Radio Shack

Service Manual

26-1181

TRS-80

VOXBOX™ SPEECH RECOGNITION DEVICE

Catalog Number 26-1181

CUSTOM MANUFACTURED FOR RADIO SHACK TC A DIVISION OF TANDY CORPORATION

1. Introduction

This manual provides the serviceman information necessary to repair the Radio Shack TRS-80 VOXBOX Speech Recognition peripheral. The hardware involved in the device is fairly simple; most of the complex task of speech recognition is accomplished by the TRS-80 computer, which executes a software algorithm on the raw data provided by the speech recognition hardware. The hardware itself simply extracts four bits of information from the speech waveform and presents it to the computer. The recognition program samples this data approximately every 10 ms.

In addition, two BASIC test programs are available to help debug the board. The first program tests the board by training and recognizing the ten digits zero through nine. The second program plots the information gathered by the board on the video monitor where it may be compared to known patterns to help isolate the problem.

2. Troubleshooting The VOXBOX

This product is easy to troubleshoot. It has a serial analog signal path which starts at the microphone and terminates at the voltage comparators. Thus the signal may be traced from beginning to end to determine where the problem lies. Use the test programs to help isolate the trouble.

Test equipment required is as follows:
- TRS-80 computer with Level II BASIC
- Oscilloscope

There are **no** adjustments to be made.

Test Programs

The first step in troubleshooting the board is to run the programs to verify improper operation. Listings for Program 1 and Program 2 are contained in this section.

PROGRAM 1

Load the speech assembly language routines using the "system" command and load the BASIC program "Test 1". Run the program, train the system on the ten digits by speaking clearly, and try the unit out. The unit should respond with at least 80% to 90% correct results. If the unit does not operate at all, go to the hardware tests in Section 2-B, and particularly inspect the power supply, mike preamp, and addressing logic. If the unit responds but operates poorly, load the second BASIC test program "Test 2".

PROGRAM 2

Run the second program and say the word "six" loudly and clearly. You should see roughly the same shaped plots as shown in Figure 1.

If any of these lines are constant across the screen with no variation at all, then the corresponding area of the circuitry is at fault.

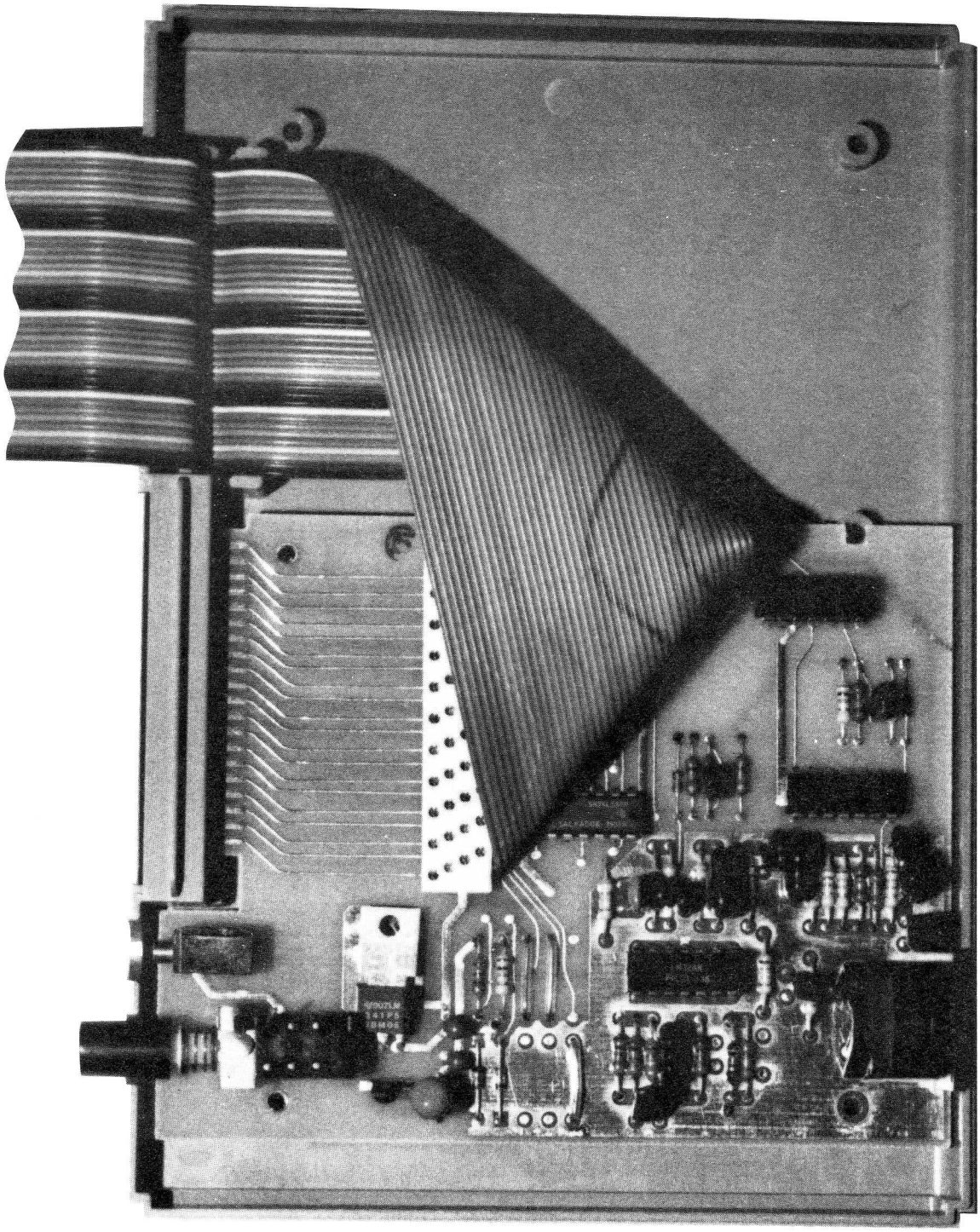
The top line is a plot of low band energy, which corresponds to the rectifier/averager output from low band on the block diagram and is the output from IC4-1 on the schematic. The second line from the top is high band energy, from the high band rectifier/averager on the block diagram, or from IC4-2 on the schematic.

The next line is the high band zero-crossing rate, from the high band zero-crossing detector on the block diagram, or from IC4-13 on the schematic. Finally, the bottom line is the low band zero-crossing rate, from the low band zero-crossing detector on the block diagram, or from IC4-14 on the schematic.

Test Program 1 can be run, if desired, before disassembling the unit to verify customer trouble complaints.

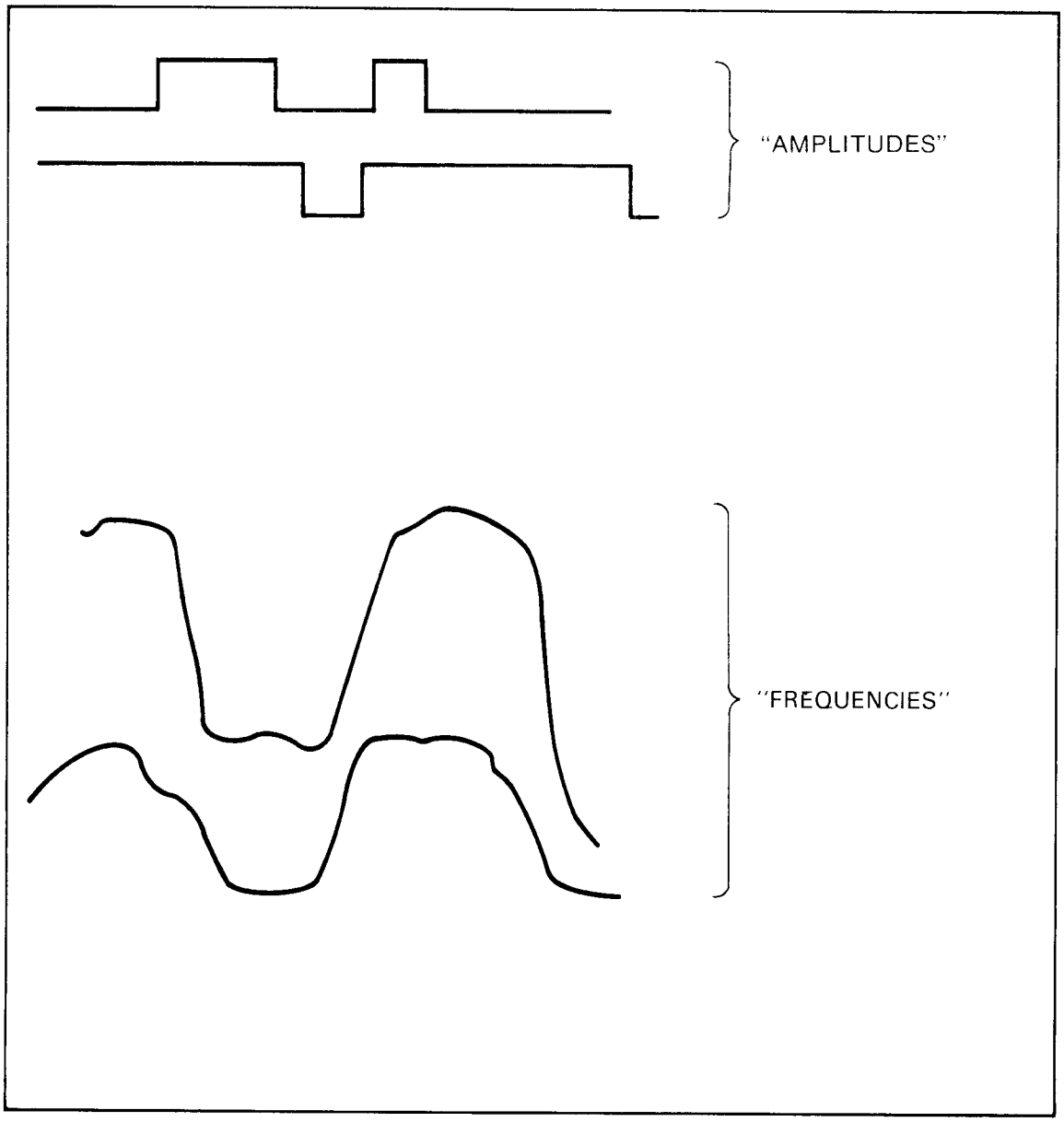
Disassembly Procedure

Place the unit upside down on a clean surface and remove the 6 screws which hold the top and bottom half of the plastic enclosure together. Remove the board from the box by lifting it out and place the board on a clean non-conducting surface.



VOXBOX BOARD (IN BOX) TOP COVER REMOVED

FIGURE 1



TYPICAL PLOT OF WORD "6"
AS SEEN ON TRS-80 VIDEO DISPLAY

FIGURE 2

TEST PROGRAM 1
DIGITS

```
1Ø REM SET UP CALLING PARAMETERS

2Ø REM MS=MEMORY SIZE IN K-BYTES

3Ø AD=112
4Ø GOTO 8Ø
8Ø POKE 16526,6
9Ø POKE 16527,AD
1ØØ X=USR(Ø)
2ØØ REM TRAIN
21Ø REM TR=INDEX; W$=STRING ARRAY
22Ø DIM W$(32)
23Ø W$(Ø)="Ø"
24Ø W$(1)="1"
25Ø W$(2)="2"
26Ø W$(3)="3"
27Ø W$(4)="4"
28Ø W$(5)="5"
29Ø W$(6)="6"
3ØØ W$(7)="7"
31Ø W$(8)="8"
32Ø W$(9)="9"
33Ø W$(1Ø)="1Ø"
34Ø FOR TR=Ø TO 1Ø
35Ø PRINT "SAY...";W$(TR)
36Ø GOSUB 1ØØØ: REM TRAIN
37Ø NEXT TR
4ØØ REM GET VOICE INPUT
41Ø POKE 16526,3
42Ø POKE 16527,AD
43Ø PRINT "SPEAK..."
44Ø X=USR(Ø):REM CALL RECOGNITION
45Ø W=PEEK(TX)
46Ø IF W>31 THEN GOTO 5ØØ
47Ø PRINT "YOU SAID ";W$(W)
48Ø GOSUB 9ØØ: REM DELAY
49Ø GOTO 4ØØ
5ØØ REM ERROR
51Ø PRINT "PLEASE REPEAT THAT"
52Ø GOSUB 9ØØ: REM DELAY
53Ø GOTO 4ØØ
9ØØ REM DELAY FOR BETTER USER INTERACTION
91Ø FOR I=1 TO 3ØØ
92Ø NEXT I
93Ø RETURN
1ØØØ REM CALL TRAINING SUBROUTINE
1Ø1Ø TX-256*AD+1Ø18
1Ø2Ø if TX > 32767 THEN TX = TX-65536
```

```
1Ø3Ø POKE 16526,Ø
1Ø4Ø POKE 16527,AD
1Ø5Ø POKE TX,TR : REM PASS TRAINING INDEX TO SBR
1Ø6Ø X=USR(Ø)
1Ø7Ø IF Peek(TX) <> Ø THEN GO TO 1Ø9Ø
1Ø8Ø RETURN
1Ø9Ø PRINT "ERROR - PLEASE REPEAT"
11ØØ GOTO 1ØØØ
```

TEST PROGRAM 2
"PLOT"

NOTE: Same program as in User Manual — on User Cassette

```
1Ø IF PEEK(-4Ø95)=12 THEN 6Ø
2Ø IF PEEK(-2Ø479=12 THEN 7Ø
3Ø IF PEEK(28673)=12 THEN 8Ø
4Ø PRINT "ERROR: VOX BOX SOFTWARE NOT LOADED"
5Ø END
6Ø R1=24Ø:B1=-3Ø78:L1=-2411:B2=-3Ø41:GOTO 9Ø
7Ø R1=176:B1=-19462:L1=-18795:B2=-19425:GOTO 9Ø
8Ø R1=112:B1=2969Ø:L1=3Ø357:B2=29727:GOTO 9Ø
9Ø CLS
1ØØ PRINT ∂5Ø,"SPEAK...";
11Ø POKE B1,Ø
12Ø POKE 16526,Ø
13Ø POKE 16527,R1
14Ø X=USR(Ø)
15Ø CLS
16Ø L=PEEK(L1)
165 PRINT∂114,"LEN=";L;
17Ø B=B2
18Ø FOR I=1Ø TO L+1Ø
19Ø IF PEEK(B)=Ø THEN X=1 ELSE X=Ø
2ØØ SET (I,X)
21Ø IF PEEK(B+1)=Ø THEN X=1 ELSE X=Ø
22Ø SET(I,X+4)
23Ø SET(I,47-PEEK(B+2)/4)
24Ø SET(I,47-PEEK(B+3)/4)
25Ø B=B+4
26Ø NEXT I
27Ø GOTO 1ØØ
28Ø END
```

Power Supply

Plug the battery eliminator into a 120 VAC outlet and into the miniature power jack on the board and check the output at the miniature power jack for DC output using the oscilloscope. The minimum *instantaneous* voltage from the battery eliminator, the lowest voltage point on its output waveform, must be 14.5 volts or greater.

If the output dips below 14.5 volts, the analog circuitry will be affected by noise on the internal power supply lines as the voltage drops out of regulation. Change battery eliminator to see if this cures the problem. If not, the problem may be the voltage regulator circuits. Test the resultant voltages on the PC board as shown in Table 1.

TABLE 1

Voltage	Test Point	Tolerance	Ripple
+12	IC6 – Pin 4	5% (±600mv)	25 mv
+5	IC1 – Pin 14	5% (±250mv)	50 mv
+6	IC6 – Pin 3	5% (±300mv)	10 mv

The +12V is generated by a 78L12 regulator, the +5V by a 78M05 regulator, and the +6V from a zener diode dropping network on the +12V supply. In particular, the +12V supply should be free from noise in the 0-10 KHz band.

Microphone Preamp

Insert the microphone into its mating connector. Close the push-to-talk switch, speak into the microphone and observe the preamp output IC6, Pin 7. The output should swing above and below the resting level of 6V. If no signal is present, test for output at the first preamp stage IC6, Pin 1. If the "no signal" output level is not 6V, check for the 6V reference level at amplifier inputs IC6-3 and IC6-5. If no signal from the first stage of the preamp, test the microphone output at the DIN connector for 10 mv to 40 mv output when speaking loudly or whistling.

Filters

Check the high and low band filters for output at IC5, Pin 7, the last stages, and if not present, check the first stage. The output should be 6V with no signal input, and should swing above and below with signal input. Table 2 summarizes these tests.

TABLE 2

Filter	Stage	Test Point	No Signal Level
Low Band	Last	IC5-7	6V
Low Band	First	IC5-1	6V
High Band	Last	IC6-14	6V
High Band	First	IC6-8	6V

Zero-Crossing Detectors

The zero-crossing detectors outputs should be 0 volts with no input and swing to 5 volts when the filter output swings much below its rest level of 6 volts. Whistling into the microphone should produce a square wave output whose period varies with the pitch (frequency) of the whistle. Table 3 summarizes this test.

TABLE 3

Signal Input (at MIC.)	High Band			Low Band		
	Output IC4-14	Input IC4-8	Input IC4-9	Output IC4-13	Input IC4-10	Input IC4-11
Whistle	Square Waves 0 to +5V at whistle frequency	Sine Waves Swinging Above & Below +6V	DC Voltage Slightly Less Than 6 Volt Reference at IC5-5	Square Waves 0 to +5V	Sine Waves Swinging Above & Below 6V	DC Voltage Slightly Less Than 6 Volt Reference at IC6-12
None	Random Square Waves	6 VDC	Same as above	Random Square Waves	6 VDC	Same as above

Rectifier/Averagers

The comparator outputs should sit at 0 volts with no signal and go to +5 volts with signal into the system. The amplifier outputs should sit at 6 volts with no signal input and sit at a steady state voltage less than 6 volts for steady state sounds (Ahhh . . . . . etc.). Table 4 summarizes the results.

TABLE 4

	Signal Input	No Signal Input
Low Band Amplifier IC5-8	0 to 5 volts	6 volts
High Band Amplifier IC5-14	0 to 5 volts	6 volts
Low Band Comparator IC4-1	5 volts	0 volts
High Band Comparator IC4-2	5 volts	0 volts

Address Decoding

This peripheral decodes address port AFH (175_{10}). Whenever this address is accessed by the processor via an input instruction the data bus buffers are enabled. This may be detected statically by disconnecting the board from the TRS-80 computer and grounding edge connector pins 38(A6) 31(A4) and 19(in). IC2 pins 1 and 13 should go to +4 volts as a result enabling the bus buffers with the 4 volt signal at IC3 pins 1,4,10, and 13. Alternatively, the address logic may be checked dynamically by entering a short assembly language routine with the TBUG program. This program does an input from Port AFH and loops back and does it over and over again. Positive pulses should be seen at IC2 pins 1 and 13. and at IC3 pins 1,4,8, and 13. Using the "M" memory fill function of TBUG, choose a memory area and enter the following program:

```
(Address)---------- DB
                    AF
                    C3
                    (Address)
```

For example, if the program is chosen to reside at 7000H, the steps would be:

```
M7000---------- DB
                AF
                C3
                00
                70
```

To execute the program at 7000H, type J7000, **ENTER**

Assembly Procedure

Place the board component side up into the bottom half of the plastic box so that the three mounting holes on the board line up with the shoulders of the posts in the box. Arrange the cable through *two* 90 degree bends and place the existing cable into the guide slot and cable clamp built into the box. Carefully place the top of the box over the bottom half and, holding the box securely, turn the box upsidedown and replace the 6 screws holding the box together.

Run the digit test program (#1) to verify correct operation of the board.

3. Theory of Operation

This section provides the theory of operation of the speech recognition hardware functional blocks, as shown in block diagram Figure 3.

Microphone

The first element in the signal chain is the microphone, a dynamic microphone with a push-to-talk switch. While there are several circuits in the microphone, the only circuit used is the audio circuit, which delivers the 10 mv — 40 mv signal from the microphone when the switch is closed and is an open circuit when the switch is open or released.

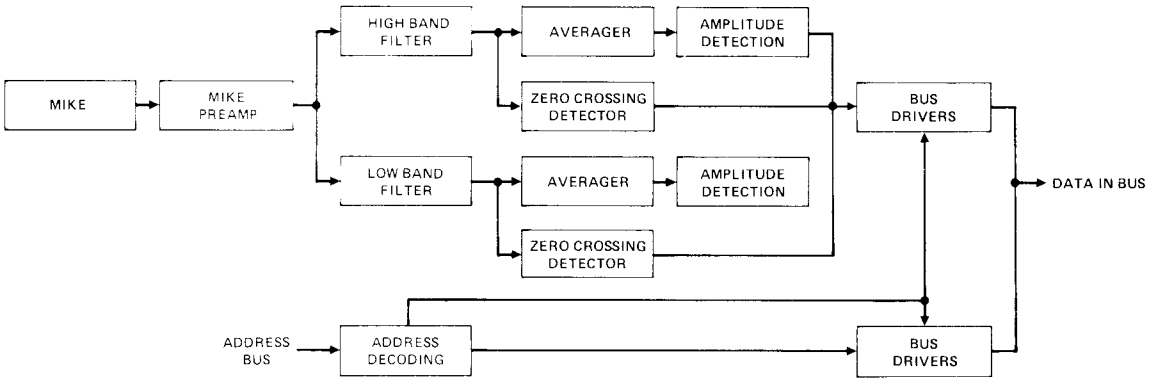
Microphone Preamp

The microphone preamp amplifies and frequency compensates the microphone signal before the signal is passed to the bandpass filters. The input from the microphone is terminated in a 1K resistor to ground which keeps the microphone input grounded when the microphone switch is released. The first stage of the microphone preamp "pre-emphasizes" the speech input, amplifying higher frequencies more than lower frequencies, with the rate of increase being 6 DB/ octave. This compensates for vocal tract characteristics, which produce less energy at higher frequencies than at lower frequencies.

This pre-emphasis continues up to about 1.5 KHz after which the preamp output rolls off, or decreases, at a rate of 12 DB/ octave. The second stage of the microphone preamp provides additional gain. The microphone preamp amplifies the 10 — 40 millivolt microphone signal and produces a signal of 1 to 10 volts peak to peak output. Since all the analog circuitry operates from a single +12V supply, the output of the microphone preamp is biased for a no-signal output of about 6V, and swings above and below this rest level. This amplified and frequency compensated signal is then applied to the inputs of the two bandpass filters.

Filters

The two bandpass filters are each implemented as a low pass filter followed by a high pass filter. The low band filter formed by IC2-1 and IC2-7 has a passband of 150 Hz to 900 Hz. The high band filter formed by IC1-8 and IC1-14 has a passband of 1 KHz to about 4 KHz. The outputs of the filter stages are biased to a rest level of about 6V, through the application of the 6V reference level to the non-inverting inputs of all the amplifiers. The output of each filter stage is sine waves whose frequencies fall within the passband of the associated filter. The frequencies of the sinewaves are the same as the frequencies contained in the input signal from the microphone, and the amplitude of the sinewaves is proportional to the amplitude of the signals from the microphone, modified by the frequency shaping in the microphone preamp. The output of each filter is applied to a zero-crossing detector and a rectifier averager circuit.



VOXBOX BLOCK DIAGRAM

FIGURE 3

Zero Crossing Detector

The zero crossing detector is a comparator which compares the filter output with a fixed voltage and generates a +5 volt output when the filter output is less than the fixed voltage, and a zero volt output when the filter output is greater than the fixed voltage. The fixed voltage is the 6V reference voltage, so that with no signal input the detector output is a random square wave pattern generated by random low level noise in the circuitry. When a slight signal comes from the filter output, the detector output will switch from zero to +5 volts and back to zero as the filter output swings above and below the fixed voltage.

Rectifier/Averager

The output of each filter also drives an associated rectifier/averager stage. The input to the circuit is through a diode. Since both the inverting and non-inverting inputs of the amplifier are at the 6 volt reference, the diode will conduct only when the filter output is at least one diode drop above its rest output of 6 volts. The diode thus rectifies the signal and the associated amplifier inverts the signal and averages it with a 20 Hz low pass filter. The output of the rectifier/averager is thus the 6 volt reference in the absence of any input signal, and moves toward ground when an input signal is applied. The higher the amplitude of the input, the closer the output is to ground. The output of the rectifier/averager stage is applied to the negative input of a voltage comparator whose positive input is a fixed voltage just slightly less than the 6 volt reference. The normal comparator output is thus zero volts. When a small amount of speech energy is amplified, filtered, and rectified, the output of the rectifier stage trips the comparator producing a 5 volt output from the comparator. This signal indicates speech energy is being produced in the bandwidth of its associated filter. This signal from each of the rectifier/averages is fed to a bus driver, along with the two zero crossing detector outputs where it is made available to the processor.

Address Decoding

From the viewpoint of the TRS-80, the speech input peripheral is a single input port at address AFH (175 decimal). Whenever this address is accessed with an input instruction, the peripheral places its data on the computer data bus in the format shown in Figure 4.

Power Supply and Regulators

The speech input peripheral uses 2 voltages internally, a +5 volt supply for the digital circuitry and a +12 volt supply for the analog circuitry. These voltages are regulated internally using the raw DC voltage supplied by the battery eliminator which plugs into the wall.

D7-D4	D3	D2	D1	D0
NOT USED	HIGH BAND AMPLITUDE	HIGH BANK ZERO CROSSING	LOW BAND ZERO CROSSING	LOW BAND ENERGY
	1=ENERGY 0=NO ENERGY			1=ENERGY 0=NO ENERGY

FIGURE 4

VOXBOX Technical Specifications

General

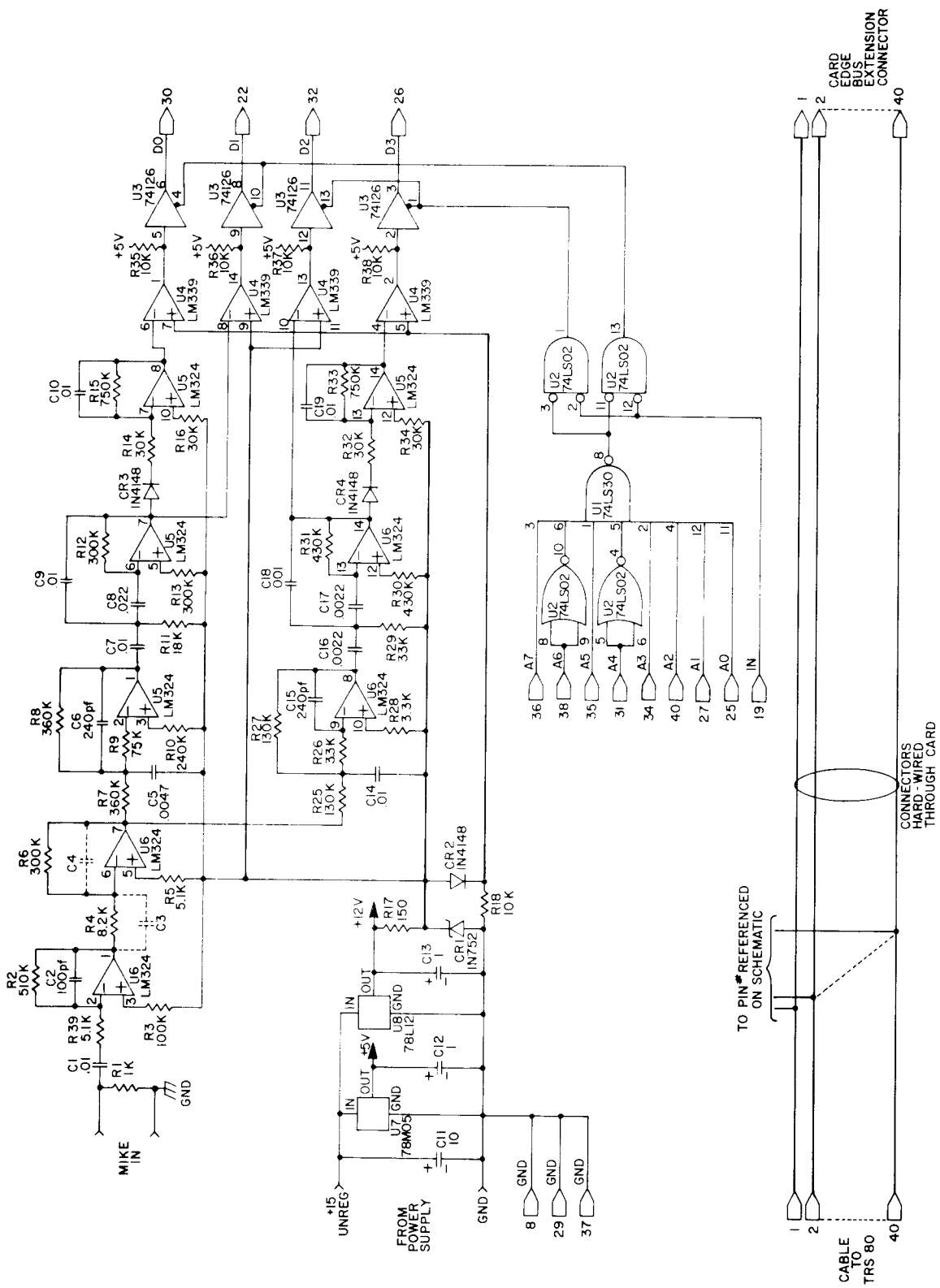
Function:	Word Recognition for Data Input and Control.
Type:	Isolated-Word, Speaker Trained
Vocabulary Size:	32 Words
Connects to:	TRS-80, or TRS-80 Expansion Interface
Method of Connection:	Cable provided for connection.
Word Definition:	Word or phrase length 0.1 to 1.5 sec. Beginning of word identified by 0.1 sec. of continuous speech. End of word identified by first interval of silence at least 0.1 sec. which follows detection of beginning of word.
Equipment Required:	TRS-80 with Level II Basic and at least 16K RAM. May be used with other peripherals and more capable versions of TRS-80 system.
Memory Requirements:	4096 bytes RAM reserved at the high end of user memory.
Peripheral Device Address Used:	I/O PORT AF HEX (175 DEC)

Inputs:

Power:	120 VAC, 50-60 Hz, 0.1 Amp via separate 15 VDC power pack (included).
Logic Signals:	TRS-80 peripheral bus
Voice:	Push-to-Talk microphone (included)

Physical Specifications

Temperature:	32° F-110° F Operating -40° F-160° F Storage
Humidity:	0-95% Non-condensing
Size:	1¾" H × 7" W × 5½" D (5 cm × 20 cm × 14 cm)
Weight (shipping):	2 lbs (1 kg)

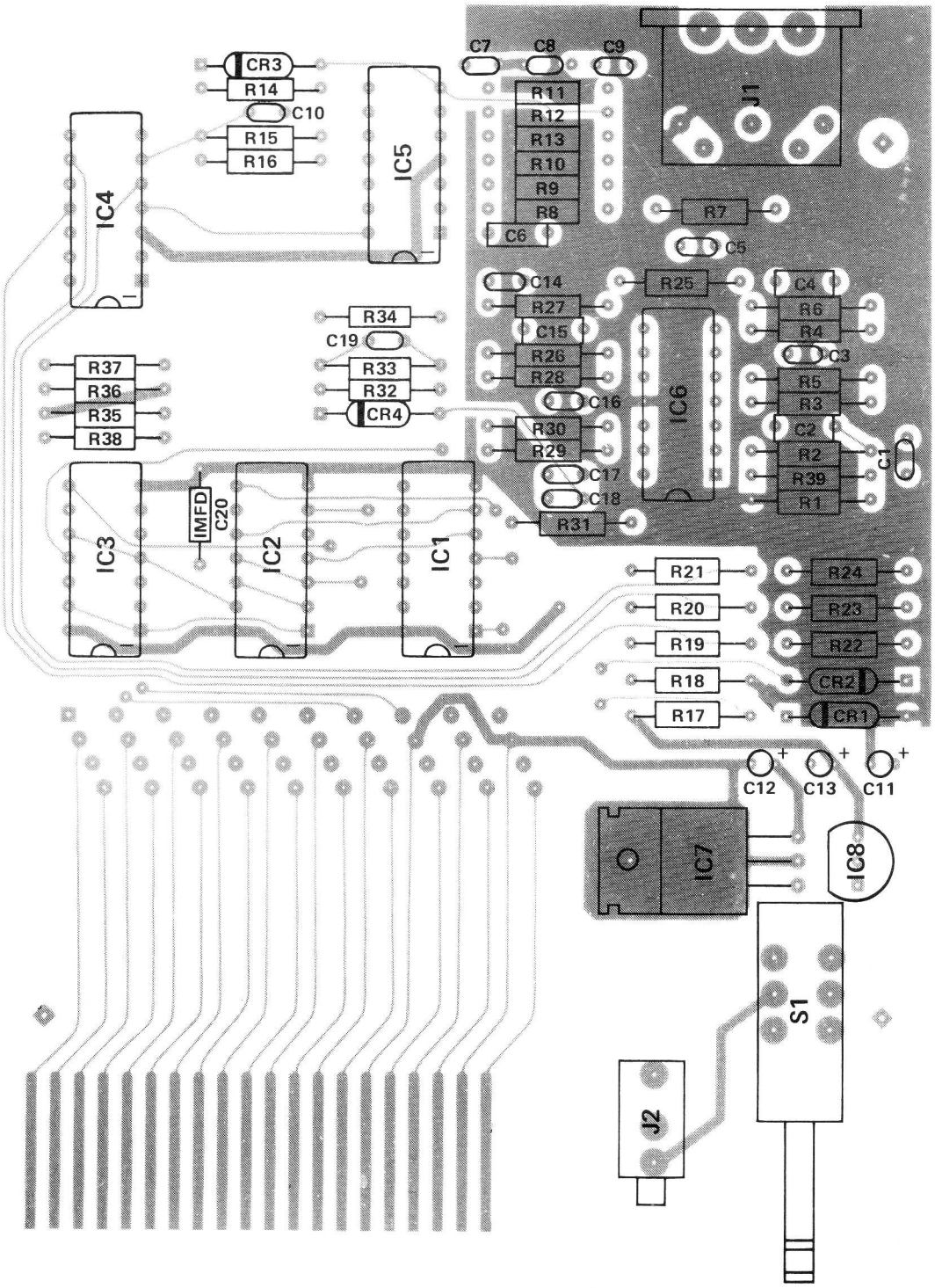

MIKE IN
GND
FROM POWER SUPPLY
+15 UNREG
GND
+12V
+5V
D0
D1
D2
D3
TO PIN* REFERENCED ON SCHEMATIC
CARD EDGE BUS EXTENSION CONNECTOR
CONNECTORS HARD-WIRED THROUGH CARD
CABLE TO TRS 80

PARTS LIST

(Order from VOXBOX Manufacturer Using Reference Designator Preceded By "V")

Ref. No.	Description				RS Part Number	MFR's Part Number
			CAPACITORS			
C1	Mylar	0.01μF	25V	±10%		
C2	Mica	100pF	25V	±10%		
C3	NOT USED					
C4	NOT USED					
C5	Mylar	0.0047μF	25V	±10%		
C6	Mylar	240pF	25V	±10%		
C7	Mylar	0.01μF	25V	±10%		
C8	Mylar	0.022μF	25V	±10%		
C9	Mylar	0.01μF	25V	±10%		
C10	Mylar	0.01μF	25V	±10%		
C11	Tantalum	10μF	25V	±10%		
C12	Tantalum	1μF	25V	±10%		
C13	Tantalum	1μF	25V	±10%		
C14	Mylar	0.01μF	25V	±10%		
C15	Mica	240pF	25V	±10%		
C16	Mylar	0.0022μF	25V	±10%		
C17	Mylar	0.0022	25V	±10%		
C18	Mylar	0.001μF	25V	±10%		
C19	Mylar	0.01μF	25V	±10%		
C20	Ceramic	0.1μF	25V	+80,-20		
			RESISTORS			
R1	Carbon Comp	1K	1/4W	5%		
R2	Carbon Comp	510K	1/4W	5%		
R3	Carbon Comp	100K	1/4W	5%		
R4	Carbon Comp	8.2K	1/4W	5%		
R5	Carbon Comp	5.1K	1/4W	5%		
R6	Carbon Comp	300K	1/4W	5%		
R7	Carbon Comp	360K	1/4W	5%		
R8	Carbon Comp	360K	1/4W	5%		
R9	Carbon Comp	75K	1/4W	5%		
R10	Carbon Comp	240K	1/4W	5%		
R11	Carbon Comp	18K	1/4W	5%		
R12	Carbon Comp	300K	1/4W	5%		
R13	Carbon Comp	300K	1/4W	5%		
R14	Carbon Comp	30K	1/4W	5%		
R15	Carbon Comp	750K	1/4W	5%		
R16	Carbon Comp	30K	1/4W	5%		
R17	Carbon Comp	150	1/4W	5%		
R18	Carbon Comp	10K	1/4W	5%		
R19	Carbon Comp	Jumper (0)	1/4W	5%		
R20	Carbon Comp	Jumper (0)	1/4W	5%		
R21	Carbon Comp	NOT USED	1/4W	5%		
R22	Carbon Comp	NOT USED	1/4W	5%		
R23	Carbon Comp	NOT USED	1/4W	5%		
R24	Carbon Comp	Jumper (0)	1/4W	5%		
R25	Carbon Comp	130K	1/4W	5%		
R26	Carbon Comp	3.3K	1/4W	5%		
R27	Carbon Comp	130K	1/4W	5%		
R28	Carbon Comp	3.3K	1/4W	5%		

Ref. No.	Description	RS Part Number	MFR's Part Number
	RESISTORS		
R29	Carbon Comp 33K 1/4W 5%		
R30	Carbon Comp 430K 1/4W 5%		
R31	Carbon Comp 430K 1/4W 5%		
R32	Carbon Comp 30K 1/4W 5%		
R33	Carbon Comp 750K 1/4W 5%		
R34	Carbon Comp 30K 1/4W 5%		
R35	Carbon Comp 10K 1/4W 5%		
R36	Carbon Comp 10K 1/4W 5%		
R37	Carbon Comp 10K 1/4W 5%		
R38	Carbon Comp 10K 1/4W 5%		
R39	Carbon Comp 5.1K 1/4W 5%		
	INTEGRATED CIRCUITS & SEMICONDUCTORS		
IC1	Integrated Circuit, Logic		74LS30
IC2	Integrated Circuit, Logic		74LS02
IC3	Integrated Circuit, Logic		74126
IC4	Integrated Circuit		LM339
IC5	Integrated Circuit		LM324
IC6	Integrated Circuit		LM324
IC7	Power Regulator Circuit		78M05
IC8	Integrated Circuit		78L12
CR1	Diode		IN752
CR2	Diode		IN4148
CR3	Diode		IN4148
CR4	Diode		IN4148
	MISCELLANEOUS		
J1	Subminiature Phone Jack		Imtronics HCY250
J2	DIN plug, Microphone Input		SMK SI-3354
J3	Cable Assy		
S1	Power Switch		Centralab 2KAB010000/132
T1	Power Unit, 15V		
LA1	Radio Shack Label		
PCB1	Printer Circuit Board		
EN1	Molded Plastic Enclosure		
M1	Microphone, Push To Talk	21-1172	
PC1	CardBoard Packing Carbon		
UM1	User Manual		
SC1	4-24 x 3/4" screws (Qty 6)		
CT1	Cassette Tape #1, Lunar Lander/Inven. Demo		
CT2	Cassette Tape #2, Voice Plot/SP48		
CT3	Cassette Tape #3, SP16/SP48		

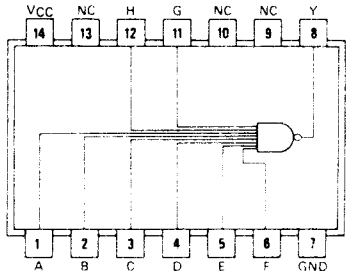

CR3
R14
C10
R15
R16
IC4
IC5
C7
C8
C9
R11
R12
R13
R10
R9
R8
C6
J1
R7
C5
C14
R25
C4
R27
R6
R4
C15
C3
R26
R5
R28
R3
C16
IC6
R34
C19
R33
R32
CR4
R37
R36
R35
R38
R30
R29
C2
R2
R39
R1
C1
C17
C18
R31
IC3
IMFD
C20
IC2
IC1
R21
R20
R19
R18
R17
R24
R23
R22
CR2
CR1
C12
C13
C11
IC7
IC8
S1
J2

APPENDIX D.

Parts Circuit Diagrams

8-INPUT
POSITIVE-NAND GATES

74LS30

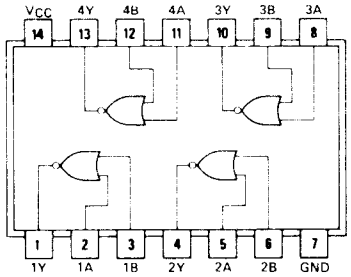


positive logic:

$Y = \overline{ABCDEFGH}$

QUADRUPLE 2-INPUT
POSITIVE-NOR GATES

74LS02

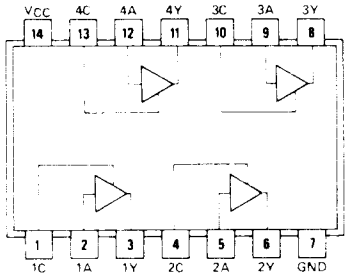


positive logic:

$Y = \overline{A+B}$

QUADRUPLE BUS BUFFER GATES WITH THREE-STATE OUTPUTS

74126



positive logic:

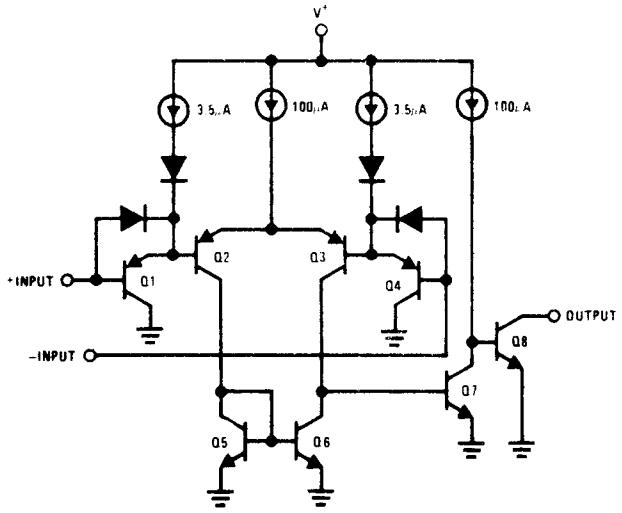
Y = A

Output is off (disabled) when C is low.

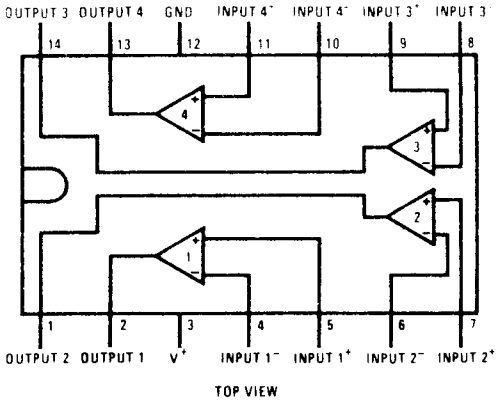
SN54126 (J, W) SN74126 (J, N)
SN54LS126 (J, W) SN74LS126 (J, N)

See page 6-33

LM339 schematic and connection diagrams



Dual-In-Line and Flat Package



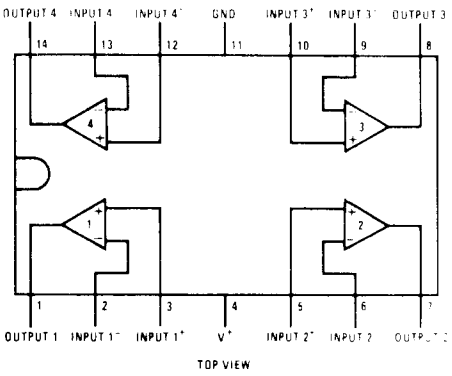
TOP VIEW

APPENDIX D. (Continued)

LM324

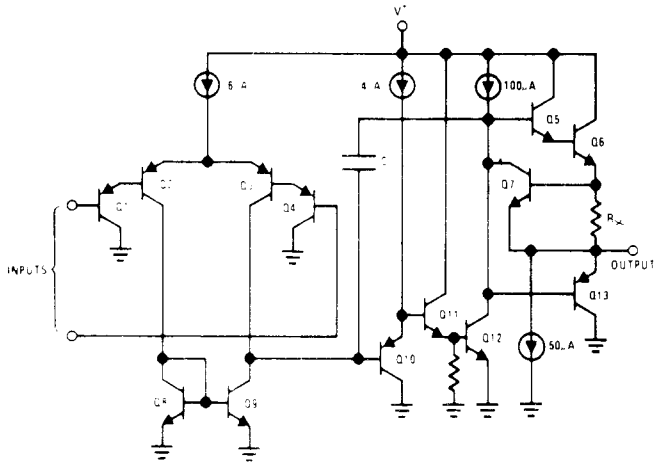
connection diagram

Dual-In-Line and Flat Package

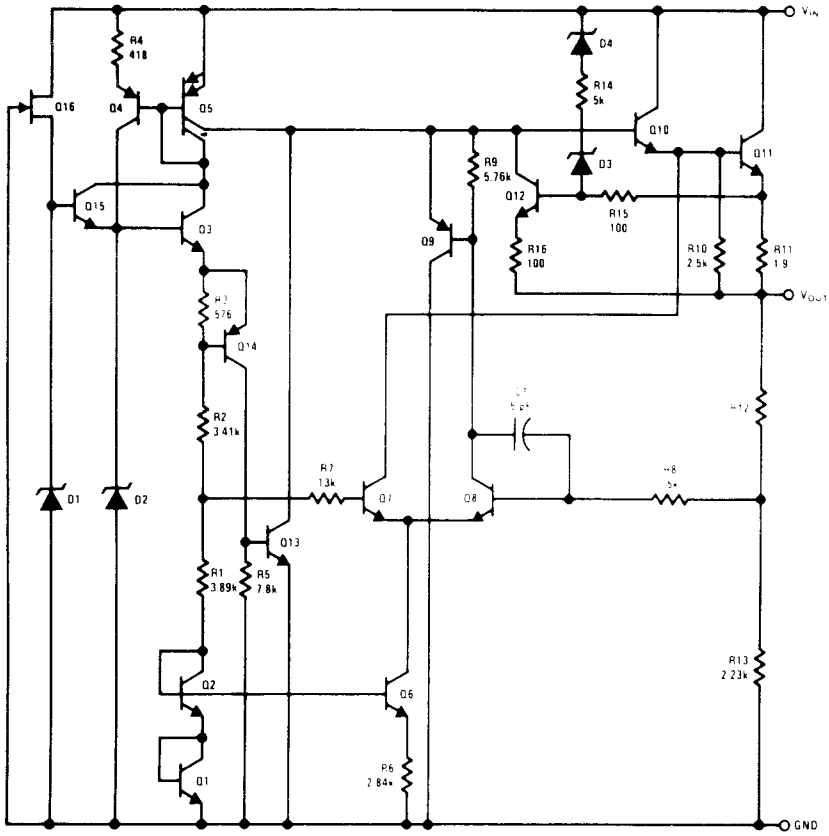


TOP VIEW

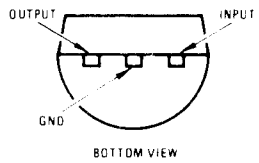
schematic diagram (Each Amplifier)



78L12



LM78LXX

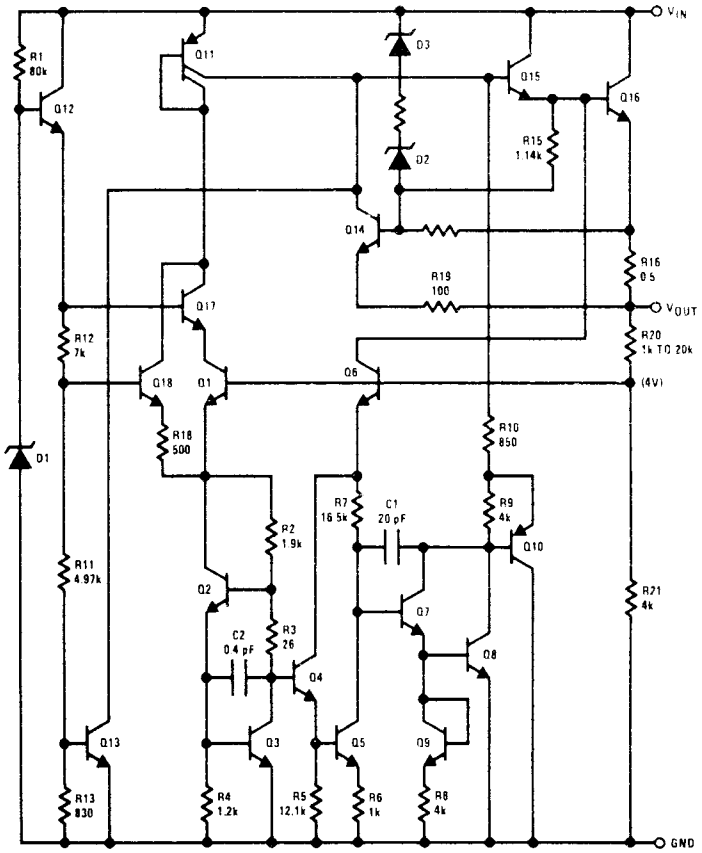


BOTTOM VIEW

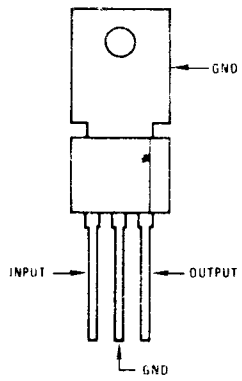
APPENDIX D. (Continued)

78M05
(or LM341)

schematic and connection diagrams



Plastic Package



FRONT VIEW

Order Numbers

LM341P-5.0	LM341P-12
LM341P-6.0	LM341P-15
LM341P-8.0	LM341P-18
LM341P-10	LM341P-24

See NS Package P03A