IRVC2 Learning Infrared Remote Volume Controller Ver 1.0 2/25/08

1 General Description

The IRVC2 device is used in conjunction with an IR sensor module and TI's PGA2310/2320 volume control IC(s) to provide high-quality remote control of audio signal amplitude. It is capable of being trained to recognize IR command sequences from many standard consumer remote controls.   It can control 2, 4, 6, 8, 10 or 12 channels of audio, and provides five additional output signals that can be used to either select between different sources or as general-purpose outputs. Three momentary pushbutton switch inputs are provided for optional front-panel Volume Up, Volume Down, and Power On/Off. IRVC2 offers low power consumption, and incorporates several features that add to its flexibility.

1.1 Applications

This device can be used add IR remote control of volume to a new product or design.

1.2 Device Pinout

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        LVSEL  1       28  PWRSWb
         SRFB  2       27  VOLDNb
          SDI  3       26  VOLUPb
          CSb  4       25  SS/GP5
        PWRON  5       24  SS/GP4
       LED/SW  6       23  SS/GP3
         SCLK  7       22  SS/GP2
         VSS1  8       21  SS/GP1
       LCDPWR  9       20  VDD
         RSVD  10      19  VSS2
        LCDRS  11      18  LCDD3
         IRIN  12      17  LCDD2
       LCDRWb  13      16  LCDD1
      LCDENAB  14      15  LCDD0
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1.3 Signal Description

VDD	20	Positive power supply voltage input
VSS	8,19	Negative power supply voltage input (Ground)
IRIN	12	Demodulated input from IR detector, low when IR signal is present
PWRON	5	Power Status/Control output signal, high when power is on
CSb	4	Chip Select output, active low, used to control PGA chip(s)
SDI	3	Serial data output, used to control PGA chip(s)
SCLK	7	Serial clk ouput, used to control PGA chip(s)
SRFB	2	Shift Register Feedback input from SDO of last PGA chip in chain
LED/SW	6	LED drive/learn switch input
PWRSWb	28	Active low input from Power Control pushbutton, with internal pullup resistor
VOLDNb	27	Active low input from Volume Down pushbutton, with internal pullup resistor (also used as B encoder signal if encoder mode is selected)
VOLUPb	26	Active low input from Volume Up pushbutton, with internal pullup resistor (also used as A encoder signal if encoder mode is selected)
SS/GP1	21	Active high Source select/general purpose output #1
SS/GP2	22	Active high Source select/general purpose output #2
SS/GP3	23	Active high Source select/general purpose output #3
SS/GP4	24	Active high Source select/general purpose output #4
SS/GP5	25	Active high Source select/general purpose output #5
LVSEL	1	Local Volume select 1=Encoder, 0 = pushbuttons or ctr-off mom toggle sw
LCDPWR	9	+5V switched power to LCD module (max source current ~5-10 mA)
LCDRS	11	Register Select to LCD module

LCDRWb	13	Read/Write bar to LCD module
LCDENAB	14	Active high enable to LCD module
LCDD0	15	Least significant bit of 4-bit data bus connection to LCD module
LCDD1	16	Part of 4-bit data bus connection to LCD module
LCDD2	17	Part of 4-bit data bus connection to LCD module
LCDD3	18	Most significant bit of 4-bit data bus connection to LCD module

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2 Selecting a configuration

2.1 Number of PGA chips

IRVC2 automatically senses the number or PGA chips connected to it, at power-up. It uses the SRFB signal to do this. This signal should be connected to the SDO pin of the last PGA chip in the SDI/SDO daisy chain. Please see PGA chip data sheet for details on how to daisy-chain multiple chips. If IRVC2 doesn't detect any feedback, it will flash the LED for 10 seconds, then set the number of channels to 2.   Each time power is applied to the IRVC2 chip, it will detect the number of chips/channels, and will flash the LED once for each channel, so the LED will flash on and off 2,4,6,8,10, or 12 times.

2.2 SS/GP Output type selection

Two types of outputs are available: "source select" and general purpose, or toggle. Only one source select signal can be active at a time. Selecting one will disable all others automatically. General purpose outputs toggle when their IR command is received. All output signals start low at initial power-on. After that, their state is saved in EEPROM and will be restored automatically if power is removed and re-applied.   To select the number of outputs that you would like to use as source selects, install a 20K resistor between the highest numbered SS/GP signal that you want to use and the SRFB signal. You should always connect a 470K resistor from SRFB to GND. Non-SS signals will be configured as GP types automatically. For instance, if you want three source selects, connect a 20K resistor between SS/GP3 and SRFB. Only connect one 20K resistor between a SS/GP signal and SRFB. If you want all SS/GP signals as general purpose (toggle) signals, do not connect any 20K resistors to SRFB, but install the 470K resistor to GND. The resistors are sensed at power-up, and will not interfere with the other use of the SRFB signal.

3 Training

Before training the device, select the remote you intend to use. If it is a universal remote, set it to the manufacturer that you want to use. A TV code setting will probably be the best choice, since you need volume control keys. (If you don't need to use a particular setting, Sony uses a simple code that should work well. Of course, many others can also be used.)

You will need to pick any 13 of the remote keys as the ones that will be used to control the IRVC2 chip functions. Here are the functions and a suggested list of keys. This assumes that you are using a TV mode on your remote.

Training order	Function	Possible Remote Key
1	Volume Up	Volume Up or Up arrow if there is one
2	Volume Dn	Volume Down or Down arrow if there is one
3	Mute	Mute
4	Pwr On/Off	On-Off
5	Enter Bal Set	Rgt arrow key if there is one
6	Exit Bal Set	Lft arrow key if there is one
7	Clr offsets/sel vol dsp	0 key
8	Ch/SS/GP1	1 key
9	Ch/SS/GP2	2 key
10	Ch/SS/GP3	3 key
11	Ch/SS/GP4	4 key
12	Ch/SS/GP5	5 key
13	Ch6	6 key

"Ch" indicates one of the possible 12 channels of audio that can be controlled. Number keys 1-6 can select those channel directly in Balance Set mode.

SS/GP1-5 can be controlled in normal operating mode by pressing the key that corresponds to them.

The functions are always trained in the order listed above, and all 13 keys must be trained whenever "learn mode" is activated. IRVC2 does not know which key you are pressing on the remote. The first command trained will always be assigned to the Volume Up function, even if you are pressing the On/Off key on the remote.   The second will be Volume Dn , etc.

To train the device, press and hold the "learn" switch while applying power to the device. Pressing the learn switch will force the LED on, so it will light. Wait at least two seconds after applying power, then release the switch. At this time, the LED will blink off for 1 second, then turn on again, to indicate that "learn" mode has been selected. For best results while training, hold the remote approx 3-5" from the IR sensor. Shade the sensor from bright light during training as well. To train the first remote button, press the button and hold it until the LED goes off, then release it quickly. This indicates that the chip has learned the first code. Release the button as soon as you see the LED blink. Now switch to the next button you wish to use. After all thirteen buttons have been trained, the chip will automatically switch out of "learn" mode. The LED will go off for a moment, then it will flash the number of PGA channels detected. Your device is now ready for use, and will retain it's code information, even if power is lost.   You can train the device as many times as desired.

The device checks incoming codes against all thirteen "learned" codes simultaneously. If you train all thirteen channels of the device with the same button on the remote, some very strange things will happen.

If, during training, the LED starts flashing continually, it means that the remote is using an unusual protocol, which will not work properly. If this happens, reduce the ambient light level near the IR receiver, remove power, and re-apply with the learn switch pressed to try again. If the same thing happens again, please switch to a different remote. If you are using a universal remote, simply switch to a different manufacturer. Some codes will appear to train properly, but will cause multiple functions to be activated. If this happens, please switch to a different remote, or manufacturer setting.

Sometimes manufacturers use two codes for each button, code A and code B. When you press and hold a button, code A will be sent repeatedly as long as you hold the button down. If you release the button and press it again, code B will be sent repeatedly while it is held. Release it and press again, and you will get code A again, etc. This makes it possible for the controlled device to tell the difference between someone releasing and pressing the key again and simply losing the signal for a moment. When IRVC2 is trained with this type of remote, it will only capture code A or code B, but not both. After training, it will recognize every other press of the key, since it only knows about one of the two codes used for that key.

If you have successfully trained the device, but find that the remote does not work more than a few feet from the IRVC2 device, it is probably not using a 38 KHz modulation frequency. To solve this, you can either switch to a different remote (or setting if you are using a universal remote) and re-train, or change to a different frequency of IR sensor.

Each code is stored independently of the others, so each cmd can use a different IR protocol, if desired.

4 Normal Operation

4.1 Getting started

After training finishes, IRVC2 will default to –50dB volume setting on all channels, all SS/GP outputs will be low, and the IRVC2 will switch to the "power on" state. Since –50dB is a very low volume setting, you will need to hold the "Volume Up" remote button or "front panel" volume up pushbutton if implemented down for maybe 15-30 seconds, before you start to hear audio. This procedure will only be required the first time power is applied to the IRVC2 chip. After that, the current volume setting is saved in EEPROM, roughly 10 seconds after it is changed, and will be restored if 5V power is removed and re-applied. (In a normal application, the IRVC2 chip should be powered all of the time, even when other equipment is off.)   You can turn the IRVC2 chip "off" by pressing the "Power On/Off" button on the remote. In this state, all channels are muted, the PWRON output is low, and the only command that will be accepted is "Power On/Off", which will turn on the power, and restore the volume setting to its previous value.

4.2 Using it

Once you have turned on the chip, selected an input source (if you are using this feature), and increased the volume to a comfortable level, you can try using the mute button to mute all controlled channels at the same time. Hit mute again to restore normal sound. You can use the number buttons to control the SS/GP output signals. Hit On-Off to put the chip in its "power off" state. The volume up/dn buttons will change at twice the normal rate if held for more than about 2 seconds.

4.3 Command lockout period

Once a valid IR command has been recognized, no new command can be received for approximately 150 mSec. Since many remotes repeat the command at a high rate as long as the button is held, some type of lockout period is necessary to allow single key presses to be registered easily. The lockout period for mute and power on/off is longer, to prevent registering two presses accidentally.

5 Setting Channel Balance

IRVC2 supports adding an offset to each channel's volume to make it louder or softer than the others. This allows you to compensate for differences in amplifier gain or speaker sensitivity between channels. If you want all channels to be set to exactly the same gain, then you don't have to do anything. To set a channel's volume offset, press the "Enter Balance Set" key. This should mute all channels except channel 1. You can select any channels that exist by pressing either the "Enter Balance Set" key again to step through the channels, or pressing the number key that corresponds to the channel that you want to adjust. (Only channels 1-6 can be accessed this way) If you have only two channels, pressing the numbers 3-6 will do nothing. (The LED will still flash) Once you have selected the desired channel, press vol up or vol down, either on the remote, or using the "front panel" pushbuttons if implemented. (The volume encoder, if selected, can not be used to adjust channel offsets) When you have finished with that channel, either select a different channel to adjust, or use the "Exit Balance Set" key to leave Balance Set mode, and write the new channel balance settings to EEPROM. You can set each channel's volume offset in the range +/- 12.5 dB. To reset all channel offsets to 0, press the "0" key while in Balance Set mode.

6 Brown-out Mute Feature

To insure that all channels mute quickly if power is accidentally lost, the Brown Out feature of the IRVC2 chip has been enabled. This will reset the chip when its power supply voltage drops below about 4.0 volts. Resetting the chip will cause all I/O pins to revert to inputs. To take advantage of this, please connect the PWRON output signal to GND with a 10K resistor, and also connect a 10K pullup resistor from PWRON to the Mute input pin (pin 8) of all controlled PGA chips. (You can add a toggle switch between GND and the Mute pins as a front panel Mute switch if you like.) As the IRVC2 chip is losing power, it's brown out feature will reset the chip, and PWRON will become an input. The 10K resistor to GND will pull it down very quickly, and since it is connected to Mute on the PGA chips, all channels will be muted instantly. Using PWRON in this way does not prevent you from also using it to turn on and off other equipment, with suitable circuitry.

7 Pushbutton/Encoder Inputs

Three inputs are provided for optional momentary switches controlling volume and power on/off state. The IRVC2 chip has internal pullup resistors on these inputs. Switches should be connected between ground and the input pins, and have the same function as the corresponding IR command. The LED will flash when these switches are pressed. The volume pushbuttons can be replaced with a binary shaft encoder, if desired. In this case connect the A shaft encoder pin to VOLUPb, B to VOLDNb, and C to ground. The LVSEL pin is used to tell the IRVC2 chip which type of volume control is connected, and must be set to match the input device(s) connected. A Grayhill shaft encoder , part number 25LB10-Q, was used during software testing . This particular one has a mechanical indent every 10 degrees, or 36 per revolution.

8) LCD Module Operation

IRVC2 supports connecting an optional 16 character by one line LCD module. Any module based on the popular Hitachi 44780 chip or equivalent parts should work. LCD modules with more than 16 characters will not work and should not be used. The 4-bit data bus connection is used, so the data pins provided should connect to the upper 4 data bus connections (D4-D7) of the LCD module. The LCD module can either be powered from 5V, in which case it will be blanked when the IRVC2 is in the power off state, or it can be powered from IRVC2's LCDPWR pin. This signal will be high whenever the IRVC2 is in the power on state, and can supply enough current to power a standard 1x16 LCD module. Do not try to pull more than 5-10 mA from this pin. **This signal cannot be used to power the backlight on an LCD module.** It can, however, be used to control a transistor to switch power to a backlight. Since the IRVC2 doesn't know if the LCD module is being powered down or merely blanked when the IRVC2 powers off, it initializes the LCD module whenever the IRVC2 powers up. This takes less than a second. The IRVC2 checks for a connected LCD module at power up. If no display is found, it will skip the code that talks to the LCD, and will use the LED for signalling, as IRVC does. IRVC2 should be completely operational without an LCD module.

Two types of LCD Volume display are available: Numeric, and Bar Graph. You can toggle between them using the 0 key in normal operating mode. In the Bar Graph mode, 80 columns are available. These are mapped directly to the top 238 counts of the 256-count adjustment range of the PGA chip. For any volume setting below this range, no bars are displayed. Each added bar corresponds to three steps, or 1.5 dB. The current volume setting is saved in EEPROM and restored on power-up.

9 Operating Voltage, Output current

9.1 Detailled hardware specs on the chip

Because this device is implemented using a PIC18F2321 chip, the data sheet for that device (available at www.microchip.com) should be consulted if more information is needed.

9.2 Operating voltage

The IRVC2 chip must be operated at 5 volts.

9.3 Output current capabilities

At 5.0 volts VDD, each output pin of the device is capable of sourcing 3 mA when it is high, and sinking 8.5 mA when it is low. In addition to these specifications, Microchip also provides graphs of current versus voltage for its output pins, which shows that the typical capabilities are much higher. If we can accept approximately 0.5 volt drop inside the chip, the typical current at room temperature would be about 8 mA sourcing (high) and 18 mA sinking (low).