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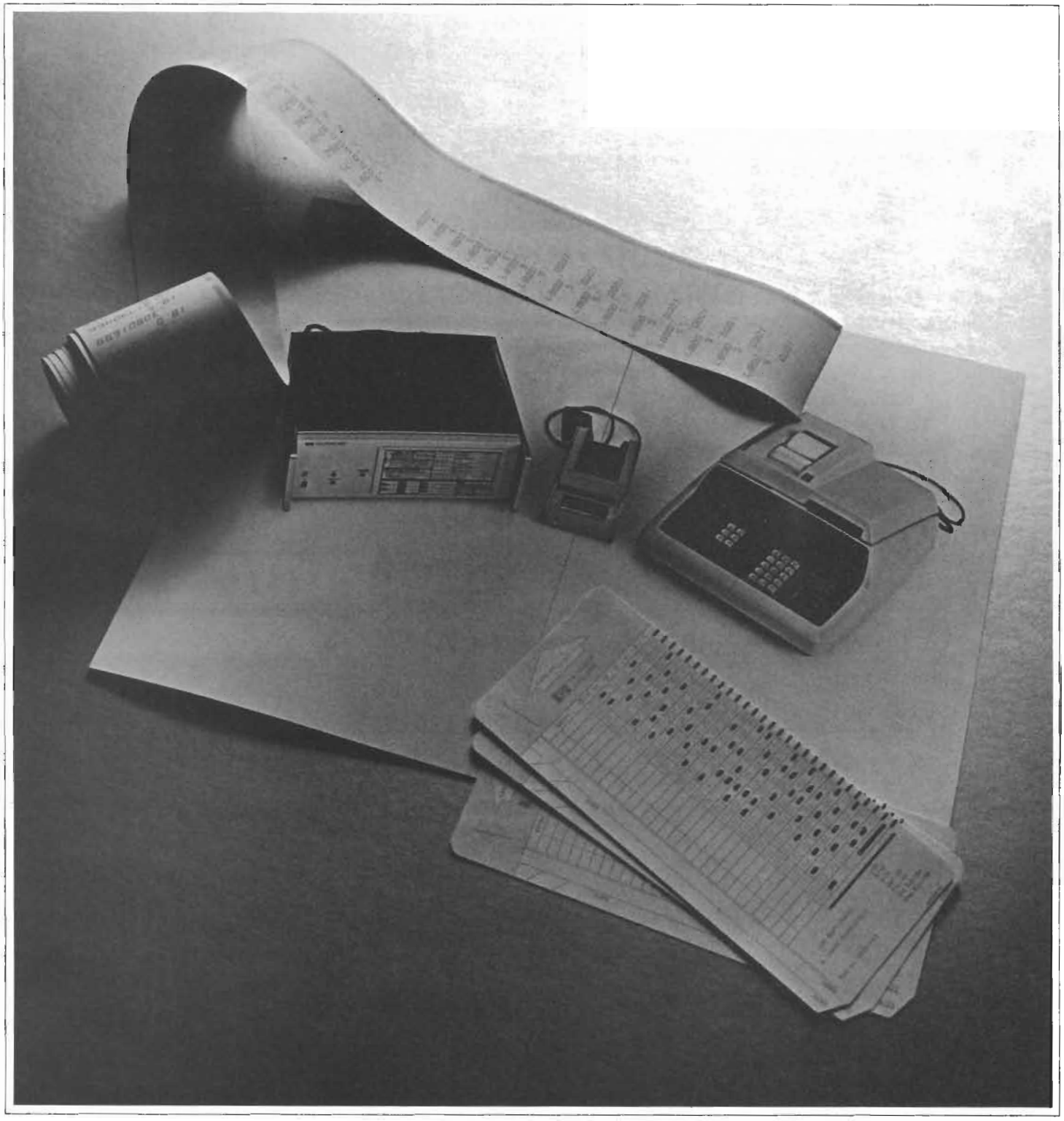


OCTOBER 1970

# Optical Card Reader for Fast Calculator Programming

**By Gene Zeller**

CARDS MARKED WITH PENCIL, PUNCHED HOLES, OR BOTH, can be used to enter programs rapidly into the HP Model 9100 Calculators. The HP Model 9160A Mark Sense Card Reader, Fig. 1, detects coded marks representing key codes. It transmits this coded information to the calculator. Many users can simultaneously write machine-readable programs without tying up the keyboard. Individual programs are entered into the calculator in seconds. Users in the field can write on the cards then, with the card reader, enter the data into the calculator during a program execution.

The model 9160A detects pencil marks and/or punched holes in the program-data card by means of photo transistors that look downward from the optical head onto the program-data card. Clock or strobe marks located near the edge of the program-data card, provide the timing and control sequence, Fig. 2.

The card reader detects marks on the card by monitoring the amount of light reflected to the individual photo transistors. The unmarked program-data card has a very rough surface that scatters the light originating from the light source. Marking the card with a soft lead pencil smooths the rough surface, causing a pseudo-mirrored surface. The optical head contains both the light source and the photo transistors. Its geometry is such that the

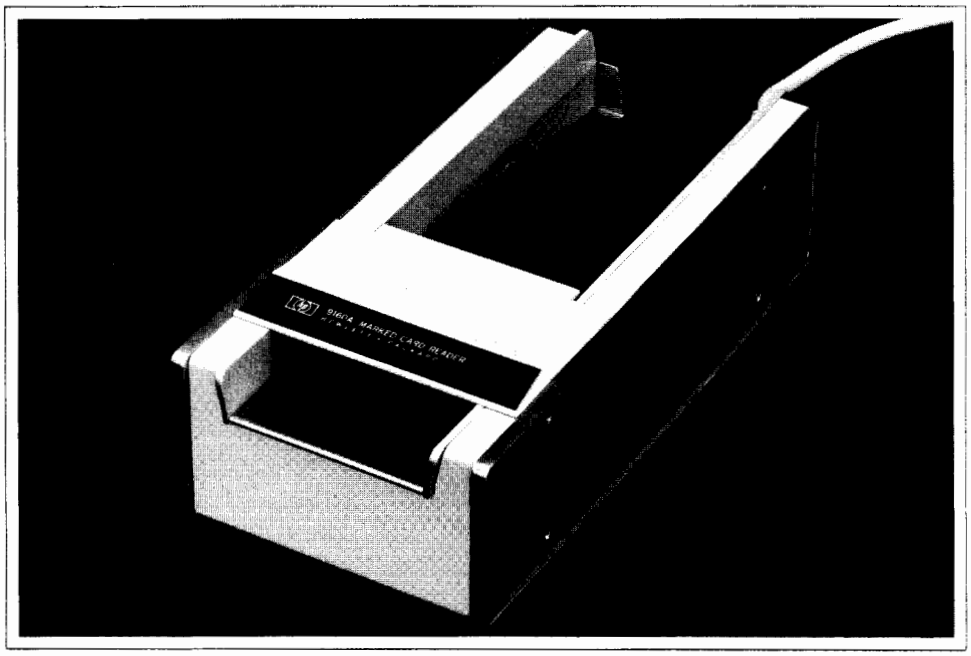


**Fig. 1.** *Pencil marks in boxes on cards are read by the Hewlett-Packard Model 9160A Marked Card Reader, and the information fed to the Model 9100A/B Calculators.*

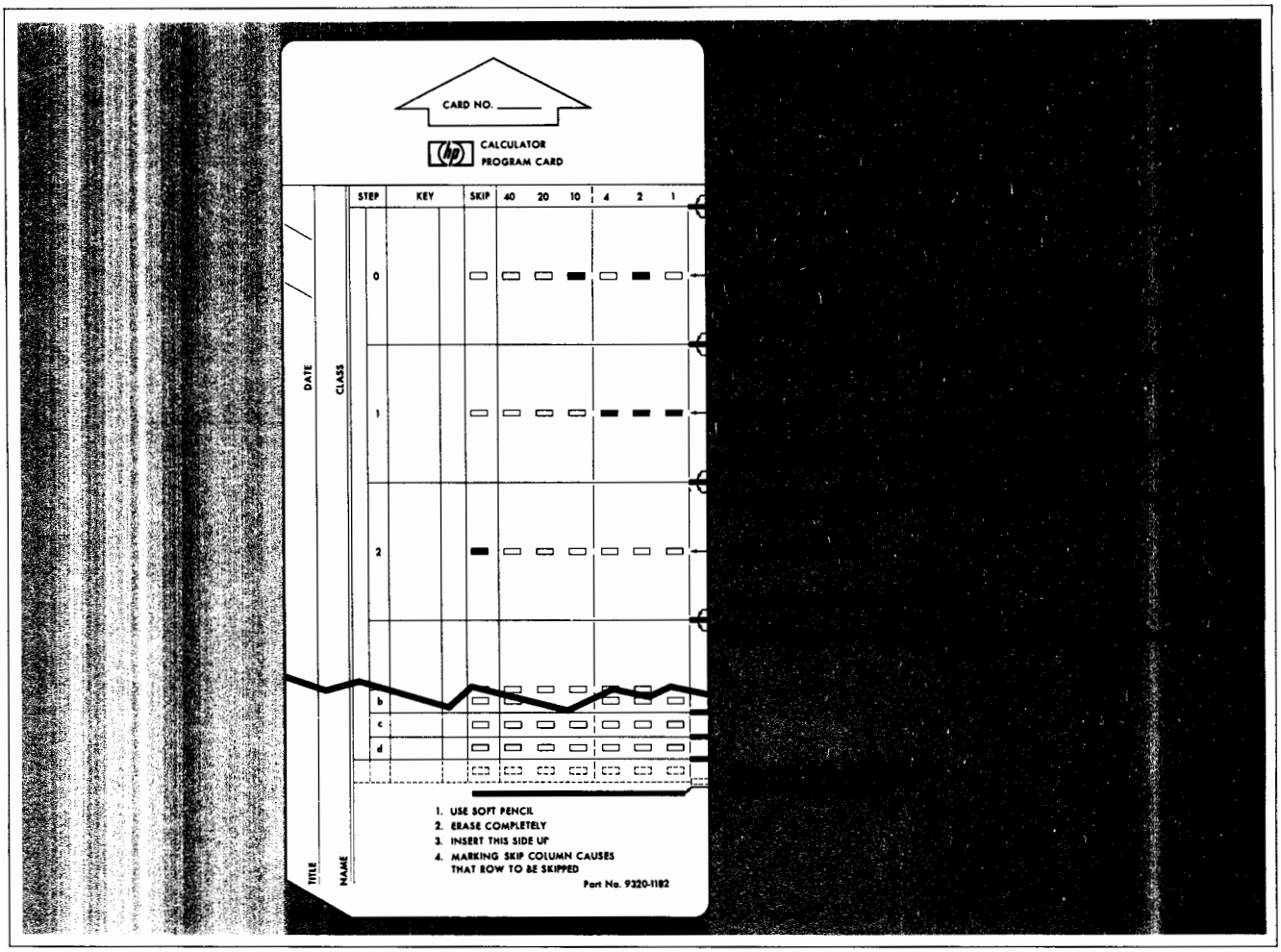



**Fig. 2.** *Interpretation of marks on a Model 9160A program card.*

reflected light, in the presence of a mark on the program-data card, is reflected away from the photo transistors. The *absence* of light is detected as a mark on the program-data card.

The Model 9160A Card Reader, Fig. 3, consists of six data channels, a skip channel and a strobe channel. The data channels read the data in the data field of the program-data card, and stores this information. The skip channel, when marked, causes skipping of the data channel information adjacent to the marked skip channel.

Functions of the strobe channel are to generate signals that 1) start the motor that draws the program-data card through the reader, 2) brighten the lamp to the required intensity, 3) load information stored in the data channel flip-flop into the calculator, and 4) reset data channel and skip channel flip-flops.

All channels contain a light sensor which depends upon the incident flux originating at the light source. Since the absolute value of incident flux can change considerably over the life of the instrument, logarithmic output is desirable. Such an output is obtained by using a phototransistor as a current source through two diodes. The voltage across the diodes varies logarithmically with the current through them.

The strobe channel receives its inputs from the clock marks located near the edge of the program-data card. When the strobe channel light sensor 'sees' the area below on the card going light to dark, a positive step is generated and amplified. This signal, after squaring, is differentiated and fed into the load signal generator whose outputs are NDGO and YDSP. These outputs are sent to the calculator if the inhibit signal is not present. NDGO and YDSP are load commands for the calculator.

Finally, as the black strobe mark passes beyond the field of vision of the strobe channel photo transistor, a negative going step is generated and amplified. The signal,

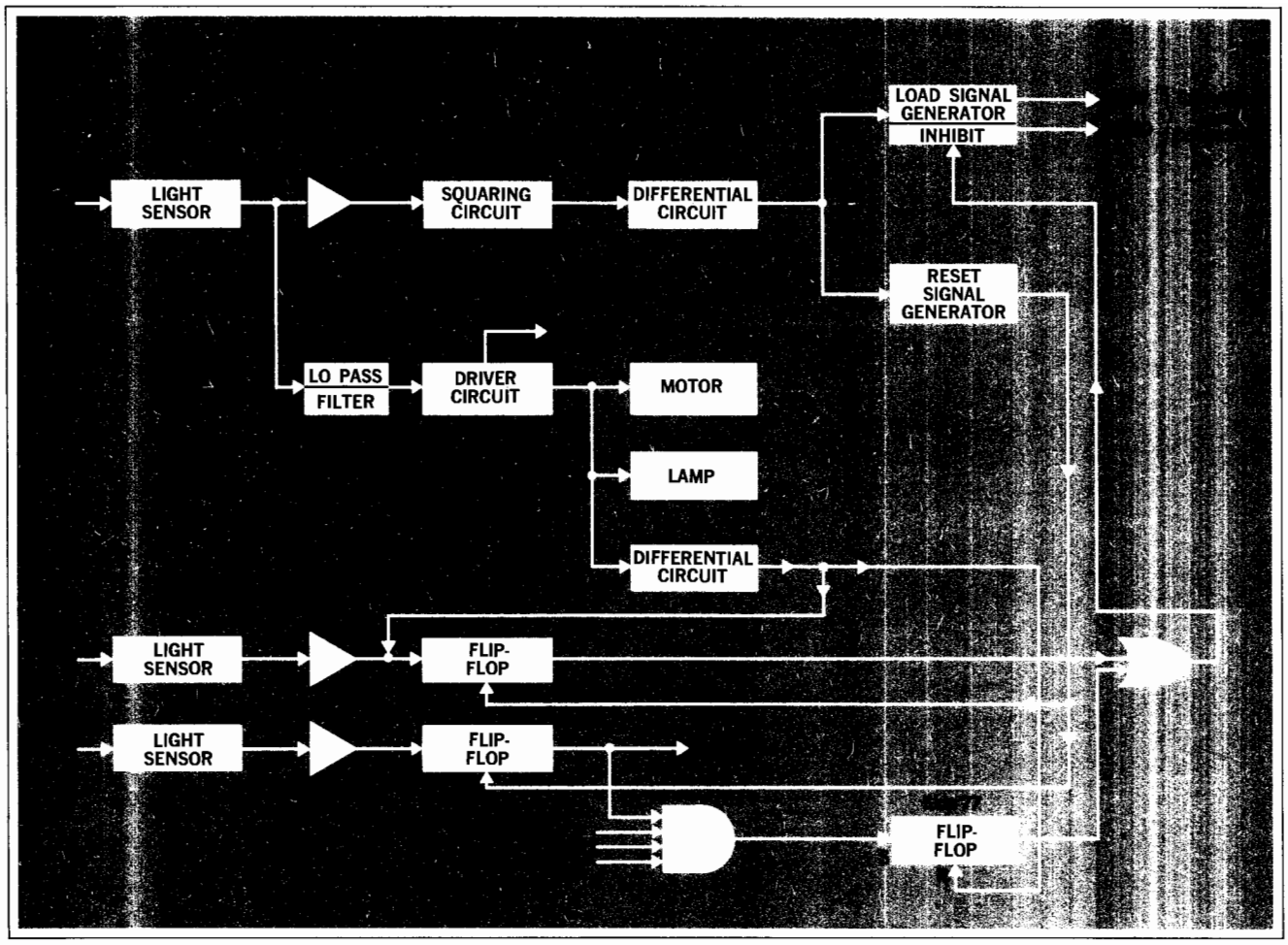



**Fig. 3.** *Block diagram of the Card Reader. There are a total of six data channels to generate signals NK 20 through NK 25.*

after squaring, is differentiated and fed into the reset signal generator. This reset signal will clear all data channel flip-flops and skip channel flip-flop if they are previously set.

In the data channel, the light sensor detects the absence of light due to the pseudo-mirrored surface created by the mark on the program-data card. A pulse is generated, amplified, and sets a flip-flop. Data is then loaded into the calculator by the strobe channel load commands.

The skip channel operates much as the data channels do with one exception. The skip channel has two ways of being set. In addition to the setting of the skip channel flip-flop by the light sensor, this flip-flop is set by way of the strobe channel every time a card is inserted into the Model 9160A Card Reader. As a result, the first clock mark is ignored but all of the data channel flip-flops are cleared.

In addition, there is a SKIP-77 flip-flop that is set whenever the skip channel and all data channels are set. The SKIP-77 flip-flop can only be cleared by card entry. Consequently, marking the card with SKIP-77 inhibits the remaining strobe mark load signals. In effect, the remaining data field is completely ignored. This important feature eliminates the necessity of marking the SKIP channel the full length of the card following the data field when using the Model 9160A for fast data entry into the calculator when in RUN mode.

When there is no card in the Model 9160A, the lamp used as the light source glows dimly, waiting to detect a card. When a card is in place, the lamp's intensity increases to that required for reading. With this automatic dimming technique, the life of the thin-line filament of the incandescent lamp (that spans the entire card width) is increased.

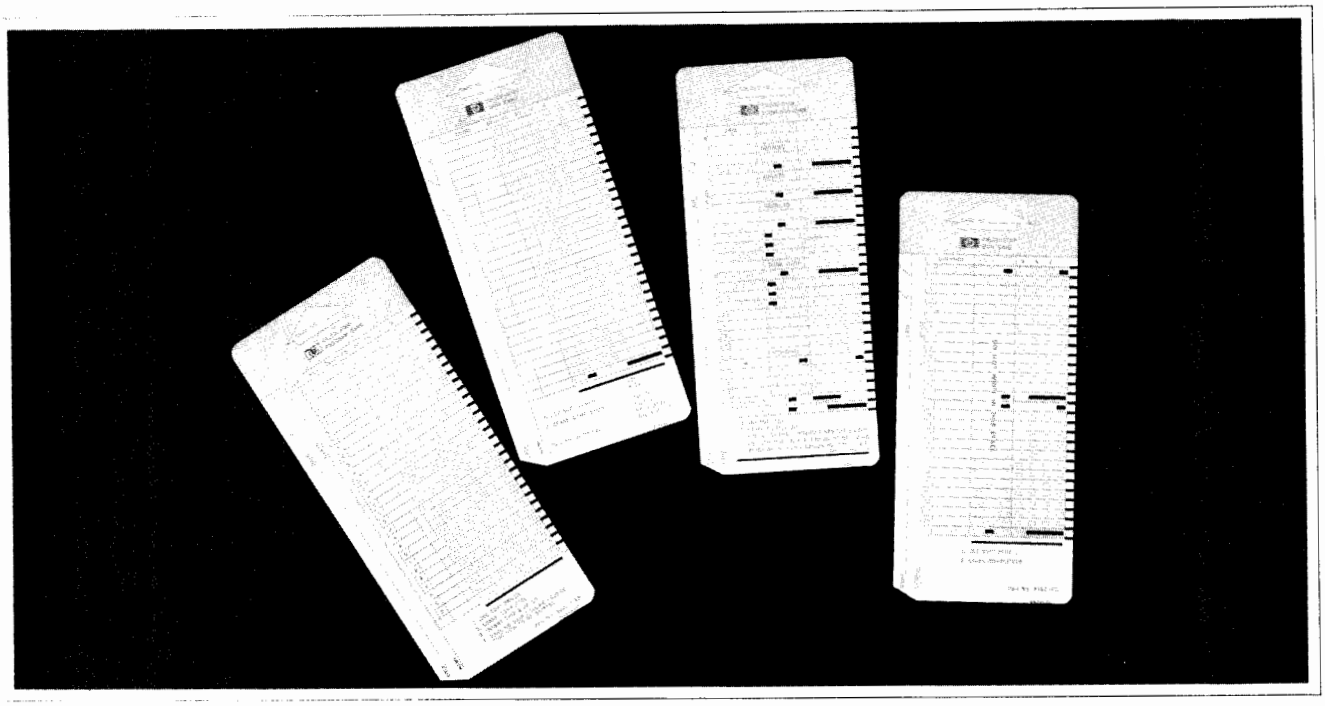


**Fig. 4.** *Four cards are used with the Card Reader. At left, a program card, next a data card, a surveying data card, and at right a quiz card. The quiz card can be used to mark answers on up to 24 multiple choice questions.*

# SPECIFICATIONS

## HP Model 9160A
## Marked Card Reader

**DESCRIPTION**

**Line Width:**
Minimum 0.020 inch pencil mark required for reliable sensing.

**Reading Rate:**
20 milliseconds per character. Inserting card starts motor which pulls card through reader.

**Codes:**
Column weights of marked columns are added to total the calculator key code.

**Operating Modes:**
a) Program mode—program instructions on the card are loaded into successive calculator core memory locations.
b) Run mode—any key operation may be performed by marking the appropriate octal key code.

**Skip Channel:**
Marking in the skip channel causes that character to be ignored.

**GENERAL**
Weight: Net 4.5 lbs., shipping 5.5 lbs.
Power: Takes power from -hp- 9100 Calculator.
(Idle 2.5 watts, running 3.5 watts.)
Dimensions: 3½" high by 5⅓" wide by 11¼" deep.
Temperature: Operating range, 0°–55°C.

**PURCHASE PLANS**

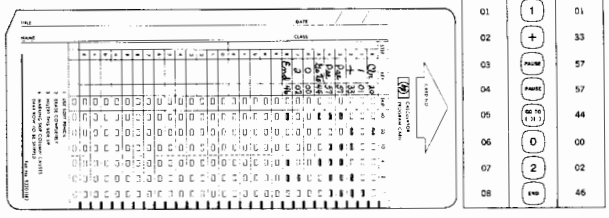
| | |
|---|---|
| **Purchase:** | **HP 9160A, $490.00.** |
| **Rent:** | **$ 35.00 per month.** |
| **Lease:** | **$ 12.74 per month.** |

**MANUFACTURING DIVISION:** LOVELAND DIVISION
P.O. BOX 301
815 FOURTEENTH STREET S.W.
LOVELAND, COLORADO 80537

**CARD FORMAT**
The 9160A uses standard size tab cards printed in the format shown here. Each card will hold 28 program instructions. Cards may be cascaded for longer programs.

Marking boxes are used to indicate areas of the card that are examined by the mark reader for presence of a pencil mark. A soft-lead pencil is recommended; the mark provided by a hard-lead pencil may not be read consistently by the mark reader.

**CARDS**
**Furnished:** Package of 100 Calculator Program Cards
**Available:** 9320–1182 Calculator Program Format
9320–1191 Quiz Answer Format
9320–1192 Calculator Data Format
**Price: Pkg. of 2,000 $15.00**
**Box of 10,000 $60.00**

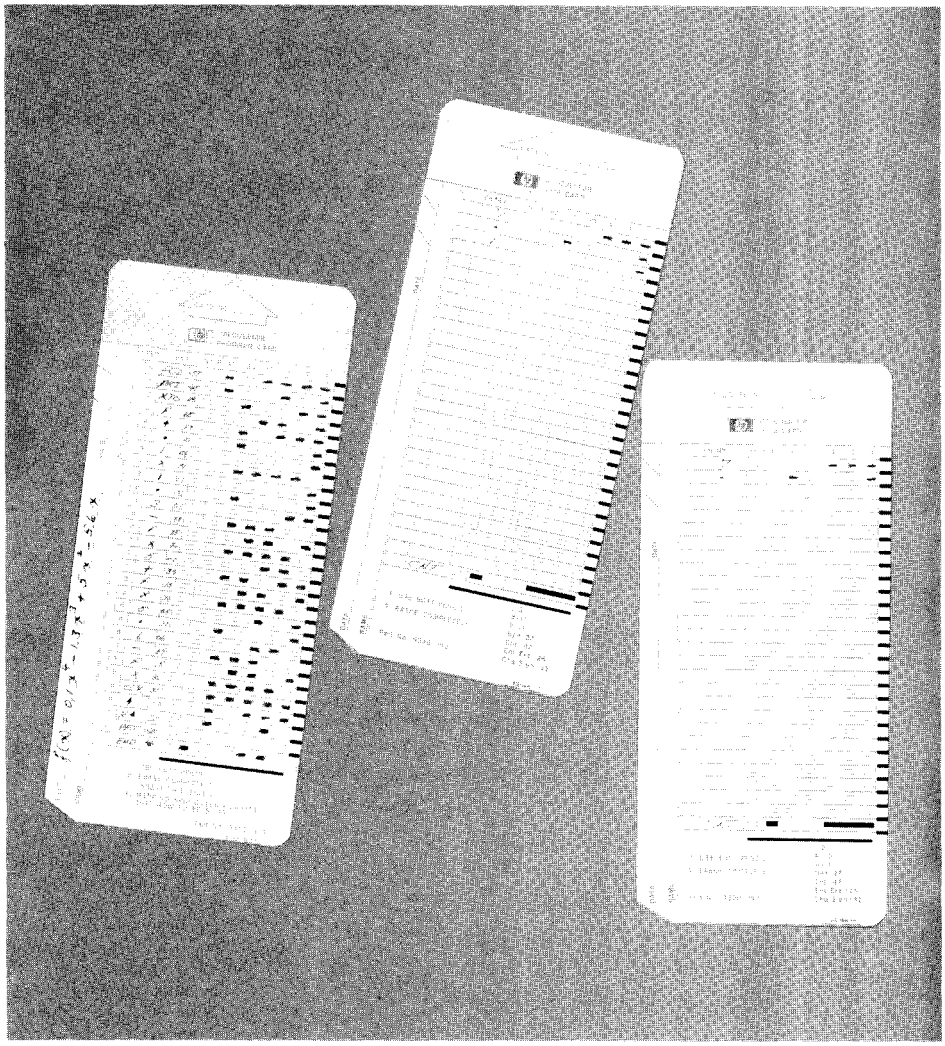



**SPECIAL PURPOSE CARD INK SPECIFICATIONS**
The mark reader reads marks on the tab card as contrasts in light reflection which are detected by photo sensors as the card passes under a reading head. If a mark is not present, a maximum amount of light will reflect; if a mark is present very little light will reflect. This requires that a non-reflective ink be used for the clock marks and reflective ink be used for all other printing on the card.

Clock marks and preprinted codes, if any, must be printed in non-reflective black ink with a reflectance value of less than 30 millivolts as measured on a Kidder MR-8 Tester. (Non-reflective ink should not be used elsewhere on the card.) The entire area of the clock mark must have solid ink coverage without voids. Edges must be sharp, clean, and free of raggedness. Marking boxes must be printed in reflective ink with a reflectance value of more than 50 millivolts as measured on a Kidder MR-8 Tester. Lithat Red ink, L 3 series, can be used.

# Typical Program

The equation for f(x) is solved by marking the cards as shown here.



**Acknowledgments**

Don Miller and Dick Osgood of HP Labs, Palo Alto, did the electrical design and mechanical design respectively of the first 9160A prototypes. Harry Schneider and Jerry Simon designed the molds and tooling for production. Al Vigil coordinated arrival of parts and assumed production engineering responsibility for the 9160A. Special thanks is due Lou Dohse whose guidance and experience contributed greatly to the project.

**Gene Zeller**

Gene is a graduate of the University of Wisconsin, 1969, with a BSEE. He joined the Hewlett-Packard Loveland Division in 1969 and had engineering responsibility for both the Model 9160A Card Reader and the Model 9102A Buffer Box. He is now working on memory system design.

Gene enjoys camping, backpacking and climbing. He is also a star softball player.