To overcome the basic problem inherent in the use of multiple paralleled rectifier cells, i.e., achieving equal current distribution, Motorola matches and guarantees the forward-voltage characteristics of each cell to within 20 millivolts at 100 amperes. These closely matched rectifier cells are then mounted on a common copper base in a manner which intimately couples each cell thermally. Under normal operating conditions, the thermal difference between cells is so low that any current unbalance is negligible.

Other advantages of the parallel-cell concept areas are as follows:

(1) the entire rectifier assembly can be factory tested prior to final assembly and any substandard cells can be replaced;

(2) a number of reserve cells can be "built in" to provide an extra current margin;

(3) current-handling potential is virtually unlimited (a 2,000-ampere unit has performed satisfactorily);

(4) higher current devices mean a sharp reduction in the number of expensive "accessories" (balancing transformers, paralleling reactors, etc.) previously required on many applications;

(5) the user can bolt the unit to busing without a torque wrench. There is virtually no possibility of damaging the individual cells by overtightening either the stud bolt or the lead connection, because there is no fragile insulator-to-metal hermetic seal between external leads and case (an inherent characteristic of single-junction devices).

Parallel Connections

Certain applications may still arise which require considerably greater currents than can be drawn from circuits with one rectifier per leg. When rectifiers must be paralleled, the current loads through each rectifier must be balanced.

In order to attain the proper division of current when paralleling silicon diodes, the following procedures are in current use:

(1) factory matched forward characteristics.

(2) the addition of resistance or reactance in series with each diode.

(3) balancing transformers or separate transformer windings.

Factory matched diodes are selected so that they will divide current properly during the normal steady-state conduction and the overload or fault conditions. Depending on the manufacturer's recommendation, the average current rating per diode must be lowered in order to compensate for the known unbalance that will remain. Use of a common heat sink is mandatory in order to keep the junction temperature nearly the same and thus assure voltage tracking with current and ambient caused temperature changes.

Generally no more than six to ten diodes should be paralleled unless careful consideration is given to the bus reactance and resistance design. Resistors used in series are the simplest method of forcing current division and are generally chosen so that the combination has a peak voltage drop approximately 30% higher than the diodes alone at the normal load current. (Fuses, in series with each rectifier, may supply all the resistance required.) In this manner, current division is markedly improved but unfortunately, more power loss is introduced into the equipment. The use of individual reactors in series with each diode offers a better choice from the standpoint of efficiency.

Use of balancing transformers is a very effective means of forcing proper current balance and may be less expensive than purchasing factory matched units. The transformers consist of laminated iron cores usually with single-turn primary and secondary windings. The current from two diodes in parallel passes around the core in opposite directions so that any unbalance will induce a voltage which serves to correct the unbalance. The basic technique is shown in Figure 2. Its extension to larger numbers of rectifiers is illustrated and briefly discussed in Figure 3.

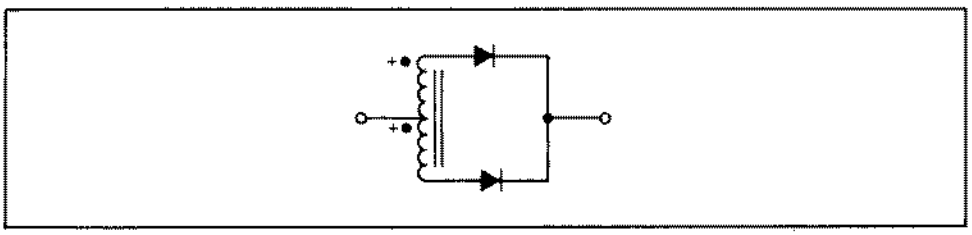
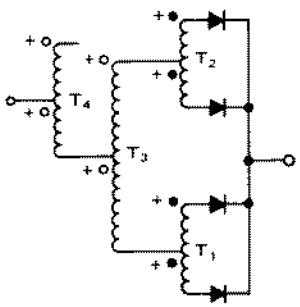
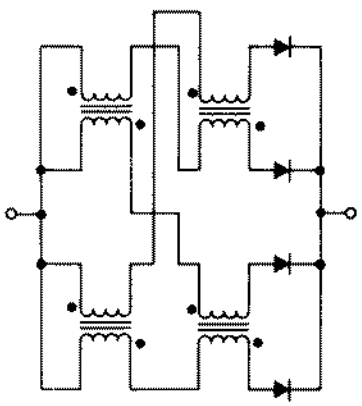


Figure 2 – Parallel Operation of Silicon Rectifiers Using Balancing Transformers



(a) Balancing Reactors Used with Diodes in an extension of the basic circuit. Transformer T_3 must handle twice the current of T_1 or T_2; T_4 must handle twice the current of T_3, etc.



(b) Balancing Reactors in a Closed-Chain System. Each winding carries only the current of one diode.

Figure 3 – Schemes for balancing the current when more than two diodes are required.