

Electro-Craft®

MOTOMATIC®

SERIES E-652

INSTRUCTION MANUAL

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Reliance Motion Control / 6950 Washington Ave. South / Eden Prairie, MN 55344 / 612-942-3600

RELIANCE
ELECTRIC 

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SERVICE BULLETIN

NUMBER 13A

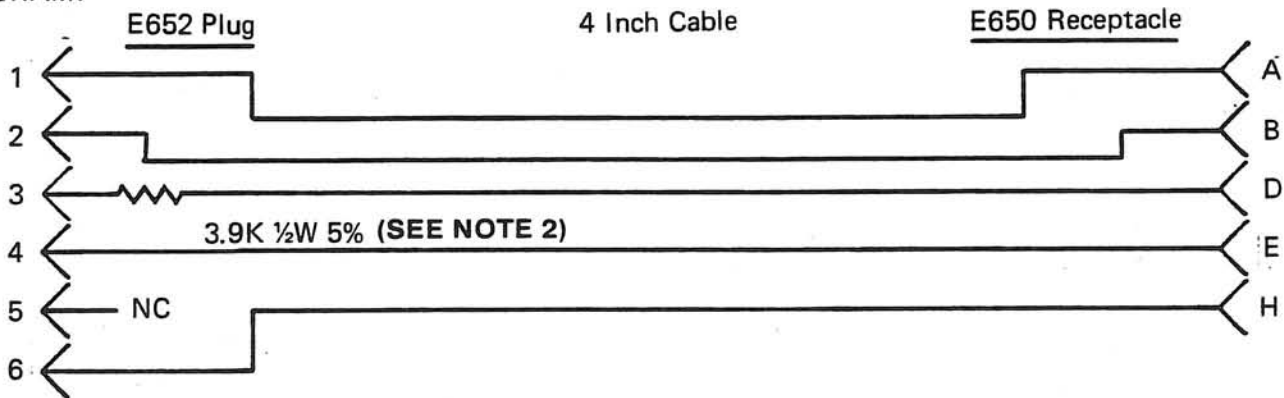
MODEL: E652 M Master Controls PART NO. 9092-0005 (E652-M)

MODIFICATIONS OR CHANGES:

6

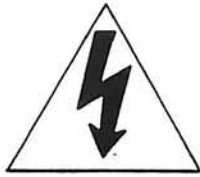
Use adapter cable Part No. 0029-0162 to connect E-650 Motor-Generators to E-652 M Master Controls directly.

DIAGRAM:

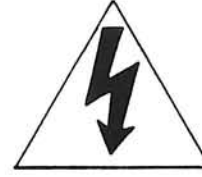


NOTES:

1. Allows rapid changeover of motors without modification of control.
2. Calibration error of $\pm 5\%$ maximum is typical.



WARNING



DANGEROUS VOLTAGES ARE PRESENT IN THIS EQUIPMENT !

CONTACT WITH LIVE PARTS

COULD CAUSE

SERIOUS INJURY OR DEATH !

REFER CONNECTION, INSTALLATION, MAINTENANCE,

ADJUSTMENT, SERVICING AND OPERATION

TO COMPETENT PERSONNEL.

WARRANTY

The warranty herein contained is in lieu of and excludes all other warranties, expressed, implied or statutory, unless otherwise stated on the face hereof.

(a) Standard products of Electro-Craft Corporation, unless otherwise stated in specifications, are warranted for a period of one year (commencing on the first day of the calendar month following the date of shipment) or 3000 hours of operation (whichever occurs first) to be free from defects in materials and workmanship and to conform to the specifications furnished or approved by Seller. Liability under this warranty shall be limited to the repair or replacement, but not the installation of any defective product at Seller's option.

(b) Development Products of Electro-Craft Corporation, unless otherwise stated in specifications, are warranted by Seller for a period of sixty days (commencing on the date of shipment) to be free from any defects in materials and workmanship and to conform to applicable preliminary specifications furnished or approved by Seller. Liability under this warranty shall be limited to replacement or issuing a credit for any defective product at Seller's option.

If any defect within this warranty appears within the warranty period, Purchaser shall notify Seller. No material will be accepted for repair or replacement without the written authorization of Seller. Upon such authorization and in accordance with the instructions of Seller, parts or materials for which replacement is requested shall be returned to Seller for examination, with all shipping charges prepaid by Purchaser. Final determination as to whether a product is actually defective rests with Seller. Replacements made under this warranty will be shipped prepaid.

This warranty does not extend to any product which has been subjected to misuse, neglect, accident, improper installation, or to use in violation of instructions furnished by Seller. The warranty does not extend to, or apply to, any unit which has been prepared or altered outside of Seller's factory by persons not expressly approved by Seller. Seller shall not be liable for any special or consequential damages or for loss, damage or expense, directly or indirectly arising from the use of the products or any inability to use them either separately or in combination with other equipment or from any other cause.

GENERAL INSTALLATION AND MAINTENANCE PROCEDURES

Motor-Generator

When installing Electro-Craft motor-generators on any application, the following procedure should be carefully followed:

INSTALLATION

1. Mount securely on a rigid foundation using maximum size bolts.
2. Align all shafts accurately. The motor-generator shaft and the driven machine shaft should be in line as near perfectly as possible. Failure to maintain proper alignment can result in excessive noise, over-heating and wear. Flexible couplings can be used to compensate for slight misalignment. Care must be used in selection of couplings as any compliance in the coupling material may cause the control to sense a false load position or speed. This can cause the system to oscillate.
3. Observe all limits listed in the specifications concerning maximum overhung loads, side thrust and end thrust.
4. For best operation, the motor-generator should be mounted in an area where air circulation is available.

MAINTENANCE

No lubrication is required or should be used. If the motor-generator is equipped with a gearhead, lubrication instructions provided by ECC and/or the gearhead manufacturer should be followed carefully.

Under normal operating conditions a 5000 hour brush life can be expected. Brushes must be installed in the same brushholder with the same orientation if they are removed. A 24-hour run-in period is recommended, if brushes are replaced.

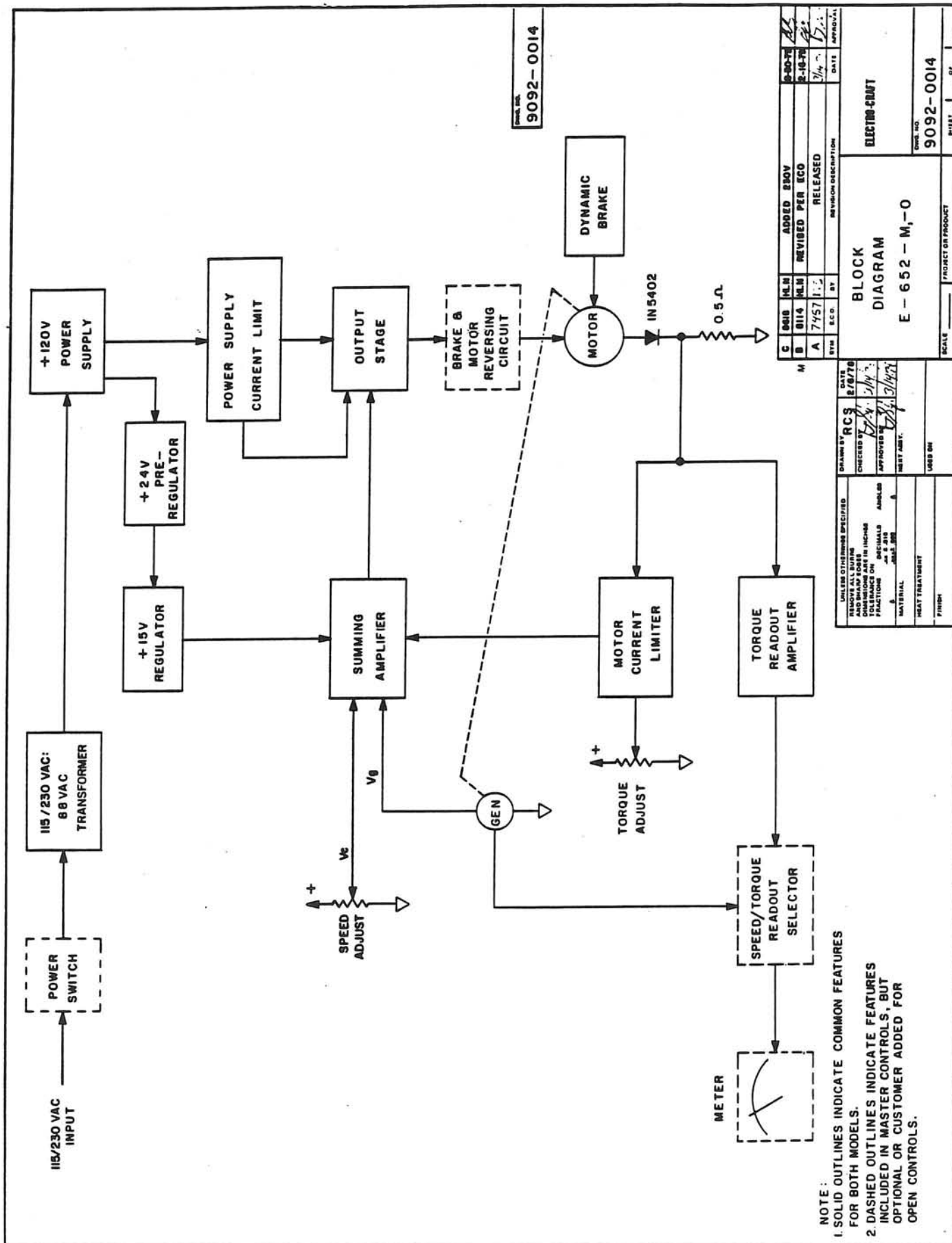
Disassembly of the motor-generator is *not* recommended. If disassembly is absolutely required, please contact Electro-Craft before proceeding.

THEORY OF OPERATION

THE MOTOMATIC® PRINCIPLE

The MOTOMATIC® drive system consists of two basic units, a permanent magnet DC motor-generator and a solid state electronic controller (refer to block diagram on following page).

The motor-generator has two armatures on the same shaft, one to drive the motor shaft and the other to generate a voltage proportional to speed. The signal, V_g , from the generator is fed to the controller where it is compared with a speed command voltage V_c . The controller provides more or less voltage to the motor winding in order to increase or decrease the speed to maintain a balance between the speed command voltage and generator voltage. Set speed is thus closely maintained, regardless of changes in load or line voltage. The MOTOMATIC® system provides a speed range and stability that is superior to systems using variable transformers or SCRs (thyristors).



E-652

AMPLIFIER FEATURES

1. **Basic Specifications:** Torque 0-5 lb.-inches, adjustable and continuous. Speed range 3-3000 rpm, adjustable.
2. **Torque Limiter:** Torque limiter can be adjusted from 0 to 5 lb.-inches.
3. **Single Polarity Power Supply:** 100 to 135 Volt operation allows adaptation to an alternate DC source.
4. **Line Fuse Protection:** A line fuse, 5 amp normal interrupting for 115 VAC 50/60 Hz input.
5. **Thermal Circuit Breaker Protection:** A line circuit breaker, rated 3 amp, in series with the line fuse.
6. **A +15 Volt Regulated Reference Voltage:** This reference voltage is used for the summing amplifier, speed and torque potentiometers, and current limit amplifier.
7. **Dual Current Limit Protection:** Amplifier is protected against current overload on both motor leads, if either or both should become shorted or overloaded.
8. **Transformer Isolation:** All amplifier circuitry in the control system is isolated from the AC line by the main supply transformer.
9. **Dynamic Brake:** This circuit allows rapid deceleration of motor speed. It essentially places a resistor across the motor windings during a down speed command.
10. **Input Sensitivity:** 3.3 Volts/krpm, 0 to +10 Volts equal to full speed range.

E-652-M (MASTER MODEL)

FEATURES

1. **Electronic Tachometer:** Indicates motor speed in rpm.
2. **High Accuracy Torque Readout:** Internal adjustment of electronic torque meter compensates for damping and internal friction of the motor.
3. **Direction Switches:** Reverse motor rotation through a stop-brake position.
4. **Remote Input:** A provision for controlling motor speed by an external potentiometer or voltage source. Mating part is a standard phone plug—use Switchcraft part number 267 or equivalent.
5. **Dual Speed Adjusts:** Dual concentric potentiometers for coarse and fine speed adjustment.
6. **Power Cord:** Line cord is a standard business or office machine cord. Federal stock No. FSN-6150-351-3405 meets NEMA 5-15P standard.

OPTIONAL FEATURE

1. **230 Volt Operation:** By connecting the transformer primaries in series and changing the line fuse to 2.5 amps and the circuit breaker to 1.5 amps, the system may be operated on 210-250V, 50/60 Hz line.

FRONT PANEL CONTROLS

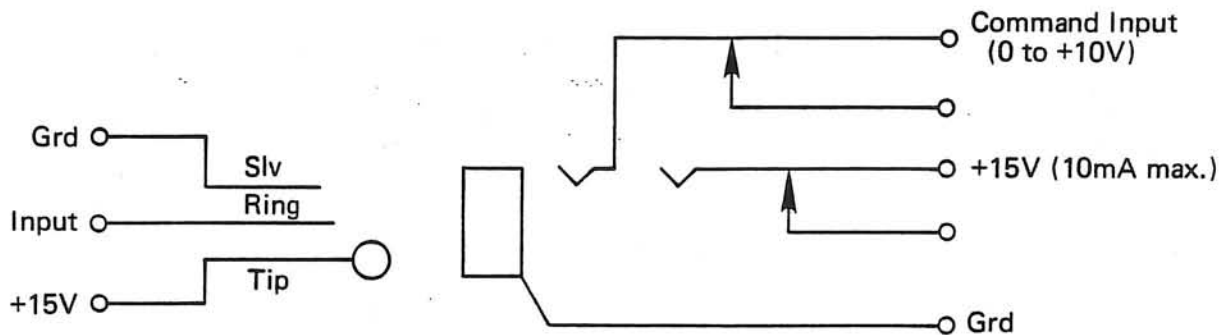
1. **Power Switch:** Right-hand pushbutton switch connects (button in) or disconnects (button out) the input line power to the transformer.
2. **Direction Switches:** Center pair of pushbuttons are motor direction control switches. Push-buttons out — motor off position. Right-hand pushbutton of this pair enables CW (clockwise*) direction of rotation. Left-hand pushbutton enables CCW (counterclockwise) direction of rotation. Both pushbuttons cannot be pushed at the same time because of an interlock.
3. **Speed Adjust Controls:** These are linear single-turn dual concentric potentiometers used to set speed between 0 and 3000 rpm. Center knob is coarse (0-2700 rpm), outer knob is fine (0-300 rpm).
4. **Scale Selector Switch:** Left-hand pushbutton will cause the meter to indicate speed (0-3000 rpm) when out or torque (0-5 lb-in) when in.
5. **Torque Limit Adjust:** This control will limit the maximum torque to a preset value, adjustable from 0-5 lb.-in.
6. **Panel Meter:** A 50 micro-ampere DC 2% full scale accuracy meter displays a reading of motor speed in rpm or motor torque in lb-in.

* The direction of rotation of the output shaft of a motor gearhead may be CW or CCW depending on the ratio.

REAR PANEL

1. **Motor-Generator Connector:** Is located in the center of the left-hand side.
2. **Remote Input Phone Jack:** Using a phone plug (Switchcraft Part Number 267) and inserting into the jack, an external voltage source or potentiometer may be connected for external speed adjustments. The jack is located at the top of the left-hand side.

SCHEMATIC OF JACK



3. **Power Cord Connector:** At the lower left-hand side is a receptacle for the power cord. Standard connection is 115 VAC, 50/60 Hz. Line cord used is a standard business or office machine power cord. Line cord is Federal Stock No. FSN-6150-351-3405 and meets NEMA 5-15P standard.

OPERATING INSTRUCTIONS

1. Before plugging in line cord, preset all front panel pushbuttons in the out position.
2. Secure motor properly. Motor will jump if speed command is set above 25% (2.5VDC).
3. Connect line cord plug to any approved 115 VAC, 50/60 Hz, grounded 3-wire receptacle.
4. Turn both speed adjusts to the counterclockwise stops and the torque limit adjust to clockwise stop.
5. **Push** on the power switch.
6. **Push** on the CW direction switch and slowly rotate the speed adjust controls clockwise. The motor shaft should rotate in a clockwise direction, looking at the shaft end of the motor. The tachometer will show an increasing reading as the speed adjusts are rotated clockwise.
7. **Push** off the CW direction and **push** on the CCW direction. The motor shaft should turn in the counterclockwise direction looking at the output shaft end of the motor.
8. **Push** in the scale selector pushbutton, which will select the torque readout. As the load on the motor is increased, the torque readout will indicate an increasing reading up to 5 lb-in, where, the motor will begin to go into stall.

E-652-O (OPEN MODEL)

OPTIONAL FEATURES

1. **Direction Switch:** Reverses motor rotation through a stop-brake position. ECC Part No. 0041-5023.
2. **10 Turn Potentiometer:** ECC Part No. 8215-0007-2.
3. **Counting Dial for 10 Turn Potentiometer:** ECC Part No. 0011-6005-2.
4. **230 Volt Operation:** By connecting the transformer primaries in series and changing the fuse to 2.5 amps and the circuit breaker to 1.5 amps, the system may be operated from 210-250 VAC, 50/60 Hz line.

SET-UP AND OPERATING PROCEDURES

All connections will be made to the terminal block unless otherwise specified.

1. Connect line cord: black wire to terminal 2, white wire to terminal 1, and green wire to chassis ground stud. Be certain to leave the green wire from chassis connected to terminal 10. See Note 1.
2. Connect speed potentiometer (10k-ohms) to terminal 3-CW tap, terminal 15-Wiper and terminal 5-CCW tap. If an alternate DC source is to be used, connect positive to terminal 15 and negative to terminal 5. The input sensitivity is equal to 3.3 Volts/krpm nominal.

CAUTION: Exceeding 10 Volts on these pins will cause motor to run at excessively high speeds, which may damage motor, or load.

3. Connect 652 motor to customer connect kit as follows: For CW operation of motor shaft — wire terminal 9 of TB-1 to terminal 1 of motor connector, terminal 8 of TB-1 to terminal 2 of motor connector, terminal 16 of TB-1 to terminal 4 of motor connector, terminal 17 of TB-1 to terminal 3 of motor connector, and terminal 10 of TB-1 to terminal 6 of motor connector.

For CCW operation of motor shaft, reverse connections on terminals 9 and 8 of TB-1 and terminals 17 and 16 of TB-1

4. An external torque pot (10k-ohms) may be wired between terminals 6 and 12 with maximum torque equal to maximum resistance. R-20 on the amplifier may have to be readjusted — refer to calibration procedures.

NOTE 1: If you wish to connect the control to an alternate AC or DC source, the DC source must be capable of 3 amps at 100* to 135 volts.

Remove the wires from the secondaries of transformer T-1 going to terminals 3 and 4 of J-1 on amplifier.

The AC source must be capable of 3 amps average at 75-95 VAC. Connect terminal 3 to one side of the AC source and terminal 4 to the other side of the AC source.

J-1 is the mate to P-1 of the amplifier board.

J-1 is an Amp Part No. 1-480270-0.

Contact pin for housing is Part No. 61117-1 or 60619-1.

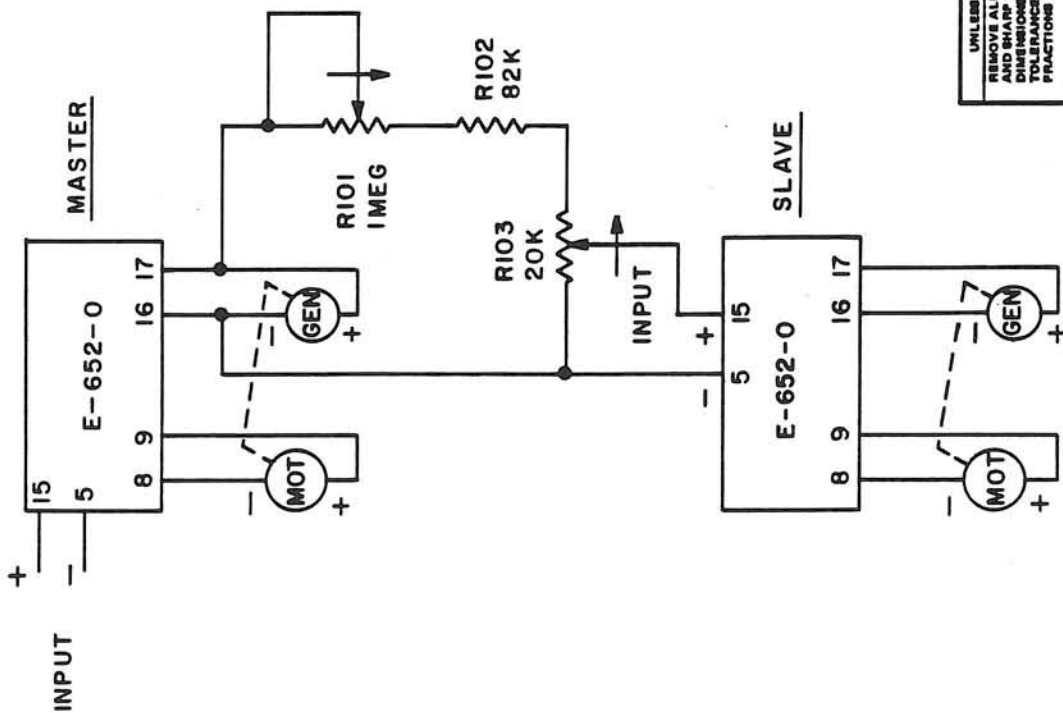
Three pins are required for each housing.

* Maximum speed may be reduced.

MASTER-SLAVE OPERATION

Wire controls as shown on schematic on next page.

Wire R-103 and R-101 at CW, ratio of speeds between master and slave will be approximately 1:1. For a decrease in speed of slave, increase the setting of R-101. R-101 will give a 10:1 ratio between master and slave systems.



NOTES:

1. IF THE E-652-M IS USED AS A MASTER UNIT, CONNECTIONS CAN BE MADE AT THE MOTOR-GENERATOR CONNECTOR; AS A SLAVE UNIT, MAKE CONNECTIONS THRU THE REMOTE INPUT JACK.

9092-0015

DWG. NO.

B	6332	HLN	REVISED PER ECO	4-4-79	APPROVAL
A	7454	BY	RELEASED	3/9/79	DATE
SYM	E.C.O.	BY	REVISION DESCRIPTION		
DIAGRAM:			ELECTRO-CRAFT		
MASTER-SLAVE			DWG. NO.		
OPERATION			9092-0015		
E-652			SHEET 1 OF 1		
SCALE			PROJECT OR PRODUCT		

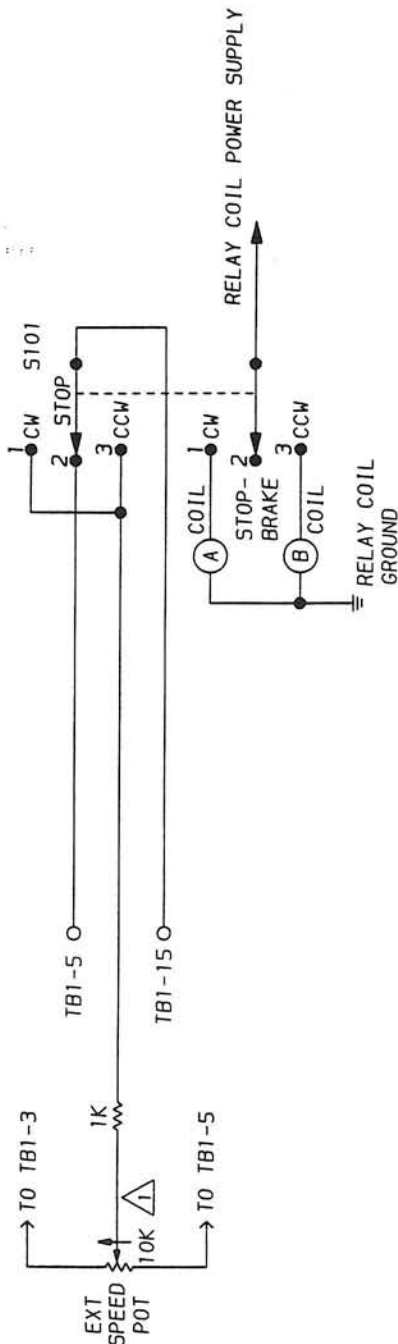
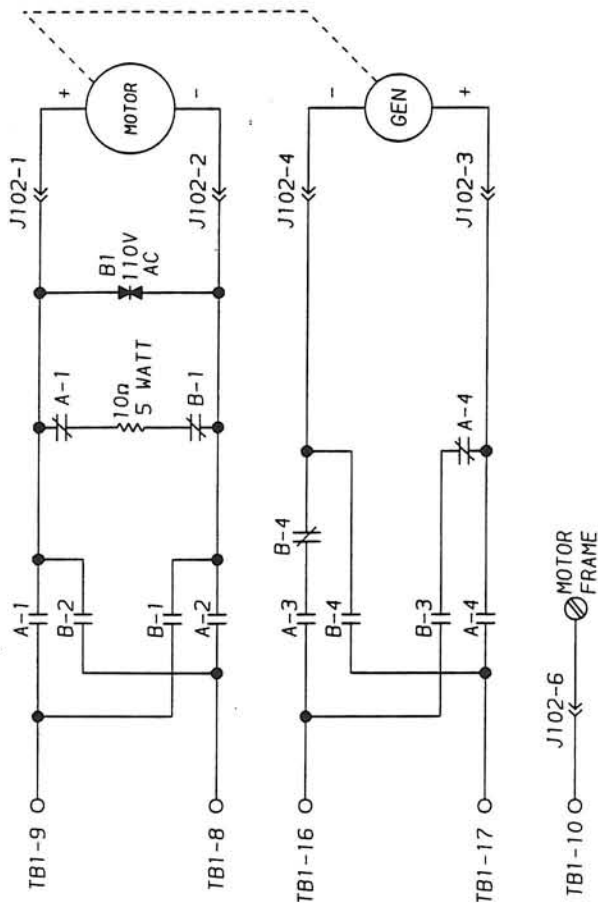
DRAWN BY	RCS	DATE	2/7/78
CHECKED BY			
APPROVED BY			
NEXT ASSY.			
UNLESS OTHERWISE SPECIFIED			
REMOVE ALL BURRS			
DIMENSIONS ARE IN INCHES			
TOLERANCES ON			
FRACTIONS	DECIMALS	ANGLES	
	.010		
	.005		
MATERIAL			
HEAT TREATMENT			
FINISH			
USED ON			

MOTOR RELAY REVERSING

Motor reversing may be done by using two 4-pole relays with form C contacts; a double pole, three position rotary switch; and a 110 VAC thyrector or varistor.

Relay contacts should be rated at 3 amps, 120 VDC minimum.

Schematic of relay reversing is on the next page.



NOTE:

USE 1K 1/2 WATT RESISTOR TO PREVENT SHORTING
+15 VOLTS TO GROUND IN STOP POSITION.

B	ISSUE	P5	ADDED EXTERNAL POT	3-22-58	DSJ
A	7454	RCS	RELEASED	3-9-78	DSJ
REV	ECO	BY	REVISION DESC.	DATE	APPR
			DIAGRAM, MOTOR, REVERSING CIRCUIT,		
			E-652-0		
			DRAWING NO. 9092-0016		
SCALE	N/A	LONG	SIZE C	SHEET 1 OF 1	

UNLESS OTHERWISE SPECIFIED	DRAWN BY	DATE
DO NOT SCALE DRAWING	RCS	2-7-78
DIMENSIONS ARE IN INCHES	DSJ	3-9-78
BREAK ALL EDGES .02 MAX	DESIGN ENGR	3-9-78
FILLET RADIUS .02 R MAX	OPERATIONS ENGR	
TOLERANCES ON:	NEXT ASSY	
FRACTIONS: 1/16"		
DECIMALS: .XX, .010		
ANGLES: .1°		
MATERIAL	USED ON	
N/A	N/A	
FINISH	N/A	

CALIBRATION PROCEDURES

1. **Equipment Needed:** A dynamometer for torque measurements and if possible speed measurements to 0.1 rpm. Speed measurements may be taken by the use of a strobe as an alternative.
 2. This calibration procedure is for setting the speed control system to a condition closer than the factory set nominal specifications.
 3. **Speed Adjustments:** Using a speed measuring instrument, set speed adjusts to desired speed. On amplifier board, adjust R-24 for proper speed indication on front panel meter. (See step 5.)
 4. *If Hi/Low option is installed, again set fine speed control to desired speed and adjust R-1 on switchboard for proper speed indication on front panel meter with high/low switch in low position.
 5. With speed adjust controls fully CW, adjust R-13 on amplifier board for 3000 rpm.
 6. **Torque Adjustments:** Load motor, while running, to 5 lb-in. Adjust R-35 on amplifier board to read 5 lb-in on front panel torque meter.
 7. Release motor to a no-load condition while running and adjust R-17 on amplifier board for "0" on torque meter. Do not turn R-17 beyond the point where downward pointer movement stops or accuracy will be diminished.
 8. Repeat step 6 and 7 for interaction.
 9. Adjust R-20 on amplifier board for maximum torque limit of 6.0 lb-in or lower if desired, at stall, motor cold.
 0. R-37 on mainboard is an I-R compensation adjustment for low speed operation (below 10 R.P.M.), this can be set by turning R-37 CCW and setting the desired speed at no-load. Apply load desired to the motor shaft and adjust R-37 back to its original speed.
- * Master Control Only.

TROUBLESHOOTING GUIDE

Problem	Check
1. Motor will not run.	<ol style="list-style-type: none">1. Line cord faulty or disconnected.2. Power switch is off.3. One of the direction switches not pushed in.4. Motor-connector-cable disconnected or faulty.5. Torque control is set at minimum.6. On amplifier board, check line fuse and circuit breaker.7. Check TP 1, 3 and 4 for proper voltages using TP 2 as common.8. Check TP 13 for 0 volts, with speed pot turned up, if not present disconnect power and check if motor shaft turns freely. If it doesn't, replace motor. If motor OK, check CR-1, Q-6, Q-7 and Q-5.9. Test terminal 9 of TB 1 for 120 volts when speed is turned up. If present, check connections to motor.10. Check TP 8 for 10-15 volts when speed pot turned up, if voltage is present, check Q1, Q2, Q3, Q-4, Q-8 and Q-9. If not, check or replace AR 1.
2. Motor runs full speed (out of control).	<p>With speed pot at minimum:</p> <ol style="list-style-type: none">1. Check TP 8 for 0 volts, if not present check pins 15 and 16 of TB 1 for 0 volts. If ok, check or replace AR 1.2. If TP 8 is 0 volts, check Q-1, Q-2, Q-3, Q-4, Q-8 and Q-9 for opens and shorts.

WARNING: Original fuses must be replaced by the same type (normal blow or slow blow) with the same voltage and current rating or damage to the motor controller will occur.

TEST POINT GUIDE FOR VOLTAGES

VAC and VDC measurements made with a VOM (Volt-ohm-meter) of 20K-ohms/volt. Peak-to-peak measurements made with an oscilloscope with a 1-Meg-ohm or greater input impedance.

T.P. 2 — Common — connected to circuit common, with jumper installed between terminal 10 and pin 6 of T.B. 1, circuit common is to chassis and through line plug to earth ground. Without jumper, circuit is isolated.

All other test points unless otherwise stated are reference common to T.P. 2.

Between T.P. 15 and 16, and T.P. 14 and 15 should be 80 to 96 VAC or alternate A.C. or D.C. source.

- T.P. 1 — 135 VDC maximum
112 VDC minimum at full load
6.5 VP-P maximum at full load - 120 Hz.
1.0 VP-P maximum at no load - 120 Hz.
- T.P. 3 — 24 VDC, 150 millivolts P-P, 120 Hz at full load.
- T.P. 4 — Regulated reference, +15 VDC, $\pm 4\%$.
- T.P. 5 — 0-10 VDC variable with speed pot. Ratio 3.3 V/krpm.
- T.P. 6 and 7 — 0-97 VDC variable with speed. Generator output with ratio = 21 V/krpm.
- T.P. 8 and 9 — 0-4 VDC, corresponding to 0-3000 rpm of the motor speed.
- T.P. 10 — 120 VDC - same as T.P. 1.

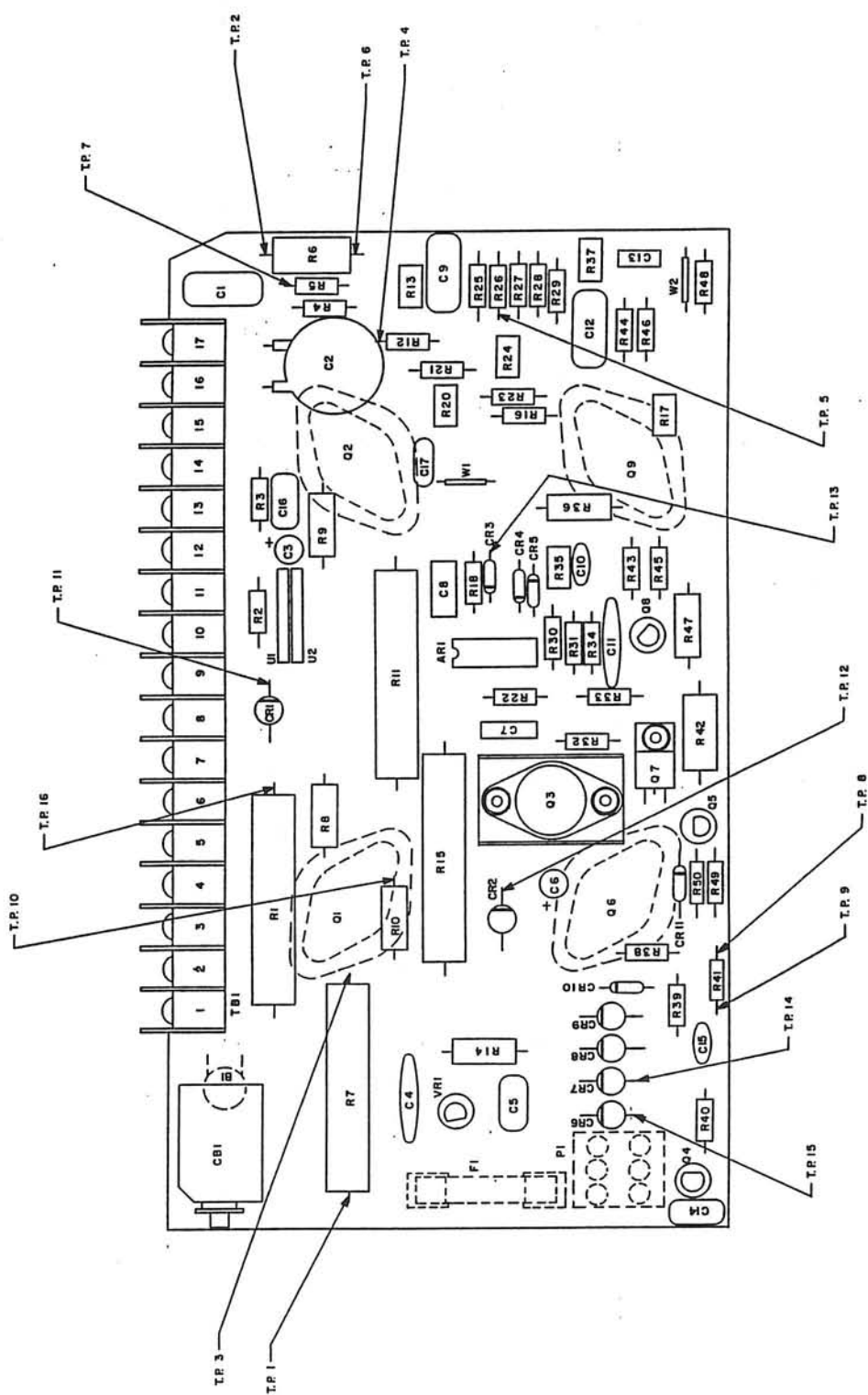
Between T.P. 10 and T.P. 1, 0-0.6 VDC maximum should exist depending load current.

- T.P. 11 — No load should be 0-100 VDC depending on motor speed, with full load, voltage could rise to 120 VDC.
- T.P. 12 — 0-1.0 VDC depending on motor torque.
- T.P. 13 — 0-0.8 VDC depending on motor torque.

REPLACEMENT PARTS LIST

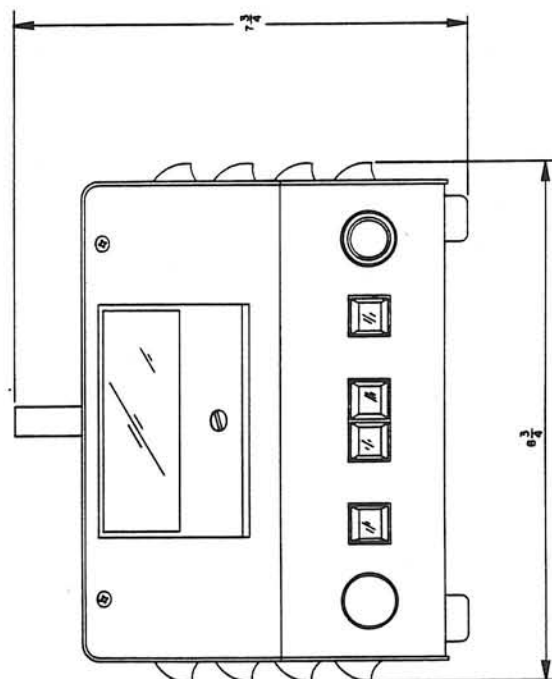
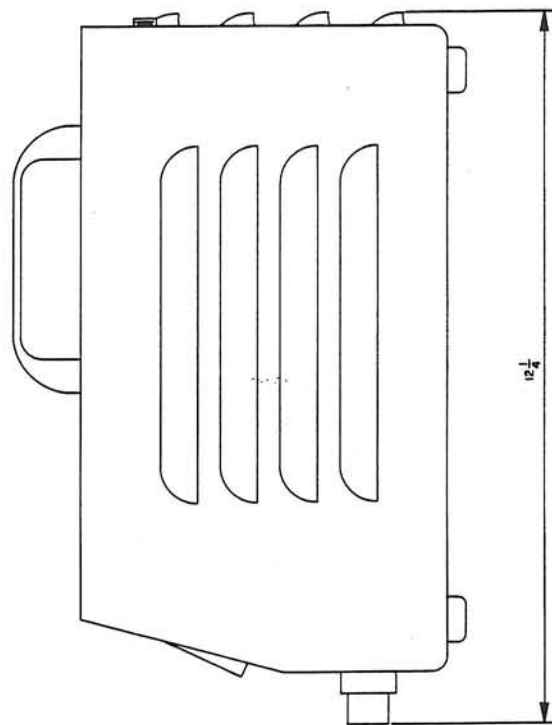
	ECC Part No.
P.C.B. Sub-Assy (Amplifier)	0042-6262
Transformer Sub-Assy	9092-0029
P.C.B. Sub-Assy (Switchboard)	0042-6263
Transistor (2N6259)	8400-0130
Insulator for above Transistor	0009-5524-013
Circuit Breakers (3 Amp) (115 VAC Operation)	0003-2033-017
Circuit Breakers (1.5 Amp) (230 VAC Operation)	0003-2033-013
Knob-Single	0011-6017-001
Knobs-Dual Concentric	0011-6016-001
Meter	0013-2035
Heatsink	9076-0009
Harness Sub-Assy (Amplifier-to-Switchboard)	9092-0007
Harness Sub-Assy (Switchboard-to-Rear-Panel)	9092-0028
AC Line Cord (Master Control)	8508-0118
Motor Connector, Socket	0003-5220
Capacitor (2100 uF)	8037-0001-0008
Fan (Sub-Assembly)	9092-0013

9092-0017

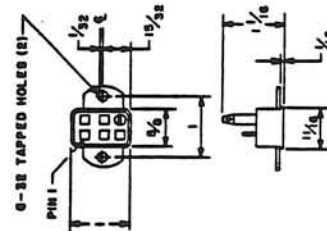
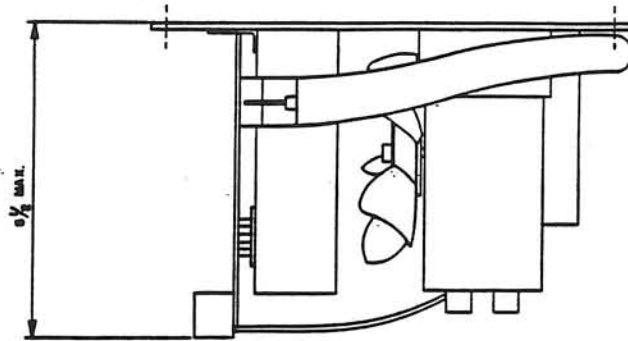


REVISIONS				TEST POINT			
NO.	DATE	BY	REASON	NO.	DATE	BY	REASON
1	10-1-64	WTH	REVISED PER AV CHANGES	1	10-1-64	WTH	REVISED PER AV CHANGES
2	10-1-64	WTH	ADDED C17	2	10-1-64	WTH	ADDED C17
3	10-1-64	WTH	ADDED C18	3	10-1-64	WTH	ADDED C18
4	10-1-64	WTH	ADDED C19	4	10-1-64	WTH	ADDED C19
5	10-1-64	WTH	ADDED C20	5	10-1-64	WTH	ADDED C20
6	10-1-64	WTH	ADDED C21	6	10-1-64	WTH	ADDED C21
7	10-1-64	WTH	ADDED C22	7	10-1-64	WTH	ADDED C22
8	10-1-64	WTH	ADDED C23	8	10-1-64	WTH	ADDED C23
9	10-1-64	WTH	ADDED C24	9	10-1-64	WTH	ADDED C24
10	10-1-64	WTH	ADDED C25	10	10-1-64	WTH	ADDED C25
11	10-1-64	WTH	ADDED C26	11	10-1-64	WTH	ADDED C26
12	10-1-64	WTH	ADDED C27	12	10-1-64	WTH	ADDED C27
13	10-1-64	WTH	ADDED C28	13	10-1-64	WTH	ADDED C28
14	10-1-64	WTH	ADDED C29	14	10-1-64	WTH	ADDED C29
15	10-1-64	WTH	ADDED C30	15	10-1-64	WTH	ADDED C30
16	10-1-64	WTH	ADDED C31	16	10-1-64	WTH	ADDED C31
17	10-1-64	WTH	ADDED C32	17	10-1-64	WTH	ADDED C32
18	10-1-64	WTH	ADDED C33	18	10-1-64	WTH	ADDED C33
19	10-1-64	WTH	ADDED C34	19	10-1-64	WTH	ADDED C34
20	10-1-64	WTH	ADDED C35	20	10-1-64	WTH	ADDED C35
21	10-1-64	WTH	ADDED C36	21	10-1-64	WTH	ADDED C36
22	10-1-64	WTH	ADDED C37	22	10-1-64	WTH	ADDED C37
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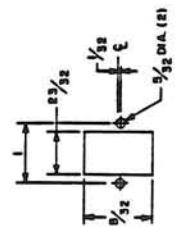
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CHANGES BY M.W.		DATE 1/25/64	
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REVISIONS			
NO. DATE BY REASON			
1 1/25/64 M.W. REVISED PER AV CHANGES			
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345 1/25/64 M.W. ADDED C360			
346 1/25/64 M.W. ADDED C361			
347 1/25/64 M.W. ADDED C362			
348 1/25/64 M.W. ADDED C363			
349 1/25/64 M.W. ADDED C364			
350 1/25/64 M.W. ADDED C365			
351 1/25/64 M.W. ADDED C366			
352 1/25/64 M.W. ADDED C367			
353 1/25/64 M.W. ADDED C368			
354 1/25/64 M.W. ADDED C369			
355 1/25/64 M.W. ADDED C370			
356 1/25/64 M.W. ADDED C371			
357 1/25/64 M.W. ADDED C372			
358 1/25/64 M.W. ADDED C373			
359 1/25/64 M.W. ADDED C374			
360 1/25/64 M.W. ADDED C375			
361 1/25/64 M.W. ADDED C376			
362 1/25/64 M.W. ADDED C377			
363 1/25/64 M.W. ADDED C378			
364 1/25/64 M.W. ADDED C379			
365 1/25/64 M.W. ADDED C380			
366 1/25/64 M.W. ADDED C381			
367 1/25/64 M.W. ADDED C382			
368 1/25/64 M.W. ADDED C383			
369 1/25/64 M.W. ADDED C384			
370 1/25/64 M.W. ADDED C385			
371 1/25/64 M.W. ADDED C386			
372 1/25/64 M.W. ADDED C387			
373 1/25/64 M.W. ADDED C388			
374 1/25/64 M.W. ADDED C389			
375 1/25/64 M.W. ADDED C390			
376 1/25/64 M.W. ADDED C391			
377 1/25/64 M.W. ADDED C392			
378 1/25/64 M.W. ADDED C393			
379 1/25/64 M.W. ADDED C394			
380 1/25/64 M.W. ADDED C395			
381 1/25/64 M.W. ADDED C396			
382 1/25/64 M.W. ADDED C397			
383 1/25/64 M.W. ADDED C398			
384 1/25/64 M.W. ADDED C399			
385 1/25/64 M.W. ADDED C400			
386 1/25/			



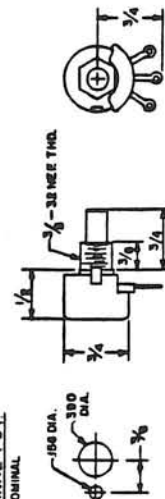
DRAWN BY: M. J. 5-57		A. 7-57		E. 4		RELEASED		E. 2-78	
CHECKED BY: P. J. 1-1		B. 1-1		C. 1-1		D. 1-1		E. 1-1	
F. 1-1		G. 1-1		H. 1-1		I. 1-1		J. 1-1	
K. 1-1		L. 1-1		M. 1-1		N. 1-1		O. 1-1	
P. 1-1		Q. 1-1		R. 1-1		S. 1-1		T. 1-1	
U. 1-1		V. 1-1		W. 1-1		X. 1-1		Y. 1-1	
Z. 1-1		AA. 1-1		AB. 1-1		AC. 1-1		AD. 1-1	
AE. 1-1		AF. 1-1		AG. 1-1		AH. 1-1		AI. 1-1	
AJ. 1-1		AK. 1-1		AL. 1-1		AM. 1-1		AN. 1-1	
AO. 1-1		AP. 1-1		AQ. 1-1		AR. 1-1		AS. 1-1	
AT. 1-1		AU. 1-1		AV. 1-1		AW. 1-1		AX. 1-1	
AY. 1-1		AZ. 1-1		BA. 1-1		BB. 1-1		BC. 1-1	
BD. 1-1		BE. 1-1		BF. 1-1		BG. 1-1		BH. 1-1	
BI. 1-1		BJ. 1-1		BK. 1-1		BL. 1-1		BM. 1-1	
BN. 1-1		BO. 1-1		BP. 1-1		BQ. 1-1		BR. 1-1	
BS. 1-1		BT. 1-1		BU. 1-1		BV. 1-1		BW. 1-1	
BX. 1-1		BY. 1-1		BZ. 1-1		CA. 1-1		CB. 1-1	
CC. 1-1		CD. 1-1		CE. 1-1		CF. 1-1		CG. 1-1	
CH. 1-1		CI. 1-1		CJ. 1-1		CK. 1-1		CL. 1-1	
CM. 1-1		CN. 1-1		CO. 1-1		CP. 1-1		CQ. 1-1	
CR. 1-1		CS. 1-1		CT. 1-1		CU. 1-1		CV. 1-1	
CW. 1-1		CX. 1-1		CY. 1-1		CZ. 1-1		DA. 1-1	
DB. 1-1		DC. 1-1		DD. 1-1		DE. 1-1		DF. 1-1	
DG. 1-1		DH. 1-1		DI. 1-1		DJ. 1-1		DK. 1-1	
DL. 1-1		DM. 1-1		DN. 1-1		DO. 1-1		DP. 1-1	
DQ. 1-1		DR. 1-1		DS. 1-1		DT. 1-1		DU. 1-1	
DV. 1-1		DW. 1-1		DX. 1-1		DY. 1-1		EZ. 1-1	
FA. 1-1		FB. 1-1		FC. 1-1		FD. 1-1		FE. 1-1	
FF. 1-1		FG. 1-1		FH. 1-1		FI. 1-1		FJ. 1-1	
FK. 1-1		FL. 1-1		FM. 1-1		FN. 1-1		FO. 1-1	
FP. 1-1		FQ. 1-1		FR. 1-1		FS. 1-1		FT. 1-1	
FU. 1-1		FV. 1-1		FW. 1-1		FX. 1-1		FY. 1-1	
FZ. 1-1		GA. 1-1		GB. 1-1		GC. 1-1		GD. 1-1	
GE. 1-1		GF. 1-1		GG. 1-1		GH. 1-1		GI. 1-1	
GJ. 1-1		GK. 1-1		GL. 1-1		GM. 1-1		GN. 1-1	
GO. 1-1		GP. 1-1		GQ. 1-1		GR. 1-1		GS. 1-1	
GT. 1-1		GU. 1-1		GV. 1-1		GW. 1-1		GX. 1-1	
GY. 1-1		GZ. 1-1		HA. 1-1		HB. 1-1		HC. 1-1	
HD. 1-1		HE. 1-1		HF. 1-1		HG. 1-1		HH. 1-1	
HI. 1-1		HJ. 1-1		HK. 1-1		HL. 1-1		HM. 1-1	
HN. 1-1		HO. 1-1		HP. 1-1		HQ. 1-1		HR. 1-1	
HS. 1-1		HT. 1-1		HU. 1-1		HV. 1-1		HW. 1-1	
HX. 1-1		HY. 1-1		HZ. 1-1		IA. 1-1		IB. 1-1	
IC. 1-1		ID. 1-1		IE. 1-1		IF. 1-1		IG. 1-1	
IH. 1-1		II. 1-1		IJ. 1-1		IK. 1-1		IL. 1-1	
IM. 1-1		IN. 1-1		IO. 1-1		IP. 1-1		IQ. 1-1	
IR. 1-1		IS. 1-1		IT. 1-1		IU. 1-1		IV. 1-1	
IW. 1-1		IX. 1-1		IY. 1-1		IZ. 1-1		JA. 1-1	
JB. 1-1		JC. 1-1		JD. 1-1		JE. 1-1		JF. 1-1	
JG. 1-1		JH. 1-1		JI. 1					



MOTOR CONNECTOR



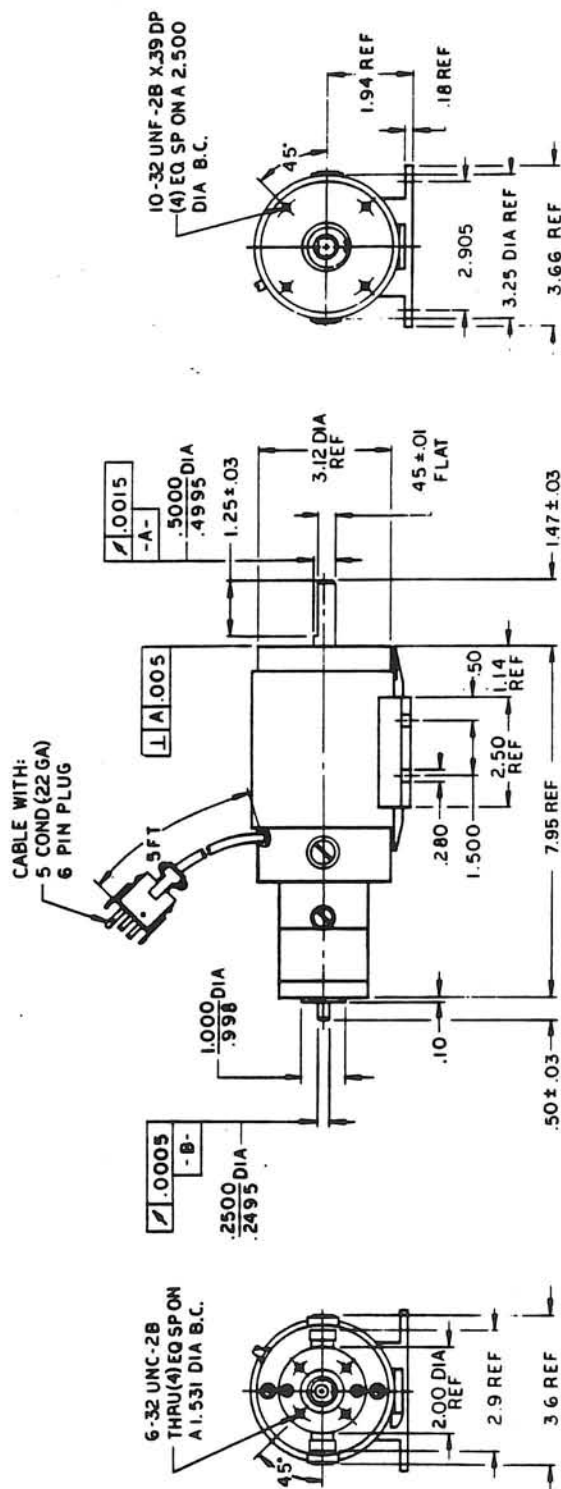
EXTERNAL POT.
FOR NOMINAL



E-652-O		DRAWING		INSTALLATION		ELECTRIC UNIT		9092-0021 9092-0021 9092-0021	
NONE									

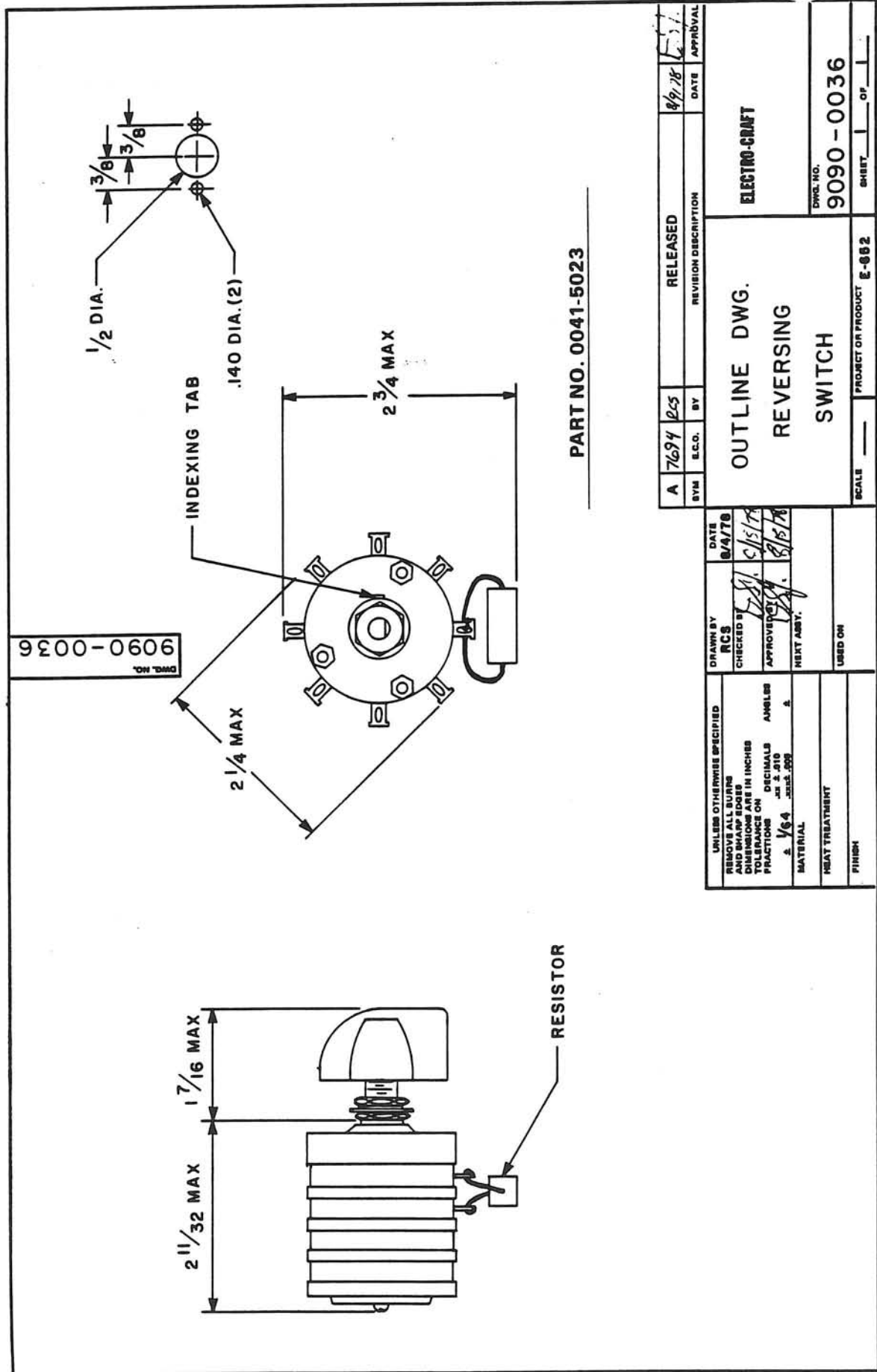
[illegible]

20



0652-00-005

UNLESS OTHERWISE SPECIFIED		DRAWN BY HRL		DATE 3-17-78		A		BTM		RELEASED		DATE		APPROVAL	
REMOVE ALL BURRS AND SHARP EDGES		CHECKED BY						ECO		BY					
MATERIAL		HRT ASBY								OUTLINE				ELECTRIC CRAFT 20HRC	
MEAT TREATMENT		USED ON												DIMS INO	
FINISH														0652.00-005	
								SCALE 1:2				SHEET 1 OF 1			

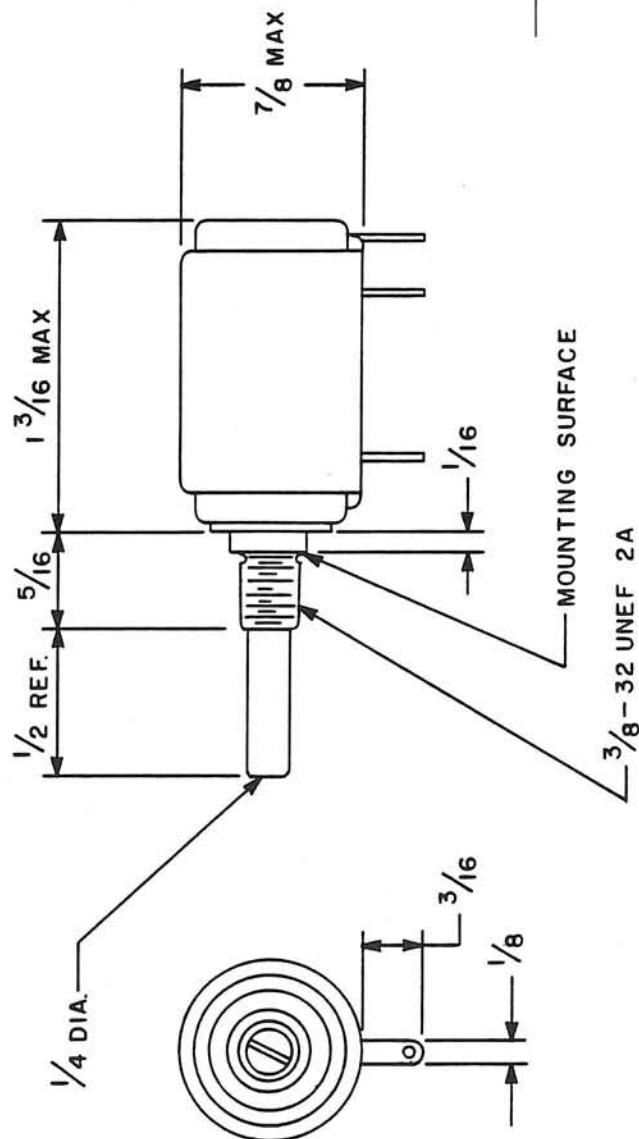


UNLESS OTHERWISE SPECIFIED REMOVE ALL BURRS AND SHARP EDGES DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS DECIMALS .010 ANGLES 2.000 MATERIAL 6061-T6 HEAT TREATMENT FINISH		DRAWN BY RCS	CHECKED BY [Signature]	DATE 8/4/78
APPROVED BY [Signature]		DATE 8/15/78	ELECTRO-CRAFT	
NEXT ASST. [Signature]		DATE 8/15/78	OUTLINE DWG. REVERSING SWITCH	
USED ON		PROJECT OR PRODUCT E-852		
FINISH		DWG. NO. 9090-0036		
SCALE		SHEET 1 OF 1		
BYM		E.C.O. BY		RELEASED
DATE		DATE		APPROVAL

RECOMMENDED PANEL CUT-OUT

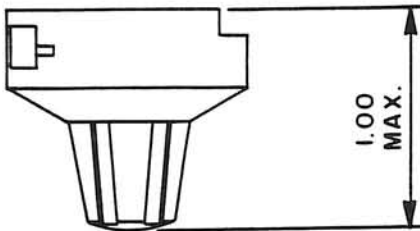
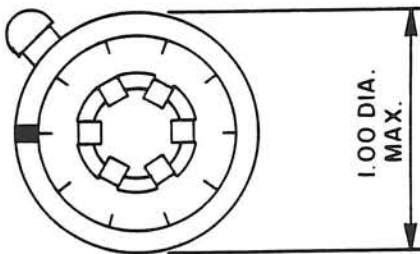


PART NO. 8215-0007-2



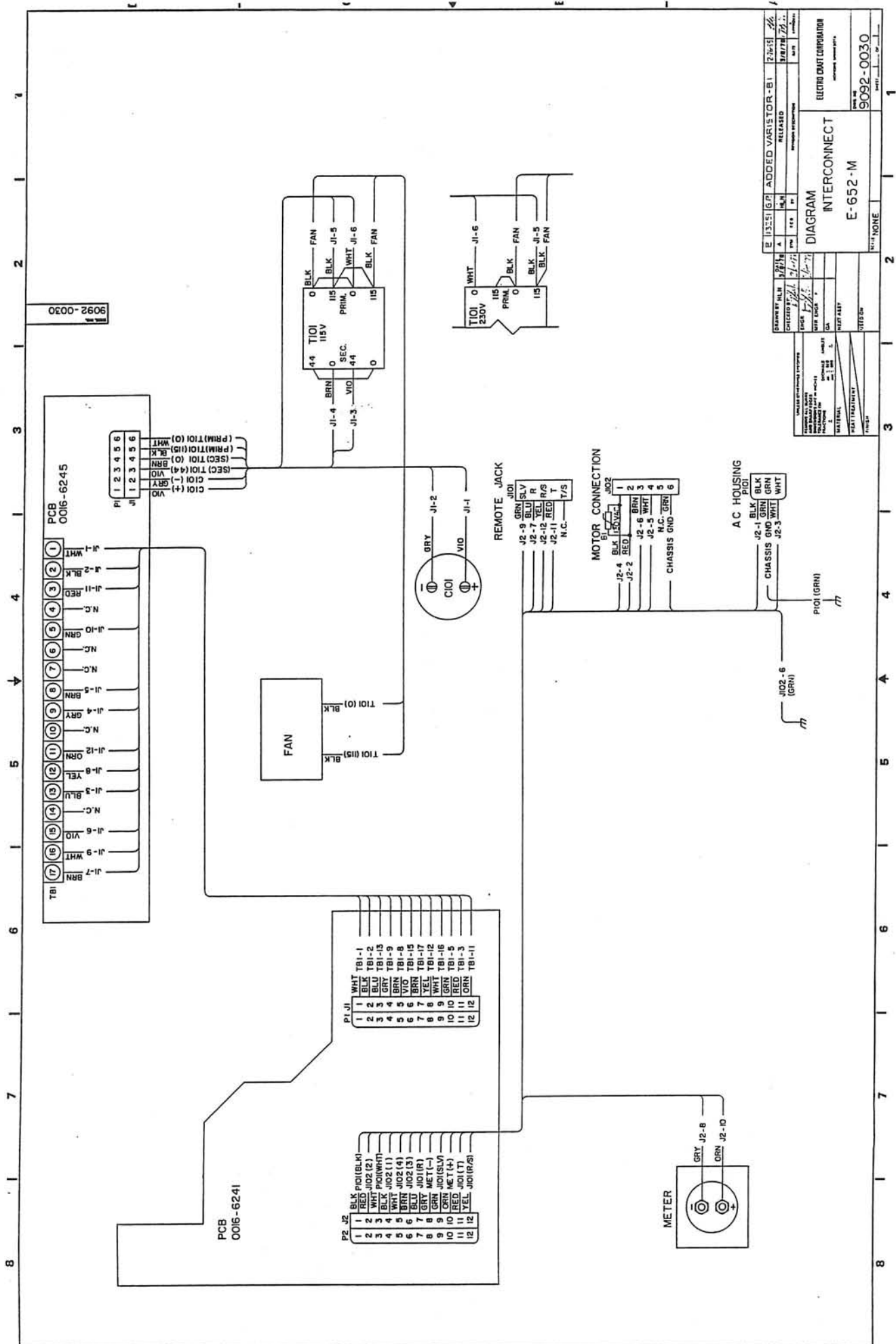
UNLESS OTHERWISE SPECIFIED		DRAWN BY	RCS	DATE	PA		RELEASED				APPROVAL	
REMOVE ALL BURRS AND SHARP EDGES DIMENSIONS ARE IN INCHES TOLERANCE ON FRACTIONS		CHECKED BY	/		SYM		E.C.O.		BY		REVISION DESCRIPTION	
DECIMALS ANGLES		APPROVED BY									ELECTRO-CRAFT	
.001 .002 .005											OUTLINE DWG.	
MATERIAL		NEXT ASSY.										10 TURN POT.
HEAT TREATMENT		USED ON										DWG. NO.
FINISH												9090-0026
						SCALE		PROJECT OR PRODUCT		SHEET		OF

DWG. NO.
9090-0025

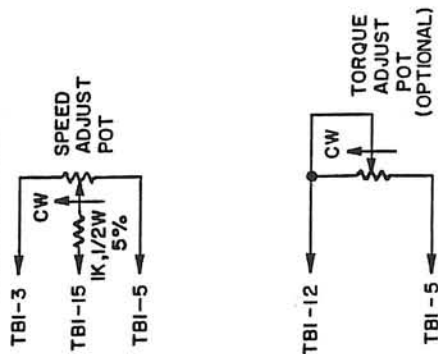


PART NO. 0011-6005-2

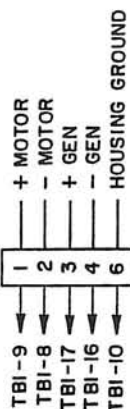
PA	SYM	E.C.O.	BY	RELEASED	DATE	APPROVAL
OUTLINE DWG. 10 TURN DIAL KNOB				ELECTRO-CRAFT		
DWG. NO. 9090-0025				SHEET 1 OF 1		
SCALE				PROJECT OR PRODUCT		
UNLESS OTHERWISE SPECIFIED REMOVE ALL BURRS AND SHARP EDGES DIMENSIONS ARE IN INCHES TOLERANCE ON FRACTIONS DECIMALS ANGLES ± .001 ± .010 ± MATERIAL NEXT ASSY. HEAT TREATMENT USED ON FINISH				DRAWN BY RCS CHECKED BY APPROVED BY DATE 4/6/78		



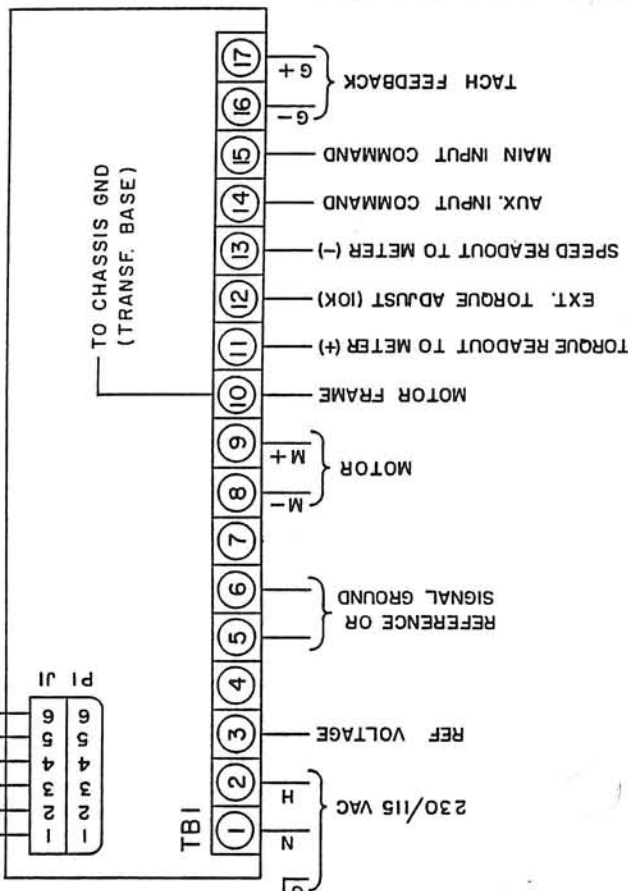
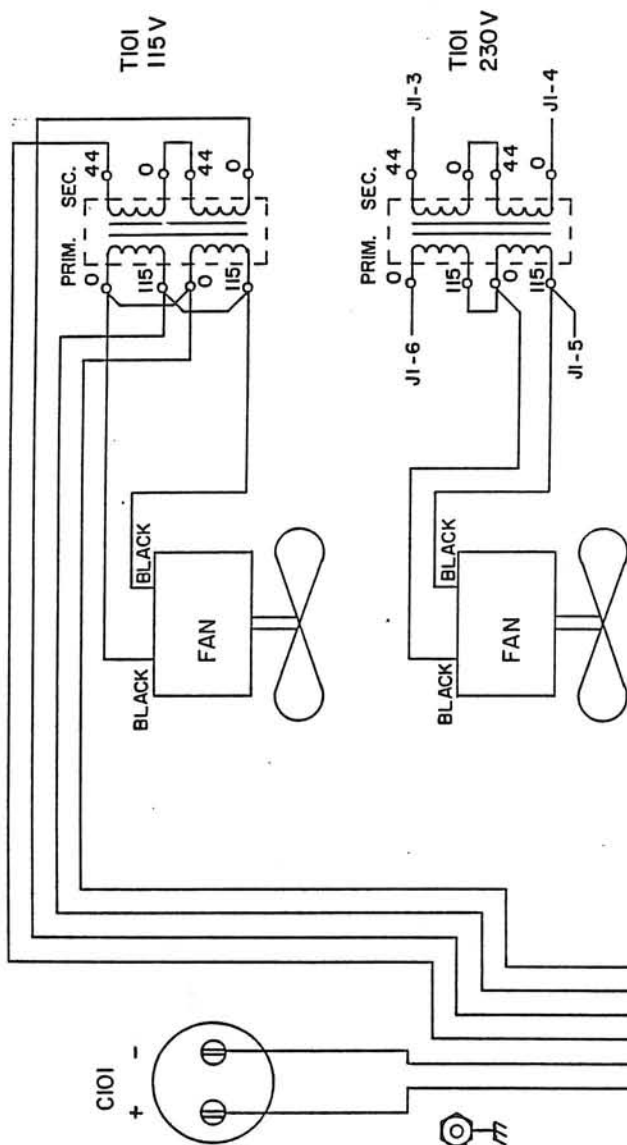
NOTE: THE 1K RESISTOR ELIMINATES THE POSSIBILITY OF SHORTING THE +15 VOLT SUPPLY WHEN THE OPTIONAL REVERSING CIRCUIT IS IN THE STOP POSITION.



MOTOR CONNECTOR



9092-0020



SYM	ECO	BY	REVISION DESCRIPTION	DATE	APPROVAL
D	9451	HLN	ADDED NOTE	11-66-80	7-2-V
C	9257	HLN	ADDED 1K, 1/2W, 5% RESISTOR	7-16-80	7-2-V
B	8300	HLN	REVISED PER ECO	5-21-79	7-2-V
A	7454	HLN	RELEASED	2-23-78	7-2-V

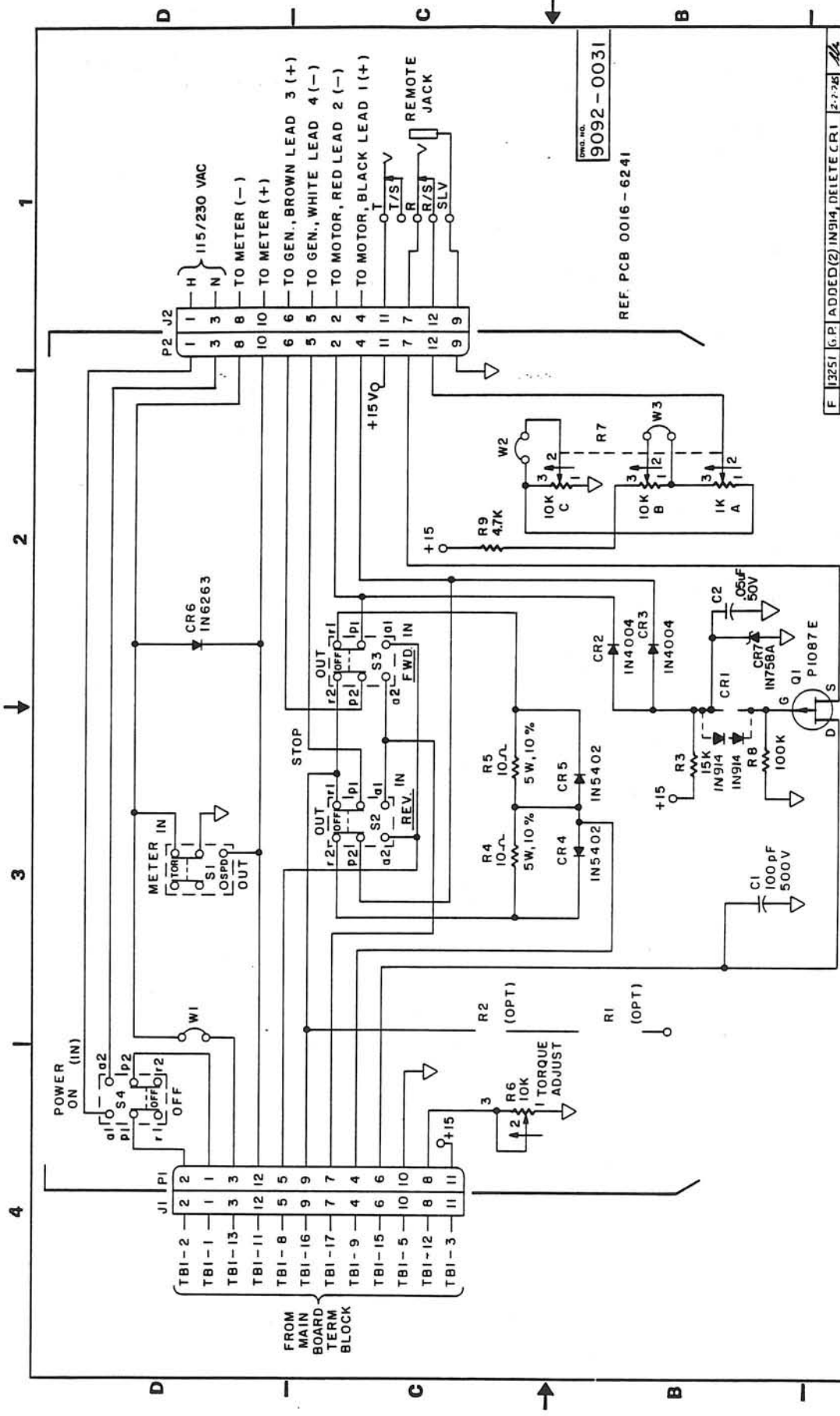
DIAGRAM,
INTERCONNECT

E-652-0

SCALE NONE PROJECT OR PRODUCT

SHEET 1 OF 1

UNLESS OTHERWISE SPECIFIED	DRAWN BY	DATE
REWORK ALL DIMENSIONS AND SHARP EDGES	HLN	2-23-78
DIMENSIONS ARE IN INCHES	CHECKED BY	7-21-79
FRACTIONS OR DECIMALS	APPROVED BY	7-21-79
ANGLES	TEST ASST.	7-21-79
MATERIAL	USED ON	
TREATMENT		
FINISH		



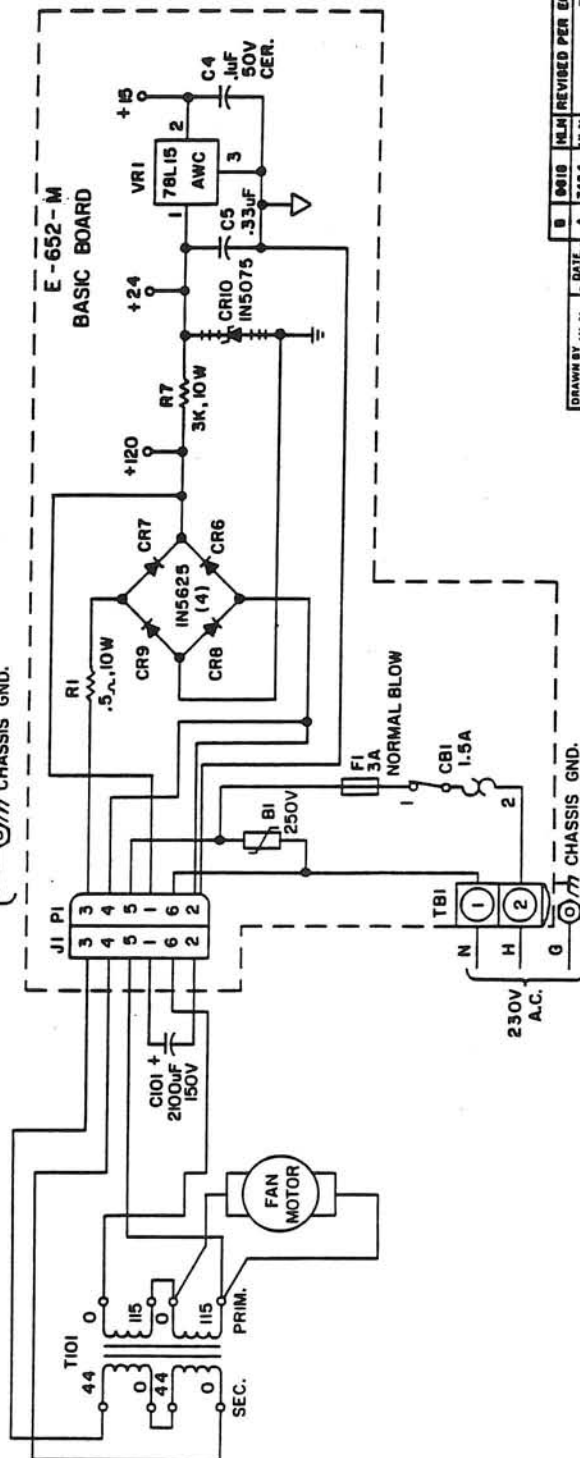
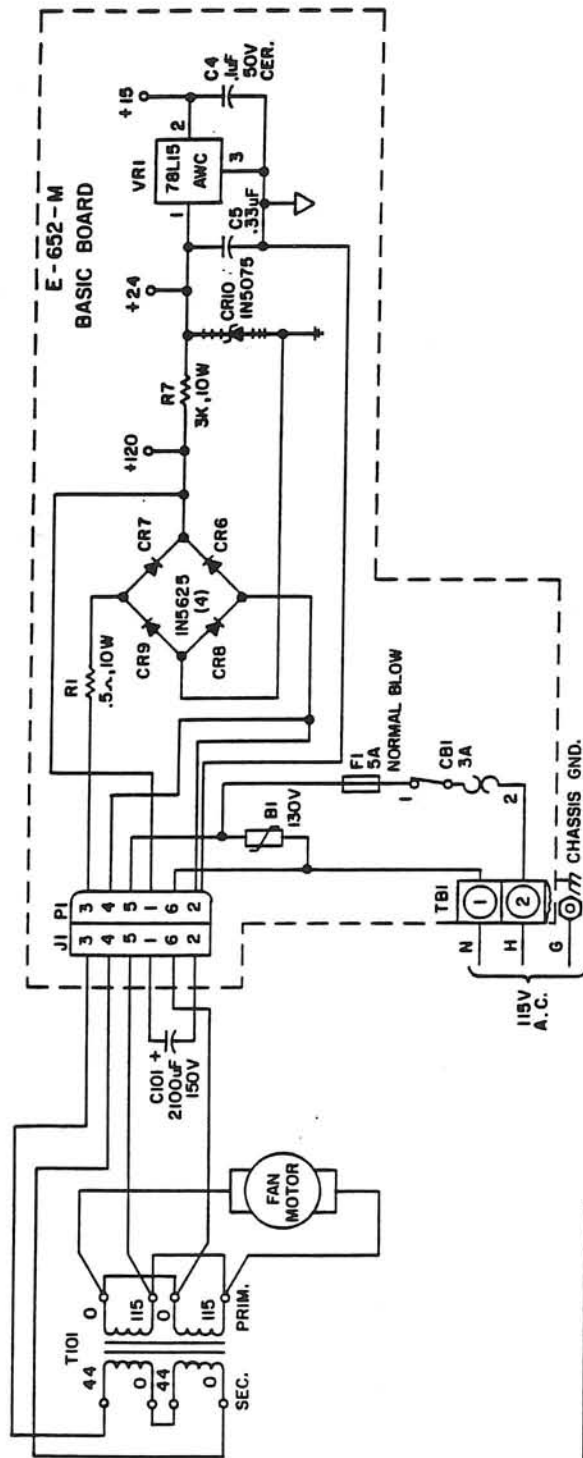
NOTE:
1. UNLESS OTHERWISE SPECIFIED ALL
RESISTORS ARE 1/4W, 5%
2. - - - - INDICATES HARDWARE MODIFICATION.

SYM	REV	DESCRIPTION	DATE	APPROVAL
F	13251	G.P. ADDED(2) IN914, DELETE CR1	2-2-76	AK
E	9761	LP ADDED CR7	6-19-81	AK
D	8818	HLN ADDED 250V	8-31-81	AK
C	3756	HUN ADDED C2 REVISED CR2+3	9-12-81	AK
B	7623	ADD R9, REDRAWN IN INK	6-9-81	AK
A	7457	REL	11-2-77	AK

SCHEM. S/A PCB E-652-M		ELECTRO-CRAFT	
SWD NO 9092-0031		SWD NO 9092-0031	
PROJECT OR PRODUCT		SHEET 1 OF 1	

DESIGNED BY	DATE	6/9/78
CHECKED BY	DATE	6/9/78
APPROVED BY	DATE	6/9/78
TEST ASBY	DATE	6/9/78
USED ON		

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES DIMENSIONS ARE IN INCHES FRACTIONS.	ANGLES IN DEGREES UNLESS OTHERWISE SPECIFIED
MATERIAL	HEAT TREATMENT
FINISH	

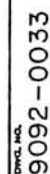


NOTES:

1. FOR 230 V LINE: MUST USE A NEUTRALIZED SOURCE OR AN ISOLATED SOURCE IN SUCH A MANNER TO PROTECT LIKE A NEUTRALIZED SOURCE.

9092-0018

DRAWN BY HLM		CHECKED BY RCB		DATE 3/23/78		REVISED PER ECO		DATE 3/23/78		INM		DATE 3/23/78		RELEASED		DATE 3/23/78		APPROVED	
A		A		A		A		A		A		A		A		A		A	
7454		7454		7454		7454		7454		7454		7454		7454		7454		7454	
ELECTRONIC		ELECTRONIC		ELECTRONIC		ELECTRONIC		ELECTRONIC		ELECTRONIC		ELECTRONIC		ELECTRONIC		ELECTRONIC		ELECTRONIC	
SCHEMATIC, POWER SUPPLY, E-652-0		SCHEMATIC, POWER SUPPLY, E-652-0		SCHEMATIC, POWER SUPPLY, E-652-0		SCHEMATIC, POWER SUPPLY, E-652-0		SCHEMATIC, POWER SUPPLY, E-652-0		SCHEMATIC, POWER SUPPLY, E-652-0		SCHEMATIC, POWER SUPPLY, E-652-0		SCHEMATIC, POWER SUPPLY, E-652-0		SCHEMATIC, POWER SUPPLY, E-652-0		SCHEMATIC, POWER SUPPLY, E-652-0	
NONE		NONE		NONE		NONE		NONE		NONE		NONE		NONE		NONE		NONE	
9092-0018		9092-0018		9092-0018		9092-0018		9092-0018		9092-0018		9092-0018		9092-0018		9092-0018		9092-0018	



UNSELECTED-PRICE SPECIFIED	SPARKS' RCS	5-28
MUCH ALL BLUE	CHECKED: 5/9	8/27/78
MAXIMUMS ARE IN INCHES		5/15/78
DIFFERENCE ON	APPROVED: 5/9	5/15/78
PUBLICATION ON	WERTZ ADV.	
2		
2		
INTERNAL		
NEAT TREATMENT		
PENDING		
USED ON		

