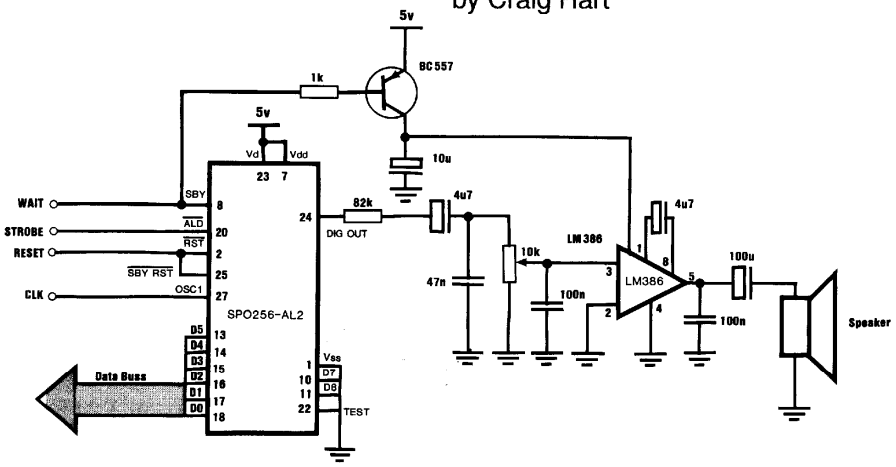
Speech Module

Parts $24.25
PC board $3.00
Total $27.25

Add speech to your TEC!

by Craig Hart



SPEECH MODULE CIRCUIT

Since the dawn of time, Colin has been fascinated by electronic speech synthesis, so it was with immense joy that we discovered the SPO256A-AL2 speech chip. This chip is a universal speech unit that can be made to speak almost any English word. The price was cheap and the interface was minimal, it was just too good to pass up! So I took took up the project and this is the result.

The module is interfaced to the TEC, and the TEC controls what is said. The only requirement is that you have a crystal oscillator, as the module requires a 3.58MHz clock signal from the unit. Demonstration programs have been included for testing and simple word sequencing, and these programs will show how the unit is accessed.

This is the ideal companion project to go with the I/O board, and a robot created out of the two projects will cause a real stir if it speaks a comment in response to what it is sensing in its environment.

The module is connected via an 8 way ribbon cable and 4 flying leads. The ribbon cable picks up D0-D5, and the 5v supply. The other 4 leads connect to STROBE 05, WAIT, RESET, and CLK. Note that only the lower six bits of the data bus are used by the speech chip. The reasons for this will be explained later.

OPERATION

The operation of the unit is straight forward, but it is important to understand its operation so that you can use it once you have built it. The SPO256A-AL2 is made to speak by sending it a series of ALLOPHONES. An allophone is the smallest individual sound that the unit can speak. Words and sentences are formed by outputting a series of allophones, one after the other.

Each allophone is assigned a number and this number is loaded into the chip via the TEC data bus, then the ALD line is pulled low (by strobe line 05).

The SPO now commences to speak the allophone and indicates so by pulling the WAIT line low, halting the TEC until the module is ready for more data. The BC557 is turned on hard by this and the LM386 amplifier is switched on.

Sound is clocked out of the unit at a rate determined by the CLOCK line. For normal speech this is 3.58MHz. Sound is filtered by an R-C network, to make the sound more "human like" and amplified by the LM386.

PARTS LIST

All resistors 1/4W 5%
1 - 1k Brown Black Red
1 - 82k Grey Red Orange

1 - 10k trimpot.

1 - 47n greencap.
2 - 100n monoblock.
2 - 4u7 electrolytic.
1 - 10u electrolytic.
1 - 100u electrolytic.

1 - BC557 transistor.
1 - LM386 amplifier IC.
1 - SPO256A-AL2 Speech IC.
1 - 8 pin IC socket.
1 - 28 pin IC socket.

1 - 8 ohm speaker.
4 - PC pins.
4 - PC pin connectors.
1 - 20 cm length 14 way ribbon cable.
1 - 24 pin DIP header.
1 - 10 cm length 2mm heatshrink tubing.

1 - 'SPEECH MODULE' PC board.

When speech output ceases, the wait line goes HIGH, and the TEC is able to continue processing. In doing so, the BC557 is switched off and thus the LM386's power supply is switched off. The reason for doing this is due to the high input impedance of the chip; it is prone to picking up stray noise. The most common noise source is the scanning of the LED displays! This results in an uncomfortable buzz when the unit is not speaking and by switching the power to the amplifier this has been eliminated.

THE ALLOPHONE SET

The SPO has little intelligence about what you want it to speak. You cannot simply feed it a word, and have it say the correct pronunciation in every case. (Although other chips do have this capability) Instead you, the programmer, must translate each word into the appropriate allophone(s) for that word. There are 64 individual allophones, and each sounds different. In these 64 allophones, there are 5 pauses of various lengths, corresponding to word and sentence breaks.

By consulting the Allophone reference table you can look up what you think the right sequence is then play around with different pronunciations of the same basic letter, until you reach the best sounding word. It can be a tedious process, but many common words have been pre calculated and a list appears at the end of the article, along with the table of individual allophones.

Take a sample word : ALARM. Sound out the word slowly, letter by letter. Now look for a matching sound in the list. Write down your guess and progress through the word. Where you have two or more choices, pick the allophone of the appropriate length. For alarm, I chose AA LL AR MM, or 18 2D 3B 10. Add a pause to the end and the terminating byte 04 FF. Plug the data into the test program at 0910 and run it.

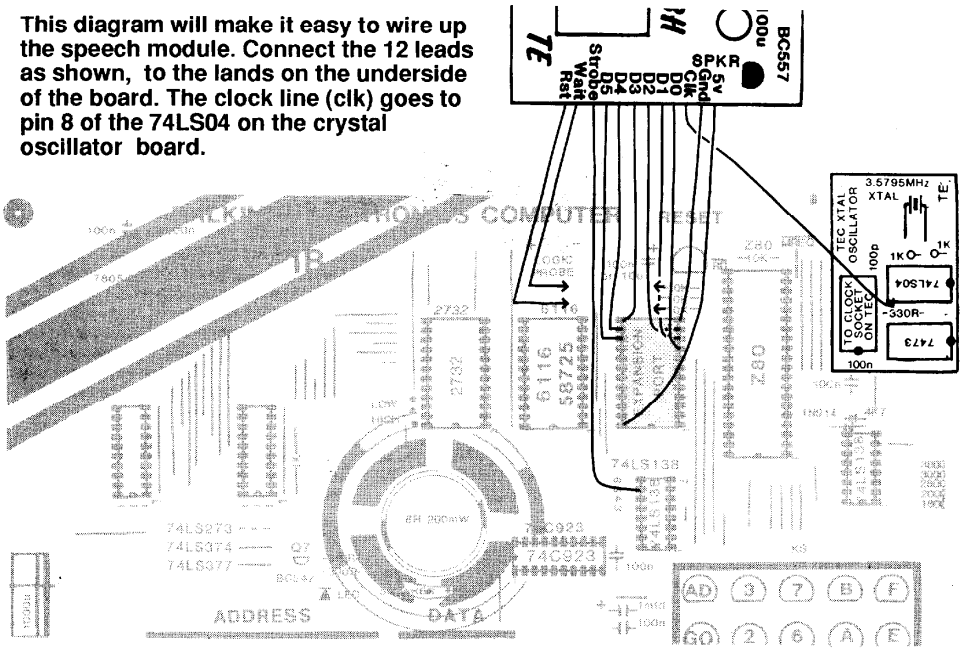
It sounds a little cut-off in the first 'a', so try a longer 'A' i.e. AX (0F) and try again. Enter 0F at 0910 and run the program again. Sounds better now doesn't it!

By following this method, you should be able to come up with any word within a short space of time. Remember, the secret is to sound each letter and syllable out and then search for the best allophone of the group. The sample word provided gives you a context in which the allophone is used. This is useful when deciding between TT1 and TT2 etc.

We also discovered that it was much easier to produce an understandable word if you used the slang way of saying it. The speech module always produces the same type of sound for any given allophone, so if you stick to spelling only, then the words always come out very strange. If you use slang then you will find that the resulting word is much easier to understand.

A perfect example of this came up when we first started work on the project. We bought our first sample chip from Tandy. It came with a list of words and full specification data. When the project was working, we started trying some given examples, and although the examples were recognizable, they were not very clear. Then Ross said to try the slang pronunciation. Voila! perfect. The words which were before just average became clearer and much more recognizable.

This diagram will make it easy to wire up the speech module. Connect the 12 leads as shown, to the lands on the underside of the board. The clock line (clk) goes to pin 8 of the 74LS04 on the crystal oscillator board.



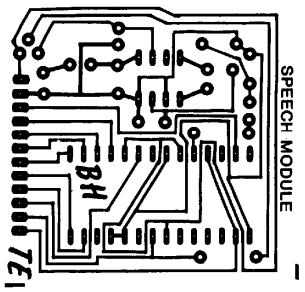
PAUSES AND REPEATING ALLOPHONES

The five pauses are worthy of a separate mention. You must always pause after a word, to make the SPO stop talking. Use a PA1 or a PA2. Use PA3 or PA4 between sentances. Refer to the following table for when to use PA1, PA2, and PA3 DURING words.

PA1 Before BB, DD, GG and JH.

PA2 Before some BB, DD, GG and JH.

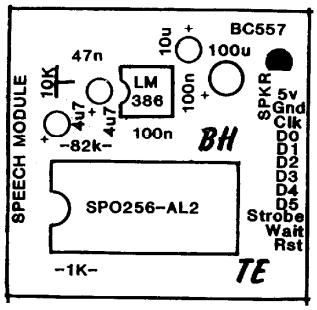
PA3 before PP, TT, KK, and CH.



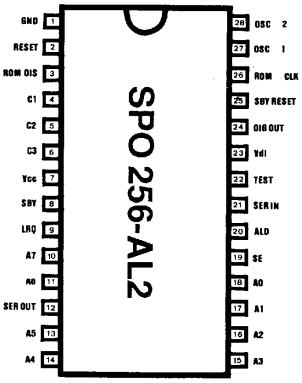
Begin by inserting the resistors. Solder them in and cut their leads short. Next insert the Capacitors, observing polarity with the Electrolytics.

Insert and solder the trimpot, then finally the transistor. Turn the trimpot fully towards the SPO - this is full volume and should be set here until testing is complete.

Check to see that you have a BC557 and insert it according to the 'D' on the overlay. Lastly insert the two IC sockets and plug the chips in, being careful to orientate pin one with the mark on the PC and avoid touching the pins of the SPO256A.



The speech board is very simple. Don't forget you will need the crystal oscillator project to get the 3.58MHz clock line.



The pin out of the SPO-256-Al2 allophone chip.

Strip 6 wires from the ribbon cable, then connect the remaining 8 between the data lines and the DIP header. Connect power with the last two strands. Follow the diagram and you can't go wrong. Separate 4 of the remaining wires into individual lengths and solder into the 4 remaining holes on the module.

Attach a matrix pin connector to the other end of each wire for connection to the TEC. Heatshrink each connector with the tubing supplied. A note on heatshrinking: Don't skip this section because you think it's a waste of time or too hard to do. Heatshrinking the connectors strengthens them and the wire is

A repeating allophone is one which can be spoken twice and flow along. i.e. EY EY produces 'AY pause AY', while FF FF produces one long 'Fff'. Only 10 of these 64 allophones are repeatable like this. They are: IH EH AE UH AO AX AA FF TH & SS. Use these allophones in preferance to long timed syllables like SH in SHirt, WE in tWEnty, or SH in leaSH.

CONSTRUCTION

Although a simple project, care should be taken to ensure that a good job is done, so do not rush. Lay all the parts out in front of you on a piece of paper or cardboard (Not the High - Low shagpile of the living room!) and check to see that you have been supplied with everything.

TEST PROGRAM

```
0900 21 10 09  LD HL,0910      HL = Points to start of table.
0903 7E        LD A,(HL)       Get next Allophone.
0904 FE FF     CP FF           End of table ?
0906 28 05     JR Z,090D       Yes, HALT.
0908 D3 05     OUT (05),A      Speak allophone.
090A 23        INC HL          Next allophone.
090B 18 F6     JR,0903         Say next ...
090D 76        HALT            EOT, stop until key pressed.
090E 18 F0     JR,0900         Key pressed, say again.

0910 0D 17 17 02 2A 0C 2C 04   Your allophones are entered
0918 04 2A 0F 10 00 31 16 0D   from 0910 onwards.
0920 33 04 04 FF               this says 'TALKING COMPUTER'

0910 1B 07 2D 35 00 36 07 2F   Here is another greeting
0918 04 06 00 1A 10 00 12 13   message.
0920 00 0D 13 03 13 03 37 13
0928 03 08 18 10 09 31 16 11   The TEC introduces itself
0930 33 04 04 04 38 20 00 30   here!
0938 0C 1D 37 09 13 32 04 FF
```

much less likely to break off. If you always melt the wire when shrinking over a candle, then try using the BARREL not the tip of your soldering iron. This gives you a better controlled heat source and a neat job can be done on those small connections.

The last two lengths of wire connect to the speaker. Wire these up and the board is complete. Now for connection to the TEC. You will need to have your crystal oscillator inserted. If you do not currently own a crystal oscillator, you must purchase one with a 3.58MHz crystal. If you have a different frequency crystal fitted, it must be around 3.2 - 4.0MHz otherwise the sound will be too high or low pitched. A 2MHz or 8MHz crystal will not suffice.

Insert a PC pin in port 5 pad, a second pin in the board for the WAIT line, and a third pin in the board for the RESET line. Most users will already have done so, but if not, see the wiring diagram for the three pin locations.

The other pin you will have to connect as best you can. To tap the 3.5MHz signal, DO NOT connect to pin 6 of the Z80. This is because the crystal's frequency is divided by two before reaching the TEC board. Instead, solder a PC pin onto pin 8 of the 74LS04 on the crystal oscillator PC. This is the 3.5MHz clock output.

TESTING

Plug everything together and power up. If your TEC locks up or the unit makes strange sounds, remove power and go to the section on troubleshooting. Your TEC should start up as normal, with the unit deadly quiet. Enter the TEST PROGRAM and you should be greeted with a message. Listen carefully and let your hearing adjust to the metallic pitch. If all you can hear is junk, check your program, then if still no go, proceed to the troubleshooting section.

If the test program produces recognisable output, try the other examples and then try making up a few words of your own. You will soon find that you can say just about any word, once you get the right allophones.

There can be hours of fun even getting it to correctly pronounce your name. 'Paul' is easy enough, but what about 'Vouzopolous'?? or even common words like 'construction' and 'calculator'?? With such a versatile unit, the sky's the limit.

ALLOPHONE REFERENCE TABLE

NUMBER	ALLOPHONE	DURATION	SAMPLE
00	PA1	10 ms	PAUSE
01	PA2	30 ms	PAUSE
02	PA3	50 ms	PAUSE
03	PA4	100 ms	PAUSE
04	PA5	200 ms	PAUSE
05	OY	420 ms	Boy
06	AY	260 ms	Sky
07	EH*	70 ms	End
08	KK3	120 ms	Comb
09	PP	210 ms	Pow
0A	JH	140 ms	Dodge
0B	NN1	140 ms	Thin
0C	IH*	70 ms	Sit
0D	TT2	140 ms	To
0E	RR1	170 ms	Rural
0F	AX*	70 ms	Succeed
10	MM	180 ms	Milk
11	TT1	100 ms	Part
12	DH1	290 ms	They
13	IY	250 ms	See
14	EY	280 ms	Beige
15	DD1	70 ms	Could
16	UW1	100 ms	To
17	AO*	100 ms	Aught
18	AA*	100 ms	Hot
19	YY2	180 ms	Yes
1A	AE	120 ms	Hat
1B	HH1	130 ms	He
1C	BB1	80 ms	Business
1D	TH*	180 ms	Thin
1E	UH*	100 ms	Book
1F	UW2	260 ms	Food
20	AW	370 ms	Out
21	DD2	160 ms	Do
22	GG3	140 ms	Wig
23	VV	190 ms	Vest
24	GG1	80 ms	Got
25	SH	160 ms	Ship
26	ZH	190 ms	Azure
27	RR2	120 ms	Brain
28	FF*	150 ms	Food
29	KK2	190 ms	Sky
2A	KK1	160 ms	Can't
2B	ZZ	210 ms	Zoo
2C	NG	220 ms	Anchor
2D	LL	110 ms	Lake
2E	WW	180 ms	Wool
2F	XR	360 ms	Repair
30	WH	200 ms	Whig
31	YY1	130 ms	Yes
32	CH	190 ms	Church
33	ER1	160 ms	Fir
34	ER2	300 ms	Fir
35	OW	240 ms	Beau
36	DH2	240 ms	They
37	SS*	90 ms	Vest
38	NN2	190 ms	No
39	HH2	180 ms	Hoe
3A	OR	330 ms	Store
3B	AR	290 ms	Alarm
3C	YR	350 ms	Clear
3D	GG2	40 ms	Guest
3E	EL	190 ms	Saddle
3F	BB2	50 ms	Business

* = Repeating Allophone.

BASIC DICTIONARY

```
0          2B 3C 35
1          30 0F 0B
2          0D 1F
3          36 27 13
4          28 17 17 27
5          28 06 23
6          37 0C 29 37
7          37 37 07 07 23 0C 0B
8          14 11
9          38 06 0B
10         0D 07 07 0B
11         13 2D 07 23 34 0B
12         0D 2E 07 3E 01 23
13         1D 33 0D 13 0B
14         28 17 27 0D 13 0B
15         28 0C 28 0D 13 0B
16         37 0C 29 37 0D 13 0B
17         37 37 07 07 23 0C 0B
           0D 13 0B
18         14 11 0D 13 0B
19         38 06 0B 0D 13 0B

A          14
Alarm      0F 2D 3B 10
Alex       1A 2D 07 29 37
Alexandra  1A 2D 07 29 37 1A 0B
           15 27 0F
All        17 17 2D
Am         1A 10
Amateur    1A 10 1A 11 31 33
An         1A 0B
And        1A 0B 15
April      14 01 09 0E 0C 2D
Are        3B
At         1A 0D
August     17 1E 22 0F 37 11

B          3F 13
Baby       01 3F 14 01 3F 13
Bathe      3F 14 36
Bather     3F 14 36 33
Be         3F 13
Becky      3F 07 29 13
Bee        3F 13
Beer       3F 3C
Beth       01 3F 07 1D
Birthday   01 3F 33 1D 01 21 07
           14
Bite       01 3F 06 03 11
Blank      01 3F 2D 1A 0B 02 29
Bob        01 3F 18 18 01 3F
Bread      1C 27 07 07 00 15
```

Brett	01 3F 27 07 03 11
Brother	01 3F 27 0F 1D 33
Buy	3F 18 06
By	3F 18 06
Byte	01 3F 06 03 11
Bytes	01 3F 06 03 11 2B
C	37 37 13
Calendar	2A 1A 1A 2D 07 0B 01 21 33
Calling	08 17 3E 2D 0C 2C
Cat	2A 1A 02 0D
Check	32 07 07 02 29
Checked	32 07 07 02 29 0D
Checker	32 07 07 02 2A 33
Checkers	32 07 07 02 2A 33 2B
Checking	32 07 07 02 2A 0C 2C
Checks	32 07 07 02 2A 37
Clock	2A 2D 18 18 02 29
Close	2A 2D 35 37 37
Clown	2A 2D 20 0B
Collide	08 0F 2D 06 36
Computer	2A 0F 10 09 31 16 11 33
Cookie	08 1E 2A 13
Correct	2A 34 07 07 01 29 01 11
Corrected	2A 34 07 07 01 29 01 0D 0C 01 15
Correcting	2A 34 07 07 01 29 01 0D 0C 2C
Correct	2A 34 07 07 01 29 01 11 37
Crane	08 27 14 0B
Crown	2A 27 20 0B
D	21 13
Data	21 18 18 01 11 33
Date	21 14 02 0D
Daughter	21 17 0D 33
Day	01 21 14
December	15 13 00 37 07 30 1C 33
Dennis	21 07 0B 0C 37
Disk	21 0C 37 37 29
Divided	21 0C 23 06 01 21 0C 01 15
Do	03 21 16 1F
Drive	21 27 06 36
Drives	21 27 06 36 2B
E	13
East	13 37 11
Eight	14 11
Eighteen	14 11 0D 13 0B
Eighty	14 0D 11 13
Eleven	13 2D 07 23 34 0B
Emergency	13 10 33 0A 07 0B 37 13
Engagement	07 07 00 0B 24 14 01 0A 10 07 07 0B 01 02 0D
Engages	07 07 00 0B 24 14 01 0A 0C 2B
Engaging	07 07 00 0B 24 14 01 0A 0C 2C
Enrage	07 0B 0E 14 01 0A
Enraged	07 0B 0E 14 01 0A 01 15
Enrages	07 0B 0E 14 01 0A 0C 2B
Enraging	07 0B 0E 14 01 0A 0C 2C
Error	07 07 27 00 33
Extent	07 2A 37 0D 07 07 0B 0D
Exterminate	07 29 37 0D 33 10 0C 00 14 0D
F	07 07 28 28
Father	28 3B 12 33
February	28 07 1C 00 19 1F 34 13
Fifteen	28 0C 28 0D 13 2B
Fifty	28 0C 28 0D 13
Fir	28 34
Five	28 06 23
Fool	28 1E 1E 2D
Force	28 3A 37 37
Four	28 17 17 27
Fourteen	28 17 27 0D 13 0B
Forty	28 17 27 0D 13
Freeze	28 28 0E 13 2B
Freezers	28 28 0E 13 2B 33 2B
Friday	28 27 06 01 21 14
From	28 27 18 10
Frozen	28 28 0E 35 2B 07 0B
G	0A 13
Glenn	01 22 2D 07 2C
H	14 01 02 32
Happy	39 1A 09 13
Has	1B 1B 1A 2B
Have	1B 1B 1A 23
Hello	1B 07 2D 35
Hertz	39 39 34 11 2B
How	39 20
Hundred	39 0F 0F 0B 01 21 27 0C 0C 00 15
I	06
Idiot	0C 01 21 0C 0C 0C 0F 11
In	0C 0B
Input	0C 0B 00 09 1E 11
Is	0C 2B
It	0C 03 11
J	0A 07 14
January	0A 1A 0B 1F 31 34 13
John	0A 18 0B
Julie	0A 31 3E 13
July	0A 1F 2D 06
June	2A 1F 0B
K	2A 07 14
Karen	2A 1A 27 00 07 0B
Kilo	2A 0C 2D 35
Know	38 35
Kristy	08 27 0C 37 11 13
L	07 07 3E
Live	2D 13 23
M	07 07 10
March	10 3B 32
Mark	10 3B 29
May	10 14
Memory	10 07 10 18 27 13
MHz	10 07 24 0F 39 39 34 11 2B
Minute	10 0C 0B 0C 02 0D
Minutes	10 0C 0B 0C 02 0D 2B
Modem	10 35 01 21 07 10
Monday	10 0F 0F 0B 01 21 14
Month	10 0F 0B 1D 1D
Mother	10 0F 36 33
My	10 06
N	07 07 0B
Name	38 14 10
Naughty	38 17 17 02 11 13
Nine	38 06 0B
Nineteen	38 06 0B 0D 13 0B
Ninety	38 06 0B 0D 13
No	38 35
November	38 35 00 23 07 10 1C 33
O	35
October	18 29 00 11 35 1C 33
Of	18 23
On	18 0B
One	30 0F 0B
Or	3A
Our	20 33
P	09 13
Past	09 3B 37 0D
Penelope	01 02 09 07 0B 07 2D 35 09 13
Penny	01 02 09 07 0B 13
Point	09 05 0B 11
Q	2A 31 1F
R	3B
RAM	27 01 1A 1A 10
Rebecca	0E 33 3F 07 02 08 3B
Ross	0E 18 37 37
S	07 07 37 37
Saturday	37 37 1A 02 0D 33 21 14
September	37 07 09 11 07 10 1C 33
Seven	37 37 07 07 23 0C 0B
Seventeen	37 37 07 07 23 0C 0B 0D 13 0B
Seventy	37 37 07 07 23 0C 0B

	0D 13
Sister	37 37 0C 37 0D 33
Six	37 0C 29 37
Sixteen	37 0C 29 37 0D 13 0B
Sixty	37 0C 29 37 0D 13
Son	37 0F 0B
Sound	37 20 0B 15
South	37 37 20 1D
Space	37 09 14 37
Speech	37 09 13 32
Statement	37 01 11 14 01 11 10 07 0B 11
Sunday	37 37 0F 0F 0B 02 21 14
T	0D 13
Talker	0D 17 17 01 29 33
Talking	0D 17 17 02 2A 0C 2C
Television	0D 07 2D 0C 23 0C 37 0C 18 0B
Ten	0D 07 07 0B
Test	0D 07 37 01 11
Testing	0D 07 37 01 11 0C 2C
The	12 13
There	36 07 2F
Thirteen	1D 33 0D 13 0B
Thirty	1D 33 0D 13
This	12 0C 37
Thousand	1D 20 2B 1A 0B 15
Three	36 27 13
Thursday	1D 34 2B 01 21 1A 14
Tim	0D 1C 10
Time	0D 06 10
To	0D 1F
Today	0D 1F 21 14
Tuesday	0D 31 2B 01 21 14
Twelve	0D 2E 07 3E 01 23
Twenty	0D 2E 07 0B 0D 13
Two	0D 1F
U	31 1F
V	23 13
Vision	23 0C 26 0C 0C 18 0B
W	21 0F 01 3F 3E 1F
Want	2E 18 0B 02 11
Wednesday	2E 07 07 0B 2B 01 21 14
What	30 18 02 11
Who	39 1E 1F
With	30 0C 1D
X	07 07 02 29 37 37
Y	2E 06
Year	19 3C
Yes	19 07 37 37
You	19 1F
Your	19 3A
Z	2B 07 02 15
Zero	26 13 27 35

IF IT DOESN'T WORK

If your speech unit does not work, DON'T PANIC. Firstly, check your wiring. Most errors are in wiring, causing the TEC to lock up. Look for obvious faults like shorts, dry joints, components of wrong value or orientation. Check that your chips are inserted correctly - pin one of each chip faces AWAY from the off-board wires.

If you bought your parts from all over the place, make sure you get a SPO256A-AL2 device. Other suffix numbers are not acceptable.

Check that the trimpot is turned all the way towards the SPO256A - full volume. You can temporarily short between the collector and the emitter of the BC557, to turn the amplifier on fully. This should produce a lot of hiss, and touching pin 3 of the LM386 should produce a buzzing sound.

Check that you have +5v on each chip, and that the SPO's reset pin (pins 2 and 25) are normally HIGH, and that they follow the reset pin of the Z80 (pin 26).

If all you get is garbage then you probably have the data lines wired around the wrong way. Check against the wiring diagram, and have a friend check it as well. Look for pins bent up under the SPO and not connecting with the IC socket. Check the program through and make sure that you are sending it the correct data.

If you are totally lost, give us a call. Sometimes we can solve a problem straight away, and most times within a few minutes. If all else fails, we offer a repair service. Costs are:

Basic repair $ 7.00
SPO256A replacement $15.00
Postage $ 3.00

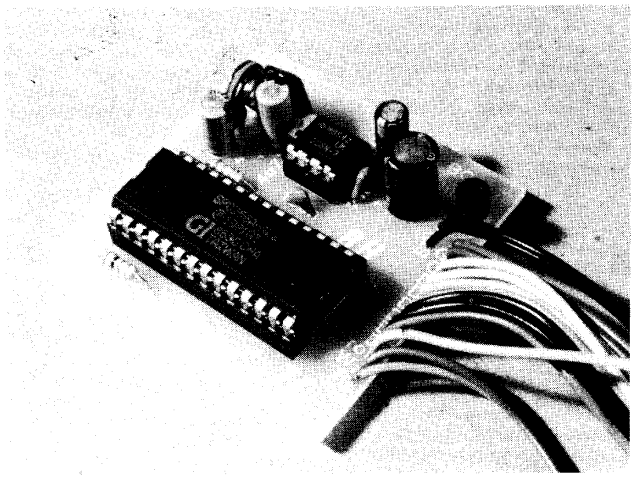
If your SPO256A-AL2 is damaged, you will be charged extra due to its high replacement cost.

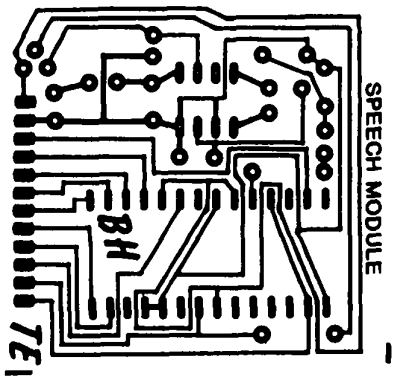
MODIFICATIONS

If you don't intend to fit a crystal oscillator to your TEC, you can put a crystal on the speech board. Simply fit the crystal across pins 27 and 28 of the SPO256A. Then fit a 27p between pin 27 and ground, and a 27p between pin 28 and ground. This enables the SPO's internal oscillator. We did not include this on the basic board because we wanted to keep the price as low as possible, in order to counter balance the cost of the SPO256A. We reasoned that most people will change over to JMON, therefore purchasing a crystal oscillator anyway.

If you find that you are using long silent periods between words, you may find that you can hear an annoying click from the speaker as the LM386 gets switched. This is because the 10u capacitor is too low in value. Increase this capacitor to 22u or 47u and the problem should go away.

If you need to make the output louder, change the 4u7 between pins 1 and 8 of the LM386 to 10u. This increases the gain of the LM386 to 200.

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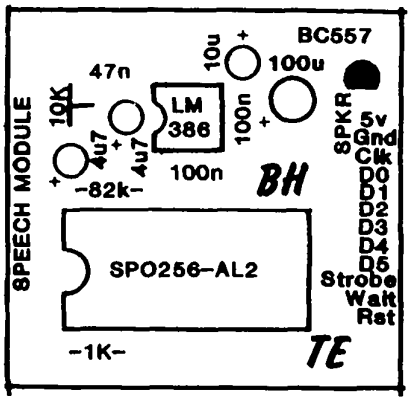
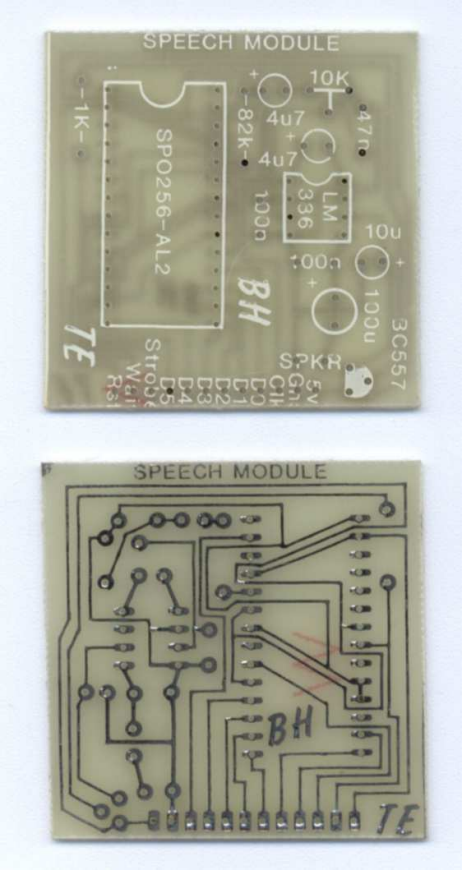
BH
TE


SPEECH MODULE
47n
10u
BC557
100u
10K
LM
386
100n
4u7
4u7
100n
-82k-
BH
SPKR
5v
Gnd
Clk
D0
D1
D2
D3
D4
D5
Strobe
Wait
Rst
SPO256-AL2
-1K-
TE


SPEECH MODULE
10K
-1K-
-82k-
4u7
4u7
47n
SPO256-AL2
LM
336
100n
100u
BH
TE
SPKR
BC557
SPEECH MODULE
BH
TE

Notes by Ben Grimmet and Ian McLean on Facebook Australian Vintage Computer Group

The mode select pin (SE) on the SP0256 must be tied high or else any change in the data pins will trigger a new alophone. This isn't in TE's schematics

SE (pin 19) of the SPO chip is connected to 5V on the original speech circuit board - it must ohave been as the board worked. It seems it was just missing off the printed schematic.

The chip is surprisingly quiet when you add some capacitance to the board too. Wonder if a 220uf cap would have been cheaper than the NPN and resistors used back in the day to get past the system noise