ARRAY E

POWER CONDITIONING UNIT

AUTOMATIC POWER MANAGEMENT CIRCUIT

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1.0 INTRODUCTION

Automatic power management (APM) is, as its name implies, a method for making the best possible use of reserve power. By controlling where the power is dissipated, central station temperature can be affected. The APM will also prevent underload/ overload conditions on the 55 watt (maximum) shunt regulator. For the purposes of this report, reserve power is defined as input (RTG) power minus output (load) power minus conversion losses.

2.0 TYPES OF APM CIRCUITS

Three types of APM circuits have been proposed: analog or proportional, switching, and digital. The proportional APM is a linear region device and control is achieved through regulation of the voltage across a fixed dump resistor. Since the device normally operates in the active region, some of the reserve power will be dissipated in the APM power transistor and will become part of the internal dissipation.

The switching APM is effectively a shunt regulator operated in a switching mode. The power handling element is operated either in cut-off or saturation. Power control is thus achieved by varying the current (averages) through a fixed resistor. A drawback of this method is that the frequency is uncontrolled and resonance with other portions of the PCU is possible.

The digital APM is similar to commandable dumps except control is automatic. This APM requires several dump resistors ordered in a digital fashion (i. e., a 7 watt dump is achieved by turning on 1, 2, and 4 watt dumps). This control is then achieved by varying the resistance in the dump circuit.

The effectiveness of these three styles of APM is graphically displayed in Figures 1 through 4.

2.1 SELECTION OF APM

All three styles of APM have advantages over the other two types. The APM was initially a switching type since that is the most efficient of the three. A schematic is shown in Figure 6. The problem stated in Section 2.0 did occur. The output filter of the 12V line had a resonance at 3.5KHz and since the square wave produced by the APM has a component at 3.5KHz, the system would go unstable. The proportional and digital types were then investigated. The digital type required an up/down counter, separate drivers for each dump, and separate dumps within the PDM. A preliminary schematic was drawn and is shown in Figure 5. Parts count eliminated the digital APM. The proposed proportional control circuit required a simple modification of the switching APM as shown in Figure 7. Parts count was reduced. This type of APM can be selected to have a comparable efficiency to the switching APM, but over a small range. Selection is based on expected operating point in Figure 1. Desired operation is APM full on or close to full on at lunar noon. The proportional APM has been designed into the DVT model.

Since the switching type APM offers good efficiency at all points within its range, an effort to eliminate the resonance by going with full capacitive output filters is under investigation.

3.0 APM INPUTS

3.1 EARTH COMMAND

The earth command will enable the APM to its automatic state. Normal operation will be to leave the APM on and allow the automatic feature to manage the power.

3.2 TEMPERATURE

Temperature of the thermal plate determines if reserve power is to be dumped internally through the shunt regulator internal heater or dumped externally through the APM. The method of temperature input is a thermostat connected to short out the base drive in the initial stages of the APM. If the temperature falls below 60°F the thermostat shunts off base drive, cutting off the APM, and puts all reserve power into the thermal plate heater. When the temperature rises above 80°F the thermostat opens and allows power to be dumped into the PDM. Between 60°F and 80°F the condition of the thermostat depends on its past history.

3.3 RESERVE POWER

The voltage at the emitter of the shunt regulator transistor (which is a linear function of reserve power) is the input to the reserve power detector. With a switching or digital type APM, this signal is modified to input a hysteresis to reduce the frequency of oscillations.

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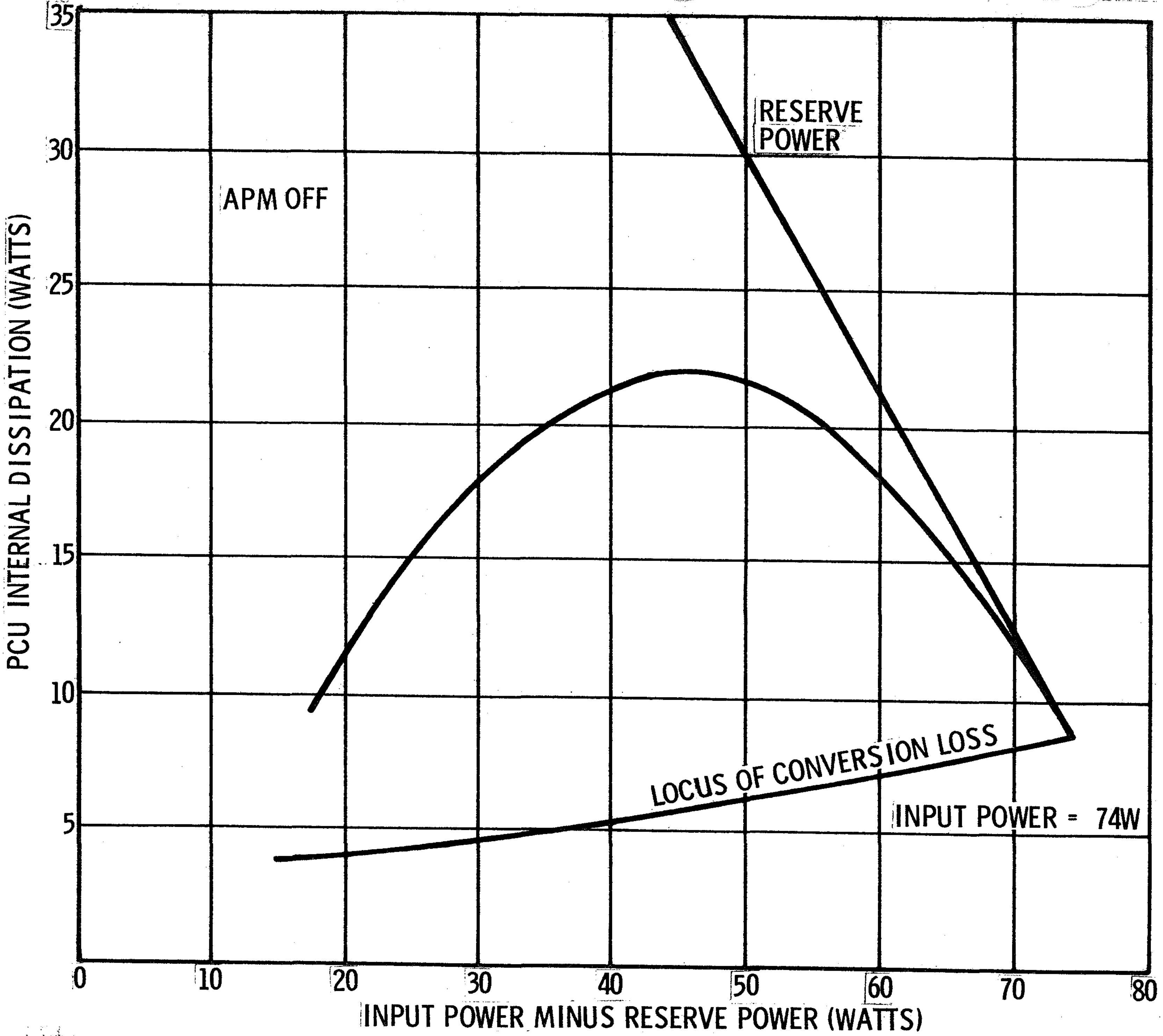

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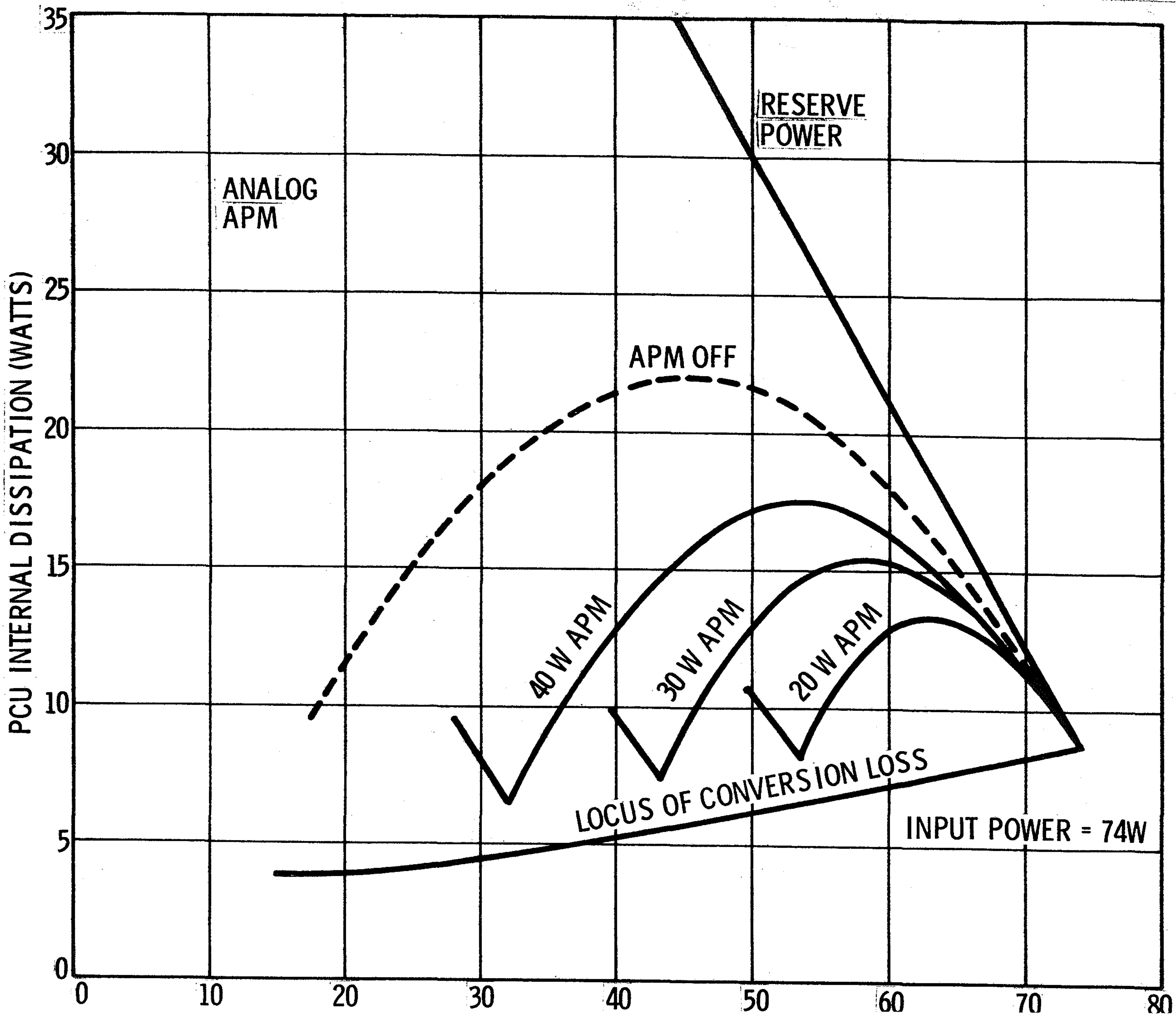
FIGURE 1

TOTAL PCU INTERNAL DISSIPATION AS A FUNCTION OF INPUT POWER MINUS RESERVE POWER



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TOTAL PCU INTERNAL DISSIPATION AS A FUNCTION OF INPUT POWER MINUS RESERVE POWER

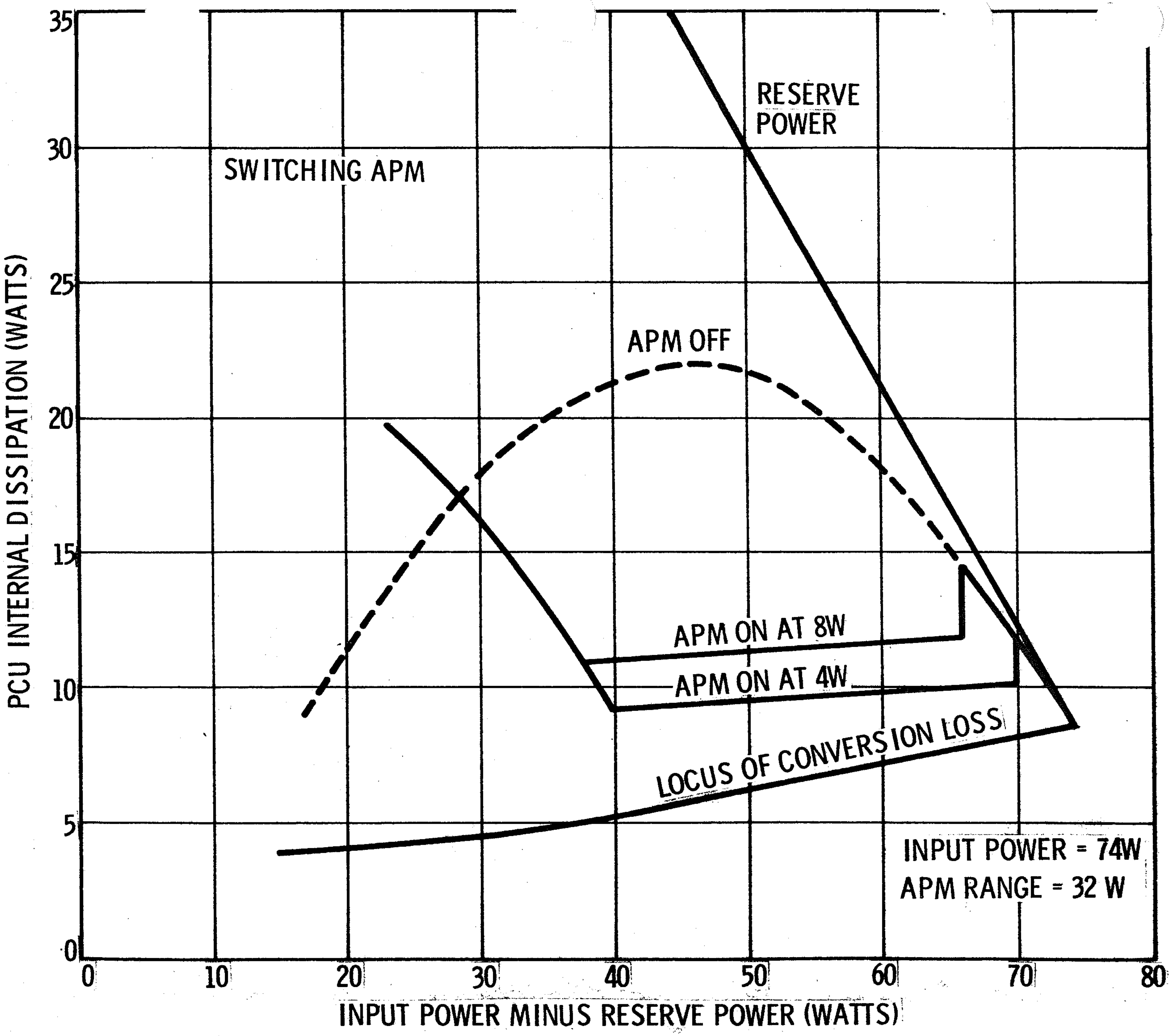

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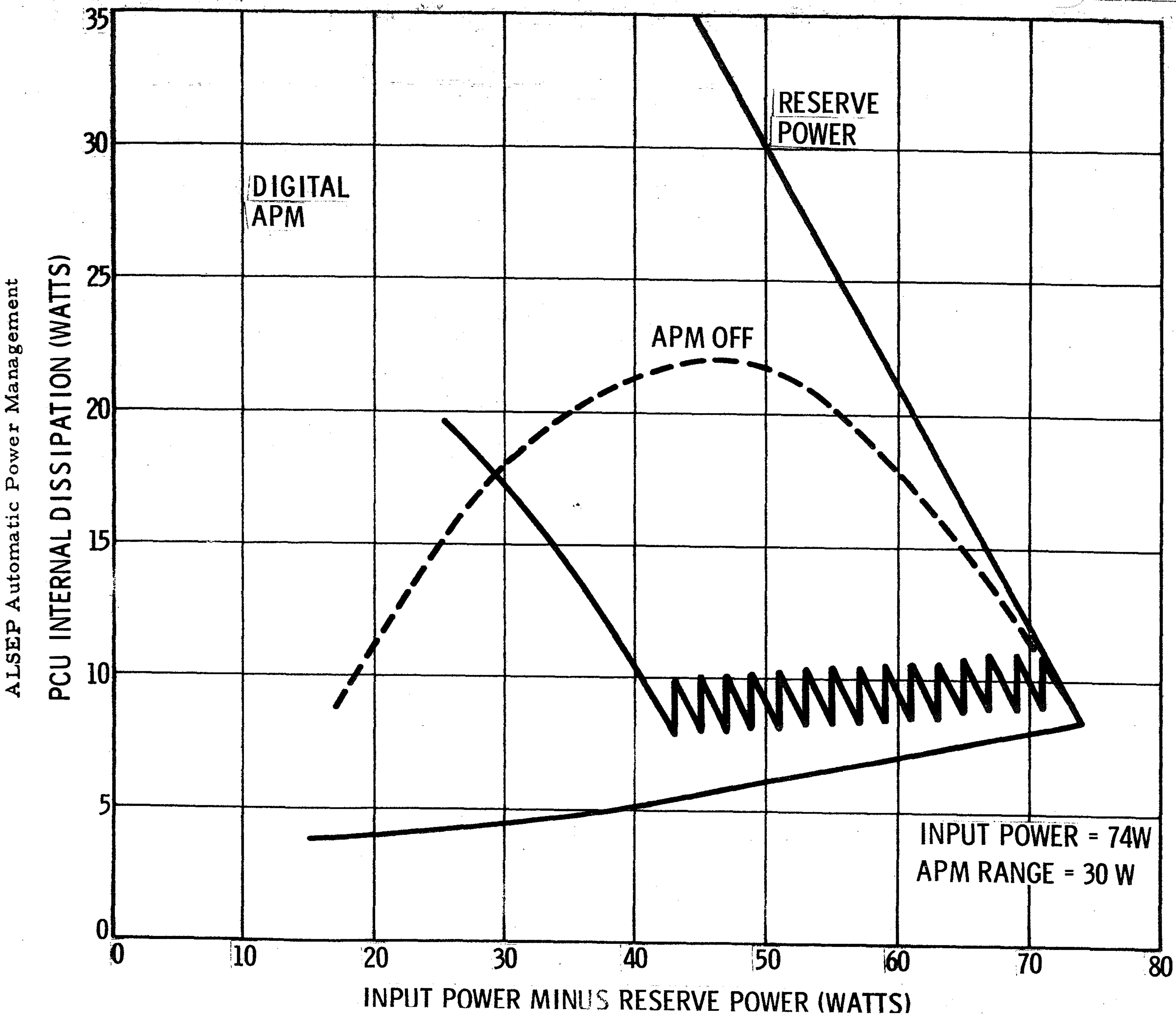
FIGURE 3

TO PCU INTE L DISSIPATION AS A FUNC F INPUT POWER MINUS RES POWER



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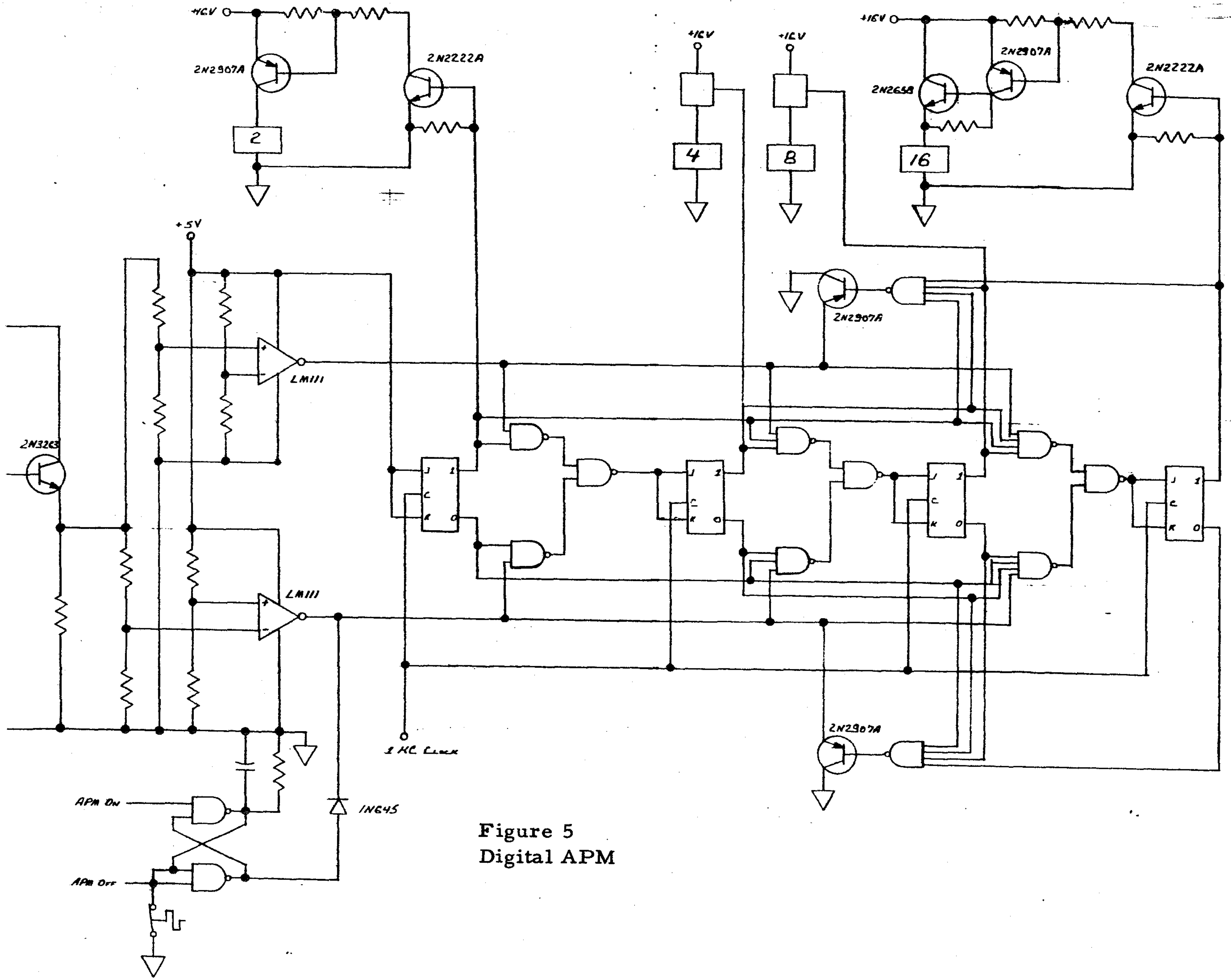

Figure 5
Digital APM

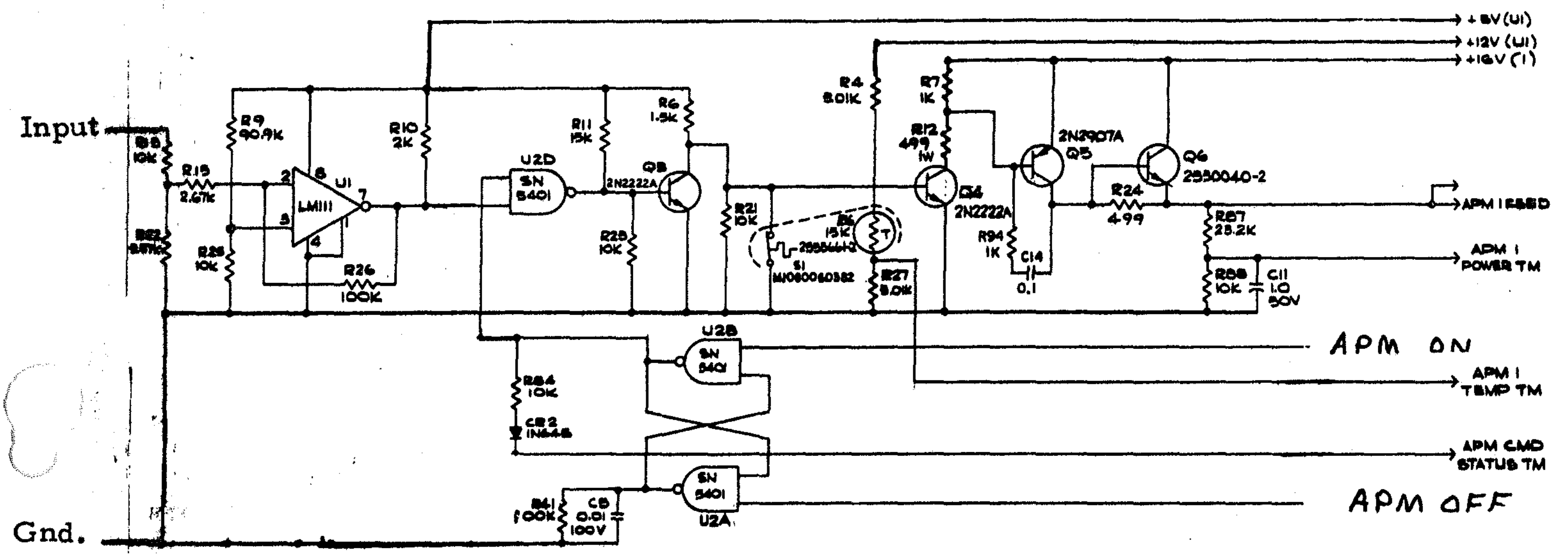

Figure 6 - Switching APM Circuit

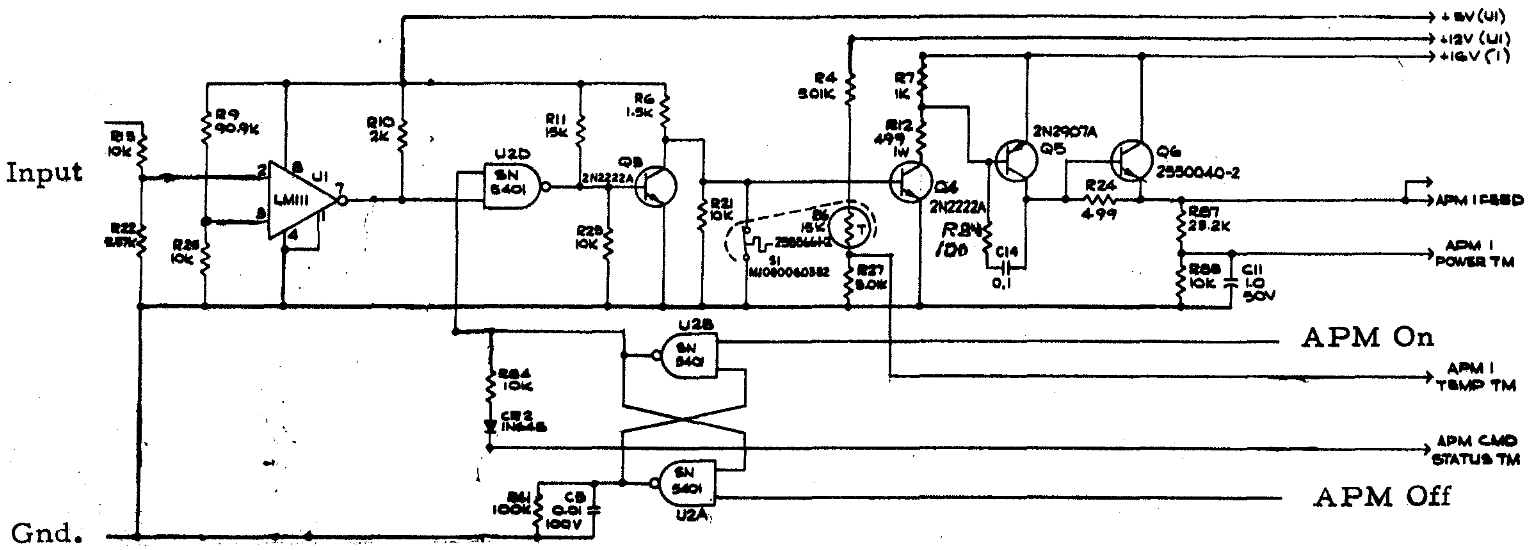

Figure 7 - Analog APM Circuit