About SL1

The SL1 is a dual-use illuminator and visible light communications transceiver.

The main challenge that it addresses is that of regulating a large amount of electrical current through the light-emitting diodes (LEDs) to provide enough light, to regulate the overall luminous flux, and to preserve the integrity of the LEDs while supporting high-speed switching for fast modulation. At the time, existing LED drivers were either able to regulate enough current to drive high-brightness LEDs for lighting purposes, or were fast enough for reasonable communication speeds; however, no commercial off-the-shelf LED drivers were found to be able to do both.

Due to the great variability in the forward voltage drop of white LEDs, the current through the LEDs cannot be regulated by regulating voltage. This variability also makes regulating the current with resistive elements difficult to do efficiently.

# Design:

See v4/Xmit\_PCB\_v4.pdf for the latest schematic and PCB layout.

## LED Driver:

The designed LED driver can be treated as two parts: one that switches current to the LEDs on and off quickly and another that regulates the current through each LED when the LED is on.

The current switching part is built around two transistors: one that provides current to the LEDs when the LEDs should be on and another that was intended to discharge the stray capacitance of the LEDs when they switch off[[1]](#footnote-1). To ensure that the two transistors do not create a direct path between the positive voltage supply and ground when the transistors switch between on and off, a MOSFET driver (the LM27222M) is used to drive the transistors.

The current regulating part uses a small resistance to measure current through each LED. The resulting voltage is compared to a reference voltage, which corresponds to the desired current, and the result is used to adjust a current-regulating transistor. To prevent the off states from throwing off this feedback loop, additional components were added to “hold” the feedback loop in the off state.

The LEDs in the transmitter are placed to align with a Khatod Optoelectronic PL1172 Fresnel lens.

## Receiver:

The receiver is designed to amplify the received optical signal to a 0V to 5V rail-to-rail digital signal for input to a FTDI TTL-232R-5V USB-to-serial cable. Note that the v3 receiver wrongly inverts the signal for the USB-to-serial cable; this is fixed in v4 by adding an extra inversion.

## Power:

The power supply receives power from a +12V DC source and produces +5V and -5V DC for the transmitter and receiver.

# Parts:

An up-to-date list of catalog numbers for the parts used in this transceiver is not available. Please see the schematic drawings and the PCB layout for specific information about parts.

**References** (available at hulk.bu.edu)

1. Jimmy Chau, Thomas Little. “Transceiver Modules for General Illumination and Free-Space Optical Communications.” Smart Lighting Engineering Research Center Site Visit. Troy, NY. Jun 2011.
2. Jimmy Chau, Thomas Little. “Improved Design for an Optical Communication System.” Smart Lighting Engineering Research Center Industry-Academia Day. Boston, MA. Feb 2011.
3. Jimmy Chau, Thomas Little. “Transceiver Modules for General Illumination and Free-Space Optical Communication.” Smart Lighting Engineering Research Center Site Review. Troy, NY. Jul 2010.
4. Jimmy Chau, Thomas Little. “LED Driver Design for an Optical Transmitter and Illuminator.” Smart Lighting Engineering Research Center Industry-Academia Day. Boston, MA. Feb 2010.
5. Smart Lighting Engineering Research Center [www.smartlighting.rpi.edu](http://www.smartlighting.rpi.edu)

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1. This additional capacitor was added for the purpose of decreasing the time needed to turn off each LED. However, it may have worsened the performance of the LED driver by increasing its complexity instead. [↑](#footnote-ref-1)