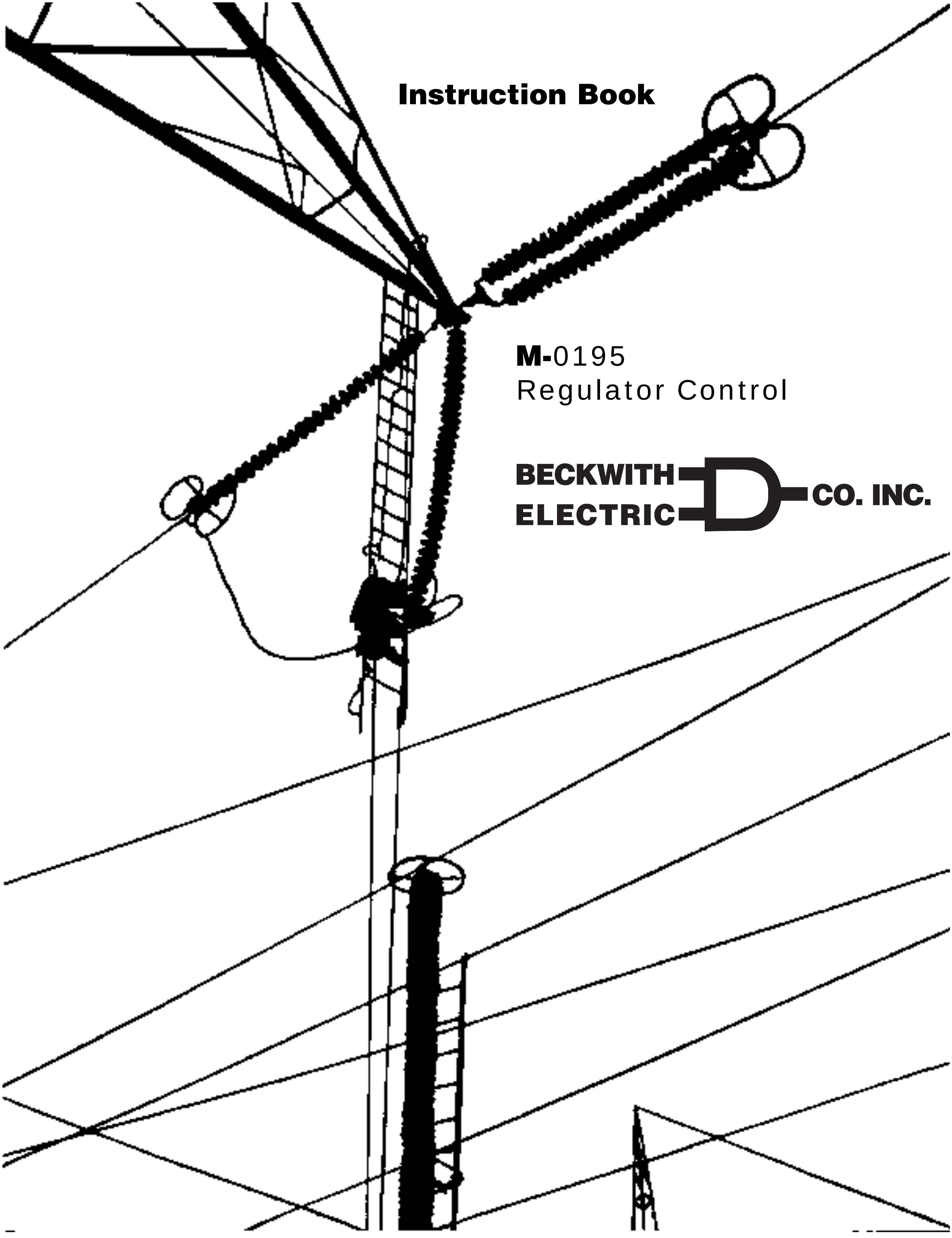


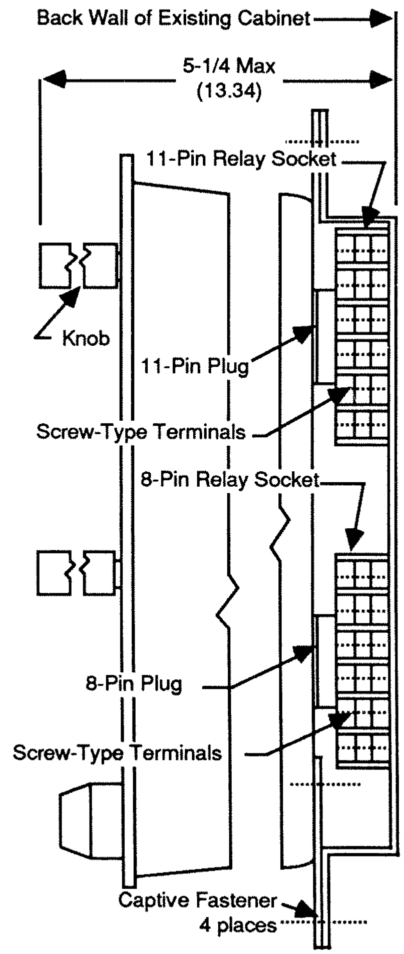
Instruction Book

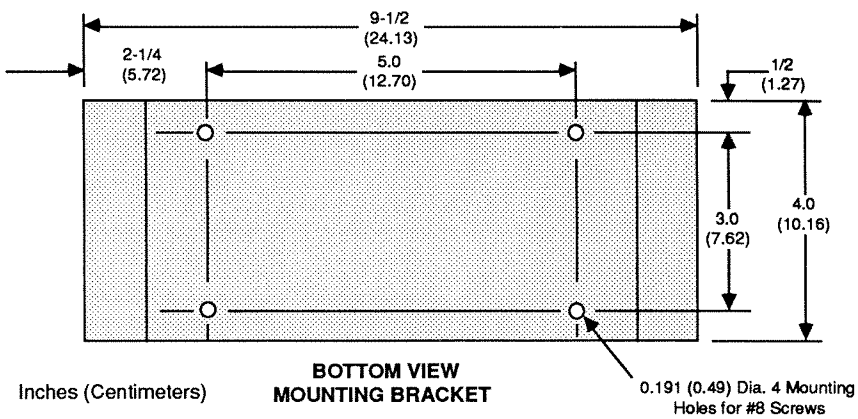
M-0195
Regulator Control

BECKWITH ELECTRIC CO. INC.

BECKWITH ELECTRIC CO. INC.

Regulator Control M-0195





Inches (Centimeters)

BOTTOM VIEW
MOUNTING BRACKET

This simplified solid-state control replaces worn out controls on single-phase load tapchanging transformers or induction voltage regulators. The mounting bracket and socket assembly are designed to be permanently installed on the inside back wall of the existing cabinet. The plug-in control can then be easily installed or removed to facilitate maintenance.

INPUTS

Voltage: A two-wire voltage input of 105 to 135 V ac nominal is required. A second input, also 105 to 135 V ac nominal with neutral common to the voltage input, is required to power the control and, through its outputs, drive the associated motor or motor relays. The power consumed by the control is less than 3 W. If a separate power supply is not available, the control and motor may be powered from a common input. Burden is 0.4 VA.

Line Current: Line drop compensation is provided by a CT input having 0.2 A full scale rating. The burden imposed by this input is 0.07 VA.

Outputs: Two separate normally open dry output relay contacts may be directly connected to the Raise and Lower windings of a regulator motor. Alternatively, they may be connected to motor relays which, in turn, drive the motor. The contacts are rated as follows:

	115 V ac	220 V ac	48 V dc	125 V dc
Carry Continuous	5 A	2 A	5 A	0.5 A
Interrupt Resistive	5 A	1 A	3 A	0.5 A
Interrupt Inductive	0.5 A	0.25 A	0.1 A	0.05 A

CONTROLS

VOLTAGE: The center of the bandwidth may be set to any voltage from 105 to 135 V ac. The center of bandwidth typically will vary no more than ±0.5 V.

BANDWIDTH: The bandwidth can be adjusted from 1 to 6 V ac.

LINE DROP COMPENSATOR: The line drop compensator provides 24 V compensation at 0.9 P.F. lagging for 0.2 A line current.

TIME: The timer is adjustable from 0 to 120 sec. The timer is initiated when the voltages go outside the band and resets within a few milliseconds upon return to the band.

VOLTAGE DROP: Voltage drop is adjustable from 0 to 6 V to compensate for the voltage drop on a voltage transformer that occurs if a common supply is used to drive the motor.

TEST: An uncalibrated dial will lower the input voltage by a maximum of 10% to permit checking the calibration of the M-0195 using a fixed voltage source. Pin jacks are provided on the front panel to measure the test voltage. When set in the **OPERATE POSITION**, the voltage measured is the regulator voltage.

DRAGHAND RESET: This pushbutton switch, when pressed, provides 120 V ac for the draghand mechanism to bring its hands back to neutral. The current drawn will not exceed 0.75 A.

LED INDICATORS

Two band-edge LEDs indicate the excursion of regulator voltage above or below its dead band. A third LED lights if the voltage stays outside the band beyond the time delay setting, indicating that the Raise or Lower output contacts are closed and the motor is energized. The **NEUTRAL LIGHT** will light when the regulator is in the neutral position.

OPERATIONS COUNTER

This rugged, nonresettable electromechanical counter can record up to 999999 operations. It retains its previous reading on loss of power.

RESPONSE TIME

The unit will respond to 5/8% voltage change in 0.2 sec., assuring freedom from hunting on minimum bandwidth.

TRANSIENT PROTECTION

Input and output circuits are protected against system transients. The M-0195 will exhibit no component failure or false commands when subjected to the requirements of ANSI/IEEE C37.90.1-1989, which defines oscillatory and fast transient 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 at up to 85% relative humidity (non-condensing).
Fungus Resistance: A conformal printed circuit board coating inhibits fungus growth.

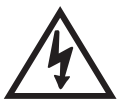
PHYSICAL

Size: 10" high x 4-3/4" wide x 5-1/4" deep (25.4 cm x 12.1 cm x 13.3 cm) including mounting bracket.
Approximate Weight: 4 lb 6 oz (2.0 kg).
Approximate Shipping Weight: 5 lb 4 oz (2.4 kg).

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

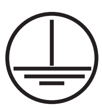


– This sign warns that the area is connected to a dangerous high voltage, and you must never touch it.

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.

TABLE OF CONTENTS

M-0195 REGULATOR CONTROL
Instruction Book

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

This page left intentionally blank.

INTRODUCTION

This all solid-state control is designed to provide long, troublefree performance, using the latest design techniques and modern solid-state components. The control is inherently stable with temperature variations and usage. No temperature compensation is included in the design. All active semiconductors are hermetically sealed, and therefore largely free from performance degradation associated with being exposed to a variety of environmental conditions.

CONSTRUCTION

The entire control is housed in a rugged die-cast aluminum box that is anodized for long life. All circuit components are mounted on a double-sided printed circuit board with plated-through holes. Components are mounted on either side of this board. The board is fastened to the front cover and held 5/8" behind it by nylon bushings. Holes are provided in the front cover to view the light emitting diodes mounted on the printed circuit board. The shafts of a switch and three potentiometers project from the front panel and rotate against marked scales. All four controls are adjusted by knobs having edge indicators. Holes in the cover permit the **TIME, BANDWIDTH** and **VOLTAGE DROP** controls to be adjusted with a screwdriver. Mounted to the cover is the motor fuse in a cartridge-type fuse holder, **OPERATIONS COUNTER, DRAGHAND RESET** pushbutton, and pin jacks to measure the test voltage as well as the normal operating voltage. The cover is held to the box by six screws. The wire cable from the printed circuit board and from the components mounted to the front cover is routed to two relay-type connector plugs mounted at the back of the box underneath the printed circuit board. A mounting plate is fastened to the bottom end of the box and the connector plugs project through it. The mounting plate has four 1/4 turn stainless steel fastener studs, held by retainers, mounted near each corner.

MOUNTING

The control is intended to be mounted inside a control cabinet. A U-bracket, with two connector sockets mounted to it, is provided separately. The bracket should be mounted inside the control cabinet by four screws. Connections are then made to the terminals of the sockets. Fastened to the bracket are four 1/4 turn receptacles that correspond to the studs on the mounting plate described above. The M-0195 control connector plugs should be aligned with the sockets and pushed in as far as they will go. The control is properly mounted by turning the 1/4 turn fastener studs with a screwdriver until they catch. Pin J2-6 on the mounting bracket should be connected to the regulator chassis ground.

Under no condition should the terminals connecting the diodes to the J1 socket be removed.

REPLACEMENT ADAPTERS

Regulator Control Replacement Adapters are available that have been designed to use the existing mounting and connection features of several models of control cabinets. At the time of printing, the following Adapters are available:

Beckwith M–0264	Beckwith M–0263
G.E. ML 32 Cabinets	**Siemens (Allis-Chalmers) Cabinets**
SN B687099 & Greater SN C183999 & Greater SN D259079 to D571998	IJ2 SJ3, 4, 5 & 6 UJ2, 4 & 5

APPLICATION

GENERAL

This simplified Regulator Control is intended to replace the obsolete controls on induction voltage regulators or single-phase load tapchanging transformers. It is offered as an alternative to the existing controls that are hard to maintain and calibrate, and are not temperature stable. Simple in design and therefore more reliable, it uses quality components and modern techniques to perform its function. There are no moving parts except output relays and adjustment controls.

VOLTAGE INPUTS

The external connections are shown in Figures 4 through 6. The voltage should be obtained from a potential transformer having a nominal 120 V ac output. The burden of the voltage input is about 0.4 VA. The power to run the motor and the control should be obtained from a separate supply. The control can run from 100 to 140 V ac but the supply voltage should be within the allowable operating range of the motor. If a separate motor supply is not available, both the voltage and the motor supply may be obtained from the volatge transformer.

CURRENT INPUT

Two current input terminals are provided to accommodate CT's that have polarity side grounded. The polarity of the input terminals must be observed for proper connections. If the CT polarity side is grounded, connect the other side to terminal J1-3 and connect J1-2 to neutral. If the CT nonpolarity side is grounded, connect the polarity side to J1-2, and connect J1-3 to neutral. In case of a floating CT, connect to both input terminals with proper polarity. The CT should be rated at 0.2 A nominal, full scale. Either a Beckwith Electric M-0121 or an M-0169A Auxiliary Current Transformer unit can be used in conjunction with the M-0195. Note that if the M-0121 is used, no other load can be used in the secondary circuit.

CURRENT INPUT WITHSTAND

AMP	MAX. TIME
5	2 Sec
4	3 Sec
3.3	4 sec
2.9	5 Sec
0.4	2 Hrs

OUTPUT

The Raise and Lower outputs should be connected to the respective motor windings or motor starter relays. The output relay contacts can handle 6 A inrush current and 3 A continuous current. If the motor draws higher current, motor starter relays must be used. The **AUTO/RAISE/LOWER** (ARL) switch should be in the **AUTO** position for automatic operation but can be used for manual control if the need arises.

These outputs are rated as follows:

	115 V ac	220 V ac	48 V dc	125 V dc
Carry Continuous	5 A	2 A	5 A	0.5 A
Interrupt Resistive	5 A	1 A	3 A	0.5 A
Interrupt Inductive	0.5 A	0.25 A	0.1 A	0.05 A

MOTOR FUSE

The control has a 3 A Slo-Blo fuse installed on the front cover. However, the fuse should be matched to the motor size for proper operation. The fuse size should be such that it will open if the motor stalls to prevent damage to the motor. In no case should the fuse be rated at more than 3 A.

NEUTRAL LIGHT

The **NEUTRAL LIGHT** inputs should be connected to a 120 V ac supply through a neutral position switch closed in neutral. The inputs are isolated from the rest of the circuit, and either input may be grounded. The neutral position switch may be connected to the hot or neutral side of the voltage supply. The burden of the inputs is about 0.4 VA.

OPERATIONS COUNTER

The inputs should be connected to a 120 V ac supply through an operations counter switch that closes momentarily at the end of a tap change. The counter takes about 8 W to operate. Either input can be grounded, and the operations counter switch may be connected to the hot or neutral side of the voltage supply.

DRAGHAND RESET

The inputs should be connected to a 120 V ac supply through a draghand solenoid. The reset switch is rated at 3/4 A. Either input may be grounded. The solenoid may be connected in the neutral or hot side of the voltage supply.

VOLTAGE DROP

If a common supply is used for the voltage input and motor supply, the voltage drop due to motor energizing will result in hunting of the motor at the upper band edge. The **VOLTAGE DROP** adjustment can compensate for up to 6 V drop in the supply voltage. The adjustment can be made experimentally for one type of motor; for all field applications involving similar motors, the same adjustment will be required. Of course, this assumes that the supply voltage load regulation is about the same for all applications.

VOLTAGE REDUCTION

The voltage setpoint may be reduced by various amounts by adding two internal and two external 1/4 W metal film resistors. Values of resistance for voltage reduction up to 15% are shown in Figure 1. Resistors R24 and R34 must be added internally in the locations shown in Figure 8. Both resistors should be 1 M±1% RN60C type. In addition, two resistors must be added externally as follows:

FROM	TO	RESISTOR VALUE
J1-1	J1-6	Refer to Figure 1 and Table 1 for value of RN60C type resistor
J1-4	J1-6	100 K ±1% RN60C type

The resistor from J1-1 to J1-6 may be connected through a switch/relay contact if the associated leads are kept relatively short and within the control cabinet. This method avoids introducing noise at pin J1-6 that could cause damage or erroneous operation of the regulator. The resistor from J1-4 to J1-6 has no effect on the circuit operation when J1-1 to J1-6 is open. The external switch/relay may be remotely controlled by supervisory equipment.

%	RN60C VALUE	%	RN60C VALUE	%	RN60C VALUE
1	2.43 M	6	309 K	11	121 K
2	1.15 M	7	249 K	12	102 K
3	732 K	8	210 K	13	86.6 K
4	523 K	9	169 K	14	71.5 K
5	392 K	10	143 K	15	59 K

TABLE 1 Voltage Reduction

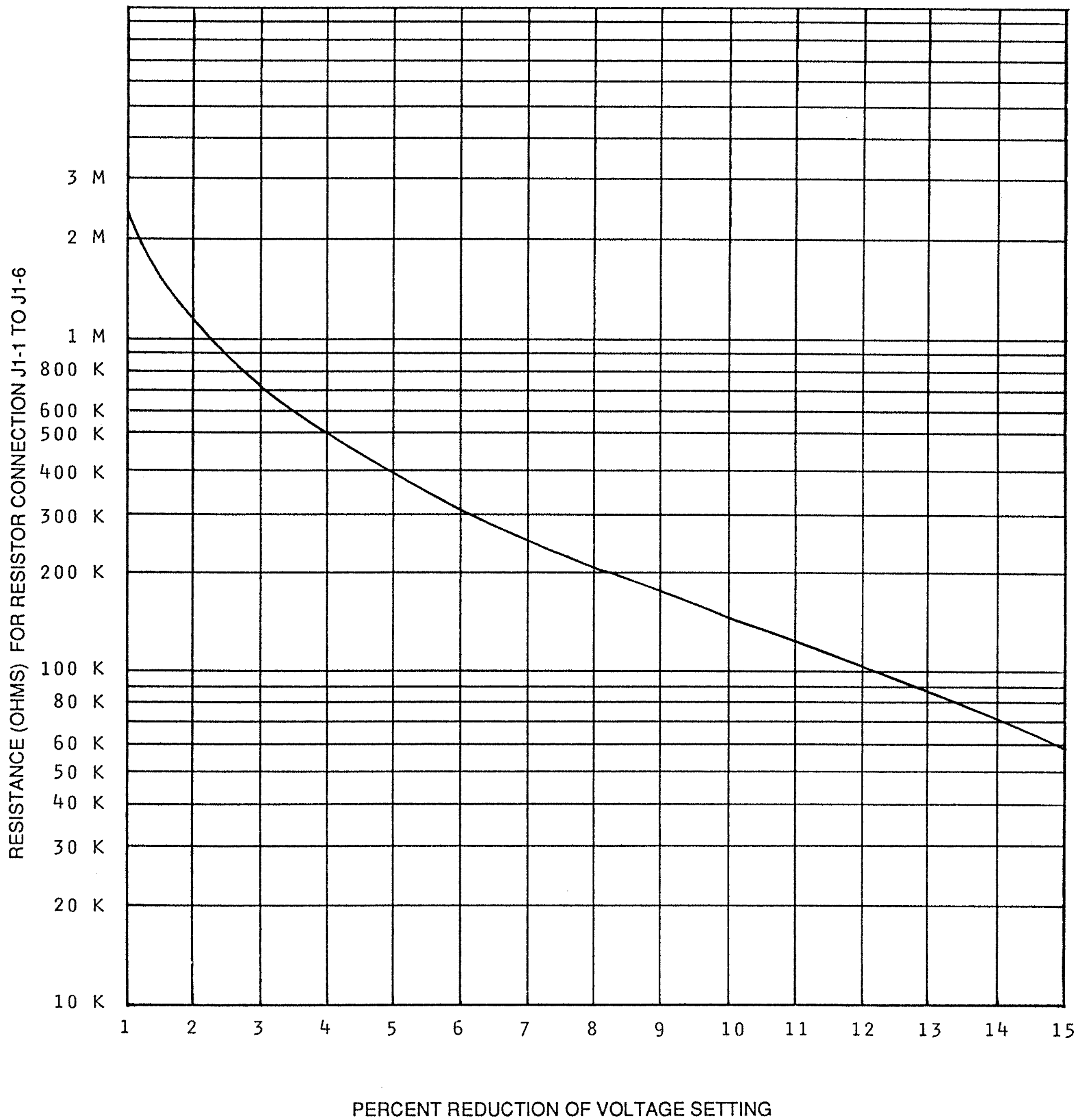


FIGURE 1 Voltage Reduction

THEORY OF OPERATION

POWER SUPPLY

Transformer T1 and diodes D1, D2, D3 & D26 form a full-wave rectifier that provides unregulated dc voltages to the regulator (Q5) input terminals. Regulator Q5 is a dual tracking regulator that produces +15 V dc and -15 V dc from the unregulated dc input. The primary of T1 is protected from external line transients by capacitor C12 and varistor Q7. The line voltage may vary from 100 to 140 V ac, which permits the control to be operated from a common supply and provides power as well as sensing inputs.

VOLTAGE SENSING

With the **TEST** control potentiometer R5 in the counter-clockwise or **OPERATE POSITION**, current proportional to the input voltage is fed into the inverting input of Q1A, which has its non-inverting input connected to ground. During the positive half cycle, Q1A pin 3 goes negative and, therefore D6 is forward biased. Current flows through R8 and R13 developing a negative voltage at the anode of D6. Op Amp Q1B has its non-inverting input also connected to ground. The negative voltage developed at the anode of D6 draws current out of the inverting pin of Q1B, causing the output of Q1B to go positive. Simultaneously, a current proportional to the input voltage flows through R7 and produces a negative voltage at Q1B output. The net voltage at Q1B is positive due to the additional gain from the ratio of R13 and R14 obtained in the first circuit. When the input voltage goes negative, Q1A pin 3 goes positive and D6 is reverse biased. Since Q1A pin 1 and Q1B pin 6 are virtually held at ground, no current flows through R13 and R14. Diode D7 provides negative feedback and prevents Q1A output from saturating. The negative input voltage causes a current to flow through R7, forcing the Q1B output to go positive. Thus Q1A and Q1B, together with their associated components, form a precise active full-wave rectifier circuit; the effect of change in voltage drop of D6 and D7 with temperature is eliminated due to their connection in the feedback circuits. Capacitor C7 and R15 form an averaging circuit, followed by R16 and C8 connected as a low-pass filter. The dc voltage across C8 is 6.0 V for a 120 V ac input voltage. Diodes D4, D5, D8 and D9 limit the voltage levels at Q1A and Q1B inverting inputs to above and below the ground by a diode drop. The ripple component of the voltage across C8 is above 4 mV peak to peak at 120 Hz.

LINE DROP COMPENSATOR

The line current flows through terminals J1-2 and J1-3 into the primary of the current transformer T2. The secondary has a burden of 25 K, and a voltage proportional to the line current develops across it. The connections of T2 secondary are polarity-reversed to provide a 180° phase shift. In addition, a phase shift equal to 0.9 p.f. lagging is obtained due to the transformer inductance and the 25 K resistive burden. The voltage across LDC control R25 is about 29 V rms for 200 mA line current. Current flows through the scaling resistors R10 and R11 into the inverting inputs of Q1A and Q1B where it is added to the currents due to the input voltage. The circuit thus effectively subtracts the LDC compensation voltage shifted by 0.9 p.f. from the input voltage. Diodes D24 and D25 are connected across socket terminals 2 and 3 so that when the control is removed from the socket with the line current flowing, the secondary circuit of the CT providing this current will not open and cause hazardous voltage to develop. The burden imposed by the LDC input circuit is small enough to ensure that the diodes do not conduct normally.

VOLTAGE BAND DETECTOR

Resistors R28, R22, potentiometer R17 and trimmer R20 form a voltage divider network across +15 V. Trimmer R20 is factory adjusted to compensate for the initial tolerances of the voltage-sensing circuit.

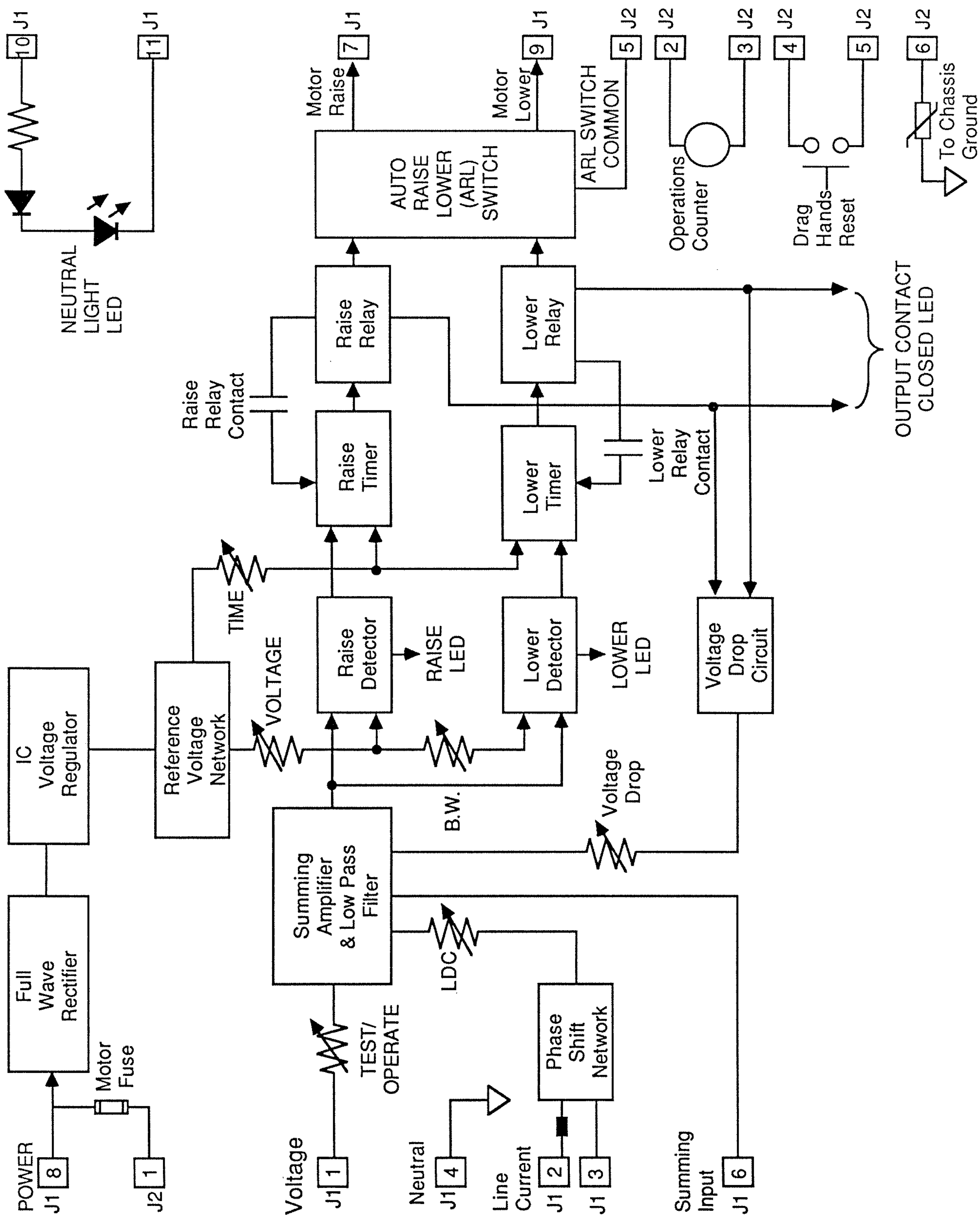


FIGURE 2 Block Diagram

VOLTAGE control potentiometer R17 provides a voltage whose range corresponds to a sensing voltage of 105 V to 135 V ac. Resistors R21, R23, and R25 produce a voltage band across R21 and R23 corresponding to 1 to 6 V ac with R21 set for the desired voltage band. The center of the voltage band is determined by the setting of R17. The reference voltages are compared with the voltage across C8, corresponding to the voltage input, by Q2A and Q2B connected as voltage comparitors.

If the input voltage falls inside the deadband established by the **VOLTAGE** control R17 and the **BANDWIDTH** trimmer R21, the outputs of Q2A and Q2B remain switched to -14 V. As the input voltage increases slightly above the upper band limit, the non-inverting input of Q2A exceeds the inverting input, causing its output to switch to +14 V. The high output of Q2A will light the **LOWER** LED D12, to indicate the voltage has moved above the band. Similarly, if the input voltage moves below the lower end of the deadband, Q2B output switches to +14 V, and the **RAISE** LED is lit. Positive feedback is used to obtain decisive switching of Q2A and Q2B outputs and, in the process, yields a precise 0.2 V ac hysteresis at the band edges. This, coupled with the slight time delay incorporated in the voltage-sensing circuit, ensures freedom from hunting at even the minimum **BANDWIDTH** setting.

TIMER

Two independent but identical integrating timer circuits are used to ensure that each circuit is already reset at the start of the timing cycle. When Q2A output switches high to +14 V as a result of the input voltage moving above the band edge, this precise voltage supplies charging current to the capacitor C9 through resistors R30 and R31. The capacitor voltage is compared with the voltage at the wiper of the **TIME** adjusting trimmer R36 by the voltage comparitor Q2C whose output is initially at -14 V. As the capacitor voltage exceeds the reference voltage, Q2C voltage switches to +14 V, developing about 28 V across the coil of the lower relay K1, which is thereby picked up. One set of the relay contacts transfer the motor supply voltage to its lower winding or otherwise to the coil of the lower motor starting relay, provided the ARL switch is in the **AUTO POSITION.**

The second set of K1 contacts short R31, causing a large charging current to flow through C9 and increasing C9 voltage instantaneously. This enables the relay K1 to pick up decisively once Q2 output begins to switch high. It also provides hysteresis in relay switching and thereby makes the circuit immune to noise. If the input voltage returns to band before the time delay is completed, C9 voltage discharges at the same rate it was charging previously because of the circuit symmetry and the fact that K1 contacts across R31 are open. Therefore, a truly integrating timer is achieved. Relay K1 will pick up only when the input voltage stays above the band more than it stays in the band by a time interval exceeding the **TIME** setting.

The raise timing circuit duplicates this sequence when the voltage input is moved below the band. Diodes D14 and D17 limit the voltage across timing capacitors C9 and C10 to 15 V. The **RAISE** LED D16 indicates the low voltage condition and the start of the timing cycle.

The current through K1 or K2 relay coil passes through the D22 LED and lights it, indicating the closing of the output contacts of the respective relay. If D12 is already lit, it means that the lower winding of the motor or lower starter relay is energized. Similarly, if D16 is already lit, it indicates the energizing of the raise motor winding or the raise starter relay. Diodes D19 and D20 across K1 and K2 relay coils absorb the inductive kick when the relays drop out. When the voltage returns inside the band after the timing is completed, the timing capacitors discharge immediately and the circuit is reset. The **TIME** trimmer R36 is common to both timing circuits and can be set for any time delay up to 120 seconds.

VOLTAGE DROP

When a common supply is used for sensing and motor supply, the voltage might drop when the motor is energized. This will result in hunting of the motor if it were moving in the lower direction, because the voltage drop will cause the sensing voltage to move inside the band. The motor will then drop out, and the sensing voltage move up again, resulting in the motor being energized again after the time delay of the Control. Therefore, a provision to compensate for voltage drop of up to 6 V is made. When relays K1 or K2 are picked up, diodes D18 or D21 provide positive voltage across **VOLTAGE DROP** trimmer R38. Current through R37 is carried to the non-inverting input of Q1A, resulting in a proportional increase of C8 voltage. When the K1 or K2 relays drop out, no current is flowing through R37, and the compensation voltage is removed.

SELF-CHECKING FEATURE

TEST control R5 should be set in the maximum counter-clockwise (switch detent) or **OPERATE POSITION** for normal operation. The regulator voltage can be monitored by plugging a high impedance (greater than or equal to 500 Ω per volt) ac voltmeter into test jacks J3 and J4 (mounted on the front cover). With the **OPERATE/TEST** switch in the maximum counter-clockwise position (switch detent), the test jacks on the M-0195 front panel can be used with low impedance instruments (up to 60 VA) to monitor the V.T. voltage. When the **OPERATE/TEST** switch is not in the maximum counter-clockwise position, the test jacks J3 and J4 can only be used for high impedance (greater than or equal to 500 Ω per volt) instrumentation. When a variable ac voltage is not available, the calibration and proper functioning of the control can be checked by setting the **VOLTAGE** control at about 10 V max. below the available voltage source. The **TEST** control is moved clockwise and the voltages, when the **RAISE** and **LOWER** lights are lit, are read on the voltmeter plugged into the test jacks. The center voltage will be halfway between the two voltages. There is no need to energize the motor during test. The **TIME** setting can be verified by determining the time it takes for the **OUTPUT CONTACTS CLOSED** LED to light after the **RAISE** or **LOWER** LED is lit. Similarly, by applying a test current for the **LINE DROP COMPENSATOR** and noting the change in bandcenter, calibration of the LDC control can be verified.

● **WARNING: After the test is completed, and during operation, make sure that the test control is set at its most counter-clockwise or OPERATE POSITION.**

OPERATIONS COUNTER

A six digit non-resettable counter is provided to record the number of tap changes made. It works from the 115 V ac source through an operations counter switch in series. A solenoid in the counter partially advances the counter by one digit on the application of the voltage, and the digit advance is completed when the voltage is removed. The operations counter switch should be normally open, and closed at the end of a tap change. Availability of both counter terminals permits connecting the operations counter switch in the voltage or neutral side of the voltage supply.

NEUTRAL LIGHT

The **NEUTRAL LIGHT** circuit has LED D11 connected in series with current limiting resistor R12 and diode D10. When 120 V ac is connected across terminals J1-10 and J1-11, D11 is lit by current flowing through it for each +ve or -ve half cycle. The terminals should be connected to a 120 V ac supply through a neutral position switch closed in neutral. The switch may be connected in the voltage or neutral side of the voltage supply.

DRAGHAND RESET

The draghand solenoid should be connected to terminals J2-4 and J2-5 through the 120 V ac supply. When the **DRAGHAND RESET** pushbutton S1 is pressed, the solenoid will be energized and the draghands will be reset. The solenoid may be connected in the voltage or neutral side of the voltage supply.

TRANSIENT PROTECTION

Circuitry throughout the design limits or bypasses the undesirable and, at times, hazardous voltages which can develop due to transients associated with external input and output signals. In general, ceramic disc and solid tantalum capacitors provide isolation of high frequency voltage transients from the sensitive solid-state components. Metal oxide varistors are connected across power inputs and outputs since they exhibit non-linear voltage dependent resistance and, therefore, clamp the short-duration high voltage pulses. Varistor Q9 clamps any voltage on the chassis to a safe 40 V from neutral. High voltage circuits are fused for safe operation.

▲ CAUTION: J2-6 on the mounting bracket must always be connected to the chassis ground of the regulator, otherwise, damage to the unit will occur.

STABILITY

Components and circuits that are inherently stable with time and environmental variations are used to achieve excellent stability over an operating range of -50° to +80° C. A conservative design approach assures that components will operate well below their rated parameters and hence their operating life will be prolonged. By keeping power dissipation and therefore the temperature rise to a minimum, the initial settling or warm-up time is negligible.

In critical voltage-sensing and reference voltage circuits, industrial grade metal film resistors are used. Cermet potentiometers and trimmers are used to set the various control levels. A rugged I.C. voltage regulator, two precision resistors and an operational amplifier provide well regulated and stable +15 and -15 V supplies. Operational amplifiers provide precise voltage gains and in other circuits are connected as comparitors to discriminate between voltages as close as 0.01 V dc.

A precise active full-wave rectifier and filter circuit, which also acts as a summing amplifier for additional inputs, is formed by Q1A, Q2A and their associated components. The effect of temperature on a conventional rectifier circuit due to temperature-variable diode drop is thereby eliminated in this circuit. In addition, the conventional voltage-sensing transformer is also eliminated in this versatile circuit.

Stable mylar capacitors are used to yield temperature-stable timer circuits. The capacitor charging current and the **TIME** adjustment voltage are derived from regulated voltage sources, resulting in a repeatable time delay for a given setting. Tantalum capacitors are also used in filter circuits to provide predictable and stable performance while attenuating any high frequency noise. The filter capacitor in the power supply circuit is chosen for superior performance at the temperature extremes.

Light emitting diodes are used to indicate various circuit conditions. These have a projected life far exceeding the anticipated life of the control itself and work off low dc voltages. Signal diodes are chosen for low leakage and designed into circuits where their forward drop is of no consequence. Rugged diodes that have reverse breakdown voltage and forward current well exceeding the design requirements are used in high voltage circuits.

All active semiconductors are hermetically sealed to ensure sound performance under adverse environmental conditions. Capacitors, resistors, trimmers, potentiometers and diodes used in the design are among the best available. After testing each control, the printed circuit board is coated on both sides with a non-conductive coating to guard against corrosion of copper foil or formation of conductive paths on the board surface.

INSTALLATION

Install the mounting bracket on the inside of the existing control cabinet using four mounting screws. Figure 3 illustrates the size of the unit and pattern for drilling the holes. Complete the external connections to the two sockets as shown in Figures 4 and 5 or 4 and 6. Plug the control in after aligning the plug-connector pins with the corresponding socket holes. Turn the quarter-turn studs clockwise using a screwdriver to fasten the control.

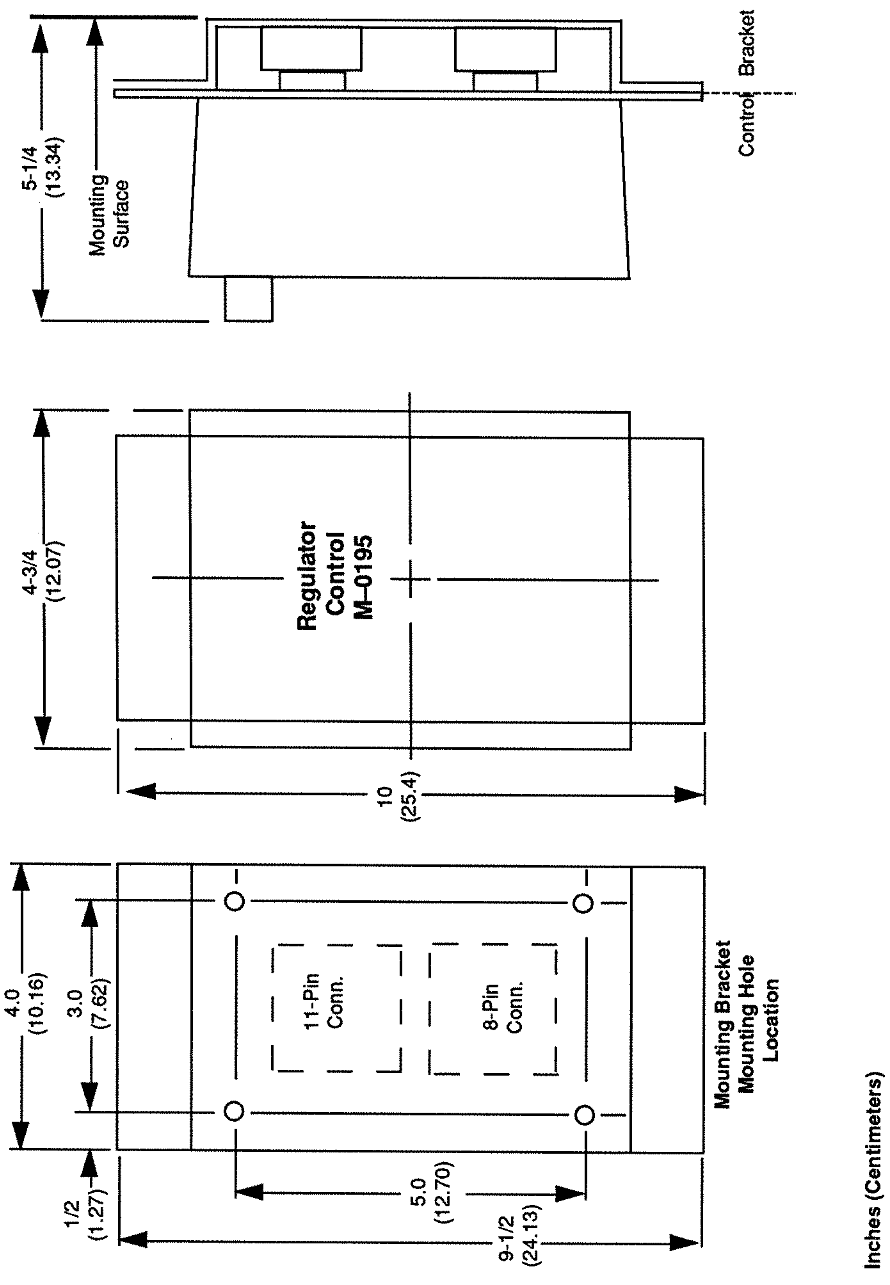
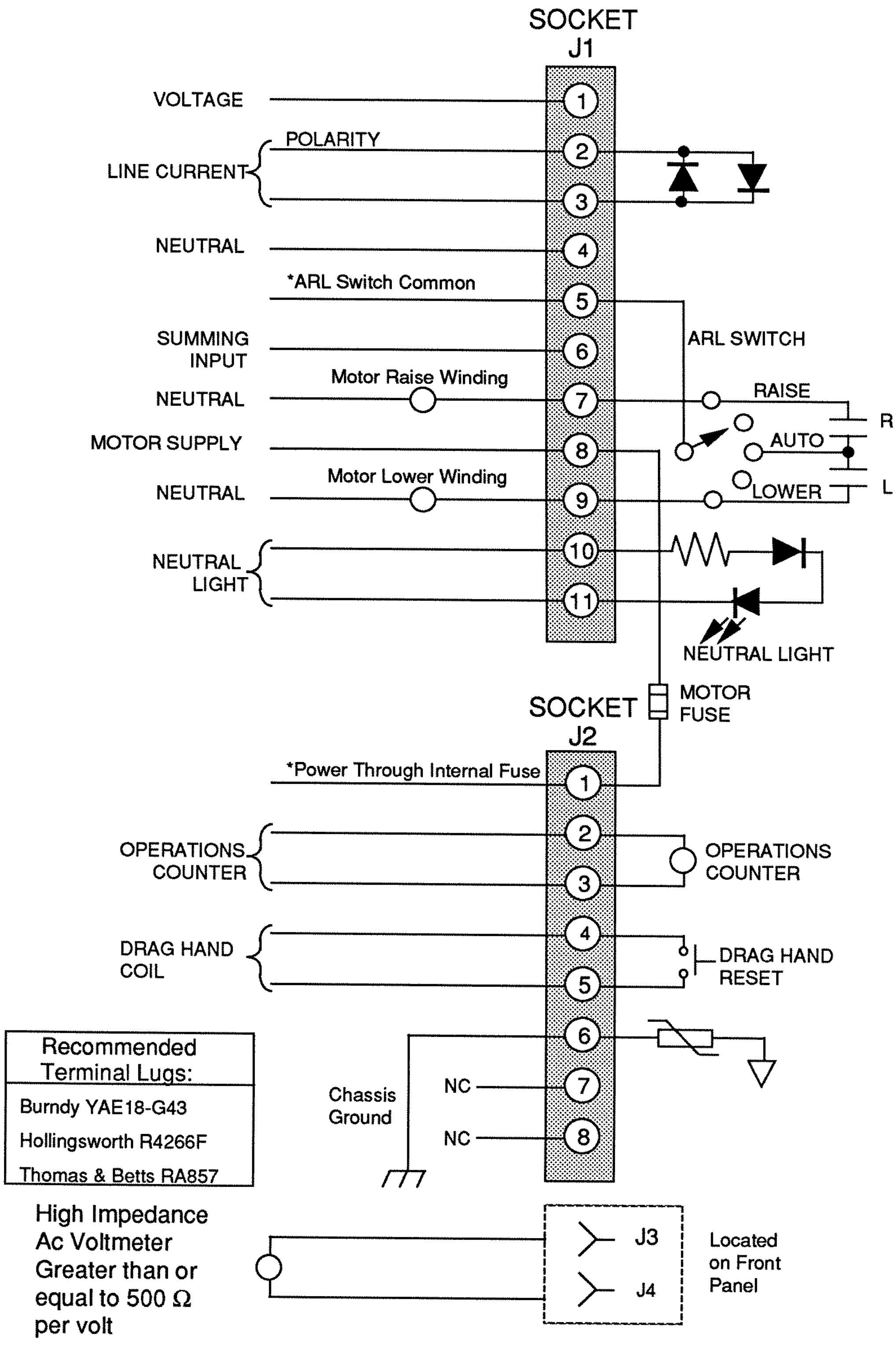
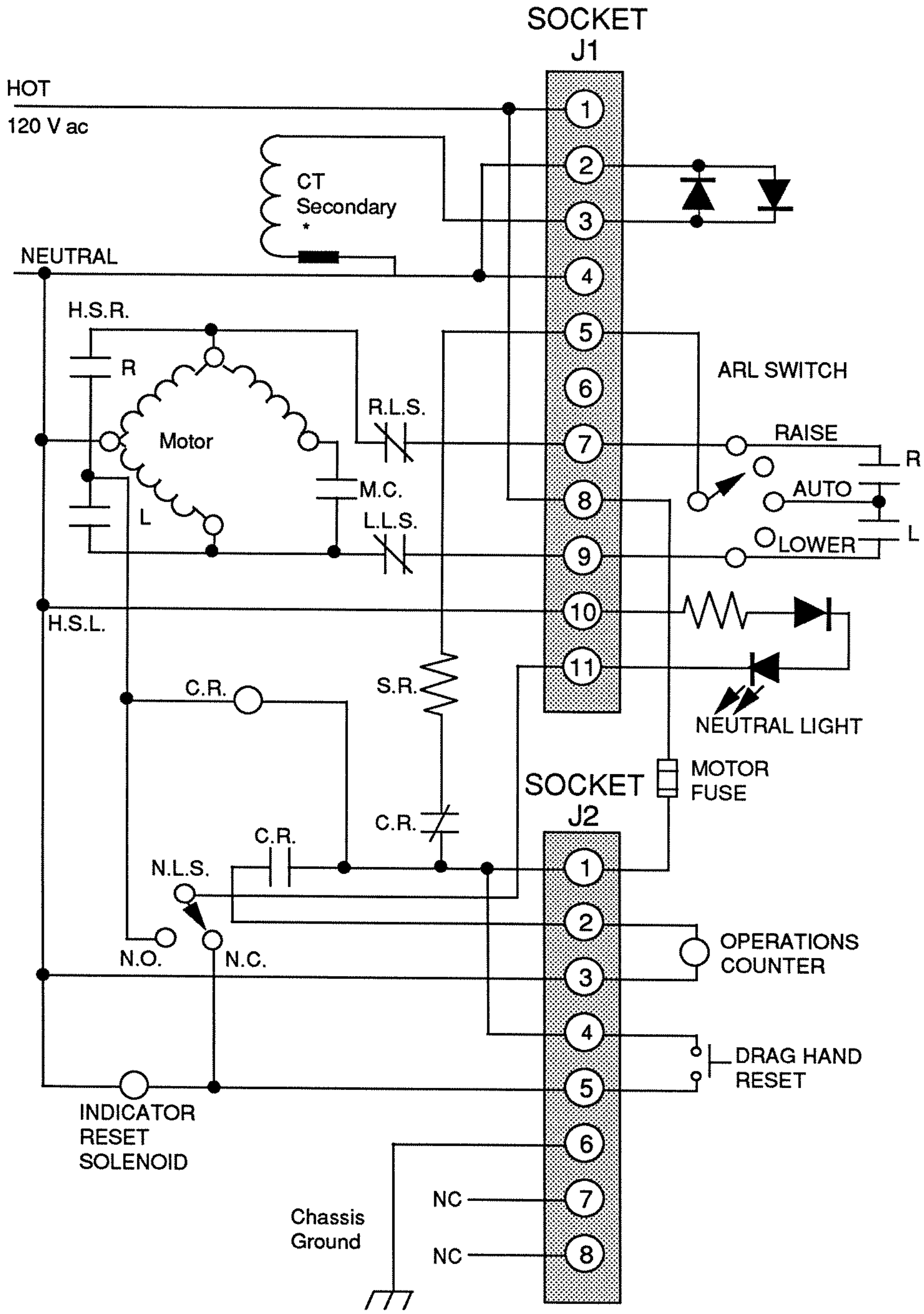


FIGURE 3 Mounting & Outline Dimensions



* ■ **NOTE:** Normally tied together through external connection.

FIGURE 4 External Connections

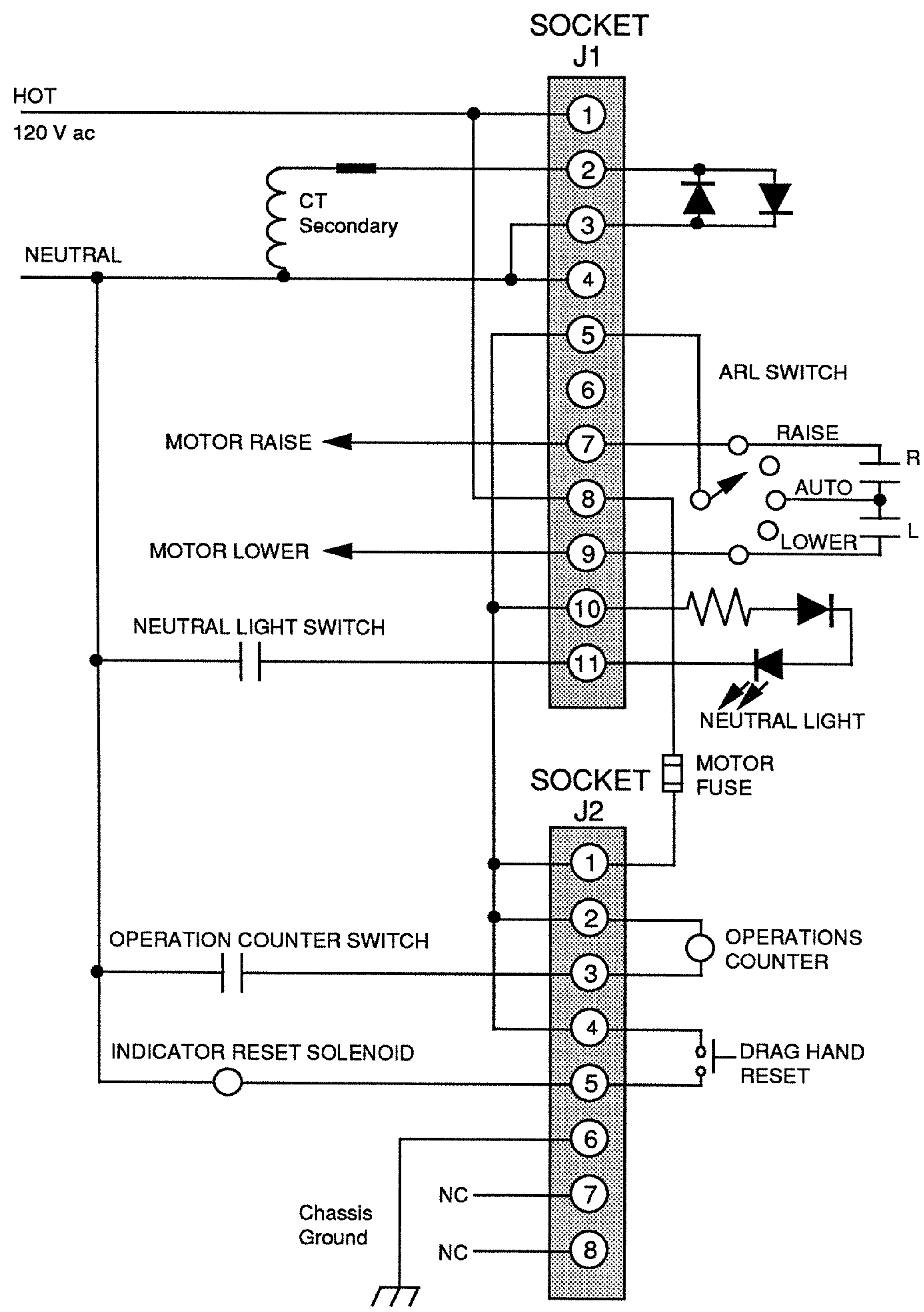


■ **NOTES:**

Connections shown are typical and may not apply to all regulator types.

* Connections where polarity lead of CT is grounded.

FIGURE 5 Typical Connections for McGraw-Edison Regulators



* ■ **NOTE:** Connections shown are typical and may not apply to all regulator types.

FIGURE 6 Typical Connections for General Electric and Siemens Regulators

ADJUSTMENT

Refer to the M-0195 front cover for controls. Adjustments should be made as follows.

Adjust the **VOLTAGE** control to the desired voltage bandcenter. Note that the control is calibrated at 120 V ac and has a scale accuracy at this point of ±0.5 V. Other scale markings are approximations only and a voltmeter should be used in setting the voltage controls. In choosing the voltage band, consideration should be given to the voltage supplied to the nearest customer due to the action of the **LINE DROP COMPENSATOR**, if used.

Adjust the **BANDWIDTH** trimmer (screwdriver adjustment) to the desired voltage band. The unit is factory calibrated at 120 V ac bandcenter and 2 V total bandwidth. When setting for a different voltage level, R20 will have to be readjusted. When setting for different **BANDWIDTH**, R20 and R21 will have to be readjusted.

Adjust the **LINE DROP COMPENSATOR** trimmer to the voltage drop expected at the load center. The voltage drop should be computed on the basis of 0.2 A full load secondary current. For lower secondary current, proportionally lower compensation will be provided. The compensation is provided at 0.9 P.F. lagging from the current phase angle. For in-phase current, about 21 V maximum full-load compensation will be achieved.

Adjust the **TIME** trimmer (screwdriver adjustment) to the time delay required between excursion of voltage outside the band and energizing of the motor. The integrating timer circuit provides good regulation of the voltage, and the time delay can be set higher than in a conventional timing circuit, thereby reducing unnecessary tapchanges. The time delay setting should be chosen to optimize for the number of tap changes on the one hand and the voltage regulation on the other hand.

Adjust the **VOLTAGE DROP** trimmer (screwdriver adjustment) for the voltage drop due to motor energizing if the voltage and motor supply are common. Observe the hunting of the motor at the upper band edge. Start with the minimum or zero setting of the **VOLTAGE DROP** trimmer and increase the setting until the hunting stops. Observe operation at the lower band edge to make sure it is free from hunting. Excessive **VOLTAGE DROP** settings will cause hunting at the lower end. If a separate motor supply is used, make sure to set the **VOLTAGE DROP** trimmer at the minimum value or zero for proper operation.

Lock the **TEST/OPERATE** switch in the maximum counter-clockwise or **OPERATE POSITION.** It should remain in this position at all times during operation. With the **TEST/OPERATE** knob locked in the maximum counter-clockwise position (switch detent) the test points on the M-0195 front panel (J3 and J4) can be used for low impedance recording devices or instruments with burdens up to 60 VA.

The **AUTO/RAISE/LOWER** (ARL) switch should remain in the **AUTO** position for automatic operation of the regulator. The manual **RAISE** and **LOWER** operation can be used if the need arises.

POWER

Set the uncalibrated knob to the **OPERATE POSITION** and the ARL switch on **AUTO**. Plug a high impedance (greater than or equal to 500 Ω per volt) ac voltmeter into the test jacks. Apply power to the Regulator Control. Move the **AUTO/RAISE/LOWER** (ARL) switch to **RAISE** and allow the regulator to provide about 5 V boost. Move the switch to the **OFF** position. Vary the **TEST/OPERATE** knob, and determine that the **RAISE** and **LOWER** lights operate on either side of the voltage setting. With voltage outside the band, determine that the corresponding output relay operates after the set **TIME** and that the **OUTPUT CONTACTS CLOSED** LED lights simultaneously. Set the **TEST** knob to the **OPERATE POSITION.** Set the ARL switch on **AUTO,** and determine that the regulator voltage is corrected and gets back in the band. Lower the voltage by manually operating the ARL switch, and then set the switch on **AUTO.** Determine that the regulator voltage is again corrected and returns in band.

Set the **LINE DROP COMPENSATOR** control at the desired setting and observe the required boost in the regulator output.

Check the operation of the **NEUTRAL LIGHT, OPERATIONS COUNTER** and **DRAG HAND RESET** (Refer to page 21).

■ NOTE: With the **OPERATE/TEST** switch in the maximum counter-clockwise position (switch detent) the test jacks (J3 and J4) on the M-0195 front panel can be used with low impedance instruments (up to 60 VA) to monitor the V.T. voltage. When the **OPERATE/TEST** switch is not in the maximum counter-clockwise position, the test jacks J3 and J4 can only be used for high impedance (greater than or equal to 500 Ω per volt) instrumentation.

MAINTENANCE

■ NOTE: Make sure that the serial number printed in front of the Instruction Book agrees with the serial number of the unit to be repaired.

In the event a unit does not operate properly, remove the six screws holding the cover to the box. To remove the printed circuit board assembly, first remove the knobs then loosen the nuts and screws holding it to the cover. It is suggested that first a careful visual inspection be made for any component that does not seem normal or appears to be overheated. Components on both sides of the board should be examined. Look for any damage to the copper foil or cable wires. Analysis of the circuit will then often lead to the cause of the failure and components that need to be replaced. If no obvious problems exist, it is suggested that the test procedure be followed until a portion of the circuit is detected which does not perform as expected or until a calibration point is reached which does not meet requirements. This procedure should lead to the defective component. With 120 V ac connected from terminals J1-1 and J1-4, typical voltages as shown on page 22 should be checked. The wave shape from TP4 to D6-D7 junction should be as follows:

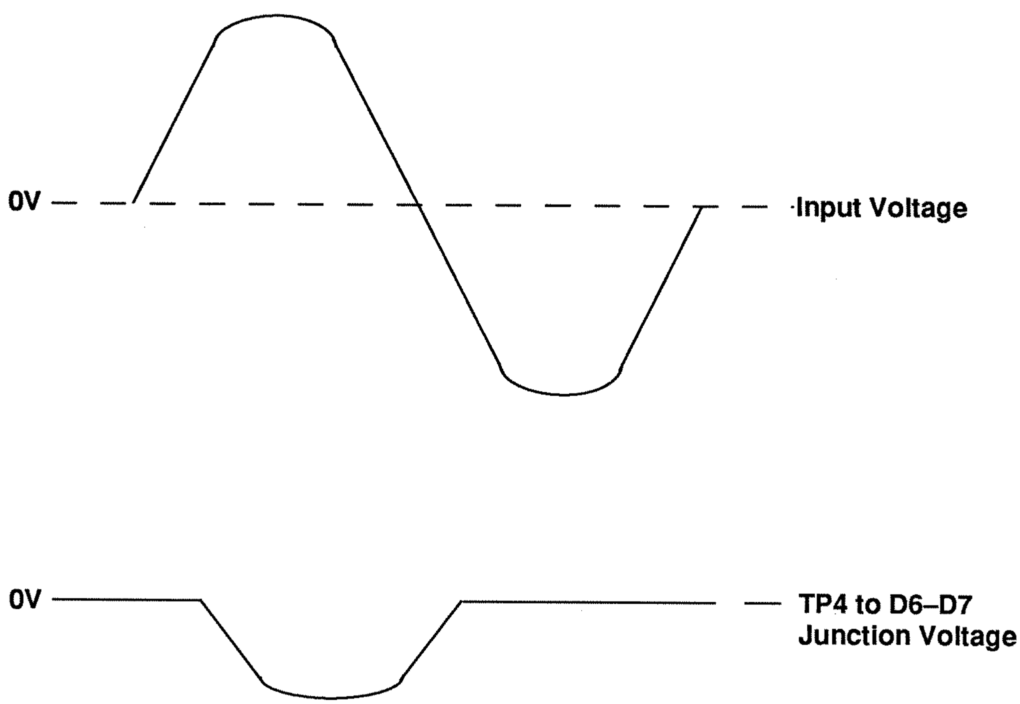


FIGURE 7 Waveshapes

If the wave shape is found to differ, Q1 or a related component may be defective. It is suggested that each front cover control be moved rapidly back and forth a few times during routine maintenance once or twice a year. This will free the control elements of dirt or oxidation film that might have accumulated, thus assuring trouble-free operation. If fuse F1 blows, determine the component that could have caused it and replace it before replacing the fuse.

Due to the sophisticated nature of the circuitry in the M–0195, field repair is not recommended. All units are fully calibrated at the factory prior to shipment; there is no need to re-calibrate a unit prior to initial installation. Calibration is only required after a component is replaced. In the event that a unit does not operate properly, it should be established that the problem is caused by malfunction of a Beckwith Electric unit and not caused by an external fault or wiring error. Once this is assured, the entire unit should be returned to Beckwith Electric. Pack the unit carefully (in the original carton if possible), assuring that there is adequate packing material to protect the contents.

■ **NOTE:** Any equipment returned for repair must be sent with transportation charges prepaid. The equipment must remain the property of the user. The warranty is void if the value of the unit is invoiced to Beckwith Electric at the time of return or if the unit is returned with transportation charges collect.

If under warranty, units will be repaired rapidly and returned at no cost and with return transportation paid if the fault is found to be due to workmanship or failure of material. If a unit is under warranty and express shipment for return of the repaired unit is requested, shipping charges will be billed at the current rate. If the fault is due to abuse or misuse, or if the unit is out of warranty, a modest charge will be made. Repair can normally be expected to take two weeks, plus shipping time. If faster service is required, it should be requested at the time of return.

■ **NOTE:** Units returned with only a blown fuse are not covered by warranty and a nominal repair charge will be made for replacement of the fuse. Please check the fuses before returning the M-0195 for repair in order to avoid unnecessary repair charges.

To help in analyzing the problem, a complete description of the malfunction and conditions leading to the failure should be included with the unit.

However, if you choose to repair the unit, it is necessary to be completely familiar with the circuitry involved, and have an adequate understanding of field effect devices. Be sure to carefully read the **WARNING** page at the beginning of this manual.

▲ **CAUTION:** This unit contains sensitive MOS circuitry that can be damaged by improper repair procedures. Work stations used for repair should be static-free and procedures for handling MOS circuitry should be followed. In addition, any attempt to measure resistances between points on the printed circuit board may cause damage to the unit.

This Page Left Intentionally Blank

ERRATA

M-0195 INSTRUCTION BOOK

Please note the following changes to the Parts List on page 26:

Delete:

R26, R 29, R31, R33, R35	200-00156	Resistor, Carbon Film, 15 M ±5%

Add:

R26	200-00156	Resistor, Carbon Film, 15 M ±5%
R29, R35	200-00475	Resistor, Carbon Film, 4.7 M, ±5%
R31, R33	200-00226	Resistor, Carbon Film, 22 M, ±5%

12/91

TEST PROCEDURE

The following procedure can be used to check and adjust calibration of the M-0195 control.

POWER SUPPLY

Connect the Hot side of 120 V ac to terminals J1-1 and J1-8, and Neutral to terminal J1-4. Check to see that the following dc voltages are obtained.

Across C1	+24 V dc	Unregulated
Across C2	+24 V dc	Unregulated
Across C13	+15 V dc	Regulated
Across C14 (- to +)	-15 V dc	Regulated

VOLTAGE AND BANDWIDTH

Connect a high impedance (greater than or equal to 500 Ω per volt) ac voltmeter to test jacks J3 and J4. Set the **VOLTAGE** control at 115.0 V. Vary the uncalibrated **TEST/OPERATE** knob. The **RAISE** and **LOWER** lights should light at some voltages, and there should be a deadband where both lights are extinguished.

Adjust the **BANDWIDTH** trimmer to obtain 2 V bandwidth. Next adjust R20 trimmer (Voltage Calibration) so that 115 V is the center of the band.

Use a regulated and variable ac voltage source if available.

LINE DROP COMPENSATOR

Set the **TEST/OPERATE** control to the **OPERATE POSITION.** Connect a separate variable ac voltage through a 100 Ω, 3 W, non-inductive resistor and then through an ammeter to J1-2. Connect neutral to J1-3. Set the **LINE DROP COMPENSATOR** control at maximum. Vary the voltage (to about 10 V) to get 0.1 A current; the center of band should move to about 130.5 V and provide 10.5 V compensation. Note that this corresponds to 24 V full-load compensation at 0.9 P.F.

TIMER

Set the **TIME** trimmer at minimum. Move the voltage outside the band so that the **LOWER** LED is lit. The **OUTPUT CONTACTS CLOSED** LED should light immediately, then should extinguish, along with the **LOWER** LED, when the voltage returns to band. Set the time delay at maximum; 120 seconds should elapse between the time when the voltage goes outside the band and the **INPUT CONTACTS CLOSED** LED lights. Check the minimum and maximum time delays when the voltage gets below the band.

OUTPUT

Connect terminal J1-5 to J2-1. Connect one 100 W lamp from J1-9 to Neutral (J1-4) and another from J1-7 to Neutral. Set the ARL switch in the **AUTO** position. Let the timer time out, and make sure that the respective lamps are lit. Move the voltage back in band. Move the ARL switch; the respective lamps are should light in the **LOWER** and **RAISE** positions only.

If the voltage source is regulated and cannot deliver 100 W of power, use smaller lamps or relays as the load.

NEUTRAL LIGHT

Connect a 120 V ac source through the normally open contacts of a pushbutton switch to terminals J1-10 and J1-11. When the switch is pressed, the **NEUTRAL LIGHT** LED is should light.

OPERATIONS COUNTER

Connect a 120 V ac source through the normally open contacts of a pushbutton switch to terminals J2-2 and J2-3. When the switch is pressed the counter should advance by one digit.

DRAG HAND RESET

Connect a 120 V ac source through a 50 W lamp or a suitable 120 V relay to terminals J1-4 and J1-5. When the **DRAG HAND RESET** pushbutton is pressed, the lamp should light or the relay should energize.

VOLTAGE DROP

Set the **TIME** trimmer at minimum and the **VOLTAGE DROP** trimmer at maximum. Lower the input voltage slightly until the **RAISE** light comes on. After a slight delay, the Raise relay should start to pick-up and then drop-out, resulting in oscillation. Lower the voltage further until the oscillation of the relay ceases. The difference between this voltage and the **VOLTAGE** control setting is the maximum value of **VOLTAGE DROP** and should be about 6 V.

> **▲ CAUTION: Any attempt to measure resistances between points on the printed circuit board is likely to cause damage to the unit.**

TYPICAL VOLTAGES

The voltages were measured with a Data Precision Model 2480R digital multimeter and waveshapes taken with a Tektronix Model T922 oscilloscope. In making the measurements, a regulated variable ac voltage source was used. The Neutral was connected to terminal J1-4 and the Hot side of the voltage supply connected to J1-1 and J1-8.

From	To	Condition	Voltage
J3	J4	Input 120 V ac, **TEST/OPERATE** control at maximum clockwise	103 to 107 V

For subsequent measurements, move **TEST/OPERATE** control to the maximum counter-clockwise or **OPERATE POSITION.**

From	To	Condition	Voltage
Jumper B	TP4	Input 100 to 140 V ac	+15 V dc, ac ripple 1 mV pp.
D22-C & C11 Junction	TP4	Input 100 to 140 V ac	-15 V dc, ac ripple 1 mV pp.
		Input 105 V ac	18.4 V dc ±5%
D27 Cathode	D27 Anode	Input 120 V ac	21.6 V dc ±5%
D28 Cathode	D28 Anode	Input 135 V ac	24.6 V dc ±5%
		Input 100 to 140 V ac	ac ripple 1.0 V pp.
TP4	TP1	Input 105 V ac	+5.07 to 5.28 V dc
		Input 120 V ac	+5.80 to 6.04 V dc
		Input 135 V ac	+6.52 to 6.80 V dc
		Input 100-140 V ac	ac ripple 5 mV pp.
D6 Cathode	TP4	Input 105 V ac	-0.5 V dc to -7 V dc *
		Input 120 V ac	-0.5 V dc to -8 V dc *
		Input 135 V ac	-0.5 V dc to -9 V dc *
R27-R30 Junction	TP4	Input voltage above the band	+13.5 V dc
		Input voltage in band or below the band	-13.5 V dc
R32-D16 Junction	TP4	Input voltage below the band	+13.5 V dc
		Input voltage in band or above the band	-13.5 V dc
TP5	TP4	R36 maximum clockwise	+7.5 V dc

*■ NOTE: For waveshapes, see Figure 7.

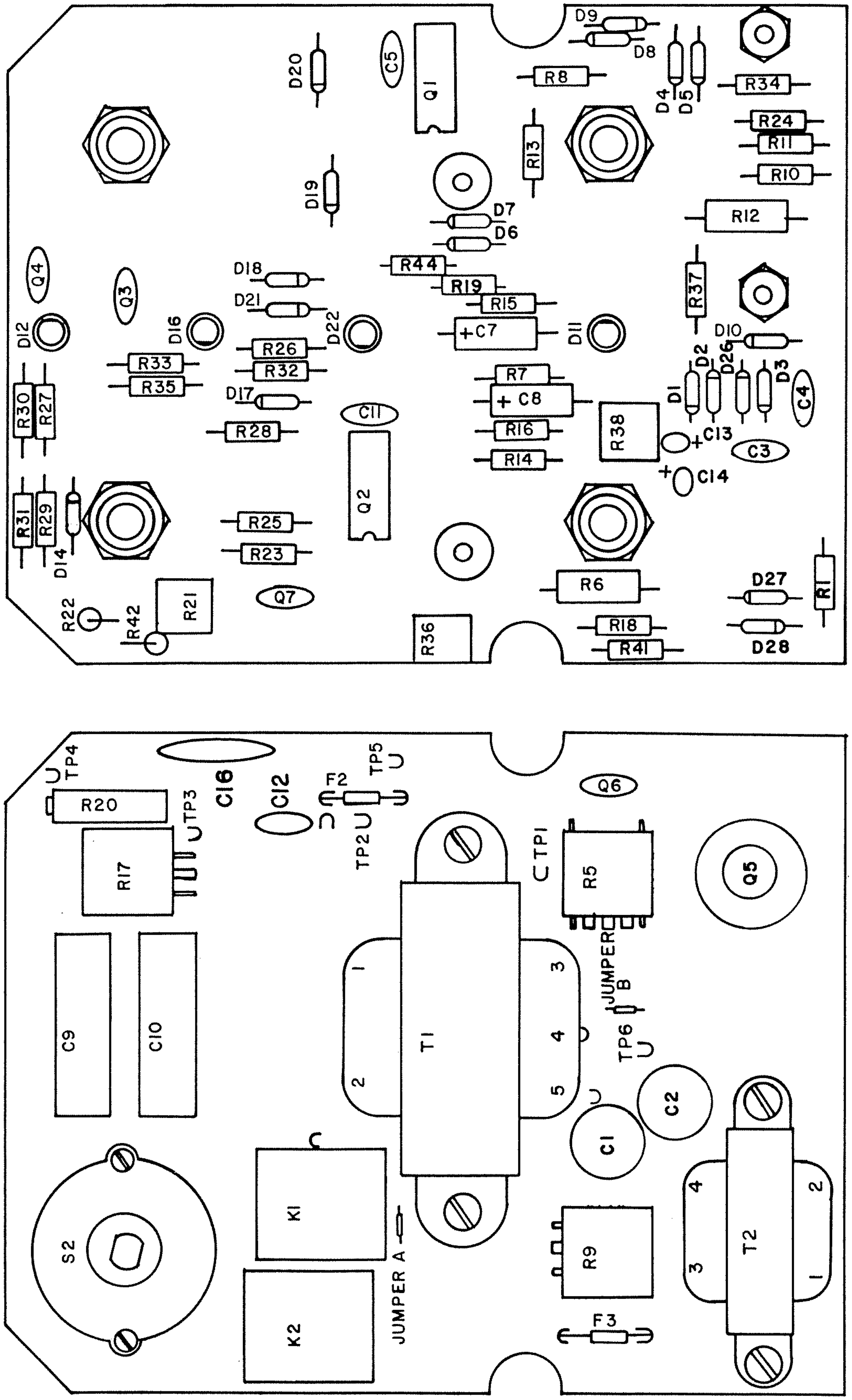


FIGURE 8 Component Location

PARTS LIST

M-0195 Regulator Control

This list includes all electrical and mechanical parts that 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
	450-00025	Printed Circuit Board, P-0454
C1,C2	000-00421	Capacitor, Electrolytic, 220 µF +50/-10%, 50 V
C3-C5,C11	000-00928	Capacitor, Ceramic Disc, 0.01 µF ±20%, 100 V
C6		Not Used
C7	000-00549	Capacitor, Tantalum, 6.8 µF ±10%, 35 V
C8	000-00544	Capacitor, Tantalum, 15 µF ±10%, 20 V
C9,C10	000-00813	Capacitor, Polyester, 4.7 µF ±10%, 100 V
C12	000-00927	Capacitor, Ceramic Disc, 0.01 µF, 1 kV
C13,C14	000-00556	Capacitor, Dip Tantalum, 10 µF ±20%, 35 V
C16	000-00905	Capacitor, Ceramic Disc, 0.05 µF +80/-20%, 600 V

COMPONENT DESIGNATION	BECO NUMBER	DESCRIPTION
D1-D3,D26	400-00232	Diode, 1N4004
D4-D9,D18,D21	400-00224	Diode, 1N4148
D10,D19,D20	400-00211	Diode, 1N5061
D11,D12,D16,D22	400-00722	Diode, Light Emitting, Hewlett-Packard 5082-4658
D13		Not Used
D14,D17	400-00228	Diode, FDH300, Fairchild
D15,D23		Not Used
D27,D28	400-00085	Diode, Zener, 28 V, 1N5362B
F2	420-00843	Fuse, 1/2 A, 125 V, Littelfuse 275.500
F3	420-00848	Fuse, 1/16 A, 125 V, Littelfuse 275.062
F4	420-00850	Fuse, 1 A, 125 V, Littelfuse 275.001
K1,K2	430-00138	Relay, DPDT, 18 V dc, American Zettler AZ420-V50-4H
Q1	400-00639	Quad Op Amp, Fairchild μA4136DM
Q2	400-00678	Quad Op Amp, Texas Instruments TL084MJ
Q3,Q4	400-00728	Varistor, 275 V, G.E. V275LA2
Q5	400-00675	Voltage Regulator, ±15 V, Raytheon RC4195T
Q6,Q7	400-00709	Varistor, 250 V, G.E. V250LA2
R1	200-00155	Resistor, Carbon Film, 1.5 M ±5%
R2-R4		Not Used
R5	360-00105	Potentiometer, with switch, 5 K ±10%, 2 W, Allen Bradley 73L1N132P502W
R6	230-00473	Resistor, Carbon Comp, 47 K ±5%, 1 W, Allen Bradley RC32
R7,R8	330-00647	Resistor, 301 K ±1%, 1/4 W, RN60E

COMPONENT DESIGNATION	BECO NUMBER	DESCRIPTION
R9	360-00090	Potentiometer, Cermet, 25 K ±10%, 2 W, Allen Bradley 73B1N124P253W
R10,R11	330-00658	Resistor, Metal Film, 392 K ±1%, 1/4 W, RN60E
R12	350-00039	Resistor, Wirewound, 10 K ±5%, 3 W
R13	330-00518	Resistor, Metal Film, 15 K ±1%, 1/4 W, RN60E
R14	330-00485	Resistor, Metal Film, 7.5 K ±1%, 1/4 W, RN60E
R15	330-00522	Resistor, Metal Film, 16.5 K ±1%, 1/4 W, RN60E
R16	200-00272	Resistor, Carbon Film, 2.7 K ±5%
R17	360-00089	Potentiometer, 5 K ±10%, 2 W, Allen Bradley 73B1N124P502W
R18	340-00473	Resistor, 5.62 K ±1%, 1/4 W, RN60C, Corning Only
R19,R44	340-00016	Resistor, Carbon Comp, 22 M ±5%, 1/4 W
R20	360-00084	Potentiometer, 5 K ±10%, Bourns 3009P-1-502
R21,R36	360-00038	Potentiometer, 50 K ±20%, Bourns 3386P-1-503
R22	330-00519	Resistor, Metal Film, 15.4 K ±1%, 1/4 W, RN60E
R23	330-00501	Resistor, Metal Film, 10 K ±1%, 1/4 W, RN60E
R24	—	Resistor, Carbon Film, Factory Select
R25	330-00701	Resistor, Metal Film, 1 M ±1%, 1/4 W, RN60E
R26,R29,R31,R33,R35	200-00156	Resistor, Carbon Film, 15 M ±5%
R27	200-00622	Resistor, Carbon Film, 6.2 K ±5%
R28	330-00543	Resistor, Metal Film, 27.4 K ±1%, 1/4 W, RN60E
R30,R32	200-00153	Resistor, Carbon Film, 15 K ±5%
R34	—	Resistor, Carbon Film, Factory Select
R37	330-00677	Resistor, Metal Film, 619 K ±1%, 1/4 W, RN60E
R38	360-00044	Potentiometer, 20 K ±20%, Bourns 3386P-1-203
R39,R40		Not Used

COMPONENT DESIGNATION	BECO NUMBER	DESCRIPTION
R41	340-00466	Resistor, 4.75 K ±1%, 1/4 W, RN60C
R42	200-00151	Resistor, Carbon Film, 150 Ω ±5%
S2	430-00058*	Switch, 5-position rotary, U-0099
T1	410-00042*	Transformer, U-0097
T2	410-00023*	Transformer, U-0025
Relay retainer	430-00121*	U-0056-3
REV M		

PARTS MOUNTED TO THE ENCLOSURE

C15	000-00905	Capacitor, Ceramic Disc, 0.05 µF +80/-20%, 600 V
D24,D25	400-00205	Diode, Rectifier, G.E. A15F
F1	420-00824	Fuse, Slo-Blo, 3 A, Littelfuse 313003
J3	420-00102	Pin Jack Black, E.F. Johnson 105-0603-001
J4	420-00101	Pin Jack Red, E.F. Johnson 105-0602-001
P1	420-00181	Connector Plug (11-Pin) Amphenol 86-RCP-11
P2	420-00185	Connector Plug (8-Pin) Amphenol 86-RCP-8
Q9	400-00713	Varistor, 40 V, G.E. V40LA2A
R43	200-00151	Resistor, Carbon Film, 150 Ω ±5%
S1	430-00056	N.O. Pushbutton Switch, Cutler Hammer 8411-K13
Z1	430-00326	Counter, ENM-E2B-62D
Fuse Holder	420-00713	Littelfuse 342014A
Knob	440-00149	Alco KN-700B-1/4
Mounting Plate	440-00139*	P-0467
Mounting Stud	470-00800	Southco 85-11-220-20-SS

COMPONENT DESIGNATION	BECO NUMBER	DESCRIPTION
Mounting Stud Retainer	470-00801	Southco 85-34-101-20-SS
Snap Bushing	440-00150	Heyco SB-312-3
REV J		

SOCKET ASSEMBLY

COMPONENT DESIGNATION	BECO NUMBER	DESCRIPTION
Mounting Bracket	440-00140*	P-0468
Mounting Stud Receptacle	470-00802	Southco 85-47-101-20-SS
J1	420-00180	Connector Socket (11-Pin) Potter & Brumfield 27E123
J2	430-00114	Connector Socket (8-Pin) Potter & Brumfield 27E122

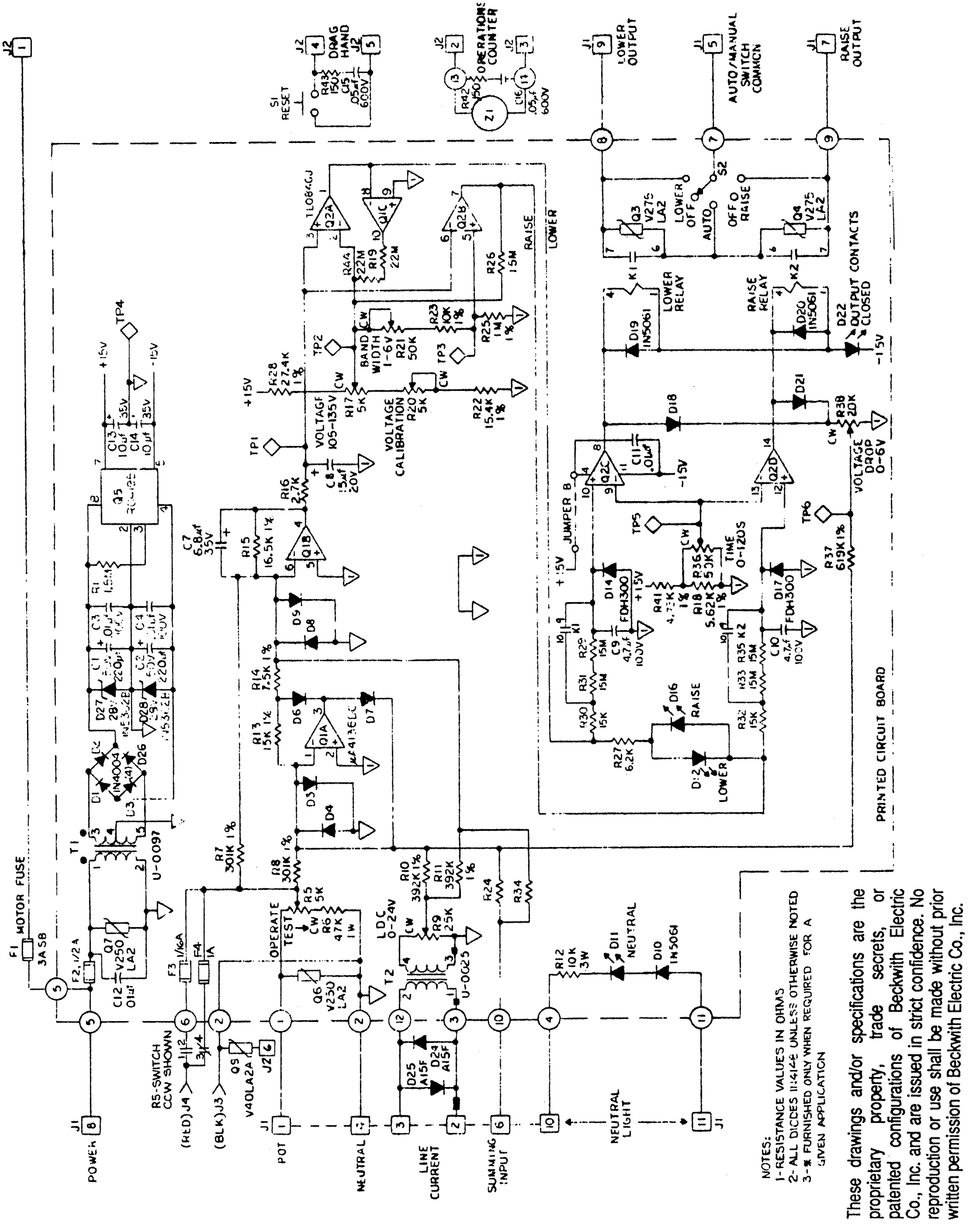


Figure 9 Schematic

Patent

The units described in this manual are covered by U.S. Patents, with other patents pending.

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.

Notice:

Any illustrations and descriptions by Beckwith Electric Co., Inc. are for the sole purpose of identification.

The drawings and/or specifications enclosed herein are the proprietary property of Beckwith Electric Co., Inc., and are issued in strict confidence; therefore, shall not be used as a basis of reproduction of the apparatus described therein without written permission of Beckwith Electric Co., Inc.

No illustration or description contained herein shall be construed as an express warranty of affirmation, promise, description, or sample, and any and all such express warranties are specifically excluded nor shall such illustration or description imply a warranty that the product is merchantable or fit for a particular purpose. There shall be no warranties which extend beyond those contained in the Beckwith Electric Co., Inc. terms of sale.

ISO 9001:1994 Registered

BECKWITH ELECTRIC CO., INC.
6190 - 118th Avenue North • Largo, Florida 33773-3724 U.S.A.
PHONE (727) 544-2326 • FAX (727) 546-0121
E-MAIL marketing@beckwithelectric.com
WEB PAGE www.beckwithelectric.com

Printed in USA

800-0195-IB-00 12/90