VE7CNF – Lightwave Circuits

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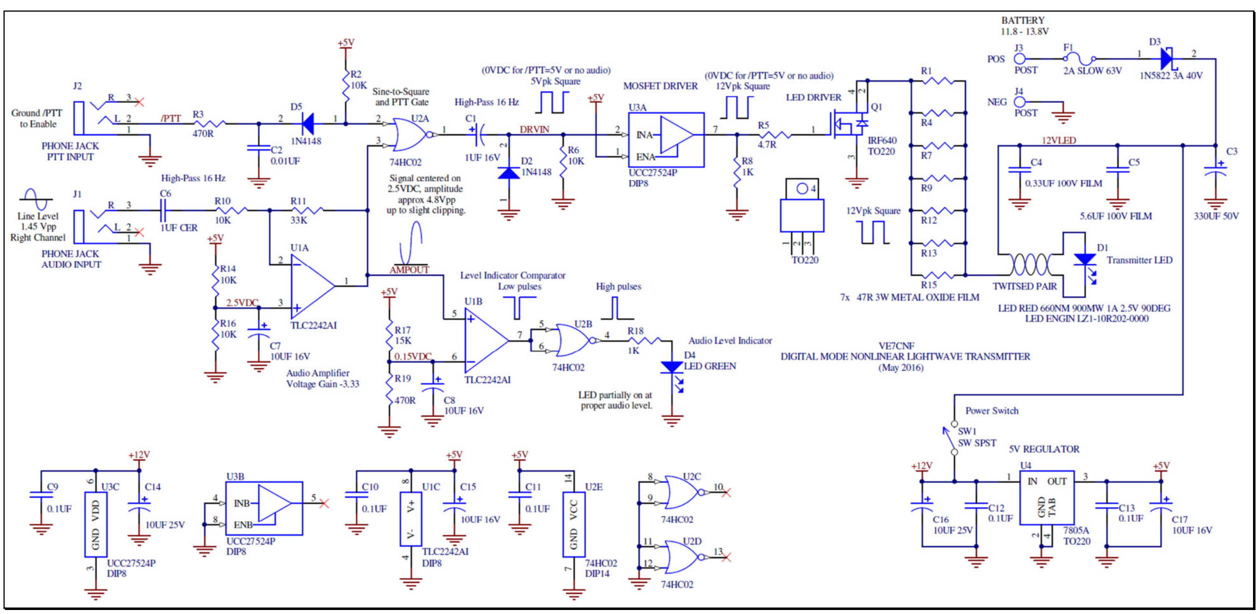
Digital Mode Lightwave Transmitter

To transmit digital modes such as WSPR and JT9 by lightwave, I've started with a simple nonlinear transmitter. Sine wave audio from a PC is converted to square waves to turn the transmitter LED on and off at the audio frequency. This was a quick addition to my CW/QRSS transmitter and allows experimentation with the low-SNR MFSK digital modes that are being used on LF and MF. Here is the schematic:



Link to PDF version of schematic: VE7CNF_LW_DMTransmitter.pdf

Line level audio signal from a PC is connected to J1. The sine wave signal is amplified to near 5 Vpp by U1A, then chopped into a square wave and inverted by gate U2A. This AC square wave passes through C1 to the input of the MOSFET driver U3A, which drives a 12V square wave into the gate of Q1 with enough current to guarantee fast switching. MOSFET Q1 then switches current on and off through the transmitter LED.

Seven 47-ohm 3W resistors in parallel form a 6.7-ohm resistor to limit LED current to about 1.5A peak, or 0.75A average for a square wave. This resistance should be adjusted to give the current you require through your pwn transmit LED. These will dissipate 7-8W of power, so space them out to allow cooling. Use metal or oxide film resistors and twisted-pair wire (#22 or larger) to the LED to minimize inductive ringing of the current at turn-on and turn-off.

Audio input signal frequencies should be 100 Hz or higher pass through C6 and C1 to give a good square wave drive to the LED.

A RIGBlaster or similar interface can control /PTT through J2. When /PTT is connected to ground, the squared audio passes through U2A. When /PTT is floating then the output of U2A is forced low, signal DRVIN is pulled to GND by R6, the MOSFET gate is driven low, and LED current stays off. Any audio from the PC is ignored if /PTT is high. Diode D5 allows other devices, which may use a higher pullup voltage, to also connected to /PTT.

If audio is shut off while /PTT is low then R6 discharges DRVIN and the transmitter LED current quickly turns off.

LED D4 is an audio level indicator. Increase the PC audio output level until the LED goes from off to dim. When signal AMPOUT exceeds 4.7 Vpp, the negative peaks drop below 0.15V. Op amp U1B operates as a comparator and its output begins to pulse low. U2B is used as an inverter to drive high pulses to the level indicator LED.

Power is supplied through J3, fuse F1, and a reverse-polarity protection rectifier D3. A Schottky rectifier is used to minimize voltage drop. Bypass capacitors C3, C4, and C5 form a low-impedance power rail for the transmitter LED, to allow fast switching of the LED current. Keep the loop through the bypass capacitors, Q1, resistors, and the LED twisted pair input as short as possible to minimize circuit inductance.

Voltage regulator U4 provides 5V for U1 and U2.

I selected parts based on what I had available that would work. The TLC2242A op amp for U1 has good bandwidth and supports true rail-to-rail input and output with minimal distortion and no unexpected output transitions. It also works well enough as a comparator. The 74HC02 NOR gate has input thresholds near 2.5V and so does a good job squaring up the sine wave. Other MOSFETs and drivers will work for Q1 and U3. The IRF640 has higher voltage and current ratings than necessary, but it has good low on-resistance (0.18 ohms), low gate and drain capacitance, and fast switching. Regulator U7 could be replaced by a smaller 78L05 with 0.1A rating.

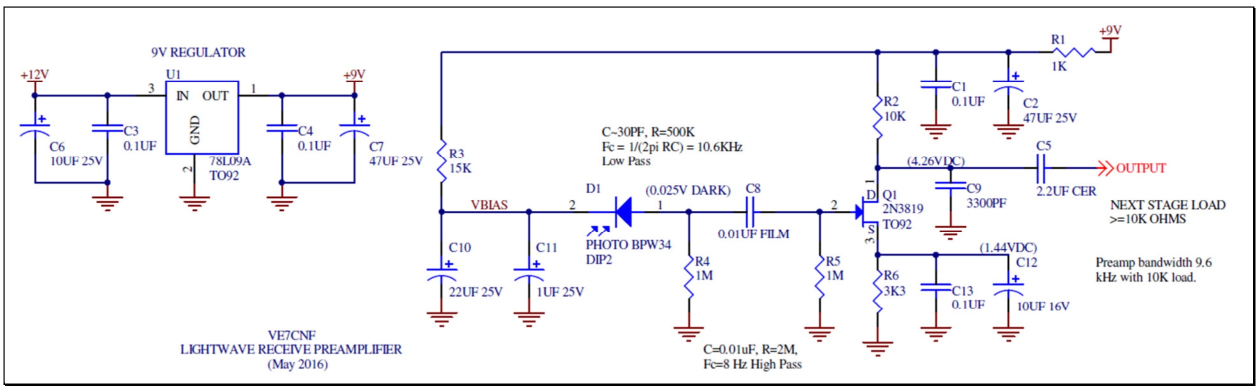
Lightwave Receive Preamplifier

Digital Modes like WSPR typically use audio frequencies near 1.5 kHz. To receive these modes by lightwave, the PIN photodiode receiver needs a bandwidth of a few kHz.

It’s been common practice to use zero reverse bias on the PIN photodiodes in lightwave receivers. At zero bias, the diode capacitance is high. The receiver circuit places a high load resistance on the diode to give more signal voltage. High capacitance and high resistance result in a low bandwidth.

Application notes for PIN photodiodes usually show a negative bias voltage applied to the diode to improve bandwidth. The BPW34 datasheet gives a graph of capacitance vs negative bias voltage.

Here is the schematic of my PIN photodiode input circuit to cover the audio band. It uses close to 9V of negative bias. Other than the bias, it’s the typical common-source JFET input stage being used for lightwave work.



Link to PDF version of schematic: VE7CNF_LW_RxPreamp.pdf