Electro-Craft®

MOTOMATIC®

SERIES E-652

INSTRUCTION MANUAL

Document 7058-9954-003

May 1994

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

RELIANCE ELECTRIC

TABLE OF CONTENTS

SERVICE BULLETIN

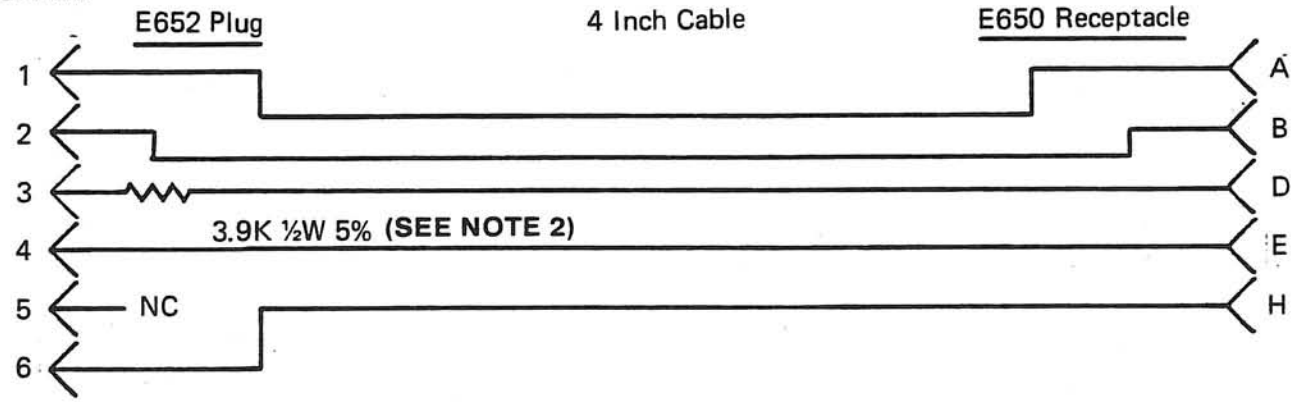
NUMBER 13A

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

MODIFICATIONS OR CHANGES: 6

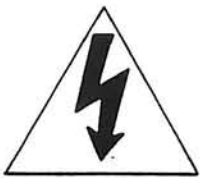
Use adapter cable Part No. 0029-0162 to connect E-650 Motor-Generators to E-652 M Master Controls directly.

DIAGRAM:

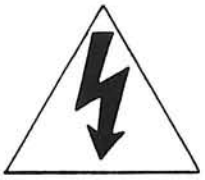


NOTES:

1. Allows rapid changeover of motors without modification of control.
2. Calibration error of ± 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.

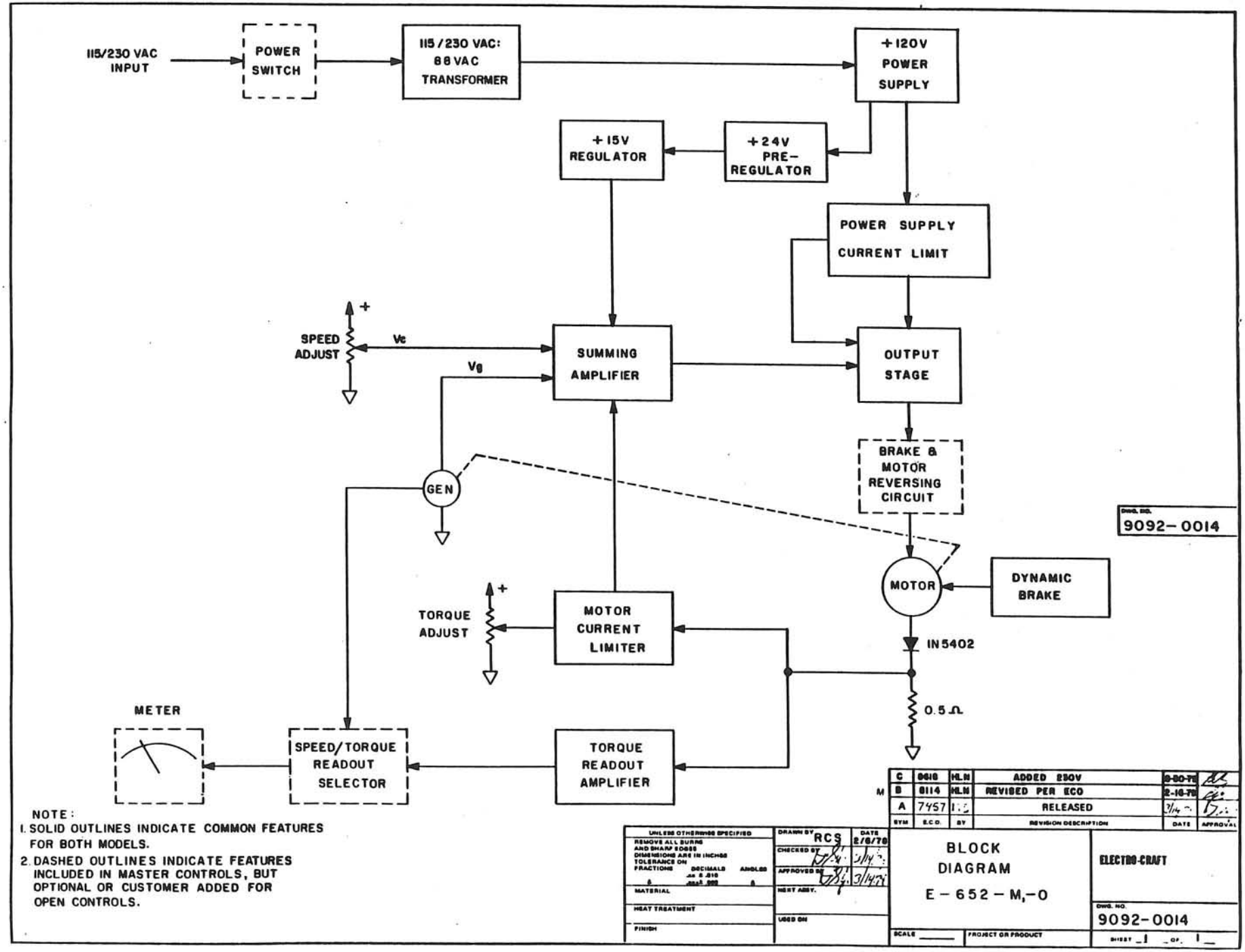
Disassembly of the motor-generator is *not* recommended. If disassembly is absolutely required, please contact Electro-Craft before proceeding.

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, Vg, from the generator is fed to the controller where it is compared with a speed command voltage Vc. 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).


115/230 VAC INPUT
POWER SWITCH
115/230 VAC: 88 VAC TRANSFORMER
+120V POWER SUPPLY
+15V REGULATOR
+24V PRE-REGULATOR
POWER SUPPLY CURRENT LIMIT
SPEED ADJUST
+
Vc
Vg
SUMMING AMPLIFIER
OUTPUT STAGE
BRAKE & MOTOR REVERSING CIRCUIT
GEN
MOTOR
DYNAMIC BRAKE
TORQUE ADJUST
+
MOTOR CURRENT LIMITER
IN5402
0.5Ω
METER
SPEED/TORQUE READOUT SELECTOR
TORQUE READOUT AMPLIFIER
NOTE:
1. SOLID OUTLINES INDICATE COMMON FEATURES FOR BOTH MODELS.
2. DASHED OUTLINES INDICATE FEATURES INCLUDED IN MASTER CONTROLS, BUT OPTIONAL OR CUSTOMER ADDED FOR OPEN CONTROLS.
DWG. NO. 9092-0014
C 0616 HLN ADDED 230V 9-30-76
B 0114 HLN REVISED PER ECO 2-16-76
A 7457 RELEASED 3/14/75
SYM E.C.O. BY REVISION DESCRIPTION DATE APPROVAL
UNLESS OTHERWISE SPECIFIED
REMOVE ALL BURRS AND SHARP EDGES
DIMENSIONS ARE IN INCHES
TOLERANCE ON FRACTIONS DECIMALS ANGLES
MATERIAL
HEAT TREATMENT
FINISH
DRAWN BY RCS DATE 2/6/75
CHECKED BY 3/14/75
APPROVED BY 3/14/75
NEXT ASSY.
USED ON
BLOCK DIAGRAM
E-652-M,-O
ELECTRO-CRAFT
DWG. NO. 9092-0014
SCALE
PROJECT OR PRODUCT
SHEET 1 OF 1

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.

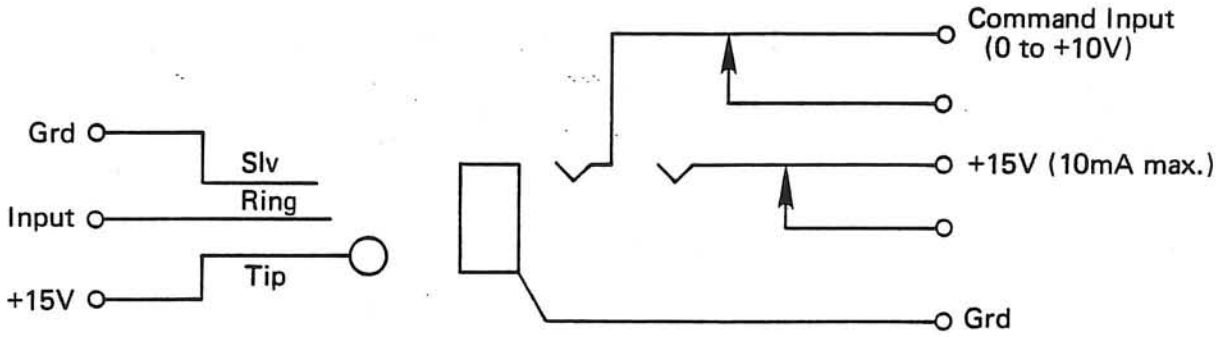
* The direction of rotation of the output shaft of a motor gearhead may be CW or CCW depending on the ratio.

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.

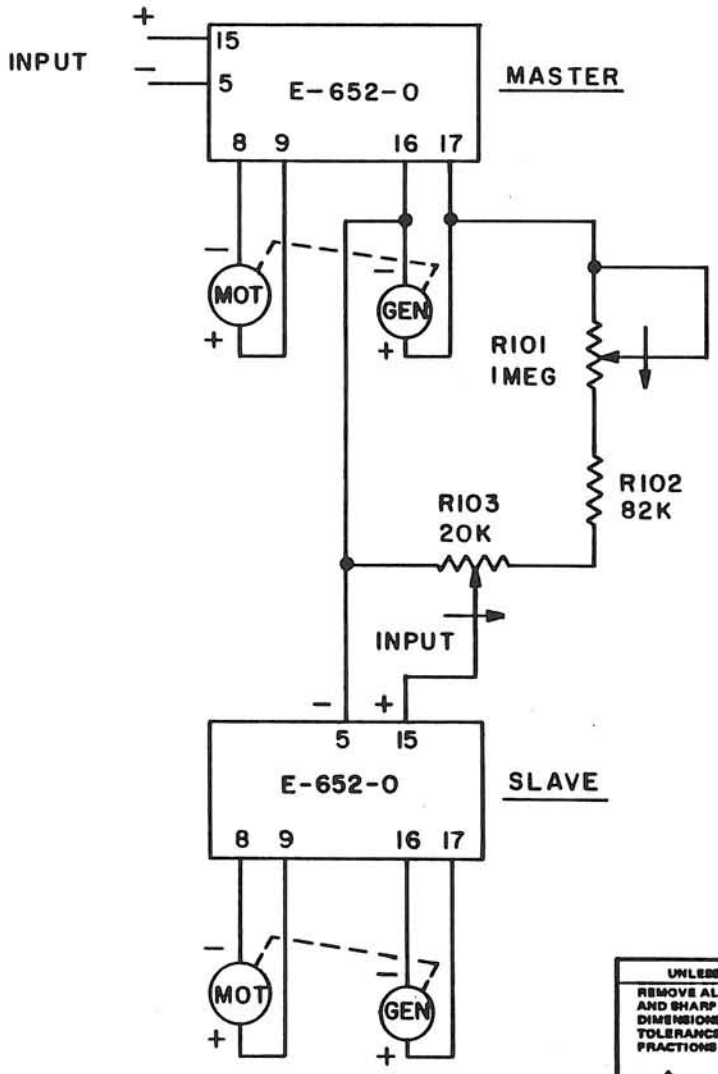
   J-1 is the mate to P-1 of the amplifier board.
   J-1 is an Amp Part No. 1-480270-0.
   Contact pin for housing is Part No. 61117-1 or 60619-1.
   Three pins are required for each housing.

   * 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.



DWG. NO. 9092-0015

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.

SYM	E.C.O.	BY	REVISION DESCRIPTION	DATE	APPROVAL
B	8332	HLN	REVISED PER ECO	4-4-79	
A	7454		RELEASED	3/9/78	

UNLESS OTHERWISE SPECIFIED	DRAWN BY	DATE
REMOVE ALL BURRS AND SHARP EDGES DIMENSIONS ARE IN INCHES TOLERANCE ON FRACTIONS ± DECIMALS .xx ± .010 .xxx ± .005 ANGLES ±	RCS	2/7/78
MATERIAL	CHECKED BY	3/9/78
HEAT TREATMENT	APPROVED BY	3/9/78
FINISH	NEXT ASSY.	
	USED ON	

DIAGRAM:
MASTER—SLAVE
OPERATION
E-652

ELECTRO-CRAFT

DWG. NO. 9092-0015

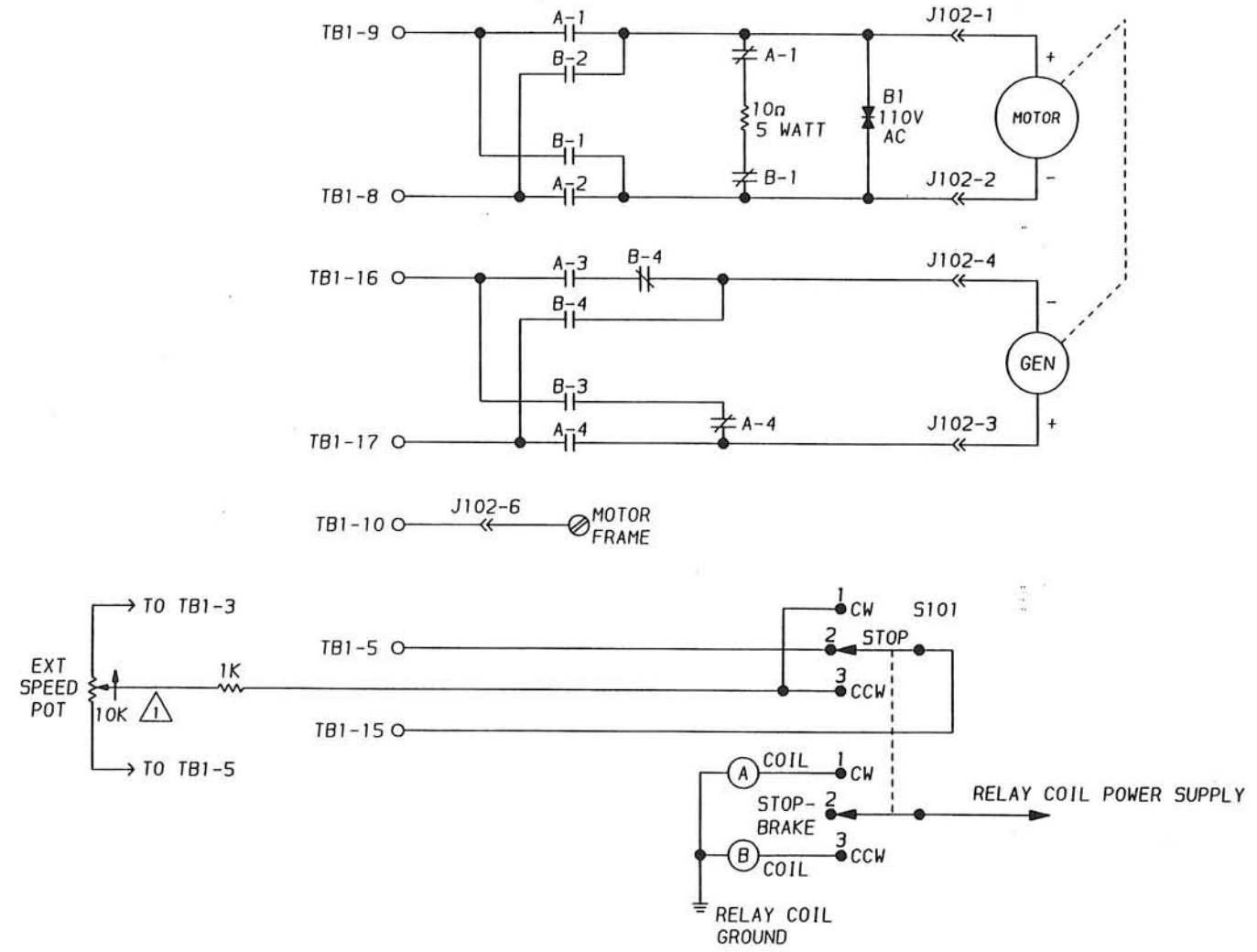
SCALE _____ PROJECT OR PRODUCT SHEET 1 OF 1

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:

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

REV	ECO	BY	REVISION DESC.	DATE	APPR
B	15918	PS	ADDED EXTERNAL POT	3-22-78	
A	7454	RCS	RELEASED	3-9-78	DSJ

UNLESS OTHERWISE SPECIFIED
DO NOT SCALE DRAWING
DIMENSIONS ARE IN INCHES
BREAK ALL EDGES .02 MAX
FILLETS AND RADII .02 R MAX
TOLERANCES ON:
FRACTIONS ±1/64"
DECIMALS: .XX ±.010
.XXX ±.005
ANGLES ±1°

MATERIAL: N/A
FINISH: N/A

DRAWN BY: RCS — DATE: 2-7-78
CHECKED BY: DSJ — 3-9-78
DESIGN ENGR: DSJ — 3-9-78
OPERATIONS ENGR:
NEXT ASSY: N/A
USED ON: N/A

DIAGRAM, MOTOR, REVERSING CIRCUIT, E-652-0

DRAWING NO. 9092-0016

SCALE N/A — DWG SIZE C — SHEET 1 OF 1

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.	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).	With speed pot at minimum: 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, ± 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.

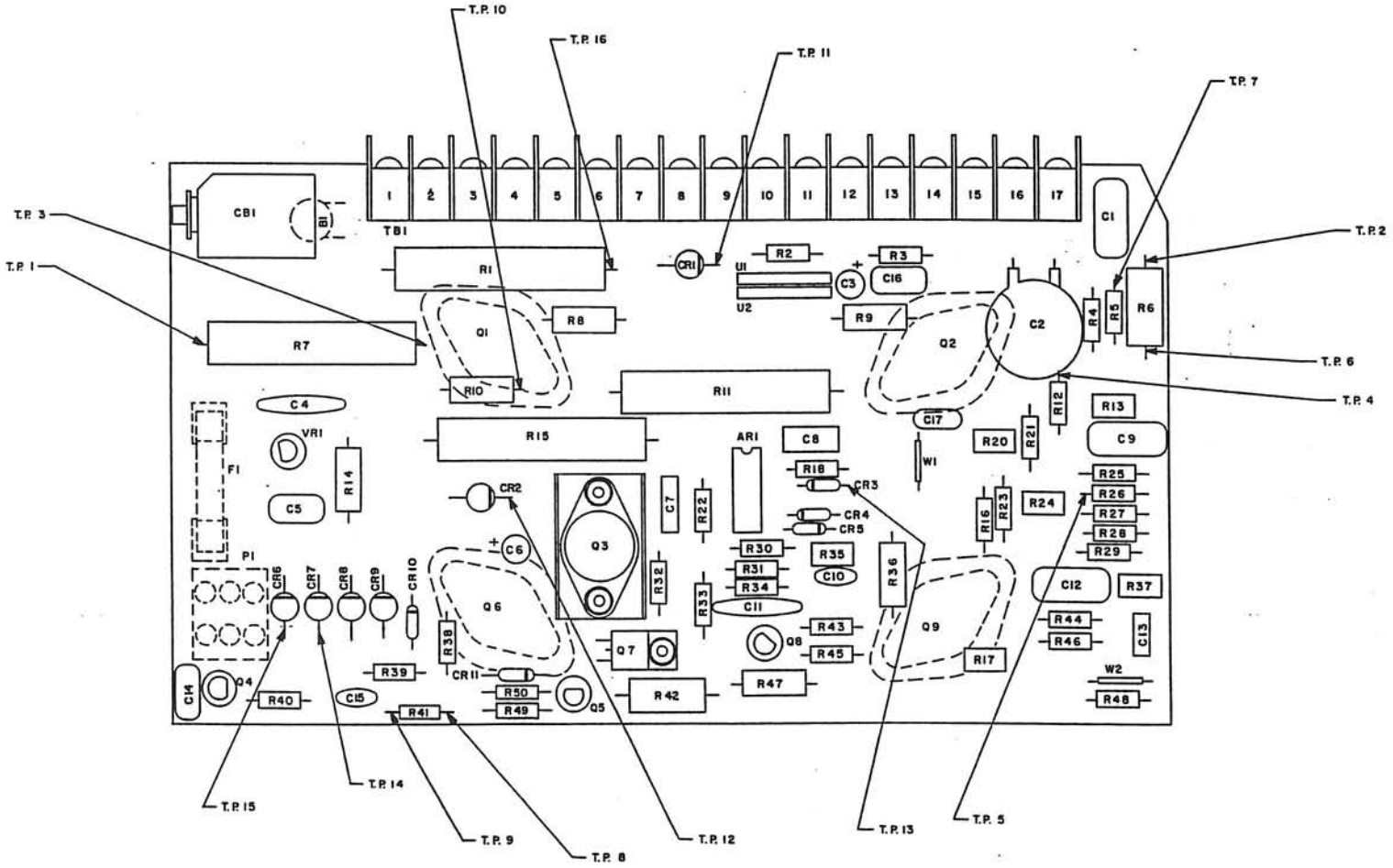
T.P. 12 – 0-1.0 VDC depending on motor torque.

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) Circuit Breakers (1.5 Amp) (230 VAC Operation)	0003-2033-017 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



D	10872	RTH	REVISED PER AW CHANGES	9-8-82	
C	8975	MLH	ADDED C17	3-11-80	
B	8818	MLH	ADDED CAP'S PER PCB CHANGE	8-30-78	
A	7457	LCS	RELEASED	2-21-78	
DWG	LCS	BY	REVISION DESCRIPTION	DATE	APPROVAL

DRAWN BY RCS 2/17/78
CHECKED BY MLH 2/15/78
ENGR.
DATE ENGR.
QA
NEXT ASSY.
USED ON

MATERIAL
HEAT TREATMENT
FINISH

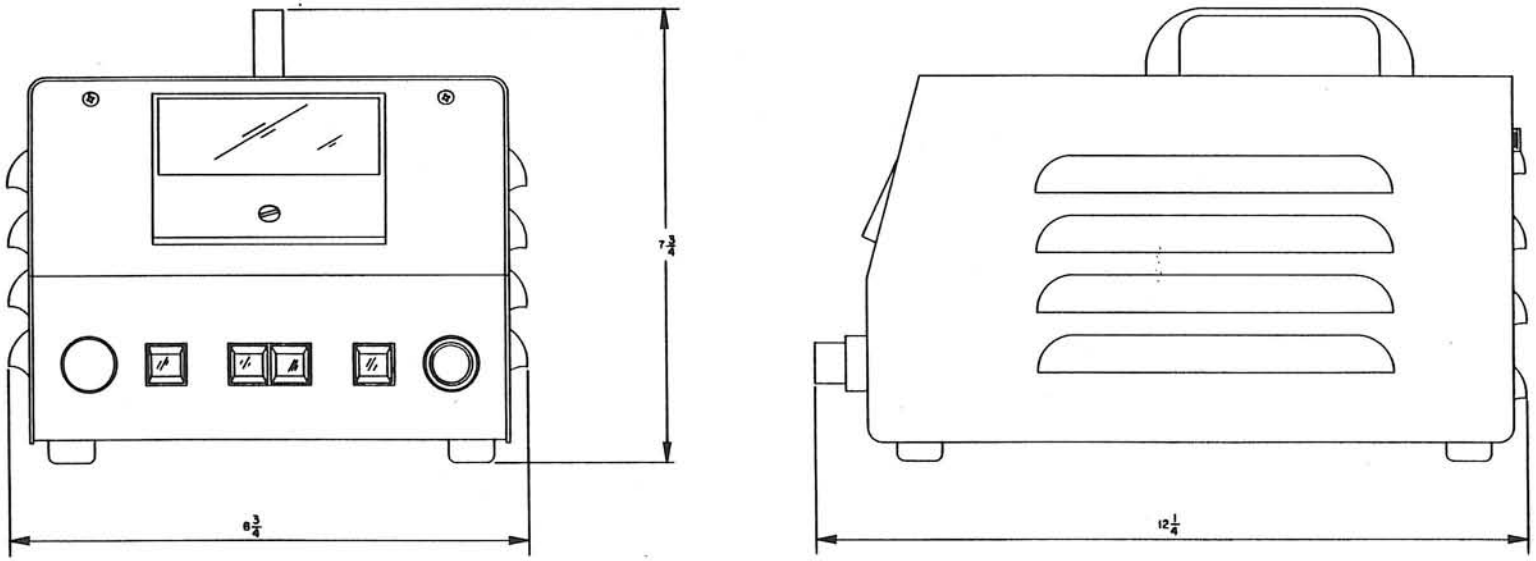
TEST POINT LOCATION E-652-MM

ELECTRO-CRAFT

9092-0017

SCALE 2 X

9092-0024



DRAWN BY HLN	DATE 3-5-79	A	7-5-7	HLN	RELEASED 3-8-79
CHECKED BY		SIM	REV	BY	REVISION DESCRIPTION DATE APPROVAL
ENGR					
MFR ENGR					
QA					
MFR ASST					
USED ON					
MATERIAL					
HEAT TREATMENT					
FINISH					

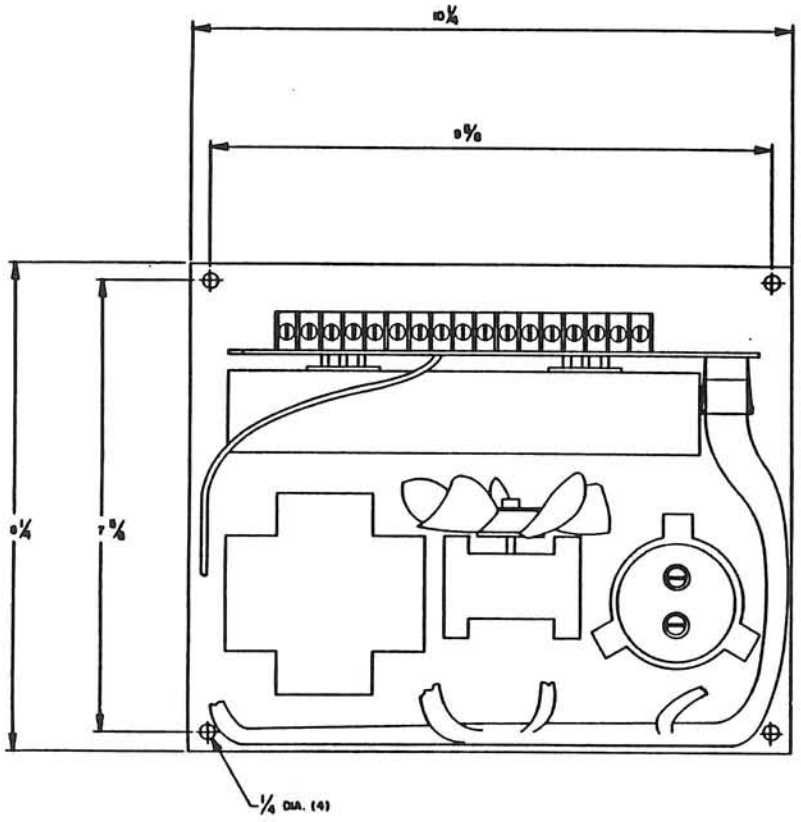
OUTLINE DRAWING
E-652-M

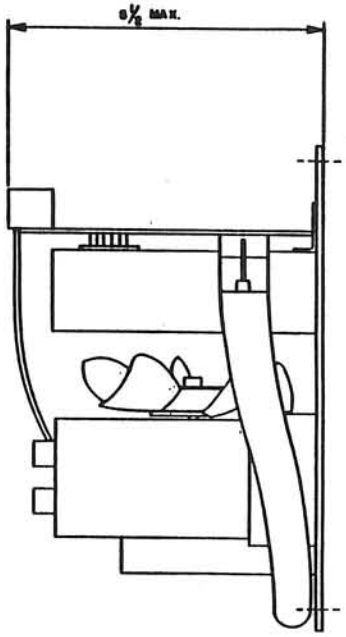
ELECTRO CRAFT

DWG NO 9092-0024

SCALE FULL

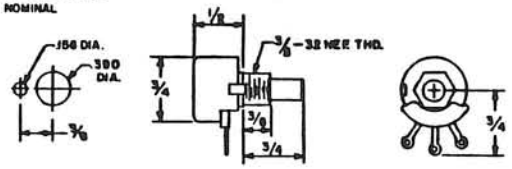
SHEET 1 OF 1



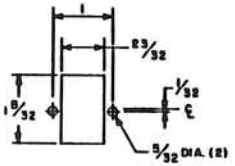


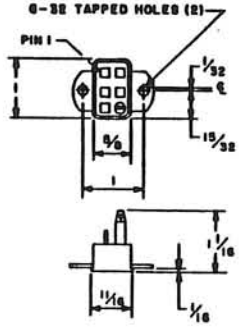
9092-0021

EXTERNAL POT
FOR NOMINAL



MOTOR CONNECTOR





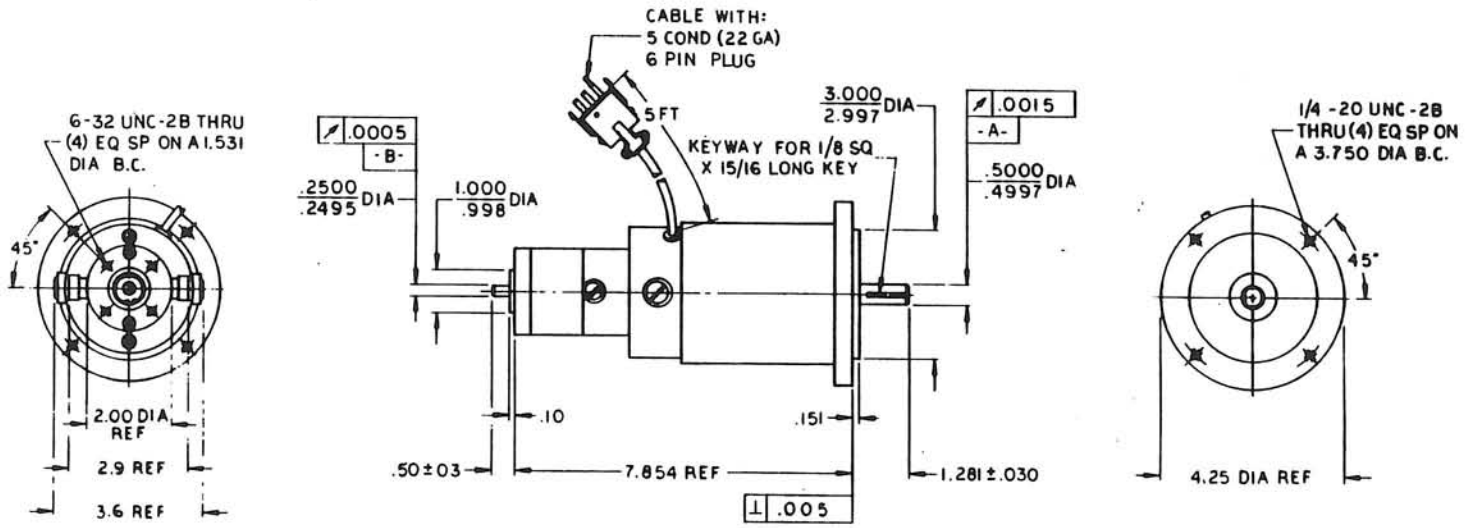
G	0610	GLR	ADDED REF TO POT	061-96
B	7694	CLS	ADD EXT POT & MOTOR CONN.	8/5/11
A	7494	GLR	RELEASED	8.28.96

INSTALLATION DRAWING
E-652-0

ELECTRO CRAFT

SIZE NONE

DWG NO 9092-0021



DWG. NO. 0652-00-004

DRAWN BY Hal	DATE 5-15-79	A			RELEASED		
CHECKED BY		BTH	ECO	BY	REVISION DESCRIPTION	DATE	APPROVAL
ENGR							
MFR ENGR							
QA							
NEXT ASSY.							
USED ON							

UNLESS OTHERWISE SPECIFIED
REMOVE ALL BURRS AND SHARP EDGES
DIMENSIONS ARE IN INCHES
TOLERANCES ON FRACTIONS ±
DECIMALS .xx ± .010 .xxx ± .005
ANGLES ±
MATERIAL
HEAT TREATMENT
FINISH

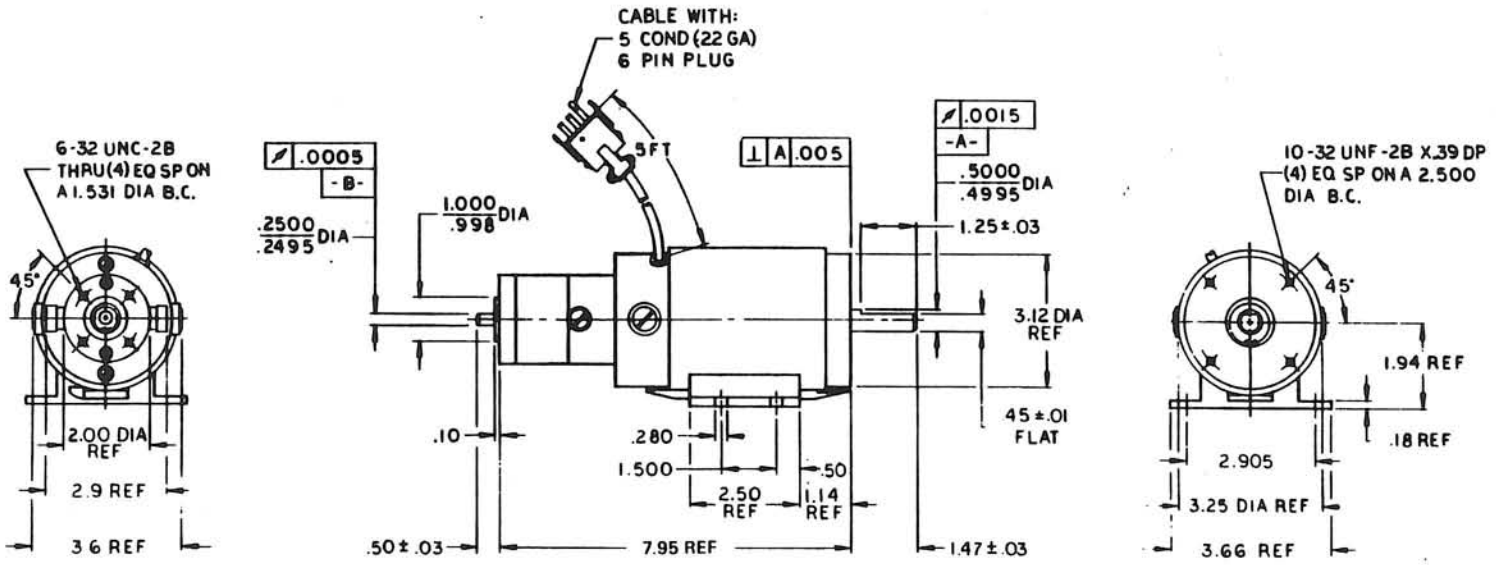
OUTLINE

ELECTRO-CRAFT

DWG. NO. 0652-00-004

SCALE 1:2

SHEET 1 OF 1



DWG. NO. 0652-00-006

DRAWN BY HAL	DATE 3-12-79	A			RELEASED		
CHECKED BY		SYM	ECO	BY	REVISION DESCRIPTION	DATE	APPROVAL
ENGR							
MFR ENGR							
QA							
NEXT ASSY							
USED ON							

UNLESS OTHERWISE SPECIFIED
REMOVE ALL BURRS AND SHARP EDGES
DIMENSIONS ARE IN INCHES
TOLERANCE ON FRACTIONS ± | DECIMALS .xx ± .030 .xxx ± .005 | ANGLES ±
MATERIAL
HEAT TREATMENT
FINISH

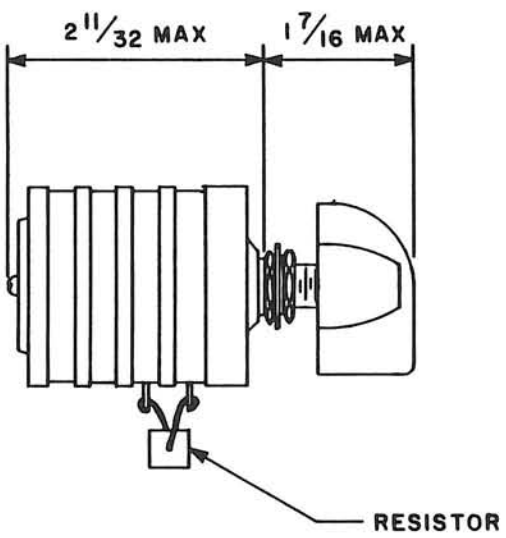
OUTLINE

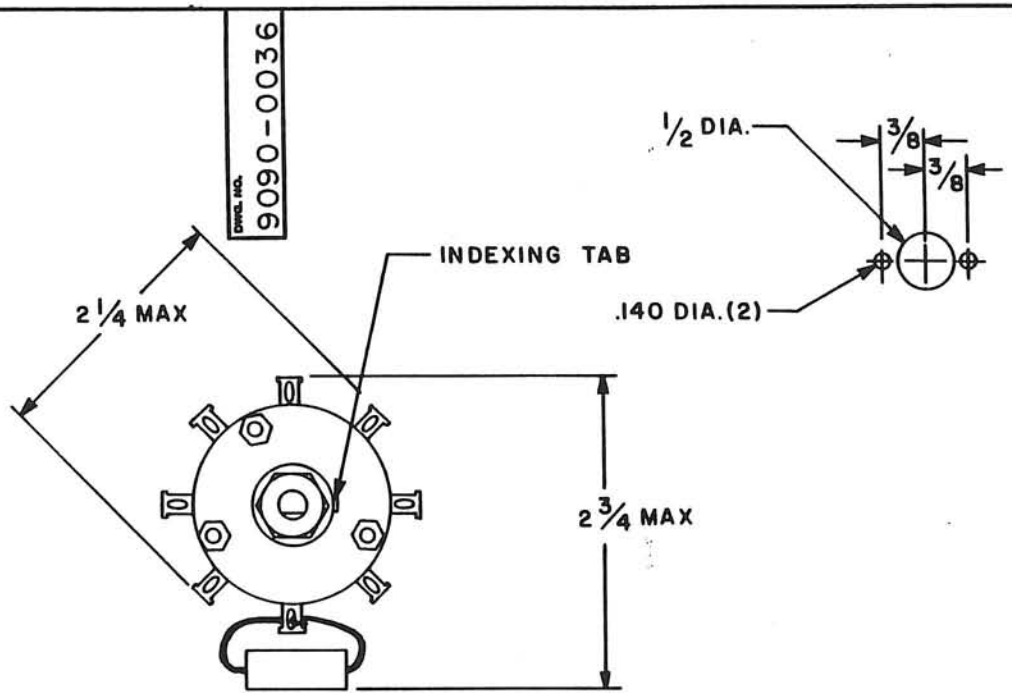
ELECTRO-CRAFT CORP.

DWG NO 0652-00-005

SCALE 1:2

SHEET 1 OF 1





PART NO. 0041-5023

SYM	E.C.O.	BY	REVISION DESCRIPTION	DATE	APPROVAL
A	7694	RCS	RELEASED	8/9/78	

UNLESS OTHERWISE SPECIFIED: REMOVE ALL BURRS AND SHARP EDGES; DIMENSIONS ARE IN INCHES; TOLERANCE ON FRACTIONS ± 1/64, DECIMALS .xx ± .010, .xxx ± .005, ANGLES ±	DRAWN BY RCS	DATE 8/4/78
	CHECKED BY	
	APPROVED BY	
MATERIAL	NEXT ASSY.	
HEAT TREATMENT	USED ON	
FINISH		

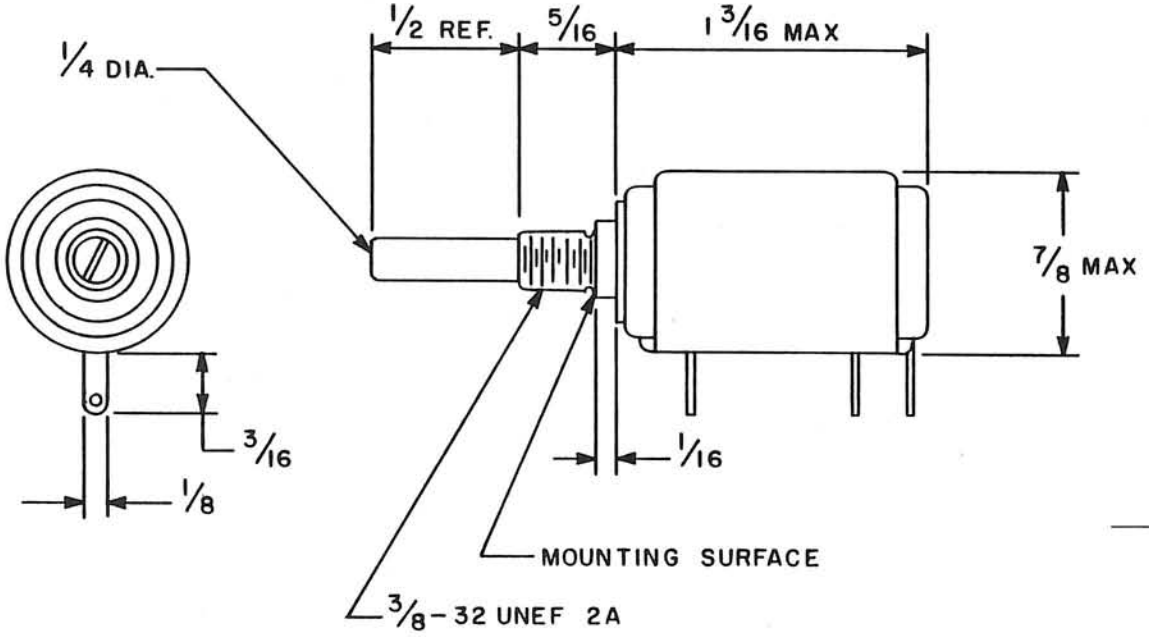
OUTLINE DWG.
REVERSING
SWITCH

ELECTRO-CRAFT

DWG. NO. 9090-0036

SCALE —— PROJECT OR PRODUCT E-662 SHEET 1 OF 1

DWG. NO. 9090-0026



RECOMMENED PANEL CUT-OUT

PART NO. 8215-0007-2

SYM	E.C.O.	BY	REVISION DESCRIPTION	DATE	APPROVAL
PA			RELEASED		

UNLESS OTHERWISE SPECIFIED	DRAWN BY RCS	DATE 4/6/78
REMOVE ALL BURRS AND SHARP EDGES DIMENSIONS ARE IN INCHES TOLERANCE ON FRACTIONS DECIMALS ANGLES ± .xx ± .010 ± .xxx ± .005 ±	CHECKED BY	
	APPROVED BY	
MATERIAL	NEXT ASSY.	
HEAT TREATMENT	USED ON	
FINISH		

OUTLINE DWG.

10 TURN POT.

ELECTRO-CRAFT

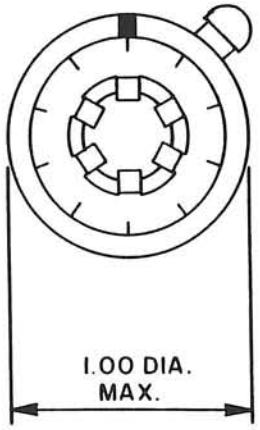
DWG. NO. 9090-0026

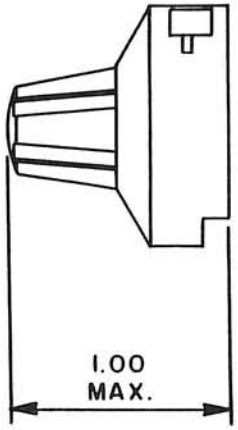
SCALE —

PROJECT OR PRODUCT

SHEET 1 OF 1

DWG. NO. 9090-0025





PART NO. 0011-6005-2

SYM	E.C.O.	BY	REVISION DESCRIPTION	DATE	APPROVAL
PA			RELEASED		

UNLESS OTHERWISE SPECIFIED REMOVE ALL BURRS AND SHARP EDGES DIMENSIONS ARE IN INCHES TOLERANCE ON FRACTIONS ± DECIMALS .xx ± .010 .xxx ± .005 ANGLES ± MATERIAL HEAT TREATMENT FINISH	DRAWN BY RCS CHECKED BY APPROVED BY NEXT ASSY. USED ON	DATE 4/6/78 5-1-78

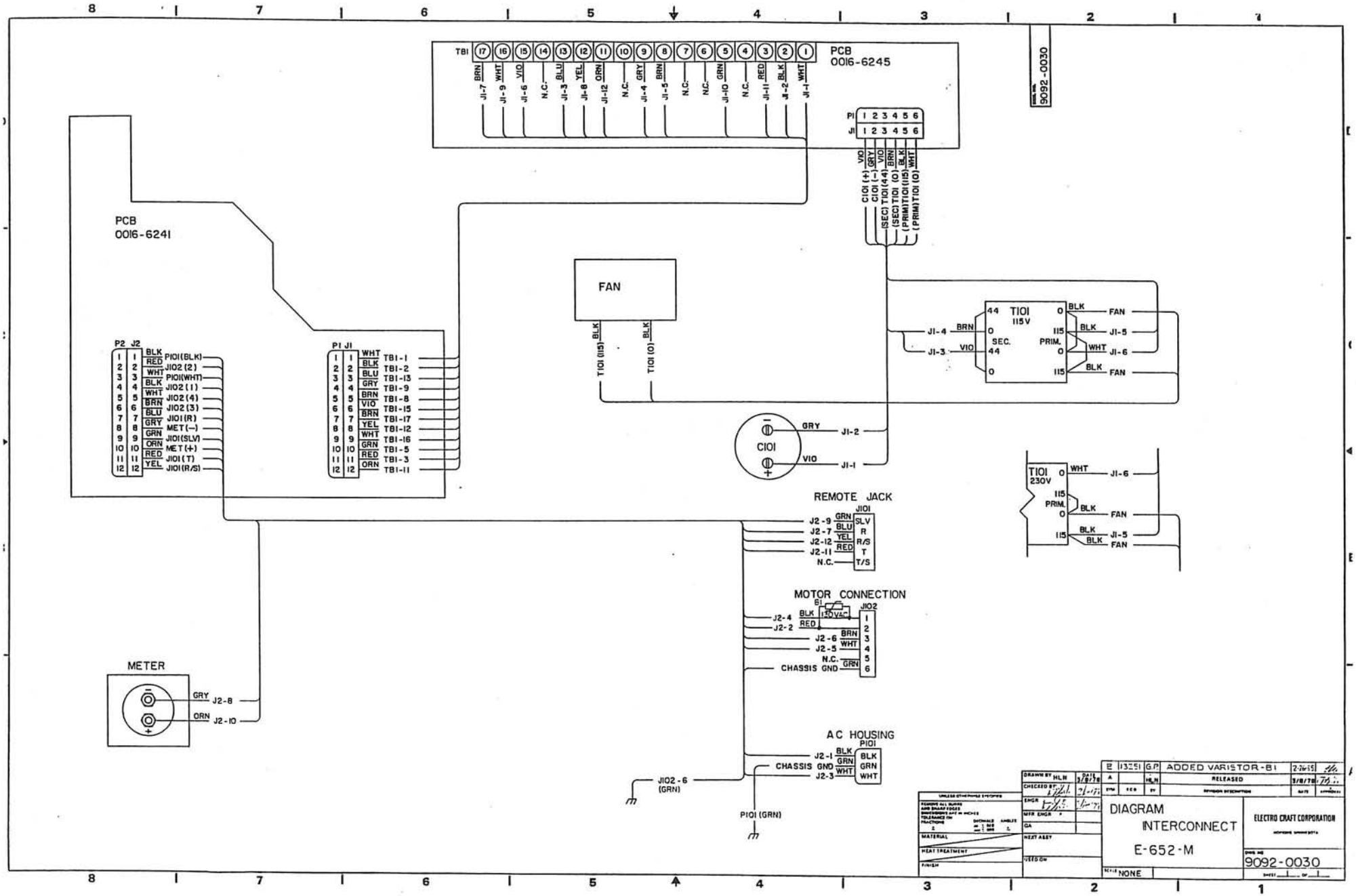
OUTLINE DWG.
10 TURN DIAL
KNOB

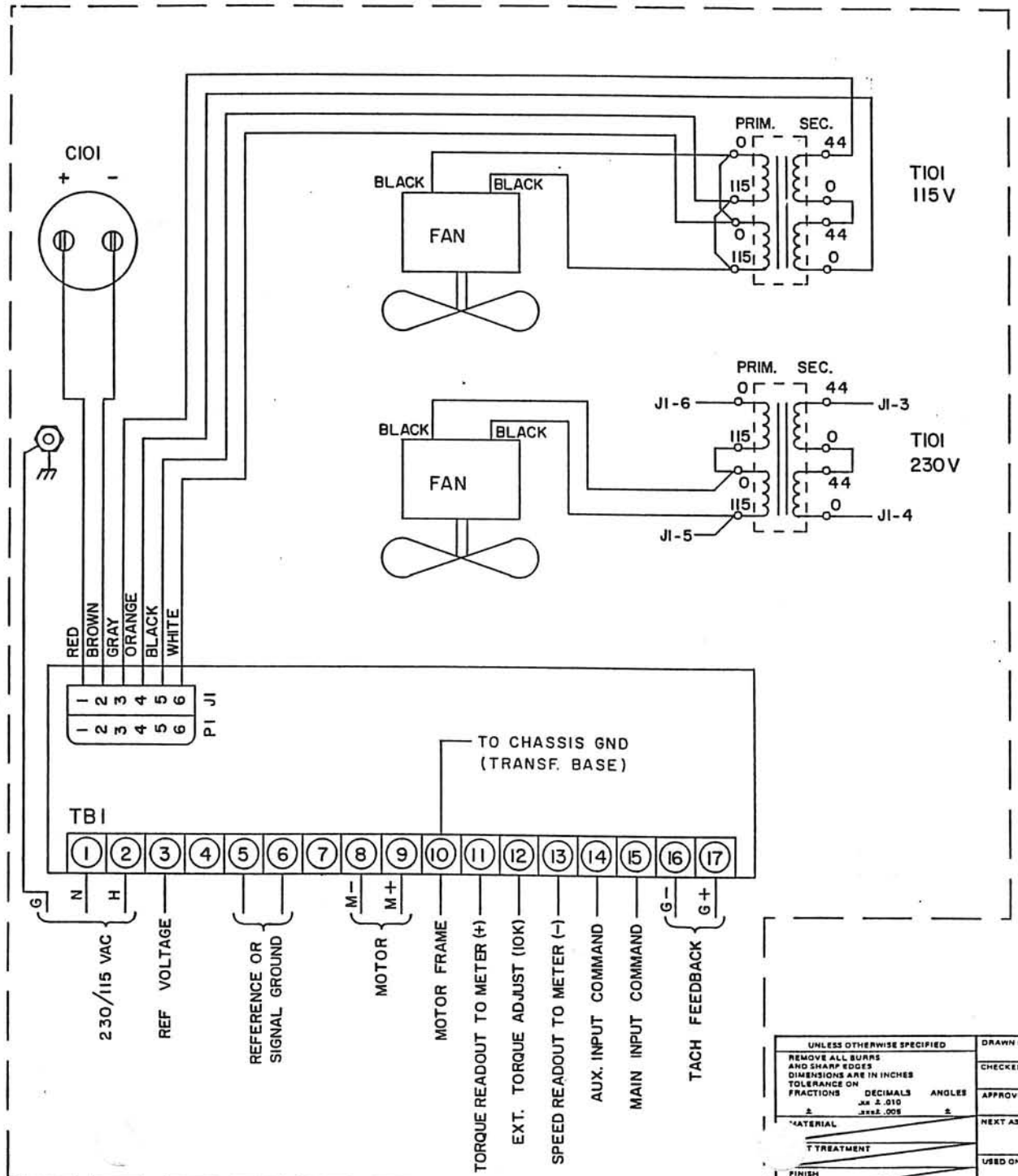
ELECTRO-CRAFT

DWG. NO. 9090-0025

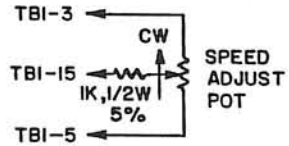
SCALE ____ PROJECT OR PRODUCT

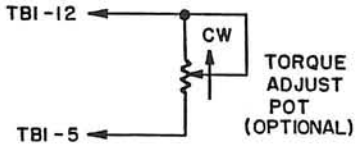
SHEET 1 OF 1


TB1
PCB
0016-6245
9092-0030
P1
J1
PCB
0016-6241
P2 J2
P1 J1
FAN
T101 (115)
T101 (0)
C101
T101
115V
SEC.
PRIM.
T101
230V
REMOTE JACK
J101
MOTOR CONNECTION
B1
120 VAC
J102
AC HOUSING
P101
METER
J102-6
(GRN)
P101 (GRN)
DIAGRAM
INTERCONNECT
E-652-M
ADDED VARISTOR-B1
RELEASED
ELECTRO CRAFT CORPORATION
NONE



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

TB1-9	1	+ MOTOR
TB1-8	2	- MOTOR
TB1-17	3	+ GEN
TB1-16	4	- GEN
TB1-10	6	HOUSING GROUND

DWG. NO. 9092-0020

SYM	E.C.O.	BY	REVISION DESCRIPTION	DATE	APPROVAL
D	9451	HLN	ADDED NOTE	11-26-80	
C	9257	HLN	ADDED 1K, 1/2W, 5% RESISTOR	7-16-80	
B	8300	HLN	REVISED PER ECO	3-21-79	
A	7454	HLN	RELEASED	2-23-78	

UNLESS OTHERWISE SPECIFIED
REMOVE ALL BURRS AND SHARP EDGES
DIMENSIONS ARE IN INCHES
TOLERANCE ON FRACTIONS ± DECIMALS .xx ± .010 .xxx ± .005 ANGLES ±
MATERIAL
T TREATMENT
FINISH

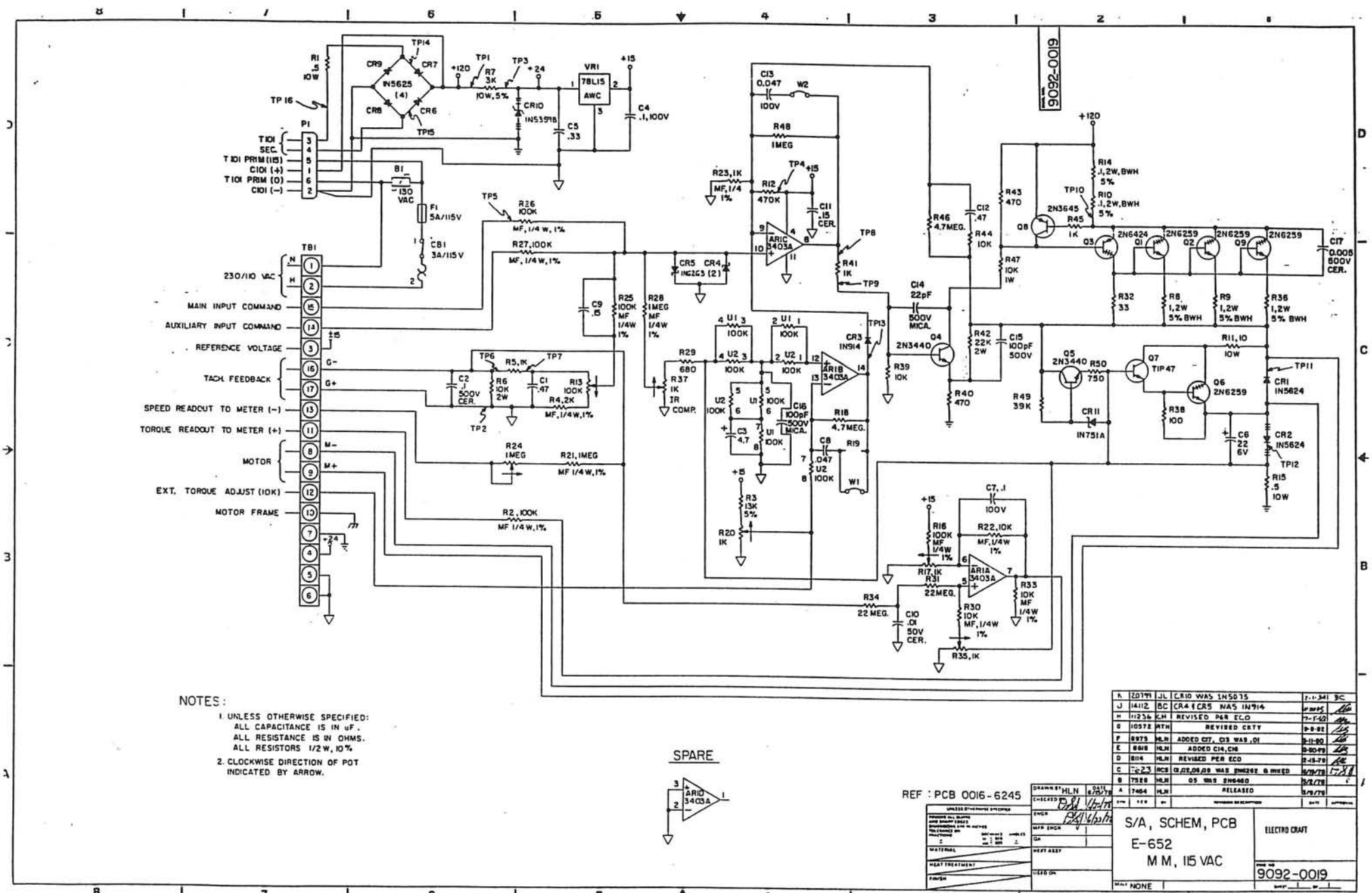
DRAWN BY HLN DATE 2-23-78
CHECKED BY
APPROVED BY
NEXT ASSY.
USED ON

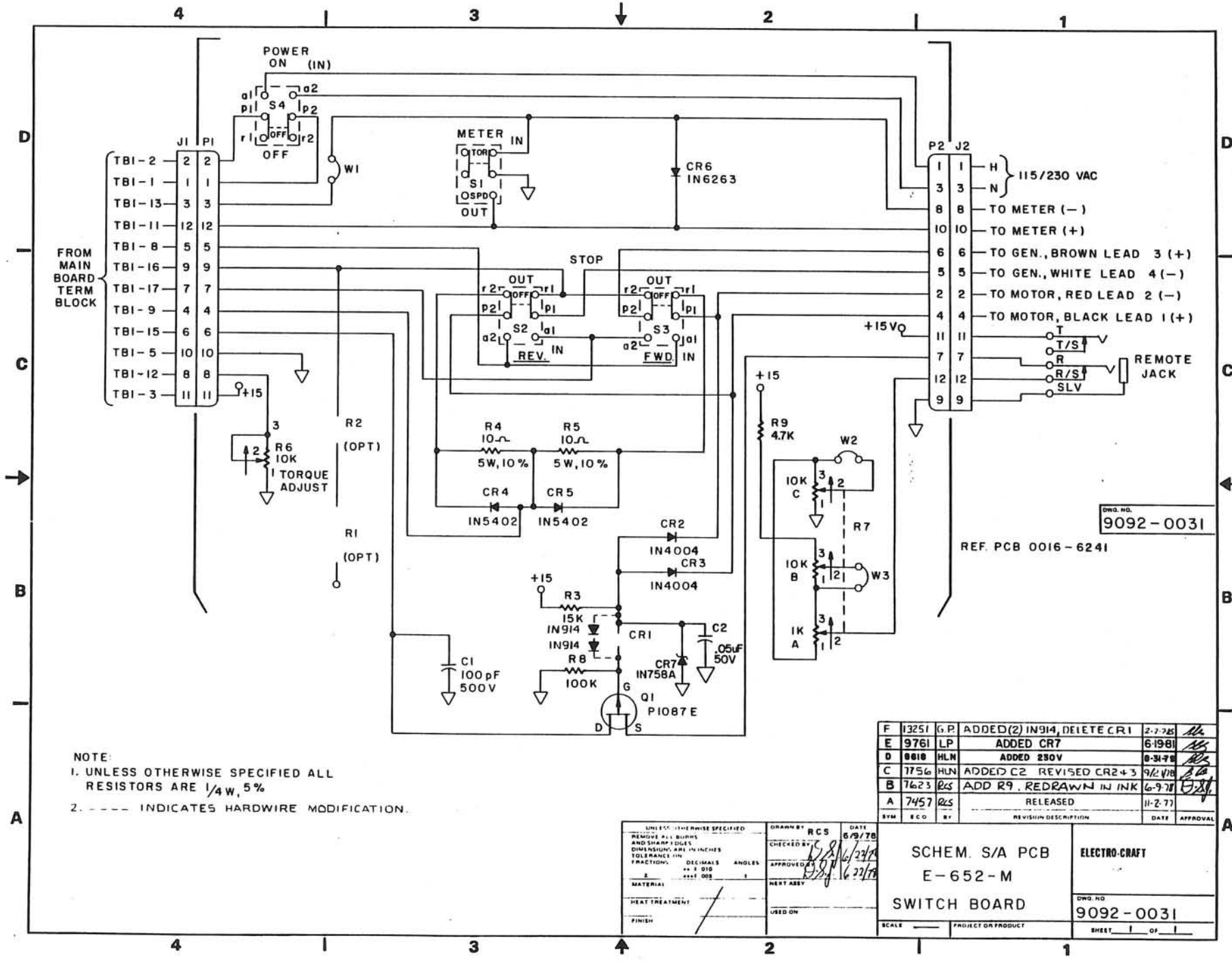
DIAGRAM, INTERCONNECT
E-652-0

ELECTRO-CRAFT

DWG. 9092-0020

SCALE NONE PROJECT OR PRODUCT SHEET 1 OF 1


9092-0019
TB1
230/110 VAC
MAIN INPUT COMMAND
AUXILIARY INPUT COMMAND
REFERENCE VOLTAGE
TACH. FEEDBACK
SPEED READOUT TO METER (-)
TORQUE READOUT TO METER (+)
MOTOR
EXT. TORQUE ADJUST (10K)
MOTOR FRAME
T101 SEC.
T101 PRIM (115)
C101 (+)
T101 PRIM (0)
C101 (-)
130 VAC
F1 5A/115V
CB1 3A/115V
IN5625 (4)
IN5391B
78L15 AWC
ARIC 3403A
ARIA 3403A
ARIB 3403A
IN2623 (2)
IN914
IN751A
IN5624
2N3440
2N3645
2N6424
2N6259
TIP47
SPARE
NOTES:
1. UNLESS OTHERWISE SPECIFIED:
ALL CAPACITANCE IS IN uF.
ALL RESISTANCE IS IN OHMS.
ALL RESISTORS 1/2 W, 10%
2. CLOCKWISE DIRECTION OF POT INDICATED BY ARROW.
REF : PCB 0016-6245
S/A, SCHEM, PCB
E-652
M M, 115 VAC
ELECTRO CRAFT
9092-0019
NONE



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

SYM	ECO	BY	REVISION DESCRIPTION	DATE	APPROVAL
F	13251	G.P.	ADDED (2) IN914, DELETE CR1	2-2-78	
E	9761	LP	ADDED CR7	6-1981	
D	8818	HLN	ADDED 230V	8-31-78	
C	7756	HLN	ADDED C2 REVISED CR2+3	9/12/78	
B	7623	RCS	ADD R9. REDRAWN IN INK	6-9-78	
A	7457	RCS	RELEASED	11-2-77	

UNLESS OTHERWISE SPECIFIED: REMOVE ALL BURRS AND SHARP EDGES. DIMENSIONS ARE IN INCHES. TOLERANCE IN FRACTION: DECIMALS ANGLES. MATERIAL. HEAT TREATMENT. FINISH.

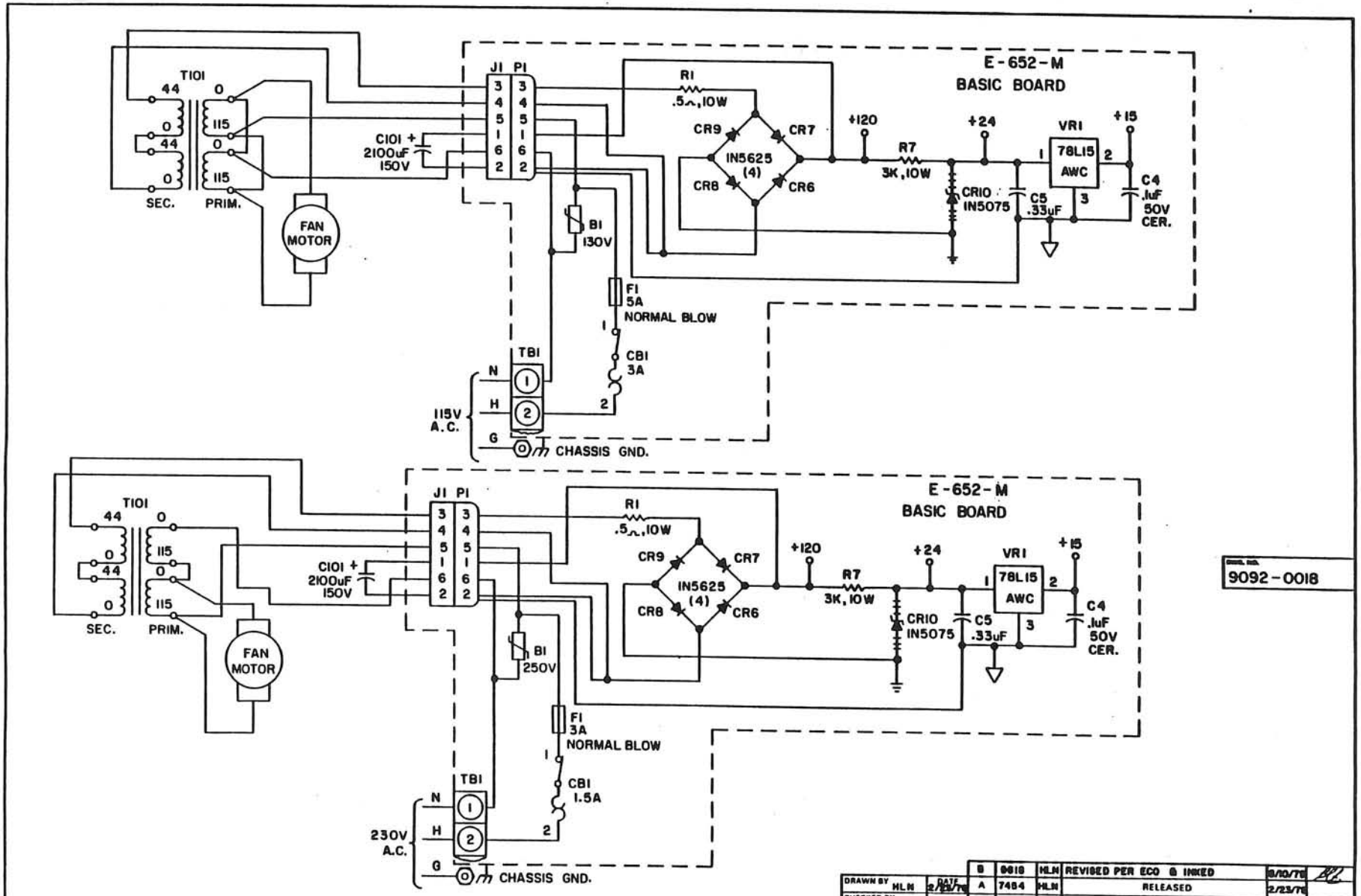
DRAWN BY RCS 6/9/78
CHECKED BY
APPROVED 6/22/78
NEXT ASSY
USED ON

SCHEM. S/A PCB
E-652-M
SWITCH BOARD

ELECTRO-CRAFT

DWG. NO. 9092-0031

SCALE — PROJECT OR PRODUCT SHEET 1 OF 1



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.

B	9818	HLN	REVISED PER ECO 6 INKED	3/10/78
A	7484	HLN	RELEASED	2/23/78
SYM	ECO	BY	REVISION DESCRIPTION	DATE

DRAWN BY	HLN	2/23/78
CHECKED BY	RCB	2/23/78
ENGR	DBJ	3/8/78
MFR ENGR		
QA		
NEXT ASSY.		
USED ON		

UNLESS OTHERWISE SPECIFIED
REMOVE ALL BURRS AND SHARP EDGES
DIMENSIONS ARE IN INCHES
TOLERANCE ON FRACTIONS ±
DECIMALS .xx ± .030 .xxx ± .005
ANGLES ±
MATERIAL
HEAT TREATMENT
FINISH

SCHEMATIC, POWER SUPPLY, E-652-0

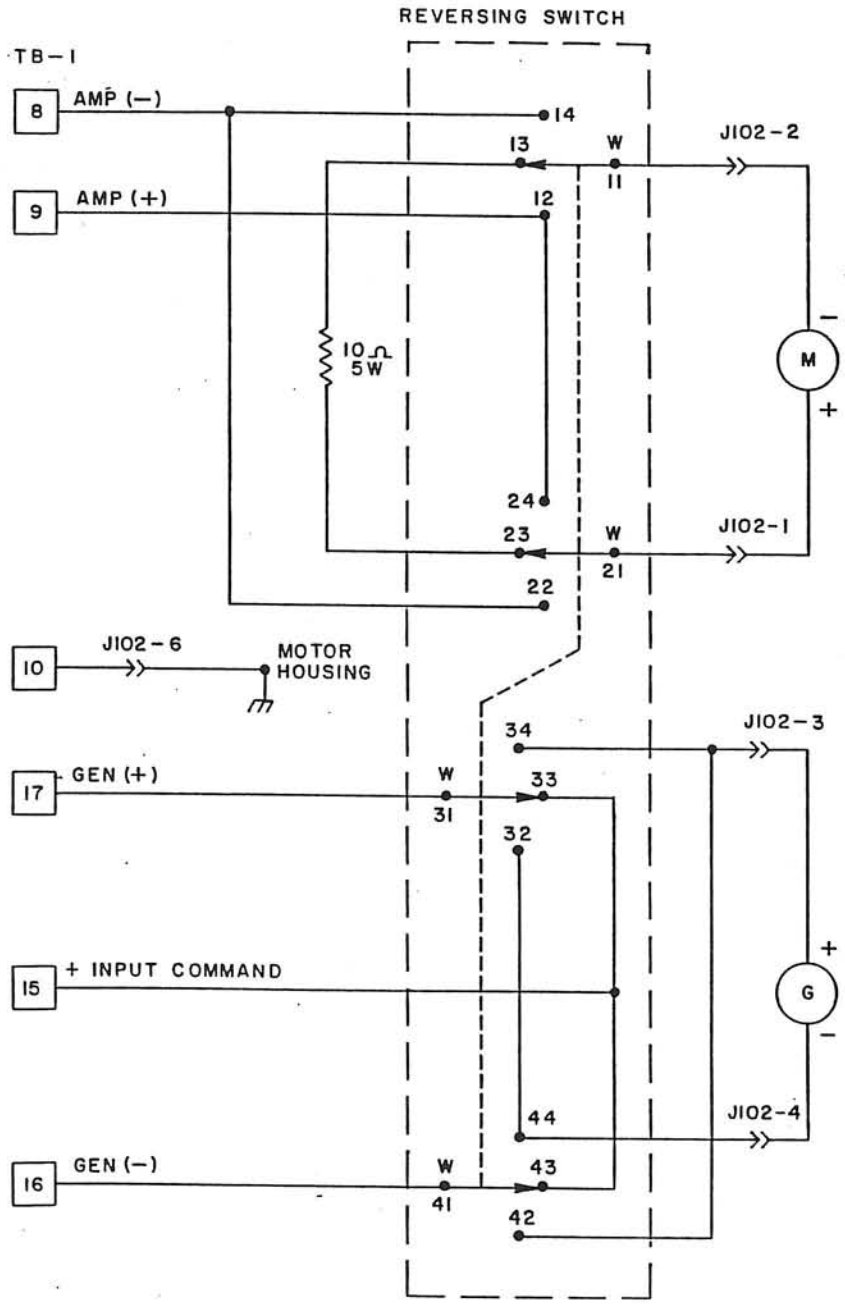
SCALE NONE

ELECTRO-CRAFT

DWG NO 9092-0018

SHEET .. OF ..

DWG. NO. 9092-0018



DWG. NO. 9092-0033

SYM	E.C.O.	BY	REVISION DESCRIPTION	DATE	APPROVAL
B	13251	G.P.	CHG'D. TITLE-ADDED OPTION	2-27-15	
A	7694	RCS	RELEASED	8/7/78	17 84

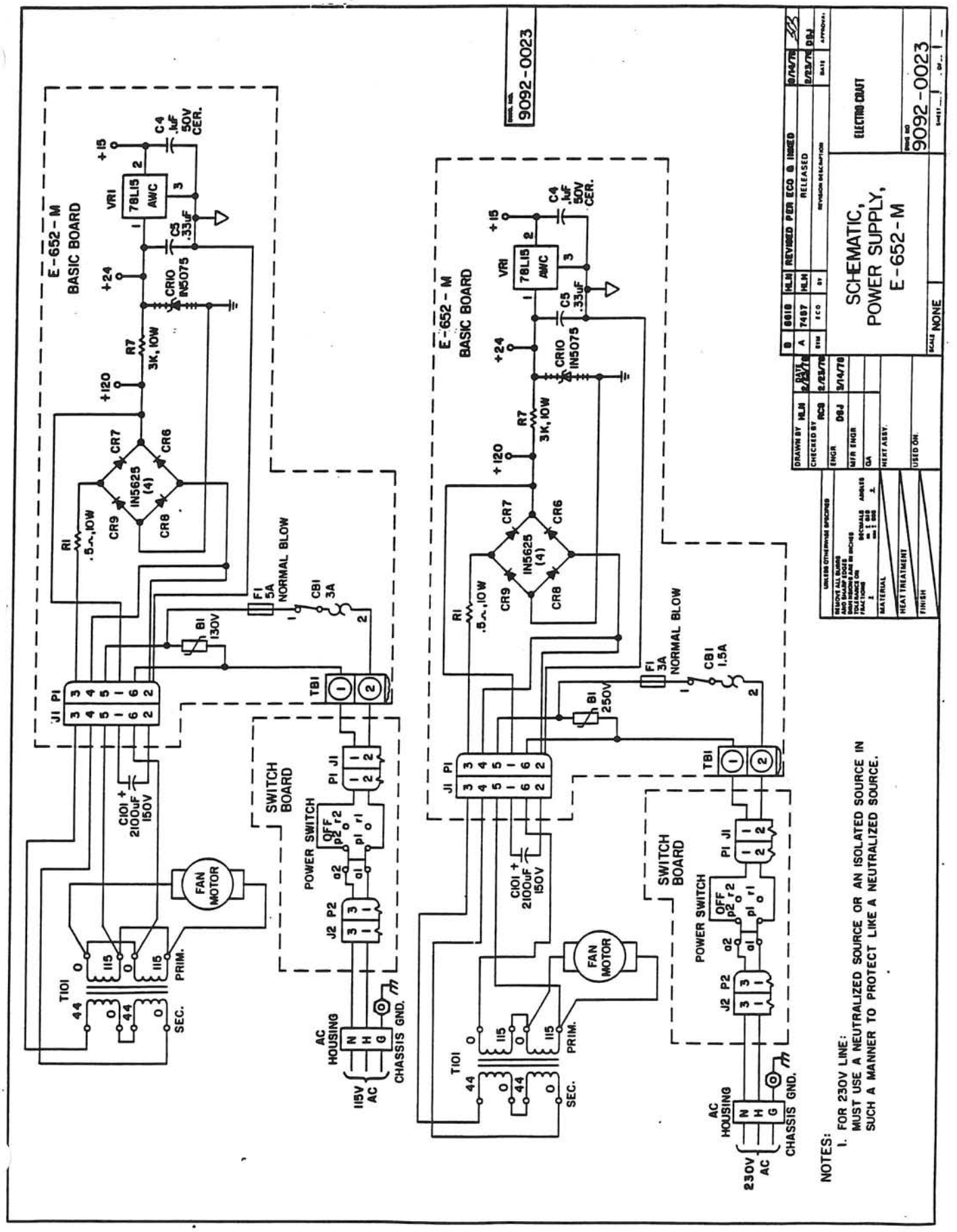
UNLESS OTHERWISE SPECIFIED
REMOVE ALL BURRS AND SHARP EDGES
DIMENSIONS ARE IN INCHES
TOLERANCE ON FRACTIONS DECIMALS ANGLES
± .xx = ± .010
± .xxx = .005 ±
MATERIAL
HEAT TREATMENT
FINISH

DRAWN BY RCS 8/2/78
CHECKED 8/15/78
APPROVED 8/15/78
NEXT ASSY.
USED ON

SCHEM.,
REVERSING SWITCH
OPTION, E-652-0

ELECTRO-CRAFT

DWG. NO. 9092-0033



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