TRS-80 Voice Synthesizer

Radio Shack®
TRS-80
MICRO
COMPUTER
SYSTEM

HARDWARE

Catalog Number 26-1180

Contents

Required Hardware

TRS-80 LEVEL I or LEVEL II
Video Display
Voice Synthesizer

CUSTOM MANUFACTURED IN THE USA FOR RADIO SHACK T C A DIVISION OF TANDY CORPORATION

Introduction

The Radio Shack Voice Synthesizer provides your TRS-80 with the ability to speak in English and limited foreign languages. The TRS-80 Voice Synthesizer is capable of producing the 62 phonemes (sound units) that are the building blocks of spoken language. The package includes an audio amplifier and speaker so no additional hardware is needed.

Both LEVEL I and LEVEL II BASIC can be used with the TRS-80 Voice Synthesizer. It is very easy to create or modify BASIC programs to include computer voice response, using a specialized PRINT statement (refer to **Software Drivers**).

Phonemes are units of sound from which speech can be constructed. For guidelines in speech construction with phonemes, refer to the Phonetic Programming and Example Programming sections of this manual.

Here are a few of the many applications for your TRS-80 Voice Synthesizer:

Computer Aided Instruction
Intrusion-Fire Alarm
Games
Talking Clock
Blind Users' Terminal
Verbally Impaired Prosthetic Aids
Home Environment Audio Response
Computer-Phone Voice Interface

Connection

Turn the ON/OFF VOLUME knob to the OFF position. Connect the power supply cord from the transformer to the power jack on the right rear of the Voice Synthesizer (see Figure 1). Plug the power supply into a standard 120 VAC outlet.

The ribbon cable from the Voice Synthesizer will plug into the Expansion Interface edge card jack on any TRS-80 (see Figure 2). The ribbon cable is long enough to let you place the Synthesizer on top of your Video Display.

LEVEL II Computers equipped with an Expansion Interface must use the parallel interface jack on the left side of the Expansion Interface (refer to Figure 3) for connecting the Voice Synthesizer ribbon cable.

NOTE: When connecting the ribbon cable, be very careful to orient it as in Figure 4, with the cable coming out of the bottom of the connector.

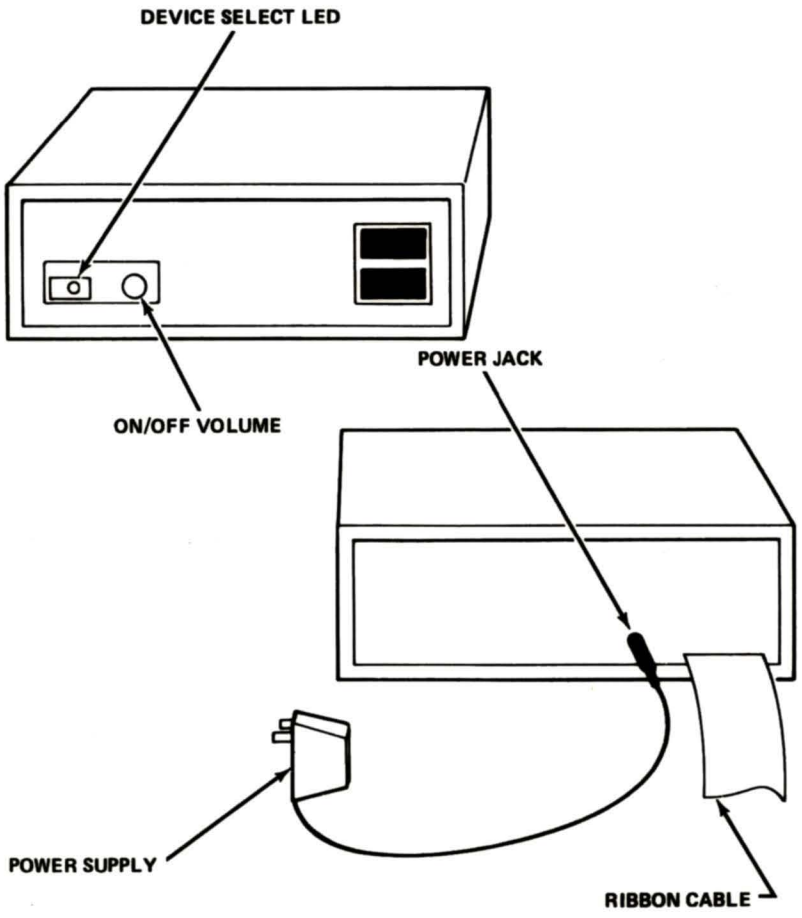

Figure 1. TRS-80 Voice Synthesizer, front and rear views.

Power-Up

After connecting the ribbon cable to the proper edge-card jack, turn the ON/OFF knob to the ON position and press the TRS-80 reset button. The LED on the Synthesizer front panel should be OFF.

NOTE: If the Synthesizer is producing a voice-sound when you first turn it on, try pressing the TRS-80 Reset button. If it continues to produce the sound, type in the following statement in the direct mode (no program line numbers necessary):

LEVEL I: `PRINT AT 992,"?-?".`

LEVEL II: `PRINT@ 992,"?-?";`

(When the Synthesizer is silent you may hear a steady but very faint tone. This is normal, and should not interfere with your use of the Synthesizer.)

Run this program to test if the Synthesizer is functioning correctly:

LEVEL I: `10 PRINT AT 992,"? H38L8↑U ?";`

LEVEL II: `10 PRINT@ 992,"? H38L8↑U ?";`

If the computer responds by saying "Hello", all is well. If not, check the connections and power before trying again.

NOTE: The DEVICE SELECT LED (Figure 1) on the front panel will only flash on momentarily when you run this program (see **Software Drivers**).

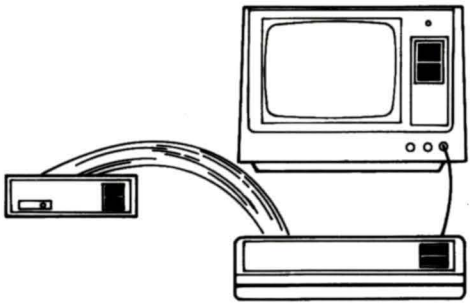

Figure 2. Synthesizer connected directly to Keyboard/Computer.

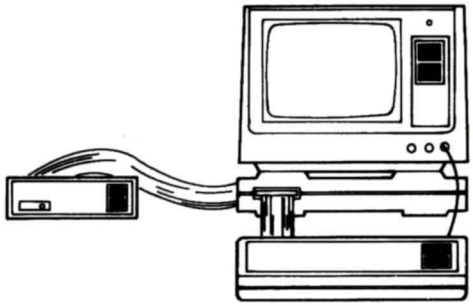

Figure 3. Synthesizer connected via Expansion Interface "Screen Printer" jack.

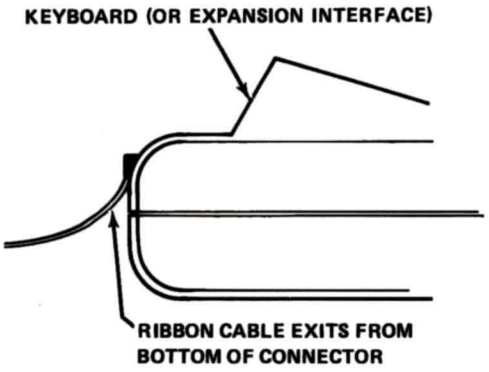

Figure 4. Proper orientation of ribbon cable plug.

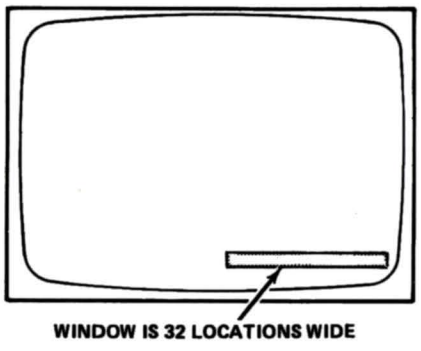

Figure 5. The Synthesizer "window" on the Video Display.

Software Drivers

The interface of the Voice Synthesizer has been designed such that a BASIC PRINT can be used as an output command. This has been achieved by address mapping the interface into the last 32 print locations on the Video Display. This area of the Display is the "Window" (see Figure 5). Any method of PRINTing, POKEing or loading (in machine language) into these locations, combined with a DEVICE SELECT character, will cause the Synthesizer to produce the specified sounds.

When the TRS-80 is reset, the Voice Synthesizer is automatically disabled, or "deselected"; in effect, the window is closed. To select the unit (open the window), a "?" must be printed anywhere in the window. The LED on the Synthesizer will remain lit while the window is open.

While the window is open, any character printed into the window is copied into the input buffer of the Synthesizer. After the transmission to the Synthesizer is complete, the window must be closed to prevent accidental outputting. This is done by PRINTing a second "?" in the window. The Synthesizer will produce the sound, and the LED will go off. (Actually, the LED might flash on and off before the voice output is heard.)

Sometimes listing a program will cause a "?" to appear in the window and make the Synthesizer jabber. When this occurs, type "−?" into the open window to silence the Synthesizer and close the window.

To help understand the Voice Synthesizer procedure, consider the following program:

LEVEL I:
```
10 CLS
20 PRINT AT 0, "ENTER PHONEME(S)";
30 INPUT A$
40 PRINT AT 992,"? ";A$;" ?";
50 GOTO20
```

LEVEL II:
```
10 CLS
20 PRINT@ 0, "ENTER PHONEME(S)";
30 INPUT A$
40 PRINT AT 992,"? ";A$," ?";
50 GOTO 20
```

This program will allow you to enter a single phoneme or strings of phonemes from the keyboard and to output them to the Voice Synthesizer. It is a good program to use while experimenting with phoneme sounds.

This program inputs a phoneme (sound-unit) string into the A$ variable. Output to the Synthesizer occurs in line 40 in the following sequence:

1. PRINT AT 992, — this positions the cursor at the front of the window.
2. "? "— this opens the window and transmits a pause.
3. A$, — this prints the characters in the A$ variable into the window, copying them into the Synthesizer's input buffer memory.
4. " ?" — this transmits an ending pause and closes the window.

After opening the window, it is important to first send over a pause phoneme (which is silent). This is to synchronize the Synthesizer when it has been idle. It is also advisable to send over a pause as the last phoneme before closing the window. This is because the buffer to the Synthesizer stops on the last phoneme, and that sound is continuously voiced until new phonemes are sent. If there will be no speech for awhile, it is also desirable to transmit a "-" before closing the window. This character (called a Ø decode) will suppress the background noise in a pause condition.

The program above allowed the characters to remain on the screen after sending them to the Synthesizer. This was to aid in associating the phoneme sounds with printed characters. Normally, it is undesirable to leave the characters on the screen. Care must be taken to not trip the automatic line scroll by printing past the end of the bottom line. Both of these points can be provided by using the following subroutine for voice output:

LEVEL I:
```
1000 PRINT AT 992,"? ";A$;" ?";
1010 PRINT AT 992,"                ";
(There are 31 spaces between the quotation marks).
1020 RETURN
```

A$ contains the phoneme string to be outputted and is defined prior to subroutine 1ØØØ. The window is opened and closed with a leading and trailing pause. The phonemes are blanked out of the window by printing 31 spaces starting at 992. Note that the closing of the window prevents the spaces from going to the Synthesizer.

Users with a LEVEL II TRS-80 may use the following subroutine for voice output. Because the POKE command is used, it is not necessary to remember where the cursor is before jumping to the voice-out subroutine. (LEVEL I has no POKE command, so PRINT must be used, which moves the cursor.)

LEVEL II:
```
1000 POKE 16383,63: POKE 16383,32
1010 FOR VX=1 TO LEN(VO$)
1020 POKE 16383,ASC(MID$(VO$,VX,1))
1030 NEXT VX
1040 POKE 16383,32: POKE 16383,63: POKE 16383,32
1050 RETURN
```

This program pulls phonemes one at a time from VO$ and POKEs them into the last window location. Since only one window location is used with the POKE command, there is less display distraction than when using the PRINT command.

The input buffer of the Voice Synthesizer is 32 phonemes deep. The duration of a phoneme varies from 4Ø-16Ø milliseconds (.04 seconds to .16 seconds). Thus, a full buffer may take from 1-5 seconds to empty. It is important not to overflow the input buffer because the extra phonemes are lost. This results in discontinuous speech. If more than 32 phonemes are required for a message, break it up into multiple blocks and insert a software delay between the blocks. It is a good idea to make the phoneme blocks based on word or phrase boundaries. The length of the

software delay should be determined by trial and error. One simple approach for a software delay is as follows:

```
1Ø5Ø FOR X = 1 TO Z: NEXT X
```

By varying Z, different delays from milliseconds to many seconds can be achieved.

When making multiple phoneme outputs in rapid succession, it is sometimes undesirable to open/close the window and insert initial and trailing pauses for each output. Such is the case when speaking the numbers for time, in a talking clock program. It is only necessary in this case to open the window and insert a pause before the first output. After the last output block, insert the trailing pause, then close the window. Be careful to not overflow the input buffer.

Note to LEVEL II users: Do not turn on the cursor while printing in the window. It causes erroneous outputs. The cursor is automatically disabled upon running a program, so no concern is needed if the cursor is left off.

Phonetic Programming

Virtually any word in the English language can be produced using the phonemes provided in the TRS-80 Voice Synthesizer. For ease of notation, these sound-units are assigned special symbols. For example, the vowel sound in "get" is represented as EH1. The shorter version of this sound is EH3 and is used in a word like "jacket". Note that as the number following a vowel becomes larger, the duration of that sound becomes shorter. These symbols are listed in the Phoneme Tables.

To get the Synthesizer to produce a phoneme, you give it the ASCII character corresponding to the phoneme symbol. For example, "3" corresponds to the symbol EH1. (See TABLE IV.).

Before you construct a word with phonemes, it may be very helpful to spend time listening to single phonemes and phoneme combinations. To do this, use the program listed in the Software Driver section for entering phonemes from the keyboard. Start by typing the ASCII characters that correspond to each phoneme (listed in Character Conversion Table) into the computer.

You will quickly learn that character AH1 (ASCII = "A") represents the vowel sound you use for the words "pop" and "clock", while AE1 (ASCII = "9") is used in "dad", "hat", and "bag". Pronounce the example word next to each character to determine which sound it represents. Notice that some vowel phoneme symbols are duplicated, but only the duration is different. The long-duration version of any vowel (e.g. EH1) is used in a word with only 1 vowel, or in the syllable of a word that is accented/stressed (e.g. "yes", "better"). Short duration versions of the vowel (e.g. EH2, EH3) are used in unstressed syllables (e.g. "seven"). Say the word you wish to create before you select the vowel phoneme. This practice will ensure appropriate selection of phonemes (e.g. say the word "said", select S-EH1-D to create it synthetically).

With a little practice, you can have your TRS-80 speaking English quite fluently. It is even possible to teach your Computer to speak with various regional accents. Within limitations, it is also possible to speak various foreign languages. If you have difficulty in creating certain words or selecting appropiate phonemes, look in the Example Programming section for words with similar sounds.

The phonemes available are listed in general groupings in the Phoneme Tables below. In a physical sense, the voiced phonemes can be thought of as those having pitch and amplitude resulting from vocal cord vibrations (like humming). Unvoiced phonemes are those without vocal chord vibrations, where pitch might not be detected (perceived like hissing).

Where to go from here...

We hope the information in this manual gets you off to a good start with the Voice Synthesizer. Like playing a musical instrument, programming the Synthesizer gets easier with practice — and the results become more and more astonishing!

If you'd like more technical information regarding the concepts presented in this manual, try looking up the subject of Phonetic Analysis at your local library.

Phonetic Tables

Table I. Phoneme Groups

	Voiced	Unvoiced	Group Names
Consonants	B, D, G	P, T, K, DT	Stop Plosives
	J , THV, V, Z, ZH	CH, TH, F, S, SH, H	Fricatives
	M, N, NG		Nasals
	L, R, W, ER		Semi-Vowels
Vowels	A , AE, AH, AW, AY, E, EH, I, IU , O, OO, U, UH, Y1		

Table II. Phoneme Sounds

Phoneme Symbol...	Sound as in these words...	Type this key to produce the phoneme...
PA1	long pause	space bar
PAØ	short pause	Ø
A	made, claim, day	→*
A1**	made, claim, day	@
A2**	made, claim, day	)
AE	dad, plaid	:*
AE1	dad, plaid	9
AH	mop, blotter	←*
AH1	honest	;
AH2	honest	A
AW	call, law, saul	,
AW1	call, law, saul	1
AW2	call, law, saul	2
AY**	made, claim, day	*
E	meet, be, even	.
E1	meet, be, even	E
EH1	heavy, beg	3
EH2	heavy, beg	4
EH3	jacket	5
ER	bird, heard, turn, over	l
I	pin, it	"*
I1	pin, it	I
I2	inhibit	!
I3	inhibit	#
IU**	you, music	(
O	for, aboard, cold	↓*
O1	for, aboard, cold	O
O2	for, aboard, cold	↑
OO	book, put, good	$
OO1	book, put, good	%
U	move, school	'
U1	move, school	U
UH1	cup, number	6
UH2	about, undone	7
UH3	mission, final	8
Y	any	&
B	bag, tub	B
CH*	chip, march, hatch	C
D	dad, paid	D
DT	butter	Q
F	fast, cuff, phone	F
G	get, dog	G
H	hoof	H
J*	job, judge	J
K	kill, trick	K
L	land, let, shallow	L
M	him, mat	M

Phoneme Symbol...	Sound as in these words...	Type this key to produce the phoneme...
N	not, sun	N
NG	thing, drink, single	+
P	past, flap, happy	P
R	red, card, pair	R
S	soap, ask, pass, city	S
SH	shop, fish, action	>
T	tap, cat, asked	T
TH	thing, path	=
THV	these, smooth, mother	<
V	van, have	V
W	win, always, where	W
Y1*	music, yard	Y
Z	zipper, haze, cans	Z
ZH	azure, measure	X

* Cannot directly input these characters from keyboard.

** These allophones (or phoneme variations) must be combined with another phoneme to complete the production of an English multi-sound unit.

A1 or A2 + AY or Y	=	long A sound (as in today)
Y or Y1 + IU	=	U sound (as in music)
T + CH	=	CH
D + J	=	J

Other multi-sound units, known as diphthongs, are also created by combining vowel phonemes (See Table III).

Table III. Diphthongs

Symbol Combination	Key Words
A1, AY	game
Y1, IU, U1	you, unit
AH1, I2, E1	climb, dime
UH1, AH2, E1	white, fight
O1, U1	coat, snow
AH1, U1	plow, bound
AH2, UH1, U1	house, about
O1, UH1, E1	boy, point
A2, EH1	care, bear
E1, I1	here, beer

NOTE: Phonemes listed as Stop Plosives do not make sound until the phoneme following it begins. At this time, the Stop Plosive phoneme explodes onto the following phoneme. An example of this is the word TOP:

Program: PA1, T, AH1, P, PA1 (where T is not perceived until AH1 begins).

Graphically, the timing of this is:

Input:	PA1	T	AH1	P	PA1
Voice Output:	silence	silence	TAH	silence	P silence

Table IV. Decimal/ASCII/Phoneme Conversion

Decimal	ASCII	Phoneme Symbol	Decimal	ASCII	Phoneme Symbol
ØØ	@	A1	32	Space	PA1**
Ø1	A	AH2	33	!	12
Ø2	B	B	34	"*	I
Ø3	C	CH	35	#	I3
Ø4	D	D	36	$	OO
Ø5	E	E1	37	%	OO1
Ø6	F	F	38	&	Y
Ø7	G	G	39	'	U
Ø8	H	H	4Ø	(	IU
Ø9	I	I1	41	)	A2
1Ø	J	J	42	*	AY
11	K	K	43	+	NG
12	L	L	44	,	AW
13	M	M	45	-	Ø DEC.
14	N	N	46	.	E
15	O	O1	47	/	ER
16	P	P	48	Ø	PAØ**
17	Q	DT	49	1	AW1
18	R	R	5Ø	2	AW2
19	S	S	51	3	EH1
2Ø	T	T	52	4	EH2
21	U	U1	53	5	EH3
22	V	V	54	6	UH1
23	W	W	55	7	UH2
24	X	ZH	56	8	UH3
25	Y	Y1	57	9	AE1
26	Z	Z	58	:*	AE
27	↑	O2	59	;	AH1
28	↓*	O	6Ø	<	THV
29	←*	AH	61	=	TH
3Ø	→*	A	62	>	SH
31	–*	Null	63	?	open /close window

* Cannot directly input these characters from keyboard.
**PA1 and PAØ are pauses which result in silence.

Example Programming

Word	Phoneme Symbols (for notation and reference) ASCII Symbols (to be PRINTED in Window)										
Zero	Z Z	AY *	I3 #	R R	UH3 8	02 ↑	U1 U				
One	W W	UH3 8	UH2 7	UH2 7	N N	N N					
Two	T T	IU (	IU (	U1 U	U1 U						
Three	TH =	TH =	R R	E .	Y &						
Four	F F	O1 O	O1 O	R R							
Five	F F	AH2 A	AH1 ;	I3 #	Y &	V V	V V				
Six	S S	I1 I	I3 #	K K	PAØ Ø	S S					
Seven	S S	EH3 5	EH2 4	V V	EH2 4	N N	N N				
Eight	A2)	A2)	AY *	Y &	T T						
Nine	N N	AH1 ;	EH2 4	Y &	N N						
Cancel	K K	AE1 9	EH3 5	N N	S S	UH3 8	L L				
Add	AE1 9	AE1 9	EH3 5	D D							
Subtract	S S	UH2 7	B B	PAØ Ø	T T	R R	AE1 9	AE1 9	K K	PAØ Ø	T T
Multiply	M M	UH2 7	L L	T T	UH3 8	P P	L L	AH1 ;	Y &		
Divide	D D	I2 !	V V	AH2 A	AH1 ;	EH3 S	I3 #	AY *	D D		

Word	Phoneme Symbols (for notation and reference) ASCII Symbols (to be PRINTED in Window)								
Equals	EI E	AY *	K K	W W	OOI %	L L	Z Z		
Enter	EHI 3	N N	T T	ER /					
Buffer	B B	UH3 8	UH2 7	F F	ER /				
Full	F F	OOI %	OOI %	L L					
From	F F	R R	UH3 8	UHI 6	M M				
Run	R R	UH3 8	UHI 6	N N	N N				
Stop	S S	T T	AHI ;	UH3 8	P P				
End	EHI 3	EH3 5	N N	N N	D D				
Ready	R R	EHI 3	EH3 5	D D	Y &				
Save	S S	S S	AI @	AY *	Y &	V V			
I am . . .	AHI ;	I3 #	Y &	AEI 9	AEI 9	M M	M M		
I	AHI ;	EH3 5	I3 #	Y &					
Hello	H H	EHI 3	UH3 8	L L	UH3 8	O2 ↑	UI U		
Thank you	TH =	AEI 9	AEI 9	NG +	K K	YI Y	IU (	UI U	UI U
Talk	T T	AW2 2	AWI 1	K K					
How are you?	H H	AHI ;	UI U	AHI ;	R R	YI Y	IU (	UI U	UI U

Word	Phoneme Symbols (for notation and reference) ASCII Symbols (to be PRINTED in Window)									
I'm fine.	AH1 ;	I3 #	AY *	M M	F F	AH1 ;	EH3 5	I3 #	Y &	N N
Yes	Y1 Y	EH2 4	EH1 3	S S	S S					
No	N N	UH3 8	O1 O	U1 U						

Specifications

Electrical

Power requirements ..... 120 VAC
60 Hz, 0.10 Amps.
U.L. listed transformer (supplied)

Physical

Cabinet ..... 12" W × 6-5/32" D × 4" H . . . or
30.5 cm W × 15.6 cm D × 10.2 cm H
Speaker ..... Internal

Environmental

Operating Temperature ... 0° C/+ 43.3° C . . . or
32°F/+ 110°F
Storage Temperature ..... −40° C/+ 70° . . . or
−40° F/+ 160° F
Operating Humidity ..... 0 to 95% with no condensation

Interface

VIA Ribbon Cable ..... Into TRS-80 CPU Edge-Card Jack or Parallel
Jack on the Expansion Interface
32 word FIFO buffered parallel
20 inputs: 1 TTL load per input, lines used:

(1) Ground
(6) DO thru D5
(1) WR
(11) A5 thru A15
(1) SYS RES — (2 TTL loads)
20 Total

LIMITED WARRANTY

Radio Shack warrants for a period of 90 days from the date of delivery to customer that the computer hardware described herein shall be free from defects in material and workmanship under normal use and service. This warranty shall be void if this unit's case or cabinet is opened or if the unit is altered or modified. During this period, if a defect should occur, the product must be returned to a Radio Shack store or dealer for repair. Customer's sole and exclusive remedy in the event of defect is expressly limited to the correction of the defect by adjustment, repair or replacement at Radio Shack's election and sole expense, except there shall be no obligation to replace or repair items which by their nature are expendable. No representation or other affirmation of fact, including but not limited to statements regarding capacity, suitability for use, or performance of the equipment, shall be or be deemed to be a warranty or representation by Radio Shack, for any purpose, nor give rise to any liability or obligation of Radio Shack whatsoever.

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