G1 Infrared Link Communication

Jesse Larson, Jing Lu, and Qingqing Liu

The two goals of this app note:

1- Introduce infrared line of sight communication and how it works with remote controls.
2- Learn how to transmit data across an infrared link using custom transmission and reception hardware programmed to your FPGA that will utilize your own simple infrared protocol optimized for 100% reliable line of sight communication tailored to the specific remote control receiver you choose.

Introduction:

Essentially television remotes generate a series of infrared pulses which are broadcast for anyone to see. The infrared television receivers must have a direct line of sight to the source of infrared pulses being broadcast otherwise the infrared receiver will not detect the data sent from the remote.

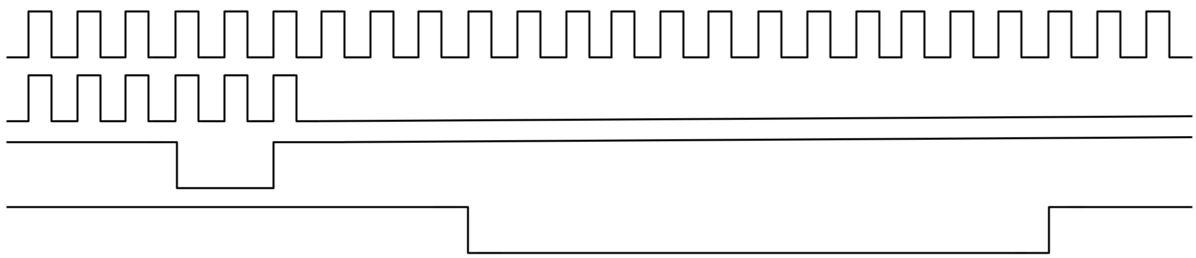
Therefore there are a few possible applications for this kind of link that come to mind. If you are looking to detect a line of sight between two objects (up to 40 meters with the receiver this app note uses as a demonstration), or send a slow speed stream of bits via line of sight with no other devices broadcasting infrared (the speed will depend on the receiver hardware you choose). Then this application note is for you.

Understanding how it works:

I'll use a simple example for clarity this is based off of the TSOP 853 data sheet attached in the app note folder. This is the infrared output of a television remote over time. The low level represents no infrared being broadcast.

Here you can see the infrared is clearly broadcast in defined sets of pulse bursts. The frequency of the pulses within the burst depends on the infrared receiver you choose. Here are the most common frequencies for reference (30, 33, 36, 38, 40, and 56 KHz). Obviously choose a 56 KHz link if you are looking to maximize communication speed.

Let’s take a closer look at what happens at the receiver when it first receives the minimum reliable set of six infrared pulses. The continuous pulsing at the top is given to give you some sense of the timing of the infrared signal, while the second line is the actual reception time of the pulses at the receiver, and the third line is the absolute fastest and shortest output signal at the TSOP 853 as a result of the 6 input pulses. While the fourth line is the absolute slowest and longest output time according to the TSOP 853 data sheet.



There is clearly a large variability in the timing of valid signal output by a single 6 pulse burst from an infrared transmitter. This is clearly why infrared used by television remotes is such a slow communication medium.

Tailoring your infrared protocol:

There are many television infrared protocols out there. And they use a variety of techniques to transmit data. Some use the same length of a burst but have different quite times between a burst representing a zero and a one. All protocols use an address header followed by a payload. Some require an additional start header bit burst and a end footer burst.

The protocol developed in this app note simply uses a different number of pulses to distinguish a zero and a one. The protocol also uses a minimum constant delay time between each bit burst at the transmitter.

The demonstration:

What you need:

- Vishay TSOP853 38 KHz Infrared Receiver
- 2 DE2 Boards
- 940 NM infrared LED
- A Current limiting resistor sized appropriately for the infrared LED
- A capacitor > .1 uF and resistor in the range of 33 ohms to 1 Kohms.

Setting up the transmitter:

- Simply restore the Quartus II project from the archived Transmit_P.qar file
- Compile the design
- Program it to the DE2 Board
- Set up the current limiting resistor and LED between GPIO_0(0) and ground.
- You now have a transmitter that can transmit a single bit based on the position of switch0 after pressing and releasing key0 and then pressing key1 for demonstration purposes.

Setting up the receiver:

- Simply restore the Quartus II project from the Receiver.qar file
- Compile the design
- Program it to the DE2
- Connect the output of the Receiver to GPIO_0(0)
- The following two things should be connected at the VCC node of the receiver. They are recommended by the Vishay data sheet to prevent electrical overstress of the receiver
    - A 1 uF capacitor between VCC and ground
    - A 33 ohm to 1K ohm resistor between VCC and the power supply
- Just to be clear connect the ground of the receiver to ground

Congratulations:

You now have a working single bit infrared receiver and transmitter required for demonstration purposes. The receiver will illuminate 4 of the 8 green LED lights, which side is lit up corresponds to the last bit value received.

Single link calculation help:

I have included an excel document as well to stream line the all the bound calculations needed for the receiver hardware that you choose to use to use this includes the bounds needed for multiple bit transfers. The current excel file is filled out in with values from the Vishay data sheet provided in app note folder as an example. Remember to debounce all off chip signals going to your board, even receiver. (there is an app note for that to if you like).

Cheers. Jesse Larson, Jing Lu, and Qingqing Liu.