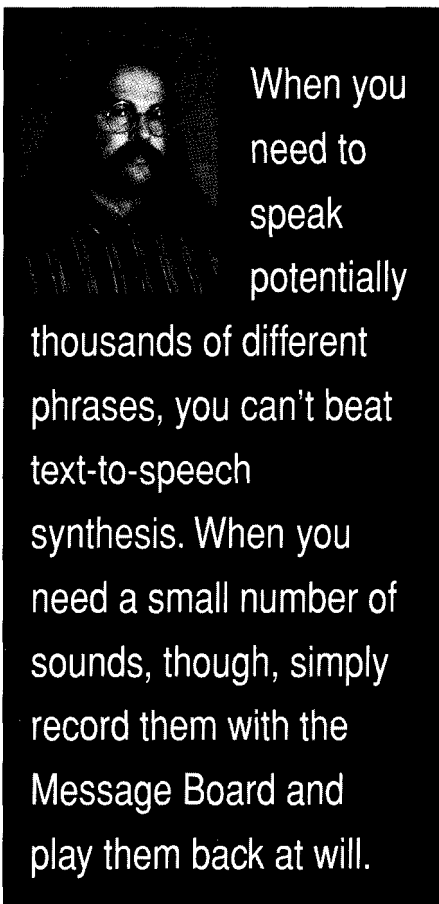


Build the Message Board

An Audio Record/ Playback Unit



When you
need to
speak
potentially

thousands of different
phrases, you can't beat
text-to-speech
synthesis. When you
need a small number of
sounds, though, simply
record them with the
Message Board and
play them back at will.

FROM THE BENCH

Jeff Bachiochi



It's the beginning of the new year as I write this. The snow is knee deep and the oil trucks are as busy as spring's honey bees. I just removed our Christmas tree's skeleton from the house. Not a needle left on it. I remember the devotion to that tree back in December when we picked it out.

Choosing a Christmas tree is always an experience. The festive spirit usually peaks as we drive toward our destination, the local tree farm. After an hour or two of "nope, too short," "that's lopsided," or "this one's missing branches," we have totally lost the spirit of the season and aren't on speaking terms. I know this happens to you; I've heard you arguing over in the next row of trees!

Things turned out a bit different this year. While picking up a few supplies at the local building supply warehouse, the kids noticed they were selling trees. "Let's look," they begged.

"A Canadian orphan," I thought. And there it was, *the* tree. We couldn't believe it: everyone was in agreement. I quickly paid for it while I thought over and over, "Still on speaking terms and the tree was chosen."

The ornaments were hung by the children with care, in hopes that all on their lists would soon be there. Each one of us has our own ornament. I have Star Trek's shuttle craft which repeats a canned message. "Shuttle craft to Enterprise. Spock here. Happy holidays. Live long and prosper."

"I've swept quite a few needles from the floor so far," Beverly prodded.

"Must be the initial shock," I surmised. For the next week it rained

evergreen spikes.

"That tree shouldn't be shedding like this," she needed. "We need a new tree."

"Look, it's only a few days 'til Christmas; it will be fine." I argued, "Besides, look at how well you can see all the ornaments!"

"Everything must be perfect." Her voice became strained, "You know we are having your family over for Christmas dinner this year."

I thought to myself, "Oh yeah, you know how a defective Christmas tree can ruin a party." I could feel the spirit making a run for the door. But it wasn't too late.

After examining the true meaning of Christmas we exchanged no harsh words, only gifts, and had a great Christmas in spite of the naked tree. Its boughs now bare, it sits upright, outside in the snow. Suet and seed decorate its branches. And you know, the birds haven't complained once.

COMPLAINT DEPARTMENT

Many readers of this column were disappointed when the circuitry for the HCS-Voice text-to-speech board was not revealed ("Updating TIM for the HCS II," October '93). We felt that since we couldn't give away the licensed software, having the schematics would only cause distraction. The board is available as a kit. Even though it wasn't covered in detail in an article, its text-to-speech capabilities make it my choice for use with the HCS.

Looking for something a bit simpler you say? This month's project, the "Message Board," uses the new ISD2500 series of analog record/playback devices from Information Storage Devices in a cascade mode to create an expandable messaging system. This is the same technology used in the Shuttle Craft ornament.

ISD2500

The ISD25xx series devices use a 480k-cell nonvolatile analog storage array to provide 45, 60, 75, or 90 seconds of storage depending on the fixed input sample rates of 10.6k, 8k, 6.4k, and 5.33k respectively. DAST (Direct Analog Storage Technology) allows analog data to be written

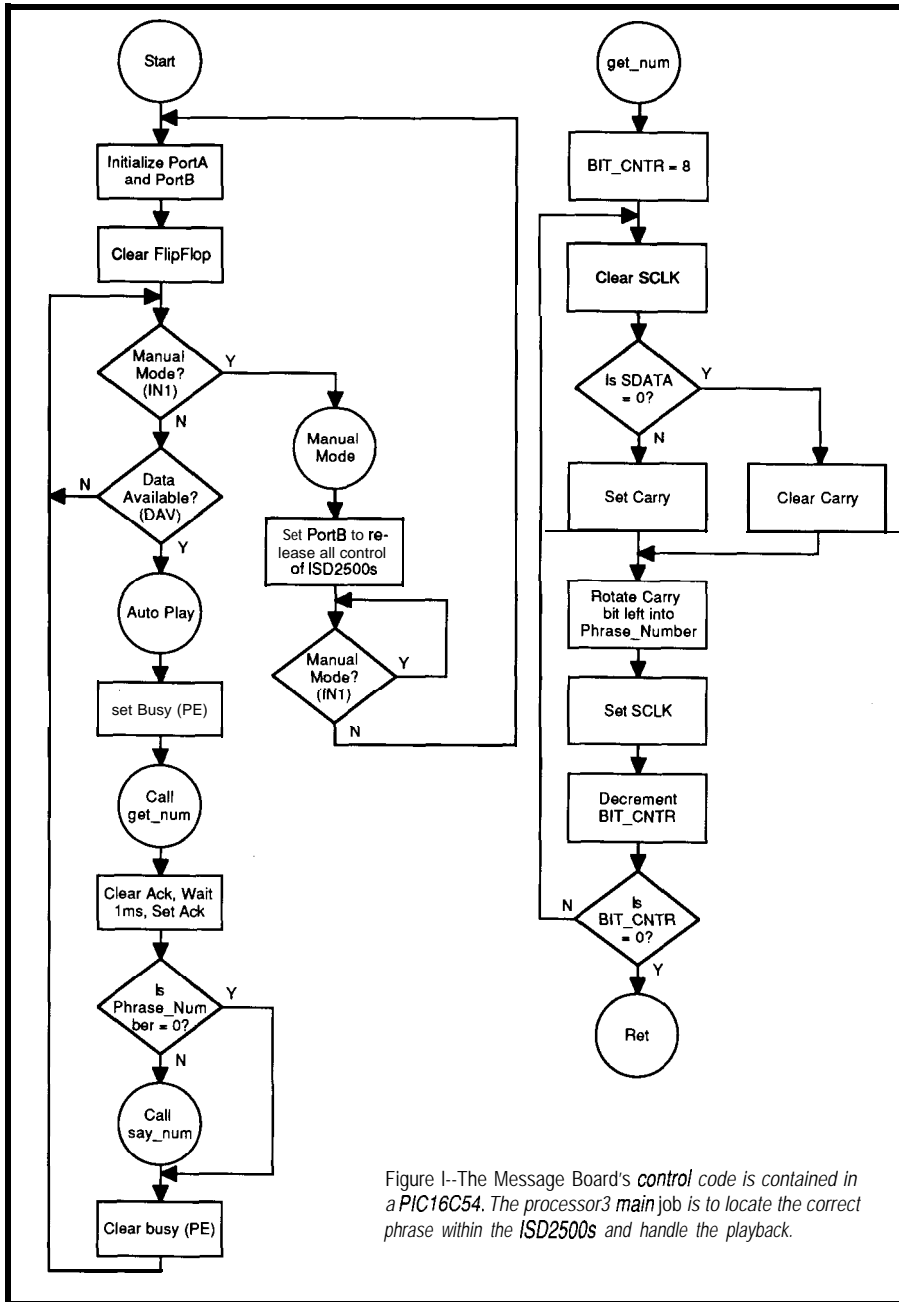


Figure 1--The Message Board's control code is contained in a PIC16C54. The processor's main job is to locate the correct phrase within the ISD2500s and handle the playback.

OPERATIONAL MODES

Message cueing mode (MO) provides the ability to step through recorded phrases without any audio output. I'll be using this mode to allow a micro to index through a message base. The cueing is done in a fast-forward mode which zips through each message at 800 times normal speed.

The Delete EOM marker mode (MI) will concatenate all message phrases into a single message. This is accomplished by eliminating all EOM markers from all previously recorded individual messages and adding one EOM marker to the final message.

Looping mode (M3, M2 is reserved) continues to replay the first message without a pause.

The consecutive addressing mode (M4) prevents the address pointer from being reset upon an EOM marker. This provides the facility to record or playback multiple message phrases within a single chip. This mode, in conjunction with the message cueing mode, is the heart of this solid-state analog record/playback system.

Level-activated mode (M5) allows the playback to be terminated by the rise of the \bullet CE line. (Normal operation would start the message on the falling edge of \bullet CE. At that point, raising \bullet CE has no effect. The message would end following an EOM marker.)

The push-button mode (M6) reduces the external component count to only those necessary to provide a simple push-button solid-state tape recorder. Start/Pause and Stop/Reset push buttons are all that is necessary

directly into an EEPROM cell without A/D conversion and to be read directly from an EEPROM cell without D/A conversion. This means an increase in storage density per word. Data retention can be as much as 100 years while record cycles can exceed 100k times.

On-chip peripherals include a microphone preamplifier with AGC (automatic gain control). During recording, a 5-pole antialiasing filter removes any audio components which approach one-half the sampling frequency. The analog storage array is based on EEPROM floating gate technology and is equivalent to 8 bits

of accuracy. During playback, a 5-pole smoothing filter helps to remove the sampling frequency component and restore the original waveform. Finally, an on-board amplifier will directly drive a 16-ohm speaker with up to 50 mW.

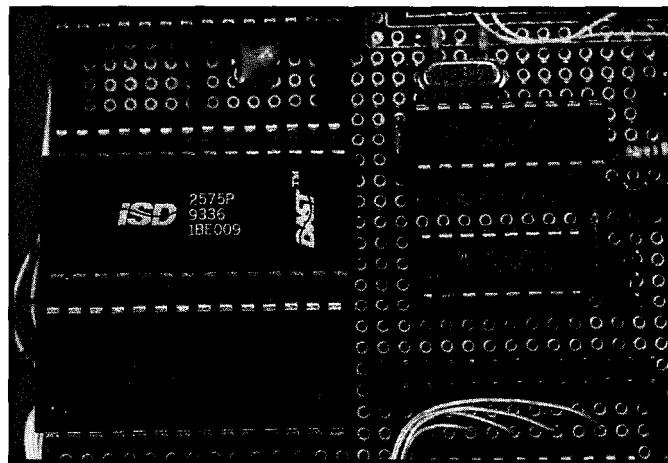


Photo 1--Up to four ISD2500 family chips may be plugged into the Message Board for up to 6 minutes of audio storage.

to provide either record or playback functions. An additional switch will allow record and playback selection. This simple mode is limited to a single message or phrase.

In addition to the previously mentioned modes, direct access addressing can point to the beginning of any of the 600 possible message segments within a single ISD2500 device. If you knew the address of each message, you could point directly to it. However, this is generally not known except in a sound development environment.

See Tom Cantrell's "Talking Chips" article in issue #36 for more information on the older ISD1000 series devices.

A MICRO CONTROLS THE MESSAGE

I wanted this message playback system to be easy to use, so I use a single byte [message number] to indicate one of a possible 255 prerecorded message phrases to play back. To accomplish this, I use a small micro (a PIC16C54) to accept a byte from any parallel port and perform the necessary twiddling on

the ISD2500 devices to fast-forward to the correct message and play it. Notice I used the plural "devices"; the option of using multiple devices increases the overall message storage capability up to a maximum of 6 minutes (four 90-second devices). More on this later.

I/O pins on a small micro are sparse; the 18-pin 16C54 has just 12 I/O lines that can be totally consumed by a parallel connection [including handshaking]. To resolve this, we must bend over backwards to interface with the micro. A parallel-loaded serial shift register requires only two I/O bits to interface as opposed to the eight required for directly reading the byte.

To ensure the byte is not missed (this version of the PIC has no external interrupts), the data's strobe is latched to become a DAV [data available] signal which is periodically scanned by the micro. The micro initiates a busy signal while serially sucking in the parallel port's data, then acknowledges its receipt once the data is digested. See the flowchart in Figure 1 for the micro's code outline.

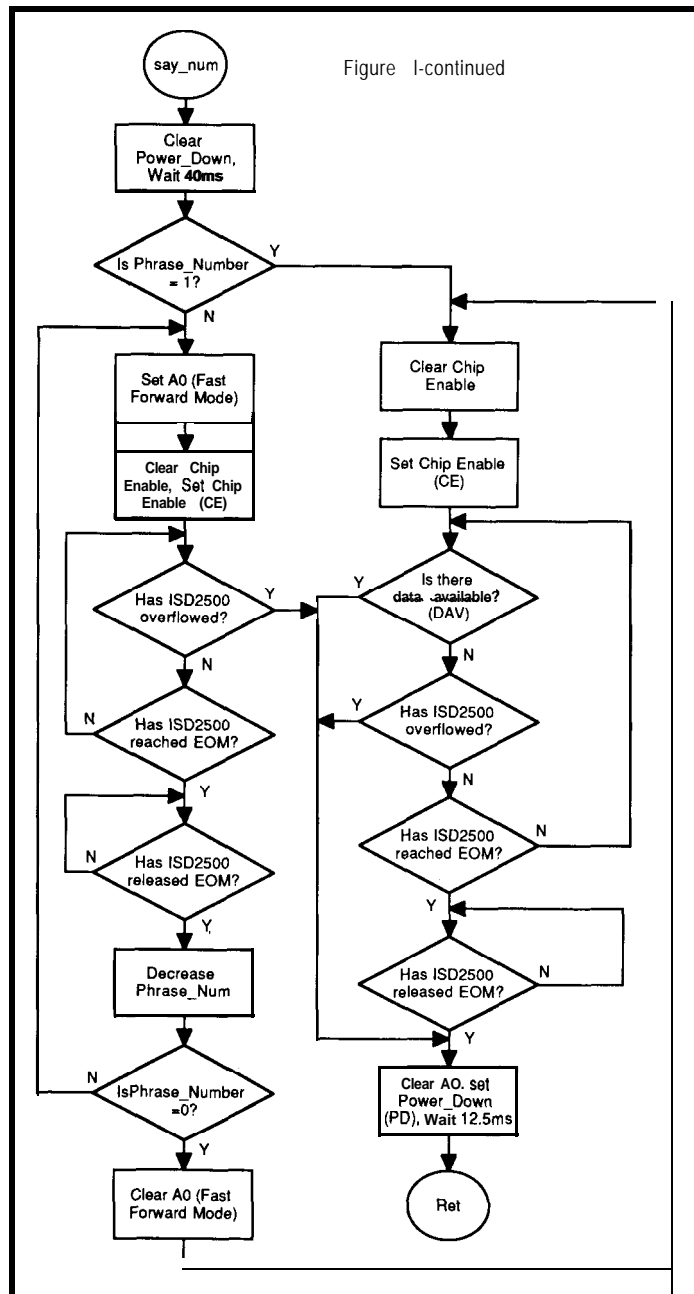
At the other end of the circuit, the micro manages four ISD2500 control functions. The P/R control bit selects the playback/record mode. The PD control bit resets the message pointer and regulates the ISD2500's power-

down mode. The ● CE control bit begins the record/playback function. Finally, the A0 addressing bit selects message cueing (fast-forwarding in the playback mode in combination with *CE). Two additional input bits to the micro are used from the micro. The ● EOM signal indicates the end of a particular message phrase. This is the feedback for cueing up a message phrase. The second input, *OVF, signals the end of the storage device has been reached.

To expand the total storage capabilities of this board, I cascade the ISD2500 devices in a daisy chain fashion. The earlier ISD1000 series devices could not handle multiple messages straddling the boundaries of two devices. Some interesting signal steering goes on when the devices are cascaded. For control, the *CE input of device #1 begins a message. If the message is longer than the storage capability of device #1 then the ● OVF output drops. This output signal from device #1 is used as the *CE input to device #2, enabling the second

device only after the storage capacity of the first has been exhausted. *OVF from the last device is used as feedback to the micro. Individual *EOM outputs from each of the storage devices are OR'ed as feedback to the micro. These two signals keep the micro abreast of the ISD2500's status.

On the audio side, an auxiliary audio input is directed to the speaker output whenever the device is not selected or is in overflow. This is important. Whenever the second device takes over its audio output, which is connected to the first device's auxiliary input, it is passed through the first device's amplifier. Audio from



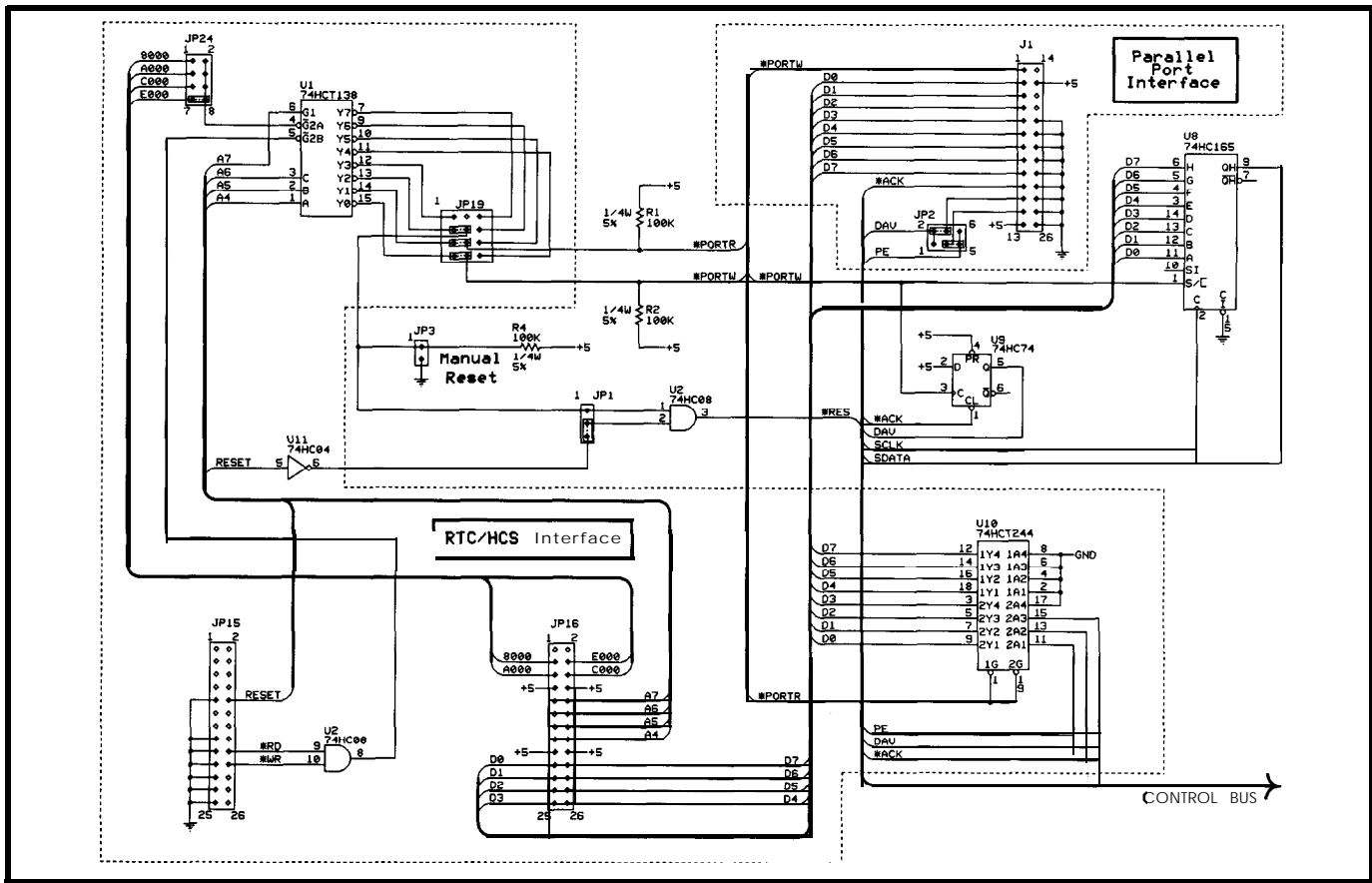


figure 2a—The Message Board can be interfaced to the HCS in the same way as the HCS-Voice board, or may be connected to a parallel port.

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all devices is daisy chained through the first device's speaker output. Likewise, when in record mode, the microphone preamp on device #1 is directed to each of the cascaded devices, resulting in a simple user interface for multiple devices. See Figure 2. Although the ISD2500s will directly drive a speaker, I've added the identical audio output circuitry used on the HCS-Voice board to maintain compatibility with the DTMF board.

SEND A BYTE, SPEAK A PHRASE

A single-byte transfer starts the message playing. Although designed with the same interface as the HCS-Voice, a PC's parallel port can alternatively be used to cue up a message and begin playback. Pre-recorded messages 1-255 are invoked by writing that particular binary value to the Message Board's parallel port. Any message can be interrupted prematurely by sending another message number (the new message begins immediately). Selecting phrase zero stops the speaking altogether.

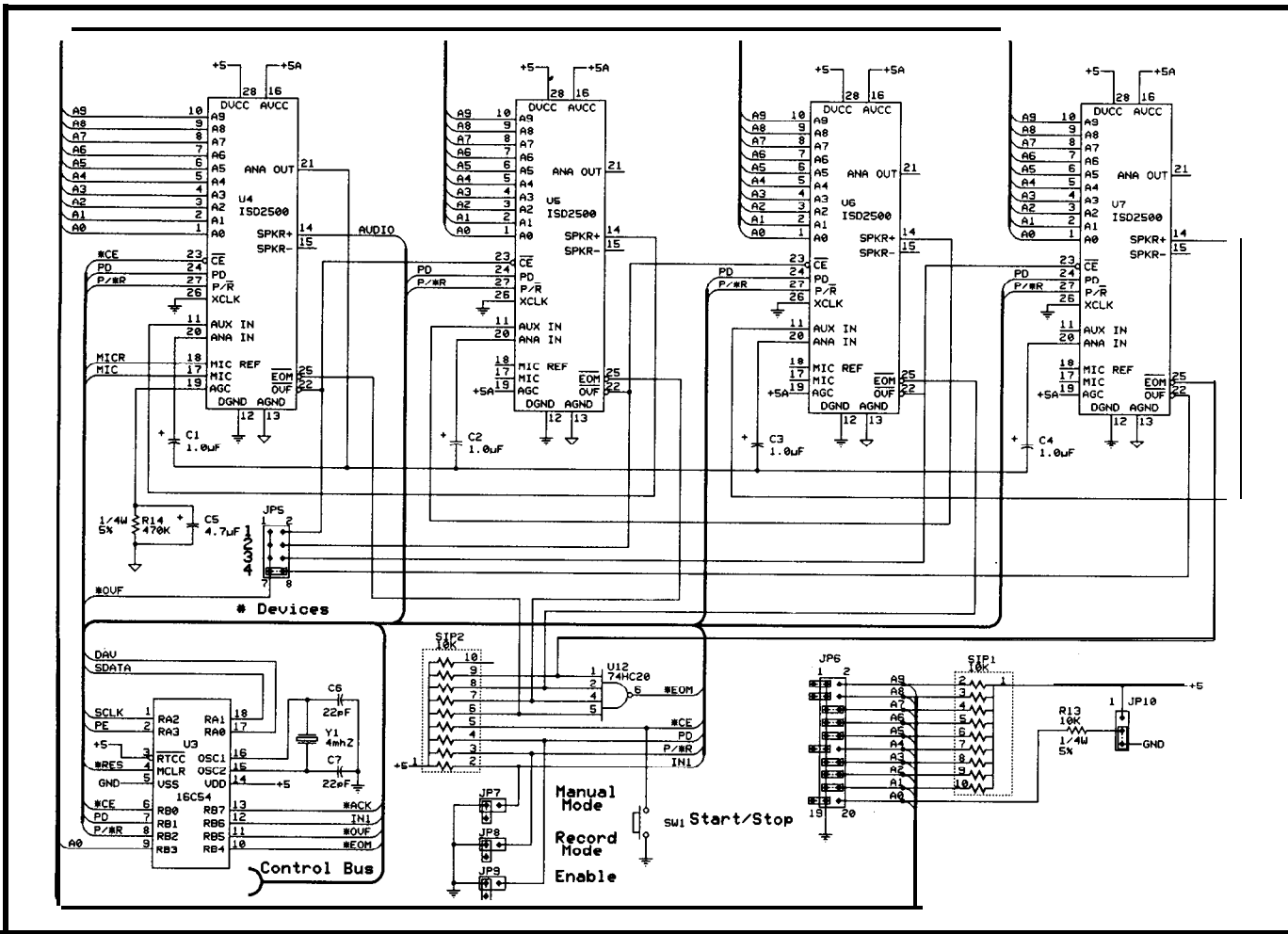


Figure 2b—At the core of the board is up to four ISD2500 parts capable of holding up to 6 minutes of audio. A PIC processor controls the show.

PRERECORDING

The Message Board can't speak unless you provide it with a message base. I suggest you start by writing down a list of all the messages (or sounds) you wish to include. Practice repeating them a few times until you feel comfortable. The Message Board can be put into manual record mode using the following steps:

Insert the "Manual Mode" jumper to instruct the micro to release all of the control lines to the ISD2500s. Insert the "Record Mode" jumper to place the ISD2500 devices into the record mode. Insert the "Enable" jumper to remove the ISD2500 devices from power-down mode.

Now plug an electret microphone into the audio input jack. You may begin recording the first message on your list by holding down the "Start/Stop" button until you are finished with the first message. Each time the button is released, an EOM marker is

inserted. You may continue to record additional messages until the OVF LED comes on. At this point the storage area is filled and will not accept additional input. If you wish to rerecord all the messages, remove and

then reinsert the "Enable" jumper. You are now ready to rerecord all of your messages. Whenever the record/playback mode is changed, the address pointer is reset within the ISD2500s, requiring you to start over if you wish

Listing 1—The Message Board is a memory-mapped device when plugged into an RTC52 and can be controlled directly from BASIC.

```

10 PRINT
20 INPUT "Phrase ii (1-255, 0=stop)" X
30 PRINT "Hit any key to cancel status reporting"
40 XBY(0E080H)=X: REM Write phrase number to port
50 Y = 255: REM Initialize to a nonstatus value
60 X = (XBY(0E090H).AND.7): REM Get status from port
70 G = GET: IF G<>0 THEN GOTO 10: REM Key pressed?
80 IF X=Y THEN GOTO 60: REM If old=new, skip status print
90 Y = X: REM Update old status
100 IF (X.AND.1)=1 THEN PRINT " Busy ",
110 IF (X.AND.1)=0 THEN PRINT " Not Busy ",
120 IF (X.AND.2)=2 THEN PRINT " Data Available ",
130 IF (X.AND.2)=0 THEN PRINT " Data Captured ",
140 IF (X.AND.4)=4 THEN PRINT " Acknowledged "
150 IF (X.AND.4)=0 THEN PRINT " Working "
160 IF X<>4 THEN 60: REM This value indicates end of phrase
170 GOTO 10

```

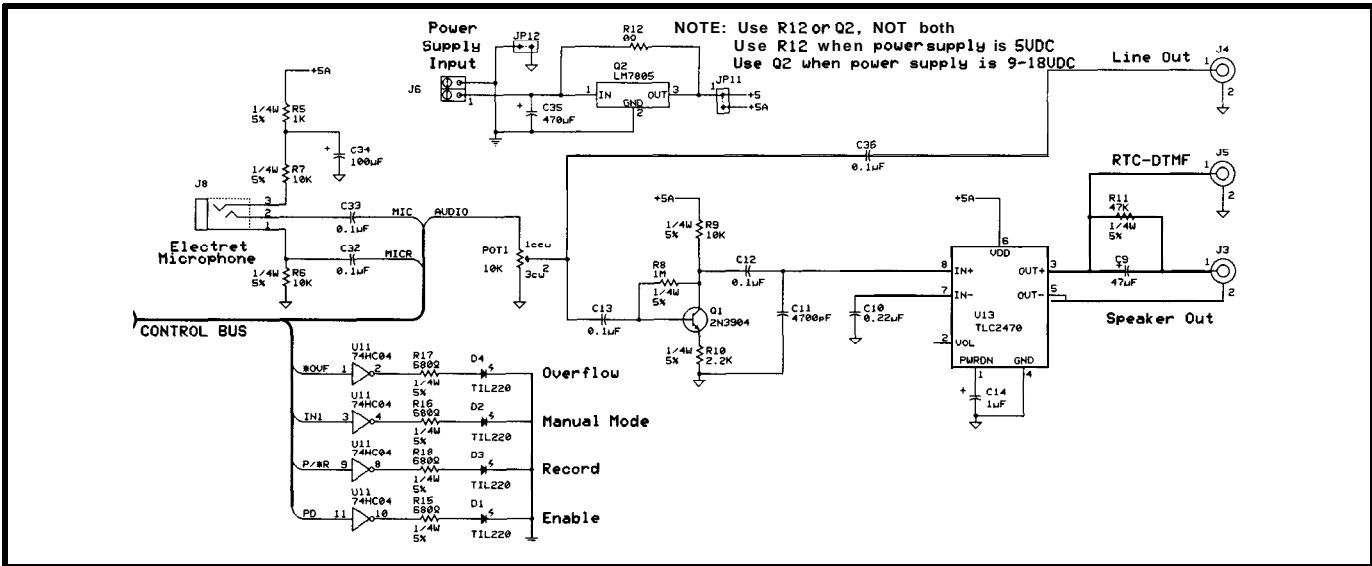


Figure 2c—An electret microphone is used to record audio. Even though the ISD2500 chips include amplifiers, one is included on the board so it functions the same as the HCS-Voice board.

to correct an error or add more messages.

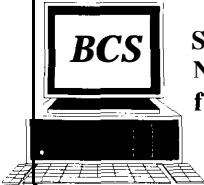
You may manually review your messages by removing both Record mode and Enable jumpers and reinserting only the Enable jumper (playback mode). Each time the Start/Stop button is pressed, a message will play.

When you are pleased with the session, remove the "Enable," "Record Mode," and "Manual Mode" jumpers. The micro has now regained control and you may command the Message Board to speak.

I have provided a couple of short no-frills programs to test out the

Message Board once you have filled its mind with message phrases. The program in Listing 1 uses the Message Board as a memory-mapped I/O device with an RTC52. Notice the "Parallel Port Interface" in the schematic is not necessary when the Message Board is to be used with either the RTC or HCS

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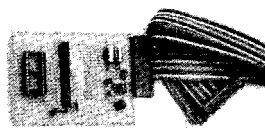
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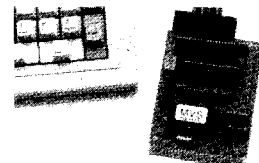
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Listing 2—The board may also be controlled from BASIC when plugged into a PC's printer port

```

10 REM Possible printer port addresses are &H278, &H378, or &H3BC
20 DPORT=&H378: CPORT=DPORT+2: SPORT=DPORT+1
30 PRINT: INPUT "Phrase # (1-255, 0=stop)",X
50 PRINT "Hit any key to quit status reporting"
60 OUT DPORT,X: REM Write phrase value to the data port
70 OUT CPORT,(INP(CPORT) AND 254): REM Strobe low
80 OUT CPORT,(INP(CPORT) OR 1): REM Strobe high
90 Y = 255: REM Initialize to an impossible status value
100 X = (INP(SPORT) AND &HE0): REM Read status port
110 IF (INKEY$<>"") THEN GOTO 30: REM Any key exits status routine
120 IF (X=Y) THEN GOTO 100: REM If old=new, skip status printing
130 Y = X: REM Update old status
140 IF (X AND 128)=128 THEN PRINT "Data Accepted ",
150 IF (X AND 128)=0 THEN PRINT "Data Available",
160 IF (X AND 64)=64 THEN PRINT "Data Acknowledged".
170 IF (X AND 64)=0 THEN PRINT "Processing Data",
180 IF (X AND 32)=32 THEN PRINT "Playback Busy"
190 IF (X AND 32)=0 THEN PRINT "Playback Not Busy"
200 IF (X=&HC0) THEN GOTO 30: REM Playback has finished
210 GOTO 100

```

system controllers. The program in Listing 2 uses GWBASIC to write directly to your PC's parallel port. The "RTC/HCS Interface" is not needed if you wish to use the Message Board stand-alone with a printer port.

Happy messaging. 📧

Jeff **Bachiochi** (pronounced "BAH-key-AH-key") is an electrical engineer on the *Computer Applications Journal's* engineering staff. His background includes product design and manufacturing. He may be reached at jeff.bachiochi@circellar.com.

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Individual ISD chips are *not* available from Circuit Cellar (except with purchase of the Message Board).

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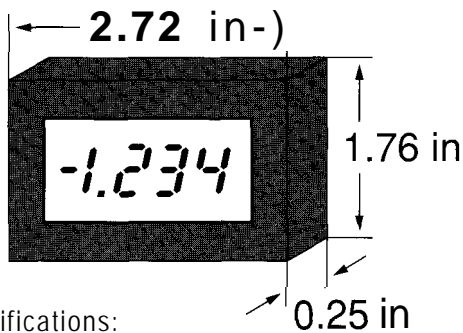
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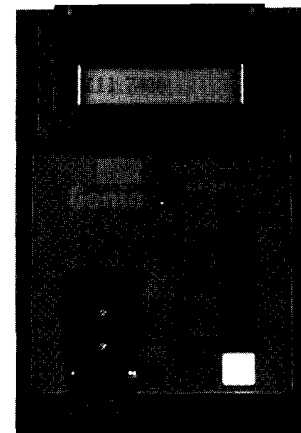
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