Vixar Application Note

Suggested Drivers for Use with Vixar Products

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1. INTRODUCTION

This document describes drivers that Vixar has identified for possible use with Vixar's VCSEL products. It is intended to serve as a guide. All references and details of third party suppliers' and/or manufacturers' products were taken directly from that vendor's or manufacturer's website, and Vixar takes no responsibility for the accuracy of the information contained in those third party vendors' and/or manufacturers' websites.

Inclusion or mention of a third party product in this document does not imply that Vixar has evaluated the third party product. Vixar takes no responsibility for the performance of any solution that integrates any of these third party products with Vixar products.

2. GENERAL PURPOSE DRIVERS

2.1. IC-Haus

The IC-Haus Ic-NZP driver provides for both Current Control(CC) and Auto Power Control (APC) control, if a Monitor PhotoDiode (MPD) is included. For CC control connect the MP pin to the IMON pin. For APC operation an MPD is needed (Vixar offers MPD solutions). One critical measurement that any Vixar customer considering this device should make is to demonstrate stable APC with small MPD currents.

2.2. Voltage Reference with Op-Amp Current Source

These current sources may typically be found in pulsed oximeter applications. They offer improved accuracy (for example to meet a ±0.03 mA tolerance needed for one Vixar customer's TE-Cooled stable-wavelength requirement) and low noise. A separate voltage reference IC, Op-Amp, transistor, and a few external components is all that is needed. It should be noted that the voltage reference ICs are stable over a range of operating temperatures. Contact Vixar sales for more information.

2.3. Integrated Voltage Reference with Op-Amp (Texas Instruments LM4121)

Another option that combines the voltage reference and op-amp into a single IC is available from Texas Instruments, namely the LM4121 "Precision Micropower Low Dropout Voltage Reference". Texas Instruments lists the following benefits:

- The LM4121 is a precision bandgap voltage reference available in a fixed 1.25V and adjustable version with up to 5 mA current source and sink capability.
- This series reference operates with input voltages as low as 1.8V and up to 12V consuming 160 µA (Typ.) supply current. In power down mode, device current drops to less than 2 µA.
- The LM4121 comes in two grades A and Standard. The best grade devices (A) have an initial accuracy of 0.2%, while the standard have an initial accuracy of

0.5%, both with a temperature coefficient of 50ppm/°C guaranteed from -40°C to +125°C.

- The very low operating voltage, low supply current and power-down capability of the LM4121 makes this product an ideal choice for battery powered and portable applications.
- The device performance is guaranteed over the industrial temperature range (-40°C to +85°C), while certain specs are guaranteed over the extended temperature range (-40°C to +125°C). Please contact National for full specifications and the LM4121 is available in a standard 5-pin SOT-23 package.

3. DVD Drivers with RF Modulation for Noise Reduction

If one goes back to the early days of DVD players (early 1990's), there once was a FP type laser that exhibited a "self pulsation". The self pulsating lasers would oscillate on and off at a frequency of 0.8 to 1.2 GHz. The self pulsation destroyed the coherence of the laser, so they were less susceptible to reflections and thus had lower noise. An interferometer was used to measure the coherence and a FFT (Fast Fourier Transform) was used to calculate the optical spectrum. The coherence parameters were used to sort lasers in those with low noise suitable for DVD players and standard lasers that were acceptable for CD players.

During this timeframe IBM was developing low cost MM fiber communications based on CD/DVD lasers. As it turns out the low coherence was needed to control modal noise on the fiber links, so the early communication links (at 266 Mb/s and 512 Mb/s) used the so called self pulsating laser. At 512 Mb/s the self pulsating frequency was pushed up to and specified to be 1.6 GHz min to keep it out of band with the data, such that the receiver would essentially filter the self pulsation. At 1 Gb/s data rate the self pulsation frequency would need to be over 3 GHz, beyond the capability of the laser devices. However, by observing the coherence function for non-self-pulsating when the 1 Gb/s data modulation signal was applied, we learned that the data modulation was sufficient to destroy coherence and control modal noise.

Even today there are DVD drivers with built-in modulators or there are external modulators that can be coupled onto the data signals. The reason is slightly different, since they claim to reduce the noise associated with laser mode hopping.

One example of a DVD driver with RF modulation is the MAX9484 with differential LVDS inputs or the MAX9483 with single ended inputs.

Another DVD driver is the Texas Instruments LMH6525. It is very similar to the MAX9483, except that it supports 4 current levels and both the freq and amplitude of the RF modulation can be controlled.

As mentioned above, the RF modulator is also available as a standalone IC that can be added to any current source. For example, RF modulation could be added to any

of the General Purpose Drivers of Section 2 by adding a bias-Tee to AC-couple the modulation. Intersil's RF modulators support up to 600 MHz. This modulator is intended to be placed close to the laser out on the optical head.

4. Communications Drivers

There are wide variety of data communications drivers available from Vitesse, Maxim, Linear Technology, IPTronics, Analog Devices, and other IC suppliers. A few drivers that Vixar has evaluated with our VCSELs are discussed briefly in the following sections.

Historically, the compensation of CW (DC) power over temperature has been accomplished by using a MPD with a control loop built into the driver. The AC modulation (Extinction Ratio) temperature compensation was accomplished by using an external microcontroller (with look up table) and a digital potentiometer. However, more sophisticated drivers that include the modulation temperature compensation within the driver IC are now available. Some simply have a few different temperature compensation levels and some allow programming of the compensation through a 2 wire serial interface.

Most drivers also offer some form of "peaking" circuits to tweak the rise or fall time of the laser.

4.1. Maxim MAX3795 1 Gb/s to 4 Gb/s VCSEL Driver

The 3795 assumes that the adjustment of bias current with temperature is taken care of by the APC control using the MPD signal. The value of the modulation current temperature compensation coefficient (ppm/oC) is adjusted by selecting the resistor value connected across the TC1 & TC2 pins. This driver was quite easy to get running using Maxim's evaluation board.

4.2. Linear Technology LTC5100, 3.2 Gb/s VCSEL Driver

This has a digital serial interface and built-in digital controller. It has a temperature sensor that allows the controller to provide some temperature compensation. It can be set up to run stand alone or with a microcontroller and offers on chip DACs, needed to eliminate potentiometers. The evaluation board comes with a USB interface to your computer and a very nice software application that is easy to set up and get running. Unlike many drivers for which the laser must be located very close to the driver, the LTC5100 can drive a controlled impedance line to the laser, allowing for some distance between the driver and the laser. This typically involves some form of back termination compensation or circuit that prevents reflections from the laser from being reflected again at the driver. Analog Devices also offer such "back reflection" control driver solutions.

4.3. Mellanox IPVD12G011 12.5 Gb/s VCSEL Driver

Mellanox provides multi-lane or parallel communication drivers, for example 4 wide for QSFP applications or 12 wide for MTP connector applications. They offer a 2 wire serial interface for setting and adjustment of bias and modulation currents and a

temperature compensation circuit. These ICs are available in die form and require that the VCSELs be mounted for direct wire bonding (flip chip options as well) to the driver.

Mellanox evaluation boards come with a software application for USB connection to your computer. However, due to the direct connection you will need the VCSEL to be in die form and have die mounting and wire bonding capability.

5. Pulsed Driver Solutions

IC-Haus offers a wide range of drivers for a variety of pulse widths and pulse repetition rates. OmniPulse offers OEM pulse generator products as well as pulsed laser drivers. Avech, Thorlabs, ILX and others offer pulsed generator instruments with laser interface options.

Another solution is to use a bias-T for DC current control and modulate the laser directly from your pulse generator or pulsed pattern generator. If higher drive currents are needed, then an RF amplifier (with a high power compression limit) can be deployed to increase the modulation voltage (current).

Some of the communications driver solutions, listed above, can be used to pulse lasers, but issues related to AC coupling vs. DC coupling and how the DC and AC modulation settings are established may arise. Communication driver ICs assume a certain level of DC balance in the pulse stream. For short duty cycles, the bias and modulation setting circuits could behave abnormally. However, Vixar was able to produce 1 ns optical pulses from our VCSELs at 1 MHz repetition rate using the DC coupled LT5100 driver.

6. Pulsed Array Driver Solutions

When driving a laser array higher currents are needed and the driver must be suitable for driving the low impedance of the array. The impedance of the laser array can be very low, a few Ohms or less. Vixar has evaluated the IC Haus model iC-HG driver for driving high power arrays. This is a 6 channel driver with up to 500 mA per channel. The channels can be connected in parallel to realize up to 3A driver current and multiple drivers can be connected in parallel to achieve still higher currents. This driver operates from CW(DC) to 200 MHz. The level of drive current is dependent on the duty cycle and the analog voltage applied to the laser (up to 12V). If you order an evaluation board, Vixar recommends revision Y1 or later that include TSV protection diodes. When driving lasers with this driver optimum performance is achieved with low inductance connections between the driver output and the laser. Too much inductance combined with a high (>8V) analog voltage at the laser can damage the driver output, unless the TSV protection diodes are included. When driving from a 50 Ohm pulse generator, Vixar added a 50 Ohm load resistor to the TTL input.
Some LED drivers are suitable for driving VCSELs and VCSEL arrays. For example the Texas Instruments LM3421 and Linear Technology LMT8042 operate under pulsed conditions (up to 2 MHz PWM dimming) up to 1 Amp. They include voltage boost circuits required for driving a series connected string of LEDs (or lasers).

For pulsing laser arrays in the laboratory up to 20A, Thorlabs offers the LDC4020 laser diode controller (or ITC 4020 with TEC controller), with pulse width capability from 100 μsec to 1 sec.

AvTech also offers high current pulsed current drivers.