IR Remote Control Codes (1)

formats, protocols and (in)compatibility

By A.N. Other

There are so many different remote control message formats currently in use that it can all be a bit confusing. If you are experimenting with remote controller IC's then its important to know the different control protocols used by each manufacturer. This article seeks to describe the most popular protocols in current use.

Its almost impossible to buy a TV today that doesn't have a IR remote controller and its only when we temporarily mislay this device that we realise how useful they are. Back in 1975 when the first remote controllers appeared they used ultra sonic signals to send the control information, these were later superseded by the controllers that we are familiar with today using infra red. The infra red devices offer lower production costs, wide operating range and good communication security. A look inside a typical remote controller will show that it consists of only one IC. The IC interprets each key press and sends a coded data signal to the transmitter IR diode. A simple resonator is also used to supply a stable clock. On the receiving side in the equipment being controlled we find a IR detector and demodulator which is normally integrated into the same device. The SFH505-xx family of devices from Siemens contains the receiver, demodulator and output driver so that the received data can be connected directly to a micro controller or control decoder. Unfortunately the actual control protocol used by each manufacturer are mostly incompatible.

The IR message transmitted by the controller is subject to interference from other IR sources in the vicinity. These include heaters, incandescent lamps and other heat generators. One standard method of rejecting this unwanted interference is to modulate each transmitted bit with a stable carrier frequency in the range of 30 to 40 kHz. Another method is the so-called flash mode, this technique is employed by the Plessey MV500 chip (described in the February 1991 edition of *Elektor Electronics*). This method outputs data in the form of 17 µs short flashes of IR light followed by different off periods. Nokia also use this method with their IRT1250 IC. This system has however not gained wide acceptance and the vast majority of remote controllers use the modulation technique.

The accompanying oscilloscope pictures show each of the described transmission formats received by the Temic TFMS5360 receiver IC. This device is optimised for reception of a signal modulated at 36 KHz but can also detect other frequencies albeit with a reduced range. In the upper half of the picture a single telegram is shown and in the lower half a continuous key-press is shown. The output of the IC goes low when the modulated signal is detected.

It is important to note that the equipment manufacturer is entirely at liberty to choose a transmitter clock frequency and as such the timing given here may not be accurate under all conditions. The timings of pulse lengths may also be affected by the sample clock in the TFMS5360 and could have an error of ±160 µs (Temic data sheet).

The communications formats described are the most popular but it does not represent all the possible formats that you are likely to find. Many firms have devised their own control format, sometimes in order to reduce costs or sometimes to incorporate different control features that are not catered for with the existing standards. If you use a mask programmable micro controller for coding and decoding you will be com-

pletely at liberty to devise your own protocol which may be more suited to your own particular hardware of software. This method also ensures that a manufacturer will not need to worry about licencing fees or possible patent infringement.

Some modern remote IR controllers transmit the message a number of times using different message formats. For example the controller will first send out the Japanese code and then 50 ms later sends out the same command but this time using RC 5 code. The advantage here for the equipment manufacturer is that for future equipment development you need not wait for a chip manufacturer to produce a controller using a particular IR coding standard. It is now possible to select the best or cheapest integrated equipment controller and be sure that the IR remote controller will produce compatible control signals.

So which manufacturer and which coding system? This article describes some of the most popular IR coding standards currently in use.

(010023-1)

Code	Manufacturer
RECS80	Thomson, Nordmende
NEC	Harman/Kardon, Yamaha, Canon
DENON	Denon
SIRCS	Sony
RC5	Loewe, Philips, Grundig, Marantz
MOTOROLA	Grundig, Kathrein
JAPAN	Panasonic, Loewe
SAMSUNG	Samsung
DAEWOO	Daewoo

RC5 Code

The most widely used coding method for IR control in Europe is the RC 5 code. This was originally developed by Philips and has the capacity to send 2048 different commands. 32 addressable groups each with 64 commands. Each piece of equipment has its own address so that for example adjusting the volume of your audio system will not affect the sound level of your TV. One complete message has a length of 14 bits and is composed of the following bits:

– 2 Start bits to control the AGC levels (Auto gain control) in the receiver IC.
– 1 Toggle bit indicates that a new key is pressed.
– 5 System address bits
– 6 command bits

The toggle bit changes its value every time a new key is pressed and is used to tell the difference between pressing the key again and holding the key down. The five address bits follow the toggle bit and indicate which piece of equipment is being controlled. Lastly the six command bits contain the control information.

RC5 code employs biphase encoding, One bit of data is represented by two half bits. A Low/High combination of these bits indicates a data '1' whereas a High/Low combination indicates a data '0' The length of each bit is 1.778 ms, and a complete message is 24.889 ms long.

The RC5 code is probably the best documented protocol for IR control and particularly interesting are the two free system addresses 7 and 13 these are not allocated to any particular equipment type but are reserved for experimental purposes. Typical IC's used for this message format are:

Transmitter:
SAA3006, SAA3010 (Philips)
HT6230 (Holtek)

Receiver:
SAA3009, SAA3049 (Philips)

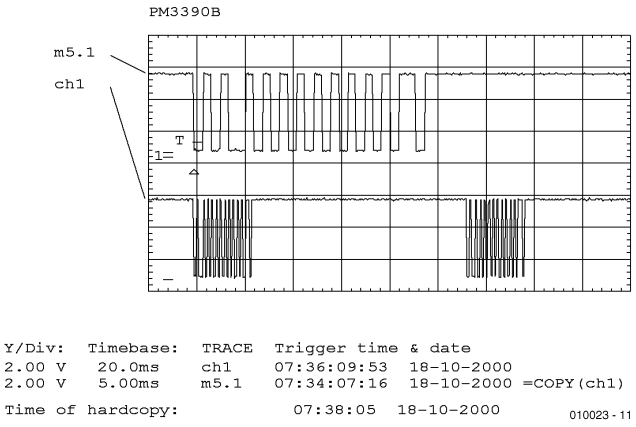

Figure 1. RC5 code at the output of the receiver IC TFMS5360.

Table 1 shows in decimal the correspondence between the equipment and command codes used for this format.

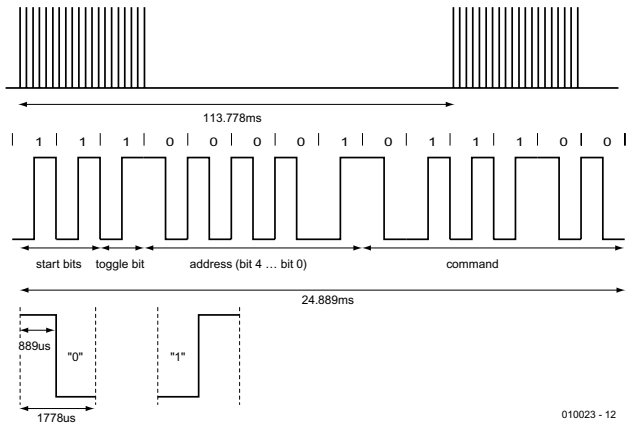

Figure 2. RC5 code message format (Address 1, command 28 shown).

The RC5 codes:

Address	Equipment
0	TV1
1	TV2
2	Videotext
3	Expansion for TV1 and TV2
4	Laser Vision Player
5	Video recorder1 (VCR1)
6	Video recorder2 (VCR2)
7	Reserved
8	SAT1
9	Expansion for VCR1 and VCR2
10	SAT2
11	Reserved
12	CD Video
13	Reserved
14	CD Photo
15	Reserved
16	Audio preamplifier1
17	Tuner
18	Analogue cassette recorder
19	Audio preamplifier2
20	CD
21	Audio Rack or Aufnahmegerät
22	Audio Satellite receiver
23	DCC Recorder
24	Reserved
25	Reserved
26	writable CD
27...31	Reserved

keycodes:

Code	Key Function
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
16	Volume +
17	Volume –
18	Brightness +
19	Brightness –
20	Colour saturation +
21	Colour saturation –
22	Bass +
23	Bass –
24	Treble +
25	Treble –
26	Balance right
27	Balance left
63	System select
71	Dim local display
77	Linear function increment
78	Linear function decrement
80	Step up
81	Step down
82	Menu on
83	Menu off
84	Display A/V system status
85	Step left
86	Step right
87	Acknowledge
88	PIP on/off (Pay TV channel + for system 3)
89	PIP shift (Pay TV channel - for system 3)
90	PIP / main swap (Radio channel + for system 3)
91	Strobe on/off (Radio system – for channel 3)
92	Multi strobe (Date + for system 9)
93	Main frozen (Date – for system 9)
94	3/9 multi-scan (Start time + for system 9)
95	PIP select (Start time – for system 9)
96	Mosaic/multi-PIP (Record program + for system 9)
97	Picture DNR (Record program – for system 9)
98	Main stored (Alternate channel for system 9)
99	PIP strobe (Stop time + for system 9)
100	Recall main picture (Stop time – for system 9)
101	PIP freeze
102	PIP step up +
103	PIP step down –
118	Sub mode
119	Options sub mode
123	Connect
124	Disconnect

Special commands for equipment addresses 0 und 1 (TV1 / TV2):

Code	Key Function
10	1/2/3 digits / 10
11	Freq./prog./ch./11
12	Standby
13	Mute/de-mute
14	Personal pref.
15	Display
28	Contrast +
29	Contrast –
30	Search +
31	Tint/hue –
32	Ch./prog. +
33	Ch./prog. –
34	Altern./ch.
35	? language
36	Spatial stereo
37	Stereo/mono
38	Sleep timer
39	Tint/hue. +
40	RF switch
41	Store/execute/vote
42	Time
43	Scan fwd./increm.
44	Decrement
46	Sec con/menu
47	Show clock
48	Pause
49	Erase/correct
50	Rewind
51	Go to
52	Wind
53	Play
54	Stop
55	Record
56	External 1
57	External 2
59	Advance
60	TXT sub-mode/12
61	Sys. Standby
62	Crispener
70	Speech/music
79	Sound scroll
104	PIP size
105	Pic. Scroll
106	Act. On/off
107	Red
108	Green
109	Yellow
110	Cyan
111	Index/white
112	Next
113	Previous
122	Store open/close
126	Movie expand
127	Parental access

SIRCS/Control S Code

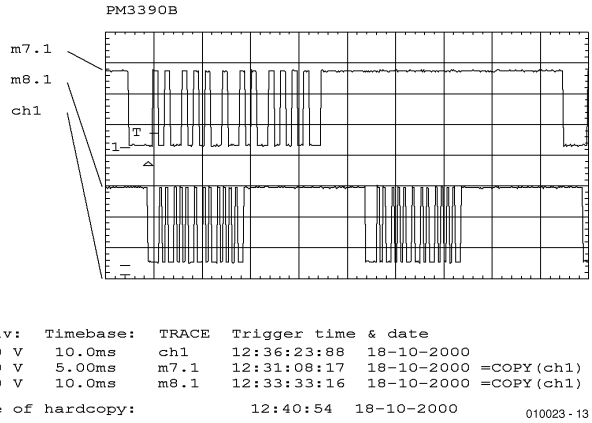

Figure 3. SIRCS code at the output of the TFMS5360 receiver IC.

A message sent using the SIRCS or CNTRL S protocol from Sony consists of twelve to twenty bits. Five to thirteen of these bits is used for the address field and seven bits for the key code.

A Start bit (2.4 ms) is sent followed by a 0.6 ms space or pause. Next comes the data. A '1' is represented by a 1.2 ms ON or mark followed by a 0.6 ms OFF or pause. A '0' is represented by a 0.6 ms ON and a 0.6 ms OFF. A typical message is shown in **Figure 4**. The message is sent a minimum of twice (five times for a camcorder). The message is discarded if an error is detected. SIRCS message coding is identical to CNTRL S, but SIRCS modulates the code at 40 kHz ready to be sent to an IR diode. CNTRL-S is the baseband (unmodulated) signal and is used between equipment where a communications cable is fitted. Sony produce the following IC:

Transmitter:
KIE RA275 S42

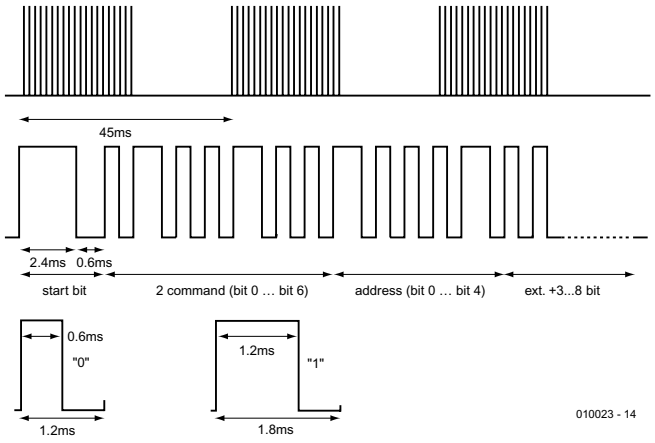

Figure 4. CNTRL-S and SIRCS message format.

The Sony codes:

Equipment address codes (decimal):

Address	Equipment type
1	TV
2	VTR1
4	VTR2
6	Laserdisc
7	VTR2
11	VTR3
12	Surround sound processor
16	Cassette deck, tuner
17	CD Player
18	Equaliser
164	TV digital effects (8 bit device code)

keycodes:

code	key Function
000	1 button
001	2 button
002	3 button
003	4 button
004	5 button
005	6 button
006	7 button
007	8 button
008	9 button
009	10 button/0 button
011	Enter
016	Channel up
017	Channel down
018	Volume up
019	Volume down
020	Mute
021	Power
022	Reset TV
023	Audio mode: mono/SAP/stereo
024	Picture up
025	Picture down
026	Colour up
027	Colour down
030	Brightness up
031	Brightness down
032	Hue up
033	Hue down
034	Sharpness up
035	Sharpness down
036	Select TV tuner
038	Balance left
039	Balance right
041	Surround on/off
042	Aux/Ant
047	Power off
048	Time display
054	Sleep timer
058	Channel display
059	Channel jump
064	Select input video1
065	Select input video2
066	Select input video3
074	Noise reduction on/off
078	Cable/broadcast
079	Notch filter on/off
088	PIP channel up
089	PIP channel down
091	PIP on
092	Freeze screen
094	PIP position
095	PIP swap
096	Guide
097	Video setup
098	Audio setup
099	Exit setup
107	Auto program
112	Treble up
113	Treble down
114	Bass up
115	Bass down
116	+ key
117	– key
120	Add channel
121	Delete channel
125	Trinitone on/off
127	Displays a red RtestS on the screen

RECS80 Code

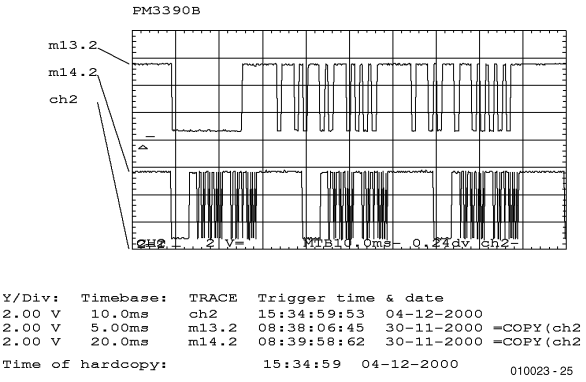

Figure 5. RECS80 code at the output of the TFMS5360 receiver IC.

The RECS80 code from Philips a pulse position modulation technique. With this system a fixed length pulse of light is followed by a variable length space. The space timing conveys the data. There are 1280 possible codes divided into 64 commands and 20 subsystems. A subsystem is simply the type of equipment being controlled i.e. a TV or a VCR. A message is composed of 11 bits. The first two bits are the toggle bits followed by three sub-system address bits and six data bits, these indicate which key was pressed. The toggle bits are incremented if a key is released for a minimum time but will remain unchanged within a multiple key-stroke sequence. If the transmitter is configured to operate in modulated mode the first toggle bit is replaced by a REF bit of fixed duration.

In the lower trace of Figure 15 not all the data is shown because of the low sampling rate of the scope some of the bits have been missed. The RECS80 protocol encodes the data by variable length spaces between constant width ON pulses (140.8 µs). If the transmitter is configured to modulation mode this time period will be represented by a burst of carrier frequency. If configured to flash mode the IR transmitter will be flashed on at this time. A '0' has a space of 5.06 ms while a '1' has a space of 7.60 ms (derived from a 455 kHz resonator in the remote control transmitter). Although the length of the data packet is dependent on the commands sent, the time between two messages is fixed at 121 ms. The modulation frequency is 38 kHz.

Typical ICs for remote control:

Transmitter:

SAA3004, SAA3007 and SAA3008 (Philips)
M3004, M3005, M3006 (ST Microelectronics)

Receiver:

SAA3009, SAA3049 (Philips)

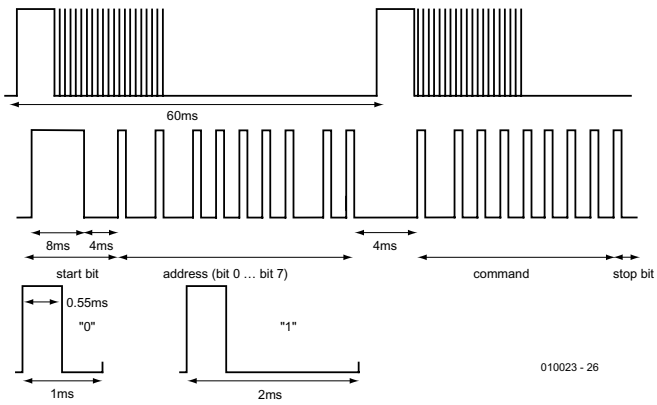

Figure 6. RECS80 code message format

Next month:

– NEC
– DENON
– MOTOROLA
– JAPAN
– SAMSUNG
– DAEWOO

Internet Links

Nec Format:
http://www.princeton.com.tw/spechtml/remote/2221.htm

Philips semiconductor:
http://www.semiconductors.com
www-us.semiconductors.com/pip/SAA3049AP

Motorola Home-Page:
http://motorola.com
Motorola-Format:
http://holtek.com

Samsung Home-Page:

http://www.intl.samsungsemi.com/System_LSI/Microcontroller/Product_Guide/Microcontroller/product_guide.html