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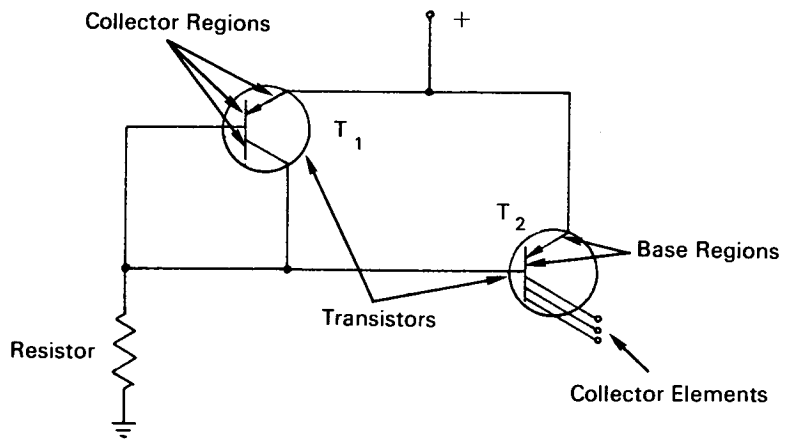
NASA TECH BRIEF

Integrated Circuit with Multiple Collector Current Source



The integrated circuit with multiple collector current source can achieve the equivalent of a large number of resistors in a small area. Functional equivalents of a transistor reduce the size requirements for low power integrated circuits, providing an efficient alternative to the conventional diffused resistor process in integrated circuit fabrication. This innovation should be of interest to designers and manufacturers of integrated circuits. Additional applications include counters and arrays of a plurality of logic gates or flip flops and related circuitry. It can also be used advantageously wherever numerous current sources fed from a common supply are required.

In integrated circuits, cost can be reduced by minimizing the semiconductor surface area required for each circuit function. Resistors can be integrated successfully using a diffused region directly analogous to a discrete resistor. In low power integrated circuits, however, high value resistance is often required to limit the current to a low value, thus reducing the power dissipation. In some applications such as counters, where repetitive arrays of many circuits are used, the area occupied by resistance is multiplied and becomes economically prohibitive to integrate conventionally.

The present invention is an improved integrated circuit resistance scheme applicable when a number of low magnitude current sources are required. Current source structures suitable for integration with low power dissipation and small size requirements are provided by a transistor structure with at least two collector regions in p-n junction relation with the base region. One collector region is shorted to the base, so that a voltage applied across the emitter region and a circuit point resistively coupled to the shorted collector makes each of the other collector regions act as a current source. In effect, two or more transistor functional equivalents are provided; the first one has the collector junction short circuited, and to that one a current is applied through a conventional resistance.

(continued overleaf)

The second transistor functional equivalent, or any additional one, has its emitter and base connected, respectively with the emitter and base of the first. The collector current of the second transistor is proportional to the current flowing in the resistance, depending on the junction area. Therefore, that collector serves as a current source. A plurality of collectors may be used to provide a plurality of current sources using only one conventional resistance in the structure. The plurality of collectors may have different characteristics such as junction area of distance from the emitter, to provide varied current sources in the same structure.

Figure 1 is a circuit schematic in which transistor T1 has emitter base and collector regions, of which the base and collector region are directly connected together to a resistor. Transistor T2 has emitter and base regions connected to the corresponding regions of transistor T1. Transistor T2 has a plurality of collector elements. Each of the collectors of T2 appears as a current source to any circuit elements connected thereto when a voltage is applied across the emitter and the end of the resistor remote from the transistors with normal polarity. In this example, voltage may be applied by a positive source connected to the emitters with the remote end of the resistor at a more negative potential such as ground.

The single resistance required in the practice of this invention is typically about 10^3–10^4 ohms, and serves to obtain the equivalent of a large number of resistors. Compared with the structure in which conventional resistances are employed, a reduction in required area of about an order of magnitude is provided. Furthermore, the resistances appearing in this circuit have lower power dissipation than conventional resistances of like magnitude because of non-linearity. The invention is not susceptible to temperature variations, resistivity or fabrication processes, because the collectors will vary proportionally to all such parameters. By the constant current gain, this versatile integrated circuit element is capable of applying equal currents with two or more current sinks at different potentials.

References:

1. Lin Patent 3,197,710, July 27, 1965.
2. Copending Application Serial Number 581,484, filed September 23, 1966 by Karcher, and assigned to the assignee of the present invention.
3. No additional documentation is available. Inquiries may be directed to:

   Technology Utilization Officer
   Marshall Space Flight Center
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Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

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