N Voice Controller Hardware Connections

Casio Key Assignments

	S9	S8	S7	S6	S5	S4	S3	S2	S1
D8	B4	A#4	A4	G#4	G4	F#4	C4*	HOLD	OCTAVE DROP
D7	F4	E4	D#4	D4	C#4	C4	C4*	SUSTAIN	SLOW VIB
D6	B3	A#3	A3	G#3	G3	F#3	C3*	MILD VIB	NORM VIB
D5	F3	E3	D#3	D3	C#3	C3	C3*	MEM #1	MEM #2
D4	B2	A#2	A2	G#2	G2	F#2	C2*	MEM #3	MEM #4
D3	F2	E2	D#2	D2	C#2	C2	C2*	VOICE SEL	VOICE 'SET'
D2	B1	A#1	A1	G#1	G1	F#1	C1*	PEDAL SUS	TUNING
D1	F1	E1	D#1	D1	C#1	C1	C1*	NONE	NONE

D1 thru D8 are the Casio Drive lines
S1 thru S9 are the Casio Sense lines
The MT-30 keys extend from C2 to B4 and include C5
The CT-202 keys extend from C1 to B4 and include C5

Connections from Micro-Processor to Casio

Name	D1	S1	S2	S3	S4	S5	S6	S7	S8	S9	gnd
*upd*775 pin	33	16	17	18	24	19	20	21	22	23	32
intface conn	7	16	15	14	1	2	3	4	5	6	11
SYM-1 AA conn	E	10		D	3	C	12	N	11	M	1
6522 pins	CA1	PA7		PA0	PA1	PA2	PA3	PA4	PA5	PA6	
MMC/03	3	22		15	16	17	18	19	20	21	1

Equivalent pins for hook-up to CT-202

S9=IC5-13 S8=IC4-1 S7=IC4-1 S6=IC3-15 S5=IC3-12
S4=IC5-1 S3=IC3-10 S2=IC3-2 S1=IC3-5

Connections to multiplexed DAC

Name	mux0	mux1	mux2	inh	DAC0	DAC1	DAC2	DAC3	DAC4	DAC5	DAC6	DAC7
SYM-1 AA	V	W	X	U	L	9	K	8	J	7	H	6
<4051>pin	11	10	9	6								
<7523>pin					11	10	9	8	7	6	5	4
MMC/03	S	T	U	Z	7	8	9	10	11	12	13	14
<6522>pin	3PA0	3PA1	3PA2	3PA7	2PB0	2PB1	2PB2	2PB3	2PB4	2PB5	2PB6	2PB7
MDAC 216	PP	MM	NN	RR	H	G	F	E	D	C	B	A

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```
                0005 ;
                0010 ; NVC.STD source
                0015 DISK       .DE 1        ; else targeted to Brachman MMC/03 6503 board
                0020 EMULATOR   .DE $F000    ; Location of emulator card
                0025 RAM        .DE $7000    ; Available area for assembly
                0030 ;
                0035 ;*************************************************************
                0040 ;*** Casio Interface for Voltage-Controlled Synthesizer ***
                0045 ;***     by Darrel Johansen     30 Oct 1982   SF,CA     ***
                0046 ;***     ALL RIGHTS RESERVED   released to R. Whittle   ***
                0047 ;***                           for personal use only    ***
                0048 ;***         CONFIDENTIAL            Dec 1982           ***
                0050 ;***     -    -   -   -   -   -   -   -   -    -       ***
                0055 ;***               STANDARD VERSION MASTER               ***
                0060 ;***  Mono Voice Processing w/High,Low, Latest logic     ***
                0065 ;***            1,2,4,6,8 Voice Polyphonic              ***
                0070 ;***     Fast Multiplexing (200 micro-seconds/Output)    ***
                0075 ;***                    8-bit DAC                        ***
                0080 ;*************************************************************
                0085            ;
                0090 ; *** IRQ takes about 2/3 of total CPU time ***
                0095            ;
                0100            .OS
                0105            ;
                0110 POLYV      .DE 4        ; default polyphony level
                0115            IFE DISK
                0120 ACCESS     .DE $8B86    ; un-write protect SYM IRQ vector
                0125 IRQ.VEC    .DE $A67E
                0130            ***
                0135            IFN DISK
                0140            .BA EMULATOR+$FFA ; end of EPROM on target
                0145            .MC RAM+$7FA
FFFA- 00 F8     0150 NMI.ROM    .SE CASIO
FFFC- 00 F8     0155 RESET.ROM  .SE CASIO
FFFE- 00 00     0160 JMP.IRQ    .SE IRQ.VEC-1 ; Vector for IRQ
                0165 ; Page Zero usage
                0170            .BA $0001    ; JMP.IRQ takes $0000
0001-           0175 IRQ.VEC    .DS 2        ; must move to RAM so can be altered during program
                0180            ***
                0185            IFE DISK
                0190            .BA $0010
                0195 SYS.IRQ    .DS 2        ; temp storage for return of system IRQ
                0200            ***
0003-           0205 POLY.VN    .DS 1        ; polyphony level
0004-           0210 EVEN.FLAG  .DS 1        ; used for setting CA1 to + or - on time check
0005-           0215 PW         .DS 2        ; Casio drive pulse width
0007-           0220 KEY        .DS 2        ; sequential counter for for GET.KEY routine
0009-           0225 TEMPX2     .DS 1        ; X reg storage for multiplexing
000A-           0230 BIT.NUM    .DS 1        ; counter for GET.KEY routine
000B-           0235 CURNT.KEY  .DS 1        ; current high key value for MONO high sustain
000C-           0240 CURNT.KEYL .DS 1        ; current low key value for MONO low sustain
000D-           0245 LAST.LOKY  .DS 1        ; flag for MONO low key updated
000E-           0250 LAST.NUKY  .DS 1        ; to prevent re-triggering
000F-           0255 LAST.KEY   .DS $12      ; memory for MONO assignment
0021-           0260 LAST.KY    .DS $12      ; "   "
0033-           0265 YTEMP      .DS 1        ; pointer to low key for MONO
0034-           0270 STROBE     .DS 8        ; Eight locations for storage of SENSE data
                0275            ;              during eight STROBE pulses
003C-           0280 MUX.KEY    .DS 8        ; current value to be assigned to DAC output
0044-           0285 TRIG.DATA  .DS 8        ; temporary, for synchronizing triggers w/MUX
004C-           0290 LATCH      .DS 8        ; latch to avoid re-triggering gate with key steal
0054-           0295 KEY.TABLE  .DS $12      ; List in descending order of current keys depressed.
                0300            ;              current high key = KEY.TABLE+0
                0305            ;              next = KEY.TABLE+1 , etc.
                0310            ;              $F0 signifies end of list.
                0315            ; KEY.TABLE should be the last designated area for Z-page
                0320            ;  storage, since it will be dynamically extended with
                0325            ;  the number of keys depressed without a limit.
                0330            ;
                0335 PAGE.ZERO  .DE $9E      ; RAE and XRAY stuff
                0340 END.PO     .DE $F8      ; end "
                0345 PAGE.ONE   .DE $0100
                0350            ;
                0355            ;
                0360            IFN DISK
                0365            .BA EMULATOR+$800 ; location of EPROM on Brachman board
                0370            .MC RAM      ; for Eprom burner
                0375            ***
                0380            ;
                0385            IFE DISK
```

```
                0390            .BA RAM
                0395            ***
                0400            ;
                0405 CASIO
                0410            IFN DISK
F800- D8        0415            CLD
F801- A2 FF     0420            LDX #$FF
F803- 9A        0425            TXS
                0430            ***
F804- 20 59 F8  0435            JSR CAS.INIT
                0440            ;
                0445 ; Outer loop is interupted by D1 sync pulse and T1
                0450 ;  time outs to get SENSE data. PA port is loaded during
                0455 ;  interupts and stored in the table called STROBE.
                0460 LOOP       ; sense stop switch on PB7
                0465            IFE DISK
                0470            SEI
                0475            LDA MUX.CTL
                0480            AND #$40
                0485            BEQ END
                0490            CLI
                0495            ***
F807- A9 CE     0500            LDA #$CE
F809- 8D 0C F6  0505            STA PCR.2    ; strobe TUNE switch
F80C- AD 01 F6  0510            LDA MUX.CTL
F80F- 29 20     0515            AND #$20
F811- F0 1B     0520            BEQ MODE.SW
F813- AD 01 F6  0525            LDA MUX.CTL
F816- 29 10     0530            AND #$10
F818- F0 03     0535            BEQ UP.2
F81A- A9 60     0540            LDA #$60     ; two volts
F81C- 2C        0545            .BY $2C
                0550 UP.2
F81D- A9 C0     0555            LDA #$C0     ; four volts
F81F- A2 07     0560            LDX #$07
F821- 95 3C     0565 TUNE.2     STA #MUX.KEY,X
F823- CA        0570            DEX
F824- 10 FB     0575            BPL TUNE.2
F826- A9 FF     0580            LDA #$FF
F828- 8D 00 F6  0585            STA TRIG.PORT
F82B- 4C 07 F8  0590            JMP LOOP
                0595 MODE.SW
F82E- A9 EC     0600            LDA #$EC     ; strobe MODE switch
F830- 8D 0C F6  0605            STA PCR.2
F833- AD 01 F6  0610            LDA MUX.CTL
F836- 29 20     0615            AND #$20
F838- D0 05     0620            BNE VOICE.6
F83A- A9 04     0625            LDA #POLYV
F83C- 4C 4B F8  0630            JMP VOICE.X
                0635 VOICE.6
F83F- AD 01 F6  0640            LDA MUX.CTL
F842- 29 10     0645            AND #$10
F844- F0 03     0650            BEQ VOICE.8
F846- A9 06     0655            LDA #$06
F848- 2C        0660            .BY $2C
                0665 VOICE.8
F849- A9 08     0670            LDA #$08
                0675 VOICE.X
F84B- 85 03     0680            STA #POLY.VN
                0685 EXEC
F84D- 20 9A F9  0690            JSR GET.KEY  ; 1.5 ms for no keys, 3.0 ms for 8 low keys
F850- 20 09 FA  0695            JSR N.VOICE  ; .5 ms for no keys, 1.5 ms for 4 keys
F853- 20 70 FA  0700            JSR MONO.KP  ; .8 ms for no keys, 1.2 ms for 4 keys
F856- 4C 07 F8  0705            JMP LOOP     ; w/o IRQ's entire LOOP takes .7 ms, all above
                0710            ;               times are w/IRQ.
                0715            ;
                0720            IFE DISK
                0725 END
                0730            LDA #$7F
                0735            STA IER
                0740            STA IER.2
                0745            LDA #SYS.IRQ ; restore system IRQ vector
                0750            STA IRQ.VEC
                0755            LDA #SYS.IRQ+1
                0760            STA IRQ.VEC+1
                0765            ;
                0770            LDX #$10
                0775 RSTR.RAE   LDA PAGE1.TMP,X
                0780            STA PAGE.ONE,X
                0785            DEX
                0790            BPL RSTR.RAE
                0795            INX
                0800 RSTR.RAO   LDA PAGE0.TMP,X
```

```
                0805            STA #PAGE.ZERO,X
                0810            INX
                0815            CPX #END.P0-PAGE.ZERO
                0820            BCC RSTR.RA0
                0825            ;
                0830            RTS
                0835            ***
                0840            ;
F859- 78        0845 CAS.INIT   SEI
                0850            IFE DISK
                0855            LDX #$10
                0860 SV.RAE.P   LDA PAGE.ONE,X
                0865            STA PAGE1.TMP,X
                0870            DEX
                0875            BPL SV.RAE.P
                0880            INX
                0885 SV.RAE.0   LDA #PAGE.ZERO,X
                0890            STA PAGE0.TMP,X
                0895            INX
                0900            CPX #END.P0-PAGE.ZERO
                0905            BCC SV.RAE.0
                0910            ***
F85A- A0 FF     0915            LDY #$FF
F85C- A2 FF     0920 RST.LOOP1  LDX #$FF
F85E- CA        0925 RST.LOOP   DEX
                0930 ;  delay for 6522's
F85F- D0 FD     0935            BNE RST.LOOP
F861- 88        0940            DEY
F862- D0 F8     0945            BNE RST.LOOP1
F864- A9 7F     0950            LDA #$7F
F866- 8D 0E F5  0955            STA IER
F869- 8D 0E F6  0960            STA IER.2
                0965            IFE DISK
                0970            JSR ACCESS   ; un-write protect SYM Ram
                0975            LDA IRQ.VEC  ; save system IRQ
                0980            STA #SYS.IRQ
                0985            LDA IRQ.VEC+1
                0990            STA #SYS.IRQ+1
                0995            ***
                1000            ;
                1005            IFN DISK
F86C- A9 4C     1010            LDA #$4C
F86E- 85 00     1015            STA #IRQ.VEC-1
F870- A9 F8     1020            LDA #H,CASIO
F872- 85 02     1025            STA #IRQ.VEC+1
F874- A9 00     1030            LDA #L,CASIO
F876- 85 01     1035            STA #IRQ.VEC
                1040            ***
                1045            ;
F878- A9 00     1050            LDA #%00000000
F87A- 8D 03 F5  1055            STA SENSE.DIR ; SENSE input lines ( 3 -> 9 only )
                1060            ;
F87D- A9 FF     1065            LDA #%11111111
F87F- 8D 02 F5  1070            STA DAC.DIR
F882- A9 FF     1075            LDA #%11111111
F884- 8D 02 F6  1080            STA TRIG.DIR
                1085            ;
F887- A9 87     1090            LDA #%10000111 ; bit 6 = STOP switch
F889- 8D 03 F6  1095            STA MUX.DIR  ; bit 7 = inhibit, 0-3 = mux select
F88C- A9 00     1100            LDA #$00
F88E- 8D 00 F5  1105            STA DAC.PORT
F891- 8D 01 F6  1110            STA MUX.CTL
F894- 85 09     1115            STA #TEMPX2
F896- 8D 00 F6  1120            STA TRIG.PORT
F899- A9 04     1125            LDA #POLYV
F89B- 85 03     1130            STA #POLY.VN
                1135            ;
F89D- A2 07     1140            LDX #$07
                1145 MKEY.INIT  ; initialize DAC's
F89F- A9 00     1150            LDA #00
F8A1- 95 3C     1155            STA #MUX.KEY,X ; zero volts
F8A3- 95 44     1160            STA #TRIG.DATA,X
F8A5- 95 4C     1165            STA #LATCH,X
F8A7- CA        1170            DEX
F8A8- 10 F5     1175            BPL MKEY.INIT
                1180            ;
                1185            ;
                1190 GET.TIME
F8AA- A9 00     1195            LDA #$00
F8AC- 85 04     1200            STA #EVEN.FLAG
F8AE- 20 75 F9  1205            JSR SET.PW.IRQ
F8B1- 58        1210            CLI
F8B2- 60        1215            RTS
```

```
                1220            ;
                1225 ;IRQ entry for initial CASIO frequency measurement
F8B3- 78        1230 TIME.IRQ   SEI
F8B4- 48        1235            PHA
F8B5- 98        1240            TYA
F8B6- 48        1245            PHA
F8B7- 8A        1250            TXA
F8B8- 48        1255            PHA
F8B9- A9 02     1260            LDA #$02     ; CA1 measures D1 pulse width with Timer #1
F8BB- 2C 0D F5  1265            BIT IFR
F8BE- D0 07     1270            BNE GET.D1
                1275 IRQ.EXIT
F8C0- 68        1280            PLA
F8C1- AA        1285            TAX
F8C2- 68        1290            PLA
F8C3- A8        1295            TAY
F8C4- 68        1300            PLA
F8C5- 58        1305            CLI
F8C6- 40        1310            RTI
                1315            ;
                1320 ;The width of the first Casio STROBE pulse (D1)
                1325 ; times all further operations. There are eight sequential
                1330 ; STROBE pulses, but only the first one is needed to sync the
                1335 ; program to get the data from the 9 SENSE lines.
                1340 GET.D1
F8C7- A5 04     1345            LDA *EVEN.FLAG ; entered on leading edge of first STROBE pulse
F8C9- D0 19     1350            BNE END.D1
F8CB- A9 FF     1355 START.D1   LDA #$FF     ; shorten count a little
F8CD- A9 FF     1360            LDA #$FF
F8CF- A9 FF     1365            LDA #$FF
F8D1- 8D 04 F5  1370            STA TIMER
F8D4- 8D 05 F5  1375            STA TIMER+1
F8D7- A9 CD     1380            LDA #%11001101 ; + trans in CA1
F8D9- 8D 0C F5  1385            STA PCR
F8DC- 85 04     1390            STA *EVEN.FLAG
F8DE- AD 01 F5  1395            LDA SENSE.PORT
F8E1- 4C C0 F8  1400            JMP IRQ.EXIT
                1405            ;
                1410 END.D1     ; entered on end of first STROBE pulse
F8E4- AD 04 F5  1415            LDA TIMER
F8E7- 85 05     1420            STA *PW
F8E9- AD 05 F5  1425            LDA TIMER+1
F8EC- 85 06     1430            STA *PW+1
                1435            ;
F8EE- 38        1440            SEC          ; calculate time difference
F8EF- A9 FF     1445            LDA #$FF
F8F1- E5 05     1450            SBC *PW
F8F3- 85 05     1455            STA *PW
F8F5- A9 FF     1460            LDA #$FF
F8F7- E5 06     1465            SBC *PW+1
F8F9- 85 06     1470            STA *PW+1
                1475            ;
                1480 GET.D1.X
F8FB- A9 7F     1485            LDA #$7F     ; disable all IRQ's
F8FD- 8D 0E F5  1490            STA IER
                1495            ;
F900- A9 F9     1500            LDA #H,DSYNC.IRQ ; set new vector for main data fetch routine
F902- A2 12     1505            LDX #L.DSYNC.IRQ
                1510            IFE DISK
                1515            STA IRQ.VEC+1
                1520            STX IRQ.VEC
                1525            ***
                1530            IFN DISK
F904- 85 02     1535            STA *IRQ.VEC+1
F906- 86 01     1540            STX *IRQ.VEC
                1545            ***
                1550            ;
F908- 20 82 F9  1555            JSR CA1.ENAB
F90B- A9 00     1560            LDA #$00
F90D- 85 04     1565            STA *EVEN.FLAG
F90F- 4C C0 F8  1570            JMP IRQ.EXIT
                1575            ;
                1580 ; Two interupts are used to get the data from the Casio SENSE
                1585 ; lines. The first syncronizes to the D1 STROBE pulse, then
                1590 ; using the measurement of the pulse width in the first part
                1595 ; of this program, Timer T1 of the 6522 provides time outs
                1600 ; for checking data at the proper time on the SENSE lines.
F912- 78        1605 DSYNC.IRQ  SEI
F913- 48        1610            PHA
F914- 98        1615            TYA
F915- 48        1620            PHA
F916- 8A        1625            TXA
F917- 48        1630            PHA
```

```
                1635 CA5.IRQ
F918- A9 02     1640            LDA #$02
F91A- 2C 0D F5  1645            BIT IFR
F91D- D0 14     1650            BNE D1.STROBE ; D1 pulse, - edge
                1655            ;
F91F- A9 40     1660            LDA #$40
F921- 2C 0D F5  1665            BIT IFR
F924- F0 9A     1670            BEQ IRQ.EXIT
                1675            ;
F926- A6 09     1680            LDX #TEMPX2
F928- AD 01 F5  1685            LDA SENSE.PORT ; get SENSE for D3 to D8
F92B- 95 34     1690            STA #STROBE,X
F92D- AD 04 F5  1695            LDA TIMER    ; clear IRQ flag
F930- 4C 4B F9  1700 EX.TIMER   JMP MULTIPLEX
                1705            ;
                1710 D1.STROBE
F933- A5 05     1715            LDA #PW
F935- 8D 04 F5  1720            STA TIMER
F938- A5 06     1725            LDA #PW+1
F93A- 8D 05 F5  1730            STA TIMER+1  ; restart Timer #1 ( 44 us after IRQ )
                1735            ;
F93D- A2 00     1740            LDX #$00
F93F- 86 09     1745            STX #TEMPX2
                1750            ; next 7 IRQ's from T1 time-out
F941- A9 C0     1755            LDA #%11000000 ; T1 time-out
F943- 8D 0E F5  1760            STA IER
F946- AD 01 F5  1765            LDA SENSE.PORT ; get SENSE for D1
F949- 85 34     1770            STA #STROBE
                1775 ; handles the 4051 routing of the DAC to
                1780 ;  eight sample/holds for multiplexed outputs.
                1785 MULTIPLEX
F94B- 8A        1790            TXA
F94C- 09 80     1795            ORA #$80     ; set bit 7 for inhibit
F94E- 8D 01 F6  1800            STA MUX.CTL  ; transfer address to 4051
F951- B5 3C     1805            LDA #MUX.KEY,X
F953- 8D 00 F5  1810            STA DAC.PORT ; transfer data to DAC
F956- B5 44     1815            LDA #TRIG.DATA,X
F958- 0D 00 F6  1820            ORA TRIG.PORT
F95B- 8D 00 F6  1825            STA TRIG.PORT
F95E- E8        1830            INX
F95F- E0 08     1835            CPX #$08
F961- D0 05     1840            BNE END.MUX
F963- A9 40     1845            LDA #%01000000 ; clear IRQ from TIMER
F965- 8D 0E F5  1850            STA IER
                1855 END.MUX
F968- 86 09     1860            STX #TEMPX2
F96A- A9 7F     1865            LDA #$7F
F96C- 2D 01 F6  1870            AND MUX.CTL
F96F- 8D 01 F6  1875            STA MUX.CTL  ; enable 4051 ( required for deglitch )
F972- 4C C0 F8  1880            JMP IRQ.EXIT
                1885            ;
                1890            ;
                1895            ;
F975- A9 F8     1900 SET.PW.IRQ LDA #H,TIME.IRQ ; IRQ used to check timing
F977- A2 B3     1905            LDX #L,TIME.IRQ
                1910            IFE DISK
                1915            STA IRQ.VEC+1
                1920            STX IRQ.VEC
                1925            ***
                1930            IFN DISK
F979- 85 02     1935            STA #IRQ.VEC+1
F97B- 86 01     1940            STX #IRQ.VEC
                1945            ***
                1950            ;
F97D- A9 60     1955            LDA #%01100000 ; no latch !
F97F- 8D 0B F5  1960            STA ACR
                1965            ; continue,  to enable CA1
                1970            ;
F982- A9 CC     1975 CA1.ENAB   LDA #%11001100 - transition on CA1 for initial IRQ
F984- 8D 0C F5  1980            STA PCR      ;     CA2, CB1, CB2 unused
F987- A9 7F     1985            LDA #$7F
F989- 8D 0E F5  1990            STA IER
F98C- AD 01 F5  1995            LDA SENSE.PORT
F98F- A9 82     2000            LDA #%10000010 ; enable IRQ from CA1
F991- 8D 0E F5  2005            STA IER
F994- A9 7F     2010            LDA #$7F
F996- 8D 0E F6  2015            STA IER.2
F999- 60        2020            RTS
                2025            ;
                2030 ;
                2035 GET.KEY    ; Gets the key #'s of all currently depressed keys
                2040            ;  and stores into KEY.TABLE in descending order
F99A- A0 00     2045            LDY #$00
```

```
F99C- A5 34     2050            LDA *STROBE
F99E- 29 02     2055            AND #$02     ; check S4 for key C5 ( out of regular order )
F9A0- D0 06     2060            BNE C5.X
F9A2- A9 C0     2065            LDA #$C0
F9A4- 99 54 00  2070            STA KEY.TABLE,Y
F9A7- C8        2075            INY
                2080 C5.X
F9A8- A2 08     2085            LDX #$08
F9AA- A9 30     2090            LDA #48      ; count down from the highest key value
F9AC- 85 07     2095            STA *KEY
                2100 NXT.SENSE
F9AE- CA        2105            DEX
F9AF- 30 2C     2110            BMI CK.C1
F9B1- A9 06     2115            LDA #06      ; check bits 1-6 for S4 through S9 ( S3 not checked )
F9B3- 85 0A     2120            STA *BIT.NUM
F9B5- B5 34     2125            LDA *STROBE,X ; check 8 STROBES
F9B7- 49 FF     2130            EOR #$FF     ; invert so =0 if no keys on this strobe
F9B9- 0A        2135            ASL A        ; roll off S1 bit ( not checked )
                2140 SHORT.CUT  ; go to next SENSE check if all=0
F9BA- D0 0A     2145            BNE FIND.BIT
F9BC- A5 07     2150            LDA *KEY
F9BE- 38        2155            SEC
F9BF- E9 06     2160            SBC #$06
F9C1- 85 07     2165            STA *KEY
F9C3- 4C AE F9  2170            JMP NXT.SENSE
                2175 FIND.BIT
F9C6- C6 07     2180            DEC *KEY
F9C8- 0A        2185            ASL A
F9C9- 90 0C     2190            BCC FIND.BIT2
                2195            ; if a bit is shifted into the CARRY flag then
                2200            ;                    key is depressed
                2205 GOT.KEY
                2210            ; put key # in table, increment pointer
F9CB- 48        2215            PHA
F9CC- A5 07     2220            LDA *KEY
F9CE- F0 06     2225            BEQ C5.GOT   ; key C5 will also show up as key #00
F9D0- 0A        2230            ASL A
F9D1- 0A        2235            ASL A
F9D2- 99 54 00  2240            STA KEY.TABLE,Y
F9D5- C8        2245            INY
F9D6- 68        2250 C5.GOT     PLA
F9D7- C6 0A     2255 FIND.BIT2  DEC *BIT.NUM
F9D9- D0 EB     2260            BNE FIND.BIT ; check next bit
F9DB- F0 D1     2265            BEQ NXT.SENSE ; check next word
                2270 CK.C1
F9DD- A5 34     2275            LDA *STROBE
F9DF- 29 01     2280            AND #$01     ; check S3 for key C1
F9E1- D0 06     2285            BNE C1.X
F9E3- A9 00     2290            LDA #$00
F9E5- 99 54 00  2295            STA KEY.TABLE,Y
F9E8- C8        2300            INY
                2305 C1.X
F9E9- 84 33     2310            STY *YTEMP
F9EB- A9 FF     2315            LDA #$FF     ; FF signifies end of key list
                2320 END.C1
F9ED- 99 54 00  2325            STA KEY.TABLE,Y ; make sure end is marked
F9F0- C8        2330            INY
F9F1- C0 12     2335            CPY #$12
F9F3- 90 F8     2340            BCC END.C1
F9F5- A4 33     2345            LDY *YTEMP
F9F7- 88        2350            DEY
F9F8- A5 3B     2355 OCT.CHK    LDA *STROBE+7 ; check custom octave switch
F9FA- 10 0C     2360            BPL OCT.X
F9FC- A9 30     2365            LDA #$30     ; one volt
F9FE- 18        2370            CLC
F9FF- 79 54 00  2375            ADC KEY.TABLE,Y
FA02- 99 54 00  2380            STA KEY.TABLE,Y
FA05- 88        2385            DEY
FA06- 10 F0     2390            BPL OCT.CHK
                2395 OCT.X
FA08- 60        2400            RTS
                2405            ;
                2410 ;Assign highest N keys (N=*POLY.VN) to mux and set gates
                2415 ; high for active keys.
                2420 N.VOICE
FA09- A2 00     2425            LDX #$00
FA0B- B5 54     2430 N.VOICE1   LDA *KEY.TABLE,X
FA0D- C9 FF     2435            CMP #$FF     ; end?
FA0F- F0 2B     2440            BEQ DEACT
                2445 MATCH
FA11- A4 03     2450            LDY *POLY.VN
FA13- 88        2455            DEY
FA14- D9 3C 00  2460 MATCH1     CMP MUX.KEY,Y ; this key been assigned somewhere before?
```

```
FA17- F0 12     2465            BEQ SET.GATE ; already assigned
FA19- 88        2470            DEY
FA1A- 10 F8     2475            BPL MATCH1   ; check each
                2480            ;
                2485 ; none assigned this key, find unused channel
                2490 GET.AVAIL
FA1C- A4 03     2495            LDY #POLY.VN
FA1E- 48        2500            PHA
                2505 GET.AV1
FA1F- 88        2510            DEY
FA20- 30 19     2515            BMI NO.AVAIL
FA22- B9 4C 00  2520            LDA LATCH,Y  ; find low gate (de-activated output)
FA25- D0 F8     2525            BNE GET.AV1
                2530 GOT.AVAIL
FA27- 68        2535            PLA
FA28- 99 3C 00  2540            STA MUX.KEY,Y
                2545 SET.GATE
FA2B- B9 6F FB  2550            LDA MASK,Y
FA2E- 99 44 00  2555            STA TRIG.DATA,Y
FA31- 99 4C 00  2560            STA LATCH,Y
FA34- E8        2565            INX
FA35- E4 03     2570            CPX #POLY.VN
FA37- 90 D2     2575            BCC N.VOICE1
FA39- B0 01     2580            BCS DEACT    ; always
                2585 NO.AVAIL
FA3B- 68        2590            PLA
                2595            ;
                2600 DEACT
FA3C- A6 03     2605            LDX #POLY.VN
FA3E- CA        2610            DEX
                2615 DEACT.1
FA3F- B5 44     2620            LDA #TRIG.DATA,X
FA41- F0 0C     2625            BEQ NX.MATCH
FA43- B5 3C     2630            LDA #MUX.KEY,X
FA45- A4 03     2635            LDY #POLY.VN
FA47- 88        2640 DEAC.MACH  DEY
FA48- 30 09     2645            BMI NO.MATCH
FA4A- D9 54 00  2650            CMP KEY.TABLE,Y
FA4D- D0 F8     2655            BNE DEAC.MACH
                2660 NX.MATCH
FA4F- CA        2665            DEX
FA50- 10 ED     2670            BPL DEACT.1
FA52- 60        2675            RTS
                2680            ;
                2685 NO.MATCH
FA53- B5 4C     2690            LDA #LATCH,X ; don't reset if high previous
FA55- D0 11     2695            BNE SKIP
FA57- A9 00     2700            LDA #$00     ; key not in MUX.KEY list, so set gate low
FA59- 95 44     2705            STA #TRIG.DATA,X
FA5B- BD 6F FB  2710            LDA MASK,X
FA5E- 49 FF     2715            EOR #$FF
FA60- 78        2720            SEI
FA61- 2D 00 F6  2725            AND TRIG.PORT
FA64- 8D 00 F6  2730            STA TRIG.PORT
FA67- 58        2735            CLI
FA68- A9 00     2740 SKIP       LDA #$00
FA6A- 95 4C     2745            STA #LATCH,X
FA6C- 4C 4F FA  2750            JMP NX.MATCH
                2755            ;
                2760            ;
                2765 NO.MONO
FA6F- 60        2770            RTS
                2775            ;
                2780 MONO.KP    ; extended mono outputs: one gate, high, low & last triggers,
                2785            ;       high sustain, high current, low current, last key
                2790            ; process current key
FA70- A5 03     2795            LDA #POLY.VN
FA72- C9 06     2800            CMP #$06
FA74- F0 0E     2805            BEQ SIX.V
FA76- C9 04     2810            CMP #POLYV
FA78- D0 F5     2815            BNE NO.MONO
                2820 FOUR.V
FA7A- A2 05     2825            LDX #5       ; reset triggers here, not in MULTIPLEX routine
FA7C- 20 5F FB  2830            JSR TRIG.NOT
FA7F- A2 04     2835            LDX #4
FA81- 20 5F FB  2840            JSR TRIG.NOT
                2845 SIX.V
FA84- A2 06     2850            LDX #6
FA86- 20 5F FB  2855            JSR TRIG.NOT
FA89- A5 54     2860            LDA #KEY.TABLE
                2865            ;  end of list ? --- then no keys depressed
FA8B- C9 FF     2870            CMP #$FF
FA8D- D0 03     2875            BNE SIX.V1
```

```
FA8F- 4C 44 FB  2880            JMP NO.KEY
                2885 SIX.V1
FA92- A4 0F     2890            LDY %LAST.KEY
FA94- C0 FF     2895            CPY #$FF
FA96- F0 13     2900            BEQ NEW.HKEY
                2905            ; if no previous keys down, then process
                2910 HI.SUSTK   ; this voice controls the VCO and holds the last high key
FA98- C5 0F     2915            CMP %LAST.KEY
FA9A- B0 0F     2920            BCS NEW.HKEY ; do new update if higher key
                2925            ; re-trigger if same key
                2930            ;    update if higher while lower keys sustained
                2935            ;        check current key against last keys sustained
                2940            ;        if a match is found, then hold last high key
FA9C- C5 0B     2945            CMP %CURNT.KEY
FA9E- F0 02     2950            BEQ HI.SUS1
FAA0- B0 09     2955            BCS NEW.HKEY ; update and trigger if higher than current held
                2960 HI.SUS1
FAA2- A2 07     2965            LDX #$07
FAA4- D5 0F     2970 SUST.CHK   CMP %LAST.KEY,X ; check for match with previous held keys
FAA6- F0 2A     2975            BEQ HELD.KEY
FAA8- CA        2980            DEX
FAA9- 10 F9     2985            BPL SUST.CHK ; check 8 keys
                2990 NEW.HKEY
FAAB- 85 42     2995            STA %MUX.KEY+6 ; high sust output
FAAD- A2 07     3000            LDX #$07     ; gate and trigger determined by this voice only
FAAF- 20 59 FB  3005            JSR TRIGGER  ; set gate high
FAB2- A5 0B     3010            LDA %CURNT.KEY
FAB4- C5 54     3015            CMP %KEY.TABLE
FAB6- 90 06     3020            BCC HI.TRIG
FAB8- A5 54     3025            LDA %KEY.TABLE
FABA- C5 0F     3030            CMP %LAST.KEY
FABC- F0 0B     3035            BEQ UPD.LSTKY
                3040 HI.TRIG
FABE- A5 03     3045            LDA %POLY.VN
FAC0- C9 06     3050            CMP #$06     ; skip high trigger for six-voice
FAC2- F0 05     3055            BEQ UPD.LSTKY
FAC4- A2 05     3060            LDX #$05
FAC6- 20 59 FB  3065            JSR TRIGGER
                3070 UPD.LSTKY
FAC9- A2 07     3075            LDX #$07
FACB- B5 54     3080 UPD.LK1    LDA %KEY.TABLE,X
FACD- 95 0F     3085            STA %LAST.KEY,X
FACF- CA        3090            DEX
FAD0- 10 F9     3095            BPL UPD.LK1
                3100 HELD.KEY
FAD2- A5 54     3105            LDA %KEY.TABLE
FAD4- 85 0B     3110            STA %CURNT.KEY ; now holds current high key depressed
FAD6- A4 03     3115            LDY %POLY.VN
FAD8- C0 06     3120            CPY #$06     ; no low keys or current high key with 6-voice
FADA- F0 34     3125            BEQ LATEST
                3130 HI.CURK    ; this voice tracks the current high key
FADC- 85 41     3135            STA %MUX.KEY+5 ; high track
FADE- A4 33     3140 LO.CURK    LDY %YTEMP   ; track current low key
FAE0- 88        3145            DEY
FAE1- 30 03     3150            BMI LO.SUSTK
FAE3- B9 54 00  3155            LDA KEY.TABLE,Y
                3160 ; STA %MUX.KEY+5 ; not output in this version
                3165 LO.SUSTK   ; track lowest key with sustain
FAE6- A6 0D     3170            LDX %LAST.LOKY
FAE8- 30 0F     3175            BMI LO.TRIG
FAEA- C5 0C     3180            CMP %CURNT.KEYL
FAEC- F0 22     3185            BEQ LATEST
FAEE- 90 09     3190            BCC LO.TRIG  ; do trigger if lower key
FAF0- A2 07     3195            LDX #$07
FAF2- D5 0F     3200 SUST.LO    CMP %LAST.KEY,X
FAF4- F0 18     3205            BEQ HELD.LOKY
FAF6- CA        3210            DEX
FAF7- 10 F9     3215            BPL SUST.LO
                3220 LO.TRIG
FAF9- 85 40     3225            STA %MUX.KEY+4 ; low sust
FAFB- A2 04     3230            LDX #$04
FAFD- 20 59 FB  3235            JSR TRIGGER
FB00- 86 0D     3240            STX %LAST.LOKY ; flag for no previous key depressed
FB02- A2 07     3245            LDX #$07
FB04- B5 54     3250 UPD.LK2    LDA %KEY.TABLE,X
FB06- 95 0F     3255            STA %LAST.KEY,X
FB08- CA        3260            DEX
FB09- 10 F9     3265            BPL UPD.LK2
FB0B- B9 54 00  3270            LDA KEY.TABLE,Y
                3275 HELD.LOKY
FB0E- 85 0C     3280            STA %CURNT.KEYL
                3285 LATEST
                3290            ; track most recent key played with trigger
```

```
FB10- A2 00     3295            LDX #$00
FB12- B5 54     3300 CK.LAST    LDA #KEY.TABLE,X
FB14- D5 21     3305            CMP #LAST.KY,X
FB16- D0 09     3310            BNE UP.NUKEY
FB18- C9 FF     3315            CMP #$FF
FB1A- F0 25     3320            BEQ NO.NEW
FB1C- E8        3325            INX
FB1D- E0 11     3330            CPX #$11
FB1F- D0 F1     3335            BNE CK.LAST
                3340 UP.NUKEY
FB21- C5 0E     3345            CMP #LAST.NUKY
FB23- F0 12     3350            BEQ UP.NUKEY2
FB25- A2 07     3355            LDX #$07
FB27- D5 21     3360 SUS.CK1    CMP #LAST.KY,X
FB29- F0 0C     3365            BEQ UP.NUKEY2
FB2B- CA        3370            DEX
FB2C- 10 F9     3375            BPL SUS.CK1
FB2E- 85 0E     3380            STA #LAST.NUKY
FB30- 85 43     3385            STA #MUX.KEY+7 ; latest key
FB32- A2 06     3390            LDX #$6      ; latest trigger
FB34- 20 59 FB  3395            JSR TRIGGER
                3400 UP.NUKEY2
FB37- A2 11     3405            LDX #$11
FB39- B5 54     3410 UP.NUKEY1  LDA #KEY.TABLE,X
FB3B- 95 21     3415            STA #LAST.KY,X
FB3D- CA        3420            DEX
FB3E- 10 F9     3425            BPL UP.NUKEY1
FB40- 60        3430            RTS
                3435 NO.NEW
FB41- 85 0E     3440            STA #LAST.NUKY
FB43- 60        3445            RTS
                3450 NO.KEY
FB44- A2 07     3455            LDX #$07
FB46- 20 5F FB  3460            JSR TRIG.NOT ; set gate low
FB49- A9 FF     3465            LDA #$FF     ; flag for no key held
FB4B- A2 07     3470            LDX #$07     ; fill all 8
FB4D- 95 0F     3475 RESET      STA #LAST.KEY,X
FB4F- 95 21     3480            STA #LAST.KY,X
FB51- 95 54     3485            STA #KEY.TABLE,X
FB53- CA        3490            DEX
FB54- 10 F7     3495            BPL RESET
FB56- 85 0D     3500            STA #LAST.LOKY
FB58- 60        3505            RTS
                3510            ;
                3515 TRIGGER
FB59- BD 6F FB  3520            LDA MASK,X
FB5C- 95 44     3525            STA #TRIG.DATA,X
FB5E- 60        3530            RTS
                3535 TRIG.NOT
FB5F- A9 00     3540            LDA #$00
FB61- 95 44     3545            STA #TRIG.DATA,X
FB63- BD 6F FB  3550            LDA MASK,X
FB66- 49 FF     3555            EOR #$FF
FB68- 2D 00 F6  3560            AND TRIG.PORT
FB6B- 8D 00 F6  3565            STA TRIG.PORT ; gates set low here not in MULTIPLEX routine
FB6E- 60        3570            RTS
                3575            ;
FB6F- 01 02 04  3580 MASK       .BY $1 $2 $4 $8 $10 $20 $40 $80
FB72- 08 10 20
FB75- 40 80
                3585            ;
                3590            IFE DISK
                3595 PAGE1.TMP  .DS $11      ; for return of RAE parameters
                3600 STOR.SPC   .DE END.PO-PAGE.ZERO
                3605 PAGE0.TMP  .DS STOR.SPC
                3610            ###
                3615            ;
FB77- EA        3620 END.RAM    NOP
                3625            ;
                3630            ;
                3635 VIA1       .DE EMULATOR+$500
                3640 VIA2       .DE EMULATOR+$600
                3645            ;
                3650            ; 6522 Addresses
                3655 IER        .DE VIA1+$0E
                3660 IFR        .DE VIA1+$0D
                3665 PCR        .DE VIA1+$0C ; CA1 input from Casio Drive pulse #1
                3670 ACR        .DE VIA1+$0B
                3675 T2         .DE VIA1+$08
                3680 TIMER      .DE VIA1+$04 ; IRQ timer for sync to Casio pulse
                3685 SENSE.DIR  .DE VIA1+$03
                3690 DAC.DIR    .DE VIA1+$02
                3695 SENSE.PORT .DE VIA1+$01 ; Casio Sense inputs
```

```
3700 DAC.PORT   .DE VIA1+$00 ; 7523 data
3705            ;
3710 ; Second 6522
3715 IER.2      .DE VIA2+$0E
3720 IFR.2      .DE VIA2+$0D
3725 PCR.2      .DE VIA2+$0C
3730 ACR.2      .DE VIA2+$0B
3735 T2.2       .DE VIA2+$08
3740 TIMER.2    .DE VIA2+$04
3745 MUX.DIR    .DE VIA2+$03
3750 TRIG.DIR   .DE VIA2+$02
3755 MUX.CTL    .DE VIA2+$01 ; bit 0,1,2=Multiplex control, bit 7 = inhibit
3760 TRIG.PORT  .DE VIA2+$00
3765            ;
3770            ;
3775            .EN
```

LABEL FILE: [/ = EXTERNAL]

```
/DISK=0001              /EMULATOR=F000          /RAM=7000
/POLYV=0004             NMI.ROM=FFFA            RESET.ROM=FFFC
JMP.IRQ=FFFE            IRQ.VEC=0001            POLY.VN=0003
EVEN.FLAG=0004          PW=0005                 KEY=0007
TEMPX2=0009             BIT.NUM=000A            CURNT.KEY=000B
CURNT.KEYL=000C         LAST.LOKY=000D          LAST.NUKY=000E
LAST.KEY=000F           LAST.KY=0021            YTEMP=0033
STROBE=0034             MUX.KEY=003C            TRIG.DATA=0044
LATCH=004C              KEY.TABLE=0054          /PAGE.ZERO=009E
/END.P0=00F8            /PAGE.ONE=0100          CASIO=F800
LOOP=F807               UP.2=F81D               TUNE.2=F821
MODE.SW=F82E            VOICE.6=F83F            VOICE.8=F849
VOICE.X=F84B            EXEC=F84D               CAS.INIT=F859
RST.LOOP1=F85C          RST.LOOP=F85E           MKEY.INIT=F89F
GET.TIME=F8AA           TIME.IRQ=F8B3           IRQ.EXIT=F8C0
GET.D1=F8C7             START.D1=F8CB           END.D1=F8E4
GET.D1.X=F8FB           DSYNC.IRQ=F912          CAS.IRQ=F918
EX.TIMER=F930           D1.STROBE=F933          MULTIPLEX=F948
END.MUX=F968            SET.PW.IRQ=F975         CA1.ENAB=F982
GET.KEY=F99A            C5.X=F9A8               NXT.SENSE=F9AE
SHORT.CUT=F9BA          FIND.BIT=F9C6           GOT.KEY=F9CB
C5.GOT=F9D6             FIND.BIT2=F9D7          CK.C1=F9DD
C1.X=F9E9               END.C1=F9ED             OCT.CHK=F9F8
OCT.X=FA08              N.VOICE=FA09            N.VOICE1=FA0B
MATCH=FA11              MATCH1=FA14             GET.AVAIL=FA1C
GET.AV1=FA1F            GOT.AVAIL=FA27          SET.GATE=FA2B
NO.AVAIL=FA3B           DEACT=FA3C              DEACT.1=FA3F
DEAC.MACH=FA47          NX.MATCH=FA4F           NO.MATCH=FA53
SKIP=FA6B               NO.MONO=FA6F            MONO.KP=FA70
FOUR.V=FA7A             SIX.V=FA84              SIX.V1=FA92
HI.SUSTK=FA98           HI.SUS1=FAA2            SUST.CHK=FAA4
NEW.HKEY=FAAB           HI.TRIG=FABE            UPD.LSTKY=FAC9
UPD.LK1=FACB            HELD.KEY=FAD2           HI.CURK=FADC
LO.CURK=FADE            LO.SUSTK=FAE6           SUST.LO=FAF2
LO.TRIG=FAF9            UPD.LK2=FB04            HELD.LOKY=FB0E
LATEST=FB10             CK.LAST=FB12            UP.NUKEY=FB21
SUS.CK1=FB27            UP.NUKEY2=FB37          UP.NUKEY1=FB39
NO.NEW=FB41             NO.KEY=FB44             RESET=FB4D
TRIGGER=FB59            TRIG.NOT=FB5F           MASK=FB6F
END.RAM=FB77            /VIA1=F500              /VIA2=F600
/IER=F50E               /IFR=F50D               /PCR=F50C
/ACR=F50B               /T2=F508                /TIMER=F504
/SENSE.DIR=F503         /DAC.DIR=F502           /SENSE.PORT=F501
/DAC.PORT=F500          /IER.2=F60E             /IFR.2=F60D
/PCR.2=F60C             /ACR.2=F60B             /T2.2=F608
/TIMER.2=F604           /MUX.DIR=F603           /TRIG.DIR=F602
/MUX.CTL=F601           /TRIG.PORT=F600
//0000,FB78,7378
>
```

Another
MICROsport™
Product

MICROsport MicroComputer

Model MMC/03D - Development Unit

Model MMC/03A - Application Unit

R. J. BRACHMAN ASSOCIATES, INC.
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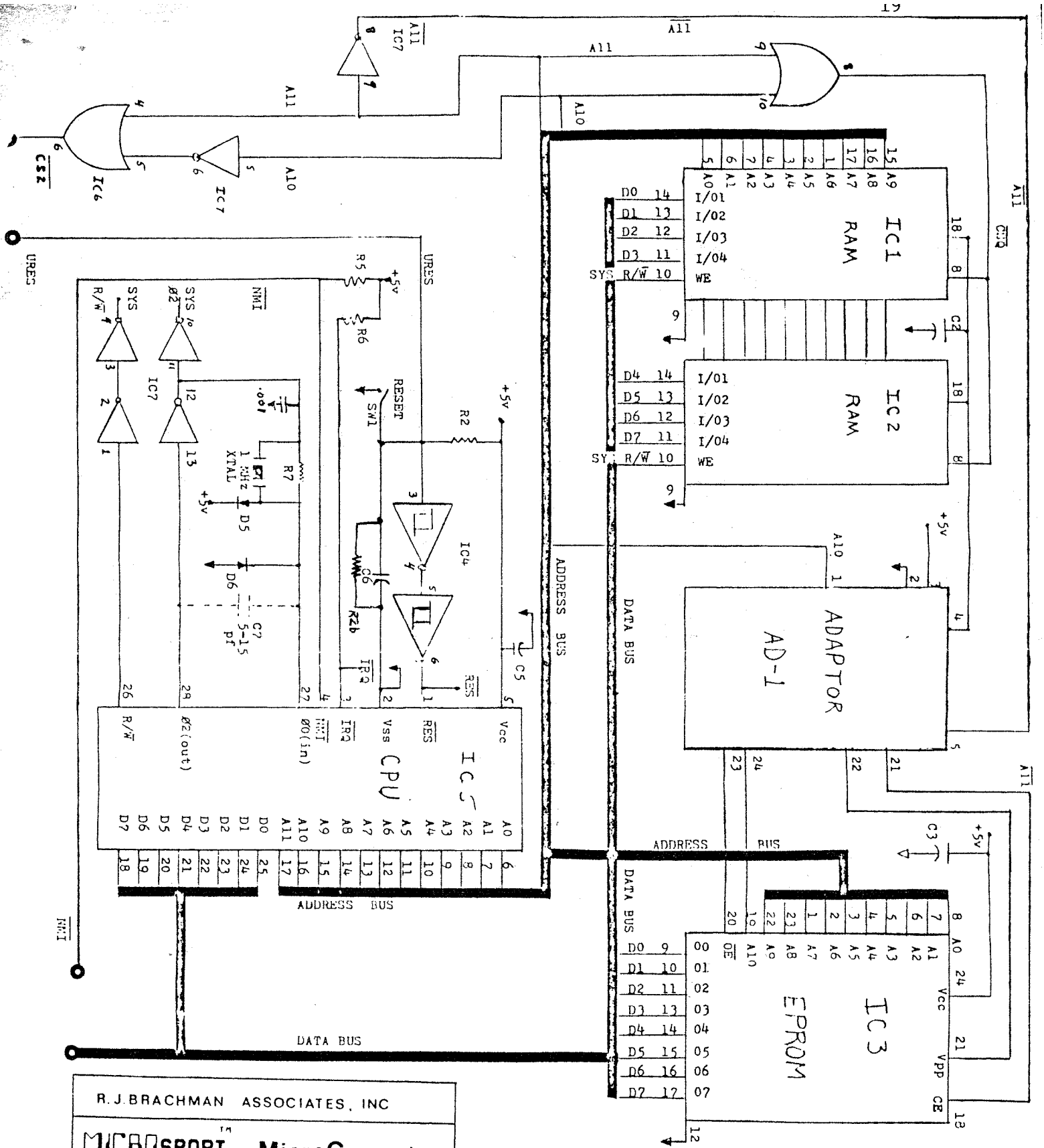
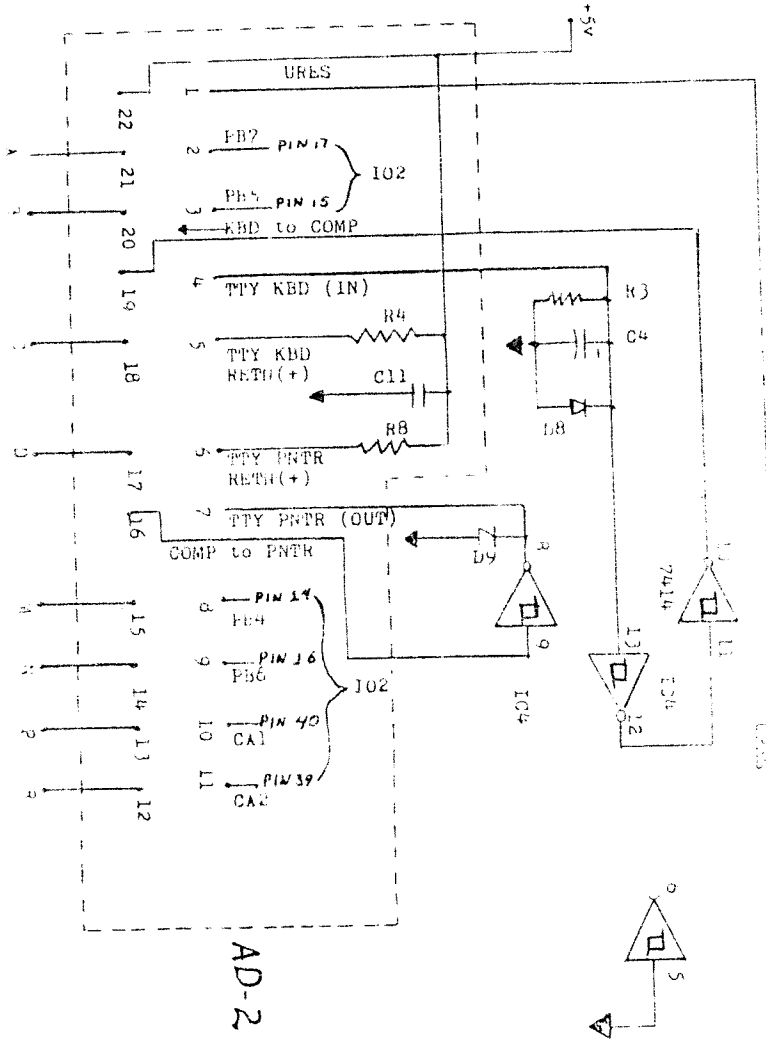


R.J.BRACHMAN ASSOCIATES, INC	
MICROSPORT™ MicroComputer MMC (PAT. PENDING)	
DATE July 7, 1977	DWG. NO. 2010
SCALE N/A	DRAWN BY BIB
REV NO. 10-3/10/80	SHEET 3 of 3

Figure 3



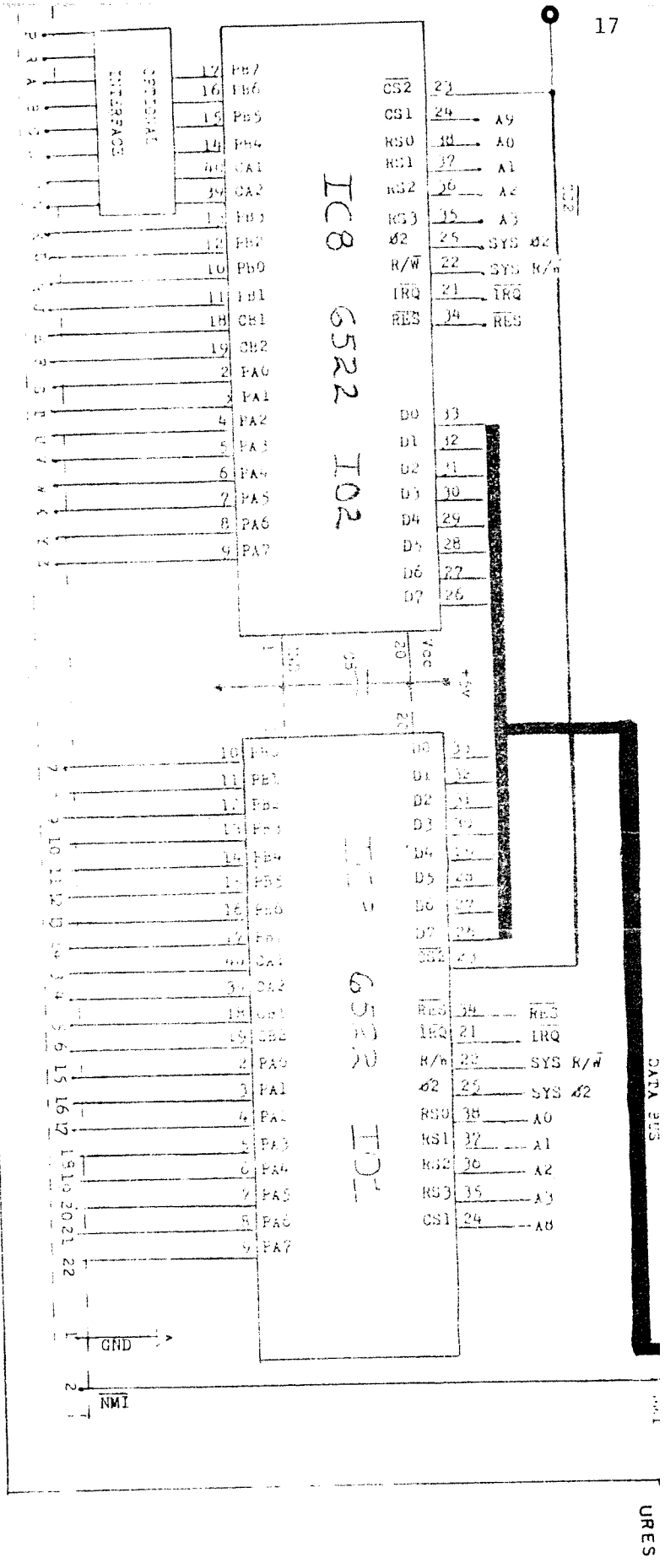


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Figure 1

MMC Parts List

Description	Quantity	Location
MPS6503	1	U5
MPS6522	2	U8, U9
MPS2114	2	U1, U2
74LS04	1	U7
74LS32	1	U6
7414	1	U4
Crystal C1YA	1	Y1
Res. 1/4W 10	1	R4
Res. 1/4W 150	1	R8
Res. 1/4W 220	1	R1, R3
Res. 1/4W 4.7K	2	R5, R6
Res. 1/4W 220K	1	R7
Res. 1/4W 2.2K, 1K	1,1	R2, R2b
Diode 1N914	2	D5, D6
Diode 1N4001	6	D1-4, D8, D9
Zener 6.3V 500mW	1	D7
LED - Green	1	LED1
Voltage regulator	1	U10
(optional) Cap.		C7
Cap. .1 uF	5	C3, C5, C8, C11, C2
Cap. 22uF	1	C6
Cap. 4.7 uF	1	C4
Cap. 100 uF	1	C1
Cap. 1000 uF	1	C9
Socket - 28 pin (ZIF)	1	U5
Socket - 24 pin (ZIF)	1	U3
Socket - 24 pin (ZIF)	1	AD1
PC board	1	PC1
Switch PB ⌿ NO	1	SW1
Terminal block	1-4	TB1
Standoffs	4	
Header (green) 24 pin	1	MMC/03 - HD1 - 1
Header 22 pin	1	MMC/03 - HD2 - 1

Note: Development unit has 2 ZIF sockets as described above. Application unit has standard sockets.

RJB ASSOCIATES, INC.