March 1974

B73-10467

NASA TECH BRIEF

NASA Pasadena Office

Versatile, Analog-to-Digital, Power-Regulator Controller

The problem:

In the future, electronics used in spacecraft and other systems will have increasingly-complex, power-processing requirements. To meet such needs, a more effective and versatile power controller will be required. It should be capable of operating from a single 5-volt bias supply and should be compatible with the three basic power-stage types, namely, buck, boost, and buck-boost, which are regulated by the duty-ratio control of a switch.

The solution:

A new power controller uses digital techniques to vary the duty ratio of switching-type power regulators. The duty ratio is adjusted by comparing the error signal with a ramp voltage signal. As compared to the previously-used switching regulators, the controller uses fewer components and no magnetics and is readily adaptable to thick-film technology.

How it's done:

A block diagram of the new controller is shown in Figure 1. The controller is connected in a feedback loop with a dc sample signal representing the instantaneous power demand of the load. The sample signal and a dc reference voltage, proportional to the desired output voltage, are applied to an operational amplifier which generates an error signal. The error signal, and a periodically descending voltage from the ramp generator

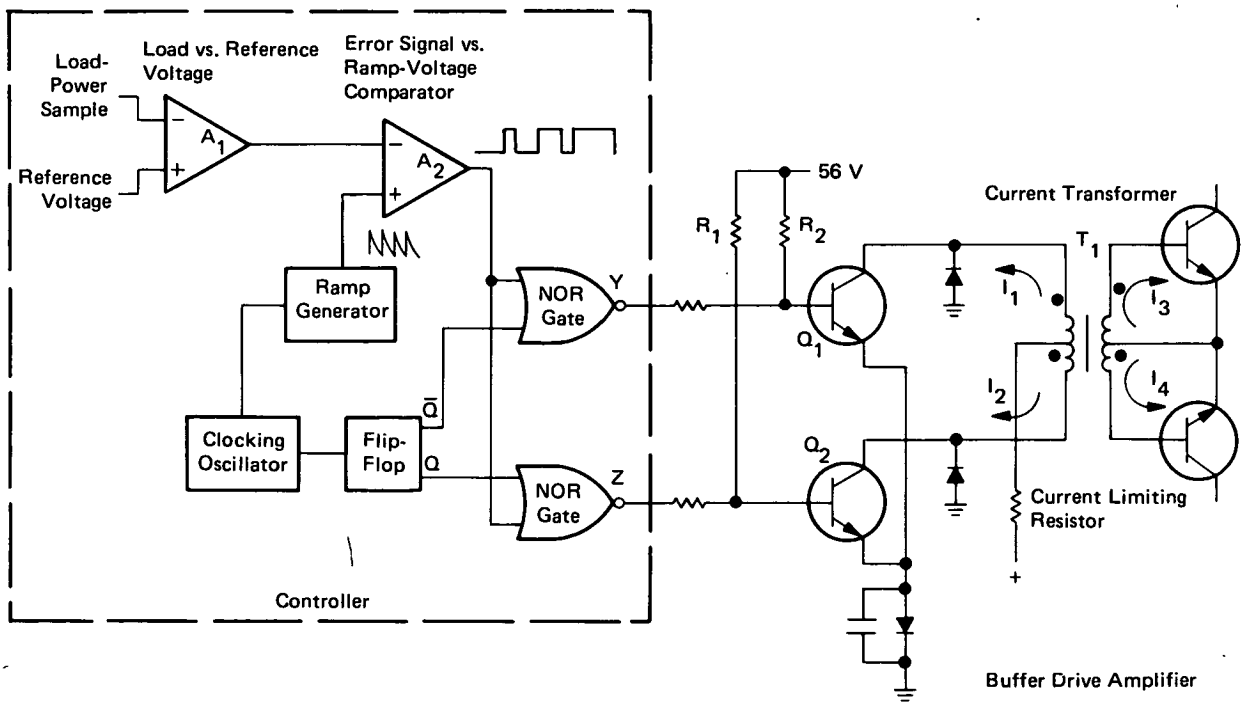

Figure 1. Power Controller

(continued overleaf)

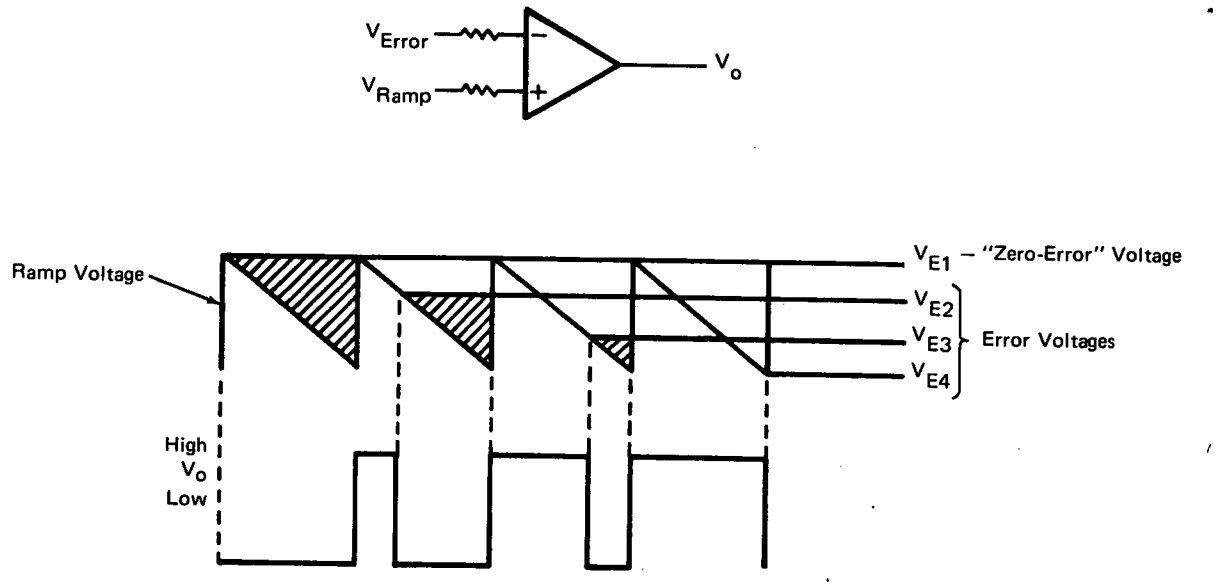

Figure 2. Comparison of Error Voltage with Ramp Voltage

(at twice the power stage switching frequency) are fed to a second operational amplifier that functions as a voltage comparator.

The output of the comparator [functions as a bang-bang system high (1) or a low (0)] operates a pair of NOR gates that control a current source. If the error signal is more positive than the peak ramp voltage, the comparator output is low, and the current source is off (see Figure 2). If the error signal is less than the peak ramp voltage, the comparator output is high and the current source is turned on. Because of the ramp shape, the more negative the error voltage compared to the peak ramp voltage, the longer the high output from the comparator. As soon as the output voltage is back to the reference level, the error signal becomes equal to the peak ramp voltage, and the alternate current source is turned off.

The new controller provides improved performance and transient response over previously-used switching regulators by an order of magnitude. Since the design eliminates all magnetic components, it can be constructed using microcircuits so that it will occupy a space of only 1 by 1/2 inches (2.5 by 1.3 cm). It is capable of operation from a single 5.00-volt (± 5 percent) power supply. In addition, it exhibits greater versatility than any previous controller in that it does not have to be modified or changed for use with any standard regulator circuit.

Note:

Requests for further information may be directed to:
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Reference: TSP73-10467

Patent status:

NASA has decided not to apply for a patent.

Source: Colonel William T. McLyman of
Caltech/JPL
under contract to
NASA Pasadena Office
(NPO-13178)