RC5 Protocol

Decoding with 8051 microcontroller

Infrared light is electromagnetic radiation with longer wavelengths than those of visible light. Infrared light is used in industrial, scientific, and medical applications. Most of the remote controllers use IR light to send information.

Courtesy :
http://ustr.sancaleve.com/infrared/infrared1.shtml

About Infrared

- InfraRed is a energy radiation with a frequency below our eyes sensitivity, so we can not see it. Even that we can not "see" sound frequencies, we know that it exist, we can listen them.
- Even that we can not see or hear infrared, we can feel it at our skin temperature sensors.
  When you approach your hand to fire or warm element, you will "feel" the heat, but you can't see it. You can see the fire because it emits other types of radiation, visible to your eyes, but it also emits lots of infrared that you can only feel in your skin.

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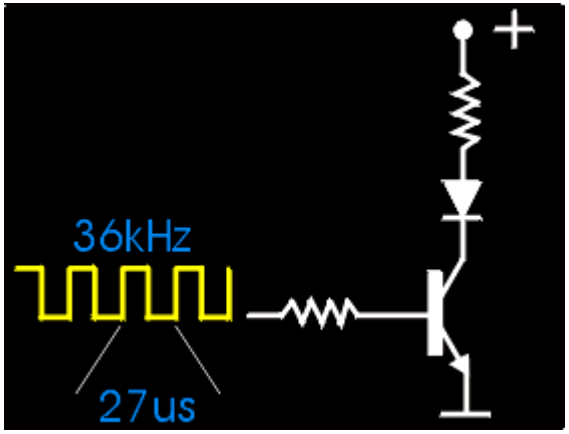
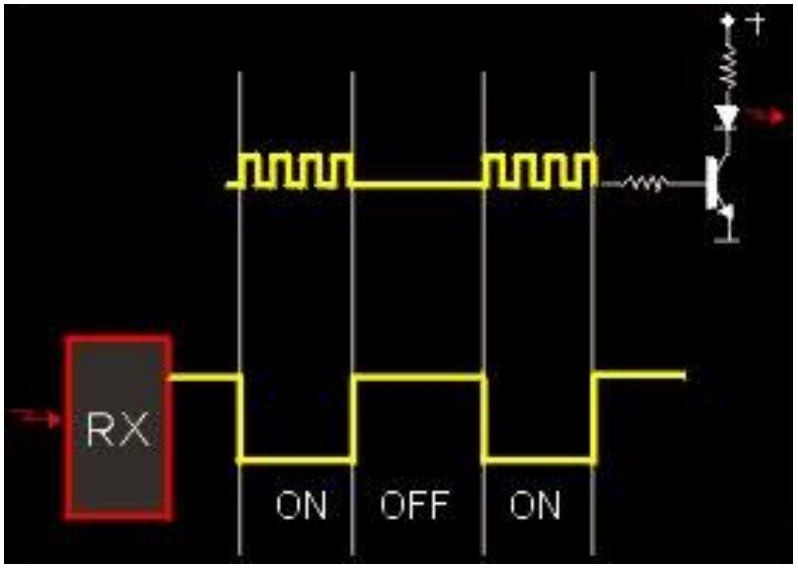
- A square wave of approximately 27uS (microseconds) injected at the base of a transistor, can drive an infrared LED to transmit this pulsating light wave. Upon its presence, the commercial receiver will switch its output to high level (+5V).



- If you can turn on and off this frequency at the transmitter, your receiver's output will indicate when the transmitter is on or off.
- Those IR demodulators have inverted logic at its output, when a burst of IR is sensed it drives its output to low level, meaning logic level = 1.



RC5 Protocol

- This protocol was developed by Phillips using Manchester Encoding. Information is sent in frames, where each frame is consist of 14 bits. First two bits are start bits, the next bit is flip bit, which toggles every next frame if same command is sent. Next five bits are system address (remote specific) bits and last 6 bits are command bits, which actually stores command. Each bit is of 64 IR pulses.

RC5 Protocol Frame

- Every bit in an RC5 transmission has uniform duration, and contains one transition. '0' is encoded by a high to low transition, and a '1' by a low to high transition. There is a transition in the middle of the bit. So bit containing '0' value will be encoded as first 32 high pulses and next 32 low pulses, while '1' will be represented by first 32 low pulses and next 32 high pulses.

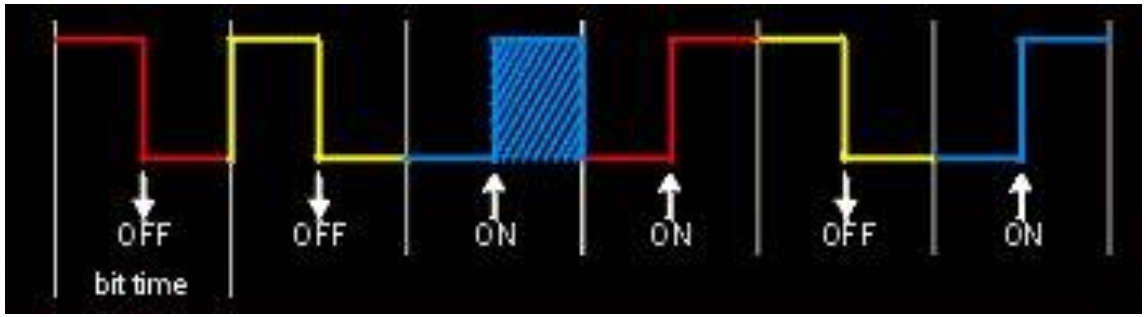
- **An Example:**
- Let's consider a remote controller with 38kHz frequency output,
- T= 1/38,000=0.000026316 ≈ 26µs
- Now each bit consists of 64 IR bits,
- 64 pulses x 26µs = 1664µs = 1.664ms
- So total time for a protocol frame is
- 14 x 1.664 = 23.24 ms

Decoding with 8051

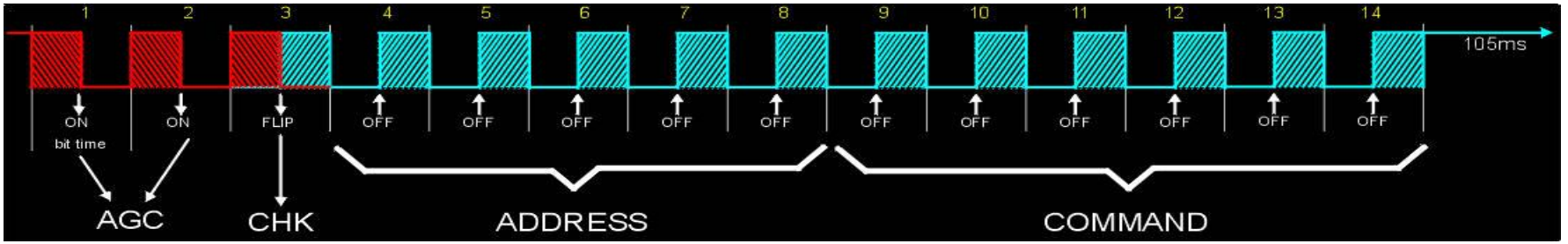
- We have used TSOP1738 sensor to decode RC5 protocol, this sensor gives active low output, so '0' received is first 32 pulses low and next 32 high. The out pin of TSOP1738 is connected to interrupt source of 8051, decoding can be done in both ways, either polling or interrupt based,
- Here we will consider interrupt based mechanism, so when it will receive a first start bit (i.e. 1, start bits are always 1 in RC5), it will be first 32 pulses high, and next will be low, here interrupt will occur, to decode information we can skip start and flip bit, i.e. MCU should skip 2.75 bits, so after an interrupt wait for 4.57ms to get next bit.
- Here comes decoding of the next 5 system address bits, which holds the address of remote controller, here after each bit time i.e. 1.664ms , MCU gets value of OUT pin and stores in a variable. Same way the next six bits are decoded and command value is calculated from protocol frame.

- First of all, Philips adopted or created the RC5 standard that uses fixed bit length and fixed quantity of bits.
- Each time you press a button at the Philips remote control, it sends a train of 14 bits, 1.728ms per bit, the whole train is repeated every 130ms if you keep the button pressed
- Each bit is sliced in two halves. The left and right half has opposed levels. If the bit to be transmitted is one (1), its left side is zero while its right side is one. If the bit to be transmitted is zero (0), its left side is one while the right side is zero.

It means that the second half of the bit is actually the same meaning of the bit to be transmitted, as you can see at the shaded blue right side of the bit as on, means bit transmitted = 1.



- You can see the 14 bits of the RC-5 system above. The RED bits are level "ON", while Blue are "OFF". The first two bits, #1 and #2, are called ACG calibration. They are "ON" level, and serve to calibrate the IR Receivers Auto Gain Control.
- In the Philips remotes, the bit #3 is the CHECK bit, every time you press a key at the remote, even pressing repeatedly the same key, this bit flips state. This feature is interesting. Suppose you pressed number "1" at the remote (trying to select channel 15 at TV) and holding it for 2 seconds, then your other hand just blocks the InfraRed signal.



- The TV would receive two trains of pulses, generated by your hand breaking a long train in two. Other systems would understand transmission of two keys "1" selecting channel "11", but this do not happens in the Philips system. This bit flips state every time you press a key, so blocking the signal with your hand doesn't change this bit, so the TV will understand that still the same key pressed. To select channel "11" you should press key "1" really twice.
- The next 5 bits, #4 to #8, are used for SYSTEM ADDRESS, or to identify which kind of device should execute the COMMAND bits. For example, TV set uses ADDRESS ZERO. Bit #8 is the Less Significant Bit.