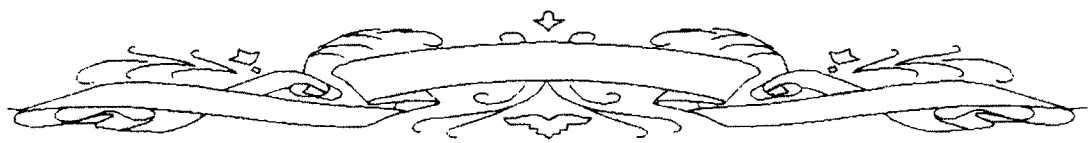

# CHAPTER-III

# SPEECH SYNTHESIS - A CASE STUDY

## 3.1 SPO 256 NARRATOR SPEECH PROCESSOR FEATURES:

- Natural speech
- Stand Alone Operation with Inexpensive support components
- Wide operating voltage
- Word, phrase or sentence library ROM expandable
- Expandable to use 491 k of ROM directly
- Simple interface to Most Micro-Computers or Microprocessors
- Supports L.P.C Synthesis: Formant Synthesis: Allophone Synthesis

The SPO 256 (speech processor) is a single chip N channel MOSLSI device that is able to use its stored program, to synthesize speech or complex sounds. The achievable output is equivalent to a flat frequency response ranging from 0 to 5 KHz a dynamic range of 42 dB and a signal to noise ratio of approximately 35 dB.

The SPO 256 incorporates 4 basic functions.

- A software programmable digital filter that can be made to model a VOCAL TRACT;
- A 16 k ROM which stores both date and instructions;
- A MICROCONTROLLER which controls the data flow from the ROM to the digital filter, the assembly of the "word strings" necessary for linking speech elements together and the amplitude and pitch information to excite the digital filter; and
- A pulse width modulator that creates a digital output which is converted to an analog signal when filtered by an external low pass filter

The SPO 256 is controlled using the address pins ($A_1$ - $A_8$), ALD (Address load) and SE (store enable). The object for controlling the chip is to load an address into it which contains the desired allophone. The speech data for the allophone set is contained within the internal 16k ROM of the SPO-256 AL2. It

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requires six address pins ($A_1$ - $A_6$) to address all the 59 allophones plus 5 pauses, a total of 64 locations. $A_7$, $A_8$ can be tied low.

There are two modes available for loading an address into the chip 'strobe enable' controls the mode that will be used. Mode-0 will latch in an address when any one or more of the address pins makes a low to high transition.

Mode-1 will latch in an address using the ALD pin. First, set up the desired address on the address bus ($A_1$ - $A_6$) and then plus ALD Low. Any address can be loaded using this mode.

Two microprocessor interface pins are available for quick loading of addresses. They are LRQ and SBY. LRQ tells the processor when the input buffer is full. SBY tells the processor that the chip has stopped talking and no new address has been loaded.

## 3.2 DETAILS OF SPO-256 SPEECH PROCESSOR:

### 3.2.1 Pin Configuration of SPO-256:

Top view

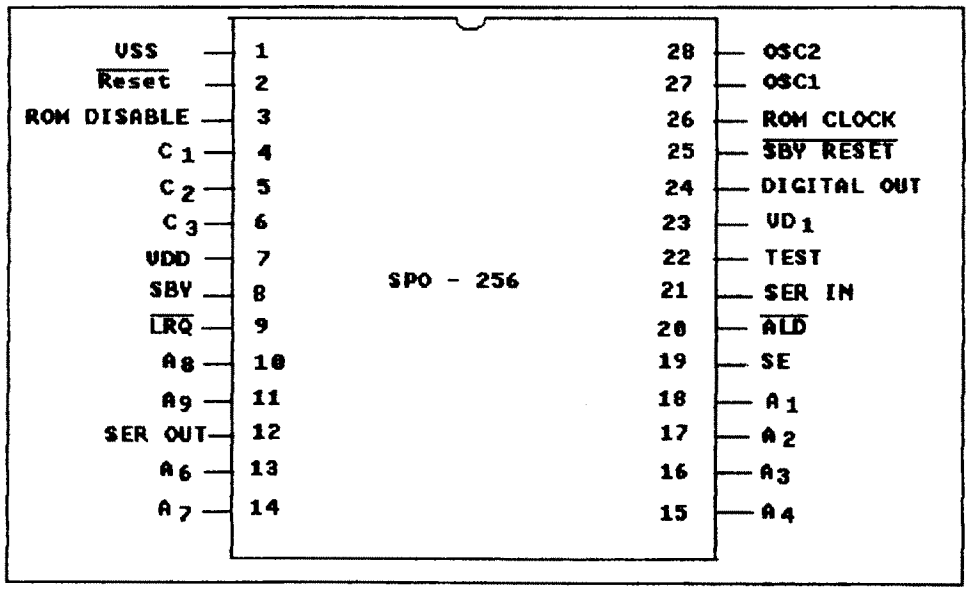



Fig 3.1 Top view of SPO-256

3.2.2 SPO-256 Block Diagram:

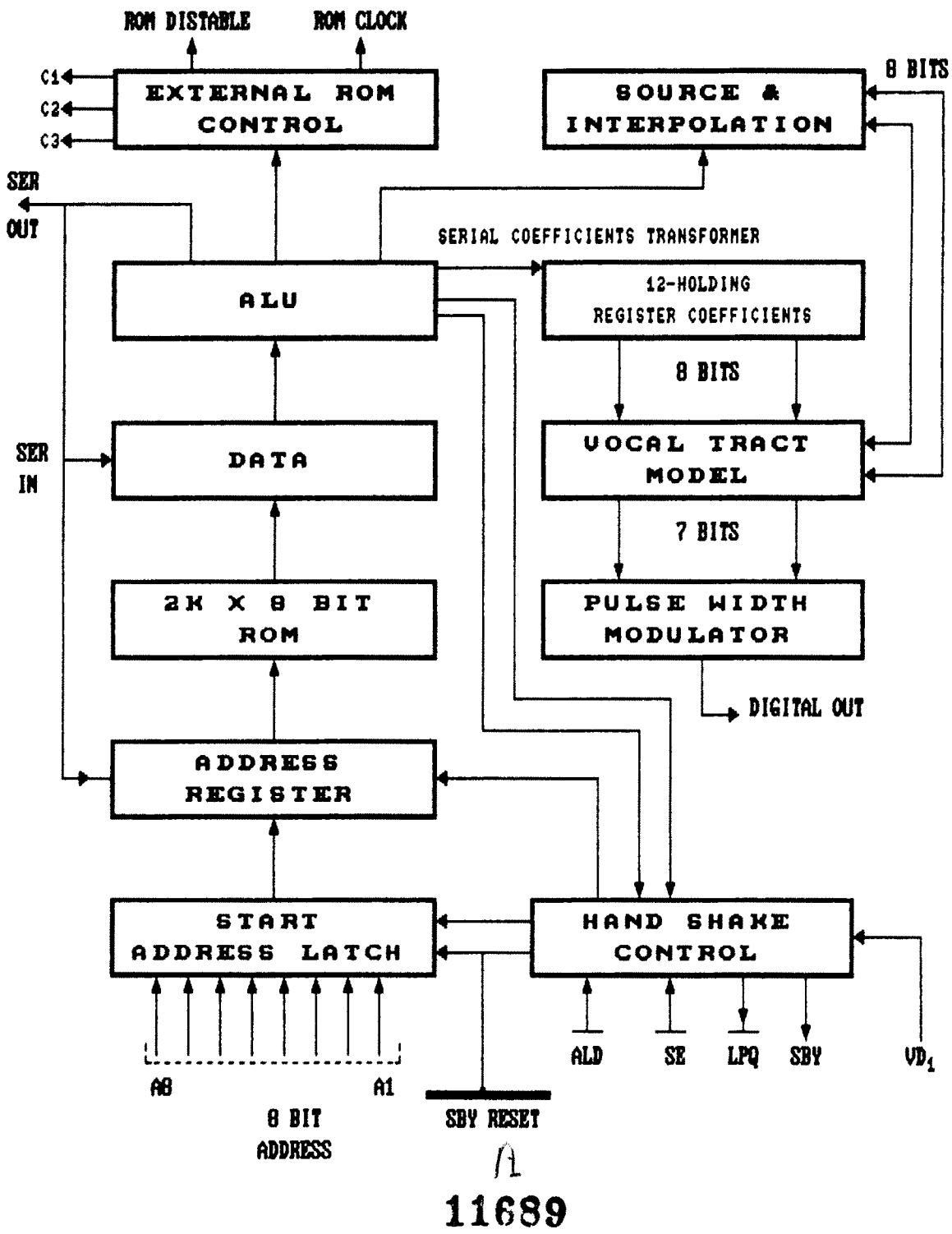



Fig. 3.2 SPO-256 block diagram

### 3.2.3 Pin Functions of SPO-256:

| PIN | NAME | FUNCTION |
|---|---|---|
| 1 | VSS | Ground |
| 2 | RESET | A logic 0 resets that portion of the SP powered by VDD. Must be returned to a logic 1 for normal operation. |
| 3 | ROM DISABLE | For use with an external serial speech ROM, a logic 1 disables the external ROM. |
| 4,5,6 | $C_1$, $C_2$, $C_3$ | Output control lines for use with an external serial speech ROM. |
| T | VDD | Power supply for all portions of the SP except the microprocessor interface logic |
| 8 | SBY | STANDBY. A logic 1 output indicates that the SP is inactive and VDD can be powered down externally to Conserve power. When the SP is reactivated by an address being loaded, SBY will go to a logic 0 |
| 9 | LRQ | LOAD REQUEST LRQ is a logical output whenever the input butter is full, when LRQ goes to a logic 0, the input port may be loaded by placing the 8 address bits on $A_1$ - $A_8$ and pulsing the ALD output. |
| 10,11,13,14<br>15,16,17,18 | $A_8$,$A_7$,$A_6$,$A_5$<br>$A_4$,$A_3$,$A_2$,$A_1$ | 8 Bit address which defines anyone of 256 speech entry points. |
| 12 | SER OUT | SERIAL ADDRESS OUT This output transfers a 16 bit address serially to an external speech ROM. |

(Continued.....)

(Continued.....)

| PIN | NAME | FUNCTION |
|---|---|---|
| 19 | SE | STROBE ENABLE. Normally held in a logic 1 state, when tied to ground ALD is disable and the SP will automatically latch in the address on the input bus approximately 1 µs after detecting a logical 1 on any address lines. |
| 20 | ALD | ADDRESS LOAD: A-ve pulse on this input loads 8 address bits into the I/P port. The -ve edge of this pulse causes LRQ to go high. |
| 21 | SER IN | SERIAL IN - This is an 8 bit serial data input from an external speech ROM. |
| 22 | TEST | This pin should be grounded for normal operation. |
| 23 | $VP_1$ | Power supply for the microprocessor interface logic and controller. |
| 24 | DIGITAL OUT | Pulse width modulated digital speech output which when filtered by a 5KHZ low pass filter and amplified, will drive a loudspeaker. |
| 25 | SBY RESET | STANDBY RESET. a logic 0 resets the microprocessor interface logic and the address latches. Must be returned to a logic 1 for normal operation. |
| 26 | ROM CLOCK | This is a 1.56 MHZ clock output used to drive an external serial speech ROM. |
| 27 | OSC 1 | XTAL In. Input connection for a 3.12 MHZ crystal. |
| 28 | OSC 2 | XTAL OUT. Output connection for a 3.12 MHZ crystal. |

### 3.2.4 Electrical characteristics:

**Maximum Ratings*:**

| | |
|---|---|
| All pins with respect to $V_{ss}$ | -0.3 to 8 OV |
| Storage temperature | -25°C to 125°C |

**Standard Conditions:**

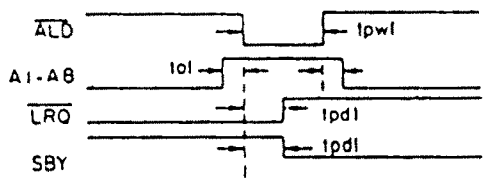
| | |
|---|---|
| Clock-Crystal frequencies | 3.120 MHZ |
| Operating temperature ($T_1$) | 0°C to 70°C |

DC CHARACTERISTICS/SPO 256

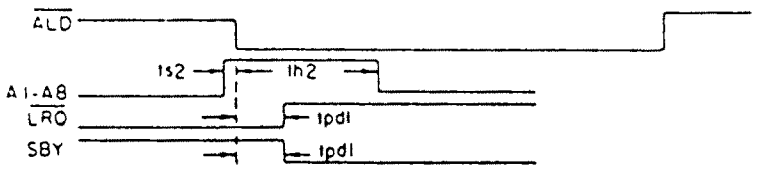
| Characte-ristic | Sym | Min | Typ | Max | Units | Conditions |
|---|---|---|---|---|---|---|
| Supply voltage | $V_{DO}$ | 4.6 | - | 7.0 | V | ------- |
| | $V_{D1}$ | 4.6 | - | 7.0 | V | ------- |
| Supply current | $I_{DO}$ | - | - | 90 | mA | $T_A$ = 25°C,$VD_1$, $V_{DD}$=7.0 V $\overline{\text{Reset}}$ & $\overline{\text{SBY Reset}}$ high All outputs floating |
| | $I_{D1}$ | - | - | 21 | mA | Same as above |
| Inputs | | | | | | |
| A1-A8, $\overline{\text{ALD}}$, SERIN TEST, SE | | | | | | |
| Logic 0 | $V_{iL}$ | 0.0 | - | 0.6 | V | |
| Logic 1 | $V_{iH}$ | 2.4 | - | $V_{D1}$ | V | |
| Capacitance | $C_{iN}$ | - | - | 10 | pF | 0 Volts Bias, F=3.12 MHZ |
| Leakage | $I_L$ | - | - | 10 | µa | $V_{PIN}$ = 7.0 V, other pins = 0.0 V |
| $\overline{\text{RESET}}$, $\overline{\text{SBY RESET}}$ | | | | | | |
| Logic 0 | $V_{IL}$ | 0.0 | - | 0.6 | V | |
| Logic 1 | $V_{IH}$ | 3.6 | - | $V_{D1}$ | V | |
| Outputs SBY digital out, C1, C2, C3 SEROUT | | | | | | |
| Logic 0 | $V_{D1}$ | 0.0 | - | 0.6 | V | $I_{DL}$ = 0.72 ma |
| Logic 1 | $V_{DH}$ | 2.5 | - | $V_{D1}$ | V | $I_{DH}$ = -50 µa |
| Oscillator OSC 2 (output) | | | | | | When driven from external source |
| Logic 0 | $V_{DL}$ | 0.0 | - | 0.6 | V | OSC1 = 3.90 V min. |
| Logic 1 | $V_{DH}$ | 2.5 | - | $V_{D1}$ | V | OSC1 = 0.60 V max. |

### 3.2.5 Timing Diagram:

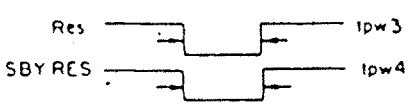
| AC CHARACTERISTICS | SYM | MIN | TYP | MAX | UNITS | CONDITIONS |
|---|---|---|---|---|---|---|
| $\overline{ALD}$ | tpw1 | 200 | — | 1100 | ns | 200 ≤ $\overline{ALD}$ ≤ 1100 ns |
| A1-A8 Set Up | ts1 | 0 | — | — | ns | |
| Hold | th1 | 160 | — | — | ns | |
| $\overline{LRQ}$ | tpd1 | — | — | 300 | ns | |
| SBY | tpd2 | — | — | 300 | ns | |




| AC CHARACTERISTICS | SYM | MIN | TYP | MAX | UNITS | CONDITIONS |
|---|---|---|---|---|---|---|
| $\overline{ALD}$ | tpw2 | 1100 | — | — | ns | $\overline{ALD}$ > 1100 ns |
| A1-A8 Set Up | ts2 | 0 | — | — | ns | |
| Hold | th2 | 1120 | — | — | ns | |
| $\overline{LRQ}$ | tpd1 | — | — | 300 | ns | |
| SBY | tpd2 | — | — | 300 | ns | |




| AC CHARACTERISTICS | SYM | MIN | TYP | MAX | UNITS | CONDITIONS |
|---|---|---|---|---|---|---|
| Clock Frequency | F | — | 3.120 | — | MHz | Crystal Oscillator |
| Clock Duty Cycle | — | 48 | — | 52 | % | driven from |
| $\overline{Reset}$ | tpw3 | 100 | — | — | us | external. |
| $\overline{SBY\ Reset}$ | tpw4 | 100 | — | — | us | |



### 3.2.6 Dictionary:

Table 1:
Numbers:

| | | | |
|---|---|---|---|
| zero | ZZ YR OW | seventeen | SS SS EH VV TH NN1 PA2 PA3 TT2 IY NN1 |
| one, WON | WW SX AX NN1 | | |
| two, to, too | TT2 UW2 | eighteen | EY PA2 PA3 TT2 IY NN1 |
| three | TH RR1 IY | nineteen | NN1 AY NN1 PA2 PA3 TT2 IY NN1 |
| four, for, fore | FF FF OR | twenty | TT2 WH EH EH NN1 PA2 PA3 |
| five | FF FF AY VV | | TT2 IY |
| Six | SS SS IH IH PA3 KK2 SS | thirty | TH ER2 PA2 PA3 TT2 IY |
| seven | SS SS EH EH VV IH NN1 | forty | FF OR PA3 TT2 IY |
| eight, ate | EY PA3 TT2 | fifty | FF FF IH FF FF PA2 PA3 TT2 IY |
| nine | NN1 AA AY NN1 | Sixty | SS SS IH PA3 KK2 SS PA2 PA3 TT2 IY |
| ten | TT2 EH EH NN1 | seventy | SS SS EH VV IH NN1 PA2 PA3 TT2 IY |
| eleven | IH LL EH EH VV IH NN1 | eighty | EY PA3 TT2 IY |
| twelve | TT2 WH EH EH LL VV | ninety | NN1 AY NN1 PA3 TT2 IY |
| thirteen | TH ER1 PA2 PA3 | hundred | HH2 AX AX NN1 PA2 DD2 RR2 IH IH PA1 DD1 |
| fourteen | FF OR PA2 PA3 NN1 | thousand | TH AA AW ZZ TH PA1 PA1 NN1 DD1 |
| fifteen | FF IH FF PA2 PA3 TT2 IY NN1 | million | MM IH IH LL YY1 AX NN1 |
| sixteen | SS SS IH PA3 KK2 SS PA2 PA3 TT2 IY NN1 | | |

Table 1 (Continued....)

DAYS OF THE WEEK:

| | | | |
|---|---|---|---|
| **Sunday** | SS SS AX AX NN1 PA2 DD2 EY | **Monday** | MM AX AX NN1 PA2 DD2 EY |
| **Tuesday** | TT2 UW2 ZZ PA2 DD2 EY | **Wednesday** | WW EH EH NN1 ZZ PA2 DD2 EY |
| **Thursday** | TH ERZ ZZ PA2 DD2 EY | **Friday** | FF RR2 AY PA2 DD2 EY |
| **Saturday** | SS SS AE PA3 TT2 DD2 EY | | |

MONTHS:

| | | | |
|---|---|---|---|
| January | JH AE AE NN1 YY2 XR 1Y | February | FF EH EH PA1 BR RR2 UW2 XR 1Y |
| March | MM AR PA3 CH | April | EY PA3 PP RR2 IH IH LL |
| May | MM EY | June | JH UW2 NN1 |
| July | JH UW1 LL AY | August | AO AO PA2 GG2 AX SS PA3 TT1 |
| September | SS SS EH PA3 PP PA3 TT2 EH EH PA1 BB2 ER1 | October | AA PA2 KK2 PA3 TT2 OW PA1 BB2 ER1 |
| November | NN2 OW VV EH EH MM PA1 BB2 ER1 | December | DD2 IY SS SS EH EH MM PA1 BB2 ER1 |

LETTERS:

| | | | | | |
|---|---|---|---|---|---|
| A | EY | B | BB2 IY | C | SS SS IY |
| D | DD2 IY | E | IY | F | EH EH FF FF |
| G | JH IY | H | EY PA2 PA3 CH | I | AA AY |
| J | JH EH EY | K | KK1 EH EY | L | EH EH EL |
| M | EH EH MM | N | EH EH NN1 | O | OW |
| P | PP IY | Q | KK1 YY1 UW2 | R | AR |
| S | EH EH SS SS | T | TT2 IY | U | YY1 UW2 |
| V | VV IY | W | DD2 AX PA2 BB2 EL YY1 UW2 | X | EH EH PA3 KK2 SS SS |
| Y | WW AY | Z | ZZ IY | | |

DICTIONARY:

| | | | |
|---|---|---|---|
| Alarm | AX LL AR MM | Bathe | BB2 EY DH2 |
| Beer | BB2 YR | By | BB2 AA AY |
| Clock | KK1 LL AA AA PA3 KK2 | Checks | CH EH EH PA3 KK1 SS |
| Cookie | KK3 UH KK1 IY | Coop | KK3 UW2 PA3 PP |
| Crown | KK1 RR2 AW NN1 | Date | DD2 EY PA3 TT2 |
| Daughter | DD2 AO TT2 ER1 | Emotional | IY MM OW SH AX NN1 AX |
| Enrage | EH NN1 RR1 EY PA2 JH | Escape | EH SS SS PA3 KK1 PA2 PA3 PP |
| Equal | IY PA2 PA3 KK3 WH AX EL | Error | EH XR OR |
| Fir | FF ER2 | Freeze | FF FF RR1 IY ZZ |
| Gauge | GG1 EY PA2 JH | Hello | HH EH LL AX OW |
| Hour | AW ER1 | Infinitive | IH NN1 FF FF IH IH NN1 IH PA2 PA3 TT2 IH VV |
| Key | KK1 IY | Letter | LL EH EH PA3 TT2 ER1 |
| Little | LL IH IH PA3 TT2 EL | Memory | MM EH EH MM ER2 IY |
| Minute | MM 1H NN1 1H PA3 TT2 | Nip | NN1 1H 1H PA2 PA3 PP |
| No | NN2 AX OW | Pin | PP 1H 1H NN1 |
| Plus | PP LL AX AX SS SS | Ray | RR1 EH EY |
| Ready | RR1 EH EH PA1 DD2 IY | Red | RR1 EH EH PA1 DD1 |
| Robot | RR1 OW PA2 BB2 AA PA3 TT2 | Score | SS SS PA3 KK3 OR |
| Sincere | SS SS IH IH NN1 SS SS YR | Sister | SS SS IH IH SS PA3 TT2 ER1 |
| Spell | SS SS PA3 PP EH EH EL | Start | SS SS PA3 TT2 AR PA3 TT2 |
| Switch | SS SS WH IH IH PA3 CH | Talk | TT2 AO AO PA2 KK2 |
| Talking | TT2 AO AO PA3 KK1 IH NG | Then | DH1 EH EH NN1 |
| Time | TT2 AA AY MM | Uncle | AX NG PA3 KK3 EL |
| Whale | WW EY EL | Yes | YY2 EH EH SS SS |

### 3.2.7 Consonant and Vowel Phonemes of English:

Consonant phonemes of English:

| | | Labial | Labio-dental | Inter-dental | Alveo-lar | Palatal | velar | glottal |
|---|---|---|---|---|---|---|---|---|
| Stops | Voiceless | pp | | | TT | | kk | |
| | voiced | BB | | | DD | | GG | |
| Frica-tives | Voiceless | WH | FF | TH | SS | SH | | HH |
| | Voiced | | VV | DH | ZZ | ZH | | |
| Affri-cates | Voiceless | | | | | CH | | |
| | Voiced | | | | | JH | | |
| Nasals | Voiced | MM | | | NN | | NG | |
| Reso-nants | Voiced | WW | | | RR,LL | YY | | |

Labial: Upper and lower lips touch or approximate
Labiodental: Upper teeth and lower lip touch
Interdental: Tongue between teeth
Alveolar: Tip of tongue touches or approximates alveolar ridge
Patal: Body of tongue approximates palate
Velar: Body of tongue touches velum
Glottal: Glottis (opening between vocal cords)

Vowel phonemes of English:

| | Front | Central | Back |
|---|---|---|---|
| High | YR<br>IY<br>IH * | | <br>UW #<br>UH * # |
| Mid | EY<br>EH *<br>XR | ER<br>AX * | OW #<br>OY # |
| Low | AE * | AW #<br>AY<br>AR<br>AA * | AO * #<br>OR # |

* Short vowels # Rounded vowels

### 3.2.8 Guidelines for Using the Allophones:

Silence:

PA1 (10 ms) _ before BB, DD, GG and JH

PA2 (30 ms) _ before BB, DD, GG and JH

PA3 (50 ms) _ before PP, TT, KK and CH and between words

PA4 (100 ms) _ between clauses and sentences

PA5 (200 ms) _ between clauses and sentences

Short vowels:

*/IH/ _ sitting, stranded

*/AE/ _ extract, acting

*/AO/ _ talking, song

*/AA/ _ pottery, cotton

*/EH/ _ extend, gentleman

*/UH/ _ cookies, full

*/AX/ _ lapel, instruct

Long vowels:

/IY/ _ treat, people, penny

/AY/ _ kite, sky, mighty

/OW/ _ zone, close, snow

/EL/ _ little, angle, gentleman

/UW2/ _ in monosyllabic words: two

/EY/ _ great, statement, tray

/OY/ _ noise, toy, voice

/AW/ _ sound, mouse, down

/UW1/ _ after, clusters with YY: computer

R-Colored vowels:

/ER1/ _ letter, furniture, interrupt

/OR/ _ fortune, store,

/YR/ _ hear, earring, irresponsible

/ER2/ _ monosyllabic, bird, fern, burn

/AR/ _ farm, alarm, garment

/XR/ _ hair, declare, store

Resonants:

/WW/ - we, warrant,

/RR2/ _ initial clusters: brown

/YY1/ _ clusters: cute, beauty

/RR1/ _ initial position: read, write

/LL/ _ like, hello, steel

/YY2/ _ initial positions: yes, yarn

Voiced fricatives:

/VV/ _ west, prove, even

/ZZ/ _ zoo, phase

/DH2/ _ word, final and between vowels: bathing

/DH1/ _ word initial position: this, then

/ZH/ _ pleasure

---

* This allophones can be doubled.

**Voiceless fricatives:**

/SH/ _ shirt, leash, nation,

/HH1/ _ before front vowels: YR, IY, IH, EY, EH, XR, AE

/HH2/ - before back vowels: UW, UH, OW, OY, AO, OR, AR

/WH/ _ White, twenty

**Voiced stops:**

/BB1/ _ final position: rib, between vowels: fibber, in clusters: bleed, brown

/BB2/_ initial position before a vowel: beast,

/DD1/_ final position: played, end

/DD2/_ initial position: down, clusters: drain

/GG1/ _ before high front vowels: YR, IY, IH, EY, EH, XR

/GG2/ _ before high back vowels: UW, UH, OW, OY, AX

/GG3/ _ before low vowels: AE, AW, AY, AR, AA, AO, OR, ER

**Voiceless stops:**

/PP/ _ pleasure, ample, trip

/TT1/ _ final clusters before SS: tests, its,

/TT2/ _ all other position: test, street

/KK1/ _ before front vowels: YR, IY, IH, EY, initial clusters: cute, clown

/KK2/ _ final position: speak, final clusters: tasks

/KK3/ _ before back vowels: UW, UH, OW, OY: initial clusters: crane, quick

**Affricates:**

/CH/ _ church, feature /JH/ _ Judge, injure

**Nasal:**

/MM/ _ milk, alarm, ample /NN1/ _ final clusters: earn, YR, IY, IH, EY

/NN2/ _ before back vowels: UH, OW /NG/ _ string, anger

### 3.2.9 Allophone Address Table:

| Decimal address | Octal address | Allophone | Sample word | Duration |
|---|---|---|---|---|
| 0 | 000 | PA1 | Pause | 10 ms |
| 1 | 001 | PA2 | Pause | 30 ms |
| 2 | 002 | PA3 | Pause | 50 ms |
| 3 | 003 | PA4 | Pause | 100 ms |
| 4 | 004 | PA5 | Pause | 200 ms |
| 5 | 005 | /OY/ | Boy | 420 ms |
| 6 | 006 | /AY/ | Sky | 260 ms |
| 7 | 007 | /EH/ | End | 70 ms |
| 8 | 010 | /KK3/ | Comb | 120 ms |
| 9 | 011 | /PP/ | Pow | 210 ms |
| 10 | 012 | /JH/ | Dodge | 140 ms |
| 11 | 013 | /NN1/ | Thin | 140 ms |
| 12 | 014 | /IH/ | Sit | 70 ms |
| 13 | 015 | /TT2/ | To | 140 ms |
| 14 | 016 | /RR1/ | Rural | 170 ms |
| 15 | 017 | /AX/ | Succeed | 70 ms |
| 16 | 020 | /NN/ | Milk | 180 ms |
| 17 | 021 | /TT1/ | Part | 100 ms |
| 18 | 022 | /DH1/ | They | 290 ms |
| 19 | 023 | /IY/ | See | 250 ms |
| 20 | 024 | /EY/ | Beige | 280 ms |
| 21 | 025 | /DD1/ | Could | 70 ms |

(Continued.....)

(Continued.....)

| Decimal address | Octal address | Allophone | Sample word | Duration |
|---|---|---|---|---|
| 22 | 026 | /UW1/ | To | 100 ms |
| 23 | 027 | /AO/ | Aught | 100 ms |
| 24 | 030 | /AA/ | Hot | 100 ms |
| 25 | 031 | /YY2/ | Yes | 180 ms |
| 26 | 032 | /AE/ | Hat | 120 ms |
| 27 | 033 | /HH1/ | He | 130 ms |
| 28 | 034 | /BB1/ | Business | 80 ms |
| 29 | 035 | /TH/ | Thin | 180 ms |
| 30 | 036 | /UH/ | Book | 100 ms |
| 31 | 037 | /UW2/ | Food | 260 ms |
| 32 | 040 | /AW/ | Out | 370 ms |
| 33 | 041 | /DD2/ | Do | 160 ms |
| 34 | 042 | /GG3/ | Wig | 140 ms |
| 35 | 043 | /VV/ | Vest | 190 ms |
| 36 | 044 | /GG1/ | Got | 80 ms |
| 37 | 045 | /SH/ | Ship | 160 ms |
| 38 | 046 | /ZH/ | Azure | 190 ms |
| 39 | 047 | /RR2/ | Brain | 120 ms |
| 40 | 050 | /FF/ | Food | 150 ms |
| 41 | 051 | /KK2/ | Sky | 190 ms |
| 42 | 052 | /KK1/ | Can't | 160 ms |
| 43 | 053 | /ZZ/ | Zoo | 210 ms |
| 44 | 054 | /NG/ | Anchor | 220 ms |

(Continued.....)

| Decimal address | Octal address | Allophone | Sample word | Duration |
|---|---|---|---|---|
| 45 | 055 | /LL/ | Lake | 110 ms |
| 46 | 056 | /WW/ | Wool | 180 ms |
| 47 | 057 | /XR/ | Repair | 360 ms |
| 48 | 060 | /WH/ | Whig | 200 ms |
| 49 | 061 | /YY1/ | Yes | 130 ms |
| 50 | 062 | /CH/ | Church | 190 ms |
| 51 | 063 | /ER1/ | Fir | 160 ms |
| 52 | 064 | /ER2/ | Fir | 300 ms |
| 53 | 065 | /OW/ | Beau | 240 ms |
| 54 | 066 | /DH2/ | They | 240 ms |
| 55 | 067 | /SS/ | Vest | 90 ms |
| 56 | 070 | /NN2/ | No | 190 ms |
| 57 | 071 | /HH2/ | Hoe | 180 ms |
| 58 | 072 | /OR/ | Store | 330 ms |
| 59 | 073 | /AR/ | Alarm | 290 ms |
| 60 | 074 | /YR/ | Clear | 350 ms |
| 61 | 075 | /GG2/ | Guest | 40 ms |
| 62 | 076 | /EL/ | Saddle | 190 ms |
| 63 | 077 | /BB2/ | Business | 50 ms |

## 3.3 HARDWARE IMPLEMENTATION:

The Intel 8255 a is a general purpose programmable I/O device designed for use with Intel microprocessor 8085. It has 24 I/O pins which may be individually programmed in 2 groups of 12 and used in 3 major modes of operations. Group A contain port B and upper bits of port C and group B contain port B and lower bits of port C.

In our interface, 8255 is used in mode '0' i.e. group of 12 I/0 pins are programmed in sets of 4 bits as Input Port/Output port. The functional configuration of each port is programmed by the system software. Control status Register initializes the functional configuration of the 8255.

Port A is used to access the memory address of SPO-256. As per requirement, only 6 lines of port A ($PA_0$ - $PA_5$) are used. Port B is used as Input Port, only one line $PB_0$ is used to connect $\overline{ALD}$ signal from SPO-256 and port C is used as Output Port. $PC_0$ line is used to connect $\overline{LRQ}$ signal.

| Port address of 8255 | |
|---|---|
| A | OOH |
| B | O1H |
| C | O2H |
| CSR | O3H |

The 8085 CPU is interfaced with 8255 and SPO 256. The main line program is written at the address 6000 H. The look up table in written at the address 6500 H. The interfacing of microprocessor and SPO-256 is shown in Fig. 3.4.

## 3.4 SYSTEM INTERFACE:

A microprocessor is of no use unless interfaced with other devices. The interfaced devices are called as peripherals or helping tools to the

microprocessor. These devices, i.e., peripherals should be compatible with each other.

The incompatibility between any two devices could arise because of one or more of the following differences.

1. Timing according to which date transfer is to take place.
2. Formant in which data is to be transferred.
3. Electrical characteristics of two devices.

The allocation of address to memory Chip and I/O device depends on microprocessor architecture. Some processor provides only one address space thereby treating I/O devices as memory locations. Some other provides two disjoint address spaces one for memory and other for I/O devices.

Thus, there are 2 schemes for memory address into devices.

1. Memory mapped I/O scheme.
2. I/O mapped I/O scheme.

In this work, the system is interfaced with I/O mapped I/O scheme. According to this scheme the memory and I/O device use distinct address space. Thus, the total address space provided for the memory can be fully used by assigning to the I/O devices address from the I/O space. For this scheme processor needs to provide following additional facilities.

1. At least two extra instruction by means of which the I/P and O/P devices could be addressed.
2. An O/P signal that may be used by memory and I/O devices to ascertain whether the address on the address bus is to the memory or for an I/O device. So, to decide address for memory or I/O the 8085 provides IO/M signal, when it is high indicates the address is for I/O and low indicates address for memory.

## 3.5 DETAILS OF AMPLIFIER TBA 810:

TBA 810 it is a monolithic silicon 7 watt Audio Power Amplifier with Thermal Shunt down. BEL TBA 810 is monolithic audio amplifier intended for class B operation. They are specifically design for mobile equipment operating from 12 V battery supplies. They operate over a wide range of supply voltages (4 to 20 V) with very low harmonic and cross-over distortion. The maximum repetitive peak output current is 2.5 A, and an integral thermal limiting circuit shunts the device down in case of O/P overload or excessive package temperature.

The TBA 810 is supplied in modified 16 head quad-in-line plastic package ("Q" suffix) with integral wingtab heat sinks. The tabs on the TBA 810 are flat and pierced for easy attachment to an external heat sink.

| Maximum ratings | Absolute maximum |
|---|---|
| Values at TA | 25°C |
| Supply voltage | 20 V. |
| Peak O/P current (non repetitive) | 3.5 A. |
| Peak O/P current (repetitive) | 2.5 A |
| device dissipation | |
| At TA = 70°C | 1W |
| AT $T_{tab}$ = 100°C | 5 W. |

**Features:**

- Power O/P = 7 W with 4 Ω load
- Supply voltage range 4 to 20 V.
- Peak output current 2.5 A (max.)
- Very low harmonic and cross over distortion.

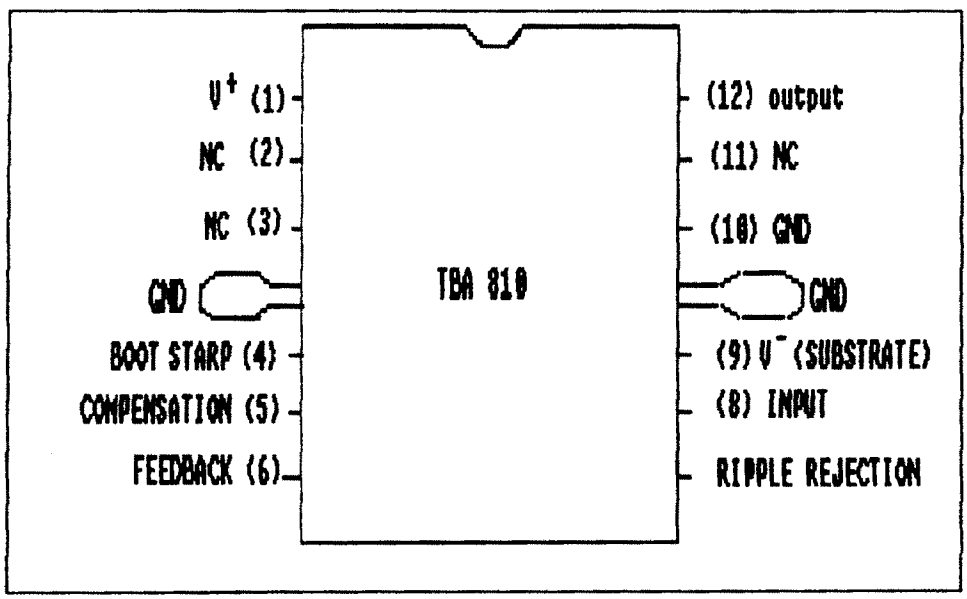



Fig. 3.3 Terminal diagram of TBA 810 As.

## 3.6 INTERFACE BLOCK DIAGRAM:

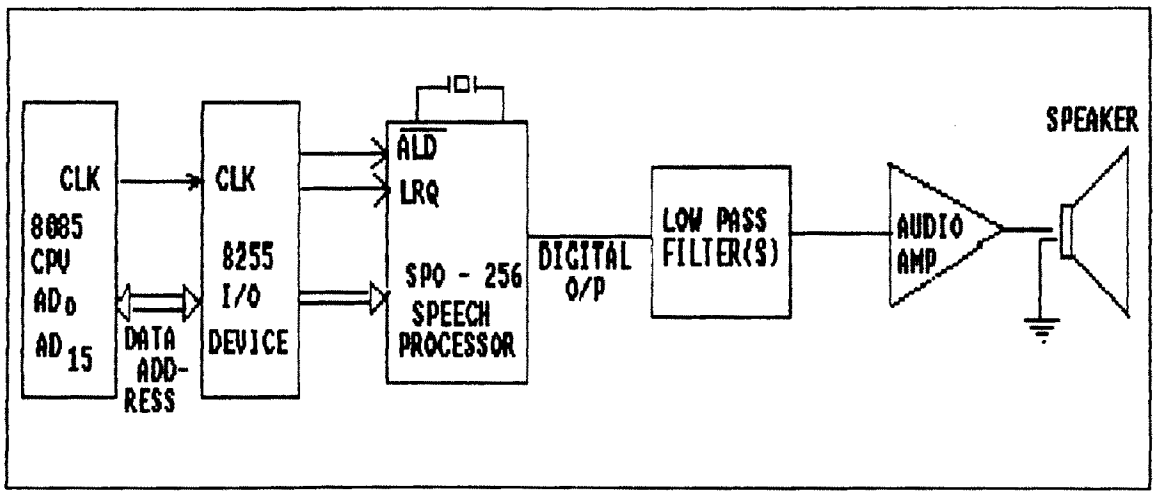
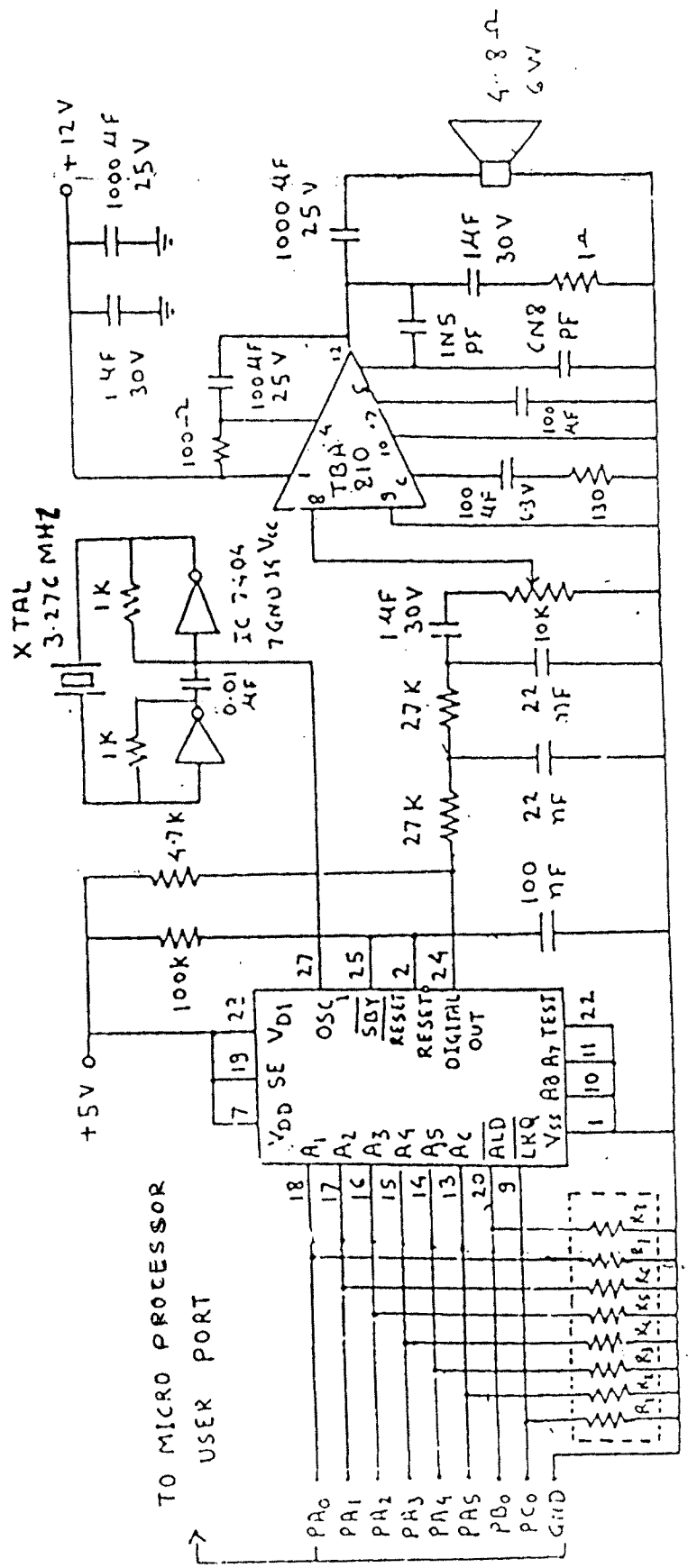



Fig. 3.4 Interface block diagram

**Electrical characteristics at TA = 25°C.**

| Characte-ristics | Symbol | Test conditions Supply voltage ($V^+$) = 14.4 V. Unless otherwise specified | Limits Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Supply voltage | $V^+$ | | 4 | - | 20 | V. |
| Input voltage | $V_1$ | | - | - | 220 | mV. |
| Input sensitivity | $e_1$ | Po = 6w, RL = 4Ω $R_1$ = 56Ω f = 1 KHZ | - | 80 | - | mV |
| Quiescent O/P voltage | Vo | | 6.4 | 7.2 | 8 | V |
| Quiescent current drain | $I_o$ | | - | 12 | 20 | mA |
| Input noise voltage | $e_n$ | Rg = o, Bw (-3 dB) = 20 to 20,000 HZ. | - | 2 | - | μV. |
| Bias current | $I_1B$ | | - | 0.4 | - | μA |
| Output power | $P_o$ | f = 1 KHZ, RL = 4Ω, TND = 10 % $V^+$ = 14.4 V. | - | 6 | - | W |
| | | $V^+$ = 6 V | - | 1 | - | |
| Input resistance | $R_1$ | | - | 5 | - | mΩ |
| Total harmonic Distortion | TND | $P_o$ = 50 mW to 3W RL = 4Ω f = 1KH2 | - | 0.3 | - | % |
| Open loop voltage gain | AOL | RL = 4Ω, f = 1 KH2 | - | 80 | - | dB |
| Closed loop voltage gain | A | RL = 4Ω, f = 1KH2 $R_1$ = 56Ω | 34 | 37 | 40 | dB |
| Efficiency | N | $P_o$ = 5W, RL = 4 Ω, f = 1KHZ | - | 70 | - | % |




3·6 COMPLETE CIRCUIT DIAGRAM FOR SPEECH SYNTHESIZER

## 3.7 SOFTWARE IMPLEMENTATION: FLOW CHART:

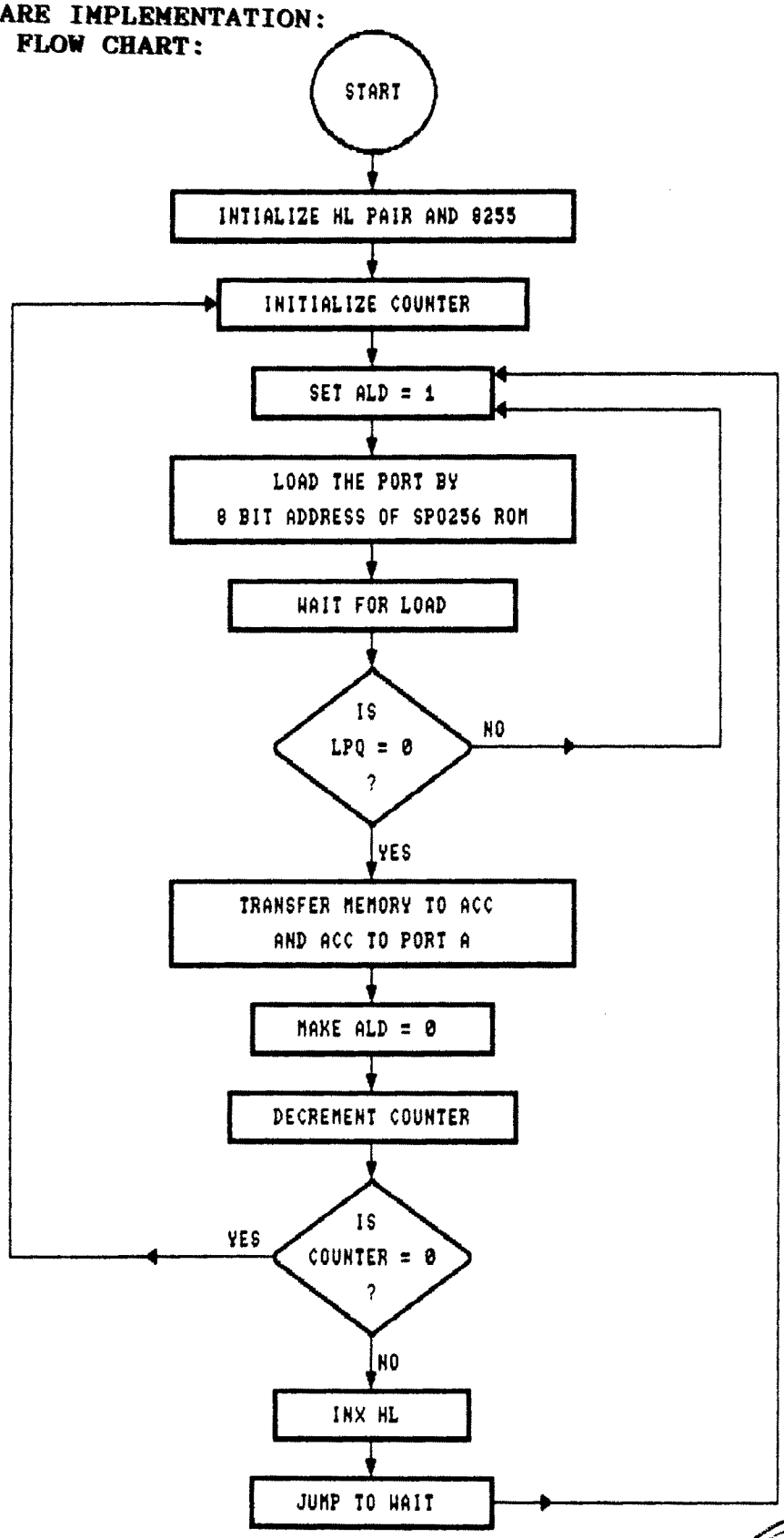



Fig. 3.7 Software implementation flow chart

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**3.8 SOFTWARE PROGRAM:**

| Label | Address | Mnemonics | Instruction | | | Comments |
|---|---|---|---|---|---|---|
| START | 6000 | LXI HL | 21 | 00 | 65 | Initialize HL pair |
| | 6003 | MVI A,89 | 3E | 89 | - | Initialize 8255 |
| | 6005 | OUT CSR | D3 | O3 | - | Control Status Register |
| | 6007 | MVI C,X | 0E | X | - | Count |
| WAIT | 6009 | MVI A,00 | 3E | 00 | - | Set ALD = 1 |
| | 600B | OUT PB (01) | D3 | 01 | - | Sent ALD Logic '0' |
| | 600D | IN PC (02) | DB | 02 | - | In LRQ |
| | 600F | ANI 01 | E6 | 01 | - | Wait for LRQ |
| | 6011 | CPI 00 | FE | 00 | - | Wait for LRQ |
| | 6013 | JNZ (WAIT) | C2 | 09 | 60 | No: go to wait |
| | 6016 | MOV A, M | 7E | - | - | Yes: Transfer M-A |
| | 6017 | OUT PA | D3 | 00 | - | - |
| | 6019 | MVI A (01) | 3E | 01 | - | Clear A & D = 0<br>ALD = 1 |
| | 601B | OUT PB (01) | D3 | 01 | - | - |
| | 601D | DCR C | 0D | - | - | - |
| | 601E | JZ (START) | CA | 00 | 60 | - |
| | 6021 | INX H | 23 | - | - | - |
| | 6022 | JMP (WAIT) | C3 | 09 | 60 | Jump to Wait |

3.8.1 Look Up Table:

| a. To send 'One' | | b. To send 'E' | | c. To send 'U' | |
|---|---|---|---|---|---|
| 6500 | 02 | 6500 | 02 | 6500 | 02 |
| 6501 | 23 | 6501 | 14 | 6501 | 16 |
| 6502 | 16 | 6502 | 02 | 6502 | 35 |
| 6503 | 1A | 6503 | 02 | 6503 | 02 |
| 6504 | 0B | 6504 | 13 | | |
| 6505 | 02 | 6505 | 03 | | |

| d. To send 'I' | | e. To send 'A' | | f. To send 'O' | |
|---|---|---|---|---|---|
| 6500 | 02 | 6500 | 02 | 6500 | 02 |
| 6501 | 0C | 6501 | 13 | 6501 | 35 |
| 6502 | 14 | 6502 | 03 | 6502 | 02 |
| 6503 | 03 | | | | |

## 3.9 UPDATING OF VOCABULARY:

| Generated sound | Phoneme code (Hex address) |
|---|---|
| A | 02, 13, 03 |
| Account | 08, 1A, 02, 2A, 20, 38, 02, 0D, 03 |
| Achievement | 0C, 1A, 02, 32, 0C, 0C, 23, 10, 07, 0B, 02, 0B, 02 |
| Agree | 06, 1A, 01, 3D, 27, 13, 03 |
| Aim | 03, 14, 10, 02 |
| Apple | 05, 1A, 02, 09, 3E, 02 |
| B | 02, 1C, 14, 02, 14, 00, 3f, 14 03 |
| Bank | 07, 01, 3F, 0B, 02, 29, 02 |
| Batch | 09, 01, 3F, 07, 01, 02, 0D, 00, 32, 02 |
| Bridge | 07, 01, 3F, 27, 0C, 00, 0A, 02 |
| C | 04, 37, 37, 13, 03 |
| Camera | 09, 02, 2A, 1A, 10, 07, 07, 0E, 18, 03 |

(Continued.....)

(Continued.....)

| Generated sound | Phoneme code (Hex address) |
|---|---|
| Car | 04, 02, 2A, 3B, 02 |
| Cinema | 08, 37, 37, 13, 0B, 1A, 10, 18, 03 |
| D | 04, 00, 21, 13, 03, 02, 21, 14, 02 |
| Data | 04, 01, 21, 1A, 02, 0D, 18, 18, 03 |
| Dress | 07, 01, 21, 27, 07, 37, 37, 03, |
| E | 02, 14, 02, 02, 13, 03 |
| Early | 04, 33, 2D, 03 |
| Echo | 05, 13, 02, 08, 17, 03 |
| End | 07, 07, 0B, 15, 03 |
| F | 02, 07, 28, 28, 03, 02, 28, 02 |
| Fair | 04, 28, 28, 2F, 03 |
| Fine | 05, 28, 28, 06, 2D, 03 |
| Four | 02, 28, 3A, 00 |
| G | 02, 22, 14, 03 |
| Gain | 05, 00, 24, 06, 0B, 03 |
| Gold | 04, 00, 22, 17, 35, 2D, 00, 15, 03, 00 |
| H | 02, 13, 1B, 03 |
| Hall | 04, 39, 18, 2D, 03 |
| Help | 04, 1B, 07, 3E, 02, 09, 02 |
| Home | 04, 39, 17, 10, 03 |
| I | 02, 0C, 14, 03 |
| Ice | 04, 18, 06, 37, 03 |
| Ink | 0C, 0C, 0B, 02, 29, 02 |

(Continued.....)

(Continued.....)

| Generated sound | Phoneme code (Hex address) |
|---|---|
| Ill | 04, 0C, 0C, 2D, 03 |
| J | 02, 0A, 13, 02 |
| Job | 05, 0A, 18, 00, 1C, 03 |
| June | 04, 0A, 1F, 0B, 03 |
| K | 02, 2A, 07, 1A, 02 |
| Key | 04, 02, 2A, 13, 02 |
| Kodak | 04, 02, 08, 17, 00, 24, 1A, 02, 29, 03 |
| L | 02, 13, 2D, 02 |
| Lamp | 02, 2D, 07, 07, 10, 02, 09, 02 |
| Law | 04, 2D, 17, 17, 03 |
| M | 02, 14, 10, 02 |
| Mail | 04, 10, 07, 3E, 02 |
| Me | 03, 10, 13, 03 |
| Mother | 05, 10, 0F, 12, 33, 03 |
| N | 02, 14, 0B, 02 |
| Nice | 04, 0B, 06, 37, 03 |
| Novel | 05, 38, 35, 23, 3E, 02 |
| O | 02, 35, 02 |
| Octal | 08, 17, 17, 02, 2A, 02, 0D, 3E, 03 |
| Omega | 07, 35, 10, 07, 00, 24, 18, 03 |
| Our | 04, 18, 23, 33, 03 |
| P | 04, 02, 09, 13, 03 |
| Pair | 04, 02, 09, 2F, 03 |

(Continued.....)

(Continued.....)

| Generated sound | Phoneme code (Hex address) |
|---|---|
| Pen | 05, 02, 09, 07, 0B, 02 |
| Q | 08, 16, 35, 02 |
| Queen | 07, 02, 2A, 23, 0C, 0C, 0B, |
| Quiz | 06, 02, 2A, 23, 13, 2B, 02 |
| R | 02, 1A, 1A, 27, 02 |
| Rain | 04, 0E, 14, 0B, 02 |
| Real | 04, 0E, 0C, 3E, 02 |
| S | 02, 13, 25, 02 |
| Save | 05, 37, 37, 1A, 23, 03 |
| Science | 08, 37, 37, 0F, 31, 18, 0B, 37, 02 |
| Ship | 05, 25, 0C, 02, 09, 03 |
| T | 02, 0D, 14, 02 |
| Talk | 07, 02, 0D, 1A, 01, 1C, 3E, 02 |
| Theory | 07, 02, 1D, 0C, 17, 3A, 13, 03 |
| Twice | 07, 02, 0D, 23, 1D, 06, 37, 03 |
| U | 02, 16, 35, 02 |
| Ultra | 08, 18, 2D, 02, 0D, 27, 06, 0F, 03 |
| Upon | 07, 0F, 02, 09, 17, 17, 0B, 02 |
| Use | 05, 31, 1F, 2B, 03 |
| V | 02, 23, 00, 00, 14, 02 |
| Value | 06, 23, 1A, 2D, 31, 16, 03 |
| Verb | 05, 23, 0F, 0E, 1C, 02 |

(Continued.....)

(Continued.....)

| Generated sound | Phoneme code (Hex address) |
|---|---|
| Vision | 07, 23, 13, 2B, 18, 01, 0B, 02 |
| W | 02, 21, 1A, 3F, 2D, 16, 02 |
| Wall | 05, 2E, 17, 35, 2D, 02 |
| Weak | 06, 2E, 0C, 0C, 02, 29, 02 |
| X | 02, 13, 39, 02 |
| Xerox | 09, 2B, 1A, 0E, 17, 02, 29, 37, 37, 03 |
| X-ray | 0A, 07, 07, 02, 29, 37, 37, 02, 0E, 14, 02 |
| Y | 03, 2E, 06, 03 |
| Yellow | 07, 31, 1A, 3E, 2D, 17, 23, 03 |
| Yoga | 06, 19, 17, 00, 3D, 18, 02 |
| Youth | 06, 19, 1F, 1F, 00, 1D, 02 |
| Z | 02, 26, 13, 21, 02 |
| Zenith | 07, 2B, 1A, 00, 0B, 0C, 1B, 02 |
| Zone | 04, 2B, 35, 0B, 02 |

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