INNOTECH SYSTEMS INC.

A Primer on Remote Control Technology

While all infrared remote controls share the basic concept of communicating from the remote control to the home entertainment device via infrared signal, there is no universal standard for the encoding method.

All infrared remote control systems use infrared light-emitting diodes (LEDs) to send out an IR (infrared) signal in response to button pushes. The pattern of pulses indicates the particular button pushed. To allow control of multiple appliances such as a TV, VCR, and cable box, without interference, systems generally have a preamble and address to synchronize the receiver and identify the source (and destination) of the infrared signal.

Some of the earliest remote controls (and to this day a few cable box remote controls) use a simple system in which the infrared light-emitting diode is simply turned on and off. However, to avoid interference by other light sources, especially flourescent bulbs, and keep the signal from being swamped out by ambient light, most systems digitally modulate a carrier frequency of between 10kHz and 100kHz. A bandpass filter in the receiving unit eliminates all but the desired frequency.

To encode the data, systems generally vary the width of the pulses (pulse-width modulation) or the width of the spaces between the pulse (pulse space modulation). Another popular system, bi-phase encoding, using signal transitions to convey information. These are described in more detail later. Each pulse is actually a burst of IR at the carrier frequency. In the following diagrams, a "high" is a burst of IR energy at the carrier frequency and a "low" is an absence of IR energy.

There is no clear-cut encoding standard. However, while a great many home entertainment devices use their own proprietary encoding schemes, some quasi-standards do exist. These include RC-5, RC-6, and REC-80. In addition, many manufacturers such as NEC have also established their own standards.

RC-5

Developed by Philips, the RC 5 code is a biphase code in which each bit has a uniform duration. The logical value of the bit is based on a transition that occurs in the middle of the defined time interval assigned to each bit. A high-to-low transition defines a "0" and a low-to-high transition

defines a "1". If two or more of the same bit are sent, a transition at the beginning of each bit time is needed to set the signal to the proper start level.

Example
of BiPhase
Encoding

| Bit Time	Bit 1	Bit 2	Bit 3	Bit 4

| Bit Value | 0 | 0 | 1 | 1 |
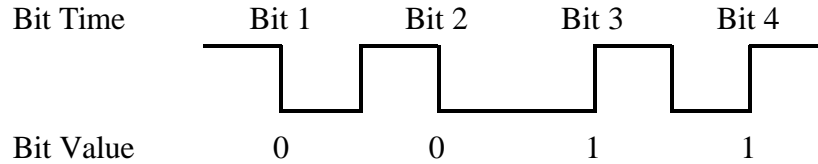
In the RC-5 standard, every command is 14 bits long. The first two bits are initialization or start bits. These allow the receiver to synchronize to the transmitter and adjust the automatic gain control. The next bit, the toggle bit, changes state with every new key press. This enables the receiver to unambiguously recognize that a particular key has been pressed multiple times in succession. The toggle bit is followed by an identifying address which allows the remote control to identify which device (TV, VCR, CD Player etc.) should respond to the command. The address is followed a code sequence identifying the button pressed.

Start		T	Address					Data					
S	S	T	A4	A3	A2	A1	A0	C5	C4	C3	C2	C1	C0

Recently introduced by Philips, the originator of RC-5, the new RC-6 expands on the structure of the RC-5. Each command consists of a header field, control field, and information field, with a defined "signal free time" between commands. The information field, which may be one to sixteen bytes in length, is designed to accommodate the complex needs of the upcoming generation of remote controls.

REC-80

Popularized by Panasonic, the REC-80 code uses space width modulation. Each bit consists of a high level of fixed time T, followed by a low level that varies in width. A space that is 2T represents a logic "0", and a space that is 3T represents a logic "1".

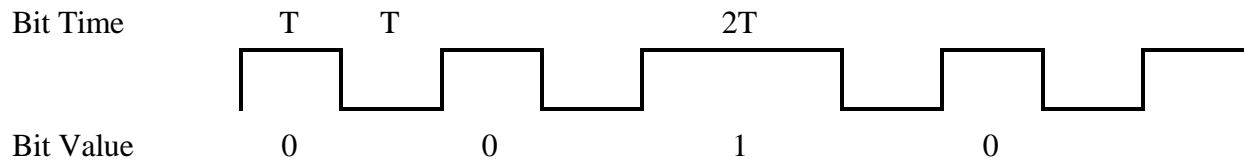| Bit Time	T	2T	T	3T	T	2T

| Bit Value | 0 | 1 | 0 |
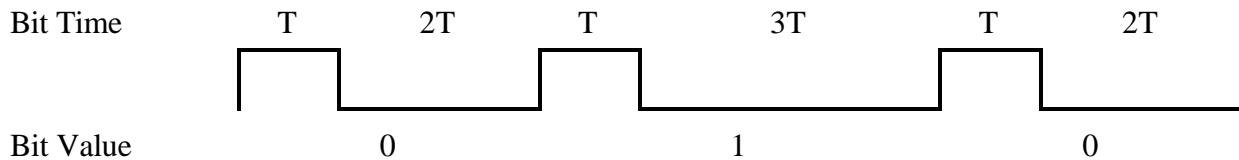
(Note that a "1" has a longer space than a "0," even though the pulses are the same length.)

SONY

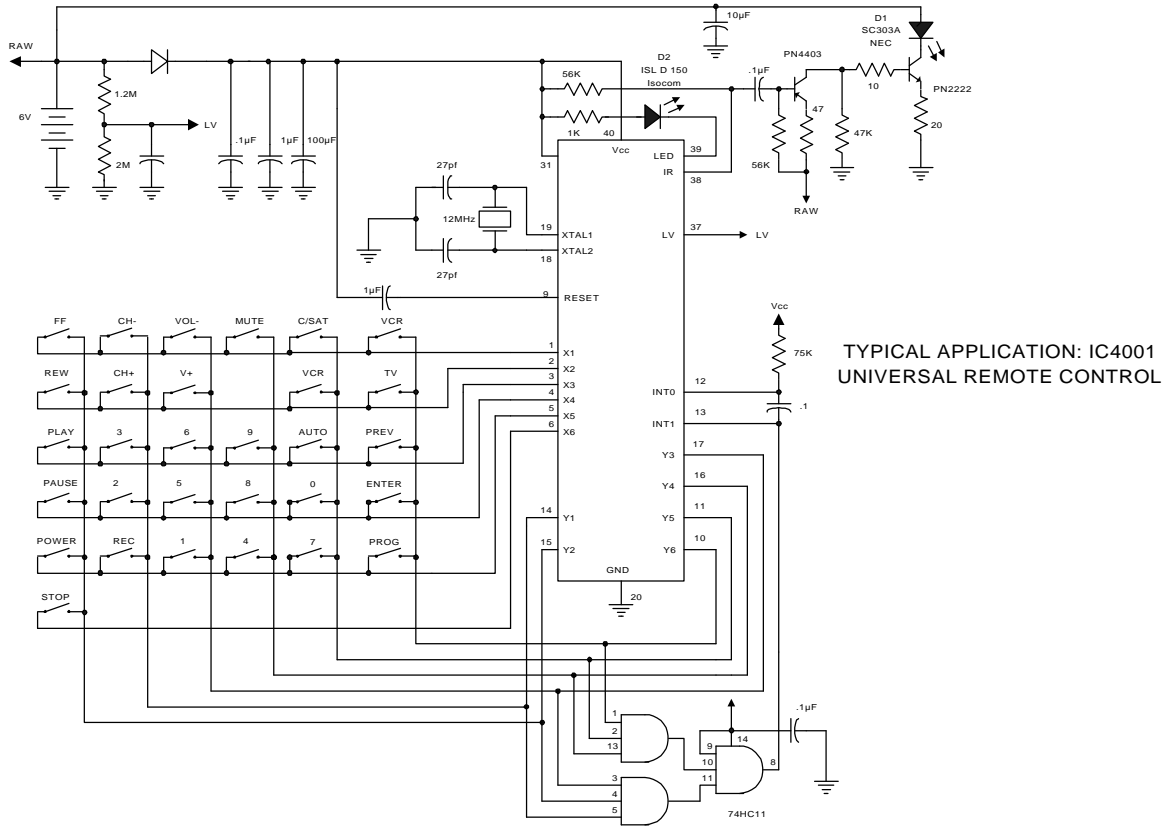Sony uses a pulse-coded signal in which the length of the pulse is varied, and the length of the space is constant.

Bit Time   T   T   2T

Bit Value   0   0   1   0
(Note that a "1" is longer than a "0".)

In addition to these various encoding techniques, different manufacturers will change the length of the preamble, address, and data, and may add redundant bits for error checking. Some also include "change bits" which allow the receiver to detect if a button is depressed twice.

REMOTE CONTROL CIRCUITS

Thanks to today's sophisticated integrated circuits, remote controls consist of little more than a keypad and an "Application Specific Integrated Circuit." A typical circuit diagram using the Innotech Systems' IC4001 is shown below.

RAW

6V

1.2M

2M

LV

.1µF 1µF 100µF

10µF

D2
ISL D 150
Isocom

56K

1K

40

Vcc

D1
SC303A
NEC

PN4403

.1µF

10

47

56K

RAW

47K

PN2222

20

LED 39

IR 38

LV 37 → LV

31

27pf

12MHz

27pf

19 XTAL1

18 XTAL2

9 RESET

1µF

Vcc

75K

.1

TYPICAL APPLICATION: IC4001
UNIVERSAL REMOTE CONTROL

FF CH- VOL- MUTE C/SAT VCR

REW CH+ V+ VCR TV

PLAY 3 6 9 AUTO PREV

PAUSE 2 5 8 0 ENTER

POWER REC 1 4 7 PROG

STOP

1 X1
2 X2
3 X3
4 X4
5 X5
6 X6

INT0 12

INT1 13

Y3 17

Y4 16

Y5 11

Y6 10

14 Y1

15 Y2

GND
20

.1µF

1
2
13

9 14

10

11 8

3
4
5

74HC11