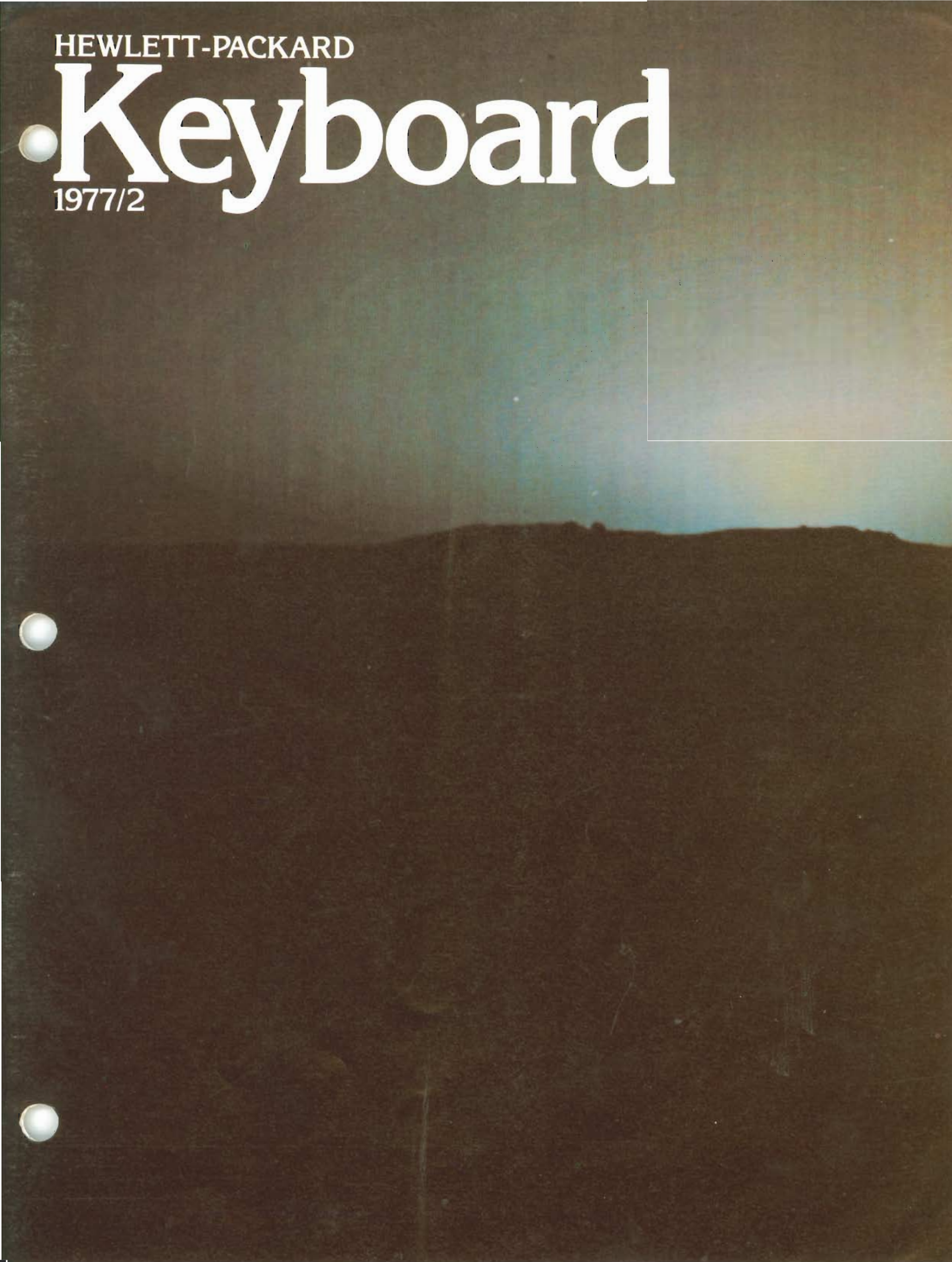
HEWLETT-PACKARD

# Keyboard

1977/2



**Overview**

The cover photograph for this issue is a Martian sunset. We are indebted to the Image Processing Laboratory at the Jet Propulsion Laboratory for this spectacular shot, as well as the photographs accompanying the article, "More on the Viking Mission." Further information on the cover photograph is on page 3.

Our editor for the feature column, "Crossroads", John Nairn, has once again become inundated with other work and the column will be missing in this issue. He promises to be back with us in our next issue to discuss the brainteasers he presented in the last issue (1977/1). "Crossroads" is one of our most popular regular columns and every effort is made to offer it to you each issue, but conflicting priorities occasionally happen - hopefully for the last time.

I have received a number of article outlines for possible future KEYBOARD articles. Thank you very much for your response. I hope to receive even more, so if you have been hesitating about sending in an article outline, please don't hesitate longer.

For the second consecutive year, KEYBOARD has won awards on graphic and journalistic excellence. Hal Andersen and I are pleased to receive this recognition, but our primary goal is to present information that is useful and interesting to you. To this end we are asking for your comments on what you like, what you don't like, and what you would like to see in KEYBOARD. If we feel we are achieving all three — good graphics, good writing, and good, relevant information — we will feel that he, I, and you, the reader, will all be winners.

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1977/2

## Features



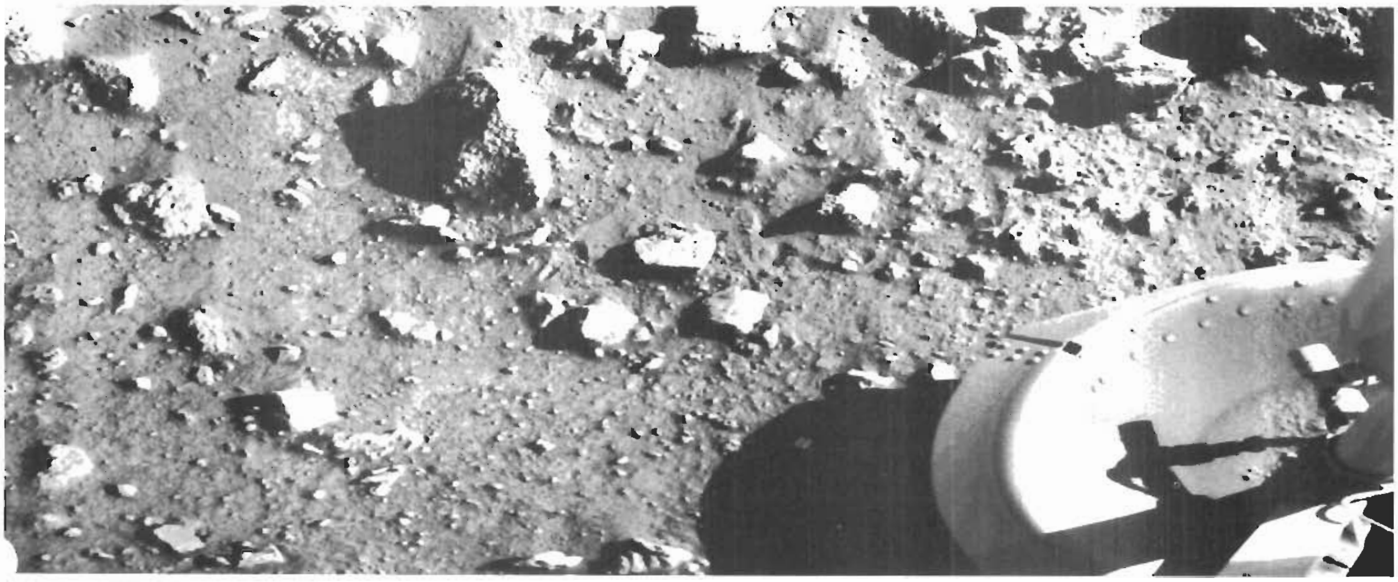
## Departments

# More on the Viking Mission

## The Viking Lander Imaging Team's Use of the 9830A

›y Robert Tucker, Genetics Department, Stanford University
Medical School, Stanford, California, 94305





This is the first photograph ever taken on the surface of the planet Mars. It was obtained by Viking 1 just minutes after the spacecraft landed successfully on July 20. The center of the image is about 1.4 meters (five feet) from Viking Lander camera #2. At the left is a vertical linear dark band which may be due to a one-minute partial obscuration of the landscape due to clouds or dust intervening between the sun and the surface. The large rock in the center is about 10 centimeters (four inches) across and shows three rough facets.

Two hundred and twelve million miles from Earth, on July 20, 1976, the Viking 1 Lander separated from its Orbiter spacecraft, touched down on Chryse Planitia, and began its work exploring the surface of Mars. The Viking 2 separated from its Orbiter on September 3 and landed at the Utopia site to begin similar work. The "eyes" of the Landers are two cameras mounted 0.8 m apart on top of each lander directed by an on-board computer that performs the imaging sequences designed by the Lander Imaging Team.

### The Viking Cameras

The unique design of the cameras deserves special attention. Each camera consists of a mirror, nodding in elevation and rotating in azimuth such that the field of view 100° in elevation and 342.5° in azimuth can be incrementally directed hrough a lens to any of 12 photosensors. ľhe instantaneous field of view may be either 0.12° or 0.04°. The scanning is done in increments of the same size.

A single vertical scan line consists of 512 such picture elements, acquired in a bottom-to-top rapid sequence. Successive scan lines are acquired in a left-to-right order.

The mechanical image scanning system also provides for a selection of elevation pointing angles and azimuth start/stop angles. Some of the photosensors are equipped with filters so that color photos can be reconstructed; imaging can be done in three near-infrared spectral bands.

The data can be sent directly from the Lander to Earth, sent to one of the Orbiters for relay to Earth, or stored by an on-board tape recorder for later transmission.

An image, then, consists of many small picture elements, or pixels, each of which is assigned a digital value and transmitted to Earth. On Earth the digital values are used to selectively expose the picture elements on film or intensify points on a television screen to reproduce the image. The images acquired by the camera's scanning method are distorted when reproduced in the simple rectilinear manner used in the photos appearing with this article. Also, the fact that the Landers rest at a slight tilt must be taken into account when interpreting the photos.

Light weight was an important consideration in the design of the Landers. Each camera, including mirror, lens, 12 photosensors, the motors controlling mirror position, microcomputer, associated electronics, and fibre-glass-type housing, weigh 16 lbs. (7.26 kg). They were designed to withstand such environmental extremes of heat as +113°C (+235°F) during sterilization on Earth and temperatures on Mars as cold as −126°C (−195°F). Extensive protection against Martian dust storms was also provided.

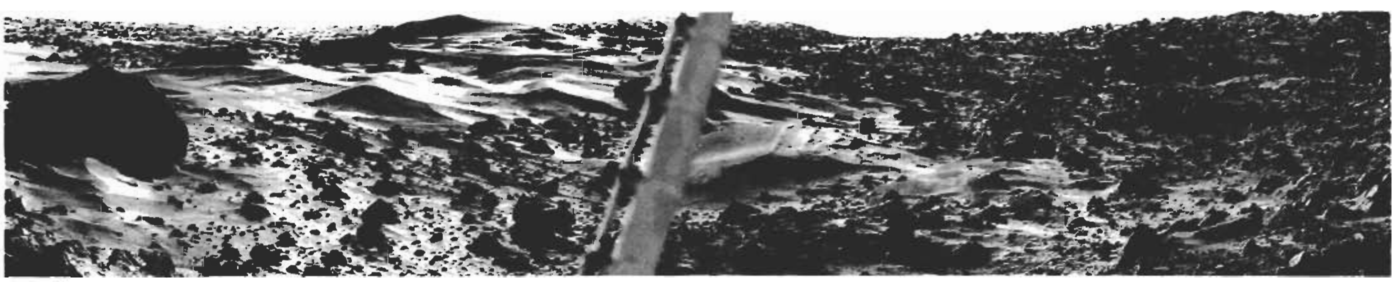
### The Imaging Team's Task

The basic objectives of the imaging investigation are to study and characterize the Martian landscape, perform certain celestial observations, and support other Lander science investigations.

The Lander Imaging Team used the 9830A for data management, engineering calculations, simulation of certain on-board activities, and generating graphics on a plotter for the planning and verification of camera system commands.

The task of preparing commands for the Viking Lander cameras is complex. The Team receives allotments of "uplink" bits (commands) and "downlink" bits (image

Sand dunes and large rocks are revealed in this panorama picture of Mars, the first photograph taken by Viking 1's Camera 1 on July 23. The horizon is approximately three kilometers (two miles) away. The late afternoon sun is high in the sky over the left side of the picture. The support struts of the S-band high-gain antenna extend to the top of the picture. The American flags are located on the two (Radioisotope Thermoelectric Generator) wind screens. In the middle third of the picture, the rocky surface is covered by thick deposits of wind-blown material, forming numerous dunes. At the center of the picture on the horizon are two low hills which may be part of the rim of a distant crater. Two very large rocks are visible in the middleground; the nearer one is three meters (10 feet) in diameter and is eight meters (25 feet) from the spacecraft. The meterology boom is located right of center. Behind it, the "White Mesa" is visible. In the near ground are numerous rocks about 10 cm (4 inches) across, with horseshoe-shaped scour marks on their upwind side and wind tails in their lee. The fine-grained material in front of them contains small pits formed by impact of material kicked out by the Lander spacecraft's rocket engines.



This spectacular picture of the Martian landscape by the Viking 1 Lander shows a dune field with features remarkable similar to many seen in the deserts of Earth. The dramatic early morning lighting — 7:30 a.m. local Mars time — reveals subtle details and shading. Taken August 3 by the Lander's Camera #1, the picture covers 100°, looking northeast at left and southeast at right. Viking scientists have studied areas very much like the one in this view in Mexico and in California. The sharp dune crests indicate the most recent wind storms capable of moving sand over the dunes in the general direction from upper left to lower right. Small deposits downwind of rocks also indicate this wind direction. The large boulder at left is about eight meters (25 feet) from the spacecraft and measures about one by three meters (three by ten feet). The meteorology boom, which supports Viking's miniature weather station, cuts through the picture's center.

data). An important part of the job is to maximize the use of the allotments.

During the primary phase of the Viking mission, downlinks generally occurred daily and uplinks occurred every two days. A particular uplink was in the planning stage for about 16 days. For ease of planning, three successive uplinks were combined into a "cycle" and planned together by a three-person squad. Thus, three squads were planning picture sequences at the same time. The Viking Lander's on-board computer has a series of tables in its memory to dictate the time images are to be taken, the elevation and azimuth angles for the camera scanning, the gain, the offset, and other specifications. It is the contents of these tables that the cycle squads planned. The HP 9830A maintained a copy of these tables as they existed at a given uplink point. One cassette tape was used to hold this information for each uplink.

During the planning of an uplink, the 9830A programs ensured that the plan stayed within the budget of uplink and downlink data bits and that certain on-board timing constraints were met. The final step in the planning was the plotting of the image positions on a preprinted "skyline drawing" using the 9862A plotter. These plots provided graphic feedback to the squad members to assure them that their images were positioned on the scene as planned. Listings were also prepared of the on-board data base contents, the required changes to it, and a day-by-day list of expected images.

During the 16-day planning period, the uplink could undergo as many as five major modification steps and many more internal or candidate revisions. One of the more difficult problems faced in the planning was that of a modification of an uplink having important consequences for a later uplink. It was important that a planning squad know exactly what the on-board data base contents would be when their uplink was sent to Mars. The results of the Imaging Team planning process were forwarded to a group that consolidated the

The Viking 2 Lander photographed this rocky scene shortly after touchdown on September 3 on the northern plains of Mars in a region known as Utopia. The picture sweeps around all but about one-tenth of the view from the Lander. The surface is strewn with rocks ranging in size up to several meters. There is no indication of sand dunes in the scene, although deposits of fine-grained material occur beneath and between boulders. This picture has been geometrically rectified to account for the fact that the spacecraft landed with an 8° tilt toward the west.

plans of all science teams. Large-scale computer systems then checked the validity of the entire set of Viking Lander uplink commands and prepared them for transmission. The imaging portion of this consolidated set of uplink information could be compared to the original team-generated data by communicating with one of the larger computer systems through the 11285A serial interface. Compatibility with the original data base was checked and a final prospectus of returned images prepared. This concise description of images was prepared for each day's downlink of image data.

### The View on Mars

The Lander cameras reveal both Mars landing sites to be boulder-strewn regions, yellowish-brown or reddish-brown in color. At the Viking Lander 1 location at Chryse Planitia, features appear on the horizon that may be impact craters. Numerious drifts of fine-grained material are seen in the photos. Wind tails on the leeward side of boulders are also very prominent. Rock textures from smooth to extremely vesicular, or pitted, are seen in the vicinity of Lander 1.

The Viking Lander 2 site, Utopia, is generally flatter than the Viking 1 site. However, a series of intersecting troughs, typically one meter wide by 150 mm deep, are evident near the Lander. Some boulders at this site appear highly vesicular, suggestive by terrestrial analogy of volcanic lavas. Etching may have enlarged the vesicles.

Preliminary data on classes of Martian rock, water flow, rock age and erosion, rock and fine material coloradion, etc., are now being processed for more definitive conclusions.

### About the Viking Lander Imaging Flight Team

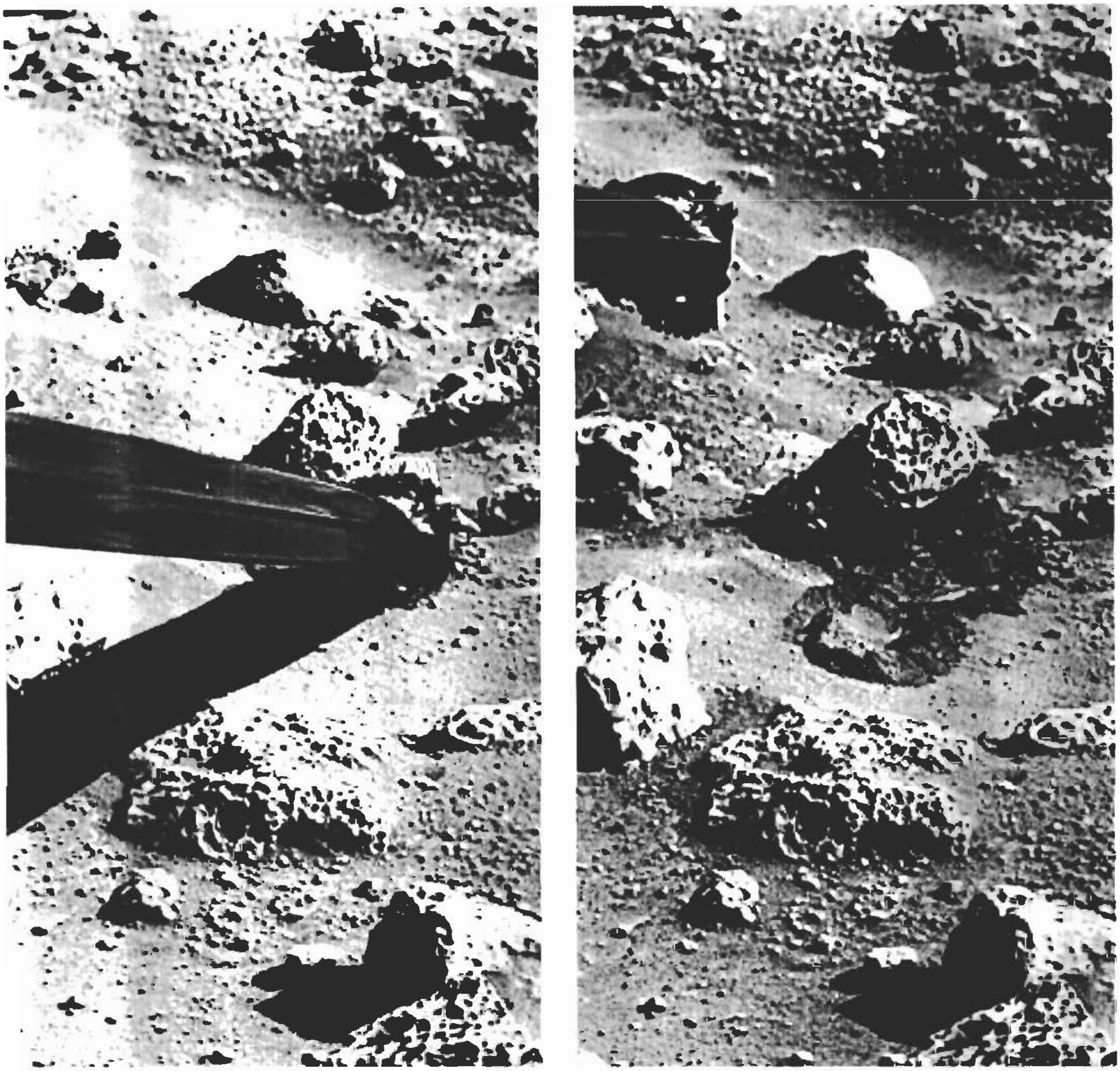
The Team consisted, for the primary phase of the mission, of 18 people who were responsible for planning the use of the camera systems on the Viking Landers. This phase of the mission lasted from July 20, 1976, until November 7, 1976, during which time the Team planned the acquisition of 1025 pictures. The Lander Imaging Flight Team was part of a group of 850, the Viking Mission Flight Team, that operated the Viking mission from the Jet Propulsion Laboratory at Pasadena, California, for the National Aeronautics and Space Administration.

The HP 9830A programming described in the article was developed by William Patterson of Brown University. Its implementation was managed by Robert Tucker during the primary phase of the Viking mission and is currently under the direction of Sven Grenander of Brown University.

**The photographic data appearing here were processed by the Image Processing Laboratory at JPL.**

### Cover

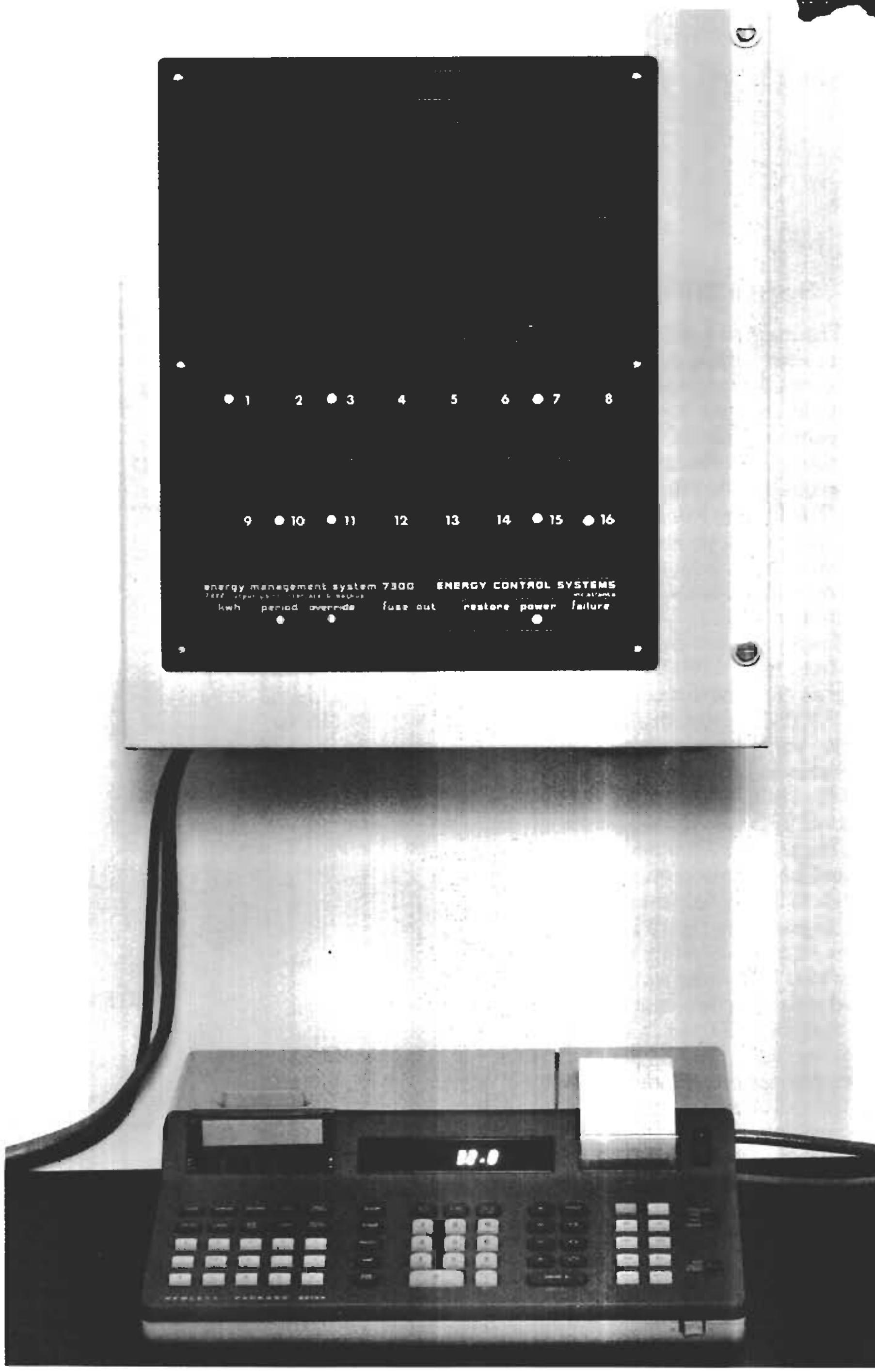
Martian sunset over Chryse Plantia was photographed on August 20 by Viking 1. The camera began scanning the scene from the left about four minutes after the sun had dipped below the horizon, continuing for 10 minutes and covering 120 degrees from left to right. The sun had set nearly three degrees below the horizon by the time the picture was completed. The Martian surface appears almost black. The horizon line is sharp, and, five degrees above it, the sky color grades from blue to red looking to the left from the region of the sky above the sun. Very near the sun position, the sky appears white in the picture due to saturation of the camera. The blue-to-red color variation is explained by a combination of scattering and absorption of sunlight by atmospheric particles. Scattering by micron-sized particles enhances the blue in the region close to the sun's position. At the larger scattering angles, preferential absorption of blue light by the particles gives the sky a progressively redder tinge. Darkening of the sky in all wavelengths very close to the horizon, which is most evident near the sun position, is caused by extinction in the very long optical path through the atmosphere between the sun and the camera in that portion of the sky.



Viking's soil sampler collector arm successfully pushed a rock on the surface of Mars during the afternoon of Friday, October 8. The irregular-shaped rock was pushed several inches by the Lander's collector arm, which displaced the rock to the left of its original position, leaving it cocked slightly upward. Photographs and other information verified the successful rockpush. The photo at left shows the soil sampler's collector head pushing against the rock, named "Mister Badger" by flight controllers, and the photo at right shows the displaced rock and the depression whence it came. The sample is being sought from beneath a rock because scientists believe that, if there are life forms on Mars, they may seek rocks as shelter from the Sun's intense ultaviolet radiation.

# A System to Conserve Energy

by Joseph Ackerman, Energy Control Systems, 6901 Peachtree Industrial Blvd., Atlanta, Georgia 30092




Conservation of energy resources has become of paramount importance, no matter where we live in this world or how much energy is locally available. Conservation demands consideration for reasons ranging from humanitarianism to cost. Energy Control Systems is a company that helps both large and small companies apply computer technology to reducing electrical usage.

Energy Control Systems incorporates the 9815A Desktop Computer into its Energy Management System 7300, which monitors, controls, and schedules the use of electrical power in real-time mode without operator intervention. Until recently, the criteria used to justify computerized control was the expenditure of at least $8000 to $10,000 U.S. per month on energy, but the lowered cost of computerization now makes it advantageous to use in much smaller plants and buildings. Even in companies with a monthly power bill as small as $2000 U.S., the System 7300 can save from 10% to 40% of the electrical power used, depending upon the operating characteristics of the facility. There are no upper limits to System 7300's capabilities or usage.

### The Concept

All enclosed environments used to accommodate people — factories, shopping centers, hospitals, commercial office buildings — are designed to provide a comfortable environment under the worst possible outside weather conditions. Here in the southeast section of the United States, typical design criteria are for 95°F (36°C) in the summer and 10°F (−12°C) in the winter. These extreme temperatures usually exist less than 1% of the time.

Many utility companies base their price to the customer on the customer's peak demand and use that rate structure for several consecutive months. The peak demand rate is determined by measuring electrical consumption during time periods of 15, 30, or 60 minutes, 30 minutes being the period generally used. The period of greatest consumption determines the cost per unit of electrical power to the company during all the time periods (called demand periods). Although utility companies presently use a price scale favoring the customer consuming more electricity (higher demand=lower per-unit cost), the trend is to change to an upended demand price scale, in which a greater demand will result in a higher per-unit cost. Keeping the peak demand as low as possible becomes increasingly beneficial to the customer.

Peak demand is normally set during adverse weather conditions (either very hot or very cold), but with the System 7300's ability to track the sun and instantaneously monitor the power being used, if a high power demand situation is in the making, the System turns off units that are not essential or that can take advantage of solar heating or cooling. Peak demand is thus reduced while making minimum impact on the facility environment.

When outside temperatures are more normal, there is considerable room for operating efficiency. For instance, units controlling air movement can be turned off (cycled) for five or ten minutes without upsetting the facility environment, "fighting" between heating and cooling can be greatly reduced, and so forth.

### System 7300 Description

The mark of a good energy management system is closed-loop control. That is, the system accepts inputs, performs computations, uses the computations to make comparisons with the desired objectives, and takes corrective action to obtain the objectives, all without operator intervention. The Energy Management System 7300 is closed loop and has the added benefit of being a single-source system — the customer deals with one vendor instead of several.

Energy Control Systems uses the Hewlett-Packard 9815A Desktop Computer as the central processor of the System 7300. The System also has a status/display panel for communication and control between the 9815A, the utility meter, and the facility. Data for use by the 9815A is stored in the status/display panel.

The System 7300 uses standard 24V control wiring to communicate its commands to the equipment under control. On the diagram (see Figure 1), the "R" denotes an electrical relay, normally located in or near the equipment to be controlled. Solid state switches, optically isolated from the System 7300, switch the 24 Vac to or from the relays. This isolation virtually assures that noise that may be picked up by the control wiring cannot find its way into the System and cause spurious noise problems.

In this article, the solid state switches will be referred to as "control points." Each control point has its own on/off cycle and can control four relays. However, one of the four relays can be used as an interposer relay, and an interposer relay makes the number of devices controlled by a single control point on the status display panel unlimited. This gives the System 7300 the flexibility to "grow" with facility needs.

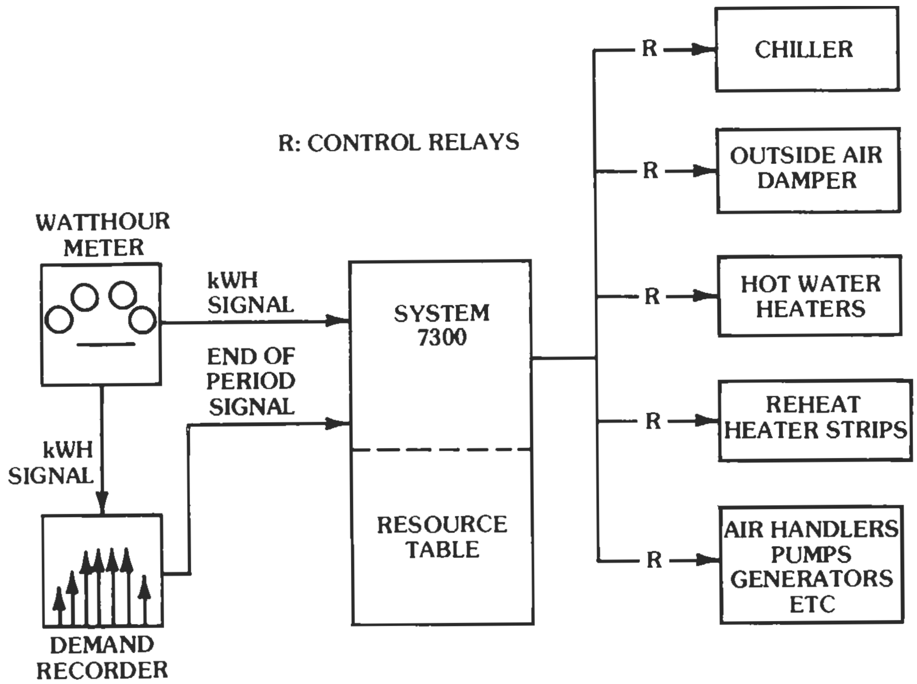



**Figure 1. System 7300 diagram.**

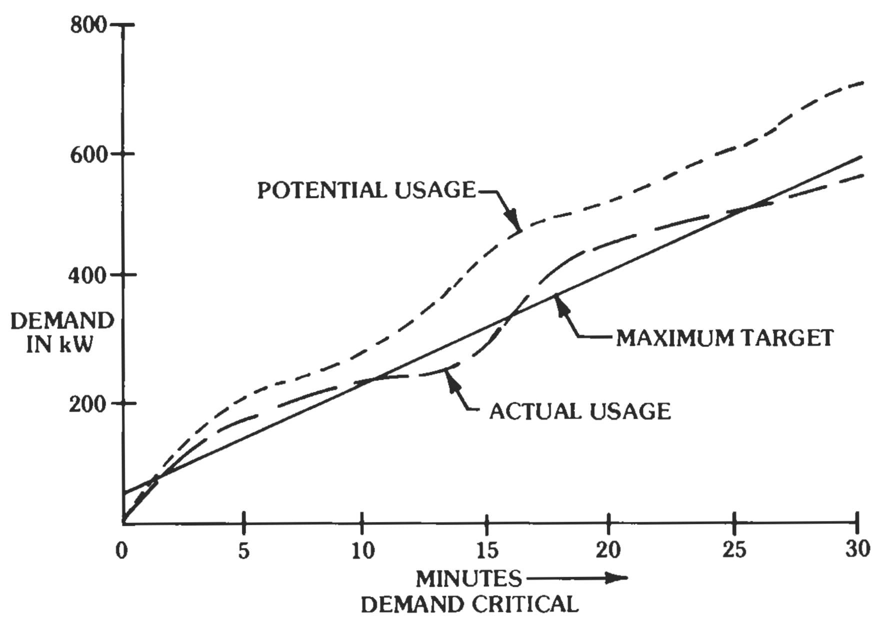



**Figure 2. Chart of a peak power demand situation.**

The programming for the System 7300 includes resource tables, or lists of all the devices to be controlled and their priorities. Because the resource tables have differing priorities for the devices and are called up by the 9815A depending on the time of day, solar loads can be tracked and facility operations are scheduled for minimum power consumption and impact on operations. Further, each control point is assigned a character that defines a specification that can be taken on a control point under a given set of electrical demand conditions. A control point may be assigned a character that will permit the point to be turned off more than once during a demand period. If wished, the character may turn a control point off for a specified time then enable the control point so that the devices connected to the control point can run.

The basic information contained in the resource table for each control point is start/stop time, number of minutes a device may be turned off (or shed), if power demand is above standard or maximum target, if the device failure mode is a fail "on" or "off", priority of the device, etc. The 9815A data cartridge is capable of holding up to 80 tables, and each table can hold information for 32 control points.

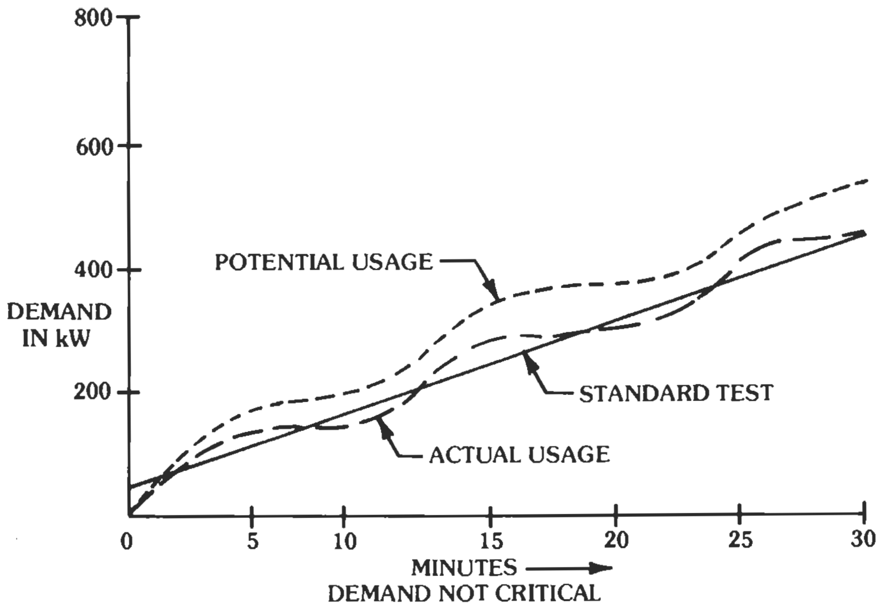



**Figure 3. Chart of a normal demand situation.**

### Peak Demand Situation

The demand critical diagram in Figure 2 depicts a peak power demand situation that may occur when activity inside the facility is high and/or outside weather conditions are adverse and how the System 7300 responds.

At zero minutes into the demand period, System 7300 generates a report of the data from the previous demand period. Items in the report are:

- Time (in military designation) that the end-of-demand period signal was received,
- How many minutes the demand period lasted,
- Actual usage of energy (kW) within the period,
- Maximum (kW) and standard (kW) targets for the period,
- The number of minutes that the actual usage exceeded the standard target,
- If any of the emergency override switches (a part of the System 7300) were not in the computer control position.

Note that in Figure 2 the maximum target line has been slightly offset at time zero. This is to keep the system from taking immediate control in the first minute of the demand period.

As the demand period is entered, kW signal pulses are received by the 7300 from the demand recorder. Two minutes into the demand period, System 7300 detects that actual usage has exceeded the maximum target. System 7300 searches the resource table to determine the control point with the lowest priority. When the control point is determined, it will be turned off.

At three minutes into the demand period, it is evident that previous action has not yielded the desired result, because the actual usage still exceeds the maximum target. System 7300 again searches the resource table to determine the device with the next lowest priority, which is turned off, and so on.

Approximately 10 minutes into the demand period, the actual usage drops below the maximum target. During this interval, System 7300 has been shutting off or shutting down devices in attempting to reach the maximum target. Generally, the number of minutes allocated for shedding of a device's electrical load is greater when demand is critical (high) than when it is not.

Sixteen minutes into the demand period, the actual usage again passes maximum target. There are a number of reasons why this could happen. For one, the base load (electrical consumption for such things as lighting and running office or production equipment) may increase. Or, devices shed previously are required to come back on because their allocated shed time has ended. System 7300 looks further into the resource table in effect and sheds additional loads.

In the 20th minute, System 7300 is 66% through the demand period. Actual usage is exceeding maximum target. Under these circumstances, System 7300 doubles the rate at which devices are shed, and at the 26th minute the actual usage drops below maximum target.

Additional loads will not be shed if actual usage remains below standard target. Loads shed near the end of the demand period will be restored at the end of their shed times, not when the demand period ends.

The line in Figure 2 marked "potential usage" indicates the power that would have been consumed if System 7300 had not been part of the facilities control. The difference between the actual usage and the potential usage at the end of the 30-minute demand period is approximately 120 kW of electrical demand saved. If the next demand period is identical to the one described, the electrical consumption savings will be 120 kWh.

### Normal Demand Situation

The System 7300 also effects savings under more normal conditions. Figure 3 charts such a period — there is no heavy activity in the facility and the weather outside is not adverse.

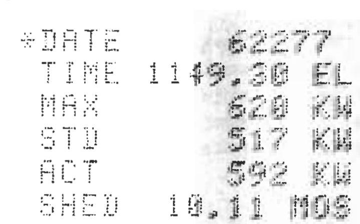
There are two differences between a demand critical (peak demand) and demand not critical (normal demand) situation. For demand not critical, a standard target for electrical consumption is used. The standard target line is established on an individual facility basis by relating the two factors of facility activity and facility external conditions to the amount of energy the facility is using. Also, during a demand not critical period, the time a device (or electrical load) is shed is considerably less than during a demand critical period.

In the example shown in Figure 3, the energy consumption saved is approximately 40 kWh. If more energy savings are needed, the standard target line is lowered.

### Software Features of the System 7300

Energy Control System's software for the 7300 is written especially for easy use and quick training. All programs are written to prompt the operator through any changes needed — from new devices to be connected to revision of cycle times. Our company also conducts a one-day training course for the new operator that features "hands-on" training.

To assist in determining the lowest amount of power required to comfortably heat, cool, and ventilate the facility, a data log is incorporated into the System. Each time a device is turned on or off, the System printer notes the occurrence and time stamps the entry. Closer adjustment of the devices controlled by System 7300 can then be made for maximum comfort and energy savings. The data log also points out imbalances caused by mechanical failure.



Besides generating the end-of-demand-period report already mentioned, the System prints a midnight report of the energy consumed and the demand peak for the day. The 9815A sequences through its numerical display, displaying such information as which week schedule is in current use, time of day, the resource table being used, maximum target, standard target, actual usage, number of minutes into the demand period, and number of devices used in the current demand period. Each item of information is displayed for four seconds. Each minute the display is updated to reflect any change that may have occurred in the current demand period.

```
    MIDNIGHT
FOR DATE:   42677
  DAY           2
 WEEK    2345671
ENERGY CONSUMED:
         2564 KWH
PEAK FOR TODAY:
          313 KWH
################
NEW DATE:   42777
  DAY           3
 WEEK    3456712
```

If the System 7300 suffers loss of electrical power for any reason, from repair of the System to electrical power loss to the facility, it will automatically restart when power is restored. No operator intervention is required.

The System even incorporates a feature that verifies valid communication between the wall-mounted unit and the desktop unit. If communications fail or are not valid, the wall-mounted unit will automatically schedule each control point (at six-second intervals) to the fail safe mode of operation.

Part of the programming supplied with the 7300 is a week scheduler and day scheduler. The operator may schedule ahead using expected facility activity and weather conditions to set maximum and standard target power consumption. The days of the week are numbered 1 to 7 respectively, with an eighth day used for holidays or as otherwise needed. Once the week and day schedules are set, the proper resource tables may be chosen. There can be 10 resource tables used within a day for up to 8 different days.

### System 7300 Users Comments.

The System 7300 represents an excellent application for the HP 9815A. The desktop computer's controller abilities, for instance, are extensively used in the 7300, but the 9815A will never reach its upper limit and thus restrict the complete system. Perhaps the best way to demonstrate customer acceptance and satisfaction with the Energy Management System 7300 is to reproduce sections of letters from two of our customers, the Florida First National Bank of Jacksonville and American Mills, Inc. of Griffin, Georgia. I believe these quotes express the general feeling of our customers.

"When I first saw the Energy Management System 7300, my reaction was, 'That small box is going to control this large building?' My skepticism was soon set aside by virtue of the fact that the system does control the building's energy use and in a very reliable manner. The system was installed February 2, 1977. Since installation, we have not been down one time. Although there was a power failure of the entire facility once, the auto-restart feature of the system worked exactly as you stated it would.

I can say that when we received our first electric bill after installation, it was a very pleasant surprise. The system reduced our bill by at least 20%. As time has progressed, we feel comfortable in stating that the savings will average 18% to 20% per month, which is considerably more than projected. That is quite a savings when you consider that we had removed as much of the energy 'fat' as possible prior to system installation.

H.J. Horne
Comptroller and
Building Manager,
Florida First National
Bank of Jacksonville

"American Mills had been looking at various electrical control systems, peak shavers, etc., for some 18 months prior to purchasing a System 7300. The systems investigated ranged from simple load-shedding devices up to a centralized computer system for six plants with a cost in the $50,000 U.S. range. In fact, we had made a tentative decision to purchase a load-shedding device when we listened to the presentation of the System 7300. We were so impressed with 7300 and its capabilities and potential, we ordered one within two weeks. Some of the features that sold us on the 7300 are:

1. Variable sizing to suit individual plant needs (8, 16, 24, 32 control points).
2. 80 custom strategies, tailored exactly to meet our individual situation.
3. Imaginative program. The more we use the system, the more impressed with the contingencies covered 'on the drawing board'.
4. Potential for information input.
5. Ease of installation
6. Realistic cost.

Prior to accepting delivery, we were concerned that we might have to assign an engineer or computer operator to operate the 7300. After a well-designed, one-day training class, these fears were laid aside and the device is now operated by persons with virtually no computer training, including the plant manager's secretary who did not attend the class. This is, I believe, a tribute to the simplicity and fail-safe features built into the operating utilities.

Our 7300 has been in operation only two months (Ed. note: letter dated June 1977) and we are just entering our peak load season, but indications are that we will recover the cost of the system in less than 14 months based on present electrical rates (which are due to rise this year) and our anticipated 15% decrease in demand and 18% savings in power consumption.

We are looking forward to the computed start time that Energy Control Systems is adding to the System 7300. We firmly believe that significant additional savings will be achieved by taking the outside weather conditions, inside temperature, and computing the ideal facility start time. This should be a far cry from the clock method now used, which is based on the worst case anticipated.

Albert A . Thrasher, Jr.
Assistant to Vice President,
American Mills, Inc.

**About the Author**

Joseph Ackerman received a BS in Electrical Engineering at Auburn University, Auburn, Alabama. His previous work experience, before becoming President of ECS, includes being Director of Engineering of International Energy Conservation Systems, Inc., and control systems engineer at IBM. While at IBM, Mr. Ackerman conceived the idea for the IBM Power Management System and developed it. He received an "Outstanding Contribution Award" for this work.

His outside interests are fishing, boating, and flying.

# Forum

**Dear Editor:**

We purchased our Hewlett-Packard 9830A Calculator primarily for use in business-related applications — mailing list maintenance and control and a variety of general bookkeeping applications including general ledger programs. If possible, I would certainly like to see more in KEYBOARD related to such business applications.

I might also mention that we here at Visualtek have prepared a couple of programs for our own use, which might also be of use to others. One is a mailing list program that accommodates up to 12,000 names/addresses on a disc-based system. This program allows the printing of a list or mailing labels in a variety of formats. The list can be divided into a large number of user-defined categories, and listing and label preparation can be done selectively based on any combination of five or more different criteria. Labels are printed out in ZIP code sequence to meet U.S. postal regulations. The system is rather slow in maintaining the list because of the poor sorting capabilities of the 9830A for large volumes of data, but is in all other respects highly effective and useful for us. It saves us $400 to $600 per month that we would otherwise have to pay to an outside mailing house to perform the same functions.

A second program is designed to maintain our capital equipment records for up to 1000 items of equipment. The program computes book depreciation each month by the straight line method, and it computes tax depreciation annually using any one of four common methods for each item. The program has proven to be an extremely powerful tool in maintaining proper records with respect to our capital equipment, as well as in ensuring that we take the maximum possible depreciation allowed for tax purposes. For instance, if accelerated depreciation is elected for a particular item, the program will automatically switch the tax depreciation method to straight line at the point in the item's life where that becomes more favorable for tax purposes.

If any reader is interested in obtaining more information about these programs and might wish to consider using them in their own business enterprise, I would be happy to provide such information on request.

Lary Israel, President
Visualtek
1610 26th Street
Santa Monica, California
90404 U.S.A.

**Dear Editor:**

My company owns a 9810A Calculator and is looking for programs for the Kilmogorov-Smirnov Two-Sample Test, Dunkel Multirange Test, and Student-Newman-Keuls Multirange Test. If anyone has a program for any or all of the above tests, I would appreciate hearing from you.

Thank you for your assistance.

Robert M. Schutsky
Ichthyological Associates, Inc.
P.O. Box 12
Drumore, Pennsylvania
17518 U.S.A.

**Dear Editor:**

The 1977/1 issue of KEYBOARD had an article on the game "Mastermind" for the 9810A . I have written a Mastermind program for the HP-65 that can be played in either a solitaire or two-player version. After initial set-up, the program card (or two cards for solitaire Mastermind) need not be inserted again. The solver is shown his or her correct score on each guess.

Would this be of interest to your readers.?

H.Z. Hurlburt
Director,
Peiser Laboratories
Stauffer Chemical Co.
8410 Manchester
Houston, Texas
77012, U.S.A.

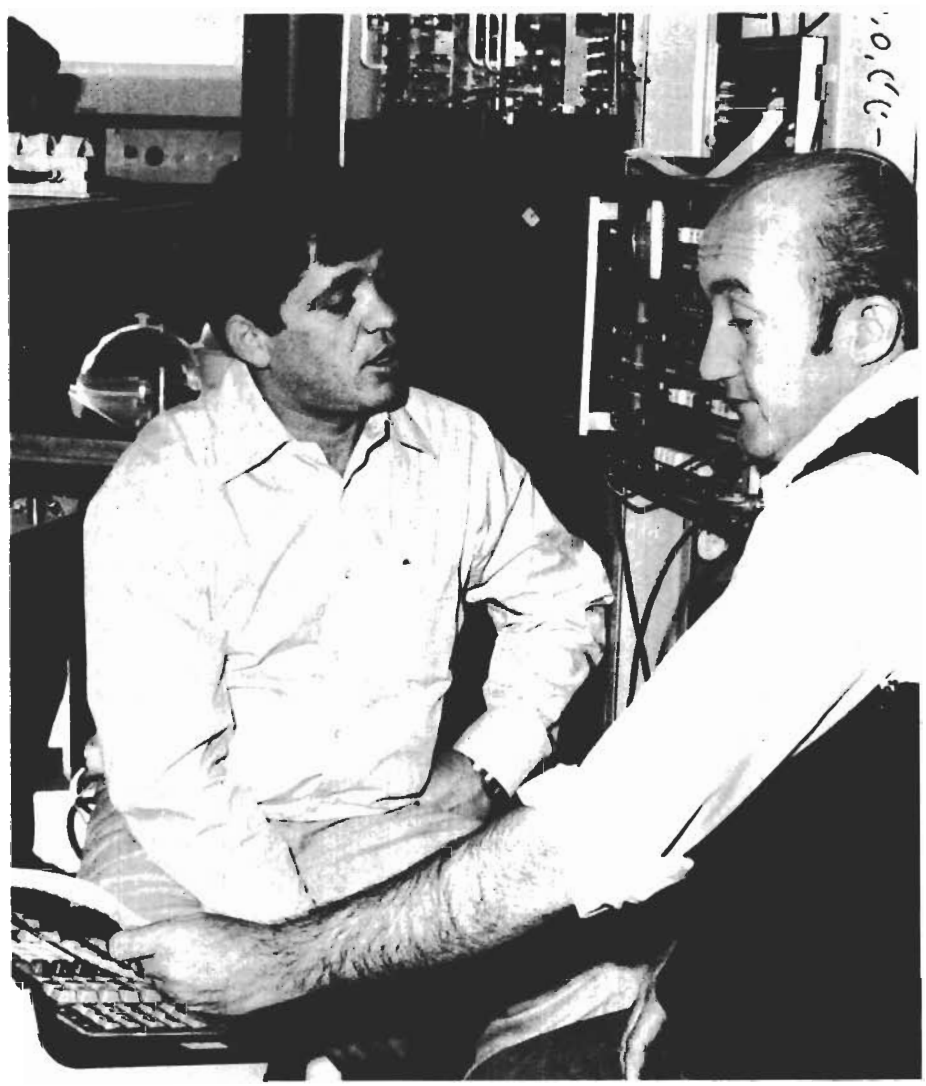
**Ed. Note:** Since there may be a large number of requests for Mr. Hurlburt's HP-65 Mastermind program, we have volunteered to respond.

Please address your request for a program listing of HP-65 Mastermind to:

KEYBOARD
Hewlett-Packard
P.O. Box 301,
Loveland, Colorado
80537, U.S.A.

# On-Line Use of the 9810A in Relative Simultaneous Two Samples Activation Measurement.

by A. Dubi and Y.S. Horowitz, University of the Negev, Beer-sheva 84 120, Israel



In vivo neutron activation analysis (IVNAA) for the determination of whole-body or partial-body content of calcium (Ca) has become an accepted clinical technique in several European and North American laboratories (ref. 1 to 5). In this technique, fast neutrons of 5 MeV to 14 MeV impinge upon the body. As a result of elastic collisions with the hydrogen nuclei in the tissue, these neutrons are moderated in energy such that when they are in the vicinity of the bones, where most of the Ca is contained, a large fraction of them acquires thermal energies (less than 0.5 eV). At these energies, there is a relatively large probability (cross section of 1.1 barn) that the neutron will be absorbed by the $Ca^{48}$ nuclei to create a $Ca^{49}$ isotope. The $Ca^{49}$ nuclei thus created decays to the ground state of $Sc^{49}$, with a half life of 8.8 min., followed by the emission of a beta particle and a 3.1 MeV gamma ray (photon). The photon can be detected by a nuclear radiation detector, usually an NaI (Tℓ) scintillation detector, and from the number of photons counted in a given time period one can determine the calcium content of the body. Similar processes are also available for other constituents of the body, such as N, P, Mg, etc.

In order to conduct absolute or relative measurements of the calcium content in the body, it is clearly essential that every Ca nucleus has the same probability of being activated; hence, it is important that the distribution of thermal neutrons is uniform throughout the body. A great amount of effort has been invested in constructing irradiation configurations, including external moderators of thermal neutrons in the body. Much less attention was paid to the uniformity of epithermal and fast neutrons (of energies above =0.5 eV) because the assumption was that these neutrons did not contribute to the cross section of $Ca^{48}$. A semi-empirical calculation of the cross section of $Ca^{48}$ (n,$\gamma$,) as a function of energy has been recently published (ref. 9) suggesting that at up to 100 keV the cross section is about 10% of that in the thermal range; thus the assumption of negligible epithermal activation is cast in doubt.

To clarify this point, we have experimentally measured the ratio of epithermal-to-thermal activation of $Ca^{48}$ by a neutron spectrum that closely simulates the spectrum of IVNAA configuration. Two identical slabs of $CaSO_4$ were simultaneously irradiated in a neutron field typical of IVNAA measurements. The two slabs were rotated around the axes of symmetry of the neutron field to ensure equivalent effective irradiation. One of the $CaSO_4$ slabs was wrapped by a 0.7 mm thick cadmium (Cd) sheet, which absorbs practically all the thermal neutrons impinging on it and allows only epithermal neutrons through. Hence the activation of the cadmium-covered slab represents activation by epithermal and fast neutrons only. The activation of the bare slab results from both thermal and epithermal neutrons, so if we denote the activation of the Cd covered slab by $A_{cd}$ and that of the bare slab by $A_b$,

$$K = \frac{A_{cd}}{A_b} \qquad (1)$$

is the derived quantity representing the relative contribution of epithermal neutrons to the overall activation of $Ca^{48}$.

## Measuring $A_{cd}$ and $A_b$

Before we describe the method by which the activities are measured, some preliminary remarks must be added.

The activity of a sample is defined as the number of particles (in our case, 3.1 MeV photons) emitted per unit time from the sample. The activity depends on the duration of the irradiation of the sample by neutrons, on the neutron flux, and on the activation cross section, which is a physical measure of the probability that a neutron will interact with the $Ca^{48}$ atom to produce the desired activity. If at the moment when the irradiation is stopped the activities are $A_{cd}$ and $A_b$, then it is well known (ref. 10) that the activity of each sample decreases exponentially with time. Thus, at any time t following the end of irradiation:

$$A_{cd}(t) = A_{cd} \bullet e^{\frac{t}{\tau}} \quad (2a)$$

$$A_b(t) = A_b \bullet e^{\frac{t}{\tau}} \quad (2b)$$

where $\tau$ is the mean life of the activation, which in our case is 8.8 min. When a scintillation detector is counting gamma rays, only a fraction F of the photons emitted by the source is detected. This is because not every photon emitted reaches the detector (geometrical effect), and not every photon impinging on the detector is counted (intrinsic effect).

In view of the above, if a detector is counting for time $t_c$ a sample with initial activity A, then the expected number of counts accumulated in that time will be given by:

$$C = F \bullet \int_0^{t_c} A(t)\, dt = AF\,(1 - e^{\frac{t_c}{\tau}} \quad (3)$$

It is important to note that the number of counts that will actually be accumulated by the detector is a poisson random number, U, whose expected value (average) is C = <u>, and its variance ($\sigma_u^2$ = C) also equals C. If we denote

$$x(t) - (1 - e^{\frac{t}{\tau}}),$$

then the quantity

$$S = \frac{u}{F\tau x}$$

is an estimate of the activity A, since its average is A:

$$<S> = \frac{1}{F\tau x} <u> = \frac{C}{F\tau x} = A. \quad (4)$$

The standard fractional error of S is the same as for u, since they are related by a multiplicative scalar, and if $\sigma^2$ stands for the variance (square of the standard deviation), we get:

$$\frac{\sigma_S}{<S>} = \frac{\sigma_c}{<C>} = \frac{1}{\sqrt{C}}\,. \quad (5)$$

In our case a consecutive measurement is impractical, since by the time the first counting is finished the second sample activity decreases (see Eq. 2) such that the measurement will lack statistical reliability. This is a typical situation when the initial activities are small and the half life is short. Thus a simultaneous counting system is required, in which case the two samples are counted simultaneously on two different detectors having efficiencies $F_1$ and $F_2$. If we count $A_{cd}$ on the first detector ($F_1$) and $A_b$ on the second for time $t_c$, then the expected number of counts will be:

$$C_1 = A_{cd} F_1 \tau x\,(t_c) \quad (6)$$

$$C_2 = A_b F_2 \tau x\,(t_c), \quad (7)$$

then the ratio K is given by:

$$K = \frac{C_1}{C_2} \bullet \frac{F_2}{F_1}\,. \quad (8)$$

Here lies the difficulty of this method. In order to get K, a knowledge of the relative efficiency

$$\frac{F_2}{F_1}$$

is required. At the specific energy and geometry of the activation, this requires at least an additional irradiation, and even then there will remain a statistical uncertainty that will add to the error in K. To avoid that difficulty, we have developed a different method of counting that eliminates the need to determine the relative efficiency.

In the new, calibration-free method, the two samples are counted simultaneously on the two detectors as before for a time period $t_1$, resulting in the expected total counts:

$$C_1 = A_{cd} F_1 \tau x\,(t_1) \quad (9)$$

$$C_2 = A_b F_2 \tau x\,(t_1). \quad (10)$$

After that period, the samples are switched so that now $A_{cd}$ is counted on the second detector ($F_2$) and $A_b$ on the first detector for time $t_2$, resulting in the expected total counts:

$$g_1 = A_{cd}\, e^{\frac{t_1}{\tau}} F_2 \tau x\,(t_2) \quad (11)$$

$$g_2 = A_b e^{\frac{t_1}{\tau}} F_1 \tau x\,(t_2)\,. \quad (12)$$

Now we combine the various results of the measurements in the following way. We define

$$y(t_1, t_2) = e^{t_1/t}\, x(t_2)$$

and then put

$$N_1 = C_1 + \frac{x(t_1)}{y(t_1, t_2)}\, g_1(^*) \quad (13)$$

$$N_2 = C_2 + \frac{x(t_1)}{y(t_1, t_2)}\, g_2\,. \quad (14$$

Using Eq. 9, 10, 11, and 12, it is seen that

$$K = \frac{N_1}{N_2}$$

and the need to know

$$\frac{F_2}{F_1}$$

is avoided. The only remaining problem is to determine $t_1$ and $t_2$ in such a way to minimize the fractional overall error in K.

*For simplicity we assumed here that the time needed to switch the samples from one detector to the other is negligible.

## Minimizing the Error in K

Remember that the measurements described above do not give the expected values but rather four random poisson numbers $u_1$, $u_2$, $v_1$, and $v_2$ that are estimates of the corresponding expected values $C_1$, $C_2$, $g_1$, and $g_2$. Moreover, practically every detector detects not only radiation from the sample but also some amount of background radioactivity coming from long-lived activities in the environment. These background counts must be subtracted from the total counts in each case to get the "true" counts. This is don using various methods (ref. 11) beyond th scope of this article. Nevertheless, if we assume the background counting rate is constant, and if detector $F_1$ counts a background rate $R_1$ and the second detector counts $R_2$ background counts per second, the variance of the various random values will be given by:

$$\begin{aligned} &a.\ \sigma^2_{u_1} = \langle u_1 \rangle + 2R_1 t_1, \\ &b.\ \sigma^2_{u_2} = \langle u_2 \rangle + 2R_2 t_1, \\ &c.\ \sigma^2_{v_1} = \langle v_1 \rangle + 2R_2 t_2, \\ &d.\ \sigma^2_{v_2} = \langle v_2 \rangle + 2R_1 t_2 \ . \end{aligned} \tag{15}$$

Using elementary rules (ref. 12) of the variance of a linear combination of random poisson numbers, it is easy to show that the square of the function error in K is given by:

$$\frac{\sigma^2_k}{K^2} = \frac{\sigma^2_{N_1}}{N_1^2} + \frac{\sigma^2_{N_2}}{N_2^2} = \frac{\sigma^2_{u_1} + \left(\frac{x(t_1)}{y(t_1t_2)}\right)^2 \sigma^2_{v_1}}{N_1^2} + \frac{\sigma^2_{u_2} + \left(\frac{x(t_1)}{y(t_1t_2)}\right)^2 \sigma^2_{v_2}}{N_2^2} \tag{16}$$

Substituting Eq. 9 - 15 into Eq. 16 and doing some algebraic steps, we can write:

$$\frac{\sigma^2_k}{K^2} = K' \frac{1}{x(t)} \left[ E + \frac{2t_1/\tau}{x(t_1)} G \right] + \frac{1}{y(t_1t_2)} \left[ H + \frac{2t_2/\tau}{y(t_1t_2)} J \right], \tag{17}$$

where K' is a constant independent of $t_1$ or $t_2$ and

$$E = \frac{A_{cd}F_1}{R_1}\left(1 + \frac{A_{cd}}{A_b} \bullet \frac{F_2}{F_1}\right)$$

$$H = \frac{A_{cd}F_1}{R_1}\left(\frac{F_2}{F_1} + \frac{A_{cd}}{A_b}\right)$$

$$G = 1 + \frac{R_2}{R_1} \bullet \left(\frac{A_{cd}}{A_b}\right)^2$$

$$J = \frac{R_2}{R_1} + \left(\frac{A_{cd}}{A_b}\right)^2$$

Thus, in order to be able to minimize

$$\frac{\sigma^2_k}{K^2}$$

one needs to know the parameters

$$\frac{A_{cd}F_1}{R_1}, \frac{A_{cd}}{A_b}, \frac{F_2}{F_1}, \frac{R_2}{R_1}.$$

Fortunately, it can be shown that Eq. 17 is not very sensitive to the values of these parameters, and a rough estimate is enough to enable the minimization. The last two parameters can be estimated before the counting, but the estimation of the first two must be done during the counting.

A two-parameter minimization program was created for the HP 9810A Calculator. This program finds the X and Y values for which any function is minimized. This is done by a search method where the steps are automatically reduced at every cycle by a factor to achieve any desired accuracy. Twenty seconds after the counting begins, enough information has been gathered to get a rough estimation of

$$A_{cd} F_1 \text{ and } \frac{A_{cd}}{A_b}$$

These quantities are then loaded into the calculator and the minimization program is operated 10 to 20 seconds later. The optimum values of $t_1$ and $t_2$ are presented by the program, and accorcdingly the measurement continues.

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**A. Dubi;** Mr. A. Dubi was born in Israel in 1945. He studied for the B.Sc. degree in physics in Tel Aviv University and went on to his M.Sc. degree in lasar optics at the Weizmann Institute of Science in Rehovoth. He is currently completing his Ph.D. requirements in Monte Carlo radiation transport problems at the Ben Gurion University of the Negev. Mr. Dubi's regions of interest are in the application of Monte Carlo methods to Medical Radiation Physics and Neutron Physics.

**Y. S. Horowitz;** Y. Horowitz was born in Winnipeg, Canada in 1940. He studied for the B.Sc., M.Sc., and Ph.D. degrees in Physics at McGill University, and carried out post-doctoral research in experimental nuclear physics at the University of Toronto and the Weizmann Institute of Science. He also did medical physics at the Massachusetts General Hospital and M.I.T. He is currently the head of the Applied Radiation Physics group at the Ben Gurion University where the main emphasis is currently on mixed field-neutron gamma ray dosimetry, Mone Carlo techniques, and thermoluminescence.

# Programming Tips

### Correction to "Subroutines and Functions (9825A)"

*Submitted by Howard Rathbun, published in KEYBOARD 1977/1).*

The editor and proofreaders suffered a fit of temporary blindness, for which apologies are extended, during the proof reading of the Tip. For the sake of our new readers, the Tip will be reprinted in its entirety.

Callable subroutines and functions should be placed at the beginning of a program for faster execution. Function and subroutine calls always search for the subprogram label starting at line Ø. The time saved is not a great amount per line (about 30 $\mu$s), but for large, long-running programs the savings in time can add up.

### Correction to "Identifying The Last Marked File (9820A)"

Dr. R. K. Littlewood of the University of Wisconsin, Madison, Wisconsin, has written to call our attention to an error in his programming tip published in Vol. 8, No. 3. For the sake of our new readers, the tip will be reprinted in its entirety.

*I sometimes find it useful to know exactly how many files have been marked on a cassette tape. The following 9820A coding sequence automatically does an Identify File operation on the last marked file on a tape, provided that the tape is not currently positioned beyond that mark.*

```
FDF 999; BKS; IDF A,B,C,X, BKS
```

Under normal circumstances, B and C will both have the value zero, as A will be a "dummy" file; i.e., the extra file marked in the last Mark Tape operation.

### How to Move a Program Line (9825A)

*Submitted by William Deatrick, Alexandria, Virgina, U.S.A.*

A friend of mine, Scott Layson, has discovered a useful technique. After writing a program, I sometimes find it necessary to move a line to another position. For long lines, retyping is very tiresome to say the least. The following method allows the user to move a line from one place in a program to another without retyping it. Fetch the line to be moved. Press BACK and then STORE. This places the line in the first of the two RECALL positions. Then fetch the line that is to be after the inserted one. Press RECALL. The last FETCH command will appear in the display. Press RECALL again and the line to be inserted will appear. (That double RECALL is quite useful!) Press INSERT (line) and the line is in place. Then go back and delete the unwanted line.

I would like to say how pleased I am with the 9825A. It is truly a great step forward in desktop programmables.

### Changing Programs From the HP65 to 9815A

*Submitted by Neville Joseph, Bucks, England*

It is fairly clear that the programming languages of the 9815A and the HP65/67 are similar, and no doubt a number of readers have converted programs from the smaller machines, normally a fairly trivial procedure with obvious differences such as conditional skips.

Not so obvious (and not appearing in the 9815A manual) is the different treatment of Last X after a RECALL instruction. The HP65 leaves Last X unchanged, while the 9815A loads the old X (and new Y) into it.

I hope that publicity on this point will save some of my colleagues a little debugging time.

### WAIT Within a DISPLAY (9830A)

*Submitted by Andrew Vettel, Jr., Science Dept. Chairman of Steel Valley School District, Homestead, Pennsylvania, U.S.A.*

If a program contains a series of DISP statements followed by WAIT statements, it is possible to place the WAIT within the DISP as follows:

```
1Ø DISP "MESSAGE NO.1" FNW2
2Ø DISP "MESSAGE NO.2" FNW4
3Ø DISP "MESSAGE NO. 3" FNW4
4Ø ....
999 END
1ØØØ DEF FNW (X)
1Ø1Ø DISP TAB32,
1Ø2Ø WAIT 1ØØØ*X
1Ø3Ø RETURN Ø
```

The multiple line function, FNW(X), is constructed to take an argument that specifies the WAIT in seconds.

### A Tip On Faulty Cassette Tapes (9830A)

*Submitted by Ian Collier of the 9825A/9830A Users' Club, Melbourne, Australia.*

If a tape becomes unusable because of an oxide fault quite close to the start of it, then careful disassembling, turning the tape over and reassembling will make the majority of the tape usable again without having any differences discernible to the operator.

### Logical Comparisons on the 9820A

*Submitted by Dr. R. K. Littlewood, University of Wisconsin, Madison, Wisconsin, U.S.A*

The 9820A performs logical comparisons by rounding both operands to 10 digits of significance befor executing any logical operation (=, =, >, ≤). Thus, for example, tests for equality may not be executed properly for pairs of numbers differing only in the eleventh or twelfth digit. However, testing for the equality of their difference to the value zero will work correctly.

## Right Justifying Input Strings on the 9830A/9871A

*Submitted by Prof. Jordan Siedband, Harper College, Palatine, Illinois, U.S.A.*

The program given below will right justify input strings if the output device for the 9830A is a 9871A Printer. Any line width (M) could be specified. The one shown is 76 normal characters in length, or 7.6 inches of text. If the number of characters is less than 56 or (M-20), the machine does not right justify. This permits ends of paragraphs or tabulated data to print in their normal fashion. For finer line adjustments, the 20 could be replaced by 12, for example. Lines 500 - 600 are intended as the printing sub and could be used in any application when s0, M, and A$ are known.

```
10 DIM A$[80]
20 M=76
25 S0=15
30 DISP "TEXT";
40 INPUT A$
50 IF LEN(A$)>76 THEN 30
500 REM 9871 LINE JUSTIFICATION
    ROUTINE; M=MAX LINE LENGTH
    (CHARS)
510 REM S0=SELECT CODE OF
    OUTPUT PRINTER
520 L=LEN(A$)
530 IF L<M-20 THEN 590
540 A=INT(12*M/L)
550 X=12*M-A*L
560 FORMAT 20B
570 WRITE (S0,560)27,72,0,A,A$
    [1,L-X],27,72,0,A+1,A$
    [L-X+1],27,72,0,12
580 GOTO 600
590 WRITE (S0,560)A$
600 REM LINE PRINTED & JUSTIFIED
    IF LENGTH NOT<M-20
610 GOTO 30
620 END
```

## Using the 9830A's Special Function Keys to Represent Data

*Submitted by R.J. Carter, CSIRO, Clayton, Victoria, Australia*

The method of using the 9830A Calculator's Special Function Keys to store sets of data and then to input those sets into a program as required is effective where:

- Some of several sets of data are required for each run;
- Sets of data are to be entered several times in each run;
- The same sets of data are entered in a different order for each run; or
- Sets of data are to be entered manually.

The method increases in value if combinations of the above are needed. In my case, the combination of all four applications occurred, and a saving of just over 1000 words in a 5100-word program was produced by the use of the method.

#### Data Entry to Special Function Keys

To put data on a Special Function Key, first enter the KEY mode by pressing the FETCH key then the desired fx key. If no information is on the key, KEY appears on the display. The data can be entered if an asterisk (*) is keyed in first. Key in the data, separating each number by a comma; then the key number, separating this from the data numbers by a comma. Complete the entry by pressing the END OF LINE key, which automatically exits the KEY mode. Pressing the FETCH and fx keys would now produce a display such as:

*0.7796, −3.584, 5.6883, −2,862,

−2.3719,12.1878,−4.0823,1.3468,8*

The key number (or an identifying string) is included so that it may be later output as a check for the correctness of input data.

Twenty such sets of data may be entered onto the Special Function Keys and conveniently stored on the first file of a program cassette by using the command STOREKEY Ø. Before each use of the program cassette, the data are restored to the Special Functions Keys by the command LOADKEY Ø

The method may be used even when there is already information on the key, but all of the previously recorded information is lost.

#### Data Entry to Mainline Program

The mainline program uses the following method of entering data:

```
510 FOR Z = 1 TO L
520 DISP "DATA & KEY: SUB-
SCRIPT" Z;
530 INPUT A[Z], B[Z], C[Z],...K[Z]
540 NEXT Z
```

Pressing the desired Special Function Key inputs the required data and automatically restarts the program. Omitting the second asterisk at entry of data to the keys allows data to be viewed at run time. In this case, pressing the Special Function Key inputs the required data and stops the program. The program is restarted by pressing the EXECUTE key.

Data may be entered manually if they have not been previously stored.

## Transferring Program Files Between Two Platters (9830A)

*Submitted by Ing. Giuseppe Barzagli, S.I.M., Bologna, Italy.*

This tip requires a 9830A, String Variables ROM, 9880B Mass Memory System and related Mass Memory ROM.

I've found the following program useful to transfer a program file between two platters without changing the name of the program file and without renumbering the lines. This is very important in cases of transferring many files of the same program without using the platter duplicate procedure; the program could not otherwise find the right subsequent files or the right line numbers.

Alternately, it is dangerous and tedious to use the keyboard command sequence UNIT, GET, UNIT, SAVE.

The program operates by building a new program with the ordered sequence of UNIT, GET, SAVE, and the right program file names and numbers. This program is immediately executed and, when the transfer has been accomplished, the control is passed again to the main program, COPRG, which is always resident in Unit #1. In Unit #1 is needed the data file COPRG of 1 record, too, as an intermediate storage for the generated program.

Lists of the main program, COPRG, and of the transfer program, PRGNAM, between Unit #0 and #1 are given.

```
100 REM *** FILE COPRG ***
110 DIM C$[80],A$[6],N$[4],O$[1],P$[1],D$[1]
120 FILES COPROG
130 Z=34
140 DBYTE Z,D$
150 DISP "PROGRAM NAME";
160 INPUT A$
170 DISP "FIRST LINE NUMBER";
180 INPUT N$
190 DISP "FROM UNIT";
200 INPUT P$
210 DISP "TO UNIT";
220 INPUT O$
230 PRINT A$;"    F.L.N = ";N$;"     FROM U. = ";P$;"     TO U. = ";O$
240 C$="1 UNIT "
250 C$[LEN(C$)+1]=P$
260 PRINT #1;C$
270 C$="2CHAIN"
280 C$[LEN(C$)+1]=D$
290 C$[LEN(C$)+1]=A$
300 C$[LEN(C$)+1]=D$
310 C$[LEN(C$)+1]=","
320 C$[LEN(C$)+1]=N$
330 PRINT #1;C$
340 C$="3 UNIT "
350 C$[LEN(C$)+1]=O$
360 PRINT #1;C$
370 C$="4 SAVE"
380 C$[LEN(C$)+1]=D$
390 C$[LEN(C$)+1]=A$
400 C$[LEN(C$)+1]=D$
410 C$[LEN(C$)+1]=","
420 C$[LEN(C$)+1]=N$
430 PRINT #1;C$
440 C$="5 UNIT 1"
450 PRINT #1;C$
460 C$="6 GET"
470 C$[LEN(C$)+1]=D$
480 C$[LEN(C$)+1]="COPRG"
490 C$[LEN(C$)+1]=D$
500 C$[LEN(C$)+1]=",100,100"
510 PRINT #1;C$,END
520 DGET"COPROG"
530 END


RUN
PROGRAM NAME? PRGNAM
FIRST LINE NUMBER? 1520
FROM UNIT? 1
TO UNIT? 0
PRGNAM    F.L.N = 1520     FROM U. = 1     TO U. = 0


LIST

1 UNIT 1
2 CHAIN "PRGNAM",1520
3 UNIT 0
4 SAVE "PRGNAM",1520
5 UNIT 1
6 GET "COPPRG",100,100
```

# Update

### 98032A Opt. 030 Interface Card

- Send data and programs between the 9830A/B and 9831A
- Send data only between the 9825A and the 9810A, 9820A, 9821A, and 9830A/B

Now owners of earlier 9800 Series Calculators can transfer programs and/or data between the 9825A and 9831A Desktop Computers without the need for manual re-entry. If a transfer error is encountered, an error message will prompt you for later correction.

The write control command is required to transfer data in both directions, but fixed direction transfer can be manually selected without this command. The write control command is in the General I/O capabilities of the 9825A and in the Flexible Disk ROM for the 9831A.

### 9878A I/O Expander

HP's new 9878A I/O Expander triples the number of usable 9825A or 9831A I/O channels from three to nine. The Expander is compatible with all 9825A and 9831A I/O cards with no effective loss in data transfer rates. A system integrity light on the interface card illuminates when the 9878A and desktop computer are properly connected and turned on. This feature proves particularly helpful when the Expander is not readily visible.

To interface with an even larger number of peripherals and instruments, two Expanders can be simultaneously connected.

### Errata

The part number of the 9825A Electrical Construction Estimating pack is not 09825-10020, as given in the last issue of KEYBOARD, 1977/1. The correct part number is 09825-12750.

### 9831A Blood Gas Package, 09831-14260

Complete analysis and interpretation of laboratory blood gas (pH, $PCO_2$, $PO_2$) measurements for arterial and mixed venous blood for both infants and adults. Requires a standard 9831A and 9871A Printer.

### 9831A Clin-Lab Quality Control Statistics Package, 09831-14270

Stores quality control values for 120 different chemistries. Programs calculate routine statistics and plot histograms, Youden & Levey-Jennings quality control charts. Correlation studies and scattergrams can be performed for any two chemistries at a time. Requires a 9831A with Opt. 001 and 9871A Printer. The 9862A or 9872A Plotter is optional.

### 9831A Radioimmunoassay Package, 09831-14250

Performs an unweighted and an iterated variance-weighted logit/log linearization on standard curve data. Interpolates patient unknowns, keeps quality control statistics for up to 15 assays/cartridge and 20 runs/assay. Requires a 9831A with Opt. 001 and 9871A Printer. The 9883A Tape Reader Subsystem is optional.

### 9831A Clinical Laboratory Library Package, 09831-14280

Consists of Radioimmunoassay Pack 09831-14250, Blood Gas Analysis Pack 09831-14260, and Clin-Lab Quality Control Statistics Pack 09831-14270. Requires a 9831A with Opt. 001, 9871A Printer. 9862A or 9872A Plotter and 9883A Tape Reader Subsystem are optional.


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HEWLETT-PACKARD
**Keyboard**
1977/2

**Applications Information on Hewlett-Packard Calculators and Desktop Computing Systems**

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Sept. 1, 1977