

PLEASE

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LISTINGS

Introduction to PLEASE

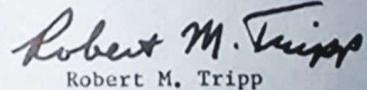
I have been working with minicomputers and microcomputers for nearly eight years. During this time I have seen some pretty horrible examples of how NOT to design small computer software packages. Often, concepts and techniques which might be appropriate to a large computer system are thoughtlessly applied to a small system, with predictably bad results. I have developed a number of programming philosophies and techniques which are designed specifically for the types of small machines that are becoming available to the computer hobbyist and small businessman.

PLEASE is a very small package which embodies several of the more important concepts. It has a tiny monitor which takes care of the basic I/O functions, timing functions, and scheduling. It has a set of functions to perform the major tasks. These functions are combined through the use of a simple interpreter which calls up the functions and passes the necessary parameters to them. Programs are written as a series of functions. Since each function does a major piece of work, a program may consist of only a few functions and can be readily "assembled" by hand. For example, the PLEASE Command Decoder which permits the user to select which game or demo to run from the keyboard is four functions, encoded in a total of 16 bytes.

I am very impressed with the capabilities of the KIM-1 Microcomputer System. Aside from the excruciatingly slow cassette dump/load, it is remarkably well thought out. However, I must admit that after getting my own KIM-1 and doing the single example in the manual I was more than a bit frustrated that there wasn't anything else to do without a great deal of effort on my part. I could only impress my wife and friends slightly by adding 2 + 3 and getting 5! I decided, therefore, to create a small games and demos package that could run on the basic KIM-1, without any additional peripherals such as teletype or special display devices. The result is PLEASE.

PLEASE has been developed entirely on a basic KIM-1. All of the assembly has been done by hand. All of the object code has been entered through the keyboard. Debugging has been via the KIM-1 Monitor. The resulting package demonstrates what can be done on a basic system. It also does suffer in some respects though. Certain changes I would have liked to make became just too much effort via hand assembly.

I welcome any suggestions, comments, or whatever. I have had fun developing PLEASE and hope you will enjoy playing with it.


Robert M. Tripp

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Overview and Fundamental Concepts

The approach that PLEASE uses to create a program is probably quite different from the traditional approaches you have encountered before. Its keywords are simplicity and modularity. Many approaches talk about simplicity and modularity, but by the time you get to really use them they require macro assemblers, linking loaders, compilers, and many other "aids" that often lead to very inefficient code that is very difficult to understand and/or debug. The basic element of PLEASE is the Function. A complex set of tasks can be performed by a fairly limited set of simple tasks, if the correct set of simple functions is selected and if there is a simple way to combine the independent functions into a useful whole. In PLEASE a set of fourteen (14) basic functions has been defined and implemented, and a routine called the Interpreter is used to combine these functions into useful entities called Programs. Certain programs have requirements that are quite unique, and PLEASE provides for special Functions to be written for these. A Program is written in PLEASE as a series of Steps. Each Step consists of the name of a Function and its associated parameters. In a sense, PLEASE programs are written in a form of microcode. Each Step is 32 bits of information: 8 bits of Function name followed by 3 8-bit units of parameter information. A PLEASE Step to get decimal input from the keypad, store the results in consecutive locations starting with a location named Buffer, and display the digits as they are input on the KIM-1 LED's from the leftmost position (0) to the rightmost position (5) is:

DECIN BUFFER 0 5

To have the digits appear in position 5 and then be shifted to the left as in a calculator, the Step would be:

DECIN BUFFER 5 0

This "microcoding" permits each PLEASE Function to perform in a number of different ways. The richness of the Functions will become apparent in the sections which describe the individual functions.

Before examining the functions in detail, there are a couple of other parts of PLEASE that should be understood. These are the Monitor, the Timer, the Interpreter, and the various memory locations which have been allocated for particular uses.

Monitor. The Monitor performs a number of basic services. It is responsible for maintaining a one millisecond main loop, for accepting in conjunction with the ROM characters from the keypad, for refreshing the LED display, and for branching off to the system Timer and application code. The Monitor is general purpose and can be used entirely independently of the remainder of PLEASE.

Timer. The Timer is based on the one millisecond loop of the Monitor. During each pass through the Monitor, a call is made to the Timer. The Timer updates an eight character timer which can count from 0.001 to 99,999.999 seconds. Every thousand times through the loop, which equals one second, the timer updates a six character clock which counts from

00:00:00 to 23:59:59 as a 24 hour clock. The maintenance of the timer and clock is independent of the remainder of PLEASE, although there are several PLEASE programs which set or display the results of the timer and clock. The contents of the Timer are used by a number of programs to provide pseudo random numbers.

Interpreter. The Interpreter is the heart of the PLEASE technique, but is itself very simple. It has three basic purposes. First, it converts the Step Number to be executed into an absolute memory address and then bumps the Step Number to the next Step, just as a Program Counter does. Second, it moves the four bytes which consist of the Function Code and the three Parameter bytes from their original location to a standard location in the Page Zero making them easily accessible to the Functions. Finally, it looks up the address of the Function via the Function Code and the Function Table, and then transfers control to the Function. In this way the independent PLEASE Functions are tied together into a meaningful whole.

Memory Locations. PLEASE has very carefully partitioned the limited KIM-1 memory. The Monitor, which never changes, is always resident, and which may be used without the rest of PLEASE, is placed "out-of-the-way" in the extra RAM locations of the 6530 chips. These locations start at 1780 and go to 17E6. The remaining RAM locations 17E7 through 17FF are used by the KIM-1 Monitor. The Timer starts at location 200, the Interpreter at 300. The remainder of the locations in 200 through 3FF are used for the fourteen basic PLEASE Functions and some subroutines which are used by the Functions. This section of memory is also never modified by the basic PLEASE programs. Page One contains the Function Table in 100 through 11F, Special Function Table in 120 through 12F, Special Functions in 130 through 1EF, and the Stack in 1F0 through 1FF. The PLEASE Programs start at location 00. Page Zero is used for many purposes as described later. The memory ordering has been made to be least volatile in high memory, most volatile in low memory. Overlays always start at location 00.

Functions. The fourteen basic PLEASE Functions may be broken down into a few categories:

Input. The only PLEASE Input device is the KIM-1 Keypad. There are three input modes: Alphabetic, Hexidecimal, and Decimal.

Output. The only PLEASE Output device is the KIM-1 Display. There are three output modes: Alphabetic, Hexidecimal, and Decimal.

Time. A timer routine provides for delays of up to 25 seconds in one-tenth of a second increments.

Pack. A pair of functions provide for data to be packed as two characters per byte or to be unpacked into separate bytes.

Branch. There are three basic forms of branch: unconditional, and conditional on an input character or conditional on a table lookup value.

Fill. There is a function to fill/clear memory locations.

Match. There are two functions which permit comparing strings of data and branching on the result.

Special Functions. The basic fourteen PLEASE Functions can not, of course, do everything. Special Functions may be added whenever the basic functions either could not do the job, or would be too inefficient. Examples of Special Functions include: MASTER - the evaluator for the Daffy (Mastermind) Game; MESAGE - the heart of the Notice and Billboard Programs; and, START and SHOT - initializer and evaluator for Shooting Stars.

Programs. The current PLEASE package consists of about fifteen programs. These vary in complexity and size. SCLOCK (set clock) is only two basic PLEASE Functions. HiLo (Number Guessing Game) is nineteen basic PLEASE Functions. Daffy (Mastermind Game) is thirteen basic Functions and one special Function. And so forth.

Subroutines. There are about six subroutines in PLEASE. These are an odd collection of chunks of code that were useful to have around and were shared by one or more independent functions, but which were not powerful enough to warrant being treated as Functions.

The only way to understand PLEASE is to use it. Write your own programs entirely in PLEASE Functions. When a special need arises, write your own Special Function. Have fun. Enjoy.

NOTE: A word of Caution. Since this was all done by hand, it is quite possible that there may be one or more errors in the typing of the Programs and/or Source Listings. All code on the cassette was entered from the listings, so that the Object of the listings is probably okay. If you see a discrepancy between the Object and the Operation, the Object is probably right and the Operation wrong.

* * * * *

The KIM-1 is made by MOS TECHNOLOGY, INC. Its list price as of December 1976 is \$245.00 + 4.50 postage and handling. This is a fully assembled and tested unit and includes three manuals: KIM-1 User Manual, Programming Manual and Hardware Manual. You must provide your own power supply which has +5vdc @ 1.2 amps and +12vdc @ .2 amps. Other modules available from the same source are KIM-2 a 4K RAM, KIM-3 an 8K RAM, a mother board, and several ROM programs including a KIMath math package and an Editor/Assembler. Address is: 950 Rittenhouse Road, Norristown PA 19401
Phone: 215/666-7950

* * * * *

IMPORTANT NOTICE: If you did not purchase your copy of PLEASE directly from The COMPUTERIST, then please send us your Name, Address, and Cassette Tape Number. This will enable us to keep you informed of any updates, new products, or corrections that occur in the future.

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PLEASE Monitor

EXINIT initializes the pointer to the first application subroutine and initializes the location CHAR to indicate no valid input character has been received.

1780	A9	00	EXINIT	LDA	#DCDLO	DCDLO = Application Low
1782	8D	CC	17	STA	EXAPLO	Address to Exec Transfer
1785	A9	03		LDA	#DCDHI	DCDHI = Application High
1787	8D	CD	17	STA	EXAPHI	Address to Exec Transfer
178A	A9	20		LDA	#20	20 is used to indicate
178C	85	DB		STA	CHAR	NO character input

EXLOOP controls a one millisecond loop which is required to permit the Display to be properly refreshed. KEYIN uses the KIM-1 ROM routines to input a character from the Keypad, and then performs "debouncing" of the Keypad. DISPLAY causes the next character in a six character Page Zero buffer to be displayed on the LED Display for one millisecond. Other routines are accessed via subroutine calls. TIMER updates a series of counters which provide decimal count from 1 millisecond up to 99,999.999 seconds. It also maintains a 24 hour clock, providing hours, minutes and seconds.

178E	A9	7B	EXLOOP	LDA	#7B	Set Millisecond Timer
1790	8D	45	17	STA	1745	(Actually 984 microseconds)
1793	20	88	1E	KEYIN	JSR	INITS
1796	20	6A	1F		JSR	GETKEY
1799	C9	14			CMP	#KEYMAX
179B	30	04			BMI	KEYIN2
179D	85	DE			STA	KEYTST
179F	D0	0A			BNE	DISPLAY
17A1	A6	DE		KEYIN2	LDX	KEYTST
17A3	F0	06			BEQ	DISPLAY
17A5	85	DB			STA	CHAR
17A7	A9	00			LDA	#00
17A9	85	DE			STA	KEYTST
17AB	A4	D9	DISPLAY	LDY	DSPPOS	Current Display Pointer
17AD	98			TYA		Calculate Select Line
17AE	0A			ASL		
17AF	69	08		ADC	#8	
17B1	8D	42	17	STA	1742	Select Display Position
17B4	A9	7F		LDA	#7F	Select All Output Lines
17B6	8D	41	17	STA	1741	
17B9	B1	CE		LDA	(DSPL0),Y	Get Display Character from
17BB	8D	40	17	STA	1740	Display Buffer and Output
17BE	88			DEY		Decrement Position Pointer
17BF	10	02		BPL	DSPLY2	Okay if Positive
17C1	A0	05		LDY	#5	Else, Reset to Maximum
17C3	84	D9	DSPLY2	STY	DSPPOS	Save Pointer for Next Loop

Other routines are now invoked via subroutine jumps. TIMER is an optional routine. The next slot is available for any other routine that is to be included in every EXLOOP. Currently it is not being used and is therefore replaced by three NOPs. The actual application that is being run is accessed via the JSR APPL where the address of the application routine has been filled in at run time. It is initially set to address 0300 by the EXINIT code. It can be simply changed by the application by use of the EXSET routine explained below.

17C5 20 00 02	JSR TIMER	Go to TIMER subroutine
17C8 EA EA EA	(JSR ??????)	NOPs can be changed
17CB 20 00 03	JSR APPL	This goes off to Application

EXWAIT waits for the interval timer to finish its 992 microsecond count. It then restarts the EXLOOP for the next millisecond loop. The testing and restart takes approximately 16 microseconds bringing the total time up to approximately 1000 microseconds or one millisecond.

17CE 2C 45 17 EXWAIT	BIT 1745	Test Current Interval
17D1 10 FB	BPL EXWAIT	Not done if Positive
17D3 30 B9	BMI EXLOOP	Done if Negative

EXSET is provided to make it easy for an application to change the location to be accessed on the next application call via the JSR APPL. The application code places a JSR EXSET immediately in front of the instruction which is to start the next application processing. EXSET picks up this address and places it into the JSR APPL instruction and then returns to EXWAIT by making a subroutine return RTS.

17D9 68 EXSET	PLA	Pull Address of Next
17DA 8D CC 17	STA EXAPLO	Application Instruction
17DD EE CC 17	INC EXAPLO	and Save and Correct
17E0 68	PLA	Pull Page Address of Next
17E1 8D CD 17	STA EXAPHI	Appl. Inst and Save it.
17E4 60	RTS	Return to EXLOOP at EXWAIT

EXAMPLE: Within an application there is a need to wait for 10 milliseconds. After JSR EXSET pointers set to call HERE on next JSR APPL.

.	LDA #10.	Set Counter = 10.
.	STA COUNT	
WAIT	JSR EXSET	Return to EXLOOP with
HERE	DEC COUNT	HERE as NEXT ADDRESS
	BNE WAIT	Keep Waiting Until BEQ
.		
.		

System Timer

On each pass through the PLEASE Monitor EXLOOP, a one millisecond loop, a subroutine call is made to a TIMER subroutine. This routine provides two services. First, it updates an eight character millisecond based counter which has a range of 0.0 to 99,999.999 seconds and which is used by many programs to generate pseudo random numbers, is used by the reaction time program to calculate reaction time, and so forth. Second, it updates a six character 24 hour clock to provide time in hours, minutes and seconds. This subroutine is written to be relocatable anywhere in memory. For PLEASE, it is assembled at location 200. The eight character timer data is stored in four bytes starting at location C0. The six character clock data is stored in three bytes starting at location C4. Location C7 is used as a counter.

200	F8	TIMER	SED	Calculations done in Decimal Mode
201	A2 03		LDX #3	Setup Counter for Timer
203	18	TIMER1	CLC	Clear Carry Bit
204	B5 C0		LDA THOUS,X	Add 1 to Current Timer Value
206	69 01		ADC #1	
208	95 C0		STA THOUS,X	
20A	90 2D		BCC TDONE	All done if no Carry
20C	E0 03		CPX #3	Test Carry from Millisecond
20E	D0 26		BNE TIMER2	Skip Clock Update unless Millisecond
210	C6 C7		DEC ONESEC	Decrement a Ten * 1/10 second counter
212	D0 22		BNE TIMER2	Skip Clock Update unless 10 counts

If one second has expired since the last update of the Clock, then the Clock is updated. First the seconds byte is incremented and tested for its limit (60 seconds). If not equal to its limit a test is performed to test the hour byte limit. If the hour byte is not equal to its limit (24 hours), then the clock portion of the Timer subroutine is complete. If the seconds byte is equal to its limit, then it is reset to zero and the minutes byte is incremented. It is tested in exactly the same manner (actually the same code) as the seconds for its limit. After the seconds, minutes, and hours bytes have been updated, the Ten * 1/10 second counter is reset and the X index register is reset.

214	18	CLOCK	CLC	
215	B5 C3		LDA MILLI,X	Get Byte Using Index
217	69 01		ADC #1	Increment Byte
219	C9 60		CMP #60	Test Second or Minute Limit
21B	D0 07		BNE HTEST	Not Limit. Test Hour Limit
21D	A9 00		LDA #0	Reset Second or Minute to Zero
21F	95 C3		STA MILLI,X	Save Modified Byte
221	CA		DEX	Decrement Index
222	10 F0		BPL CLOCK	Unconditional Branch

```

224 E0 01      HTEST    CPX #1      Is this the Hour Byte?
226 D0 06      BNE CDONE   If not, then Clock is Done
228 C9 24      CMP #24    Test Hour Limit
22A D0 02      BNE CDONE   If not Limit, then Clock is Done
22C A9 00      LDA #0      If Limit, Reset to Zero

22E 95 C3      CDONE    STA MILLI,X Store Modified Value
230 A2 03      LDX #3     Restore Index Value
232 A9 0A      LDA #A     Reset Ten * 1/10 Counter
234 85 C7      STA ONESEC

236 CA          TIMER2   DEX      Decrement Index
237 10 CA      BPL  TIMER1  If Index Positive, Continue Updates

239 D8          TDONE    CLD      All Done. Clear Decimal Mode
23A 60          RTS      RTS      Subroutine Return

```

These updated Timer and Clock values are now ready to be used for the various purposes of PLEASE and can be displayed on the six character display.

* * * * *

Alpha Display Table

Loc	Value	Key	Character
3F0	77	Ø	A
3F1	7C	1	b
3F2	58	2	c
3F3	5E	3	d
3F4	79	4	E
3F5	71	5	F
3F6	76	6	H
3F7	30	7	I
3F8	38	8	L
3F9	54	9	n
3FA	5C	A	o
3FB	73	B	P
3FC	50	C	r
3FD	6D	D	S
3FE	78	E	t
3FF	6E	F	Y

Hexidecimal Display Table

Loc	Value	Key	Character
1FE7	3F	Ø	Ø
1FE8	06	1	1
1FE9	5B	2	2
1FEA	4F	3	3
1FEB	66	4	4
1FEC	6D	5	5
1FED	7D	6	6
1FEE	07	7	7
1FEF	7F	8	8
1FF0	6F	9	9
1FF1	77	A	A
1FF2	7C	B	b
1FF3	39	C	C
1FF4	5E	D	d
1FF5	79	E	E
1FF6	71	F	F

Note: The Hexidecimal Display Table is located in the KIM-1 ROM. The table actually has bit 80 on in each byte, that is location 1FE7 actually contains a BF which is 3F + 80. Only those bits which have associated display segments are listed in this table.

Interpreter

A program written in PLEASE consists of a series of Functions and their associated Parameters. It is the responsibility of the Interpreter to: maintain a pointer to the next Step to be executed; convert the Step Number to the actual Step Location in memory; move the Function Code and the Parameter Values to standard Page Zero locations; lookup the actual memory address of the Function in the Function Table; and, transfer control to the selected Function. The Interpreter is the "glue" that holds the independent Functions together to form a Program.

A portion of the Monitor initialization sequence invoked when the system is started at location 1780 sets up a pointer in the Monitor so that the first call to the Application code comes to the Interpreter at location DECODE. This causes the Step Number STEPNO to be set to zero. This will cause the PLEASE Function at STEPNO 0 or Location 0000 to be the first Function executed. In all of the current PLEASE programs this is the start of the Command Decoder which occupies four Steps. If a PLEASE module is written which only contains a single program and therefore does not require a Command Decoder, then the first Function could be the start of the program itself. The entry point SETSTP is used to permit certain Functions to change the order of execution, that is cause a branch, by entering with the new next step value in the Accumulator. The entry point NXTSTP is the normal entry point where no modification of the Step Number is required. The subroutine jump to EXSET guarantees that the Monitor will gain control at least once during each Step, permitting the Keyboard to be tested for input, the Display to be refreshed, and the System Clock and Timer to be updated. On return from EXSET the Step Number is converted into the actual Step Location in memory. Valid Step Numbers range from 00 to 27 and address locations 0000 to 009C.

300	A9	00	DECODE	LDA	#00
302	85	B7	SETSTP	STA	STEPNO
304	20	D9	17	NXTSTP	JSR
					EXSET
307	A5	B7		LDA	STEPNO
309	0A			ASL	
30A	0A			ASL	
30B	85	B8		STA	STEPLO

STEPLO now points to the first byte of the four byte Step. These four bytes are transferred to standard locations in Page Zero. The data is moved in reverse order: PARAM3, PARAM2, PARAM1, and PARAM0. STEPNO is incremented in preparation for the next step.

```

300 A0 03      LDY  #3
30F B1 B8      PARMOV LDA  (STEPLO),Y
311 99 B0 00    STA  PARM0,Y
314 B8          DEY
315 10 F8      BPL  PARMOV
317 B6 B7      INC  STEPNO

```

The Function Code and the three Parameters have now been moved to the standard Page Zero locations where they are readily available to the specific Functions. The Function Code itself is still in the Accumulator and is now multiplied by two via the ASL command to be used as an index into the Function Table which contains the two byte memory address of each Function. The Function Code * 2 which is in the A register now, becomes the low address for the Function Table lookup, and is stored in location 320 where it becomes part of an Indirect Jump instruction. The location BREAK contains the first of two consecutive NOP instructions. Normally this code will be executed with no effect on the process. The NOP at EREAK may be changed into a BRK instruction for debugging purposes. To use the BREAK, you must first set up a transfer vector to the KIM Monitor at locations 17FE and 17FF: 17FE 00 and 17FF 1C. Then you can change the NOP at 31D to a BRK: 031D 00. Now when you execute PLEASE, starting at 1780 as usual, you will be "trapped" back to the KIM Monitor. The display will show 031F 6C which is the first byte of the Indirect Jump instruction at location 031F. You may now examine and/or modify any memory locations, registers, and so forth using the KIM Monitor commands. When you are ready to execute the current PLEASE Function, press PC to restore the pointer to 031F and then GO to run the program. You may also put the machine into single step mode at this point by setting the transfer vector at 17FA to 00 and 17FB to 1C. Then put the Single Step switch into single step mode. Then pressing GO will cause a single step to execute. In this way you can step through any Function.

```

319 0A          ASL
31A 8D 20 03    STA  0320
31D EA          BREAK  NOP
31E EA          NOP
31F 6C 00 01    JMP  (FUNCTION NUMBER * 2, 01)

```

The PLEASE Function Table starts at location 0100. Since each Function requires two bytes of address, locations 0100 through 011F are used for the standard PLEASE Functions. Locations 0120 through 012F are reserved for any future expansion of PLEASE or for special Functions which are required by some of the programs.

Every Function returns to the Interpreter when finished with its operation. Some return via the SETSTP location when they are modifying the order of Step execution, that is are causing a branch. Most Functions return via the NXTSTP location which causes the next Step in sequence to be executed.

B0	PARAMØ	Parameter Ø is usually the COMMAND CODE
B1	PARAM1	Parameter 1 is usually DATA
B2	PARAM2	Parameter 2 is usually DATA
B3	PARAM3	Parameter 3 is usually DATA
B4	ADRLO	Low Address pointer for Indirect Address
B5	ADRHI	High Address pointer for Indirect Address
B6	PNTR	Temporary Pointer Storage
B7	STEPNO	Number of NEXT PLEASE Step
B8	STEPLO	Low Address of Current PLEASE Step
B9	STEPHI	High Address of Current PLEASE Step
BA	TRANLO	Temporary Transfer Pointer to PLEASE Function
BB	TRANHI	Temporary Transfer Pointer to PLEASE Function
BC	FUNTBL	Low Address of PLEASE Function Table
BD	FUNTBH	High Address of PLEASE Function Table
BE	PTEMPØ	PLEASE Temporary Storage
BF	PTEMP1	PLEASE Temporary Storage
C0	THOUS	Thousands and Tens of Thousands of Seconds
C1	TENS	Tens and Hundreds of Seconds
C2	TENTHS	Tenths and Seconds
C3	MILLI	Thousandths and Hundredths of Seconds
C4	HOUR	Hour portion of 24 Hour Clock
C5	MINUTE	Minute portion of 24 Hour Clock
C6	SECOND	Second portion of 24 Hour Clock
C7	ONESEC	Counter for One Second
C8	DSPØ	Display Position Ø (Leftmost Digit)
C9	DSP1	Display Position 1
CA	DSP2	Display Position 2
CB	DSP3	Display Position 3
CC	DSP4	Display Position 4
CD	DSP5	Display Position 5 (Rightmost Digit)
CE	DSPLO	Low Address of Display Buffer (Usually = DSPØ = C8)
CF	DSPHI	High Address of Display Buffer (Usually = DSPØ = 00)
D0	DCONLO	Display Conversion Table Low Address
D1	DCONHI	Display Conversion Table High Address
D2	HEXLO	Hexadecimal (and Decimal) Conversion Table Low Address = E7
D3	HEXHI	Hexadecimal (and Decimal) Conversion Table High Address = 17
D4	ALPHLO	Alphabetic Conversion Table Low Address (usually = FØ)
D5	ALPHHI	Alphabetic Conversion Table High Address (usually = 03)
D6	XTABLE	Used by Conversion Routine to Point to HEX or ALPHA Table
D7	TEMP	General Purpose Temporary Save Location
D8	LIMIT	Used by Conversion Routine. General Purpose Register
D9	DSPPPOS	Executive Pointer to Current Display Position
DA	CURPNT	Used by Input Routines as Current Data Pointer.
DB	CHAR	Save Location for Input Character
DC	CTABLO	Command Table Low Address (usually = AØ)
DD	CTABHI	Command Table High Address (usually = ØØ)
DE	KEYTST	Used by Executive as part of Keyboard Input
DF	KEYVAL	Contains Last Character of Input String

E0	BUFØ	General Purpose Buffer
E1	BUF1	
E2	BUF2	
E3	BUF3	
E4	BUF4	
E5	BUF5	
E6	ALTØ	Alternate General Purpose Buffer
E7	ALT1	
E8	ALT2	
E9	ALT3	
EA	ALT4	
EB	ALT5	
EC	APLØ	Application General Registers
ED	APL1	
EE	APL2	

Other PAGE ZERO Location Information

00 to 9F	PLEASE CODE, four bytes per STEP, max 40. (28) Steps.
00 to 0F	PLEASE CODE for COMMAND DECODER
A0 to AF	COMMAND TABLE contains two bytes per entry, max eight
EF to FF	Used by KIM-1 Monitor (8) Commands
EF	PCL Program Counter - Low Order Byte
F0	PCH Program Counter - High Order Byte
F1	P Status Register
F2	SP Stack Pointer
F3	A Accumulator
F4	Y Y-Index Register
F5	X X-Index Register

Other MEMORY Location Information

100 to 11F	PLEASE Function Table, two bytes per entry, Low-High Address
120 to 12F	APPLICATION Specific Function Table
130 to 1EF	APPLICATION Specific Assembly Level Code
1FO to 1FF	STACK
200 to 3FF	Standard PLEASE Functions Assembly Level Code
1780 to 17E6	PLEASE Executive
17E7 to 17FF	Used by KIM-1 Monitor
1800 to 1FFF	KIM-1 Monitor (ROM)

Function: ALPIN

Code: ØØ

Purpose: Accept Alphabetic Input from the Keypad, store it in memory, convert to displayable characters, and display characters as input.

Command: ALPIN

Param1: Memory Address to Store Characters. Page Zero Locations.

Param2: Start Display Location. Leftmost = Ø, Rightmost = 5.

Param3: End Display Location. Leftmost = Ø, Rightmost = 5.

Param2 and Param3 control how many characters may be input - 1 to 6, where the characters get displayed within the six digit LED, and the mode of displaying - either fillin or shift. The number of characters equals the absolute difference between Param2 and Param3 plus 1. Where they are displayed is determined by Param2, the Start Display Location. The mode of displaying is fillin if the Start Location is less than the End Location. The mode of displaying is shift if the Start Location is greater than the End Location. If equal the mode is fillin.

The input data is stored as one character per byte in consecutive memory locations in Page Zero starting at the location specified by Param1. The order of storing is independent of the display mode. The first character typed is stored in the specified memory location, the second character in the next location,.... See page 9 for the Keypad to Alpha Conversions.

Function: HEXIN

Code: Ø1

Purpose: Accept Hexidecimal Input from the Keypad, store it in memory, convert to displayable characters, and display characters as they are input.

Command: HEXIN

Param1: Memory Address to Store Characters. Page Zero Locations.

Param2: Start Display Location. Leftmost = Ø, Rightmost = 5.

Param3: End Display Location. Leftmost = Ø, Rightmost = 5.

See ALPIN above for details on operation and parameters.

Function: DECIN

Code: Ø2

Purpose: Accept Decimal Input from the Keypad, store it in memory, convert to displayable characters, and display characters as they are input.

Command: DECIN

Param1: Memory Address to Store Characters. Page Zero Locations.

Param2: Start Display Location. Leftmost = Ø, Rightmost = 5.

Param3: End Display Location. Leftmost = Ø, Rightmost = 5.

See ALPIN above for details on operation and parameters.

ALPIN, HEXIN, and DECIN use the same source code. The only difference is in the conversion tables used and the input limits set. These differences are taken care of by short initialization sequences as follows.

ALPIN uses the entry point ALPHA. It sets up a pointer to the Alpha Table and sets the input limit to 10 which permits input in the range 0 to F.

```
329 A9 10      ALPHA    LDA #10
32B A2 D4      LDX #ALPHLO
32D D0 08      BNE SETTAB
```

HEXIN uses the entry point HEXIN. It sets up a pointer to the Hexidecimal Table and sets the input limit to 10 which permits input in the range 0 to F.

```
32F A9 10      HEXIN    LDA #10
331 D0 02      BNE SETHEX
```

DECIN uses the entry point DECIN. It sets up a pointer to the Hexidecimal Table and sets the input limit to 10. which permits input in the range 0 to 9. A call is then made to the subroutine DIRADR which converts the Param1 address into a two byte address which is stored in a pair of Page Zero locations ADRLO and ADRHI for general usage.

```
333 A9 0A      DECIN    LDA #0A
335 A2 D2      SETHEX   LDX #HEXDEC
337 86 D6      SETTAB   STX XTABLE
339 85 D8      STA LIMIT
33B 20 83 03   JSR DIRADR
```

RSTART calls a subroutine CLRDSP which clears that portion of the display specified by Param2 and Param3 as the display limits. It then sets a value called current pointer CURPNT to equal Param2 the start location. This initializes the input routine and is also used to reinit in the event that a special character to clear the display is received, the PC key. The PC key may be used at any time to clear that portion of the display under control of the current function. Remember that as little as one character may be specified by these input functions, and that the display may at any time consist of sections which were input or generated by other functions. Param2 and Param3 totally define the portion of the display that will be affected by the current function.

```
33E 20 97 03  RSTART  JSR CLRDSP
341 A5 B2      LDA PARAM2
343 85 DA      STA CURPNT
345 10 03      BPL MORE
```

SAVE is skipped over the first time since there is no input data to be stored. MORE performs several functions. First it calls a subroutine to convert the raw data in the Param1 defined buffer to displayable form in the display buffer. It specifies the conversion table by loading X with a pointer to the correct conversion table. CONDSP is on page 18. A call is then made to EXSET to permit the Monitor to gain control for a millisecond cycle and to permit keypad input. The location CHAR will contain a 20 if there has been no input or the value of the input if there was any. The CHAR is moved to A and the location reset to 20. Then a test is made for the "erase" key, the PC key. If the last character was a PC then the program branches to RSTART. If there was no character, then the program branches to MORE. If there was a character, then it is tested for the limit. If the input character is less than the limit, then it is saved by branching to SAVE which calls a store the character subroutine STORE. If the input character is equal to or greater than the limit, then the function exits to the next step NXTSTP after storing the final character value in KEYVAL for testing by other functions.

```

347 20 D0 03  SAVE   JSR   STORE
34A A6 D6    MORE   LDX   XTABLE
34C 20 A9 03  JSR   CONDSP
34F 20 D9 17  JSR   EXSET
352 A5 DB    LDA   CHAR
354 A2 20    LDX   #20
356 86 DB    STX   CHAR
358 C9 14    CMP   #PC
35A F0 E2    BEQ   RSTART
35C 10 EC    BPL   MORE
35E C5 D8    CMP   LIMIT
360 30 E5    BMI   SAVE

362 85 DF    FINISH STA   KEYVAL
364 10 9E    BPL   NXTSTP

```

Any of the "control" keys except PC will cause termination of the input function. This means that GO, +, AD or DA may be used as valid terminators. Because the final character is saved in KEYVAL, a BRTABL Function can be used to branch within the program as a function of the terminator. This feature is used in the ADDSUB Program.

Subroutine: DIRADR

Purpose: Move Page Zero Direct Address value from Param1 to the full address pointers ADRLO/ADRHI for general use.

```

383 A5 B1    DIRADR  LDA   PARAM1
385 85 B4    STA   ADRLO
387 A9 00    LDA   #00
389 85 B5    STA   ADRHI
38B 60      RTS

```

Subroutine: INDADR

Purpose: To move a pair of Page Zero bytes which contain a full memory address from the location pointed to by Param1 to the full address pointers ADRLO/ADRHI for general use. This permits a full two byte address to be referenced by a single byte parameter. This subroutine is used by the Branch on Table Lookup Function BRTABL to point to the table to be searched.

```
38C A6 B1    INDADR  LDX  PARAM1
38E B5 00    XNDADR  LDA  0,X
390 85 B4    STA  ADRLO
392 B5 01    LDA  1,X
394 85 B5    STA  ADRHI
396 60        RTS
```

Subroutine: CLRDSP

Purpose: To Clear that portion of the Display defined by Param2 and Param3 by filling it with nulls.

Subroutine: FILDSP

Purpose: To Fill that portion of the Display defined by Param2 and Param3 with the value contained in the Accumulator.

These two subroutines use the same code except that CLRDSP sets a value of FF in the Accumulator as a special value which will be converted to a blank by the CONDSP subroutine.

```
397 A9 FF    CLRDSP  LDA  #FF
399 A2 06    FILDSP  LDX  #06
39B 86 D7    STX  TEMP
39D A4 B2    LDY  PARAM2
39F 84 DA    STY  CURPNT
3A1 20 D0 03  FILNXT  JSR  STORE
3A4 C6 D7    DEC  TEMP
3A6 D0 F9    BNE  FILNXT
3A8 60        RTS
```

These routines actually do not directly effect the display. They work by modifying the data in the memory storage area which is then converted and moved to the Display buffer by the CONDSP routine. They are special purpose routines and are intended for use with the Keypad Input routines ALPIN, HEXIN and DECIN. There is a FILL Function for more general memory filling and clearing.

Subroutine: CONDSP

Purpose: Convert data from binary form to LED Segment Display Format.

The KIM-1 Display consists of six elements each of which in turn is composed of seven independent light emitting diode LED segments. Each segment is turned on or off under program control. The seven segments each have a binary value as shown in the diagram.

For example, to show the digit "8" all segments are turned on by putting a 7F on the display output lines. $7F = 40 + 20 + 10 + 08 + 04 + 02 + 01$. The letter "L" has a value of $38 = 20 + 10 + 08$. Since the display values of the various characters bear no relation to their binary form, a translation is required. The binary value 08 will be displayed as an eight "8" in Hexadecimal or Decimal mode and as ell "L" in Alpha mode. The convert to display subroutine CONDSP performs this conversion. On entry X contains the address of a Page Zero location which has the low order address of a conversion table, followed by a byte which contains the high order address of the table. Normally PLEASE supports two tables: ALPHA and HEXIDECLMAL as described on page 9. The programmer could make other tables to suit his own needs. CONDSP moves the table address to a standard Page Zero pair of locations for easy use. It picks up the Param2 address for Start Location. Locations ADRLO/ADRHI point to the buffer.

3A9 B5 00	CONDSP	LDA 0,X			
3AB 85 D0		STA DTABLO			01
3AD B5 01		LDA 1,X		20	/
3AF 85 D1		STA DTABHI		/	02
3B1 A4 B2		LDY PARAM2		10	/
					40
					/
					04
					/
					08
					/

CON saves the current location. It then picks up the character in the buffer and tests it for a negative value. Normally the value of a character being output must range between 0 and F, or 0 and 9 for decimal. A negative value is used to cause a blank output. This is why CLRDSP filled the buffer with FF not 00. A positive value is used to perform the table lookup for the translated value. The value from the table is placed in the display buffer. Tests are made against Param3 to determine if all positions have been converted, or if not which direction to shift the pointer to handle both fillin and shift modes of input.

3B3 84 D7	CON	STY TEMP			
3B5 B1 B4		LDA (ADRLO),Y			
3B7 10 04		BPL CON2			
3B9 A9 00		LDA #00			
3BB F0 03		BEQ CON3			
3BD A8	CON2	TAY			
3BE B1 D0		LDA (DTABLO),Y			
3C0 A4 D7	CON3	LDY TEMP			
3C2 91 CE		STA (DSPL0),Y			
3C4 C4 B3		CPY PARAM3			
3C6 F0 27		BEQ RETURN			
3C8 30 03		BMI INCR			
3CA 88		DEY			
3CB 10 E6		BPL CON			
3CD C8	INCR	INY			
3CE 10 E3		BPL CON			

Subroutine: STORE

Purpose: To place data in a buffer with parameters controlling the amount of data and the mode of storing: fillin or shift.

STORE is an integral part of the Keypad Input routines. Before it is called the address of the storage buffer is placed in the standard Page Zero locations ADRLO/ADRHI. Param2 determines the Start of storage within the buffer, Param3 determines the End, and the relative values of Param2 and Param3 determine whether the mode is fillin or shift. The character to be stored is in the Accumulator on entry. The character is saved in X. A test is made for mode by comparing Param2 and Param3. If Param3 is greater than Param2 or equal, then fillin mode is used. A test is made for end of buffer by comparing Param3 with the current pointer CURPNT. If Param3 is greater than the CURPNT, then CURPNT is incremented and the character is stored. If Param3 is less than CURPNT, then an immediate return is made and no character is stored.

3D0	AA	STORE	TAX
3D1	A4 B3		LDY PARAM3
3D3	C4 B2		CPY PARAM2
3D5	30 OA		BMI SHIFT
3D7	C4 DA		CPY CURPNT
3D9	30 14		BMI RETURN
3DB	A4 DA		LDY CURPNT
3DD	E6 DA		INC CURPNT
3DF	10 OC		BPL PUT

If Param3 was less than Param2 then shift mode is used. SHIFT first moves all characters within the portion of the buffer defined by Param2 and Param3 one position up in memory. When all characters have been shifted it gets the new character back from X and stores it in the buffer at the last position as defined by Param3.

3E1	C8	SHIFT	INY
3E2	B1 B4		LDA (ADRLO),Y
3E4	88		DEY
3E5	91 B4		STA (ADRLO),Y
3E7	C8		INY
3E8	C4 B2		CPY PARAM2
3EA	30 F5		BMI SHIFT
3EC	8A		TXA
3ED	91 B4	PUT	STA (ADRLO),Y
3EF	60	RETURN	RTS

Function: ALPOUT

Code: 03

Purpose: Convert and Display data in Alpha mode, using standard PLEASE Alpha Table.

Command: ALPOUT

Param1: Memory Address of Buffer. Page Zero Locations.

Param2: Start Display Location. Leftmost = 0, Rightmost = 5.

Param3: End Display Location. Leftmost = 0, Rightmost = 5.

Data to be output should be in range 00 to 0F for real data or FF for a blank. Other values will give strange results. The Alpha Table on page 9 shows the standard conversions. The order of the Start and End does not matter. Start less than End will be handled as fillin and End less than Start will be handled as shift, but since the whole conversion takes place within a single millisecond cycle there will be no visible difference.

Function: HEXOUT or DECOUT

Code: 04

Purpose: Convert and Display data in Hexidecimal mode, using standard KIM-1 Hexidecimal Table.

Command: HEXOUT or DECOUT

Param1: Memory Address of Buffer. Page Zero Locations.

Param2: Start Display Location. Leftmost = 0, Rightmost = 5.

Param3: End Display Location. Leftmost = 0, Rightmost = 5.

Data to be output should be in range 00 to 0F for Hex or 00 to 09 for Decimal. A value with bit 80 set will produce a blank. Values in the range 10 to 7F will give strange results. See ALPOUT comments above for other details. HEXOUT is the entry point for HEXOUT/DECOUT.

```
283 A2 D4    ALPOUT  LDX  #ALPHLO
285 D0 02    BNE    GETADR
287 A2 D2    HEXOUT  LDX  #HEXDEC
289 20 83 03 GETADR  JSR  DIRADR
28C 20 A9 03           JSR  CONDSP
28F 4C 04 03 TONEXT  JMP  NXTSTP
```

For an example of the use of ALPOUT see the HiLo program.

For an example of the use of HEXOUT and DECOUT see the Decimal/Hexidecimal Conversion program.

Function: TIMER

Code: 05

Purpose: Provide a programmable delay while maintaining the basic system operations of Display Refresh and System Clock Updating.

Command: TIMER

Param1: Delay Time in Tents of a Second. Range 0.1 to 25.6 seconds.
Param2: Step Number to Branch to when Delay is done.
Param3: not used

There are a number of uses for a timer. Several programs flash all or part of the Display. This is easily accomplished by changing all or part of the Display, waiting a set period of time using TIMER, changing the Display again, waiting, and so forth. Another use for TIMER is in TIPSY in which the Player is shown the test numbers for 2 seconds and then must wait 1 second before typing his answer. The basic unit of TIMER is 0.1 seconds. This is generated from the Monitor Millisecond loop by setting up two counters to provide a 100 millisecond * 0.1 second delay. Intermediate returns are made to the Monitor to permit the basic system operations to take place and to complete the millisecond loop. After 0.1 seconds have been timed, the Delay Time is decremented and tested. If the Delay Time has gone to zero, then the next Step Number is pickup and a return is made to the Interpreter at the Set Step SETSTP location. Delay Time is held in Param1 and next Step Number in Param2.

2AA A9 0A	TIMER	LDA	#10.
2AC 85 BE		STA	TEMP1
2AE A9 0A	RESET	LDA	#10.
2B0 85 BF		STA	TEMP2
2B2 20 D9 17	WAIT	JSR	EXSET
2B5 C6 BF		DEC	TEMP2
2B7 D0 F9		BNE	WAIT
2B9 C6 BE		DEC	TEMP1
2BB D0 F1		BNE	RESET
2BD C6 B1		DEC	PARAM1
2BF D0 E9		BNE	TIMER
2C1 A5 B2		LDA	PARAM2
2C3 10 3D		BPL	SETSTP

Warning: Remember that the Delay Time in Param1 is in tenths of a second.

Note: Obviously only a single counter is required to keep a 100. count. The double counter is provided so that a longer base interval can be generated by changing the two counter constants. The maximum base interval would be slightly over one minute (65,536 milliseconds) which means that a delay can be specified of over four hours (256+ minutes) if the base interval is changed. An even longer interval could be generated by having multiple TIMER calls. However, since the TIMER is based on the crystal and a slight variation in time can cause a large error when accumulated over millions of cycles, this TIMER will not be very accurate for long periods.

Function: PACK

Code: Ø6

Purpose: To take a series of characters and pack them two to a byte.

Command: PACK

Param1: Source Buffer which contains Characters. Page Zero.

Param2: Destination Buffer or Byte to receive result. Page Zero.

Param3: Number of Bytes in the Destination

While it is convenient to input characters in four bit chunks and keep them that way for displaying, it is often an inconvenient form for processing data. PACK provides a simple method of combining the raw input data into compact bytes. An input character must be in the range ØØ to ØF. Two such characters fit into a single byte. PACK can handle as little as one byte or as many as 256. PACK picks up the first character of the pair to be packed and shifts it into the Most Significant Bits of the Accumulator and then performs a logical inclusive Or to get the second character into the Least Significant Bits. It then tests the Carry bit to see if a dummy blank character FF was the first character. If it was it loads the second character into the Accumulator and test if it was a blank character. If it was it loads zero as the result of packing two blank characters. If the first or second character is not a blank, then the combined characters are now stored as a single packed byte. This packing of character pairs continues until the requested number of bytes have been created.

23B	A6	B1	PACK	LDX	PARAM1
23D	B5	00		LDA	0,X
23F	0A			ASL	
240	0A			ASL	
241	0A			ASL	
242	0A			ASL	
243	15	01		ORA	1,X
245	90	06		BCC	PACK2
247	B5	01		LDA	1,X
249	10	02		BPL	PACK2
24B	A9	00		LDA	#00
24D	A6	B2	PACK2	LDX	PARAM2
24F	95	00		STA	0,X
251	E6	B1		INC	PARAM1
253	E6	B1		INC	PARAM1
255	E6	B2		INC	PARAM2
257	C6	B3		DEC	PARAM3
259	D0	E0		BNE	PACK
25B	F0	32		BEQ	TONEXT

For examples of PACK in use, see the DECODE program, SCLOCK program, or STIMER program.

Function: UNPACK

Code: 07

Purpose: To separate bytes into characters, normally in order to make them available for displaying.

Command: UNPACK

Param1: Source Buffer which contains Bytes. Page Zero.

Param2: Destination Buffer to receive Characters. Page Zero.

Param3: Number of Characters in the Destination.

Normally data is processed in a packed form or binary form. Since the display only uses values in the range 00 to 0F for its normal character generation, a means of converting from packed to unpacked form is required. UNPACK performs this function. One or more bytes are split into their component characters. The Most Significant Bits are used as the first character of a pair, the Least Significant Bits as the second character. UNPACK can be used to generate from one to 256 characters. UNPACK picks up the byte to be unpacked, shifts off the second character and stores the first character in the destination buffer. It then tests for any more characters required. If no more, then it is done and goes to the next step NXTSTP in the Interpreter. If more is required it masks off the second character from the same byte and stores it in the destination buffer. After some housekeeping, it test for any more characters required. If so it gets the next byte and continues. If no more are required it goes to the next step NXTSTP in the Interpreter.

25D A6 B1	UNPACK	LDX PARAM1
25F B5 00		LDA 0,X
261 4A		LSR
262 4A		LSR
263 4A		LSR
264 4A		LSR
265 A6 B2		LDX PARAM2
267 95 00		STA 0,X
269 E6 B2		INC PARAM2
26B C6 B3		DEC PARAM3
26D F0 1E		BEQ TONEXT
26F A6 B1		LDX PARAM1
271 A9 0F		LDA #0F
273 35 00		AND 0,X
275 A6 B2		LDX PARAM2
277 95 00		STA 0,X
279 E6 B2		INC PARAM2
27B E6 B1		INC PARAM1
27D C6 B3		DEC PARAM3
27F D0 DC		BNE UNPACK
281 F0 0C		BEQ TONEXT

For examples of UNPACK in use see DCLOCK program, DTIMER program, or the Shooting Stars program.

Function: BRANCH

Code: 08

Purpose: Provides an Unconditional Branch to any specified Step.

Command: BRANCH

Param1: Step to Branch To.

Param2: not used

Param3: not used

Almost every conceivable PLEASE program has one or more loops in it or is itself a large loop. The BRANCH function permits transfer of control to a Step other than the next sequential Step. BRANCH picks up the Step number from Param1 and then goes to the Set Step SETSTP entry of the Interpreter.

```
2A6 A5 B1      BRANCH LDA PARAM1
2A8 10 58      BPL SETSTP
```

Function: BRCHAR

Code: 09

Purpose: Provide Program Control from the Keypad.

Command: BRCHAR

Param1: Character for Match.

Param2: Step to Branch to on Match.

Param3: Step to Branch to on Non-match.

BRCHAR picks up the current value of the Page Zero location CHAR which contains the last input character or a 20 if there is no valid input. It clears the CHAR location and tests for valid input. If there is no character ready, then a return is made to the Next Step NXTSTP entry of the Interpreter and the next Step is executed. If there is a character it is tested for a match with the specified match character in Param1. If they match, then the Match Step in Param2 is used as the next step. If they do not match, then the Non-match Step in Param3 is used. In either case the parameter value is loaded into the Accumulator and control goes to the Set Step SETSTP entry of the Interpreter.

```
292 A6 DB      BRCHAR LDX CHAR
294 A9 20      LDA #20
296 85 DB      STA CHAR
298 E0 20      CPX #20
29A F0 F3      BEQ TONEXT
29C A5 B2      LDA PARAM2
29E E4 B1      CPX PARAM1
2A0 F0 02      BEQ OKAY
2A2 A5 B3      LDA PARAM3
2A4 10 5C      OKAY BPL SETSTP
```

For examples of BRCHAR see DCLOCK program or DTIMER program.

Function: BRTABL

Code: 0A

Purpose: Provide Program Control as a function of a Table Lookup.

Command: BRTABL

Param1: Page Zero Indirect Address of Table.

Param2: Direct Address of Value to be Matched. Page Zero.

Param3: Step Number to Branch to if No Match.

This is a very powerful method of branching. A value may be generated by any means such as characters from the Keypad, result of a calculation, or whatever. A table is set up which contains the permitted values and the step number to go to if that value occurs. Many value can branch to the same Step. Every value may branch to a different Step. The table could itself be modified and/or generated under the program.

BRTABL starts by calling the INDADR subroutine to move the table address into the standard locations ADRLO/ADRHI. It then picks up the test value via Param2 and compares it with a value in the table. If a match is found, then the next byte in the table is picked up and used as the next step number by going to the Set Step SETSTP entry of the Interpreter. If it is not a match, then the pointers are moved to the next value in the table which is checked for zero. If the next value is a zero it indicates the end of the table and a no match condition. In this case the value of Param3 is used as the next step number via the Set Step SETSTP entry to the Interpreter. If the next value is not a zero, then BRTABL continues testing until either a match is found or the end of the table is reached.

366	20	8C	03	BRTABL	JSR	INDADR
369	A6	B2			LDX	PARAM2
36B	A0	00			LDY	#00
36D	B5	00		MORE	LDA	0,X
36F	D1	B4			CMP	(ADRLO),Y
371	F0	0A			BEQ	FOUND
373	C8				INY	
374	C8				INY	
375	B1	B4			LDA	(ADRLO),Y
377	D0	F4			BNE	MORE
379	A5	B3			LDA	PARAM3
37B	10	85		BRDONE	BPL	SETSTP
37D	C8			FOUND	INY	
37E	B1	B4			LDA	(ADRLO),Y
380	10	F9			BPL	BRDONE

The table has two bytes per entry. The first byte is the value to be tested. The second value is the Step Number to go to on a match. The table must be terminated by a zero value, therefore, zero may not be used for a test value unless it is the first test value which is matched before the end of table test is performed. For examples of BRTABL see the DECODE program or the ADDSUB program.

Function: FILL

Code: $\emptyset B$

Purpose: Provide a means of filling a section of Page Zero memory with a specified value.

Command: FILL

Param1: Memory Address of Start of Page Zero Memory to be Filled.

Param2: Value to Fill Memory with.

Param3: Number of bytes of Memory to Fill.

Since all of the working locations, buffers, and so forth for PLEASE are in Page Zero, this limited Fill command is sufficient for most purposes. It is used to initialize buffers, clear specific bytes, clear the Display via its buffer, etc. FILL first calls the DIRADR subroutine to get the Page Zero address to be modified into the standard ADRLO/ADRHI location. It then picks up the Fill value from Param2 and proceeds to fill memory starting at the last location to be modified and working back to the first location. When finished it returns via the Next Step NXTSTP entry in the Interpreter.

```
2E9 20 83 03 FILL    JSR  DIRADR
2EC A5 B2            LDA  PARAM2
2EE A4 B3            LDY  PARAM3
2F0 88              DEY

2F1 91 B4    FILLIT STA  (ADRLO),Y
2F3 88          DEY
2F4 10 FB    BPL  FILLIT
2F6 30 0C    BMI  NXTSTP
```

For examples of FILL see the DECODE program or the DAFFY program.

Function: COMPARE

Code: $\emptyset C$

Purpose: Provide a String Compare with a Three-way Branch on Less, Equal, or Greater.

Command: COMPAR

Param1: Page Zero Address of Test Value Start

Param2: Page Zero Address of String to be Compared with.

Param3: Number of Bytes to be Compared.

Function: MATCH

Code: $\emptyset D$

Purpose: Provide a String Compare with a Two-way Branch on Equal or Not Equal.

Command: MATCH

Param1: Page Zero Address of Test Value Start

Param2: Page Zero Address of String to be Matched to.

Param3: Number of Bytes to be Matched.

These two functions use essentially the same code. The only difference is a test which causes MATCH to treat Less and Greater as a single condition: Not Equal. First a call is made to the DIRADR subroutine to get the Test String address in the standard ADRLO/ADRHI locations. A byte from the second string is picked up. A byte from the first string is subtracted from the second string byte and the result tested. If the first string byte is less than the second string, then testing is complete and control is returned to the Interpreter through the Next Step NXTSTP entry point. If the first string byte is greater than the second string byte, then an additional test is made to determine if this is a COMPAR or MATCH. If a MATCH, then it is treated identically as the less. If a COMPAR, then the Step Number STEPNO is incremented twice to cause the next two Steps to be skipped. If the first and second bytes are equal, then the number of bytes to test is checked. If all bytes have been tested, then the Step Number STEPNO is increment once to cause the next Step to be skipped. If all bytes have not been tested, then testing continues with the next pair of bytes.

COMPAR and MATCH Branch Summary: First String to Second String

COMPARE

Less	Skip Ø Steps
Equal	Skip 1 Step
Greater	Skip 2 Steps

MATCH

Less	Skip Ø Steps
Equal	Skip 1 Step
Greater	Skip Ø Steps

2C5 20 83 03	COMPAR	JSR DIRADR
2C8 A6 B2		LDX PARAM2
2CA A0 00		LDY #00
2CC B5 00	CTEST	LDA 0,X
2CE 38		SEC
2CF D1 B4		SBC (ADRLO),Y
2D1 F0 0E		BEQ SAME
2D3 B0 0A		BCS LESS
2D5 A9 0D	GREAT	LDA #MATCH
2D7 C5 B0		CMP PARAMØ
2D9 F0 04		BEQ LESS
2DB E6 B7		INC STEPNO
2DD E6 B7	EQUAL	INC STEPNO
2DF 10 23	LESS	BPL NXTSTP
2E1 E8	SAME	INX
2E2 C8		INY
2E3 C4 B3		CPY PARAM3
2E5 D0 E5		BNE CTEST
2E7 F0 F4		BEQ EQUAL

For examples of COMPARE see the HILO program.
 For examples of MATCH see the TIPSY program.

Program Module #1

LOC	OBJECT	STEP	LABEL	COMMAND	PARAM1	PARAM2	PARAM3
Command Decoder							
00	00E00005	Ø	DECODE	ALPIN	BUFFER	Ø	5
04	06E0DF01	1		PACK	BUFFER	KEYVAL	1
08	0BC80006	2		FILL	DISPLAY	Ø	6
0C	0ADCDF00	3		BRTABL	CMDTBL	KEYVAL	DECODE
Set Clock and Display Clock							
10	02E00005	4	SCLOCK	DECIN	BUFFER	Ø	5
14	06E0C403	5		PACK	BUFFER	HOUR	3
18	07C4E006	6	DCLOCK	UNPACK	HOUR	BUFFER	6
1C	04E00005	7		DECOUT	BUFFER	Ø	5
20	09130004	8		BRCHAR	GO	DECODE	SCLOCK
24	08060000	9		BRANCH	DCLOCK		
Set Timer and Display Timer							
28	02E00500	A	STIMER	DECIN	BUFFER	5	Ø
2C	06E0C103	B		PACK	BUFFER	TENS	3
30	07C1E006	C	DTIMER	UNPACK	TENS	BUFFER	6
34	04E00005	D		DECOUT	BUFFER	Ø	5
38	0913000A	E		BRCHAR	GO	DECODE	STIMER
3C	080C0000	F		BRANCH	DTIMER		
Notice and Billboard							
40	11D0010A	10	NOTICE	MESAGE	NMSGLO	MSGHI	10.
44	09130013	11		BRCHAR	GO	DECODE	BILBRD
48	08100000	12		BRANCH	NOTICE		
4C	12CA0104	13	BILBRD	BBOARD	BMSGLO	MSGHI	4.
50	09130010	14		BRCHAR	GO	DECODE	NOTICE
54	08130000	15		BRANCH	BILBRD		
Daffy							
58	0BE00006	16	DAFFY	FILL	ANSWER	Ø	6
5C	07C1E004	17		UNPACK	TENS	ANSWER	4
60	02E60003	18	GET	DECIN	GUESS	Ø	3
64	10E6EC20	19		MASTER	GUESS	ANSWER	BAD
68	04E00005	1A	GOOD	DECOUT	ANSWER	Ø	5
6C	05021C00	1B		TIMER	2.	BLANK	
70	0BCC0002	1C	BLANK	FILL	DISPLAY+4	Ø	2.
74	05011E00	1D		TIMER	1	WAIT	
78	09130016	1E	WAIT	BRCHAR	GO	DECODE	DAFFY
7C	081A0000	1F		BRANCH	GOOD		
80	04E60405	20	BAD	DECOUT	GUESS	4	5
84	09130018	21	HOLD	BRCHAR	GO	DECODE	GET
88	08210000	22		BRANCH	HOLD		

Program Module #1

Notes and Comments

DECODE Command Decoder

This program is called when the system is initialized or when various programs are complete. Its purpose is to allow the user to select a program from the keypad. ALPIN is used to input the program name from the keypad. At least two characters of the name must be typed, additional characters are optional. PACK is used to combine the first two characters into a single byte for testing by BRTABL. FILL is used to clear the display by filling the display buffer with nulls. BRTABL is used to lookup in the Command Table CMDTBL the Step Number STEPNO of the requested program and to transfer control to that program.

SCLOCK and DCLOCK Set Clock and Display Clock

These programs set the system clock and display the current contents of the system clock. DECIN is used to input up to six characters in the fillin mode. PACK converts the input characters into three bytes in the system clock. UNPACK converts the current contents of the system clock into separate characters. DECOUP converts these characters into their displayable form and moves them to the display buffer. BRCHAR returns to DECODE if the GO key is pressed; goes to SCLOCK if any other key is pressed; or goes to the next step if no key is pressed. BRANCH which is reached by no key being pressed goes to DCLOCK so that the display is constantly updated with the current value of the system clock.

STIMER and DTIMER Set Timer and Display Timer

These programs set the system timer and display the current contents of the system timer. DECIN is used to input up to six characters in the shift mode. The remainder of the program is identical to SCLOCK and DCLOCK described above.

NOTICE and BILBRD Notice and Billboard Message Display

These programs display a message in alphabetic characters. NOTICE displays six characters per frame for one second per frame. BILBRD displays its characters by shifting them in one at a time from the right to the left at a shift rate of one shift every 0.4 seconds. MESSAGE/BBOARD call the same routine, the only difference being an internal test performed on the value of the command MESSAGE = 11 and BBOARD = 12 which determines how the data is presented. BRCHAR goes to DECODE on a GO key; goes to the other program on any other key NOTICE to BILBRD or BILBRD to NOTICE; or goes to the next step if no key is pressed. BRANCH goes to restart the program which causes the message to be repeated continuously until some key is pressed.

DAFFY The Daffy (Mastermind) Number Guessing Game

FILL clears the answer buffer. UNPACK is used to create an answer from the system timer. DECIN gets the users four digit decimal guess. MASTER is special code to evaluate the guess. It compares GUESS and ANSWER and if not a match, branches to BAD. On a perfect match it drops through to GOOD. The remainder of the program displays the number of guesses in a flashing mode on GOOD or the evaluation of the guess on BAD.

MESSAGE and BBOARD special functions.

The NOTICE program uses a special function MESSAGE to output the "canned" message six characters at a time. The BILBRD program uses a special function BBOARD to output the "canned" message one character at a time producing a moving message. Actually both MESSAGE and BBOARD are the same routine, differing only by a single internal test which causes the six or one character change in the display. Both functions are

called by entering at the MESSAGE entry point. The value of the Command is used to determine the particular function.

Notice and Billboard

LOC	OBJECT	LABEL	OPERATION	
190	A0 00	MESSAGE	LDY #00	Initialize start of message.
192	84 BB		STY PLACE	
194	A2 00	MORE	LDX #00	Get next character.
196	B1 B1	FETCH	LDA (PARAM1),Y	If character is minus, then end of message.
198	10 03		BPL OKAY	
19A	4C 04 03		JMP NXTSTP	
19D	95 C8	OKAY	STA DSPØ,X	Store character in display buffer. Bump pointers.
1A0	E8		INY	
			INX	
1A1	E0 06		CPX #6	Test six characters done. If not, get next.
1A3	D0 F1		BNE FETCH	
1A5	A5 BB		LDA PLACE	Get message place pointer.
1A7	A2 12		LDX #12	Test MESSAGE or BILBRD
1A9	E4 B0		CPX PARAMØ	If MESSAGE, then move place pointer forward six places.
1AB	F0 02		BEQ INCR	If BILBRD, then move one place.
1AD	69 05		ADC #5	
1AF	69 00	INCR	ADC #0	Save modified PLACE. Get Delay from PARAM3
1B1	85 BB		STA PLACE	
1B3	A5 B3		LDA PARAM3	
1B5	85 BE		STA PTEMPØ	
1B7	A9 64	SETIME	LDA #100.	Set 1/10 second timer.
1B9	85 BF		STA PTEMP1	
1BB	20 D9 17	WAIT	JSR EXSET	Wait 1 millisecond
1BE	C6 BF		DEC PTEMP1	Bump 1/10 second counter until zero.
1C0	D0 F9		BNE WAIT	Then bump Delay counter until zero.
1C2	C6 BE		DEC PTEMPØ	Now get next frame of the message.
1C4	D0 F1		BNE SETIME	
1C6	A4 BB		LDY PLACE	
1C8	10 CA		BPL MORE	

Message for Notice and Billboard

1CA	00 00 00 00 00 00	Blanks for Billboard
1D0	73 38 79 77 6D 79	PLEASE
1D6	00 39 77 37 00 30	CAN I
1DC	00 76 79 38 73 00	HELP
1E2	00 53 00 00 00 00	?
1E8	00 00 00 00 00 00	Trailing blanks
1EE	FF	Terminator

Daffy

LOC	OBJECT	LABEL	OPERATION	
130	20 83 03	MASTER	JSR DIRADR	
133	A6 B2		LDX PARAM2	Address of Guess
135	F6 05		INC 5,X	Bump Guesses Counter
137	A9 0A		LDA #0A	Test Units digit = 10.
139	D5 05		CMP 5,X	
13B	D0 06		BNE TEST	
13D	A9 00		LDA #0	Set Units = 0.
13F	95 05		STA 5,X	Incr Tens digit
141	F6 04		INC 4,X	
143	A9 00	TEST	LDA #0	Clear Evaluation
145	85 BE		STA PTEMPØ	Counters
147	85 BF		STA PTEMP1	
149	A0 03		LDY #3	Set Digit Counter
14B	B1 B4	PTEST	LDA (ADRLO),Y	Get a Guess Character
14D	D5 03		CMP 3,X	Test Correct Char.
14F	D0 02		BNE NOTPER	in Correct Location.
151	E6 BE		INC PTEMPØ	Bump Counter
153	CA	NOTPER	DEX	Test all four Guess
154	88		DEY	Characters.
155	10 F4		BPL PTEST	
157	A6 B2		LDX PARAM2	Test Correct without
159	A9 03		LDA #3	regard to position.
15B	85 D7		STA TEMP	
15D	A0 03	SETUP	LDY #3	
15F	B5 03	MATCH	LDA 3,X	Get Answer Digit
161	D1 B4		CMP (ADRLO),Y	Test Match
163	D0 08		BNE NMATCH	
165	A9 FF		LDA #FF	If Match, wipe out the
167	91 B4		STA (ADRLO),Y	Guess digit to prevent
169	E6 BF		INC PTEMP1	multiple matches.
16B	10 03		BPL NEXT	
16D	88	NMATCH	DEY	If No-match, keep trying
16E	10 EF		BPL MATCH	
170	CA	NEXT	DEX	Get next Answer digit
171	C6 D7		DEC TEMP	until all four done.
173	10 E8		BPL SETUP	
175	A0 04		LDY #4	Test Perfect Match on
177	C4 BE		CPY PTEMPØ	all four digits.
179	F0 04		BEQ DONE	If so, then done.
17B	A5 B3		LDA PARAM3	Else, use PARAM3 for next
17D	85 B7		STA STEPNO	Step Number.
17F	A5 BE	DONE	LDA PTEMPØ	Move Evaluation counters
181	91 B4		STA (ADRLO),Y	to Guess Buffer for
183	C8		INY	displaying.
184	A5 BF		LDA PTEMP1	
186	91 B4		STA (ADRLO),Y	
188	4C 04 03		JMP NXTSTP	

Program Module #2

LOC	OBJECT	STEP	LABEL	COMMAND	PARAM1	PARAM2	PARAM3
-----	--------	------	-------	---------	--------	--------	--------

Command Decoder

00	00E00005	Ø	DECODE	ALPIN	BUFFER	Ø	5
04	06E0DF01	1		PACK	BUFFER	KEYVAL	1
08	0BC80006	2		FILL	DISPLAY	Ø	6
0C	0ADCDF00	3		BRTABL	CMDTBL	KEYVAL	DECODE

Shooting Stars

10	10000000	4	STAR	START			
14	01E00303	5	NEXT	HEXIN	BUFFER	3	3
18	110B0E00	6		SHOT	LOSE	WIN	
1C	07E6E402	7	RUN	UNPACK	COUNT	BUFFER+4	2
20	04E00405	8		DECOUT	BUFFER	4	5
24	09130005	9	RWAIT	BRCHAR	GO	DECODE	NEXT
28	08090000	A		BRANCH	RWAIT		
2C	OBCC5302	B	LOSE	FILL	DISPLAY+4	"?"	2
30	09130004	C	WAIT	BRCHAR	GO	DECODE	STAR
34	080C0000	D		BRANCH	WAIT		
38	07E6E402	E	WIN	UNPACK	COUNT	BUFFER+4	2
3C	04E00405	F		DECOUT	BUFFER	4	5
40	080C0000	10		BRANCH	WAIT		

HILO Number Guessing Game

44	0BE6FF06	11	HILO	FILL	GUESS	FF	6
48	07C2E402	12		UNPACK	TENTHS	BUFFER+4	2
4C	09130015	13	WAIT	BRCHAR	GO	DECODE	READY
50	08130000	14		BRANCH	WAIT		
54	OBCC0002	15	READY	FILL	DISPLAY+4	Ø	2
58	02E60001	16		DECIN	GUESS	Ø	1
5C	0CE6E402	17		COMPARE	GUESS	BUFFER+4	2
60	081C0000	18		BRANCH	LOW		
64	081E0000	19		BRANCH	EQUAL		
68	036A0405	1A	HIGH	ALPOUT	HI	4	5
6C	08130607	1B		BRANCH	WAIT	"H	"I
70	03720405	1C	LOW	ALPOUT	LO	4	5
74	0813080A	1D		BRANCH	WAIT	"L	"0
78	04E00405	1E	EQUAL	DECOUT	BUFFER	4	5
7C	05012000	1F		TIMER	1	BLANK	
80	OBCC0002	20	BLANK	FILL	DISPLAY+4	Ø	2
84	05012200	21		TIMER	1	NEXT	
88	09130011	22	NEXT	BRCHAR	GO	DECODE	HILO
8C	081E0000	23		BRANCH	EQUAL		

Program Module #2

Notes and Comments

DECODE Command Decoder See page 29.

STAR Shooting Stars Puzzle

This is the puzzle described by Willard I Nico in the May 1976 issue of BYTE, and described and implemented by a number of other individuals since. START initializes the puzzle by setting up the initial star map, clearing the number of guesses counter, and so forth. HEXIN accepts a single input from the user and displays it in position 3 of the display. SHOT evaluates the user's shot. If the shot is invalid, that is it is not an existing star, then the display is changed to a question mark and the shot is not counted. If the shot is valid a complex table lookup is performed which produces the required changes in the galaxy. The result is then evaluated. If all stars have vanished the program branches to LOSE. If the winning position has been achieved the program branches to WIN. Otherwise the program continues at RUN. UNPACK and DECOUP are used to display the current shot count. BRCHAR and BRANCH are used to wait for the user to press either GO to give up and return to DECODE or to press any other key and go to NEXT for the next shot. LOSE uses FILL to put two question marks in the count field of the display to indicate the loss. WIN uses UNPACK and DECOUP to display the final shot count. Both WIN and LOSE go to WAIT and use BRCHAR and BRANCH to wait for a GO to return to DECODE or any other key to go to STAR and restart the game.

HILO High/Low Simple Number Guessing Game

FILL and UNPACK use the system timer to generate a two digit decimal value. WAIT uses BRCHAR and BRANCH to wait until the user presses any key to continue or GO to return to DECODE. READY uses FILL to clear the old message HI or LO and DECIN to get the new guess. COMPARE evaluates the guess and in conjunction with BRANCH goes to LOW, EQUAL, or HIGH. HIGH or LOW use ALPOUT to display the appropriate message and then BRANCH to WAIT. EQUAL uses the sequence of functions DECOUP, TIMER, FILL, TIMER, BRCHAR, and BRANCH to flash the correct answer until a GO is pressed for DECODE or any other key is pressed for another round of HILO.

SHOOTING STARS - Shot Map

LOC	SHOT	POS	GALAXY	CENTER
1C0	0	08	68	01
1C4	1	20	38	00
1C8	2	10	B0	01
1CC	4	40	49	00
1D0	5	00	E4	01
1D4	6	80	92	00
1D8	8	01	45	01
1DC	9	04	07	00
1E0	A	02	86	01

Shooting Stars

LOC	OBJECT	LABEL	OPERATION	
130	A9 00	START	LDA #0	Initialize Shooting Stars
132	85 E6		STA COUNT	Clear Shot Counter
134	85 E7		STA UNIV	Clear Universe
136	A9 01		LDA #1	Set Center Star
138	85 E8		STA CENTER	to be on
13A	10 47		BPL FIRST	Go Map Universe to Display
13C	A9 C0	SHOT	LDA #MAP	Shot Evaluation
13E	85 B4		STA ADRLO	Set ADRLO/ADRHI to
140	A9 01		LDA #1	point to Shot Map
142	85 B5		STA ADRHI	
144	A0 00		LDY #0	
146	A5 E3	SEARCH	LDA BUFFER+3	Get current shot value
148	D1 B4		CMP (ADRLO),Y	Test Shot Map match
14A	F0 0B		BEQ MATCH	Branch on match
14C	98		TYA	Else set for next position
14D	18		CLC	in Shot Map.
14E	69 04		ADC #4	Four bytes per entry
150	C9 24		CMP #36.	Test end of Shot Map
152	F0 20		BEQ NMATCH	for Invalid Shot
154	A8		TAY	Set to get next.
155	10 EF		BPL SEARCH	Continue Search
157	C8	MATCH	INY	Set for next byte
158	B1 B4		LDA (ADRLO),Y	Get POS from Shot Map
15A	F0 14		BEQ CTEST	Test Center
15C	25 E7		AND UNIV	Else mask to see if Star
15E	F0 14		BEQ NMATCH	exists. If not, invalid.
160	C8	FIX	INY	Set for next byte.
161	B1 B4		LDA (ADRLO),Y	Get GALAXY
163	45 E7		EOR UNIV	Exclusive OR to turn on/off
165	85 E7		STA UNIV	associated Stars.
167	C8		INY	Set for next byte.
168	B1 B4		LDA (ADRLO),Y	Get Center value
16A	45 E8		EOR CENTER	Exclusive OR
16C	85 E8		STA CENTER	
16E	10 0A		BPL SHOWIT	
170	A5 E8	CTEST	LDA CENTER	Test if Center Exists
172	D0 EC		BNE FIX	Okay if Center Exists
174	A9 53	NMATCH	LDA #53	Invalid Shot. Show a
176	85 CB		STA DSP3	Question Mark in Shot
178	10 41		BPL RUN	position of display.

Shooting Stars - continued

LOC	OBJECT	LABEL	OPERATION	
17A	F8	SHOWIT	SED	
17B	18		CLC	
17C	A9 01		LDA #01	Increment two digit Decimal Shot Counter
17E	65 E6		ADC COUNT	
180	85 E6		STA COUNT	
182	D8		CLD	
183	A9 49	FIRST	LDA #49	
185	25 E7		AND UNIV	Convert Universe to Display Segment Values
187	85 C8		STA DSPØ	First Position
189	A9 24	SECOND	LDA #24	
18B	25 E7		AND UNIV	Mask Second Position to calculate Segments
18D	4A		LSR	Shift for actual segment values
18E	4A		LSR	
18F	85 C9		STA DSP1	
191	A5 E8		LDA CENTER	Get Center value
193	F0 06		BEQ THIRD	Test on/off
195	A5 C9		LDA DSP1	ON so add in the
197	69 40		ADC #40	Center segment value
199	85 C9		STA DSP1	
19B	A9 92	THIRD	LDA #92	Mask Third Position
19D	25 E7		AND UNIV	and then shift into correct positions
19F	85 CA		STA DSP2	
1A1	46 CA		LSR DSP2	
1A3	A5 E7	TEST	LDA UNIV	Test Empty Universe
1A5	F0 08		BEQ TEST2	Maybe
1A7	C9 FF		CMP #FF	Test Win Position
1A9	D0 10		BNE RUN	No
1AB	A5 E8		LDA CENTER	Maybe. Win if Center
1AD	F0 08		BEQ WIN	position is OFF
1AF	A5 E8	TEST2	LDA CENTER	Empty or Win
1B1	D0 08		BNE RUN	Not if Center is ON
1B3	A5 B1	LOSE	LDA PARAM1	Empty Universe. LOSE.
1B5	10 02		BPL STEP	Use PARAM1 Step No.
1B7	A5 B2	WIN	LDA PARAM2	WIN. Use PARAM2.
1B9	85 B7	STEP	STA STEPNO	Save new Step No.
1BB	4C 04 03	RUN	JMP NXTSTP	

Program Module #3

LOC	OBJECT	STEP	LABEL	COMMAND	PARAM1	PARAM2	PARAM3
Command Decoder							
00	00E00005	Ø	DECODE	ALPIN	BUFFER	Ø	5
04	06E0DF01	1		PACK	BUFFER	KEYVAL	1
08	0BC80006	2		FILL	DISPLAY	Ø	6
0C	0ADCDF00	3		BRTABL	CMDTBL	KEYVAL	DECODE
Tipsy							
10	0BC80006	4	TIPSY	FILL	DISPLAY	Ø	6
14	09130007	5	PLUS	BRCHAR	GO	DECODE	READY
18	08050000	6		BRANCH	PLUS		
1C	0BE0FF06	7	READY	FILL	BUFFER	FF	6
20	07C2E004	8		UNPACK	TENTHS	BUFFER	4
24	04E00005	9		HEXOUT	BUFFER	Ø	5
28	05140B00	A		TIMER	20.	BLANK	
2C	0BC80004	B	BLANK	FILL	DISPLAY	Ø	4
30	050A0D00	C		TIMER	10.	ACCEPT	
34	0BCC4002	D	ACCEPT	FILL	DISPLAY+4	DASH	2
38	0BDB2001	E		FILL	CHAR	20	1
3C	0BC00004	F		FILL	THOUS	Ø	4
40	02E60003	10		DECIN	GUESS	Ø	3
44	0DE0E604	11		MATCH	BUFFER	GUESS	4
48	08180000	12		BRANCH	NO	Ø	Ø
4C	0D52C101	13	YES	MATCH	ZERO	TENS	1
50	08180000	14		BRANCH	NO	Ø	Ø
54	07C2E402	15		UNPACK	TENTHS	BUFFER+4	2
58	04E00405	16		DECOUT	BUFFER	4	5
5C	08050000	17		BRANCH	PLUS		
60	0BCC5302	18	NO	FILL	DISPLAY+4	"?"	2
64	08050000	19		BRANCH	PLUS		

TIPSY uses FILL, BRCHAR and BRANCH to clear the display and wait for the user to press GO to return to DECODE or any other key to start the test. READY uses FILL and UNPACK to generate a four digit decimal number from the system timer. HEXOUT and TIMER are used to display this number for two seconds. FILL and TIMER are then used to blank the display and wait for one second before accepting input. ACCEPT uses three FILL commands to: display two dashes as a signal that the user may give his input, clear any "premature" character that may have been input, and clear the system timer to be used as the ten second counter. The DECIN function is used to input the four digit guess. MATCH evaluates the guess and skips no steps if less than or greater than the actual value, where a BRANCH transfers control to NO. If the guess is correct, then one step is skipped and control goes to YES which uses another MATCH to determine if the amount of time taken to answer exceeded ten seconds. If less than ten seconds were used, then the time taken is displayed via UNPACK and DECOUT in tenths of a second. If the answer was wrong or took too long, then FILL is used to output two question marks to the display. Whether the answer was correct and in time or not, control returns to PLUS and another run can be started or control may be returned to DECODE.

Program Module #4

LOC	OBJECT	STEP	LABEL	COMMAND	PARAM1	PARAM2	PARAM3
-----	--------	------	-------	---------	--------	--------	--------

Command Decoder

00	00E00005	Ø	DECODE	ALPIN	BUFFER	Ø	5
04	06E0DF01	1		PACK	BUFFER	KEYVAL	1
08	0BC80006	2		FILL	DISPLAY	Ø	6
0C	0ADCDF00	3		BRTABL	CMDTBL	KEYVAL	DECODE

Decimal/Hexidecimal Conversion

10	02E00500	4	DEC	DECIN	BUFFER	5	Ø
14	10E0E606	5		DECHEX	BUFFER	DATA	6
18	080F0000	6		BRANCH	OVRFLO		
1C	07E6E006	7	SHOW	UNPACK	DATA	BUFFER	6
20	04E00005	8		HEXOUT	BUFFER	Ø	5
24	09130B04	9	WAIT	BRCHAR	GO	HEX	DEC
28	08090000	A		BRANCH	WAIT		
2C	01E00500	B	HEX	HEXIN	BUFFER	5	Ø
30	11E0E606	C		HEXDEC	BUFFER	DATA	6
34	080F0000	D		BRANCH	OVRFLO		
38	08070000	E		BRANCH	SHOW		
3C	0BC85306	F	OVRFLO	FILL	DISPLAY	"?"	6
40	08090000	10		BRANCH	WAIT		

DEC Decimal to Hexidecimal Conversion

HEX Hexidecimal to Decimal Conversion

DEC uses DECIN to input up to six digits in the shift mode, that is the digits enter from the rightmost digit position and are shifted left one position as each new digit is entered. The digit in the leftmost position is lost if another shift occurs. DECHEX is a special routine for doing most of the conversion work. It converts decimal values in BUFFER to hexidecimal values in DATA. The number of digits to be converted can be specified, and in this program is set to six. An overflow condition can not occur when converting from decimal to hexidecimal, but since the code for DECHEX and HEXDEC are basically identical and share most routines, the DECHEX has an overflow return = skip Ø steps. The only possible return from DECHEX is the normal return = skip 1 step. SHOW uses UNPACK and HEXOUT to convert the result to separate characters and output them to the display. WAIT uses BRCHAR and BRANCH to wait for the user to select HEX to decimal conversion by pressing GO or DEC to hexidecimal conversion by pressing any other key.

HEX uses HEXIN to input up to six digits in the shift mode as in DEC above. The special routine HEXDEC does the conversion. Since a six digit HEX value may convert to a seven digit decimal value, the possibility of an overflow occurring is real. An overflow will cause the next sequential step to be executed, which is a BRANCH to OVRFLO. OVRFLO fills the display with question marks and returns to WAIT. If there is no overflow, then the decimal result is displayed by SHOW. The maximum HEX value that can be handled is F423F, which equals 999999 decimal.

Hexidecimal Conversion Subroutine

LOC	OBJECT	LABEL	OPERATION	
130	A6 B2	HEXDEC	LDX PARAM2	Get Pointer to Answer Buffer
132	A9 00		LDA #Ø	Clear three bytes or six
134	95 00		STA Ø,X	digit positions
136	95 01		STA 1,X	
138	95 02		STA 2,X	
13A	A6 B1	NEXT	LDX PARAM1	Get Pointer to Input Buffer
13C	B5 00		LDA Ø,X	Get next character
13E	30 0D		BMI LZERO	Test leading blanks
140	A6 B2		LDX PARAM2	Get Pointer to Answer Buffer
142	A0 11		LDY #HEX	Test Hex to Dec or Dec To Hex
144	C4 B0		CPY PARAMØ	
146	F0 10		BEQ HX	Hex to Dec
148	20 75 01		JSR XTEN	Dec to Hex Subroutine
14B	B0 08		BCS OVRFLO	Branch on Overflow
14D	E6 B1	LZERO	INC PARAM1	Bump Pointer
14F	C6 B3		DEC PARAM3	Decrement No. Digits
150	DO E7		BNE NEXT	Get Next
153	E6 B7		INC STEPNO	Incr. Step No. for Normal
155	4C 04 03	OVRFLO	JMP NXTSTP	or Next Step for Overflow
158	C9 0A	HX	CMP #10.	Hex to Dec. Convert from
15A	30 02		BMI OKAY	Hex Character to BCD byte
15C	69 05		ADC #5	
15E	20 70 01	OKAY	JSR DSIXT	Hex to Dec Subroutine
161	B0 F2		BCS OVRFLO	Branch on Overflow
163	90 E8		BCC LZERO	Normal return

Command Table Format

The Command Decoder uses a Command Table for its determination of which Step to go to as a function of the Program name typed in. Only the first two characters of a Program name are used. They are packed into a single byte and then used in a BRTABL Function. Each entry in the Command Table consists of two bytes: the packed character byte and the Step Number. For example, SCLOCK or Set Clock has an entry of D2 04, where the D2 is the packed representation of SC (S = D on keypad, C = 2) and 04 is the Step Number of the start of the SCLOCK Program. The Command Table is usually found starting at location A0 and is terminated by a ØØ byte.

Function Table Format

The Interpreter looks up the absolute memory address of a Function in the Function Table. This consists of two bytes of address, low order then high order, for each function. The addresses are ordered by Function number, the first being ALPIN, ..., the last MATCH. The basic Function Table starts at location 100. The Special Function Table follows the same rules but starts at location 120.

Hexadecimal Conversion Subroutine

- Continued -

LOC	OBJECT	LABEL	OPERATION	
170	A0 10	DSIXT	LDY #16.	Set Counter for 16 loops
172	F8		SED	Set Decimal Mode
173	10 03		BPL COMMON	
175	A0 0A	XTEN	LDY #10.	Set Counter for 10 loops
177	D8		CLD	Set Binary Mode
178	85 D7	COMMON	STA TEMP	Store New Value
17A	18		CLC	Clear Carry
17B	A9 00		LDA #Ø	Clear Temporary bytes
17D	95 03		STA 3,X	
17F	95 04		STA 4,X	
181	95 05		STA 5,X	
183	B5 02	NTIMES	LDA 2,X	Shift old value by
185	75 05	LAST	ADC 5,X	adding to itself the
187	95 05		STA 5,X	required number of times
189	B5 01		LDA 1,X	16 for Hex
18B	75 04		ADC 4,X	10 for Decimal
18D	95 04		STA 4,X	Do addition for all three
18F	B5 00		LDA Ø,X	bytes worth of data
191	75 03		ADC 3,X	
193	95 03		STA 3,X	
195	B0 1D		BCS ERROR	Branch on Overflow
197	88		DEY	Decrement Loop Counter
198	30 0E		BMI DONE	When minus, then done
19A	D0 E7		BNE NTIMES	If no zero, keep looping
19C	A9 00		LDA #Ø	On zero, set up to add
19E	95 00		STA Ø,X	in the new value by
1A0	95 01		STA 1,X	clearing the old values
1A2	95 02		STA 2,X	and then pick up the
1A4	A5 D7		LDA TEMP	new value and make final
1A6	10 DD		BPL LAST	loop.
1A8	B5 05	DONE	LDA 5,X	Move result from Temp
1AA	95 02		STA 2,X	to Result bytes
1AC	B5 04		LDA 4,X	
1AE	95 01		STA 1,X	
1B0	B5 03		LDA 3,X	
1B2	95 00		STA Ø,X	
1B4	D8	ERROR	CLD	Clear Decimal Mode
1B5	60		RTS	Return

Program Module #5

LOC	OBJECT	STEP	LABEL	COMMAND	PARAM1	PARAM2	PARAM3
Command Decoder							
00	00E00005	Ø	DECODE	ALPIN	BUFFER	Ø	
04	06E0DF01	1		PACK	BUFFER	KEYVAL	5
08	0BC80006	2		FILL	DISPLAY	Ø	1
0C	0ADCDF00	3		BRTABL	CMDTBL	KEYVAL	6
							DECODE
Add and Subtract							
10	02E00500	4	ADDSUB	DEC IN	BUFFER	5	
14	06E0E603	5	NEW	PACK	BUFFER	AREG	Ø
18	02E00500	6	NEXT	DEC IN	BUFFER	5	3
1C	06E0E903	7		PACK	BUFFER	BREG	Ø
20	0A5EDF05	8		BRTABL	ASTABL	KEYVAL	3
24	10E6E9E6	9	ADD	DECADD	AREG	BREG	NEW
28	08120000	A		BRANCH	FLASH	AREG	AREG
2C	07E6E006	B	SHOW	UNPACK	AREG	BUFFER	6
30	04E00005	C		DECOUT	BUFFER	Ø	5
34	09130006	D	WAIT	BRCHAR	GO	DECODE	NEXT
38	080D0000	E		BRANCH	WAIT		
3C	11E6E9E6	F	SUB	DEC SUB	AREG	BREG	AREG
40	08120000	10		BRANCH	FLASH		
44	080B0000	11		BRANCH	SHOW		
48	05021300	12	FLASH	TIMER	2	BLANK	
4C	0BC80006	13	BLANK	FILL	DISPLAY	Ø	6
50	05021500	14		TIMER	2	WAIT2	
54	04E00005	15	WAIT2	DECOUT	BUFFER	Ø	5
58	09130004	16		BRCHAR	GO	DECODE	ADDSUB
5C	08126000	17		BRANCH	FLASH	ASTABL	ASTABH
60	1209110F	18	"+"	ADD	"DA"	SUB	
64	00000000	19		0			
Reaction Time Tester							
68	0913001C	1A	REACT	BRCHAR	GO	DECODE	START
6C	081A0000	1B		BRANCH	REACT	00	00
70	0BC83F06	1C	START	FILL	DISPLAY	"Ø"	6
74	0A9EC21D	1D	TEST	BRTABL	TTABLE	TENTHS	TEST
78	0BC80006	1E	HALT	FILL	DISPLAY	BLANK	6
7C	07C1E006	1F		UNPACK	TENS	BUFFER	6
80	06E0E603	20		PACK	BUFFER	AREG	3
84	09130023	21	WAIT	BRCHAR	GO	DECODE	STOP
88	08210000	22		BRANCH	WAIT		
8C	11C1E6E6	23	STOP	DEC SUB	TENS	AREG	AREG
90	011E0000	24		01	HALT	Ø	Ø
94	07E6E006	25		UNPACK	AREG	BUFFER	6
98	04E00005	26		DECOUT	BUFFER	Ø	5
9C	081A9000	27		BRANCH	REACT	TTABLO	TTABHI

ADDSUB Add and Subtract Decimal Numbers

ADDSUB permits a chained series of additions and/or subtractions to be made with up to six digit decimal numbers. One major restriction to be aware of: negative numbers and negative results are not permitted. ADDSUB uses DECIN to input the first decimal value in the shift mode, that is the current input digit appears in the rightmost display location and all previously input digits are shifted one position to the left with the leftmost digit being lost. The entire number may be erased by pressing the PC key. PACK converts the data from decimal characters to binary coded decimal BCD form two digits per byte. DECIN and PACK are then used to input the second value. BRTABL determines whether the operation is to be an Add or Subtract as a function of the key used to terminate the decimal input. A + terminator will cause a branch to the ADD Step. A DA key will cause a branch to the SUB Step. Any other terminator will cause the current input value to replace the old total and thereby start a new chain operation. ADD uses a special function DECADD to add the contents of the old total AREG to the new input value BREG and stores the result in buffer AREG. If the total exceeds 999999., the capacity of the display, then the next Step is executed which causes a BRANCH to FLASH which flashes the last input value to indicate an overflow condition. If there is no overflow, then one Step is skipped and control goes to SHOW. SHOW uses UNPACK to convert from BCD form to separate characters. DECOUP then converts the decimal characters to displayable form and displays them. WAIT uses BRCHAR to wait for a GO to return to DECODE or any other key to go to NEXT. SUB is handled in an identical fashion except that the function DECSUB is called to process the subtraction operation, and instead of overflow, the error will occur on the total going negative. FLASH is just a combination of FILL, TIMER, DECOUP and BRCHAR/BRANCH. The only real tricky part of ADDSUB is the location of the ASTABL used by the BRTABL command at Step 8. Since the BRTABL function permits the table to be anywhere in memory, it requires a Page Zero pair of bytes to specify the start of the table. In ADDSUB this byte pair is tacked on to the end of the BRANCH function in Step 17. Since BRANCH does not use Param2 or Param3 this is permissible. The table itself is in the following Step and is terminated by the zero in the next following Step.

REACT Reaction Time Tester

REACT uses BRCHAR and BRANCH to wait until the user is ready to start a test. FILL is used to put Ø characters in all positions of the display. Step TEST uses BRTABL to wait until the system clock has a Ø1 in the TENTHS position, by using a table located as Step 24 which has as its only valid value an Ø1. When TENTHS equals Ø1, control goes to Step HALT. FILL clears the display. UNPACK and PACK combine to move the current value of the system clock TENS, TENTHS, and MILLI into buffer AREG, in effect saving the time at the start of the test. WAIT uses BRCHAR and BRANCH to loop until a key is pressed. GO returns to the command decoder and any other key stops the clock. The elapsed time is calculated by subtracting the start time from the current time via DECSUB. UNPACK and DECOUP display the reaction time accurate to the millisecond. BRANCH resets to the start of REACT. Since there can be no negative result from the DECSUB, there can be no possibility of executing Step 24, the table.

DECIMAL ADD and HEXIDECLIMAL ADD

LOC	OBJECT	LABEL	OPERATION	
130	F8	DECADD	SED	Set Decimal Mode
131	18	HEXADD	CLC	Entry for Hex Add
132	A0 03		LDY #3	Service three bytes
134	A6 B1	NEXT	LDX PARAM1	Get A buffer digit
136	B5 02		LDA 2,X	
138	A6 B2		LDX PARAM2	Add to B buffer digit
13A	75 02		ADC 2,X	
13C	A6 B3		LDX PARAM3	Store in C buffer
13E	95 02		STA 2,X	
140	C6 B1		DEC PARAM1	Decrement buffer pointers
142	C6 B2		DEC PARAM2	
144	C6 B3		DEC PARAM3	
146	88		DEY	Decrement byte counter
147	D0 EB		BNE NEXT	Continue if not zero
149	D8		CLD	Clear Decimal Mode
14A	B0 02		BCS RETURN	Test Carry
14C	E6 B7		INC STEPNO	Skip one Step on Normal
14E	4C 04 03	RETURN	JMP NXTSTP	Next Step on Overflow

DECIMAL SUBSTRACT and HEXIDECLIMAL SUBSTRACT

LOC	OBJECT	LABEL	OPERATION	
151	F8	DECSUB	SED	Set Decimal Mode
152	38	HEXSUB	SEC	Entry for Hex Subtract
153	A0 03		LDY #3	Service three bytes
155	A6 B1	NEXT	LDX PARAM1	Get A buffer digit
157	B5 02		LDA 2,X	
159	A6 B2		LDX PARAM2	Subtract B buffer digit
15B	F5 02		SBC 2,X	
15D	A6 B3		LDX PARAM3	Store in C buffer
15F	95 02		STA 2,X	
161	C6 B1		DEC PARAM1	Decrement buffer pointers
163	C6 B2		DEC PARAM2	
165	C6 B3		DEC PARAM3	
167	88		DEY	Decrement byte counter
168	D0 EB		BNE NEXT	Continue if not zero
16A	D8		CLD	Clear Decimal Mode
16B	90 02		BCC RETURN	Test Borrow
16D	E6 B7		INC STEPNO	Skip one Step if no borrow
16F	4C 04 03	RETURN	JMP NXTSTP	Next Step if borrow

HEX DUMP of Program Module #1

0000:	00 E0 00 05 06 E0 DF 01 0B C8 00 06 0A DC DF 00	0200: F8 A2 03 18 B5 C0 69 01 95 C0 90 2D E0 03 D0 26
0010:	02 E0 00 05 06 E0 C4 03 07 C4 E0 06 04 E0 00 05	0210: C6 C7 D0 22 18 B5 C3 69 01 C9 60 D0 07 A9 00 95
0020:	09 13 00 04 08 06 00 00 02 E0 05 00 06 E0 C1 03	0220: C3 CA 10 F0 E0 01 D0 06 C9 24 D0 02 A9 00 95 C3
0030:	07 C1 E0 06 04 E0 00 05 09 13 00 0A 08 0C 00 00	0230: A2 03 A9 0A 85 C7 CA 10 CA D6 60 A6 B1 B5 00 0A
0040:	11 D0 01 0A 09 13 00 13 08 01 00 00 12 CA 01 04	0240: OA OA 0A 15 01 90 06 B5 01 10 02 A9 00 A6 B2 95
0050:	09 13 00 10 08 13 00 00 0B E0 00 06 07 C1 E0 04	0250: 00 E6 B1 B6 B2 C6 B3 D0 E0 F0 32 A6 B1 B5
0060:	02 E6 00 03 10 E6 E0 20 04 E0 00 05 05 02 1C 00	0260: 00 4A
0070:	0B CC 00 02 05 01 1E 00 09 13 00 16 08 1A 00 00	0270: B1 A9 0F 35 00 A6 B2 95 00 E6 B2 E6 B1 C0 B3 D0
0080:	04 E6 04 05 09 13 00 18 08 21 00 00 00 00 00 00	0280: DC F0 OC A2 D4 D0 02 A2 D2 20 83 03 20 A9 05 4C
0090:	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00	0290: 04 03 A6 DB A9 20 85 DB E0 20 F0 F3 A5 B2 B4 B1
00A0:	D2 04 32 06 DE OA 3E OC 30 16 9A 10 11 13 00 00	02A0: F0 02 A5 B3 10 5C A5 B1 10 58 A9 0A 85 BE A9 04
00B0:	11 D0 01 0A A0 00 00 11 40 00 90 1E 00 01 04 54	02B0: 85 BF 20 D9 17 C6 BF D0 F9 C6 BE D0 F1 C0 B1 D0
00C0:	02 55 82 04 12 18 53 09 00 00 00 00 00 C8 00	02C0: E9 A5 B2 10 3D 20 83 03 A6 B2 A0 00 B5 00 58 D1
00D0:	F0 03 E7 1F F0 03 D4 05 10 03 02 20 A0 00 15 11	02D0: B4 F0 0E B0 OA A9 0D C5 B0 F0 04 E6 B7 E6 B7 10
00E0:	01 01 FF FF FF FF FF FF 04 04 00 00 89	02E0: 23 E8 C8 C4 B3 D0 E5 F0 F4 20 83 03 A5 B2 A4 B3
00F0:	02 00 FF 02 09 FF 12 CA 00 80 17 17 04 00 01	02F0: 88 91 B4 88 10 FB 30 OC 00 00 00 00 00 00 00 00 00
0100:	04 01 34 04 00 34 04 00 34 04 00 34 04 00 34 04 00	0300: A9 00 85 B7 20 D9 17 A5 B7 OA 0A 85 B6 A0 05 B1
0110:	04 00 34 04 00 34 04 00 34 04 00 34 04 00 34 04 00	0310: B8 99 B0 00 88 10 F8 E6 57 OA 8D 20 03 EA EA 6C
0120:	00 34 04 00 34 04 00 34 04 00 34 04 00 34 04 00 34 00	0320: 00 01 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0130:	34 04 00 34 04 00 34 04 00 34 04 00 34 04 00 34 04 00	0330: 10 D0 02 A9 OA A2 D2 86 D6 85 D8 20 85 05 20 97
0140:	04 00 34 04 00 34 04 00 34 04 00 34 04 00 34 04 00	0340: 03 A5 B2 85 DA 10 03 20 D0 03 A6 D6 20 A9 05 20
0150:	00 34 04 00 34 04 00 34 04 00 34 04 00 34 04 00 34 00	0350: D9 17 A5 DB A2 20 86 DB C9 14 F0 E2 10 EC C5 D8
0160:	34 04 00 34 04 00 34 04 00 34 04 00 34 04 00 34 04 00	0360: 30 E5 85 DF 10 9E 20 8C 03 A6 B2 A0 00 E5 00 D1
0170:	04 00 34 04 00 34 04 00 34 04 00 34 04 00 34 04 00	0370: B4 F0 OA C8 B1 B4 D0 F4 A5 B3 10 85 C0 B1 B4
0180:	00 34 04 00 34 04 00 34 04 00 34 04 00 34 04 00 34 00	0380: 10 F9 00 A5 B1 85 B4 A9 00 85 B5 60 A6 B1 B5 00
0190:	34 04 00 34 04 00 34 04 00 34 04 00 34 04 00 34 04 00	0390: 85 B4 B5 01 85 B5 60 A9 FF A2 06 86 D7 A4 B2 04
01A0:	04 00 34 04 00 34 04 00 34 04 00 34 04 00 34 04 00 34 04	03A0: DA 20 D0 03 C6 D7 D0 F9 60 B5 00 85 D0 B5 01 B5
01B0:	00 34 04 00 34 04 00 34 04 00 34 04 00 34 04 00 34 00	03B0: D1 A4 B2 84 D7 B1 B4 10 04 A9 00 F0 03 A6 B1 D0
01C0:	34 04 00 34 04 00 34 04 00 34 04 00 34 04 00 34 04 00	03C0: A4 D7 91 CE C4 B3 F0 27 30 03 86 10 E6 00 10 E3
01D0:	04 00 34 04 00 34 04 00 34 04 00 34 04 00 34 04 00 34 04	03D0: AA A4 B3 C4 B2 30 OA C4 DA 30 14 A4 DA E6 DA 10
01E0:	00 34 04 00 34 04 00 34 04 00 34 04 00 34 04 00 34 04 00	03E0: OC C8 B1 B4 88 91 B4 C6 C4 B2 30 F5 OA 91 E4 00
01F0:	34 04 00 34 04 00 34 04 00 34 04 00 34 04 00 34 04 00 34 04	03F0: 77 7C 58 5E 79 71 76 30 38 54 5C 75 50 0D 70 0C

PLEASE Function Summary

Code	Command	Param1	Param2	Param3	Page
00	ALPIN	Buffer	Start	End	14
01	HEXIN	Address	Display	Display	14
02	DECIN	Page Zero	Position	Position	14
03	ALPOUT	Buffer	Start	End	20
04	HEXOUT	Address	Display	Display	20
04	DECOUT	Page Zero	Position	Position	20
05	TIMER	Delay Time	Step Number		21
06	PACK	Source	Destination	Number of	22
07	UNPACK	Buffer	Buffer	Bytes	23
		Page Zero	Page Zero		
08	BRANCH	Step Number			24
09	BRCHAR	Character to Match on	Step Number if Match	Step Number if Non-match	24
0A	BRTABL	Table Address Indirect	Value Address Page Zero	Non-Match Step Number	25
0B	FILL	Memory Address	Fill Value	Number of Bytes	26
0C	COMPAR	First String	Second String	Number of	26
0D	MATCH	Page Zero	Page Zero	Bytes in String	26

Some Important Numbers

00A0	PLEASE Command Table - two bytes per entry
00B0	Current Command Function Number
00B1	Current Param1
00B2	Current Param2
00B3	Current Param3
00EF	KIM - Program Counter - Low Order Byte
00F0	KIM - Program Counter - High Order Byte
00F1	KIM - Status Register
00F2	KIM - Stack Pointer
00F3	KIM - Accumulator
00F4	KIM - Y-Index Register
00F5	KIM - X-Index Register
0100	PLEASE Standard Function Table
0120	PLEASE Special Functions Table
617/256-3649	Where to call if a real problem occurs.