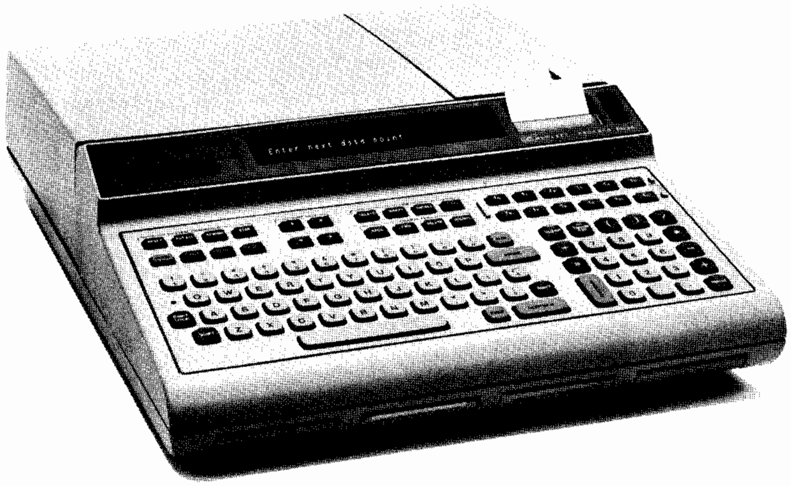
Hewlett-Packard 9825A Calculator Systems Programming

Systems Programming



9825A Calculator

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Chapter 1

General Information

Description

The 98224A Systems Programming ROM extends the 9825A language to include capabilities for remote keyboard operation, program self-modification, run-time read/write storage allocation, and intelligent terminal emulation.

The Systems Programming ROM uses 160 bytes of user read/write memory when installed in the 9825A. The Systems Programming ROM and the 98211A Matrix ROM cannot be used simultaneously. If your 9825A currently has the Matrix ROM installed, it must be removed before installing the Systems Programming ROM since a memory conflict will occur and result in unpredictable operation of the 9825A.

CAUTION

USE OF THE SYSTEMS PROGRAMMING ROM AND THE MATRIX ROM CONCURRENTLY MAY RESULT IN DAMAGE TO THE 9825A CALCULATOR OR THE ROMS, AND SHOULD NOT BE ATTEMPTED.

Inspection and Installation

Refer to the HP 9825A System Test Booklet for the procedure to verify the operation of your ROM.

Your Systems Programming ROM can be plugged into any one of the four ROM slots located on the bottom front of the calculator, as shown below.

Installing the ROM

To install your ROM card, first turn off the calculator. With the label right side up, slide the ROM through the ROM slot door. Press it in until the front of the ROM card is even with the front of the calculator. Then turn your calculator on.

Syntax

The following conventions apply to the syntax for the statements and functions found in this manual.

dot matrix –	All items in dot matrix are required, exactly as shown.
[ ] –	All items in square brackets are optional, unless the brackets are in dot matrix.
| –	A vertical bar is read as "or" in the syntax statement.

See the Appendix for a complete list of the syntax of the Systems Programming ROM statements and functions.

Error Messages

The Systems Programming ROM generates error messages C0 through C9. A complete description of the error messages is in the Appendix. A short listing of error messages is available on the inside back cover for quick reference.

Requirements

Several statements of the Systems Programming ROM require the presence of other ROMs. The relationships of the statements and their requirements are shown in the following table:

Mnemonic – ROM Option Requirements

Mnemonic	Description	ROM Option Necessary
on key	Keyboard Interrupt Routine enable	None
key	Key Buffer Empty function	None
kret	Keyboard Interrupt Routine return	None
asc	Keycode to ASCII Conversion function	None
bred	Read Transfer Buffer function	Extended I/O[1] and General I/O
eol	End-of-Line specification	General I/O
wsm	Write Serial Mode Word statement	General I/O
wsc	Write Serial Control Word statement	General I/O
rss	Read Serial Status Word function	General I/O
rkbd	Remote Keyboard Enable	General I/O
nal	Next Available Line function	None
%	Free Syntax prefix	None
store	Store String instruction	String[2]
avm	Available Memory function	None
cln	Current Line Number function	None

1 Extended I/O Binary Tape can not be used.

2 The String Programming ROM is not necessary if only literals are to be stored.

With the 9825A Option 003 (32K R/W memory), it is necessary to load Extended I/O as a binary tape. The Systems Programming ROM will not operate properly if the Extended I/O binary tape is loaded into the 9825A. Do not use the Systems Programming ROM and the Extended I/O binary tape concurrently, as erratic and unpredictable calculator operation will result.

The 9825A is primarily a computing controller, but the Systems Programming ROM can facilitate use of the 9825A as an intelligent terminal on an asynchronous serial data link, further extending the capabilities and usefulness of the 9825A Calculator.

Chapter 2

Intelligent Terminals

An intelligent terminal should represent a logical extension of the capabilities of a basic data terminal. The minimum facilities of a basic data terminal usually include a keyboard for operator entry, a printer or CRT display for data records and communications link status information, and a serial interface to the central processor. An intelligent terminal should include the minimum terminal functions and be user programmable.

The programmability of an intelligent terminal allows the user to define key functions, set special formats, establish communication formatting, and in the case of the 9825A, perform off-line computing as well. Some of the features an intelligent terminal makes possible include:

- Extension of the throughput capabilities of an overloaded central processing system;
- Faster effective turnaround time with much of the data processing done locally;
- Local formatting of input and output data records;
- Local concentration of data, with high speed block data transmission;
- Local content error correction and editing;
- Appending local, variant data, such as operator code, date and security information;
- Reduction of repeated communication link transfers due to local message correction and verification.

The 9825A, when used in conjunction with the Systems Programming ROM, can provide all of the features of an intelligent terminal and additional features that aren't usually available. The 9825A contains a high speed data cartridge for temporary off-line data storage if the communication link goes down, and an internal printer to list operator instructions and prompt messages.

The internal printer and the display can be treated as external devices by the program, and can be used to list two different message levels simultaneously. For example, the display could be used to list the data as typed by the operator and the printer utilized to update the communications link and system status.

Chapter 3
Intelligent Terminal Instructions

Overview

The Intelligent Terminal Instructions facilitate segmentation of the internal 9825A calculator "peripherals" into program controllable modules. With the three instructions "on key", "key", and "kret" the programmer can set up the 9825A keyboard as an external peripheral input device. The "asc" function returns the ASCII code equivalent of a 9825A keycode (which can be output to an ASCII coded printing device such as a teletype). The "eol" specification extends the generality of the communication format by allowing the programmer to specify output line delimiters other than the standard carriage return/line feed of the General I/O ROM.

Mnemonic External ROM Requirements

Mnemonic	Required ROM Option	Description
on key	None	Keyboard interrupt directive
key	None	Key buffer empty function
kret	None	Keyboard interrupt routine return
asc	None	9825A keycode to ASCII conversion
bred	Extended I/O ROM and General I/O ROM	Read transfer buffer function
eol	General I/O ROM	Line delimiter specification

Keyboard Interrupt Service Enable

The "on key" statement enables the programmer to establish the 9825A keyboard as an external input device, operating on an interrupt service level.

Syntax:

on key "Routine Name" [, Flag Number]

The routine name parameter may be either a string or a literal, and the flag number parameter either a fixed value or an expression.

Routine Name: Specifies the label of the keyboard service routine that is to process keyboard interrupts.

Flag Number: (Optional) specifies which flag to set if the key buffer overflows. If a flag number is specified, error C5 will not be issued for a key buffer overflow. The flag number may specify any one of the 16 system flags, however flags 14 and 15 should not be used if any math processing is being performed. (Refer to the 9825A Operating and Programming Manual for a detailed description of system flags.)

When activated by an "on key" statement, a dedicated 16 character circular buffer is established, as well as a link to the "on key" service routine. This routine (specified in the Routine Name parameter) changes the status of the system keyboard from calculator controller to input device (with the exception of the RESET key).

Thereafter, when a key is pressed, the keycode is placed into the 16 character circular buffer and end-of-line interrupt service is requested. If no other interrupts are pending, program control is passed to the keyboard service routine for processing. If any interrupts other than a keyboard interrupt occur before the end of the current line, they will be processed in descending order by select code until all pending interrupts have been processed. (Refer to the "on key" execution chart, execution priority block diagrams, and program execution flowchart in the Appendix). The 16 character key buffer allows for execution of long program lines and multiple interrupt processing before the key buffer overflows.

A key buffer overflow results if more than 16 keys are pressed before program control transfers to the "on key"service routine. An overflow is indicated either by error C5 or by setting the "on key" flag (use the optional Flag Number parameter).

Syntax:

```
on key
```

The "on key" statement specified without parameters disables the on key service routine, clears the key buffer, and returns the 9825A to normal keyboard operation. The "on key" optional flag (if used) is not affected, and it should be noted that "on key" cannot be disabled from live keyboard. (The "on key" statement effectively disables live keyboard.)

NOTE

Whenever the "on key" statement is executed the key buffer is cleared and any data remaining in the buffer will be lost. This applies to the "on key" statement with or without parameters.

NOTE

Do not execute a branch command (`ldf`, `ldp`, `jmp`, `gto`, etc.) from within the "on key" routine if program execution will branch from the routine without executing a kret. The result will be that no more keys will be processed from the keyboard.

Key Buffer Empty Function

Syntax:

```
key
```

Parameters are not required for the "key" function.

The "key" function returns the earliest entered unprocessed keycode in the key buffer. When all keycodes have been processed by the "on key" routine, `key` returns a value of zero and `kret` execution is allowed. If an exit from the subroutine is attempted (by a "kret") with any remaining keycodes in the key buffer, the "on key" routine will be restarted. (See the "kret" execution flow chart in the Appendix.)

Example:

`0: on key "kbd"` `1: gto +0`	0,1: Enable on key service routine `"kbd"`, and hang in loop.
`2: "kbd":`	2: on key routine label.
`3: dsp char(asc key);wait 500`	3: Display each consecutive keycode in buffer.
`4: kret` `*9272`	4: When buffer is empty, return.

NOTE

The "kret" will cause an immediate routine reentry unless the key buffer has been emptied.

Keyboard Interrupt Routine Return

Syntax:

`kret`

Parameters are not required for the "kret" syntax.

The "kret" statement serves to return program execution to the main program after emptying the key buffer. The reentry point of the main program is the program line that would have been executed before control was passed to the keyboard service routine.

If kret is executed before emptying the key buffer, control is not transferred to the main program, and the keyboard service routine is restarted. (See the on key execution flow chart in the Appendix.)

9825A Keycode to ASCII* Code Conversion Function

The "asc" function provides a single statement conversion from 9825A keycodes to an ASCII equivalent code. It is useful when outputting 9825A keycodes to an external ASCII device.

Syntax:

`asc` keycode

The keycode parameter may be either a fixed value or an expression.

The "asc" function returns the ASCII equivalent of a 9825A keycode, including the system control keys and special function keys. The value returned by the "asc" function for the shifted function keys will be greater than 127 decimal, and therefore out of range of the ASCII character set. If the Extended I/O ROM is present, the "asc" function will return an octal or decimal value depending on the oct/dec mode of the calculator. If the octal mode is set, the value returned by "asc" will be in octal, which is an improper format for the "char" function of the Strings ROM. (In this case use the octal-to-decimal function to restore the "asc" value to decimal; refer to the Extended I/O Manual.)

* ASCII: American Standard Code for Information Interchange.

A 9825A keycode to ASCII translation table is included in the Appendix for reference.

Example:

Typing a key on the keyboard will result in the ASCII character and code shown in the left of the display and the 9825A internal character and code to the right.

```
0: on key "kbd"
1: sto +0
2: "kbd":
3: key→K;dsp
 char(asc K),
 asc K,char(K),
 K;wait 500
4: kret
*25604
```

Read Transfer Buffer Function

The "bred" statement facilitates use of the 9825A over a high speed data link, offering a means of reading an active interrupt input buffer without having to wait for the buffer transfer to run to completion.

Syntax:

bred ("Buffer Name")

Buffer Name: A string or literal parameter specifying the name of the transfer buffer to be emptied. The buffer specified must be an active*, interrupt type, byte input buffer (type 1) as implemented by the Extended I/O ROM. An error (C4) is displayed if "bred" is executed specifying a non-interrupt type or non-busy buffer. If the "bred" function is used to read a transfer buffer, the General I/O "red" statement should not be used. Using both "bred" and "red" on the same buffer disrupts the buffer pointers and incorrect data is read from the buffer.(A more detailed discussion of the Extended I/O transfer buffer pointers is found in the Extended I/O ROM Manual.)

Use of the "bred" function in conjunction with the Extended I/O transfer buffer facilitates 9825A data communications on a high speed data link. The "bred" function allows the programmer to implement a high speed input buffer which is emptied at memory speed without having to run the buffer transfer to completion. This input scheme presents a broader data input window to incoming messages than does a double buffer input scheme of alternating

* The transfer operation must be in effect.

input transfer buffers. The double buffer input method offers only limited control over the time window between buffer available periods, due to the necessity of completing the current program line before acknowledging a buffer completion interrupt. If a long program line is being executed when a buffer terminates, the time delay encountered before reenabling another input buffer may be too large to insure reception of all incoming data when operating at high data rates.

When high speed data communication is implemented on the 9825A, use of the "bred" buffer read function on a frequent basis is suggested. Interrupts are disabled by "bred" for a time span dependent upon the number of bytes in the buffer to be read out, so it is suggested that the program be designed to execute a "bred" periodically. If a buffer overflow occurs, possible alternatives are to add more "bred" instructions to the program or to execute bred within a subroutine which is called from several program locations.

Example:

```
0: dim B$[650]
1: buf "Buff";
 180
2: tfr 12;"Buff"
3: "loop":
          •
          •
          •
          •
          •
          •
          •
          •
          •
          •
          •
15: bred("Buff")
 →B$[len(B$)+1]
16: gto "loop"
17: "Overrun":pr
 t "More frequen
 t bred needed."
```

Line 1 establishes a type 1 buffer of 200 bytes ("Buff").

Line 2 enables a full buffer interrupt routine.

Line 3 starts the transfer operation into "Buff".

Line 4-14 are program lines that process the incoming data.

Line 15 initiates a bred operation on "Buff", specifying the contents of the buffer to go to B$.

Line 16 returns to "loop".

Line 17 is executed on a buffer completion interrupt. If this happens, "bred" must be executed more frequently.

End-of-Line Specification

The end-of-line sequence specification furnishes the programmer with a means of substituting any character sequence (up to seven characters) for the General I/O carriage-return/line-feed for tailoring output to the needs of the external device.

Syntax:

eol [eol Character] [, eol Character$_2$]...[, eol Character$_7$] [, -eol Sequence Delay]

From zero to seven eol Characters may be specified; each may be a fixed value or an expression. The Sequence Delay parameter (if specified) must be given as a negative value, and may be either a fixed value or an expression.

eol Character: Is the numeric value of each character code to be output as an end-of-line delimiter. The maximum value that may be specified for an eol character is 127 decimal, as only 7-bit characters are transmitted. The eol characters are fixed at the time the eol specification is executed, and the octal/decimal mode setting of the calculator will determine the interpretation of the eol character value. This value is not reevaluated when the octal/decimal mode is switched subsequent to the eol specification.

eol Sequence Delay: Specifies the milliseconds of delay between output of the last character of an eol sequence and the start of the next line of output. The maximum possible delay is 32768 milliseconds (decimal value), allowing a flexible approach to a peripheral's physical requirements. (For example, some teletype printers require about 200 msec after performing a carriage return before being ready for new characters.)

The end-of-line specification is useful for formatting output to specialized devices such as the HP 2640 Terminal. The 2640 terminal requires specific codes in an end-of-line sequence to keep the display in the special enhancement mode on the next display line. Since the "eol" sequence specification may be executed at any time, it is possible to extensively reformat output to a device by specifying tabs, spaces, double spaces, or whatever sequence is desired, as necessary.

In operation, the eol sequence is substituted for the carriage-return/line-feed delimiters of the General I/O format. This substitution affects output to any device using the statements "list#" and "wrt" (General I/O), and "cat" (mass storage).

The General I/O format statement ("fmt") is also affected by the eol sequence specification. The slashes (new line) will cause an eol sequence to be output to the specified device instead of a carriage-return/line-feed, and the suppress line-feed (z) will suppress an eol sequence output.

Examples:

`eol 13,10,32,32,32,32,32`	Changes format to carriage return, line feed, and five spaces.
`fmt 1,/,/,c20`	This format will output two eol sequences and a twenty character string.

Chapter 4

98036A Serial Interface Control Instructions

Preface

The material covered in this chapter assumes reader familiarity with the uses and functions of the 98036A Serial Interface. Due to the technical nature of serial data communications, this section is not oriented toward the newcomer in the field of serial I/O. A brief discussion of asynchronous data communication is included in the Appendix to assist those readers not familiar with the asynchronous format.

Overview

Serial I/O communications allow considerable flexibility in format, with different devices using different formats. Normally, the 98036A Interface is configured to the format set by the internal switch settings upon power-up. It is convenient to be able to override the switch settings (without requiring interface disassembly) through program control, and this can be accomplished by writing bit patterns into the interface registers.

The 98036A Serial Interface Control Instructions allow considerable simplification of the programming necessary to access the registers of the 98036A Interface. The "wsc", "wsm", and "rss" mnemonics directly access the control, mode, and status registers in the required sequence, and in addition the interface is not left disarmed for interrupts between program statements as can occur when accessing the interface registers using the write control and write byte instructions of the General I/O ROM (refer to the access sequence flow chart in the Appendix). The "rkbd" instruction utilizes the full duplex capabilities of the 98036A Serial Interface to provide remote keyboard operation of the 9825A Calculator. Characters sent from the remote terminal are echoed back to the terminal when in the "rkbd" mode, however, error messages are not automatically transmitted to the remote terminal.

Mnemonic External ROM Requirements

Mnemonic	Required ROM Option	Description
wsm	General I/O	Write Serial Mode Word statement
wsc	General I/O	Write Serial Control Word statement
rss	General I/O	Read Serial Status Word function
rkbd	General I/O	Remote Keyboard Enable/Disable

Write Serial Control Word Statement

The "wsc" statement insulates the programmer from the complex control register access sequence for the 98036A Serial Interface. A single statement is all that is necessary to access the 98036A control word, making the implementation of specialized I/O formats a much simpler task with the Systems Programming ROM.

Syntax:

wsc Select Code, Control Word

Parameters specified may be either fixed values or expressions.

Select Code: Specifies a 98036A Serial Interface select code set to the range [2 ≤ select code ≤ 15]. If the interface specified by the select code is not a 98036A, or if no interface is set to the specified select code, error C9 is issued. Extended I/O device names are disallowed.

Control Word: Specifies a bit pattern to be written into the control register (R4D) of the 98036A Serial Interface. Note that the value of the control word (mod 256) follows the octal/decimal mode setting of the calculator (for Extended I/O ROM only), and is interpreted accordingly. (Bit 6 is masked out to avoid resetting the 98036A.)

R4D USART Control Word

R4D holds the USART control word. The USART is the integrated circuit in the interface that transmits and receives data in the proper format. Here is a description of the R4D bit positions.

BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
Always 0	USART Reset	Clear To Send Pin 5 (Standard) Request To Send Pin 4 (Option 001)	Reset Status Bits of USART Status Word	Send Break Character	Enable Data Receiver	Data Set Ready Pin 6 (Standard) Data Terminal Ready Pin 20 (Option 001)	Enable Data Transmitter

Bit 7 – Bit 7 is not used and must always be a 0.

Bit 6 – Is used to reset the USART. When bit 6 is a 1, the USART is forced into an idle mode. This bit is masked out when using the "wsc" statement.

Bit 5 – This is a programmable RS-232 signal. In the case of the standard cable, the signal is sent to the device on the Clear-To-Send line (pin 5). In the case of the Option 001 cable, the signal is sent to the device on the Request-To-Send line (pin 4).

Bit 4 – Status bits 3, 4 and 5 of the R4E status register are reset to 0.

Bit 3 – Enables the USART to output a break to the data communications device. This causes a continuous space character to be output. Setting this bit to a zero will terminate the break.

Bit 2 – When this bit is a 1, it allows the interface to receive characters for transfer to the calculator.

Bit 1 – Using the standard cable, when bit 1 is a 1, a Data Set Ready signal is sent to the data terminal on pin 6 of the terminal connector. Using the Option 001 cable, when bit 1 is a 1, a Data Terminal Ready signal is sent to the modem on pin 20 of the modem connector.

Bit 0 – The USART transmitter (R4A) is enabled when this bit is a 1.

NOTE

It is not possible to set bit 6 of the USART R4D register (USART Reset) by using the "wsc" command. This bit is masked out since the interface would be left in an idle state and important data could be lost.

To set a specific bit, add two raised-to-the-power of that bit number to the value of the mode word.

Example:

Enable data transmitter, send Data Terminal Ready (98036A Option 001) or Data Set Ready (standard), send Clear-To-Send, and enable data receiver...(Interface select code = 11):

Control word = 2↑0 + 2↑1 + 2↑2 + 2↑5 = 39 (decimal)

```
wsc# 11,39
```

Write Serial Mode Word Statement

The "wsm" statement accesses the mode register of the 98036A Serial Interface with a single statement, reducing the programming necessary to reconfigure the 98036A mode word. This function is useful when temporarily logging on to a serial I/O link which uses a word format different from the one set by the 98036A mode switches.

Syntax:

wsm Select Code , Mode Word [, Control Word]

Parameters specified may be either fixed values or expressions.

Select Code: Designates a 98036A select code with the same specifications and limitations as described for the "wsc" function.

Mode Word: Specifies a bit pattern to be written into the R4C register of the 98036A Serial Interface. Note that the value of the mode word follows the octal/decimal mode setting of the calculator (Extended I/O ROM only), and is interpreted accordingly.

Control Word: (Optional; default value = 5) If a value different from the default value is desired, it can be specified as a parameter to the "wsm" syntax. See the "wsc" syntax for the 98036A control word (R4D) details.

R4C Mode Word

R4C is the mode word buffer. The mode word determines the mode of operation of the interface. A mode word from the calculator overrides the default mode word that was set (from the default mode word switches) during an interface reset. Following is a description of the R4C bit positions.

BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
Number of Stop Bits 00 = not valid 01 = 1 bit 10 = 1.5 bits 11 = 2 bits		Parity Type 0 = Odd 1 = Even	Parity Enable 0 = Disable 1 = Enable	Character Length 00 = 5 bits 01 = 6 bits 10 = 7 bits 11 = 8 bits		Bit Rate Factor 00 = not used 01 = 1 X bit rate clock 10 = 1/16 X bit rate clock 11 = 1/64 X bit rate clock	

Bits 7 and 6 – Determine the number of stop bits used.

Bit 5 – Determines whether odd or even parity is to be used (when parity is enabled).

Bit 4 – Enables or disables parity.

Bits 3 and 2 – Should be set to indicate the length of the characters that are to be transferred. Character length is not inclusive of the parity bit.

Bits 1 and 0 – Determine the rate at which characters will be transferred. Characters can be transferred at: the exact rate of the bit rate clock, 1/16 the rate of the bit rate clock or 1/64 the rate of the bit rate clock. The 1/64 position is recommended for increased immunity to signal distortion.

NOTE

Do not use the 1/64 bit rate factor setting when the bit rate is set to 4800 or 9600 bits per second. Use the 1/16 bit rate factor.

NOTE

Setting bits 1 and 0 both to zeros will result in erroneous interface operation. Do not operate the interface with bits 1 and 0 of the mode word both set to zero.

To set a specific bit add two raised-to-the-power of that bit number to the value of the mode word.

Example:

Select 1 stop bit, even parity, parity enabled, 7 bits/character, 1/64 bit rate factor, default control word of 5...(interface select code = 11):

Mode Word 2↑0 + 2↑1 + 2↑3 + 2↑4 + 2↑5 + 2↑6 = 123 (decimal)

```
wsm# 11,123
```

Read Serial Status Word Function

The "rss" function returns the contents of the 98036A status register, giving the programmer easy access to the current status of the serial I/O link.

Syntax:

`rss` Select Code

Parameters may be specified as either fixed values or expressions.

Select Code: Designates a 98036A select code with the same specifications and limitations as described for the "wsc" function.

The 98036A status word (register R4E) is accessed by the "rss" function and returned as a value interpreted according to the octal/decimal mode setting of the calculator. The following table describes the bit position functions of the R4E status word:

R4E USART Status Word

BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
Request To Send Pin 4 (Standard) Data Set Ready Pin 6 (Option 001)	Always 0	Framing Error	Overrun Error	Parity Error	Transmitter Empty	Receiver Ready	Transmitter Ready

Bit 7 – Using the standard cable, bit 7 indicates the status of the request to send line (pin 4) of the terminal connector. Using the Option 001 cable, bit 7 indicates the status of the data set ready line (pin 6) of the modem connector.

Bit 6 – Not used; always 0.

Bit 5 – This bit is a 1 when the received data does not contain the proper number of stop bits.*

Bit 4 – This bit is a 1 when data is received before the data receiver buffer is emptied (overrun error*).

Bit 3 – This bit is a 1 when parity error occurs.*

Bit 2 – This bit is a 1 when the USART's data transmitter buffer is empty.

Bit 1 – When a 1, this bit indicates that the USART's data receiver is ready with a received character.

Bit 0 – This bit is a 1 when the USART's data transmitter buffer is ready to transmit data.

Example:

```
0: rss 11→X
1: if bit(7,X);
 gsb "Data Set
 Ready"
2: if bit(2,X);
 gsb "Output
 Next Byte"
3: if bit(0,X);
 gsb "Transmitte
 r Ready"
4: gto 0
5: "Data Set
 Ready":
          •
          •
          •
          •
```

* Refer to the Asynchronous Communication Section in the Appendix for a discussion of parity, overrun, and framing errors.

After the rss function value is placed into the variable "X", the status register bits are tested and if set, the program branches to the appropriate routines to do the necessary processing for that particular condition.

NOTE

When using the "wsc", or "wsm" commands, a parameter error could leave the 98036A in an undefined state. Use care when selecting the parameters for these functions, as data loss could result if the interface locks up. If this state is encountered, it is necessary to reset the 9825A.

Remote Keyboard Statement

The "rkbd" statement enables a remote keyboard to control the 9825A over a serial data link through the 98036A interface.

Syntax:

rkbd Select Code [, Code Type]

Parameters may be either fixed values or expressions.

Select Code: Must specify the select code of a 98036A Interface, and must be in the range [2 ≤ select code ≤ 7].

Code Type: Specifies the remote keyboard code interpretation as follows:

Code Type = 0: ASCII keyboard
Code Type = 1: 9825A keycode keyboard

If code type is not specified, a default value of zero is assumed (ASCII).

The "rkbd" statement operates in conjuction with the 98036A Serial Interface to enable full duplex remote operation of the 9825A. This capability allows the 9825A to be used with a multiline display and to be controlled remotely while the calculator is operating in a hostile or inaccessible environment. All characters sent to the 9825A from the remote keyboard are echoed to the remote display, allowing continual monitoring of the data link status.

When operating with a remote keyboard, the local keyboard is not disabled and characters generated by the 9825A's keyboard are not transmitted to the remote display. Error messages are treated as local data and are not transmitted to the remote display. To enable error message monitoring on the remote display, the error trapping facility of the Extended I/O ROM must be used in conjuction with the "wrt" statement. (Note that an "rkbd" interface may be written to, but not read from, by the 9825A.)

Example:

```
3: on err "trape
 rr"
        •
        •
17: "traperr":wr
 t 6;"error";
 char(rom);ern;
 ";line";erl;
 gto 3
```

The error recovery routine "traperr" outputs the error number and the line it occurs in to the remote keyboard set to select code 6.

Pressing the calculator "Reset" key will take the calculator out of the remote keyboard mode.

To prevent erroneous character transmission over the data link, the interface character format (#of stop bits, parity, #character bits) should be identical for the remote keyboard and the 9825A. When the calculator is operating in the ASCII mode, the input characters are masked to seven bits. When operating in the 9825A keycode mode, the interface should be configured for 8 bit characters, or the shifted special function keycodes will be inaccessible.

Some peripherals, such as the HP 2640 Terminal, have block output capability and can transmit a line or more of characters at a time. If block transmission is to be used with a 9825A enabled for remote keyboard operation, a data rate of not higher than 110 baud should be used. (For large block transmissions use 50-75 baud.)

NOTE

Buffered I/O operations should not be used with a 98036A configured as a remote keyboard interface, as erratic calculator operation will result.

Limited editing of 9825A program lines is possible from the remote keyboard by using the "list#" statement to output selected program lines to the remote terminal, however the 9825A cursor position is not accessible and it is necessary to retype the entire program line. The remote edit sequence for line 7, interface select code 6 becomes:

`list#6,7,7`	(typed at remote keyboard)
LF	(line-feed = "execute")
`fetch 7`	(typed at remote keyboard)
LF	(line-feed = "execute")
(Retype edited version of line.)	(typed at remote keyboard)
CR	(carriage-return = "store")

Although remote control of 9825A operation is possible with the "rkbd" statement, remote keyboard editing is awkward (as demonstrated above) and not recommended for extensive program development.

The ASCII to keyboard function chart in the appendix relates ASCII control codes to 9825A functions, and is included for reference when using an ASCII coded remote keyboard with the 9825A. ASCII control codes do not generate locally displayable characters, and it may be difficult to keep track of calculator operations. Typing out commands is therefore recommended so the operator can have a record of calculator operation for reference.

Power-Up Remote Keyboard Operation

Upon power-up of the 9825A, the Systems Programming ROM checks select codes 2 through 7 (in descending order) for a 98036A Interface configured for remote keyboard operation. The interface with the highest select code configured for remote keyboard operation will be used for the system remote keyboard.

To set up the 98036A Interface for power up remote keyboard operation, two jumpers must be located and changed as described below:

1. Disassembly of the 98036A Interface:

   a. Remove the four screws that hold the rear housing to the front housing.

   b. Pull the rear housing off the front housing slightly, disconnect the cable connector from the PC assembly and remove the rear housing.

   c. Remove the remaining four screws in the front housing and separate the front housing cases.

   d. Carefully separate the printed circuit assemblies.

2. Locate the 98036-66502 printed circuit board and orient it as shown in the figure labeled "Component Side".

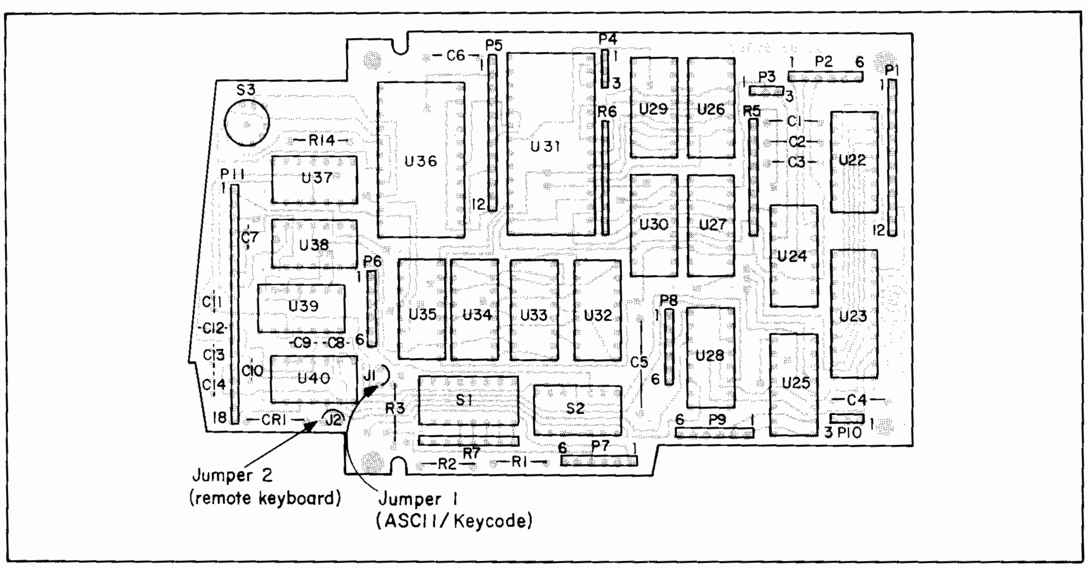
3. Locate and identify the two wire jumpers on the board corresponding to J1 and J2 in the figure.

4. For power-up remote keyboard operation, cut jumper 2 (J2) and slightly spread the wire pieces so no electrical contact is made.

5. If the remote keyboard is to be an ASCII coded keyboard, cut jumper 1 (J1). If the remote keyboard is a 9825A type keyboard, leave J1 connected.

6. To reassemble the interface, reverse procedures 1d through 1a, being careful that the pins on the A2 assembly are properly seated in the connectors of the A1 assembly.

These jumpers affect only power-up remote keyboard operation. Programmable remote keyboard using "rkbd" is independent of the jumper configuration.



98036-66502 Diagram

Pressing the reset key of the 9825A takes the calculator out of the remote keyboard mode, regardless of the state of the 98036A jumpers J1 and J2. Turning power off then on will put the 9825A back into remote keyboard mode (as set by jumpers J1 and J2).

Chapter 5

Systems Programming Instructions

Overview

The System Programming Instructions extend the 9825A's capability to generate or modify programs under program control. The "store", "%", and "nal" statements enable the 9825A to handle string text (regardless of its source) and store the text at designated program lines. The string text can be obtained from any source, such as mass memory, external systems, or another 9825A. The "avm" function returns the amount of available memory remaining in user read/write memory, and "cln" returns the current program line number.

Mnemonic External ROM Requirements

Mnemonic	ROM Option	Description
nal	None	Next available line.
%	None	Free-text prefix.
store	String ROM*	Store string statement.
avm	None	Available memory function.
cln	None	Current program line number.

* String ROM is not required for literals.

Store Statement

The "store" statement provides the capability of storing program lines from an executing program.

Syntax:

store String Name | "Literal" [; Line Number]

The string name parameter may be either a string (requiring the string ROM) or a literal. The line number parameter may be either a fixed value or an expression.

String Name: Names a string containing any valid HPL program line, specified as a string variable or a literal. If a string is specified, the String Programming ROM must be present in the system. If the syntax of the line to be stored is invalid, an error message is issued and program execution halted. It is possible, however, to recover from this type error and disable syntax checking by concatenating the free text prefix to the beginning of the line. A further discussion of this concept and an example are included under the "%" free text syntax.

Line Number: If included in the `store` statement, the line number must specify a line number less than the last program line number plus one. If the specified line number is greater than this value, the default (nal) value will be substituted. (Refer to the priority list below.)

To determine which program line the "store" text will actually be stored at, consider the following priorities:

(Highest Priority)

3. Line number* (parameter of "store" statement);

Example: `store "dsp A";5`

2. Line number* (prefix of text;)

Example: `store "5: dsp A"`

1. `nal` (default value if no others are specified;)

Example: `store "dsp A"`

(Lowest Priority)

There are four cases to consider in determining the actual program line number where the text is stored:

1. If the Line Number syntax parameter is not given, and no line number prefixes the program line text — the text will be stored at the default value (next available line).

* If a line number is specified, but is a number greater than the value of the last program line number plus one, the default value (`nal`) will be substituted.

2. If the Line Number syntax parameter is not given, but there is a line number prefix to the text — the text line number is compared to the value of the last program line number plus one ("nal"). If the line number is greater than the "nal" value, the line number prefix is stripped from the text and the text is stored at the next available program line. If the text line number prefix is within the program line limits, the text is stored at the specified program line.

3. If both a prefix Line Number and the line number parameter are given – the text is stored at the program line specified by the line number parameter, conditional on the parameter designating a line number less than or equal to the "nal" value. Otherwise, the text is stored at the next available line and the prefix line number is stripped from the text.

4. If there is no prefix Line Number, and the line number parameter is given – the line number parameter is checked against the "nal" value. If the line number is within the range of the program, it then specifies the program line at which to store the text. Otherwise the text is stored at the next available line ("nal").

The store instruction must be the last statement of an HPL program line, and can be executed from either an idle keyboard or a running program. It may not be executed from the live keyboard, or error C7 is issued. (This includes a "store" within a subroutine executed from live keyboard.)

There are some programming considerations to take into account when using the "store" instruction, as this instruction can significantly alter the execution flow of a running program.

- When a "store" is executed and the line is stored at a lower line number than any subroutines or interrupt routines, they will be disabled, as will any "for...next" links.

Example:

```
0: dsp 8
1: for I=1 to 5
2: store "dsp
 char(66)";0
3: next I                  (error A2 in 3)
```

- Interrupts are disabled for a period of several hundred milliseconds when a "store" instruction is executing; "store" should not be used during high speed data transmissions.

- When storing an executable expression or a string literal, the "store" instruction will actually store the interpreter representation of the expression or literal, and the resulting line will have "dsp" appended to the beginning of the text.

The store statement is a powerful programming tool, and should be used with discretion. The principal use for the store statement is in conjuction with the "nal" function given as a line number parameter. If the store statement is to be used to modify a running program, the potential consequences as mentioned above should be carefully considered.

CAUTION

USING THE STORE INSTRUCTION TO MODIFY THE PROGRAM AT A LINE NUMBER LOWER THAN THE CURRENTLY EXECUTING PROGRAM LINE CAN CAUSE UNPREDICTABLE PROGRAM EXECUTION.

An expanded example of the "store" capabilities is listed and explained in the appendix. The example provides the 9825A with externally stored program loading capability. A shorter example of the "store" statement used to input a program listing from an external source is included here to demonstrate the basic operations necessary.

Example:

`0: dim A$[80]` `1: red 10,A$`	Line 1 reads one line of text into A$.
`2: store A$,nal`	Line 2 stores the text at the next available line.
`3: gto 1` `*9666`	Line 3 returns to read a new line of input text.

Next Available Line Function

Syntax:

```
nal
```

The `nal` function returns the value of the last program line number plus one. For example, if the resident HPL program has lines numbered 0 through 54, `nal` will return the value 55. When specified as a "store" statement parameter, the "nal" value overrides the line number prefix (if present) of the string to be stored, and the result is to store the line after the last program line.

Examples:

Ex. 1

```
0: ent "Append
 Mod Routine?",
 A;if not A;gto
 2
1: trk 1;ldf 12,
 nal,2
2: "Main Prog":
```

Ex. 2

Before Execution

```
0: store "0:
 dsp A";nal
1: 5→A;gto 0
*25826
```

After Execution

```
0: store "0:
 dsp A";nal
1: 5→A;gto 0
2: dsp A
3: dsp A
4: dsp A
5: dsp A
6: dsp A
7: dsp A
8: dsp A
```

Example 1 loads the specified file into program memory beginning with the next available program line number, allowing program editing (line insertion and deletion) without requiring modification of the load statement.

Example 2 demonstrates the use of `nal` to override the line number prefix of the literal, and the result is to store the literal at successive lines after the last program line.

Free Text Syntax Prefix

Syntax:

% String or text to be stored

Any text following a "%" symbol prefix is stored into program memory with no syntax checking performed. Note however, that the percent symbol prefix eliminates all blanks in the line except those occurring within quotation marks, and that a semicolon in the line masks all following statements in the line from the free text prefix protection. Use of the free text syntax prefix does not permit storing text with unmatched quotes.

Example 1:

```
0: % Thislineisi
 nvalidlysyntaxe
 d;buthasbeensto
 redwiththe"%"pr
 efix.

1: % "Note that
 all blanks are
 removed outside
  of quotes."
*16486
```

Line 0, the literal is stored but the blanks are removed because the interpreter causes blanks to be removed from the string.

Line 1, the blanks in the text are preserved by surrounding it with quote marks.

Example 2:

```
0: dim A$[80]
1: ent "Next
 Line?";A$
2: on err "inser
 t %"
3: store A$;nal
4: gto 1
5: "insert %":
6: "%"&A$→A$
7: gto 2
*28218
```

1 Enter the input line to A$.

2 Enable the error recovery routine "insert %".

3 Try to store the string.

4 Return to enter another line if no errors.

5 If an error occurred, append the free text prefix to the front of the string and return to line 2 to store the text. (This will not work if the statement contained an error after a semicolon. The example in the Appendix resolve this problem by replacing all semicolons with % signs.)

Example 3:

The free syntax prefix enables the programmer to write end-of-line comments for a program.

```
0: % "    EXAMPLE OF COMMENTED HPL"
1: dim A$[85]
2: ent "NEXT LINE...",A$;% "       Input one line of text"
3: on err "insert %";% "          Enable the error recovery routine"
4: % "                            Store the line if possible"
5: store A$,nal
6: gto 2;% "                      Input another line"
7: "insert %":
8: "%"&A$→A$;gto 3;% "            Append the percent sign to invalid lines"
*39
```

Available Memory Function

Syntax:

```
avm
```

The "avm" function returns the number of unused bytes remaining in the 9825A's read-write memory. This feature enables a program to allocate storage based on remaining memory. For example, a listing routine can use as much memory as possible in creating a list buffer, or an edit program can allocate as large an edit string as is currently available in the machine.

Note

Since the 9825A system memory requirements change during program execution, the amount of available memory is constantly changing and a several hundred byte safety factor should be allowed for (to prevent an insufficient-memory error) and subtracted from the avm value. (Useable memory = avm − safety factor.)

Current Line Number Function

Syntax:

```
cln
```

No parameters are required for the cln function.

The "cln" function returns the value of the current line number at the point of execution. Note, however, that the value returned by "cln" will be different when executed from within a program than when executed from live keyboard. When "cln" is executed within a program, it returns the line number of the current program line. When executed from live keyboard, "cln" will return the line number of the next program line to be executed. This is because "cln" is incremented after the end of the program line and before the live keyboard statement is executed.

The "cln" function makes possible an absolute computed gosub or go to, and a relative store. Examples of these functions follow:

Example 1, computed gosub to absolute line number:

```
6: ent "Subrouti
 ne Line Number?
 ",A
7: gsb 0;jmp A-
 cln
```

Line 6 "computes" the line number of the desired subroutine.

Line 7 executes the computed go sub to the line number in A.

Example 2, "store" relative.

```
3: store A$,cln+
 4
```

Line 3 stores the string A$ at the program line four lines down.

Example 1 enables a program to branch to an absolute line number that has previously been computed and placed into a variable. It is not necessary to perform a subroutine branch, as it is possible to simply jump to the computed location. Example 2 allows editing of the program (inserting or deleting program lines) before the "store" program line without having to modify the line number parameter of the "store" statement.

Appendix

Systems Programming ROM Syntax

Syntax Conventions

The following conventions apply to the syntax for the statements and functions of the Systems Programming ROM.

dot matrix — All items in dot matrix are required, exactly as shown.

[ ] — All items in square brackets are optional, unless the brackets are in dot matrix.

| — A vertical bar is read as "or" in the syntax statement.

Mnemonics

asc Keycode

avm

bred ("Buffer Name")

cln

eol [eol Character] [, eol Character$_2$]...[, eol Character$_7$] [, − eol Sequence Delay]

key

kret

nal

on key String Name [, Flag Number]

rkbd Select Code [, Code Type]

rss Select Code [, Line Number]

store String Name | Literal

wsc Select Code, Control Word

wsm Select Code, Mode Word [, Control Word]

% String | Literal

Systems Programming ROM Error Messages*

error C0: Missing General I/O ROM.

- Attempted to execute one of the following without the General I/O ROM in the calculator:

  wsc (Write Serial Control)
  wsm (Write Serial Mode)
  rss (Read Serial Status)
  rkbd (Remote Keyboard Enable)
  eol (End-of-Line Specification)

error C1: Incorrect number of parameters specified.

- Specified an insufficient number of parameters for the instruction.
- Specified too many parameters in a store statement.

error C2: Improper parameter specified.

- Specified a select code out of range (see following).
- rkbd: select code <2 or >7.
- rss, wsc, wsm: Select code <2 or >15.

error C3: Wrong parameter type.

- Specified a numeric value or null string where a string was called for.
- Specified a non-numeric where a numeric was called for.

error C4: Illegal buffer type in bred statement.

- Specified a buffer type other than an interrupt-type, byte oriented, active input transfer buffer. (See the Extended I/O Manual.)

* Mainframe Error Messages 00, 02, 03, 06, and 07 can be generated from execution of a "store" instruction with an illegal program line as the string or literal.

error C5: Key buffer overflow.

- The "on key" buffer has overflowed and a flag was not specified in the on key statement.

error C6: Parameter overflow (too large for integer) or wrong parameter sign.

- A negative number was specified in a store statement.
- Too many positive parameters in the eol statement.

error C7: Improper store execution.

- The store statement was not the last statement on an HPL line.
- The store instruction must be executed from a running program or while the machine is in idle mode. Live keyboard execution of the store instruction is disallowed.

error C8: Illegal use of kret instruction.

- kret may only be used from a running program, and execution from the keyboard is disallowed.
- kret may only be executed when the "on key" service routine has been entered.

error C9: 98036A Interface not present at specified select code.

- The select code parameter for the following instructions may specify the 98036A only:

```
wsc
wsm
rss
rkbd
```

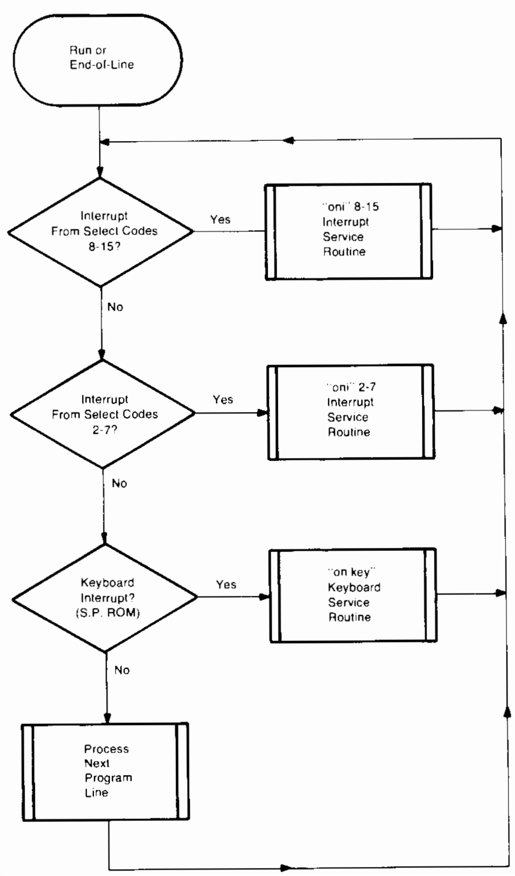
- No interface is set to the select code specified in the parameters of the 98036A control statements.
- The rkbd statement specifies an interface already enabled for interrupt and not presently the remote keyboard interface.

Execution Priority Diagrams

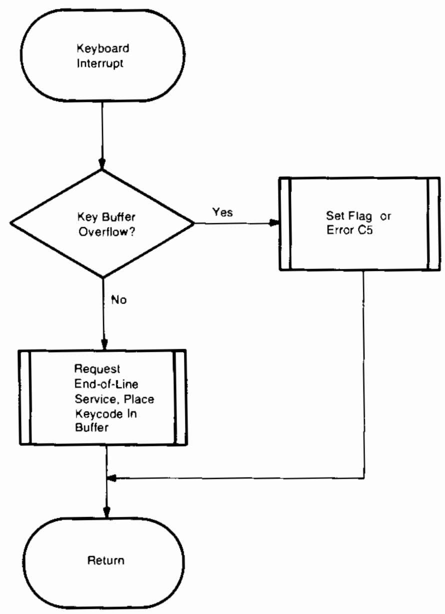
Increasing Priority (↑)

Hardware Priorities	Software Priorities
	"oni" Routines, Select Codes 8-15
Select Codes 8-15	"oni" Routines, Select Codes 2-7
Keyboard, Select Codes 2-7	"on key" Routine
Interrupt Source	Main Program

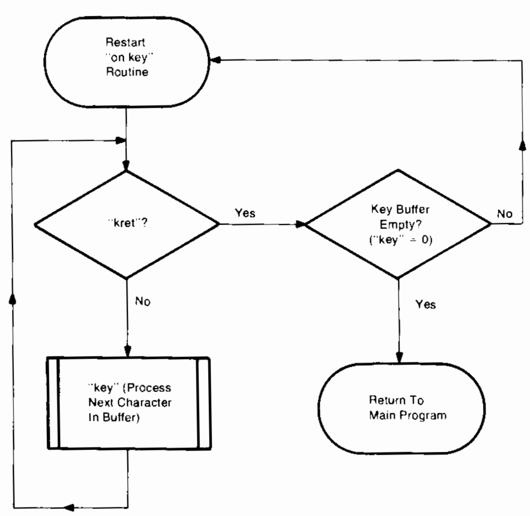
Program Execution Flowchart



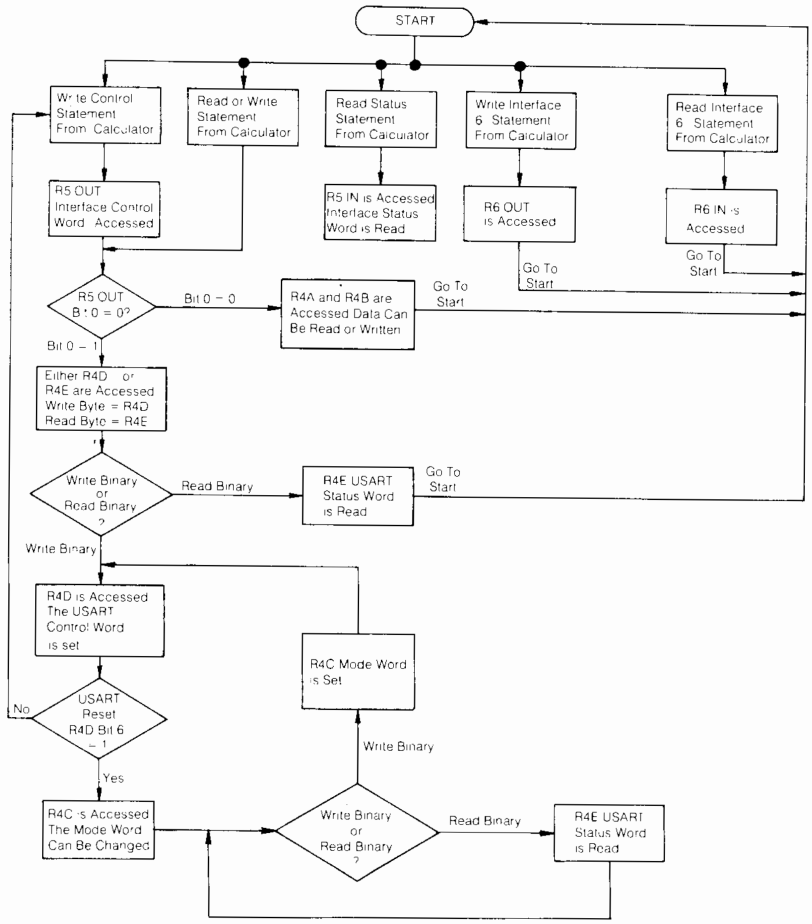
"on key" Execution Flowchart



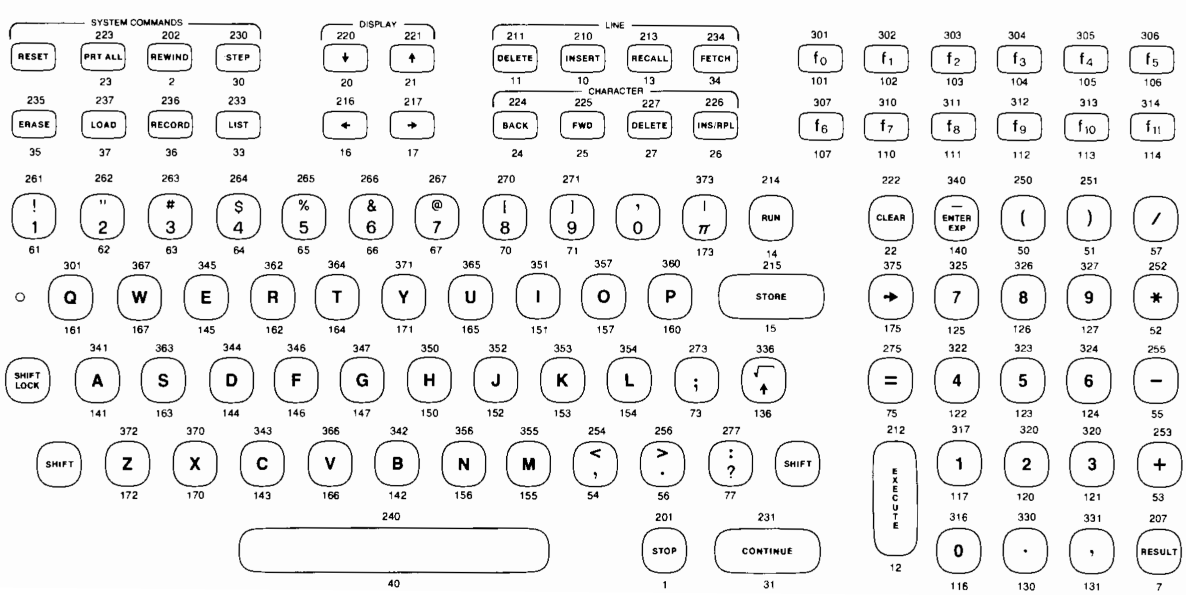
"on key" Service Routine and "kret" Flowchart



98036A Register Access Flowchart



Octal Keyboard Code Chart



"PTAPE"

This program is offered as an example of the capabilities of the "store" instruction when augmented by the free text prefix and error recovery facilities. The program takes input from an external source which has previously recorded a program in the "list#" format. It requests a cartridge track and file number for recording the input program, or it can mark a file the size of the input program (allowing 500 bytes for expansion) at the last unused file (null file) on the cartridge. (If a negative file number is entered, "PTAPE" will mark its own file.) The file number at which the program is recorded is printed out for future reference.

```
0: "Program Loader or PTAPE":
1: ent "Input Select Code = ?",S;ent "Record on Track# ?",T;ent "File# ?",F
2: dim A$[85];avm→A;nal→X
3: "input":red S,A$;if len(A$)<=2;gto +0
4: if A$[1,1]="*";gto "out"
5: if num(A$[1])=0;gto "input"
6: on err "err";store A$,nal
7: if avm<250;beep;dsp "INSUFFICIENT MEMORY";stp
8: gto "input"
9: "out":A-avm→A;trk T;if F>=0;gto "rec"
10: for F=0 to 9999
11: fdf F;idf F,Y,C,Q;if Q;next F
12: mrk 1,A+500,Z;if Z<0;beep;prt "Not enough tape,",A,"bytes needed";stp
13: "rec":rcf F,1X;prt "PROGRAM ON FILE#",F;stp
14: "err":"%"&A$→A$
15: if not (pos(A$,";")→X);gto 6
16: "%"→A$[X,X];gto -1
*4328
```

Line 1: Input interface select code and the cartridge track and file number for storing the program. If given a negative file number, the routine (lines 10-12) will search for the last cartridge file (null file) and mark it to the correct program size allowing 500 bytes for expansion.

Line 2: Saves the available memory and next available line values into variables A and X.

Line 3: Inputs one program line, rejects lines consisting of only carriage-return/line-feeds.

Line 4: Checks for the asterisk at the end of the program listing.

Line 5: Strips null lines from the input.

Line 6: Enables the error recovery routine "err" and attempts to store the program at the next available line.

Line 7: Checks for enough remaining memory to input more source program.

Line 8: Returns to line 3 for more input.

Line 9: Computes the source program size in bytes, and checks the file number specified for a negative value. If negative, it proceeds to find and mark the null file.

Lines 10-12: Find the null file (last file) and mark it to the size of the source program plus 500 bytes for modification and expansion.

Line 13: Records the program on either the specified or the marked file, and prints the file number used.

Line 14: The error recovery routine appends a "%" (free text prefix) to the beginning of the program line.

Lines 15 and 16: Check for semicolons in the source line, substituting them with %'s, because a semicolon will mask the following line statements from free text protection. This avoids a possible loop from illegal statements after a semicolon in the source line.

This program (with slight modification) makes possible an interesting method of program editing using the HP 2640 terminal's block output capability. It is possible to list a program to the HP 2640 terminal, inspect and edit it from the terminal as desired, then place the program back on the cartridge at the specified track and file number. The necessary modification is a write byte (wtb) statement inserted at line 3, which now becomes (assuming the 2640 set up for single line transmission blocks, with select code 2):

```
3: "input": wtb2,27,100,17; red S,A$; if len (A$)<=2;
                    gto +0
```

The program now reads the text from the HP 2640 terminal a line at a time, beginning with the first character after the cursor, then records it on the specified track and file of the HP 9825A data cartridge as a program.

Technical Appendix On Asynchronous Data Formats

Asnychronous I/O is a serial mode of communication that in its simplest form requires no handshaking ("I'm ready, are you ready?") signals. This is made possible through special codes that are added to each character being sent. These extra codes are the "Start Bit" and the "Stop Bits". An additional bit, the "Parity Bit" may be added for purposes of error detection.

For example, the ASCII character "T" looks like this in binary:

(most significant bit) 1010100 (least significant bit).

When the start, parity and stop bits are added, the character "U" looks like this:

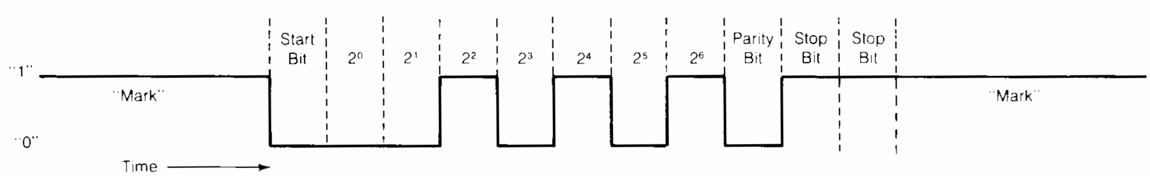
(msb) 11010101000 (lsb).

The number of bits per character is not changed by adding the start, parity, and stop bits, as these bits are not considered when looking at character bits.

The start bit is always a "0", and comes before the least significant bit of the character. The parity bit is set to a "1" or "0" to make the sum of the "1" bits of the character plus the parity bit either odd or even, depending on whether odd or even parity is selected. (The "1" character bits are added to the parity bit, yielding an odd or even sum.) The character "T" above has odd parity. The two leftmost bits of the above character are stop bits, and the stop bits are always a "1".

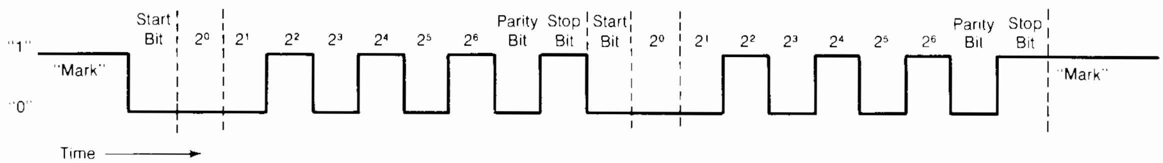
Each bit is transmitted at a specific time, controlled by an extremely accurate crystal timer. The rate at which bits are transmitted is referred to as the bit rate, sometimes known as the baud rate. The bits can be sent and received at the clock frequency, 1/16 the clock frequency, or 1/64 the clock frequency. The 1/64 rate provides the highest degree of accuracy in timing, and is used whenever error-free communications is a must.

A diagram of a single character ("T" again) being transmitted asynchronously looks like this:



The start bit is the first bit transmitted, and when received means "wake up, get ready for a new character". The next bits are the data bits of the character "T", beginning with the least significant (2^0) bit and ending with the most significant (2^6) bit. The next bit is the parity bit (odd parity), which is used for error checking. The last two bits are the stop bits, which mean "end of this character".

By using the 98036A Mode Word, we can change the format of the ASCII character, so let's send two "T" 's, but this time with only one stop bit selected. The diagram looks like this:

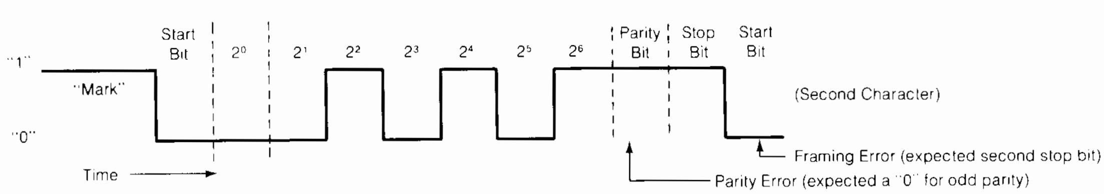


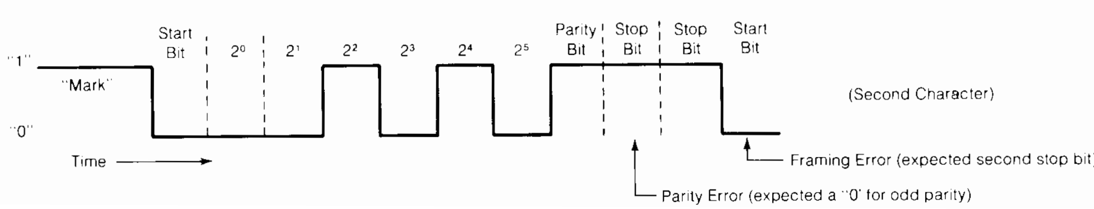
The 98036A Status Word can give us some clues about the incoming data on the serial I/O link. These are the "framing", "parity", and the "overrun" status bits of the 98036A Status Word. The "framing" bit will be set to a "1" if our interface doesn't find all the stop bits that it expects. There is no way for the interface to detect too many stop bits, but if too few are received then the framing error bit is set. (The interface looks for a "1" in the stop bit time slot.) Some causes of framing errors are incorrect number of data bits, no parity, or too few stop bits.

The "parity" bit of the 98036A Status Word will be set if the incoming parity bit is wrong. This can be caused by an incorrect number of data bits, having the wrong parity selected, or no parity bit being received.

A "overrun" error simply means that the incoming data is coming in faster than it is being taken from the interface. If the baud rate being operated at is too high, it may not be possible to read the data from the interface before a new character is received. A lower baud rate can alleviate this problem. (The baud rates for the sender and the receiver must always be the same.)

Two examples showing how the same error can be generated in two completely different ways are shown below. Assume the interface is configured to expect seven data bits, odd parity, and two stop bits.





The first example is simple: the sender is sending the wrong parity and only one stop bit. Changing the interface parity and stop bits will clear the problem. The second example is also simple, but wouldn't be corrected by changing the parity and stop bit format. The fewer data bits sent (6) will always generate a framing error, and only sometimes generate a parity error. This is a difficult problem to track down from the receiver end.

Hopefully, this discussion has served to introduce the reader to the purpose of the changeable asynchronous data format, and to the necessity of accessing the status bits of the 98036A Serial Interface. In a typical system, both sender and receiver data formats are known and accessible, making interfacing a simple task.

A program which could be used to establish the correct number of stop bits and the correct parity setting is included as an example of how the 98036A control statements can be used. The program makes two assumptions for the purpose of simplification: first, an ASCII format is assumed – that is, seven data bits per character; second, it assumes that a parity bit is part of the character and not disabled (if no parity bit is present, this program cannot get a correct frame count).

Mode Word Finder Program

```
0: dim A$[80];
 0→F;2↑0+2↑1+
 2↑2+2↑3+2↑6+
 2↑7→M;2↑0+2↑1+
 2↑2+2↑5→C
1: ent "Select
 Code Is?",S;
 wsm S,M,C
2: "read1":rdb(S
 )→X;rss S→X
3: if bit(5,X);
 gto "framing"
4: if F<2;2→F;M-
 2↑2+2↑4→M;wsm
 S,M,C;gto "read
 1"
5: if not bit(3,
 X);prt "Mode
 Word Is",M;red
 S,A$;prt A$[1,
 80];stp
6: if F<3;3→F;M+
 2↑5→M;wsm S,M,
 C;gto "read1"
7: if F<4;4→F;M+
 2↑2-2↑4→M;wsm
 S,M;gto "read1"
```

Line 0 sets the mode variable (M) to 8 data bits, no parity, 2 stop bits (to avoid parity checking).

Line 1 configures the interface mode.

Line 2 inputs one byte and reads the status.

Line 3 checks for framing error.

Line 4 reconfigures the interface to 7 data bits, odd parity.

Line 5 checks for parity error, and prints the mode value if no error.

Line 6 sets even parity if a parity error was detected.

Line 7 resets to 8 data bits, no parity if a parity error still exists.

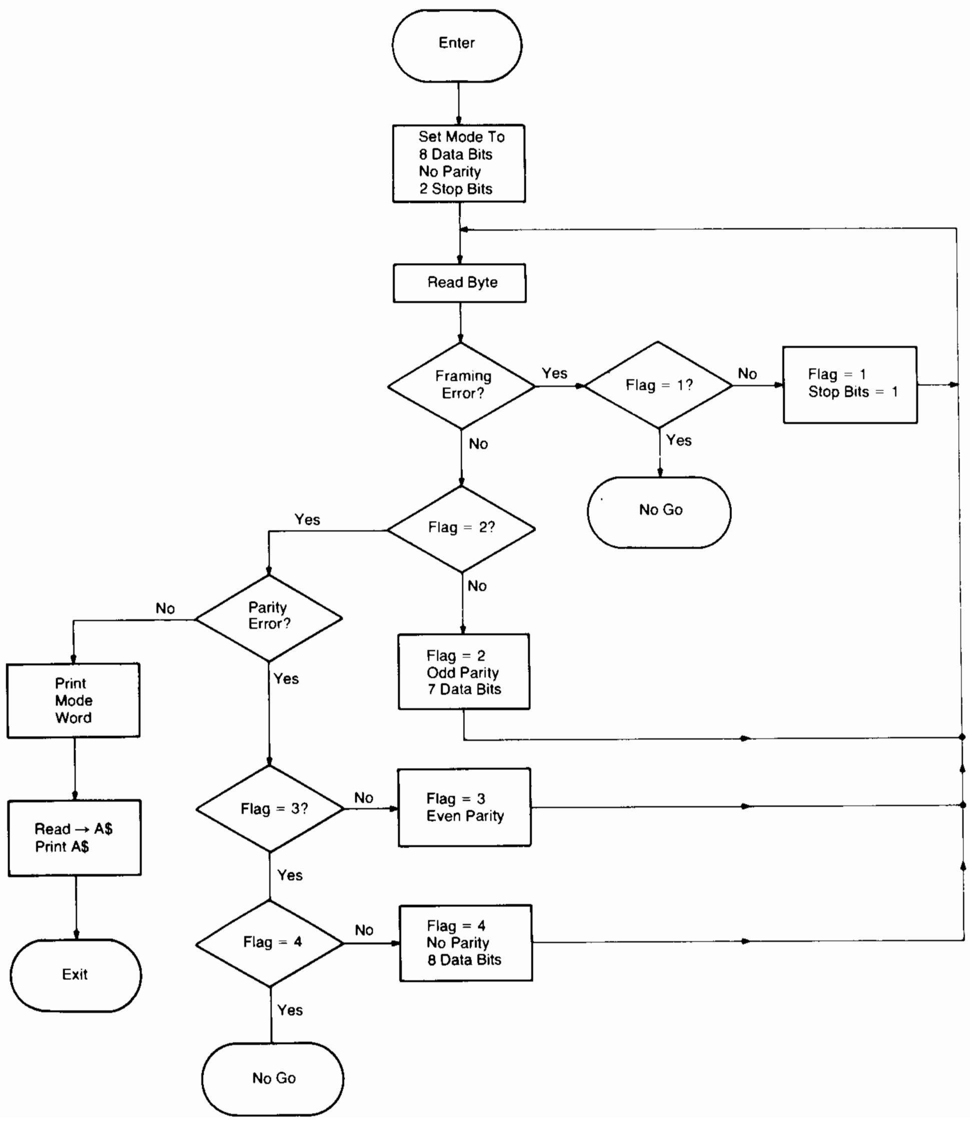
```
8: prt "No Go,
 Try New Baud
 Rate...";stp
9: "framing":if
 F<1;1→F;M-2↑7→M
 ;wsm S,M;gto
 "read1"
10: gto 8
*12072
```

Line 8 stops execution if all combinations have been tried.

Line 9 sets the interface to 1 stop bit on the first framing error.

Line 10 goes back to 8 if a framing error still exists with only 1 stop bit.

Flowchart For Mode Word Finder



ASCII to Keyboard Function Chart

Control*	9825A Command	Octal Code	Decimal Code
]	erase	35	29
–	ldf	37	31
↑	rcf	36	30
[	list	33	27
S	prt all	23	19
B	rewind	2	2
X	step	30	24
P	↓	20	16
Q	↑	21	17
N	←	16	14
O	→	17	15
I	del	11	9
H	ins	10	8
K	recall	13	11
\	fetch	34	28
T	back	24	20
U	fwd	25	21
W	del	27	23
V	ins/rep	26	22
L	RUN	14	12
M	STORE	15	13
Y	CONTINUE	31	25
A	STOP	1	1
J	EXECUTE	12	10
R	clear	22	18
G	result	7	7

Alternate ASCII Code Functions:

Carriage-Return (15 Octal): Store

Line-Feed (12 Octal): Execute

* The Control Key and the specified character key are pressed simultaneously.

"ASC" Conversion Values

Display Char	Key Code	ASCII Dec	ASCII Oct	Display Char	Key Code	ASCII Dec	ASCII Oct
[illegible]	0	0	0	@	64	64	100
[illegible]	1	1	1	[illegible]	65	128	200
⊠	2	2	2	[illegible]	66	129	201
[illegible]	3	3	3	⊠	67	130	202
α	4	4	4	[illegible]	68	131	203
β	5	5	5	α	69	132	204
Γ	6	6	6	β	70	133	205
[illegible]	7	7	7	Γ	71	134	206
Δ	8	8	10	[illegible]	72	135	207
σ	9	9	11	Δ	73	136	210
↓	10	10	12	σ	74	137	211
λ	11	11	13	↓	75	138	212
μ	12	12	14	λ	76	139	213
←	13	13	15	[illegible]	77	0	0
τ	14	14	16	0	78	48	60
Φ	15	15	17	1	79	49	61
Θ	16	16	20	2	80	50	62
Ω	17	17	21	3	81	51	63
δ	18	18	22	4	82	52	64
Â	19	19	23	5	83	53	65
â	20	20	24	6	84	54	66
Ä	21	21	25	7	85	55	67
ä	22	22	26	8	86	56	70
Ö	23	23	27	9	87	57	71
ö	24	24	30	.	88	46	56
Ü	25	25	31	,	89	44	54
ü	26	26	32	Z	90	90	132
Æ	27	27	33	[	91	91	133
æ	28	28	34	[illegible]	92	92	134
≠	29	29	35	]	93	93	135
£	30	30	36	↑	94	94	136
▒	31	31	37	_	95	95	137
	32	32	40	e	96	101	145
!	33	33	41	a	97	97	141
"	34	34	42	b	98	98	142
#	35	35	43	c	99	99	143
$	36	36	44	d	100	100	144
%	37	37	45	e	101	101	145
&	38	38	46	f	102	102	146
'	39	39	47	g	103	103	147
(	40	40	50	h	104	104	150
)	41	41	51	i	105	105	151
*	42	42	52	j	106	106	152
+	43	43	53	k	107	107	153
,	44	44	54	l	108	108	154
-	45	45	55	m	109	109	155
.	46	46	56	n	110	110	156
/	47	47	57	o	111	111	157
0	48	48	60	p	112	112	160
1	49	49	61	q	113	113	161
2	50	50	62	r	114	114	162
3	51	51	63	s	115	115	163
4	52	52	64	t	116	116	164
5	53	53	65	u	117	117	165
6	54	54	66	v	118	118	166
7	55	55	67	w	119	119	167
8	56	56	70	x	120	120	170
9	57	57	71	y	121	121	171
:	58	58	72	z	122	122	172
;	59	59	73	π	123	123	173
<	60	60	74	|	124	124	174
=	61	61	75	→	125	125	175
>	62	62	76	Σ	126	126	176
?	63	63	77	⊢	127	127	177

"ASC" Conversion Values

Display Char	Key Code	ASCII Dec	ASCII Oct
	128	0	0
	129	1	1
	130	2	2
	131	3	3
	132	4	4
	133	5	5
	134	6	6
	135	7	7
	136	8	10
	137	9	11
	138	10	12
	139	11	13
	140	12	14
	141	13	15
	142	14	16
	143	15	17
	144	16	20
	145	17	21
	146	18	22
	147	19	23
	148	20	24
	149	21	25
	150	22	26
	151	23	27
	152	24	30
	153	25	31
	154	26	32
	155	27	33
	156	28	34
	157	29	35
	158	30	36
	159	31	37
	160	32	40
!	161	33	41
"	162	34	42
#	163	35	43
$	164	36	44
%	165	37	45
&	166	38	46
'	167	39	47
(	168	40	50
)	169	41	51
*	170	42	52
+	171	43	53
<	172	60	74
-	173	45	55
>	174	62	76
/	175	47	57
	176	39	47
	177	33	41
	178	34	42
	179	35	43
	180	36	44
	181	37	45
	182	38	46
@	183	64	100
[	184	91	133
]	185	93	135
	186	0	0
;	187	59	73
	188	0	0
=	189	61	75
	190	0	0
:	191	58	72

Display Char	Key Code	ASCII Dec	ASCII Oct
	192	0	0
	193	140	214
	194	141	215
	195	142	216
	196	142	217
	197	144	220
	198	145	221
	199	146	222
	200	147	223
	201	148	224
	202	149	225
	203	150	226
	204	151	227
	205	0	0
0	206	48	60
1	207	49	61
2	208	50	62
3	209	51	63
4	210	52	64
5	211	53	65
6	212	54	66
7	213	55	67
8	214	56	70
9	215	57	71
.	216	46	56
,	217	44	54
	218	0	0
	219	0	0
	220	0	0
	221	0	0
	222	92	134
	223	0	0
_	224	95	137
A	225	65	101
B	226	66	102
C	227	67	103
D	228	68	104
E	229	69	105
F	230	70	106
G	231	71	107
H	232	72	110
I	233	73	111
J	234	74	112
K	235	75	113
L	236	76	114
M	237	77	115
N	238	78	116
O	239	79	117
P	240	80	120
Q	241	81	121
R	242	82	122
S	243	83	123
T	244	84	124
U	245	85	125
V	246	86	126
W	247	87	127
X	248	88	130
Y	249	89	131
Z	250	90	132
|	251	124	174
	252	92	134
	253	125	175
↑	254	94	136
_	255	95	137

ASCII Control Codes to 9825A Keyboard Keys

ASCII Char.	EQUIVALENT FORMS Binary	Octal	Dec	9825A Key Equivalent
NULL	00000000	000	0	*
SOH	00000001	001	1	STOP
STX	00000010	002	2	REWIND
ETX	00000011	003	3	*
EOT	00000100	004	4	*
ENQ	00000101	005	5	*
ACK	00000110	006	6	*
BELL	00000111	007	7	RESULT
BS	00001000	010	8	INSERT
HT	00001001	011	9	DELETE
LF	00001010	012	10	EXEC
V_{TAB}	00001011	013	11	RECALL
FF	00001100	014	12	RUN
CR	00001101	015	13	STORE
SO	00001110	016	14	←
SI	00001111	017	15	→
DLE	00010000	020	16	↓
DC_1	00010001	021	17	↑
DC_2	00010010	022	18	CLEAR
DC_3	00010011	023	19	PRT ALL
DC_4	00010100	024	20	BACK
NAK	00010101	025	21	FWD
SYNC	00010110	026	22	INS/RPL
ETB	00010111	027	23	DELETE
CAN	00011000	030	24	STEP
EM	00011001	031	25	CONT
SUB	00011010	032	26	*
ESC	00011011	033	27	LIST
FS	00011100	034	28	FETCH
GS	00011101	035	29	ERASE
RS	00011110	036	30	RECORD
US	00011111	037	31	LOAD

* = No direct 9825A key equivalent.

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Error Messages

error C0: Missing General I/O ROM.

error C1: Incorrect number of parameters.

error C2: Improper parameter specified.

error C3: Wrong parameter type.

error C4: Illegal buffer type for bred statement.

error C5: Key buffer overflow.

error C6: Too large or wrong sign of parameter.

error C7: Improper execution of store statement.

error C8: Illegal use of kret.

error C9: Missing 98036A Interface card.

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