SSB-MPF-IP

SPEECH SYNTHESIZER BOARD OPERATION MANUAL

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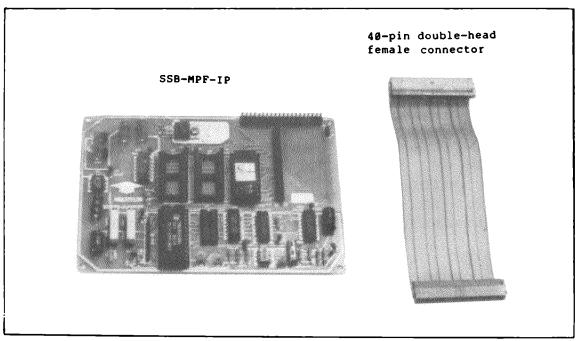
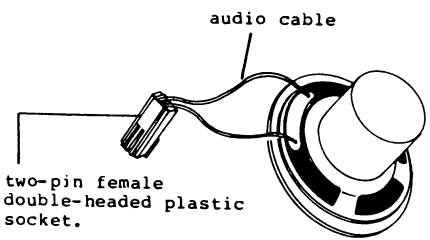
CONGRATULATIONS

Your SSB-MPF-IP will help you discover the mystery of speech synthesis. Unpacking your SSB-MPF-IP package, you will find:

1) The SSB-MPF-IP board, a complete speech synthesis system.
2) Operation Manual.
3) A 40-pin double-head female cable connector.
4) An audio jumper wire.
5) A two-pin male connector.
6) A 9V, 200mA power adaptor.





I. INTRODUCTION

SSB-MPF-IP is a Speech Synthesizer Board especially designed to be used with MPF-IP. It is a low-cost, programmable printed circuit board based on Texas Instruments' Voice Synthesis Processor TMS5220. However, SSB-MPF-IP itself is a complete speech synthesis system.

Before we go into details of our SSB-MPF-IP, we would like to introduce briefly the principles on how speech synthesis system works and what is a speech synthesis system.

The diagram below shows a speech synthesis system. Varying air pressure of sound and voices, after being received by the microphone, is transformed into varying voltages and frequency. Varying electrical voltages frequencies are further converted through a converter to digital signals which afterwards go through the digital speech analyzer and a coding process, and are eventually stored in the Read Only Memory (ROM). To reproduce the sound signals stored in the ROM, the data in the ROM should go through a decoding process, a digital speech synthesizer before being converted into analog electrical voltages and frequencies which activate a speaker.

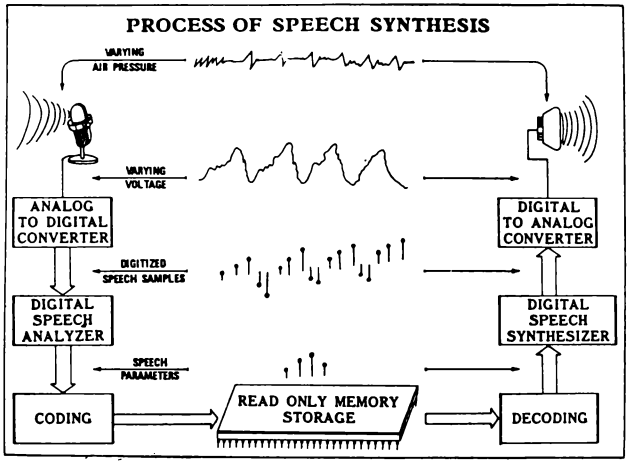


Figure 1-1 Process of Speech Synthesis

In short, a speech synthesis board is a printed circuit board which can reproduce different voices and sounds. The Multitech SSB-MPF-IP is a typical speech synthesis board with these functions.

Users can easily operate the SSB-MPF-IP after connecting the SSB-MPF-IP to MPF-IP with a flat 40-pin female double-head cable.

The technology of speech synthesis, first commercially introduced by TI for use on automobile gadgetry, has been used for applications on modern daily life for some time. The Multetich SSB-MPF-IP speech board will lead you discover the interesting and mysterious world of "speaking" boards at the lowest possible cost.

Ⅱ. FEATURES

The most outstanding feature of SSB-MPF-IP is that it is a basic as well as complete speech synthesis system. Therefore, a beginner can use the system with ease to understand every aspect about speech synthesis systems. Yet, the simplicity in design of the SSB-MPF-IP makes the machine highly reliable and cost-efficient. The major features of the SSB-MPF-IP are as follows:

A. Structure: (See Figure 2-1)

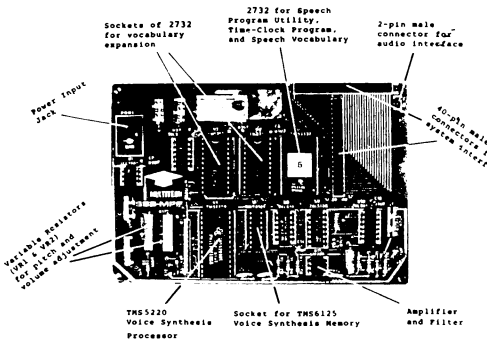


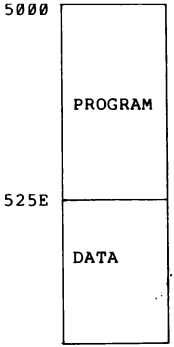
Figure 2-1

B. System Control Unit

1) TI's TMS5220 Voice Synthesis Processor is the speech synthesizer of the speech synthesis system.
2) The host controller of the system (SSB-MPF-IP) is the Z-80 CPU on MPF-IP.

C. Memory: featuring strong vocabulary expansion ability.

1) The memory chip 2732 on the board is used to store speech data and utility programs for demonstration purpose.



The functions of the on-board memory are list below.

* Talking clock
* Speak the built-in vocabulary
* Speak the vocabulary in expansion memory
* Speak a single word

2) The two sockets, U3 and U4, are reserved for two optional memory chips of TMS2732 to expand SSB-MPF-IP vocabulary.

3) A socket (U7) is reserved for TMS6125, the 32K bits ROM, which functions as the advanced Voice Synthesis Memory (VSM) for storing speech data.

D. System input/output devices:

1) The data input device of the speech synthesis system is the keyboard of the MPF-IP.

2) The data output devices of the system are the speaker and a six-digit display panel above the keyboard.

3) An external speaker can be connected to the SSB-MPF-IP with audio jumper wire, Jumper 2.

E. System power supply: It only needs 5V, 200mA to operate.

F. System interface: Two 40-pin male double-head cable connectors are used for any possible external connection such as interfacing with MPF-IP or with our EPB-MPF-IP (EPROM Programmer Board).

Ⅲ. FUNCTIONAL DESCRIPTION

The major functional units of the SSB-MPF-IP are shown in figure 3-1 and described below:

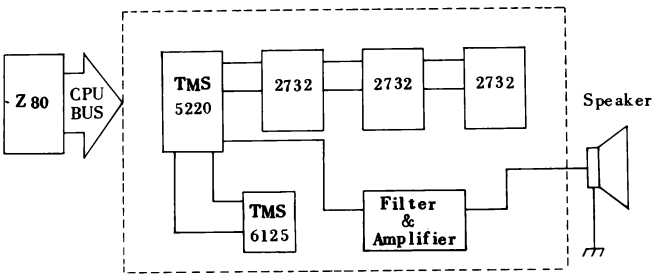


Figure 3-1 Block Diagram of SSB-MPF-IP

1) Voice Synthesis Processor:

a) TI's solid state speech chip TMS5220 is used as VSP of the unit. It can fetch speech data and programs stored in memory chips such as 2732, and reproduce or synthesize human voice through filter/amplifier and speaker.

b) The TMS5220 VSP operates on Linear Predictive Coding (LPC) method, which converts analog speech data to digital data that are suitable for processing by VSP. The TMS5220 can access LPC-encoded data stored in memory and convert the data into sound signal of specific pitch and amplitude.

2) Speech Data EPROM: The maximum memory capacity of the system can be expanded to 12K bytes by adding two more additional 2732 memory chips to the system. The speech data is encoded in LPC which provides a speech quality comparable to that of voices generated by Pulse-Coded Modulation (PCM) system. Furthermore, it only takes 1200 bits to memorize the speech data that is produced in one second in the LPC system. In the PCM system, it takes 64,000 bits to memorize the speech data that is produced in one second.

3) System Z-80 Controller: The Z-80 CPU on the MPF-IP is used as speech synthesis system controller. It accepts the commands from MPF-IP keyboard and fetches the speech programs.

4) Filter: A low-pass filter is used to generate smooth and clear speech signal.

5) Amplifier: An audio amplifier is used to drive the 8 Ohm speaker.

IV. INSTALLATION PROCEDURES

1. Before connecting the SSB-MPF-IP to the MPF-IP, make sure that the electricity power source for both are not plugged.

2. Connect the speech synthesis system (SSB-MPF-IP) to the external speaker in the following steps:

   A. Locate the external speaker and the two-pin audio cable that come in with the package of SSB-MPF-IP. The two-pin audio cable is soldered to the speaker as shown in Fig. 4-1 below:

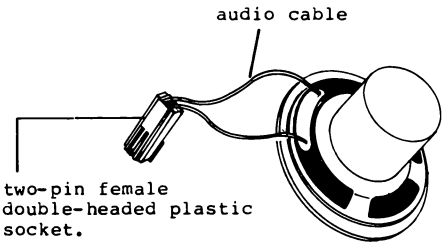


Fig. 4-1 Speaker with soldered audio cable.

The other end of the audio cable is fitted with a two-pin female double-headed plastic socket.

B. Locate the audio socket on the upper right corner of the SSB-MPF-IP as shown in Fig. 4-2.

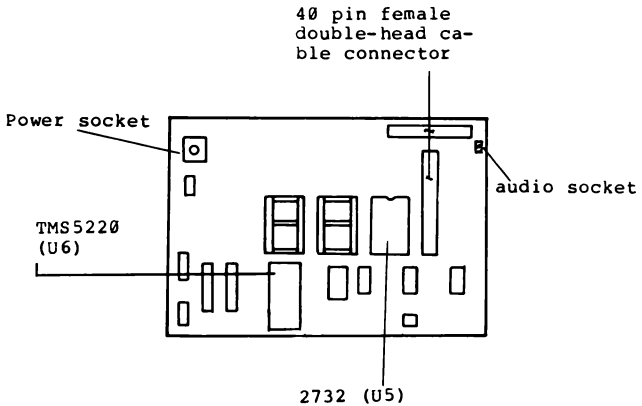


Fig. 4-2 Audio socket on the SSB-MPF-IP

C. Plug the two-pin female double-head socket from the speaker to the 2 pins of the audio socket in the upper right corner of the SSB-MPF-IP as shown below in Fig. 4-3.

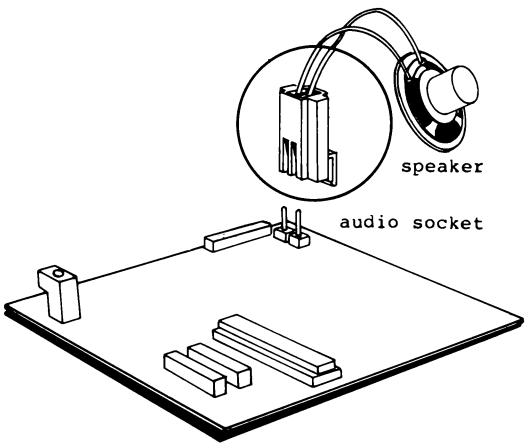


Fig.4-3 Connection of SSB-MPF-IP to the speaker

3. Connect the SSB-MPF-IP to the MPF-IP with a 40 pin female double-head cable connector as shown in Fig. 4-4.

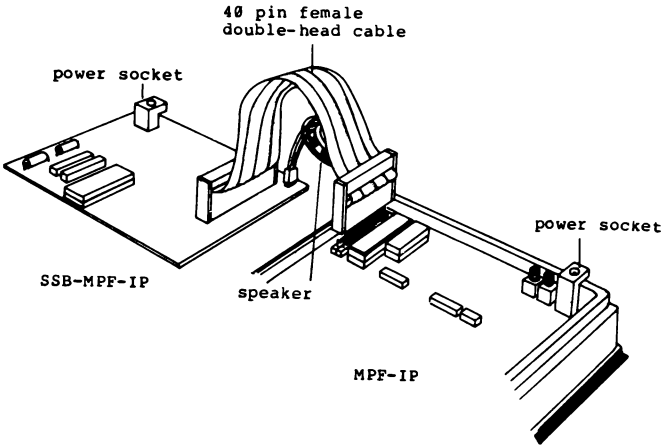


Fig. 4-4 Connection of SSB-MPF-IP to MPF-IP

4. Connect the SSB-MPF-IP and MPF-IP to their respective power sources:

   A. An adaptor (9V, 600mA, output) is plugged to the power socket in the upper right corner of the MPF-IP.

   B. An adaptor (9V, 200mA, output) is then plugged to the power socket in the upper left corner of the SSB-MF-IP.

Note: The power source for the SSB-MPF-IP can ONLY be connected after the power source for MPF-IP has been connected.

Now, we have completed the installation procedures, and will proceed to test our speech synthesis system, SSB-MPF-IP.

V. OPERATION PROCEDURES

1. TALKING CLOCK

Once your SSB-MPF-IP have been interfaced, the system is ready for test run. To test run the system, our Time-clock Program is used for you to familiarize with the operations of the system. The running of our time-clock Program is as easy as adjusting the time of a digital watch.

Before running the Time-clock Program on the system, you have to set the time of the system to the current time. After you have keyed in the time, press key (G), 5000 and ⏎. The system will start displaying time on its display panel, and it will announce the time in English in an interval of one minute. For example, if the display panel of the system shows 09:21:58, the system will announce in English "Nine, twenty-two" after two seconds, while the display panel showing 09:22:00. A full sentence --"It is X o'clock AM (or PM)"--will be heard each hour as long as the Time-clock Program is kept on.

If the current time is 9:53 a.m., the steps you have to follow in executing the Time-clock Program are as follows:

Step 1: Press key M.
Step 2: Press key F800.
Step 3: Press key :
Step 4: Set hour: press key 09; then press space key.
Set minute: Press key 53; then press space key.
Set second: press key 00; then press space key.
Set AM/PM : press key 10/11; then press key ⏎
Please take note that 10 signifies AM, while 11 signifies PM.
Step 5: press key "G" 5000, then press key ⏎.

You will be amazed at how the system works. If it doesn't work, please check if the SSB-MPF-IP is operated correctly and try again.

2. SPEAKS ALL THE BUILT-IN VOCABULARY

Run the program starting at memory 51F9. The operation sequence is pressing "G" 51F9 and <⏎. Then it will speak the first word in the built-in vocabulary--"THE" and display "SPEECH". Any time it displays "SPEECH" means it is ready to accept the command from the keyboard. Press the "R" key will repeat the same word and press the "N" key will speak the next word. It will speak the first word after speaking the last word.

3. SPEAKS THE VOCABULARY IN EXPANSION MEMORY

a) Before running this program, you should put the 2732 with speech data in either socket U3(or U4). And there should have a look-up table in your 2732. The format of the look-up table is shown below.

2732 address	Data
FFF	low order byte of starting address of first speech data
FFE	high order byte of starting address of first speech data
FFD	low order byte of starting address of second speech data
FFC	high order byte of starting address of second speech data
XXX	low order byte of starting address of last speech data
XXX	high order byte of starting address of last speech data
XXX	FF
XXX	FF(end of speech data)

b) After putting the 2732 into the U3 (or U4), set the starting address of your speech data in memory location F00C and F00D , ie, set 7000 (or 6000) in memory location F00C and F00D. Then run the program starting at 51FF. The operation sequence is:

Step 1: press key M.
Step 2: press key F80C.
Step 3: press key :
Step 4: press key 00; then press space key.
press key 60(70): then press ⏎.
Step 5: press key "G", 51FF: then press ⏎.

After finishing the five steps, the SSB-MPF-IP will speak the vocabulary in the expansion memory the same way as it speaks the built-in vocabulary.

c) If you want to put the speech data in other 4K memory segment, you can set the starting address of your speech data memory in location F00C and F00D and run the program starting at 51FF. It will speak the vocabulary too.

4. SPEAK A SINGLE WORD

"Set the starting address of the speech data of the word in memory location F00E and F00F and run the program starting at 5179. For example, if you want to speak the word with its speech data starting at memory location 525E, first set 525E in memory location F00E and F00F then run the program starting at 5179. The operation sequence is:"

Step 1: press key M
Step 2: press key F80E
Step 3: press key :
Step 4: press key 5E,then press space key
press key 52, then press 
press key "G" 5179, then press 

Ⅵ. VOICE VOLUME AND PITCH ADJUSTMENT

Sound reproduced by the system can be easily adjusted for desirable effects.

A. The Adjustment of VR-1:

1) To lower the voice pitch, turn the adjusting screw of VR-1 (Variable resistor-1) clockwise.

2) To increase the voice pitch, turn the adjusting screw of VR-1 counterclockwise. This may require more than one or two turns, depending on the efficiency of the speaker used.

B. The Adjustment of VR-2:

1) To lower the voice volume, turn the adjusting screw of VR-2 clockwise.

2) To increase the voice volume, turn the adjusting screw of VR-2 counterclockwise.

This also may require more than one or two turns, depending on the efficiency of the speaker used.

Please take note that the position of the VRs with respect to the SSB-MPF-IP should be the same as Fig. 6-1 below:

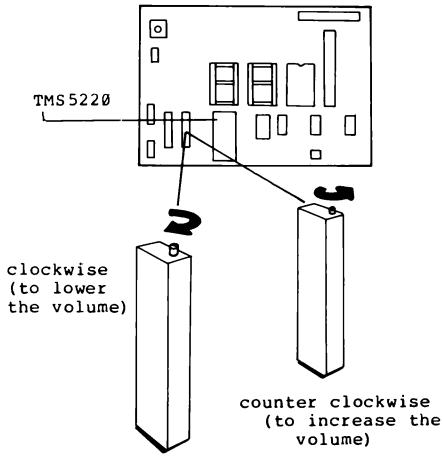


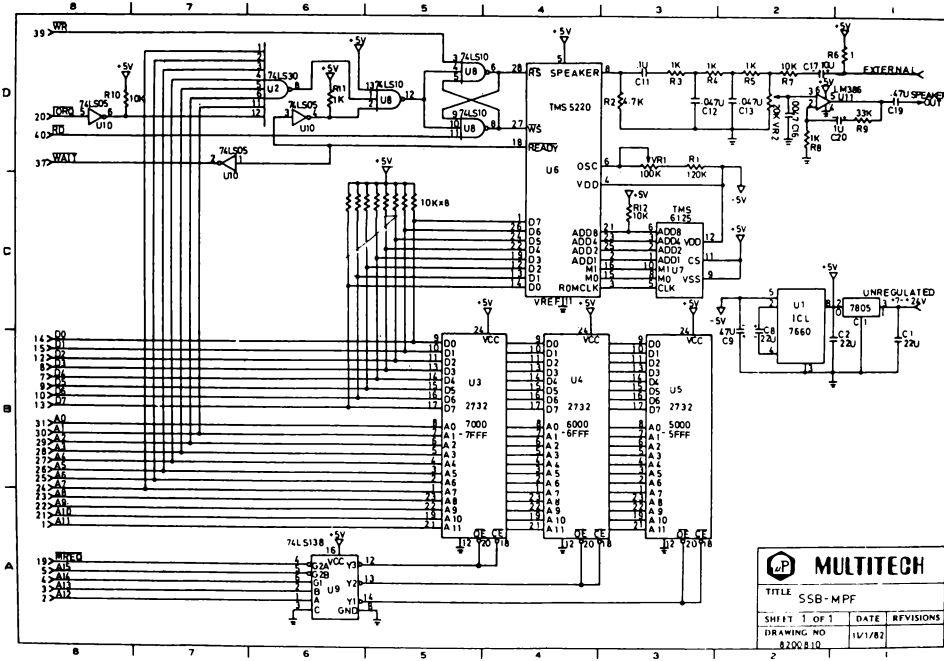
Fig. 6-1 Position of the VRs.

VII. SPECIFICATIONS

1)	Power Requirement:		+5V, ±5%, 200mA
2)	Connector	:	D-Connector double-head 40 holes
3)	Size	:	Width - 10.9 cm Length - 15.8 cm
4)	Environment	:	Operating temperature 0° C to 40° C Storage temperature 125° C to 80° C Relative Humidity Noncondensing up to 90%

Ⅷ. APPENDICES

1. SCHEMATIC


MULTITECH
TITLE SSB-MPF
SHEET 1 OF 1
DATE 11/1/82
DRAWING NO 8200810
REVISIONS
TMS 5220
SPEAKER
EXTERNAL
47U SPEAKER OUT
TMS 6125
ROMCLK
VREF
UNREGULATED
ICL 7660
7805
U3 2732
U4 2732
U5 2732
74LS138
WR
RD
IORQ
WAIT
MREQ
10K×8

2. SSB-MPF-IP PROGRAM

```
                    1  ;
                    2  ;       *********************************
                    3  ;       *                               *
                    4  ;       *          SSB-MPF-IP           *
                    5  ;       *                               *
                    6  ;       *********************************
                    7  ;
                    8  ;COPYRIGHT, MULTITECH INDUSTRIAL CORP. 1982.
                    9  ;Written by the engineer of R&D department
                   10  ;Routine address is 5000H
                   11  ;Demo program of SSB-MPF-IP. Talking clock in English.
                   12  ;This program is to tell you the current time.
                   13  ;Before you run this program, set the time buffer
                   14  ;including SECOND, MINUTE, HOUR, and AM PM flag.
                   15  ;For example:      buffer adds       time indicate
                   16  ;          HOUR          F800H              10
                   17  ;          MINUTE        F801H              40
                   18  ;          SECON         F802H              55
                   19  ;          AM/PM         F803H              10/11
                   20  ;
                   21  SCAN     EQU     0246H   ;Utility subroutine of MPF-IP
                   22  SCAN1    EQU     029BH   ;Utility subroutine of MPF-IP
                   23  DEC-SP   EQU     0399H   ;Utility subroutine of MPF-IP
                   24  PORT     EQU     0FEH    ;I/O port of SSB-MPF-IP
                   25  CLEAR    EQU     09B9H   ;Utility subroutine of MPF-IP
                   26  DISP     EQU     0FF84H  ;The buffer of display buffer
                   27                           ;pointer
                   28  MSG      EQU     09CAH   ;Utility subroutine of MPF-IP
                   29  DISPBF   EQU     0FF2CH  ;Display buffer
                   30  CONVER   EQU     0821H   ;Utility subroutine of MPF-IP
5000               31           ORG     5000H
                   32  ; ONESEC loop takes one second to execute,include
                   33  ; six subroutine and one delay loop.
5000  CDB909       34  ONESEC   CALL    CLEAR           ;clear display buffer,
                   35                                   ;make OUTPTR and DISP
                   36                                   ;initial position
5003  3A03F8       37           LD      A,(APMFLG)
5006  CB47         38           BIT     0,A             ;cheak AM or PM
5008  2805         39           JR      Z,AMD
500A  21C851       40           LD      HL,PM
500D  1803         41           JR      MID
500F  21C351       42  AMD      LD      HL,AM
5012  CDCA09       43  MID      CALL    MSG             ;convert ascii code to
                   44                                   ;display format
5015  CD9903       45           CALL    DEC-SP          ;delete cursor
5018  CD7B50       46           CALL    BFUPDT
501B  063E         47           LD      B,62
501D  DD212CFF     48           LD      IX,DISPBF
5021  CD9B02       49  LOOP1    CALL    SCAN1           ;the time of SCAN1 is
                   50                                   ;about 15.667mS
5024  C5           51           PUSH    BC
5025  0601         52           LD      B,01H
5027  10FE         53  TEMP     DJNZ    TEMP            ;addition delay
5029  C1           54           POP     BC
502A  10F5         55           DJNZ    LOOP1
502C  CD3150       56           CALL    TMUPDT
502F  18CF         57           JR      ONESEC
                   58  ;TMUPDT is a time buffer updata subroutine
```

```
5031  217A50      59  TMUPDT  LD      HL,MAXTAB+2
5034  1102F8      60          LD      DE,SEC
5037  0603        61          LD      B,3
5039  37          62          SCF
503A  1A          63  TMINC   LD      A,(DE)
503B  CE00        64          ADC     A,0
503D  27          65          DAA
503E  12          66          LD      (DE),A
503F  96          67          SUB     (HL)            ;compare with MAX_TABLE
5040  3801        68          JR      C,COMPL
5042  12          69          LD      (DE),A
5043  3F          70  COMPL   CCF
5044  2B          71          DEC     HL
5045  1B          72          DEC     DE
5046  10F2        73          DJNZ    TMINC
5C48  3A00F8      74          LD      A,(HOUR)
504B  A7          75          AND     A
504C  2815        76          JR      Z,SUC           . ;if reach max, jump to
                  77                                  ;routine SUC
504E  3C          78          INC     A
504F  FE13        79          CP      13H
5051  2015        80          JR      NZ,HAL          ;over twelve o'clock ?
5053  3A03F8      81          LD      A,(APMFLG)
5056  CB67        82          BIT     4,A
5058  2016        83          JR      NZ,CONT
505A  EE01        84          XOR     01H             ;change AM to PM; PM
                  85                                  ;to AM
505C  F610        86          OR      10H
505E  3203F8      87          LD      (APMFLG),A
5061  180D        88          JR      CONT
5063  3E01        89  SUC     LD      A,1H
5065  3200F8      90          LD      (HOUR),A
5068  3A03F8      91  HAL     LD      A,(APMFLG)
506B  E6EF        92          AND     0EFH
506D  3203F8      93          LD      (APMFLG),A
5070  3A02F8      94  CONT    LD      A,(SEC)         ;one minute is up ?
5073  A7          95          AND     A
5074  CCA750      96          CALL    Z,SPEAK
5077  C9          97          RET
5078  13          98  MAXTAB  DEFB    13H
5079  60          99          DEFB    60H
507A  60         100          DEFB    60H
                 101  ;BFUPDT is a subroutine where display time buffer
                 102  ;is updataed
507B  1138FF     103  BFUPDT  LD      DE,DISPBF+12
507E  ED5384FF   104          LD      (DISP),DE
5082  0603       105          LD      B,3
5084  2100F8     106          LD      HL,TMBF
5087  3E30       107  LOOP2   LD      A,30H
5089  ED6F       108          RLD
508B  F5         109          PUSH    AF
508C  CD2108     110          CALL    CONVER          ;convert ascii code to
                 111                                  ;display format
508F  F1         112          POP     AF
5090  ED6F       113          RLD
5092  F5         114          PUSH    AF
5093  CD2108     115          CALL    CONVER
5096  F1         116          POP     AF
```

```
5097  ED6F          117          RLD
5099  23            118          INC     HL
509A  ED5B84FF      119          LD      DE,(DISP)
509E  13            120          INC     DE
509F  13            121          INC     DE
50A0  ED5384FF      122          LD      (DISP),DE
50A4  10E1          123          DJNZ    LOOP2
50A6  C9            124          RET
                    125  ;
                    126  ;SPEAK routine is executed when every minute
                    127  ;is reach. It include many subroutines as the
                    128  ;following:
                    129  ;           1. APMDEC- AM or PM decision
                    130  ;           2. CHKOCK- check the o'clock
                    131  ;                      time
                    132  ;           3. SPKPM - speak PM and save
                    133  ;                      the speech address
                    134  ;           4. GO*   - tell time routine
                    135  ;           5. CNTMIN- check and count the
                    136  ;                      updated time
                    137  ;
                    138  ;
50A7  3E02          139  SPEAK   LD      A,2
50A9  3202F8        140          LD      (SEC),A          ;compensate timing
                    141                                   ;lose during the
                    142                                   ;speech routine
50AC  21AF51        143          LD      HL,HOUR_MIN
50AF  3A00F8        144          LD      A,(HOUR)
50B2  87            145          ADD     A,A
50B3  5F            146          LD      E,A
50B4  1600          147          LD      D,0
50B6  19            148          ADD     HL,DE
50B7  2204F8        149          LD      (TLKHOR1),HL
                    150  APMDEC                           ;this routine decide AM
                    151                                   ;or PM
50BA  3A03F8        152          LD      A,(APMFLG)       ;define bit0=0,AM
                    153                                   ;       bit0=1,PM
50BD  CB47          154          BIT     0,A
50BF  2008          155          JR      NZ,SPKPM         ;PM is speaking
50C1  2AF551        156          LD      HL,(AMADDS)
50C4  220AF8        157          LD      (APMTLK),HL      ;APMTLK choice talk
                    158                                   ;AM or PM
50C7  1806          159          JR      CHKOCK
50C9  2AF751        160  SPKPM   LD      HL,(PMADDS)
50CC  220AF8        161          LD      (APMTLK),HL
50CF  3A01F8        162  CHKOCK  LD      A,(MIN)          ;check the o'clock
50D2  A7            163          AND     A                ;
50D3  2025          164          JR      NZ,CNTMIN        ;if minute is not
                    165                                   ;zero check the
                    166                                   ;actual minute no.
                    167  ;
                    168  ;GO routine is to tell o`clock time
                    169  ;include AM,PM
                    170  ;GO* routine save all the update time
                    171  ;HOUR and MINUTE. Speech routine is
                    172  ;called now.
                    173  ;
                    174  GO
```

```
50D5  21EF51      175          LD      HL,THE
50D8  CD7251      176          CALL    START           ;speak "the"
50DB  21F151      177          LD      HL,TIME
50DE  CD7251      178          CALL    START           ;speak "time"
50E1  21F351      179          LD      HL,IS
50E4  CD7251      180          CALL    START           ;speak "is"
50E7  2A04F8      181          LD      HL,(TLKHOR1)
50EA  CD7251      182          CALL    START
50ED  21CD51      183          LD      HL,JUST
50F0  CD7251      184          CALL    START           ;speak "o`clock"
50F3  210AF8      185          LD      HL,APMTLK
50F6  CD7251      186          CALL    START           ;speak AM or PM
50F9  C9          187          RET
                  188
                  189  ;
                  190  ;CNTMIN routine to count the updata minutes
                  191  ;for the GO routine to tell actual time reach
                  192  ;including hour and minutes.
                  193  ;
50FA  3A01F8      194  CNTMIN   LD      A,(MIN)
50FD  FE10        195          CP      10H
50FF  3837        196          JR      C,CNTMN2
5101  FE20        197          CP      20H
5103  3854        198          JR      C,CNTMN1
5105  3A01F8      199  CNTMN3  LD      A,(MIN)
5108  E60F        200          AND     0FH
510A  21AF51      201          LD      HL,HOUR-MIN
510D  87          202          ADD     A,A
510E  85          203          ADD     A,L
510F  6F          204          LD      L,A
5110  2208F8      205          LD      (TKMIN2),HL
5113  3A01F8      206          LD      A,(MIN)
5116  0F          207          RRCA
5117  0F          208          RRCA
5118  0F          209          RRCA
5119  0F          210          RRCA
511A  E60F        211          AND     0FH
511C  21E351      212          LD      HL,TXBLE-MIN
511F  87          213          ADD     A,A
5120  85          214          ADD     A,L
5121  6F          215          LD      L,A
5122  2206F8      216          LD      (TLKMIN1),HL
                  217  ;
                  218  ;GO3 routine is to tell minute time
                  219  ;above 20.
                  220  ;
5125  2A04F8      221  GO3     LD      HL,(TLKHOR1)
5128  CD7251      222          CALL    START
512B  2A06F8      223          LD      HL,(TLKMIN1)
512E  CD7251      224          CALL    START
5131  2A08F8      225          LD      HL,(TKMIN2)
5134  CD7251      226          CALL    START
5137  C9          227          RET
5138  3A01F8      228  CNTMN2  LD      A,(MIN)
513B  E60F        229          AND     0FH
513D  21AF51      230          LD      HL,HOUR-MIN
5140  87          231          ADD     A,A
5141  85          232          ADD     A,L
```

```
5142  6F          233          LD      L,A
5143  2208F8      234          LD      (TKMIN2),HL
                  235  ;
                  236  ;GO2 routine is to tell time
                  237  ;range from 01 to 09 minutes.
                  238  ;
5146  2A04F8      239  GO2     LD      HL,(TLKHOR1)
5149  CD7251      240          CALL    START           ;speak HOUR
514C  21E351      241          LD      HL,OH           ;speak word "OH"
514F  CD7251      242          CALL    START
5152  2A08F8      243          LD      HL,(TKMIN2)
5155  CD7251      244          CALL    START           ;speak minute
5158  C9          245          RET
5159  3A01F8      246  CNTMN1  LD      A,(MIN)
515C  21AF51      247          LD      HL,HOUR-MIN
515F  87          248          ADD     A,A
5160  85          249          ADD     A,L
5161  6F          250          LD      L,A
5162  2208F8      251          LD      (TKMIN2),HL
                  252  ;
                  253  ;GO1 routine is to tell minute time
                  254  ;range between 10 to 19.
                  255  ;
5165  2A04F8      256  GO1     LD      HL,(TLKHOR1)
5168  CD7251      257          CALL    START
516B  2A08F8      258          LD      HL,(TKMIN2)
516E  CD7251      259          CALL    START
5171  C9          260          RET
                  261  ;
                  262  ;
                  263  ;
                  264  ;       ************************************
                  265  ;       *                                  *
                  266  ;       *    SSB-MPF-IP-DEMO-SUBROUTINE    *
                  267  ;       *                                  *
                  268  ;       ************************************
                  269  ;
5172  4E          270  START   LD      C,(HL)
5173  23          271          INC     HL
5174  46          272          LD      B,(HL)
5175  ED430EF8    273          LD      (CODAD),BC
5179  2A0EF8      274  START1  LD      HL,(CODAD)
517C  0610        275          LD      B,10H           ;reset counter
517E  3EFF        276  RESET   LD      A,0FFH          ;TMS 5220 reset code is
                  277                                  ;*111****
5180  D3FE        278          OUT     (PORT),A        ;send the reset command
5182  CDA851      279          CALL    DELY
5185  10F7        280          DJNZ    RESET           ;reset routine
5187  3E60        281          LD      A,60H           ;enable speak external
                  282                                  ;command
5189  D3FE        283          OUT     (PORT),A        ;VSP is ready
518B  CDA851      284          CALL    DELY
518E  7E          285  SEND1   LD      A,(HL)          ;fetch speak data
518F  D3FE        286          OUT     (PORT),A        ;send data to TMS 5220
5191  CDA851      287          CALL    DELY
5194  23          288          INC     HL              ;next data
5195  DBFE        289          IN      A,(PORT)        ;read the status of VSP
5197  CB7F        290          BIT     7,A             ;check talking status
```

```
LOC   OBJ CODE M STMT SOURCE STATEMENT

5199  28F3       291          JR      Z,SEND1         ;need more data to VSP
519B  7E         292  SEND2   LD      A,(HL)          ;load the next data of
                 293                                  ;send1 loop
519C  D3FE       294          OUT     (PORT),A        ;send data continue
519E  CDA851     295          CALL    DELY
51A1  23         296          INC     HL              ;next address
51A2  DBFE       297          IN      A,(PORT)        ;check the talk status
                 298                                  ;activate or not
51A4  CB7F       299          BIT     7,A             ;get the stop code?
51A6  20F3       300          JR      NZ,SEND2        ;if no,send the rest
                 301                                  ;data and check
51A8  C5         302  DELY    PUSH    BC              ;delay routine
51A9  06FF       303          LD      B,0FFH          ;delay counter
51AB  10FE       304          DJNZ    $
51AD  C1         305          POP     BC
51AE  C9         306          RET
                 307  HOUR-MIN                ;table used in both
                 308                          ;HOUR and MINUTE
51AF  BE5F       309          DEFW    5FBEH   ;PAUSE
51B1  3355       310          DEFW    5533H   ;ONE
51B3  9955       311          DEFW    5599H   ;TWO
51B5  CC55       312          DEFW    55CCH   ;THREE
51B7  3456       313          DEFW    5634H   ;FOUR
51B9  9156       314          DEFW    5691H   ;FIVE
51BB  0F57       315          DEFW    570FH   ;SIX
51BD  4257       316          DEFW    5742H   ;SEVEN
51BF  9A57       317          DEFW    579AH   ;EIGHT
51C1  E157       318          DEFW    57E1H   ;NINE
51C3  2020414D   319  AM      DEFM    '  AM'
51C7  0D         320          DEFB    0DH
51C8  2020504D   321  PM      DEFM    '  PM'
51CC  0D         322          DEFB    0DH
51CD  D554       323  JUST    DEFW    54D5H   ;o'clock data
51CF  5558       324          DEFW    5855H   ;TEN
51D1  BC58       325          DEFW    58BCH   ;ELEVEN
51D3  4959       326          DEFW    5949H   ;TWELVE
51D5  C459       327          DEFW    59C4H   ;THIRTEEN
51D7  645A       328          DEFW    5A64H   ;FOURTEEN
51D9  DB5A       329          DEFW    5ADBH   ;FIFTEEN
51DB  6E5B       330          DEFW    5B6EH   ;SIXTEEN
51DD  065C       331          DEFW    5C06H   ;SEVENTEEN
51DF  C15C       332          DEFW    5CC1H   ;EIGHTEEN
51E1  5C5D       333          DEFW    5D5CH   ;NINETEEN
                 334  TXBLE_MIN
51E3  9954       335  OH      DEFW    5499H   ;SPEECH DATA "OH"
51E5  5558       336          DEFW    5855H   ;TEN
51E7  1E5E       337          DEFW    5E1EH   ;TWENTY
51E9  875E       338          DEFW    5E87H   ;THIRTY
51EB  F25E       339          DEFW    5EF2H   ;FORTY
51ED  5D5F       340          DEFW    5F5DH   ;FIFTY
61EF  5E52       341  THE     DEFW    525EH   ;word "the" address
51F1  0052       342  TIME    DEFW    5280H   ;word "time" address
51F3  0D53       343  IS      DEFW    530DH   ;word "is" address
51F5  7253       344  AMADDS  DEFW    5372H   ;AM data address
51F7  1954       345  PMADDS  DEFW    5419H   ;PM data address
                 346
```

```
                    347  *H
                    348  ;       **********************************
                    349  ;       *                                *
                    350  ;       *   SPEAK THE WORDS IN THE       *
                    351  ;       *   SPEECH DATA MEMORY WITH      *
                    352  ;       *   MANUAL CONTROL               *
                    353  ;       *                                *
                    354  ;       **********************************
                    355  ;
51F9   210050       356  SPALL   LD      HL,5000H        ;code memory start address
51FC   220CF8       357          LD      (CODST),HL
51FF   DD2A0CF8     358  SPALL1  LD      IX,(CODST)
5203   01FF0F       359          LD      BC,0FFFH
5206   DD09         360          ADD     IX,BC
5208   DD6E00       361  LOOP3   LD      L,(IX)
520B   DD2B         362          DEC     IX
520D   DD6600       363          LD      H,(IX)
5210   DD2B         364          DEC     IX
5212   23           365          INC     HL
5213   7D           366          LD      A,L
5214   B4           367          OR      H
5215   28E8         368          JR      Z,SPALL1        ;end of look up table
5217   2B           369          DEC     HL
5218   ED4B0CF8     370          LD      BC,(CODST)
521C   09           371          ADD     HL,BC
521D   220EF8       372          LD      (CODAD),HL
5220   CD7951       373          CALL    START1
5223   DDE5         374          PUSH    IX
5225   CDB909       375          CALL    CLEAR
5228   214E52       376          LD      HL,SPEECH
522B   CDCA09       377          CALL    MSG
522E   CD9903       378          CALL    DEC_SP
5231   DD212CFF     379          LD      IX,DISPBF
5235   CD4602       380  LOOP4   CALL    SCAN
5238   FE4E         381          CP      4EH             ;next?
523A   2806         382          JR      Z,NEXT
523C   FE52         383          CP      52H             ;repeat?
523E   2806         384          JR      Z,REPEAT
5240   18F3         385          JR      LOOP4
5242   DDE1         386  NEXT    POP     IX
5244   18C2         387          JR      LOOP3
5246   DDE1         388  REPEAT  POP     IX
5248   DD23         389          INC     IX
524A   DD23         390          INC     IX
524C   18BA         391          JR      LOOP3
524E   20202020     392  SPEECH  DEFM    '       SPEECH'
525B   0D           393          DEFB    0DH
                    394  ;
                    395  ;RAM Buffer starting address
                    396  ;
F800                397          ORG     0F800H
                    398  TMBF                    ;Time Buffer for HOUR,
                    399                          ;MINUTE and SECOND.
F800                400  HOUR    DEFS    1
F801                401  MIN     DEFS    1
F802                402  SEC     DEFS    1
F803                403  APMFLG  DEFS    1
F804                404  TLKHOR1 DEFS    2
```

```
F806                405  TLKMIN1 DEFS    2
F808                406  TKMIN2  DEFS    2
F80A                407  APMTLK  DEFS    2
F80C                408  CODST   DEFS    2
F80E                409  CODAD   DEFS    2
                    410          END
```

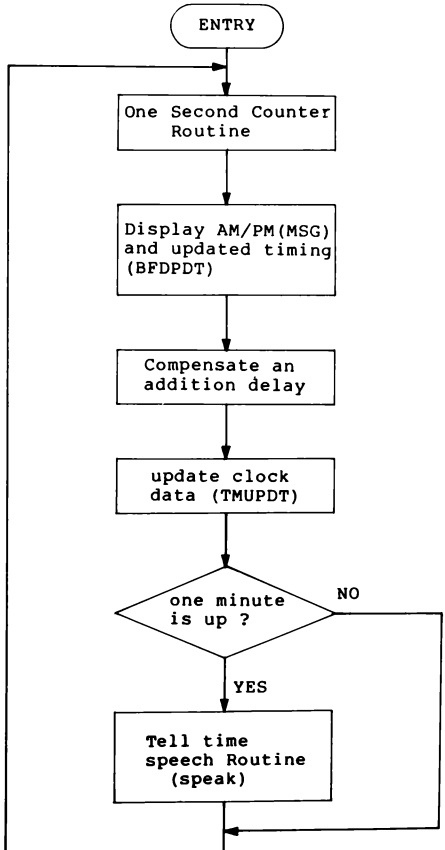
SYMBOL VAL M DEFN REFS

```
AM      51C3     319   42
AMADDS  51F5     344  156
AMD     500F      42   39
APMDEC  50BA     150
APMFLG  F803     403   37   81   87   91   93  152
APMTLK  F80A     407  157  161  185
BFUPDT  507B     103   46
CHKOCK  50CF     162  159
CLEAR   09B9      25   34  375
CNTMIN  50FA     194  164
CNTMN1  5159     246  198
CNTMN2  5138     228  196
CNTMN3  5105     199
CODAD   F80E     409  273  274  372
CODST   F80C     408  357  358  370
COMPL   5043      70   68
CONT    5070      94   83   88
CONVER  0821      30  110  115
DEC_SP  0399      23   45  378
DELY    51A8     302  279  284  287  295
DISP    FF84      26  104  119  122
DISPBF  FF2C      29   48  103  379
GO      50D5     174
GO1     5165     256
GO2     5146     239
GO3     5125     221
HAL     5068      91   80
HOUR    F800     400   74   90  144
HOUR_M  51AF     307  143  201  230  247
IS      51F3     343  179
JUST    51CD     323  183
LOOP1   5021      49   55
LOOP2   5087     107  123
LOOP3   5208     361  387  391
LOOP4   5235     380  385
MAXTAB  5078      98   59
MID     5012      43   41
MIN     F801     401  162  194  199  206  228  246
MSG     09CA      28   43  377
NEXT    5242     386  382
OH      51E3     335  241
ONESEC  5000      34   57
PM      51C8     321   40
PMADDS  51F7     345  160
PORT    00FE      24  278  283  286  289  294  297
REPEAT  5246     388  384
RESET   517E     276  280
SCAN    0246      21  380
SCAN1   029B      22   49
SEC     F802     402   60   94  140
SEND1   518E     285  291
SEND2   519B     292  300
SPALL   51F9     356
SPALL1  51FF     358  368
SPEAK   50A7     139   96
SPEECH  524E     392  376
SPKPM   50C9     160  155
START   5172     270  176  178  180  182  184  186  222  224  226  240
```

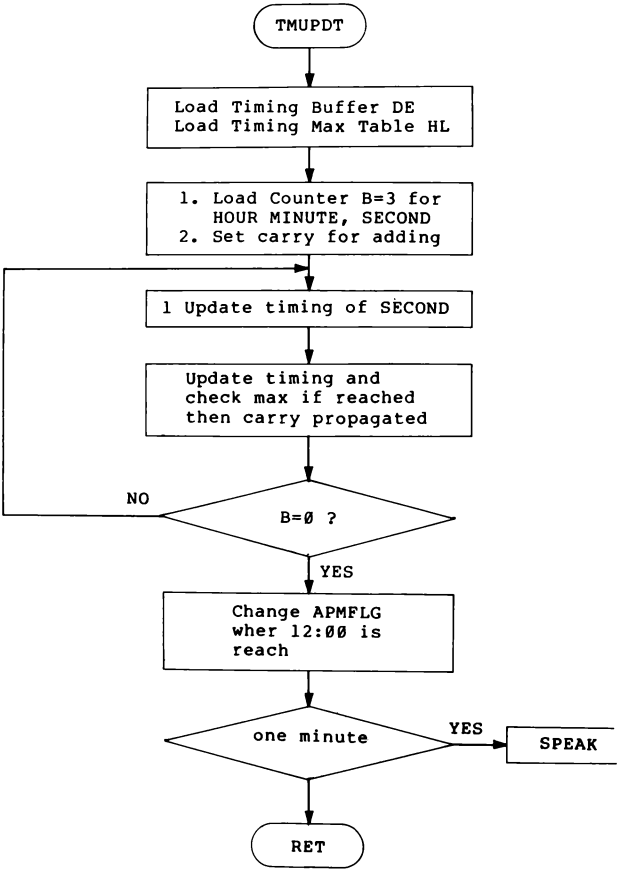
SYMBOL VAL M DEFN REFS

			242	244	257	259		
START1	5179		274	373				
SUC	5063		89	76				
TEMP	5027		53	53				
THE	51EF		341	175				
TIME	51F1		342	177				
TKMIN2	F808		406	205	225	234	243	251	258
TLKHOR	F804		404	149	181	221	239	256	
TLKMIN	F806		405	216	223				
TMBF	F800		398	106					
TMINC	503A		63	73					
TMUPDT	5031		59	56					
TXBLE_	51E3		334	212					

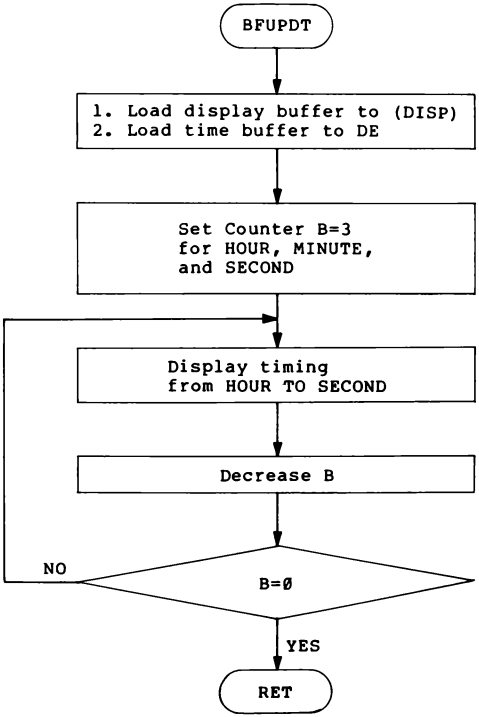
CLOCK-ENGLISH.S
Flowchart



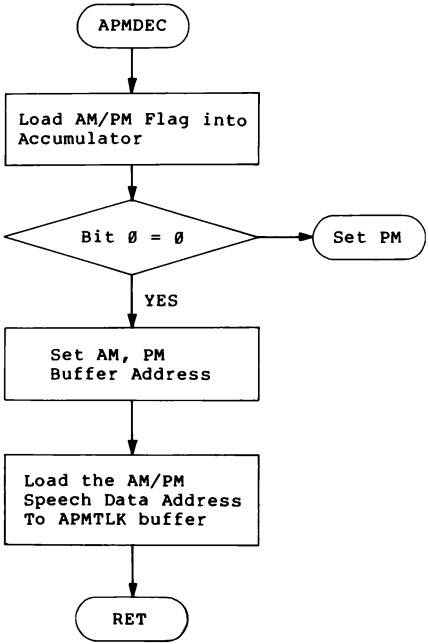
Time Bufffer Update
Flowchart



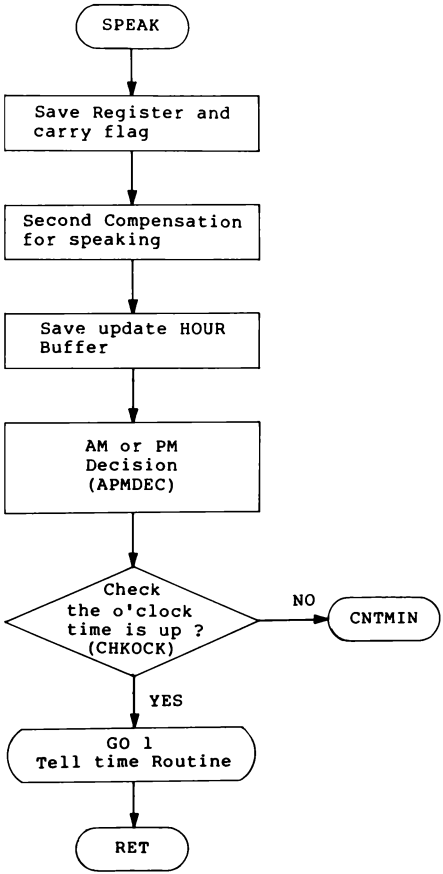
Update Display Buffer
Flowchart



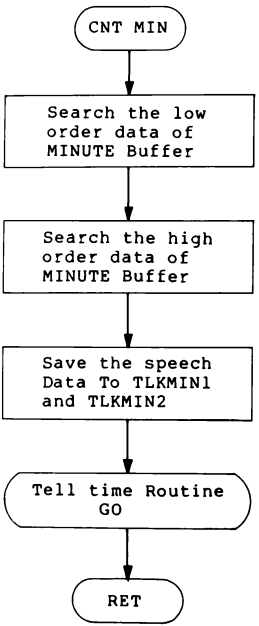
AM. PM. Decision
Floechart



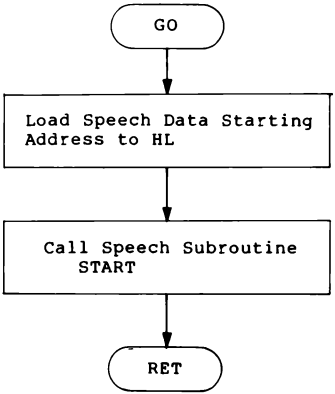
Speech Routine
Flowchart



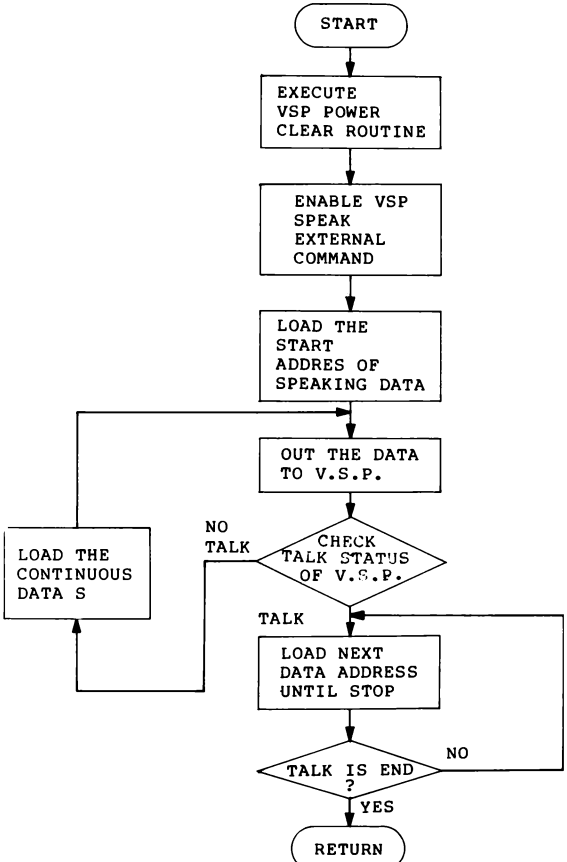
Count MINUTE Buffer
Flowchart



Tell Time Routine
Flowchart
GO & GO1



SUBROUTINE START is the same as DEMO-SUBROUTINE.S


START
EXECUTE VSP POWER CLEAR ROUTINE
ENABLE VSP SPEAK EXTERNAL COMMAND
LOAD THE START ADDRES OF SPEAKING DATA
OUT THE DATA TO V.S.P.
CHECK TALK STATUS OF V.S.P.
NO TALK
LOAD THE CONTINUOUS DATA S
TALK
LOAD NEXT DATA ADDRESS UNTIL STOP
TALK IS END ?
NO
YES
RETURN

3. TMS5220 VOICE SYNTHESIS PROCESSOR DATA MANUAL

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SUPPLEMENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

1. INTRODUCTION

1.1 SCOPE

This manual describes in detail the functional characteristics of a linear predictive coding (LPC) speech synthesis device, the TMS 5220. In addition to this document, the user may wish to refer to the TMS 6100 128K bit ROM electrical specification.

1.2 KEY FEATURES

- High-quality voice communication from a microcomputer system
- Low-data-rate LPC encoding
- Low-cost P-channel MOS technology
- +5 V and −5 V supplies only
- Interrupt-based service requests
- TTL compatible

1.3 DEVICE OPERATION

The TMS 5220 Voice Synthesis Processor (VSP) enables verbal communication with a microcomputer based system. The VSP is fabricated using P-channel MOS technology and is TTL compatible.

Speech data that has been compressed using pitch-excited linear predictive coding (LPC), is supplied to the VSP either by the CPU or by direct serial access of a Voice Synthesis Memory (VSM). The VSP decodes this data to construct a time-varying digital filter model of the vocal tract. This model is excited with a digital representation of either glottal air impulses (voiced sounds) or the rush of air (unvoiced sounds). The output of this model is passed through an eight-bit digital-to-analog converter to produce a synthetic speech waveform.

The VSP has been designed to minimize the data rate required to produce synthetic speech and to simplify the interface with the host CPU. The CPU may service the device either in a polled fashion, by monitoring device status, or by responding to interrupt service requests generated by the VSP. A simplified block diagram of the VSP is shown in Figure 1.

2. SYSTEM CLOCK

This manual describes all VSP timing based on an 8-kHz sample rate (limiting the output frequency to 4 kHz) and a 40-Hz frame rate (the rate at which new speech data is fetched and processed). This requires the internal RC oscillator in the VSP to run at 640 kHz. The user has the mask-programmable option of balancing the internal oscillator with a resistor (completing the RC network).

The 640-kHz clock is divided by four to produce two major phases, PHI-1 and PHI-2, with corresponding precharge clocks, PHI-3 and PHI-4 (see Appendix A). All control and timing operations within the VSP occur on one of the two 6.25-microsecond major phases. Twenty of these 6.25-microsecond bit times comprise each sample period (8-kHz sample rate). Twenty-five of these 125-microsecond sample periods make up one 3.25-millisecond interpolation interval, eight of which (IC0-IC7) make up the 25-millisecond frame period. During IC0, new speech data is transferred to the Synthesizer, at a 40-Hz frame rate.

3. CPU INTERFACE

The CPU interface consists of an eight-bit bidirectional data bus (D0-D7), separate selects for read operations and write operations ($\overline{RS}$ & $\overline{WS}$), a ready line for synchronization ($\overline{READY}$) and an interrupt line ($\overline{INT}$) to indicate a status change on the VSP that requires CPU attention.

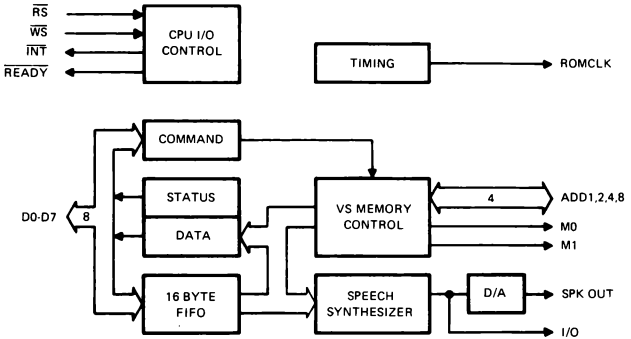


FIGURE 1 – VOICE SYNTHESIS PROCESSOR BLOCK DIAGRAM

3.1 $\overline{RS}$ AND $\overline{WS}$

VSP activity on the memory data bus is controlled by the select lines as shown below.

TABLE 1 – $\overline{RS}$ AND $\overline{WS}$ FUNCTION

$\overline{RS}$	$\overline{WS}$	BUFFER CONDITION
H	H	High impedance state
H	L	Input to VSP. Some other device must be driving the bus (typically the CPU)
L	H	Output from VSP. No other device should be driving the bus at this time.
L	L	Illegal condition. Results not predictable.

It is important to note that no device can successfully complete a Read cycle (from the VSP) while $\overline{WS}$ is active (low) nor can a successful Write cycle (to the VSP) be carried out while $\overline{RS}$ is active (low). Device behavior cannot be predicted if both $\overline{WS}$ and $\overline{RS}$ go active simultaneously. System logic should be designed to prevent this condition from occurring.

3.2 $\overline{\text{READY}}$

The VSP is a "Slow Memory"[1] device requiring wait states from the CPU to successfully complete a memory cycle. The effect of inserting wait states into memory access cycles is to extend the minimum allowable access time by one clock period for each wait state. The VSP controls the number of wait states executed by the CPU with the $\overline{\text{READY}}$ signal. The logic timing for typical read and write cycles to the VSP is shown in Figure 2.

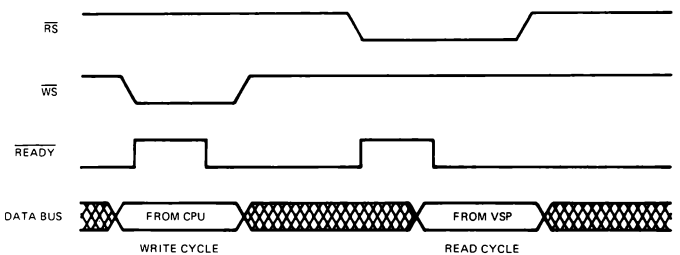


FIGURE 2 – READ AND WRITE CYCLES TO THE VSP

The $\overline{\text{READY}}$ line on the VSP goes high 100 ns after $\overline{\text{RS}}$ or $\overline{\text{WS}}$ goes active (low) to let the CPU know that the data transfer cycle cannot yet be completed. When the VSP has established stable data on the data bus (in the case of $\overline{\text{RS}}$) or has completed latching data in from the data bus (in the case of $\overline{\text{WS}}$), the $\overline{\text{READY}}$ line will go low indicating that the CPU may complete the data transfer cycle.

3.3 INTERRUPTS

The interrupt line ($\overline{\text{INT}}$) indicates changes in the status of the VSP that may require CPU attention. $\overline{\text{INT}}$ goes active (low) when any of the following occur:

- Talk Status (TS) makes a one-to-zero transition indicating the end of speech processing.
- Buffer Low (BL) makes a zero-to-one transition indicating that more phrase data needs to be supplied to the FIFO for Speak External Command.
- Buffer Empty (BE) makes a zero-to-one transition indicating that the CPU failed to supply data fast enough for a Speak External Command.[2]

$\overline{\text{INT}}$ goes inactive (high) when the Status Register is read, or if the Reset instruction is executed.

4. VOICE SYNTHESIS MEMORY (VSM) – (TMS 6100)

In addition to receiving speech data from the CPU, the VSP may directly access up to 16 TMS 6100's (128K-bit serial ROM) with no external hardware required. This is accomplished with a four-bit parallel bus (ADD8,4,2,1), (ADD8 is multiplexed as the Data Out line out of the TMS 6100 as well as the most-significant bit of the 4-bit address bus into the TMS 6100), two control lines (M0, M1), and a synchronizing clock (ROMCLK).

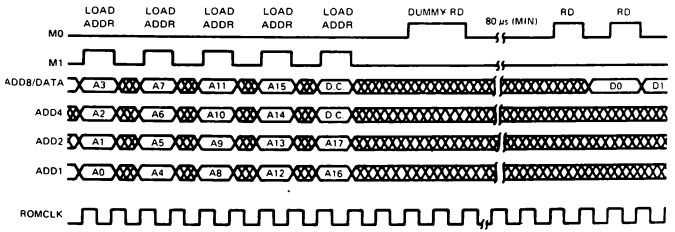
[1]Slow Memory devices are those devices that cannot properly respond to system memory cycles within the minimum access time as determined by the CPU clock rate.

[2]An interrupt will be generated at the initiation of a Speak External Instruction if BE was previously low.

The TMS 6100 is a mask programmable 128K-bit Read-Only Memory internally organized as 16K words of eight bits; externally it appears as 128K X 1. Once the 20-bit address (14 bits to select a byte within the device, four chip select bits, two bits ignored) is loaded through ADD1, ADD2, ADD4, and ADD8 in five Load Address sequences, data is read out bit-wise by toggling a control pin (M0). The ROM contains an on-chip address counter that is incremented every eight bits (eight toggles of M0). The four internal chip select bits are a mask programmable option, and allow parallel connection of up to 16 ROMs (about 30 minutes of speech) without the need of external select circuitry.

M0	M1	FUNCTION
L	L	Idle – The passive NOP state of TMS 6100
L	H	Load Address – The four bits of data on ADD8,4,2,1 are loaded to the internal address register at the location indicated by the TMS 6100 Load Pointer. After each Load Address function, the Load Pointer is advanced to the left by four bit positions to allow the next most-significant nibble of the address to be properly loaded. The first read function[3], following a Load Address function, resets the Load Pointer to the LS bit and initiates a ROM access to fetch the address data byte. This is the only function of this "Dummy Read". No data is transferred out of VSM until the second read function following a Load Address.
H	L	Read – When the addressed data byte has been fetched and stored in the VSM Data Register, it is ready to be serially transferred out starting with the MSB. Each successive read function causes the next least-significant bit to be driven on the Data Out line of the VSM that is currently selected. The next data byte is being fetched at the same time the serial transfer is taking place so that when the last bit of the current byte is transferred, the VSM Data Register can be reloaded without delay. When the Read function immediately follows a Load Address function, it is treated as a "Dummy Read". No data is transferred, but the Load Pointer is reset and ROM access is initiated.
H	H	Read and Branch – Starting at the current address, two bytes are fetched from the ROM to form a 16-bit word. The 14 low-order bits of this word replace the 14 low-order bits of the Address Register. The Load Pointer is then reset and a ROM access initiated to fetch the byte at this new address.*

Figure 3 shows a typical sequence of loading the Address Register and reading two data bits back. For more critical timing constraints, consult the TMS 6100 Electrical Specification.



NOTE: A0 is the LSB in 6100 address.

FIGURE 3 – TMS 6100 FUNCTION TIMING

[3]A minimum of two Load Address instructions are required to change the VSM address.

*Read and Branch will not work with multiple VSM systems. Bus contention will occur.

A full set of coded parameters for each frame would require a data rate of 40 Hz X 50 bits = 2000 bits per second. Three special cases, in which a full frame is not necessary, allow the data rate to be considerably reduced:

(1) Since the vocal tract changes shape relatively slowly, it is often possible to repeat previous reflection coefficient data. To facilitate the repeat feature, a control bit has been added to each frame (an additional bit following energy). If the repeat bit is 1, only energy and pitch data are accessed from the VSM and the previous K1-K10 values are retained.

(2) Unvoiced speech requires fewer filter reflection coefficients. When Pitch = 000000, only K1-K4 are fetched from the VSM and stored in the Parameter RAM. K5-K10 are zeroed.

(3) When Energy = 0000 no other data is required. Energy = 0000 during interword or intersyllable pauses. The combination of these three cases has reduced average data rate for male speech to approximately 1200 bits per second.

Figure 5 shows the four possibilities of frame data string lengths.

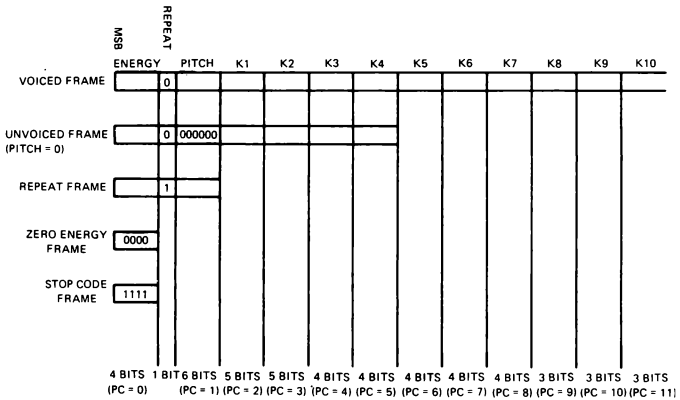


FIGURE 5 – FRAME DATA STRING LENGTHS

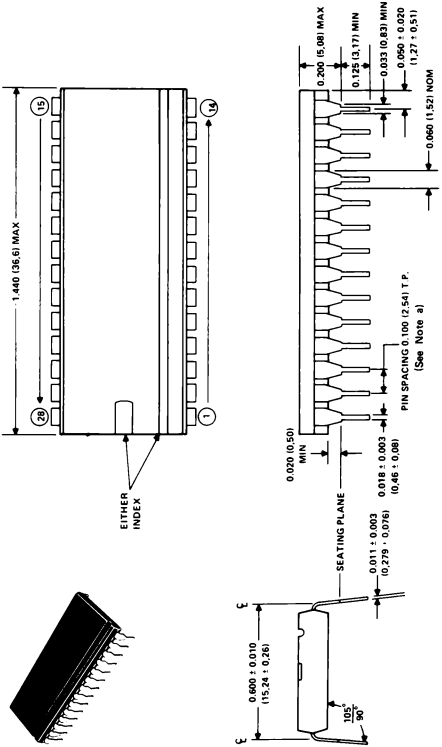
One complete set of parameters (12), used as target values during interpolation, is stored in coded form in the synthesizer. The storage medium is a 50-bit RAM of variable word length, e.g., six bits for pitch, three bits for K10. Data is supplied to the RAM via the parallel outputs of a serial shift register which accepts data from some VSM. The Parameter RAM outputs are used as inputs for the Parameter ROM.

8.2 D/A CONVERSION

The VSP contains an eight-bit digital-to-analog converter with 2% linearity LSB resolution. Every 125 microseconds the most-significant 10 bits of the 14-bit lattice filter output are sampled. From this sample, the seven low-order bits and the sign bit (MSB) are sent to the D/A converter. The remaining two bits are combined logically with the sign bit and used to clip the driver to either a full ON or full OFF condition. Table 4 shows the analog output from the D/A converter for various inputs from the lattice filter.

11. MECHANICAL DATA

11.1 28-PIN 600-MIL PLASTIC PACKAGE (100-MIL PIN SPACING)

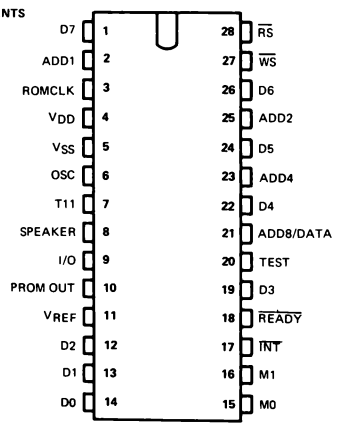


NOTES: a. Each pin centerline is located within 0.010 inch (0.26 millimeters) of its true longitudinal position.
b. All linear dimensions are shown in inches (and parenthetically in millimeters for reference only). Inch dimensions govern.

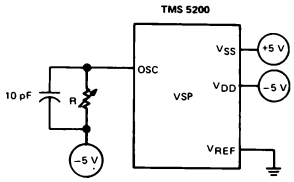
11.2 PIN ASSIGNMENTS AND FUNCTIONS

PIN	NAME	IN/OUT	FUNCTION
1	DBUS 7	I/O	Memory data bus (LSB)
2	ADD1	O	Address bus to VSM (LSB)
3	ROMCLK	O	Clock to VSM
4	V_{DD}	I	Drain supply voltage (−5 V NOM)
5	V_{SS}	I	Substrate supply voltage (+5 V NOM)
6	OSC	I	Oscillator input
7	T11	O	Sync
8	SPEAKER	O	Audio output
9	I/O	O	Serial data out
10	PROM OUT	O	Testing use only
11	V_{REF}	I	Ground reference voltage (0 V NOM)
12	DBUS 2	I/O	Memory data bus
13	DBUS 1	I/O	Memory data bus
14	DBUS 0	I/O	Memory data bus (MSB)
15	M0	O	Command bit 0 to VSM
16	M1	O	Command bit 1 to VSM
17	$\overline{INT}$	O	Interrupt (active low)
18	$\overline{READY}$	O	Transfer cycle W/CPU complete
19	DBUS 3	I/O	Memory data bus
20	TEST	I	Testing use only
21	ADD8/DATA	I/O	Address to VSM and serial data in (MSB)
22	DBUS 4	I/O	Memory data bus
23	ADD 4	O	Address bus to VSM
24	DBUS 5	I/O	Memory data bus
25	ADD 2	O	Address bus to VSM
26	DBUS 6	I/O	Memory data bus
27	$\overline{WS}$	I	Write select (active low)
28	$\overline{RS}$	I	Read select (active low)

11.3 TERMINAL ASSIGNMENTS



SYSTEM CLOCK



RC OPTION

TYPICAL VALUES:

SAMPLE FREQUENCY	R
10 kHz	R = 80-100 kΩ
8 kHz	R = 120-200 kΩ

FIGURE A-1 – TMS 5200 OSCILLATOR OPTIONS

A.1 OSCILLATOR TRIMMING PROCEDURE

To avoid capacitive loading of the high impedance OSC input, the following procedure is recommended for setting the TMS 5220 clock frequency. Reference to Table A-1, Comparison of System Times (page 16), shows that an RC oscillator frequency of 640 kHz corresponds to a ROM clock rate of 160 kHz. This signal is buffered and not affected by measurement instrument capacities.

To set the RC oscillator frequency, connect a frequency counter to the ROM clock output of the TMS 5220 and trim the reading to 160 kHz. Use of 10 pF shunt capacitor is recommended to prevent circuit layout and environmental stray noise from affecting device operation.

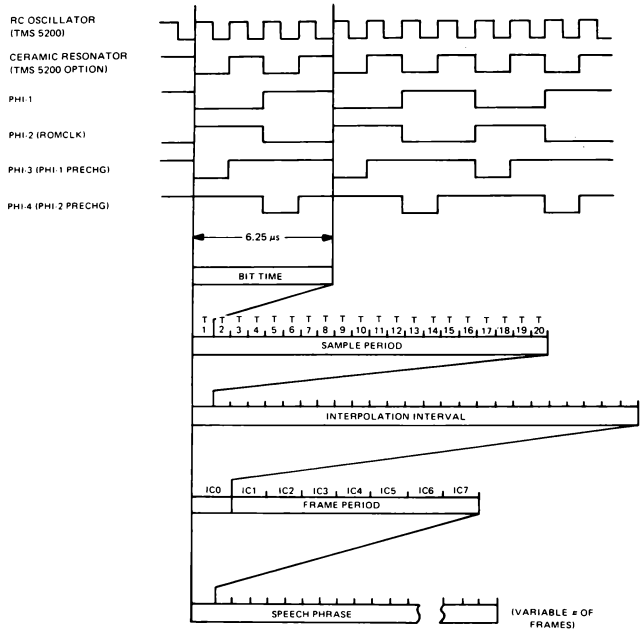


FIGURE A-2 – SYSTEM TIMING SUMMARY

TABLE A-1 – A COMPARISON OF SYSTEM TIMES

SAMPLE RATE:	10 kHz	8 kHz
FRAME RATE	50 Hz	40 Hz
FRAME PERIOD	20 ms	25 ms
INTERPOLATION RATE	400 Hz	320 Hz
INTERPOLATION INTERVAL	2.5 ms	3.125 ms
SAMPLE RATE	10 kHz	8 kHz
SAMPLE PERIOD	100 μs	125 μs
ROM CLOCK RATE	200 kHz	160 kHz
ROM CLOCK PERIOD	5 μs	6.25 μs
RC OSC RATE	800 kHz	640 kHz
RC OSC PERIOD	1250 ns	1562.5 ns

NOTE: All timing references in this data manual are based on an 8-kHz sample rate.

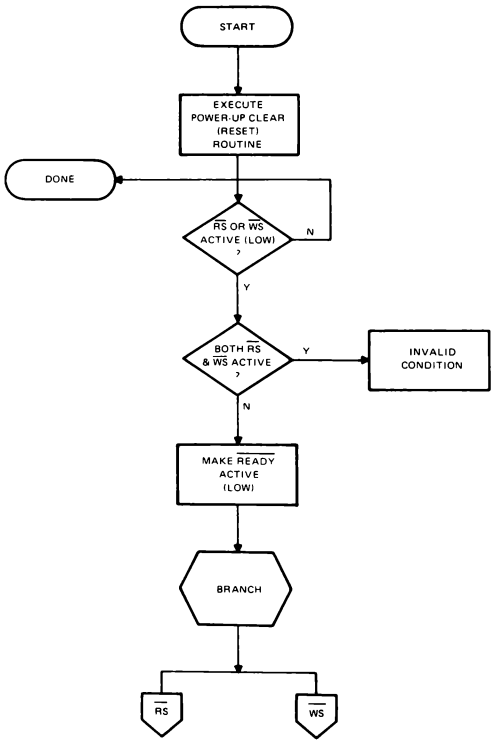


FIGURE B-1 – POWER ON

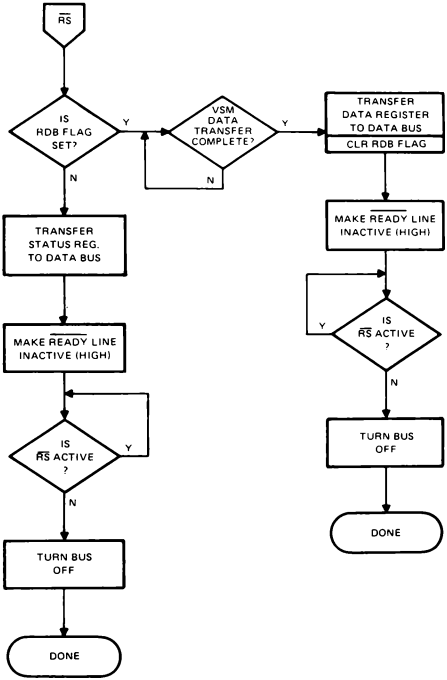


FIGURE B-2 – READ SELECT ACTIVE

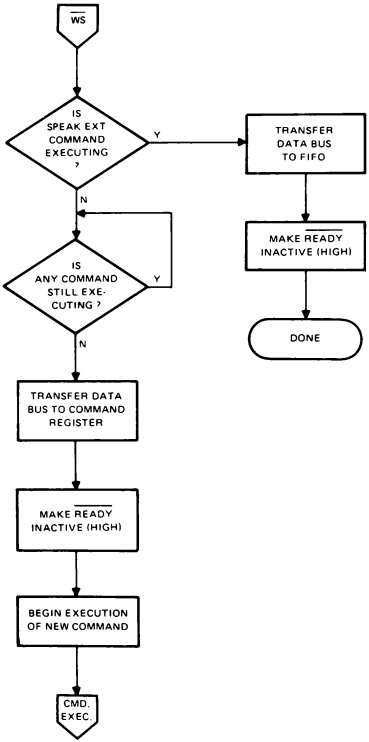


FIGURE B-3 – WRITE SELECT ACTIVE

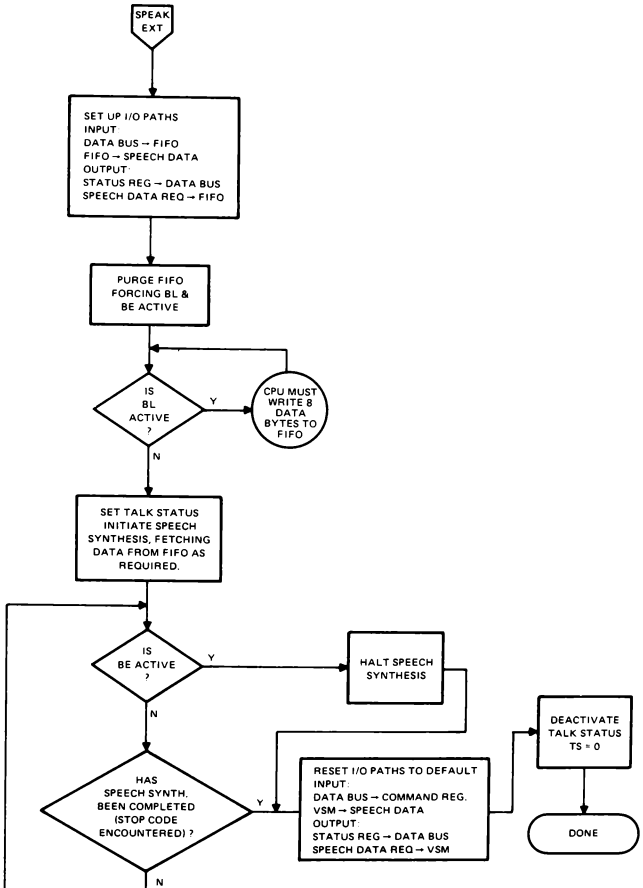


FIGURE 8-4 – SPEAK EXTERNAL COMMAND

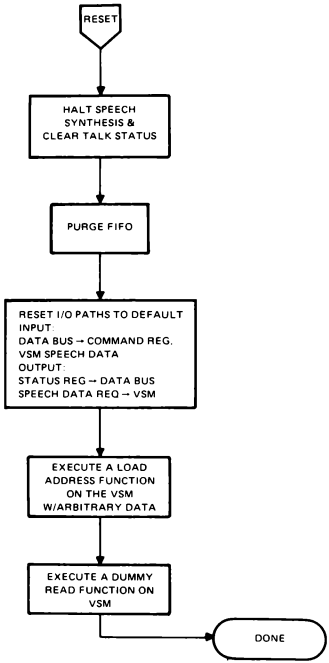


FIGURE B-5 – RESET COMMAND

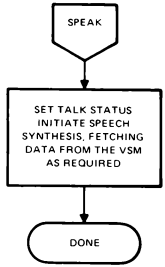


FIGURE 8-6 – SPEAK

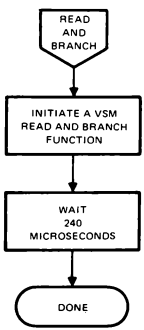


FIGURE 8-7 – READ AND BRANCH

SYSTEM TIMING DIAGRAMS

Write Cycle for Read and Branch, Load Address, Speak, Speak External and Reset Commands

timing requirements

PARAMETER			MIN	NOM	MAX	UNIT
t_{WSL-DV}	Delay time from $\overline{WS}$ low to data valid				7	µs
t_{RL-DX}	Delay time from $\overline{READY}$ low to data invalid		0			µs
t_{RH-WSH}	Delay time from $\overline{READY}$ high to $\overline{WS}$ high		6			µs
t_{wait}	Read-and-branch command wait time from $\overline{READY}$ high until next allowable* command				595	µs
t_{wait}	Load-address command wait time from $\overline{READY}$ high until next allowable* command				42	µs
t_{wait}	Speak command wait time from $\overline{READY}$ high until next allowable* command	Preceded by load-address command			287	µs
		Not preceded by load-address command	56			
t_{wait}	Reset command wait time from $\overline{READY}$ high until next allowable* command				300	µs
t_{wait}	Speak external command wait time from $\overline{READY}$ high until next allowable* command				42	µs

switching characteristics

PARAMETER		MIN	NOM	MAX	UNIT
t_{WSL-RH}	Delay time from $\overline{WS}$ low to $\overline{READY}$ high			100	ns
$t_{w(R)}$	$\overline{READY}$ high pulse width	18		26	µs

All timing is based on a clock frequency of 8 kHz.

* If a new command is issued prior to the completion of the present command (before the end of t_{wait}), then the $\overline{READY}$ signal will go high and stay high until the present command is finished executing in the VSP.

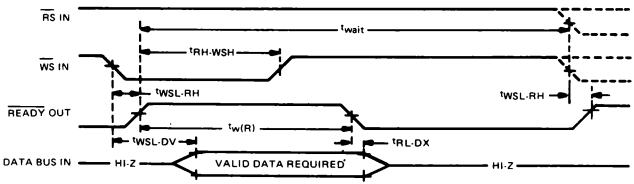


FIGURE C-1

WRITE CYCLE FOR EXTERNAL SPEECH DATA

timing requirements

	PARAMETER	MIN	NOM	MAX	UNIT
t_{WSL-DV}	Delay time from $\overline{WS}$ low to data valid			7	μs
t_{RL-DX}	Delay time from $\overline{READY}$ low to data invalid	0			μs
t_{RH-WSH}	Delay time from $\overline{READY}$ high to $\overline{WS}$ high	6			μs
t_{wait}	Wait time from $\overline{WS}$ high until next allowable* access	10			μs

switching characteristics

	PARAMETER	MIN	TYP	MAX	UNIT
t_{WSL-RH}	Delay time from $\overline{WS}$ low to $\overline{READY}$ high			100	ns
$t_{w(R)}$	$\overline{READY}$ high pulse width			23	μs

All timing is based on a clock frequency of 8 kHz.

* If a new command is issued to the VSP prior to the completion of the present command then the $\overline{READY}$ command will go high (as usual and remain high until the completion of the present command as defined by t_{wait} above.

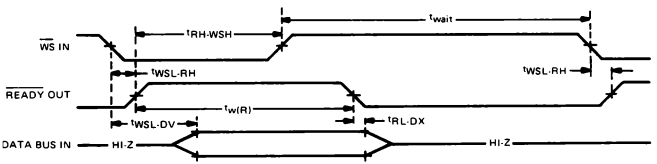


FIGURE C-2

READ CYCLE FOR STATUS TRANSFERS

timing requirements

	PARAMETER	MIN	NOM	MAX	UNIT
t_{RH-RSH}	Delay time from $\overline{READY}$ high to $\overline{RS}$ high	6			μs
t_{wait}	Wait time from $\overline{RS}$ high to next allowable* command	12			μs

switching characteristics

	PARAMETER	MIN	TYP	MAX	UNIT
t_{RSL-RH}	Delay time from $\overline{RS}$ low to $\overline{READY}$ high			100	ns
t_{RH-DV}	Delay time from $\overline{READY}$ high to data valid (stable)	6		11	μs
t_{RSL-DX}	Delay time from $\overline{RS}$ low to data bus driven (output unstable)		$t_{RH-DV}-2$		μs
t_{RSH-DZ}	Delay time from $\overline{RS}$ high to data output disabled			10.5	μs

* If a new command is issued to the VSP prior to the completion of the present command, then after the $\overline{READY}$ signal goes high, in its normal response time, it will remain high until the present command has been fully executed by the VSP.

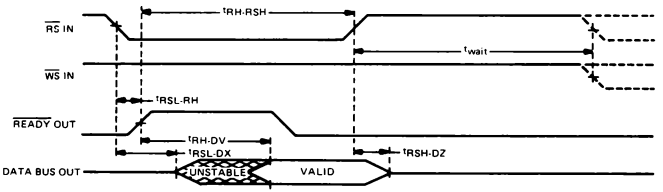


FIGURE C-3

READ BYTE SEQUENCE

timing requirements

	PARAMETER	MIN	NOM	MAX	UNIT
t_{WSL-DV}	Delay time from $\overline{WS}$ low to data valid			7	µs
t_{RH-WSH}	Delay time from $\overline{READY}$ high to $\overline{WS}$ high	6			µs
t_{WSH-DX}	Delay time from $\overline{WS}$ high to data invalid	0			µs
t_{RH-RSH}	Delay time from $\overline{READY}$ high to $\overline{RS}$ high	8			µs
$t_{WSH-RSL}$	Delay time from $\overline{WS}$ high to $\overline{RS}$ low	12			µs

switching characteristics

	PARAMETER		MIN	TYP	MAX	UNIT
t_{WSL-RH}	Delay time from $\overline{WS}$ low to $\overline{READY}$ high				100	ns
t_{RSL-RH}	Delay time from $\overline{RS}$ low to $\overline{READY}$ high				100	ns
$t_{w(R)}$	$\overline{READY}$ high pulse width (write)				26	µs
t_{RL-RL}	Delay time from $\overline{READY}$ low (write) to $\overline{READY}$ low (read)	No previous load address			320	µs
		Previous load address			440	
t_{RSH-DZ}	Delay time from $\overline{RS}$ high to data output disabled		4		9	µs

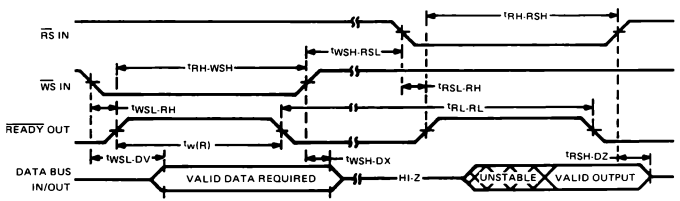


FIGURE C-4

TMS 5220 CODING TABLE

RMS	PITCH	K(1)	K(2)	K(3)	K(4)	K(5)	K(6)	K(7)	K(8)	K(9)	K(10)
0	0	−0.97850	−0.64000	−0.86000	−0.64000	−0.64000	−0.50000	−0.60000	−0.50000	−0.50000	−0.40000
52	15	−0.97270	−0.58999	−0.75467	−0.53145	−0.54933	−0.41333	−0.50667	−0.31429	−0.34286	−0.25714
87	16	−0.97070	−0.53500	−0.64933	−0.42289	−0.45867	−0.32667	−0.41333	−0.12857	−0.18571	−0.11429
123	17	−0.96680	−0.47507	−0.54400	−0.31434	−0.36800	−0.24000	−0.32000	0.05714	−0.02857	0.02857
174	18	−0.96290	−0.41039	−0.43867	−0.20579	−0.27733	−0.15333	−0.22667	0.24286	0.12857	0.17143
246	19	−0.95900	−0.34129	−0.33333	−0.09723	−0.18667	−0.06667	−0.13333	0.42857	0.28571	0.31429
348	20	−0.95310	−0.26830	−0.22800	0.01132	−0.09600	0.02000	−0.04000	0.61429	0.44286	0.45714
491	21	−0.94140	−0.19209	−0.12267	0.11987	−0.00533	0.10667	0.05333	0.80000	0.60000	0.60000
694	22	−0.93360	−0.11350	−0.01733	0.22843	0.08533	0.19333	0.14667			
981	23	−0.92580	−0.03345	0.08800	0.33698	0.17600	0.28000	0.24000			
1385	24	−0.91600	0.04702	0.19333	0.44553	0.26667	0.36667	0.33333			
1957	25	−0.90620	0.12690	0.29867	0.55409	0.35733	0.45333	0.42667			
2764	26	−0.89650	0.20515	0.40400	0.66264	0.44800	0.54000	0.52000			
3904	27	−0.88280	0.28087	0.50933	0.77119	0.53867	0.62667	0.61333			
5514	28	−0.86910	0.35325	0.61467	0.87975	0.62933	0.71333	0.70667			
7789	29	−0.85350	0.42163	0.72000	0.98830	0.72000	0.80000	0.80000			
	30	−0.80420	0.48553								
	31	−0.74058	0.54464								
	32	−0.66019	0.59878								
	33	−0.56116	0.64796								
	34	−0.44296	0.69227								
	35	−0.30706	0.73190								
	36	−0.15735	0.76714								
	37	−0.00005	0.79828								
	38	0.15725	0.82567								
	39	0.30696	0.84965								
	40	0.44288	0.87057								
	41	0.56109	0.88875								
	42	0.66013	0.90451								
	44	0.74054	0.91813								
	46	0.80416	0.92988								
	48	0.85350	0.98830								
	50										
	52										
	53										
	56										
	58										
	60										
	62										
	65										
	68										
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	105										
	109										
	114										
	118										
	122										
	127										
	132										
	137										
	142										
	148										
	153										
	159										

5. SPEECH VOCABULARY LIBRARY

The SSB-MPF-IB or SSB-MPF-IP is shipped to you with a built-in (standard) vocabulary. Multitech provides another 56 optional 2732 EPROMs whose storage capacity is 4K. Each EPROM contains a file of words. The vocabulary contained in these optional EPROMs is listed as follows:

Vocabulary List FOR OPTIONAL EPROMS

FILE NAME : SSB-E1

ADDRESS	WORD	ADDRESS	WORD
000	A	751	ACE
074	ABLE	7CC	ACKNOWLEDGE
12C	ABORT	8A7	ACTION
1BC	ABOUT	965	ADD
242	ABOVE	9E3	ADDER
2CF	ABSOLUTE	A86	ADDRESS
3AE	ACCELERATED	B33	ADJUST
4C4	ACCEPT	BD2	ADVISE
559	ACCESS	CA2	AERIAL
604	ACCESSING	D67	AFFIRMATIVE
6B4	ACCOUNT	E3[illegible]	AFTER
		EE7	AGE

FILE NAME : SSB-E2

ADDRESS	WORD	ADDRESS	WORD
000	AGAIN	680	ALMOST
0B3	AGAINST	76F	ALPHA
159	AIM	7FC	ALPHANUMERIC
1CD	AIR	930	ALREADY
24D	AIRCRAFT	9F2	ALSO
307	AIRPORT	A89	ALTERNATE
3D5	AIRSPEED	B41	ALTHOUGH
4B2	ALARM	BF7	ALTIMETER
562	ALERT	CDC	ALTITUDE
5F3	ALL	DB4	ALWAYS
		E74	AM

FILE NAME : SSB-E3

ADDRESS	WORD	ADDRESS	WORD
000	AMERICAN	7B4	ANSWERED
0EE	AMONG	88C	ANY
18B	AMOUNT	90A	ANYWAY
224	AMPS	9E8	APPLE
2A0	AN	A77	APPROACH
31A	ANALOG	B0F	APPROVE
3F5	ANALYZER	BC0	APRIL
4E3	AND	C4B	ARE
567	ANIMAL	CD5	AREA
63F	ANOTHER	D85	AROUND
704	ANSWER	E67	ARRIVAL

FILE NAME : SSB-E4

ADDRESS	WORD	ADDRESS	WORD
000	ARRIVE	6F0	AUTO
0CB	ARROW	799	AUTOMATIC
15B	AS	8A0	AUTOPILOT
1FF	ASK	9D8	AVAILABLE
267	ASSUME	AFC	AWAY
322	ASTONISHED	BD4	AXLE
40B	ASTRONAUT	CA9	BACK
502	AT	D21	BAD
583	ATTENTION	DE1	BALANCE
668	AUNT	EBD	BALL

FILE NAME : SSB-E5

ADDRESS	WORD	ADDRESS	WORD
000	BAND	733	BECAUSE
0B3	BANG	813	BECOME
163	BANK	8E1	BED
1E6	BASE	98C	BEEN
279	BATTERY	A2C	BEFORE
36B	BAUD	B03	BEGIN
418	BE	BCB	BEHIND
4A8	BEAMS	CD6	BEING
597	BEAR	D9B	BELOW
635	BEAUTIFUL	E57	BELT
		EE0	BENCH

FILE NAME : SSB-E6

ADDRESS	WORD	ADDRESS	WORD
000	BESIDE	902	BLOW
0F6	BEST	9B2	BLUE
189	BETTER	A32	BONUS
203	BETWEEN	AE0	BOOK
2D6	BIDIRECTIONAL	B34	BOOLEAN
447	BIG	BE4	BOOTH
4C8	BINARY	C50	BOTH
5A6	BIPOLAR	CD7	BOTTOM
68D	BIRTH	D8C	BOUND
71D	BIRTHDAY	E3F	BOY
7E7	BIT	ECF	BRAKE
873	BLACK	F3D	BRAKES

FILE NAME : SSB-E7

ADDRESS	WORD	ADDRESS	WORD
000	BRAVO	706	BUSINESS
0B1	BREAK	7EF	BUSY
11D	BRIGHT	897	BUT
1C1	BRIGHTNESS	8EF	BUTTON
2B5	BRING	99F	BUY
339	BROKEN	A31	BY
3F3	BROTHER	AB8	BYE
4C0	BUFFER	B4B	BYTE
567	BUILDING	BD7	CABIN
659	BULLET	CD7	CALIBRATE
		DE4	CALIFORNIA

FILE NAME : SSB-E8

ADDRESS	WORD	ADDRESS	WORD
000	CALL	7B0	CARD
0D4	CALLING	85D	CARRY
1CA	CALM	92A	CASSETTE
285	CAN	9CA	CAUGHT
34C	CAN'T	A76	CAUTION
420	CANCEL	B61	CEILING
516	CANNOT	C58	CELSIUS
5D5	CAPACITANCE	D4F	CENT
706	CAR	DD3	CENTER

FILE NAME : SSB-E9

ADDRESS	WORD	ADDRESS	WORD
000	CENTIGRADE	7BE	CHILDREN
13E	CHAIN	8B5	CHIME
1ED	CHANGE	96A	CHIP
2EB	CHANNEL	9E4	CHOICE
3E2	CHARLIE	A76	CHRISTMAS
4CA	CHECK	B53	CHURCH
555	CHECKSUM	BD7	CIRCUIT
62C	CHICKEN	CB3	CITY
6DD	CHILD	D7A	CLEAN
		E2C	CLEARANCE

FILE NAME : SSB-E10

ADDRESS	WORD	ADDRESS	WORD
000	CLIMB	6C8	COLOR
0B8	CLOCK	793	COME.
130	CLOSE	82B	COMES
20D	CLUB	8F7	COMMA
2B2	COAXIAL	9BB	COMMAND
3DE	CODE	AB0	COMMANDER
476	COLD	BA8	COMMON
543	COLLECT	C72	COMPANY
5EC	COLON	D4A	COMPILER
		E64	COMPLEMENT

FILE NAME : SSB-E11

ADDRESS	WORD	ADDRESS	WORD
000	COMPLETE	87F	CONTACT
0C8	COMPUTER	96D	CONTRACT
1B3	CONE	A6C	CONTROL
297	CONFERENCE	B7D	CONVERGING
3C4	CONGRATULATIONS	CC7	COOKING
58C	CONNECT	D6B	COPY
640	CONNECTED	DFF	CORE
765	CONSOLE	E93	CORRECT
		F38	COST

FILE NAME : SSB-E12

ADDRESS	WORD	ADDRESS	WORD
000	COURSE	767	CURRENT
08D	COWL	859	CURSOR
148	CRANE	934	CYAN
1FA	CRASH	A02	CYCLE
290	CRAZY	AAA	CYLINDER
380	CREASE	BA1	D
414	CREST	C0C	DAISY
4A6	CROSS	CAA	DANGER
568	CROWN	D70	DATA
620	CRYSTAL	E1A	DATE
6FE	CUP	E8A	DAUGHTER

FILE NAME : SSB-E13

ADDRESS	WORD	ADDRESS	WORD
000	DAY	768	DEGREE
085	DAYS	81C	DEGREES
126	DEAD	911	DELETE
1C9	DECEMBER	9CC	DELIVERY
2EB	DECIDE	AE4	DELTA
3E1	DECIMAL	BA7	DENSITY
4D6	DECREASE	C76	DEPARTURE
59C	DECREASING	D80	DEPOSIT
6AD	DEFECTS	E8C	DESTROY

FILE NAME : SSB-E14

ADDRESS	WORD	ADDRESS	WORD
000	DESTROYED	731	DINNER
0F9	DETECTOR	7C8	DIRECT
1F2	DETERGENT	85D	DIRECTION
317	DEVICE	942	DIRECTORY
3DF	DID	A39	DISK
463	DIE	AB2	DISKETTE
4F6	DIFFERENT	B59	DISPENSER
5A4	DIFFICULT	C3B	DISPLAY
661	DIGITAL	D04	DIVE
		DCF	DIVIDED

FILE NAME : SSB-E15

ADDRESS	WORD	ADDRESS	WORD
000	DIVISION	7B5	DOWNWIND
101	DO	89E	DRAGON
17F	DOCTOR	95A	DRAIN
240	DOG	A0A	DRAW
2DA	DOING	A9A	DRAWING
38A	DOLLAR	B63	DRINK
449	DOLLARS	BCC	DRIVE
52E	DONE	C7F	DRIVER
5C5	DOOR	D45	DRUM
665	DOUBLE	DD5	DUMP
712	DOWN	E3B	DUPLEX
		EDF	DUPLICATE

FILE NAME : SSB-E16

ADDRESS	WORD	ADDRESS	WORD
000	DURING	6DD	EIGHTH
0A1	DUST	73E	EIGHTY
12A	DYNAMIC	7D2	EITHER
216	EACH	892	ELAPSED
289	EARLY	975	ELECTRICIAN
348	EAST	A84	ELEVATE
3B8	EASY	B4F	ELEVATION
465	EAT	C6C	ELEVEN
4B8	EDITOR	D5D	ELSE
594	EIGHT	DD2	EMERGENCY
604	EIGHTEEN	EE3	EMPTY

FILE NAME : SSB-E17

ADDRESS	WORD	ADDRESS	WORD
000	END	69A	ERASED
097	ENDS	750	ERROR
144	ENEMY	81B	ESTIMATED
1F6	ENGINE	920	EVACUATION
2D5	ENOUGH	A65	EVACUATE
371	ENTER	B6B	EVEN
429	ENTRY	C0B	EVENING
4DC	EQUALS	CF6	EVENT
5C8	EQUIPMENT	D9D	EVER
		E51	EVERY

FILE NAME : SSB-E18

ADDRESS	WORD	ADDRESS	WORD
000	EVERYTHING	7E6	EXPERIMENTAL
10B	EXACTLY	907	EXPLOSION
222	EXCEEDED	A17	EXPRESS
322	EXCELLENT	AC2	EXTENSION
3EB	EXCITED	BB6	EXTERNAL
4EB	EXCLAIM	C97	EYE
5D6	EXECUTE	D27	F
697	EXIT	D89	FAHRENHEIT
746	EXPECT	E8B	FAIL

FILE NAME : SSB-E19

ADDRESS	WORD	ADDRESS	WORD
000	FAILED	72C	FATHRE
0CE	FAILING	80D	FATHOMS
1B9	FAILURE	905	FEBRUARY
2AB	FALSE	9FA	FEED
345	FAMILY	A91	FEEL
426	FAR	B40	FEET
4D2	FARAD	BA8	FIFTEEN
59C	FAST	CA5	FIFTH
62B	FASTEN	D2A	FIFTY
607	FAT	DE0	FILE
		EB1	FILL

FILE NAME : SSB-E20

ADDRESS	WORD	ADDRESS	WORD
000	FINAL	732	FLAG
0E1	FINALLY	7DD	FLAME
1C8	FIND	88A	FLASHER
275	FINISH	94B	FLIER
30F	FIRE	A19	FLIGHT
3C1	FIRES	A9B	FLOW
497	FIRM	B2D	FLUID
53F	FIRST	BF3	FOCUS
5C4	FIT	CA8	FOG
61D	FIVE	D42	FOLLOW
6CF	FIXED	E1C	FOOD
		EBA	FOR

FILE NAME : SSB-E21

ADDRESS	WORD	ADDRESS	WORD
000	FORMAT	7DF	FRIEND
0CB	FORTY	89C	FRIENDLY
173	FORWARD	9BD	FROM
25A	FOUR	A80	FRONT
2E6	FOURTEEN	B02	FUEL
3E8	FOURTH	BC6	FULL
485	FREE	C62	FUSE
516	FREEZING	D36	G
639	FREQUENT	DA8	GAGE
6E6	FREQUENTLY	E44	GAUGE
		EE7	GAIN

FILE NAME : SSB-E22

ADDRESS	WORD	ADDRESS	WORD
000	GALAXY	732	GLAD
0BC	GALLON	7D9	GLIDE
178	GAME	893	GLOW
21B	GAS	934	GO
2A2	GATE	9C2	GOES
30E	GEAR	A82	GOING
3A8	GEGA	B2E	GOLD
43C	GET	BDF	GOLF
493	GETTING	C57	GOOD
53D	GIRL	CE5	GOT
5E7	GIVE	D4C	GRAIN
688	GIVES	DFD	GRAM
		EAA	GRAMMAR

FILE NAME : SSB-E23

ADDRESS	WORD	ADDRESS	WORD
000	GREAT	7A1	HAD
067	GREEN	845	HALE
11A	GREETINGS	8F9	HALF
201	GREY	970	HALT
28E	GRODY	9EF	HAND
361	GROSS	AA6	HANG
3E9	GROUND	B4A	HAPPEN
4B5	GUESS	BFE	HARD
538	GUILT	CBC	HARDLY
5BB	GUN	DCF	HAS
64B	GUNSHOT	E90	HAT
742	H	EF6	HAVE

FILE NAME : SSB-E24

ADDRESS	WORD	ADDRESS	WORD
000	HAZARDOUS	79B	HEXADECIMAL
0F9	HE	86D	HIGH
16B	HEAD	905	HIGHER
213	HEAR	9BC	HIM
29C	HEAT	A69	HIS
308	HEIGHT	B0A	HIT
37F	HELD	B61	HITTING
430	HELLO	C09	HOLD
4F0	HELP	CB7	HOME
569	HENRY	D55	HONEST
626	HER	E0D	HONOR
6A2	HERE	EBF	HOOD
723	HERTZ	F2C	HOOK

FILE NAME : SSB-E25

ADDRESS	WORD	ADDRESS	WORD
000	HOPE	6EA	HUNT
07D	HORIZONTAL	772	HUNTER
195	HOT	826	HURRY
20B	HOUR	8AE	I
2B4	HOURS	935	ICE
366	HOUSE	9A6	ICING
3E3	HOW	A69	IDENTIFICATION
47F	HOWEVER	BA6	IDENTIFY
544	HUNDRED	C89	IGNITE
637	HUNGRY	D5E	IMMEDIATE
		E4B	IMMEDIATELY

FILE NAME : SSB-E26

ADDRESS	WORD	ADDRESS	WORD
000	IN	6FB	INFLIGHT
08D	INBOUND	7D3	INFORMATION
1B0	INCHES	92D	INHABITANT
28E	INCREASE	A51	INNER
34E	INCREASING	B04	INNKEEPER
429	INDEXED	BFC	INSERT
516	INDICATED	CBB	INSPECT
613	INDIRECT	D8E	INSPECTOR
		E86	INSTRUCTION

FILE NAME : SSB-E27

ADDRESS	WORD	ADDRESS	WORD
000	INSTRUMENT	8C5	JETS
111	INTEGRATED	93D	JOB
21B	INTERESTING	9DE	JOURNEY
34F	INTERVAL	A9B	JOY
461	INTRUDER	B2C	JULIET
558	INVALID	C06	JULY
677	IS	CB6	JUMP
704	IT	D2A	JUNE
75B	J	DD7	JUNK
7D6	JANUARY	E40	JUST
		ECF	K

FILE NAME : SSB-E28

ADDRESS	WORD	ADDRESS	WORD
000	KEEP	644	KNOWN
061	KEY	709	KONG
0D1	KEYBOARD	7A2	L
19A	KILL	839	LABRATORY
236	KILO	953	LADY
301	KIND	A18	LAKE
3BE	KNAPSACK	AA5	LAND
48F	KNOCK	B71	LANDING
588	KNOTS	C62	LARGE
598	KNOW	D1E	LARGER
		E01	LARGEST

FILE NAME : SSB-E29

ADDRESS	WORD	ADDRESS	WORD
000	LASER	72D	LEFT
0D9	LAST	7D4	LENT
185	LATE	854	LESS
200	LAUGH	8DB	LESSON
29D	LAUNCH	9AA	LETTER
32C	LAY	A6B	LEVEL
3CC	LAZY	B34	LIAR
47F	LEADER	BE7	LICENSE
542	LEAN	CC7	LIE
5DB	LEARN	D73	LIGHT
67B	LEAVE	E12	LIKE
		E96	LIMIT

FILE NAME : SSB-E30

ADDRESS	WORD	ADDRRESS	WORD
000	LINE	83C	LONG
0C3	LIST	8E8	LOOK
16F	LISTEN	976	LOOP
22C	LITTLE	9FB	LOSE
2F1	LIVE	ACD	LOSS
3B6	LIVE	B66	LOST
485	LOAD	C06	LOUD
53B	LOCALIZER	CCF	LOVE
680	LOCATED	D88	LOW
77B	LOGIC	E3E	LUCK
		EB5	LUCKY

FILE NAME : SSB-E31

ADDRESS	WORD	ADDRESS	WORD
000	M	890	MARCH
084	MACHINE	918	MARGIN
157	MACRO	9F8	MARK
251	MADE	A7C	MARKER
2F4	MAGNETS	B13	MATTER
403	MAINTAIN	BC4	MAX
520	MAKE	C42	MAY
59E	MAN	CD5	MAYBE
64A	MANUAL	D85	MAYDAY
758	MANY	E4E	ME
811	MAP	ED5	MEAN

FILE NAME : SSB-E32

ADDRESS	WORD	ADDRESS	WORD
000	MEASURE	6BA	METROPOLIS
0C3	MEGA	7A2	MICRO
176	MEMORY	84F	MICROPROCESSOR
24E	MENTION	981	MICROPROFESSOR
321	MENU	AA7	MIDDLE
3F9	MERCHANT	B40	MIDPOINT
4BD	MERRY	C2E	MIKE
569	MESSAGE	CA3	MILEPOST
607	METER	DBF	MILLION
		EB0	MINUTE

FILE NAME : SSB-E33

ADDRESS	WORD	ADDRESS	WORD
000	MINUTES	843	MOTHER
0B1	MISS	90E	MOVE
11F	MIST	9D7	MOVING
1A8	MIXTURE	AA9	MR.
270	MOBILE	B5B	MRS.
37E	MODERATE	C17	MS.
455	MODULE	CD6	MUCH
557	MONITOR	D48	MUST
642	MONKEY	DCD	MY
6EB	MOREX	E66	N
77E	MORNING	EE6	NAME

FILE NAME : SSB-E34

ADDRESS	WORD	ADDRESS	WORD
000	NANO	755	NICE
0D8	NATURALLY	7CE	NIGHT
1D8	NEAR	84A	NINE
27B	NEED	8FC	NINER
31B	NEGATIVES	9D4	NINETEEN
3F3	NEUTRAL	AF6	NINETY
4B9	NEVER	BAA	NO
57C	NEW	C43	NOISE
609	NEWSPAPER	D1B	NOISY
6CD	NEXT	DDD	NOON
		E8F	NORMAL

FILE NAME : SSB-E35

ADDRESS	WORD	ADDRESS	WORD
000	NORTH	823	NOW
089	NORTHEAST	8D5	NUMBER
169	NORTHWEST	99F	O
256	NOT	A26	OCTOBER
2E0	NOTEBOOK	B28	OF
3A8	NOTHING	BBF	OFF
477	NOTIFY	C29	OFTEN
586	NOVA	CCF	OH
64B	NOVEL	D49	OIL
724	NOVEMBER	DFB	OK
		E97	OLD

FILE NAME : SSB-E36

ADDRESS	WORD	ADDRESS	WORD
000	ON	7CC	OUT
0A0	ONCE	845	OUTER
128	ONE	8E0	OVER
1AF	ONLY	990	OVERSPEED
27C	OPEN	AB7	OWE
31F	OPERATING	B2B	P
420	OR	B7A	PAC
4A7	ORDER	BDD	PAGE
569	OTHER	C85	PAIN
635	OUGHT	D20	PAPA
6A1	OUNCE	DB3	PAPER
735	OUR	E41	PARENTS
		EFB	PARK

FILE NAME : SSB-E37

ADDRESS	WORD	ADDRESS	WORD
000	PART	6CC	PER
071	PARTIALLY	73C	PERCENT
137	PARTS	7DF	PERIOD
1BA	PARTY	8C0	PERIPHERAL
24C	PASS	9B5	PERMITTED
2DB	PAST	AA6	PERSONAL
362	PATH	B7C	PHASER
3ED	PAUSE	C22	PHONE
4AE	PAY	CC5	PHYSICS
533	PEACE	D75	PICK
5A1	PELLETS	DC5	PICO
647	PEN	E4F	PIECE
		EBC	PLACE

FILE NAME : SSB-E38

ADDRESS	WORD	ADDRESS	WORD
000	PLAN	63B	POLLING
0AB	PLAY	6EF	POOR
141	PLAYER	76E	POPULARITY
1E4	PLAYS	88A	POSITION
2A0	PLEASANT	96B	POSITIVE
345	PLEASE	A52	POSSIBLE
402	PLOTTER	B36	POSTAGE
4BA	PLUS	C12	POUND
536	POCKET	CC4	POUNDS
5C3	POINT	D88	POWER
		E32	PRECISION

FILE NAME : SSB-E39

ADDRESS	WORD	ADDRESS	WORD
000	PREFER	847	PROCEEDING
0BF	PREMISES	958	PROGRAM
1A8	PRESS	A39	PROGRAMMED
217	PRESSURE	B40	PROMISE
2B0	PRICE	BE9	PROPS
334	PRINT	C54	PULL
398	PRINTER	CD5	PUMPS
430	PRIORITY	D43	PURCHASE
511	PRISON	DF0	PUSH
5BC	PRISONER	E52	PUT
685	PROBABLY	E99	PUTTING
76B	PROBLEM	F2B	Q

FILE NAME : SSB-E40

ADDRESS	WORD	ADDRESS	WORD
000	QUESTION	7F1	RAISE
0B7	R	8AF	RANDDMLY
144	RABBIT	9B9	RANGE
1D9	RADAR	A75	RAPID
292	RADIAL	B25	RATE
37A	RADIATOR	BAD	REACHED
478	RADIO	C3A	READ
560	RADIUS	CC8	READ
624	RAILROAD	D5D	READY
74B	RAIN	DF0	REALLY
		E99	REAR

FILE NAME : SSB-E41

ADDRESS	WORD	ADDRESS	WORD
000	RECEIVE	774	REMARK
0DA	RECORDER	815	REMENBER
1D2	RED	919	REPAIR
26C	REENTER	9E6	REPEAT
35D	REFER	A3A	REPLY
438	REFERRAL	B6F	REPORTED
526	REJECT	C55	RESISTANCE
5D6	RELEASE	D5C	RESISTOR
690	REMAIN	E73	RESPONSE

FILE NAME : SSB-E42

ADDRESS	WORD	ADDRESS	WORD
000	RETURN	80C	ROGER
0E8	REVERSED	8CA	ROMEO
1D2	REVOLT	995	ROOM
299	REWIND	A3B	ROUND
39E	RICH	AFD	ROUTE
419	RIDE	B81	RUN
4D0	RIGHT	C14	RUNWAY
54D	RINSE	CF8	S
5D4	RISE	D58	SAFE
68E	RISING	DD6	SAME
76D	ROAST	E7C	SAND

FILE NAME : SSB-E43

ADDRESS	WORD	ADDRESS	WORD
000	SAVE	76B	SELL
0BC	SAY	7FA	SEND
15F	SCATTERED	890	SENT
22A	SCHOOL	903	SEPTEMBER
2DA	SCORE	9F3	SEQUENCE
388	SCREEN	AA9	SERVICE
447	SEARCH	B5D	SET
4C3	SEAT	BB5	SEVEN
534	SECONDS	C68	SEVENTEEN
5F6	SEE	D5E	SEVENTY
683	SELECTION	E2C	SHAPE
		EAA	SHE

FILE NAME : SSB-E44

ADDRESS	WORD	ADDRESS	WORD
000	SHIELDS	6F5	SICK
0B8	SHIFT	759	SIDE
12C	SHIH	80A	SIDES
1AE	SHIP	8F1	SILICON
218	SHOOT	9DF	SILVER
29D	SHORE	A97	SINCE
340	SHORT	B1B	SING
3C0	SHORTER	B9E	SINGLE
479	SHOT	C62	SISTER
4F6	SHOW	D1D	SIT
58D	SHOWERS	D87	SIX
684	SHUT	DF0	SIXTEEN
		ED0	SIXTY

FILE NAME : SSB-E45

ADDRESS	WORD	ADDRESS	WORD
000	SKILL	759	SOME
0C3	SLEEP	7EB	SOMETHING
15F	SLEET	8BE	SON
1EC	SLOPE	952	SOON
288	SLOW	9F6	SORRY
352	SMALL	AAC	SORT
403	SMALLER	B29	SOUND
4DB	SMOKE	BDD	SOUTH
561	SNOW	C6B	SOUTHEAST
611	SO	D46	SOUTHWEST
6A7	SOCKET	E35	SPACE
		EC0	SPACES

FILE NAME : SSB-E46

ADDRESS	WORD	ADDRESS	WORD
000	SPEAK	7F7	STALL
081	SPEED	8B8	STAMP
12A	SPELL	94A	STAN
1D2	SPITE	9FB	STAND
25D	SPOON	ABF	STAR
30D	SPRAY	B70	START
3C8	SQUADRON	BFD	STATE
4C5	SQUAK	C90	STATIC
561	SQUARE	D4F	STATUS
61F	STABILIZER	E12	STAY
777	STACK	EB3	STEP
		F2C	STICK

FILE NAME : SSB-E47

ADDRESS	WORD	ADDRESS	WORD
000	STILL	74D	STRICT
0A2	STOCK	7D2	STUDENT
118	STOLEN	88E	STUDY
20B	STONE	939	STUPID
2B4	STOP	9EE	SUBJECT
329	STOPPED	ACC	SUBSTANCE
3C9	STORE	BBF	SUCCEED
46D	STORED	C86	SUCCESSFUL
528	STORM	D7F	SUCH
5F1	STRANGE	DE9	SUM
6C6	STREET	E73	SUMMER

FILE NAME : SSB-E48

ADDRESS	WORD	ADDRESS	WORD
000	SUNNYVALE	827	SYSTEMS
0FE	SUPER	910	T
1A0	SUPERIOR	992	TAB
2CC	SUPPLY	A43	TABLE
3B0	SUPPOSED	B16	TAILOR
4AD	SURRENDER	BD7	TAIPEI
5A7	SUSPECT	CA6	TAIWAN
655	SWEEP	D92	TAKE
6D7	SWITCH	DFE	TANGO
765	SYSTEM	EB9	TANK
		F24	TAPE

FILE NAME : SSB-E49

ADDRESS	WORD	ADDRESS	WORD
000	TAXI	880	THAN
09D	TEACHER	90D	THANK
13C	TEEN	977	THAT
1D4	TELECREDIT	A00	THE
2C8	TELEPHONE	A78	THEATER
3A6	TELEVISION	B2B	THEIR
494	TELL	BD1	THEN
51F	TEMPERATURE	C65	THERE
62B	TEN	CFF	THEREFORE
6A7	TEST	DDA	THEY
727	TESTING	E6A	THIEF
7E2	TEXAS	ECC	THIN
		F3A	THING

FILE NAME : SSB-E50

ADDRESS	WORD	ADDRESS	WORD
000	THINGS	779	TO
08B	THINK	7F1	TODAY
0E0	THINLY	8A9	TOGETHER
189	THIRD	972	TOLL
217	THIRTY	A1A	TOMORROW
2A7	THIS	AF0	TONE
313	THOUSAND	B8F	TOO
3F3	THREE	BFF	TOP
477	THREW	C6B	TOUCH
50A	THROUGH	CCD	TOUCHDOWN
594	TICKET	D95	TOWER
613	TIME	E41	TRACK
6C4	TIMER	EAE	TRAFFIC

FILE NAME : SSB-E51

ADDRESS	WORD	ADDRESS	WORD
000	TRAIN	894	TRIGGER
0A8	TRANSACTION	934	TRIM
1C9	TRANSFERRED	9CD	TROUBLE
2C9	TRANSLATE	A85	TRY
3BE	TRANSMISSION	B2A	TURBULANCE
4D5	TRAVEL	C30	TURN
5A6	TRAVELER	CD7	TWELVE
698	TRAVELING	D98	TWENTIETH
7A6	TREAT	E7A	TWENTY
80A	TREF	F18	TWICE

FILE NAME : SSB-E52

ADDRESS	WORD	ADDRESS	WORD
000	TWO	789	UNQUOTE
088	TYPE	86A	UNTIL
0FE	U	94E	UP
197	UNAUTHORIZED	9A1	UPPER
2F6	UNCLE	A32	USE
3A4	UNDER	AFB	USER
463	UNDERRCARRIAGE	BE2	V
59C	UNDERSTAND	C7B	VACUUM
6D8	UNIT	D51	VALID
		E25	VALLEY

FILE NAME : SSB-E53

ADDRESS	WORD	ADDRESS	WORD
000	VALUE	959	VOLT
0E4	VARIABLE	9F0	VOLTAGE
214	VECTORS	AC4	W
31D	VERIFY	B71	WAIT
40B	VERTICAL	BED	WAKE
505	VERY	C65	WALL
5D0	VICTOR	D00	WAND
6A3	VIDEO	DBA	WANT
787	VISIBILITY	E43	WAR
8B2	VISIT	EE9	WARM

FILE NAME : SSB-E54

ADDRESS	WORD	ADDRESS	WORD
000	WARNING	79B	WELL
0D2	WAS	847	WERE
18D	WASH	8F9	WEST
216	WATCH	988	WHAT
29C	WATER	9F7	WHEEL
36A	WATT	AA2	WHENEVER
3E9	WATTS	B96	WHERE
46B	WAY	C40	WHICH
504	WE	CA9	WHILE
59D	WEAPON	D62	WHISKEY
652	WEATHER	E0A	WHISTLE
721	WEEK	EB7	WHITE

FILE NAME : SSB-E55

ADDRESS	WORD	ADDRESS	WORD
000	WHOEVER	817	WITHOUT
0A8	WHY	8B7	WON
145	WIFE	944	WORD
1D3	WILL	9F0	WORK
273	WIN	A61	WORKING
300	WIND	B07	WORKMAN
3B6	WINDOW	BCC	WORLD
478	WINDOWS	C83	WOUND
594	WING	D3F	WRITE
61B	WINTER	DB9	WRONG
6D8	WISE	E41	X
7A4	WITH	EB0	Y

FILE NAME : SSB-E56

ADDRESS	WORD	ADDRESS	WORD
000	YEAR	1C5	YOU
098	YES	24C	YOUR
113	YELLOW	2EA	Z
		3A9	ZERO

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