EARLY BIPOLAR TRANSISTOR LOGIC

ISSCC 1956

SESSION II

2:30 p.m.—5:30 p.m.—Irvine Auditorium
SWITCHING CIRCUITS

Chairman: H. E. Tompkins, *Burroughs Corporation*

2.1 Direct-Coupled Transistor Logic Circuitry in Digital Computers

J. R. Harris, *Bell Telephone Laboratories, Murray Hill*

The TRADIC Computer Research Project is studying direct-coupled transistor logic (DCTL) circuitry for use in airborne computers. This circuitry, described by Philco in March, 1955, puts the burden of good performance on the transistor. Certain germanium alloy transistors are attractive because of high current-gain and low saturation resistance. Philco SB100 surface barrier units are attractive where more speed and less gain are needed. A new Texas Instruments grown silicon unit having low saturation voltage (LSV) offers high temperature operation plus greater signal voltage which gives greater freedom in logical design and minimizes crosstalk. Crosstalk studies indicate a possibility of false switching in a large system of germanium transistors. This problem, which is more severe with faster transistors, appears readily soluble in a system of a few thousand 10-megacycle germanium alloy units.

In order to write logical design rules and a transistor specification, a system has been viewed as an assemblage of current-supply resistors, all the same size, with bases and collectors attached to each resistor (node). When all transistors driving a node are nominally off, the object is that maximum leakage currents of the collectors, plus current that is adequate for the bases on that node under worst conditions, shall never exceed the supply current. When a transistor driving a node is nominally conducting, the object is that it shall handle the entire supply current, and do this at a collector voltage that is near enough ground that collector leakage in every transistor driven from the node is below a fixed maximum. These concepts (with specific allowance for crosstalk voltage, resistor tolerances, "regulation" of an individual current supply, unbalance of base currents and temperature) have led to transistor specifications and logical design rules in which simple restrictions on the number of bases and collectors on a node are sufficient to guarantee safe operation. The germanium transistor specification permits a maximum total of 7 bases and collectors on a node, fewer when a series circuit (2 level AND circuit) is driven.

A DCTL word generator using 119 Radio Receptor RR163 germanium alloy units operated without cut-and-try over a temperature range exceeding −50°C to +65°C at 400,000 parallel words per second. An 800-transistor system for exercising a magnetic core memory is being tested.

Direct-Coupled Transistor Logic Circuitry in Digital Computers

THE EVOLUTION OF bipolar logic circuits started with the introduction of direct-coupled transistor logic as described in this early paper at ISSCC. This marked the start of a period of rapid development in bipolar circuit design and technology, with bipolar transistors soon being adopted for use in mainframe and other high-speed computer applications. Bipolar transistor logic is still used today for many applications (both analog and digital), although mainstream high-speed digital computers now rely on CMOS logic.

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