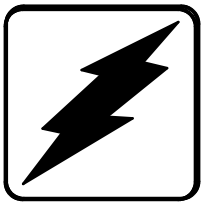
Service and Parts

Automatic Transfer Switches



Models:

ZCS

ZCB

Contactors:

150-3000 Amperes

ISO 9001
KOHLER GENERATORS
INTERNATIONALLY REGISTERED
U.S.A. Plant ISO Registered

KOHLER®
POWER SYSTEMS

TP-5668 11/95c

Table of Contents

Safety Precautions and Instructions

A transfer switch, like any other electromechanical device, can pose potential dangers to life and limb if improperly maintained or imprudently operated. The best way to prevent accidents is to be aware of the potential dangers and to always use good common sense. Below are some general precautions relating to the operation of a transfer switch. This manual contains several types of safety precautions which are explained below. SAVE THESE INSTRUCTIONS.

DANGER

Danger indicates the presence of a hazard that *will* cause *severe* personal injury, death, or substantial property damage if the danger is ignored.

WARNING

Warning indicates the presence of a hazard that *can* cause *severe* personal injury, death, or substantial property damage if the warning is ignored.

CAUTION

Caution indicates the presence of a hazard that *will* or *can* cause *minor* personal injury or property damage if the caution is ignored.

NOTE

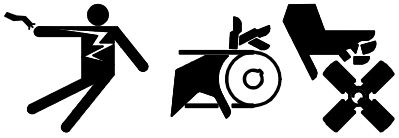
Note communicates installation, operation, or maintenance information that is important but not hazard related.

Safety decals are affixed to the generator set in prominent places to advise the operator or service technician of potential hazards. The decals are reproduced here to improve operator recognition. For a further explanation of decal information, refer to the safety precautions throughout this manual. Before operating or servicing the generator set, be sure you understand the messages of these decals. Replace decals if missing or damaged.

Safety decals are affixed to the transfer switch in prominent places to advise the operator or service technician of potential hazards. The decals are reproduced here to improve operator recognition. For a further explanation of decal information, refer to the safety precautions throughout this manual. Before operating or servicing the transfer switch, be sure you understand the messages of these decals. Replace decals if missing or damaged.

Accidental Starting

⚠ WARNING



Accidental starting.
Can cause severe injury or death.

Disconnect battery cables before working on generator set (negative lead first and reconnect it last).

Accidental starting can cause severe injury or death. Turn generator set master switch to OFF position, disconnect power to battery charger, and remove battery cables (remove negative lead first and reconnect it last) to disable generator set before working on any equipment connected to generator set. The generator set can be started by automatic transfer switch or remote start/stop switch unless these precautions are followed.

Battery

⚠ WARNING

Sulfuric acid in batteries.
Can cause severe injury or death.

Use protective goggles and clothes. Battery acid can cause permanent damage to eyes, burn skin, and eat holes in clothing.

⚠ WARNING

Explosion.
Can cause severe injury or death. Relays in battery charger cause arcs or sparks.

Locate in a well-ventilated area. Keep explosive fumes away.

Sulfuric acid in batteries can cause severe injury or death. Sulfuric acid in battery can cause permanent damage to eyes, burn skin, and eat holes in clothing. Always wear splash-proof safety goggles when working around the battery. If battery electrolyte is splashed in the eyes or on skin, immediately flush the affected area for 15 minutes with large quantities of clean water. Seek immediate medical aid in the case of eye contact. Never add acid to a battery once the battery has been placed in service. This may result in hazardous spattering of electrolyte.

Sulfuric acid in batteries can cause severe injury or death. Sulfuric acid in battery can cause permanent damage to eyes, burn skin, and eat holes in clothing. Always wear splash-proof safety goggles when working around the battery. If battery electrolyte is splashed in the eyes or on skin, immediately flush the affected area with large quantities of clean water. Continue flushing with water until emergency help arrives Seek immediate medical aid in the case of eye contact. Never add acid to a battery once the battery has been placed in service. This may result in hazardous spattering of electrolyte.

Explosion can cause severe injury or death. Battery gases can cause an explosion. Do not smoke or permit flame or spark to occur near a battery at any time, particularly when it is being charged. Avoid contacting terminals with tools, etc., to prevent burns and sparks that could cause an explosion. Remove wristwatch, rings, and any other jewelry before handling battery. Never connect negative (–) battery cable to positive (+) connection terminal of starter solenoid. Do not test battery condition by shorting terminals together. Sparks could ignite battery gases or fuel vapors. Ventilate any compartment containing batteries to prevent accumulation of explosive gases. To avoid sparks, do not disturb battery charger connections while battery is being changed. Always turn battery charger off before disconnecting battery connections. Remove negative lead first and reconnect it last when disconnecting battery.

Hazardous Voltage/ Electrical Shock

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Do not open enclosure until all power sources are disconnected.

(600 Volt and above)

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect power sources before servicing. Barrier must be installed after adjustments, maintenance, or servicing.

(600 Volt and above)

⚠ WARNING

Hazardous voltage.
Can cause severe injury or death.

Disconnect power sources before servicing. Barrier must be installed after adjustments, maintenance, or servicing.

(under 600 Volt)

⚠ WARNING

Hazardous voltage.
Can cause severe injury or death.

Do not open enclosure until all power sources are disconnected.

(under 600 Volt)

Hazardous voltage can cause severe injury or death. Whenever electricity is present, there is the hazard of electrocution. Open main circuit breaker on all power sources before servicing equipment. Electrically ground the generator set and electrical circuits when in use. Never come into contact with electrical leads or appliances when standing in water or on wet ground, as the chance of electrocution is increased under such conditions.

Hazardous voltage can cause severe injury or death. Short circuits can cause bodily injury and/or equipment damage**.** Do not contact electrical connections with tools or jewelry while adjustments are made. Remove wristwatch, rings, and jewelry that can cause short circuits.

Hazardous voltage can cause severe injury or death. To prevent the possibility of electrical shock, disconnect harness plug before installing any accessories involving connection to transformer assembly primary terminals 76, 77, 78, and 79. Terminals are at line voltage!
(S340, R340, and R33 models only.)

Hazardous voltage can cause severe injury or death. To prevent the possibility of electrical shock, disconnect harness plug before installing any accessories involving connection to transformer assembly primary terminals on microprocessor logic models. Terminals are at line voltage!

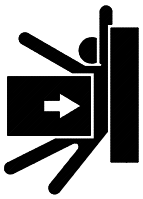
Hazardous voltage can cause severe injury or death. To prevent the possibility of electrical shock, de-energize the normal power source to be connected to the transfer switch before making any line or auxiliary connections.

Hazardous voltage can cause severe injury or death. De-energize both normal and emergency power sources before proceeding. Move generator set master switch on controller to OFF position and disconnect battery negative (–) before working on transfer switch! Turn the transfer switch selector switch to the OFF position.

Hazardous voltage can cause severe injury or death. Disconnect inner panel harness at in-line connector. This will de-energize circuit board and logic circuitry, but allow transfer switch to continue to supply utility power to necessary lighting and equipment. Hazardous voltage will exist if any accessories mounted to inner panel are NOT wired through the inner panel harness and de-energized by in-line connector separation. Such accessories are at line voltage.

Heavy Equipment

⚠ WARNING



Unbalanced weight.
Improper lift can cause severe injury or death and/or equipment damage.

Use adequate lifting capacity.
Never leave transfer switch standing upright unless it is securely bolted in place or stabilized.

Notes

NOTE

Hardware Damage! Transfer switch may use both American standard and metric hardware. Use the correct size tools to prevent rounding of bolt heads and nuts.

NOTE

When replacing hardware, do not substitute with inferior grade hardware. Screws and nuts are available in different hardness ratings. American Standard hardware uses a series of markings and metric hardware uses a numeric system to indicate hardness. Check markings on bolt head and nuts for identification.

NOTE

A manual operator handle is provided on the transfer switch for maintenance purposes only. Return the transfer switch to the normal position. Remove manual operator handle (if used) and store it on the transfer switch in the place provided when service is completed.

NOTE

Perform voltage checks in the order given to avoid damaging the switch.

NOTE

These battery chargers are designed strictly for use in this transfer switch and conform with UL and CSA listing requirements where specified. Do not use battery charger before reading instructions.

NOTE

Connect source and load phases as indicated by the markings and drawings. Improper connections may cause short circuits and can cause phase-sensitive load devices to run in reverse or prevent load devices from functioning.

NOTE

Charger Damage! Connect battery charger only to a battery with the same DC voltage as the battery charger output rating.

NOTE

Cover transfer switch during installation to keep dirt, grit, metal drill chips, etc., out of components. Cover solenoid mechanism during installation. After installation, use manual operating handle to position contactor to ensure that it operates freely. Do not use a screwdriver to force contactor mechanism.

Introduction

This manual covers the operation, troubleshooting, repair, and service parts for the power conversion units that use 150 to 3000 ampere power contactor for the power switching devices.

Read through this manual and carefully follow all procedures and safety precautions to ensure proper equipment operation and to avoid bodily injury. Read and follow the safety Precautions and Instructions section at the beginning of this manual. Keep this manual with the equipment for future reference.

Service requirements are minimal but are very important to the safe and reliable operation of the transfer switch; therefore, inspect associated parts often. It is recommended that an authorized service distributor perform required servicing to keep the switch in top condition.

All information found in this publication is based on data available at time of printing. The manufacturer reserves the right to make changes to this literature and the products represented at any time without notice and without incurring obligation.

List of Related Manuals

The power conversion units covered in this manual are part of a family of related devices. Separate service and parts manuals are available for each group within the overall family. Be sure this manual is the correct manual for the automatic transfer switch.

A logic controller is included in each automatic transfer switch. There are three types of logic controllers and each type is covered in a separate service and parts manual. Available logic controllers and the related manual numbers are as follows:

Controller	Service/ Parts Manual
Controller E33+ (ZCS only)	TP-5670
Controller S340+	TP-5671
Controller M340+	TP-5672

Service Assistance

For sales and service in the U.S.A. and Canada check the yellow pages of the telephone directory under the heading GENERATORS– ELECTRIC for an authorized service distributor/dealer or call 1-800-544-2444.

KOHLER CO., Kohler, Wisconsin 53044 U.S.A.
Phone: 414-565-3381
Fax: 414-459-1646 (U.S.A. Sales)
414-459-1614 (International)

To ensure supply of correct parts or information, make note of the following identification numbers in the spaces provided:

PART NUMBER AND SERIAL NUMBER

Part and serial numbers are provided on the nameplate attached to the transfer switch.

Part No. _____

Serial No. _____

Notes

Section 1. Specifications

Purpose of Automatic Transfer Switch

An Automatic Transfer Switch (ATS) is a device that transfers critical electrical loads from a normal (preferred) source of electrical power to an emergency (standby) source. This transfer occurs automatically when the normal source voltage fails, or is substantially reduced, and the emergency source's voltage reaches an acceptable level.

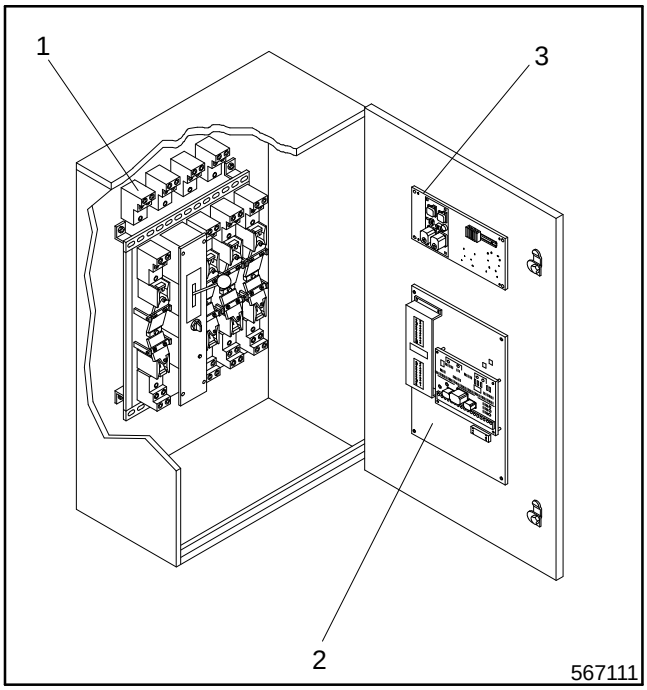
Upon normal source failure, the automatic transfer switch controller signals the generator set(s) to start and transfer to the emergency source. The automatic transfer switch controller continuously senses for an acceptable normal source and will retransfer the load to the normal source after it has been restored to an acceptable level. After retransfer of the load, the generator set start signal is removed and the generator set(s) is allowed to shut down.

Components of ZCS Switch

A typical automatic transfer switch includes the actual power switching device and the logic controller to perform power monitoring and transfer sequencing tasks. See Figure 1-1. An ATS also includes an interface board to match the controller inputs/outputs to the levels required by a specific switching device.

The power switching device used in the models covered by this manual is a true power transfer switch. The switch is electrically actuated and then mechanically latched in the selected position. However, the switch also includes provisions for manual mechanical operation in emergency conditions. Within the switch, there are two sets of multipole contactors. One set selects power from the normal source while the other set selects power from the emergency source. The two sets of contacts are mechanically interlocked within the switch so that only one set of contactors can be closed at a given time. With this feature it is possible to select one power source to feed the load without crosscoupling that power source to the other power source.

The three functional units that make up the automatic transfer switch mount in an enclosure with a hinged front door. The controller mounts on the back of the front door with controls and indicators available to the operator. A signal cable with in-line connectors to facilitate component replacement and door removal connects the controller to the interface board and the switching devices.



1. Power conversion unit
2. Interface panel
3. Logic controller

Figure 1-1. Transfer switch components

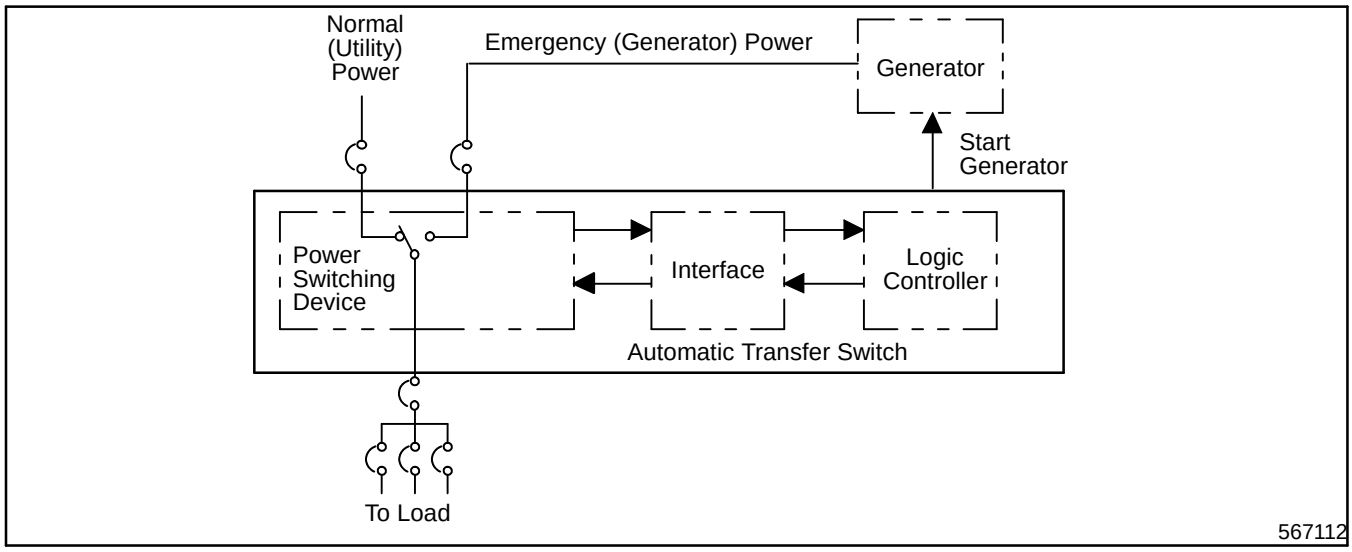


Figure 1-2. Basic transfer switch block diagram

Purpose of Bypass/Isolation Switch

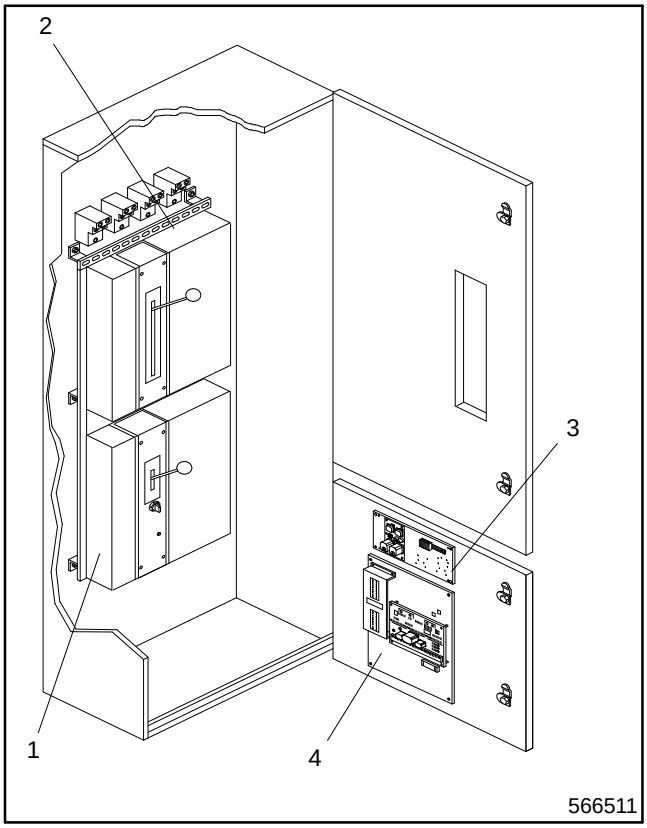
A bypass/isolation switch is a manually operated device. Use a bypass/isolation switch in conjunction with an ATS to directly connect load conductors to either a normal (preferred) power source or to an emergency (standby) power source. Use it also to disconnect the automatic transfer switch from the power sources and the load for inspection and maintenance.

The bypass switch also functions as a manual transfer switch, allowing transfer of the load from one source to the other, if required, with the automatic transfer switch removed from the system.

Components of ZCB Switch

A typical bypass/isolation transfer switch includes the actual power switching device, the bypass/isolation switching device, and the logic controller which performs power monitoring and transfer sequencing tasks. See Figure 1-3. A bypass/isolation transfer switch also includes an interface board to match the controller inputs/outputs to the levels required by a specific switching device.

The four functional units that make up the bypass/isolation automatic transfer switch mount in an enclosure with a hinged front door. The controller mounts on the back of the door so its controls and indicators are available to an operator. A signal cable with inline connectors to facilitate component replacement and door removal connects the controller to the interface board and the switching devices.



1. ATS
2. Bypass/isolation switch
3. Interface panel
4. Logic controller

Figure 1-3. Transfer switch components

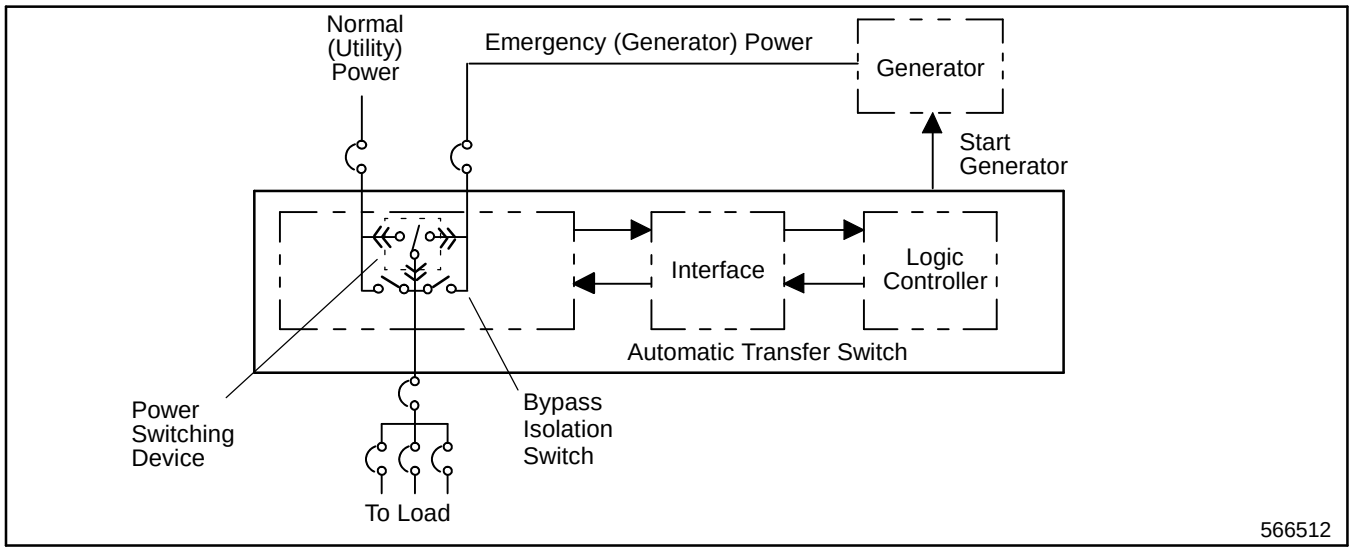


Figure 1-4. Basic bypass/isolation transfer switch block diagram

Ratings

A nameplate affixed to the ATS enclosure identifies the switch. See Figure 1-5. The nameplate label includes a factory part number coded to provide characteristic and rating information that affects installation and operation. Copy the part number into the blank spaces provided in the introduction and then use the tables in Figure 1-6 to interpret the part number.

NOTE

Also copy the part number and serial number from the nameplate into the spaces provided in the **Service Assistance** Section of the Introduction for use when requesting service or parts.

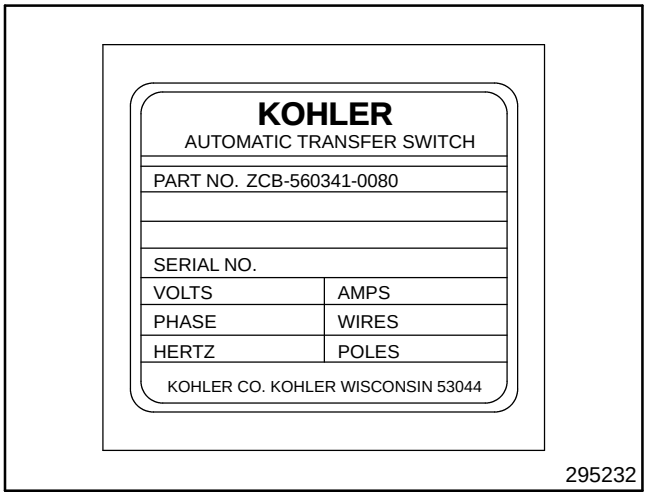
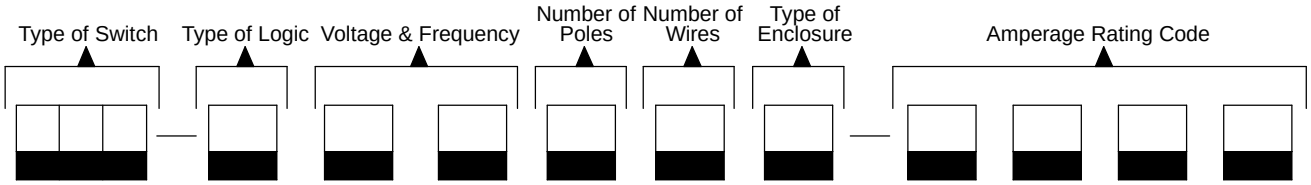


Figure 1-5. Transfer switch nameplate

Interpreting a Transfer Switch Part Number

Record the transfer switch part number in the boxes below. The transfer switch part number defines characteristics and ratings explained in the accompanying chart.



Kohler Part Number Key

This chart explains the Kohler transfer switch part numbering system. The sample part number shown is for a standard mechanical power conversion unit with M340+ logic rated at 600 volts, 60 hertz, 3-phase, 3-pole, and 4 wires in a NEMA 1 enclosure with an amperage rating of 1000 amperes.

SAMPLE PART NUMBER

ZCS-560341-1000

Classification of Power Switch
Z: Power Switch

Type of Power Switch
C: Contactor

Type of Switch
S: Standard
B: Bypass/Isolation

Type of Logic
1: S340+
2: E33+
3: S340+ with Programmed Transition
4: E33+ with Programmed Transition
5: M340+
6: M340+ with Programmed Transition

Voltage Code

60: 600 Volt, 60 Hz	66: 480 Volt, 60 Hz
62: 120 Volt, 60 Hz	68: 208 Volt, 60 Hz
63: 220 Volt, 50 Hz	71: 380 Volt, 50/60 Hz
64: 240 Volt, 60 Hz	

Number of Poles
2: 2 Pole, 1 Phase
3: 3 Pole, 3 Phase
6: 4 Pole, Fully Rated

Number of Wires
3: 3 wire
4: 4 wire

Enclosure
1: NEMA type 1

Amperes
Available sizes vary with the type of switch.

566513

Figure 1-6. Transfer switch model description

ZCS Specifications

ZCS power switching device specifications follow:

- Transfer switch is provided as a complete automatic transfer switch with E33+, S340+ or M340+ controller in a NEMA type 1 enclosure
- Transfer switch meets UL and CSA standards
- Transfer switch is rated up to 600 vac
- Programmed Transition Switch is rated from 150 to 3000 amperes
- Standard Switch is rated from 800 to 3000 amperes
- Transfer switch is electrically and mechanically interlocked.
- Transfer switch is available in two pole, three pole, and four-pole configuration.
- Four-pole switch is fully rated.
- Transfer switch can be operated manually
- Transfer switch withstand and current closing ratings as shown in Figure 1-7.

	Standard and Programmed Transition Models Withstand and Closing Ratings When Coordinated With Any Current-Limiting Fuse		Standard Models Withstand and Closing Ratings With Coordinated Molded-Case Circuit Breakers		Standard Models Withstand and Closing Ratings For 3 Cycles per UL-1008 (Any Breaker)	Programmed Transition Models Withstand and Closing Ratings With Coordinated Molded-Case Circuit Breakers		Programmed Transition Models Withstand and Closing Ratings For 3 Cycles per UL-1008 (Any Breaker)
UL-1008 Switch Ratings	Max. Fuse Size (Amps)	Max. Circuit (Amps)	Max. Circuit Breaker Size (Amps)	Max. Circuit (Amps)	Max. Circuit (Amps)	Max. Circuit Breaker Size (Amps)	Max. Circuit (Amps)	Max. Circuit (Amps)
150	200	200,000				350	50,000	35,000
225	300	200,000				350	50,000	35,000
260	350	200,000				350	50,000	35,000
400	600	200,000				500	50,000	35,000
600	750	200,000				800	65,000	50,000
800	1000	200,000	1600	85,000	50,000	1600	85,000	50,000
1000	1250	200,000	1600	85,000	50,000	1600	85,000	50,000
1200	1500	200,000	1600	85,000	50,000	1600	85,000	50,000
1600	2000	200,000	2000	100,000	100,000	2500	100,000	100,000
2000	2500	200,000	2500	100,000	100,000	2500	100,000	100,000
2500	2500	200,000	2500	100,000	100,000	2500	100,000	100,000
3000	4000	200,000	4000	100,000	100,000	4000	100,000	100,000

Figure 1-7. Withstand and current closing ratings at 480 VAC

ZCB Specifications

The specifications listed below are for the power conversion units. See the respective logic controller manual for its specifications.

Standard Features

- Transfer switch is rated identical to the ZCS.
- Transfer switch is provided as a complete automatic transfer switch with S340+ or M340 + controller in a NEMA type 1 enclosure.
- Transfer switch meets UL and CSA standards.
- Transfer switch is rated voltage up to 600 vac.
- Transfer switch is rated from 150 to 3000 amps.
- Transfer switch is available with ZCS standard or programmed transition automatic transfer switches.
- Transfer switch is electrically and mechanically interlocked.
- Transfer switch is available in two pole, three pole, and four-pole configuration.
- Four-pole switch is fully rated.
- The load is not interrupted during bypass operation.

Section 2. Operation

ATS Sequence of Operation

Automatic transfer switch operation typically consists of two separate sequences: (1) normal power failure and the resulting transfer to emergency power and (2) normal power restoration and the resulting transfer back to normal power. A brief description of both sequences follows below. Accessories described in the applicable controller operation and installation manual may affect these sequences. For more specific details on circuit operation including time delays, refer to the applicable Logic Controller Operation and Installation Manual. See **List of Related Manuals** in the Introduction.

Normal Source Failure

Source monitors within the controller detect normal source failure, either loss or deterioration of one or more phases (logic dependent). The monitor that detects the failure starts a time delay called Time Delay Engine Start (TDES). If power is restored before the time delay expires, the timer resets. But, if the failure persists and the time delay expires, the controller issues a signal to start the standby (emergency) power generator. This time delay scheme prevents generator set starting during short power interruptions.

A second set of source monitors within the controller checks the status of the emergency power. When the voltage and frequency of the emergency (generator) power are acceptable, these monitors start a Time Delay Normal to Emergency (TDNE) timing cycle which allows the generator outputs to stabilize. At the end of this timing cycle, the controller issues a signal to the transfer switch operators to remove normal power and then connect emergency power to the load.

The transfer switch mechanically latches in the emergency position once the emergency power connects to the load. The transfer switch supplies emergency source power to the load until normal power is restored.

Normal Source Restoration

Normal source restoration automatically begins a sequence that transfers the load back to the normal power source. The source monitors within the controller continue to check the status of the normal power, even when the load is operating on emergency power. When these monitors detect stable normal power, a Time Delay Emergency to Normal (TDEN) time delay starts. If the normal power fails again before the time delay expires, the time delay resets. This timing period ensures that the normal power stabilizes before it is reconnected to the load.

If the normal power remains acceptable and the time delay expires, the controller issues a signal to the transfer switch to remove emergency power and reconnect normal power to the load. After switching, the transfer switch mechanically latches in the normal position. Depending upon which logic is used, the controller starts a Time Delay Engine Cooldown (TDEC) timer simultaneously with the power transfer. After this time delay expires, the generator engine is stopped.

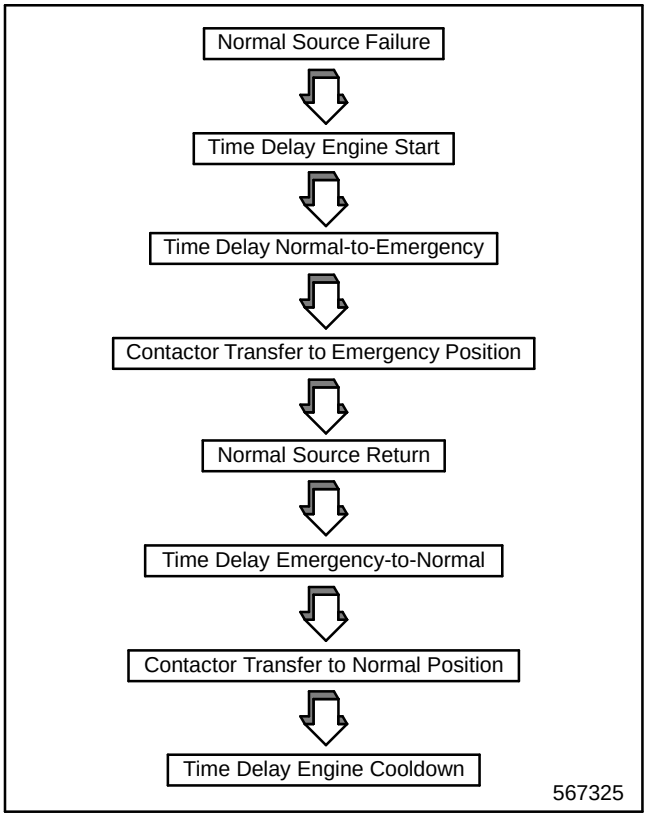


Figure 2-1. Logic board operation

Control Switches and Indicators

Logic controller choice determines the switches and indicators on the automatic transfer switch. For details on the control switches and indicators, refer to the appropriate Logic Controller Operation and Installation Manual. See **List of Related Manuals** in the Introduction.

Manual ZCS Operation

Manually operate the automatic transfer switch when the controller fails or to test/troubleshoot the unit. An operator handle is provided for manual operation.

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect power sources before servicing. Barrier must be installed after adjustments, maintenance, or servicing.

To manually operate the automatic transfer switch, proceed as follows:

1. Disconnect or turn off both the normal and emergency power sources.
2. Open enclosure door of automatic transfer switch.
3. Set the disconnect switch (DS) to the DISCONNECT position to prevent the controller from energizing the solenoid(s). See Figure 2-2.
4. Insert the operator handle and set the transfer switch to the desired position.
5. Remove and stow the operator handle.
6. Close the enclosure door.
7. Reconnect or turn on the applicable (normal or emergency) power source.

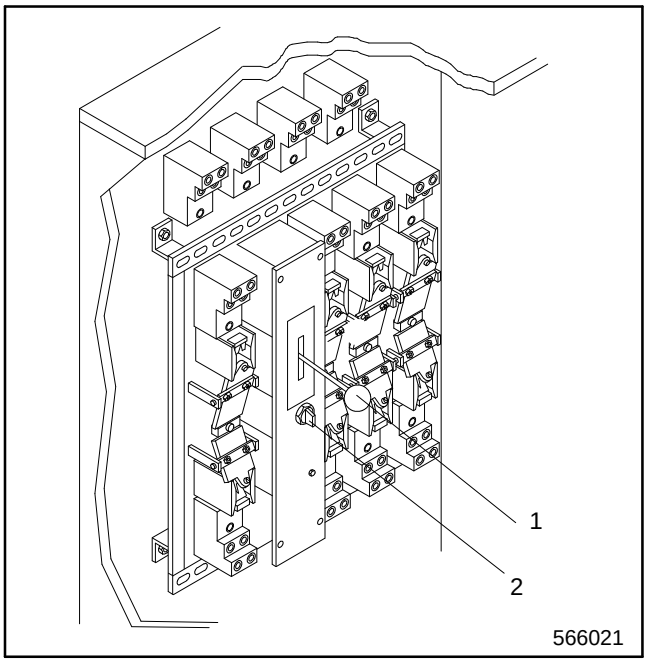
Automatic ZCS Operation

Initial Settings

Before turning on the power for the first time, or when returning from manual operation to automatic operation, manually operate the automatic transfer switch to select the normal power source as described in **Manual Operation** above. Before closing the enclosure door and activating the normal power source, return the disconnect (DS) switch to its normal position to reconnect the logic controller to the transfer switch solenoids.

Automatic Operation Procedures

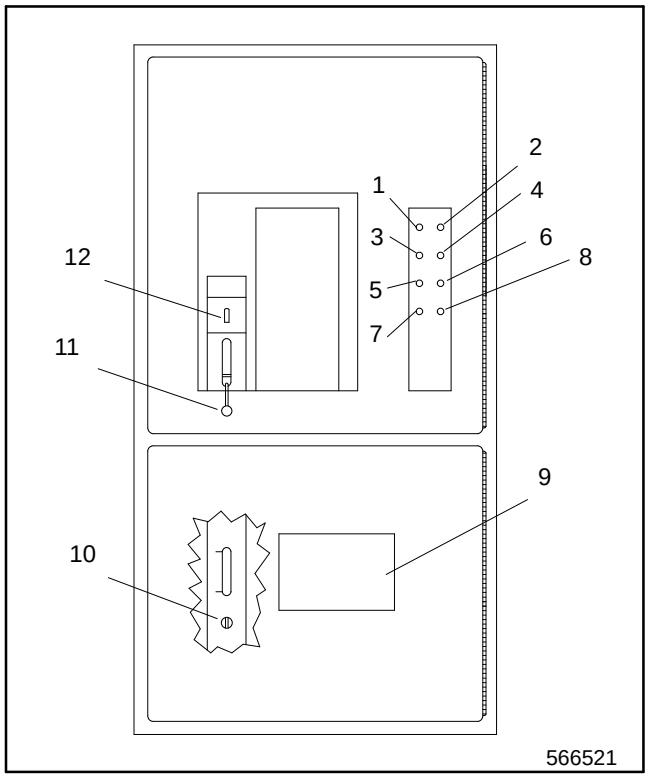
Automatic operation is a function of the logic controller installed in the ATS. For automatic operation details and procedures, refer to the appropriate Logic Controller Operation and Installation Manual. See **List of Related Manuals** in the Introduction.



1. Manual Handle
2. Disconnect switch

Figure 2-2. Manual operation of automatic transfer switch

ZCB Operation
Switches and Indicators



1. LBE
2. LEA
3. LBN
4. LNA
5. LAI
6. LAI
7. LIT/LAH
8. LDS
9. Logic controls
10. Disconnect switch
11. Manual bypass handle
12. Bypass selector switch

Figure 2-3. Bypass/isolation switch

Disconnect Switch. The disconnect switch controls the ATS coil operation. In the auto position the logic controls the ATS operation. In the inhibit position, the logic controller cannot energize the ATS coils.

ATS Location Pointer. The ATS location pointer indicates the three positions of the ATS switch:

Auto: The ATS is connected to all of the buses.

Test: The ATS is disconnected from the load bus but connected to the normal and emergency buses.

Isolate: The ATS is disconnected from all buses.

Description of the Bypass/Isolation Cabinet Lights

Bottom Door

Choice of controller determines the switches and indicators for the automatic transfer switch. For details on switches and indicators, refer to the respective Logic Controller Operation and Installation Manual. See **List of Related Manuals** in the Introduction.

Top Door

LNA Lamp. Lamp illuminates when the normal power source is available.

LEA Lamp. Lamp illuminates when the emergency power source is available.

LBN Lamp.* Lamp illuminates when the normal bypass contacts are closed.

LBE Lamp.* Lamp illuminates when the emergency bypass contacts are closed.

LAT Lamp.* Lamp illuminates when the ATS is in the test location.

LAI Lamp.* Lamp illuminates when the ATS is isolated from the switch.

LAH Lamp.* Lamp illuminates when the ATS is not in the automatic mode (600-1200 amp switches only).

LIT Lamp.* Lamp illuminates when the ATS is not in the automatic mode (all except 600-1200 amp switches).

LDS Lamp.* Lamp flashes when the ATS coils are prevented from operating by the disconnect switch.

* These lamps will illuminate when any of the following are true:

1. The disconnect switch is in the inhibit position.
2. The bypass selector switch is in the normal or emergency position.
3. The ATS is not in the auto location.

Description of Bypass/Isolation Switch Components

Bypass Normal Contacts. The bypass normal contact connects the load directly to the normal source, bypassing the ATS.

Bypass Emergency Contacts. The bypass emergency contacts connect the load directly to the emergency source, bypassing the ATS.

Bypass Operator. The bypass operator opens and closes the bypass normal or emergency contacts.

Manual Bypass Handle. The manual-bypass handle actuates the bypass operator. In the lower (open) position, the bypass normal and emergency contacts are open. In the upper (bypass) position, the bypass normal or emergency contacts are closed.

Bypass Selector Switch. The bypass selector switch determines which contacts the manual bypass handle actuates. Turn the bypass selector switch to the right to close the bypass normal contacts, center to open the bypass normal and emergency contacts, and left to close the bypass emergency contacts.

ATS Location Handle (150- to 400-amp switches only). The position of the ATS location handle determines the ATS mode of operation: auto, test or isolate. The ATS location handle can be moved only when the manual bypass handle is in the bypass position.

Crank Mechanism (600- to 3000-amp switches only). The crank mechanism determines the ATS mode of operation: auto, test or isolate. Turn the crank mechanism clockwise to raise the ATS and counterclockwise to lower the ATS through the three positions. The crank mechanism can be rotated only when the manual bypass handle is in the bypass position.

Operation of the Bypass/Isolation Switch

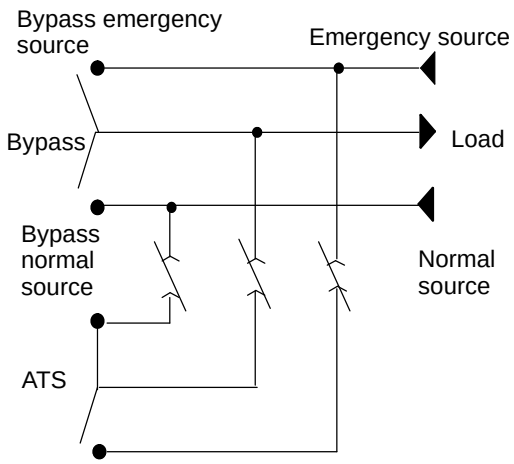
To place the ATS in the Automatic Mode

For 150- to 400-amp switches

1. Verify that the ATS contacts are in the same position as the bypass contacts.
2. Turn the disconnect switch to the INHIBIT position.
3. Move the ATS location handle to the AUTO position.
4. Move the manual bypass handle to the OPEN position.
5. Turn the disconnect switch to the AUTO position.

For 600- to 3000-amp switches

1. Verify that the ATS contacts are in the same position as the bypass contacts.
2. Turn the disconnect switch to the INHIBIT position.
3. Rotate the crank mechanism clockwise until the ATS is in the AUTO position.
4. Move the manual bypass handle to the OPEN position.
5. Turn the bypass selector switch to the OFF position.
6. Turn the disconnect switch to the AUTO position.



Bypass in the open position and ATS in the normal position

567326

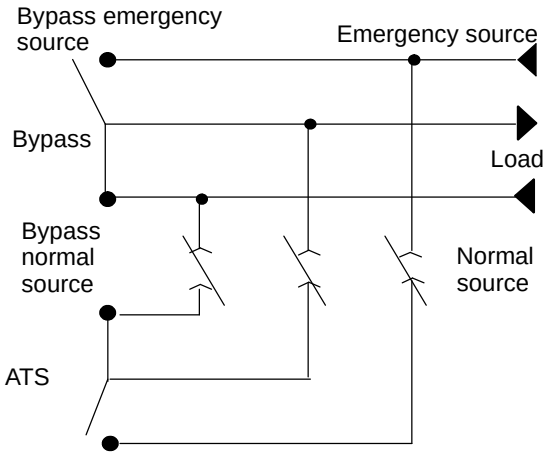
To Bypass the ATS

For 150- to 400-amp switches

1. Open the bottom cabinet door.
2. Turn the disconnect switch to the INHIBIT position.
3. Position the manual bypass handle to the same power source as the ATS. Note: The bypass switch uses safety interlocks to prevent cross phasing.

For 600- to 3000-amp switches

1. Open the bottom cabinet door.
2. Turn the disconnect switch to the INHIBIT position.
3. Position the bypass-selector switch to the same power source as the ATS. Note: The bypass switch uses safety interlocks to prevent cross phasing.
4. Move the manual-bypass handle to the BYPASS position.



Bypass in the normal position and ATS in the normal position

567327

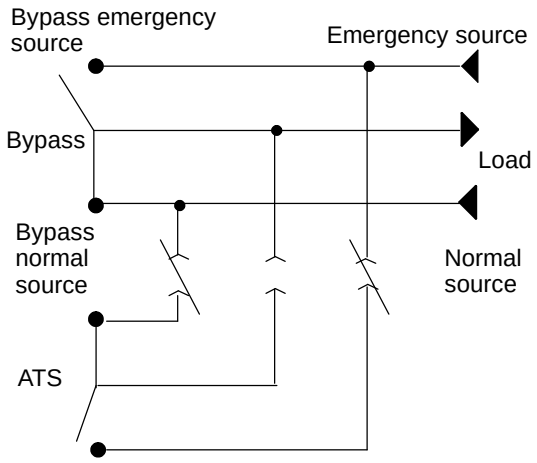
To Test the ATS

For 150- to 400-amp switches

1. Open the bottom cabinet door.
2. Turn the disconnect switch to the INHIBIT position.
3. Position the manual bypass handle to the ATS power source.
4. Move the ATS location handle to the TEST position.
5. Turn the disconnect switch to the AUTO position.
6. Move and hold the test switch on the logic controller to the TEST position.
7. Once the ATS transfers to the emergency position release the test switch.
8. The ATS will transfer back to the normal position.

For 600- to 3000-amp switches

1. Open the bottom cabinet door.
2. Turn the disconnect switch to the INHIBIT position.
3. Position the bypass-selector switch to the source that powers the ATS.
4. Move the manual bypass handle to the BYPASS position.
5. Rotate the crank mechanism counterclockwise until the ATS location pointer is aligned with isolate; the ATS isolate position lamp will illuminate.
6. Turn the disconnect switch to the AUTO position.
7. Move and hold the test switch on the logic controller to the TEST position.
8. Once the ATS transfers to the emergency position release the test switch.
9. The ATS will transfer back to the normal position.



Bypass in the normal position and ATS in the test position (ATS load connection is open)

567328

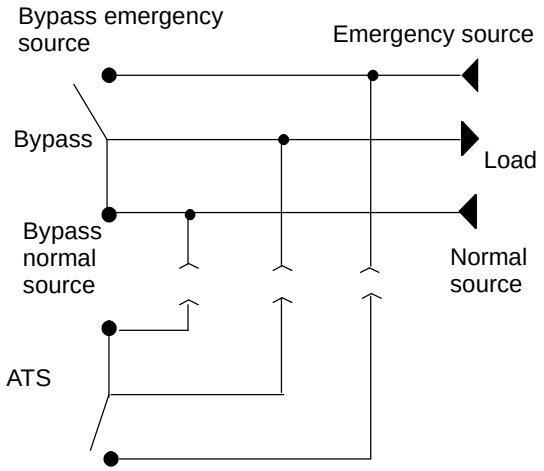
To Isolate the ATS

For 150- to 400-amp switches

1. Open the bottom cabinet door.
2. Turn the disconnect switch to the INHIBIT position.
3. Position the manual bypass handle to the power source that powers the ATS.
4. Move the ATS location handle to the ISOLATE position; the ATS isolate position lamp will illuminate.

For 600- to 3000-amp switches

1. Open the bottom cabinet door.
2. Turn the disconnect switch to the INHIBIT position.
3. Position the bypass-selector switch to the source that powers the ATS.
4. Move the manual bypass handle to the BYPASS position.
5. Rotate the crank mechanism counterclockwise until the ATS location pointer is aligned with isolate; the ATS isolate position lamp will illuminate.



Bypass in the normal position and ATS in the isolate position

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Bypass/Isolation Switch Operation Notes

When the ATS is in the test or isolate position the bypass switch serves as a manual transfer switch. The transfer from the bypass emergency contacts to the bypass normal contacts results in a momentary loss of power to the load while the bypass switch is open.

The ATS will not operate if any of the following is true:

1. The harness plugs are not connected.
2. The disconnect switch is in the inhibit position.
3. The ATS is not in the auto or test positions.
4. The ATS is in the auto position and the bypass switch is not open.

The manual-bypass handle will not close in the bypass position if any of the following is true:

100- to 400-amp switches

1. The ATS location handle is not engaged in one of the following positions: auto, test, or isolate.
2. The selected source is opposite of the ATS position while in the auto position.
3. The ATS is in the test or isolate position and the selected source is not available.

600- to 3000-amp switches

1. The bypass selector switch is turned to the source opposite the ATS.
2. The bypass selector switch is turned to the source opposite the ATS.
3. The ATS location handle is not engaged in one of the following positions: auto, test, or isolate.
4. The source selected is opposite of the ATS position while in the auto position.
5. The ATS is in the test or isolate position and the source selected is not available.

The manual bypass handle will not open the bypass if any of the following is true:

600- to 3000-amp switches only

1. The ATS is not in one of the following positions: auto, test, or isolate.
2. The ATS is in the test or isolate position and the opposite source is not available.

The ATS location handle will not operate if any of the following is true:

100- to 400-amp switches only

1. The bypass switch and ATS are not positioned to the same source.
2. Power is not available.
3. The harness plugs are not connected.
4. The ATS has reached its limit of travel in the auto or isolate positions

The crank handle will not operate if any of the following is true:

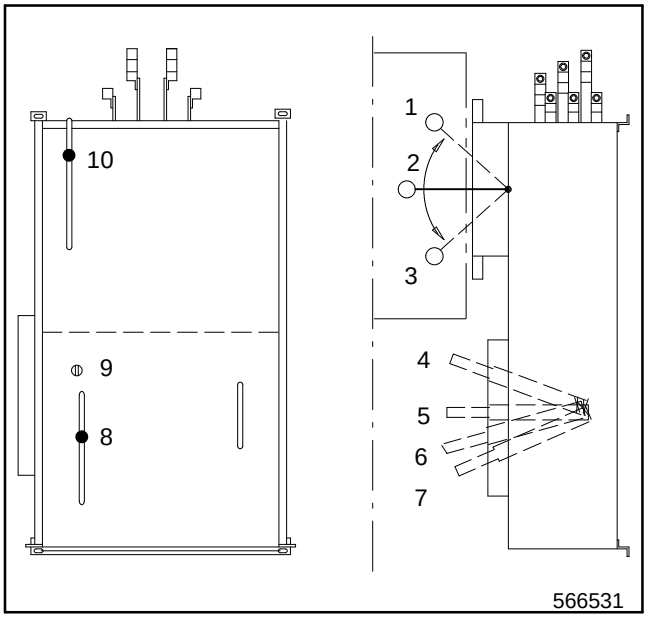
600- to 3000-amp switches only

1. The bypass switch and ATS are not positioned to the same source.
2. Power is not available.
3. The harness plugs are not connected.
4. The ATS has reached its limit of travel in the auto or isolate positions (clutch device on the crank mechanism slips).

Removal and Reconnection of the ATS

To Remove the ATS in 150- to 400-amp switches

1. Open the cabinet door. See Figure 2-4.
2. Turn the disconnect switch to the inhibit position.
3. Position the manual bypass handle to the same power source as the ATS.
4. Move the ATS location handle to the RELEASE position.
5. Disconnect the multipin plugs and external connections from the ATS.
6. Lift the ATS out of its drawer.



1. Manual bypass handle EMERGENCY position
2. Manual bypass handle OPEN position
3. Manual bypass handle NORMAL position
4. Release position
5. Isolate position
6. Test position
7. Auto position
8. ATS location handle
9. Disconnect switches
10. Manual bypass handle

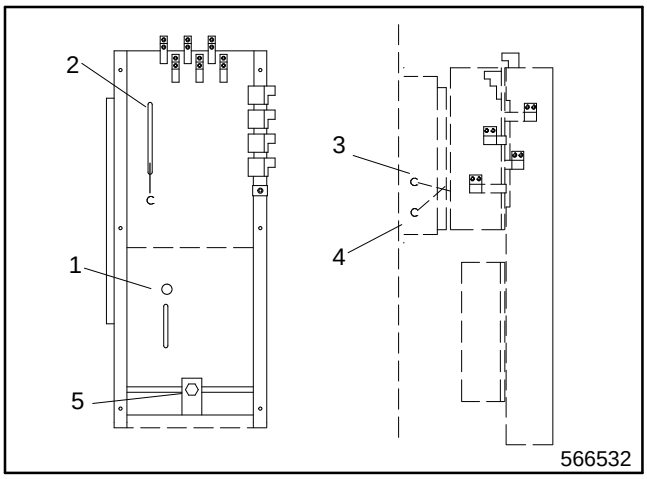
Figure 2-4. Bypass switch handle positions

To Reconnect the ATS in 150- to 400-amp switches

1. Turn the disconnect switch to the INHIBIT position.
2. Place the ATS into its drawer slots (front rollers first).
3. Manually position the ATS to the same source as the bypass switch.
4. Reconnect the multipin plugs and external connections to the ATS.
5. Push the ATS inward to engage the carriage.
6. Move the ATS location handle to the test position.
7. Turn the disconnect switch to the AUTO position and use the test switch on the logic controller to electrically operate the ATS.
8. Move the ATS location handle to the AUTO position.
9. Turn the disconnect to the AUTO position and move the manual bypass handle to the OPEN position.
10. To ensure correct ATS operation use the test steps in Section 2– **Transfer Switch Operation**.

To Remove the ATS in 600- to 1200-amp switches

1. Open the cabinet door. See Figure 2-5.
2. Turn the disconnect switch to the INHIBIT position.
3. Move the bypass selector switch to the source that powers the ATS.
4. Move the manual bypass handle to the BYPASS position.
5. Rotate the crank mechanism counterclockwise until the ATS location pointer is aligned with isolate.
6. Disconnect the multipin plugs and external connections from the ATS.
7. Rotate the four panel latches to the vertical position. See Figure 2-6.
8. Pull the ATS outward until the slide brackets are fully extended.
9. Engage the slide locks to prevent movement of the brackets.
10. Connect a lift bar to the ATS lifting brackets



1. Disconnect switch
2. Bypass selector switch
3. Bypass selector switch BYPASS position
4. Bypass selector switch OPEN position
5. Crank mechanism

Figure 2-5. Bypass switch crank mechanism location

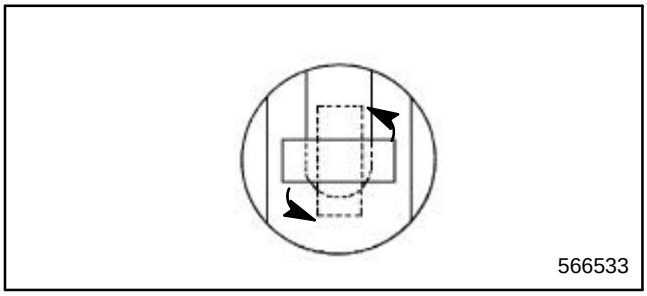


Figure 2-6. Rotation of the panel latch

To Reconnect the ATS in 600- to 1200-amp switches

1. Turn the disconnect switch to the INHIBIT position.
2. Seat the ATS on the slide brackets.
3. Remove the lift bar assembly.
4. Release the slide locks (Note: Raise the slide locks approximately 60° to disengage.) See Figure 2-7.
5. Push the ATS in until the power panel latches can be engaged and rotated to the horizontal position.
6. Confirm that the bypass switch is in the ISOLATE position.
7. Reconnect the multipin harness plugs.
8. Rotate the crank mechanism clockwise until the ATS is in the AUTO position.
9. Move the manual-bypass handle to the AUTO position.
10. Turn bypass-selector switch to the OFF position.
11. Turn the disconnect switch to the AUTO position.
12. To ensure correct ATS operation use the step in Section 2– Transfer Switch Operation**.**

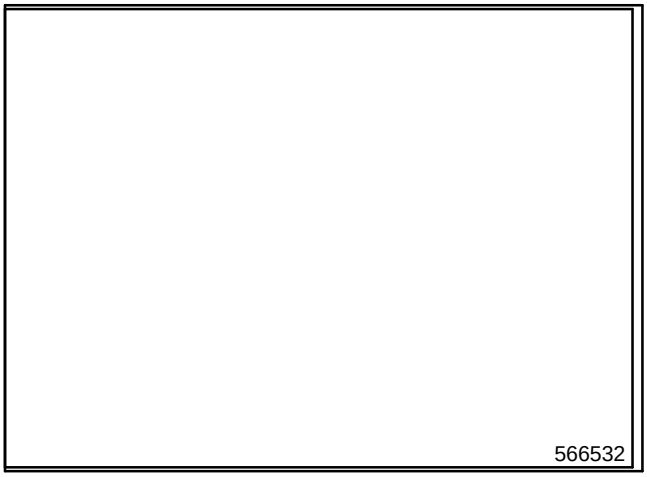


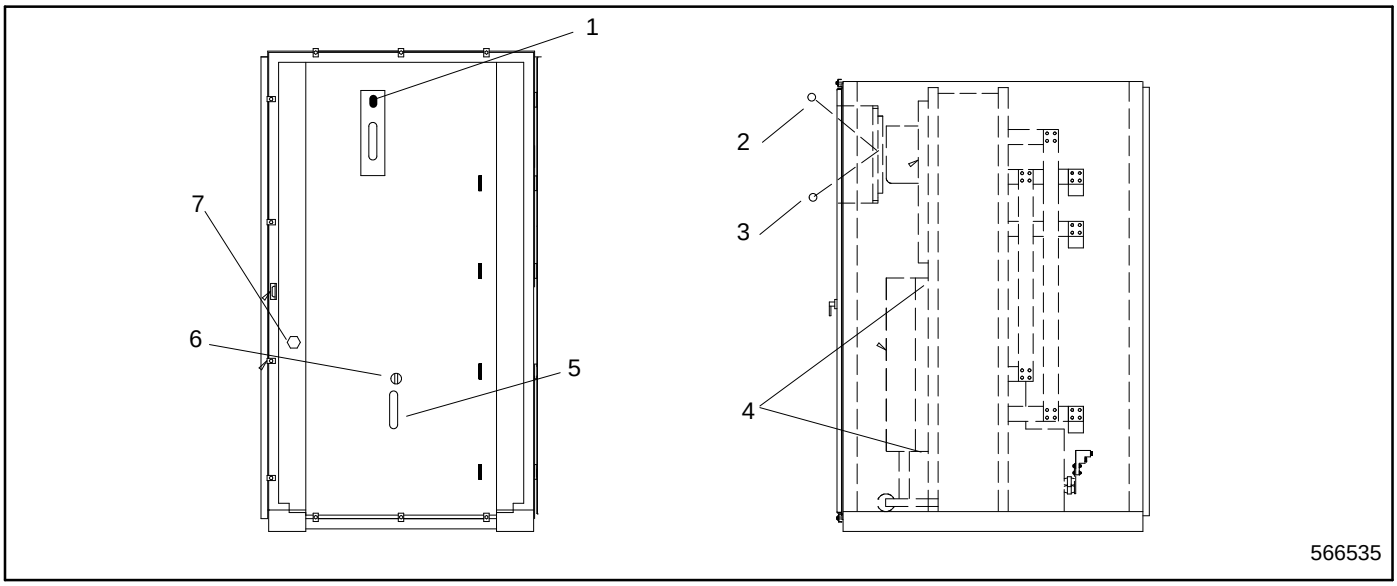
Figure 2-7. Panel latch

To Remove the ATS in 1600- to 3000-amp switches

1. Open the cabinet door.
2. Turn the disconnect switch to the INHIBIT position.
3. Move the bypass-selector switch to the source that powers the ATS.
4. Move the manual-bypass handle to the BYPASS position.
5. Rotate the crank mechanism counterclockwise until the ATS location pointer aligns with isolate.
6. Disconnect the multipin plugs and external connections from the ATS.
7. Slide the four corner latches of the ATS to the innermost position.
8. The ATS can now be rolled out of the cabinet on the built-in cart.

To Reconnect the ATS in 1600- to 3000-amp switches

1. Turn the disconnect switch to the INHIBIT position.
2. Roll cart back in the cabinet.
3. Slide the four corner latches of the ATS to the outermost position.
4. Turn the disconnect switch to the INHIBIT position.
5. Manually position the ATS to the same source as the bypass switch.
6. Reconnect the multipin harness plugs.
7. Rotate the crank mechanism clockwise until the ATS is in the AUTO location.
8. Move the manual bypass switch to the OPEN position.
9. Turn the disconnect switch to the AUTO position.
10. To ensure correct ATS operation use the step in Section 2– Transfer Switch Operation.



1. Bypass selector switch
2. Manual bypass handle BYPASS position
3. Manual bypass handle OPEN position
4. Corner latches
5. Manual ATS handle
6. Disconnect switch
7. Crank mechanism

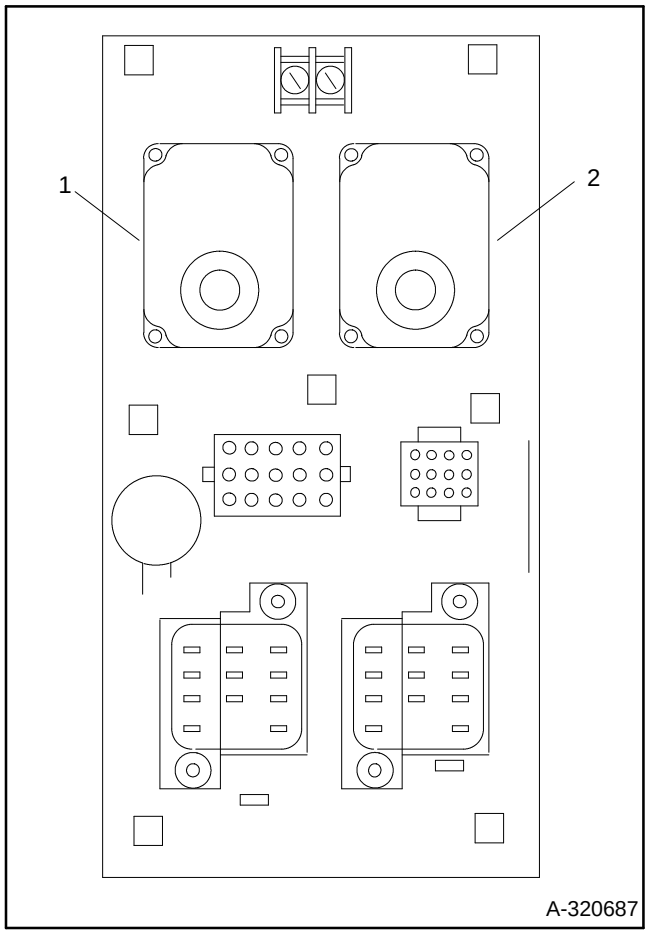
Figure 2-8. 1600-3000 amp bypass handle positions

Accessories

Time Delay Off

The time-delay-off accessory normally consists of two timing relays that plug into the interface board. See Figure 2-9. However, when the ATS is equipped with an M340+ controller, the accessory is programmed into the controller's microprocessor. If the ATS has a time-delay-off accessory, power transfers from normal to emergency or emergency to normal power sources occur in three steps:

1. The switch for the previously connected power source opens.
2. There is a delay period, adjustable from 2 to 40 seconds, to allow residual voltage in the load circuit to decay.
3. The switch or circuit breaker for the new power source close.



1. K3 (TDON) 2. K4 (TDOE)

Figure 2-9. Interface board with time delay relays

Other Accessories

With the exception of the time-delay-off accessory, all other accessories are controller accessories. For controller accessory information and procedures, refer to the appropriate controller manual. See List of Related Manuals in the Introduction.

Section 3. General Maintenance

Reasonable preventive maintenance will ensure high reliability and long life for the automatic transfer switch. Follow all applicable local codes and standards, and keep a log book for scheduled maintenance and repairs.

Operate Transfer Switch at Least Once a Month. Use the test switch to check the electrical operation of the transfer switch. The test switch simulates failure of the normal source. Service is interrupted only during the actual transfer of the load. The manufacturer recommends connecting an actual load during transfer.

Keep Automatic Transfer Switch Clean. During installation, protect the switch from construction grit and metal chips. Once each year, with the control panel cover in place, brush and vacuum away any excessive dust accumulation.

Maintain Transfer Switch Lubrication. The transfer switch is factory lubricated. The transfer switch requires no further lubrication.

Inspect Main Current-Carrying Contacts. Once each year, de-energize all sources and remove barriers to check condition of contact material. Replace switch or circuit breaker contactor unit when contacts are pitted or excessively worn.

Torquing of Contactor Lug Set Screws. Torque set screws to spec when installing in the ATS. Check torque every six months. When using an aluminum conductor, apply joint compound to conductors. Check contactor lugs after tightening and wipe off excess joint compound.

Effect of Ambient Temperature and Humidity Conditions. Operate the contactor in an ambient temperature of 32°to 104°F (0°to 40°C). Contact the manufacturer if operating the contactor in a higher or lower ambient temperature. Humidity can vary from 5 to 95% without affecting operation.

Section 4. Troubleshooting

This section provides troubleshooting procedures for mechanical failures of the switching device. Refer to the applicable logic controller service and parts manual for troubleshooting the electrical functions of the switching device as well as the overall operation of the automatic transfer switch. See **List of Related Manuals** in the Introduction of this manual.

Troubleshooting Chart

Use the following chart as a reference to troubleshoot individual problems. The chart includes troubleshooting information for a specific automatic transfer switch problem. Included in this information is a list of possible causes of the problem, the recommended remedy for each possible cause, and a reference to detailed information or procedures for the remedy.

Have an authorized service dealer preform repairs. Improper repairs by unqualified personnel can lead to additional failures.

Problem	Possible Cause	Corrective Action	Reference
Contactor fails to move	Solenoid burned out	Replace Solenoid	Section 6– Component Removal and Installation
	Contactor Binding	Realign Contactor	Section 6– Component Removal and Installation
	Logic not functioning correctly	Check Logic controller	See applicable logic controller service and parts manual
Contactor transfers then hums or burns out solenoid	Auxiliary switches misaligned	Realign switches	Section 6– Component Removal and Installation
	Auxiliary switches failed	Replace switches	Section 6– Component Removal and Installation
Contactor Hangs up	Contactor misaligned	Realign contactor	Section 6– Component Removal and Installation

Section 5. Accessory Testing and Adjustment

Programmed Transition

NOTE

This section does not apply to ATS utilizing the microprocessor logic control. The microprocessor controls the programmed transition function. Standard c-form relays replace the timing relays and therefore require no relay adjustment. See TP-5664 for operational details.

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

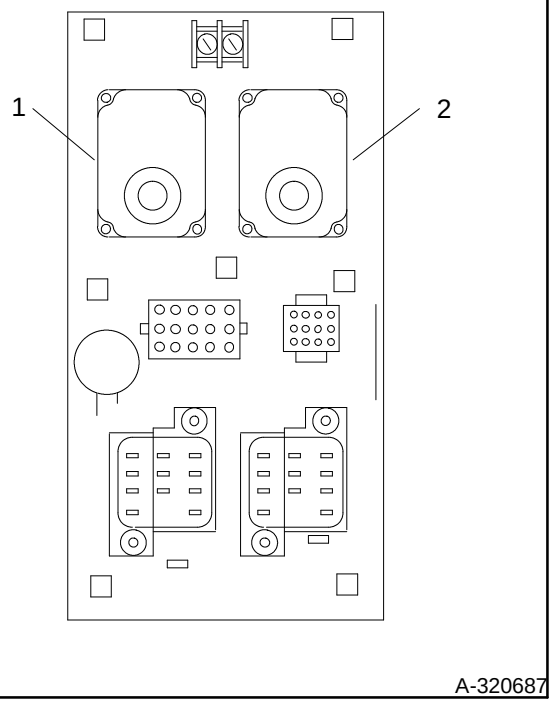
Disconnect power sources before servicing. Barrier must be installed after adjustments, maintenance, or servicing.

(600 Volt and above)

Hazardous voltage can cause severe injury or death. Whenever electricity is present, there is the hazard of electrocution. Open main circuit breaker on all power sources before servicing equipment. Electrically ground the generator set and electrical circuits when in use. Never come into contact with electrical leads or appliances when standing in water or on wet ground, as the chance of electrocution is increased under such conditions.

There are two separate timing relays used: K4 (TDOE) and K3 (TDON). K4 produces the time delay for the normal to emergency power transfer; K3 produces the time delay for the emergency to normal power transfer. Each relay has a separate adjustment. To make an adjustment, proceed as follows:

1. Disconnect both the normal and emergency power sources.
2. Open the ATS door.
3. Locate the appropriate relay on the interface board. See Figure 5-1.
4. Insert a screwdriver into the adjustment slot of the adjustment screw. The adjustment slot is visible through the cover of the relay.
5. Turn the adjustment screw to the desired time delay period.
6. Close the enclosure door.
7. Reconnect the normal and emergency power source.
8. Operate the automatic transfer switch automatically and check the time-delay-off period to ensure that it is properly adjusted.



1. K3 (TDON) 2. K4 (TDOE)

Figure 5-1. Interface Board with Programmed Transition Relays

Other Accessories

All other accessories for this automatic transfer switch are controller accessories. For controller accessory information and procedures, refer to the appropriate controller manual. See **List of Related Manuals** in the Introduction.

Section 6. Disassembly/Reassembly

Introduction

This section covers the removal and replacement procedures for the transfer switch assembly. Although there are four separate amperage ranges, many of the procedures apply to more then one switch assembly. For servicing purposes, each transfer switch assembly is separated into the following components:

- Linear Actuator/Solenoids
- Contact Assemblies
- Auxiliary Switches

Linear Actuator/Solenoid Removal and Replacement 150-400 Amperes

Disconnect both the normal and emergency power sources from the transfer switch before servicing. If a generator set provides standby emergency power, turn the operation selector switch to STOP and disconnect the negative (–) battery cable from the generator set starting battery. Locate the selector switch on the generator set control panel.

Removing Actuator Solenoid

Refer to Figure 6-1 for the following procedure.

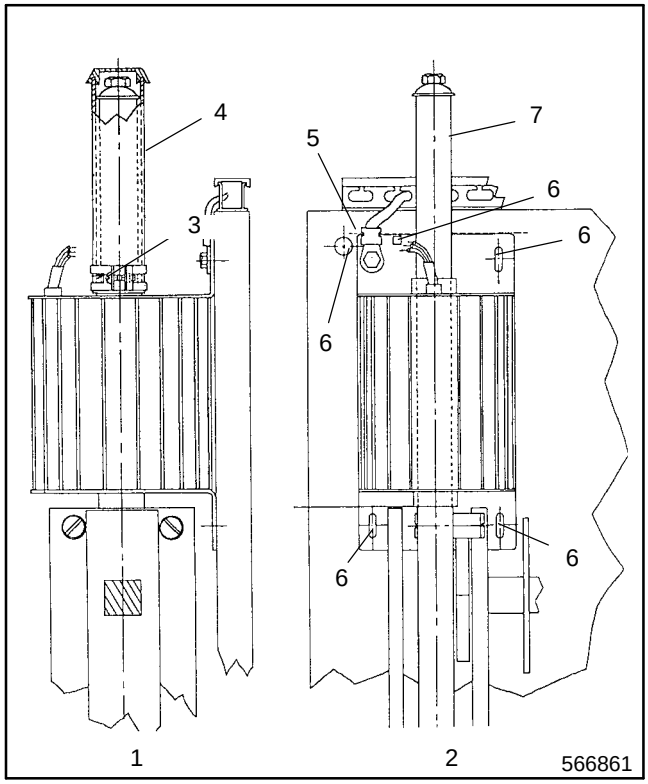
1. Loosen screw from shaft protector clamp.
2. Raise protector tube and remove.
3. Scribe position of linear actuator on panel.
4. Wrap plunger with cloth and clamp a vise grip to hold plunger. Be sure not to nick or distort the plunger.
5. Remove bolt, belleville washer, and split lockwasher using an open end 1/2 in. wrench across the flats of the plunger.
6. Remove actuator mounting bolts, lockwasher, and screw.
7. Use the manual handle to move the transfer switch to the emergency position.
8. Remove the leads at terminal board numbers 26, 28, and 36.
9. Pull out the leads and remove the actuator.

NOTE

In some actuator burnouts the plunger in the linear actuator freezes to the internal components, because of excessive heat build up, making it impossible to remove. If this situation develops, perform the following steps:

A. Tap the top of plunger downward with a hammer to loosen the plunger.

B. Pull the entire assembly (actuator, plunger and roller plate) out of the transfer switch and disassemble.



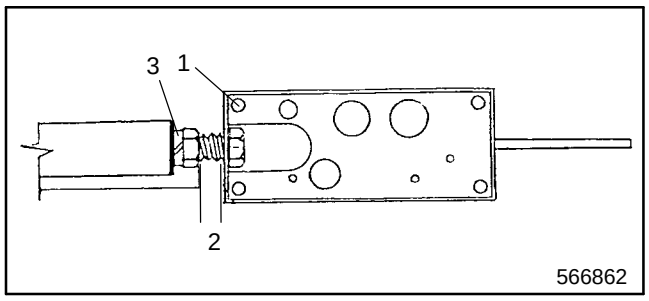
1. Side view
2. Front view
3. Shaft protector clamp
4. Protector tube
5. Scribe line
6. Plunger
7. Actuator mounting bolts

Figure 6-1. 150-400 Amp actuator/solenoid

Replacing Actuator Solenoid 150-400 Amperes

Observe the following when reassembling the plunger and roller plate:

1. Insert the bolt through the hole in roller plate assembly. See Figure 6-1.
2. Maintain a 1-2 thread gap between the nut and frame of the assembly.
3. Tighten the lockwasher and nut to the plunger.
4. On 400 amp units, use a flatwasher between the plunger and lockwasher



1. Roller plate
2. 1-2 Thread and gap
3. Lock washer and nut

Figure 6-2. 150-400 Amp plunger assembly

NOTE

Do not tighten plunger to roller plate assembly– actuator binding occurs.

Refer to Figure 6-1 for the following procedure:

1. Match the new actuator to the scribed lines. Reinstall the actuator mounter bolts and lockwasher.
2. Connect the actuator wires to 3pt terminal block as follows:
   - D #26– black actuator lead
   - D #28– white actuator lead. #28 is a double connection one lead going to DS switch.
   - D #36– red actuator lead
3. Replace and tighten nut, belleville washer, lockwasher, and actuator plunger. Do not burr plunger.
4. Manually rotate the plunger in the shaft to ensure binding does not occur. If binding occurs, loosen the actuator mounting bolts and adjust the actuator by tapping the left or right side while rotating the plunger until binding is eliminated. Retighten actuator mounting bolts and insert screw.
5. Replace plunger protector and tighten shaft protector clamp.
6. Check the upper and lower cams to ensure they are tight.
7. Test the switch operation with the manual handle. While manually operating the switch to normal, check the roller plate assembly to verify that nothing interferes with its operation.

During Manual Operation

1. Check contact force into the normal and emergency position.
2. Check that the distance between paddle and movable contact is .060 minimum to .094 maximum.

Linear Actuator/Solenoid Removal and Replacement 600-1200 Amperes

Disconnect both the normal and emergency power sources from the transfer switch before servicing. If a generator set provides standby Emergency power, turn the operation selector switch to stop and disconnect the negative (–) battery cable from the generator set starting battery. The selector switch is located on the generator set control panel.

NOTE

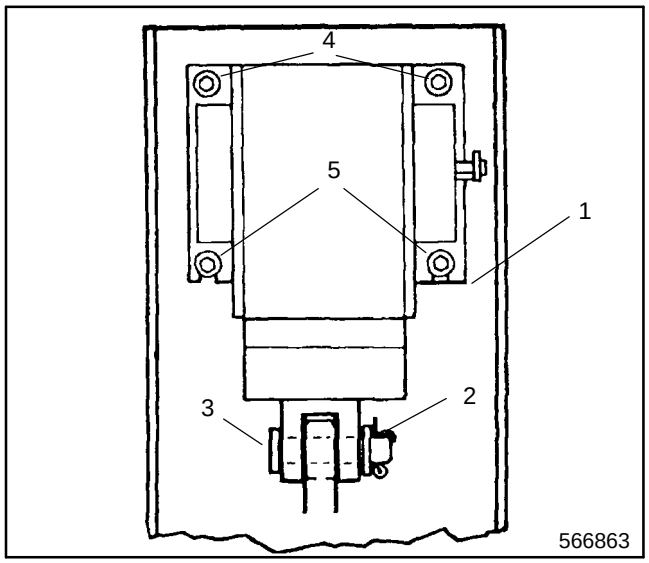
The disconnect switch contact block may also need replacement.

Removing Actuator Solenoid

Refer to Figure 6-3 for the following procedure:

1. Remove the solenoid assembly cover.
2. Mark the solenoid location using a marker or scribe.
3. Remove the clevis pin holding the solenoid plunger to the actuator linkage.
4. Manually position the transfer switch to the position of the solenoid being replaced.
5. Remove the two 1/4 in. socket head capscrews from the base of the solenoid.

6. Loosen the other two 1/4 in. socket head capscrews.
7. Remove the solenoid assembly.



1. Scribe line
2. Cotter pin and washer
3. Clevis pin
4. Capscrews to remove
5. Capscrew to loosen

Figure 6-3. 600-1200 Amp linear actuator solenoid

Replacing Actuator Solenoid

Refer to Figure 6-3 for the following procedure:

1. Align the actuator linkage with the solenoid plunger.
2. Align the mounting slots on the solenoid assembly base with the screws loosened in step 7 of Removing Actuator Solenoid.
3. Tighten the capscrews loosened in step 7 of Removing Actuator Solenoid.
4. Insert and tighten the capscrews removed in step 6 of Removing Actuator Solenoid.
5. Install the clevis pin through the solenoid plunger and actuator linkage.
6. Reinstall the washer and cotter pin on the clevis pin.
7. Connect the coil leads.
8. Check the operation of the transfer switch by manually opening and closing the switch assemblies. Make sure there is no binding.
9. Check the auxiliary switches for proper tripping action. The auxiliary switch should close just as the mechanism reaches the over-center point during closure to normal or emergency.
10. Make certain that the plunger of the solenoid can touch the iron of the coil but is not bottomed out. The plunger must have play at all points of travel. If this is not true, readjust location of solenoid.
11. Reinstall the solenoid assembly cover.
12. Place the operator handle in its storage position.
13. Reconnect the normal power source and the emergency power source. If a generator set is the emergency power source, connect the negative (−) battery cable to the starting battery and place the operation selector switch to its original position.
14. Close the cabinet door.
15. Test the switch for proper operation.

Linear Actuator/Solenoid Removal and Replacement 1600-3000 Amperes

Disconnect both the normal and emergency power sources from the transfer switch before servicing. If a generator set provides standby emergency power, turn the operation selector switch to STOP and disconnect the negative (−) battery cable from the generator set starting battery. Locate the selector switch on the generator set control panel.

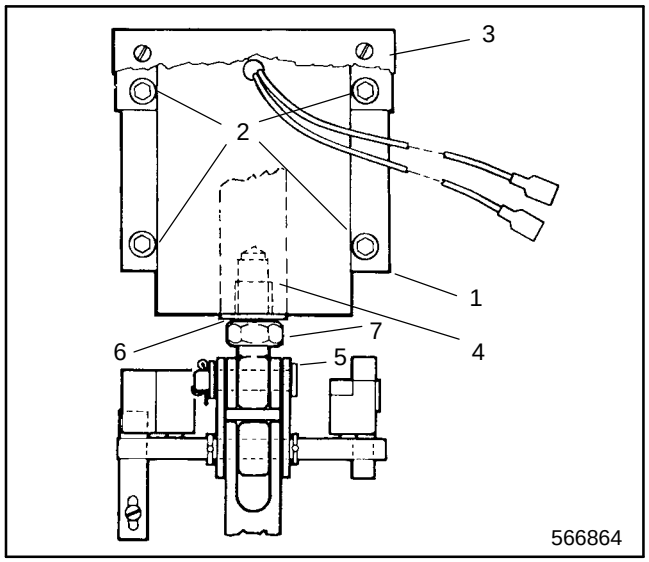
NOTE

Always replace rectifier assembly when replacing solenoid.

Removing Actuator Solenoid

Refer to Figure 6-4 for the following procedure.

1. Loosen and remove the mounting screws and washers (4) that secure the solenoid cover to the transfer switch. Remove the cover.
2. Mark the solenoid location using a marker or scribe.



1. Scribe line
2. Mounting bolts
3. Solenoid assembly
4. Plunger
5. Swing bolt
6. 1/16" plunger protrude
7. Plunger jam nut

Figure 6-4. 1600-3000 Amp linear actuator solenoid

3. Manually position the transfer switch to the position of the solenoid being replaced.
4. Remove the four mounting bolts that secure the solenoid, solenoid cover plate, and ground wire.
5. Remove the cotter pin and washer from the solenoid plunger.
6. Remove the solenoid assembly from the plunger
7. Wipe the plunger with a clean cloth and inspect for damage, excessive wear, or any foreign matter. If the plunger is in good condition proceed to the solenoid replacement procedure. If the plunger is damaged or shows excessive wear, proceed to step 8.
8. Measure the total length of the old plunger, swing bolt to plunger bottom. Use a 7/8 in. opening wrench to hold the plunger jam nut and a 1-1/4 in. open-end wrench on the plunger flats. Turn the plunger counterclockwise to remove the plunger from the swing bolt.

Replacing the Actuator Solenoid

1. If replacing the plunger, install the new plunger on the swing bolt. Assemble plunger to the same length as the one removed in step 8 of 1600-3000, Removing Actuator Solenoid.
2. Align the solenoid plunger with the solenoid assembly and mount the solenoid assembly with the bolts removed in step 2 of 1600-3000, Removing Actuator Solenoid. The plunger should protrude approximately 1/16 in. from the plunger tube.
3. If replacing the plunger, tighten the plunger to the nut by turning the plunger clockwise.
4. Connect the coil leads.
5. Check the operation of the transfer switch and the alignment of the plunger by manually opening and closing the switch.
6. Make sure that the plunger is not binding throughout its full range of travel.
7. Check that the auxiliary switches close just as the mechanism reaches the over-center point during closure to normal or emergency.
8. Reinstall the solenoid cover. Secure with the mounting screws and flatwashers (4).
9. Place the operator handle in its storage position.
10. Reconnect the normal and emergency power source. If a generator set is the emergency power source, connect the negative (–) battery cable to the starting battery and place the operation selector switch in its original position.
11. Close the cabinet door.
12. Test the switch for proper operation.

Linear Actuator/Solenoid Removal and Replacement 1200-3000 Amperes Programmed Transition

Refer to Figure 6-5 for the following procedure.

Disconnect both the normal and emergency power sources from the transfer switch before servicing. If a generator set provides standby emergency power, turn the operation selector switch to Stop and disconnect the negative (–) battery cable from the generator set starting battery. The selector switch is located on the generator set control panel.

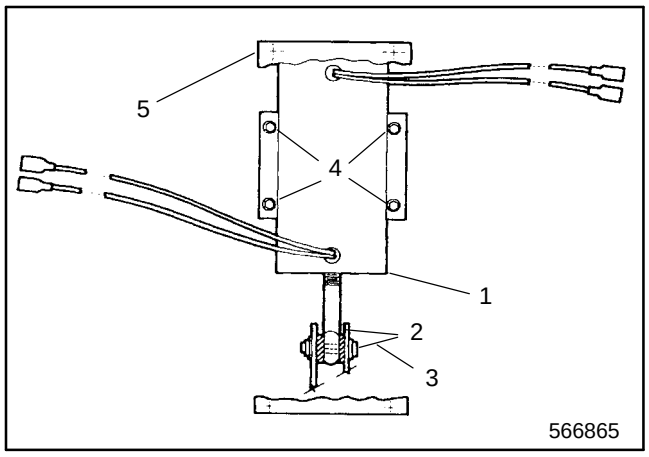
NOTE

Always replace rectifier assembly when replacing solenoid.

Removing Actuator Solenoid

Refer to Figure 6-5 for the following procedure.

1. Loosen and remove the mounting screws and washers (4) that secure the solenoid cover to the transfer switch and remove the cover.
2. Mark the solenoid location using a marker or scribe line.
3. Remove the cotter pin and washer from the solenoid plunger.
4. Remove the clevis pin from the two side links and sector yoke.
5. Remove the mounting bolts, lockwashers, and flatwashers that secure the solenoid assembly to the transfer switch.
6. Remove the solenoid assembly.



1. Scribe line
2. Clevis pin
3. Cotter pin and washer
4. Mounting bolts
5. Solenoid assemble

Figure 6-5. 1200-3000 Amp linear actuator solenoid

Replacing Actuator Solenoid

Refer to Figure 6-5 for the following procedure:

1. Align the actuator linkage with the solenoid plunger and align the solenoid assembly base with the scribe line.
2. Secure the solenoid assembly with the mounting bolts, lockwashers, and flatwashers that were removed in step 5 of Removing Actuator Solenoid.
3. Reinstall the clevis pin.
4. Reinstall the washer and cotter pin.
5. Connect the coil leads.
6. Check the operation of the transfer switch by manually opening and closing the switch.
7. Check that the auxiliary switches close just as the mechanism reaches the over-center point during closure to normal or emergency.
8. Reinstall the solenoid cover. Secure with the mounting screws and flatwashers (4).
9. Place the operator handle in its storage position.
10. Reconnect the normal and emergency power source. If a generator set is the emergency power source, connect the negative (–) battery cable to the starting battery and place the operation selector switch in its original position.
11. Close the cabinet door.
12. Test the switch for proper operation.

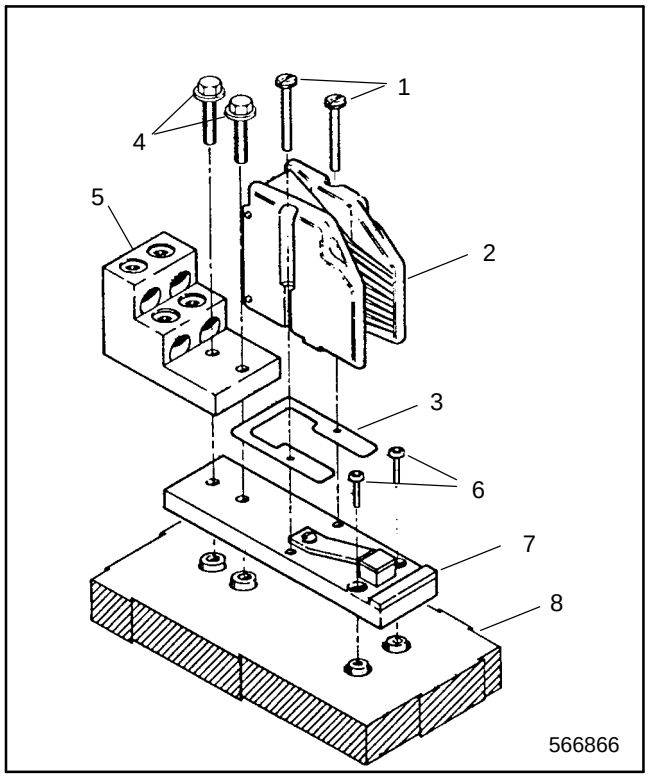
Contact Assembly Removal and Replacement 800-1200 Amperes

Disconnect both the normal and emergency power sources from the transfer switch before servicing. If a generator set provides standby emergency power, turn the operation selector switch to STOP and disconnect the negative (–) battery cable from the generator set starting battery. Locate the selector switch on the generator set control panel.

Removing The Contact Assemblies

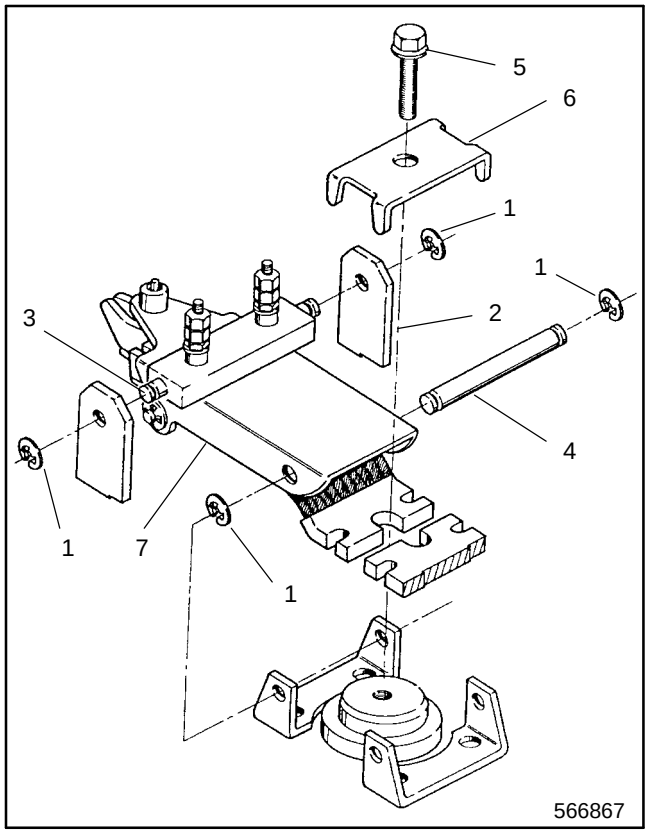
Refer to Figure 6-6 and Figure 6-7 for the following procedure:

1. Remove the machine screws and flatwashers that secure the blue plastic switch cover.
2. Remove the cover.
3. Manually place the movable contact assembly in the open position.
4. Remove the screws that secure the arc chute.
5. Remove the arc chute and arc chute pad.
6. Remove the two retaining rings and slide the actuator arms from the contact posts.



1. Arc chute retaining screws
2. Arc chute
3. Arc chute pad
4. Hex head cap screw
5. Lug terminal
6. Machine screws
7. Stationary contact assembly
8. Transfer switch panel

Figure 6-6. 800-1200 Amp stationary contact



1. Retaining ring
2. Actuator arms
3. Contact posts
4. Pivot pin
5. Bus stub bolt
6. Clamp bracket
7. Movable contact assembly

Figure 6-7. 800-1200 Amp movable contact

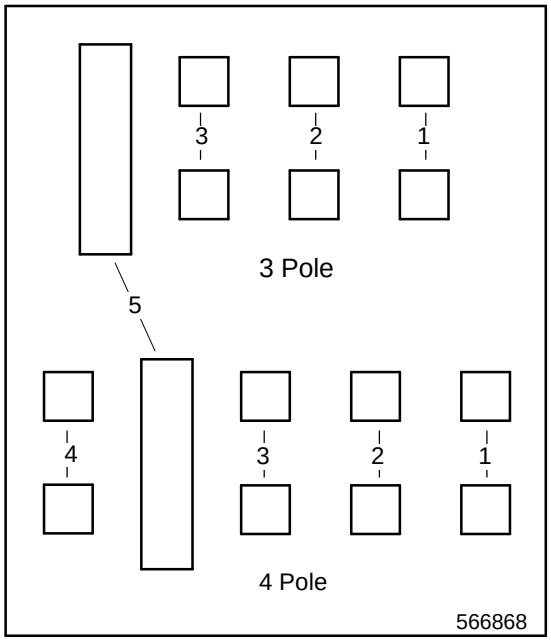
7. Remove one of the retaining rings from the pivot pin.
8. Slide out the pivot pin.
9. Remove the bus stub bolt, compression washer, and clamp bracket.
10. Remove the movable contact assembly.
11. If replacing the stationary contact, proceed to step 12. If not replacing the stationary contact, proceed to the replacement procedure.
12. Remove the hex head capscrews and the compression washers (2) that secure the lug terminal.
13. Remove the machine screws (2) that secure the other end of the stationary contact to the transfer switch panel.
14. Remove the stationary contact.

Replacing the Contact Assemblies

Refer to Figure 6-6, Figure 6-7, Figure 6-8, Figure 6-9, and Figure 6-10 for the following procedure:

1. If replacing the stationary contact, position the new stationary contact on the transfer switch panel.

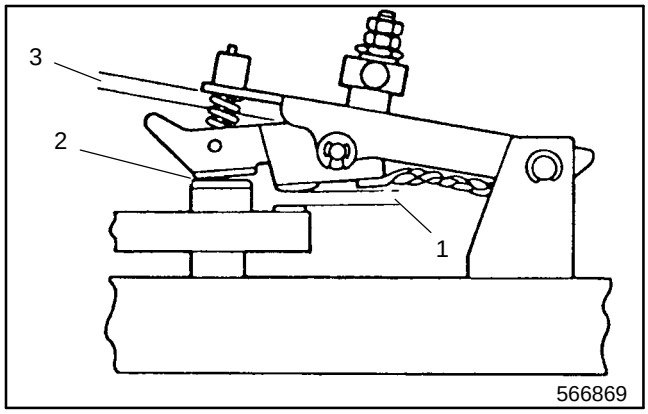
2. Secure the new stationary contact and the lug assembly using hex head capscrews, compression washers, and machine screws (2).
3. Torque the capscrews to 23 ft-lbs and the machine screws to 10 ft-lbs.
4. Using the new hardware supplied with the contact assemblies kit secure the new movable contact assembly with the bus stud bolt, compression washer, and clamp bracket.
5. Torque the bus stud bolt to 23 ft-lbs.
6. Install the pivot pin and secure with the retaining ring.
7. Connect the actuator arms to the contact posts and secure with the two retaining rings. See Figure 6-7.



1. C Pole
2. B Pole
3. A Pole
4. Neutral pole
5. Operator

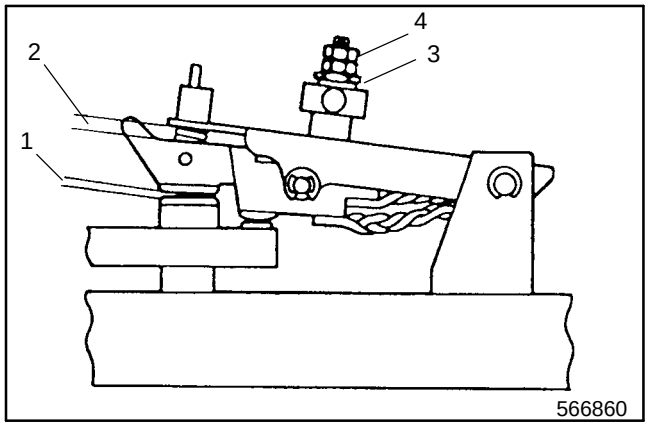
Figure 6-8. Contact adjustment order

8. Adjust the contacts (steps 9, 10, 12, and 13) in the sequence shown in Figure 6-8. For 3-pole switch all contacts should close at approximately the same time. For 4 pole switches poles A, B, and C should close at approximately at the same time. The neutral pole should close approximately 1/2 in. before the other three poles.
9. Manually close the contacts until the arcing contacts touch. See Figure 6-9. The main contacts should have a 1/16 in. minimum gap. If they do not, reject the contact assembly. Measure and record the prespring gap.



1. Main contact gap
2. Arcing contact
3. Prespring gap

Figure 6-9. Contact adjustment part 1



1. Arching contacts 0.003 gap
2. Spring gap
3. Adjustment screw
4. Locknuts

Figure 6-10. Contact adjustment part 2

10. Close the contacts fully. See Figure 6-10.
11. Rock the arcing contact from toe to heel and verify that there is a .003 in. minimum gap at the arching contacts. The feeler gauge must enter 1/16 in. past the edge of the silver.
12. Adjust the spring gap dimension to 1/8 in. maximum to 1/16 in. minimum deflection on the mains less than the prespring gap, measured in step 6, Bias to 1/16 in.
13. Turn the adjustment screw by hand to set the spring gap dimension.
14. Lock the setting by tightening the locknuts.
15. Check both sides of the main contacts to ensure they are level. Recheck the arch contact to make sure that it has not changed.

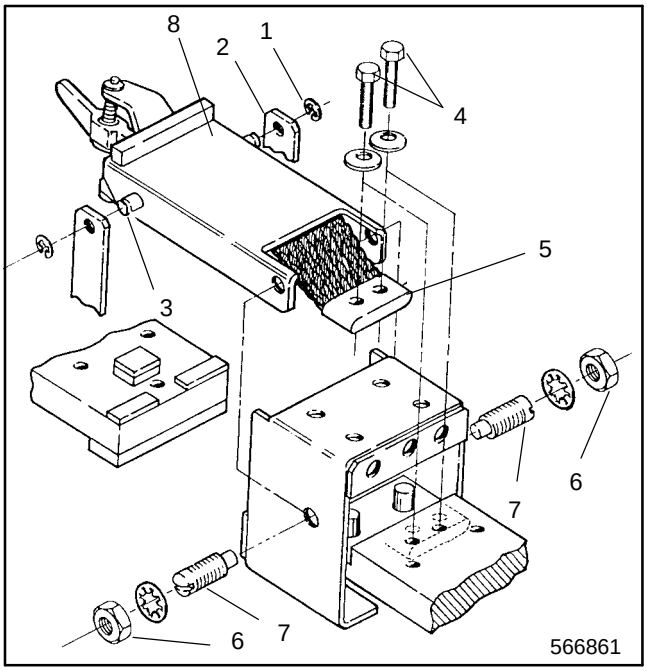
16. Secure the arc chute and arc chute pad with the two machine screws.
17. Check the operation of the transfer switch by manually opening and closing the switch assemblies.
18. Reinstall and secure the blue plastic cover.
19. Close cabinet door.
20. Reconnect the normal power source and the emergency power source. If a generator set is the emergency power source, connect the negative (−) battery cable to the starting battery and place the operation selector switch in its original position.
21. Test the switch for proper operation.

Contact Assembly Removal and Replacement 1600-2000 Amperes

Removing The Contact Assembly

Refer to Figure 6-6 and 6-11 for the following procedure:

1. Remove the machine screws and flatwashers that secure the blue plastic switch cover.
2. Remove the cover.
3. Remove the screws that secure the arc chute.
4. Remove the arc chute and arc chute pad.
5. Manually place the movable contact assembly that will be removed in the open position.
6. Remove the two retaining rings and slide the actuator arms from the contact posts. See Figure 6-11.
7. Remove the bolts and compression washers (2) from the braid lug.
8. Loosen the locknuts and remove the pivot studs.
9. Remove the contact assembly.



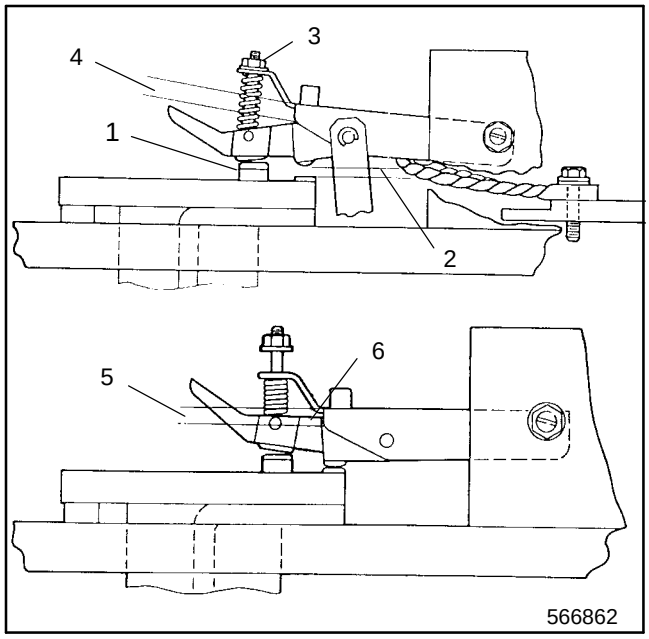
1. Retaining rings
2. Actuator arms
3. Contact ports
4. Bolts
5. Braid lug
6. Locknuts
7. Pivot studs
8. Contact assembly

Figure 6-11. 1600-2000 Amp movable contact

Replacing the Contact Assembly

Refer to Figure 6-11 and Figure 6-12 for the following procedure:

1. Secure the new movable contact assembly with the pivot studs, locknuts, and lockwashers.
2. Torque the locknuts to 10 ft-lbs.
3. Secure the braid lug with the braid lug bolts and compression washers.
4. Torque the bolts to 23 ft-lbs.
5. Connect the actuator arms to the contact posts and secure with the two retaining rings.
6. Manual close the contacts slowly until the arcing contacts touch. The main contacts should have 1/4 in. minimum gap. If not, adjust the arc finger adjustment nut as required. If the contacts cannot be brought within specifications, reject the contact assembly.
7. Measure and record the gap at the prespring gap.



1. Arcing contacts
2. Main contacts
3. Arc finger adjustment nut
4. Prespring gap
5. Spring gap
6. Arc finger

Figure 6-12. Contact adjustment

8. Close the contacts fully.
9. Rock the arcing contact from toe to heel and verify that there is a .003 in. minimum gap at the arcing contacts. The feeler gauge must enter 1/16 in. past the edge of the silver.
10. The spring gap dimension must be 1/16 in. less than prespring gap measured in step 4. If the contacts are not within specs, reject the contact assembly.
11. Check that the contact pressure of each of the three outside main contacts is between 3-3/4 and 4-1/2 lbs (1.7 to 2 kg).
12. Check that the contact pressure of the arc finger is between 9 and 14 lbs (4 to 6.4 kg).
13. Check that both main and arc contact fingers are not bottomed out when closed.
14. Secure the arc chute and arc chute pad with the two machine screws.
15. Check the operation of the transfer switch by manually opening and closing the switch assemblies.
16. Reinstall and secure the blue plastic cover.
17. Close cabinet door.
18. Reconnect the normal power source and the emergency power source. If a generator set is the emergency power source, connect the negative (–) battery cable to the starting battery and place the operation selector switch in its original position.
19. Test the switch for proper operation.

Contact Assembly Removal and Replacement 3000 Amperes

Removing The Contact Assembly

Disconnect both the normal and emergency power sources from the transfer switch before servicing. If a generator set provides standby emergency power, turn the operation selector switch to Stop and disconnect the negative (–) battery cable from the generator set starting battery. Locate the selector switch on the generator set control panel.

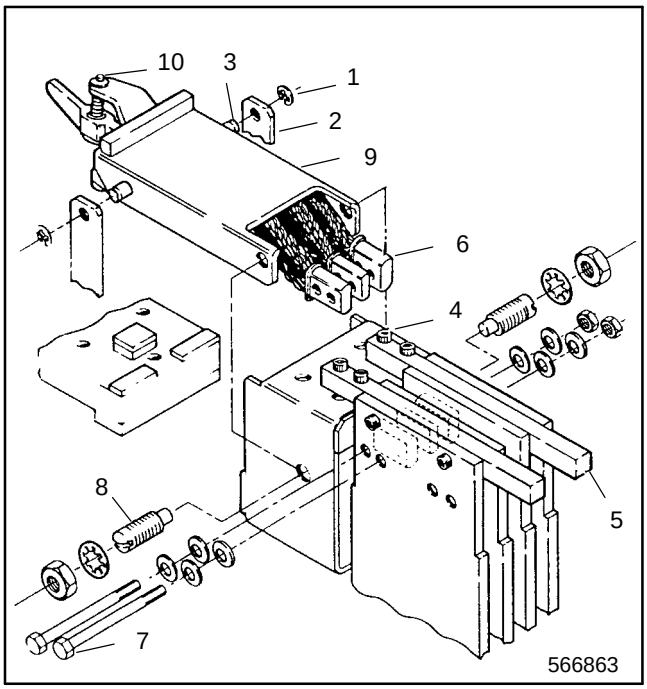
NOTE

Replace the B-phase contact assembly only by first removing two bolts from the adjacent C-phase contact assembly. Refer to step 6b for this replacement procedure.

Refer to Figure 6-6 and Figure 6-13 for the following procedure:

1. Remove the machine screws and flatwashers that secure the blue plastic switch cover.
2. Remove the cover.
3. Remove the screws that secure the arc chute.
4. Remove the arc chute and arc chute pad.
5. Manually place the movable contact assembly that will be removed in the open position.
6. Remove the two retaining rings and slide the actuator arms from the contact posts.
7. Remove the twelve 1/4-20 socket head capscrews from the load bus assembly and lift out the anchor bars. The longer capscrews are used on the sides.

7a. To remove an A-phase, C-phase, or neutral contact assembly: Remove the bolts, nuts, and compression washers that secure the braid lugs to the bus bars. To remove a B-phase contact assembly follow the procedure described in step 7b.



1. Retaining rings
2. Actuator arms
3. Contact post
4. Socket head cap screws
5. Anchor bolts
6. Braid lug
7. Braid lug bolts
8. Pivot studs
9. Contact assembly
10. .Arc finger adjustment nuts

Figure 6-13. 3000 Amp movable contact A or C phase

7b. To remove a B-phase contact assembly:

A. Remove the nuts and compression washers from the ends of the braid lug studs.

B. Remove the nut and washers from the lower bolt on the C-phase braid lug.

C. Remove the bolt.

D. Slide the lower B-phase threaded stud into the hole where the C-phase bolt had been.

E. Repeat this procedure with the upper C-phase bolt and corresponding upper B-phase stud. Keep the threaded studs in the C-phase assembly to hold the C-phase braid lugs in position.

8. Loosen the locknuts and remove the pivot studs.
9. Remove the contact assembly.

Replacing the Contact Assembly

Refer to Figure 6-12, Figure 6-13 and Figure 6-14 for the following procedure:

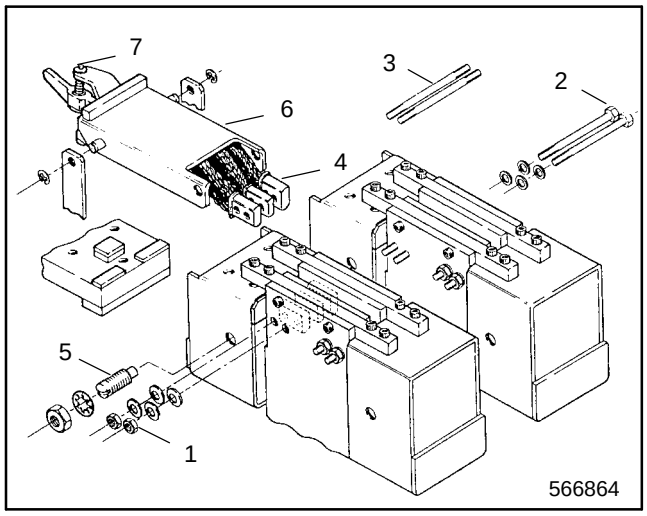
1. Secure the new movable contact assembly with the pivot studs, locknuts, and lockwashers. Torque the locknuts to 10 ft-lbs.

2a. To replace an A-phase, C-phase, or neutral contact assembly secure the braid lugs to the bus bars with the bolts, nuts and compression washers. Torque the nuts to 14 ft-lbs. To replace a B-phase contact assembly, follow the procedure described in step 2b.

2b. To replace a B-phase contact assembly:

A. Use a bent wire to align the bus bar holes with the braid lug holes.

B. Use the braid lug bolts that were removed from the C-phase assembly to push the B-phase braid lug studs back into position in the B-phase assembly. Tap the bolts lightly with a hammer, if necessary.



1. Braid lug nuts and washers
2. C-Phase braid lug bolts
3. B-Phase brads lug studs
4. Braid lug
5. Pivot stud
6. Contact assembly
7. Arc finger, adjustment nut

Figure 6-14. 3000 Amp movable contact B phase

C. Secure the B-phase studs and C-phase bolts with compression washers and nuts. Torque the nuts to 14 ft-lbs.

3. Install the anchor bars on the load bus assembly with twelve 1/4-20 socket head capscrews. The longer capscrews are used on the sides. Torque the capscrews to 90 in-lbs.

4. Connect the actuator arms to the contact posts and secure with two retaining rings.

5. Close the contacts slowly until the arcing contacts touch. The main contacts should have a 1/4 in. minimum gap. If they do not, adjust the arc finger adjustment nut as required. If the contacts cannot be brought within specifications, reject the contact assembly.

6. Measure and record the prespring gap.

7. Close the contacts fully.

8. Rock the arcing contact from toe to heel and verify that there is a .003 in. minimum gap at the arcing contact. A feeler gauge must enter 1/16 in. past the edge of the silver.

9. The spring gap dimension must be 1/16 in. less than the prespring gap dimension measured in step 5. If the contacts are not within specifications, reject the contact assembly.

10. Check that the contact pressure of each of the three outside main contacts is between 3-3/4 and 4-1/2 lbs (1.7 to 2 kg). Check that the contact pressure of the arc finger, is between 9 and 14 lbs (4 to 6.4 kg).

11. Check that both main and arc contact fingers are not bottomed out when closed.

12. Secure the arc chute and arc chute pad with two machine screws.

13. Check the operation of the transfer switch by manually opening and closing the switch assemblies.

14. Reinstall and secure the blue plastic cover.

15. Close the cabinet door.

16. Reconnect the normal power source and the emergency power source. If a generator set is the emergency power source, connect the negative (–) battery cable to the starting battery and place the operation selector switch in the Auto (or Remote) position.

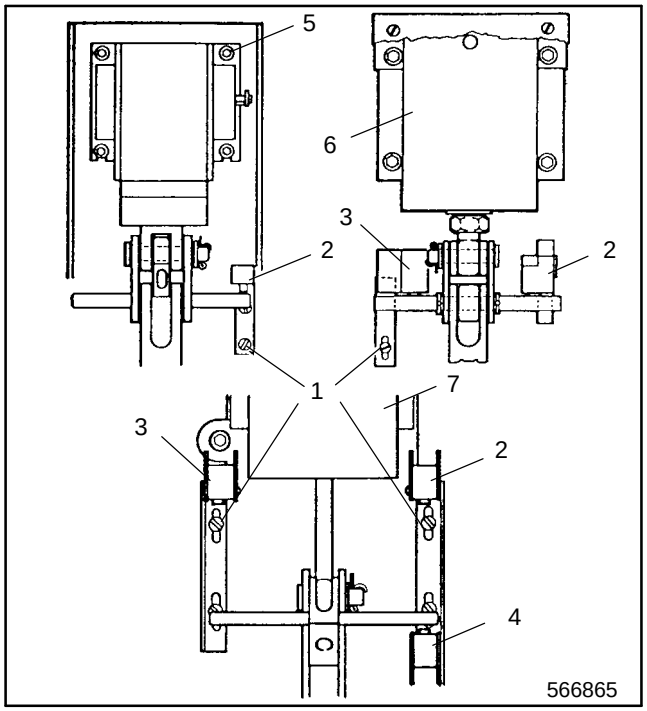
17. Test the switch for proper operation.

Auxiliary Switch Removal and Replacement

Disconnect both the normal and emergency power sources from the transfer switch before servicing. If a generator set provides standby emergency power, turn the operation selector switch to Stop located on the generator set control panel and disconnect the negative (−) battery cable from the set starting battery.

Removing and Replacing An Auxiliary Switch Assembly

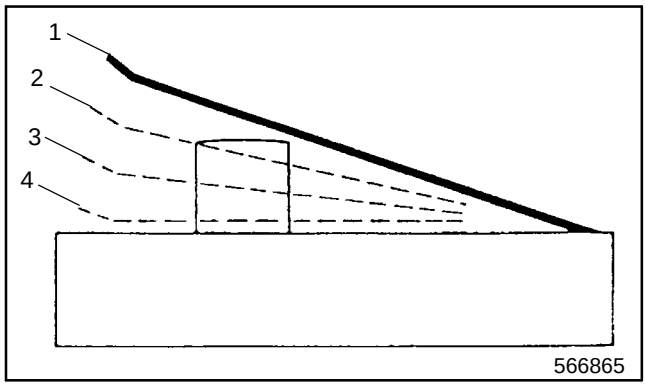
1. Remove the four machine screws, if applicable, and lift off the metal solenoid cover.
2. Remove the two mounting screws that secure the bracket-mounted switch assembly to the panel.



1. Set screws
2. SN switches
3. SE switches
4. SNO switches
5. 1200 Amp 2-position switches
6. 1600-3000 Amp 2-position switches
7. 1200-3000 Amp 3-position switches

Figure 6-15. Auxiliary switch

3. Before disconnecting the control wiring leads from the auxiliary switch, observe and note the switch terminal markings, NO, NC, and C, and which wire connects to each.
4. Disconnect the wires and connect them to the corresponding terminals of the replacement switch assembly.
5. Install the new auxiliary switch assembly with the two mounting screws.
6. Manually operate the transfer switch to make sure that the new auxiliary switch trips. Listen for an audible click when the switch trips.



1. Full release position
2. Trip position
3. Over travel position
4. Fully operated position

Figure 6-16. Auxiliary adjustment

7. Check the following on the new auxiliary switch:
   A. SN/SNO and SE/SEO pairs are adjusted to have the same overtravel.
   B. The auxiliary switch trips 1/16 in. before it reaches its fully seated position.
   C. After the auxiliary switch trips, there must be overtravel to ensure good switch operation.
   D. Do not force the auxiliary switch into the fully operated position.
   E. The auxiliary switches that operate as the main contacts are closing should trip just as the contact mechanism reaches the over-center point.
8. Close the cabinet door.
9. Reconnect the normal power source and emergency power source. If a generator set is the emergency power source, connect the negative (−) battery cable to the starting battery and place the operation selector switch in the Auto or Remote position.
10. Test the switch for proper operation.

Section 7. Service Parts

Introduction

Use this section to locate and identify service parts for the 150-3000 ampere models of the automatic transfer switches that use a contactor as the power conversion unit. The part numbers of the automatic transfer switches covered by the parts lists in this section will begin ZCS- or ZCB-.

This section does not include nonserviceable parts of the automatic transfer switch or any parts of the logic controller within the automatic transfer switch. A separate service and parts manual is provided for each logic controller model. To locate and identify logic controller parts, refer to the List of Related Manuals in the Introduction for the name and number of the service and parts manual for the applicable logic controller.

Using Parts Lists

Finding Parts Information

1. Use the illustration on page 7-2 to determine the group that lists the part needed.

   Example: An enclosed door hinge is needed. It is part of the enclosure.

2. Use the list on page 7-2 to locate the illustration identified in step 1.

   Example: Turn to the **Enclosures** illustration on page 7-3.

   NOTE

   Some items have more than one illustration. In this case, be sure to pick the illustration that corresponds to the ATS rating.

3. Locate the part needed in the illustration.

   Example: The door hinge is item 4.

4. Find the item number in the associated parts list on the same or facing page.

   Example: Find number 4 in the **Item** column.

5. Use the remaining columns of the parts list to find the factory part name and number.

   Example: The name in the **Description** column for item 4 is Hinge. The number listed in the **Part Number** columns for both sets of ratings given for item 4 is 294749-BLK. The number 2 or 3 in parentheses ( ) at the end of the entry in the **Part Number** columns indicates the quantity of the item used.

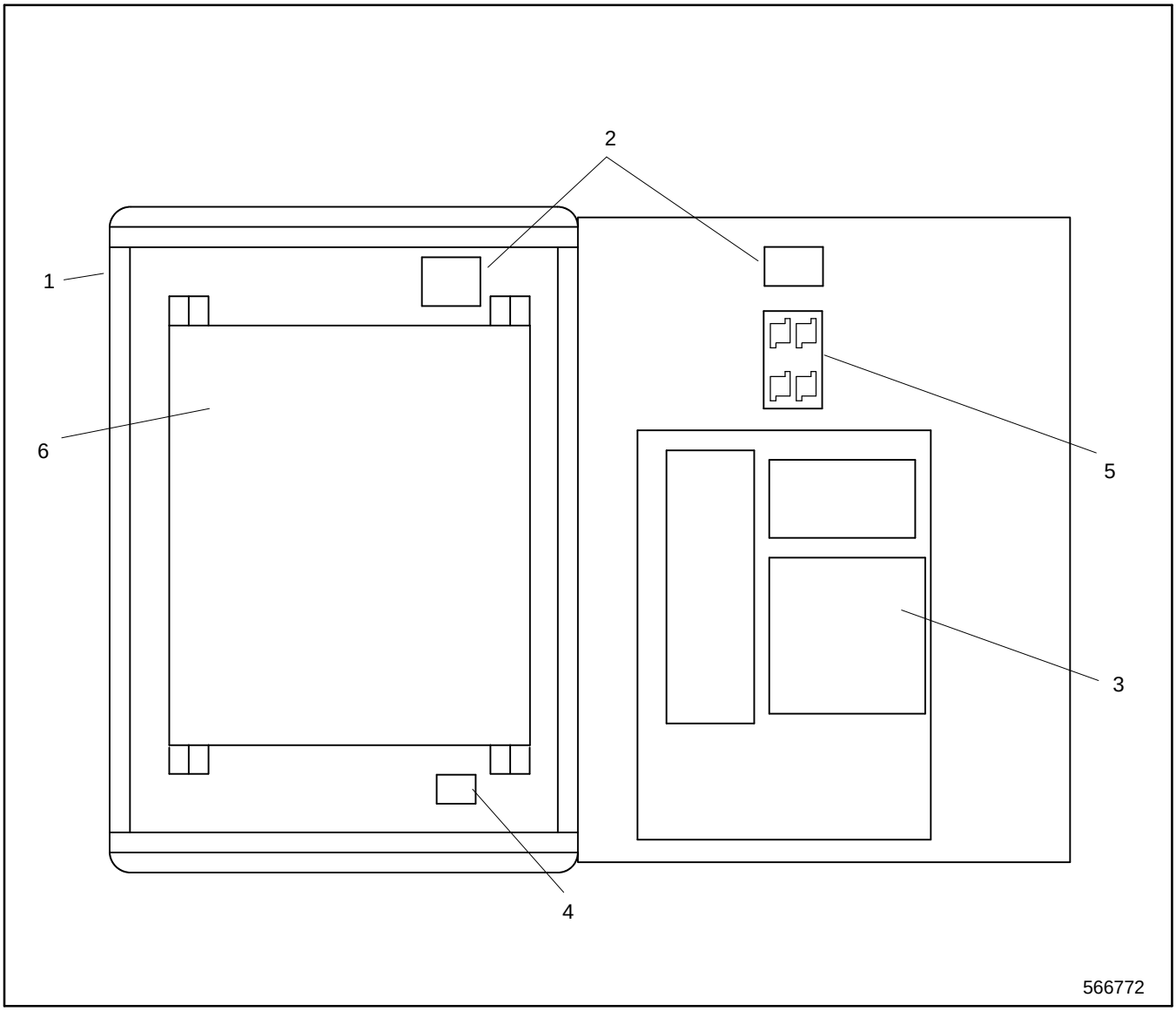
   NOTE

   If there is no number in parentheses at the end of the listing in the Part Number column, the quantity of that item is one (1). All contact assembly kits and arc chute kits include the parts for one contact; therefore, each pole requires two kits.

Leads

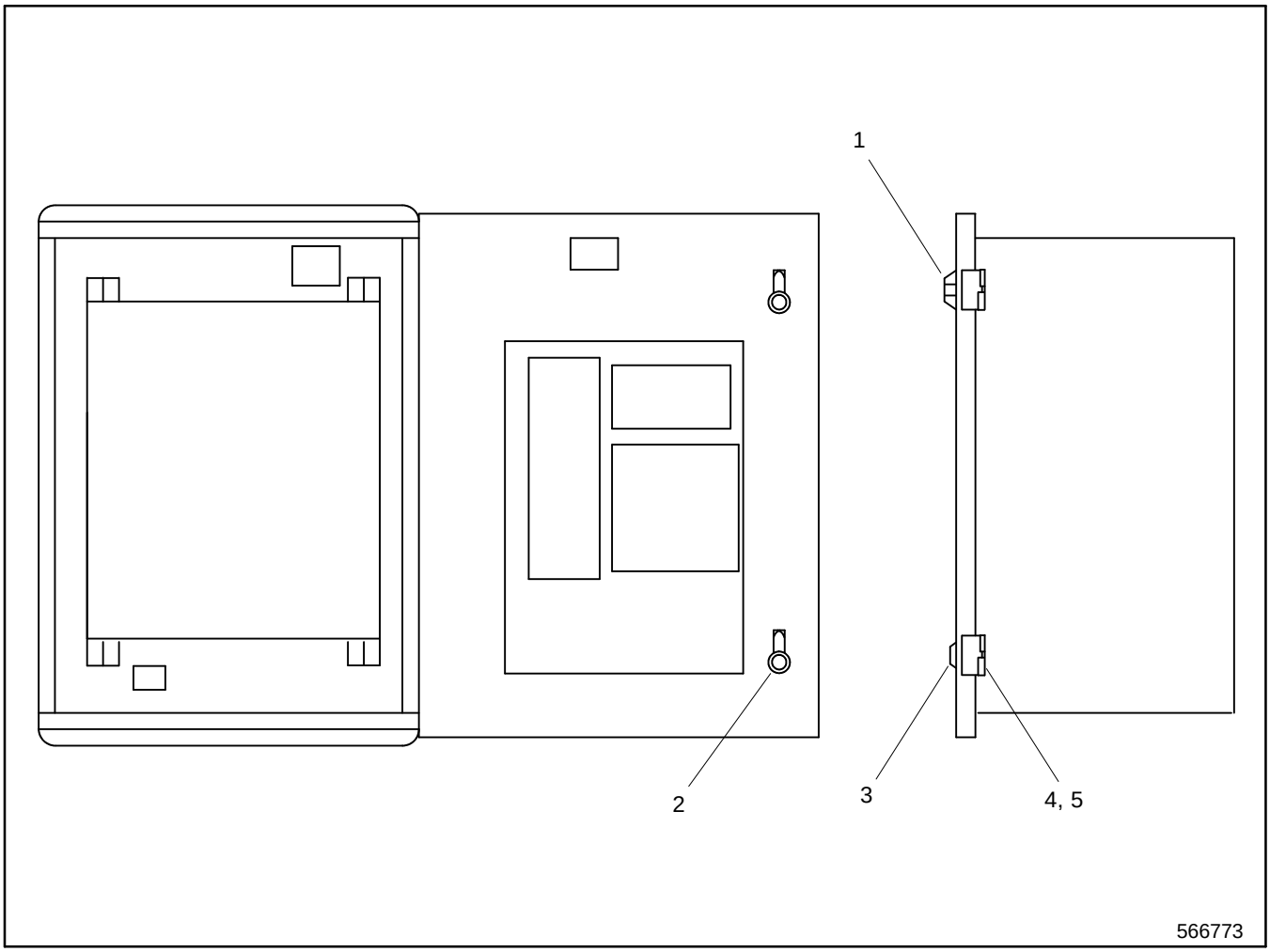
Most leads are included with the wiring harness. For lead replacement, fabricate a lead using the same type of standard copper wire (gauge, color, length). Add terminals and lead designations at each end of the new lead.

Automatic Transfer Switch



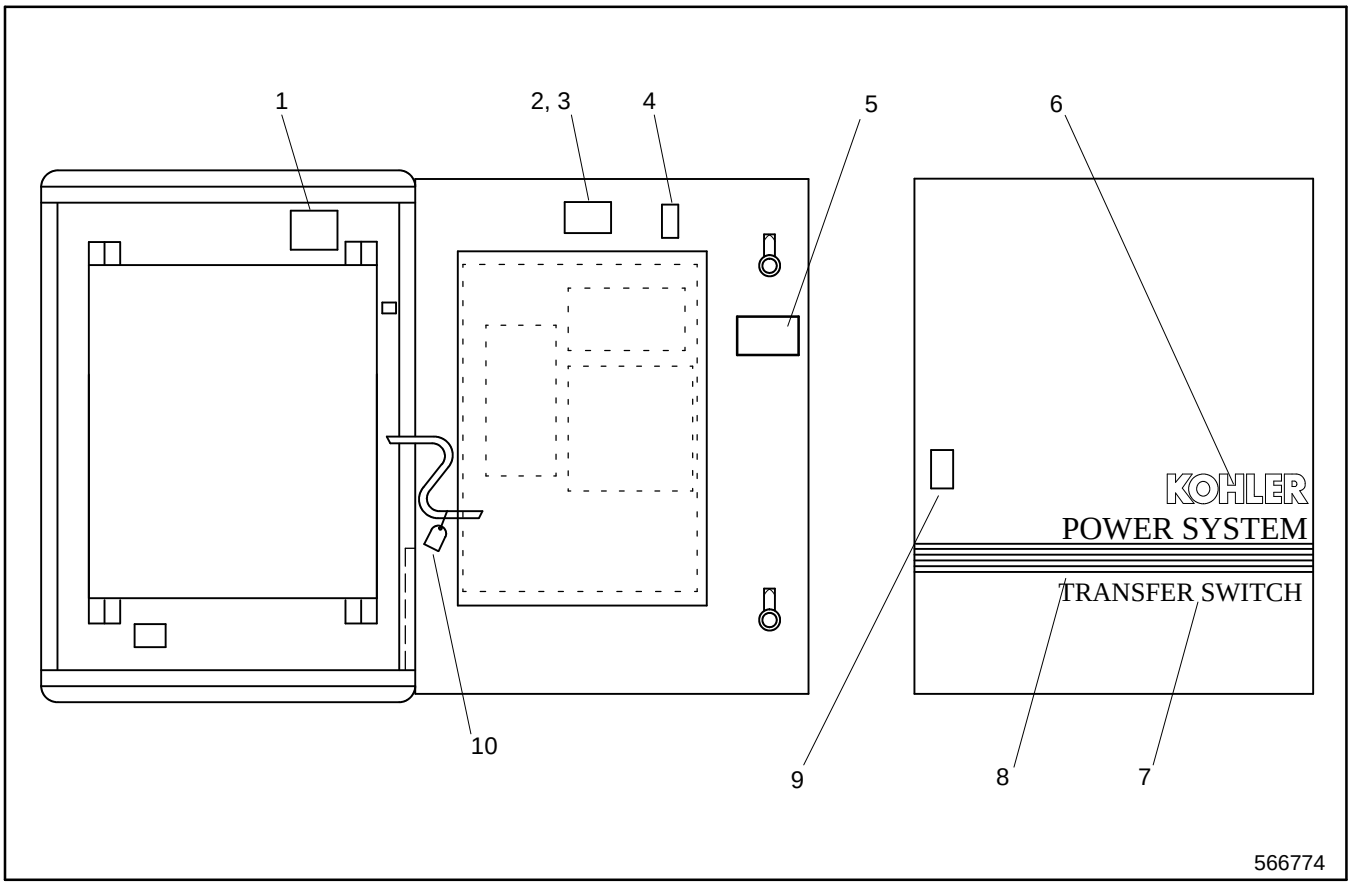
Item	Description	For further breakdown, see
1	Enclosure	**Enclosures**, page 7-3
2	Decals	**Decals**, page 7-4
3	Logic controller	Appropriate logic controller manual
4	Neutral lug (optional)	**Neutral Lugs**, page 7-5 thru 7-6
5	Interface panel assembly	**Interface Panel Assemblies**, page 7-7
6	Contractor assembly	**Contactor Assemblies**, pages 7-8 thru 7-27

Enclosures, ZCS Only



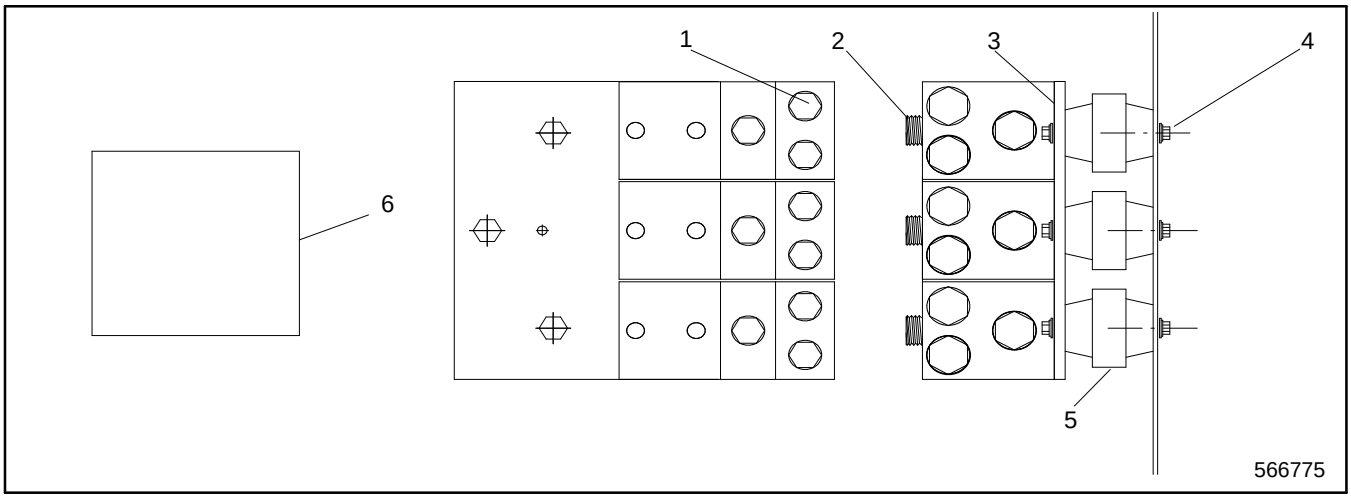
Item	Description	Part Number	
		150-400 Amp	600-3000 Amp
1	Handle, latch	320822	320822
2	Cam	320824 (2)	320824 (2)
3	Latch	320823	320823
4	Hinge	294749 (2)	294749 (3)
5	Screw	295098 (4)	295098 (6)

Decals

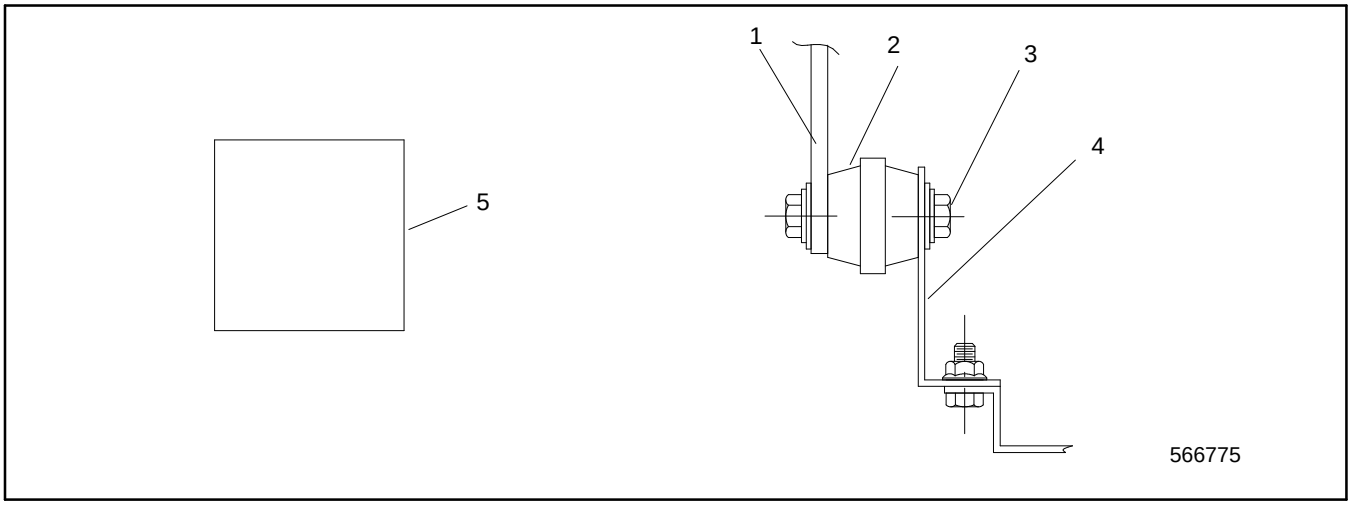


Item	Description	Part Number	
		E33+/ S340+ Logic	M340+ Logic
1	Decal, notice	294414	294414
2	Decal, nameplate	346019	346019
3	Decal, serial number	295392	295392
4	Decal, 1-800 number	224233	224233
5	Decal, notice	297721	297721
6	Decal, "Kohler Power System"	X-6246-3	X-6246-3
7	Decal, "Transfer Switch"	273746	273746
8	Decal, gold stripes	X-6232-2	X-6232-2
9	Decal, danger	N/A	294520
10	Tag, hang	297949	297949

Neutral Lugs

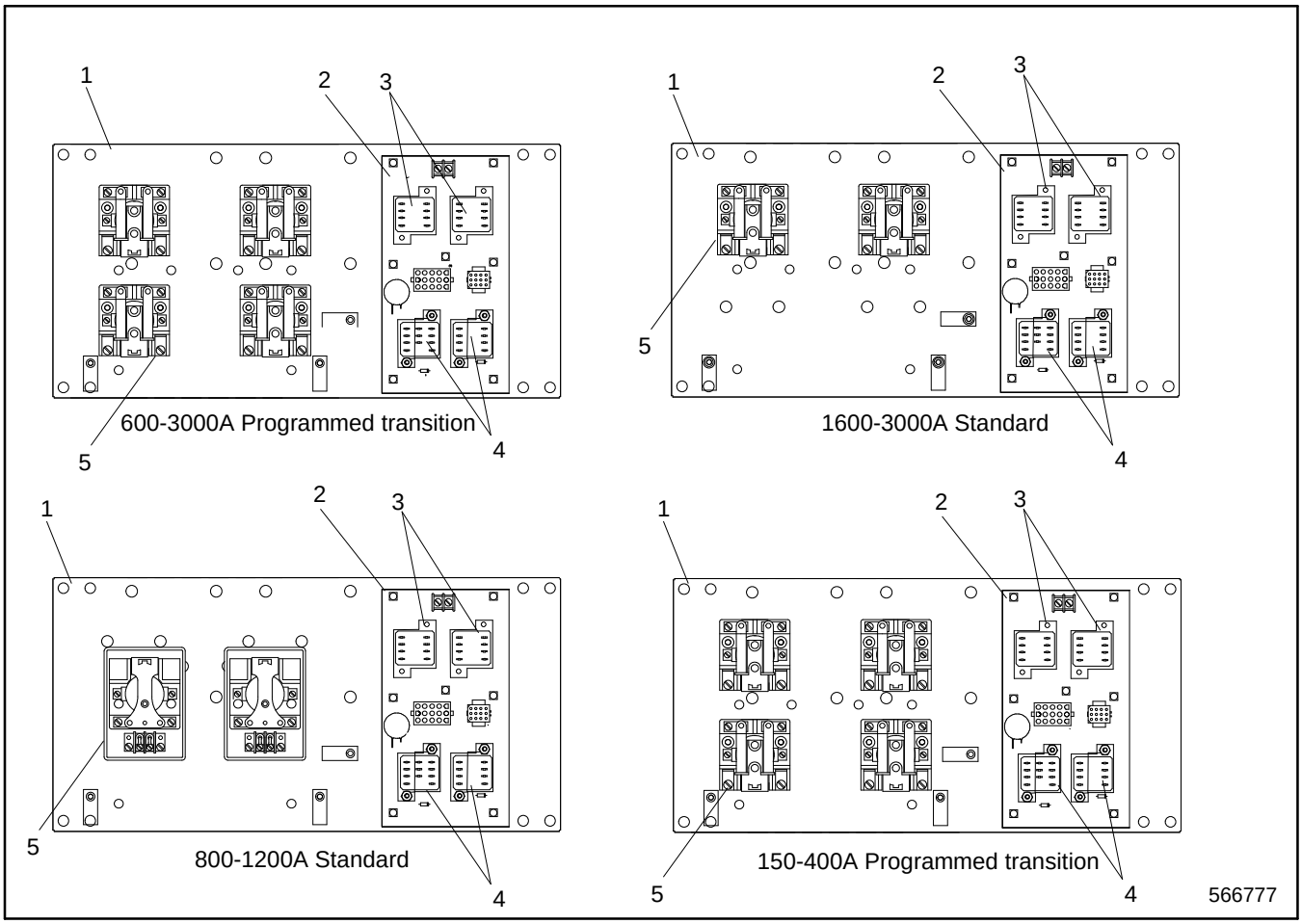


Item	Description	Part Number			
		150 Amp	225-260 Amp	400 Amp	600-800 Amp
1	Lug terminal	(3) 297712	(3) X-6207-5	(3) X-6207-9	(3) 295296
2	Screw, H.C.	(3) X-465-6	(4) X-6238-2	(3) X-22-10	(6) X-22-10
3	Bracket, mounting	297913	294362	294359	295298
4	Screw	(2) X-6238-2	(2) X-22-10	(2) X-6238-2	(3) X-6238-2
5	Insulator, standoff	(2) X-6128-31	(2) 233568	(2) 233568	(2) 233568
6	Decal	297556	297556	297556	297556



Item	Description	Part Number			
		1600 Amp Standard	2000-3000 Amp Standard	1600 Amp Bypass	2000-3000 Amp Bypass
1	Bracket, mounting	346208	(6) 346206	346208	(6) 346206
2	Insulator, standoff	(4) 233568	(4) 233568	(4) 233568	(4) 233568
3	Screw, H.C.	(4) X-6238-2	(4) X-6238-2	(4) X-6238-2	(4) X-6238-2
4	Bracket, neutral	(2) 346209	(2) 346209	(2) 346210	(2) 346210
5	Decal	297556	297556	297556	297556

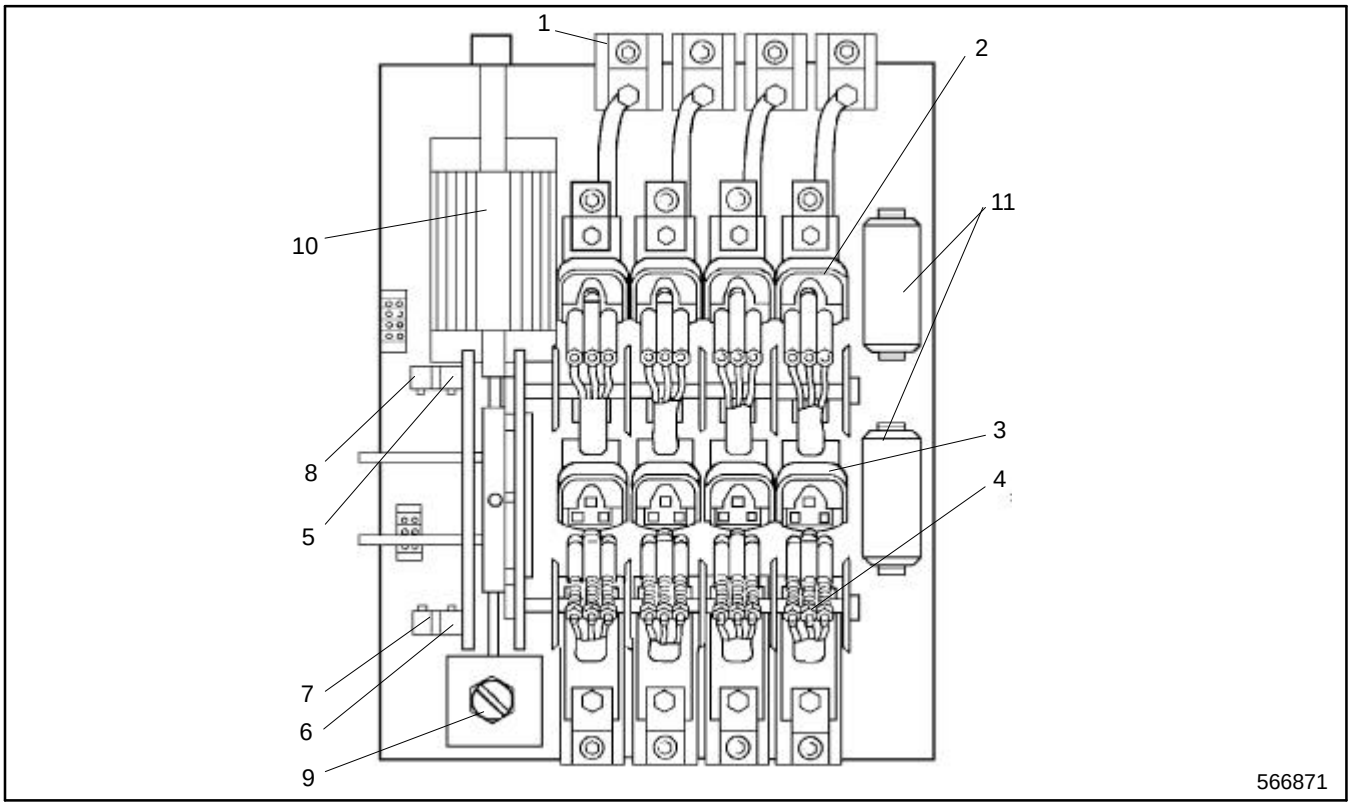
Interface Panel Assemblies



Item	Description	Part Number			
		800-1200 Amp Standard	1600-3000 Amp Standard	150-400 Amp Programmed Transition	600-3000 Amp Programmed Transition
1	Panel, interface	320737	320737	320737	320737
2	Interface Board Assembly	A-320687	A-320687	A-320687	A-320687
3	Relay, Time Delay	(2) 320695	(2) 320695	(2) 320695	(2) 320695
4	Relay	(2) 395318	(2) 395318	(2) 395318	(2) 395318
5	Relay Control	(2) 320726	(2) 320725	(4) 320725	(4) 320725

Contactor Assemblies

40-260 ATS



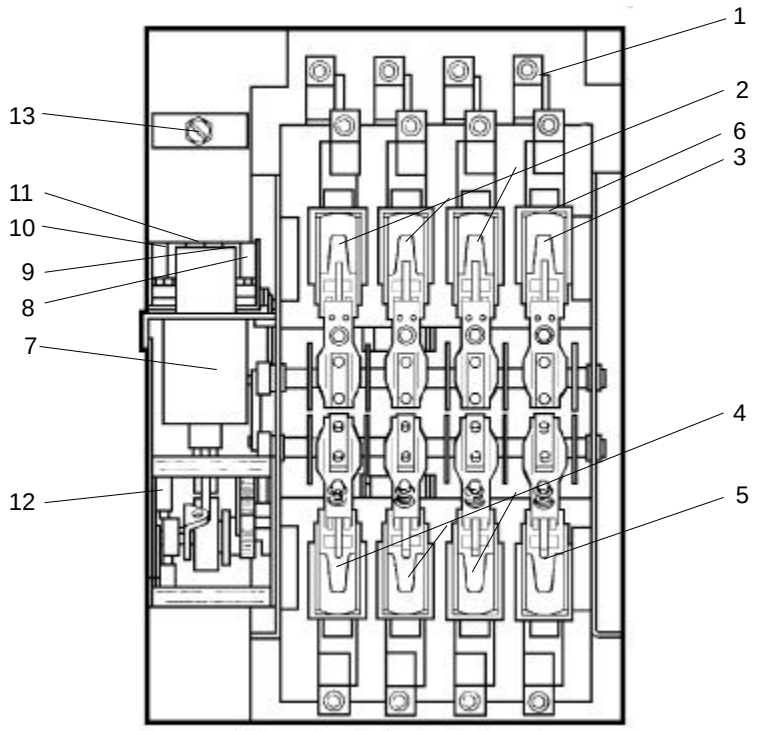
ITEM	DESCRIPTION	PART NUMBERS BY AMPERAGE			
		100	150	225	260
1	Cable Connection Lug	346584	346543	346544	346545
2	Stationary Contact Assembly Kit*	346546	346547	346547	346547
3	Arc Chute Assembly Kit*	346549	346549	346549	346549
4	Moveable Contact Assembly*	346550	346551	346551	346551
5	CN1 Cutout Switch	346562			
6	CE1 Cutout Switch	346563			
7	Emergency Position Aux. Contact	SPDT 346564; DPDT 321819			
8	Normal Position Aux. Contact	SPDT 346564; DPDT 321819			
9	Disconnect Switch	Operator 321773; Contact Block 296300			

* All kits include the parts for one contact; therefore, each pole requires two kits.

		Part Numbers	
Volts	**Poles**	**ITEM 10** Linear Actuator	**ITEM 11** Capacitors
120	2	346552	346559
240	2	346553	346560
	3	346553	346560
208	3	346554	346561
	4	346555	346561
575/600	3	346556	346560
480	3	346557	346560
	4	346558	346560
416	3	346557	346560

Contactor Assemblies

400 ATS



Item 14 not shown

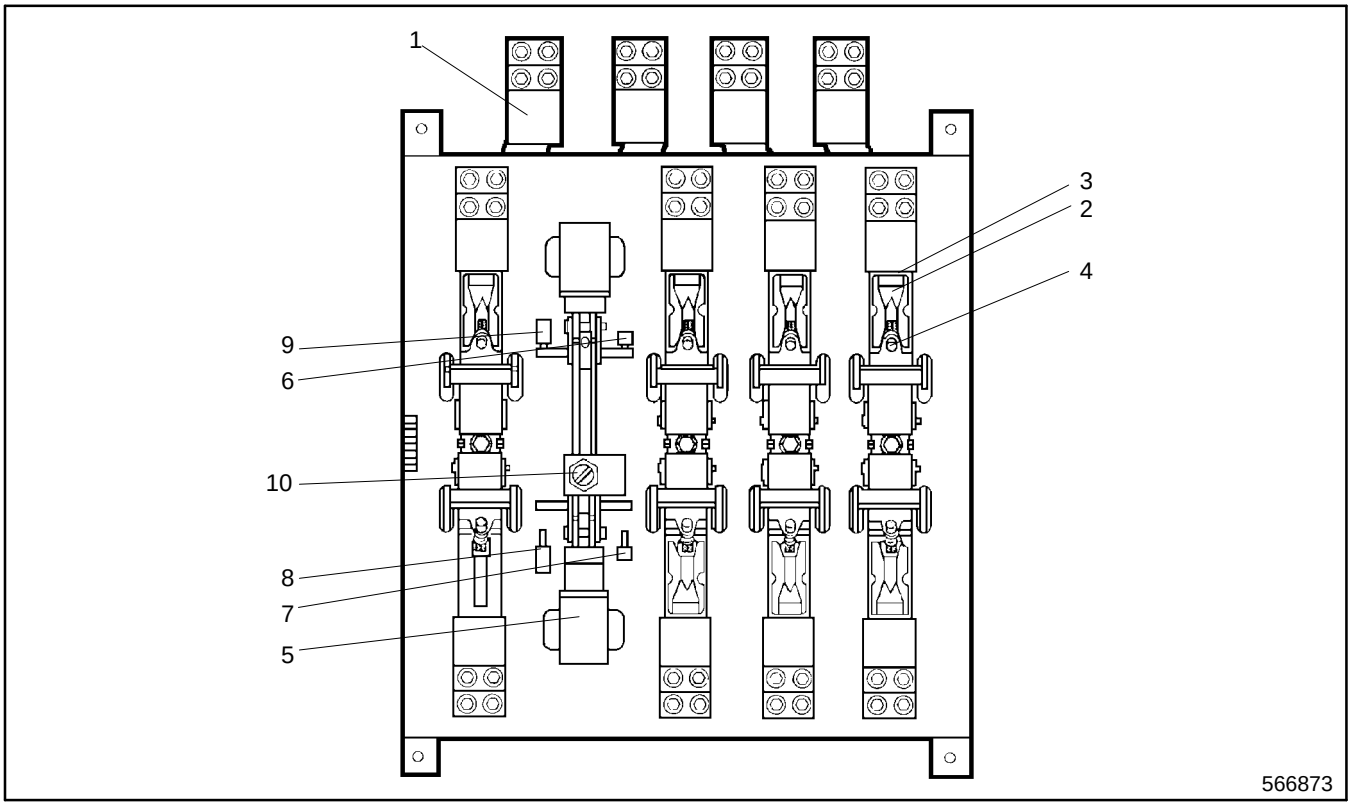
566872

ITEM	DESCRIPTION			PART NUMBER
1	Cable Connection Lugs			321743
2	Normal contact assembly kit*			321787
3	Switched neutral. (normal) contact assembly kit*			321792
4	Emergency contact assembly kit*			321797
5	Switched neutral. (emergency) contact assembly kit*			321802
6	Arc Chute Assembly*			346567
7	Main ATS Operating Coils	**Coil Volts**	**Poles**	
		120	2	321806
		240	3,4	321808
		208	3,4	321805
		575/600	3,4	346548
		480	3,4	321804
		416	3,4	321807
		380	3,4	321807
8	CN1 Limit Switch			321822
9	CE1 Limit Switch			321822
10	ATS Emergency Position Switch			321822
11	ATS Normal Position Switch			
12	CNE Limit Switches			321782
13	ATS Solenoid Disconnect Switch Operator			321772
	Disconnect Switch Contact Block (N.C.)			321774
14	Rectifier			321781

* All kits include the parts for one contact; therefore, each pole requires two kits.

Contactor Assemblies

600-1200 ATS

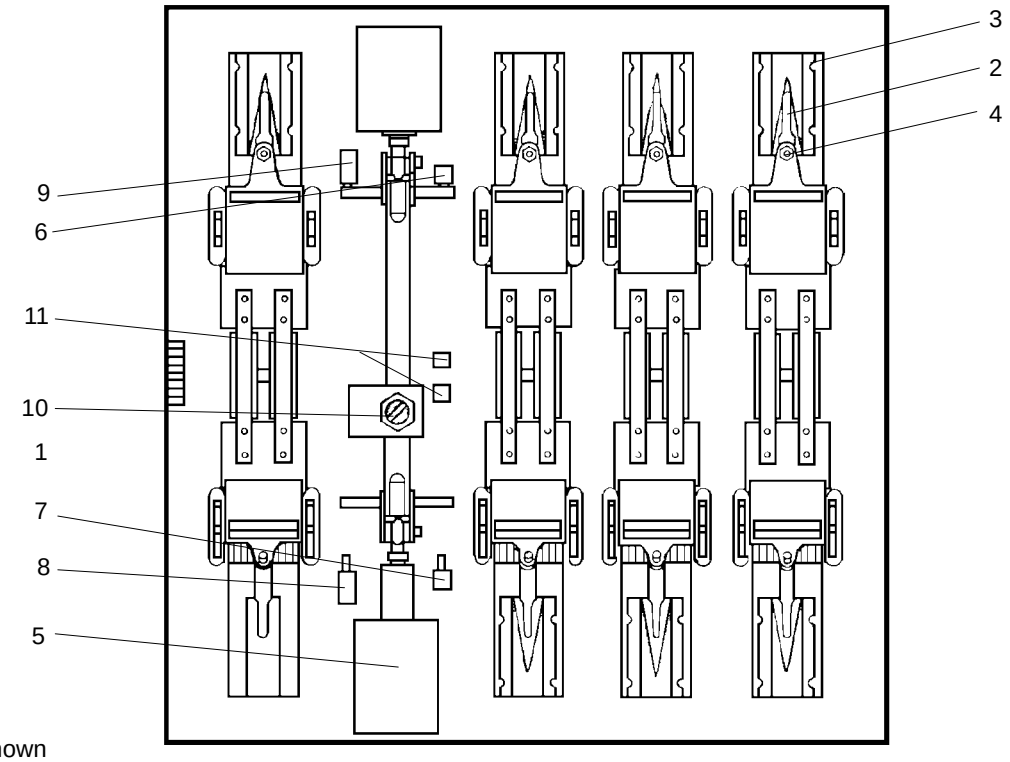


ITEM	DESCRIPTION			PART NUMBER BY AMPERAGE			
				600	800	1000	1200
1	Cable Connection Lugs			321744	321746	321746	321746
2	Stationary Contact Assembly Kit*			Consult Factory			
3	Arc Chute Assembly Kit*			321753			
4	Moveable Contact Assembly Kit*			Consult Factory			
5	Main Operating Coils	**Volts**	**Poles**	**Part Number**			
		120	2	321859	321860	321860	321860
		240	2	321861	321862	321862	321862
			3	321865	321862	321862	321862
			4	321865	321862	321862	321862
		208	3,4	321866	296296	296296	296296
		575/600	3,4	321868	346571	346571	346571
		480	3	321867	296297	296297	296297
			4	321869	296297	296297	296297
		416	3	321867	296297	296297	296297
6	CCN Cutout Switch			296298	296298	296298	296298
7	CCE Cutout Switch			296299	346572	346572	346572
8	Emergency Position Aux. Contact			(Qty. 1) 296298, (Qty. 2) 321758, (Qty. 3) 346573, (Qty. 4) 321863			
9	Normal Position Aux. Contact			(Qty. 1) 296299, (Qty. 2) 321855, (Qty. 3) 346574, (Qty. 4) 346575			
10	Disconnect Switch			Operator 321773; Contact Block 296300			

* All kits include the parts for one contact; therefore, each pole requires two kits.

Contactor Assemblies

1600-3000 ATS



Item 1 not shown

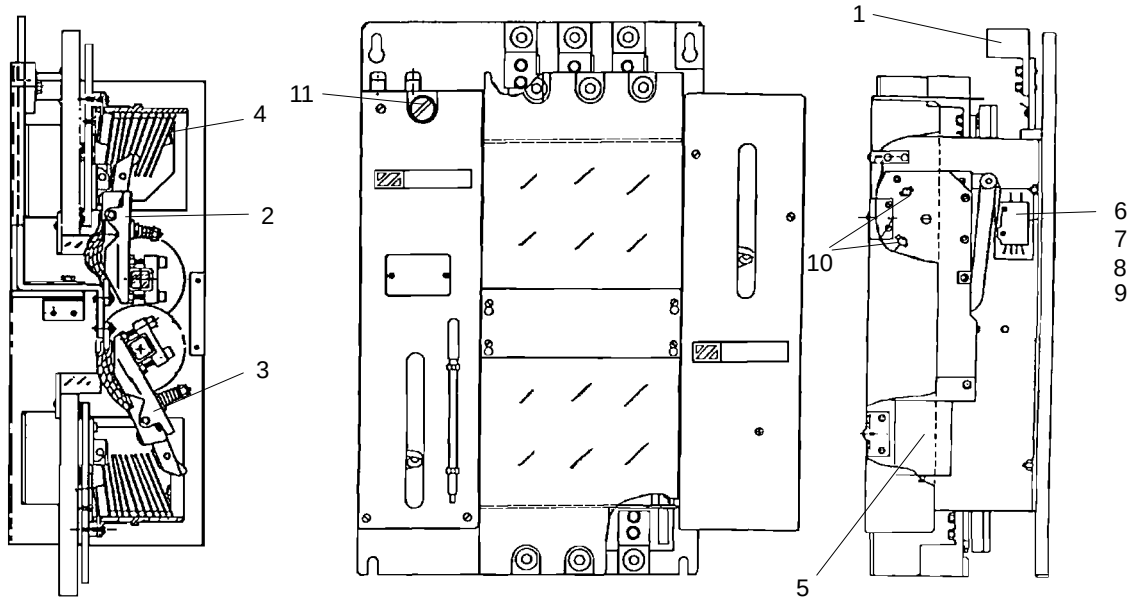
566874

ITEM	DESCRIPTION			PART NUMBER BY AMPERAGE		
				1600	2000	3000
1	Cable Connection at Rear			321747	321747	321747
2	Stationary Contact Assembly Kit*			321750	321750	321751
3	Arc Chute Assembly Kit*			321872	321872	321872
4	Moveable Contact Assembly Kit*			321757	321757	321757
5	Main Operating Coils	**Coil Volts**	**Poles**	**Part Number**		
		120	2	Consult Factory		
		240	2,3	321891	321891	321891
			4	321893	321893	321893
		208	3	321892	321892	321892
			4	321895	321895	321895
		575/600	3	346577	346577	346577
			4	346578	346578	346578
		480	3	296301	296301	296301
			4	296302	296302	296302
		416	3	321896	321896	321896
6	CN Cutout Switch			269303		
7	CE Cutout Switch			296304		
8	Emergency Position Aux. Contact			(Qty. 1) 296303 (Qty. 2) 321877 (Qty. 3) 321878 (Qty. 4) 321879		
9	Normal Position Aux. Contact			(Qty. 1) 296304 (Qty. 2) 321881 (Qty. 3) 321882 (Qty. 4) 321883		
10	Disconnect Switch			Operator 321773; Contact Block 296300		
11	Rectifier			321761		

* All kits include the parts for one contact; therefore, each pole requires two kits.

Contactor Assemblies

100-400 ATS/DELAY



Item 12 not shown

566875

ITEM	DESCRIPTION	PART NUMBER BY AMPERAGE				
		100	150	225	260	400
1	Cable Connection Lugs	321742	321742	321742	321743	321743
2	Normal Contact Assembly*	321783	321784	321785	321786	321787
3	Switched. Neutral Normal*	321788	321789	321790	321791	321792
4	Emergency Contact Assembly*	321793	321794	321795	321796	321797
5	Switched. Neutral Emergency*	321798	321799	321800	321801	321802
6	Arc Chute assembly*	321752				
	Main ATS Operating Coils					

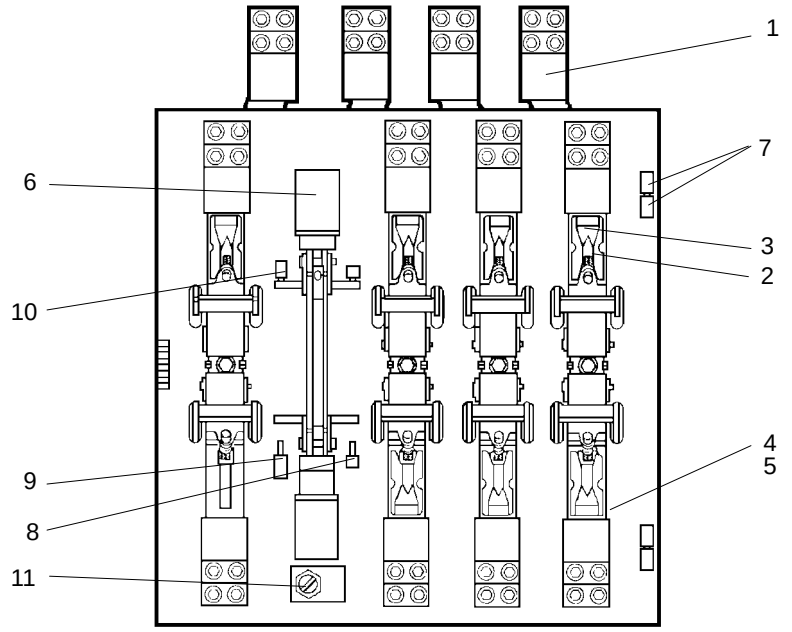
7	Volts	Ph	Wire	Coil Volts	Poles	Part Number
	120	1	2	120	2	321806
	120/240	1	3	240	2,3	321808
	240	3	3	240	3	321808
	120/240	3	4	240	3,4	321808
	120/208	3	4	208	3,4	321805
	480	3	3	480	3	321804
	575/600	3	3	575/600	3	Consult Factory
	277/480	3	4	480	3,4	321804
	240/416	3	4	416	3,4	Consult Factory
	220/380	3	4	380	3,4	321807

8	Limit Switch CN1/CNO CE1 ATS Emergency	321803
9	ATS Normal Position Switch	321803
10	CNE Limit Switch	321782
11	ATS Solenoid Disconnect Switch Operator 2-Position Maintain Contact Block N.C. (1)	 321772 321774
12	Rectifier	321781

* All kits include the parts for one contact; therefore, each pole requires two kits.

Contactor Assemblies

600-1200 ATS/DELAY



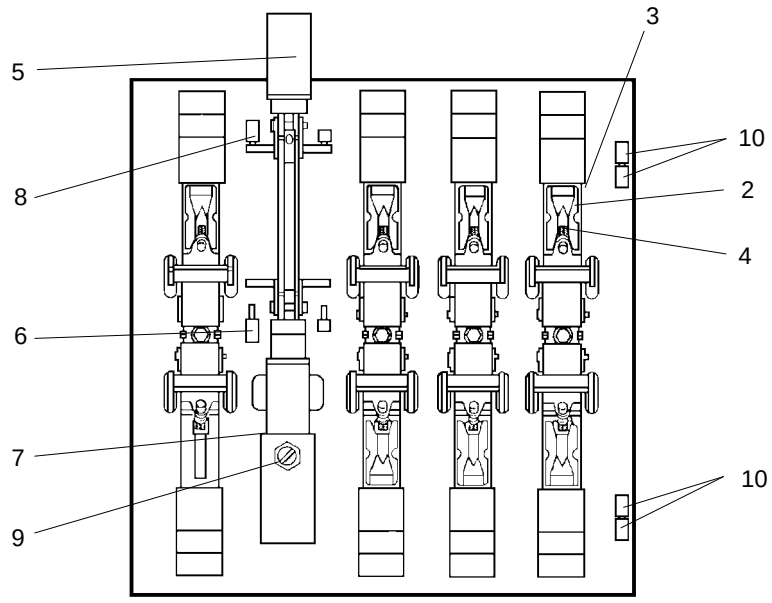
566876

ITEM	DESCRIPTION					PART NUMBER BY AMPERAGE			
						600	800	1000	1200
1	Cable Connection Lugs					321744	321745	321746	321746
2	Stationary Contact Assembly Kit*					321748	346530	321748	321748
3	Arc Chute Assembly Kit*					321753	321753	321753	321753
4	Movable Contact Assembly Kit*					321755	321756	321756	321756
5	Movable Contact Switched Neutral*					321759	321760	321760	321760
6	Main Operating Coils DC								
	Volts	**Ph**	**Wire**	**Coil Volts**	**Pole**	**Part Number**			
	120 -	1 -	2 -	120 -	2 2	Consult Factory			
	120/240	1	3	240	3	321811	321813	321813	321813
	240	3	3	240	3	321811	321813	321813	321813
	120/208	3	4	208	3,4	321811	321813	321813	321813
	480	3	3	480	3	321812	321814	321814	321814
	575	3	3	575/600	3	Consult Factory			
	277/480	3	4	480	3,4	321812	321814	321814	321814
	120/240	2	4	240	4	321811	321813	321813	321813
	240/416	3	4	416	3	Consult Factory			
7	Coil Rectifier					321761			
8	Cutout Switch CN/CNO CE/CEO					321762			
9	Emergency Position Auxiliary Contact					(Qty. 1) 321764 (Qty. 2) 321766			
10	Normal Position Auxiliary Contact					(Qty. 1) 321768 (Qty. 2) 321770			
11	Disconnect Switch					Operator 321773; Contact Block 296300			

* All kits include the parts for one contact; therefore, each pole requires two kits.

Contactor Assemblies

1600-3000 ATS/DELAY



Item 1 not shown

566877

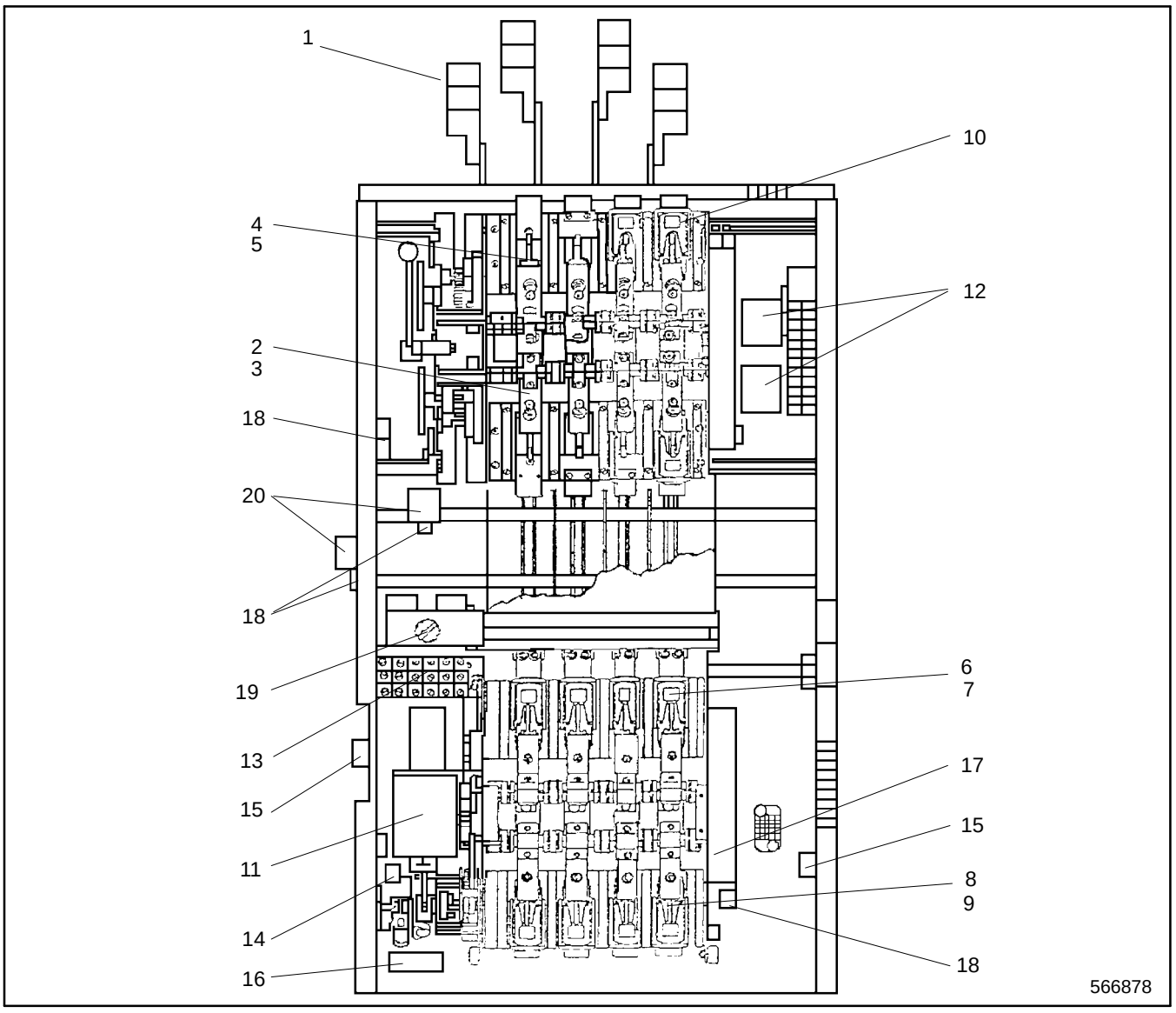
ITEM	DESCRIPTION					PART NUMBER BY AMPERAGE		
						1500	2000	3000
1	Cable Connection at rear					321747	321747	321747
2	Stationary Contact Assembly Kit*					321749	321750	321751
3	Arc Chute Assembly Kit*					321872	321872	321872
4	Movable Contact Assembly Kit*					321757	321757	321873
5	Main Operating Coils DC							
	Volts	**Ph**	**Wire**	**Coil Volts**	**Pole**	**Part Number**		
	120	1	2	120	2	Consult Factory		
	120/240	1	3	240	2	321809	321809	321809
					3	321809	321809	321809
	240	3	3	240	3	321809	321809	321809
	120/208	3	4	208	3,4	321809	321809	321809
	480	3	3	480	3	321810	321810	321810
	575	3	3	575/600	3	Consult Factory		
	277/480 277/480	3 3	4 4	480 480	3 4	321810 321810	321810 321810	321810 321810
	120/240	2	4	240	4	321809	321809	321809
	240/416	3	4	416	3	Consult Factory		
6	Cutout Switch CN/CNO CE/CEO					321763		
7	Emergency Position Aux. Contact					(Qty. 1) 321765 (Qty. 2) 321767		
8	Normal Position Aux. Contact					(Qty. 1) 321769 (Qty. 2) 321771		
9	Disconnect Switch					Operator 321773; Contact Block 296300		
10	Rectifier					321761		

* All kits include the parts for one contact; therefore, each pole requires two kits.

Notes

Contactor Assemblies

100-400 ATS/BIS



ITEM	DESCRIPTION	PART NUMBER BY AMPERAGE				
		100	150	225	260	400
1	Cable Connection Lugs	321742	321742	321742	321743	321743
2	Bypass Normal Contact Assembly*	321823	321824	321825	321826	321827
3	Bypass Switched Neutral Normal Contact Assembly*	321828	321829	321830	321831	321832
4	Bypass Emergency Contact Assembly*	321833	321834	321835	321836	321837
5	Bypass Switched Neutral Emergency Contact Assembly*	321838	321839	321840	321841	321842
6	ATS Normal Contact Assembly*	321783	321784	321785	321786	321787
7	ATS Switched Neutral Normal Contact Assembly*	321788	321789	321790	321791	321792
8	ATS Emergency Contact Assembly*	321793	321794	321795	321796	321797
9	ATS Switched Neutral Emergency Contact Assembly*	321798	321799	321800	3217801	3217802
10	Arc Chute Assembly*	321752				

* All kits include the parts for one contact; therefore, each pole requires two kits.

(continued on next page)

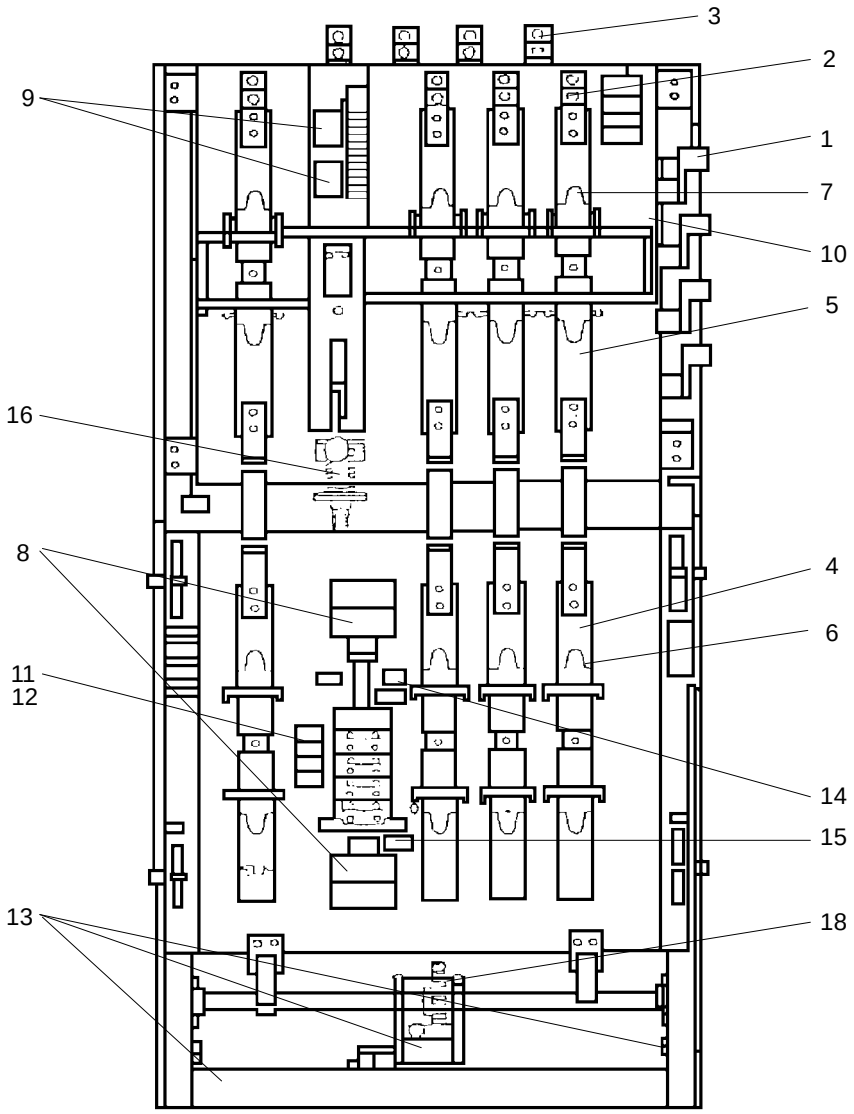
Contactor Assemblies

100-400 ATS/BIS

ITEM	DESCRIPTION					PART NUMBER
11	Main ATS Operating Coils					
	Volts	**Ph**	**Wire**	**Coil Volts**	**Poles**	
	120	1	2	120	2	321806
	120/240	1	3	240	2,3	321808
	240	3	3	240	3	321808
	120/240	3	4	240	3,4	321808
	120/208	3	4	208	3,4	321805
	480	3	3	480	3	321804
	575/600	3	3	575/600	3	Consult Factory
	277/480	3	4	480	3,4	321804
	240/416	3	4	416	3,4	Consult Factory
	220/380	3	4	380	3,4	321807
				Voltage		
12	Bypass Stepdown Transformer 25VA Secondary 24V			120/240 208/416 220/440 240/480 380 575 600		321864 321844 321845 321846 321894 321848 321849
13	Switch CN 1 CE 1 ATS Emergency ATS Normal					321822
14	CNE Limit Switches					321782
15	Switch ATS Auto Location ATS Isolate/Remove Location Position Lever					321821
16	Location Switch ATS Isolate ATS Test					321820
17	Switch Bypass Emergency Position Bypass Normal Position Normal TRS Limit Switch Emergency TRS Limit Switch					321819
18	Switch Bypass Emergency Position Bypass Normal Position ATS Engaged Bypass Lock Location ATS Lock Location					321818
19	ATS Solenoid Disconnect Switch Operator 2-Position Maintain Contact Block N.O. (1) Contact Block N.O. (2)					321772 321774 321888 321817
20	Interlock Solenoid Bypass Interlock Transfer Release					321815

Contactor Assemblies

600-1200 ATS/BIS



Item 17 not shown

566879

ITEM	DESCRIPTION	PART NUMBER BY AMPERAGE			
		600	800	1000	1200
1	Normal Lugs	321843	321853	321854	321854
2	Emergency Lugs	321744	321745	321746	321746
3	Load Lugs	321744	321745	321746	321746
4	Stationary Contact Assembly Bypass*	321847	346583	346583	346583
5	Stationary Contact Assembly ATS*	321847	346583	346583	346583
6	Arc Chute Assembly Kit*	321753	321753	321753	321753
7	Moveable Contact Assembly* Moveable Contact (Switched Neutral)*	321876 321876	321880 321816	321880 321816	321880 321816

* All kits include the parts for one contact; therefore, each pole requires two kits.

(continued on next page)

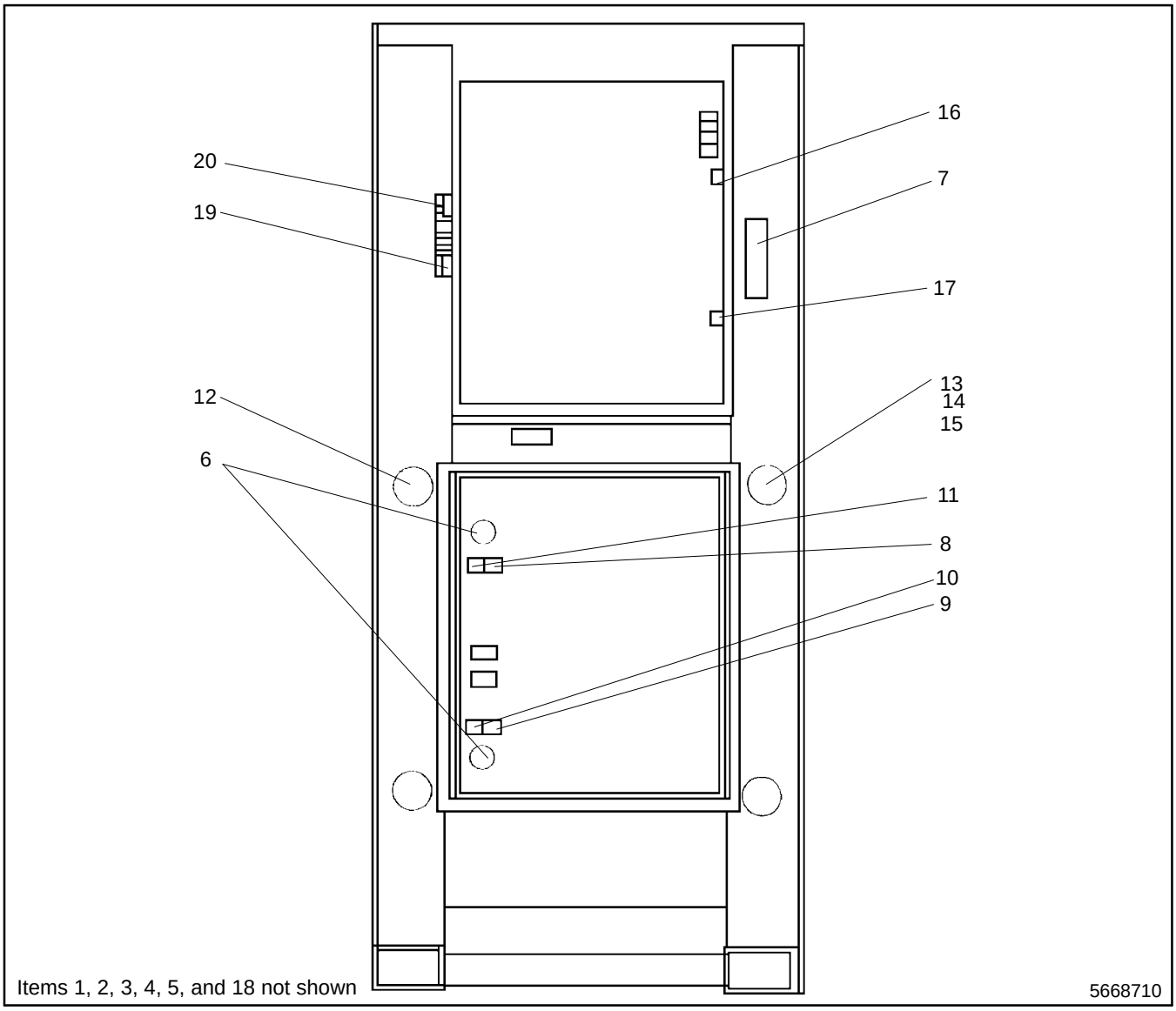
Contactor Assemblies

600-1200 ATS/BIS

ITEM	DESCRIPTION					PART NUMBER BY AMPERAGE			
						600	800	1000	1200
8	ATS Main Operating Coils								
	Voltage System					Part Numbers By Amperage			
	Volts	Ph	Wire	Coil Volts	Pole	600	800	1000	1200
	120	1	2	120	2	321859	321860	321860	321860
	120/240	1	2	240	2	321861	321862	321862	321862
		1	2	240	3	321865	321862	321862	321862
	120/240	3	4	240	3	321865	321862	321862	321862
	120/208	3	4	208	3,4	321866	296296	296296	296296
	480	3	3	480	3	321867	296297	296297	296297
	575	3	3	575/600	3	321868	Consult Factory	Consult Factory	Consult Factory
	277/480	3	4	480	3	321867	296297	296297	296297
		3	4	480	4	321869	296297	296297	296297
	240/416	3	4	416	3	321867	296297	296297	296297
						Voltage		Part Number	
9	Bypass Step Down Transformer 25VA, 24 Volt Secondary					120/240 208/416 220/440 240/480 380 575 600		321864 321844 321845 321846 321894 321848 321849	
10	Switch Bypass Emergency Position Bypass Normal Position BSS Emergency Position BSS Normal Position Limit Switch DPDT, Lever Actuator					321819			
11	ATS Auto Location Switch ATS Test Location Switch Crank Limit Switches ATS Isolate Location Switch Limit Switch DPDT, Roller Actuator					321851 321852 321818 321851 321852			
12	ATS Emergency Position Switch					(SPDT) 296298		(DPDT) 321758	
13	ATS Normal Position Switch (Aux. Contact)					296299		321855	
14	ATS Normal Position Coil Cutout Switch DPDT					321758			
15	ATS Emergency Position Coil Cutout Switch DPDT					321856			
16	ATS Solenoid Disconnect Switch Operator 2-Position Maintain Contact Block N.O. Contact Block N.O.					321773 296300 321857			
17	Solenoid Emergency Interlock Normal Interlock					321858			
18	Crank Mechanism Solenoid					321858			

Contactor Assemblies

1600-3000 ATS/BIS



ITEM	DESCRIPTION	PART NUMBER BY AMPERAGE		
		1600	2000	3000
1	Cable Connection at Rear	321746 (2)	321746	321746
2	Stationary Contact Assembly (Bypass)*	321870	321870	321871
3	Stationary Contact Assembly (ATS)*	321870	321870	321871
4	Arc Chute Assembly*	321872	321872	321872
5	Movable Contact Assembly*	321757	321757	321873

* All kits include the parts for one contact; therefore, each pole requires two kits.

(continued on next page)

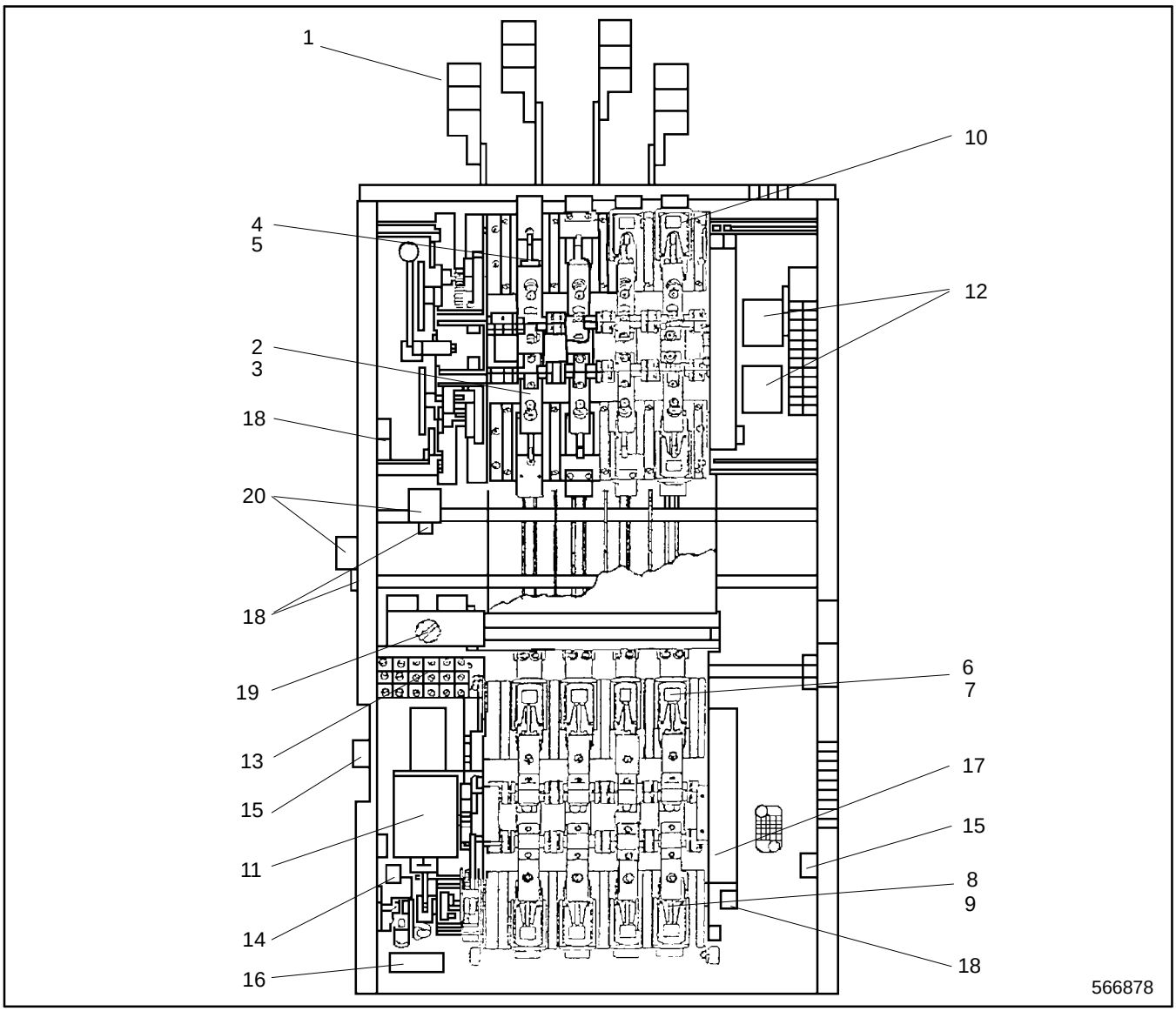
Contactor Assemblies

1600-3000 ATS/BIS

ITEM	DESCRIPTION					PART NUMBER BY AMPERAGE		
6	ATS Main Operating Coils							
	Volts	**Ph**	**Wire**	**Coil Volts**	**Pole**	**1600**	**2000**	**3000**
	120/240	1	3	240	3	321891	321891	321891
	240	3	3	240	3	321891	321891	321891
	240	3	4	240	4	321893	321893	321893
	120/280	3	4	208	3	321892	321892	321892
	120/208	3	4	208	4	321895	321895	321895
	480	3	3	480	3	296301	296301	296301
	277/480	3	4	480	3	296301	296301	296301
	277/480	3	4	480	4	296302	296302	296302
	240/416	3	4	416	3	321896	321896	321896
						Voltage	**Part Number**	
7	Bypass Step Down Transformer 24 Volt Secondary					120/240 208/416 220/440 240/480 380 575 600	321864 321844 321845 321846 321894 321848 321849	
8	ATS Normal Position Coil Cutout Switch					321874		
9	ATS Emerg. Position Coil Cutout Switch					321875		
10	ATS Emergency Position Switch					296303, 321877, 321878, 321879		
11	ATS Normal Position Switch					296304, 321881, 321882, 321883		
12	Crank Handle Limit Switch					321851		
13	ATS Auto Location Switch					321821		
14	ATS Isolate/Remove Location Switch					321851		
15	Location Switch ATS Isolate ATS Test					321821		
16	Position Switch Bypass Emergency Bypass Normal					321819		
17	ATS Latched Limit Switch					321818		
18	ATS Solenoid Disconnect Switch Operator 2-Position Maintain Contact Block N.O. (1) Contact Block N.O. (2) Contact Block Mounting Plate					 321772 321774 321888 321817		
19	Bypass Interlock Solenoid					321884		
20	Crank Enable Solenoid					321885		

Contactor Assemblies

100-400 ATS/BIS DELAY



ITEM	DESCRIPTION	PART NUMBER BY AMPERAGE				
		100	150	225	260	400
1	Cable Connection Lugs	321742	321742	321742	321743	321743
2	Bypass Normal Contact Assembly*	321823	321824	321825	321826	321827
3	Bypass Switched Neutral Normal Contact Assembly*	321828	321829	321830	321831	321832
4	Bypass Emergency Contact Assembly*	321833	321834	321835	321836	321837
5	Bypass Switched Neutral Emergency Contact Assembly*	321838	321839	321840	321841	321842
6	ATS Normal Contact Assembly*	321783	321784	321785	321786	321787
7	ATS Switched Neutral Normal Contact Assembly*	321788	321789	321790	321791	321792
8	ATS Emergency Contact Assembly*	321793	321794	321795	321796	321797
9	ATS Switched Neutral Emergency Contact Assembly*	321798	321799	321800	3217801	3217802
10	Arc Chute Assembly*	321752				

* All kits include the parts for one contact; therefore, each pole requires two kits.

(continued on next page)

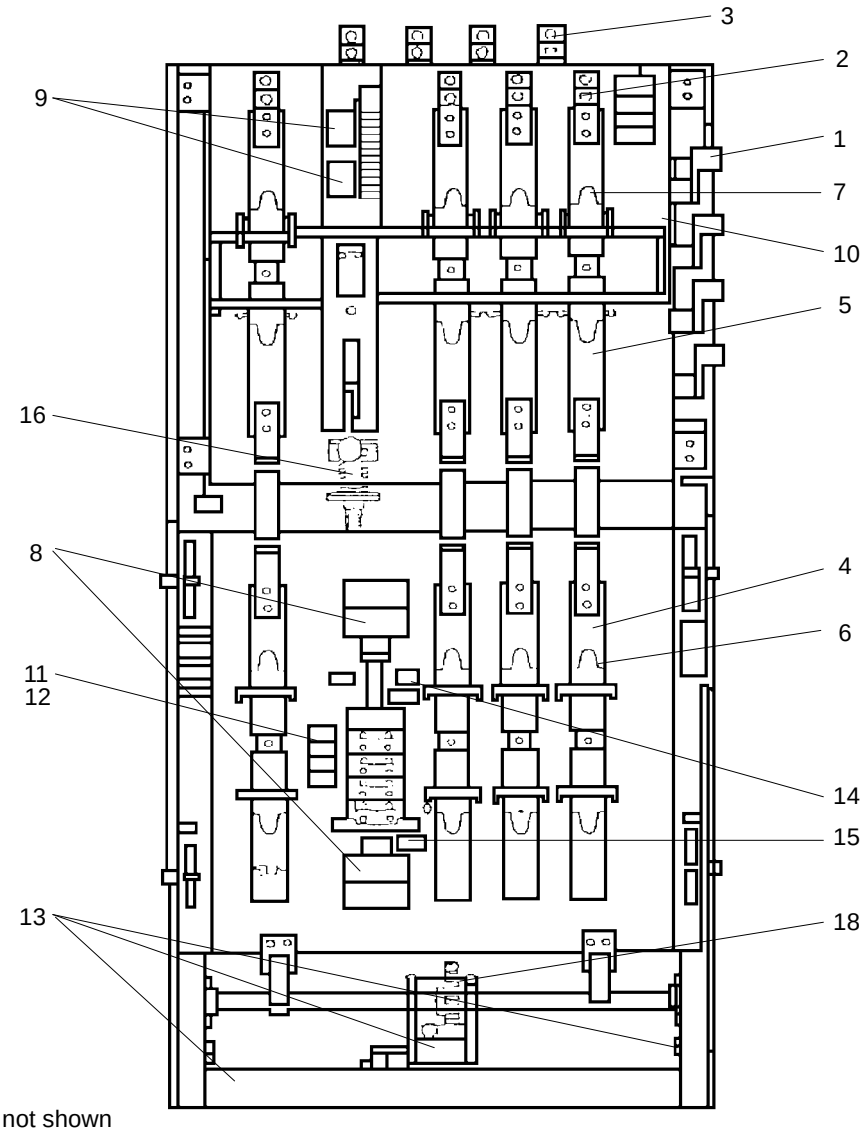
Contactor Assemblies

100-400 ATS/BIS DELAY

ITEM	DESCRIPTION					PART NUMBER
11	Main ATS Operating Coils					
	Volts	**Ph**	**Wire**	**Coil Volts**	**Poles**	
	120	1	2	120	2	321806
	120/240	1	3	240	2,3	321808
	240	3	3	240	3	321808
	120/240	3	4	240	3,4	321808
	120/208	3	4	208	3,4	321805
	480	3	3	480	3	321804
	575/600	3	3	575/600	3	Consult Factory
	277/480	3	4	480	3,4	321804
	240/416	3	4	416	3,4	Consult Factory
	220/380	3	4	380	3,4	321807
				Voltage		
12	Bypass Stepdown Transformer 25VA Secondary 24V			120/240 208/416 220/440 240/480 380 575 600		321864 321844 321845 321846 321894 321848 321849
13	Switch CN 1 Limit Switch CE 1 Limit Switch ATS Emergency Position ATS Normal Position					321803
14	CNE Limit Switches					321782
15	Switch ATS Auto Location ATS Isolate/Remove Location Position Lever					321821
16	Location Switch ATS Isolate ATS Test					321820
17	Switch Bypass Emergency Position Bypass Normal Position Normal TRS Limit Switch Emergency TRS Limit Switch					321819
18	Switch Bypass Emergency Position Bypass Normal Position ATS Engaged Bypass Lock Location ATS Lock Location					321818
19	ATS Solenoid Disconnect Switch Operator 2-Position Maintain Contact Block N.O. (1) Contact Block N.O. (2)					321772 321774 321888 321817
20	Solenoid Bypass Interlock Transfer Release					321815

Contactor Assemblies

600-1200 ATS/BIS DELAY



Items 17, 19, and 20 not shown

566879

ITEM	DESCRIPTION	PART NUMBER BY AMPERAGE			
		600	800	1000	1200
1	Normal Lugs	321843	321853	321854	321854
2	Emergency Lugs	321744	321745	321746	321746
3	Load Lugs	321744	321745	321746	321746
4	Stationary Contact Assembly Bypass*	321847	346583	346583	346583
5	Stationary Contact Assembly ATS*	321847	346583	346583	346583
6	Arc Chute Assembly Kit*	321753	321753	321753	321753
7	Moveable Contact Assembly* Moveable Contact (Switched Neutral)*	321876 321876	321880 321816	321880 321816	321880 321816

* All kits include the parts for one contact; therefore, each pole requires two kits.

(continued on next page)

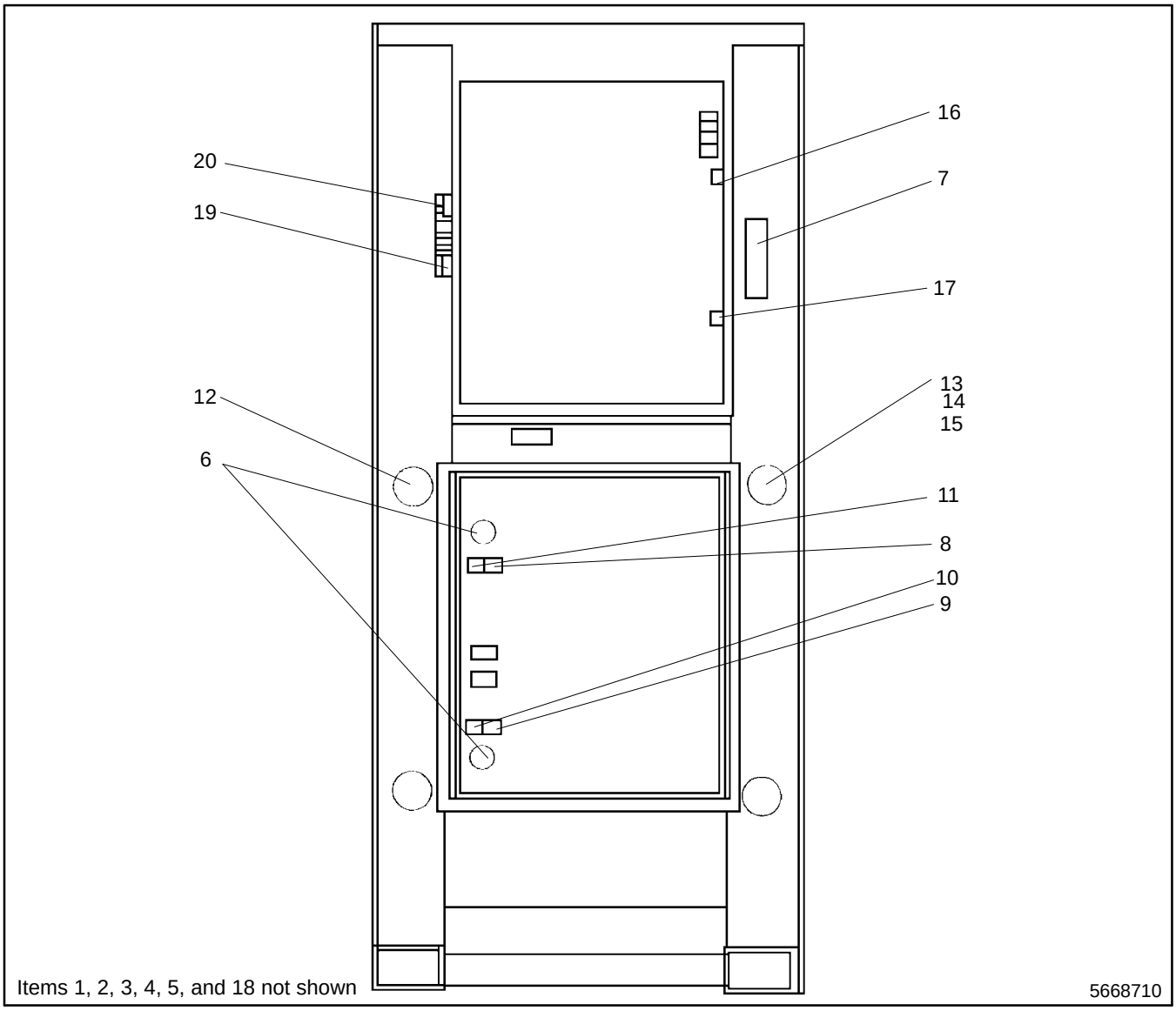
Contactor Assemblies

600-1200 ATS/BIS DELAY

ITEM	DESCRIPTION					PART NUMBER BY AMPERAGE			
						600	800	1000	1200
8	ATS Main Operating Coils								
	Voltage System					Part Numbers By Amperage			
	Volts	Ph	Wire	Coil Volts	Pole	600	800	1000	1200
	120	1	2	120	2	Consult Factory	Consult Factory	Consult Factory	Consult Factory
	120/240	1	2	240	2	Consult Factory	Consult Factory	Consult Factory	Consult Factory
		1	2	240	3	321811	321813	321813	321813
	120/240	3	4	240	3	321811	321813	321813	321813
	120/208	3	4	208	3,4	321811	321813	321813	321813
	480	3	3	480	3	321812	321814	321814	321814
	277/480	3	4	480	3	321812	321814	321814	321814
		3	4	480	4	321812	321814	321814	321814
	240/416	3	4	416	3	Consult Factory	Consult Factory	Consult Factory	Consult Factory
						Voltage		Part Number	
9	Bypass Step Down Transformer 25VA, 24 Volt Secondary					120/240 208/416 220/440 240/480 380 575 600		321864 321844 321845 321846 321894 321848 321849	
10	Switch Bypass Normal Position BSS Emergency Position BSS Normal Position Limit Switch DPOT, Lever Actuator					321819			
11	ATS Auto Location Switch ATS Test Location Switch Crank Limit Switches ATS Isolate Location Switch Limit Switch DPOT, Roller Actuator					321851 321852 321818 321851 321852			
12	ATS Emergency Position Switch					(SPDT) 296298		(DPDT) 321758	
13	ATS Normal Position Switch (Aux. Contact)					296299		321855	
14	ATS Normal Position Coil Cutout Switch DPDT					321758			
15	ATS Emergency Position Coil Cutout Switch DPDT					321856			
16	ATS Solenoid Disconnect Switch Operator 2-Position Maintain Contact Block N.O. Contact Block N.O.					321773 296300 321857			
17	Solenoid Emergency Interlock Normal Interlock					321858			
18	Crank Mechanism Solenoid					321858			
19	Bypass Permissive Pushbutton Operator Pushbutton Contact Block N.O.					321887 321888			
20	Coil Rectifiers					321761			

Contactor Assemblies

1600-3000 ATS/BIS DELAY



ITEM	DESCRIPTION	PART NUMBER BY AMPERAGE		
		1600	2000	3000
1	Cable Connection at Rear	321746 (2)	321746	321746
2	Stationary Contact Assembly (Bypass)*	321870	321870	321871
3	Stationary Contact Assembly (ATS)*	321870	321870	321871
4	Arc Chute Assembly*	321872	321872	321872
5	Movable Contact Assembly*	321757	321757	321873

* All kits include the parts for one contact; therefore, each pole requires two kits.

(continued on next page)

Contactor Assemblies

1600-3000 ATS/BIS DELAY

ITEM	DESCRIPTION					PART NUMBER BY AMPERAGE		
6	ATS Main Operating Coils							
	Volts	**Ph**	**Wire**	**Coil Volts**	**Pole**	**1600**	**2000**	**3000**
7	120	1	2	120	2	Consult Factory	Consult Factory	Consult Factory
	120/240	1	3	240	3	321809	321809	321809
	240	3	3	240	4	321809	321809	321809
	120/208	3	4	208	3,4	321809	321809	321809
	480	3	3	480	3	321810	321810	321820
	575	3	3	575/600	3	Consult Factory	Consult Factory	Consult Factory
	277/480	3	4	480	3,4	321810	321810	321810
	240/416	3	4	416	3	Consult Factory	Consult Factory	Consult Factory
						Voltage	**Part Number**	
8	Bypass Step Down Transformer 24 Volt Secondary					120/240	321864	
						208/416	321844	
						220/440	321845	
						240/480	321846	
						380	321894	
						575	321848	
						600	321849	
9	ATS Normal Position Coil Cutout Switch					321889		
10	ATS Emerg. Position Coil Cutout Switch					321890		
11	ATS Emergency Position Switch					296303, 321877, 321878, 321879		
12	ATS Normal Position Switch					296304, 321881, 321882, 321883		
13	Crank Handle Limit Switch					321851		
14	ATS Auto Location Switch					321821		
15	ATS Isolate/Remove Location Switch					321851		
16	Location Switch ATS Isolate ATS Test					321821		
17	Position Switch Bypass Emergency Bypass Normal					321819		
18	ATS Latched Limit Switch					321818		
19	ATS Solenoid Disconnect Switch							
	Operator 2-Position Maintain					321772		
	Contact Block N.O. (1)					321774		
	Contact Block N.O. (2)					321888		
	Contact Block Mounting Plate					321817		
20	Bypass Interlock Solenoid					321884		
21	Crank Enable Solenoid					321885		

Appendix A. Glossary of Abbreviations

Abbreviations are used throughout this manual. Normally in the text they will appear in complete form with the abbreviation following in parenthesis the first time they are used. After that they will appear in the abbreviated form. The commonly used abbreviations are shown below.

Abbreviation	Description
AC	alternating current
AHWT	anticipatory high water temp.
ALOP	anticipatory low oil pressure
AM	amplitude modulation
Amp	ampere
Amps	amperes
ANSI	American National Standard Institute
API	American Petroleum Institute
approx.	approximate, approximately
A/R	as required, as requested
A/S	as supplied, as stated, as suggested
ASA	American Standards Association
assy.	assembly
ASTM	American Society for Testing Materials
ATDC	after top dead center
ATS	automatic transfer switch
aux.	auxiliary
AWG	American Wire Gauge
AWM	appliance wiring material
bhp	brake horsepower
bmep	brake mean effective power
Btu	British thermal unit
°C	Celsius degree
cc	cubic centimeter
CCA	cold cranking Amps.
CEC	Canadian Electrical Code
cfh	cubic feet per hour
cfm	cubic feet per minute
CID	cubic inch displacement
cm	centimeter, centimeters
cmm	cubic meters per minute
co.	company
cont'd.	continued
C.S.A.	Canadian Standards Association
cu. in.	cubic inch, cubic inches
cyl.	cylinder
dBA	decibels
DC	direct current
DCR	direct current resistance
deg.	degree

Abbreviation	Description
dept.	department
dia.	diameter
e.g.	example given
EMI	electromagnetic interference
etc.	et cetera, (and so forth)
ext.	external
°F	Fahrenheit degree
fl. oz.	fluid ounce, fluid ounces
FM	frequency modulation
fs	full scale
ft.	foot, feet
ft. lbs.	foot pound, foot pounds
ga.	gauge
gal., gals.	gallon, gallons
gal./hr.	gallons per hour
gph	gallons per hour
gpm	gallons per minute
gr.	grade
grd.	ground
HCHT	high cylinder head temperature
HET	high exhaust temperature
Hg	mercury (element)
H_2O	water
hp	horsepower
hr, hrs	hour
HWT	high water temperature
Hz	hertz (cycles per second)
ID	inside diameter
in.	inch(es)
inc.	incorporated
in. lbs.	inch pounds
int.	internal
int.-ext.	internal-external
ISO	International Standards Organization
J	joule, joules
JIS	Japanese Industry Standard
kg	kilogram, kilograms
kg/cm^2	kilograms per square centimeter
kgm	kilogram meter(s)
km	kilometer, kilometers

Abbreviation	Description
kPa	kiloPascal, kiloPascals
kph	kilometers per hour
kV	kilovolt
kVA	kilovolt amperes
kW	kilowatt, kilowatts
kWH	kilowatt hour
L	liter, liters
LxWxH	length x width x height
LED, LEDs	light emitting diode
lb., lbs.	pound, pounds
L/hr.	liter per hour, liters per hour
L/min.	liter(s) per minutes
LOP	low oil pressure
LP	liquefied petroleum
LWT	low water temperature
m	meter, meters
m^3	cubic meter, cubic meters
max.	maximum
MCM	one thousand circular mils.
mi.	mile, miles
mil	one one-thousandth of an inch
min.	minimum
mJ	millijoule, millijoules
MJ	mega joule, mega joules
mm	millimeter, millimeters
m^3/min	cubic meters per minute
MPa	megaPascal
mph	miles per hour
MS	military standard
mW	milliwatt, milliwatts
MW	megawatt, megawatts
N/A	not available
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
Nm	Newton meter, Newton meters
no., nos.	number, numbers
NPT	National Standard taper pipe thread per general use

Abbreviation	Description
N/R	not required
OC	overcrank
OD	outside diameter
OEM	original equipment manufacturer
OS	overspeed, oversize
OV	overvoltage
oz.	ounce, ounces
PF	power factor
pot.	potentiometer
ppm	parts per million
psi	pounds per square inch
pt., pts.	pint, pints
qt., qts.	quart, quarts
qty.	quantity
ref.	reference
RFI	radio frequency interference
rms	root mean square
rpm	revolutions per inch
SAE	Society of Automotive Engineers
sec.	second, seconds
SCR	silicon controlled rectifier
spec, specs	specification
sq.	square
sq. cm	square centimeters
sq. in.	square inch, square inches
tach	tachometer
TDC	top dead center
temp.	temperature
TIF	telephone influence factor
turbo	turbocharger
UNC	Unified coarse thread (was NC)
UNF	Unified fine thread (was NF)
UL	Underwriter ъ Laboratories, Inc.
US	undersize
V	volt, volts
VAC	Volts alternating current
VDC	volts direct current
W	watt, watts

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