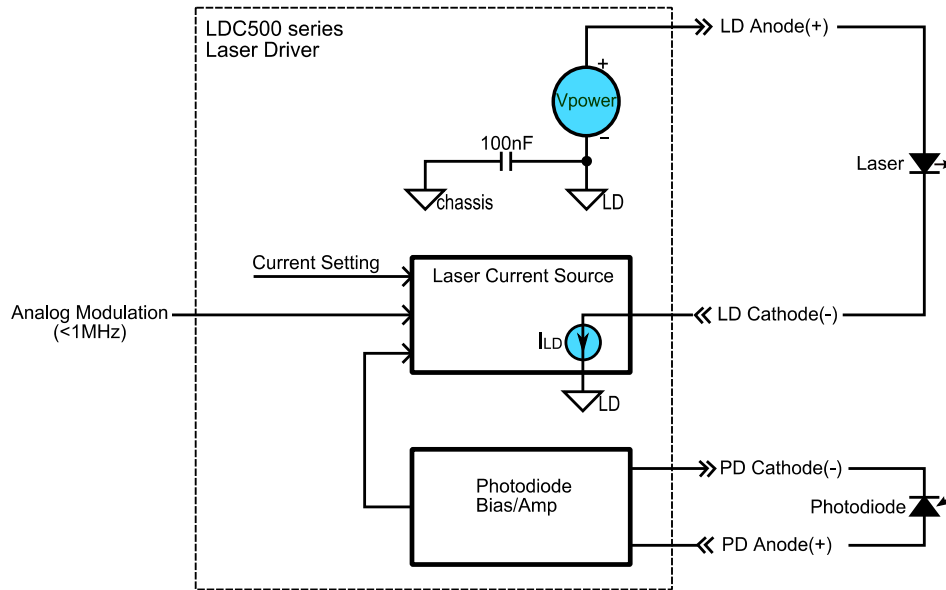# LDC500 Series: RF Modulation of Injection Current

Fig.1 LDC500 laser diode driver block diagram

LDC500 series laser diode controller has an analog modulation input which allows the output current to be modulated up to 1MHz. To achieve higher frequency modulation, directly injecting RF current into the laser diode can be used.

Fig.1 is a simplified schematic of the LDC500 series laser diode driver. The circuit is floating, with the internal "LD ground" node AC-coupled to chassis ground through a 100 nF capacitor to suppress 50/60Hz line noise. The laser **anode** is tied to the LDC internal power rail, which is at low impedance relative to internal LD ground. The laser **cathode** is connected to the sinking current source, which has high output impedance.

RF signal can be injected into either cathode or anode of the laser diode as shown in Fig. 2.
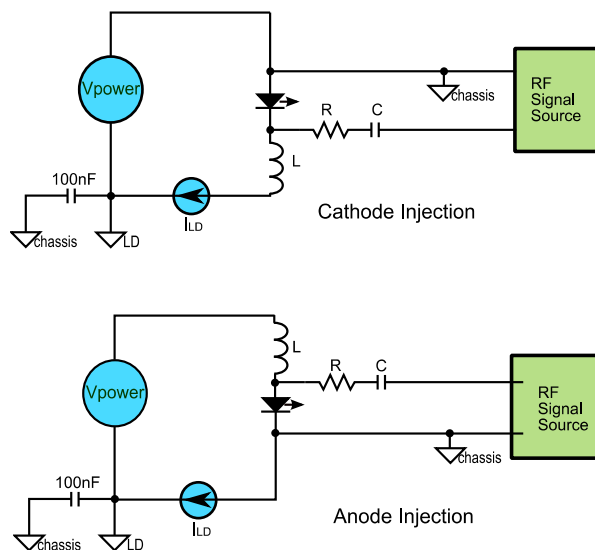
Fig.2 Two ways of RF Signal Injection

In **cathode injection**, the laser anode is grounded to RF source chassis and the RF signal is injected to the cathode through R and C. Resistor R together with the laser diode internal AC resistance should match the RF cable impedance. Capacitor C is used to block the possible DC signal from RF source. An inductor L is used to prevent the RF signal from flowing through the LDC500 source. If the current source I_{LD} were ideal, inductor L would be unnecessary. But in reality, the output impedance of the I_{LD} becomes lower as frequency increases. So inductor L is helpful.

In **anode injection**, the cathode is grounded to chassis and the RF signal is injected to the anode through R and C. The inductor L must be there to isolate the power rail which is low impedance to ground chassis through 100nF.

Generally **cathode injection** is preferred, when consistent with constraints of the laser diode packaging.

RF injection works without complications when the LDC500 is operating in Constant Current mode. The situation is slightly more subtle when operating in Constant Power mode. In this mode, the optical feedback loop has a bandwidth of less than 5kHz, so any injection signal with 5kHz or higher won't affect the photocurrent. If the injection signal frequency is within the feedback loop bandwidth, the photodiode current will be suppressed. So the modulation effect will fade away as frequency goes lower.

In all cases, be careful that the RF signal is not so large as to reverse bias or overdrive the laser diode. Otherwise permanent damage may happen to the laser diode. When configured for external RF injection, the built-in protection features of the LDC500 controller **cannot protect the laser diode from electrical stresses generated by the RF injection.**

Fig.3 shows an experiment of injecting RF signal to a DFB laser and the result is shown on a scope. The red trace is the modulation signal directly from DS335 function generator. The green trace is the optical output from the DFB laser. The optical signal is converted to electric signal by a photo detector (Model 1181).
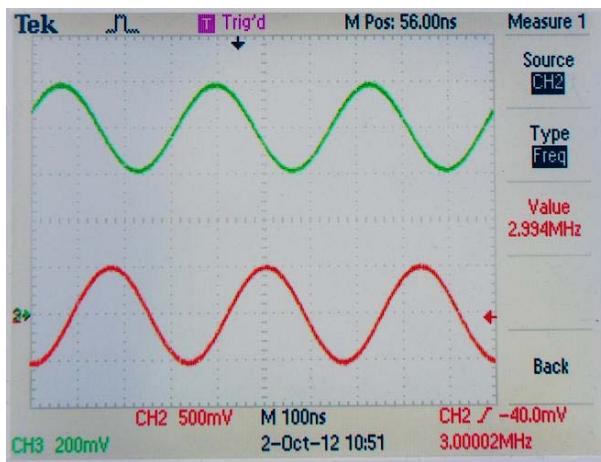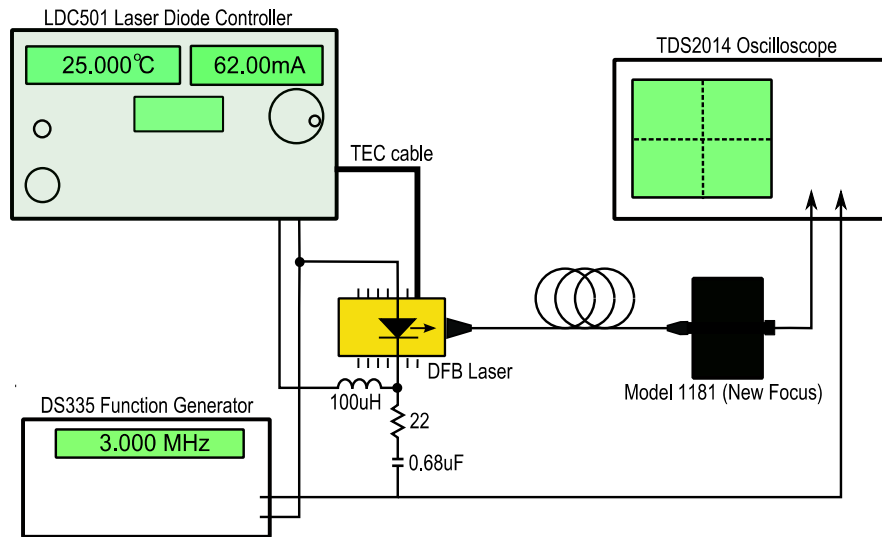
Fig.3 RF injection to a DFB laser and the Result