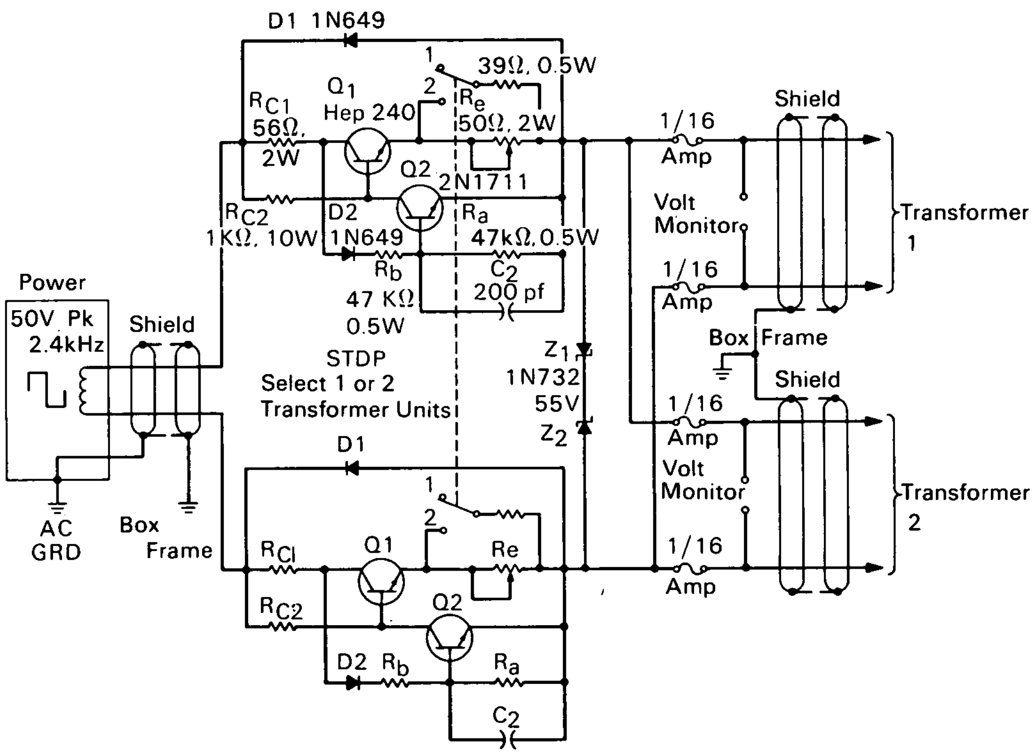
NASA TECH BRIEF

Transistor Current and Voltage Limiting Switch



Limiting-Switch Circuit

The problem:

A main power supply, used to power a series of electronic modules undergoing extended life tests, requires an overload circuit to protect the main supply and to limit and control the current drawn by each module in the event of a shortcircuit. The entire sequence must be automated due to the long and unattended nature of the test operation.

The solution:

A limiting circuit in a balanced configuration that limits current within 1 mA when used with direct current of either polarity or with pulse or ac power sources from direct current to about 100 kHz.

How it's done:

For an isolated power supply whose output is a 50-V-peak 2.4-kHz square wave, the circuit (see fig.) consists of two identical stages that alternately perform the limiting operation or bypass the current through diode D1, depending on the polarity of the supply voltage. Resistors R_{C1} and R_{C2} are chosen so that, for normal load current, Q_1 is saturated; D_2, R_b, and R_a form a voltage- divider network that feeds

(continued overleaf)

back part of the voltage across Q_1 and R_e to the base of Q_2. When Q_1 is saturated, and with normal load current through R_e, Q_2 is biased off. The current limit is controllable within 1 mA by variation of R_e.

As load current through R_e increases above the selected safe level, the voltage at the base of Q_2 rises, causing Q_2 to turn on; thus Q_1 is turned off, and regeneration then keeps Q_2 on and Q_1 off. By switching of the high resistance of R_{C2} in the path of the load current, both load and power supply are protected.

The circuit automatically resets to the on state when the supply voltage is dropped to zero and raised again; capacitor C_2 ensures that Q_1 turns on first when voltage is reapplied. By use of two stages and bypass diodes D1, this circuit limits current for direct current of either polarity or for a non-dc type of supply.

In this particular case, the load of the transformer's primary is considerably inductive; therefore, zeners Z_1 and Z_2 are used to limit inductive spikes that would occur if the circuit limited. The collector-to-emitter breakdown voltage of Q_1 and power rating of R_{C2} are chosen so that even with a worst-case power-supply failure, resulting in a supply output of 120 V rms (170-V peak), the transformer is not damaged. The circuit also protects the power supply and eliminates the chance of fire resulting from direct shorting of the outputs; it is capable of limiting continuously more than 120 V rms supplied to a direct short at the output. The switch's limiting speed for this circuit is about 5μsec; therefore it can be used for supply-voltage frequencies from direct current to about 100 kHz. The frequency range could be increased, if desired, by use of high-frequency transistors if the high collector-to-emitter breakdown voltage were not required.

Note:

Requests for further information may be directed to:

Technology Utilization Officer
NASA Pasadena Office
4800 Oak Grove Drive
Pasadena, California 91103
Reference: TSP70-10414

Patent status:

No patent action is contemplated by NASA.

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