



CS - 87

**CASSETTE INTERFACE
ASSEMBLY
AND
USING MANUAL**

PS-87 PARTS LIST

Prior to beginning assembly, check the supplied parts against the following parts list.

QUANTITY

1	8:500 Transformer
1	.1 mfd. mylar capacitor
1	16 pin IC socket
1	8 pin IC socket
1	1702A (POTSHOT) PROM
1	4042 Integrated Circuit
1	24 pin IC socket
1	8 pin header
1	TIL-209 LED
1	27K resistor (red-violet-orange)
1	3.3K resistor (orange-orange-red)
1	12 inch length of 4 conductor ribbon cable
2	1K resistor (brown-black-red)
2	10K resistor (brown-black-orange)
2	100K resistor (brown-black-yellow)
2	2N5139 transistors
2	miniature phone plug

If you should find any parts missing, damaged, or otherwise unusable, contact PAIA Electronics, Tech. Services for replacement. Along with your request, we must have the packer number from the parts bag, and the order number under which this kit was ordered.

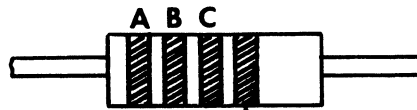
The parts that constitute the CS-87 cassette interface option fit entirely on the 8700 Computer/Controller board.

CS-87 ASSEMBLY

Install the following components on a PROPERLY OPERATING 8700 Computer Controller circuit board. DO NOT proceed with the assembly of this option until the 8700 has been fully verified as being operational. Remove all power and peripheral connectors from the 8700 before proceeding with the CS-87 installation.

All of the DOs and DON'Ts that were mentioned in the assembly manual for the 8700 apply here also.

Begin assembly by installing the following resistors:



Silver or gold - disregard this band.

PART NUMBER	VALUE	COLOR CODE A-B-C
() R4	3300 ohms	orange-orange-red
() R46, R47 (2 parts)	100K	brown-black-yellow
() R48	1000 ohms	brown-black-red
() R49, R50 (2 parts)	10K	brown-black-orange
() R51	1000 ohms	brown-black-red
() R52	27K	red-violet-orange

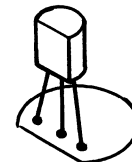
Install the single ceramic disk (or in some kits, mylar) capacitor

- () C10 0.1 mfd.



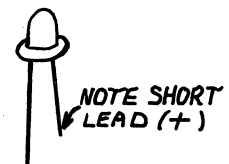
There are two 2N5139 transistors which are used for relay drivers in conjunction with the POTSHOT Cassette system tape motion control software. Install these transistors now.

- () Q8, Q9 (2 parts) 2N5139



The single Light Emitting Diode provides an indication that data is coming into the computer from the cassette player. Orientation of the LED is keyed by the length of the two leads, the short lead is the cathode and should be installed in the circuit board hole marked +. When installing the LED, leave it as high above the surface of the board as possible so that it will be visible above the displays in the cut-out provided in the 8700 Keyboard circuit board. When installing, leave the lead of the LED as long as possible for maximum visibility.

- () D2 TIL-209 Light Emitting Diode



The 500:8 interstage transformer provides coupling between the cassette recorders output and the computer's output. NOTE that while a solder pad is provided for the center tap on the primary side of this transformer, there are no connections to the pad and this lead may be clipped off if desired. NOTE ALSO that some transformers may have three leads coming from both sides. On these devices, the primary side of the transformer is marked with a "P" (which on some transformers comes out nothing more than a black smudge). The leads coming from this side of the transformer are to be installed in the circuit board holes closest to the edge of the board and the center leads may be clipped from both sides of these transformers.

- () T1 500:8 interstage transformer

Install the following sockets at the positions indicated. As with the 8700, observe the polarity notches of the sockets.

- () 24 pin socket at IC 18
- () 16 pin socket at IC 20
- () 8 pin socket at J9

Install the 2 IC's in their sockets. WARNING CMOS PARTS. Leave these parts in their conductive foam carrier until ready to install, do not wear synthetic clothing during installation. Observe orientation notches during installation.

- () IC 18..... 1702A POT-SHOT Cassette PROM
- () IC 20..... 4042 quad latch

A piezo-electric transducer is part of the CS-87, which produces an audible "beep" providing positive indication of keyboard activations. The software required to drive the beeper is included in the PIEBUG monitor program. THE BEEPER IS NOT REQUIRED FOR POT-SHOT OPERATION.

Depending on the final installation of the 8700 system, the beeper may be mounted either on the 8700 board as illustrated shortly, or, for maximum volume, may be mounted on a sounding surface external to the computer.

If you elect to mount the beeper on the 8700 board, proceed as follows:

- () Solder the wire connected to the center silver colored disc of the transducer to the top end of resistor R46 as shown in figure 2 . Be careful not to short adjacent conductors during soldering.

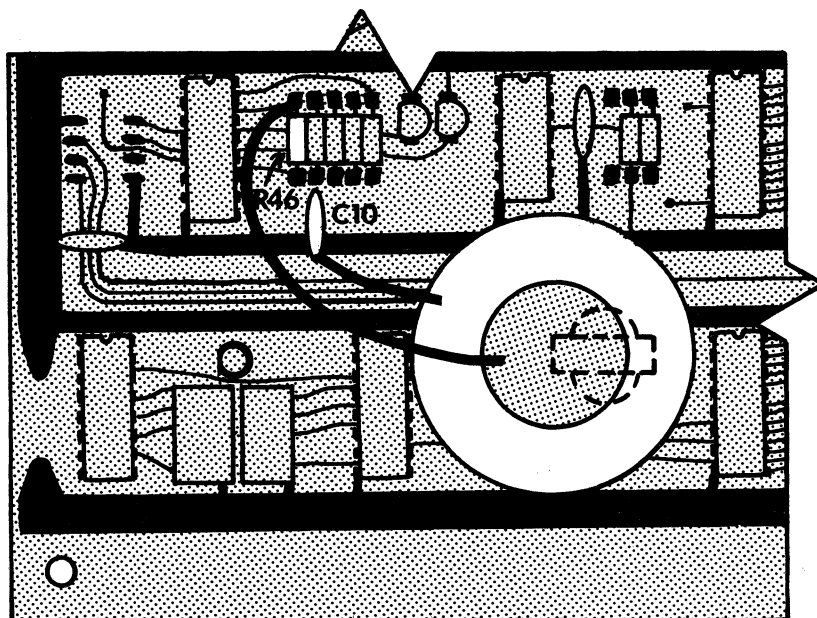


FIGURE 2

() Solder the wire coming from the copper outer disk of the transducer to the ground conductor at the bottom of C10.

() Thoroughly clean the back of the beeper and the top of the transformer T1 and using contact cement or other adhesive mount the beeper to the transformer as shown in figure 3 . NOTE that the beeper mounts off-center on the transformer.

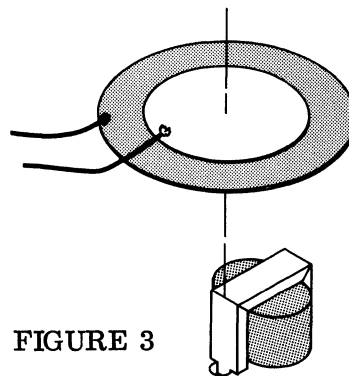


FIGURE 3

THIS COMPLETES INSTALLATION OF COMPONENTS ON THE 8700 CIRCUIT BOARD. We are now ready to prepare connecting cables.

The header to which the cables connect is somewhat fragile and can also be damaged by excessive soldering temperatures.

Because of the variety of configurations and user-options available, pre-assembled cables are not supplied for the cassette interface.

While wires are being soldered to the header, some sort of vise must be used to serve both as heat sink and to hold the pins rigid. If a vise with small enough jaws is not available, one may be rigged from a pair of needle-nosed pliers held closed by wrapping a rubber band around the handles. PROVIDING SOME SORT OF MECHANICAL SUPPORT AND HEAT SINK IS ESSENTIAL. Do not attempt the following assembly steps without this.

ALSO, proper preparation of both wires and header will simplify assembly. Pre-tin the header pins before soldering the wire in place (note that only the "U" shaped part of the pin to which the wire will attach need be tinned - do not tin the portion of the pin which will mate with the socket).

Prepare the ends of the wire which are to be soldered to the header pin by stripping approximately 1/4" of insulation from its end, tightly twisting the exposed strands, tinning by heating the strands and flowing a small amount of solder into them, and, finally, by clipping the now-tinned exposed wire so that only 1/8" extends beyond the end of the insulation.

() Prepare one end of the 4 conductor ribbon cable by first separating the four conductors into two pairs. Cut 1/4" from the end of one of the two pairs. Separate into two pairs of conductors and remove 1/4" from the length of one pair. Separate the ribbon into four conductors and strip 1/4" of insulation from the end of each of the leads. Tightly twist and tin the exposed conductors. Finally, clip the 4 exposed, tinned conductors so that only 1/16" extends beyond the ends of the insulation. Snip

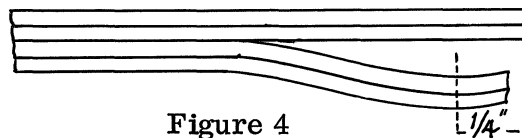


Figure 4

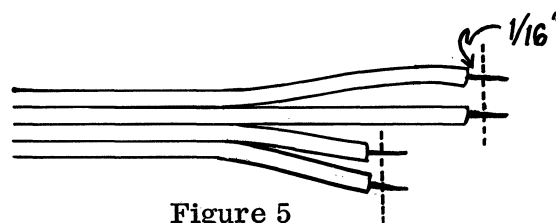


Figure 5

1/4" of insulation from the end of each of the conductors. Twist tightly and tin. After tinning, cut so that 1/16" of twisted conductor extends beyond insulation.

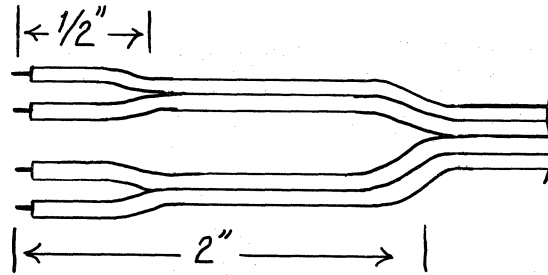


Figure 6

() While pins 1-4 of the cassette connector header are being held in a vise, solder the two shorter leads prepared above to pins 3 and 4 of the header.

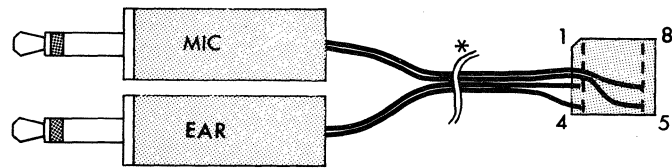


Figure 7

() Similarly, while holding pins 5-8 in a vise, solder the longer leads prepared above to pins 5 and 6.

The length of ribbon cable supplied with the CS-87 option is intentionally longer than will be required for most applications. Trim the length of the cable as required before installing the miniature phone jacks.

() Separate the free end of the ribbon cable into two pairs of conductors. About 2 inches of separation will be sufficient in most cases. Further separate the two pairs into individual conductors (about 1/2" separation) and strip 1/4" of insulation from each end wire before twisting and tinning the exposed strands.

() Locate the two miniature phone plugs supplied, unscrew the cover from one and slip the cover over the end of the pair of wires coming from header pins 3 and 4, (the threaded end of the cover should be toward the free end of the cable.) Solder one of the two wires to the short soldering lug of the plug and the other to the ground frame. (Polarity is not important here). Screw the plug cover back in place. This plug should be labeled "EAR".

() Unscrew the cover of the second phone jack and slide it over the remaining two conductors of the cable. Solder the wire coming from pin 6 of the header to the soldering lug of the phone plug and the wire coming from pin 5 of the header to the ground frame of the plug. OBSERVE POLARITY. Screw the plug cover back in place. This plug should be labeled "mic".

() Mate the cassette connector header with the socket J9 on the 8700 board (observe orientation - if assembled as above, the cables will naturally exit the connector over the nearest edge of the 8700 board).

THIS COMPLETES ASSEMBLY OF THE CS-87 CASSETTE INTERFACE SYSTEM.
Re-connect the power supply and keyboard for an initial testing sequence to follow, but do not yet totally re-assemble the computer.

Testing and Familiarization

RECORDER SELECTION

The CS-87 "POT-SHOT" cassette option has been carefully designed to reliably save and retrieve programs and data using extremely inexpensive, low-fidelity, audio recording equipment. While the Phillips format cassettes have proven to be exceptionally convenient because of their size and ease of storing and handling, any recording scheme (even reel-to-reel) can be used with equally predictable results, though perhaps more hassle.

The only hard and fast requirements of the recorder selected are that it have ready access to external input sources (mic and/or aux. inputs) and some provision for a high level output (ear and/or ext. spkr. jacks). The presence or absence of an Automatic Level Control circuit is immaterial to the operation of the system. A "remote" input jack capable of starting and stopping the recorder will be handy if you think you may be adding the optional tape motion control relays at a later date.

We highly recommend the Realistic CTR-34 recorder sold by Radio-Shack for a number of reasons including low cost, convenient size and ready availability.

TAPE SELECTION

Consideration should be given to the kind of tape you will use for storing digital programs. A problem known to magnetic tape media as "dropout" can scrub your programs. Dropout causes the signal on tape to fade away for very brief periods of time and is caused by fluctuations in the thickness of the iron oxide coating on the tape. This is a problem that can go unnoticed when recording voice or music but the loss of one bit of data is fatal when trying to load a program into your computer. Therefore you should find a brand of tape that is reliable and stick with it. Also dropout is always a problem with any tape at the very front of the tape where it is connected to the leader. Avoid this area by skipping the first 15 or 30 seconds of the tape before saving the first program on that cassette.

TESTING

Connect the cassette connectors "mic" plug to your recorders "mic" (first choice) or "aux" (second choice) input jacks and the "ear" plug to the "ear" or "ext spkr" jacks. Apply power to the 8700 Computer/Controller and verify that nothing has happened during installation of the interface system to change the normal operating characteristics of the processor. Since we will be initially testing the system by storing and then retrieving the counting demo program from the 8700 Assembly and Using Manual, entry and execution of this program is a reasonable vehicle for accomplishing this initial important test. Load this program from the keyboard and verify that it runs properly.

DEMO COUNTING PROGRAM

ADDR	CODE	LABEL	INSTRUCTION	COMMENTS
0000	A9 00	BEGIN	LDA #0	;CLEAR ACCUMULATOR
0002	8D 20 08	REPEAT	STA \$0820	;DISPLAY ACC
0005	A0 00		LDY #0	;CLR Y
0007	A2 50		LDX #\$50	;SPEED SETTING (IN HEX)
0009	C8	LOOP	INY	;DELAY LOOP
000A	D0 FD		BNE LOOP	;BRANCH UNTIL Y=0
000C	CA		DEX	;CHECK SPEED
000D	D0 FA		BNE LOOP	;BRANCH UNTIL X=0
000F	F8		SED	;SET DECIMAL MODE
0010	18		CLC	;CLR CARRY
0011	69 01		ADC #1	;ADD 1 TO ACC
0013	4C 02 00		JMP REPEAT	;DO IT ALL AGAIN

SAVING AND LOADING PROGRAMS

Before performing tape operations, there is some information that the computer needs to successfully complete these tasks:

- 1) The beginning address of the program or data to be saved or loaded.
(4 hexadecimal digits; two bytes)
- 2) The ending address of the block of data that is to be saved or loaded.
(4 hexadecimal digits; two bytes)
- 3) A file identifier number (2 hex digits; one byte)
- 4) A one byte (2 hex digits) indicator for either a load operation (11) or a dump operation (DD).

All of this information is entered as a continuous string of digits from the processor keyboard. THE ENTER KEY IS NEVER USED WHILE KEYING IN THIS INFORMATION.

Using the counting program (which you should have entered by now) as an example; this program begins at location \$0000 and ends at location \$0015 (the second byte of the operand for the JUMP at location \$13). Our first 8 entries from the keyboard will, therefore, be;

BEG. ADDR. END ADDR.

0-0-0-0-0-0-1-5

display shows: 15

Any file identifier number may be assigned to this file (except 00 which has special significance as we will see shortly). Since this is our first file on the tape, we will assign it number 01. Your next two keystrokes will be;

ID

0-1

display shows: 01

The final entry will be the LOAD/DUMP "switch". In this case, for a dump from the computer to the tape recorder, DD (think of the D as meaning Dump). Your next two keystrokes

DUMP
D-D

display shows: dd

If you made any mistakes while keying in the preceding information you have no choice but to begin again and key in the whole sequence;

BEG. ADDR. END ADDR. ID DUMP
0-0-0-0-0-0-1-5-0-1-D-D

When the preceding data has been entered correctly, you are ready to perform the dump. Put your recorder in the "record" mode and start the tape rolling. Allow about a ten second interval (see TAPE SELECTION) and press the 8700's TAPE control key.

A number of things will happen now. Simultaneously the display should clear to 00 and the beeper should begin to produce a constant tone (which is the leader and synchronization bits). After about three seconds of this tone, its sound should change slightly (as data begins to flow out) and the displays should begin counting, showing the low byte of the address of the data currently being transferred.

It will only take a second or two for the program to dump and when finished the displays will once again clear to 00 and the tone from the beeper should stop.

The program is now stored on tape and if you wish you may rewind the tape, put the recorder in "play" mode and listen to the tone that was recorded on the tape (it should sound very similar to what you heard through the beeper). Be sure to unplug the "ear" jack if you want to listen to the tape - and plug it back in when ready to load a program.

THE BIG TEST

Now we are ready to find out if it worked. Wipe out the program in the memory of the computer by temporarily disrupting power. Restore power and RESET.

Before loading the program for the first time, the playback level of the recorder must be set. With many tape interfaces this is a hit-or-miss proposition, but POT-SHOT provides the level indicating LED D2 (directly above the displays) for this purpose.

Turn your recorders volume control up fully and begin playing the tape. When the program is found the level-LED should begin to glow brightly. (residual clicks and pops on the tape may cause the LED to wink briefly - this should not affect the operation of the system). When sustained glow is observed, quickly (since you have only a few seconds of actual material recorded on tape) reduce the level of the volume control until you see a slight decrease in the brightness of the LED. This should be the proper playback level.

Loading programs follows the same format as did the dump with a continuous string of keyboard entries indicating beginning address, ending address, ID number and LOAD/DUMP switch.

The first 8 entries, beginning and ending address;

BEG. ADDR. END ADDR.

0-0-0-0-0-0-1-5

display shows: 15

The next two entries, ID#;

0-1

display shows: 01

and finally the LOAD "switch"; think of the 1's as L's - as in LOAD.

L5

1-1

display shows: 11

As with the dumping procedure, if you make any mistakes in entering this data you have no alternative but to begin again and enter the entire sequence;

BEG. ADDR. END ADDR. ID LOAD

0-0-0-0-0-0-1-5 0-1-1-1

Rewind, put your recorder in the "play mode, start the tape rolling and touch the 8700's TAPE key. You should immediately hear an artoo-type "bleep" from the beeper (it will sound different from the normal key-stroke beep) and the display should clear to 00.

When the leader and synch tone of the information recorded on tape is found, the single level LED will begin to glow continuously and after a few seconds the displays will begin to count. The counting will continue for a few seconds after which one of three things will happen:

- 1) The level LED will extinguish, the beeper will beep and the displays will show "AA". If this happens you're in good shape - the AA indicates "A-OK", a good load. You may now verify that the program is back by keying in its beginning address and RUNning it.

~~-otherwise-~~

- 2) The level LED will extinguish, the beeper will sound and the displays will show EE, an Error. This is a check sum error and it may mean that a transient (probably on the tape itself) prevented the data being entered back into the computer properly. You may try varying the volume control setting of the recorder and trying again.
NOTE - when POT-SHOT announces an error it is in most cases not necessary to enter all of the addresses, identifiers, etc. again. These are saved in the memory of the computer and it is only necessary to re-wind the tape and try again by touching the TAPE key. The exception is when any other keyboard entries other than TAPE are made before trying to load again.
- 3) A third possibility is that the level LED will extinguish and everything will simply stop with no beep and the displays showing some apparently random number. This indicates that the computer does not realize that it should be finished and is still looking for more data. This is a strong indication that improper keyboard entries were made either during preparation for the dump or the load. Try again and if still no luck try Dumping the program again (which at this point must unfortunately be loaded from the keyboard).

SUMMARY

LOAD

Entry Sequence: $\begin{array}{ccccccc} & & & & \text{IDENTIFIER} & & \\ & & & & | & & \\ \text{BEGINNING} & \text{ENDING} & & & & & \\ \text{ADDRESS} & \text{ADDRESS} & & & \text{LOAD} & & \\ \hline \text{x-x-x-x} & \text{y-y-y-y} & \text{z-z} & \text{1-1} & \text{TAPE} & & \end{array}$

- 1) Keyboard entries of beginning and ending addresses must each be 4 digits, short addresses not allowed.
- 2) ENTER key not used during entry sequence.
- 3) $\emptyset\emptyset$ identifier causes first file encountered to be loaded.
- 4) AA - displayed at end of load indicates OK
EE - displayed at end of load indicates check sum error.
- 5) If you have a file on tape of which the end address is not known, it can be determined with the following method:
 - 01) Load the file as normal but with an end address of "FFFF".
 - 02) Hit RESET when the displays stop counting.
 - 03) Examine the pointer with the pointer keys (PCH, PCL).
 - 04) Subtract 2 from the pointer (in HEX) and that will be the end address.

DUMP

Entry Sequence: $\begin{array}{ccccccc} \text{BEG. ADDR.} & \text{END ADDR.} & \text{IDENT.} & \text{DUMP} & & & \\ \hline \text{x-x-x-x} & \text{y-y-y-y} & \text{z-z} & \text{D-D} & \text{TAPE} & & \end{array}$

- 1) Keyboard entries of beginning and ending addresses must each be 4 digits, short addresses not allowed.
- 2) ENTER key not used during entry sequence.
- 3) $\emptyset\emptyset$ identifier NOT ALLOWED.

TAPE MOTION CONTROL

(if used)

Manual control sequence:

0-0-TAPE

Recorder will remain activated until next keyboard entry.

ZERO PAGE LOCATIONS

PIEBUG BUFFER

F0	DUMP/LOAD/MAN SWITCH (tested for zero, bit 7)
F1	IDENTIFIER
F2	LSB END ADDR.
F3	MSB END ADDR.
F4	LSB BEG ADDR.
F5	MSB BEG ADDR.
F6	LSB POINTER
F7	MSB POINTER

POT-SHOT

Monitor Listing

```

0150 0200      ;
0160 0200      ;
0170 0200      ;
0180 0200      ; *****
0190 0200      ; *
0200 0200      ; * POT-SHOT CASSETTE SYSTEM *
0210 0200      ; * WRITTEN BY ROGER WALTON *
0220 0200      ; * COPYRIGHT 1977 BY PAIA *
0230 0200      ; * ELECTRONICS, INC. *
0240 0200      ; * VERSION 1.0 *
0250 0200      ; *
0260 0200      ; *****
0270 0200      ;
0280 0200      PORT      = $0900      ; CASSETTE I/O PORT
0290 0200      DISPLY    = $0820      ; LED DISPLAY
0300 0200      PIEBUG    = $0F52      ; DISP ACC; GOTO PIEBUG
0310 0200      BEEP      = $0F22      ; BEEP SUB IN PIEBUG
0320 0200      ;
0330 0200      STATUS    = $EF        ; INPUT BIT STATUS
0340 0200      CHKSUM    = $EE        ; CHECKSUM
0350 0200      PNTER     = $F6        ; 16 BIT ADDR POINTER
0360 0200      COMAND    = $F0        ; LOAD/DUMP COMMAND
0370 0200      IDENT     = $F1        ; FILE IDENTIFIER
0380 0200      ENDADR    = $F2        ; END ADDR
0390 0200      BEGADR    = $F4        ; BEGINNING ADDR
0400 0200      ;
0410 0200      ;          * = $0E00
0420 0E00      ;
0430 0E00 20 25 0E  START    JSR SNDBIT      ; START TAPE
0440 0E03 8C 20 08      STY DISPLY      ; CLEAR DISPLAY
0450 0E06 A5 F4          LDA BEGADR      ; MOVE BEGINNING
0460 0E08 85 F6          STA PNTER      ; ADDR TO POINTER
0470 0E0A A5 F5          LDA BEGADR+1
0480 0E0C 85 F7          STA PNTER+1
0490 0E0E A5 F0          LDA COMAND      ; GET COMMAND
0500 0E10 F0 07          BEQ MANUAL      ; BR IF COMMAND= "00"
0510 0E12 20 AA 0E      JSR CASS      ; DUMP OR LOAD BLOCK
0520 0E15 18            CLC
0530 0E16 20 22 0F      JSR BEEP      ; STOP TAPE AND BEEP
0540 0E19 4C 52 0F      MANUAL JMP PIEBUG  ; RETURN TO MONITOR
0550 0E1C      ;
0560 0E1C      ;
0570 0E1C      ;
0580 0E1C      ; DELAY SUBROUTINE
0590 0E1C      ; THIS SUB DELAYS FOR ONE HALF CYCLE
0600 0E1C      ; (2000 HZ). Y IS CLEARED, X, A, AND
0610 0E1C      ; CARRY ARE PRESERVED.
0620 0E1C      ;

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0630 0E1C 8D 00 09      DELAY STA PORT      ;UPDATE TONE
0640 0E1F A0 0F          LDY #15
0650 0E21 88            DLY   DEY
0660 0E22 D0 FD          BNE DLY             ;BR UNTIL DELAY FINISHED
0670 0E24 60            RTS                  ;RETURN
0680 0E25              ;
0690 0E25              ;
0700 0E25              ;
0710 0E25              ;   SEND BIT SUBROUTINE
0720 0E25              ;   THIS SUB SENDS THE CARRY BIT TO THE TAPE.
0730 0E25              ;   A "1" BIT CONSISTS OF 16 CYCLES OF 2000 HZ
0740 0E25              ;   AND A "0" BIT CONSISTS OF 8.  THIS SUB
0750 0E25              ;   TURNS RELAY 1 ON AND RELAY 2 OFF.  Y IS
0760 0E25              ;   CLEARED, X, A, AND CARRY ARE PRESERVED.
0770 0E25              ;
0780 0E25 48          SNDBIT PHA          ;SAVE A
0790 0E26 8A          TXA
0800 0E27 48          PHA          ;SAVE X
0810 0E28 A2 10          LDX #16          ;NO. OF CYCLES FOR A "1"
0820 0E2A B0 02          BCS CYCLE        ;BRANCH IF "1" BIT
0830 0E2C A2 08          LDX #8          ;NO. OF CYCLES FOR A "0"
0840 0E2E A9 B0          CYCLE LDA #%10110000    ;TAPE ON; OUTPUT HIGH
0850 0E30 20 1C 0E      JSR DELAY        ;UPDATE PORT AND DELAY
0860 0E33 A9 80          LDA #%10000000   ;TAPE ON; OUTPUT LOW
0870 0E35 20 1C 0E      JSR DELAY        ;UPDATE PORT AND DELAY
0880 0E38 CA            DEX              ;LAST CYCLE?
0890 0E39 D0 F3          BNE CYCLE        ;BRANCH IF NOT
0900 0E3B A9 90          LDA #%10010000   ;TAPE ON; OUTPUT NEUTRAL
0910 0E3D A2 10          LDX #16          ;DELAY COUNTER
0920 0E3F 20 1C 0E      GAP   JSR DELAY    ;PRODUCE A GAP
0930 0E42 CA            DEX              ;DELAY FINISHED?
0940 0E43 D0 FA          BNE GAP          ;BRANCH IF NOT
0950 0E45 68            PLA
0960 0E46 AA            TAX          ;RESTORE X
0970 0E47 68            PLA          ;RESTORE A
0980 0E48 60            RTS          ;RETURN
0990 0E49              ;
1000 0E49              ;
1010 0E49              ;
1020 0E49              ;   DETECT BIT SUBROUTINE
1030 0E49              ;   THIS SUB WILL PICK UP ONE BIT FROM
1040 0E49              ;   THE TAPE AND RETURN WITH IT IN THE
1050 0E49              ;   CARRY FLAG.  Y IS CLOBBERED, X AND A
1060 0E49              ;   ARE PRESERVED.  RELAYS ARE NOT AFFECTED.
1070 0E49              ;
1080 0E49 48          DETBIT PHA          ;SAVE A
1090 0E4A 8A          TXA
1100 0E4B 48          PHA          ;SAVE X
1110 0E4C AD 00 09      TONE  LDA PORT      ;LOOK FOR START OF TONE
1120 0E4F 10 FB          BPL TONE        ;BRANCH UNTIL FOUND
1130 0E51 A2 00          LDX #0          ;CLEAR COUNTER
1140 0E53 E8            COUNT INX          ;COUNT TRANSITIONS
1150 0E54 A0 23          LDY #35         ;TIME LIMIT
1160 0E56 AD 00 09      LDA PORT        ;CHECK INPUT
1170 0E59 85 EF          STA STATUS      ;SAVE INPUT STATUS
1180 0E5B AD 00 09      CHECK LDA PORT      ;CHECK INPUT

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1190 0E5E 45 EF      EOR STATUS      ;HAS IT SWITCHED?
1200 0E60 30 F1      BMI COUNT       ;IF SO, BRANCH
1210 0E62 88         DEY             ;TIME UP?
1220 0E63 D0 F6      BNE CHECK       ;IF NOT, BRANCH
1230 0E65 E0 08      CPX #8         ;DOES TONE BURST QUALIFY?
1240 0E67 90 E3      BCC TONE        ;BRANCH IF NOT
1250 0E69 E0 18      CPX #24        ;SEC IF "1"; CLC IF "0"
1260 0E6B 68         PLA
1270 0E6C AA         TAX             ;RESTORE X
1280 0E6D 68         PLA             ;RESTORE A
1290 0E6E 60         RTS            ;RETURN
1300 0E6F           ;
1310 0E6F           ;
1320 0E6F           ;
1330 0E6F           ; SEND BYTE SUBROUTINE
1340 0E6F           ; THIS SUB SENDS THE BYTE CONTAINED
1350 0E6F           ; IN THE ACC TO THE TAPE ALONG WITH
1360 0E6F           ; A START BIT AND ONE STOP BIT. X AND
1370 0E6F           ; Y ARE CLEARED, A IS PRESERVED,
1380 0E6F           ; CARRY IS SET. RELAY 1 IS TURNED ON,
1390 0E6F           ; RELAY 2 IS TURNED OFF.
1400 0E6F           ;
1410 0E6F 18         SNDBYT CLC
1420 0E70 20 25 OE   JSR SNDBIT      ;SEND START BIT
1430 0E73 A2 09      LDX #9         ;SET BIT COUNTER TO 9
1440 0E75 38         SEC             ;SET STOP BIT
1450 0E76 2A         NEXT1 ROL A     ;MOVE BIT TO CARRY
1460 0E77 20 25 OE   JSR SNDBIT      ;SEND IT
1470 0E7A CA         DEX             ;LAST BIT?
1480 0E7B D0 F9      BNE NEXT1      ;BRANCH IF NOT
1490 0E7D 60         RTS            ;RETURN
1500 0E7E           ;
1510 0E7E           ;
1520 0E7E           ;
1530 0E7E           ; GET BYTE SUBROUTINE
1540 0E7E           ; THIS SUB WILL PICK UP A BYTE FROM
1550 0E7E           ; TAPE AND RETURN IT IN THE ACC.
1560 0E7E           ; X AND Y ARE CLEARED, CARRY CONTAINS
1570 0E7E           ; THE STOP BIT. RELAYS ARE NOT AFFECTED.
1580 0E7E           ;
1590 0E7E 20 49 OE   GETBYT JSR DETBIT    ;LOOK FOR START BIT
1600 0E81 B0 FB      BCS GETBYT     ;BRANCH UNTIL FOUND
1610 0E83 A2 09      LDX #9         ;SET BIT COUNTER TO 9
1620 0E85 2A         NEXT2 ROL A     ;MOVE BIT TO ACC
1630 0E86 20 49 OE   JSR DETBIT     ;GET NEXT BIT
1640 0E89 CA         DEX             ;LAST BIT?
1650 0E8A D0 F9      BNE NEXT2      ;BRANCH IF NOT
1660 0E8C 60         RTS            ;RETURN

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1670 OE8D      ;
1680 OE8D      ;
1690 OE8D      ;
1700 OE8D      ; CHECK ADDRESS SUBROUTINE
1710 OE8D      ; THIS SUB COMPARES THE POINTER TO
1720 OE8D      ; THE END ADDRESS AND SETS THE CARRY
1730 OE8D      ; IF THEY ARE THE SAME. IF THEY ARE
1740 OE8D      ; NOT, THE CARRY IS CLEARED AND POINTER
1750 OE8D      ; IS INCREMENTED. IT ALSO ADDS THE
1760 OE8D      ; CONTENTS OF THE ACC TO THE CHECKSUM
1770 OE8D      ; AND DISPLAYS THE LOW BYTE OF POINTER.
1780 OE8D      ; A IS MUTILATED, X AND Y ARE PRESERVED.
1790 OE8D      ; RELAYS ARE NOT AFFECTED.
1800 OE8D      ;
1810 OE8D      D8      CHKADD CLD
1820 OE8E      18      CLC
1830 OE8F      65 EE    ADC CHKSUM      ;UPDATE CHECKSUM
1840 OE91      85 EE    STA CHKSUM      ;SAVE IT
1850 OE93      A5 F6    LDA PNTER      ;GET POINTER LOW
1860 OE95      8D 20 08 STA DISPLY     ;DISPLAY IT
1870 OE98      C5 F2    CMP ENDADR     ;CMP WITH END ADDR LOW
1880 OE9A      D0 06    BNE INCPTR     ;BRANCH IF NOT EQUAL
1890 OE9C      A5 F7    LDA PNTER+1     ;GET POINTER HIGH
1900 OE9E      C5 F3    CMP ENDADR+1    ;CMP WITH END ADDR HIGH
1910 OEA0      F0 07    BEQ RET         ;BRANCH AND SEC IF SAME
1920 OEA2      E6 F6    INCPTR INC PNTER   ;INC LOW BYTE
1930 OEA4      D0 02    BNE SKIP2      ;BRANCH IF NO CARRY
1940 OEA6      E6 F7    INC PNTER+1     ;INC HIGH BYTE
1950 OEA8      18      SKIP2 CLC
1960 OEA9      60      RET          RTS      ;RETURN
1970 OEAA      ;
1980 OEAA      ;
1990 OEAA      ;
2000 OEAA      ;
2010 OEAA      10 21    CASS      BPL LOAD      ;BR IF COMMAND= "LOAD"
2020 OEAC      ;
2030 OEAC      ;
2040 OEAC      ;
2050 OEAC      ; DUMP BLOCK SUBROUTINE
2060 OEAC      ; THIS SUB TRANSFERS A BLOCK OF MEMORY
2070 OEAC      ; TO TAPE. BEGINNING OF THE BLOCK IS
2080 OEAC      ; SPECIFIED WITH "PNTER", END OF THE
2090 OEAC      ; BLOCK WITH "ENDADR", AND BLOCK
2100 OEAC      ; IDENTIFICATION WITH "IDENT". A
2110 OEAC      ; CHECKSUM IS SENT AT THE END OF
2120 OEAC      ; THE BLOCK. A, X, AND Y ARE CLEARED,
2130 OEAC      ; CARRY IS SET. RELAY 1 IS TURNED ON,
2140 OEAC      ; RELAY 2 IS TURNED OFF.
2150 OEAC      ;
2160 OEAC      A2 FF    DUMP      LDX #255     ;SET UP BIT COUNTER
2170 OEAE      38      NEXT3     SEC         ;"1" BIT
2180 OEAF      20 25 OE JSR SNDBIT    ;SEND LEADER
2190 OEB2      CA      DEX         ;FINISHED?
2200 OEB3      D0 F9    BNE NEXT3     ;BRANCH IF NOT
2210 OEB5      ;
2220 OEB5      86 EE    STX CHKSUM    ;CLEAR CHECKSUM
2230 OEB7      A5 F1    LDA IDENT     ;GET IDENTIFIER

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2240 OEB9 20 6F 0E      JSR SNDBYT      ;SEND IT
2250 OEBC                ;
2260 OEBC A1 F6        NEXT4 LDA (PNTER,X)    ;GET BYTE
2270 OEBC 20 6F 0E    JSR SNDBYT      ;SEND IT
2280 OEC1 20 8D 0E    JSR CHKADD     ;LAST BYTE?
2290 OEC4 90 F6        BCC NEXT4        ;BRANCH IF NOT
2300 OEC6                ;
2310 OEC6 A5 EE        LDA CHKSUM     ;GET CHECKSUM
2320 OEC8 20 6F 0E    JSR SNDBYT      ;SEND IT
2330 OECB 8A           TXA             ;CLEAR ACC
2340 OECC 60           RTS             ;RETURN
2350 OECD                ;
2360 OECD                ;
2370 OECD                ;
2380 OECD                ;
2390 OECD                ;
2400 OECD                ;
2410 OECD                ;
2420 OECD                ;
2430 OECD                ;
2440 OECD                ;
2450 OECD                ;
2460 OECD                ;
2470 OECD                ;
2480 OECD                ;
2490 OECD                ;
2500 OECD                ;
2510 OECD A2 14        LOAD   LDX #20      ;SEARCH FOR LEADER
2520 OECF 20 49 0E    LOOP   JSR DETBIT    ;GET A BIT
2530 OED2 90 F9        BCC LOAD     ;START OVER IF "0" BIT
2540 OED4 CA          DEX             ;20 BITS YET?
2550 OED5 D0 F8        BNE LOOP     ;BRANCH IF NOT
2560 OED7 20 7E 0E    JSR GETBYT    ;GET IDENTIFIER FROM TAPE
2570 OEDA 8D 20 08    STA DISPLY    ;DISPLAY IT
2580 OEDD A4 F1        LDY IDENT     ;GET DESIRED ID
2590 OEDF F0 04        BEQ SKIP3    ;SKIP COMPARISON IF ID=00
2600 OEE1 C5 F1        CMP IDENT     ;CORRECT ID?
2610 OEE3 D0 E8        BNE LOAD     ;START OVER IF NOT
2620 OEE5 86 EE        SKIP3  STX CHKSUM    ;CLEAR CHECKSUM
2630 OEE7                ;
2640 OEE7 20 7E 0E    NEXT5  JSR GETBYT    ;GET A BYTE
2650 OEEA 90 10        BCC ERROR    ;BRANCH IF STOP BIT=0
2660 OEEC 81 F6        STA (PNTER,X) ;STORE BYTE BY POINTER
2670 OEED 20 8D 0E    JSR CHKADD     ;LAST BYTE?
2680 OEEF 90 F4        BCC NEXT5    ;IF NOT, GET NEXT BYTE
2690 OEEF                ;
2700 OEEF 20 7E 0E    JSR GETBYT    ;GET CHECKSUM
2710 OEF6 A0 AA        LDY #$AA     ;A-OK MESSAGE
2720 OEF8 C5 EE        CMP CHKSUM    ;IS CHECKSUM OK?
2730 OEF9 F0 02        BEQ SKIP4    ;SKIP ERROR MESSAGE IF SO
2740 OEFB A0 EE        ERROR  LDY #$EE     ;ERROR MESSAGE
2750 OEFE 98          SKIP4  TYA             ;XFER MESSAGE TO ACC
2760 OEFF 60           RTS             ;RETURN
2770 OF00                ;
2780 OF00                ;
2790 OF00                ;
2800 OF00                ;
                                END
                                .END

```

ERRORS = 0000

SYMBOL TABLE

MANUAL	0E19	CASS	0EAA	CYCLE	0E2E	INCPTR	0EA2
RET	0EA9	SKIP2	0EA8	LOAD	0ECD	SKIP3	0EE5
ERROR	0EFC	SKIP4	0EFE	SNDBIT	0E25	PORT	0900
DISPLY	0820	PIEBUG	0F52	BEEP	0F22	STATUS	00EF
CHKSUM	00EE	PNTER	00F6	COMAND	00F0	IDENT	00F1
ENDADR	00F2	BEGADR	00F4	START	0E00	DELAY	0E1C
DLY	0E21	GAP	0E3F	DETBIT	0E49	TONE	0E4C
COUNT	0E53	CHECK	0E5B	SNDBYT	0E6F	NEXT1	0E76
GETBYT	0E7E	NEXT2	0E85	CHKADD	0E8D	DUMP	0EAC
NEXT3	0EAE	NEXT4	0EBC	LOOP	0ECF	NEXT5	0EE7
END	0F00						

TAPE MOTION CONTROLS

One of the more unique features of the CS-87 POT-SHOT cassette interface system is the built-in hardware and software provision for relays to control tape motion. The relays are to be supplied by the user and it should be understood that when used with simple cassette recorders only start and stop control is possible.

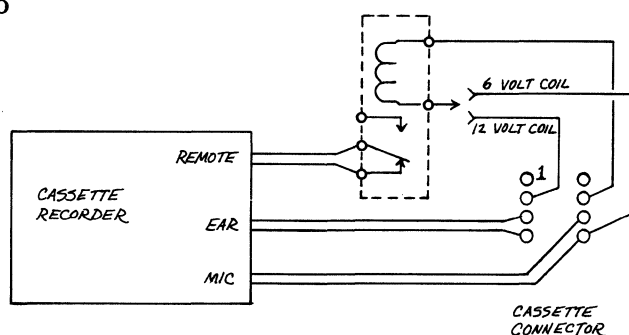
THE RELAYS

Almost any small relays having either 6 volt or 12 volt coils may be used with the tape motion control, with the following two restrictions:

- 1) The coils should pull no more than 20 ma. of current when activated.
- 2) The relay must have a set of NORMALLY CLOSED contacts.

As shown in the accompanying illustration, relays with 6 volt coils are to be connected between GND (pin 5) and the appropriate relay control pin of the cassette connector header (pin 7 for relay 1 and pin 8 for relay 2).

Relays with 12 volt coils are connected between the appropriate relay control pin of the cassette connector header and its -9 volt supply point (pin 2).



NOTE that the Normally Closed contacts of the relay are used to control the recorder (so that the recorder will be operational when power to the computer is off).

THE SOFTWARE

The normal operating software for the CS-87 POT-SHOT cassette system controls relay #1 only (except that relay #2 is initialized as being off both by PIEBUG and POT-SHOT's SNDBIT subroutine).

Relay #1 is automatically turned on at the beginning of LOADs and DUMPs and turned off when the tape operation is complete.

To facilitate fast forward and rewind operations of the recorder, a bypass function over the normal operating sequence of the relays has been provided. This by-pass is activated by entering $\emptyset\emptyset$ from the 8700 keyboard followed by touching the TAPE control pad. This operation turns relay #1 on and leaves it on until any key of the 8700 keyboard is touched, at which time the relay is de-activated.

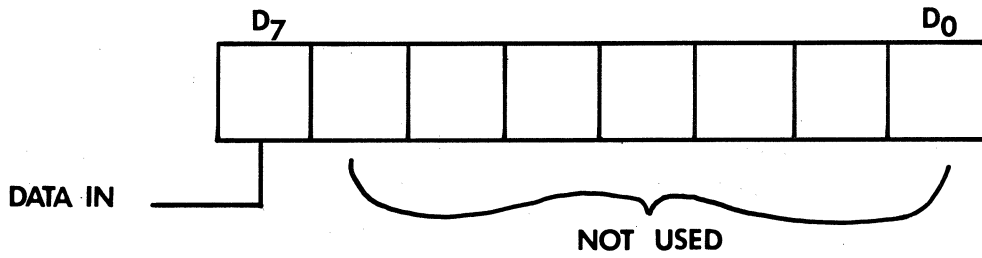
POT-SHOT TAPE FORMAT

POT-SHOT uses a technique that was first described in the September 1975 issue of Popular Electronics as the "HIT" System (Hobbyist Interchange Tape System). The technique is one that uses tone bursts to represent bits on the tape. However, the format has been changed to gain greater reliability. A "0" bit is represented as 8 cycles of 2000 Hz. and a "1" bit is 16 cycles of 2000 Hz. The dead space between bits is a constant 4 milliseconds (same amount of time as a "0" bit takes). We found this technique and format to be the most tolerant of speed variations and distortion produced by the cassette recorder.

The format of a file on tape is as follows: First there is a 3 second leader tone that consists of 255 "1" bits. This leader serves three purposes; it gives the tape recorder time to come up to the speed, the automatic level control time to stabilize (if the recorder has one), and identifies the start of a file. Next the file identifier byte is sent. Then the actual file is sent starting with the byte specified by "BEGINNING ADDRESS" and continuing to the byte specified by "END ADDRESS". After the file, a one byte checksum is put on tape to ensure data integrity when the file is loaded back into the computer.

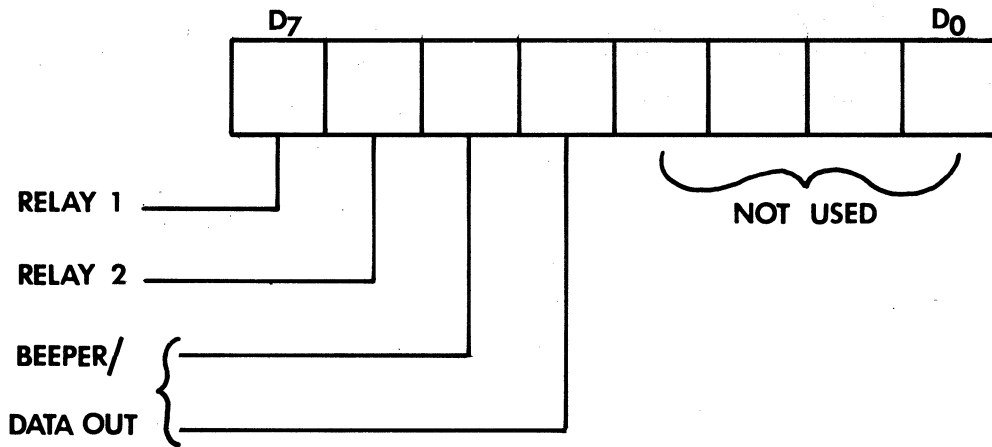
CASSETTE INPUT PORT

ADDRESS-F900



CASSETTE OUTPUT PORT

ADDRESS-F900



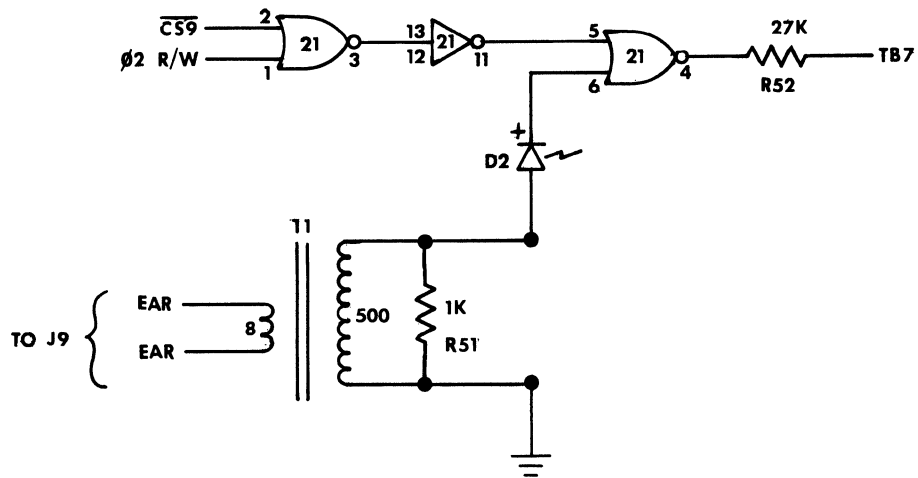
CASSETTE CONNECTOR

J9

- | | |
|---------------------|-------------|
| +5 - ○ ¹ | ○ - RELAY 2 |
| -9 - ○ | ○ - RELAY 1 |
| EAR - ○ | ○ - MIC |
| EAR - ○ | ○ - GND |

Schematics

CASSETTE INPUT PORT



CASSETTE OUTPUT PORT

