This booklet contains information for advanced programmers who want to modify the keypad handler program or create their own program to read data from the keypad. The *ATARI® CX85™ Numerical Keypad Owner's Guide* contains additional information with which you should be familiar.

Modifying the Keypad Handler Program

The diskette that came with this package contains a keypad handler program which is written with the ATARI Macro Assembler AMAC. You can modify or rewrite this program with the Program-Text Editor. When your modifications are complete, reassemble the code with AMAC using a unique filename.

Hardware Notes:

Keypad Interface and Timing

The keypad uses eight signals on the controller port. Positive 5 volts (+5 v) is on pin 7, and signal ground on pin 8. A 5-bit binary code is presented on pins 1 through 5, corresponding to the signals FWD, BACK, LEFT, RIGHT and BPOT. A data valid signal, presented on pin 6, corresponds to TRIGGER. TRIGGER goes low to indicate a valid code.

Timing is as follows:

- With no key pressed, the code for the previously pressed key remains on pins 1 through 5 and TRIGGER remains high (logic 1 or True).
- When a key is pressed, the TRIGGER signal goes low (logic 0 or False) and the keycode for that key is established on pins 1 through 5.
- TRIGGER stays low as long as the key remains pressed. When the key is released, TRIGGER returns high but the keycode does not change.
- Two-key rollover handles simultaneous or multiple keystrokes. If one or more additional keys are pressed while the first key is still pressed, nothing happens; the additional keys are locked out. When the first key is released, TRIGGER goes high and the scanning electronics searches for the next active key in the sequence. TRIGGER then goes low and the new keycode is presented.

After the system receives the TRIGGER signal there is a slight delay before BPOT data is valid. This can be compensated for by inserting a delay in your program. Details about this timing difference are provided on page 5.

Software Notes

Signals generated by the keypad electronics are delivered to specific registers in your computer's memory through the joystick port. The keypad makes use of registers normally used for both joystick and paddle controllers. The sequence in which your program reads these signals and the operations your program performs on the signals are both important factors. TRIGGER must be read first to see if a key has been pressed. If a key has been pressed, it must be decoded. Four bits of the 5-bit keycode are sent to the joystick registers and the fifth bit is read through the paddle (BPOT) register. These bits must be manipulated and logically combined for your program to know which key has been pressed. Once the keypad key has been decoded, it can be associated with any key on the keyboard, or any operation for which your keypad handler is designed.

Controller Port Selection

The handler program, as written, allows the keypad to work only through joystick port 2. However, it can be rewritten to allow the keypad to work through any one of the four controller ports. You'll have to modify the handler to use alternate registers or write those registers into a new program to recognize the port.

Determining a Keypress

To determine if a key has been pressed, your program must read the OS shadow for the joystick controller port to which the keypad is connected.

For port 1 read STRIG0 ($284).

For port 2 read STRIG1 ($285).

For port 3 read STRIG2 ($286).

For port 4 read STRIG3 ($287).

Only the least significant bit is used (bit 0). If a key has been pressed, the LSB will contain a zero (0). If the bit contains a one (1) no key has been pressed. The remaining seven bits will contain zeroes.

Decoding Keys

Once the STRIG value has been read and a data-valid signal exists, the incoming 5-bit code must be decoded. To do this, you must read the hardware registers, not the OS shadows. Read the joystick byte first.

Registers PORTA ($D300) and PORTB ($D301) pick up the first four incoming bits (see Figures 1 and 2). Depending on which port is selected, the bits will come into positions 1 through 4 (bits 0-3), or positions 5 through 8 (bits 4-7). They must be shifted to bits 0 through 3, and bits 4 through 7 must be forced to zero.

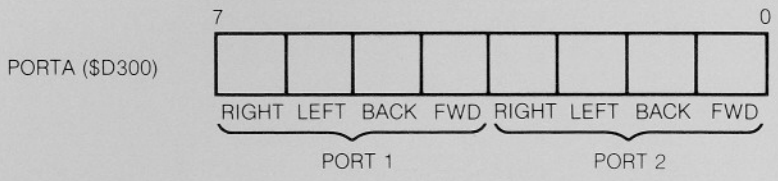


Figure 1

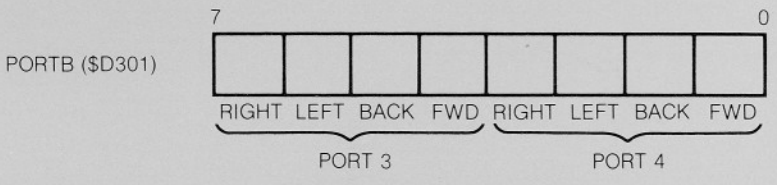


Figure 2

Note: All shifting and masking operations must be done in the accumulator—do not use memory address shift instructions.

BPOT is extracted from ALLPOT ($D208)—see Figure 3. All bits in the byte, except the bit for the desired port, must be forced to zero. The chosen BPOT bit must be complemented and shifted so that it's in the fifth position (bit 4).

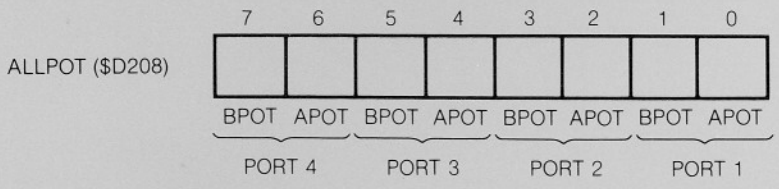


Figure 3

Finally, a logical OR must be used to integrate the BPOT value and the values of the joystick operation. The resultant binary value, represented in Figure 4, can be decoded from the truth table on pages 6-7.

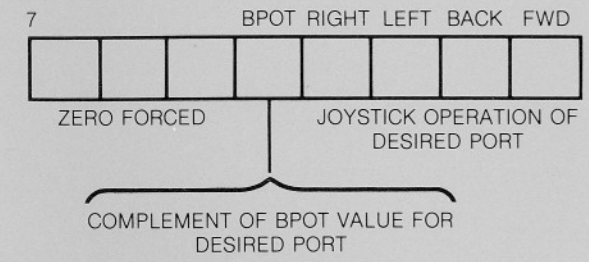


Figure 4

Timing Differences Between TRIGGER and BPOT

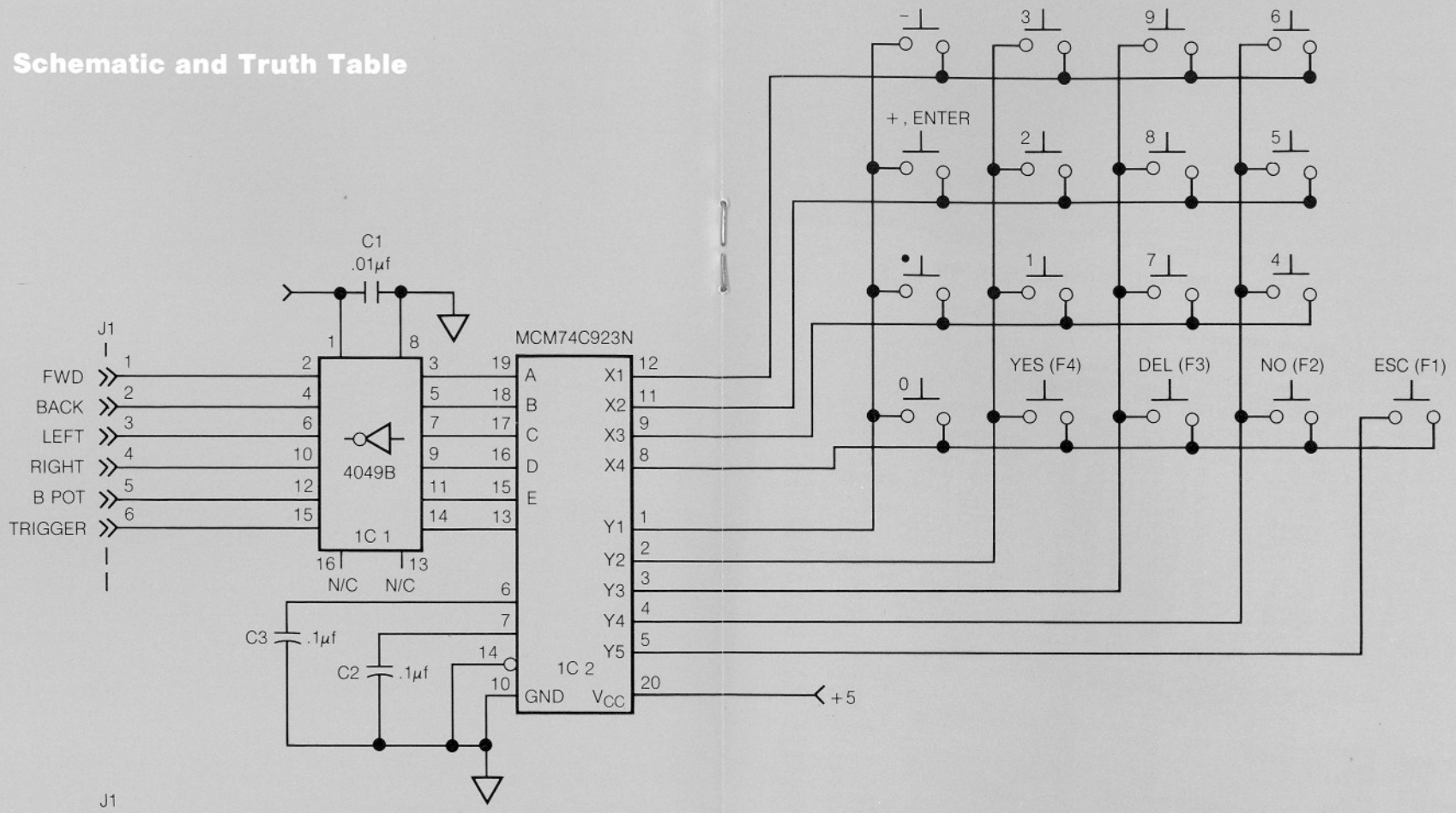
The BPOT value is input to POKEY through a resistor-capacitor delay circuit in your computer. The TRIGGER signal indicating a new keypress occurs instantly, while the BPOT signal might be delayed up to 150 microseconds. Insert an intentional delay in your program to compensate for this time difference—150 microseconds corresponds to approximately 150 NOPs—or insert a loop decrementing a register from 30 to zero.

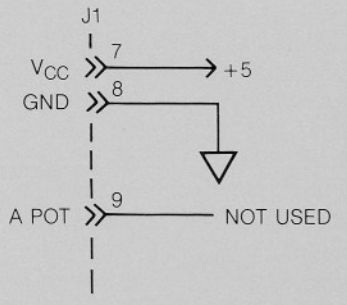
Appending to DOS II

To use the serial ports on your ATARI 850™ Interface Module and load the keypad handler at the same time, you must append KEYPAD.OBJ to the end of the DOS II AUTORUN.SYS file. The interface module is booted automatically with the AUTORUN.SYS file. If you append the keypad handler to the end of this file, the interface module will be booted and your keypad enabled as well. This should be done to a copy of the DOS II Master Diskette using the COPY FILE command in DOS II. Please refer to the *ATARI Disk Operating System II Reference Manual* for the correct procedures.

If you plan to load a keypad handler and use DOS more than once while programming, your keypad handler diskette must have a MEM.SAV file.

Schematic and Truth Table





PIN	SIGNAL
1	FWD
2	BACK
3	LEFT
4	RIGHT
5	B POT
6	TRIGGER
7	+5v
8	GND
9	UNUSED

SIGNAL DEFINITION	
LOGIC "0"	0.4v AT 3.2 mA
LOGIC "1"	4.0v AT -0.7 mA

KEY	BPOT	STICK	HEX
0	0001	1100	$1C
1	0001	1001	$19
2	0001	1010	$1A
3	0001	1011	$1B
4	0001	0001	$11
5	0001	0010	$12
6	0001	0011	$13
7	0001	0101	$15
8	0001	0110	$16
9	0001	0111	$17
•	0001	1101	$1D
–	0001	1111	$1F
+ ENT	0001	1110	$1E
F1	0000	1100	$0C
F2	0001	0100	$14
F3	0001	0000	$10
F4	0001	1000	$18

Figure 5

Keypad Interrupt Handler Source Code

```
ATARI MACRO Assembler Ver  1.0A  Page 1
                                D1:KEYPAD.SRC

;DEMONSTRATION OF CX-85 KEYPAD INTERRUPT HANDLER
;
;This keypad interrupt handler detects and handles all
;keys pressed on a CX-85 keypad plugged into port 2.
;This is assembled using Atari Macro Assembler.
;
= 0030          TIMER   EQU     $30
= 0006          TIMER1  EQU     6       ;START MASK
= 0009          START   EQU     $9      ;SELECT MASK
= 000A          SELECT  EQU     $A      ;OPTION MASK
= 000C          OPTION  EQU     $C      ;BPOT BIT MASK
= 0008          BPOT    EQU     $08     ;VERTICAL BLANK INTERRUPT
= 0224          VVBLKD  EQU     $224    ;TRIGGER 1
= 0285          STRIG1  EQU     $285    ;ATTRACT MODE FLAG
= 004D          ATTRACT EQU     $4D     ;KEYBOARD CODE
= 02FC          CH      EQU     $2FC    ;ALL POT STATUS
= D208          ALLPOT  EQU     $D208   ;PORTA
= D300          PORTA   EQU     $D300   ;ROUTINE FOR SETTING VECTORS
= E45C          SETVBV  EQU     $E45C   ;WARM START ADDR
= 000C          DOSINI  EQU     $0C     ;CONSOL SWITCH PORT
= D01F          CONSOL  EQU     $D01F   ;BREAK KEY FLAG
= 0011          BREAK   EQU     $11     ;BREAK KEY FLAG
;LOCATED IN PAGE 6 BUT MAY BE REASSEMBLED ELSEWHERE
;
;INITIAL ENTRY POINT TO ESTABLISH VBLANK ENTRY
;SYSTEM RESET KEY RESETS VBLANK VECTORS,
;HENCE CHAIN TO DOS INIT
;SAVE VALUE IN DOSINI
0000            ORG     $600
0600 A50C       COLDST: LDA     DOSINI
0602 8D2C06             STA     WRMEXT+1
0605 A50D               LDA     DOSINI+1
0607 8D2D06             STA     WRMEXT+2
;
;REPLACE DOSINI WITH WARMST
060A A928               LDA     #LOW WARMST
060C 850C               STA     DOSINI
060E A906               LDA     #HIGH WARMST
0610 850D               STA     DOSINI+1
;
;CHAIN KEYPAD INTO DEFERRED VBLANK PROCESSING
;SAVE VVBLKD FOR KEYPAD EXIT POINT
0612 AD2402     KPADVBI:LDA     VVBLKD
0615 8DBA06             STA     EXIT+1
0618 AD2502             LDA     VVBLKD+1
061B 8DBB06             STA     EXIT+2
;
;REPLACE VVBLKD WITH KEYPAD ENTRY POINT
061E A051               LDY     #LOW KPAD
0620 A206               LDX     #HIGH KPAD
0622 A907               LDA     #7      ;DEFERRED VBI
0624 205CE4             JSR     SETVBV
0627 60                 RTS
;
;ENTERED WHEN USER HITS SYSTEM RESET
;REESTABLISH VBLANK VECTOR
0628 201206     WARMST: JSR     KPADVBI
062B 4C0000     WRMEXT: JMP     0       ;CHAIN TO DOSINI
```



```
ATARI MACRO Assembler Ver  1.0A  Page 2
                                D1:KEYPAD.SRC

;
;KEYPAD TRANSLATION TABLE
;
062E 0C0C       KPADTAB:DB      $0C,$0C ;FUNCTION 1
0630 1434               DB      $14,$34 ;FUNCTION 2
0632 1007               DB      $10,$07 ;FUNCTION 3
0634 1826               DB      $18,$26 ;FUNCTION 4
0636 1C32               DB      $1C,$32 ;0
0638 191F               DB      $19,$1F ;1
063A 1A1E               DB      $1A,$1E ;2
063C 1B1A               DB      $1B,$1A ;3
063E 1118               DB      $11,$18 ;4
0640 121D               DB      $12,$1D ;5
0642 131B               DB      $13,$1B ;6
0644 1533               DB      $15,$33 ;7
0646 1635               DB      $16,$35 ;8
0648 1730               DB      $17,$30 ;9
064A 1D22               DB      $1D,$22 ; .
064C 1F0E               DB      $1F,$0E ; -
064E 1E06               DB      $1E,$06 ; + ENTER
0650 00                 DB      0       ;END OF TABLE
;ENTERED AT EACH VBLANK TO READ THE KEYPAD
0651 AD8502     KPAD:   LDA     STRIG1  ;KEY PRESSED?
0654 D044 ^069A         BNE     KPADDM  ;EXIT FOR KEY NOT PRESSED
0656 A900               LDA     #0      ;RESET ATTRACT MODE
0658 854D               STA     ATTRACT
;DETERMINE VALUE OF KEY PRESSED
065A AD00D3             LDA     PORTA   ;READ CABLE PIN OF PORT 2
065D 4A                 LSR     A
065E 4A                 LSR     A
065F 4A                 LSR     A
0660 4A                 LSR     A
0661 8DBC06             STA     TEMP
0664 AD08D2             LDA     ALLPOT  ;READ ALLPOT FOR 5TH CABLE PIN STAT:
0667 2908               AND     #BPOT   ;MASK FOR 5TH PIN
0669 4908               EOR     #BPOT   ;COMPLEMENT BIT (0 IS VALID)
066B 0A                 ASL     A
066C 0DBC06             ORA     TEMP    ;A HAS KEY VALUE
066F A000               LDY     #0      ;INIT COUNTER
;
;SCAN TRANSLATION TABLE
0671 D92E06     KPADCK: CMP     KPADTAB,Y       ;MATCH KEYPAD TABLE ENTRY?
0674 F009 ^067F         BEQ     KPADMAT ;JUMP IF MATCH
0676 C8                 INY             ;INC TO NEXT ENTRY
0677 C8                 INY
0678 BE2E06             LDX     KPADTAB,Y       ;END OF TABLE?
067B F03C ^06B9         BEQ     EXIT    ;EXIT FOR END OF TABLE
067D D0F2  0671         BNE     KPADCK
;
;KEY VALUE MATCHES
;PUT NEW KEYCODE IN CH AND RESET AUTO-REPEAT
067F AA         KPADMAT:TAX             ;SAVE KEY VALUE
0680 C8                 INY             ;GET POKEY KEYCODE
0681 B92E06             LDA     KPADTAB,Y       ;A HAS KEYCODE
0684 C9FF               CMP     #$FF    ;VECTOR ROUTINE?
0686 F040 ^06C8         BEQ     KPADFUN ;EXIT FOR VECTOR ROUTINE
```

Keypad Interrupt Handler Source Code

```
                ATARI MACRO Assembler Ver  1.0A  Page 3
                                                D1:KEYPAD.SRC

                        CMP   KPADCOD  ;SAME AS PRIOR KEYCODE?
                        BEQ   KPADSAM  ;BRANCH IF SAME
                        STA   KPADCOD  ;ELSE STORE NEW KEYCODE
                        STA   CH
0688  CDBD06            STA   #TIMER   ;RESET TIMER
068B  F019 ^06A6        LDA   KPADREP
068D  8DBD06            STA   EXIT1
0690  8DFC02            BNE
0693  A930
0695  8DBE06
0698  D005  069F        LDA   #$C0     ;LOAD DUMMY VARIABLE
                KPADDM: STA   KPADCOD
069A  A9C0
069C  8DBD06    EXIT1:
069F                    ****************
                        LDA   #1       ;RESET BRK PRESS FLAG
                        STA   BRKPRS

069F  A901              ****************
06A1  8DBF06            BNE   EXIT

06A4  D013 ^06B9        ;SAME AS PRIOR KEY, CHECK AUTO-REPEAT
                KPADSAM: LDX  KPADREP  ;AUTO-REPEAT EXPIRED?
06A6  AEBE06            DEX           ;DEC TIMER
06A9  CA                BNE   KPADXX  ;BRANCH IF NOT
06AA  D00A  06B6        STA   CH      ;STORE KEYCODE
06AC  8DFC02            LDA   #TIMER1 ;RESET TIMER
06AF  A906              STA   KPADREP
06B1  8DBE06            BNE   EXIT1
06B4  D0E9  069F        STX   KPADREP
06B6  8EBE06    KPADXX:
                ;
                ;EXIT THIS VBLANK INTERRUPT
                EXIT:   JMP   0        ;CHAIN TO DEFERRED VBLANK
                TEMP:   DB    0        ;TEMP VARIABLE
                KPADCOD: DB   0        ;PRIOR KEYCODE
                KPADREP: DB   $30      ;AUTO-REPEAT TIMER
06B9  4C0000    ;
06BC  00        ;IF NO $FF IN TRANSLATION TABLE, THE SECTIONS
06BD  00        ;ENCLOSED WITHIN *** MAY BE DELETED
06BE  30
                ****************
                BRKPRS: DB    1        ;BREAK PRESS FLAG
06BF  01        ;
                ;FUNCTION VECTOR TABLE
                KPADFTB: DW   KPADF1   ;F1 VECTOR
                         DW   KPADF2   ;F2 VECTOR
                         DW   KPADF3   ;F3 VECTOR
06C0  DC06               DW   KPADF4   ;F4 VECTOR
06C2  EE06
06C4  F406
06C6  FA06      ;GET FUNCTION VECTOR
                KPADFUN: DEY
                         LDA   KPADFTB,Y
06C8  88                 STA   KPADFV+1
06C9  89C006             INY
06CC  BDD706             LDA   KPADFTB,Y
06CF  C8                 STA   KPADFV+2
06D0  B9C006
06D3  8DD806    ;CALL TO FUNCTION VECTOR
                KPADFV: JSR   0        ;CALL TO FUNCTION
06D6  200000            JMP   EXIT
06D9  4CB906            LDA   BRKPRS
06DC  ADBF06    KPADF1: BEQ   KPADFR
06DF  F00C ^06ED        LDA   #0       ;BREAK PRESSED
06E1  A900              STA   BREAK
06E3  8511
```



```
                ATARI MACRO Assembler Ver  1.0A  Page 4
                                                D1:KEYPAD.SRC

06E5  8DBF06                    STA   BRKPRS
06E8  A9C0                      LDA   #$C0     ;LOAD DUMMY KEYCODE
06EA  8DBD06                    STA   KPADCOD
06ED  60        KPADFR:         RTS
06EE  A90C      KPADF2:         LDA   #OPTION
06F0  8D1FD0                    STA   CONSOL
06F3  60                        RTS
06F4  A904      KPADF3:         LDA   #SELECT
06F6  8D1FD0                    STA   CONSOL
06F9  60                        RTS
06FA  A909      KPADF4:         LDA   #START
06FC  8D1FD0                    STA   CONSOL
06FF  60                        RTS

                ****************
0700                    END     COLDST

no ERROR, 41 Labels, $4732 free.
```

ALLPOT	D208	1#22	2/39				
ATTRAC	004D	1#20	2/31				
BPOT	0008	1#17	2/40	2/41			
BREAK	0011	1#27	3/61				
BRKPRS	06BF	3/18	3#41	3/58	3/62		
CH	02FC	1#21	3/ 8	3/26			
COLDST	0600	1#35	4/19				
CONSOL	D01F	1#26	4/10	4/13	4/16		
DOSINI	000C	1#25	1/35	1/37	1/41	1/43	
EXIT	06B9	1/47	1/49	2/52	3/20	3#33	3/57
EXIT1	069F	3/11	3#15	3/29			
KPAD	0651	1/52	1/53	2#28			
KPADCK	0671	2#47	2/53				
KPADCO	06BD	2/62	3/ 7	3/14	3#35	4/ 7	
KPADDM	069A	2/29	3#13				
KPADF1	06DC	3/44	3#58				
KPADF2	06EE	3/45	4# 9				
KPADF3	06F4	3/46	4#12				
KPADF4	06FA	3/47	4#15				
KPADFR	06ED	3/59	4# 8				
KPADFT	06C0	3#44	3/50	3/53			
KPADFU	06C8	2/61	3#49				
KPADFV	06D6	3/51	3/54	3#56			
KPADMA	067F	2/48	2#57				
KPADRE	06BE	3/10	3/23	3/28	3/30	3#36	
KPADSA	06A6	3/ 6	3#23				
KPADTA	062E	2# 9	2/47	2/51	2/59		
KPADVB	0612	1#46	1/60				
KPADXX	06B6	3/25	3#30				
OPTION	000C	1#16	4/ 9				
PORTA	D300	1#23	2/33				
SELECT	000A	1#15	4/12				
SETVBV	E45C	1#24	1/55				
START	0009	1#14	4/15				
STRIG1	0285	1#19	2/28				
TEMP	06BC	2/38	2/43	3#34			
TIMER	0030	1#12	3/ 9				
TIMER1	0006	1#13	3/27				
VVBLKD	0224	1#18	1/46	1/48			
WARMST	0628	1/40	1/42	1#60			
WRMEXT	062B	1/36	1/38	1#61			

ATARI CX85 NUMERICAL KEYPAD
Technical Reference Notes

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PRINTED IN U.S.A. **CO61037 REV. A**