1VAL255101-MB Rev E (replaces IB 38-929M-15A)

R-MAG Medium Voltage Outdoor Dead Tank Vacuum Magnetic Circuit Breaker

Instruction Manual
15.5 kV 1250/2000/3000/3700 A
27 kV 1250/2000 A

Table Of Contents

List Of Illustrations

Figure 1. Hazardous Voltage Nameplate

1.0 SAFETY NOTICES

Install the R-MAG circuit breaker within the design limitations as described on its nameplate and in these instructions.

Follow your company's safety procedures.

This breaker should not be used by itself as the sole means of isolating a high voltage circuit. For the safety of personnel performing maintenance operations on the breaker or connecting equipment, all components should be electrically disconnected by means of a visible break and should be securely grounded.

This product is intended to be operated and maintained by qualified persons, thoroughly trained and knowledgeable of the hazards involved. This publication is written only for such qualified persons and is not intended to be a substitute for adequate training and experience in the safety procedures for this device.

WARNING
Detailed descriptions of standard repair procedures, safety principles and service operations are not included. It is important to note this document contains some warnings and cautions against some specific service methods that could cause personal injury to service personnel, damage equipment, or render it unsafe. These warnings do not cover all conceivable ways in which service, whether or not recommended by ABB, might be performed or the possible hazardous consequences of each conceivable way, nor could ABB investigate all such ways. Anyone using service procedures or tools, whether or not recommended by ABB, must satisfy himself thoroughly that neither personal safety nor equipment safety will be jeopardized by the service method or tools selected.

All information contained in this manual is based on the latest product information available at the time of printing. The right is reserved to make changes at any time without notice.

2.0 INTRODUCTION

These instructions do not attempt to provide the user of this equipment with every possible difficulty that may occur in the application, operation and maintenance of the product. Also, as improvement in parts and assemblies are made, some parts may differ in appearance as depicted in the illustrations; however, functionality will be equivalent.

The Type R-MAG vacuum breaker is a high-voltage, three-phase device incorporating three vacuum interrupters, gang operated by a magnetic actuator. Together with the optional relaying and current transformers, the breaker will sense an overload and automatically open.

Satisfactory performance of the breaker is contingent upon the correct installation, and adequate maintenance and service of the product. Careful study of these instructions will permit the user to obtain maximum benefit from this device.

3.0 RECEIVING, HANDLING AND STORAGE

Each breaker is assembled and tested at the factory prior to shipment.

This equipment was packed and shipped in factory new condition. If damage is noted, call the carrier at once for inspection and request an inspection report. File a formal claim with the carrier, supported with paid freight bill, inspection report and invoice. The local ABB Sales Office must be notified. This must be done within 10 days of receipt or receiver assumes all responsibility for damage.

3.1 Receiving Inspection

Upon receipt, it is important to inspect promptly to be certain that the correct material has been received. In case of shortage, immediately notify the local ABB Sales Office.

Check all parts against the shipping list as they are unpacked. Instructions and literature packed with the breaker should be kept with the unit. The cabinet provides a convenient place to keep this instruction book, a copy of the schematic diagram and the card with the service record of the unit. Additional copies may be obtained upon request from the local ABB Sales Office.

If the breaker is not to be placed in service immediately, it is essential that proper care be exercised in the handling and storage to ensure good operating conditions in the future. (See 3.3 Storage)

3.2 Handling

The R-MAG solid dielectric breaker comes with two brackets that attach to the sides of the cabinet and provide provisions for lifting the breaker. A two-point lift is recommended using the loops in these brackets. (See Figure 2 Lifting Detail)

Caution - Exercise care during lifting to avoid damage to the bushings. Breaker has high center of gravity.

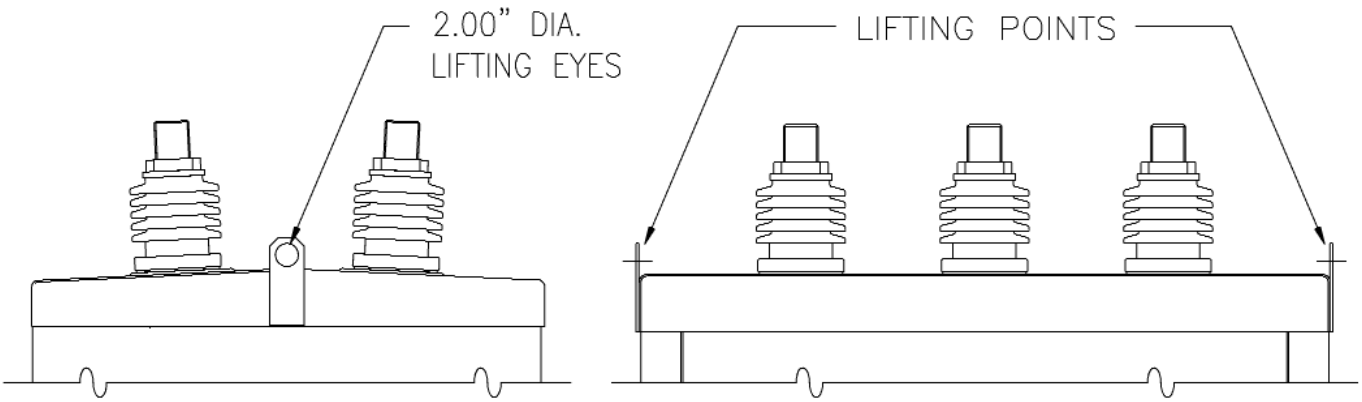


Figure 2. Lifting Detail

3.3 Storage

For prolonged storage, indoor storage is recommended. If stored outdoors, the cabinet heaters must be energized to maintain the warranty. The mechanism and control compartment is equipped with heaters to reduce condensation.

4.0 GENERAL DESCRIPTION

4.1 High-Voltage Assembly

The high-voltage section of the R-MAG consists of three individual phase assemblies mounted on insulating standoffs. Each phase of the R-MAG consists of a single vacuum interrupter, flexible shunt and operating rod.

4.2 Housing

The doors of the breaker housing are removable and retained by hinge pins. The position indicator is visible through the front door. The breaker nameplate showing rating information, serial number and shop order number is mounted on the right-hand side of the housing.

4.3 Phase Assembly

Figure 3 shows the details of the phase assembly. The back bus work is attached directly to the fixed contact stud on the back end of the vacuum interrupter. The current transfer assembly housing is fastened to the opposite end of the vacuum interrupter. In the current transfer assembly, a contact block/flexible shunt transfers current from the moving contact of the vacuum interrupter directly through the bus to the bushing.

4.4 Magnetic Actuator

The magnetic actuator incorporates a very powerful permanent magnet assembly. When the armature is in contact with the upper plate, the magnet produces a holding force in excess of 1500 lbs. Two stainless steel guide rods are attached to the armature. The upper guide rod attaches to the lower end of the main operating rod, which connects directly to the moving contacts of the vacuum interrupters. The lower guide rod mounts to the manual trip assembly.

Disassembly of the magnetic actuator is not necessary, nor recommended. Lubrication or maintenance is not required. Should an actuator fail to operate, contact ABB for service. The permanent magnet inside the actuator is extremely powerful, with the potential to trap fingers.

4.5 Standard Control (ED2.0)

The standard control package of the R-MAG is the ED2.0. The ED2.0 consists of a power supply, position indication and capacitor charging/discharging system. Refer to Appendix A for an overview of the ED2.0.

5.0 STANDARD PRODUCTION TESTS

Standard production tests include:

1. Verification of all wiring per connection diagrams.
2. Electrical Operation: Close and trip. Overcurrent response and automatic closing, with relaying control option.
3. Check functioning of all manual controls: Local/remote, non-reclosing, ground fault bypass, etc.
4. Three readings are made on each phase of the breaker using a Biddle “Ductor.” Typical values do not exceed 150 micro ohms.
5. Voltage Withstand: The complete breaker is tested between live parts and tank, across open contacts and between phases. In compliance with ANSI C37.09 and IEC, an AC dielectric withstand test at 50 kV (15 kV), 60 kV (27 kV) is performed. Test duration is one minute.
6. Wiring Insulation: The terminal block connections are given an over-potential test of 1800 volts AC to ground (for 1 sec).

6.0 OPERATION

6.1 Closing

In the open position, the magnetic actuator’s armature rests against the bottom plate in the actuator assembly. The armature is held there by the force developed by the magnet. When the top coil is energized, the magnetic flux generated is in the same direction as the magnet assembly. The armature is drawn into the coil and brought into contact with the upper plate. In this position, the coil is de-energized and the armature is held in position by the magnet alone. As the armature is drawn into the coil, the operating rod, which is attached to the top guide rod, moves the moving contact of the vacuum interrupter towards the closed position. The actuator has more stroke than the vacuum interrupter and the interrupter contacts make contact before the actuator has completed the stroke. The additional movement of the operating rod after the contact closing causes the contact pressure spring to compress at the top of the operating rod. This “over-travel” allows for contact wear in service.

6.2 Opening

When the bottom coil is energized, the magnetic flux opposes the force generated by the magnet assembly. This reduces the holding force, the armature is released and the coil attracts the armature to the bottom plate. Once there, it is held open by the magnet.

7.0 OPERATIONAL CHECK PRIOR TO INSTALLATION

The breaker should be tested for mechanical and electrical operation before delivery to the installation site. Make the necessary control power connections. Open the door of the low voltage compartment to observe the mechanical operations. A manual trip handle is provided on the outside of the cabinet. (See Figure 10)

7.1 Electrical Close and Open

Observe the position-indicator located on the front of the actuator cover plate. If the panel is green, the breaker is open, and if the panel is red, the breaker is closed. To perform a close or open, ensure the “Ready” light is illuminated above the Close (1) and Open (0) buttons. Press the appropriate button firmly, keeping hands and loose clothing clear of operating linkages. If the breaker is already open, nothing will happen when the open button is pressed. If the breaker is already closed, nothing will happen when the close button is pressed.

Note: In the event of a malfunction or loss of source voltage, the “Ready” light will not be illuminated.

7.2 Vacuum Test

Perform an over-voltage test on each phase assembly to verify that there has been no loss of vacuum in transportation or handling. Experience has shown that a vacuum interrupter with the vacuum seal intact will withstand 37.5 kVAC across the open contacts for one minute, and the same vacuum interrupter open to normal atmosphere will flashover at the gap at a much lower voltage.

TEST PROCEDURE

RADIATION WARNING: High voltage applied across an open gap in a vacuum can produce X-radiation. No radiation is emitted when the interrupter is closed, since no gap exists. Also, when the breaker is open to the specified contact spacing in service or tested within the voltages specified, X-radiation at one meter is below the level of concern. A danger could exist at voltages above or contact spacing below that specified on the nameplate.

1. With the breaker in the open position, jumper both sets of three top terminals together. Ground one set of terminals and the housing. Connect the high voltage to the other set of terminals.
2. Stand clear more than one meter before energizing the high voltage source.
3. Apply a test voltage of 37.5 kVAC for one minute. Do not exceed 37.5 kVAC.
4. If internal flashover occurs, isolate the phases and test each one independently to identify the defective interrupter. Any defective interrupter must be replaced prior to the breaker being placed in service.

8.0 INSTALLATION

The breaker must be be vertical, level and securely fastened. Follow your company guidelines and codes for setting the height of the breaker, securing the frame to the pole or foundation, and making connections.

8.1 Mounting

The breaker is normally shipped suitable for substation mounting. The following is the recommended installation procedure:

Substation Mounting:

1. With the lifting brackets mounted to the breaker roof, lift the breaker off the pallet and move into position.
2. Bolt the legs to the pad and raise the upper portion to the desired height.
3. Bolt the legs to the sides of the breaker.
4. Make sure all hardware is tight.

8.2 Grounding

The breaker cabinet has two ground parts, one on each side sheet. It is important that both of these be connected to the ground grid with #6 or larger wire. If the ground pad is provided on the roof, it should be connected to the ground pad on the side sheet.

8.3 Arrester Protection

ABB recommends that surge arresters be properly applied in the substation.

8.4 Control Power

Supply the control power as indicated on the wiring diagram. If 240 VAC is used, verify the connections for the heaters before applying power. Check all terminal block connections for proper tightness. For details of the overall control circuit, refer to the specific wiring diagrams supplied with the breaker.

8.5 Final Inspection

When the breaker has been installed and all mechanical and electrical connections completed, EXCEPT ENERGIZING THE POWER LINE, the following points of inspection are recommended:

1. Ensure the breaker is properly leveled and securely anchored.
2. Make a final check of tightness of all hardware.
3. Check that the heaters work.
4. Securely tighten terminal and ground connections.
5. Check control cable entrance fittings for tightness.
6. Operate the breaker from the control box to verify normal operation.
7. Secure all doors and ensure proper gasketing for weather.
8. Ensure that all tools are removed.

9.0 INSPECTION, MAINTENANCE AND ADJUSTMENT

The R-MAG circuit breaker is an extremely simple device and requires minimal maintenance, depending on the frequency of operation and local environmental conditions.

The safety and successful functioning of any apparatus or system connected with the breaker largely depends on the proper and reliable operation of the unit.

To provide long reliable service, the breaker must have systematic inspections at regular intervals. Operating experience based on environmental conditions, the number of operations, magnitude of current and any unusual operation, will establish a maintenance schedule that gives assurance of proper breaker reliability. The following check list is a minimum guide:

1. Check the phase assemblies for external damage and clean if contamination is evident.
2. Lubricate wear points and all pins in linkage assemblies with grease (Dow Corning 55 silicone lubricant).
3. Check contact wear. As a vacuum interrupter continues to perform, material from the butt contacts is gradually eroded away, and the moving contact is driven deeper into the interrupter by the operating mechanism. The over-travel spring at the upper end of the operating rods ensures that proper contact pressure is maintained in the closed position. Contact erosion reduces the compression of the over-travel spring, which in turn increases the contact travel. (Total travel of the actuator is fixed.) See 9.3 for minor adjustments. Contact wear can be visually inspected. A line is scribed on the moving contact stem 0.08" from VI end guide. When the line reaches the VI end guide, replace vacuum interrupters. See Figures 3-8 and Procedures 9.2 and 9.3. Contact wear can also be monitored by interruption magnitudes and quantity.
4. Verify that the breaker operates correctly using the electrical controls.
5. A Hi-Pot test can be performed to verify the vacuum integrity (see section 7.2).
6. **Contact Resistance: Measure contact resistance with suitable equipment rated not less than 100 A. The value should not exceed 150 micro ohms.**
7. Check heaters to verify proper operation.
8. When inspecting breaker, verify torque on current carrying parts are within tolerances:

.250-20 flex connectors	7-10 ft-lbs
.375-16 bus connections	27-35 ft-lbs
.500-13 bottle clamp*	65-80 ft-lbs

*Note: This block must be supported when tightening. Do not exert a torque on the movable contact of the vacuum interrupter, as damage may result.
Bushing clamp hardware (bushing flange mounted to roof) is aluminum and care must be taken to prevent over tightening. Tighten aluminum nuts on bushing flange collar until lock washers are compressed.
Values listed above are for grade 5 hardware. Contact the factory for other torque values.

9.1 High Pot Test

RADIATION WARNING: High voltage applied across an open gap in a vacuum can produce X-radiation. No radiation is emitted when the breaker is closed, since no gap exists. Also, when the breaker is open to the specified contact spacing in service or tested within the voltages specified, X-radiation at one meter is below the level of concern. A danger could exist at voltages above or contact spacing below that specified on the nameplate.

1. With the breaker in the open position, jumper both sets of three top terminals. Ground one set of terminals and the housing. Connect the high voltage to the other set of terminals.
2. Stand clear more than one meter before energizing the high voltage source.
3. Do not exceed 37.5 kV.
4. If internal flashover occurs, isolate the phases and test each one independently to identify the defective interrupter. Any defective pole assembly must be replaced prior to the breaker being in service.

9.2 Replacement of Vacuum Interrupter Assemblies (See Figures 3-8)

The following procedure is made with the R-MAG breaker in the open position, control power off and locked out, and stored energy capacitors discharged.

CAUTION

If power is removed from unit, and the Dip Switch I1004-1 is placed in the “on” position, the breaker will automatically trip in approximately 3 minutes. Make sure personnel and tools are clear from breaker.

Removing the existing interrupter assemblies:

1. Using pliers, expand the "X" type retaining rings (G) at the top of the pullrod (A) and disconnect the pullrod from the triangle bellcranks. (Figure 8)
2. Loosen hardware at the point where the bottom of the bushing studs attach to each end of the top of the interrupter bus assemblies (M) and remove hardware. (Figures 3-7)
3. Loosen the mounting hardware that fastens the interrupter assembly to the top of the insulators (N). (Figures 3-7)
4. With the loosened hardware removed, lift the interrupter assembly from the breaker. Repeat for all three phases.

Installing the new interrupter assemblies:

5. Replace with new interrupter assemblies (contact ABB for instructions on installation) on all three phases using the new hardware provided. (Figures 3-7)
6. After all interrupter assemblies are in place, reinstall the triangle bellcranks to the top of the pullrod (G) using the new "X" type retaining washers provided and compress the "X" rings with pliers. (Figures 3-7)

7. Support the moving contact of the vacuum interrupter at the contact block (C) and loosen the nut (F) taking care not to apply any torque to the end of the vacuum interrupter as damage may result. (Figures 8).
8. With the stem nut loose (F), install the shoulder pin and washers through the triangular bell-cranks) to the bolt stem (B) (E) and fasten with the new locknut provided.
9. Install the opposite end of the new bellcranks to the top of the pullrod (G) using the new "X" type retaining washers provided and compress with pliers.
10. Torque the bolts and connections at (M) (N) per the torque specifications in section 9.0.8. DO NOT TIGHTEN THE BOTTLE STEM NUT (F) ON THE VACUUM INTERRUPTER UNTIL INSTRUCTED TO DO SO.
11. Ensure that the locknut (F) on the bolt stem (E) is loose while supporting the moving contact to prevent any torque from being exerted on the internal bellows of the vacuum interrupter.
12. Remove the shoulder bolt (B) while applying pressure from the back of the contact block. Allow the contact block to move slowly to the closed position. Caution: Finger pinch point.
13. Loosen the pullrod locknut (D).
14. Turn the pullrod until the center of the hole for the shoulder bolt (B) is 1.687" from the contact block (C). (This step sets a reference point for the bell cranks.)
15. Spin the bolt stem (E) until the shoulder bolt (B) can be inserted, then remove the shoulder bolt (B). (This step establishes a reference from VI contact to the bell cranks.)
16. Spin the bolt stem (E) 6 to 6.5 full turns (6.5 turns is preferred final travel, but 6 is acceptable prior to contact conditioning) clockwise. (This step sets the contact travel.)
17. Pull from back of contact block (C) until shoulder bolt (B) can be inserted.
18. Install a new locknut and tighten all hardware. Note: When tightening the nut (F) on the stem bolt (E), support the moving contact at the contact block (C) to prevent any torque from being exerted on the internal bellows of the vacuum interrupter as damage may result.
19. Do not reuse washers.
20. Operate the breaker a minimum of 200 times to season the new contacts, and then readjust the breaker (Step 9-19). Proceed to section 9.3 for final adjustment.

9.3 Contact Travel and Over-Travel Adjustment (See Figure 8) (Control power required)

1. Measure travel and over-travel by opening and closing the breaker. Confirm the breaker is within the limits below (by voltage rating). While the breaker is in the closed position, minor adjustments can be made by loosening the nut (D) and rotating the pullrod (A). Make sure all hardware is tightened before operating the breaker and proceed to step 2 below by your breaker voltage rating.
2. Over-travel gaps (L) (produced at top of each pullrod while the breaker is in the closed position) are recommended to be set from 0.170” to 0.260" (when measuring breakers in operation, it is acceptable to be 0.125”).
3. Travel limits (K) (difference in measurements between contact block in open and closed position) are:
   For 15.5 kV breakers = 0.413" to 0.492" (10.5 mm - 12.5 mm).
   For 27 kV breakers = 0.591" to 0.630" (15.0 mm - 16.0 mm).

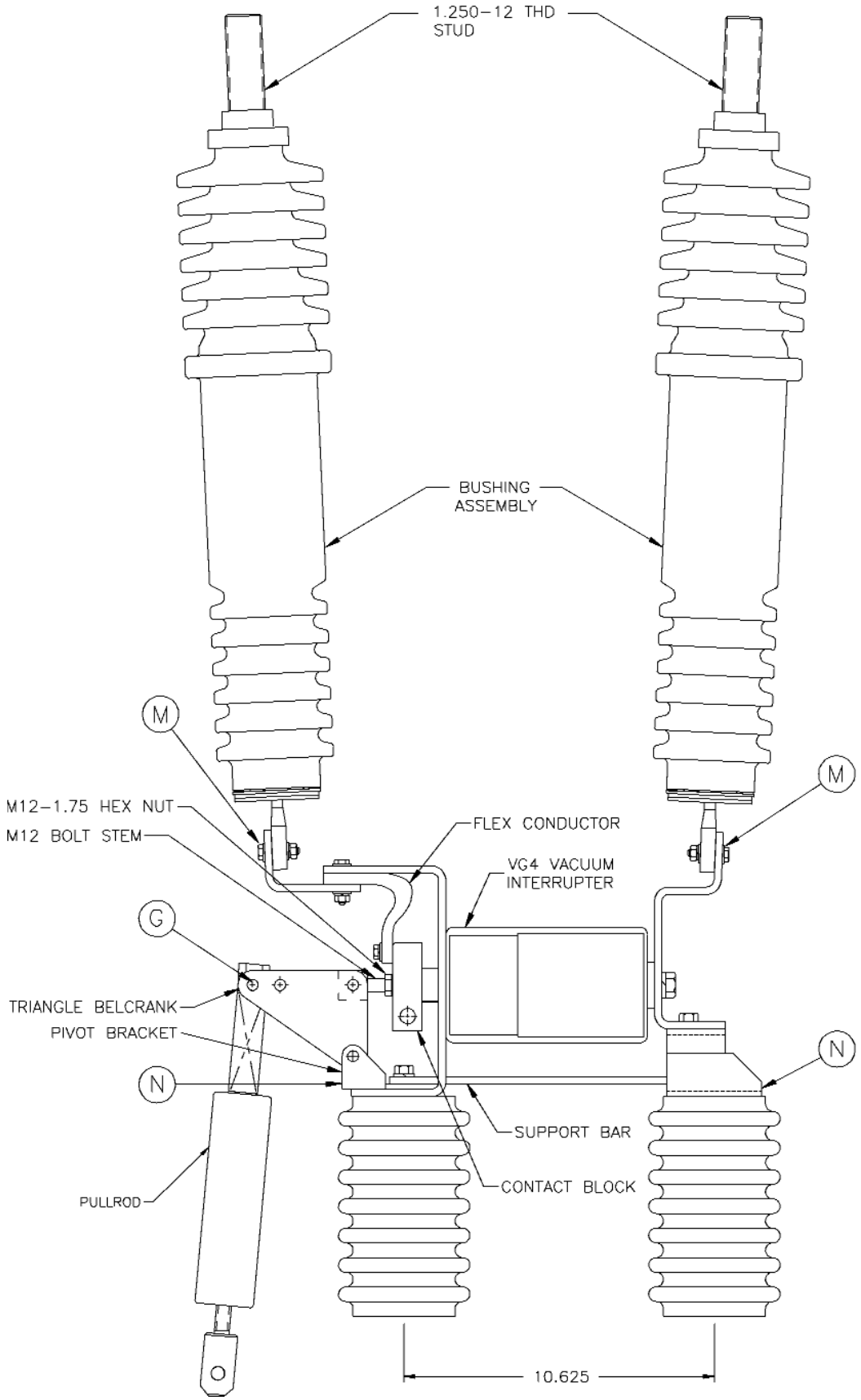


Figure 3. Interrupter Assembly 15.5 kV, 1250 A

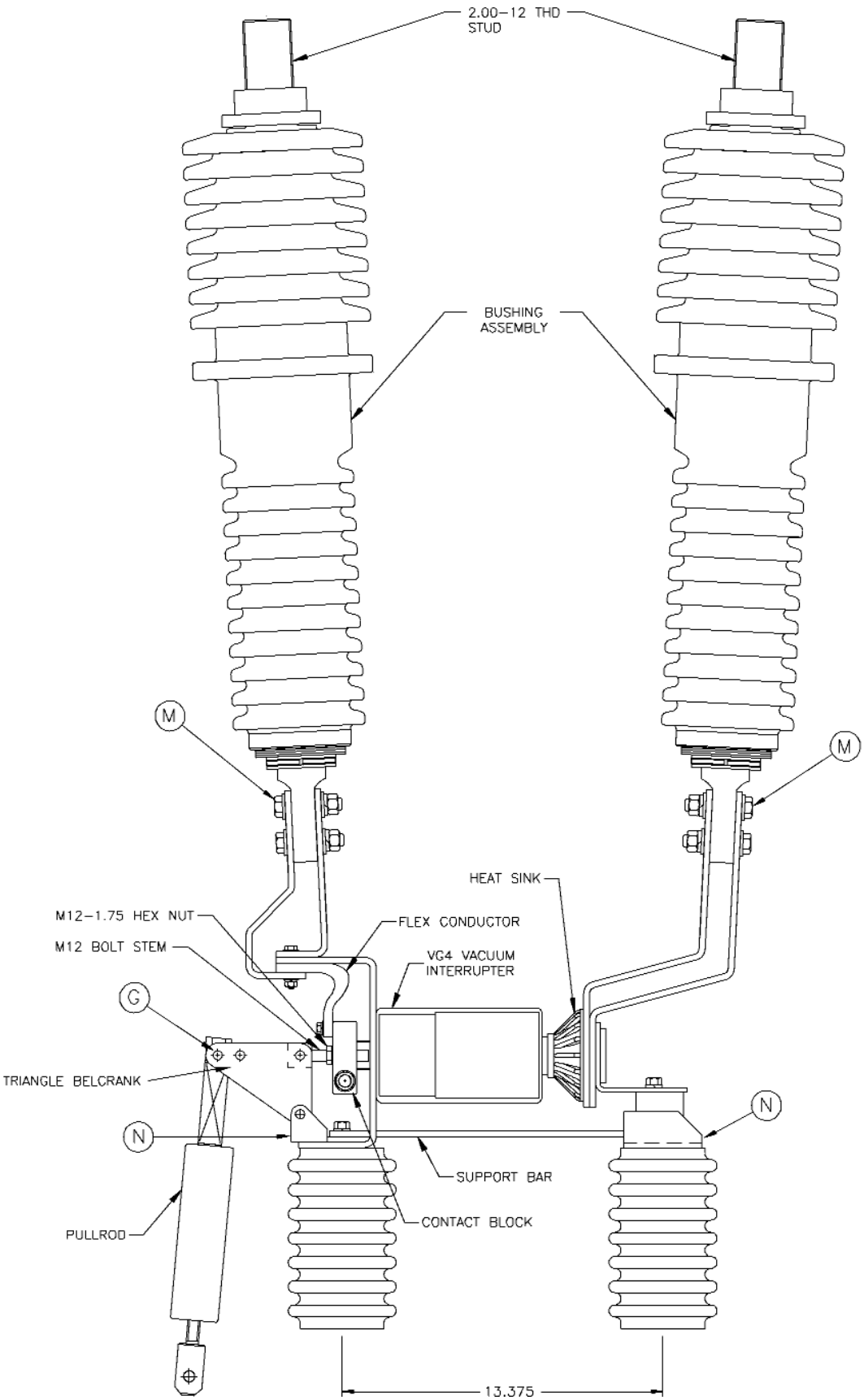


Figure 4. Interrupter Assembly 15.5 kV, 2000 A

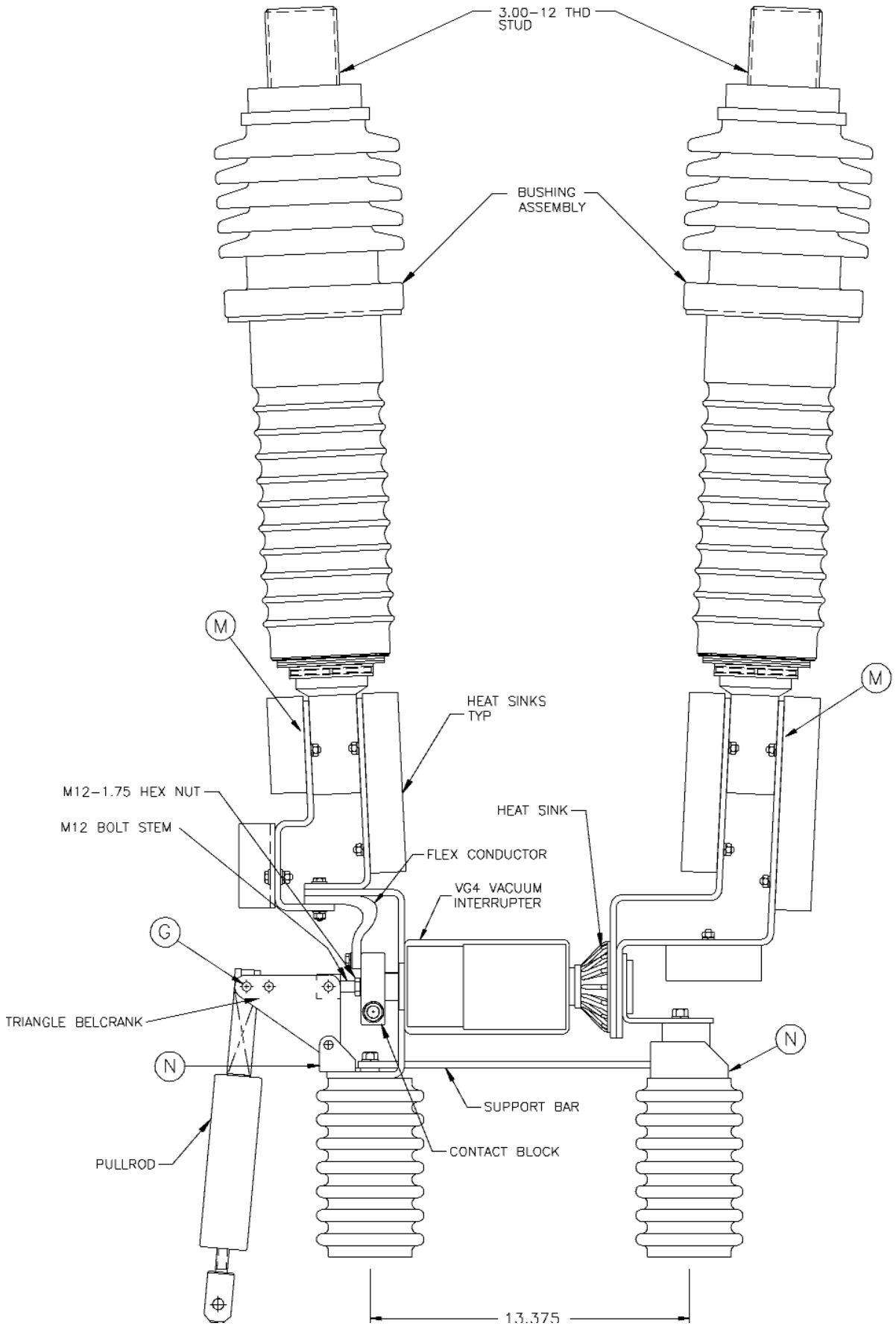


Figure 5. Interrupter Assembly 15.5 kV, 3000 A/3700 FA

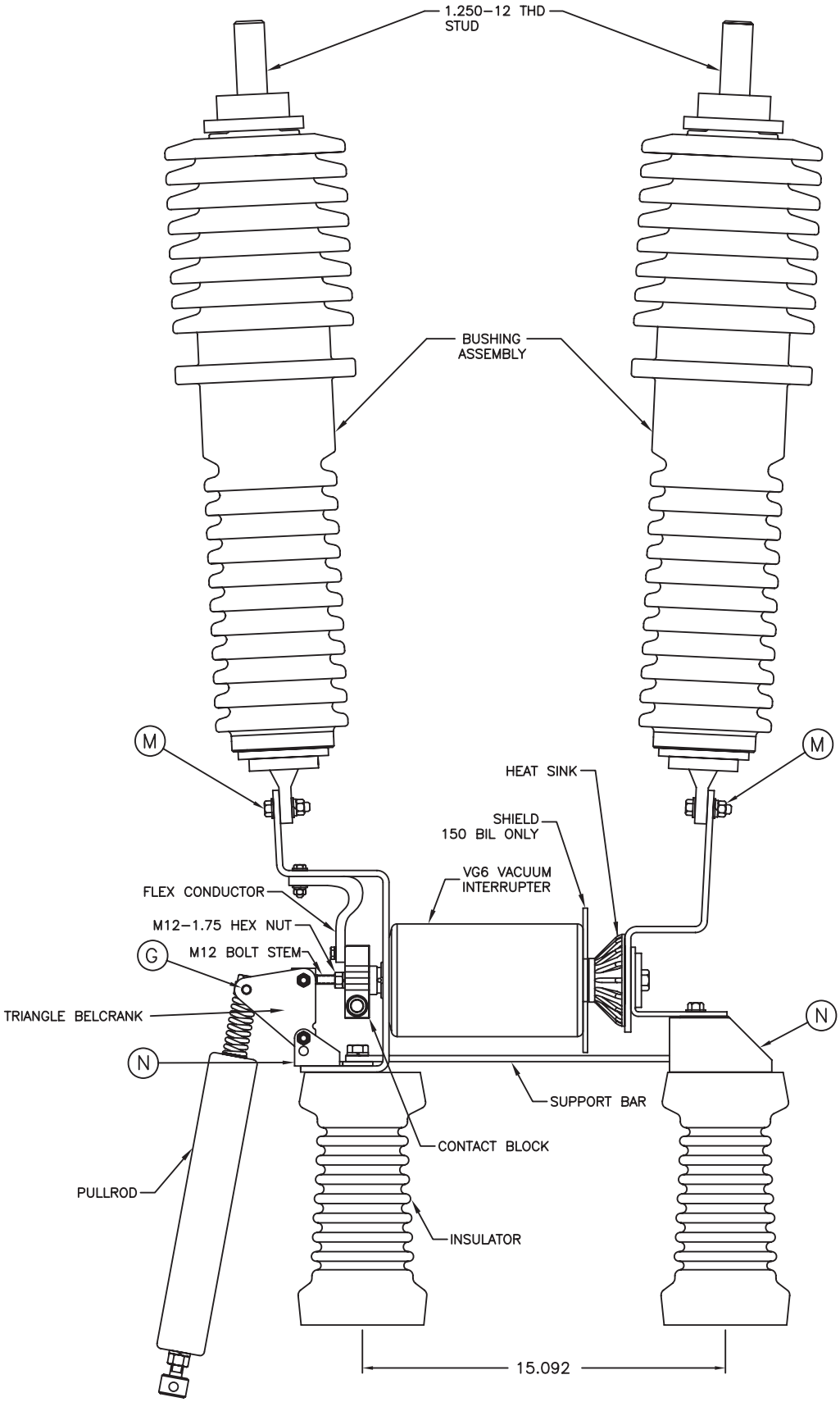


Figure 6. Interrupter Assembly 27 kV, 1250 A

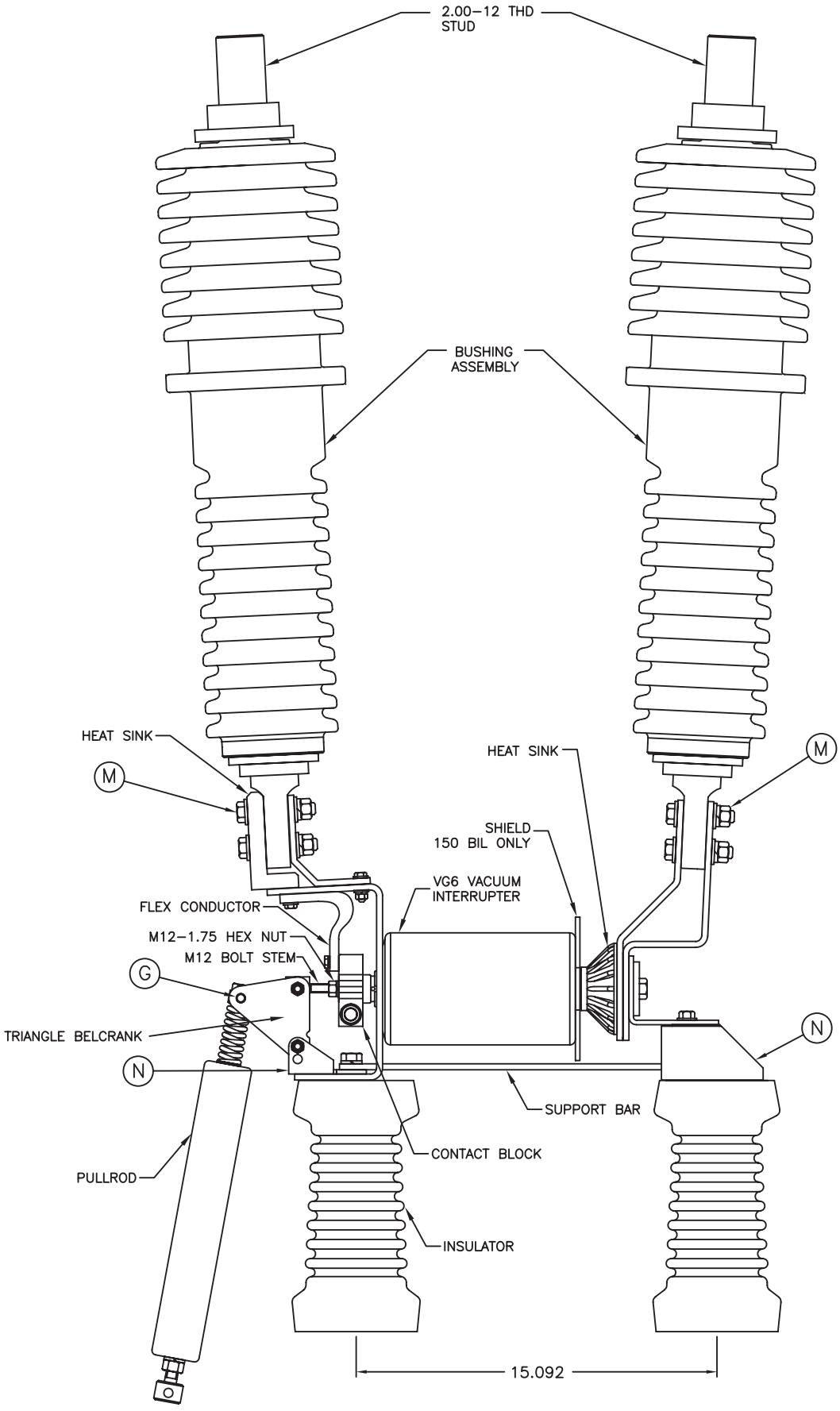


Figure 7. Interrupter Assembly 27 kV, 2000 A

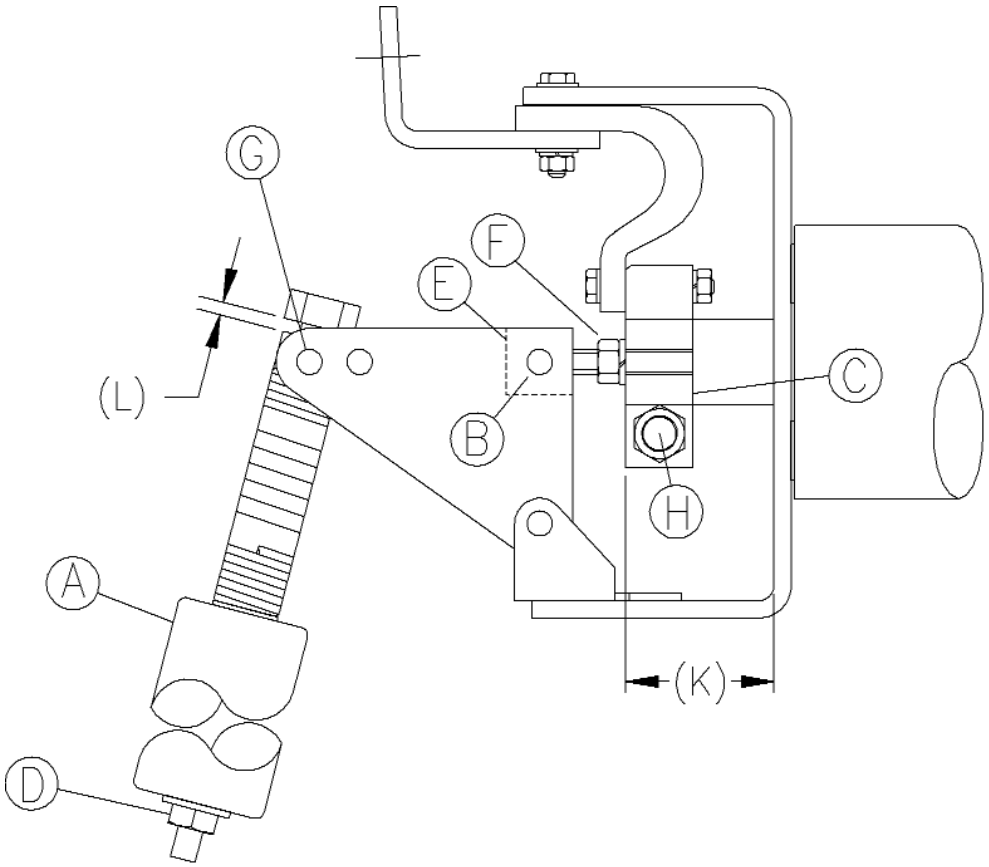


Figure 8. Contact Travel and Over-Travel Adjustment 15.5 and 27 kV

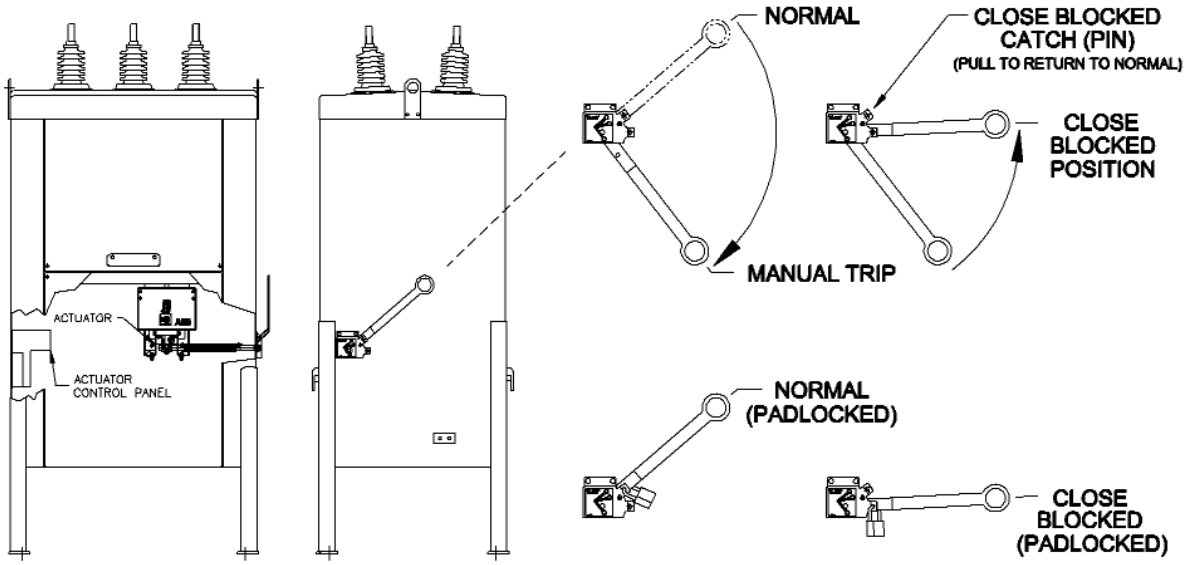
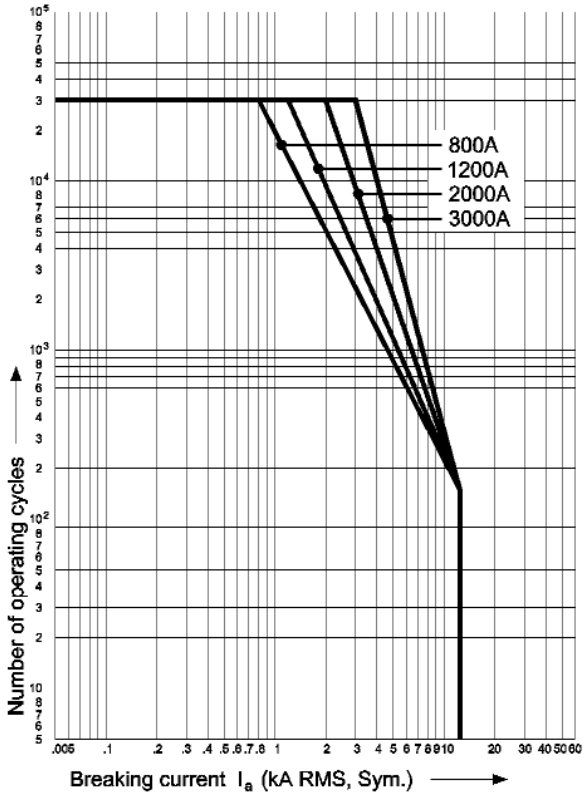
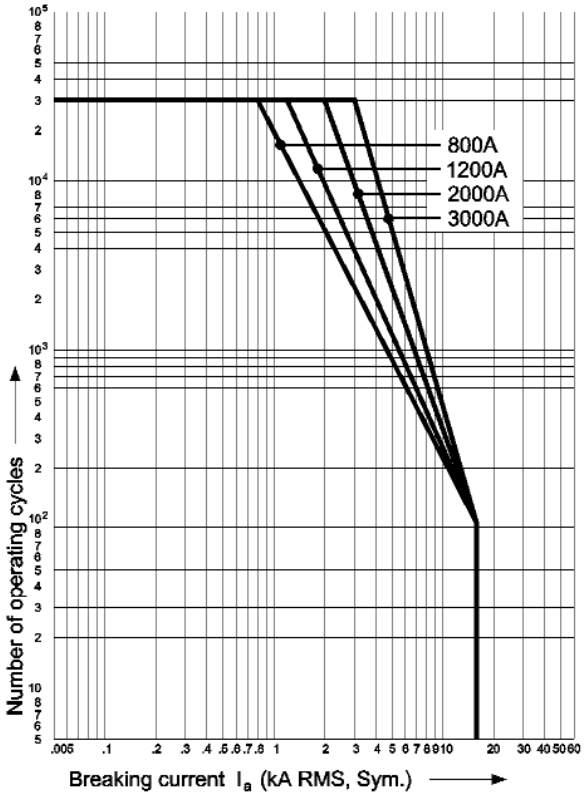


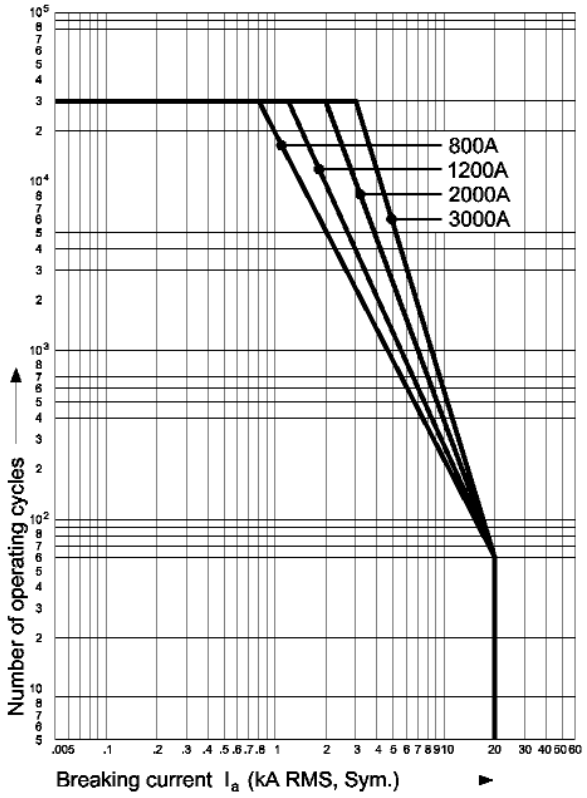
Figure 9. Trip Handle 15.5 and 27 kV



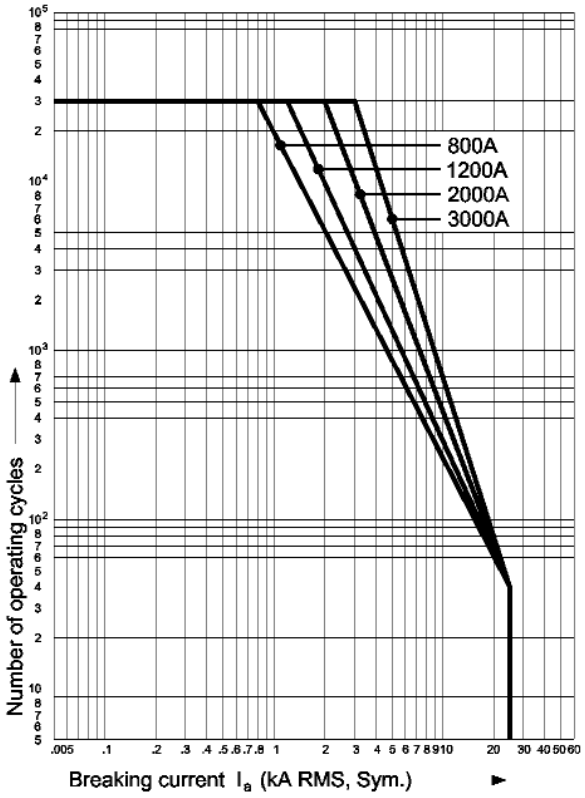
12.5 kA Interruption



16 kA Interruption



20 kA Interruption



25 kA Interruption

Figure 10. 15.5 and 27 kV Contact Erosion Graphs

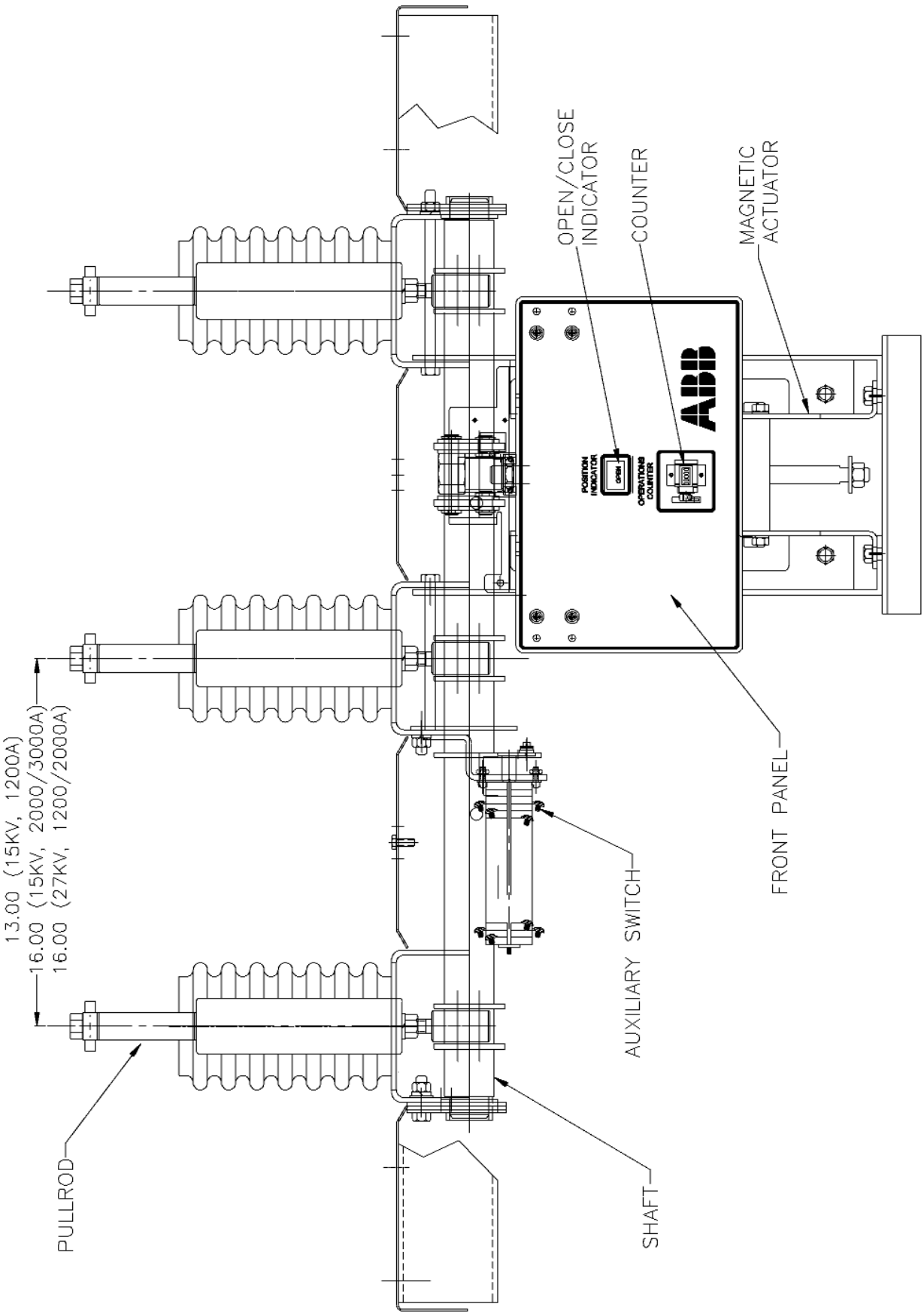


Figure 11. High Voltage Cabinet Layout 15.5 and 27 kV

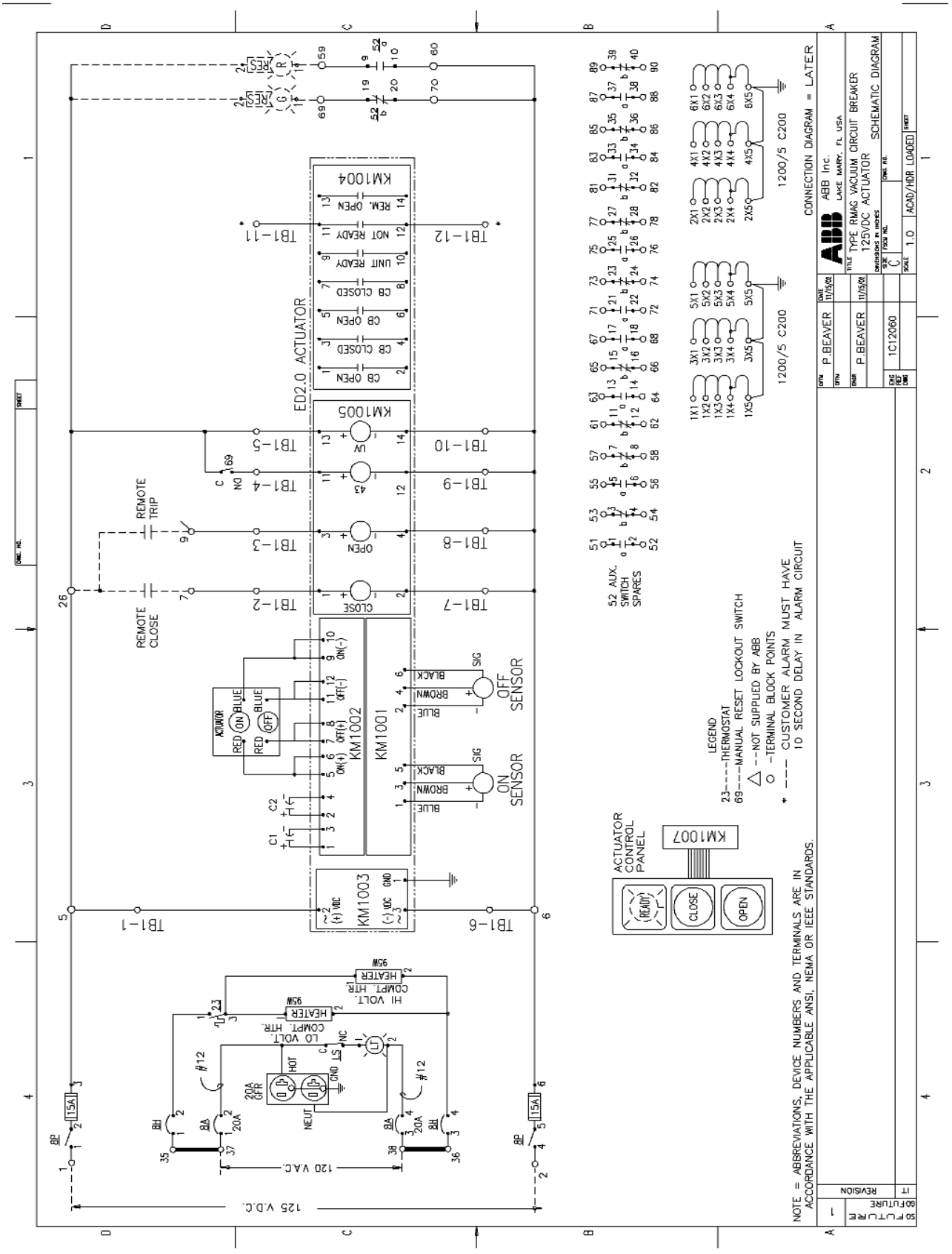


Figure 12. Typical Schematic Diagram

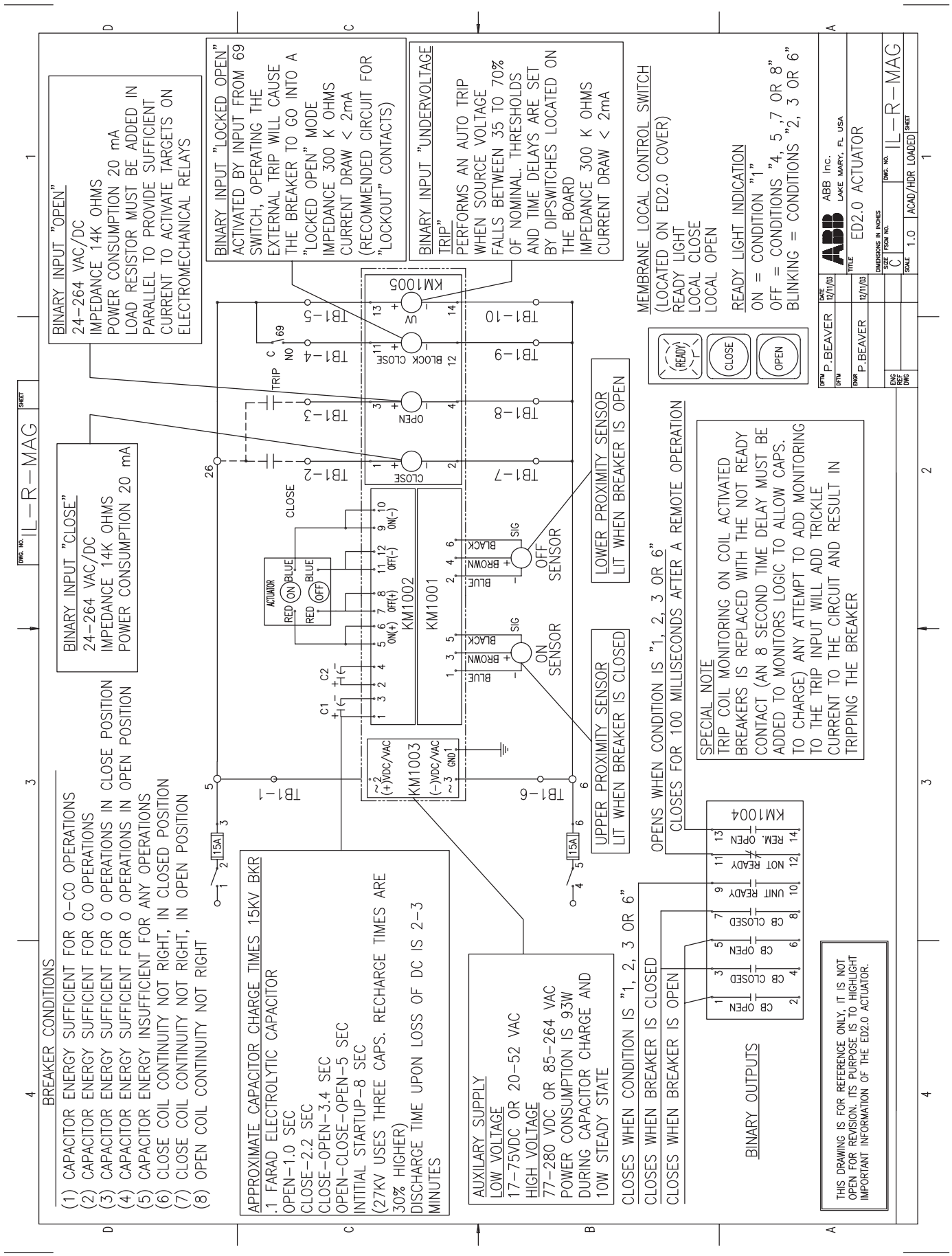


Figure 13. Standard ED2.0 Circuit Board

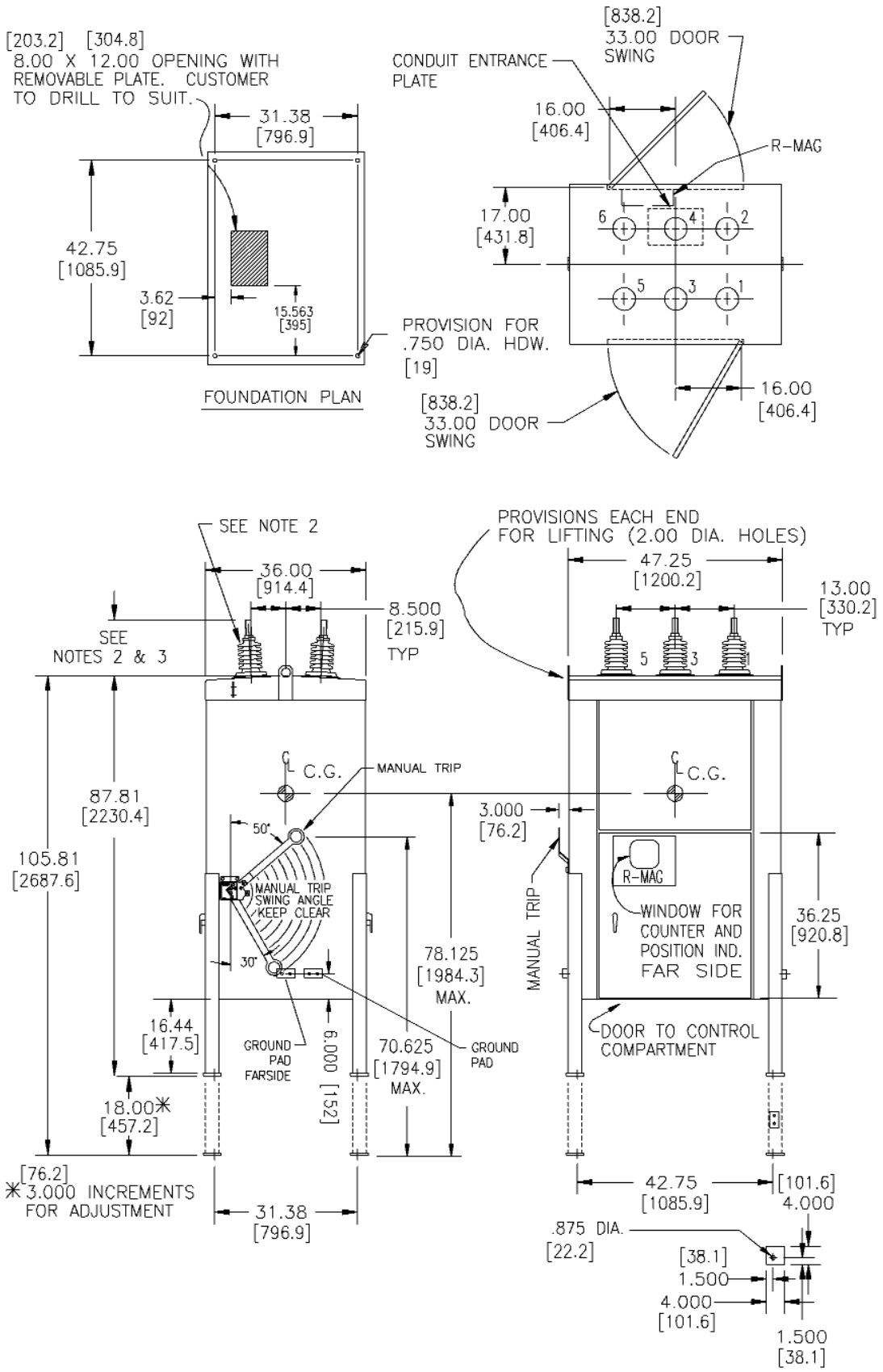


Figure 14. Typical Outline 15.5 kV, 1250 A

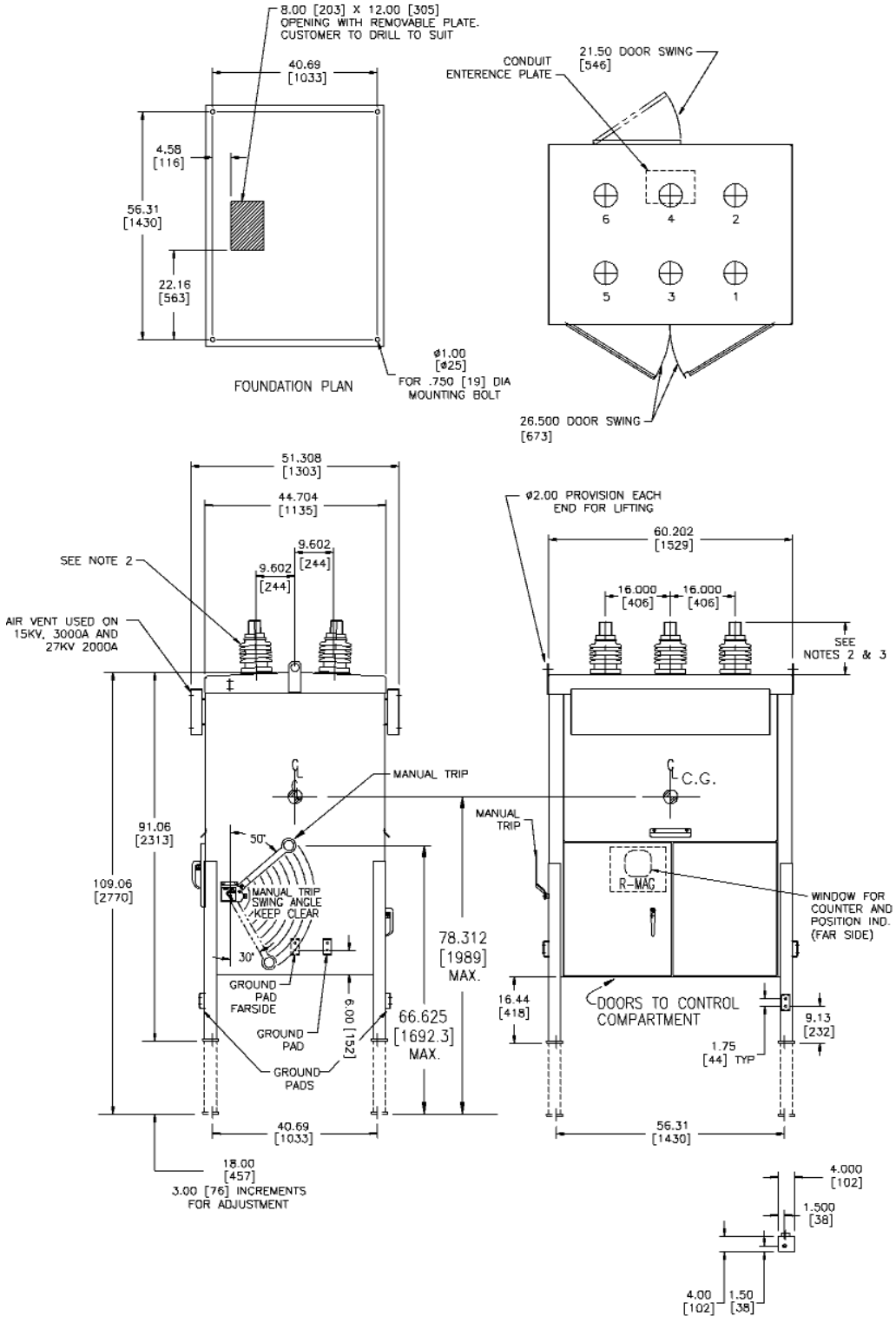


Figure 15. Typical Outline 15.5 kV, 2000/3000/3700 A and 27 kV, 1250/2000 A

10.0 15.5 kV R-MAG ELECTRICAL SPECIFICATIONS

Rated Maximum Voltage	15.5 kV
Voltage Range Factor, K	1.0
Continuous Current (Ratings Available R1-R4)	600 A 800 A 1250 A 2000 A 3000 A 3700 FA
Temperature Range	-50°C to +55° C
Dielectric Strength	
Low Frequency Withstand	
Dry 60 Hz 1 minute	50 kV RMS
Wet 60 Hz 10 seconds	45 kV RMS
Full Wave Withstand	110 kV BIL
Minimum Creep to Ground (External)	17.8 inches
ANSI Standard Operating Duty	O-0.3s-CO-3Min-CO*
Interrupting Time	3.0 cycles (seconds)
Permissible Tripping Delay (Y)	2 seconds
Reclosing Time	0.3 seconds
Interrupting Ratings	
Short-Circuit (At Contact Part) RMS R1	12.5 kA Sym / 14.5 kA Asym
Short-Circuit (At Contact Part) RMS R2	16.0 kA Sym / 18.5 kA Asym
Short-Circuit (At Contact Part) RMS R3	20.0 kA Sym / 23.2 kA Asym
Short-Circuit (At Contact Part) RMS R4	25 kA Sym / 29 kA Asym
Close and Latch (Initial Current Loop) Peak	2.6 x Sym interrupting rating
Transient Recovery Voltage (time to peak = 36 µsec)	29 kV peak
Load Current Switching Capability	same as continuous current rating
Rated Line Charging Breaking Current	100 A
Rated Cable Charging Breaking Current	600 A
Rated Isolated Capacitor Bank Breaking (Definite Purpose)	600 A
Rated Back-to-Back Capacitor Bank Breaking (Definite Purpose)	600 A
Rated Capacitor Bank Inrush Making	20 kA
Rated Capacitor Inrush Frequency	4240 Hz
Mechanical Life	
Between Servicing	2,000
No-Load Mechanical	10,000
Continuous Current Switching	10,000

**Operating duty conforms to old ANSI Standard (actual time can be CO-15 Sec-CO).*

11.0 27 kV R-MAG ELECTRICAL SPECIFICATIONS

Rated Maximum Voltage	27 kV
Voltage Range Factor, K	1.0
Continuous Current (Ratings Available R1-R4)	1250 A 2000 A
Temperature Range	-50°C to +55° C
Dielectric Strength	
Low Frequency Withstand	
Dry 60 Hz 1 minute	60 kV RMS
Wet 60 Hz 10 seconds	50 kV RMS
Full Wave Withstand	125/150 kV BIL
Minimum Creep to Ground (External)	27.5 inches
ANSI Standard Operating Duty	O-0.3s-CO-3Min-CO*
Interrupting Time	3.0 cycles (seconds)
Permissible Tripping Delay (Y)	2 seconds
Reclosing Time	0.3 seconds
Interrupting Ratings	
Short-Circuit (At Contact Part) RMS R1	12.5 kA Sym / 14.5 kA Asym
Short-Circuit (At Contact Part) RMS R2	16.0 kA Sym / 18.5 kA Asym
Short-Circuit (At Contact Part) RMS R3	20.0 kA Sym / 23.2 kA Asym
Short-Circuit (At Contact Part) RMS R4	25 kA Sym / 29 kA Asym
Close and Latch (Initial Current Loop) Peak	2.6 x Sym interrupting rating
Transient Recovery Voltage (time to peak = 63 µsec)	51 kV peak
Load Current Switching Capability	same as continuous current rating
Rated Line Charging Breaking Current	100 A
Rated Cable Charging Breaking Current	400 A
Rated Isolated Capacitor Bank Breaking (Definite Purpose)	400 A
Rated Back-to-Back Capacitor Bank Breaking (Definite Purpose)	400 A
Rated Capacitor Bank Inrush Making	20 kA
Rated Capacitor Inrush Frequency	4240 Hz
Mechanical Life	
Between Servicing	2,000
No-Load Mechanical	10,000
Continuous Current Switching	10,000

**Operating duty conforms to old ANSI Standard (actual time can be CO-15 Sec-CO).*

CURRENT TRANSFORMER CONNECTIONS

600:5 MULTI-RATIO CURRENT TRANSFORMER		1200:5 MULTI-RATIO CURRENT TRANSFORMER	
TERMINAL	**RATIO**	**TERMINAL**	**RATIO**
X2-X3	50-5	X2-X3	100-5
X1-X2	100-5	X1-X1	200-5
X1-X3	150-5	X1-X3	300-5
X4-X5	200-5	X4-X5	400-5
X3-X4	250-5	X3-X4	500-5
X2-X4	300-5	X2-X4	600-5
X1-X4	400-5	X1-X4	800-5
X3-X5	450-5	X3-X5	900-5
X2-X5	500-5	X2-X5	1000-5
X1-X5	600-5	X1-X5	1200-5

2000:5 MULTI-RATIO CURRENT TRANSFORMER		3000:5 MULTI-RATIO CURRENT TRANSFORMER	
TERMINAL	**RATIO**	**TERMINAL**	**RATIO**
X3-X4	300-5	X3-X4	300-5
X1-X2	400-5	X4-X5	500-5
X4-X5	500-5	X3-X5	800-5
X2-X3	800-5	X1-X2	1000-5
X2-X4	1100-5	X2-X3	1200-5
X1-X3	1200-5	X2-X4	1500-5
X1-X4	1500-5	X2-X5	2000-5
X2-X5	1600-5	X1-X3	2200-5
X1-X5	2000-5	X1-X4	2500-5
		X1-X5	3000-5

AUXILIARY SWITCH CURRENT SPECIFICATIONS

- Tested per UL Document 1054. AC tests specs with one set of contacts. DC tests specs with two sets of contacts in series.
- Contacts will carry 140 A for 3 seconds.
- Overload test – 50 operations at 90 A and 120 VAC.

VOLTS	NON INDUCTIVE CIRCUITS MAKE AND BREAK (A)	INDUCTIVE CIRCUITS MAKE AND BREAK (A)	CONTINUOUS RATING (A)
24/48 VDC	16	16	20
125 VDC	10	10	20
250 VDC	5	5	20
115 VAC	15	15	20
230 VAC	10	10	20

ED2.0 BOARD VOLTAGE REQUIREMENTS

CONTROL RANGE	LOW VOLTAGE BOARD	HIGH VOLTAGE BOARD
BINARY INPUTS AC - KM1005[1, 2] (INCLUDES TRIP AND CLOSE)	20.4 VOLTS TO 264 VOLTS OPENING COMMANDS CAN GO AS LOW AS 16.8 VAC	20.4 VOLTS TO 264 VOLTS OPENING COMMANDS CAN GO AS LOW AS 16.8 VAC
BINARY INPUTS DC – KM1005[1] (INCLUDES TRIP AND CLOSE)	20.4 VOLTS TO 264 VOLTS OPENING COMMANDS CAN GO AS LOW AS 16.8 VDC	20.4 VOLTS TO 264 VOLTS OPENING COMMANDS CAN GO AS LOW AS 16.8 VDC
AUXILIARY POWER AC - KM1003[1]	20.4 VOLTS TO 52.8 VOLTS	85 VOLTS TO 264 VOLTS
AUXILIARY POWER DC - KM1003[1]	16.8 VOLTS TO 75 VOLTS	77 VOLTS TO 280 VOLTS

[1] *The threshold for the binary inputs occurs at approximately 18 VDC or 19 VAC. The threshold for the protection relay input is approximately 7 VDC.*

[2] *Binary input threshold depends on filter card jumpers. See section 3.0 of Appendix A.*

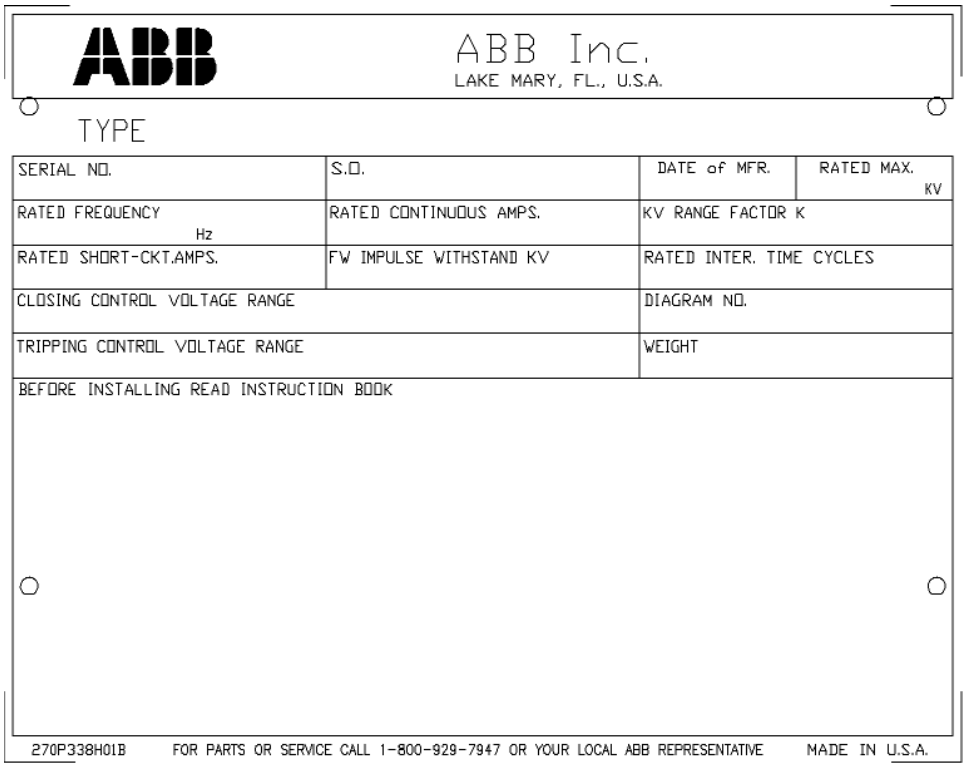


Figure 16. Breaker Nameplate

APPENDIX A

INSTALLATION / MAINTENANCE INSTRUCTIONS

R-MAG Medium Voltage

Vacuum Power Circuit Breaker

ED2.0 MAGNETIC ACTUATOR CONTROL BOARD

Table Of Contents

Description **Page**

1.0 OVERVIEW

The ED2.0 electronic control board is comprised of a Power Supply Recharge Unit, Control Unit, and FET Switching circuit which connects the Storage Unit Capacitors to the Magnetic Actuator coils.

The power supply recharge circuitry adapts whatever input voltage, within the specified range (Section 2.0), is supplied to maintain an 80 V charge voltage across the capacitors. The Control Unit monitors binary inputs and outputs, hardware and software configurations, position sensors, capacitor charge, and switches the FET circuit to connect the capacitor voltage to the Magnetic Actuator coils following an open or close command.

The Capacitor Storage Unit consists of two 0.1 farad Aluminum Electrolytic capacitors connected in parallel to provide a total capacitance of 0.2 farad on the 15 kV rating. The Capacitor Storage Unit consists of three 0.1 farad Aluminum Electrolytic capacitors connected in parallel to provide a total capacitance of 0.3 farad on the 27 kV rating. The energy stored is approximately 640 Joules on 15 kV and 960 Joules on 27 kV. When called to energize the Magnetic Actuator coils, the capacitors will deliver a peak current of approximately 35 A and a pulse width of 45 milliseconds for opening operations and 60 milliseconds for closing operations.

The ED2.0, with external circuitry, system Block Diagram is given in Illustration 1 below.

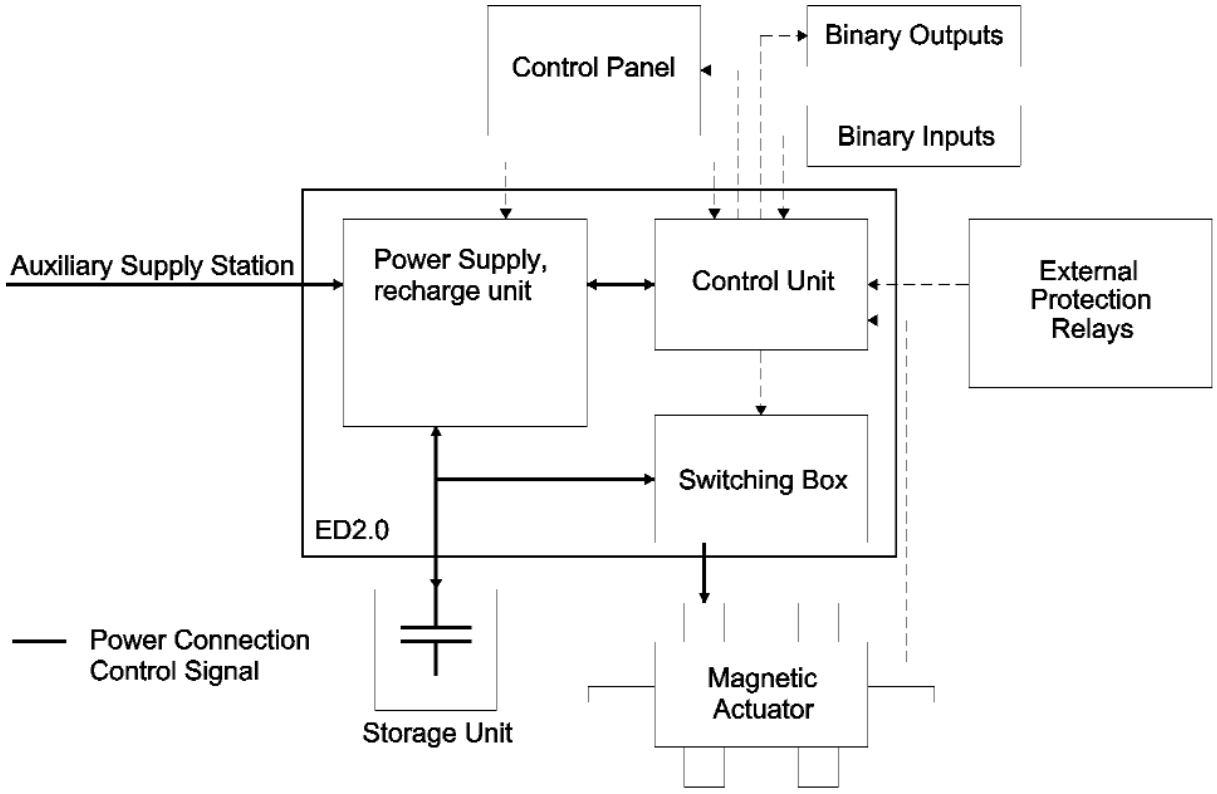


ILLUSTRATION 1 – ELECTRICAL SYSTEM BLOCK DIAGRAM

2.0 ED2.0 BOARDS AVAILABLE/MAGNETIC ACTUATOR COIL ENERGIZING CAPACITOR

1. Low voltage full optional board (17 – 75 VDC or 20 – 52 VAC)
2. High voltage full optional board (77 – 280 VDC or 85 – 264 VAC)
3. 0.1 farad aluminum electrolytic capacitor

3.0 BINARY

There is a removable filter card plugged into the ED2.0 board. This filter card has five metal jumpers on it. When the jumpers are cut, the binary input threshold is raised by 20 V. It is recommended that these be cut for 125 VDC operation.

Binary input channels work properly with a voltage range of 24 to 264 VAC/DC regardless of which board is used. All inputs have a low threshold at about 18 VDC and 19 VAC with the exception of the Protection Relay input, which has a low threshold of about 7 VDC. To avoid false triggering by noise, the inputs must be active for at least 6 milliseconds. The current draw for most inputs is < 2 milliamperes. The exception is the Remote Open and Close inputs, which draw up to approximately 20 milliamperes. The input impedance (Z) is 300 kOhms except for binary inputs 1 and 2 (Remote open and close) which are around 14 kOhms input Z.

There are seven different input channels. Only six of them are used for the R-MAG breaker (channel 5 is not used).

3.1 Remote Close (KM1005, CH 1, Pins 1 and 2)

The Remote Close input is used to close the breaker remotely. The input impedance is approximately 14 kOhms.

3.2 Remote Open (KM1005, CH 2, Pins 3 and 4)

The Remote Open input is used to trip breaker remotely. The input impedance is approximately 14 kOhms. When tripping with electromechanical relays, an additional resistor will be required to drop the trip flags.

3.3 Auxiliary Open / Safe Open (KM1005, CH 3, Pins 5 and 6)

This input can be configured as either an Auxiliary Open function or a Safe Open function. The position of dip switch I1002 determines which is selected. If it is Off, it is used as Auxiliary. If the dip switch is On, it is used as Safe Open.

The Auxiliary Open functions the same as the Remote Open function, with the exception of the input impedance which is approximately 300 kOhms.

The Safe Open function allows the user to open the circuit breaker when the on board microcontroller is faulty. During normal conditions, all opening inputs work, but if the microcontroller is damaged, only the Safe Open input can perform the opening command. When the microcontroller is damaged, capacitor monitoring is not active so other inputs will be ignored. In order for the breaker to open correctly, there must be sufficient energy in the capacitors.

3.4 Protection Trip / Second Trip (KM1005, CH 4, Pins 7 and 8)

This input can be configured as either a Protection Trip or Second Trip function. It is programmed via Jumper JP1001 Pins 1 and 2 or as a normal input by jumpering JP1001 pins 2 and 3.

The Protection Trip input is designed to work at a lower threshold of 7 VDC. This input is provided to use with special protection relay requirements. It can also be used as a normal trip input.

The Second Trip is often referred to as “Shunt Trip.” It functions the same as the Remote Input with the exception of the input impedance which is 300 kOhms.

3.5 Circuit Breaker Locked Open (KM1005, CH 6, Pins 11 and 12)

The Circuit Breaker Locked Open feature functions like the familiar 69 switch. The circuit is deenergized when the external trip handle is moved from its normal position (i.e., in the trip position). In this position the breaker cannot be either locally or remotely closed.

When the circuit breaker is tripped, by operating the manual trip handle, the breaker will go into the Open Lock mode. This prevents any future closings until the Trip Handle is returned to the Normal Position. The Manual Trip Handle must be left in the down position for the switch to remain open (i.e., locked open). It is important that the handle be moved all the way to the bottom of the trip position to enable this function.

There is a padlock provision for locking the manual lever in the Locked Open position.

See figure 9.

3.6 Under Voltage Trip (KM1005, CH 7, Pins 13 and 14)

The Under Voltage Trip input will perform an auto trip in the event the voltage source being monitored, by this input, falls between 35% to 70% of nominal. It is enabled through DIP Switch I1004/2-3-4. The response of this input also has a programmable time delay from 500 milliseconds to 5 seconds. The delay is set by the various combinations of DIP Switch I1004/2-3-4. The Under Voltage Threshold is set by I1001. See Table below.

DIP SWITCH I1001 POSITION	THRESHOLD
1	100 – 127 VAC/DC
2	48 – 60 VDC
3	24 – 30 VDC
NONE	220 – 240 VAC/DC

4.0 BINARY OUTPUTS

Binary outputs are simply pairs of mechanical wipe relay contacts. They can be employed to switch in other circuitry or to an alarm indicator. See Illustration 3 and 4 for the power limitations of the contacts. Notice the flat curve for AC voltage in Illustration 4. On the inside of the low voltage cabinet there is a membrane style button plate that contains a “Ready” LED. The Ready light will either flash or turn off depending on the state of the Capacitor voltage, Coil continuity, and the state of the position sensors. The “Unit Ready” output contact can be used to alarm for the more serious of the three types of problems, but will not signal for all levels of the above problems. See Illustration 6.

4.1 Circuit Breaker Opened (KM1004 Pins 1 and 2)

The Circuit Breaker Opened contacts are normally open. They close only when the circuit breaker is in the Open position.

4.2 Circuit Breaker Closed (KM1004 Pins 3 and 4)

The Circuit Breaker Closed contacts are normally open. They close only when the circuit breaker is in the Closed position.

4.3 Circuit Breaker Auxiliary Open (KM1004 Pins 5 and 6)

The Circuit Breaker Auxiliary Open contacts which close whenever the breaker is in the Open position.

4.4 Circuit Breaker Auxiliary Closed (KM1004 Pins 7 and 8)

Additional set of normally open contacts which close whenever the breaker is in the Close position.

4.5 Unit Ready (KM1004 Pins 9 and 10)

These contacts are normally open. They close when the breaker is ready. They are used to monitor capacitor charge (O-CO operation ready), valid circuit breaker position, and coil continuity.

4.6 Unit Not Ready (KM1004 Pins 11 and 12)

The Unit Not Ready contacts are normally closed. They open when the Unit is Ready. These contacts are the inverse (negative) of the Unit Ready contacts.

When using the Not Ready contacts to provide an alarm to SCADA, an 8 second delay is recommended since the unit will go to Not Ready when the capacitors are below 49 V. The 8 second delay allows the capacitors to charge prior to alarming.

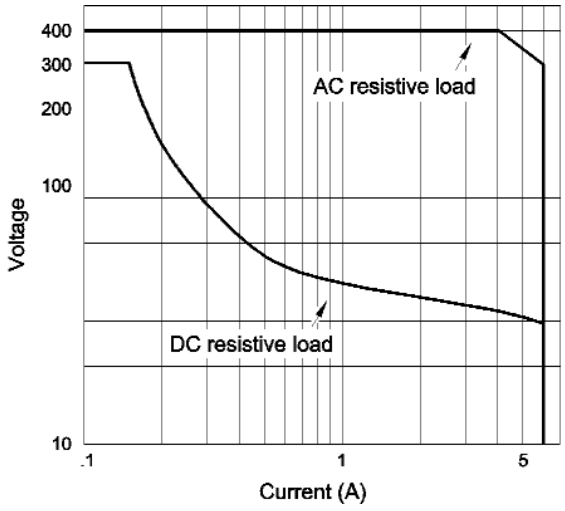
4.7 Circuit Breaker Remote Open (KM1004 Pins 13 and 14)

The Circuit Breaker Remote Open contacts are referred to as the “Fleeting Output Contacts.” This means that they only close for 100 milliseconds after a Remote Operation is performed.

OUTPUT CONTACT SPECIFICATIONS:

SEE ILLUSTRATION 2 FOR SPECIFIC LOADS AND VOLTAGES

CHARACTERISTIC	WIPE CONTACTS RELAY
SWITCHING CHARACTERISTICS	
Maximum Switching Power	1500 VA on Resistive load
Maximum Switching Voltage	400 VAC, 300 VDC
Maximum Switching Current	6 A
Maximum Rated Current	6 A
CONTACTS CHARACTERISTICS	
Maximum On Resistance (Ron)	100 milliohms (measured by voltage drop 6 VDC 1 A)
Maximum Capacitance	1.5 pF
TIMING CHARACTERISTICS	
Maximum Actuating Time	5.0 milliseconds
Maximum Releasing Time	3.0 milliseconds
INSULATION	
Between Contacts and Coil	4000 Vrms (50 Hz/1 min.)
Between Open Contact	1000 Vrms (50 Hz/1 min.)
Resistance (Roff)	>1000 Megohms at 500 VDC
ENVIRONMENTAL CHARACTERISTICS	
Operating Temperature Range	-50 to +55 Degrees C
Storing Temperature Range	-40 to +55 Degrees C
Expected contacts life (min. operations)	
Mechanical (at 180 cpm)	5 million
Electrical (6 A / 277 VAC/resistive load)	30,000



5.0 FEATURES

5.1 Temperature Protection

The Temperature Protection circuit monitors the average temperature of a critical area on the ED2.0 power supply. The output power will be linearly reduced to zero as the temperature increases from 78 degrees C to 95 degrees C.

5.2 Actuator Close and Trip Coil Continuity Monitor

See Illustration 10 - Troubleshooting Guide.

5.3 Wrong Position Auto Trip

An Auto Trip command will be issued in the event the breaker does not perform a successful close operation within 95 milliseconds after the close command is issued.

5.4 Energy Failure Auto Trip

CAUTION

If power is removed from unit, and the Dip Switch I1004-1 is placed in the "on" position, the breaker will automatically trip in approximately 3 minutes. Make sure personnel and tools are clear from breaker.

The Energy Failure Auto Trip function is selected by Dip Switch I1004-1 and will cause the breaker to auto trip in the event the capacitor voltage falls below 49 volts. Necessary precautions must be taken when power is removed (e.g., power removed for maintenance) as the breaker will automatically trip if I1004-1 is in the "On" position.

5.5 Reduced Power Consumption

The Reduced Power Consumption setting will lower the power output of the power supply recharge unit, on the ED2.0 board, from 75 W power to 33 W. This enables the ED2.0 board to be supplied with the energy delivered by a voltage transformer if necessary. The Power Supply Recharge Unit is 80% efficient. This means that the Auxiliary Power supply input must be at least 93.75 W for the 75 W setting or 41.3 W for the 33 W setting. The 33 W option is hardware selectable with Jumper JP1019.

5.6 RS-232 Port / JTAG Communication Port

Used by ABB factory only.

6.0 POWER CONSIDERATIONS

The ED2.0 power supply recharge unit adapts any voltage within the specified range of the board to maintain 80 V across the capacitors. The following voltage thresholds must be reached to complete the specified operations:

1. The capacitor voltage threshold for an Open operation is 49 volts.
2. The capacitor voltage threshold for a Close-Open operation is 72.5 volts.
3. The capacitor voltage threshold for a Open-Close-Open operation is 78 volts.

Illustrations 5 and 6 are provided to indicate the states of the Ready LED, Ready and Not Ready output contacts.

CB OPERATIONS VS AVAILABLE CAPACITOR CHARGE:

CAPACITOR CHARGE	CIRCUIT BREAKER POSITION	
	CLOSE	OPEN
Energy sufficient for O-CO operations	Open allowed	Close allowed
Energy sufficient for CO operations	Open allowed	Close allowed
Energy sufficient for O operations	Open allowed	Blocked in open position
Energy insufficient for any operation	Blocked in closed position or CB opened (depending on dip switch setting - I1004)	Blocked in open position

RECHARGE TIME

As with all energy storage devices, there is a recharge time required for operation of the breaker. A fully charged unit will do an Open-Close-Open operation. Average values for recharge on 15 kV units are listed below. The 27 kV units require additional recharge time. The values shown are minimums and will change as capacitor life and operation conditions vary.

Open-1.0 sec
Close-2.2 sec
Close-Open-3.4 sec
Open-Close-Open-5 sec

6.1 Discharging Storage Unit Capacitors

WARNING

Make sure ED2.0 Control Power is removed before attempting to discharge the capacitors. See paragraph below.

The ED2.0 board provides access through KM1003 for discharging the Storage Unit capacitors. Make sure the ED2.0 Control Board Power is removed before attempting to discharge the capacitors.

PROCEDURE:

A 10 kOhm capacitor discharge resistor is mounted on the circuit board. Discharging is done by jumpering KM1003 pins 4 and 5. The time constant is 33 minutes. An external resistor can be used for quicker discharging, but the discharge current should be restricted to 10 A maximum. This means that no lower than 10 Ohms external resistance should be used to perform capacitor discharging. In this case an external 10 Ohm, 25 watt resistor can be connected to KM1003 Pins 4 and 6. Approximately 30 seconds is needed to discharge the capacitors using the 10 Ohm external resistor.

6.2 Capacitor Life

The 0.1 Farad Electrolytic capacitors are designed to be operated in the temperature range of -40°F to 185°F. The End of Life corresponds to the point at which the capacitance decreases by 20% or more.

It is recommended that replacement of capacitors be performed every 15 years for tropical climates and 20 years for an average yearly temperature (in the outdoor breaker enclosure) of less than 122°F.

6.3 Breaker Ready / Not Ready Binary Output Contacts and Ready Light Status

CONDITION	CIRCUIT BREAKER POSITION	
	CLOSE	OPEN
Capacitor Energy sufficient For O-CO operations	**Ready LED:** on **Ready contact:** closed **Not ready contact:** opened	**Ready LED:** on **Ready contact:** closed **Not ready contact:** opened
Capacitor Energy sufficient for CO operations	**Ready LED:** blinking **Ready contact:** closed **Not ready contact:** opened	**Ready LED:** blinking **Ready contact:** closed **Not ready contact:** opened
Capacitor Energy sufficient for O operations	**Ready LED:** blinking **Ready contact:** closed **Not ready contact:** opened	**Ready LED:** off **Ready contact:** opened **Not ready contact:** closed
Capacitor Energy insufficient for any operations	**Ready LED:** off **Ready contact:** opened **Not ready contact:** closed	**Ready LED:** off **Ready contact:** opened **Not ready contact:** closed
Close Coil continuity not right	**Ready LED:** blinking **Ready contact:** closed **Not ready contact:** opened	**Ready LED:** off **Ready contact:** opened **Not ready contact:** closed
Open Coil continuity not right	**Ready LED:** off **Ready contact:** opened **Not ready contact:** closed	**Ready LED:** off **Ready contact:** opened **Not ready contact:** closed

7.0 STANDARD ED2.0 CIRCUIT BOARD AND CONNECTING DIAGRAM

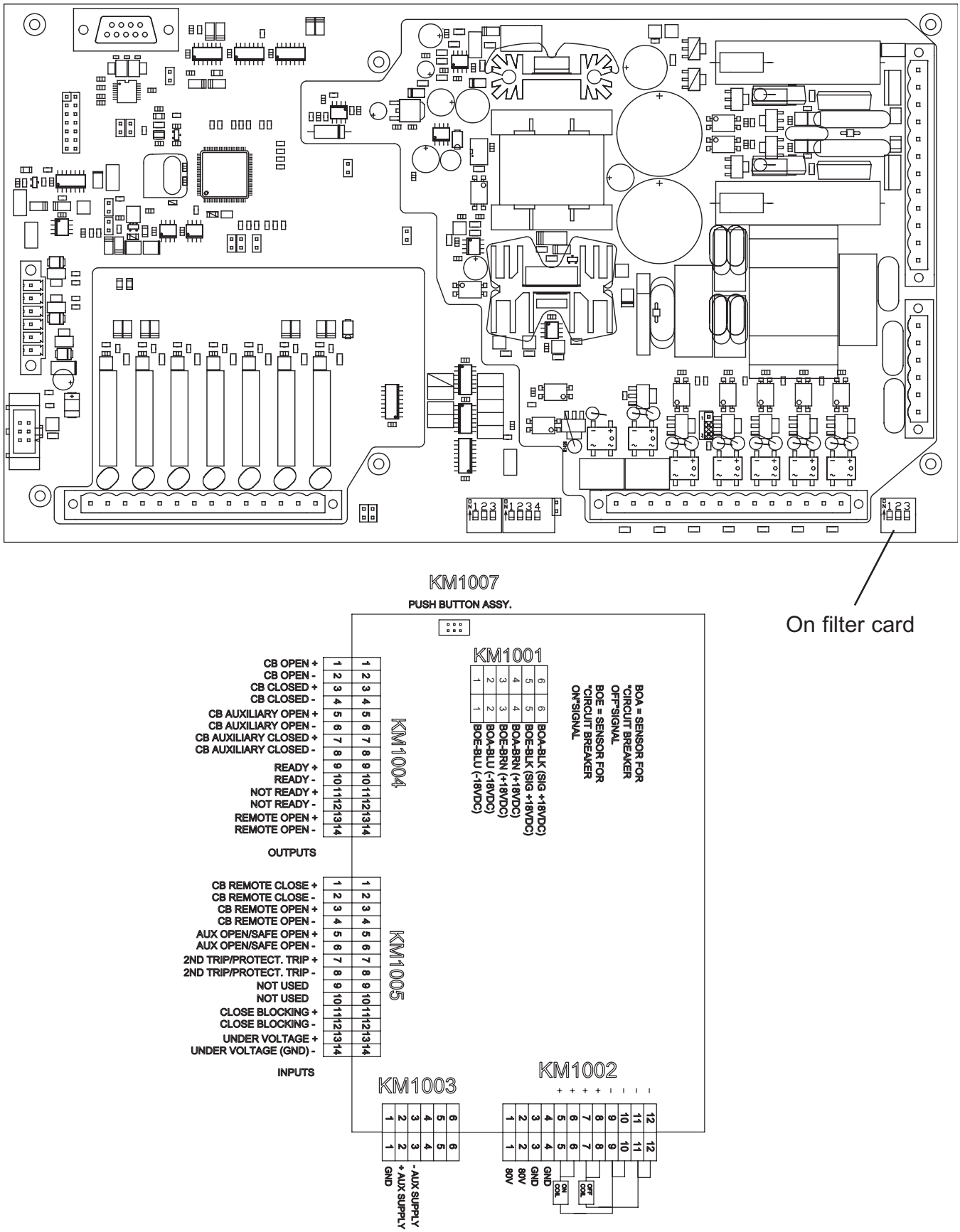
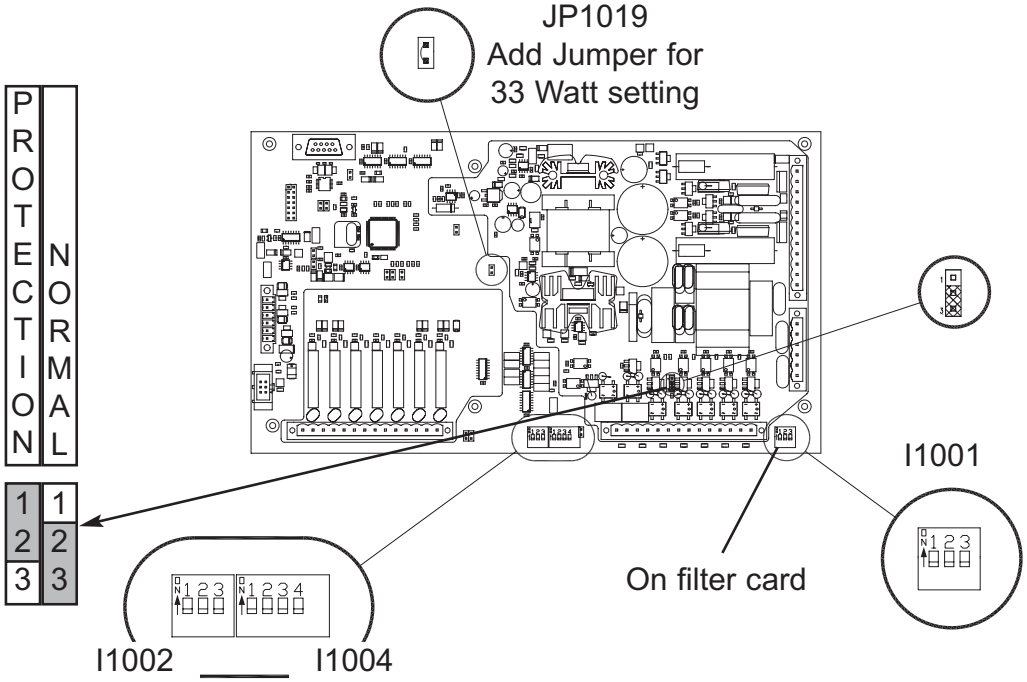


ILLUSTRATION 3 – ED2.0 CIRCUIT BOARD AND CONNECTIONS

8.0 DEFAULT JUMPER AND DIP SWITCH SETTINGS REV 02 AND GREATER ED2.0

Unless specified by the customer, the Low Energy and Under Voltage trip functions are disabled. Input three is set for Auxiliary trip mode as opposed to the Protection Relay trip mode. The Protection Relay mode has a lower switching threshold (12 V). See Section 3.0 in Appendix A for Switch and Jumper locations. The following represents the functional Jumper and Dip Switch settings which are the shipped configuration.



I1004 Energy failure auto trip and UV delay time				
	1	**2**	**3**	**4**
Energy failure Auto Trip Enabled	ON			
Energy failure Auto Trip Disabled	OFF			
UV Disabled		OFF	OFF	OFF
UV Delay 500 ms		OFF	ON	OFF
UV Delay 1000 ms		ON	ON	OFF
UV Delay 2000 ms		OFF	OFF	ON
UV Delay 3000 ms		ON	OFF	ON
UV Delay 4000 ms		OFF	ON	ON
UV Delay 5000 ms		ON	ON	ON

I1002 UV Threshold Setting			
	1	2	3
Binary input used as Aux Open	OFF		
Binary input 3 used as Safe Open	ON		
Not Used leave in Off position		OFF	
Undervoltage: CB Block in Open Position			OFF
Undervoltage: CB			ON

I1001 UV Threshold			
	1	**2**	**3**
220-240 VAC/VDC	OFF	OFF	OFF
100-127 VAC/VDC	ON	OFF	OFF
48-60 VAC/VDC	OFF	ON	OFF
24-30 VAC/VDC	OFF	OFF	ON

9.0 TROUBLESHOOTING FLOWCHARTS

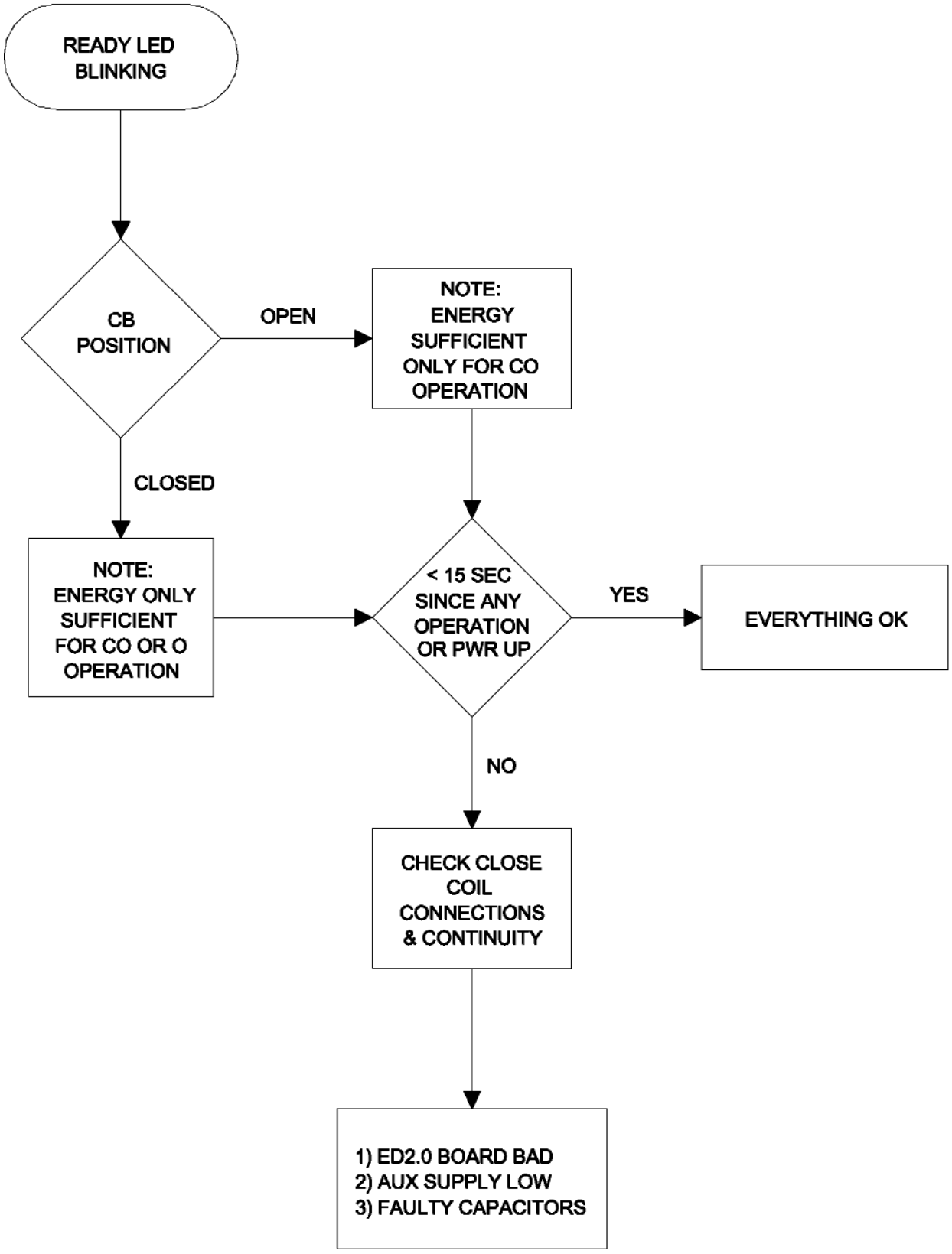


ILLUSTRATION 5 – READY LED CONTINUALLY FLASHING

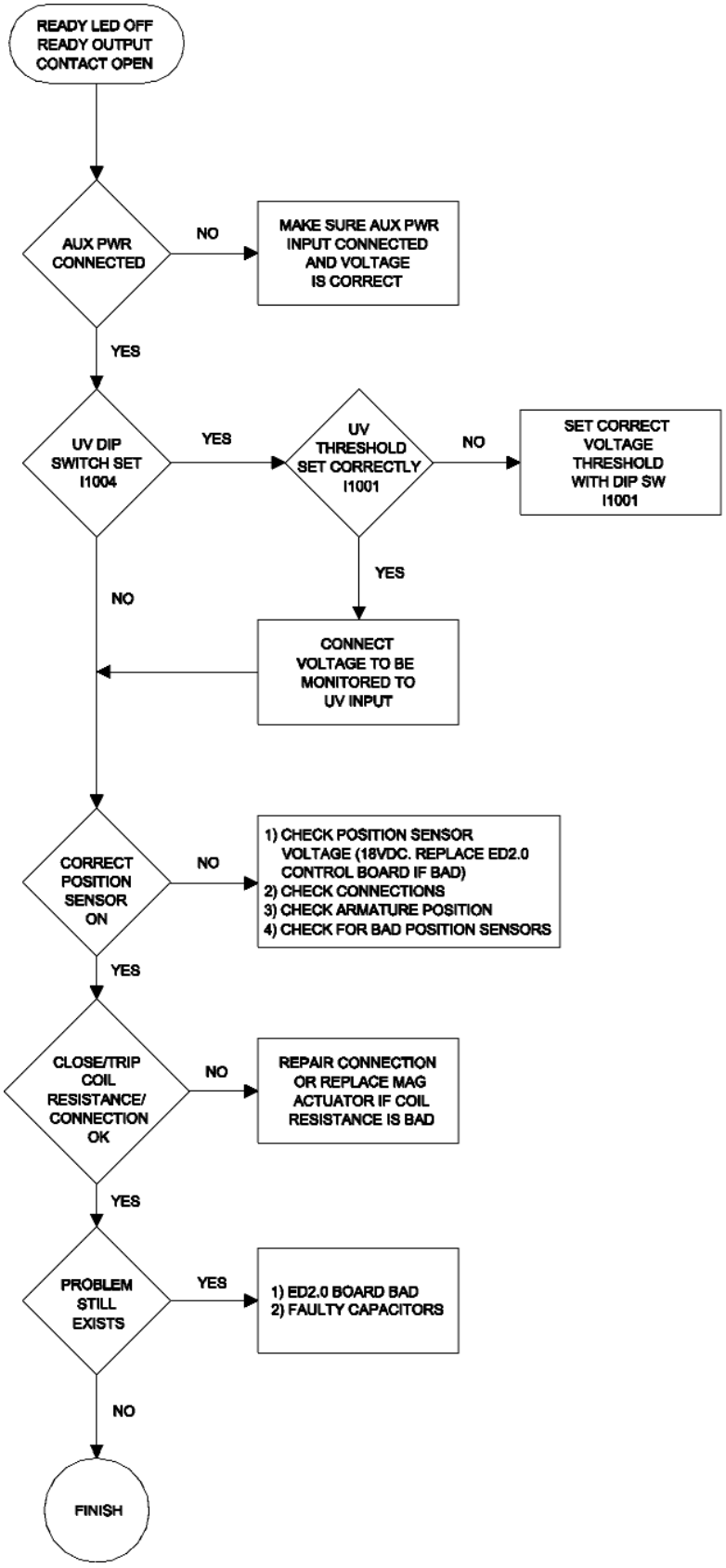


ILLUSTRATION 6 – READY LED OFF

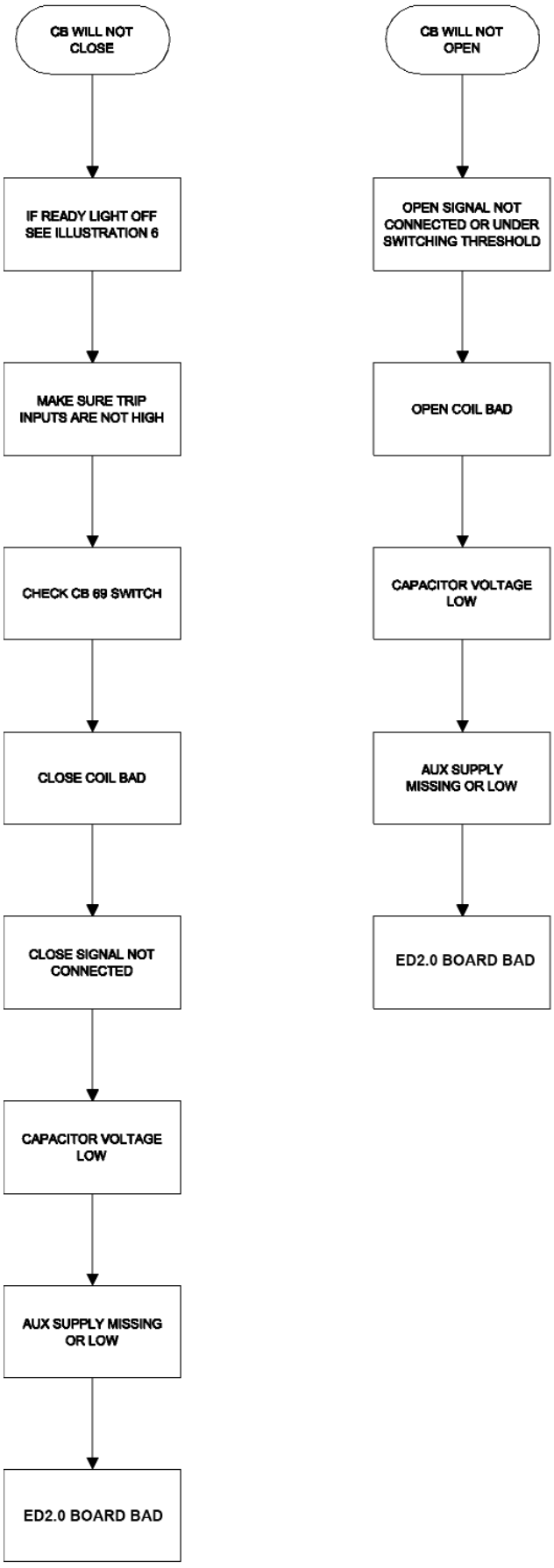


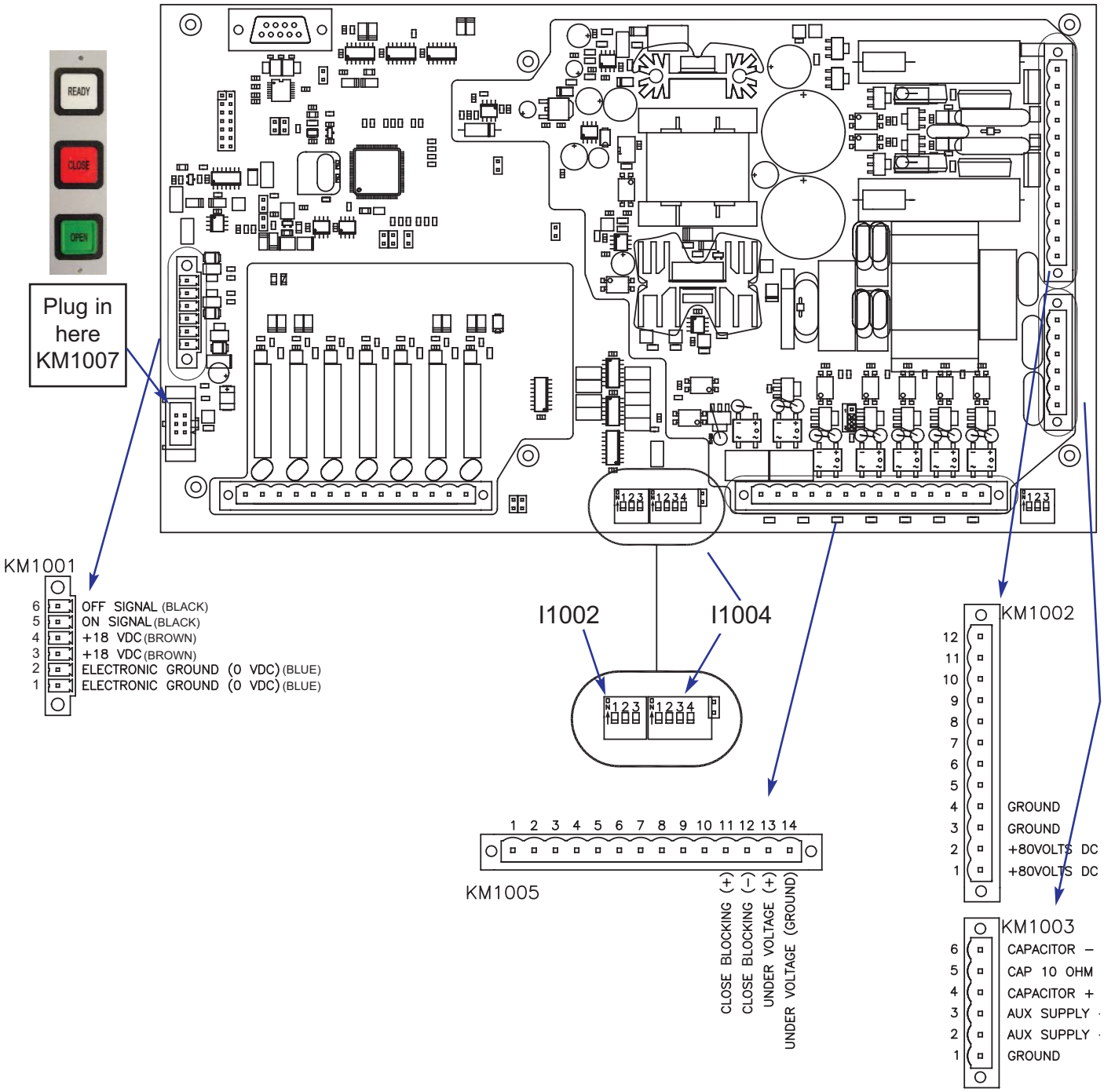
ILLUSTRATION 7 – CB WILL EITHER NOT OPEN OR CLOSE

10.0 INSTRUCTIONS FOR TROUBLESHOOTING AN ED2.0 CONTROL BOARD

The Power Supply recharge circuitry either reduces (high voltage board) or increases (low voltage board) input voltage within the specified range supplied to maintain an 80 V charge voltage across the capacitors.

The Control Unit monitors binary inputs and outputs, hardware and software configurations, position sensors, capacitor charge, and switches the FET circuit to connect the capacitor voltage to the magnetic actuator coils following an open or close command.

The Switching Box connects the FET circuit from the storage unit to the magnetic actuators.



1. Use diagram on the previous page for references to troubleshooting the ED2.0 board
2. Disconnect source power to outdoor breaker
3. Warning: removing cover exposes live voltage
4. Remove the two #4 screws holding on the Push button plate and let it hang down
5. Remove the four .250 X 20 screws from the corners of the ED2.0 cover

Follow these instructions for a quick setup check on a breaker that has operated previously:

READY LIGHT IS OFF:

1. Check pins 2 and 3 on KM1003 to confirm proper input voltage is applied.
2. Verify that there is 18 VDC on terminals 1 (-) to 3 (+) on KM1001.
3. Verify there is 80 VDC from KM1002 1 (-) to 3 (+).
4. If correct voltage is applied and DC is not reading, then the board needs to be replaced.

READY LIGHT IS ON:

Check proximity sensors located on top of the mechanism. The metal guard will have to be removed prior to inspection. When the sensor is properly positioned, you will see a yellow light on the rear of the sensor for each breaker position. When breaker is closed, the upper sensor will be lit. When open, the lower sensor will be lit. The gap between the sensor and the metal flag must be not be greater than .045. If this gap is incorrect, the sensor may not see the position of the breaker.

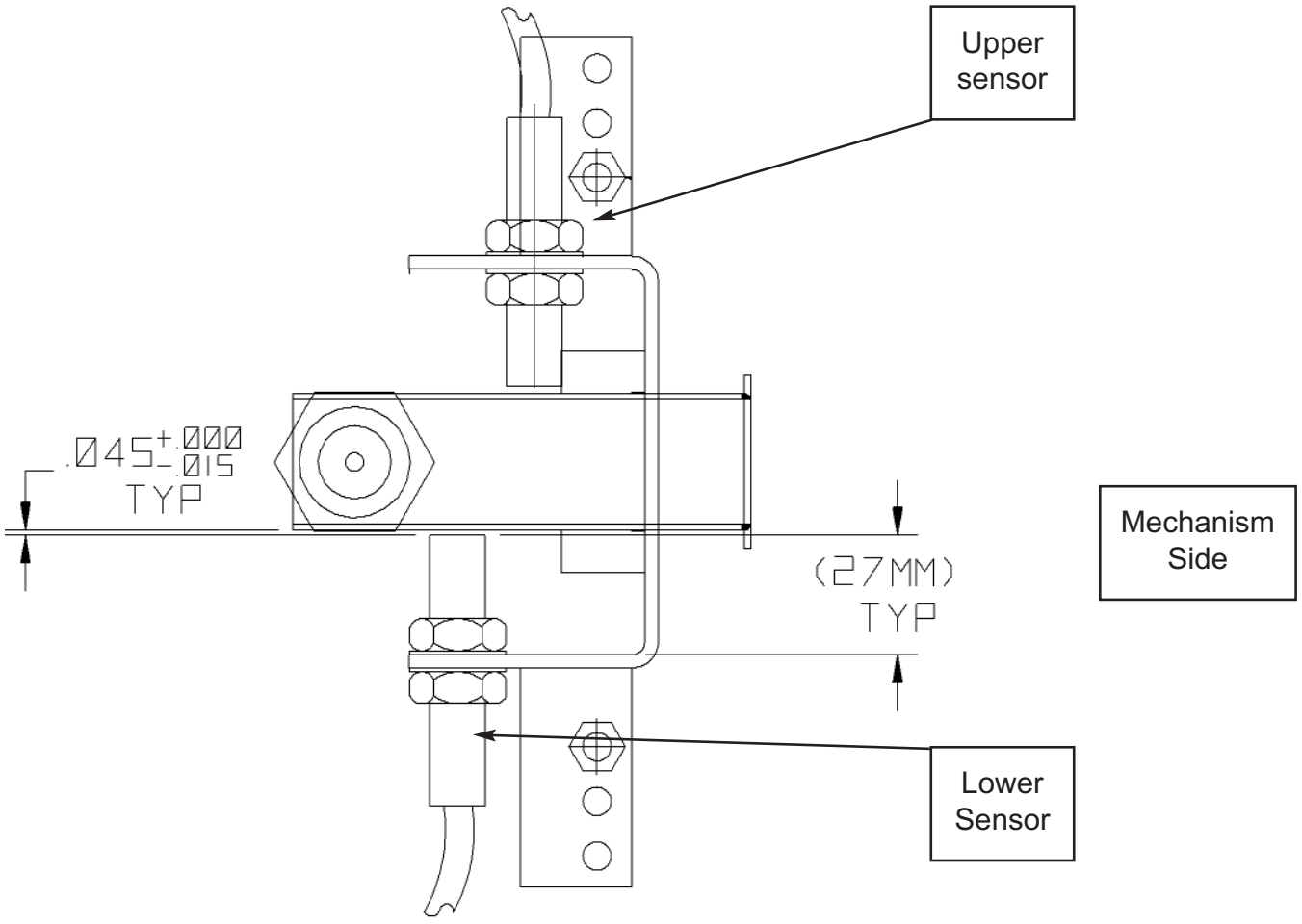


ILLUSTRATION 8 – POSITION (PROXIMITY) SENSORS

SPECIFIC LINE ITEM CHECK IS SHOWN BELOW:

PROBLEMS	POSSIBLE CAUSES	POSSIBLE SOLUTIONS
Ready LED is off (unit not ready)	The auxiliary supply voltage is absent.	Check pins 2 and 3 on KM1003 to confirm proper input voltage is applied.
	The magnetic actuator is damaged or not connected.	Check the magnetic actuator circuit. Unplug the magnetic actuator from the plug to the left of the mechanism (MA). There are two Phillips head screws that keep the plug held together. The top two wires are red the bottom two wires are blue. The bottom red (43) and bottom blue (45) wire go to the "On" (close) coil. The other two wires go to the off (open) coil. Each of these coils should read between 0.6 -1.0 ohms.
	The position sensors are damaged or not connected correctly.	There are 3 wires connected to the proximity sensors- Black is the signal wire, Brown is connected to +18 volts and Blue is connected to ground. When metal is placed in front of a sensor, it will be picked up and you will see the yellow LED lit on the back of the sensor. From the black wire to the blue wire verify it reads +18V. When the metal is removed the voltage should drop to near 0.
	The Under Voltage (UV) function is enabled and input is open.	Inspect dip switch I1004. Ensure switches 2, 3, 4 and 5 are in the off (down) position (disables UV), or apply correct input voltage to pins 13 and 14 on KM1005.
	The UV function is enabled and the monitored voltage is connected to the UV input, but the voltage is lower than the threshold.	Set the correct UV threshold level via DIP switch I1001 or disable UV by putting switches 2, 3, 4 and 5 in the off (down) position on I1004.
	The auxiliary supply voltage has been turned off and the voltage on the capacitor is under the O-CO levels.	Check pins 2 and 3 on KM1003 to confirm proper source input voltage is applied.
	The control panel is damaged or not connected correctly.	Verify the control panel 6-pin plug is plugged into KM1007.

PROBLEMS	POSSIBLE CAUSES	POSSIBLE SOLUTIONS
Ready LED is blinking	The circuit breaker is closed and the close coil is disconnected or broken.	In this case, only the opening operation is available; open the circuit breaker (the ready LED will be turned off) and check the closing coil circuit. Unplug the magnetic actuator from the plug to the left of the mechanism (MA). There are two Phillips head screws that keep the plug held together. The top two wires are red the bottom two wires are blue. The bottom red (43) and bottom blue (45) wire go to the "On" (close) coil. The coil should read between 0.6 -1.0 ohms.
	The auxiliary supply voltage has been turned off.	If the circuit breaker is closed you can perform a CO-operation; connect the auxiliary supply. Check pins 2 and 3 on KM1003 to confirm proper input voltage is applied.
	The capacitor bank is]charging during start up or after an operation.	Wait a few seconds.
The opening command is not performed	The opening coil is broken or damaged.	In this case, only the closing operation is available; open the circuit breaker (the ready LED will be turned off) and check the closing coil circuit. Disconnect the magnetic actuator from the plug to the left of the mechanism. There are two Phillips head screws that keep the plug held together. The top two wires are red and the bottom two wires are blue. The top red (43) and top blue (45) wire go to the "Off" (open) coil. The coil should read between 0.6 -1.0 ohms.
	The capacitor bank is not connected.	Check the capacitor bank circuit. Verify the capaci-tors are connected to the control board. Ensure that there is 80 VDC across KM1002 terminals 1 and 3.
	No external opening input is connected.	Verify opening input is wired.
	The control panel is either damaged or not connected correctly.	Verify the control panel 6-pin plug is plugged into
	ED2.0 switching circuit board	Replace ED2.0 board
All indication output contacts are open	The voltage on the capacitor bank is under 46 VDC.	Connect the auxiliary power supply voltage.
	Capacitor bank is not connected.	If it happens immediately when the supply voltage is switched off and the ready LED is immediately turned off, check the capacitor bank circuit.

PROBLEMS	POSSIBLE CAUSES	POSSIBLE SOLUTIONS
The closing command is not performed	The closing coil is broken or damaged.	Check the closing coil circuit. Disconnect the magnetic actuator from the plug to the left of the mechanism. There are two Phillips head screws that keep the plug held together. The top two wires are red and the bottom two wires are blue. The bottom red (43) and bottom blue (45) wire go to the "On" (close) coil. The coil should read between 0.6 -1.0 ohms.
	One open input is active.	Verify there is not a held trip signal on the ED2.0 board. Verify the voltage across TB1-8 and TB1-3 is "0" (KM1005 3, 4), and also across KM1005 5, 6 Safe open (if used), and KM1005 7, 8 second trip (if used).
	The block in open input is open (manual trip lever).	Check the manual trip lever to verify it is in the up (normal) position. If it is, verify the microswitch (mounted on the mechanism side) has continuity across the wires.
	The capacitor bank is not connected.	Check the capacitor bank circuit. Verify the capacitors are connected to the control board. Ensure that there is 80 VDC across KM1002 terminals 1 and 3.
	The ready LED on control panel is off.	See conditions under "Ready LED is off (unit not ready)".
	The control panel is damaged or not connected properly.	Verify the control panel 6-pin plug is plugged into KM1007.
	The energy in the capacitor bank is not enough for a CO-operation.	Ensure the auxiliary supply voltage is connected. See "ready light blinking" section.
	input is not supplied.	Verify close command is wired to input.
	ED2.0 switching circuit board	Replace ED2.0 board
The circuit breaker closes and then opens during a close operation	Verify the close position sensor circuit.	Verify the close position sensor circuit.
	Verify the presence of unwanted objects under the magnetic actuator plunger.	Verify the presence of unwanted objects under the magnetic actuator plunger.
The circuit breaker opens if the auxiliary supply is switched off	Either disable the UV function or connect to a different voltage source.	Either disable the UV function or connect to a different voltage source.
	If possible, disable the function via I1004-1. Switch 1 should be in the off position.	If possible, disable the function via I1004-1. Switch 1 should be in the off position.

11.0 INSTRUCTIONS FOR CHANGING OUT AN ED2.0 CONTROL BOARD

Warning: removing the cover exposes live voltage.

1. Disconnect the source power to the R-MAG.
2. Remove the two #4 screws holding on the Push button plate and let it hang down.
3. Remove the four .250 X 20 screws from the corners of the ED2.0 cover.
4. With the cover removed, verify the voltage input to the board is off by measuring the voltage at KM1003 terminals 2 and 3. It should be zero.

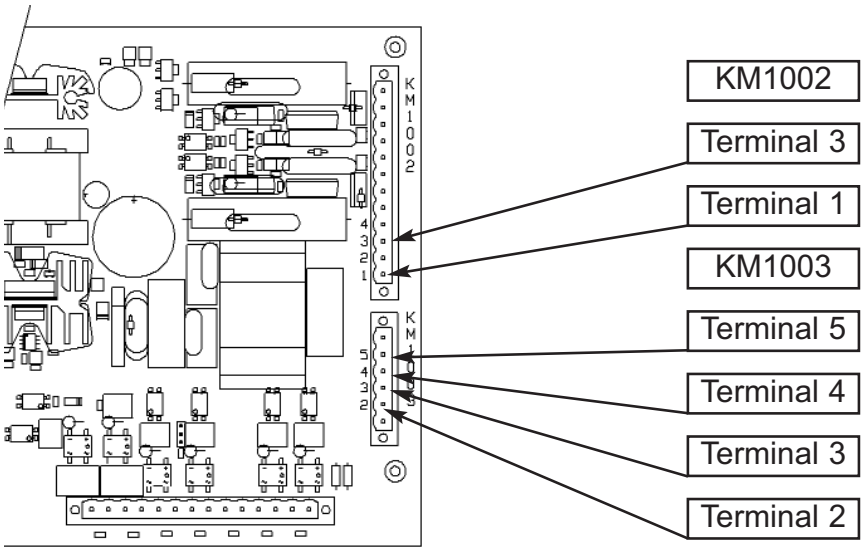
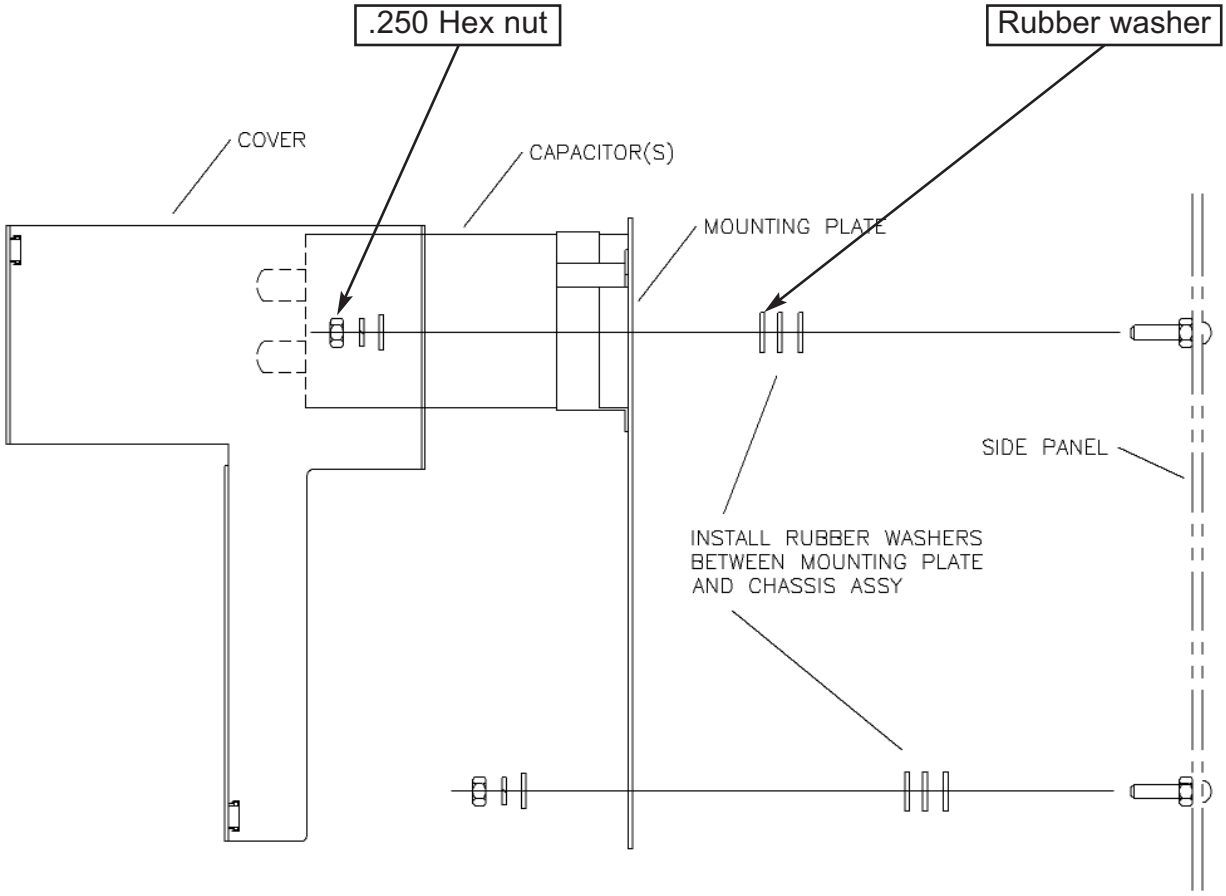


ILLUSTRATION 9 – KM1002 AND KM1003 TERMINALS

5. Before proceeding, discharge the capacitors by jumpering KM1003 pins 4 and 5. The time constant is 33 minutes. A smaller external resistor can be used for a quicker discharge, but the discharge current should be restricted to 10 amperes maximum. This means that no lower than 10 ohms 25 watt external resistance should be used to perform capacitor dis charging. When discharging with a external capacitor, connect to pins 2 and 3 on KM1002.
6. After the capacitors are discharged, take a small screwdriver and remove the capacitor plug.

7. Remove five plugs: KM1001, KM1002, KM1003, KM1004, KM1005, and KM1007. To remove, loosen hold down screws from each plug.
8. Remove plug for push button plate. This is not held by retainers.
9. Remove four .250-20 nut, lock and flat washer from the four corners. Keep the three rubber washers behind each screw.



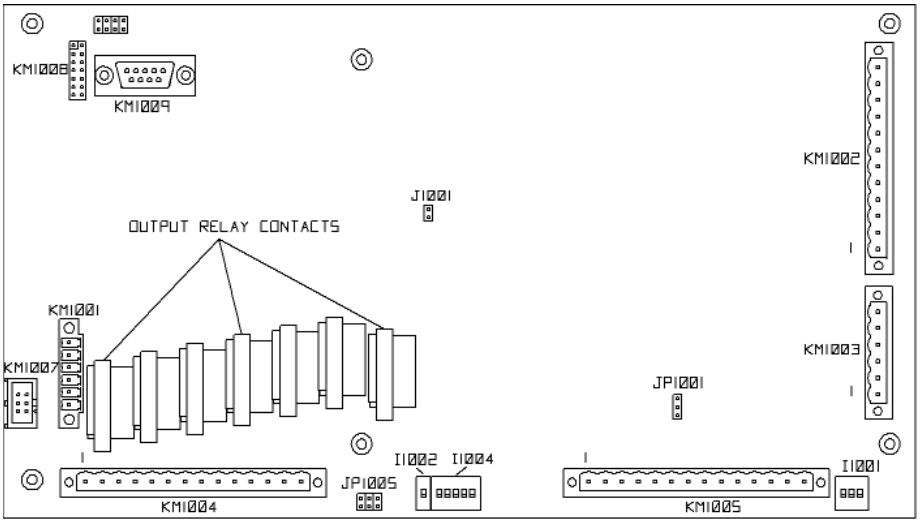


ILLUSTRATION 10 – ED2.0 CIRCUIT BOARD CONNECTORS

NOTES

NOTES

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1VAL255101-MB March 2009 Rev E (replaces IB 38-929M-15A)