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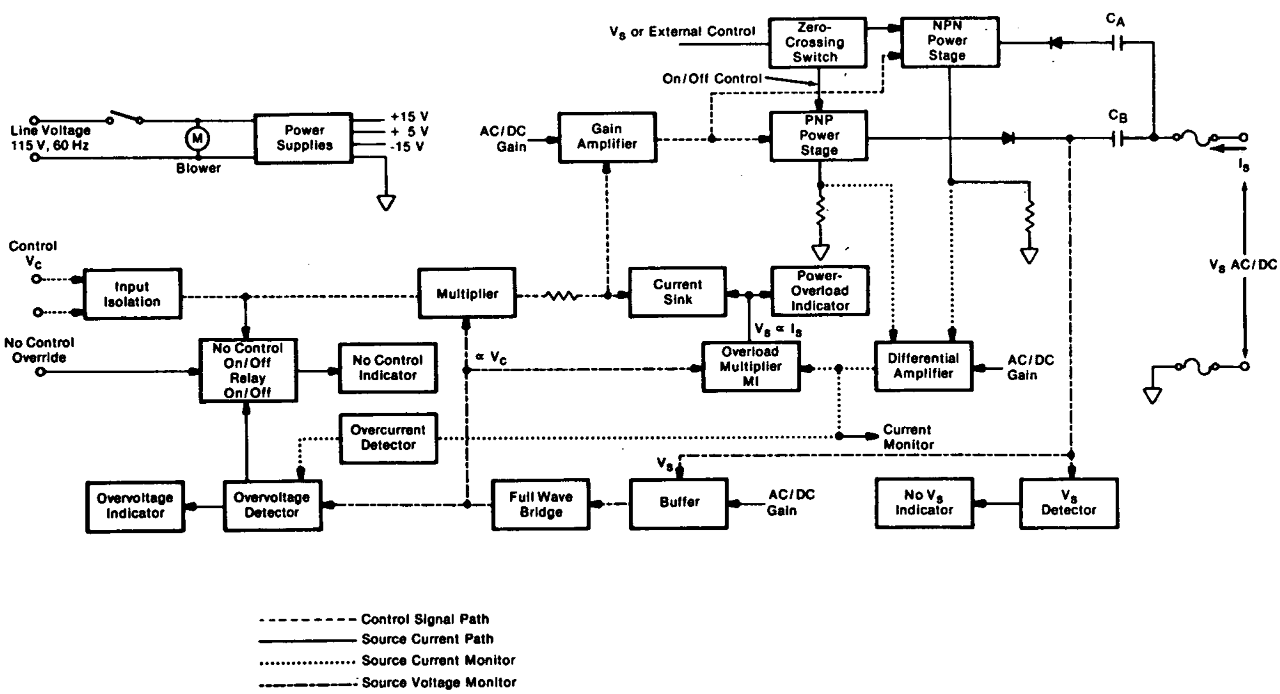
NASA TECH BRIEF

Lyndon B. Johnson Space Center

High-Power AC/DC Variable Load Simulator

The design and development of electrical power distribution and conditioning systems is highly dependent on the characteristics of power sources and loads. A significant factor in the design of these systems is the effect of the transient, or dynamic, characteristics of the various loads reflected back into the systems. This dynamic behavior, if not identified and accommodated, can result in faulty operation or catastrophic failure of the power sources and the other loads connected to these sources.

Earlier development (described in NASA Tech Brief B73-10305) has produced a medium-power dynamic electrical load simulator capable of representing both the transient and steady-state characteristics of electrical equipment operating on dc powerlines. The design of this device has been extended to permit the simulation of ac as well as dc loads and to provide for operation at higher power levels.



Block Diagram of AC/DC Variable R Dynamic Electrical Load Simulator

(continued overleaf)

The new simulator, called a high-power ac/dc variable R (variable resistance) simulator, responds to control signals over a wide frequency range and is capable of dissipating high power. The prototype operates over a frequency range of from dc to 10 kHz and up to 500 W continuous power in load voltage ranges of 20 to 60 V dc and 30 to 130 V ac. A variable R load-simulator operating at higher levels may be constructed by adding more output stage modules.

The system, as shown in the illustration, operates as follows: A control voltage V_C is applied to an input isolation stage and from there to the input of a multiplier. The second input to the multiplier is obtained from a full-wave bridge circuit which samples an applied source voltage V_S through a buffer stage. The output of the multiplier, a product of the two inputs, is then used to drive the power stages. This feature makes the load current I_S proportional to the applied load voltage V_S and, therefore, simulates a true resistance. The unit provides a separate system gain for ac and dc operation to assure optimum dynamic range for each mode.

The simulator contains an npn power stage for all positive load voltage inputs and pnp power stage for all negative load voltage inputs. Each power stage is comprised of four power modules, each of which consists of an operational amplifier and driver transistors in a voltage follower configuration. The source current is monitored through series resistors that provide feedback to the operational amplifiers. Additional power modules may be used, as necessary, to allow each power stage to accommodate larger power requirements. The source currents through the power modules are summed providing a current flow proportional to control voltage V_C and source voltage V_S.

The general form of the variable R transfer characteristic is:

$$I_S = \frac{V_S V_C}{K}$$

where I_S is the source current, V_S is the source voltage, V_C is the control voltage, and K is a scaling constant. The output resistance R is given by

$$R_S = \frac{K}{V_C}$$

The simulator is internally protected against reverse voltage, overvoltage, overcurrent, and overload conditions.

Notes:

1. The simulator is described in the following report:
   High Power AC/DC Variable R Dynamic Electrical Load Simulator
   NASA CR-140331 (N75-12199)

   Copies of this report may be obtained at cost from:
   Technology Application Center
   University of New Mexico
   Albuquerque, New Mexico 87131
   Telephone: (505) 277-3622
   Reference: B75-10108
2. Specific technical questions may be directed to:
   Technology Utilization Officer
   Johnson Space Center
   Code AT3
   Houston, Texas 77058
   Reference: B75-10108

Patent status:

NASA has decided not to apply for a patent.

Source: K. P. Joncas, S. Birnbach, L. D. Bruce, and L. Smith of Avco Corp. under contract to Johnson Space Center (MSC-14788)