KRONA ELECTRONICS

DiodeGuard™: A Breakthrough in Laser Diode Protection

DiodeGuard™ is a revolutionary advance in laser diode protection. Designed to guard against two of the most costly laser diode failure modes, the DiodeGuard™ circuit and its supporting firmware will protect your valuable laser diode investment in ways that were not possible before. DiodeGuard™ is a standard feature on all MV-21 and MV-40 products.

Since laser diodes are expensive and fragile devices, their protection is a critical consideration in any system design. In a typical application, the laser diode is the single most important component – and the most easily damaged or destroyed. Conventional power supplies, regardless of the quality or sophistication of their design, do not support the safety and diagnostic measures that are uniquely important to laser diode operation. Simple laser diode driver modules also suffer many of these limitations. Our products, on the other hand, are designed from the ground up for the specific requirements of laser diodes. That is why we refer to our products as “laser diode controllers” rather than “power supplies” or “drivers” - to distinguish them from more general purpose systems that typically do not provide features that are vital for the task of laser diode control.

The problem of laser diode protection becomes especially critical for groups of multiple laser diodes, whether packaged as a single device or wired together in a series of discrete components. This type of arrangement, while creating a powerful and useful light source, opens up the possibility of an abrupt cascade failure of an entire string of laser diodes. Avoiding this expensive proposition is the purpose of DiodeGuard™.

There are two failure scenarios addressed by DiodeGuard™. The first is a sudden electrical short of one diode in a series of several diodes. In this case the voltage across the series of diodes abruptly drops. A conventional power supply or driver responds to this situation by rapidly discharging its output capacitor through the diode string, causing an enormous spike of current to pass through the diodes. Even if the driver's current servo responds quickly to this situation, the response time of such circuitry may be insufficient to prevent catastrophic damage to the diodes. DiodeGuard™ prevents this by clamping the output current to a point just slightly above its steady-state value, suppressing the dangerous spike almost entirely. This is illustrated in Figure 1.

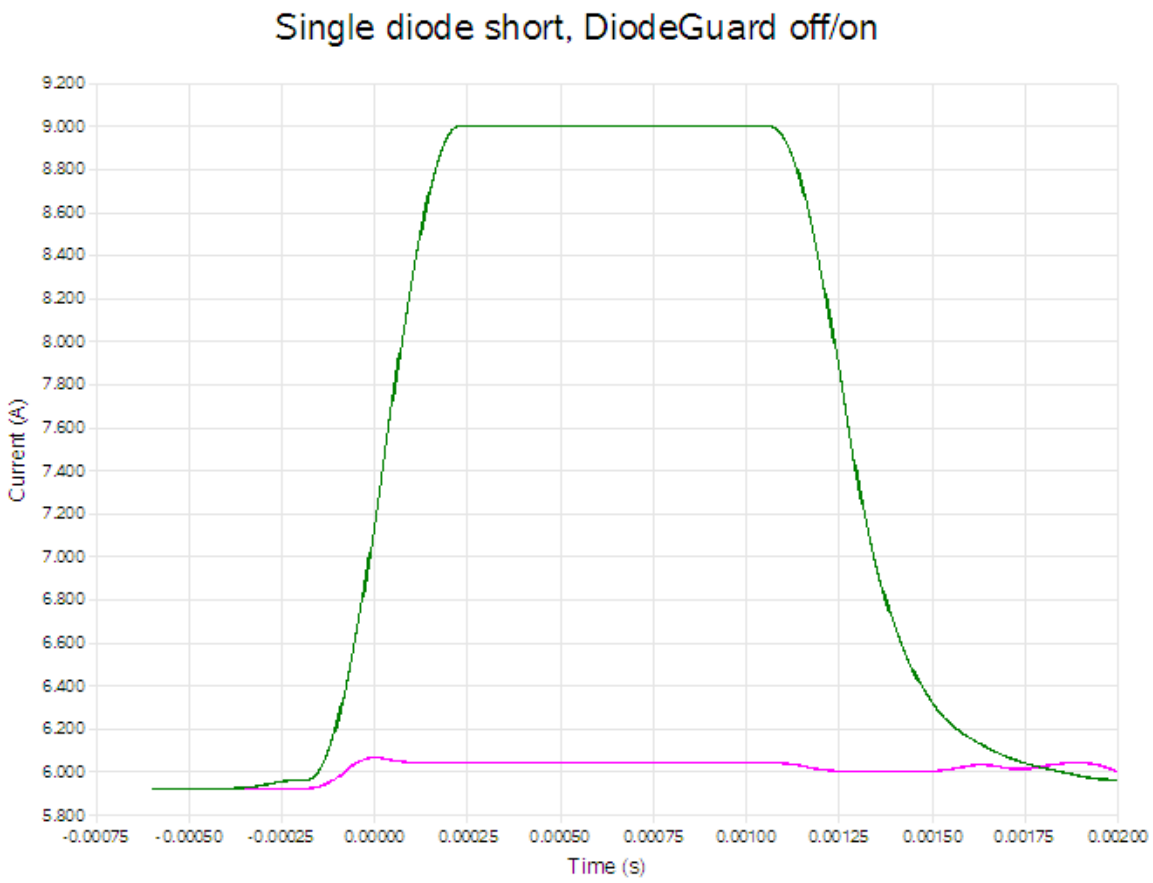

Figure 1: Controller response to a short in a string of diodes
Short occurs at t = 0
Green curve: DiodeGuard™ off
Red curve: DiodeGuard™ on

In this experiment, a modified MV-21 controller was used to power a series of 6 silicon rectifier diodes. The current from the controller was set to 5.9 A. At t = 0 seconds, a MOSFET switch was used to create a short across one of the rectifier diodes. The green curve illustrates the controller's output current with DiodeGuard™ off. Note that the current spike is actually far greater than illustrated since the detector saturated at 9A. Although the current spike lasted only about 1 ms before the controller's constant current servo was able to recover, the excess current would probably have been sufficient to destroy a string of laser diodes. The red curve is the same measurement performed with DiodeGuard™ on. In this case the string of diodes sees only a small current excursion of about 100 mA – a dramatic difference, and well within the damage tolerance of laser diodes.

The second scenario addressed by DiodeGuard™ is an intermittent loss of connection between the controller and the laser diodes. This common scenario can occur because of a faulty or loose connector, and is a notoriously difficult type of problem to avoid, diagnose, and correct. Almost any experienced laser diode user has lost one or more devices in this way. It is particularly likely to occur when a group of laser diodes is connected in an electrical series, because of the multiplicity of possible failure points. A conventional constant current source, at the instant the connection to its load is lost, responds to the detected drop in current by attempting to increase the output voltage. If the connection is now suddenly restored, the result is an instantaneous over-current condition. The result can be catastrophic

damage to the laser diodes – through no defect of either the controller or the laser diodes themselves. With DiodeGuard™ present, however, this situation is handled safely. As in the case previously discussed, DiodeGuard™ clamps the output current. At the critical instant when the connection is restored, DiodeGuard™ ramps the current gently back to its steady-state value with only a small overshoot. This is illustrated in Figure 2.

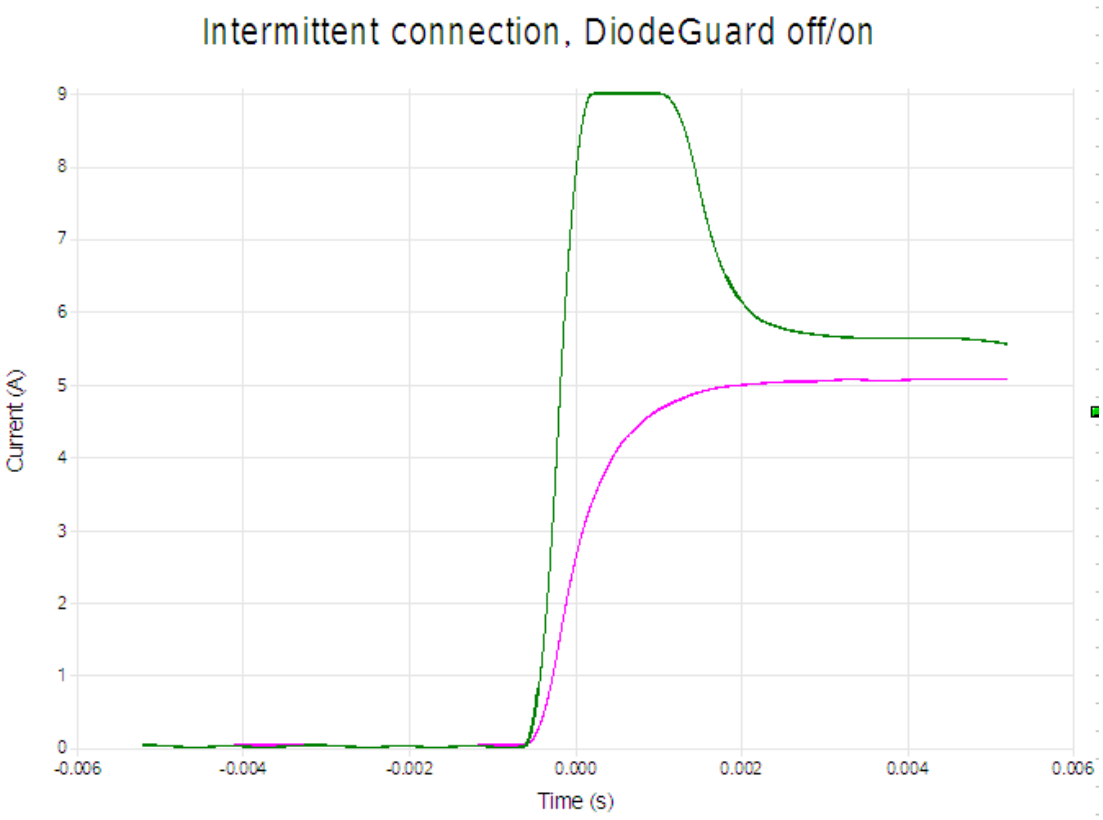

Figure 2. Controller response to the restoration of an intermittent connection
Intermittent Connection restored at t=0
Green curve: DiodeGuard™ off
Red curve: DiodeGuard™ on

In this experiment, a modified MV-21 controller was used to power a series of 6 silicon rectifier diodes. The current from the controller was set to 5 A. A MOSFET switch was used to break periodically the connection to the load and remake it, in a pulsed fashion. This simulates an intermittent connection. The width of the MOSFET pulse was 0.25 seconds. This is sufficiently long for the controller's protection algorithm to detect an over-voltage condition and turn off the output current, but this capability was disabled for the purpose of this experiment. At t = 0 seconds, the connection was remade. The green curve illustrates the controller's output current with DiodeGuard™ off. Note that the current spike is actually far greater than illustrated since the detector saturated at 9A. Although the current spike lasted only about 1 ms before the controller's constant current servo was able to recover, the excess current would probably have been sufficient to destroy a string of laser diodes. The red curve is the same measurement performed with DiodeGuard™ on - in this case the current ramps smoothly to the commanded value of 5A.

All our controllers detect and report an over-voltage condition when the connection between the controller and the laser diode is broken. Thanks to DiodeGuard™, the MV-21 now extends this capability. If a standard (unmodified) MV-21 is subjected to the intermittent connection scenario just described, even if the connection is broken and restored too rapidly for the over-voltage protection algorithm, the system firmware will detect the activation of the DiodeGuard™ circuit. It will then shut off the laser diode current and report a fault to the user. The connection problem can be diagnosed and solved in complete safety.

The MV-21 firmware, in addition to providing the high level of laser diode safety common to all our products, also monitors the DiodeGuard™ circuit to insure proper operation. Thus the user of the MV-21 can have confidence that their valuable laser diodes are thoroughly protected by this novel design. In the event of a system failure - whether of the controller itself, the laser diode, or the connections between them – the system firmware is always on the job to diagnose and report the cause of the problem.

The MV-21 and MV-40 products, with their unique combination of innovative circuit design, software diagnostics, and digital control, set a new standard in laser diode control. Contact us today for more information about these products, and the rest of the Krona Electronics line of state-of-the-art laser diode controllers.

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