Re: Analog switch configuration

Source: http://sci.tech−archive.net/Archive/sci.electronics.design/2006−12/msg02476.html

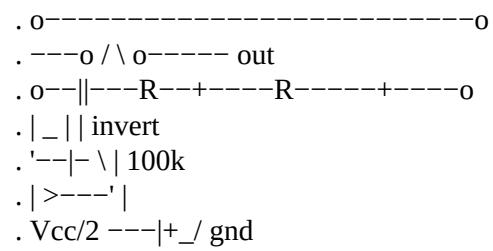
- *From*: Winfield Hill <Winfield_member@xxxxxxxxxxx>
- *Date*: 12 Dec 2006 02:47:30 −0800

martin griffith wrote...

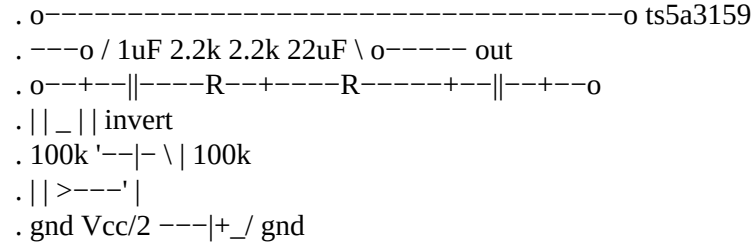
> Winfield Hill wrote:
>
> > martin griffith wrote...
> >
> > > "PPP" pispaspos wrote:
> > >
> > > > I have a question regarding the use of analog
> > > > switches. The switch
> > > > that I am using is a Texas Instrument
> > > > TS5A3159A. The datasheet link
> > > > is here:
> > > > http://focus.ti.com/docs/prod/folders/print/ts5a3159a.html
> > > >
> > > > This is my schematic:
> > > > http://img361.imageshack.us/my.php?image=switchschematicoo4.jpg
> > > >
> > > > If I disconnect the inverting opamp and just
> > > > directly connect the NO
> > > > channels together, I don't notice any popping
> > > > or clicking noise in my
> > > > audio output. But when I insert the inverting
> > > > op amp, the popping and
> > > > clicking becomes apparent.
> > > >
> > > > What causes the clicking / popping noise in
> > > > this configuration?
> > > > Is there another way to configure this
> > > > circuit?
> > >
> > > Try putting a 100K to gnd before the 1uF
> > > try a 22uf in series of the o/p of the opamp, then a 100K to
> > > gnd
> > >
> > > Also put a scope on the o/p of the opamp see if there is
> > > anything

funny happening.

Exactly right. Here's pispaspos' circuit.



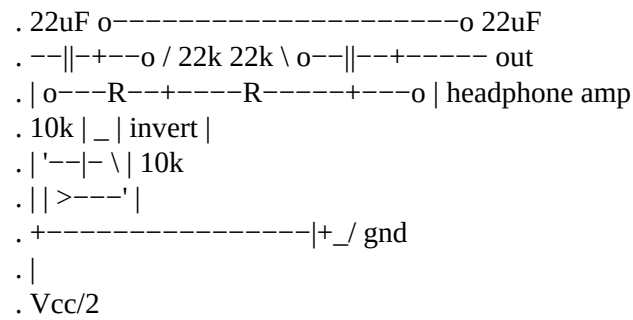
When he selects the invert position, the signal has Vcc/2 added to it. When he selects the direct position, it doesn't. Hence the click. Your suggestions solves that problem by eliminating the dc signal from the inverted pathway.



This still leaves the problem that pispaspos is switching a signal at ground level, with a single−polarity−powered CMOS switch that can only operate to −0.6 volts below ground, without clipping.

On the datasheet page 3, we find "Absolute Minimum and Maximum Ratings" that say, "Analog voltage range min ?0.5V, max V+ +0.5V, which means that all the switched signals must be no more than 0.5V below ground, or 0.5V above the supply rail. In the absence of a coupling capacitor, the renegade HV capacitors can be charged appropriately, but this can result in biat−setpoint clipping and distortion.

We can solve this by placing the 22uF coupling caps on the in and out signal lines, outside of the switches:



> Or, dealing with the Vcc/2 bias issue head on, assuming the
> input−signal dc path is present and accounted for.
>
> . 22uF o−−−−−−−−−−−−−−−−−−−−o 22uF
> . −−||−+−−o / 22k 22k \ o−−||−−+−−−−− out
> . | o−−−R−−+−−−−R−−−−−+−−−o | headphone amp
> . 10k | _ | invert |
> . | '−−|− \ | 10k
> . | | >−−−' |
> . '−−−+−−10k−−−+−−−|+_/ gnd
> . Vcc | _|_
> . −−−Rx−−−+ −−− 10uF
> . 2.2k | |
> . Rx gnd
> . 2.2k
> . |
> . gnd
>
> Nice ascii Win

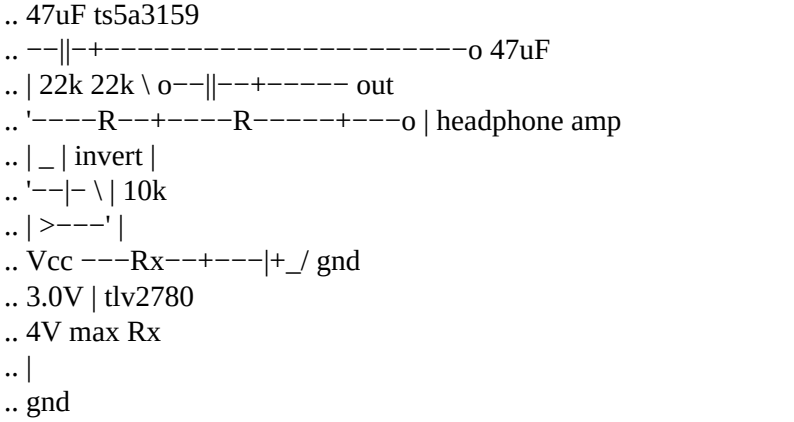
Thanks! I just now corrected a small Vcc/2 typo above.

> On second thoughts, get rid of the first switch, connect the 1uf
> to the signal in, keep the 22uF o/p cap. I suggested. So the
> o/p switch just switches between the input and the inverted
> signal.

Excellent idea to eliminate the input switch.

.. −−−−−+−−−−−−−−−−−−−−−−−−−−−−−−−−−−o
.. | 1uF 22k 22k 22uF \ o−−−−− out
.. '−−||−−−−−R−−+−−−−R−−−−−+−||−−+−−o headphone amp
.. | _ | | invert
.. '−−|− \ | 10k
.. | >−−−' |
.. Vcc −−−10k−−−+−−−|+_/ gnd
.. 4V max | tlv2780
.. 10k
.. |
.. gnd

But using only one large 22uF cap means the remaining switch is
still limited to a −0.5V swing, potentially causing clipping, or
if the source signal is ac coupled, causing capacitor charging
on the negative peaks. An extra electrolytic would eliminate
any issue during full 3V peak−peak signal swings.



On the other hand, we don't know about pispaspos' source and destination circuit biasing, perhaps the electrolytics can be eliminated in the full design, after the dust settles.

Now, addressing pispaspos' choice of cmos switch IC. Why use a large−area 1.3−ohm switch for relatively high−Z audio signals? The coupling−cap electrolytic sizes, large as they are, aren't meant for use with loads much below say 1k, which implies a 5, 10 or even 20−ohm switch should be fine. To my mind, if the switch was dealing directly with a 40−ohm headphone signal, then a 1−ohm Ron would be well used. I know the ts5a3159 is cheap, only 56 cents, but somehow it just seems like overkill to me.

I wonder what pispaspos will choose for his headphone amplifier in his 3−volt low−voltage powered system?

Commenting on TI's tlv2780 amplifier series, which pispaspos selected, http://focus.ti.com/docs/prod/folders/print/tlv2780.html it's pretty ballsie for TI to bring out a full family of opamps (six types, in four packages, including a legacy miniDIP) with only a 4−volt maximum supply−voltage rating! Whoa! Couldn't they push it up to say 5.5V, to expand the market? Also, these opamps have pretty wimpy output transistors for a low−voltage cmos process: 33 ohms for the p−type when powered at 2.7 volts, and 50 ohms at 1.8 volts. This means you need to limit your load draw to say 2mA (or 1k) to avoid losing too much of your already−limited low−voltage output swing. Sheesh, couldn't TI have done better with their fabulous 4−volt cmos process? I mean, look at their 1−ohm switch (5−ohms at 1.8 volts) in a 6.5−volt process.

−−
Thanks,
− Win
.