Thank you for your interest in Aeolian Kinetics' PDL-24
Programmable Data Logger - selected by the Solar Energy
Research Institute for its nationwide passive solar home
monitoring program.

The PDL-24 is an extremely versatile instrument, capable
of performing a wide range of data acquisition and analysis
tasks. Although developed for solar research, the system
has been employed in meteorological and environmental data
acquisition; energy monitoring/control; and general engineer-
ing applications.

Feel free to contact us directly with your questions and
you data requirements.

Sincerely yours,

ANDREW M. SHAPIRO
Applications Engineer

Enclosure
AMS/eas

"It's easier than it first appears. Once you start using the system,
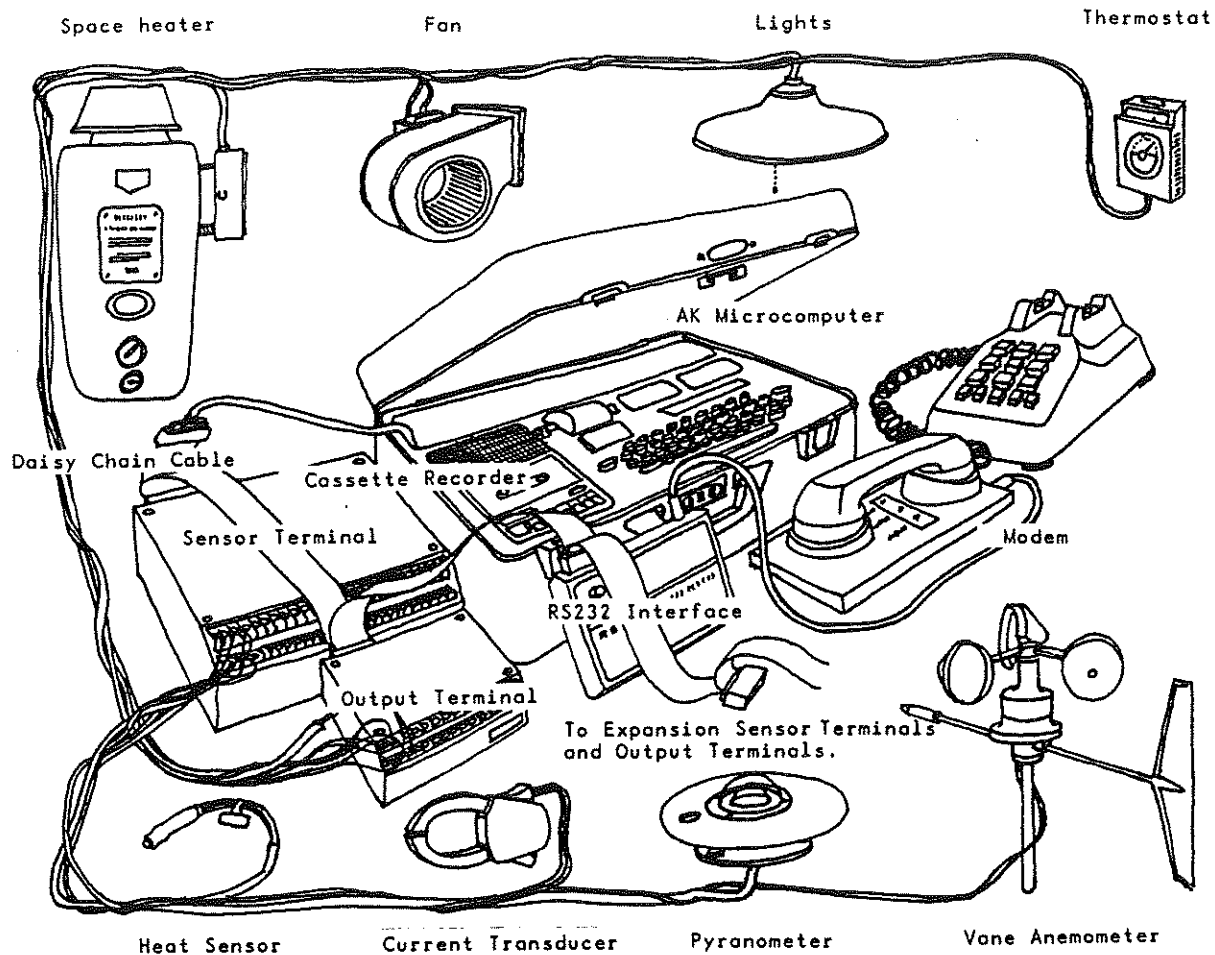its logic and flexibility become very clear." A PDL-24 user

THE SYSTEM

Aeolian Kinetics has combined state-of-the-art computer technology with
sophisticated software to yield a powerful and easy-to-use data acquisition
system. The PDL-24 Monitoring System both monitors the activity of sensors
and performs analysis of the sensed data. Preliminary analysis occurs
simultaneously with the collection of data; further analysis occurs by
reading the stored data back into the System. Analysis, performed under
user control, is fully programmable in the BASIC computer language. Data
and results of preliminary analysis are printed on paper tape and stored on
magnetic cassette tape; results of further analysis are printed on paper
tape.

In its minimum configuration the PDL-24 can accept inputs from 22 sensors --
14 analog or digital and 8 status. Any sensor generating an output which
varies with the quantity measured can be used with the system. Expansion of
the System can occur in several ways. It can be made to communicate with
other computer systems, it can generate on/off outputs, and can accept up to
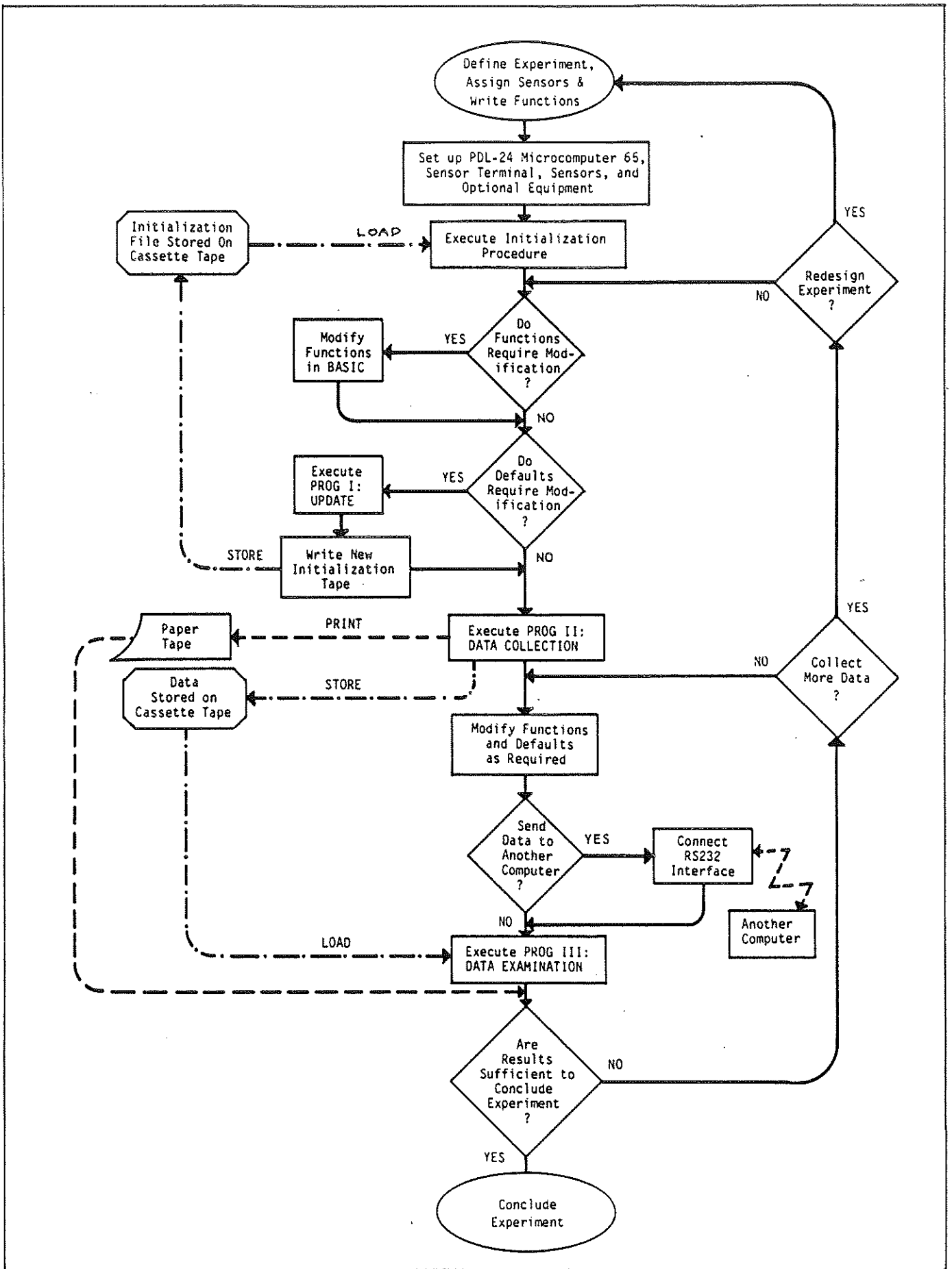56 analog or digital sensors, 32 status sensors, and 32 output relays.

Features

- STATE-OF-THE-ART: Microcomputer based data acquisition system performs real time analysis while data is being collected. Data results are stored on cassette tape and printed on paper tape for further analysis.

- FULLY PROGRAMMABLE:

  *FUNCTIONS - The user may create up to 50 functions which correlate sensor readings, alter output port conditions, and force printouts to record special events.
  *PRINT INTERVAL - The on-board printer can be instructed to print data summaries, time of events, sensor values at any interval of up to one year in duraction.
  *FUNCTION & DATA STORAGE INTERVALS - Data and function values are stored on cassette tape at user-specified intervals.
  *SENSOR CALIBRATION - The PDL-24 can accept slope and intercept data to linearize and calibrate sensor readings to engineering units.

- SIGNAL CONDITIONING: All analog sensor levels can be matched to the PDL-24 using "plug-in" signal conditioning cards.

- REAL TIME CLOCK: The PDL-24 maintains a quartz crystal clock and perpetual calendar (Leap Years included!) to an accuracy of ± 2 seconds/day.

- RAPID SCAN RATE: Each sensor is read for 1/30 second, every 15 seconds (user can re-program scan rate.)

- DIRECT ACCESS TO SENSOR READINGS: Numerous keyboard options allow the users to examine sensor readings and perform special tasks without interrupting data collection.

- CASSETTE STORAGE: Accumulated data is stored on cassette tape at regular, user-specified intervals. The permanent data can be analyzed with the PDL-24 software or transferred to another system for further analysis.

- BATTERY BACKUP: The PDL-24 contains a rechargeable battery pack to power the unit during power failures or remote use.

- TRULY PORTABLE: The PDL-24 is packaged in a rugged aluminum carrying case and weighs 32 pounds.

- EXPANDABLE: The PDL-24 can accept up to four Sensor Terminals and four Output Terminals, offering up to 56 analog/digital channels, 32 status channels, and 32 output ports.

- OUTPUTS: The PDL-24 can generate binary outputs controlling relays which power furnaces, control processes or other electronic devices.

- RS232 INTERFACE: The PDL-24 can be connected to other computer systems using the optional RS232 Interface (and modem, if needed).

Space heater   Fan   Lights   Thermostat

AK Microcomputer

Daisy Chain Cable

Cassette Recorder

Sensor Terminal

Modem

RS232 Interface

Output Terminal

To Expansion Sensor Terminals and Output Terminals.

Heat Sensor   Current Transducer   Pyranometer   Vane Anemometer

SYSTEM OPERATION

The PDL-24 Monitoring System has been designed so that it can be used by both the novice and the experienced user. For example, a homeowner or technician can set up the System and have it running in a short time using prepared programs stored on cassette tape. He/she can "initialize" the System and begin data collection by hitting only a few keys on the keyboard. Accumulated data and functions relating the sensor readings to one another will automatically store on cassette tape and print out at regular intervals. This user need only change the cassette and paper tape at regular intervals. Depending on the extent of data being stored, a 60-minute cassette tape will store upwards of six weeks' data per side. After data has been collected, further analysis can be done using the System in "Data Examination" mode or by sending the cassette to more experienced personnel at a central location (or by transmitting the data over telephone lines using the optional RS232 Interface and modem).

The more experienced user or researcher can perform on-line, real-time inspection and analysis of data. He/she can easily modify the sensor assignment and implement new mathematical and logic functions relating the sensor readings to one another. Furthermore, the researcher can perform on-line analysis of previously collected data.

```
                    ┌─────────────────────┐
                    │  Define Experiment, │
                    │  Assign Sensors &   │◄──────────────────────┐
                    │   Write Functions   │                       │
                    └─────────────────────┘                       │
                               │                                  │
                    ┌─────────────────────────┐                  │
                    │ Set up PDL-24 Microcomputer 65,            │
                    │ Sensor Terminal, Sensors, and              │
                    │  Optional Equipment     │                  │
                    └─────────────────────────┘                  │
                               │                            YES   │
  ┌──────────────┐   LOAD  ┌──────────────────┐                  │
  │Initialization│········►│Execute Initialization│              │
  │File Stored On│         │     Procedure     │◄────────┐       │
  │Cassette Tape │         └──────────────────┘          │   ╱──────╲
  └──────────────┘                  │                    │  ╱ Redesign╲
                                    ▼                    └─┤Experiment ├
                          ╱──────────────╲    NO            ╲    ?    ╱
  ┌────────────┐  YES    ╱ Do Functions   ╲                  ╲──────╱
  │  Modify    │◄───────┤  Require Mod-    │
  │ Functions  │         ╲ ification       ╲
  │ in BASIC   │          ╲      ?         ╱
  └────────────┘           ╲──────────────╱
        │                         │ NO
        │              ┌──────────▼────────╲
        │             ╱  Do Defaults        ╲
  ┌──────────┐  YES  ╱   Require Mod-        ╲
  │ Execute  │◄─────┤    ification           │
  │ PROG I:  │       ╲       ?               ╱
  │ UPDATE   │        ╲─────────────────────╱
  └──────────┘               │ NO
        │                     │
  ┌──────────────┐  STORE     │
  │ Write New    │············│
  │Initialization│            │
  │   Tape       │            │
  └──────────────┘            │
                              ▼                               YES
  ┌──────────┐   PRINT  ┌──────────────────┐                  │
  │  Paper   │◄─────────│Execute PROG II:  │              ╱──────╲
  │  Tape    │          │DATA COLLECTION   │◄────────────┤Collect ├
  └──────────┘          └──────────────────┘   NO         ╲More Data╱
                              │                            ╲   ?   ╱
  ┌──────────┐  STORE         │                             ╲────╱
  │  Data    │◄···············│
  │Stored on │                │
  │Cassette  │                ▼
  │  Tape    │      ┌──────────────────┐
  └──────────┘      │ Modify Functions │
                    │ and Defaults     │
                    │ as Required      │
                    └──────────────────┘
                              │
                    ╱──────────────╲
                   ╱    Send         ╲  YES  ┌──────────┐
                  ╱  Data to          ╲─────►│ Connect  │◄─ ─ ─7
                 ┤  Another           ├      │ RS232    │  ╱
                  ╲  Computer         ╱      │Interface │ ∠──7
                   ╲      ?          ╱       └──────────┘
                    ╲──────────────╱              │
                         │ NO                     ▼
                         │                   ┌──────────┐
  ┌──────────┐   LOAD    │                   │ Another  │
  │ (data)   │···········│                   │ Computer │
  └──────────┘    ┌──────────────────┐       └──────────┘
                  │Execute PROG III: │
                  │DATA EXAMINATION  │
                  └──────────────────┘
                         │
                ╱─────────────────╲
               ╱      Are           ╲
              ╱     Results          ╲  NO
             ┤  Sufficient to         ├──────────────►
              ╲   Conclude           ╱
               ╲  Experiment        ╱
                ╲      ?           ╱
                 ╲────────────────╱
                      │ YES
                ┌──────────────┐
                │  Conclude    │
                │ Experiment   │
                └──────────────┘
```

The great advantage of a computer-based data acquisition system over a simple data logger is that the sensor data can be processed according to a user-specified program while data collection takes place. This allows function values to be calculated from the sensed data, decisions to be made according to the values, and special events to be recognized and noted by the computer. This program is written in the BASIC* computer language and is executed each time the sensors are read. The System offers the user tremendous flexibility within this arrangement. Functions which relate sensor readings to one another can be entered into the program; instructions can be entered to note the occurrence of special or unusual conditions; and signals can be sent to specific output ports to control other mechanical or electrical systems via relays.

Four major components make up the PDL-24 Monitoring System: the sensors, the AK Sensor Terminal(s), the AK Microcomputer 65, and the Software. Each of these is discussed below.

SENSORS and SENSOR TERMINAL(S)

Some typical sensors (transducers) which can be used with the PDL-24 include temperature probes, pressure transducers, radiation sensors, electric current transformers, voltage sensors, electric power transducers, heat flow sensors, liquid or gas flow transducers, humidity sensors, on/off sensors and a wealth of others.

Each sensor connects to the Sensor Terminal (or one of the Expansion Sensor Terminals). Signal conditioning cards, which fit into the Sensor Terminal, modify the sensor's electrical output so that it is compatible with the System. The interchangeability of signal conditioning cards (which each plug into a slot corresponding to a channel) allows a wide range of sensors to be connected to the System.

In addition to analog and pulse counting (digital) sensors, status sensors (switches) which indicate on/off, closed/open, and yes/no conditions can be connected to the System directly without a signal conditioning card.

OUTPUT TERMINALS

Optional Output Terminals, which can be connected to the System, generate low level signals sufficient for operating relays to control a number of mechanical and electrical devices, such as solenoid valves, motors, thermostats, and others. Functions controlling the signals can be based on sensor readings, time-of-day, or other programmable relationships.

* BASIC (Beginners All-purpose Symbolic Instruction Code)

MICROCOMPUTER 65

The Microcomputer 65 includes the necessary electronic hardware and software for acquiring, manipulating, and analyzing the data from the Sensor Terminal. With the optional RS232 interface, the Microcomputer 65 can act as terminal or input/output device to another computer. With a modem, this communication can take place over telephone lines. The battery backup allows the System to continue operating during a two-to-three hour power outage.

SOFTWARE

The Software is the collection of computer programs (in both machine language and in BASIC) that enables the components of the System and the user to interface with each other. The Software is comprised of an initialization procedure (start-up) and three routines -- a default updating routine, a data collection routine, and a data examination routine.

INITIALIZATON

In the initialization procedure, a file containing system operating parameters is loaded from cassette tape into the Microcomputer 65. The initialization file includes default values for user-specified constants, channel processing directives, and sensor calibrations. It also contains a default function program which relates sensor readings to one another and one-time values. The defaults supplied with the PDL-24 and explained in this manual are based on the SERI/DOE* Class "B" National Passive/Hybrid Performance Evaluation Program, explained in Appendix V. These defaults may be used as a departure point for creating similar programs or may be replaced completely.

PROGRAM UPDATING

"PROG I: Update" is used to enter sensor calibrations, specify channel processing options, and modify the intervals at which the functions are stored and printed. These values and the functions can be modified to fit the needs of the particular user or a particular run of the Data Collection or Data Examination routines. The modifications along with new or modified functions can be stored on cassette tape and re-entered into the System at a later date in place of the original initialization file.

*Solar Energy Research Institute of the U.S. Department of Energy.

DATA COLLECTION

After the System is initialized and updated, the second routine, "PROG II: Data Collection" is run. During this routine sensors are read every fifteen seconds. Totals, averages and functions (defined in the function program) are computed at fifteen second intervals. At user-specified intervals, the channel totals and averages, and function values are printed; channel data is stored on cassette tape; and function values are stored on cassette tape. These data tapes can be used in later analysis. At a fourth interval, function values are zeroed. Zeroing the functions at specified intervals allows for automatic calculation of data totals for parts of the diurnal cycle or for periods of longer duration.

Flow of information
in the PDL-24 System
During Data Collection
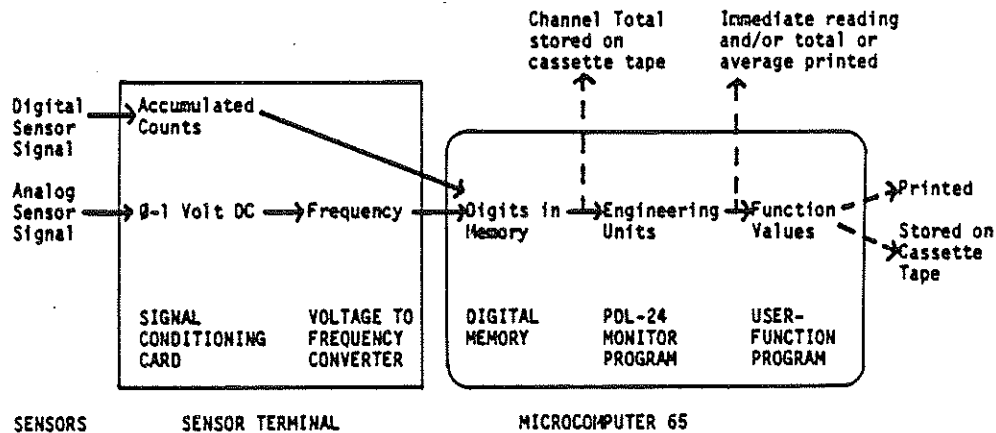
With appropriate programming by the user, some functions can be computed at one interval and others computed at another interval. For example, averages of various temperatures and types of energy use may be computed daily while some complex interaction of these may be computed on a monthly basis.

While data is being collected, the time of day is flashed to the display and printed after every reading. Typing single characters at the keyboard allows the user to instruct the System to perform various operations, such as examine the instantaneous readings of any or all sensors, or turn off the printer. One can also force a printout of totals and function values or a zeroing of totals and averages. It is also possible to stop the Data Collection routine, modify the function definitions in order to more closely examine some observed situation, and then continue collecting data.

DATA EXAMINATION

In the final part of the software, "PROG III: Data Examination," the data that has been stored on cassette is examined and analyzed. Data for a specified interval is read in, printed out, and operated on by user-defined functions. After all the data which is being examined has been entered, the computed function values are printed. Using the optional RS232 interface, data can be transferred to another computer during Data Examination.

Specifications

System

Sensor Inputs:

Analog Channels

- 2 reference voltage levels
- 14 single ended
- 0-1 volt full scale
- 250 M Ω input resistance

Switch Channels

- 8SPST (NO or NC)

Analog to Digital Conversion

- Resolution: 1 part in 3333 (11-1/2 bits accuracy)
- Linearity error: < +.05% full scale
- Temp. Coefficient: +30 ppm/°C
- Conversion time: 33 Microseconds

Data Storage

30 days per side on C-60 cassette storing 10 channels and 10 functions hourly

Programmable Variables

- Sensor calibrations (slope + intercept)
- Channel totals/averages
- Print Interval
- Channel Store Interval
- Function Store Interval
- Function Zero Interval
- 100 user-defined functions
- User-defined constants
- 3 special variables
- Channel print/process/store
- RS232 interface (optional)

Major Software Routines

- Initialization/Update Defaults
- Data Collection
- Data Examination

Real Time Clock & Calendar

- Quartz crystal timebase accurate to ÷2 seconds/day (battery backup provided)
- Data filed by month, day, hour, minute for easy retrieval

Expansion Capability

- **Up to 56 analog/digital and 32 status channels**
- **Up to 32 output relays**

Hardware

Physical

	Microcomputer 65	Sensor Termina
Width:	17.0 in	8.0 in
Height:	7.5 in	3.0 in
Length:	21.0 in	8.0 in
Weight:	27 lb	2 lb

Power Supply

Power Requirements: 120 VAC, 60 Hz
Battery Pack Data
- Rechargeable sealed lead-acid cells
- Operates from AC while charging
- Battery test indicator
- 2 hour operation from full charge

Environmental

- Operating Temperature: 0°C - 70°C
- Storage Temperature: -40°C - 70°C
- Humidity: 0-95% Rh without condensation

Cassette Recorder

- Panasonic RQ-2785 Cassette Recorder
- Auto stop, built-in microphone
- Tape counter
- Automatic level control

Thermal Printer

- 64 ASCII alphanumeric characters and symbols
- 120 lines per minute
- 20 column, 5X7 dot matrix

Keyboard

- Standard 54 key layout
- full ASCII alphanumerics and symbols plus control and function keys

Processor and Peripherals

- 6502 8 bit CPU at 1 MHz
- 6532 RAM Input/Output Timer
- 6522 Interface Adapters

Memory

- 8K ROM System Monitor
- 8K ROM PDL-24 Monitor
- 8K BASIC Interpreter
- 5K User RAM (expandable)

Sampling Rate

One complete scan every 15 seconds

Input/Output

- 20 ma. current loop TTY interface (RS232C optional)
- Two audio cassette interfaces
- Two 8 bit bidirectional I/O ports (TTL levels)
- 44 Pin Application Connector
- 44 Pin Expansion Connector

Documentation

Full software and hardware documentation includes:

- PDL-24 User's Guide
- BASIC Programming Manual
- Hardware Guide
- User Operating Manual
- Monitor Listing
- Machine Language Programming Manual
- System reference cards

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PDL-24 Monitoring System Price List
1 July 1983


Item                                                Price
---------------------------------------------       --------


PDL-24 Monitoring System (5 K RAM)                  5400.00
Expansion Sensor Terminal --------------------- 886.00
Output Terminal                                      570.00
RS-232 Interface - DUMB ----------------------- 403.00
RS-232 Interface - SMART                             518.00
Communication Modem --------------------------- 253.00
Auto-Answer/Auto-Dial Modem                          443.00


Expansion of MC65 RAM to 6 K)----------------- 126.00
Expansion of MC65 RAM to 8 K)                        380.00
Expansion of MC65 RAM to 16 K)--------------- 1725.00
Expansion of MC65 RAM to 24 K)                      1955.00


PDL-24 Daisy Chain Bus Cable ----------------- 66.00
      with 1 female, 2 male connectors
Additional Male connectors, each                      18.00


PDL-24 User Manual --------------------------- 64.00
PDL-24 Schematic set                                 58.00


Double Cassette Recorder Option -------------- 575.00


Special Firmware and Software
INIT1 on  PROM ------------------------------- 250.00
Special initialization on PROM                       315.00
PDL-24 firmware only ------------------------- 885.00
MXB board                                            127.00
2114 chip on MXB, each ----------------------- 6.00


Auto Answer Software Package ----------------- 380.00
Cassette Emergencey Store Software                   63.00
Auto-Dial Software --------------------------- 127.00
Copies of Auto Answer software, per system           66.00


Accessories

PDL-24 Tape Reader --------------------------- 2400.00


Data Cassettes, 12 C-60 --------------------- 55.00
                12 C-10                             39.00


Printer Paper, 3 roll set -------------------- 9.00
Paper winder                                         195.00
Lid clip ------------------------------------- 13.00
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Spare Fuse Kit for PDL-24 and TPM 101 and 105    95.00
Spare Parts Kit, including data sheets --------253.00
Spare Parts Kit, w/ schematics & data sheets   316.00


Sensor Wire 2-cond 24 AWG individually          .23/ft
            shielded conductors w/drain wire    .75/m
            9-conductor 24 AWG, shielded        .58/ft
                                               1.88/m
```

Sensors

```
Hollis MR5/122 ----------------------------------- 242.00
Eppley Black and White (model 8-48)             1320.00
Amprobe --------------------------------------------  52.00
Duncan pulse initiating KWH                      180.00
      200 amp, 240 V, 1 phase
Line Voltage, 80 - 150 VAC-------------------      40.00
              160 - 300 VAC                      138.00


AD-590 J-Grade
      A --------------------------------------------- 35.00
      B                                            35.00
      C ---------------------------------------------- 58.00
      D                                            63.00
      E --------------------------------------------- 69.00
AD-590, K-Grade
      A --------------------------------------------- 41.00
      B                                            41.00
      C ---------------------------------------------- 63.00
      D                                            69.00
      E ---------------------------------------------- 75.00

WPA-10 anemometer (contact type) -----------      76.00
RM Young 05102 anemometer/direction sensor      1093.00

DE-1000 wind direction ----------------------     110.00
Weathertronics 24301 Vane Anemometer             716.00

AK/Vaisala RH Package ----------------------- 677.00
      Vaisala HMK11 Calibrator                   380.00
      Vaisala Spare Sensor Element ------------ 155.00
      Vaisala 6685 37 micron filter               44.00

C700-FE water flow meter (5/8x3/4)              175.00
    -D (register retained)                       175.00

Setra 270 barometric pressure sensor package  1670.00

Microswitch -------------------------------------------- 13.00
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Fenwall thermal switch                                    42.00
Relay, 110 VAC --------------------------------------- 29.00

Rockwell R-275 Pulse-initiating gas meter        210.00
Signal Conditioning Cards

                    ----------------------------------- 58.00
Hollis  --------------------------------------------  58.00
Amprobe
MV amplifier, specify range  -------------------- 85.00
Offset amplifier, specify range                  108.00
AD-590 --------------------------------------------- 25.00
Jumper                                                21.00
0 - 5 VDC voltage divider ----------------------- 58.00
    specify 5K or 50K ompedance
0 - 1 mA  (1K input impedance)                        58.00
0 - 20 mA (50 ohm input impedance)------------ 58.00
Pulse counting, specify 0-25, 0-500,                  74.00
    or 0-2500 Hz.


Accessories

Outdoor Radiation Shield ----------------------- 75.00
Sunspace   "            "                             34.00
Indoor     "            "    ------------------- 23.00

TPM-101 ------------------------------------------- 86.00
TPM-105                                              408.00
TPM-115 ---------------------------------------- 157.00
TPM-230                                              195.00

Spare Sensor Terminal fuses, box of 5                12.00
    specify pico fuse (old type) or
    Micro fuse (new type)

                                                    489.00
DC Power Kit

                                                     86.00
PDL-24 Main Bus Cable
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(file PDLXPRIC:AMS6)

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