A.15: A compact and cost-effective laser diode power supply for laser marker system

A 40 A, 2.5 V dc current controlled power supply for laser diode has been developed at Power Supplies and Industrial Accelerator Division for laser marker system, which is developed at SSLD, RRCAT. The power supply operates on 230 V, 50 Hz single-phase ac mains and has output current ripple less than ±0.5%. The salient features of power supply are: small size, light weight, low cost, simple configuration, high reliability and ruggedness. It is based on two switch forward converter topology operating at 100 kHz.

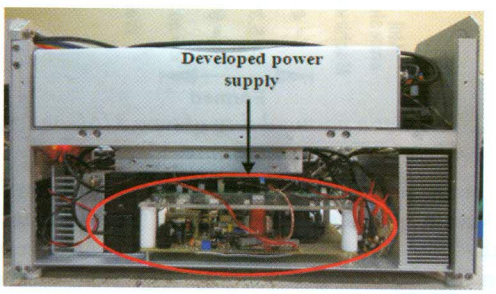

Fig. A.15.1: Integration of power supply with laser marker machine

Two-switch forward converter topology is chosen amongst various SMPS topologies due to its distinctive merits such as better efficiency, simple configuration, free from shoot through failure, high reliability and ruggedness, voltage rating of each of the switches is one-half of that in a single switch topology, no requirement of demagnetizing winding, etc.

Power supply is interfaced with the laser marker machine using various remote interface signals like remote reference, read back, reset and fault/ok status which are terminated on a 12-pin terminal block mounted on the power supply board. The power supply is capable of being operated in dc as well as in slow pulse mode by keeping output current rise and fall times of the order of 5 ms. This is done by incorporating a rate limiter circuit in the power supply. An over current protection feature is incorporated in the power supply in order to trip the supply in case of occurrence of fault.

Peculiarities in fabrication:

The application constrains the allowable size of the laser diode power supply to be less than 150 mm × 230 mm. Judicious selection of PCB layout is done by designing the power supply as an open-frame unit with the power circuit as well as the control circuit on the same PCB. In doing so various other aspects such as physical separation between the power and control circuit so as to minimize interference between the two, accessibility of components, maintenance etc. has also been taken care of. This is done in order to achieve the objective of compactness of the power supply, which is necessary to make it suitable to be mounted in the limited space inside laser marking machine. While assembling components on the PCB due care has been taken to provide easy accessibility to important components such as switches, schottky diodes, etc. for monitoring and maintenance purpose. Also, arrangements have been made to use a compact heat sink for the schottky diodes mounted on the secondary side of the transformer by mounting a small 12 V operated fan on the heat sink itself with proper channeling for the air flow. In addition to this, efforts have been made to integrate the feedback control circuit with the PWM generation circuit, which helped in further reduction of the power supply size by reducing the number of components in the control circuit.

By following the aforementioned steps, it has been possible to reduce the size of power supply by around 50 % over the existing power supply. This made mounting of the power supply inside the compact laser marker machine possible, which can be seen in Fig. A.15.1. Consequently, the material cost of the developed power supply is also reduced.

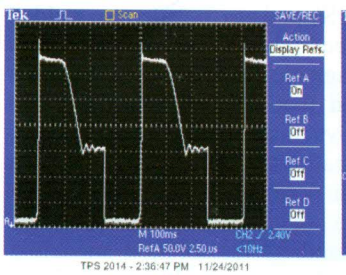

Fig. A.15.2: Voltage across switches

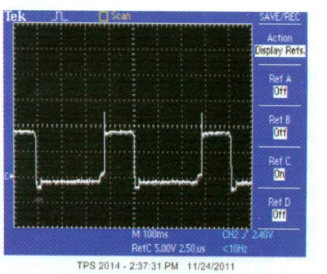

Fig. A.15.3: Voltage across schottky diode

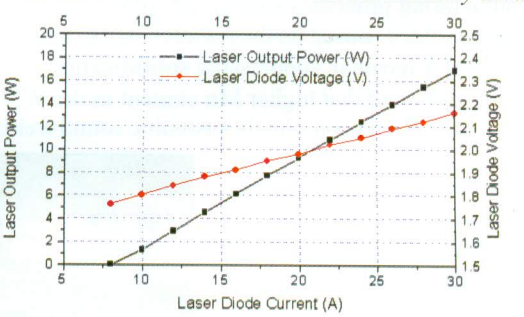

Fig. A.15. 4: Laser diode output power and compliance voltage versus laser diode current

Figures A.15.2 and A.15.3 respectively show voltage across switches and schottky diode. Figure A.15.4 shows experimental data of laser diode output power and compliance voltage with respect to laser diode input current. It can be seen that the laser output power is proportional to the drive current, however, the compliance voltage increases very slowly with the drive current.

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