Putting The Telephone In Control

Richard B Sagar describes how to use touch tones to send commands down the telephone. This decoder can be used to control equipment anywhere there is a phone.

Anybody who has had a new phone delivered recently, or has seen a BT advert on TV for call waiting, will probably now be connected to a digital telephone exchange. If you don't know for sure, one way to tell is if your phone "beeps" when you dial. Phones on digital exchanges use these beeps to signal to the exchange the numbers dialled. For each key pressed there is a unique pair of tones from the set of eight available – the signalling method is therefore called Dual Tone Multiple Frequency (DTMF).

If you have ever leant on the buttons of the phone during a call you will know that, firstly, the tones are still active during the call and, secondly, no detrimental effect on the call occurs (bar a slight deafening of the person at the other end). It is these two features that make DTMF signalling useful for accessing services such as remote banking.

This project makes use of DTMF codes to switch equipment remotely over a telephone. This is not necessarily limited to telephone lines, for instance ham radio users could utilise the circuit to control a repeater station via the radio, turning it on or off or changing its channel. In practice, using the unit with the telephone introduces a problem as direct connection of unlicensed equipment to a BT line is prohibited. However, a way around this is to use an answering machine. By connecting a microphone to the circuit input and positioning it close to the monitor loudspeaker of the answering machine the tones can be picked up. A magnetic pickup gives good results and gets around the problem of acoustic interference.

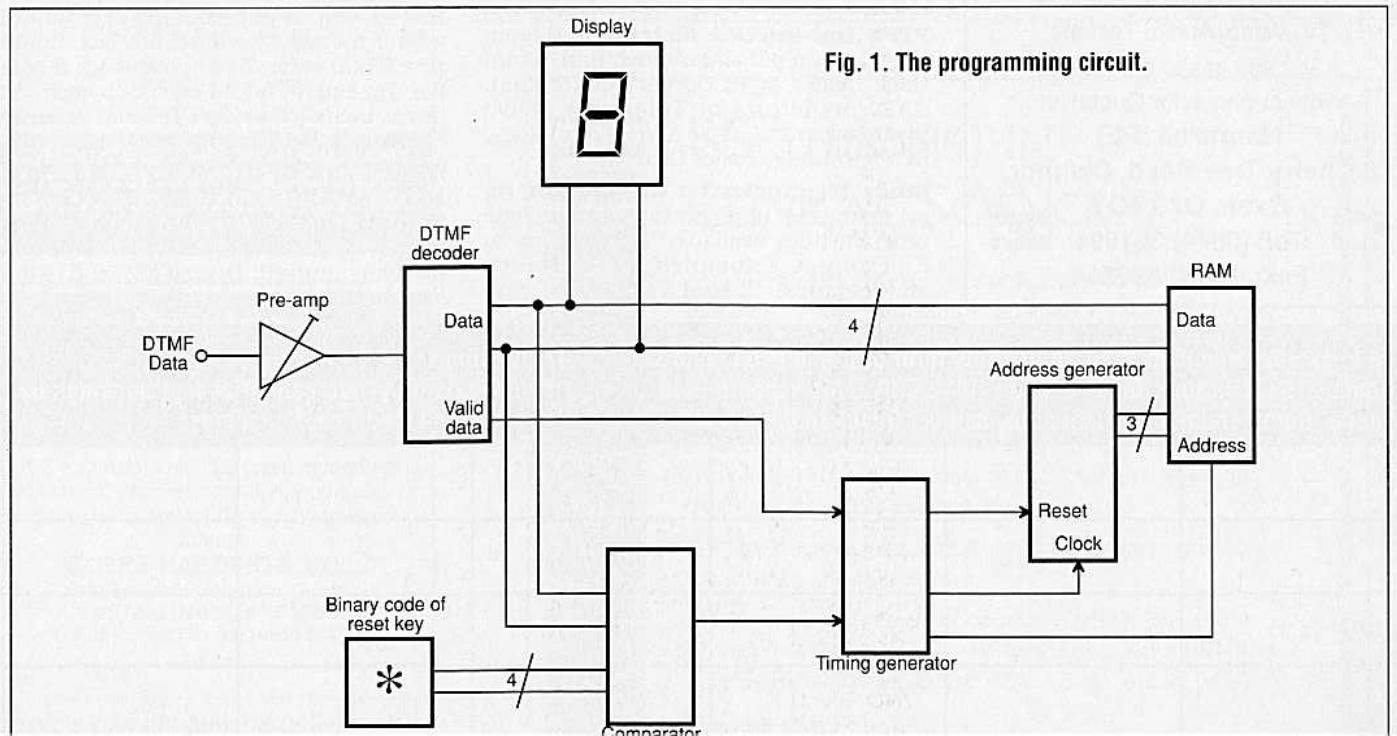

Fig. 1. The programming circuit.

How It Works

The design offers a good level of security against any would be 'haekers'. Before any DTMF codes are passed on for device control an 8 digit access code must be entered. The code needs to be programmed when the power is switched on and it is then stored in RAM. In use the same code is entered first with any subsequent digits being output to the user port for further decoding. To access the unit from a non-DTMF phone a DTMF keypad can be used, these can be bought for around £5 and in some cases come with a ten number memory. Needless to say it isn't worth trying to make your own, for that price you wouldn't be able to buy the box to keep it in. During programming the same keypad is used, held in front of the microphone and the code typed in. After use the unit is put back into the code entry phase by the user pressing the '*' key on the key pad, or if this doesn't occur it will automatically time-out after approximately one minute, helping to prevent any unauthorised access. The '*' key is also used in the programming stage, to indicate that the access code is about to be entered, this allows the user to re– start if a typing error was made. Bearing this in mind the '*' should not be used for any control functions or included in the access code.

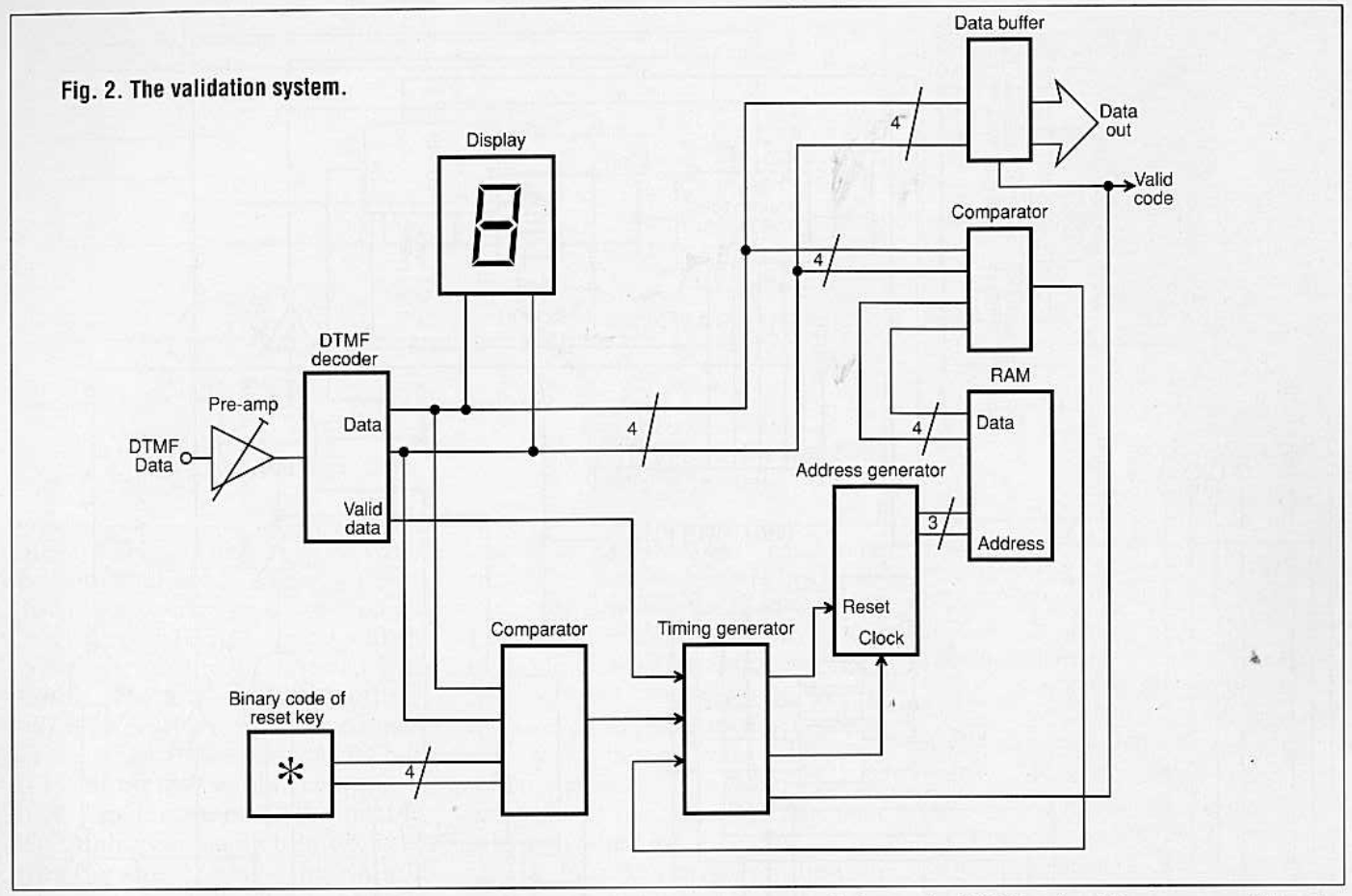

Fig. 2. The validation system.

Basic Operation

Operation falls into two phases, programming and validation. During programming a circuit configuration of that in Fig. 1 is needed, with the data output from the DTMF decoder feeding the input of the RAM for storage. The timing decoder will determine the sequence for writing data. For validation the circuit of Fig. 2 is needed so that the RAM contents and the digit being entered can be compared. The timing block now has to take into consideration the comparison of the stored and entered digits and only allow the address to increment when the two are equal, the VALID output can only go high when all 8 digits have been entered in the correct sequence.

The Electronics

The decoding of the DTMF signals is performed by IC2. The input can be taken directly from the microphone as the chip contains its own pre-amp circuit. The ratio R1/R2 sets the pre-amp gain and this may need to be changed depending on the sensitivity of the microphone used. The amplified signal level at pin 3 of IC2 needs to be set between 61mV and 2.4V for correct decoding. When a valid DTMF pair is detected the corresponding number is output on Q1-Q4 and the SID output goes high, remaining high until the input is removed. The crystal is required to produce a clock of the high accuracy needed for this application. Though the frequency may seem a little strange it is quite a standard crystal used for the colour sub-carrier frequency in NTSC televisions as used in the USA and Japan.

During the programming phase the received digits are routed to the RAM data bus through IC6 the tri-state buffer. To allow this the $\overline{PROG}$ input is taken low. The WRITE ENABLE and the timing decoding block (the circuit around IC's 4 and 7) are also connected to this input to set the RAM in WRITE mode and allow the data to be latched at the correct time. The address of the RAM is set by IC9, a 4 bit counter. As Fig. 3 shows, a reset on this chip can be caused by the output of IC1 or IC5. IC1 detects the reset key (*) being pressed and so allows code entry to be restarted, IC5 is used during the verification phase. When eight digits of code have been entered the output of IC10, the monostable, will go high, opening the data bus, to set the unit into the validation mode $\overline{PROG}$ is taken high. The data bus can then be turned off by pressing the '*' key on the keypad.

Easy Access

For verification of the access code IC3 compares a digit of the code stored in RAM with the data entered over the channel. The out-