:         END;
126:     CALL PLTLIN;
127:     PUT FILE(LST) SKIP EDIT((MOUT(I) DO I = 1 TO 138))
128:         (A(1));
129:     CHECK = CHECK + 1;
130:     IF CHECK = 80 THEN CHECK = 0;
131:     GOTO START;
132:
133: PLTLIN:
134:     PROCEDURE;
135:     DECLARE II FIXED BINARY(15);
136:
137:     /* CHECK FOR AND INDICATE MANUAL OVERRIDE */
138:     IF MSWITCHES ^= '222222' THEN FILLER1 = '+';
139:     SSWITCH = SUBSTR(SSWITCHES,1,2) !! SUBSTR(SSWITCHES,5,2);
140:     D_N = DAY_NIGHT;
141:     PSTATE = STATE;
142:     PTIME = SUBSTR(TIME,1,5);
143:     PMODE = MODE;
144:     GRAPH(POSITION(0)) = 'I';
145:     IF DAY_NIGHT = 'D' THEN /* DAY, PLOT RADIATION */
146:         DO;
147:             II = CONVERT(SOLAR_RADIATION);
148:             II = 33 - II;
149:             GRAPH(II) = '*';
150:         END;
151:     GRAPH(POSITION(INSIDE_TEMP)) = 'I';
152:     GRAPH(POSITION(GROUND_TEMP)) = 'M';
153:     GRAPH(POSITION(SOLAR_WALL_8INCH_TEMP)) = '8';
154:     GRAPH(POSITION(SOLAR_WALL_4INCH_TEMP)) = '4';
155:     GRAPH(POSITION(SOLAR_WALL_SURFACE_TEMP)) = '0';
156:     GRAPH(POSITION(SOLAR_SPACE_OUTLET_TEMP)) = 'X';
157:     GRAPH(POSITION(SOLAR_SPACE_TEMP)) = '+';
158:     GRAPH(POSITION(AMBIENT_TEMP)) = 'A';
159:     GRAPH(POSITION(LOOP_OUTLET_TEMP)) = '6';
160:     RETURN;
161:     END PLTLIN;
162:
163: CONVERT:
164:     PROCEDURE(INPUT) RETURNS(FIXED BINARY(15));
165:     DECLARE INPUT CHARACTER(2);
166:     DECLARE KOUNT FIXED BINARY(15);
167:     DECLARE TCHAR CHARACTER(1);
168:
169:     TCHAR = SUBSTR(INPUT,1,1);
170:     KOUNT = NUMBER(TCHAR) * 16;
171:     TCHAR = SUBSTR(INPUT,2,1);
172:     KOUNT = KOUNT + NUMBER(TCHAR);
173:     RETURN(KOUNT);
174:     END CONVERT;
175:
176: NUMBER:
177:     PROCEDURE(TCHAR) RETURNS(FIXED BINARY(15));
178:     DECLARE TCHAR CHARACTER(1);
179:     DECLARE TEMP FIXED BINARY(15);
180:

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181:      IF TCHAR > '9' THEN
182:          DO;
183:              IF TCHAR = 'A' THEN TEMP = 10;
184:              ELSE IF TCHAR = 'B' THEN TEMP = 11;
185:              ELSE IF TCHAR = 'C' THEN TEMP = 12;
186:              ELSE IF TCHAR = 'D' THEN TEMP = 13;
187:              ELSE IF TCHAR = 'E' THEN TEMP = 14;
188:              ELSE IF TCHAR = 'F' THEN TEMP = 15;
189:          END;
190:      ELSE TEMP = TCHAR;
191:      RETURN(TEMP);
192:      END NUMBER;
193:
194:  POSITION:
195:      PROCEDURE(INPUT) RETURNS(FIXED BINARY(15));
196:      DECLARE (CONSTANT, INPUT, MULTIPLIER) FLOAT BINARY(24);
197:
198:      CONSTANT = 14;
199:      MULTIPLIER = 2.6;
200:      RETURN(INPUT * MULTIPLIER + CONSTANT + 0.5);
201:      END POSITION;
202:
203:  HEADING:
204:      PROCEDURE;
205:      DECLARE START FIXED BINARY(7);
206:
207:      START = 18;
208:      MOUT(2) = SUBSTR(DATE, 1, 1);
209:      MOUT(3) = SUBSTR(DATE, 2, 1);
210:      MOUT(4) = SUBSTR(DATE, 3, 1);
211:      MOUT(5) = SUBSTR(DATE, 4, 1);
212:      MOUT(6) = SUBSTR(DATE, 5, 1);
213:      MOUT(7) = SUBSTR(DATE, 6, 1);
214:      MOUT(8) = SUBSTR(DATE, 7, 1);
215:      MOUT(9) = SUBSTR(DATE, 8, 1);
216:      MOUT(START) = '-';
217:      MOUT(START + POSITION(-5)) = '5';
218:      MOUT(START + POSITION(0)) = '0';
219:      MOUT(START + POSITION(5)) = '5';
220:      MOUT(START + POSITION(10) - 1) = '1';
221:      MOUT(START + POSITION(10)) = '0';
222:      MOUT(START + POSITION(15) - 1) = '1';
223:      MOUT(START + POSITION(15)) = '5';
224:      MOUT(START + POSITION(20) - 1) = '2';
225:      MOUT(START + POSITION(20)) = '0';
226:      MOUT(START + POSITION(25) - 1) = '2';
227:      MOUT(START + POSITION(25)) = '5';
228:      MOUT(START + POSITION(30) - 1) = '3';
229:      MOUT(START + POSITION(30)) = '0';
230:      MOUT(START + POSITION(35) - 1) = '3';
231:      MOUT(START + POSITION(35)) = '5';
232:      MOUT(START + POSITION(40) - 1) = '4';
233:      MOUT(START + POSITION(40)) = '0';
234:      RETURN;
235:      END HEADING;
236:
237:      END PLOT;

```

DIR

A: DOWNLOAD	COM : TIME	COM : DATE	COM : DOWNLOAD	ASM
A: FEB0882	DAT : MAKSYS	SUB : SYSTEM	LIB : MAKPLAY	SUB
A: MAKDOWN	SUB : PLOT	COM : SYSTEM	COM : PIP	COM
A: PLAYBACK	COM : SYSTEM	ASM : SUBS	LIB : RECORD	COM
A: PLAYBACK	PLI : FEB1382	DAT : MAKPLOT	SUB : MATH	LIB
A: RECORD	PLI : MAKREC	SUB : PLOT	REL : TEST	DAT
A: DOE	LTR : STAT	COM : PLOT	PLI	

A)DIR B:

B: FEB0882	DAT : FEB1182	DAT : FEB1282	DAT : FEB1382	DAT
B: FEB1482	DAT : FEB1582	DAT : FEB2182	DAT : FEB2382	DAT
B: FEB2582	DAT : MAR0182	DAT : MAR0282	DAT : MAR0382	DAT
B: MAR0882	DAT : MAR0982	DAT : MAR1082	DAT : MAR1182	DAT
B: MAR1682	DAT : MAR2082	DAT : MAR2382	DAT : MAR2582	DAT
B: MAR2982	DAT : APR0782	DAT : APR1982	DAT : APR2282	DAT
B: APR2782	DAT : MAY0382	DAT : MAY0682	DAT : MAY1482	DAT
B: MAY1982	DAT : MAY2882	DAT : JUN0782	DAT : JUN1482	DAT
B: JUN2482	DAT : JUL0682	DAT		

A)DIR B:

B: JUL1882	DAT : PIP	COM : JUL2782	DAT : AUG0282	DAT
B: AUG2082	DAT : AUG3082	DAT : OCT0282	DAT : OCT1182M	DAT
B: DEC0782	DAT : DEC0882	DAT : DEC1382	DAT : DEC1982T	DAT
B: DEC2182	DAT : DEC2582	DAT : DEC3182	DAT : JAN1483	DAT
B: JAN2183	DAT : FEB2683	DAT : APR3083	DAT : MAY1983	DAT
B: MAY2083	DAT : MAY2783	DAT		

A)

5-

102^M

02/11/82 -5

Time	Location	Altitude	Speed	Direction	Remarks
1110	H0	D	13:23		*
1110	H0	D	13:38		*
1110	H0	D	13:53		*
1110	H0	D	14:08		*
1110	H0	D	14:23		*
1110	H0	D	14:38		*
1110	H0	D	14:54		*
1110	H0	D	15:09		*
1110	H0	D	15:24		*
1110	H0	D	15:39		*
1110	H0	D	15:54		*
1110	H0	D	16:10		*
1110	H0	D	16:25		*
1110	H0	D	16:40		*
0010	H0	D	16:55		*
0010	H0	D	17:10		*
0010	H0	D	17:25		*
0010	H0	D	17:40		*
0000	H0	N	17:56		
0000	H0	N	18:11		
0000	H0	N	18:26		
0000	H0	N	18:41		
0000	H0	N	18:56		
0000	H0	N	19:11		
0000	H0	N	19:26		
0000	H0	N	19:41		
0000	H0	N	19:56		
0000	H0	N	20:11		
0000	H0	N	20:26		
0000	H0	N	20:42		
0000	H0	N	20:57		
0000	H0	N	21:12		
0000	H0	N	21:27		
0000	H0	N	21:42		
0000	H0	N	21:58		
0000	H0	N	22:13		
0000	H0	N	22:28		
0000	H0	N	22:43		

Time	Location	Altitude	Speed	Direction	Remarks
10	AG				
15	M				
20	M				
25	M				
30	M				
35	M				
40	M				
45	M				
50	M				
55	M				
60	M				
65	M				
70	M				
75	M				
80	M				
85	M				
90	M				
95	M				
100	M				
105	M				
110	M				
115	M				
120	M				
125	M				
130	M				
135	M				
140	M				
145	M				
150	M				
155	M				
160	M				
165	M				
170	M				
175	M				
180	M				
185	M				
190	M				
195	M				
200	M				
205	M				
210	M				
215	M				
220	M				
225	M				
230	M				
235	M				
240	M				
245	M				
250	M				
255	M				
260	M				
265	M				
270	M				
275	M				
280	M				
285	M				
290	M				
295	M				
300	M				
305	M				
310	M				
315	M				
320	M				
325	M				
330	M				
335	M				
340	M				
345	M				
350	M				
355	M				
360	M				
365	M				
370	M				
375	M				
380	M				
385	M				
390	M				
395	M				
400	M				
405	M				
410	M				
415	M				
420	M				
425	M				
430	M				
435	M				
440	M				
445	M				
450	M				
455	M				
460	M				
465	M				
470	M				
475	M				
480	M				
485	M				
490	M				
495	M				
500	M				
505	M				
510	M				
515	M				
520	M				
525	M				
530	M				
535	M				
540	M				
545	M				
550	M				
555	M				
560	M				
565	M				
570	M				
575	M				
580	M				
585	M				
590	M				
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635	M				
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645	M				
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655	M				
660	M				
665	M				
670	M				
675	M				
680	M				
685	M				
690	M				
695	M				
700	M				
705	M				
710	M				
715	M				
720	M				
725	M				
730	M				
735	M				
740	M				
745	M				
750	M				
755	M				
760	M				
765	M				
770	M				
775	M				
780	M				
785	M				
790	M				
795	M				
800	M				
805	M				
810	M				
815	M				
820	M				
825	M				
830	M				
835	M				
840	M				
845	M				
850	M				
855	M				
860	M				
865	M				
870	M				
875	M				
880	M				
885	M				
890	M				
895	M				
900	M				
905	M				
910	M				
915	M				
920	M				
925	M				
930	M				
935	M				
940	M				
945	M				
950	M				
955	M				
960	M				
965	M				
970	M				
975	M				
980	M				
985	M				
990	M				
995	M				

02/13/82	-5	0	5	10	15	20	25	30	35	40
0000 H1 D 10:53	I *	MA	G	X	8 +0	I				
0000 H0 D 10:55	I *	MA	G	X X	8 +0	I				
0000 H0 D 11:10	I *	A	M6	X X	8 4+	I				
0000 H1 D 11:11	I *	A	M6	X	8 4+	I				
0000 H0 D 11:19	I *	A	G	X	8 4	I				
0000 H0 D 11:34	I *	A	G	M	X 8	I				
0000 H1 D 11:36	I *	A	G	M	X 8	I				
0000 H0 D 11:42	I *	A	M	G	X 8	I				
0010 H0 D 11:57	I *	A	M	G	X	I				
0010 H1 D 12:01	I *	A	G	M	X	I				
0010 H0 D 12:07	I *	A	G	M	X	I				
1110 H0 D 12:22	I *	A	G	M	8X	I				
1110 H1 D 12:34	I *	A	G	M	8X	I				
1110 H0 D 12:40	I *	A	G	M	8X	I				
1110 H0 D 12:55	I *	A	G	M	8X	I				
1110 H1 D 13:10	I *	A	G	M	8X	I				
1110 H0 D 13:16	I *	A	G	M	8X	I				
1110 H0 D 13:31	I *	A	G	M	8X	I				
1110 H0 D 13:46	I *	A	G	M	8X	I				
1110 H1 D 13:51	I *	A	G	M	8X	I				
1110 H0 D 13:57	I *	A	G	M	8X	I				
1110 H0 D 14:12	I *	A	G	M	8X	I				
1110 H0 D 14:27	I *	A	G	M	8X	I				
1110 H0 D 14:42	I *	A	G	M	8X	I				
1110 H0 D 14:57	I *	A	G	M	8X	I				
1110 H0 D 15:12	I *	A	G	M	8X	I				
1110 H0 D 15:27	I *	A	G	M	8X	I				
1110 H0 D 15:42	I *	A	G	M	8X	I				
1110 H0 D 15:58	I *	A	G	M	8X	I				
1110 H0 D 16:13	I *	A	G	M	8X	I				
1110 H0 D 16:28	I *	A	G	M	8X	I				
1110 H0 D 16:43	I *	A	G	M	8X	I				
1110 H0 D 16:58	I *	A	G	M	8X	I				
0010 H0 D 17:13	I *	A	G	M	8X	I				
0010 H0 D 17:28	I *	A	G	M	8X	I				
0000 H0 D 17:44	I *	A	G	M	8X	I				
0000 H0 N 17:59	I *	A	G	M	8X	I				
0000 H0 N 18:14	I *	A	G	M	8X	I				
0000 H0 N 18:29	I *	A	G	M	8X	I				
0000 H0 N 18:44	I *	A	G	M	8X	I				
0000 H0 N 18:59	I *	A	G	M	8X	I				
0000 H0 N 19:14	I *	A	G	M	8X	I				
0000 H0 N 19:29	I *	A	G	M	8X	I				
0000 H1 N 19:41	I *	A	G	M	8X	I				
0000 H0 N 19:48	I *	A	G	M	8X	I				
0000 H0 N 20:03	I *	A	G	M	8X	I				
0000 H1 N 20:12	I *	A	G	M	8X	I				
0000 H0 N 20:17	I *	A	G	M	8X	I				
0000 H0 N 20:33	I *	A	G	M	8X	I				
0000 H0 N 20:48	I *	A	G	M	8X	I				
0000 H0 N 21:03	I *	A	G	M	8X	I				
0000 H1 N 21:14	I *	A	G	M	8X	I				
0000 H0 N 21:20	I *	A	G	M	8X	I				
0001 H0 N 21:35	I *	A	G	M	8X	I				
0000 H0 N 21:50	I *	A	G	M	8X	I				
0000 H1 N 22:03	I *	A	G	M	8X	I				
0000 H0 N 22:09	I *	A	G	M	8X	I				
0000 H0 N 22:24	I *	A	G	M	8X	I				
0001 H0 N 22:39	I *	A	G	M	8X	I				
0001 H1 N 22:51	I *	A	G	M	8X	I				
0001 H0 N 22:57	I *	A	G	M	8X	I				
0001 H0 N 23:12	I *	A	G	M	8X	I				
0001 H1 N 23:25	I *	A	G	M	8X	I				
0001 H0 N 23:31	I *	A	G	M	8X	I				
0001 H0 N 23:46	I *	A	G	M	8X	I				
0001 H1 N 23:52	I *	A	G	M	8X	I				
0001 H1 N 23:53	I *	A	G	M	8X	I				
0001 H0 N 23:58	I *	A	G	M	8X	I				

02/14/82	-5	0	5	10	15	20	25	30	35	40
0001 H0 N 00:13		I MA		6 X +	0	48 I				
0001 H1 N 00:17		I MA		6 X +	0	48 I				
0001 H0 N 00:24		A M		6 X +	0	48 I				
0001 H0 N 00:39		I A M		6 X +	0	48 I				
0001 H1 N 00:41		I A M		6 X +	0	48 I				
0001 H0 N 00:48		I A M		6 X +	0	48 I				
0001 H1 N 01:01		I A M		6 X +	0	48 I				
0001 H1 N 01:06		I A M		6 X +	0	48 I				
0001 H0 N 01:09		IM A		6 X +	0	48 I				
0001 H1 N 01:23		I A		6 X +	0	48 I				
0001 H0 N 01:32	A	I M		6 X +	0	48 I				
0001 H1 N 01:44		IA M		6 X +	0	48 I				
0001 H0 N 01:52	A	I M		6 X +	0	4 I				
0001 H1 N 02:04		IA M		6 X +	0	4 I				
0001 H0 N 02:13	A	I M		6 X +	0	48 I				
0001 H1 N 02:25		IA M		6 X +	0	48 I				
0001 H0 N 02:35	A	I M		6 X +	0	48 I				
0001 H1 N 02:47		IA M		6 X +	0	46 I				
0001 H0 N 02:58	A	I M		6 X +	0	48 I				
0001 H1 N 03:09		IA M		6 X +	0	48 I				
0001 H1 N 03:13	A	M		6 X +	0	48 I				
0001 H0 N 03:20	M	A		6 X +	0	48 I				
0001 H1 N 03:29		A		6 X +	0	48 I				
0001 H0 N 03:40	A	I M		6 X +	0	48 I				
0001 H1 N 03:50	A	IM		6 X +	0	48 I				
0001 H0 N 04:02	A	I M		6 X +	0	48 I				
0001 H1 N 04:12		A M		6 X +	0	48 I				
0001 H0 N 04:25	A	I M		6 X +	0	48 I				
0001 H1 N 04:34		A M		6 X +	0	48 I				
0001 H0 N 04:47	A	I M		6 X +	0	48 I				
0001 H1 N 04:57		A IM		6 X +	0	48 I				
0001 H0 N 05:10	A	I M		6 X +	0	48 I				
0001 H1 N 05:19	A	X I		6 X +	0	46 I				
0001 H0 N 05:33	A	I M		6 X +	0	48 I				
0001 H1 N 05:41	A	M I		6 X +	0	48 I				
0001 H0 N 05:55	A	I M		6 X +	0	48 I				
0001 H1 N 06:03	A	M I		6 X +	0	48 I				
0001 H0 N 06:17	A	I M		6 X +	0	48 I				
0001 H1 N 06:25	A	M I		6 X +	0	48 I				
0001 H0 N 06:40	A	IM		6 X +	0	48 I				
0001 H1 N 06:48	A	M I		6 X +	0	48 I				
0001 H1 N 07:03	A	I M		6 X +	0	48 I				
0001 H0 N 07:04	A	I M		6 X +	0	48 I				
0001 H1 N 07:12	A	M I		6 X +	0	48 I				
0001 H1 N 07:27	A	I M		6 X +	0	48 I				
0001 H0 N 07:28	A	I M		6 X +	0	48 I				
0001 H1 D 07:36	A	M I		6 X +	0	48 I				
0001 D1 D 07:51	M	A I		6 X +	0	48 I				
0001 H1 D 08:25	MA	I		6 X +	0	48 I				
0001 H0 D 08:11	MA	I		6 X +	0	48 I				
0001 H1 D 08:18	MA*	I		6 X +	0	48 I				
0001 H0 D 08:33	MA*	I		6 X +	0	48 I				
0001 H1 D 08:41	MA*	I		6 X +	0	48 I				
0001 H0 D 08:56	*MA	I		6 X +	0	48 I				
0001 H1 D 09:04	*I MA	I		6 X +	0	48 I				
0001 H0 D 09:18	*I MA	I		6 X +	0	48 I				
0001 H1 D 09:25	*I MA	I		6 X +	0	48 I				
0001 H0 D 09:40	*I MA	I		6 X +	0	48 I				
0001 H1 D 09:48	*I MA	I		6 X +	0	48 I				

03/08/82	-5	0	5	10	15	20	25	30	35	40
0001 H0 N 00:28		I	A M		6X + 0	48		I		
0001 H0 N 00:43		I	A M		G + 0	48		I		
0001 H1 N 00:45		I	AM		G + 0	48		I		
0001 H0 N 00:51		A	M		G + 0	48		I		
0001 H0 N 01:06		I	A M		G + 0	4		I		
0001 H1 N 01:15		I	AM		G + 0	4		I		
0001 H0 N 01:21	A	I	M		6X + 0	4		I		
0001 H0 N 01:36		I	A M		G + 0	48		I		
0001 H1 N 01:40		I	A M		6X + 0	48		I		
0001 H0 N 01:48	A	I	M		G + 0	48		I		
0001 H0 N 02:03		I	A M		6X + 0	48		I		
0001 H1 N 02:03		I	A M		6X + 0	48		I		
0001 H0 N 02:12	A	I	M		6X + 0	48		I		
0001 H1 N 02:25		AM			6X + 0	4		I		
0001 H0 N 02:34	A	IM			G + 0	4		I		
0001 H1 N 02:45		AM			G + 0	4		I		
0001 H0 N 02:54	A	M			6X + 0	48		I		
0001 H1 N 03:06		AM			6X + 0	48		I		
0001 H0 N 03:16	A	M			G + 0	48		I		
0001 H1 N 03:28	A	M			6X + 0	48		I		
0001 H0 N 03:39	A	M			6X + 0	48		I		
0001 H1 N 03:49	A	M			6X + 0	4		I		
0001 H0 N 04:00	A	IM			G + 0	48		I		
0001 H1 N 04:10	A	M			6X + 0	48		I		
0001 H0 N 04:21	A	M			6X + 0	48		I		
0001 H1 N 04:31	AM				6X + 0	48		I		
0001 H0 N 04:44	A	M			G + 0	48		I		
0001 H1 N 04:53	A	M			6X + 0	48		I		
0001 H0 N 05:07	A	IM			G + 0	48		I		
0001 H1 N 05:16	AM				6X + 0	48		I		
0001 H0 N 05:28	A	M			6X + 0	48		I		
0001 H1 N 05:38	AM				6X + 0	48		I		
0001 H0 N 05:51	A	M			6X + 0	48		I		
0001 H1 N 06:00	AM				6X + 0	48		I		
0001 H0 N 06:12	A	M			G + 0	48		I		
0001 H1 N 06:20	A	M			6X + 0	4		I		
0001 H0 N 06:34	A	M			GX + 0	48		I		
0001 H1 N 06:43	A	M			GX + 0	48		I		
0001 H0 N 06:57	A	M			GX + 0	48		I		
0001 H1 N 07:06	AM				GX + 0	48		I		
0000 H1 D 07:06 *	A	M			GX + 0	48		I		
0000 H0 D 07:20	M + A				GX + 0	48		I		
0000 H1 D 07:20	AM				GX + 0	48		I		
0000 H0 D 07:41	M + A				GX + 0	49		I		
0000 H1 D 07:49	AM*				GX + 0	4		I		
0000 H0 D 08:03	M	A*			GX + 0	4		I		
0000 H1 D 08:11	MA*				GX + 0	4		I		
0000 H0 D 08:24	M	A*			GX + 0	4		I		
0000 H1 D 08:32	M*	A			GX + 0	4		I		
0000 H0 D 08:46	M	*A			GX + 0	4		I		
0000 H1 D 08:54	*M	A			GX + 0	4		I		
0000 H0 D 09:06	M	*)	A		GX + 0	4		I		
0000 H1 D 09:14	*M	A			GX + 0	84		I		
0000 H0 D 09:27	M	*	A		GX + 0	+0		I		
0000 H1 D 09:34	I	A	M		GX + 0	84+		I		
0000 H0 D 09:46	IM	A	M		GX + 0	84	+0	I		
0000 H1 D 09:56	I	A	M		GX + 0	84	+	I		
0000 H0 D 10:07	I	A	M		GX + 0	84	+	I		
0000 H1 D 10:17	I	A	M		GX + 0	84	+	I		
0000 H0 D 10:26	I	A	M		GX + 0	84	+	I		
0010 H1 D 10:37	I	A	M		GX + 0	84	+	I		
0010 H0 D 10:45	I	A	M		GX + 0	84	+	I		
1110 H1 D 10:57	I	A	M		GX + 0	84	+	I		
1110 H0 D 11:10	I	A	M		GX + 0	84	+	I		
1110 H1 D 11:19	I	A	M		GX + 0	84	+	I		
1110 H0 D 11:33	I	A	M		GX + 0	84	+	I		
1110 H1 D 11:42	I	A	M		GX + 0	84	+	I		
1110 H0 D 11:55	I	A	M		GX + 0	84	+	I		
1110 H1 D 12:04	I	A	M		GX + 0	84	+	I		
1110 H0 D 12:14	I	A	M		GX + 0	84	+	I		
1110 H1 D 12:25	I	A	M		GX + 0	84	+	I		
1110 H0 D 12:35	I	A	M		GX + 0	84	+	I		
1110 H1 D 12:47	I	A	M		GX + 0	84	+	I		
1110 H0 D 12:57	I	A	M		GX + 0	84	+	I		
1110 H1 D 13:11	I	A	M		GX + 0	84	+	I		
1110 H0 D 13:18	I	A	M		GX + 0	84	+	I		
1110 H1 D 13:33	I	A	M		GX + 0	84	+	I		
1110 H0 D 13:40	I	A	M		GX + 0	84	+	I		
1110 H1 D 13:46	I	A	M		GX + 0	84	+	I		

1110 H0 D 14:01	I*	A 6				I 8	X 4	+ 0
1110 H1 D 14:07	I*	A 6				I 8	X 4	+ 0
1110 H0 D 14:13	I*	A 6				I 8	X 4	+ 0
1110 H0 D 14:20	I*	A 6				I 8	X 4	+ 0
1110 H1 D 14:41	I*	A 6				I 8	X 4	+ 0
1110 H0 D 14:48	I*	A 6				I 8	X 4	+ 0
1110 H0 D 15:03	I*	A 6				I 8	X 4	+ 0
1110 H1 D 15:13	I*	A 6				I 8	X 4	+ 0
1110 H0 D 15:20	I*	A 6				I 8	X 4	+ 0
1110 H0 D 15:35	I*	A 6				I 8	X 4	+ 0
1110 H1 D 15:37	I*	A 6				I 8	X 4	+ 0
1110 H1 D 15:42	I*	A 6				I 8	X 4	+ 0
0010 H1 D 15:42	I*	A 6				I 8	X 4	+ 0
0010 H0 D 15:45	I*	A 6				I 8	X 4	+ 0
1110 H0 D 16:00	I*	A 6				I 8	X 4	+ 0
1110 H1 D 16:01	I*	A 6				I 8	X 4	+ 0
1110 H0 D 16:08	I*	A 6				I 8	X 4	+ 0
1110 H0 D 16:23	I*	A 6				I 8	X 4	+ 0
1110 H1 D 16:24	I*	A 6				I 8	X 4	+ 0
1110 H1 D 16:30	I*	A 6				I 8	X 4	+ 0
0010 H1 D 16:30	I*	A 6				I 8	X 4	+ 0
0010 H0 D 16:35	I*	A 6				I 8	X 4	+ 0
1110 H1 D 16:47	I*	A 6				I 8	X 4	+ 0
0010 H1 D 16:47	I*	A 6				I 8	X 4	+ 0
0010 H0 D 16:55	I*	A 6				I 8	X 4	+ 0
1110 H1 D 17:09	I*	A 6				I 8	X 4	+ 0
1110 H1 D 17:11	I*	A 6				I 8	X 4	+ 0
0010 H1 D 17:12	I*	A 6				I 8	X 4	+ 0
1110 H1 D 17:15	I*	A 6				I 8	X 4	+ 0
0010 H1 D 17:15	I*	A 6				I 8	X 4	+ 0
0010 H0 D 17:18	I*	A 6				I 8	X 4	+ 0
0010 H1 D 17:30	I*	A 6				I 8	X 4	+ 0
0010 H0 D 17:37	I*	A 6				I 8	X 4	+ 0
0010 H0 D 17:52	I*	A 6				I 8	X 4	+ 0
0010 H1 D 17:54	I*	A 6				I 8	X 4	+ 0
0000 H1 D 17:55	I*	A 6				I 8	X 4	+ 0
0000 H0 D 18:02	I*	A 6				I 8	X 4	+ 0
0001 H0 N 18:15	I*	A 6				I 8	X 4	+ 0
0000 H1 N 18:20	I*	A 6				I 8	X 4	+ 0
0000 H0 N 18:25	I*	A 6				I 8	X 4	+ 0
0001 H0 N 18:41	I*	A 6				I 8	X 4	+ 0
0001 H1 N 18:55	I*	A 6				I 8	X 4	+ 0
0000 H1 N 18:55	I*	A 6				I 8	X 4	+ 0
0000 H0 N 19:00	I*	A 6				I 8	X 4	+ 0
0001 H0 N 19:15	I*	A 6				I 8	X 4	+ 0
0001 H0 N 19:30	I*	A 6				I 8	X 4	+ 0
0001 H0 N 19:45	I*	A 6				I 8	X 4	+ 0
0001 H0 N 20:00	I*	A 6				I 8	X 4	+ 0
0001 H0 N 20:16	I*	A 6				I 8	X 4	+ 0
0001 H0 N 20:31	I*	A 6				I 8	X 4	+ 0
0001 H1 N 20:33	I*	A 6				I 8	X 4	+ 0
0001 H1 N 20:36	I*	A 6				I 8	X 4	+ 0
0001 H0 N 20:39	I*	A 6				I 8	X 4	+ 0
0001 H0 N 20:54	I*	A 6				I 8	X 4	+ 0
0001 H1 N 21:04	I*	A 6				I 8	X 4	+ 0
0000 H1 N 21:05	I*	A 6				I 8	X 4	+ 0
0001 H0 N 21:10	I*	A 6				I 8	X 4	+ 0
0001 H0 N 21:25	I*	A 6				I 8	X 4	+ 0
0001 H1 N 21:29	I*	A 6				I 8	X 4	+ 0
0000 H1 N 21:32	I*	A 6				I 8	X 4	+ 0
0001 H0 N 21:37	I*	A 6				I 8	X 4	+ 0
0001 H0 N 21:52	I*	A 6				I 8	X 4	+ 0
0001 H1 N 21:53	I*	A 6				I 8	X 4	+ 0
0000 H1 N 21:55	I*	A 6				I 8	X 4	+ 0
0001 H0 N 22:01	I*	A 6				I 8	X 4	+ 0
0001 H1 N 22:15	I*	A 6				I 8	X 4	+ 0
0001 H0 N 22:22	I*	A 6				I 8	X 4	+ 0
0001 H0 N 22:37	I*	A 6				I 8	X 4	+ 0
0001 H1 N 22:38	I*	A 6				I 8	X 4	+ 0
0001 H0 N 22:44	I*	A 6				I 8	X 4	+ 0
0001 H0 N 22:59	I*	A 6				I 8	X 4	+ 0
0001 H1 N 23:03	I*	A 6				I 8	X 4	+ 0
0001 H0 N 23:10	I*	A 6				I 8	X 4	+ 0
0001 H0 N 23:25	I*	A 6				I 8	X 4	+ 0
0001 H1 N 23:27	I*	A 6				I 8	X 4	+ 0
0001 H0 N 23:35	I*	A 6				I 8	X 4	+ 0
0001 H0 N 23:50	I*	A 6				I 8	X 4	+ 0
0001 H1 N 23:51	I*	A 6				I 8	X 4	+ 0
0001 H0 N 23:59	I*	A 6				I 8	X 4	+ 0

03/09/82 -5
0001 H0 N 00:14
0001 H1 N 00:14

0
1 A M
1A M

5

10
6
6

X +
X +

15

0
0

20

4 8
4 8

25

30

35

40

03/09/82	-5	5	10	15	20	25	30	35	40
0001 H1 N 00:18	A	I	M						
0001 H0 N 00:22	A	I	M						
0001 H1 N 00:35	A	I	M						
0001 H0 N 00:45	A	I	M						
0001 H1 N 00:57	A	I	M						
0001 H0 N 01:06	A	I	M						
0001 H1 N 01:20	A	I	M						
0001 H0 N 01:29	A	I	M						
0001 H1 N 01:39	A	I	M						
0001 H0 N 01:50	A	I	M						
0001 H1 N 02:02	A	I	M						
0001 H0 N 02:13	A	I	M						
0001 H1 N 02:23	A	I	M						
0001 H0 N 02:35	A	I	M						
0001 H1 N 02:44	A	I	M						
0001 H0 N 02:56	A	I	M						
0001 H1 N 03:06	A	I	M						
0001 H0 N 03:18	A	I	M						
0001 H1 N 03:27	A	I	M						
0001 H0 N 03:40	A	I	M						
0001 H1 N 03:49	A	I	M						
0001 H0 N 04:02	A	I	M						
0001 H1 N 04:11	A	I	M						
0001 H0 N 04:25	A	I	M						
0001 H1 N 04:34	A	I	M						
0001 H0 N 04:48	A	I	M						
0001 H1 N 04:58	A	I	M						
0001 H0 N 05:11	A	I	M						
0001 H1 N 05:20	A	I	M						
0001 H0 N 05:33	A	I	M						
0001 H1 N 05:41	A	I	M						
0001 H0 N 05:56	A	I	M						
0001 H1 N 06:04	A	I	M						
0001 H0 N 06:19	A	I	M						
0001 H1 N 06:19	A	I	M						
0001 H0 N 06:28	A	I	M						
0001 H1 N 06:43	A	I	M						
0001 H0 N 06:44	A	I	M						
0001 H1 N 06:52	A	I	M						
0001 H0 N 07:05	A	I	M						
0000 H0 D 07:07	A	I	M						
0000 H1 D 07:15	A	I	M						
0000 H0 D 07:30	A	I	M						
0000 H1 D 07:31	A	I	M						
0000 H0 D 07:39	A	I	M						
0000 H1 D 07:54	A	I	M						
0000 H0 D 08:08	A	I	M						
0000 H1 D 08:15	A	I	M						
0000 H0 D 08:30	A	I	M						
0000 H1 D 08:39	A	I	M						
0000 H0 D 08:52	A	I	M						
0000 H1 D 09:00	A	I	M						
0000 H0 D 09:11	A	I	M						
0000 H1 D 09:13	A	I	M						
0000 H0 D 09:29	A	I	M						
0000 H1 D 09:29	A	I	M						
0000 H0 D 09:36	A	I	M						
0000 H1 D 09:48	A	I	M						
0000 H0 D 09:55	A	I	M						
0000 H1 D 10:07	A	I	M						
0010 H1 D 10:20	A	I	M						
0010 H0 D 10:28	A	I	M						
1110 H1 D 10:42	A	I	M						
1110 H0 D 10:53	A	I	M						
1110 H1 D 11:02	A	I	M						
1110 H0 D 11:17	A	I	M						
1110 H1 D 11:17	A	I	M						
1110 H0 D 11:26	A	I	M						
1110 H1 D 11:39	A	I	M						
1110 H0 D 11:54	A	I	M						
1110 H1 D 12:09	A	I	M						
1110 H0 D 12:24	A	I	M						
1110 H1 D 12:40	A	I	M						
1110 H0 D 12:55	A	I	M						
1110 H1 D 13:10	A	I	M						
1110 H0 D 13:26	A	I	M						
1110 H1 D 13:41	A	I	M						
1110 H0 D 13:56	A	I	M						
1110 H1 D 14:12	A	I	M						

03/09/82	-5	0	5	10	15	20	25	30	35	40
1110 H0 D 14:27	1*			6	A	M	I	X	4	+0
1110 H0 D 14:42	1*			6	A	M	I	X	8	4 + 0
1110 H0 D 14:58	1*			6	A	M	I	X	8	4+ 0
1110 H0 D 15:13	1*			6	A	M	I	X	8	4+ 0
1110 H0 D 15:28	1*			6	A	M	I	X	8	4+ 0
1110 H0 D 15:44	1*			6	A	M	I	X	8	4+0
1110 H0 D 15:59	1*			6	A	M	I	X	8	4+ 0
1110 H0 D 16:14	*			6	A	M	I	X	8	4+ 0
1110 H0 D 16:30	*			6	A	M	I	X	8	+0
1110 H0 D 16:45	*			6	A	M	I	X	8	8 + 0
1110 H0 D 17:00	*			6	A	M	I	X	8	8 + 0
1110 H0 D 17:15	*			6	A	M	I	X	8	8 + 04
1110 H0 D 17:30	*			6	A	M	I	X	8	+0 4
1110 H0 D 17:46	*			6	A	M	I	X	8	+ 0 4
1110 H0 D 18:01 *	*			6	A	M	I	X	8	+ 0 4
1110 H0 N 18:16				6	A	M	I	X	8	+ 0 84
0010 H0 N 18:31				6	A	M	I	X	8	+ 0 4
0010 H0 N 18:46				6	A	M	I	X	8	+ 0 84
0010 H0 N 19:01				6	A	M	I	X	8	+ 0 4
0010 H0 N 19:16				6	A	M	I	X	8	+ 0 4
0010 H0 N 19:31				6	A	M	I	X	8	+ 0 4
0000 H0 N 19:46				6	A	M	I	X	8	+ 0 4
0000 H0 N 20:01				6	A	M	I	X	8	+ 0 4
0000 H0 N 20:16				6	A	M	I	X	8	+ 0 4
0000 H0 N 20:31				6	A	M	I	X	8	+ 0 4
0000 H0 N 20:46				6	A	M	I	X	8	+ 0 4
0000 H0 N 21:02				6	A	M	I	X	8	+ 0 4
0000 H0 N 21:17				6	A	M	I	X	8	+ 0 48
0000 H0 N 21:32				6	A	M	I	X	8	+ 0 48
0000 H0 N 21:47				6	A	M	I	X	8	+ 0 48
0000 H0 N 22:02				6	A	M	I	X	8	+ 0 48
0000 H0 N 22:17				6	A	M	I	X	8	+ 0 48
0000 H0 N 22:33				6	A	M	I	X	8	+ 0 48
0000 H0 N 22:48				6	A	M	I	X	8	+ 0 48
0000 H0 N 23:03				6	A	M	I	X	8	+ 0 48
0000 H0 N 23:18				6	A	M	I	X	8	+ 0 48
0000 H0 N 23:34				6	A	M	I	X	8	+ 0 4
0000 H0 N 23:49				6	A	M	I	X	8	+ 0 4

03/10/82	-5	0	5	10	15	20	25	30	35	40
0000 H0 N 00:04			A	M	6	X	+	0	I	4
0000 H0 N 00:19			A	M	6	X	+	0	I	48
0000 H0 N 00:34			A	M	6	X	+	0	I	48
0000 H0 N 00:50			A	M	6	X	+	0	I	48
0000 H0 N 01:05			A	M	6	X	+	0	I	48

04/06/82 -5
0001 H0 N 23:58

0
1

A S
M

10

15
6 X +

20
0 14 8 25

30

35

40

94/07/82

-5

	0	5	10	15	20	25	30	35	40
0001 H0 N 00:13		A		6	+	0		148	
0001 H1 N 00:18		A		GX	+	0		148	
0001 H0 N 00:25		A		GX	+	0		48I	
0001 H0 N 00:40		A		6	X	+	0	48	
0001 H1 N 00:53		A		GX	+	0		48	
0001 H0 N 01:00		A		GX	+	0		48I	
0001 H0 N 01:15		A		6	X	+	0	48	
0001 H1 N 01:19		A		GX	+	0		48	
0001 H0 N 01:26		A		GX	+	0		48I	
0001 H0 N 01:41		A		GX	+	0		48	
0001 H1 N 01:44		A		GX	+	0		48I	
0001 H0 N 01:51		A	M	GX	+	0		48I	
0001 H0 N 02:06		A	M	GX	+	0		48I	
0001 H1 N 02:10		A	M	GX	+	0		48	
0001 H0 N 02:17	A		M	GX	+	0		48I	
0001 H0 N 02:32	A		M	6	X	+	0	48	
0001 H1 N 02:34	IA		M	6	X	+	0	48	
0001 H0 N 02:42	A		M	GX	+	0		48I	
0001 H1 N 02:56	A		M	GX	+	0		48	
0001 H0 N 03:05	A		M	GX	+	0		4I	
0001 H1 N 03:17	IA		M	GX	+	0		4I	
0001 H0 N 03:26	A		M	GX	+	0		48I	
0001 H1 N 03:40	A		M	GX	+	0		48I	
0001 H0 N 03:50	A		M	GX	+	0		48I	
0001 H1 N 04:03	IA		M	GX	+	0		48I	
0001 H0 N 04:12	A		M	GX	+	0		48I	
0001 H1 N 04:24	A		M	GX	+	0		48I	
0001 H0 N 04:34	A		M	GX	+	0		48I	
0001 H1 N 04:46	A		M	GX	+	0		48I	
0001 H0 N 04:56	A		M	GX	+	0		48I	
0001 H1 N 05:08	A		M	GX	+	0		48I	
0001 H0 N 05:18	A		M	GX	+	0		48I	
0001 H1 N 05:29	A		M	GX	+	0		48I	
0001 H0 N 05:40	A		M	G	+	0		48I	
0001 H1 N 05:51	A		M	GX	+	0		48I	
0001 H0 N 06:03	A		M	G	+	0		48I	
0001 H1 N 06:12	A		M	GX	+	0		48I	
0001 H0 N 06:24	A		M	G	+	0		48I	
0000 H1 D 06:34	A		M	GX	+	0		48I	
0000 H0 D 06:47	M	A		GX	+	0		4I	
0000 H1 D 06:57	M	A		GX	+	0		4I	
0000 H0 D 07:10	M	A		GX	+	0		4I	
0000 H1 D 07:20	M	A		G	+	0		4I	
0000 H0 D 07:32	M	A		GX	+	0		4I	
0000 H1 D 07:41	M	A		G	+	0		4I	
0000 H0 D 07:53	M	A		GX	+	0		4I	
0000 H1 D 08:02	M	A		GX	+	0		4I	
0000 H0 D 08:15	M	A		GX	+	0		4I	
0000 H1 D 08:24	M	A		GX	+	0		4I	
0000 H0 D 08:37	M	A		GX	+	0		4I	
0000 H1 D 08:48	M	A		GX	+	0		4I	
0000 H0 D 08:58	M	A		GX	+	0		4I	
0000 H1 D 09:10	M	A		GX	+	0		4I	
0000 H0 D 09:20	M	A		GX	+	0		4I	
0000 H1 D 09:30	M	A		GX	+	0		4I	
0000 H0 D 09:39	M	A		GX	+	0		4I	
0000 H1 D 09:52	M	A		GX	+	0		4I	
0000 H0 D 10:00	M	A		GX	+	0		4I	
0010 H0 D 10:15	M	A		GX	+	0		4I	
0010 H1 D 10:15	M	A		GX	+	0		4I	
0010 H0 D 10:21	M	A		GX	+	0		4I	
1110 H0 D 10:37	M	A		GX	+	0		4I	
1110 H1 D 10:39	M	A		GX	+	0		4I	
1110 H0 D 10:46	M	A		GX	+	0		4I	
1110 H1 D 11:01	M	A		GX	+	0		4I	
1110 H0 D 11:08	M	A		GX	+	0		4I	
1110 H0 D 11:24	M	A		GX	+	0		4I	
1110 H1 D 11:30	M	A		GX	+	0		4I	
1110 H0 D 11:36	M	A		GX	+	0		4I	
1110 H0 D 11:51	M	A		GX	+	0		4I	
1110 H0 D 12:07	M	A		GX	+	0		4I	
1110 H0 D 12:22	M	A		GX	+	0		4I	
1110 H0 D 12:37	M	A		GX	+	0		4I	
1110 H0 D 12:52	M	A		GX	+	0		4I	
1110 H0 D 13:08	M	A		GX	+	0		4I	
1110 H0 D 13:23	M	A		GX	+	0		4I	
1110 H0 D 13:36	M	A		GX	+	0		4I	
1110 H0 D 13:54	M	A		GX	+	0		4I	
1110 H0 D 14:09	M	A		GX	+	0		4I	

04/07/82	-5	0	5	10	15	20	25	30	35	40
1110 H0 D 14:24	*				A G	M	I 8 X4 0 +			
1110 H0 D 14:40	*				G	M	I 8 X4 0 +			
1110 H0 D 14:55	1*				A G	M	I 8 X4 0 +			
1110 H0 D 15:11	*				A G	M	I 8 X4 0 +			
1110 H0 D 15:26	1*				A G	M	I 8 X 0 +			
1110 H0 D 15:41	1*				A G	M	I 8 X4 0 +			
1110 H0 D 15:57	*				A G	M	I 8 4 X 0 +			
1110 H0 D 16:12	*				A G	M	I 8 X4 0 +			
1110 H0 D 16:28	*				A G	M	I 8 X4 0 +			
1110 H0 D 16:43	*				G A	M	I 8 X4 0 +			
1110 H0 D 16:58	*				G	M	I X 8 0 +			
1110 H0 D 17:14	*				G	A	I X 8 0 +			
1110 H0 D 17:29	*				A G	M	X I 80 +			
0010 H0 D 17:44	*				A G	M	X I + 4			
0010 H0 D 17:59	*				A G	M	X I +08 4			
0010 H0 D 18:15	*				A G	M	X I +08 4			
0010 H0 N 18:30					A G	M	X + 0 84			
0001 H0 N 18:45					A G	M	X + 0 84			
0000 H0 N 19:00					A G	M	X +10 4			
0001 H0 N 19:15					A G	M	X + 10 84			
0000 H0 N 19:30					A G	M	X + 10 4			
0000 H0 N 19:45					A G	M	X + 10 4			
0000 H0 N 20:00					A G	M	X + 0 4			
0000 H0 N 20:15					A G	M	X + 0 4			

05/14/82	-5	0	5	10	15	20	25	30	35	40
0000 C0 N 00:29						6A	M + 0 I4			
0000 C0 N 00:44						G	M + 0 I4			
0000 C0 N 00:59						G	M X+ 0 I 4			
0000 C0 N 01:14						AG	M X+ 0 I 4			
0000 C0 N 01:30						G	M X+ 0 I84			
0000 C0 N 01:45						G	M X+ 0 I84			
0000 C0 N 02:00						AG	M X+ 0 I84			
0000 C0 N 02:16						AG	M X+ 0 I4			
0000 C0 N 02:31						AG	M X+ 0 I 4			
0000 C0 N 02:46						AG	M X+ 0 I 4			
0000 C0 N 03:01						AG	M X+ 0 I 4			
0000 C0 N 03:16						AG	M X+ 0 I 4			
0000 C0 N 03:32						AG	M X+ 0 I 4			
0000 C0 N 03:47						G	M X+ 0 I 4			
0000 C0 N 04:02						AG	M X+ 0 I 4			
0000 C0 N 04:17						A	G M X+ 0 I 4			
0000 C0 N 04:33						A	G M X+ 0 I 4			
0000 C0 N 04:48						A	G M X+ 0 I 4			
0000 C0 N 05:03						A	G M X+ 0 I 84			
0000 C0 N 05:19						A	G M X+ 0 I 84			
0000 C0 N 05:34						A	G M + 0 I 4			
0000 C0 N 05:49						A	G M X+ 0 I 4			
0000 C0 N 06:05						A	G M X+ 0 4			
0000 C0 N 06:20						A	G X+ 0 4			
0000 C0 N 06:35						A	G X+ 0 I 4			
0000 C0 N 06:51						A	G M X+ 0 I 4			
0000 C0 D 07:06	*					A	G M X+ 0 84			
0000 C0 D 07:21	*					A	G M X+ 0 84			
0000 C0 D 07:37	*					A	G M X+ 0 84			
0000 C0 D 07:52	*					A	G M X+ 0 84			
0000 C0 D 08:07	*					A	G M X+ 0 84			
0000 C0 D 08:22	*					A	G M X+ 0 84			
0000 C0 D 08:38	*					A	G M X+ 0 84			
0000 C0 D 08:53	*					A	G M X+ 0 84			
0000 C0 D 09:08	*					A	G M X+ 0 84			
0000 C0 D 09:23	*					A	G M X+ 0 84			
0000 C0 D 09:39	*					A	G M X+ 0 84			
0000 C0 D 09:54	*					A	G M X+ 0 84			
0000 C0 D 10:10	*					A	G M X+ 0 84			
0000 C0 D 10:25	*					A	G M X+ 0 84			
0000 C0 D 10:40	*					A	G M X+ 0 84			
0000 C0 D 10:56	*					A	G M X+ 0 84			
0000 C0 D 11:11	*					A	G M X+ 0 84			
0000 C0 D 11:27	*					A	G M X+ 0 84			
0000 C0 D 11:42	*					A	G M X+ 0 84			
0000 C1 D 11:57	*					A	G M X+ 0 84			
0000 C0 D 12:05	*					A	G M X+ 0 84			
0000 C0 D 12:21	*					A	G M X+ 0 84			
0000 C1 D 12:24	*					A	G M X+ 0 84			
0000 C0 D 12:31	*					A	G M X+ 0 84			
0000 C0 D 12:46	*					A	G M X+ 0 84			
0000 C1 D 12:47	*					A	G M X+ 0 84			
0000 C0 D 12:57	*					A	G M X+ 0 84			
0000 C0 D 13:13	*					A	G M X+ 0 84			
0000 C1 D 13:15	*					A	G M X+ 0 84			
0000 C0 D 13:26	*					A	G M X+ 0 84			
0000 C0 D 13:42	*					A	G M X+ 0 84			
0000 C1 D 13:44	*					A	G M X+ 0 84			
0000 C0 D 13:56	*					A	G M X+ 0 84			
0000 C1 D 14:10	*					A	G M X+ 0 84			
0000 C0 D 14:22	*					A	G M X+ 0 84			
0000 C1 D 14:32	*					A	G M X+ 0 84			
0000 C0 D 14:47	*					A	G M X+ 0 84			
0000 C1 D 15:01	*					A	G M X+ 0 84			
0000 C0 D 15:15	*					A	G M X+ 0 84			
0000 C1 D 15:25	*					A	G M X+ 0 84			
0000 C1 D 15:41	*					A	G M X+ 0 84			
0000 C0 D 15:43	*					A	G M X+ 0 84			
0000 C1 D 15:53	*					A	G M X+ 0 84			
0000 C1 D 16:08	*					A	G M X+ 0 84			
0000 C0 D 16:12	*					A	G M X+ 0 84			
0000 C1 D 16:21	*					A	G M X+ 0 84			
0000 C1 D 16:36	*					A	G M X+ 0 84			
0000 C0 D 16:38	*					A	G M X+ 0 84			
0000 C1 D 16:50	*					A	G M X+ 0 84			
0000 C1 D 17:05	*					A	G M X+ 0 84			
0000 C0 D 17:09	*					A	G M X+ 0 84			
0000 C1 D 17:22	*					A	G M X+ 0 84			
0000 C1 D 17:37	*					A	G M X+ 0 84			

05/14/82	-5	0	5	10	15	20	25	30	35	40
0000 C0 D 17:39		+						I X 4A + M		
0000 C1 D 17:49		+						I X A0 + M		
0000 C0 D 18:04		+						I X8 A0 + M		
0000 C1 D 18:15		+						I X8A04+ M		
0000 C1 D 18:31		+						I X 8A0+ M		
0000 C0 D 18:33		+						I X 8A0+ M		
0000 C1 D 18:47		+						IX 8A+ M		
0000 C1 D 19:02		+						I X 8A4 M		
0000 C0 D 19:02		+						I X A+4 M		
0000 C1 D 19:18		+						IA 8+ M		
0000 C1 D 19:33		+						I XA +4 M		
0000 C0 D 19:36		+						I X A8+4M		
0000 C1 N 19:43		+						I XA + 4		
0000 C0 N 19:56		+						IX A+0 4		
0000 C1 N 20:06		+						IA +8 4		
0000 C0 N 20:20		+						IA +8 4		
0000 C1 N 20:32		+						AI X +084		
0000 C0 N 20:42		+						AX +084		
0000 C1 N 20:53		+						A +084		
0000 C0 N 21:04		+						IA +08 4		

06/14/82 -5
0000 C1 N 23:58

0
1

5

10

15

20

25
AMGX+ 0 4

30

35

40

06/15/82	-5	0	5	10	15	20	25	30	35	40
0000 C0 N 00:12							A GX+ 0 4			
0000 C0 N 00:27							A GX+ 0 4			
0000 C0 N 00:43							A GI+ 0 4			
0000 C0 N 00:58							A GIX+0 4			
0000 C0 N 01:13							A G X+0 4			
0000 C0 N 01:29							A G X+0 4			
0000 C0 N 01:44							A G +0 4			
0000 C0 N 01:59							A G X+ 4			
0000 C0 N 02:14							A G +0 4			
0000 C1 N 02:23							A MG +0 4			
0000 C0 N 02:28							A M G +0 4			
0000 C0 N 02:43							A MGX+0 84			
0000 C0 N 02:59							A MGX+0 84			
0000 C0 N 03:14							A GX+0 84			
0000 C0 N 03:29							A GX+0 84			
0000 C0 N 03:45							A G +0 4			
0000 C0 N 04:00							A GX+0 4			
0000 C1 N 04:15							A MGX+0 4			
0000 C0 N 04:21							A MG+ 0 4			
0000 C0 N 04:36							A G+ 0 4			
0000 C0 N 04:51							A GX+0 4			
0000 C0 N 05:07							A GX+0 4			
0000 C0 N 05:22							A GX+0 84			
0000 C0 N 05:37							A GX+0 84			
0000 C0 N 05:52							A GX+0 84			
0000 C0 N 06:08							A GX+0 84			
0000 C0 N 06:23							A GX+0 84			
0000 C1 N 06:32							A GX+0 84			
0000 C0 N 06:38							A GX+0 4			
0000 C0 N 06:53							A GX+0 4			
0000 C0 N 07:09							A GX+0 4			
0000 C0 D 07:24 *							A GX + 4			
0000 C0 D 07:39	*						A G X+ 4			
0000 C0 D 07:55	*						A GMX+ 4			
0000 C1 D 07:58	*						A GMX+ 4			
0000 C0 D 08:06	*						AG MX+ 4			
0000 C0 D 08:21	*						A GMX+ 4			
0000 C1 D 08:27	*						A GMX+ 4			
0000 C0 D 08:35	*						AG X+ 4			
0000 C0 D 08:51	*						AG X+084			
0000 C1 D 08:57	*						G X+84			
0000 C0 D 09:04	*						GA X+084			
0000 C1 D 09:06	*						G +084			
0000 C1 D 09:24	*						GA +084			
0000 C1 D 09:39	*						GA X+084			
0000 C0 D 09:42	*						GA X+084			
0000 C1 D 09:50	*						G X+84			
0000 C1 D 10:05	*						G AIX+04			
0000 C0 D 10:07	*						G AIX+04			
0000 C1 D 10:14	*						G AIX+04			
0000 C0 D 10:26	*						0 IA +04 M			
0000 C1 D 10:35	*						G AX 8+4			
0000 C1 D 10:51	*						G IA + 4			
0000 C0 D 10:51	*						G IA + 4			
0000 C1 D 10:59	*						G IA 8+4			
0000 C1 D 11:14	*						G IA 8+4M			
0000 C0 D 11:14	*						G IA 8+4 M			
0000 C1 D 11:22	*						G IAX8 +M			
0000 C1 D 11:37	*						G IXA + M			
0000 C0 D 11:40	*						G IXA + M			
0000 C1 D 11:47	*						G AX 8+ M			
0000 C1 D 12:03	*						G I X8A+0 M			
0000 C0 D 12:07	*						G I XA + M			
0000 C1 D 12:14	*						G I A40+ M			
0000 C1 D 12:29	*						G I XA4+ M			
0000 C0 D 12:33	*						G I X A+0 M			
0000 C1 D 12:41	*						G I 8A4 0+ M			
0000 C1 D 12:56	*						G I 8XA + M			
0000 C1 D 13:12	*						G I X 4A+ M			
0000 C0 D 13:18	*						G I X 4 A0 M			
0000 C1 D 13:24	*						G I 8X A 0+ M			
0000 C1 D 13:40	*						G I 8 X4A + M			
0000 C0 D 13:51	*						G I 8 X4A 0+ M			
0000 C1 D 13:58	*						G I 8 A 0+ M			
0000 C1 D 14:14	*						G I 8 X A+ M			
0000 C0 D 14:18	*						G I 8 X A0+ M			
0000 C1 D 14:24	*						G I 8 XA 0 + M			
0000 C1 D 14:40	*						G I 8 X A + M			
0000 C1 D 14:55	*						G I 8 X A0+ M			

05/15/82	-5	0	5	10	15	20	25	30	35	40
0000 C1 D 15:11		I*					G I	B X A0+		M
0000 C0 D 15:18		I*					G I	B X A0+	M	
0000 C1 D 15:24		I*					G I	B XA 0+		M
0000 C1 D 15:40		I*					G I	B XA 0+		M
0000 C0 D 15:54	*	I					G I	B X A0+	M	
0000 C1 D 16:00	*	I					G I	BA X 40+		
0000 C1 D 16:16		*					G I	A X M40+		
0000 C0 D 16:19		*					G I	A X 4+		
0000 C1 D 16:28		*					G I	A X 4 +		
0000 C1 D 16:43		*					G I	XA 4 + M		
0000 C0 D 16:48		*					G I	AB 40+		
0000 C1 D 16:55		*					G I	AB 40+		
0000 C0 D 17:07		*					G I	XA 4 +M		
0000 C1 D 17:15		*					G I	A 4 +M		
0000 C1 D 17:30		*					G I	XBA4+	M	
0000 C0 D 17:33		*					G I	X BA4+ M		
0000 C1 D 17:42		*I					GI	XA 4+M		
0000 C0 D 17:57		*I					G I	X A + M		
0000 C1 D 18:05		*I					GI	XAB + M		
0000 C0 D 18:16		*I					G I	XAB + M		
0000 C1 D 18:24		*I					GI	XAB + M		
0000 C1 D 18:40	*	I					G I	X AB+4 M		
0000 C0 D 18:40	*	I					G I	X AB+4 M		
0000 C1 D 18:49	*	I					GI	XA 8+4M		
0000 C0 D 19:01	*	I					G I	X AB+ M		
0000 C1 D 19:08	*	I					GI	A 8+ M		
0000 C0 D 19:21	*	I					G I	XA +4 M		
0000 C1 D 19:31	*	I					GI	A +4M		
0000 C0 D 19:45	*	I					G I	XA +04M		
0000 C1 D 19:53	*	I					G	A +04		
0000 C0 D 20:01 *		I					G I	XA+0 4M		
0000 C1 N 20:11		I					GI	XA+0M4		

07/27/82	-5	0	5	10	15	20	25	30	35	40
0000	C0 N 05:58						A 6IM4			
0000	C1 N 06:04						AGIM4			
0000	C0 N 06:13						AGIM4			
0000	C1 N 06:25						AGM 4			
0000	C0 N 06:36						GX M4			
0000	C1 N 06:50						A+GM 4			
0000	C0 N 07:00						AGM M4			
0000	C0 D 07:16	*					AIGM 4			
0000	C1 D 07:20	*					A GM 4			
0000	C0 D 07:30	*					AIGM 4			
0000	C1 D 07:45	*					AGM4			
0000	C0 D 07:54	*					G+0 4			
0000	C1 D 08:09	*					GE 4			
0000	C0 D 08:19	*					GA0 4M			
0000	C0 D 08:35	*					GA04			
0000	C1 D 08:37	*					GA04M			
0000	C0 D 08:47	*					G +0A M			
0000	C1 D 09:00	*					GX+A M			
0000	C0 D 09:12	*					G +0A M			
0000	C1 D 09:24	*					G X+ A M			
0000	C0 D 09:33	*					G X+ A M			
0000	C1 D 09:46	*					G + A M			
0000	C0 D 10:00	*					G X+ A M			
0000	C1 D 10:13	*					G X+ A M			
0000	C0 D 10:23	*					G X4+ A M			
0000	C1 D 10:35	*					G X4+ A M			
0000	C0 D 10:46	*					G 8X4+ A M			
0000	C1 D 10:58	*					IG 8X4+ A M			
0000	C0 D 11:11	*					G 8 X+ A M			
0000	C1 D 11:23	*					G 8 X4+ A M			
0000	C0 D 11:38	*					GI 8 X0+ A M			
0000	C1 D 11:49	*					G 8 X0+ A M			
0000	C0 D 12:03	*					G 8 X 0A M			
0000	C1 D 12:13	*					G 8 X+ A M			
0000	C0 D 12:27	*					GI 8 4X +A M			
0000	C1 D 12:36	*					G 8 4X 0+ A M			
0000	C0 D 12:48	*					GI 8 4 X0 +A M			
0000	C1 D 12:58	*					G 8 4 X 0 A M			
0000	C1 D 13:13	*					G 8 4X 0 A M			
0000	C0 D 13:14	*					G 8 4X 0A M			
0000	C1 D 13:23	*					GI 8 4X 0A M			
0000	C1 D 13:38	*					G 8 4X 0A M			
0000	C0 D 13:41	*					G 8 4X 0 A M			
0000	C1 D 13:50	*					GI 8 X40 A M			
0000	C1 D 14:05	*					GI 8X 40+ A M			
0000	C0 D 14:09	*					G 8X 4+ A M			
0000	C1 D 14:17	*					GI 8X 4A M			
0000	C1 D 14:33	*					G A X 0+ M			
0000	C0 D 14:33	*					G AMX 0+ M			
0000	C1 D 14:43	*					GI A XM0+ M			
0000	C0 D 14:58	*					G XA0+M M			
0000	C1 D 15:09	*					GI XA +M M			
0000	C0 D 15:22	*					G X A M			
0000	C1 D 15:32	*					GI XA4+ M			
0000	C0 D 15:45	*					G X+ A M			
0000	C1 D 15:54	*					GI 8X4A M			
0000	C0 D 16:10	*					G 8 X4+ A M			
0000	C1 D 16:19	*					GI 8 4X+ A M			
0000	C1 D 16:35	*					GI 8 X+ A M			
0000	C0 D 16:37	*					G 8 X 0+ A M			
0000	C1 D 16:47	*					GI 8 4X0+ A M			
0000	C1 D 17:02	*					GI 8 X40+ A M			
0000	C0 D 17:14	*					G 8X 4+ A M			
0000	C1 D 17:22	*					G 8 X40+ A M			
0000	C1 D 17:37	*					GI 3X 0+ A M			
0000	C0 D 17:46	*					G X+ A M			
0000	C1 D 17:55	*					G 8X+ A M			
0000	C1 D 18:11	*					G X+ A M			
0000	C0 D 18:13	*					G X0+ A M			
0000	C1 D 18:20	*					G X0+ A M			
0000	C0 D 18:33	*					G X0+ A M			
0000	C1 D 18:41	*					G X0+ A M			
0000	C1 D 18:57	*					IG X8+4 A M			
0000	C0 D 18:57	*					IG X8+4 A M			
0000	C1 D 19:07	*					G X8+4 A M			
0000	C1 D 19:23	*					G X+ 4A M			
0000	C0 D 19:24	*					IG X+ 4A M			
0000	C1 D 19:34	*					G X+ 4A M			
0000	C1 N 19:50	*					IG X+4 A M			

07/27/82 -5
 0000 C0 N 19:53
 0000 C1 N 20:01
 0000 C1 N 20:17
 0000 C0 N 20:18

0
 1
 1
 1

5

10

15

20

25
 6
 6
 6
 6

X +4A
 X +4A
 X +8A
 X +8A

30
 M
 M
 M
 M

35

40

00/20/82	-5	0	5	10	15	20	25	30	35	40
0000 C1 N 00:32							A MIG+0	4		
0000 C0 N 00:42							A M 6 0	4		
0000 C1 N 00:51							A MG+X0	4		
0000 C0 N 01:06							A MI 6 0	4		
0000 C1 N 01:18							A MG+X0	4		
0000 C0 N 01:31							A MI 6 0	84		
0000 C1 N 01:41							A MG+ 0	84		
0000 C0 N 01:50							A M 6 0	84		
0000 C1 N 02:04							A MIG+ 0	84		
0000 C0 N 02:15							A MSX 0	4		
0000 C1 N 02:29							A MIG+ 0	4		
0000 C0 N 02:38							AM I+6 0	4		
0000 C1 N 02:52							A MIGX 0	4		
0000 C0 N 03:01							A MIG 0	4		
0000 C0 N 03:16							A MIGX 0	4		
0000 C1 N 03:19							A MIGX 0	4		
0000 C0 N 03:28							A M 16 0	84		
0000 C0 N 03:44							A M 16 0	84		
0000 C1 N 03:49							A M 16X0	84		
0000 C0 N 03:58							A M +6 0	84		
0000 C0 N 04:13							A M 16 0	4		
0000 C1 N 04:17							A M 16 0	4		
0000 C0 N 04:24							A M +6 0	4		
0000 C0 N 04:40							A M 16 0	4		
0000 C1 N 04:43							A M 16 0	4		
0000 C0 N 04:51							A M +6 0	4		
0000 C0 N 05:06							A M +6 0	4		
0000 C1 N 05:15							A M +6 0	4		
0000 C0 N 05:23							A M +60	4		
0000 C0 N 05:39							A M +6 0	84		
0000 C1 N 05:51							A M +60	84		
0000 C0 N 05:58							A M +60	84		
0000 C0 N 06:14							A M +60	84		
0000 C0 N 06:29							A M +60	4		
0000 C1 N 06:29							A M +60	4		
0000 C0 N 06:36							A M +60	4		
0000 C0 N 06:52							A M 6 0	4		
0000 C0 N 07:07							A M X60	4		
0000 C0 D 07:22 *							A M X60	4		
0000 C1 D 07:37 *							A M X6 0	4		
0000 C0 D 07:45 *							A M +60	4		
0000 C0 D 08:00 *							A M X6 084			
0000 C1 D 08:14 *							A M X6 084			
0000 C0 D 08:22 *							A M X6 084			
0000 C0 D 08:37 *							A M 16+084			
0000 C1 D 08:40 *							AM 6+ 04			
0000 C0 D 08:49 *							A MG+ 04			
0000 C1 D 08:59 *							A MGX+04			
0000 C1 D 09:15 *							AIG +04			
0000 C0 D 09:30 *							IAGX+04			
0000 C1 D 09:39 *							AGX +04			
0000 C0 D 09:50 *							IAG X+04			
0000 C1 D 10:01 *							AG X+04			
0000 C0 D 10:12 *							IAG X+80			
0000 C1 D 10:22 *							IG X+0M			
0000 C0 D 10:31 *							I 6 X+24M			
0000 C1 D 10:43 *							IGA X8 +			
0000 C0 D 10:54 *							I 6 AB +0 M			
0000 C1 D 11:07 *							I 6 ABX 40+ M			
0000 C0 D 11:18 *							I 6 BA 4 0+M			
0000 C1 D 11:28 *							I 6 AB X 0 + M			
0000 C0 D 11:38 *							I 6 BAX 0 + M			
0000 C1 D 11:49 *							I 6 A 4X 0 + M			
0000 C0 D 12:02 *							I 6 BAX4 0 + M			
0000 C1 D 12:13 *							I 6 A 4X 0 + M			
0000 C0 D 12:24 *							I 6 8 A X 0 + M			
0000 C1 D 12:34 *							I 6 8 A 4 X 0 + M			
0000 C0 D 12:45 *							I 6 8 A X 0 + M			
0000 C1 D 12:55 *							I 6 8 A 4 X0 + M			
0000 C0 D 13:10 *							I 6 8 A4 X0 M + M			
0000 C1 D 13:20 *							I 6 8 A 4 X0 M + M			
0000 C0 D 13:35 *							I 6 8 A 4 X0 + M			
0000 C1 D 13:37 *							I 6 8 A 4 X0M + M			
0000 C0 D 13:46 *							I 6 8 A 4 0X + M			
0000 C1 D 14:00 *							I 6 8 A 4 X0 M + M			
0000 C0 D 14:08 *							I 6 8 A 4 0X + M			
0000 C1 D 14:23 *							I 6 8 A 4 XM + M			
0000 C0 D 14:24 *							I 6 8A 4 X + M			
0000 C1 D 14:32 *							I 6 A 4 0X + M			

08/20/82	-5	0	5	10	15	20	25	30	35	40
0000 C1 D 14:48		1*					I 6	8 A 4 0 +X		
0000 C0 D 14:53		1*					I 6	8 A 4 0 X+ M		
0000 C1 D 15:01		1*					I 6	8 A 4 X +M		
0000 C1 D 15:17		1*					I 6	8 A4 0 +M		
0000 C0 D 15:17		1*					I 6	8 A4 0 +M		
0000 C1 D 15:26		1*					I 6	8 A 4X 0 +M		
0000 C1 D 15:41		1*					I 6	8 A4X 0 +M		
0000 C0 D 15:46		1*					I 6	8 A X 0 M+		
0000 C1 D 15:53		1*					I 6	8 A 4 X 0 +		
0000 C1 D 16:08		1*					I 6	8 A 4X 0 M+		
0000 C0 D 16:18		1*					I 6	8 A 4 X 0 M+		
0000 C1 D 16:25		1*					I 6	A 4 X0 + M		
0000 C1 D 16:40		1*					I 6	8 A 4 X 0 M+		
0000 C0 D 16:44		1*					I 6	8 A 4 X0 +		
0000 C1 D 16:51		1*					I 6	A 4 X + M		
0000 C1 D 17:06		1*					I 6	8 A 4X 0 M+		
0000 C0 D 17:13		*					I 6	8 A X 0 M+		
0000 C1 D 17:21		*					I 6	8A 4X0 + M		
0000 C1 D 17:36		*					I 6	8 A 40+ M		
0000 C0 D 17:42		*					I 6	8X A 0+ M		
0000 C1 D 17:49		*					I 6	8A 40 +		
0000 C1 D 18:05		*					I 6	X8 A0+ M		
0000 C0 D 18:08		*					I 6	X8 A+4 M		
0000 C1 D 18:12		*					I 6	X8A 0+ M		
0000 C1 D 18:27		*					I 6	X 8A+4 M		
0000 C1 D 18:43		*					I 6	X A0 4 M		
0000 C1 D 18:59	*						I 6	X A0 4 M		
0000 C1 D 19:14	*						I 6	X A0 4 M		
0000 C0 D 19:27	*						I 6	X +A8 4 M		
0000 C1 N 19:33							I 6	XA +8M4		
0000 C1 N 19:49							I 6	X A 0 4M		
0000 C1 N 20:05							I 6	XA 08 4		
0000 C1 N 20:20							I 6	X A 084		
0000 C0 N 20:22							I 6	X A 084		
0000 C1 N 20:29							I 6	A+ 084		
0000 C1 N 20:45							I 6	A+M0 84		
0000 C0 N 20:55							I 6	XA 0 4		
0000 C1 N 21:02							I 6	A+M0 4		
0000 C1 N 21:17							I 6	A+M0 4		

04/30/83	-5	0	5	10	15	20	25	30	35	40
1111 C1 D 10:33	*				6	X + A0 84				
1111 C1 D 10:48	*				6	X + A 84				
1111 C1 D 11:03	*				6	X + A0 84				
1111 C1 D 11:18	*				6	X + 0A84				
1111 C1 D 11:33	*				6	X + A004				
1111 C1 D 11:48	*				6	X + A004				
1111 C1 D 12:03	*				GM	X + A				
1111 C1 D 12:18	*				G	X + A0				
1111 C1 D 12:34	*				G	X + A4				
1111 C1 D 12:49	*				G	X + 80A				
1111 C1 D 13:04	*				GM	X + I0A				
1111 C1 D 13:19	*				GM	X + 8I0A				
1111 C1 D 13:35	*				GM	X + 80A				
1111 C1 D 13:50	*				G	X + 8 0A				
1111 C1 D 14:05	*				G	X + I4A				
1111 C1 D 14:20	*				G	X + I0 A				
1111 C1 D 14:36	*				G	X + 804A				
1111 C1 D 14:51	*				GM	X + 804A				
1111 C1 D 15:06	*				GM	X + 804A				
1111 C1 D 15:21	*				GM	X + 0 4A				
1111 C1 D 15:37	*				GM	X + 0 4A				
1111 C1 D 15:52	*				G	X + 804 A				
1111 C1 D 16:07	*				G	X + 08 4A				
1111 C1 D 16:22	*				GM	X + 08 4A				
1111 C1 D 16:38	*				GM	X + 0 4 A				
1111 C1 D 16:53	*				GM	X + 08 4A				
1111 C1 D 17:08	*				GM	X + 084IA				
1111 C1 D 17:23	*				GM	X + 084I A				
1111 C1 D 17:39	*				G	X + 0 84IA				
1111 C1 D 17:54	*				G	X + 0 84IA				
1111 C1 D 18:09	*				GM	X + 0 84IA				
1111 C1 D 18:24	*				GM	X + 0 84 IA				
1111 C1 D 18:40	*				GM	+ 0 84 A				
1111 C1 D 18:55	*				GM	X+ 0 A I				
1111 C1 D 19:10	*				GM	+ 0 A I				
1111 C1 N 19:25	*				GM	+ 0 A4 I				
1111 C1 N 19:40	*				GM	+ 0 A 4 I				
1111 C1 N 19:55	*				GM	+ 0 A 4I				
1111 C1 N 20:10	*				GM	+X0 A 4I				
1111 C1 N 20:26	*				GM	+X0 A 48I				
1111 C1 N 20:41	*				GM	+ X0 A 4I				
1111 C1 N 20:56	*				GM	+ 0 A 4 I				
1111 C1 N 21:11	*				GM	+ 0 A 4 I				
1111 C1 N 21:26	*				GM	+ 0 A 48 I				
1111 C1 N 21:41	*				GM	+ 0 A 4 I				
1111 C1 N 21:56	*				GM	+ A 4 I				
1111 C1 N 22:11	*				GM	+ A 4 I				
1111 C1 N 22:26	*				G	+ A 4 I				
1111 C1 N 22:41	*				G	+ A 48 I				
1111 C1 N 22:56	*				G	+ A0 4 I				
1111 C1 N 23:11	*				G	+XA0 4 I				
1111 C1 N 23:26	*				G	+ A0 4 I				
1111 C1 N 23:41	*				G	+A 0 4 I				
1111 C1 N 23:56	*				G	+A 0 4 I				

35/01/83	-5	0	5	10	15	20	25	30	35	40
1111 C1 N 00:12						6	+A 0	4	I	
1111 C1 N 00:27						6	+A 0	4	I	
1111 C1 N 00:42						6	+A 0	4	I	
1111 C1 N 00:58						GM	+A0	4	I	
1111 C1 N 01:13						6	A 0	48	I	
1111 C1 N 01:28						6	A 0	48	I	
1111 C1 N 01:43						GM	A+ 0	4	I	
1111 C1 N 01:59						GM	A+ 0	4	I	
1111 C1 N 02:14						MS A	+ 0	4	I	
1111 C1 N 02:29						MS A	+ 0	4	I	
1111 C1 N 02:45						MS A	+X 0	48	I	
1111 C1 N 03:00						MS A	+0	48	I	
1111 C1 N 03:15						MSA	+X0	4	I	
1111 C1 N 03:31						6 A	+X0	4	I	
1111 C1 N 03:46						MS A	+X0	4	I	
1111 C1 N 04:01						6 A	+X0	4	I	
1111 C1 N 04:17						6 A	+X0	4	I	
1111 C1 N 04:32						6 A	+X0	4	I	
1111 C1 N 04:47						6 A	+X0	48	I	
1111 C1 N 05:03						6 A	+X0	4	I	
1111 C1 N 05:18						6	AX0	4	I	
1111 C1 N 05:33						6 A	+X0	4	I	
1111 C1 N 05:49						6 A	+X0	4	I	
1111 C1 N 06:04						6A	+X0	4	I	
1111 C1 N 06:19						6A	+X0	4	I	
1111 C1 N 06:35						6A	+0	4	I	
1111 C1 N 06:50						6A	+0	4	I	
1111 C1 D 07:05 *						MSA	+0	4	I	
1111 C1 D 07:21	*					6 A	+0	84	I	
1111 C1 D 07:36	*					6 A	+0	4	I	
1111 C1 D 07:52	*					6 A	+0	4	I	
1111 C1 D 08:07	*					6 A	X+	4	I	
1111 C1 D 08:23	*					6	A+0	4	I	
1111 C1 D 08:38	*					6	A0	84	I	
1111 C1 D 08:53	*					6	+0A84		I	
1111 C1 D 09:08	*					6	+ 0A4		I	
1111 C1 D 09:23	*					6	X+0A4		I	
1111 C1 D 09:38	*					6	X+ 0A4		I	
1111 C1 D 09:53	*					6	X +04	A	I	
1111 C1 D 10:08	*					6	X+0	4 A	I	
1111 C1 D 10:23	*					6	X +04	AI		
1111 C1 D 10:38	*					6	X +0	A		
1111 C1 D 10:54	*					GM	X8+0	AI		
1111 C1 D 11:09	*					6	X + 0	AI		
1111 C1 D 11:24	*					6	X + 0	AI		
1111 C1 D 11:39	*					6	X + 0	AI		
1111 C1 D 11:54	*					6	X 8+0	AI		
1111 C1 D 12:09	*					6	X 8 +	A		
1111 C1 D 12:25	*					6	X 8 +	A		
1111 C1 D 12:42	*					6	M	8X+0	I	A
1111 C1 D 12:55	*					6	M	8 X +	I	A
1111 C1 D 13:10	*					6	M	8X +0	I	A
1111 C1 D 13:26	*					6	M	X8 +0	IA	
1111 C1 D 13:41	*					6	M	8 X +0		A
1111 C1 D 13:56	*					6	M	X +0I	A	
1111 C1 D 14:11	*					6	M	X8 +0	I	A
1111 C1 D 14:27	*					6	M	X +	I	A
1111 C1 D 14:42	*					6	G	8 +0	I	A
1111 C0 D 14:46	*					6	M	8 X+	I	A

05/20/83	-5	0	5	10	15	20	25	30	35	40
0000 C1 N 21:28						MG	AX +184			
0000+C1 N 21:43						MG	A +08 4			
0000+C1 N 21:44						MG	A X+8 4			
0000+C1 N 21:44						MG	A +08 4			
0000+C1 N 21:45						MG	A X+0 4			
0000+C1 N 21:45						MG	A X+0 4			
0000+C1 N 21:50						MG	A+0 84			
0000+C1 N 21:50						MG	A+0 84			
0000+C1 N 21:51						MG	A+0184			
0000 C1 N 22:06						M 6	XA + 84			
0000 C1 N 22:21						M 6	XA+0 84			
0000 C1 N 22:36						M 6	XA+084			
0000 C1 N 22:51						M 6	AI+084			
0000 C0 N 22:54						M 6	AI+084			
0000 C1 N 23:05						M 6	AI+084			
0000 C1 N 23:20						M 6	A+ 084			
0000 C0 N 23:21						M 6	A+0 84			
0000 C1 N 23:30						M 6	AI+084			
0000 C0 N 23:44						M 6	A+0 84			
0000 C1 N 23:54						M 6	AX+0 84			

05/21/83	-5	0	5	10	15	20	25	30	35	40
1111 C1 D 13:51	*					6	8 X4+	A		
1111 C1 D 14:06	*					6	8 X+	A		
1111 C1 D 14:22	*					6	8 X+	A		
1111 C1 D 14:37	*					6	8 X+	A		
1111 C1 D 14:53	*					6	8 X+	A		
1111 C1 D 15:08	*					6	8 X+	A		
1111 C1 D 15:23	*					6M	8X +	A		
1111 C1 D 15:39	*					6M	8X +	A		
1111 C1 D 15:54	*					6M	8 X+	A		
1111 C1 D 16:09	*					6M	8 X+	A		
1111 C1 D 16:25	*					6M	8 X+	A		
1111 C1 D 16:40	*					6	8 X0+	A		
1111 C1 D 16:56	*					6	8X0+	A		
1111 C1 D 17:11	*					6	X +I	A		
1111 C1 D 17:27	*					6	X8 +I	A		
1111 C1 D 17:42	*					6	X8 +I	A		
1111 C1 D 17:57	*					6	X8+4I	A		
1111 C1 D 18:13	*					6	X +04I	A		
1111 C1 D 18:28	*					6	X + 4I	A		
	*					6	X+0 4I	A		