DE2Bot Remote Control

For the purpose of determining proposed usage of the remote control provided for you in the lab, this document describes its capabilities. Figure 1 shows the remote control in an illustration from the product user manual. This is also at the powersof2 web site on the project page, or directly at http://powersof2.gatech.edu/resources/RCU300T_DOC_OM.pdf . Although that user manual carries no explicit copyright notice, you should cite the original source of this figure, if you choose to use it (this document you are reading now is NOT the original source). Or you may choose to make your own drawing.

Four of the buttons, all near the top of the remote, are used to change the behavior of the remote itself, and two of them should not be used in your design. If you were to change the behavior of the remote with these two buttons, it would generate codes that could not be interpreted unless you rewrote the VHDL receiver code. The two buttons that should NOT be used are:

- CODE SEARCH, and

- CABLE (or DBS/CABLE, depending on exactly which remote you have)

The remaining two buttons at the top of the remote may be used, but you should realize that using them changes the codes being sent by the remote:

- VCR (or VCR/DVD), and

- TV

Specifically, you can press "TV" to make the remote send codes from a set of TV codes and "VCR" to make it send from a set of VCR codes. Although using both modes would have the benefit is a larger number of codes, it is far more likely that you would pick one mode or the other and manage with the available codes. It is also worth mentioning that one other button near the top of the remote, OFF-ON, is just a button like any other, sending a code depending on the mode it is in (TV or VCR).

Depending on whether the remote is in TV or VCR mode, all of the buttons may generate unique codes, but since MENU does not exist on some remotes, it does not make sense to use it in your design.

Buttons, when held down continuously, do NOT auto-repeat. You should design under the assumption that you have to press a button every time you want to send an infrared code to the robot.

Figure 1. Universal remote control used for communication with the DE2bot. (Source: RCA branded products, Audiovox Corporation.)

Code specifics

There are many different definitions of infrared codes used by electronics manufacturers, and discussing them is beyond the scope of this project. This was actually a topic of an earlier DDL project, and the intent here is that you benefit from work that was done previously. But a small amount of background on the actual technical details will help to explain why certain numbers show up as codes when SCOMP reads from the I/O addresses assigned to the IR receiver. This IR receiver device was designed to interpret the "NEC protocol," shown in Figure 2.
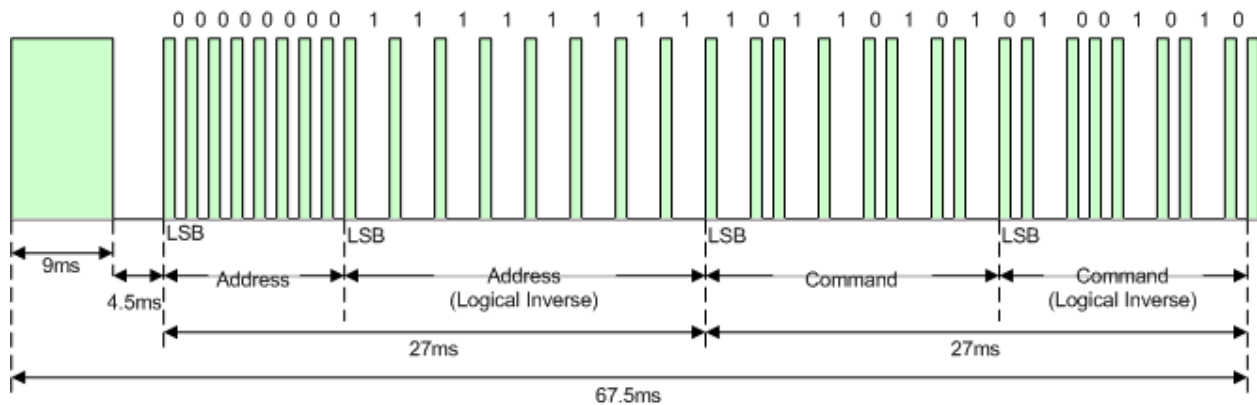

Figure 2. NEC infrared transmission protocol used by universal remote controls for DE2bot project.
[Image source: http://techdocs.altium.com/display/FPGA/NEC+Infrared+Transmission+Protocol]

For the purposes of our discussion, closely-spaced pulses of infrared emission correspond to binary values of 0, and widely-spaced pulses correspond to binary values of 1. Noting also that there is an unmistakable VERY wide pulse at the beginning, it is possible to sense the beginning of a "packet" of IR data. Each packet includes two 16-bit words:

- First word: A code for the addressed device. This will be either the TV address (0x04) or the VCR address 0x31, BUT it will be in reverse-bit order, and it will be sent twice (both normal and inverted logically). Figure 1 shows an address of 0x00.
- Second word: A code corresponding to the command associated with the button being pressed. This is ALSO sent in reverse-bit order, and it is ALSO sent both normal and inverted logically. Figure 1 shows a command of 0xAD (not 0xB5, because of the bit reversal – see below for further explanation).

On the falling edge of the final pulse of the initial message, the decoded 32-bit value is latched internally to the IR Receiver device provided as part of the Quartus project files (IR_RCVR). In the above example, that would be 0x00FFB54A. The upper word (0x00FF in this example) can be read by SCOMP at the IR_HI I/O address, and the lower word (0xB54A in this example) can be read by SCOMP at the IR_LO I/O address. Both values can be read multiple times, because they are only cleared by performing an OUT command to either address, but they can also be overwritten by a new IR command if SCOMP does not read them first.

The IDLE signal will be high if the IR signal has been inactive for >120ms. IDLE goes low immediately after ANY activity on the IR signal, regardless of whether or not it is a valid communication. In the Quartus project provided for you, IDLE is not directly available to SCOMP, because it is unlikely that it would be useful.

Because the NEC data format is LSB first (bit-reversed), the address in the above example is 0x00 (the same, whether bit-reversed or not), and the command is 0xAD (note that this is 10101101, and reversing it produces 10110101, or 0xB5, the pattern in the figure above.

Note also that these two codes, bit-reversed address and bit-reversed command, appear in the upper byte of the two 16-bit words of the 32-bit packet. The lower byte of each word should hold the logical inverse (one's complement), which is 0xFF for the address, and 0x4A for the command. Optionally, your software can use this feature to detect invalid codes, by disregarding any code that is not confirmed by its complement.

A recommended way to use the remote is to start by pressing the VCR (or VCR/DVD) button to enter VCR mode. Using the remote in VCR mode gives access to all buttons listed here. If you were to use it in TV mode, VCR functions (PLAY, etc) would be disabled.

	Address	Command
POWER	0x31	0x00
VOL UP	0x04	0x02
VOL DOWN	0x04	0x03
MUTE	0x04	0x09
CHAN UP	0x31	0x01
CHAN DOWN	0x31	0x02
PREV CHAN	0x31	0x42
1	0x31	0x04
2	0x31	0x05
3	0x31	0x06
4	0x31	0x07
5	0x31	0x0C
6	0x31	0x0D
7	0x31	0x0E
8	0x31	0x0F
9	0x31	0x1C
0	0x31	0x1D
ENTER	0x31	0x5C
TV-VCR	0x31	0xFF
REW	0x31	0x12
PLAY	0x31	0x14
FF	0x31	0x13
PAUSE	0x31	0x11
STOP	0x31	0x10
REC*	0x31	0x15

* Volume control is sent to TV, even in VCR mode
   (hence address 0x04 instead of 0x31)

* REC button only transmits on every other button press

Do not forget that you will only read these codes as shown above if you isolate the upper byte of each of the two IR device words, and if you perform the bit reversal. If you wish to use any other

buttons, or if you prefer to use only TV mode, you can experiment to determine what codes correspond to the different buttons.

The remotes should already be properly programmed, but if necessary, the process for doing so is
1)   Hold CODE SEARCH until the LED lights
2)   Press the desired device button (TV or VCR/DVD)
3)   Enter the appropriate three digit code
The programming code for the TV is 004, and for the VCR/DVD is 011. These values select an NEC format with the above values. Note that these codes are not related to the device addresses sent by the remote depending on mode (although by coincidence, the TV device code is 0x04, and the TV programming code is 0x004).