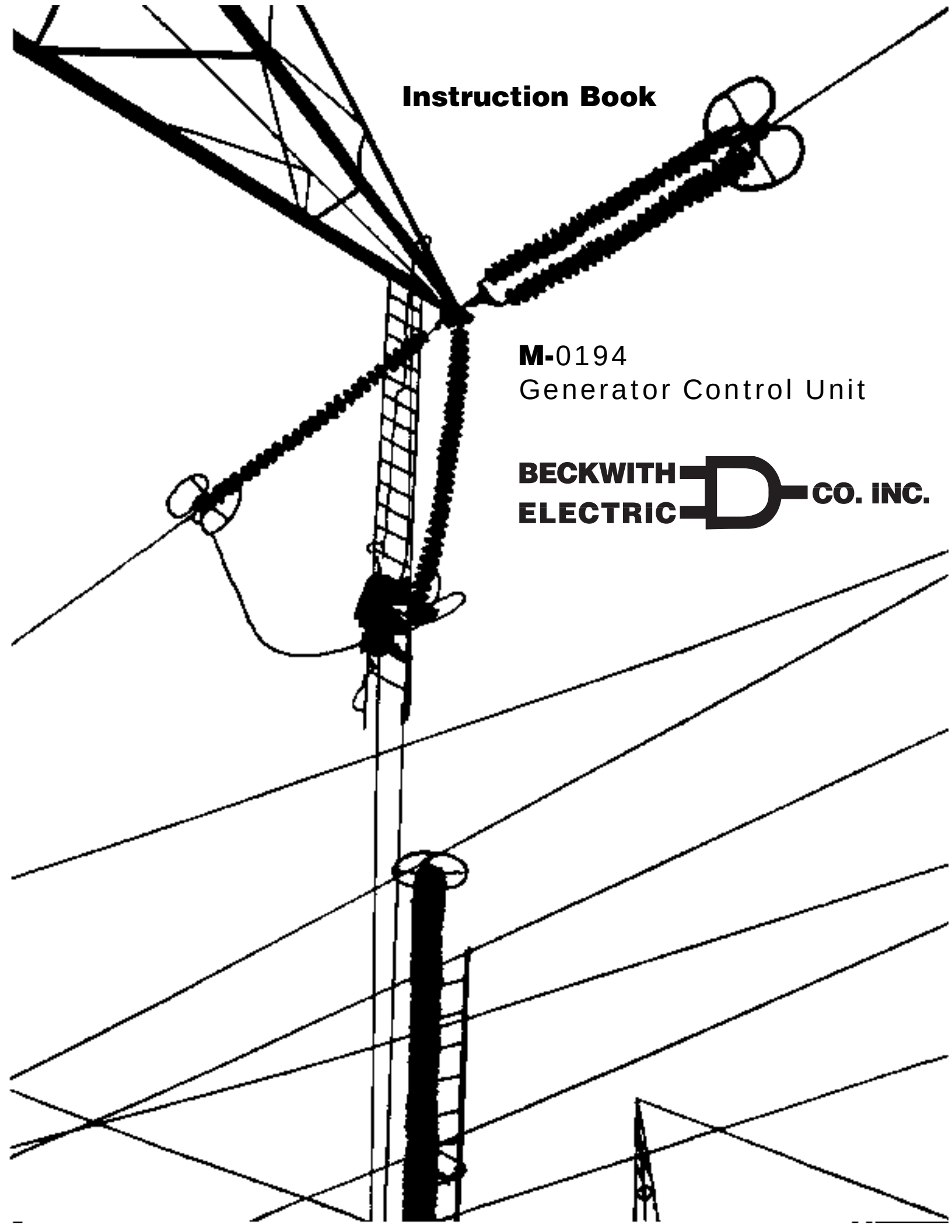
Instruction Book

M-0194
Generator Control Unit

BECKWITH ELECTRIC CO. INC.



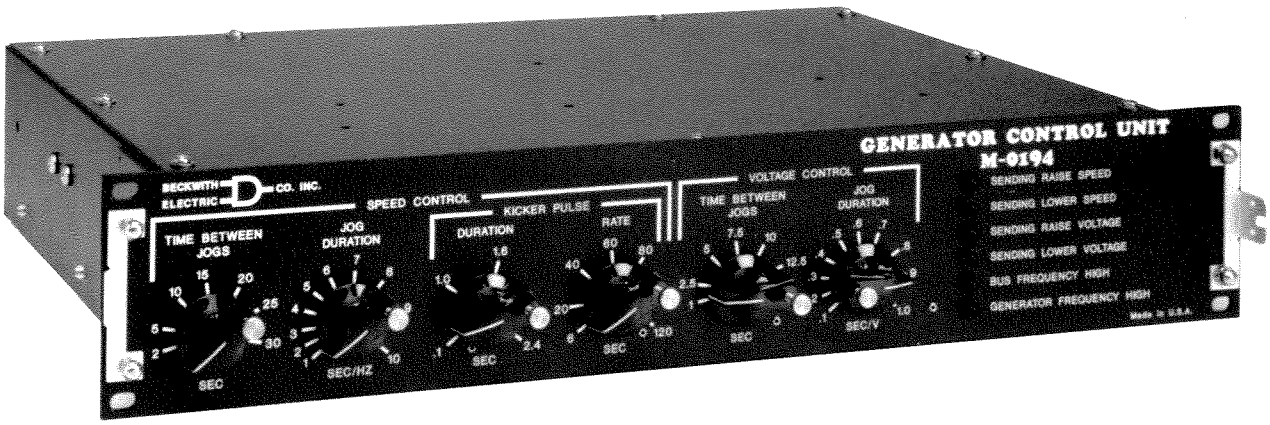
BECKWITH ELECTRIC CO. INC.

SYNCROCLOSER® LINE

Generator Control Unit M-0194

Matches Generator Speed And Voltage To System

Works In Conjunction With M-0193B Syncrocloser® Unit To Close Breaker At Zero Degrees Phase Angle Error



- Adjustable Jog Durations, proportional to error, for Voltage and Speed control.
- Time Between Jogs adjustments bring the generator to a matched condition in minimum time and eliminate overshoot and hunting.
- Kicker Pulse brings phase angle around through zero if speed is matched but synchronism has not yet occurred. Adjustable pulse duration compensates for the sensitivity of the governor.

INPUTS

Power: 120 V ac ±10%, 60 Hz ±5 Hz or optional 50 Hz ±5 Hz, 10 VA maximum burden. Will withstand 150 V ac maximum continuous, 200 V ac for 1 sec.

Interconnector Cable (Included): Provides logic inputs by connecting M-0194 Generator Control Unit to M-0193 Syncrocloser® Unit. Length of cable is approximately three feet.

SPEED CONTROL

Speed Matching Range of Operation: 30 to 85 Hz

TIME BETWEEN JOGS: available in two ranges: 1 to 15 sec. or 2 to 30 sec.

JOG DURATION: proportional to error. Proportional Jog Duration is 1 to 10 sec. per Hz of frequency mismatch; linear for ΔF of 0.015 Hz to 1.5 Hz of mismatch.

KICKER PULSE: A generator raise speed jog is produced if the speed matcher does not operate in the time set on the **KICKER PULSE DURATION** dial. The kicker pulse duration is adjustable from 0.1 to 1.5 seconds at a kicker pulse rate of one pulse per 6 to 120 seconds.

VOLTAGE CONTROL

Voltage Matching Range of Operation: 30-200 V ac

TIME BETWEEN JOGS, available in two ranges: 1 to 15 sec. or 2 to 30 sec.

JOG DURATION, proportional to error. Proportional Jog Duration: 0.1 to 1.0 sec. per volt of mismatch; linear from 1 to 20 V of mismatch.

OUTPUT RELAY CONTACTS

Raise Voltage Jog	Raise Speed Jog
Lower Voltage Jog	Lower Speed Jog

CONTACT RATING

Dry output contacts rated to make and carry 20 A up to 250 V dc, or to interrupt 0.9 A, 120 V dc inductive load or 0.4 A, 250 V dc inductive load. Open contacts will withstand 1500 V ac for one minute. Contacts to ground will withstand 1500 V ac for one minute.

LED INDICATORS

SENDING RAISE SPEED	**SENDING RAISE VOLTAGE**	**BUS FREQUENCY HIGH**
SENDING LOWER SPEED	**SENDING LOWER VOLTAGE**	**GENERATOR FREQUENCY HIGH**

ACCURACY

Jog times and Kicker Pulse Duration will be within ±20% of setting.

MOUNTING OPTIONS

Horizontal mounting is standard; vertical mounting or vertical General Electric GTL14B Retrofit Panel mounting are available as options.

GENERATOR CONTROL UNIT COVER KIT

The M-0194 Generator Control Unit includes a transparent cover with associated mounting bracket to cover the dials and prevent accidental resetting.

TRANSIENT PROTECTION

Input and output circuits are protected against system transients. The M-0194 will pass all requirements of ANSI/IEEE C37.90.1-1989 defining oscillatory surge withstand capability. All inputs and outputs will withstand 1500 V ac to chassis or instrument ground for one minute. Voltage inputs are electrically isolated from each other, from other circuits, and from ground.

ENVIRONMENTAL

Temperature Range: Stated accuracies are maintained from –40° to +80°C.
Humidity: Stated accuracies are maintained under 95% relative humidity (non-condensing).
Fungus Resistance: A conformal printed circuit board coating inhibits fungus growth.

PHYSICAL

Size: 19" wide x 3-1/2" high x 14" deep (48.3 cm x 8.9 cm x 35.6 cm).
Horizontal mounting requires two rack units space in a standard 19" rack.
Approximate Weight: 15 lbs (6.8 kg). **Approximate Shipping Weight:** 23 lbs (10.4 kg).

WARRANTY

The M-0194 Generator Control Unit is covered by a two year warranty from date of shipment.

Printed in the U.S.A.

WARNING

DANGEROUS VOLTAGES, capable of causing death or serious injury, are present on the external terminals and inside the equipment. Use extreme caution and follow all safety rules when handling, testing or adjusting the equipment. However, these internal voltage levels are no greater than the voltages applied to the external terminals.

DANGER! HIGH VOLTAGE

– This sign warns that the area is connected to a dangerous high voltage, and you must never touch it.

PERSONNEL SAFETY PRECAUTIONS

The following general rules and other specific warnings throughout the manual must be followed during application, test or repair of this equipment. Failure to do so will violate standards for safety in the design, manufacture, and intended use of the product. Qualified personnel should be the only ones who operate and maintain this equipment. Beckwith Electric Co., Inc. assumes no liability for the customer's failure to comply with these requirements.

– This sign means that you should refer to the corresponding section of the operation manual for important information before proceeding.

Always Ground the Equipment

To avoid possible shock hazard, the chassis must be connected to an electrical ground. When servicing equipment in a test area, the Protective Earth Terminal must be attached to a separate ground securely by use of a tool, since it is not grounded by external connectors.

Do NOT operate in an explosive environment

Do not operate this equipment in the presence of flammable or explosive gases or fumes. To do so would risk a possible fire or explosion.

Keep away from live circuits

Operating personnel must not remove the cover or expose the printed circuit board while power is applied. In no case may components be replaced with power applied. In some instances, dangerous voltages may exist even when power is disconnected. To avoid electrical shock, always disconnect power and discharge circuits before working on the unit.

Exercise care during installation, operation, & maintenance procedures

The equipment described in this manual contains voltages high enough to cause serious injury or death. Only qualified personnel should install, operate, test, and maintain this equipment. Be sure that all personnel safety procedures are carefully followed. Exercise due care when operating or servicing alone.

Do not modify equipment

Do not perform any unauthorized modifications on this instrument. Return of the unit to a Beckwith Electric repair facility is preferred. If authorized modifications are to be attempted, be sure to follow replacement procedures carefully to assure that safety features are maintained.

PRODUCT CAUTIONS

Before attempting any test, calibration, or maintenance procedure, personnel must be completely familiar with the particular circuitry of this unit, and have an adequate understanding of field effect devices. If a component is found to be defective, always follow replacement procedures carefully to that assure safety features are maintained. Always replace components with those of equal or better quality as shown in the Parts List of the Instruction Book.

Avoid static charge

This unit contains MOS circuitry, which can be damaged by improper test or rework procedures. Care should be taken to avoid static charge on work surfaces and service personnel.

Use caution when measuring resistances

Any attempt to measure resistances between points on the printed circuit board, unless otherwise noted in the Instruction Book, is likely to cause damage to the unit.

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Instruction Book

In our effort to provide accurate and informative technical literature, suggestions to improve the clarity or to correct errors will receive immediate attention. Please contact the Marketing Services Department, specifying the publication and page number.

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INTRODUCTION

Please refer to the M-0194 Application Guide in conjunction with this Instruction Book, since information contained in one may not be repeated in the other.

The Beckwith Electric M-0194 uses advanced, state of the art semiconductors and circuits to achieve an overall stability and resolution unattainable with current electromechanical relays. Modern hybrid and monolithic semiconductors using ion implantation and laser trimming are used throughout the Syncrocloser® Line to gain temperature stability without critical compensation or trimming.

All components except the power transformer are mounted on a single double-sided circuit board for reliability and ease of servicing.

■ **NOTE:** Values that change for the 50 Hz Operation option are shown in brackets.

THEORY OF OPERATION

Please refer to Figure 1 Block Diagram and Figure 5 Schematic.

POWER SUPPLY

Transformer T1 steps down the voltage to 36 V rms center-tapped. The secondary voltage is full–wave rectified by diodes D45 through D48 and produces +24 V and –24 V unregulated dc voltages. Two linear voltage regulators produce the +15 V dc and –15 V dc regulated supplies.

INPUT SIGNALS

The M-0194 Generator Control works in conjunction with the M-0193 Syncrocloser® Unit, and all sensing signals are connected through the Connector Cable. The only rear terminal connections required to the M-0194 are line power supply (TB1-1 and TB1-2; note that TB1-1 is HOT) and a jumper to inhibit relay closure (TB1-4 to TB1-27).

DETECTION OF FREQUENCIES

Phase Angle Detector

The phase angle between the bus and generator inputs is precisely measured by the Phase Angle Detector circuit which compares two square waves from the M-0193 voltage input secondaries. This circuit provides a pulse width proportional to the phase angle between two inputs. A low–pass filter, Q2 and associated components, produces a dc voltage proportional to the phase angle.

Derivative Amplifier

A Derivative Amplifier measures the slope of the phase angle and provides a triangular wave. This slope is proportional to the difference in frequency (ΔF).

Generator Frequency High Detector

The highly accurate frequency detector (Generator High Detector) will detect whether the generator's frequency is higher or lower than 60 [50] Hz. This signal will be one of the three inputs to a Logic Selector to give correct indication and commands for speed matching.

Frequency Transducer ±0.45 Hz Detector and 30 Hz Detector

The Frequency Transducer precisely senses the generator frequency and produces a voltage level which is proportional to the frequency. Another precision detector is used to detect whether the generator's frequency is higher than 60.45 [50.45] Hz or less than 59.55 [49.55] Hz. This signal is another input to a logic selector for indication. The voltage level from the transducer is also detected and will inhibit all of the command outputs if the generator frequency is less than 30 Hz. Speed control is inhibited for generator frequencies below 30 Hz.

Precision Derivative and Absolute Value Amplifiers

The Precision Derivative Amplifier measures the rate of change of the Phase Analog Voltage from the M-0193. This signal is then rectified in the Absolute Value Amplifier. The output of the Absolute Value Amplifier is a voltage, proportional to the magnitude of ΔF between the generator and the bus voltages.

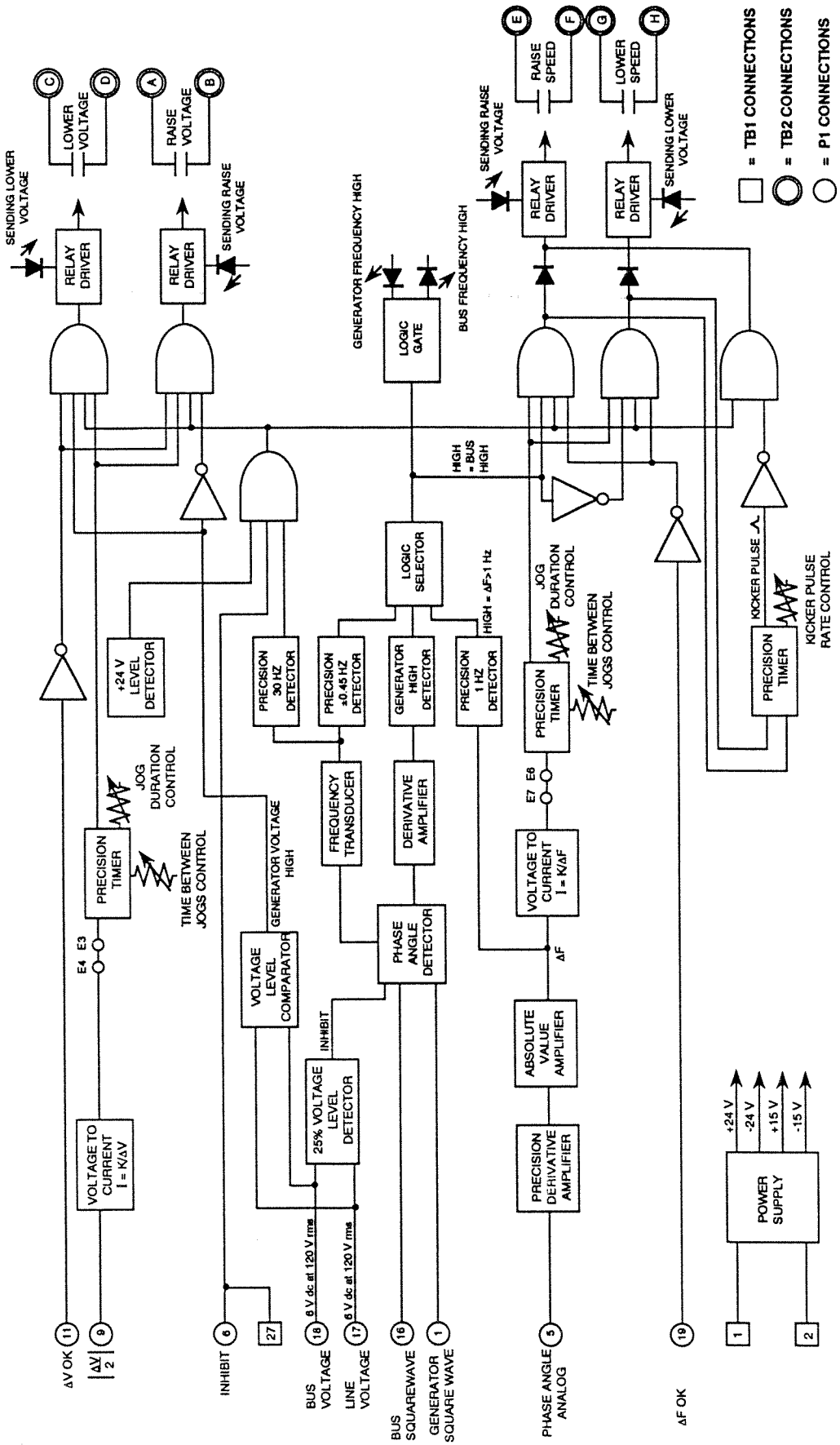


FIGURE 1 Block Diagram

Precision 1 Hz ΔF Detector

A comparator circuit (Q37) compares the magnitude of ΔF from the Derivative Amplifier to a fixed reference voltage. The output (Q37-7) goes "high" when the magnitude of ΔF is greater than 1 Hz. This signal is used by the Logic Selector to choose between the Precision ±0.45 Hz Detector or the Generator High Detector. When the magnitude of ΔF is greater than 1 Hz, the Precision ±0.45 Hz Detector circuit indication is used. When the magnitude of ΔF is less than 1 Hz, the precision Generator High Detector is used. The Generator High Detector is not reliable above 1.5 Hz frequency difference.

SPEED JOG DURATION TIMER

Proportional

The Voltage level from the output of Q16 is inversely proportional to ΔF and is converted into a current source for the input of timer Q13. When the timer times out, pulses are provided for closing either the Raise Speed or the Lower Speed relay, with the pulse width directly proportional to ΔF.

VOLTAGE JOG DURATION TIMER

Proportional

Similar to the proportional speed circuit, the output of divider Q1 is also inversely proportional to ΔV and is converted into a current source for the input of timer Q7. The pulse width from the output of timer Q7 is directly proportional to the actual voltage difference.

25% OF VOLTAGE LEVEL DETECTOR

A dual comparator (Q35) monitors the voltage level of the bus and generator sources to ensure that the Phase Angle Detector can precisely measure the phase difference. If one of the two source voltage levels drops below 25% of nominal, this level detector will inhibit the Phase Angle Detector circuit.

VOLTAGE LEVEL COMPARATOR

A differential amplifier (Q2) compares two dc voltage levels which are stepped down from the bus and generator voltage sources and rectified by the M-0193 input circuit. This amplifier will determine the higher voltage level of the two and will enable the proper relay for either a Raise or Lower Voltage command.

KICKER PULSE RATE AND KICKER PULSE DURATION

A charge current goes through R75 and C32 to another low leakage 7555 timer (Q21). This generates a short pulse after a time delay as set by the **KICKER PULSE RATE** dial (R75) on the M-0194. This pulse only exists when the ΔF is within the limit set on the M-0193. If the speed matching circuit sends either a Raise Speed or a Lower Speed Jog, this timer is reset. An adjustable raise speed jog is sent when the kicker pulse timer times out. The Kicker Pulse length is set by a front panel dial, marked **KICKER PULSE DURATION** (R126), and can be adjusted from 0.1 to 1.5 sec.

TEST PROCEDURE

Please refer to the **WARNING** page at the beginning of this manual before proceeding.

EQUIPMENT REQUIRED

1. Two distortion–free 60 [50] Hz variable voltage sources, as follows:
   a. A variable 60 [50] Hz phase source that is capable of providing 120 V ac; maximum phase jitter of 1°.
   b. A fixed 60 [50] Hz phase source that is capable of providing 120 V ac; maximum phase jitter of 1°.
2. A high impedance true rms digital multimeter with an ac accuracy of at least ±0.01% of reading, Hewlett–Packard 3466A or equivalent.
3. Solder sucking syringe or solder wick.
4. Soldering iron: Weller Controlled Output Soldering Station Model MTCPL, 60 W, 120 V, 50/60 Hz or equivalent with grounded tip.
5. An accurate timing device.

REMOVING THE PRINTED CIRCUIT BOARDS

1. Remove all external voltages.
2. Remove the top and bottom panel. The printed circuit board and components can now be easily tested and changed.

▲ CAUTION: Be sure to discharge any static on the body or tools by touching the outer case before touching any of the printed circuit boards.

3. Visually inspect the boards for any component which does not appear normal or appears to have overheated. This can often lead to finding the cause of the trouble and the component that needs to be replaced.

COMPONENT REPLACEMENT PROCEDURE

1. The M-0194 printed circuit board is coated with a moisture–resistant, conformal coating. If a component needs to be changed, carefully scrape away the coating surrounding the component using a small, sharp knife, being careful not to damage the foil on the printed circuit board.
2. Clip out the old component and discard.
3. Remove the clipped wire using the solder syringe or wick, leaving the hole clear to facilitate insertion of the new component.

▲ CAUTION: Do not attempt to melt the solder and push the new component through the hole as the leads are likely to catch the edge of the foil and lift it off of the board.

4. When replacing the Dual–In–Line (DIP) packages, ensure that the cutout is pointing in the same direction as the arrow marked on the printed circuit board. When replacing integrated circuits, make sure to insert the unit into the transipad so that the tab fits into the slot. Once this is done, there is only one way to insert the combination into the printed circuit board.

EQUIPMENT SETUP

■ NOTE: Throughout this procedure, the "top" of the printed circuit board is nearest the back of the unit, the "bottom" is nearest the front panel.

1. Connect the M-0193 to the M-0194 by using the Connector Cable.
2. Apply 120 V ac power to the M-0193 by connecting to TB1-26 and TB1-27, noting that TB1-27 is the HOT terminal. Apply 120 V ac power to the M-0194 by connecting to TB1-1 and TB1-2, noting that TB1-1 is the HOT terminal.
3. Connect a 120 V ac variable voltage, fixed 60 [50] Hz frequency source to TB1-1 and TB1-2 of the M-0193, noting that TB1-1 is the HOT terminal.
4. Connect a 120 V ac variable frequency source, to TB1-3 and TB1-4 of the M-0193, noting that TB1-4 is the HOT terminal. Adjust the frequency to 60 [50] Hz ±0.01 Hz.
5. Set the **ΔV LIMIT** front panel dial of the M-0193 to minimum and the **ΔF LIMIT** to minimum.
6. Refer to Figure 5, Schematic, and Figure 6, Component Location.

TEST PROCEDURES

FREQUENCY INDICATION CHECK

■ NOTE: Since a minimum difference in frequency is required, the circuitry will not indicate whether the bus is high or the generator is high if the ΔF is exactly 0 Hz. Therefore, the **BUS FREQUENCY HIGH** or **GENERATOR FREQUENCY HIGH** LED indicators will stay on until a minimum ΔF is detected (approximately 0.0002 Hz).

1. Attach an oscilloscope ground lead to the negative end of C24, and the probe to the bottom end of R117 (Q37-7).
2. Increase the generator frequency from 60 [50] Hz. The signal should go "high" at approximately 61.08 [51.08] Hz ("high" indicates greater than ±12 V dc) as shown in Figure 2. Slowly reduce the generator frequency. The signal should go "low" at approximately 61.0 [51.0] Hz ±0.02 Hz ("low" indicates less than 2 V dc).
3. Continue to slowly reduce the generator frequency. The signal should go "high" again at approximately 58.92 [48.92] Hz ±0.02 Hz. Slowly increase the generator frequency. The signal should go "low" at approximately 59 [49] Hz ±0.02 Hz.

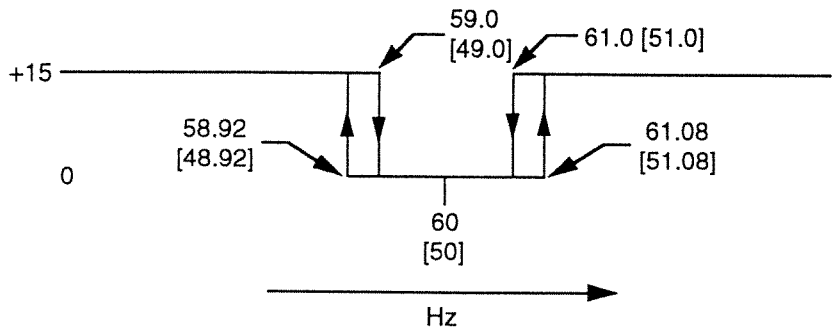


FIGURE 2 Frequency Indication Signal at R117

4. Reset the generator frequency to 59.9 [49.9] Hz.
5. Move the scope probe to D65 anode and slowly raise the generator frequency. The signal should go "low" as the generator frequency passes 60.0001 [50.0001] Hz +0.0005, -0.0000 Hz, as shown in Figure 3. The **GENERATOR FREQUENCY HIGH** LED should be lit. Slowly reduce the generator frequency. The signal should go "high" as the generator frequency drops below 59.9992 [49.9992] Hz ±0.0005 Hz. The **BUS FREQUENCY HIGH** LED should be lit.

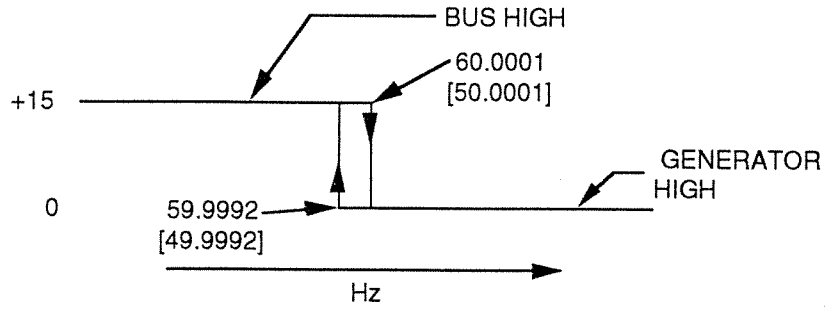


FIGURE 3 Frequency Indication Signal at D65

MINIMUM GENERATOR FREQUENCY FOR OPERATION CIRCUIT

1. Attach the probe of the scope to D34 (Q37-10) cathode.
2. Reduce the generator frequency until the signal goes "low." The signal should go "low" as the generator frequency is dropped below 30 Hz ±0.5.
3. Increase the generator frequency until the signal goes "high." The signal will go high as the frequency passes 30.8 Hz ±0.5.

VERIFY LED OPERATION

1. Adjust the generator frequency to 60.001 [50.001] Hz. The **GENERATOR FREQUENCY HIGH** LED should be lit.
2. Continue to increase the generator frequency. The **GENERATOR FREQUENCY HIGH** LED should remain on as the frequency is increased to 90 [80] Hz.
3. Reduce the generator frequency to 59.999 [49.999] Hz. The **BUS FREQUENCY HIGH** LED should be lit.
4. Continue to lower the generator frequency to 35 Hz. The **BUS FREQUENCY HIGH** LED should still be lit.
5. Set the generator frequency to 59 [49] Hz. The **SENDING RAISE SPEED** LED should be lit.

6. Set the generator frequency to 61 [51] Hz. The **SENDING LOWER SPEED** LED should be lit.
7. Readjust the generator frequency to 60.0 [50.0] Hz.
8. Adjust the bus voltage to 120 V ac.
9. Adjust the generator voltage to 125 V ac.
10. Set the **ΔV** dial on the M-0193 to the minimum setting.
11. The **SENDING LOWER VOLTAGE** LED should be lit.
12. Adjust the generator voltage to 115 V ac.
13. The **SENDING RAISE VOLTAGE** LED should be lit.
14. Readjust the generator voltage to 120 V ac.

■ NOTE: The Lower Voltage or Raise Voltage output pulse will stop if either the **GEN/LINE LOWER VOLTAGE LIMIT** or **GEN/LINE UPPER VOLTAGE LIMIT** LED on the M-0193 is not lit.

SPEED JOG TIME MEASUREMENT

Proportional Speed Jog Duration

■ NOTE: The jumper must be in the E6 to E7 position.

1. Set the **SPEED CONTROL JOG DURATION** dial on the M-0194 to **5.0 SEC/HZ** (midscale).
2. Set the generator frequency at 59 [49] Hz (ΔF = 1 Hz).
3. The Raise Speed relay K8 should stay closed for approximately 5 sec. ±1 sec. and the **SENDING RAISE SPEED** LED should stay on for the same amount of time.
4. Raise the generator frequency to 59.5 [49.5] Hz (ΔF = 0.5 Hz).
5. The Raise Speed relay should stay closed for 2.5 sec. ±0.5 sec.
6. The **SENDING RAISE SPEED** LED should remain lit for 2.5 sec.

Time Between Speed Jogs

1. Set the **SPEED CONTROL JOG DURATION** dial to 1.
2. Set the **SPEED CONTROL TIME BETWEEN JOGS** dial to midscale (7.5 for the 1 to 15 sec range and 15 for the 2 to 30 sec. range).
3. Set ΔF = 1 Hz.
4. Measure the time between jogs (see Figure 4). Measured times should be ±20 % of setting.

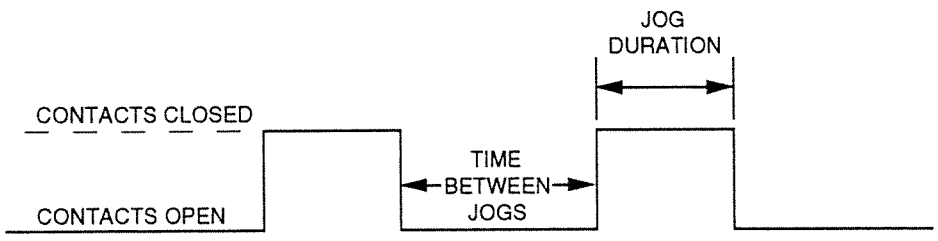


FIGURE 4 Time Between Jogs and Jog Duration Diagram

VOLTAGE JOG TIME MEASUREMENT

■ NOTE: Since the M-0194 voltage jog time depends on the accuracy of the ΔV from the M-0193 ΔV circuitry, make sure that the M-0193 ΔV circuit is accurately calibrated.

Proportional Voltage Jog Duration

■ NOTE: The jumper must be in the E3 to E4 position.

1. Set the generator source voltage to 122 V, at 60 [50] Hz (ΔV = 2 V rms). Set the **ΔV LIMIT** dial on the M-0193 to the minimum setting (fully counterclockwise). Verify that the actual voltage difference is great enough for the **ΔV OK** LED on M-0193 to turn off. The voltage jog on the M-0194 will only operate when the M-0194 senses that the voltage is not proper (the **ΔV OK** LED will be off).
2. Set the bus voltage at 120 V rms.
3. Set the **VOLTAGE CONTROL JOG DURATION** dial to **0.5 SEC/V**.
4. Set the **ΔV LIMIT** dial of the M-0193 to the minimum setting.
5. The Lower Voltage relay K1 should stay closed for 1.0 sec. ± 0.2 sec.

Time Between Voltage Jogs

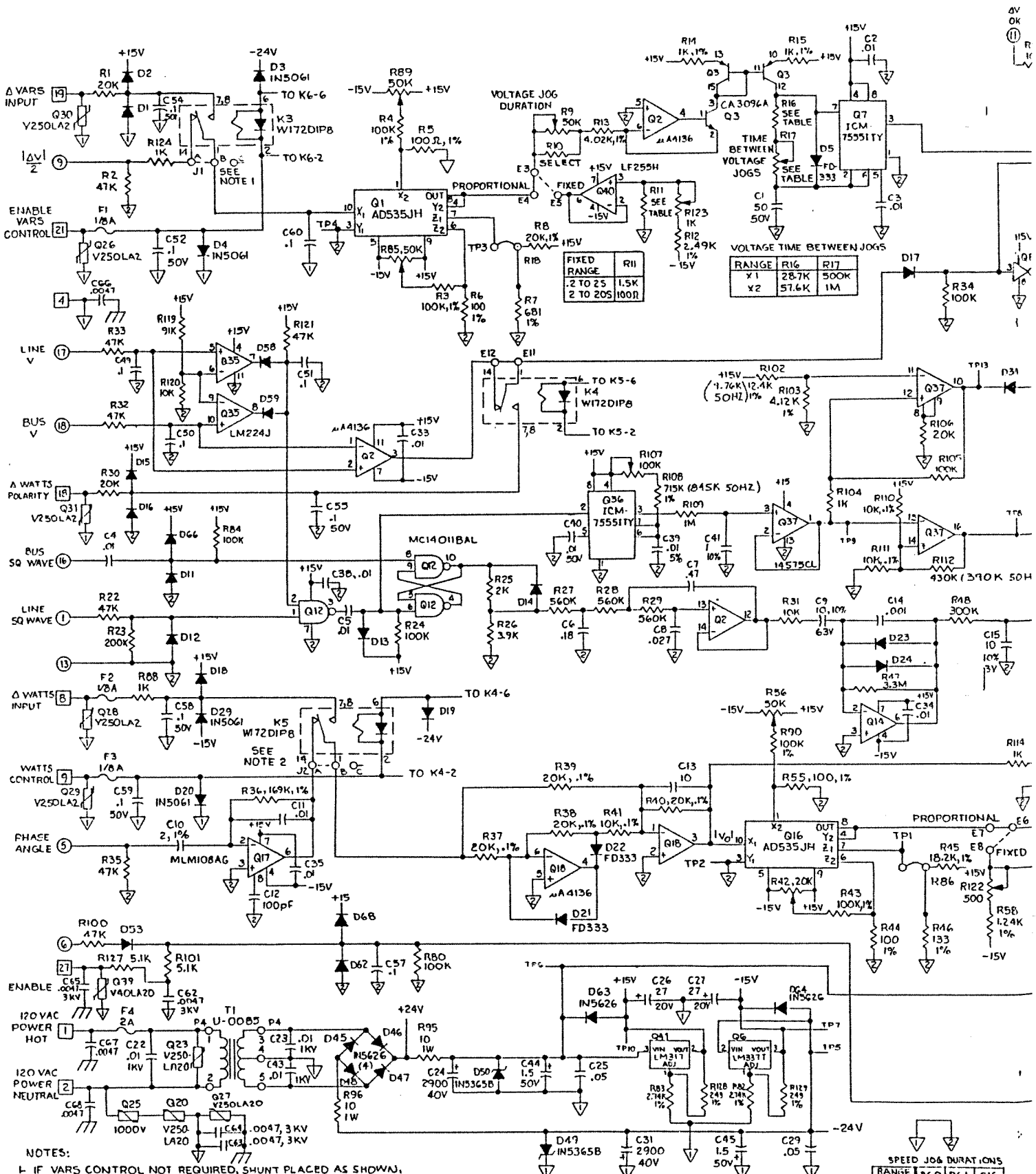
1. Set the **VOLTAGE CONTROL JOG DURATION** dial to the minimum setting.
2. Set the **VOLTAGE CONTROL TIME BETWEEN JOGS** dial to midscale (7.5 sec. for the 1 to 15 sec. range and 15 for the 2 to 30 sec. range).
3. Adjust the generator voltage until the **ΔV OK** LED on the M-0193 goes off.
4. The Lower Voltage relay K1 should be open for 7.5 sec. ±1.5 sec. between voltage jogs (15 sec. ±3 sec. if the 2 to 30 sec. range is used.)
5. The proper LED should light as the generator voltage goes higher or lower than the bus voltage.

KICKER PULSE RATE

1. Set the generator frequency to 120 V, 60 [50] Hz.
2. Set the bus frequency and voltage to 120 V, 60 [50] Hz. Set the **ΔF LIMIT** dial on the M-0193 to maximum. The **ΔF OK** LED should be lit.
3. Set the **KICKER PULSE RATE** dial to **60 SEC** (midscale).
4. The Raise Speed relay should close every 60 sec.

KICKER PULSE DURATION

1. Set **KICKER PULSE DURATION** dial to **1.0 SEC.**
2. Measure the time from when the Raise Speed relay closes to when the relay drops out. The measured time should be 1 sec ±0.2 sec.



NOTES:

1 - IF VARS CONTROL NOT REQUIRED, SHUNT PLACED AS SHOWN.

2 - IF WATTS CONTROL NOT REQUIRED, SHUNT PLACED AS SHOWN.

3 - Q3-16 & Q4-16 ARE CONNECTED TO -15V

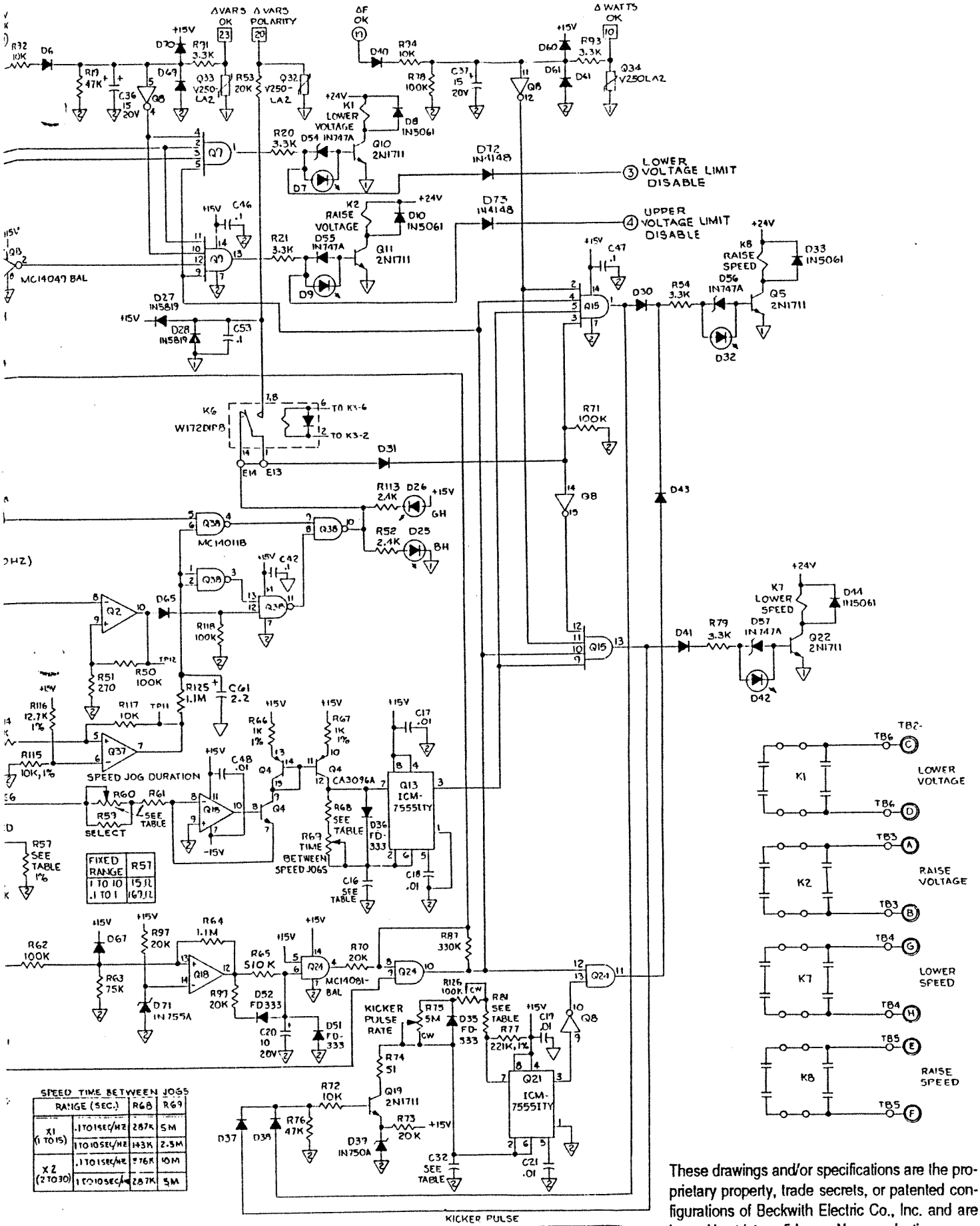
4 - UNLESS OTHERWISE SPECIFIED ALL RESISTANCE VALUES ARE IN OHMS ±5%, CAPACITANCE VALUES IN MICROFARADS, AND ALL DIODES ARE IN4148

5 - □ INDICATES TB1 CONNECTION, ○ INDICATES P1 CONNECTION (INTERCONNECT WITH M-0193), ○ INDICATES TB 2 CONNECTION

6 - TB1 CONNECTIONS 3,5-7,11-17,22,24-26 & 28 ARE NOT USED.

7 - P1 CONNECTIONS 2,7,8,10,12,14,15 & 20-25 ARE NOT USED.

FIGURE 5 Schematic



FIXED RANGE	R57
1 TO 10	15 Ω
.1 TO 1	169 Ω

SPEED TIME BETWEEN JOGS

RANGE (SEC.)		R68	R69
X1 (1 TO 15)	.1 TO 1 SEC/HZ	287K	5M
	1 TO 10 SEC/HZ	143K	2.5M
X2 (2 TO 30)	.1 TO 1 SEC/HZ	576K	10M
	1 TO 10 SEC/HZ	287K	5M

KICKER PULSE

RANGE	C32	R81
X3	50 μf	5K
X2	33 μf (30 μf + 3 μf)	43K
X1	16.5 μf (15 μf + 1.5 μf)	9.1K

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TYPICAL VOLTAGES

FROM	TO	CONDITIONS	VOLTAGE
C26 (–)	D63 (Cathode)	120 V ac input power	+24 V dc
C26 (–)	D49 (Anode)	120 V ac input power	–24 V dc
C26 (–)	C26 (+)	120 V ac input power	+15 V dc
C26 (–)	C27 (–)	120 V ac input power	–15 V dc

TYPICAL RESISTANCES

FROM	TO	RESISTANCE
TB1-1	TB1-2	43.0 Ω ±2 Ω
TB1-2	TB1-4	Open Circuit
TB1-4	TB2-A	Open Circuit
TB1-4	TB2-C	Open Circuit
TB1-4	TB2-E	Open Circuit
TB1-4	TB2-G	Open Circuit

● WARNING: Any attempt to measure resistances between points on the printed circuit board is likely to cause damage to the unit.

CALIBRATION

■ NOTE: The M-0193 and M-0194 units have been fully calibrated at the factory using highly sophisticated computer-controlled test equipment. There is no need to recalibrate the units before initial installation. Further calibration is only necessary if a component was changed during a repair procedure. Access to the calibration points is only possible with the cover removed, therefore after field repair do not install the units in a rack or panel before following the calibration or test procedure.

For component and test point locations, see Figure 5, Schematic, and Figure 6, Component Location.

FREQUENCY TRANSDUCER ADJUSTMENT

■ NOTE: Throughout this procedure, the "top" of the printed circuit board is nearest the back of the unit, the "bottom" is nearest the front panel.

1. Connect the M-0193 to the M-0194 by using the Connector Cable.
2. Connect a 120 V ac variable voltage, fixed 60 [50] Hz frequency source to terminal TB1-1 and TB1-2 of the M-0193, noting that TB1-1 is the HOT terminal.
3. Apply a 120 V ac variable frequency source to TB1-3 and TB1-4 of the M-0193, noting that TB1-4 is the HOT terminal. Adjust the frequency to 60 [50] Hz ±0.01 Hz.
4. Apply 120 V ac line power to TB1-26 and TB1-27 of the M-0193, noting that TB1-27 is the HOT terminal; and to TB1-1 and TB1-2 of M-0194, noting that TB1-1 is the HOT terminal.
5. Place the negative lead of a digital voltmeter (DVM) to circuit ground at the negative end of C24. Place the positive lead of a digital voltmeter to R104 bottom (Q37-1).
6. Record the +15 V ac supply level at the positive end of C27.
7. Adjust R107 so that the voltage at the bottom of R104 equals precisely 1/2 of the +15 V supply level.
8. Attach an oscilloscope ground lead to the negative end of C24, and the probe to the top of R112 (Q37-16). Ensure that the oscilloscope ground is isolated from the power line.
9. Starting at 59.0 [49.0] Hz, slowly increase the variable generator (line) frequency and watch for the voltage on R112 to drop to less than 2 V dc as the generator frequency approaches 60.45 [50.45] Hz.
10. Lower the generator frequency until the signal goes "high" (greater than +12 V dc) at approximately 59.55 [49.55] Hz.
11. Adjust R107 and repeat steps 9 and 10 until the R112 voltage switches at the frequencies specified in steps 9 and 10 (within ±0.02 Hz).

■ NOTE: Raising the voltage at R104 raises the frequency where the voltage on R112 switches "low."

PROPORTIONAL VOLTAGE JOG DURATION ADJUSTMENT

1. Place a jumper between TP3 (using the flea clip) and TP4.
2. Attach the positive lead of the DVM to flea clip E4.
3. Adjust R85 until the voltage at E4 = 0.00 V ±0.001 V, then remove the jumper on TP3.
4. Turn off the power to the M-0193 and M-0194. Unsolder and remove the jumper from flea clip E1 to flea clip E2.
5. Place a jumper between TP3 and E1.
6. Turn on the power to M-0193 and M-0194.
7. Adjust R89 until the voltage at E4 = -10.00 V ±.05 V.
8. Turn off the power to the M-0193 and M-0194. Re-solder the jumper from E1 to E2.
9. Reapply power to the M-0193 and M-0194. Attach the positive lead of the DVM to E1.
10. Lower the generator voltage to approximately 110 V ac, until the voltage at E1 reads 5.0 V. Check that the voltage at E4 is –1.0 V ±0.01 using the DVM, (ΔV is approximately 10 V).
11. Continue to lower the generator voltage until the voltage at E1 reads 10.0 V. Check to be sure that the voltage at E4 is –0.5 V ±0.01 V (ΔV is approximately 20 V).

PROPORTIONAL VOLTAGE JOG DURATION DIAL ADJUSTMENT

1. Attach the DVM to E1.
2. Slowly lower the generator voltage so that the voltage at E1 reads 5 V dc (actual voltage difference is approximately 10 V rms). Remove the meter lead.
3. Set the front panel **VOLTAGE CONTROL JOG DURATION** dial to **0.5 SEC/V**.
4. Use a stopwatch to measure the time that the Raise Voltage relay remains closed. The time should be 5 sec. ±1 sec.
5. If the time is not correct, loosen the front panel dial, turn in either direction and then relock. Repeat steps 4 and 5 until the dial is properly calibrated.
6. Move the dial to the **0.1 SEC/V** position.
7. Measure the time that the Raise Voltage relay remains closed. The time should be 1 sec. ±0.2 sec.
8. Move the dial to the **1 SEC/V** position.
9. Measure the time that the Raise Voltage relay closes. The time should be 10 sec. ±2 sec.
10. Reset the knob to the **0.5 SEC/V** position.
11. Raise the generator voltage so the voltage at E1 equals 5 V dc and then remove the meter lead.
12. Ensure that the Lower Voltage relay remains closed for 5 sec ±1 sec.
13. If the time is not correct, loosen the front panel dial, turn in either direction and then relock. Repeat steps 12 and 13 until the dial is properly calibrated.
14. Repeat steps 6 through 9 for the Lower Voltage relay.

PROPORTIONAL SPEED JOG DURATION ADJUSTMENT

1. Return the Generator voltage to 120 V, at a frequency of 60.12 [50.12] Hz.
2. Place a jumper between TP1 (using the flea clip) and TP2.
3. Attach the positive lead of a digital voltmeter to E7.
4. Adjust R42 until the voltage at E7 equals 0.00 ±0.001 V. Remove the jumper.
5. Turn off the power to the M-0193 and M-0194. Unsolder and remove the jumper from flea clip E9 to flea clip E10.
6. Place a jumper between TP1 and E10.
7. Turn on the power to the M-0193 and M-0194.
8. Adjust R56 until the voltage at E7 equals -10.00 V dc ±0.05 V dc.
9. Turn off the power to the M-0193 and M-0194. Resolder the jumper from E9 to E10.
10. Reapply power to the M-0193 and M-0194. Attach the positive lead of the DVM to the junction of R40 and C13 (Q18-3).
11. Vary the generator frequency until the voltage at the junction of R40 and C13 (Q18-3) is 0.1 V dc ±0.005 V dc. The generator frequency should be approximately 60.015 [50.015] Hz.
12. Continue to increase the generator frequency until the voltage at the junction of R40 and C13 is 5 V. Check that the voltage at E7 is 0.2 V ±0.02. (The generator frequency should be approximately 60.75 [50.75] Hz.)
13. Again adjust the generator frequency until the voltage at R40 equals 10 V, then check that the voltage of E7 equals 0.1 V. (The generator frequency should be approximately 61.5 [51.5] Hz.)

PROPORTIONAL SPEED JOG DURATION DIAL ADJUSTMENT

1. Set the generator frequency to 61 [51] Hz.
2. Set the **SPEED CONTROL JOG DURATION** dial to **0.5 SEC/HZ** position (X10 scale).
3. Use a stopwatch to measure the time that the Lower Speed relay remains closed. The time should be 5 sec. ±1 sec.
4. If the time is not correct, loosen the dial, turn in either direction and relock, then reset the dial to the **0.5 SEC/HZ** position. Repeat steps 3 and 4 until knob is properly calibrated.
5. Set the knob to the **0.1 SEC/HZ** position. The measured time should be 1 sec. ±0.2 sec.
6. Set the knob to **1 SEC/HZ** position. Measured time should be 10 sec. ±2 sec.

TIME BETWEEN JOGS DIAL ADJUSTMENTS (Fixed and Proportional)

Time Between Voltage Jogs

1. Raise the generator voltage until the **ΔV OK** LED on the M-0193 is off.
2. Set the **VOLTAGE CONTROL TIME BETWEEN JOGS** dial to midscale.
3. Measure the time from when the Lower Voltage relay drops out to when the relay picks up. Time should be 7.5 sec. ±1 sec. (15 sec. ±3 sec. if the 2 to 30 sec. range is used).
4. If time is incorrect, loosen the knob and turn in either direction and relock the knob. Repeat steps 3 and 4 until time measured agrees with the setting.
5. Move the dial to the fully counterclockwise position (1 or 2 sec. depending on the range selected) and measure the time.

6. Repeat step 5 with the knob in the fully clockwise position (15 or 30 depending on the range selected).

Time Between Speed Jogs

Repeat the above calibration procedure for **SPEED CONTROL TIME BETWEEN JOGS** with the **ΔF OK** LED on the M-0193 off.

KICKER PULSE RATE DIAL ADJUSTMENT

1. Ensure that the **ΔV OK** and **ΔF OK** LEDs on the M-0193 are on.
2. Set the **KICKER PULSE RATE** dial to the **60 SEC** position.
3. Measure that the time delay between closures of the Raise Speed relay is equal to 60 sec.
4. If time is incorrect, loosen the knob. Turn in either direction and relock. Repeat steps 3 and 4 until the timing is properly calibrated.
5. Set the dial to the **6 SEC** position and measure the time delay. Calibrate if necessary.
6. Set the dial to the **120 SEC** position and measure the time delay. Calibrate if necessary.

KICKER PULSE DURATION DIAL ADJUSTMENT

1. Ensure that the **ΔV OK** and **ΔF OK** LEDs on the M-0193 are on.
2. Set the **KICKER PULSE DURATION** dial to the **1.0 SEC** position.
3. Measure the time from when the Raise relay closes to when the relay drops out. The time should be equal to 1.0 sec. ±0.2 sec.
4. If the time is incorrect, loosen the dial. Turn in either direction and relock. Repeat steps 3 and 4 until the timing is properly calibrated.

PARTS LIST

M-0194 Generator Control Unit

This list includes all electrical and mechanical parts which could conceivably either require replacement or be lost. The **COMPONENT DESIGNATION** is the same as that appearing on schematics or referred to in Instruction Books.

The **BECO NUMBER** refers to an index maintained by the company. This lists the currently available device which may be substituted even though the device originally supplied is obsolete and no longer available. Parts marked by an asterisk* are not available from other sources. Either the original component or a current substitute will be carried in stock by Beckwith Electric.

Parts not marked with an asterisk are normally available from an electronics components house. Those parts or a current substitute will normally be available from Beckwith Electric stock.

In either case, when parts are ordered from Beckwith Electric, we will be responsible for supplying the current replacement in the shortest possible time.

Sufficient detailed description is also given to permit purchasing from an electronics parts house, providing the part is of equal or better quality to insure reliable operation. This may require some interpretation of specifications which may be avoided by direct purchase from Beckwith Electric using the **BECO NUMBER**.

Note that in a few instances, components are selected in final test. Procedures described in the **TEST PROCEDURES** Section must be followed in replacing these components.

All resistors are 1/2 W unless noted.

COMPONENT DESIGNATION	BECO NUMBER	DESCRIPTION
-	450-00012*	Printed Circuit Board, P-0431
C1	010-00436	Capacitor, Polycarbonate, 50 µF ±10%, 50 V
C2,C3,C11,C17-C19, C21,C33-C35,C38, C40,C48	000-00917	Capacitor, Ceramic Disc, 0.01 µF ±20%, 50 V
C4,C5	010-00424	Capacitor, Polycarbonate, 0.01 µF ±10%, 50 V
C6	000-00716	Capacitor, Polyester, 0.18 µF ±10%, 50 V
C7	010-00418	Capacitor, Polycarbonate, 0.47 µF ±10%, 50 V
C8	000-00717	Capacitor, Polyester, 0.027 µF ±10%, 50 V
C9,C15	000-00847	Capacitor, Polyester, 10 µF, 10%, 63 V
C10	010-00419	Capacitor, Polycarbonate, 2 µF ±1%, 50 V
C12	000-00903	Capacitor, Ceramic Disc, 100 pF ±20%, 1 kV

COMPONENT DESIGNATION	BECO NUMBER	DESCRIPTION
C13	000-00857	Capacitor, Polyester, 10 µF ±10%, 50 V
C14	000-00812	Capacitor, Polyester, 0.001 µF ±10%, 100 V
C16	000-00857	Capacitor, Polyester, 10 µF ±10%, 50 V
C20	000-00500	Capacitor, Tantalum, 10 µF ±10%, 25 V
C22,C23,C43	000-00904	Capacitor, Ceramic Disc, 0.01 µF ±20%, 1 kV
C24,C31	000-00637	Capacitor, Electrolytic, 2900 µF, 40 V
C25,C29	000-00905	Capacitor, Ceramic Disc, 0.05 µF +80/-20%, 600 V
C26,C27	000-00543	Capacitor, Tantalum, 27 µF ±10%, 20 V
C32	010-00438 010-00440	Capacitor, Polycarbonate, 3 µF ±10%, 50 V *and* Capacitor, Polycarbonate, 30 µF ±10%, 50 V
C36,C37	000-00544	Capacitor, Tantalum, 15 µF ±10%, 20 V
C39	010-00105	Capacitor, Mica, 0.01 µF ±5%, 500 V
C41	000-00826	Capacitor, Polyester, 1 µF ±10%, 100 V
C42,C46,C47,C49-53, C55,C56-C60	000-00914	Capacitor, Ceramic Disc, 0.1 µF ±20%, 50 V
C44,C45	000-00018	Capacitor, Electrolytic, 1.5 µF ±20%, 50 V
C54		Not Used
C61	000-00553	Capacitor, Tantalum, 2.2 µF, 25 V
C62-C68	000-00939	Capacitor, Ceramic Disc, 0.0047 µF ±20%, 3 kV
D1,D2,D6,D11-D17, D23,D24,D27,D28,D30, D31,D34,D37,D38,D40, D41,D43,D53,D58-D62, D65-D70,D72,D73	400-00224	Diode, 1N4148
D3,D4,D8,D10,D18-D20,D29,D33,D44	400-00211	Diode, 1N5061
D5,D21,D22,D35, D36,D51,D52	400-00225	Diode, FD333, Fairchild

COMPONENT DESIGNATION	BECO NUMBER	DESCRIPTION
D7,D9,D25,D26, D32,D42	400-00722	Diode, Light Emitting, Hewlett-Packard 5082-4658
D39	400-00059	Diode, Zener, 1N750A
D45-D48,D63,D64	400-00213	Diode, 1N5626
D49,D50	400-00061	Diode, 1N5365B
D54-D57	400-00017	Diode, Zener, 1N747A
D71	400-00018	Diode, Zener, 1N755A
F1-F4	420-00849	Fuse, 2 A, Littelfuse 275002
F2,F3	420-00844	Fuse, 1/8 A, Littelfuse 275.125
K1,K2	430-00153	Relay, 24 V dc, IDEC, RH-4BU-24VDC
K3-K6	430-00127	Relay, 24 V dc, SPST, Magnecraft W172DIP8
K7,K8	430-00153	Relay, 24 V dc, 4PDT
P1	420-00200	Connector, Amphenol 205858-2
P4	030-00045	Connector, 5-position, Amphenol 640466-1
Q1,Q16	400-00691	Divider, Analog Devices AD535JH
Q2,Q18	400-00639	Quad Op Amp, Fairchild µA4136DC
Q3,Q4	400-00642	Transistor Array, RCA CA3096A
Q5,Q10,Q11,Q19,Q22	400-00300	Transistor, Motorola, 2N1711
Q6	560-00010	Voltage Regulator, Linear Technology LM 337T
Q7,Q13,Q21,Q36	400-00690	Timer, Intersil ICM7555ITY
Q8	400-00638	Hex Inverter, Motorola MC14049BAL
Q9,Q15	400-00635	Dual 4-Input AND-Gate, Motorola MC14082BAL

COMPONENT DESIGNATION	BECO NUMBER	DESCRIPTION
Q12,Q38	400-00634	Quad 2-Input NAND-Gate, Motorola MC14011BAL
Q14,Q40	400-00620	Op Amp, National LF255H
Q17	400-00633	Op Amp, Motorola MLM108AG
Q20,Q23,Q27	400-00724	Varistor, 250 V ac, G.E. V250LA20
Q24	400-00636	Quad 2-Input AND-Gate, Motorola MC14081BAL
Q25	400-00718	Varistor, 1 kV, G.E. V1000LB80A
Q26,Q28-Q34	400-00709	Varistor, 250 V, G.E. V250LA2
Q35	400-00665	Quad Op Amp, National LM224J
Q37	400-00674	Dual/Dual Programmable Op Amp, Motorola MC14575CL
Q39	400-00713	Varistor, 40 V ac, G.E. V40LA2A
Q41	560-00008	Voltage Regulator, Linear Technology LM 317
R1,R30,R53,R70,R73, R97,R99,R106	200-00203	Resistor, Carbon Film, 20 K ±5%
R2,R19,R22,R32,R33, R35,R76,R100,R121	200-00473	Resistor, Carbon Film, 47 K ±5%
R3,R4,R43,R90	340-00601	Resistor, Metal Film, 100 K ±1%, RN60C
R5,R6,R44,R55	340-00301	Resistor, Metal Film, 100 Ω ±1%, RN60C
R7	340-00381	Resistor, Metal Film, 681 Ω ±1%, RN60C
R8	340-00530	Resistor, Metal Film, 20 K ±1%, RN60C
R9	360-00119	Potentiometer, 50 K, Cermet Element, Allen Bradley 73B1GO40S503W
R10		Refer to **SELECTED RESISTORS**
R11	340-00418	Resistor, Metal Film, 1.5 K ±1%
R12	340-00439	Resistor, Metal Film, 2.49 K ±1%, RN60C
R13	340-00459	Resistor, Metal Film, 4.02 K ± 1%, RN60C

COMPONENT DESIGNATION	BECO NUMBER	DESCRIPTION
R14,R15,R66,R67,R88	340-00401	Resistor, Metal Film, 1 K ±1%, RN60C
R16,R17		Refer to **OPTIONAL COMPONENTS**
R18,R86		Jumper, Refer to **OPTIONAL COMPONENTS**
R20,R21,R54,R79,R91 R93	200-00332	Resistor, Carbon Film, 3.3 K ±5%
R23	200-00204	Resistor, Carbon Film, 200 K ±5%
R24,R34,R50,R62,R71, R78,R80,R84,R105,R118	200-00104	Resistor, Carbon Film, 100 K ±5%
R25	200-00202	Resistor, Carbon Film, 2 K ±5%
R26	200-00392	Resistor, Carbon Film, 3.9 K ±5%
R27-R29	200-00564	Resistor, Carbon FIlm, 560 K ±5%
R31,R72,R92,R94,R117, R120	200-00103	Resistor, Carbon Film, 10 K ±5%
R36	340-00623	Resistor, Metal Film, 169 K ±1%, RN60C
R37-R40	340-00002	Resistor, 20 K ±0.1%, RN60E2002B
R41,R110,R111	340-00001	Resistor, 10 K ±0.1%, RN60E
R42	360-00068	Potentioneter, 20 K, Bourns 3009P-1-203
R45	340-00526	Resistor, Metal Film, 18.2 K ±1%, RN60C
R46	340-00313	Resistor, Metal Film, 133 Ω ±1%, RN60C
R47	200-00335	Resistor, Carbon Film, 3.3 M ±5%
R48	200-00304	Resistor, Carbon Film, 300 K ±5%
R49		Not Used
R51	200-00271	Resistor, Carbon Film, 270 Ω ±5%
R52,R113	200-00242	Resistor, Carbon Film, 2.4 K ±5%
R85,R89	360-00142	Potentiometer, 50 K, Bourns 3266W-1-503
R57	340-00017	Resistor, Metal Film, 15 Ω ±1%

COMPONENT DESIGNATION	BECO NUMBER	DESCRIPTION
R58	340-00410	Resistor, Metal Film, 1.24 K ±1%, RN60C
R59		Refer to **SELECTED RESISTORS**
R60	360-00119	Potentiometer, 50 K, Allen Bradley 73B1G040S503W
R61	340-00446	Resistor, Metal Film, 2.94 K ±1%
R63	200-00753	Resistor, Carbon Film, 75 K ±5%
R64,R125	200-00115	Resistor, Carbon Film, 1.1 M ±5%
R65	200-00514	Resistor, Carbon Film, 510 K ±5%
R68,R69		Refer to **OPTIONAL COMPONENTS FOR RANGE SELECTION**
R74	200-00510	Resistor, Carbon Film, 51 Ω ±5%
R75	360-00127	Potentiometer, 5 M, Cermet Element, Allen Bradley 73BIG040S505W
R77	340-00634	Resistor, Metal Film, 221 K ±1%, RN60C
R81	200-00432	Resistor, Carbon Film, 4.3 K ±5%
R82, R83	340-00443	Resistor, Metal Film, 2.74 K ±1%, RN60C
R87	200-00334	Resistor, Carbon Film, 330 K ±5%
R95,R96	230-00100	Resistor, Carbon Film, 10 Ω ±5%, 1 W
R98		Not Used
R101,R127	180-00512	Resistor, Carbon Comp., 5.1 K ±5%, 1/4 W
R102	340-00510	Resistor, Metal Film, 12.4 K ±1%
R103	340-00460	Resistor, Metal Film, 4.12 K ±1%, RN60C
R104,R114,R124	200-00102	Resistor, Carbon Film, 1 K ±5%
R107	360-00139	Potentiometer, 100 K, Bourns 3266W-1-104
R108	340-00683	Resistor, Metal Film, 715 K ±1%, RN60C
R109	200-00105	Resistor, Carbon Film, 1 M ±5%
R112	200-00434	Resistor, Carbon Film, 430 K ±5%

COMPONENT DESIGNATION	BECO NUMBER	DESCRIPTION
R115	340-00501	Resistor, Metal Film, 10 K ±1%, RN60C, 1/4 W
R116	340-00511	Resistor, Metal Film, 12.7 K ±1%, RN60C
R119	200-00913	Resistor, Carbon Film, 91 K ±5%
R122	360-00073	Potentiometer, 500 Ω, Bourns, 3386P-1-501
R123	360-00094	Potentiometer, 1 K, Bourns 3386P-1-102
R126	360-00132	Potentiometer, 100 K, Allen Bradley 73B1G040S104W
R128, R129	390-00339	Resistor, Metal Film, 249 Ω, ±1%
TB1	420-00052	Terminal Strip, 28-position, RDI 6PCR-28C3
TB3-TB6 *REV X*	420-00066	Terminal Strip, 2-position, Curtis EPR-2

OPTIONAL COMPONENTS FOR RANGE SELECTION (Refer to Tables 1 and 2)

R16	340-00545 340-00574	Resistor, Metal Film, 28.7 K ±1% Resistor, Metal Film, 57.6 K ±1%
R17	360-00124 360-00125	Potentiometer, 500 K, Allen Bradley, 72B1G040S504W Potentiometer, 1 M, Allen Bradley, 72B1G040S105W
R68	340-00638 340-00645	Resistor, Metal Film, 143 K ±1% Resistor, Metal Film, 287 K ±1%
R69	360-00126 360-00127	Potentiometer, 2.5 M, Allen Bradley 73B1G040S255W Potentiometer, 5 M, Allen Bradley 73B1G040S505W

SELECTED RESISTORS

R10	390-00609	Resistor, Metal Film, 121 K ±1%
	390-00610	Resistor, Metal Film, 124 K ±1%
	390-00612	Resistor, Metal Film, 130 K ±1%
	390-00614	Resistor, Metal Film, 137 K ±1%
	390-00616	Resistor, Metal Film, 143 K ±1%
	390-00618	Resistor, Metal Film, 150 K ±1%

COMPONENT DESIGNATION	BECO NUMBER	DESCRIPTION
R59	390-00573 390-00575 390-00576 390-00577 390-00578	Resistor, Metal Film, 56.2 K ±1% Resistor, Metal Film, 59 K ±1% Resistor, Metal Film, 60.4 K ±1% Resistor, Metal Film, 61.9 K ±1% Resistor, Metal Film, 63.4 K ±1%
50 HZ OPERATION OPTION		
R102	390-00496	Resistor, Metal Film, 9.76 K ±1%, RN55C
R108	330-00690	Resistor, Metal Film, 845 K ±1%, RN60E
R112	200-00394	Resistor, Carbon Film, 390 K ±5%
IF REQUIRED FOR CALIBRATION		
R18,R86	360-00042	Potentiometer, 2 K, Bourns 3386P-1-202
REV T		
PARTS MOUNTED TO THE ENCLOSURE		
T1	410-00030*	Transformer, Power, U-0085
TB2	420-00051	Terminal Block, Cinch 8-142Y
REV G		

OPTIONAL COMPONENTS

TIME BETWEEN SPEED JOGS

RANGE	R68	R69
1 to 15 sec.	143 K	2.5 M
2 to 30 sec.	287 K	5 M

TABLE 1

TIME BETWEEN VOLTAGE JOGS

RANGE	R16	R17
1 to 15 sec.	28.7 K	500 K
2 to 30 sec.	57.6 K	1 M

TABLE 2

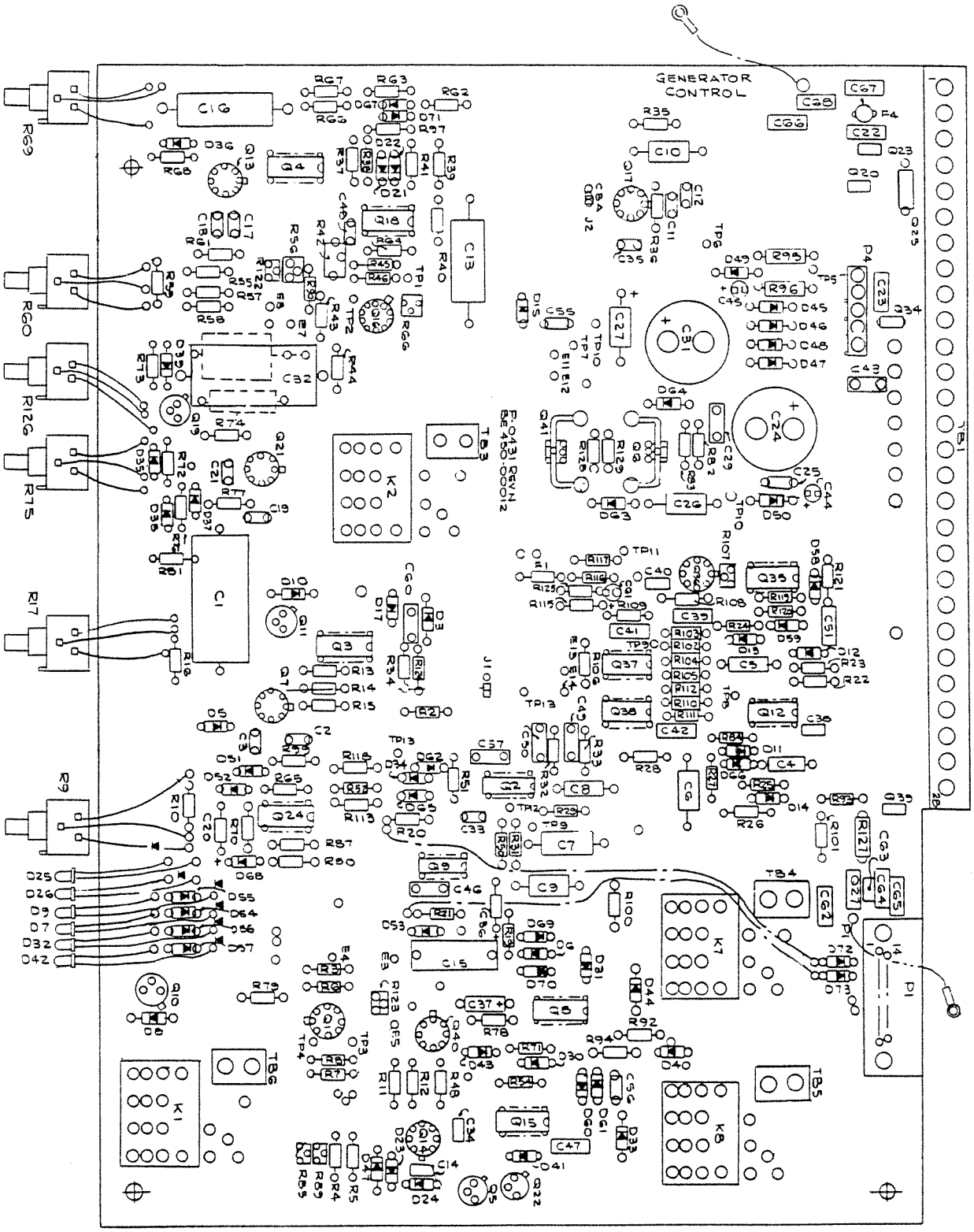

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FIGURE 6 Component Location

Legal Information

Patent

The units described in this manual are covered by U.S. Patents, 3,491,248 and 4,218,625.

Buyer shall hold harmless and indemnify the Seller, its directors, officers, agents, and employees from any and all costs and expense, damage or loss, resulting from any alleged infringementof United States Letters Patent or rights accruing thereform or trademarks, whether federal, state, or common law, arising from the Seller's compliance with Buyer's designs, specifications, or instructions.

Warranty

Seller hereby warrants that the goods which are the subject matter of this contract will be manufactured in a good workmanlike manner and all materials used herein will be new and reasonably suitable for the equipment. Seller warrants that if, during a period of two years from date of shipment of the equipment, the equipment rendered shall be found by the Buyer to be faulty or shall fail to peform in accordance with Seller's specifications of the product, Seller shall at his expense correct the same, provided, however, that Buyers shall ship the equipment prepaid to Seller's facility. The Seller's responsibility hereunder shall be limited to replacement value of the equipment furnished under this contract.

Seller makes no warranties expressed or implied other than those set out above. Seller specifically excludes the implied warranties of merchantibility and fitness for a particular purpose. There are no warranties which extend beyond the description contained herein. In no event shall Seller be liable for consequential, exemplary, or punitive damages of whatever nature.

Any equipment returned for repair must be sent with transportation charges prepaid. The equipment must remain the property of the Buyer. The aforementioned warranties are void if the value of the unit is invoiced to the Seller at the time of return.

Indemnification

The Seller shall not be liable for any property damages whatsoever or for any loss or damage arising out of, connected with, or resulting from this contract, or from the performance or breach thereof, or from all services covered by or furnished under this contract.

In no event shall the Seller be liable for special, incidental, exemplary, or consequential damages, including but not limited to, loss of profits or revenue, loss of use of the equipment or any associated equipment, cost of capital, cost of purchased power, cost of substitute equipment, facilities or services, downtime costs, or claims or damages of customers or employees of the Buyer for such damages, regardless of whether said claim or damages is based on contract, warranty, tort including negligence, or otherwise.

Under no circumstances shall the Seller be liable for any personal injury whatsoever.

It is agreed that when the equipment furnished hereunder are to be used or performed in connection with any nuclear installation, facility, or activity, Seller shall have no liability for any nuclear damage, personal injury, property damage, or nuclear contamination to any property located at or near the site of the nuclear facility. Buyer agrees to indemnify and hold harmless the Seller against any and all liability associated therewith whatsoever whether based on contract, tort, or otherwise. Nuclear installation or facility means any nuclear reactor and includes the site on which any of the foregoing is located, all operations conducted on such site, and all premises used for such operations.

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