TIME PROPORTIONAL HEATER CONTROL MODULE

I. INTRODUCTION

The time proportional heater control module controls and supplies the gating signals required to operate a Time Proportional Heater.

The control module is identified by one of two Westinghouse style numbers 2050A38G01 and 2050A38G02. The difference in the two styles is a result of the two possible temperature sensor operating modes.

Control Module Style No. 2050A38G01 is used for a temperature sensor which provides maximum output current for maximum power delivered by power thyristors.

Control module Style No. 2050A38G02 is used for a temperature sensor which provides minimum output current for maximum power delivered by power thyristors.

II. DESCRIPTION

A. REFERENCES

Module wiring diagram	-	3433D20
Logic circuit schematic	-	3420D17
Logic circuit board assy.	-	3420D18

B. GENERAL

The logic circuitry can be divided functionally into two sections, a time proportioning and a carrier gate drive section. These two sections can again be broken down into eight subsections, as follows:

1. Temperature sensor load
2. Sawtooth ramp generator
3. Bias offset
4. Comparator operational amplifier
5. Unijunction carrier oscillator
6. One-shot blocking oscillator
7. Amplifier, pulse shaping and isolation circuits
8. Power Supply

The next section describes these circuits and their operation. Refer to Schematic Diagram 3420D17.

C. CIRCUIT SUBSECTIONS

1. Temperature Sensor Load

The temperature sensor produces an output current that is conducted by potentiometer 28P1. The resulting voltage between the potentiometer slider and common is directly proportional to the input current signal. This temperature sensor voltage is used by the comparator operational amplifier as explained in Section 4.

The function of capacitor 31C2, between the slider arm and common, is to eliminate the effect of noise on the input line and to reduce any AC component in the temperature sensor output. In applications where the maximum output current of the temperature sensor can exceed 30 mA, a shunting resistor of suitable value is placed across the input terminals so that the potentiometer 28P1 current will not exceed 20 mA and overload the potentiometer.

2. Sawtooth Ramp Generator

The ramp generator is formed by unijunction transistor 36Q1, transistor 37Q1, timing capacitor 30C2 and associated resistors. Transistor 37Q1 is a current source used to provide a linear charging rate on the unijunction timing capacitor 30C2.

3. Bias Offset

Bias voltage is obtained from potentiometer 49P1. The adjustable offset voltage is used to set operating points for the comparator operational amplifier as explained in the next section.

4. Comparator Operational Amplifier

This consists of operation amplifier 41A1 with inputs formed by the algebraic sum of the three signals: temperature sensor voltage, sawtooth ramp and bias offset.

An algebraic sum of these voltage signals less than zero volts, with respect to common, gives an amplifier output of zero volts. When the algebraic sum of these voltages is greater than zero, the output of amplifier 41A1 is nominally 3.2 volts. Resistors 15R1 and 7R3 provide positive feedback to give hysteresis. Capacitor 48C1 is used to eliminate parasitic oscillations.

At the beginning of each period when timing capacitor 30C2 begins charging, the output of amplifier 41A1 is zero. As capacitor 30C2 is charged, the algebraic sum of the voltage signals at the input of the amplifier increases. When the inner voltage crosses the zero level, the amplifier output abruptly switches to 3.2 volts. After the capacitor has changed to the point that the unijunction transistor 36Q1 fires, the input sum drops to less than zero and the amplifier output returns to zero. The period then repeats.

A change in the magnitude of temperature sensor current causes a proportional change in the temperature sensor voltage between the slider arm of potentiometer 28P1 and common. This in turn changes the length of time that the amplifier 41A1 output is zero, which changes the fraction of the total period that the output is zero. The output of amplifier 41A1 blocks or releases the oscillation of the unijunction transistor 36Q2 through transistor 38Q1.

5. Unijunction Carrier Oscillator

This circuit is formed by unijunction transistor 36Q2, capacitor 33C1 and associated resistor circuitry. The oscillator is set to operate at 11 KHZ by potentiometer 29P1. Output pulses are used to trigger the one shot blocking oscillator.

6. One-Shot Blocking Oscillator

Transistor 38Q2 and transformer 40T1 comprise the one shot blocking oscillator circuit. The pulse from the unijunction transistor 36Q2 turns transistor 38Q2 ON initially and transformer 40T1 holds the transistor ON by positive feedback through the base winding 3-4. The current through the collector winding 1-2 increases until the ferrite core saturates at which time the voltage across winding 3-4 collapses.

7. Amplifier, Pulse Shaping and Isolation Circuits

The blocking oscillator circuit provides a strong drive signal with fast rise time for amplifier transistors 39Q1, 39Q2, 39Q3. The amplifier transistors in turn drive their respective isolation transformers 42T1, 42T2, 42T3. The RC network resistors 24R1, 24R2 or 24R3 and capacitors 34C1, 34C2, or 34C3 provide a sharp, fast rise, leading edge to the gate pulse to insure fast turn ON of the power thyristors. The secondary windings of the gate transformers 42T1, 42T2, and 42T3 are isolated from each other as well as the rest of the circuitry. Diodes 2D15 - 3D20 are used to provide positive gate pulses for the power thyristors.

8. Power Supplies

The power supplies used to operate the logic circuits described, are single phase bridge rectifiers with zener diode regulators. Capacitor 35C1 and resistor 26R1 are used to isolate and filter the high current pulse drawn by the amplifying transistors 39Q1, 39Q2 and 39Q3.

III. SERVICES

A. ADJUSTMENTS

Adjustments for the bias and gain potentiometers have been made at the factory. If readjustment is necessary, the adjustment procedures for both styles of control modules are as follows:

1. Observe gate signals or heating elements to tell when power thyristors are conducting (ON) or blocking (OFF). Connect a DC power supply to the input terminals to simulate the temperature sensor output. Note proper polarities.

2. Adjust input current to minimum control current plus 10% of the minimum to maximum control current range.

   a. For S#2050A38G01 (Power thyristors OFF with minimum temperature sensor current). Adjust potentiometer 49P1 so that the gate is OFF most of the time. Reduce control current to minimum and the gate signals should be held OFF all the time, if not, readjust potentiometer 49P1.

   b. For S#2050A38G02 (Power thyristors ON with minimum temperature sensor current). Adjust potentiometer 49P1 so that the gate is ON most of the time. Reduce control current to minimum and the gate signal should be held ON all the time, if not, readjust potentiometer 49P1.

3. Apply 90% maximum control current

   a. For S#2050A38G01 (Power thyristor ON with maximum temperature sensor current). Adjust potentiometer 28P1 so that the gate signal is ON most of the period (or OFF the shortest possible time). Increase control current to maximum and the gate signal should be ON all the time. If not, readjust potentiometer 28P1.

   b. For S#2050A38G02 (Power thyristor OFF with maximum temperature sensor current). Adjust potentiometer 28P1 so that the gate signal is OFF most of the period. Increase the control current to maximum, and the gate signal should be OFF all the time, if not, readjust potentiometer 28P1.

4. Set control current to midvalue of its operating range. The gate signal should be ON approximately one half the period and OFF the remaining portion of the period.

B. TROUBLESHOOTING OF TIME PROPORTIONAL HEATER CONTROL

If trouble develops that can be traced to the time proportional heater control module, a preliminary check should be made to insure that the temperature sensor unit is connected as specified and an output is present. If everything is in order, check the AC voltages from the power supply transformer. The voltage between terminals 1 and 2 of the printed circuit board should be 20.7 volts ±10% and between terminals 3 and 4, the voltage should be 18 volts ±10%.

If both voltages are incorrect, the power supply transformer may be connected improperly. If only one of the voltages is wrong, that winding may be opened or shorted. If the voltages appear to be at satisfactory levels, the problem is in the circuitry on the printed circuit board. The following list of checks to be made on these circuits should lead to the source of the trouble. All voltages are referred to COMMON, unless otherwise specified.

1. Check voltage across capacitor 30C2.

   a. Should observe a linear sawtooth waveform with a period of approximately 9 sec. and magnitude of approximately 10 volts. See Figure 1.

   b. If results negative, short emitter to collector of transistor 37Q1. If RC ramp appears across capacitor 30C2, transistor 37Q1 is failed. If no ramp appears, then unijunction transistor 36Q1 is failed.

2. Check output of amplifier 41A1 (connects to resistor 16R1)

   a. Should observe a rectangular wave with an amplitude of 0.0 to 3.2 volts ±10% and a period of approximately 9 Sec. See Figure 2.

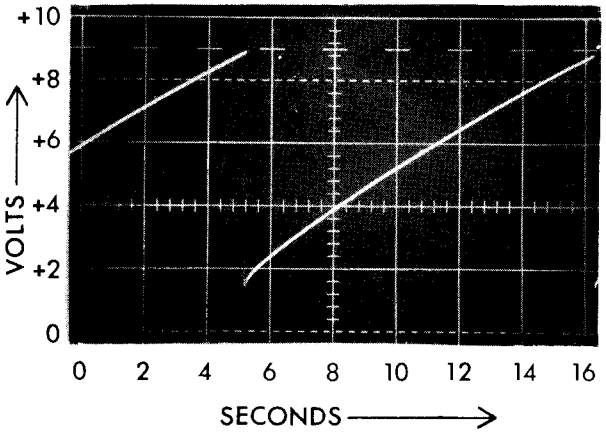

FIGURE 1

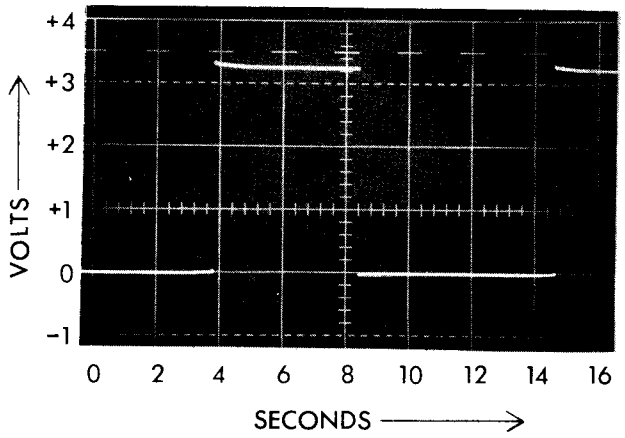

FIGURE 2

   b. If results negative, remove temperature sensor input and adjust bias potentiometer 49P1. If the rectangular wave does not appear for several settings of potentiometer 49P1;

      1. Check voltage on slider of potentiometer.
         (a) Should observe a DC level which varies from 0 to -6.8 volts as slider is moved.
         (b) If result positive, amplifier 41A1 is failed.
         (c) If result negative, potentiometer is failed.

3. Check voltage at collector of transistor 38Q1.

   a. Should observe a rectangular waveform with amplitudes of 0 and 12 volts ±10%. See Figure 3.

   b. If result negative, transistor 38Q1 is failed.

4. Set bias potentiometer 49P1 so that collector of transistor 38Q1 is high continuously. Check voltage across capacitor 33C1.

   a. Should observe 11 KHZ RC sawtooth wave. See Figure 4.

   b. If result negative, unijunction transistor 36Q2 is failed.

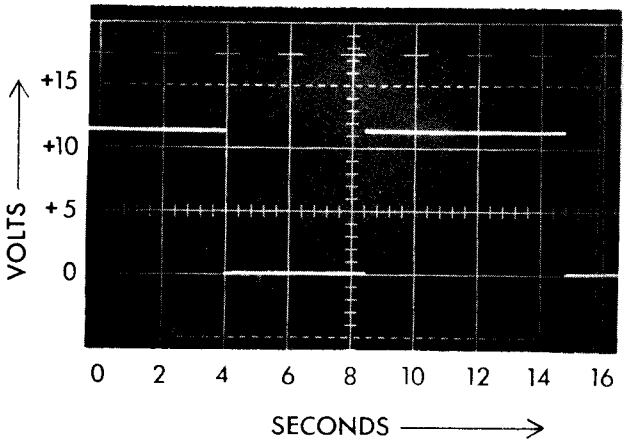

FIGURE 3

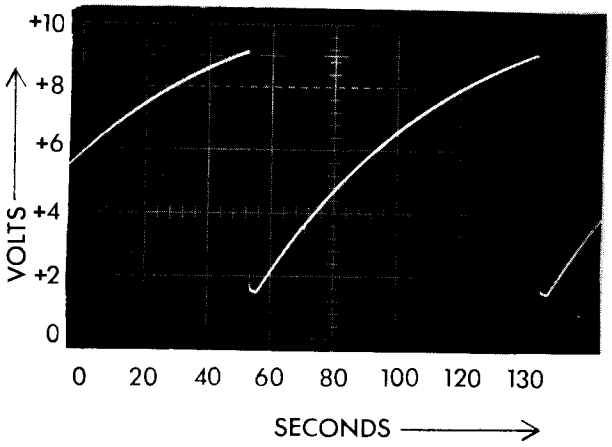

FIGURE 4

5. Check voltage at collector of transistor 38Q2.
   a. Should observe 11 KHZ rectangular waveform. See Figure 5.
   b. If results negative, transformer 40T1 or transistor 38Q2 is failed.
6. Check voltage across primary winding 1-2 of transformer 42T1.
   a. Will observe 11 KHZ rectangular waveform. See Figure 6.
   b. If results negative, transistor 39Q1 or transformer 42T1 is failed

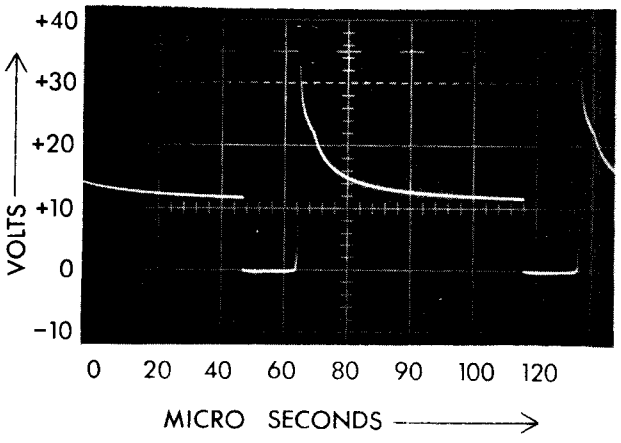

FIGURE 5

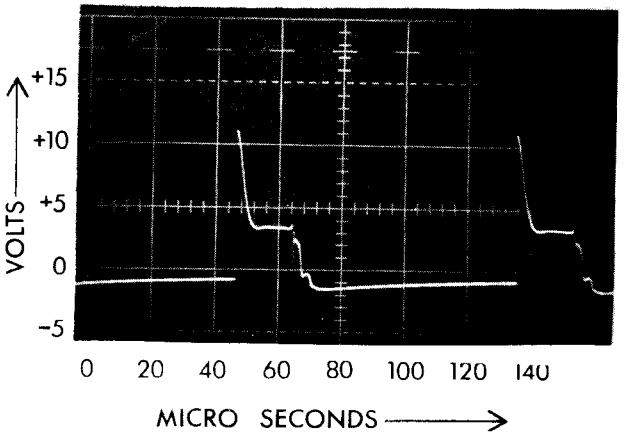

FIGURE 6

7. Repeat check #6 for transformers 42T2 and 42T3 and transistors 39Q2 and 39Q3.
8. Check voltage across secondary winding 3-4 of transformer 42T1.
   a. Should observe 11 KHZ rectangular waveform similar to that observed on the primary side. See Figure 7.
   b. If results negative transformer 42T1 is failed.

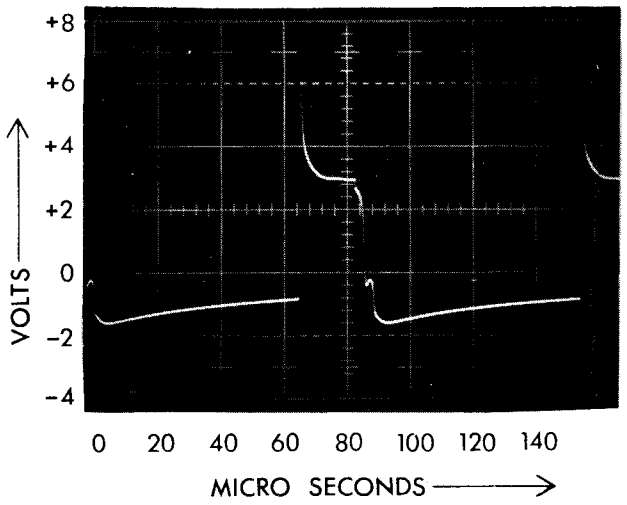

FIGURE 7

9. Repeat check #8 for transformers 42T2 and 42T3.

10. Disconnect gate leads from power thyristors. Check gate signals at all gate connects. A current check is not mandatory, but helpful.

    a. With the gate output circuit disconnected, check that the peak gate voltage is 3.0 volts or more.

    b. Short gate (G1) to cathode (K1) and observe current signal. It must rise to 0.5 amp in 1.0 uS and peak at 0.7 amps in 2.0 uS to insure that the power thyristor will be gated ON properly. Repeat for G2-K2 and G3-K3.

    c. Gate holding current should be 0.1 amp or more at 10 uS after start of pulse.

    d. Current signal is shown on Figure 8 and voltage on Figure 9. If any of the above conditions are not met, the pulse shaping RC networks resistor 24R1, 24R2 or 24R3 and capacitor 34C1, 34C2, 34C3 may have failed or changed value drastically.

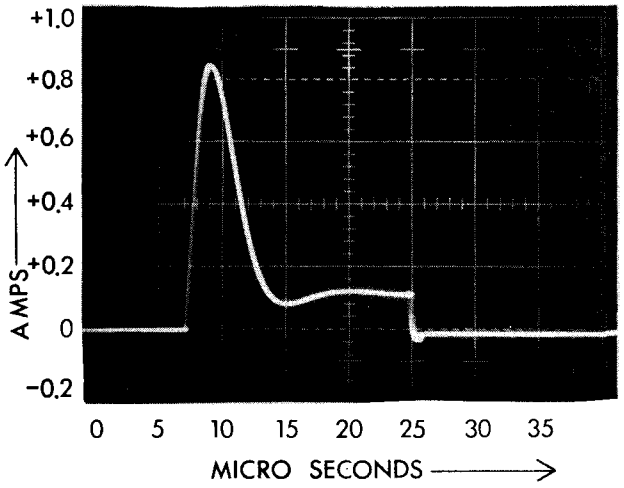

FIGURE 8

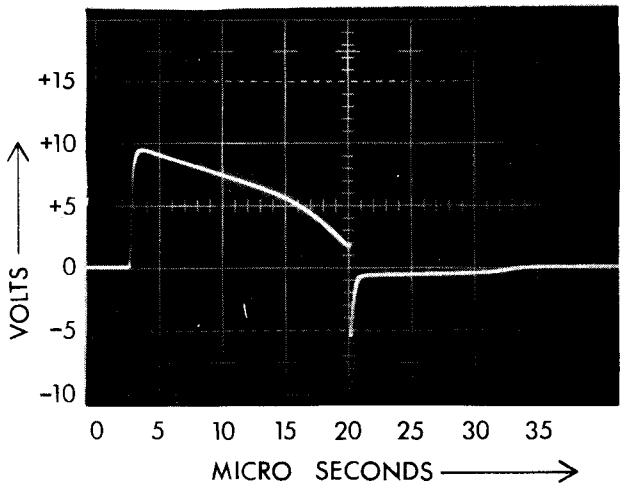

FIGURE 9

If all the above checks are successful, adjust the bias and gain potentiometer for operation conditions as per Section A and reconnect the power thyristors. If an individual thyristor does not conduct when gated, it must be failed. Refer to the section on power circuit equipment.