A description of the pockels cell driver fiber decoder and LED driver.

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The Helicity Pockels cell at CEBAF is presently a KD*P crystal type. This crystal has a piezo-electric property and as such, it is subject to ringing when switched to high voltage with a fast rise time. In 2007 I developed a switch system that used high voltage opto-diodes as a low cost means to gently switch between the two high voltage states with 10's of microseconds rise time, which is slow enough to prevent a piezo-electric ringing. The system is quite simple. When infrared light from an LED is applied to an opto-diode, the diode reverse conducts. By employing two opto-diodes and two LED's, the voltage state on the Pockels cell can be taken either the positive rail voltage state, or the negative rail voltage state. This is demonstrated in figure 1 below.

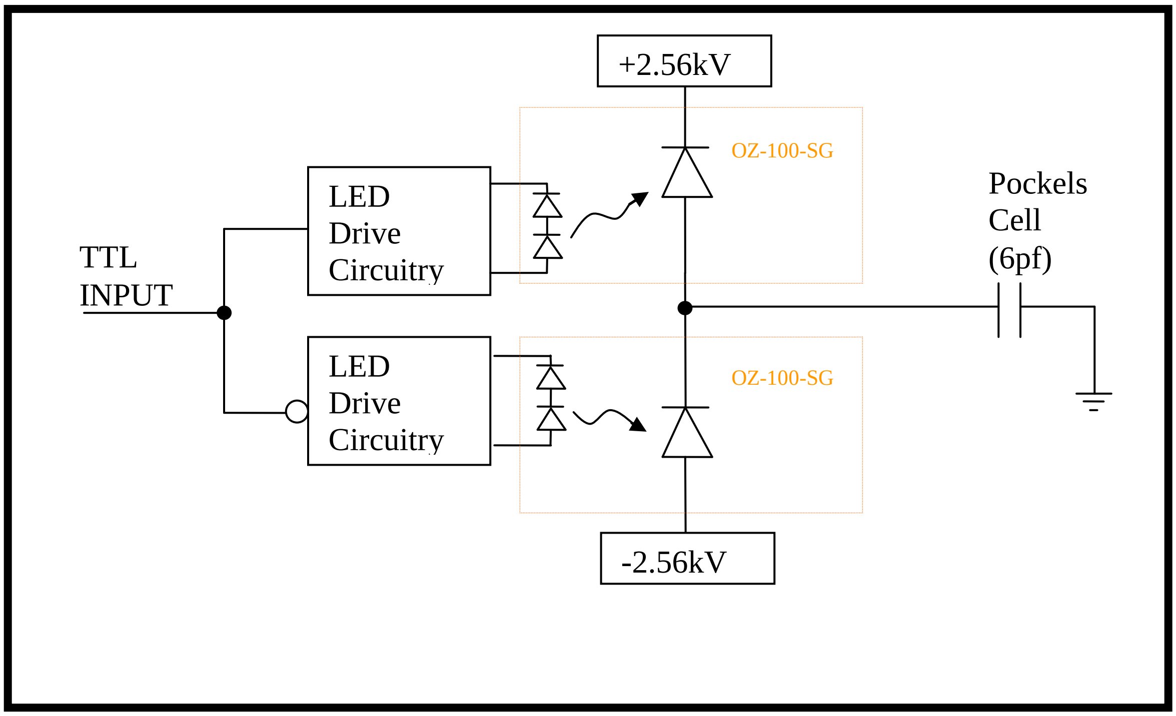
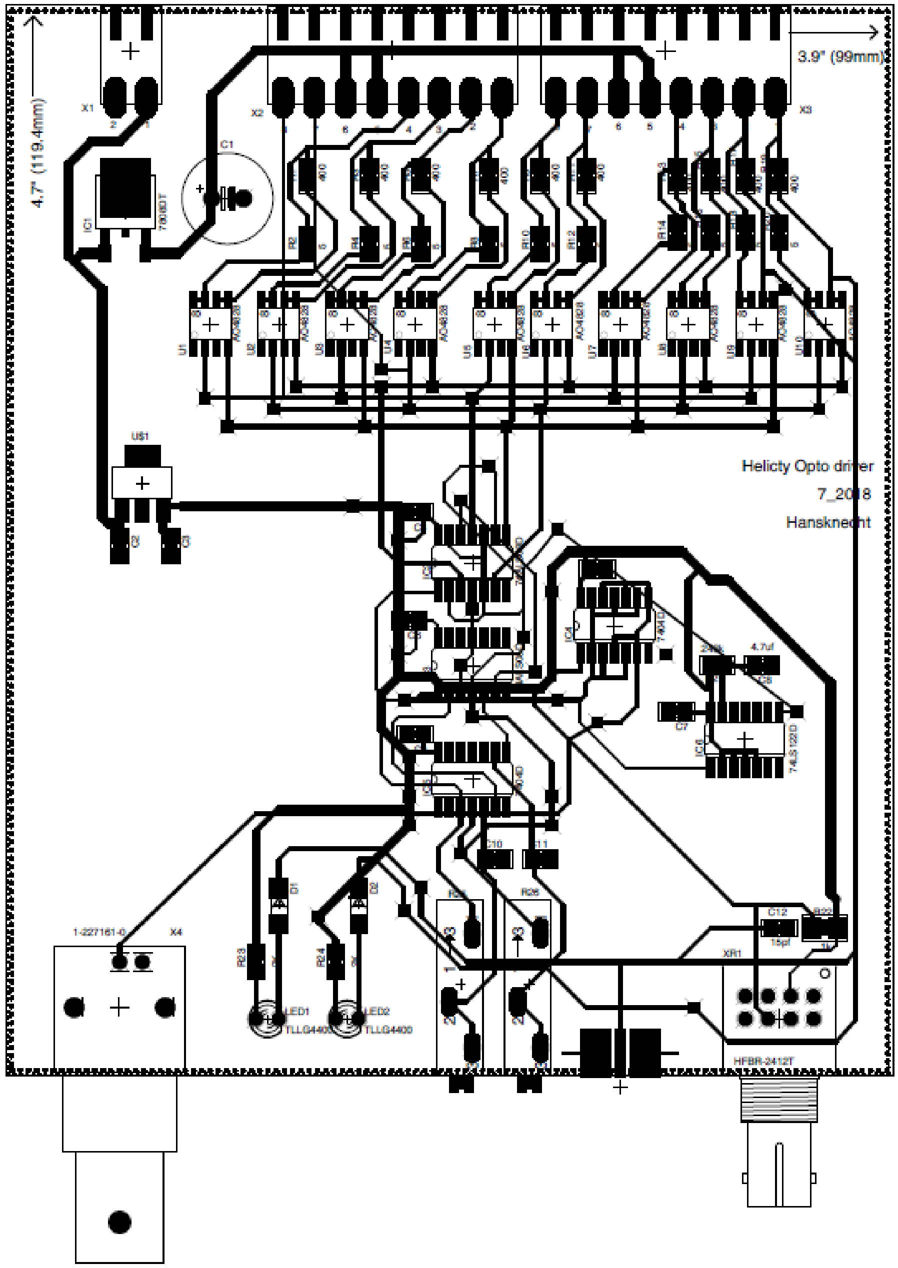


Figure 1

The high voltage diodes are purchased from Voltage Multipliers Inc.
The LED we use is the OSRAM SFH 4235-Z in the "Golden DRAGON" package. This LED produces 950mw of 850nm infrared light at 1 amp current drive and can be pulsed with much higher currents (5A) to achieve significantly more radiant flux.

The driver board for these dragon LED's is described in the remainder of this tech note.

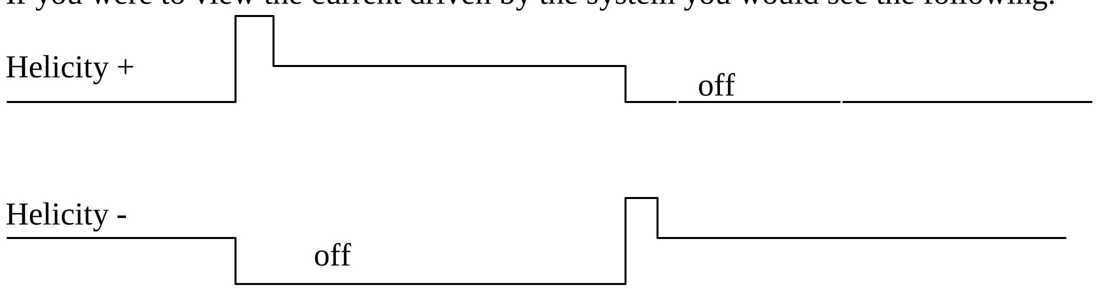


The board is physically capable of driving five sets of dragon LED's. It will never need to drive 5 at a time. At most, when used with the RTP cell being developed by Caryn Palatchi, it will be driving four sets of dragon led's. The fifth spare dragon driver circuit is for driving the existing KD*P dragon LED set. The printed circuit board is designed to slip fit into Hammond Manufacturing aluminum enclosure part #1455L1201. The primary purpose is to decode a fiber optic input and drive the LED outputs, but there are some additional features to be discussed.

Refer to pcdriver 2018 schematic.pdf during the following description of circuit operation.

Helicity fiber signal is decoded by XR1 HFBR-2412 and is buffered to a sharp ttl signal by IC4 gate A. If a helicity fiber is not available, an SMA connection is provided where a user can input a TTL level helicity signal from a function generator for testing.
IC4 gates BCDEF are ganged to produce a robust drive signal for a scope trigger or future circuits that may be loaded down to 50 ohms. NOTE: When connecting to a grounded scope trigger input, the entire helicity system will see the earth ground, so disconnect this scope trigger output when running parity beam that should not have an earth ground on helicity.
The helicity flip signal from IC4 gate A goes to a dual branch circuit of IC5 and IC3. If you follow the logic, you will understand that the small RC network provided by R25 and C10 produces a brief TTL high pulse out of IC3 pin 3 on each rising edge of the incoming helicity pulse. The same thing happens on the R26 and C11 path. The purpose of these brief timers is to drive transistors that can give the LED's a brief "uummph" (strong current) pulse during the transition to the helicity+ state or the helicity- state.

If you were to view the current driven by the system you would see the following:



As shown, there is a brief H+ high pulse current, followed by a H+ maintain current. Then when we transition to a helicity minus state, there is a H- high current, followed by a H- maintain current.

These are the four state signals we see at the outputs of IC2 AND gates A,B, C, D.

The Helicity signal from IC4 Gate A also goes to IC6, which is a retriggerable one-shot. The purpose of the one shot is to provide a TTL high output to the IC2 AND gates that enables them when the helicity flip rate is over 5 Hz. If helicity drops below 5 Hz and is stuck in a low state, or a high state, the enable signal will drop and all of the LED drive transistors will shut off. This prevents the application of high voltage to a pockels cell in a DC state for an extended period of time.

Moving over to page 2 of the schematic, we see the helicity maintain signals and high pulse signals going to the AO4828 transistors. Each Dragon LED is biased on the Anode with a fixed voltage of 8 volts. The cathodes of these LED's have two potential paths to ground. When the "High pulse" transistor turns on, there is only 5 ohms in series with the LED, so we get close to a 1 amp pulse going through the LED. This shuts off quickly because of the aforementioned RC time constant and the "maintain" transistor remains on for the remainder of the helicity state. With 400 ohms, the current through the Dragon LED will be about 12mA, which is fine for holding the attached opto-diode in a conduction state.

All system outputs are shown page 2 at the X2 and X3 connectors. One part of ensuring that the H= and H- states have equal transition times is to monitor X2 pins 7 and 8 using an oscilloscope as you adjust R25 and R26 pulse timers.

You may have noticed that I have not done anything extraordinary to ensure that we do not have a brief simultaneous conduction of H+ transistors and H- transistors. In most high voltage switching systems this would be catastrophic if both transistors turned on at the same time because the positive rail could flow directly to the negative rail. In the case of opto-diodes, they never turn on to a hard full conduction state and they have a time lag of 10's of nano-seconds, so they will not see any of the brief 2-4 ns transition signals as we switch between the two helicity states.

The entire circuit is powered through X1 connection. This can be a floating voltage of 12-15 VDC, or, if you think about it, it can be a grounded power supply as well because the light produced by the LED's separates the actual high voltage lines from this driver. Yes, there are brief 1 amp currents flowing to earth ground, but they are flowing equally during each helicity state. A parity detection scheme could see the helicity rate appearing on earth ground, but it could not determine the helicity state. Well, perhaps I exaggerate, because there is a real but minute difference at XR1 between the light-on current draw and the light-off current draw.