Message Converter Paper

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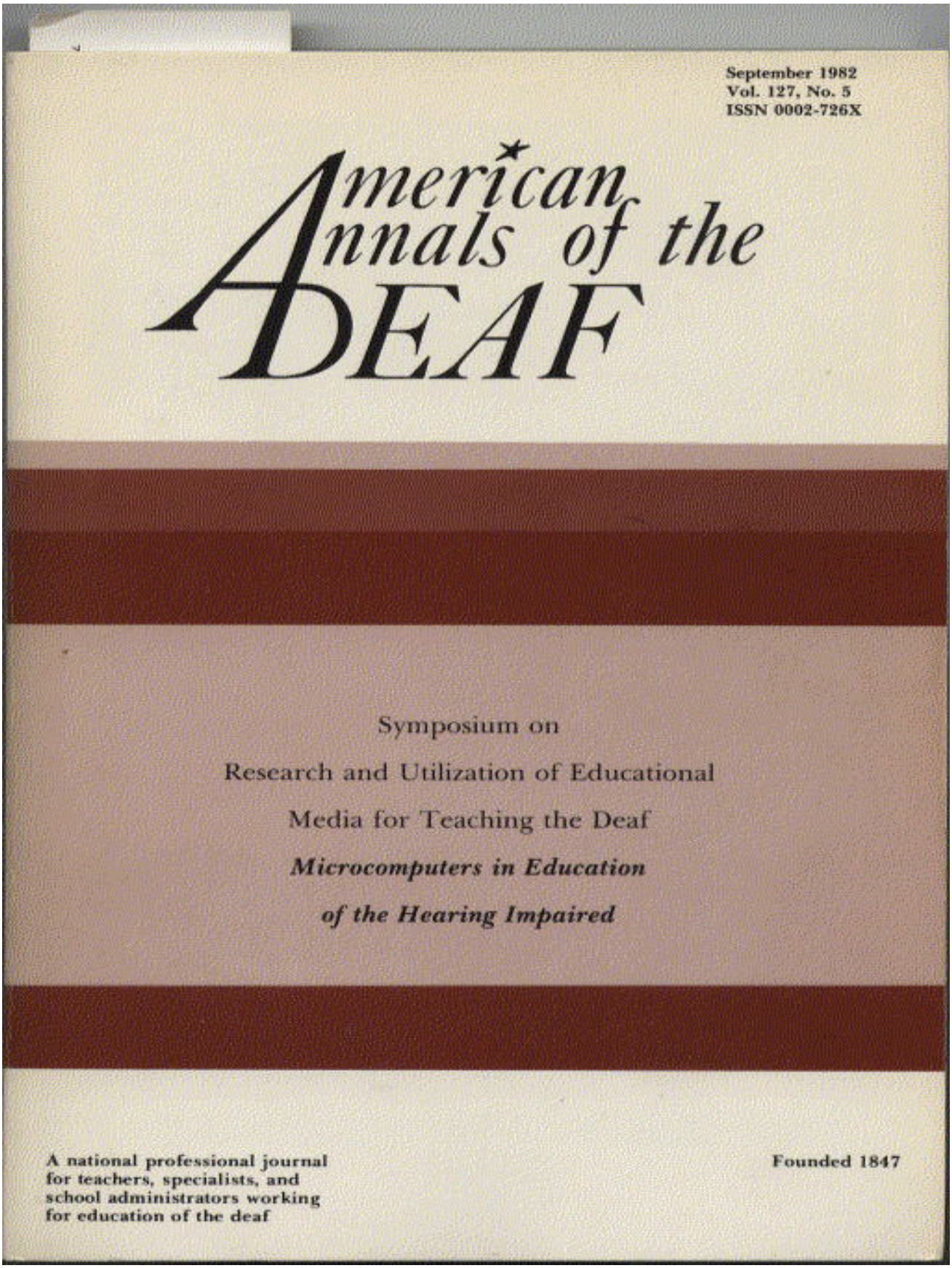
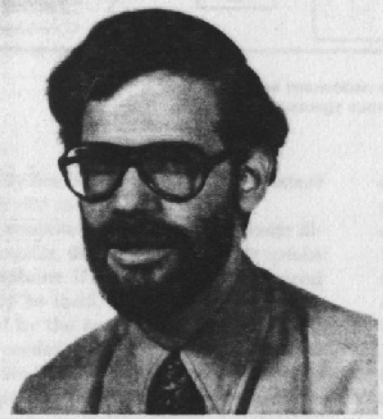
(American Annals of the Deaf, September 1982, pages 550-555)
Very similar to the original contest paper



CHAPTER 12

Telephone Communication for the Deaf

Robert E. Glaser, Ph.D.



The deaf currently communicate over the telephone network through the use of teletypes or CRT terminals. These aids, while of great benefit to individuals so equipped, do not permit communication with persons not owning special equipment. A device presented here provides telephone communication for the deaf without requiring special equipment at the hearing party's location. The aid operates via tones received from a standard Touch Tone (TM) telephone which greatly expands potential telephone usage for the deaf.

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On a consulting basis, he has designed and constructed special purpose microprocessor-based control systems. Since 1981, he has held a post doctoral fellowship at The Johns Hopkins University, pursuing research interests in the area of fault tolerant computing. Dr. Graser is also Director of Research and Development at Telesaver, Inc., Owings Mills, Maryland, where he is charged with the design of telephone switching systems and telephone consumer aids.

Dr. Glaser was a national award winner in The Johns Hopkins University First National Search for Personal Computing to Aid the Handicapped for his entry, "A Telephone Communication Aid for the Deaf." He has publications in technical and hobby journals and is a member of the IEEE and the IEEE Computer Society.

INTRODUCTION

Telephones present a great barrier to the deaf. The severity of this problem is increasing in recent years as much personal contact is being supplanted by the telephone due to rising costs of fuel and transportation. This tendency is causing even greater isolation of the deaf community from the speaking/hearing community. The psychological and educational impact of this additional and most obvious separation of the deaf from the rest of the world is certain to be significant, if not directly measurable.

Currently, to allow use of the telephone, teletype communications over the telephone lines is in common use among the deaf. Typically,

five-level Baudot machines are used, due to their low cost and availability on the surplus market. A modem interfaces the teletype to the telephone line. Parties at both ends of the conversation must possess a teletype and a modem. Communications are provided by each person typing on his or her teletype keyboard for transmission and reading the printout for reception.

The proliferation of low cost personal computers has brought ASCII CRT terminals within a price range which permits their replacing older Baudot teletypes. Operation remains the same: both parties must have ASCII terminals and a matching modem.

It is not unreasonable to assume that deaf individuals will own special equipment to assist them in overcoming their handicap; it is unreasonable to expect more than a small fraction of the hearing population to possess such gear. The disadvantage of teletype/modem communications is that the telephone world of the deaf is restricted to that small segment which does own special equipment.

The Message Converter is a versatile device which eliminates this disadvantage. This aid is not intended to replace existing teletype communications—this is still the preferred method when both parties are capable of such operations—it is intended as an adjunct to be used when the distant party does not have a teletype. The new device is utilized with the old equipment to provide an entirely new dimension to telephone communications for the deaf.

DEVICE DESCRIPTION

Rotary dial telephones are being replaced in much of the country with pushbutton telephones which function by generating DTMF (dual tone, multiple frequency) audio tones used to place a call. Once a telephone connection is established, the pushbuttons still operate, and the DTMF tones can be used for further signalling. The advantage of this scheme over teletype/modem communications is clear: the common pushbutton telephone already contains the encoder necesssary to effect communication, and this permits all of the special equipment to be concentrated at the handicapped person's location.

The Message Converter transforms DTMF audio signals received from the telephone into an appropriate serial output to drive either an ASCII or Baudot CRT terminal or printer. For standalone operation, visual Morse Code output is also available. A simple, easily learned sending code converts the button depressions into an alphanumeric message.

Connection to a terminal or teletype is through a serial RS-232 compatible line which permits readily available computer equipment to be used without modification. The versatility of high and low baud rates allows the use of any ASCII or Baudot terminal. The Message Converter connects to a telephone with readily available equipment. A speaker amplifier, tape recorder interface, or general purpose telephone coupler can be used for connection with the telephone. The unit is powered from the 117 volt AC line.

USE OF THE DEVICE

A typical connection is shown in Figure 1. The local telephone can be connected to the Message Converter in a number of ways. An inexpensive method is to use a telephone amplifier such as Radio Shack #43-230. This is a speakerphone, not a modem. A standard patch cord connects the amplifier to the AUDIO IN jack on the Message Converter. The volume control should be adjusted during the presence of an incoming DTMF signal to center the range where the TONE indicator lamp is consistently illuminated. A standard RS-232 cable connects the output of the Message Converter to the display terminal. In addition, a visual ring indicator will usually be needed to inform the deaf individual when to answer the telephone.

The distant party requires no equipment other than the pushbutton telephone with which the call is made. If such service is not available, the telephone call can be made with a standard rotary dial and communications established with a tone encoder commercially available. The encoder either replaces the telephone mouthpiece or produces a speaker output which can be used to audio couple the encoder to the telephone microphone.

After the call is answered, the hearing person sends messages to the deaf person by depressing keys on the pushbutton telephone. A translation code is used to interpret the key depressions as alphanumeric messages. The interpretation is independent from the choice of output codes: ASCII, Baudot, and Morse. The

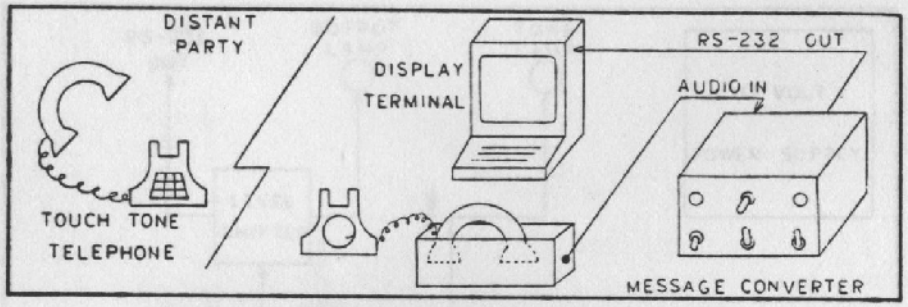

Figure 1. The connection of a telephone and a message converter.

sending party needs no knowledge of the actual receiving device used.

To effect communications in the opposite direction, if possible, the deaf person simply speaks into the telephone. If this is not possible, several options may be used. Simple yes or no questions posed by the hearing person can be answered by predefining a code, such as short or long tones sent by the deaf person on his push-button telephone; the distant party can hear the tones and properly decipher them. Another option is that of prerecording a small number of common statements on a tape recorder; the deaf person can play the appropriate tape as necessary. The most elaborate option, and most versatile, is that of using a voice synthesizer controlled by a personal computer; the deaf person types on the computer keyboard which causes the computer to speak for him/her. Such devices are currently commercially available. Note that the voice synthesizer does not replace the Message Converter—it is used in addition to it. The Message Converter remains a vital element in the overall system, whether that system is simple or complex.

TRANSLATION CODE

A 10- or 12-button DTMF pad on the sending telephone is used to transmit messages (Figure 2). Two translation codes may be selected: interpret and direct. The usual operation will be in the interpret mode.

Interpret (Message) Mode

In the Message translation mode, the standard 10- or 12-button keyboard is used to send numbers and the entire alphabet. Two key depressions are required for every character sent. To send numbers 0 through 9, the appropriate key is depressed, followed by the # key. To send a letter, the button containing the desired letter is pushed, followed by either the 1, 2, or 3 key if the desired letter is the first, second, or third printed on the button, respectively. The 0 key followed by a 1 indicates a sending error (ASCII:\, Baudot: /, Morse: 7 dits). Note the Q, Z, and dash added to the 1 key.

A single * or # sends a space between words. A period is sent with **, and a question mark with ##. If only a 10-button DTMF pad is available, 02 can be used to send a space and 03 used for a question mark. *** or ### will begin a new line after sending a "." or "?".

Any undefined sequence will display "?". In

QZ - 1	ABC 2	DEF 3
GHI 4	JKL 5	MNO 6
PRS . 7	TUV 8	WXY 9
*	/ Space ? 0	#

Figure 2. Sample of a 10- or 12-button DTMF pad on the sending telephone.

the Message Mode, fourth column tones (A, B, C, D) are ignored. These keys are only found on special telephones.

The interpretation code is devised to be simple to learn and use, yet permit unique encoding for each letter and number. A certain degree of error detection is possible since the second key in every 2-button pair can only be a subset of all possible keys: 1, 2, 3, or #. The Message Converter incorporates a decoding algorithm which forces synchronization whenever an invalid second digit is encountered. In practice, this means that sending errors are often completely masked by the decoder after displaying a "?"—otherwise, resynchronization is usually accomplished within the transmission of several letters. Synchronization is guaranteed after transmission of the error (01) code.

Example:

To send:

HI.
THE ANSWER IS 10. BYE

Enter: 42 43 * 81 42 32 * 21 62 73 91 32 72 * 43 73 * 1# 0# ** 22 93 32.**

Direct Mode

In the Direct translation mode, each button is transmitted immediately (Figure 3). This mode is intended to be used for testing and computer decoding. This permits a personal computer to be programmed to implement any desired translation code. Additionally, the Message Converter provides a convenient means to communicate remotely with a computer using DTMF tones.

DEVICE SPECIFICATION

Controls

ON/OFF switch—This powers the unit.

ASCII/MORSE/BAUDOT switch—This sets the translation code. ASCII is sent with the eighth bit zero, no parity, and two stop bits.

HIGH/LOW switch—The transmission speed is set as follows:

	ASCII	Baudot	Morse
Low	110 baud	45 baud	5 WPM
High	300 baud	75 baud	10 WPM

Via internal jumpers, the Morse low speed can be optionally set to 10 WPM, and the high speed can be optionally set to 15, 20, or 25 WPM.

DIRECT/MESSAGE switch—The direct mode causes each of 16 valid DTMF tones to immediately be output. The message mode activates the interpreter.

Indicators

TONE—This lamp is lit for the duration of any valid DTMF tone.

OUTPUT—This lamp indicates the status of the output line. It is lit when the output is -5 volts and extinguished when the output is +5 volts. In the ASCII and Baudot modes, the lamp is normally lit, and it flickers during transmission. In the Morse mode, the lamp is normally out, and lights to indicate the key-down condition.

Connectors

AUDIO IN—Telephone audio is fed into this miniature jack on the chassis rear. The tone level should fall between 50 and 1500 millivolts RMS.

RS-232 OUT—On this DB-25S connector (on the chassis rear), pin 3 is the output, and pin 7 is signal ground. In the ASCII and Baudot modes, the idle state is −5 volts, pulsing to +5 volts during transmission. In the Morse mode, the output idles at +5 volts, and switches to −5 volts during key-down periods.

THEORY OF OPERATION

A block diagram of the unit is shown in Figure 4.

Button	1	2	3	4	5	6	7	8	9	0	*	#	A	B	C	D
ASCII	1	2	3	4	5	6	7	8	9	0	*	#	A	B	C	D
Baudot	1	2	3	4	5	6	7	8	9	0	S	#	A	B	C	D
Morse	1	2	3	4	5	6	7	8	9	0	S	P	A	B	C	D

Figure 3. Transmission of each button in the direct translation mode.

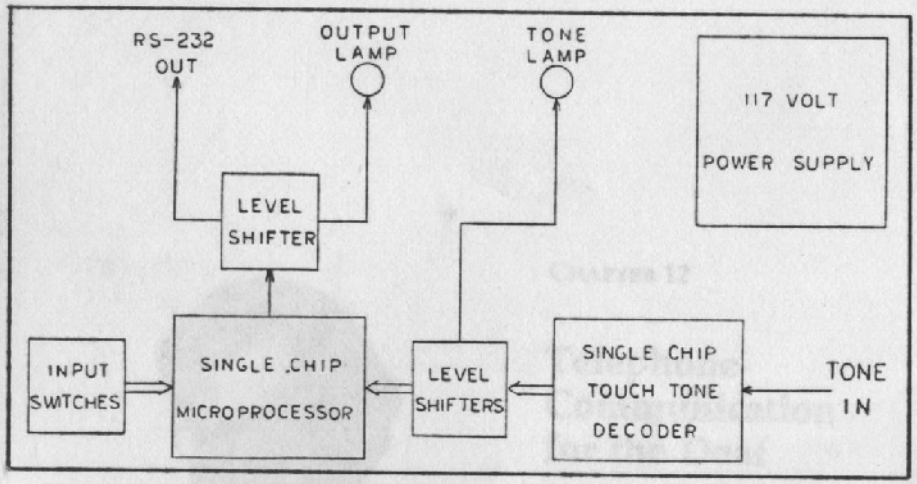

Figure 4. Block diagram of the unit.

Figure 5. Message converter.

A microprocessor is interfaced with a DTMF decoder, input switches, and an RS-232 output line. The microprocessor receives incoming digits from the decoder. The microprocessor is programmed to check the control switches to determine what mode of translation is required: direct or interpretive.

The translated output characters are then converted into either the ASCII, Baudot, or Morse codes, as requested, and sent serially at the specified speed. The computing power of the microprocessor permits such a small device to translate telephone pushbutton depressions into English messages, providing as a bonus several different output codes. The low parts count contributes to overall reliability of the device.

EQUIPMENT AVAILABILITY

The following equipment is or will shortly become available as either modules or assembled units from Telesaver, Inc. (20 Gwynns Mill Ct., Owings Mills, Maryland 21117): Message Converter; direct-connect telephone coupler (UVC-1); screw-in microphone replacement with DTMF encoder for conversion of rotary dial telephones; and a portable, audio coupled DTMF encoder. The UVC-1 (universal voice coupler) indicates ringing visually and can be configured for auto-answer/auto-disconnect applications. Inquire for pricing and delivery schedules.