THE MAX3740 / MAX3795 LASER DRIVER AVERAGE POWER MONITORS (PWRMON)

The MAX3740 and MAX3795 laser drivers provide a monitor output voltage of the average optical power of a laser diode. The monitor output is derived from the monitor diode current of the laser assembly. Monitoring the average optical power is often done in data communication type laser drivers. The operation of this feature on the MAX3740 and MAX3795 is different than conventional methods used in other laser drivers, which can lead to confusion when implementing SFF 8472 digital diagnostics.

The monitor diode current from a laser assembly is approximately proportional to the average optical output power from the laser. Laser drivers, in general, use the monitor diode current output to regulate the average power emitted from the laser diode (Figures 1, 2). This function of the driver is called the automatic power control (APC) loop.

Laser drivers used in SFP module applications will often provide a current output which is a mirror of the monitor diode current through one of the device's output pins (Figure 1). By placing a resistor on the pin, the module controller (DS1856 for example) can monitor the voltage which will be proportional to the monitor diode current, which in turn is proportional to the average power. The appropriate scaling and offsets are then provided inside the controller to meet the SFF 8472 requirements.

The MAX3740 and MAX3795 use a voltage output PWRMON pin (Figure 2) to report the average power instead of a current mirror output. The difference with these devices is the PWRMON voltage will always be 0.4V as long as the automatic power control loop of the laser driver is working properly regardless of the absolute monitor diode current. One would then ask, how is it that the monitor output can be used by the controller to monitor the average optical power?

To explain how this feature is used, let's take for example two optical modules. Each module is set for an average power of -4dBm. For module 1 this translates to a monitor diode current of 100uA and for module 2 this translates to a monitor diode current of 200uA (A variation of monitor diode current for the same average optical power is common due to part-to-part coupling variations between the laser and monitor diode).

For both modules, the voltage reported by PWRMON will be 0.4V since the APC loop regulates the output to this voltage. The only difference in the two modules is the set resistance.

For module 1, the set resistance is approximately 2k Ω (0.2V / R_{PWRSET}) and for module 2 the set resistance is approximately 1k Ω (0.2V / R_{PWRSET}). If for some reason, the module vendor needed to know and store the actual monitor diode current, they would simply need to know the set resistance given the formula above. However, the value that is reported over an internally calibrated I^2C bus for the SFF 8472 requirements is the optical power output not the MD current.

If the part is working correctly and there is no fault then the PWRMON voltage will remain at 0.4V. Since the voltage will always be 0.4V regardless of the absolute monitor diode current set point, the internal calibration procedure is simplified because the same offset and scaling can be used for every module as long as each module is calibrated to the same average power.

If the APC loop goes out of regulation then the voltage will change as a function of the MD current variation. This is because all paths are high impedance for the MD current except through the set resistor. Therefore, if the power doubles, the current doubles and the voltage will then double because R is a fixed value.

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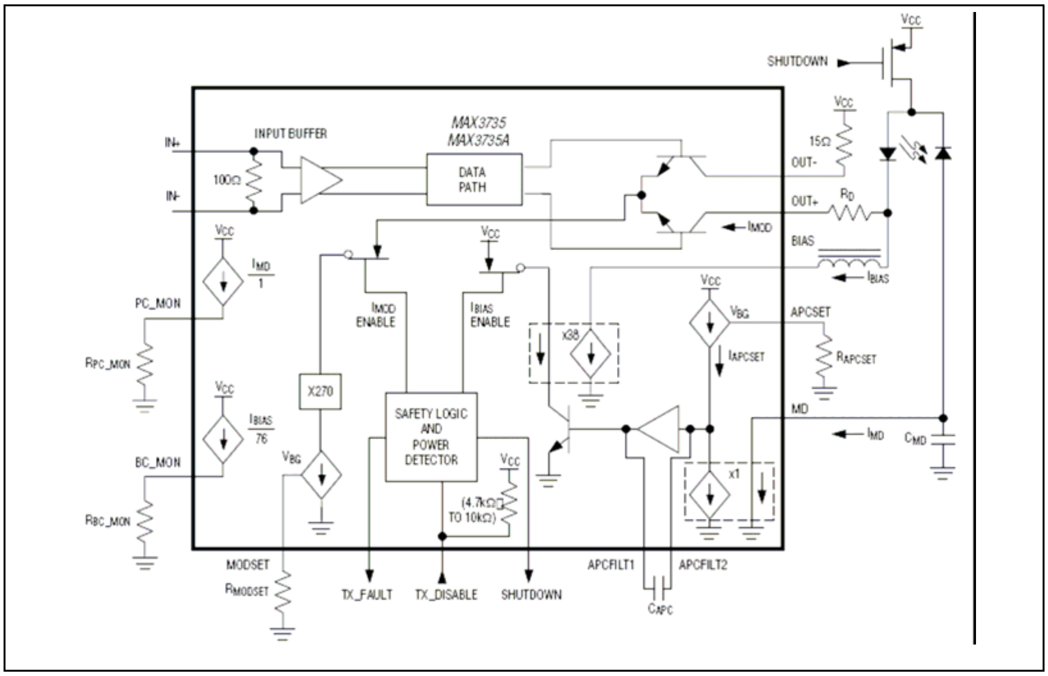

Figure 1: Conventional Monitor Block Diagram

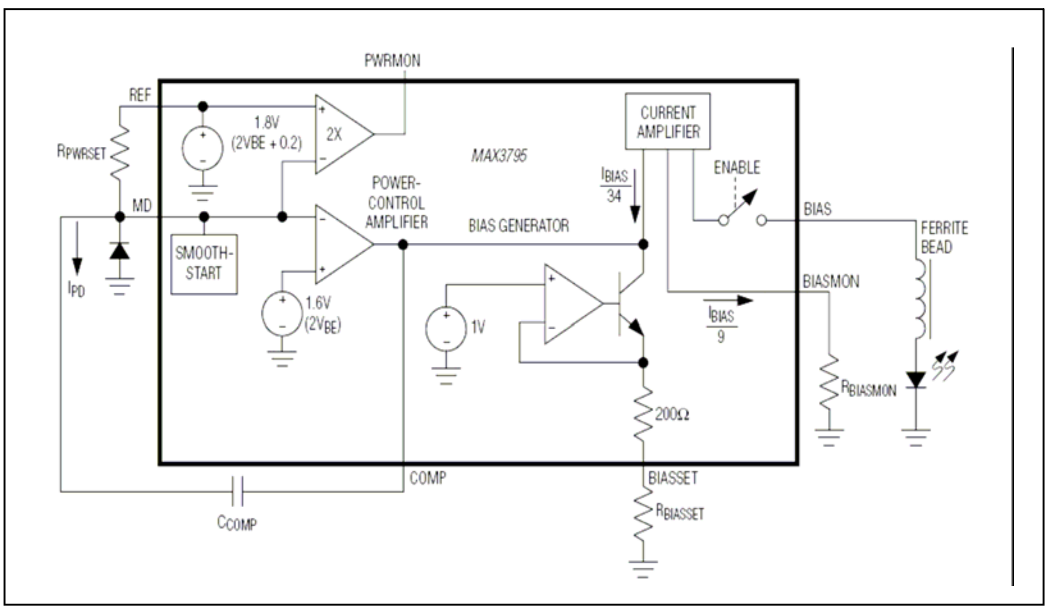

Figure 2: MAX3795 Monitor Block Diagram

The fault threshold of the device is set to 0.8V this means that a fault will be reported if the MD current ever doubles from the original set point. If it is somewhere in the middle, a fault will not be reported but the power can be calculated given that the same voltage increase at PWRMON relates to a relative MD current change.

So for the case of the two modules, module 1 would have a monitor diode current of 100uA for a power of -4dBm which is reported as a 0.4V output from PWRMON. If the loop goes out of regulation due to a safety fault or some other reason, the power will increase to -1dBm and the voltage at PWRMON will be 0.8V which relates to a monitor diode current of 200uA in this case. For a monitor diode current of 150uA the voltage would be about 0.6V.

For module 2, the monitor diode current would be 200uA for an average power of -4dBm and a voltage on PWRMON of 0.4V. Again if the loop goes out of regulation and the power increases to -1dBm the voltage at PWRMON would be 0.8V and the monitor diode current would be 400uA (always the same ratio, if the monitor diode current double the voltage will double).

This method of monitoring the average power also has other advantages over the conventional methods. In laser drivers where there is simply a current mirror of the MD current which generates a voltage over a fixed resistor, the fault level may be too high or too low for an individual module due to part-to-part variation of the monitor diode current.

Going back to the original example and using the conventional current mirror method for monitoring average power such as that found on the MAX3735A (Figure 1), we have module 1 and module 2 set for an average power of -4dBm with MD currents of 100uA and 200uA respectively. The fault level in this case is set by the driver at a fixed value of approximately 1.3V.

The monitor resistor in both cases is set at 3.25kOhm for this example. Therefore module 1 would report a voltage of 100uA*3.25kOhm = 0.325V and module 2 would report a voltage of 200uA*3.25kOhm = 0.65V each for the same average optical output power.

If the MD current doubles (approximate double of the average power) then module 1 would have an average power of -1dBm and a voltage of 200uA*3.25k Ω =0.65V and module 2 would have an average power of -1dBm and a voltage of 400uA*3.25kOhm = 1.3V. Note that for this case, only module 2 would report a fault although both modules doubled their power. In many cases, this conventional method will work well because the part-to-part variation in the laser of the MD current for a given average power will not vary significantly. However, as seen above, if there is a large variation there can be issues in setting a proper safety level unless you use an adjustable resistor on the monitor and calibrate it for each module as well. The MAX3740 and MAX3795 alleviate this problem and simplify the calibration process.

It has been shown that the MAX3740 and MAX3795 provide a useful and simple method to monitoring the output power of a laser diode in module applications that implement SFF 8472 diagnostics and that this method provides a stable fault level even when there is a large monitor diode part-to-part variation.