CHAPTER 13
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Beeper/Pager Activating System

INTRODUCTION
The Beeper/Pager Activating System is designed to enable a person to summon an emergency care provider by simply touching a button on a wireless transmitter. The system is connected in series with a telephone line and any touch-tone telephone. The Emergency Care Provider (ECP) carries a standard Beeper/Pager and can be paged automatically by the touch of a button. The ECP can then call back from any telephone to see if assistance is needed. When the ECP calls back, the system automatically answers and places the telephone in speakerphone mode to allow communication with the ECP to assess the severity of the emergency. The system also comes with a Regular Page feature. This simply pages the ECP but does not leave an emergency code. All programming, such as the telephone number, the beeper number and the emergency codes, are entered via the tone pad on the telephone.

SUMMARY OF IMPACT
The Beeper/Pager Activating System is designed for a man who has Cerebral Palsy. He lives independently despite the fact that he is unable to get into and out of his electric wheelchair without assistance. For several hours each day and for most of each night, he is alone. While his personal care attendant (PCA) lives nearby and can respond to emergencies, the client needed a way to activate the PCA’s beeper. Sometimes the client is unable to get his wheelchair close enough to the telephone to dial for help. This device makes it possible for the client to summon the PCA from anywhere in his apartment.

Figure 13.1. Paging System.
TECHNICAL DESCRIPTION
The Paging System has five major sections: Speaker Phone, Ring Detect, Memory, Tone Transmitter and Receiver, and the Microprocessor Controller.

The Speaker Phone is external to the circuitry and is wired to a relay. The speakerphone is turned on when a ring is detected if the system is in auto answer mode. It is also turned on when the unit is receiving or sending tones to allow the user to hear the tones present on the line.

The Ring Detect circuit is activated through the telephone line by a ring voltage. When a ring is detected, the circuit generates a TTL compatible non-inverted five-volt output that is passed to the microprocessor. The microprocessor senses the incoming ring and, if the system is in auto answer mode, sends the appropriate signal to turn on the speakerphone.

The Memory circuit stores the digits of phone numbers in consecutive addresses, or retrieves the number stored and sends it to the tone transmitter, depending on the signal from the microprocessor. The memory circuit is battery backed up RAM to allow the numbers to be retained in case power is lost.

The Tone Transmit/Receive section transmits or receives tones on the telephone line, depending on the position of the selector switch.

When the switch is in the program position and a push button is pressed, the tones received from the telephone line are translated into their equivalent digits. The microprocessor, in turn, takes these digits and stores them in the memory location that corresponds to the push button pressed.

When the switch is in the run position and a push button is pressed, the microprocessor sends the corresponding digits from memory to the transmitter. The transmitter then translates the digits into their equivalent tones and sends them out onto the telephone line.

The Microprocessor Control Section controls the action of every other section. It resets the memory addresses, sends a write or read signal to memory and increments or decrements the address depending on the signal it receives. It sends the appropriate signal to the relay to turn on the speaker phone and open or close the phone line. It also monitors the ring detect signal in order to see if the ring voltage is present on the telephone line.

The Microprocessor Control Section monitors the push buttons and selector switch in order to send the appropriate signals to the transmitter and receiver. When a button is pressed it retrieves the corresponding digits from memory and sends them to the transmitter or retrieves the digits from the receiver and stores them in the appropriate memory location.

The system costs about $50 to build, not including the cost of the standard telephone used for the programming and the speaker phone used in the talk back mode.

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**Figure 13.2.** Circuitry of the Paging System.
Talking Single Switch Appliance Controller

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INTRODUCTION
The Talking Single Switch Appliance Controller is designed to enable a person who is both blind and severely physically impaired to turn on and off up to three electrical appliances by operating a single remote control switch.

The user must have the ability to operate a simple control switch, such as a head tilt switch, an eyebrow switch, or a squeeze ball switch. Following the first closure of the switch, the unit speaks a greeting and then it repeats the names of three appliances such as “tape player”, “radio”, “coffee pot”, “tape player”, “coffee pot”, “radio”, etc.

The next time the switch is closed, the controller turns on the selected appliance if it was off, or turns it off if it was on. A particular appliance is selected by closing the switch just after its name is spoken. The unit automatically enters a standby mode if the switch is not closed for two consecutive cycles of the voice menu. Operational mode is reentered by closing the control switch.

SUMMARY OF IMPACT
The talking appliance controller is designed for a woman who is blind and cannot use her hands to operate standard push button switches. The controller enables her to control the operation of her radio, tape player and VHF scanner. Without the controller, she has to rely upon others to control these devices, and she cannot change independently from one device to another.

TECHNICAL DESCRIPTION
The Talking Single Switch Appliance Controller consists of an infrared transmitter, (3) X-10 wireless control modules, an X-10 controller and a receiver-controller module. The receiver-controller module is powered by a 5-volt power supply. The front panel of this unit consists of a speaker, an infrared receiver, a power On/Off switch, a power indicator and a reset switch.

The infrared transmitter and receiver were purchased as a kit at Radio Shack. Circuit diagrams are provided with the kit. The receiver circuitry triggers a 74121-monostable multivibrator that is connected to the TO line of the 8748 microprocessor. (See Schematic) There are two separate conditions (states) of operation. The first condition is after each appliance option is spoken and the second condition is when the controller is in standby mode.

After each appliance option is spoken, the operator has 12 seconds to respond by closing the control switch that energizes the infrared transmitter. During this 12-second interval, the TO line is tested to see if a signal is received. The function of the monostable multivibrator is to keep the received signal in a high state for a fixed period of time. The microprocessor waits for the signal to go low before accessing the appliance. Therefore, the appliance is activated only after the switch is released. If an appliance is selected,
the 8748 are programmed to communicate with the MAX232 X-10 interface that is connected to bit zero of port 1 of the microprocessor. (See Schematic) This communication is accomplished over a single line by means of a serial data transfer routine.

The second condition TO is monitored when the controller is in standby mode. The device goes into automatic standby once the appliance names are spoken twice without a response. In standby mode the microprocessor continually tests the TO line for a signal requesting operational mode.

The audio circuitry consists of an ISD 2575 Audio Chip that records, stores and plays back speech. The four controlling pins for the ISD 2575 are: the chip enable CE, power down I’D, end of message EOM and playback/record P/R. CE and I’D are tied together. The address inputs and P/R inputs are latched by the falling edge of CE.

For a record cycle, the address inputs provide the starting address, and recording continues until PD or CE is pulled high or an overflow is detected. Anytime a record cycle is stopped by a rising CE signal, an EOM bit is set.

A momentary low at CE initiates the playback cycle. Once initiated, it continues playing until the device reads the internal EOM bit that is set during the record cycle.

The EOM pin goes low for a period of 12.5 ms at the end of each message. This pin is monitored from the T1 line, which returns control back to the microprocessor when the message is through playing.

The address on the audio chip corresponds to the time associated with each message. Pins A0-A5 and A9 are grounded and pins A6-A8 are used to address eight separate time segments.

The cost to produce the device was $250, including the MAX 232 controller, the X-10 transmitter and three X-10 wireless control modules.

<table>
<thead>
<tr>
<th>MESSAGE</th>
<th>ADDRESS</th>
<th>DECIMAL</th>
<th>TIME SEGMENT</th>
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<tr>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>APPLIANCE1</td>
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<td>8 sec</td>
</tr>
<tr>
<td>APPLIANCE2</td>
<td>0010000000</td>
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<td>16 sec</td>
</tr>
<tr>
<td>APPLIANCE3</td>
<td>0100000000</td>
<td>256</td>
<td>32 sec</td>
</tr>
<tr>
<td>STANDBY</td>
<td>0110000000</td>
<td>384</td>
<td>48 sec</td>
</tr>
</tbody>
</table>

Figure 13.4. Talking Single Switch Appliance Controller Circuitry.
INTRODUCTION
The Joystick Message Talker (JMT) is a device that speaks one of four digitally recorded messages by simply moving the joystick UP, DOWN, LEFT, or RIGHT. It can be programmed to speak in any human voice: male, female, or child. The JMT is used as a training device by people who have lost the use of their voice or those who have never been able to speak. It is used by the physically disabled as a first step in learning to use more advanced communication devices later in their rehabilitation.

This device is unique because it uses digitized human speech instead of synthesized speech. The digitized speech is stored in an EPROM that can be easily reprogrammed with a new voice to accommodate the needs of various users. The sound of a realistic voice coming from the device is intended to be more personal and appealing than the sound of a synthesized voice. The JMT is about the size of a WALKMAN and connects to a standard ATARI joystick via a DB-9 male jack. The JMT is powered by a standard 9-volt battery that powers the device only when the joystick is moved to one of the four possible positions. This feature makes a power switch unnecessary.

SUMMARY OF IMPACT
The Joystick Message Talker is designed for a youngster with Cerebral Palsy who is mentally retarded and does not speak. His teacher introduced him to slow speed video games, which gave him a fair degree of dexterity in using a joystick. Since he is able to play simple video games, it is hoped that he may be able to learn to use the message talker as a communication device. The unit is initially programmed to say "YES", "NO", "HI", and "GOOD-BYE". If he uses the talker appropriately, consideration will be given to building a more sophisticated device.

TECHNICAL DESCRIPTION
The box measures 4" x 2.75" x 1.5" (length, width, height). The speaker and microphone are located on top of the box. A DB-9 male jack for connecting the joystick is located on the right of the box. A 9 volt battery clip and a red momentary push-button which is used for recording, are located on the back of the box. The schematic illustrates the components that comprise the JMT. The heart of the device is an ISD1000 series Digital Record / Playback chip. The ISD1000 is available from Information Storage Devices in 12, 16, and 20-second duration for recording. Also available is the ISD2500 series chip capable of 45, 60, 75, and 90-second durations. These are CMOS chips with built in oscillator, microphone preamplifier, automatic gain control, antialiasing filter, smoothing filter, and speaker amplifier. These chips are also microprocessor bus compatible allowing for a wide range of addressing. Digitized voice is stored in non-volatile memory within the ISD chip, which provides zero-power storage. In the JMT, address lines A5 and A6 are connected to 4.7k pull-up resistors which will generate a logic HIGH or LOW depending on which switch is pressed. The remaining six address lines are grounded. This results in four distinct addresses applied to the ISD chip. For example, if switch 3 is pressed, the ISD sees logic 1 at A5 and
logic 0 at A6. This selects one of the four possible messages. A capacitor is tied between the Power Down (PD) pin and ground. This capacitor is charged to $V_{cc}$ through the 22k resistor. When the I'D pin is at logic HIGH, the device is in power down mode. When a message button is pressed, the capacitor begins discharging. This removes the IDS chip from the power down state and starts the play or record operation. The operation is determined by the state of the Play/Record (P/R) pin. When the button is released, the capacitor begins to charge. When the PD line returns to HIGH, the device stops playing or recording the message and returns to the power down state. The RC time constant of this resistor-capacitor pair determines the message length. The External Clock (XCLK) pin is grounded, which enables the internal oscillator. The Play/Record (P/R) pin is pulled high through a 4.7k pull-up resistor, which is pulled LOW by the momentary switch. A message is recorded by pressing and holding the Record button, pressing and releasing the associated message button, and speaking the message into the microphone. The Automatic Gain Control (AGC) pin has a resistor and capacitor connected from pin 19 to ground. These two components set up the attack and release time constants for the internal Automatic Gain Control circuit in the microphone preamplifier. The attack time is determined by a network consisting of an internal R and external C, while the release time is determined by the two external components in parallel. The MIC REF input is the inverting input to the microphone preamplifier. The capacitor connected from this pin to ground has exactly the same value as the Microphone preamplifier input coupling capacitor. In addition, the ground for the microphone is physically close to the ground connection for the MIC REF capacitor. The addition of this “noise canceling” input gives approximately 10 dB of improvement in the background noise level. If this input is not used, it must be left unconnected.

The ANA OUT is the direct output of the microphone preamplifier. In a typical application, the output is capacitively coupled to the ANA IN pin. The ANA IN pin feeds an input amplifier with an input impedance of 2.7k. As with the microphone input, the coupling capacitor that connects ANA IN and ANA OUT sets the low-end frequency response of this section of the circuit. SP+ and SP- represent the speaker outputs. The ISD devices include a differential speaker driver. It has the capability to drive 50 mW into 16 ohms. The signals are exactly 180 degrees out of phase. A lower impedance speaker may be used, but distortion and peak $I_{pp}$ current will increase as the speaker impedance decreases. Impedance less than 8 ohms should not be used. These outputs may be used single ended with the signal taken from either pin, but should never be shorted together or tied to ground. When driving a single ended connection, capacitive coupling is recommended because of possible large DC bias current that could result. If the outputs are used single ended mode, the unused pin must be left unconnected. DO NOT GROUND THE UNUSED INPUT. The JMT is designed to use an ATARI brand joystick since it uses momentary closures. Some joysticks use variable resistors to indicate joystick positioning and are therefore incompatible with the JMT. The cost to produce the talker is approximately $50.

Figure 13.6. Schematic for JMT.
INTRODUCTION
The single switch mouse emulator is designed to make it possible for a disabled person to use a mouse without physically moving the device. Instead, a user who has the ability to operate a single switch can select from a menu of mouse commands. Command options available with the device include: pointer movement up, down, left and right as well as the ability to click, double click, and click and drag icons.

Movement - If the user wants to move the pointer in a certain direction, the button should be held once that option is lit on the device menu. The pointer continues to move either until it reaches the edge of the screen or until the button is released. If the cursor reaches the edge of the screen, it remains there and waits until the button is released. Releasing the button tells the device the command is complete and to re-initialize the menu.

Clicking - Single or double click selections work as on a conventional mouse. After they are selected and executed, the device waits to return to the menu when the button is released. The click & drag option works differently however. Here, the user must first select “drag” then release the button so a direction can be chosen. Once the direction is chosen (button activated again) and the cursor is told to stop (button released), the click and drag option is complete.

SUMMARY OF IMPACT
The Single Switch Mouse Emulator is designed for use by a man who has Cerebral Palsy and is not able to use his hands. He controls his computer by means of a single switch and a scanning keyboard emulator. The keyboard emulator does not emulate mouse functions, with the result that he is unable to use any software package that requires input from a mouse. The mouse emulator used together with a keyboard emulator enables the client to fully use his computer with virtually any software package.

The circuit for the mouse emulator is shown in Figure 13.8. Not shown are the three external connections that must be made on the device: 1) Power, 2) a serial port plug connected to the computer, and 3) the user switch (which is any type of switch that suits the individual’s abilities and needs).

The two major components that make up the device are the 8748 microcontroller and the inside of a conventional mouse. The 8748 contain the program that operates the device and interface. Program operation is as follows:

As the microcontroller strobes through the options menu, it continuously looks for input from the user push-button on line T1. If the push-button is activated, a check is performed to determine which option was selected. After this check, the program
jumps to the corresponding output routines. The routines output a binary sequence on the 8748 data bus. This sequence pulses the appropriate transistors to simulate either movement or clicking on the conventional mouse.

The conventional mouse interface interprets movement in the following manner.

**Movement** - From Figure 13.8 - transistors Q1 and Q2 are responsible for moving the pointer left and right. Left is seen as turning transistor Q1 on, Q2 on, Q1 off and finally Q2 off. This pattern is repeated to continue the movement. Right is the exact opposite procedure: Q2 on, Q1 on, Q2 off, Q1 off, repeat.

Transistors Q3 and Q4 move in the up/down direction. Up is achieved when the 8748 data bus pulses Q3 on, Q4 on, Q3 off, Q4 off, repeat. Down reverses this pattern: Q4 on, Q3 on, then Q4 off, Q3 off, repeat. Depending on the type of conventional mouse used to interface with the device, this sequence may vary, but the same principle should apply. The mouse track rollers are replaced with transistors to close the appropriate lines on the conventional mouse. Usually, there are three lines dedicated to left/right, and another three lines dedicated to up/down movement.

With three lines, one is common and depending on which of the other two are connected first, this tells the mouse which direction it is moving in. Once the design of the conventional mouse is understood, the modifications to be made are straightforward.

**Clicking** - On Figure 13.8 - transistor Q5 is pulsed OFF, ON and OFF again to click once (with double click this is done twice with a shorter delay). Click and drag simply holds Q5 high while the movement option is executed and then turns Q5 off when the procedure is complete.

The clicking part of this design should be the same for most mice. Two connections are made to the bottom of the mouse’s switch and they are pulsed shut with a transistor switch.

The unit requires a 5-volt power supply such as a standard wall charger. The supply used on the prototype is regulated down from a 7.5 volt DC adapter rated to deliver 1 amp. The 4N25 opto isolators are necessary to eliminate grounding problems between the computer and the device. Without the opto isolators, any movement on the screen will be unpredictable and erratic. The entire system can be duplicated for under $50, including $10 for a new mouse.

![Figure 13.8. Schematic for Single Switch Mouse Emulator.](image-url)