MULTI-CONTROL REMOTE TRANSMITTER

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ABSTRACT

The undesirability of requiring a viewer to juggle several transmitters in attempting to control his decoder, VCR, and TV receiver has long been recognized. Early attempts to alleviate this problem developed transmitters which could control two units provided the units were from the same manufacturer and the user could remember to operate a slide switch or shift key to select which device was to be controlled. More recently, various manufacturers have developed units which can control VCR's, television receivers, and decoders from more than one manufacturer. One technique used for this is to "train" the transmitter to generate the proper IR format by exposing it to the IR codes that it is to replicate. A second approach is to program algorithms for generating different IR formats in firmware and then provide some means of telling the device which algorithm to branch to when it is to transmit, say, "Channel Up" for a decoder or "Pause" for VCR. The shift key or slide switch inconvenience could be eliminated by providing separate keys for all functions, but this would make for a very crowded keyboard. An improvement on this is to retain the slide switch but provide multiple keys for such functions as "On/Off", thus minimizing the need for operating the switch.

INTRODUCTION

The history of remote control transmitters is replete with example of man's continuing attempt to make television-viewing effortless, both physically and mentally. The earliest transmitters had few functions, typically power, channel change, volume change and possibly mute. For other adjustments, made less frequently, the viewer was expected to walk over to controls on the receiver. With the onset of crystal-controlled digital IC's and resultant finer resolution of signals, it became possible to include more controls on the transmitter. The forced requirement that UHF tuning capability be added to all receivers made more channels available. This made direct access highly desirable, adding ten or so keys. More and more buttons appeared, adding conveniences such as "Flashback" and signal source selection along with exotic features such as "Zoom" and telephone dialing.

The popularity of accessories such as video-cassette recorders (VCR's) and cable converter/decoders dictated that they, too, should be controlled from the easy chair. The early days saw the user sitting in that chair operating, possibly, three transmitters. With enough practice, the true genius could make a decision to control one of the units, reach for the correct transmitter, pick the proper key for accomplishing the control, press that key, assimilate the feedback that confirmed a command had been sent, received, interpreted, and responded to, and return the transmitter to its proper position, all without missing a beat in munching the turkey drumstick in his free hand. The average person had more of a problem. Simplification was clearly needed.

One phase in simplifying things was the inclusion of controls for TV and VCR in one transmitter. A purchaser of a TV and VCR from a single manufacturer could control both by the simple expedient of manipulating a selector switch, either a slide switch or a push button. The logical extension of the technique, adding a cable unit by incorporating a three-way selector, was slow in coming. This was probably due to the scarcity of manufacturers who have all three types of devices in their product line. In fact, the approach was leapfrogged by various manufacturers who realized that the three-way selector could be used to select a control set for a Brand X TV, a Brand Y VCR, and a Brand Z decoder. Different ways to realize this type of device will be examined in the following paragraphs.

DESIGN CONSIDERATIONS

Anyone involved with the design of remote control transmitters is familiar with such design aspects as keyboard scan, format generation, IR diode currents and the like. To develop a transmitter that controls TV, VCR, and decoder, possibly from three different manufacturers, one must consider four new elements:

1. How does the unit know which device it is to control?
2. How does it know which IR format to generate to control that particular device?
3. How is this information defined?
4. How was knowledge of the various IR formats put into the unit?

SELECTING THE DEVICE

The brute force approach to design of the multi-control transmitter is to provide separate sets of keys for each unit to be controlled. Because the TV, the VCR, and the decoder all probably respond to a direct channel number entry, the design thus starts with thirty digit keys. Add six more for up/down scan and four for volume up/down and it quickly becomes obvious that the final key count is in the 50-70 neighborhood. The operator of such a unit might be required to pass a test and be licensed! Technically, however, determining which device is to be controlled is a relatively simple task. Using a large number of keyboard scan lines (minimum of seventeen for 65-70 switches), the circuit couples any command key with the unit it controls as part of the scan-decoding process.

The next task, clearly, is to reduce the number of keys. The first step is to determine which keys are duplicated in two or three groups. All of the keys mentioned in the preceding paragraph send commands that are valid for at least two devices, and there are several other such keys as well. By controlling a 3-state circuit in some way, one can specify which of three devices the command is meant for. The circuit scans the keyboard to detect that, say, the "Channel Up" key is being depressed and then interrogates the 3-state circuit to determine that the command is to be sent to the cable decoder. With this knowledge, the circuit selects the proper IR data format to command the decoder.

To reduce the number of keys even further, a command used only in the VCR mode, such as "Fast Forward", can share a key with a command used only in the cable decoder, such as "Data Enter". Again, the circuit does a scan to determine which key is depressed and then interrogates the 3-state circuit. The resultant information allows the circuit to select the proper IR format.

There are several forms that may be taken by the 3-state device. The most straightforward is a 3-position slide switch, shown in Figure 1 (a). Alternately, the 3-state circuit can be comprised of flip-flops. The circuit can be forced directly to the proper state for controlling a specific device by use of the set/clear inputs, as shown in Figure 1 (b), or it may be clocked sequentially through the three states, as illustrated in the circuit of Figure 1 (c).

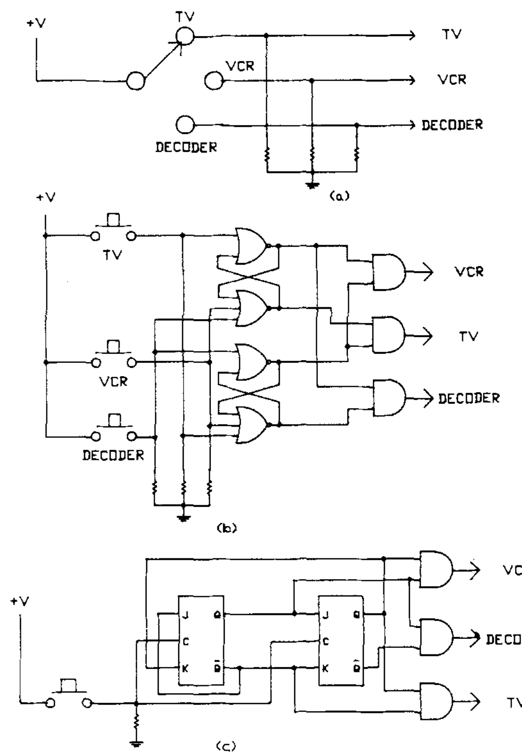

FIGURE 1 THREE-STATE CIRCUITS

The user does not wish to experiment to ascertain the state of his control determination circuit. The 3-position slide switch should have the positions clearly designated. For the circuits of Figures 1 (b) and 1 (c), some sort of readout or indicator lights must be provided, all timed out, of course, to conserve battery power. For keys which have two or more different functions, it is advisable to give the user additional help. This may take the form of color coding (green ≡ TV, etc.), backlit legends, or masked legends.

A compromise between the two key-reduction techniques is to have certain keys such as the digit and channel-scan keys selectable while duplicating the on/off keys. The theory is that in the normal lashup, the TV will have the proper channel selected once and, if it has last-channel memory, will rarely be changed. On the other hand, power will be turned on for more than one of the units the majority of time. The compromise allows minimum switching of the selector circuit, decreasing user confusion and increasing the life of the 3-position switch, if it is used as the selector.

One final effort at key reduction is to generate multiple commands from a single key closure. As an example, it may be safe to transmit a command to turn the decoder power on any time the TV power is turned on, and likewise for power off. The rationale is that in a lashup with a decoder, the decoder is on if the TV is on, while in a lashup without a decoder, no harm is done in transmitting an "On/Off" command for a decoder. Another possible multiple function would be to tune the TV to the decoder output channel automatically any time TV power is turned on. The would-be designer will conceive of others. A word of caution is in order: should two devices get out-of-sync as a result of different IR receiver sensitivities or different physical locations, the result can be confusing and, ultimately, frustrating for the user.

DETERMINING THE IR FORMAT

Once the unit has decoded a keypush and determined that it must tell the decoder to scan channels in an upward direction, it now has to generate the proper format for the IR stream. The unit needs two pieces of information. The first is the actual digital word that is to be transmitted. The designer of the device to be controlled has assigned a digital word to each command. An example might be as shown in Figure 2.

00000	DIGIT 1
00001	DIGIT 2
.	.
.	.
10100	CHANNEL UP
10101	CHANNEL DOWN
.	.
.	.
11111	MUTE

FIGURE 2 POSSIBLE FUNCTION ASSIGNMENTS.

The assignment can vary from manufacturer to manufacturer, even between those using the same off-the-shelf integrated circuit in their transmitters.

In our example, the transmitter ascertains from a lookup table that it must send the digital word 10100. The remaining information needed is how to modulate the IR stream to make 0's and 1's. This format is also likely to be contained in a lookup table. The end result is that the circuit sends out the proper waveform to turn the IR diode on and off in a properly-timed sequence recognizable by the receiving device (a cable decoder in our example) as a "Channel Up" command.

DATA DEFINITION

There are two techniques for storing the information needed to generate the IR stream. For a sampling technique, the IR stream to be replicated is sampled at a number of points and the value of the waveform at each of the points is stored in random-access-memory (RAM). The second method, an algorithmic approach, relies on program steps in firmwave to tell the unit how to compose the IR signal.

THE SAMPLING METHOD

A crude example of the sampling technique is shown in Figure 3 (a). The uppermost illustration is the waveform to be replicated. The sample points and the values stored are also shown. To replicate the waveform, the data can be shifted out of RAM serially using the same clock that samples the data. The end result is shown in the last line. Note that it has reasonable fidelity to the original waveform; in this case that is only a happy coincidence. The accuracy of the reproduction is a function of the phase. In Figure 3 (b), the phase between the waveform to be replicated and the sampling clock is shifted slightly. Because the two are asynchronous, this is an entirely reasonable possibility. Note that in this case, with the same starting waveform and sampling rate, there is considerable distortion in the replicated waveform.

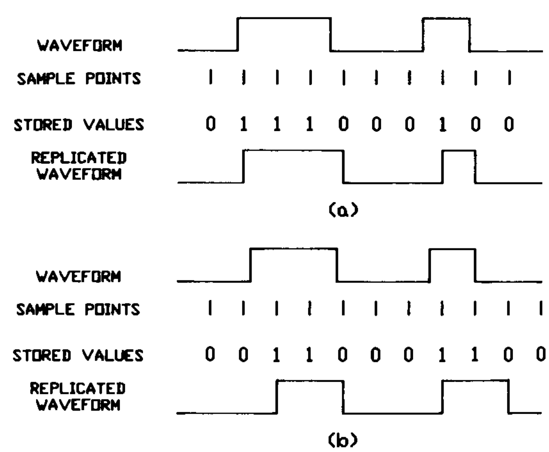

FIGURE 3 WAVEFORMS, SAMPLES, AND REPLICATED WAVEFORMS

To minimize the distortion, the samples must be taken more often. If, say, 100 samples had been taken rather than the 10 in our example, the reproduced waveform would have been truer to the original regardless of relative phases. For high-fidelity reproduction, many samples must be taken, with one bit of memory required for each sample. Consequently, the sampling circuits are very memory-intensive.

ALGORITHMIC APPROACH

To understand this approach, consider the previous example. Sampling the waveform at 100 points required 100 bits of memory. With the algorithmic approach, one can use firmwave to instruct the box to:

> "Increment a counter with the system clock. Generate a signal which goes high at W-count, low at X-count, high at Y-count, and low again at Z-count."

Storage of W, X, Y, and Z requires seven bits each, a saving of 100 - 28 or 72 bits. The savings become more impressive if one considers 1000 samples. Here, each count requires storage of 10 bits, a saving of 1000 40 or 960 bits.

COMPARISON

A sampling unit has circuitry that is more memory-intensive; consequently, it will tend to be more expensive. It is also the only device that can be called "universal" with reasonable accuracy. It can be trained to replicate any IR waveform for which its clock rate is high enough to give adequate resolution. The algorithmic unit is limited to only the devices for which it has stored algorithms.

FORMAT INPUT

The last consideration of the design concerns how the information is stored in the device. In the case of a sampling unit, the unit must have exposure to the waveforms it is to reproduce. A typical way to do this is to butt the unit to be replicated against the unit to be trained and to push a function key on the replicated unit while holding down a corresponding key on the unit being trained. An IR receiver in the unit being trained produces a signal to be sampled while decoding of the key being pressed determines where the data samples will be stored.

An algorithmic unit can also be trained. Again, by butting two units together, the unit being trained can circulate through its various IR-producing algorithms to determine if there is a match. An alternative procedure is to put the transmitter into a learning mode, point it at the device to be controlled, and push a function key. The transmitter cycles through its stored algorithms, generating IR outputs from each, until the controlled device responds. At this point, the key is released, storing the data showing which is the proper algorithm for controlling the device.

Still another technique also uses stored algorithms. Rather than undergo a training cycle, however, the unit is configured through a series of switches accessible within the battery compartment. The dedicated switches for the TV receiver can be set to a code which tells the microcomputer which TV receiver is to be controlled, and similarly for the VCR and the cable decoder.

CONCLUSION

The preceding paragraphs have supplied an overview of different techniques that have been employed in the generation of multi-function transmitters. The fact that different manufacturers have taken different approaches should not imply that any is showing better judgement than any other. Rather, it demonstrates that different vendors have different assessments of the relative importance of the different features as each tries to be the one most successful in judging what the market really wants.