THOMSON TECHNOLOGY
POWER & CONTROL
A REGAL-BELOIT COMPANY

TS 880

AUTOMATIC TRANSFER SWITCHES

INSTALLATION, OPERATING & SERVICE MANUAL

PM064 REV 6 07/02/27

9087A – 198th Street, Langley, BC Canada V1M 3B1 • Telephone (604) 888-0110
Telefax (604) 888-3381 • E-Mail: info@thomsontechnology.com • www.thomsontechnology.com

TABLE OF CONTENTS

1. PRODUCT REVISION HISTORY

The following information provides an historical summary of changes made to this product since the original release.

Operating & Service Manual Version

Rev 0 04/11/15	Original release.
Rev1 04/12/21	Additional information for Closed Transition Operation
Rev 2 05/03/08	Changes to incorporate reversing style ATS motor for 100-250A transfer switches
Rev 3 05/05/11	Changes to Section 5 & Section 21.
Rev 4 06/05/08	Changes to Section 13.
Rev 5 07/02/01	Changes to Section 13.
Rev 6 07/02/27	Changes to Section 12, Cable Terminal Information

Contact Thomson Technology, to obtain applicable instruction manuals or if in doubt about any matter relating to installation, operation or maintenance. Soft copy of the most current version is available at www.thomsontechnology.com.

NOTE: All information contained in this manual is for reference only and is subject to change without notice.

2. EQUIPMENT STORAGE

The following procedures are required for correct storage of the transfer switch prior to installation.

2.1. *ENVIRONMENTAL CONDITIONS*

CAUTION!!!

Failure to store and operate equipment under the specified environmental conditions may cause equipment damage and void warranty***.***

2.1.1. EQUIPMENT STORAGE

The transfer switch shall be stored in an environment with a temperature range not exceeding -4° to +158° Fahrenheit (-20° to +70° Celsius) and a humidity range not exceeding 5%-95% non-condensing. Before storing, unpack sufficiently to check for concealed damage. If concealed damage is found, notify the ATS supplier and the Carrier immediately. Repack with the original, or equivalent packing materials.

Protect from physical damage. Do not stack. Store indoors in a clean, dry, well ventilated area free of corrosive agents including fumes, salt and concrete/cement dust. Apply heat as necessary to prevent condensation.

2.1.2. EQUIPMENT OPERATING

The transfer switch shall be operated in an environment with a temperature range not exceeding +5° to +122° Fahrenheit (-15° to +50° Celsius) and a humidity range not exceeding 5%-95% non-condensing.

3. NOTES TO INSTALLER

Before opening the transfer switch enclosure to perform any service task, or to manually transfer the mechanism, it is imperative to isolate the transfer switch from any possible source of power. Failure to do so may result in serious personal injury or death due to electrical shock.

CAUTION!!!

All installation and/or service work performed must be done by qualified personnel only. Failure to do so may cause personal injury or death.

3.1. *UPSTREAM CIRCUIT PROTECTIVE DEVICES/ELECTRICAL CONNECTIONS*

To ensure satisfactory installation of this equipment be sure to observe "Cable Terminal Information" regarding power cable connection tightness and "Requirements for Upstream Circuit Protective Devices" located in this manual.

All mechanical and electrical connections must be checked for tightness prior to placing this equipment in service to ensure proper operation and to validate applicable warranty coverage.

3.2. *TRANSFER SWITCHES WITH INTEGRAL OVER CURRENT PROTECTION*

For models of transfer switch with integral over current protection, the over current protection must be set prior to operation. The equipment will be shipped from the factory with a long-time current setting of 100% (of the equipment rating) and maximum short-time/instantaneous current and time delay settings.

***WARNING*!**

Do Not Energize this equipment until device settings have been verified to

ensure proper system protection & coordination. Failure to do so may result in equipment failure.

Refer to ***Section 5.2.2*** of this manual for additional information on operation of the Transfer switch following an over current trip condition.

Refer to information supplied with the transfer switch documentation package for adjustment procedures on the power switching units over current protection trip unit. Contact the factory if any additional information is required.

3.3. *TRANSFER SWITCHES WITH MULTI-TAP VOLTAGE CAPABILITY*

If the transfer switch has programmable multi-tap voltage capability (refer to engineered drawings), confirm the transfer switch has been configured for the correct system voltage prior to installation.

WARNING!

Failure to confirm and match transfer switch voltage with the system voltage could cause serious equipment damage.

The voltage selections and connections are shown on the engineered drawings attached to each transfer switch. The factory default settings will be indicated on the calibration label attached on the inside of the enclosure door (supplied loose on open style models). A blank label is included to record the applicable settings if the configuration is changed from the factory default settings.

To change the transfer switch configuration the following must be accomplished:

- Change voltage taps of the potential transformers (i.e. PT's) to system voltage (refer to drawings)
- Once the voltage taps have been set to correct operating voltage, the "control circuit isolation plug" on the mechanism, may be reconnected, prior to voltage energization.
- Change TSC 800 programming (refer to the TSC 800 instruction manual (PM049). The following settings will require reprogramming:
  - System voltage
  - Utility under voltage pickup (typically 90% of system voltage)
  - Utility under voltage dropout (typically 80% of system voltage)
  - Utility over voltage pickup (typically 110% of system voltage)

- Utility over voltage dropout (typically 105% of system voltage)
- Generator under voltage pickup (typically 90% of system voltage)
- Generator under voltage dropout (typically 80% of system voltage)
- Generator over voltage pickup (typically110% of system voltage)
- Generator over voltage dropout (typically 105% of system voltage)

Record any changed setting on the TSC 800 Programming Data Sheets for future reference.

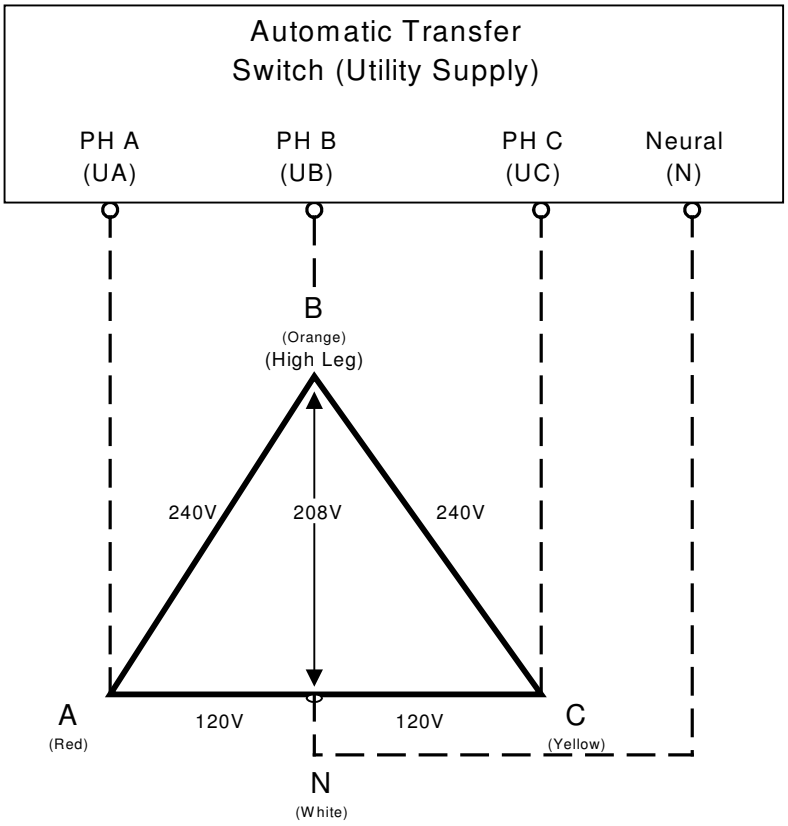
- Complete the blank calibration label and attach to the inside of the transfer switch enclosure door.

3.4. *SYSTEM PHASING-HIGH LEG DELTA SYSTEMS*

For systems using high leg delta 240V 3 phase 4 wire systems, connection of supply conductors must have the correct phasing as shown below.

WARNING!

Failure to match correct system phasing will result in serious damage to the TSC 800 controller.



CAUTION!!!

All installation and/or service work performed must be done by qualified personnel only. Failure to do so may cause personal injury or death.

Where transfer switches are supplied without power isolation transformers (PT1 & PT2) for ATS control logic it is essential that the orientation of phase conductors of the supply source be arranged such that the phase of highest potential with respect to ground is not connected to the power supply inputs to the controller (A Phase for both supplies). Failure to do so will result in equipment damage.

Per NEC Article 384-3 (f) "The B phase shall be that phase having the higher voltage to ground on a 3-phase, 4-wire delta connected systems."

3.5. *REMOTE START CONTACT FIELD WIRING*

As a minimum, the remote engine start control field wiring shall conform to the local regulatory authority on electrical installations. Field wiring of a remote start contact from a transfer switch to a control panel should conform to the following guidelines to avoid possible controller malfunction and/or damage.

3.5.1. Minimum #14 AWG ($2.5mm^2$) wire size shall be used for distances up to 100ft (30m)[1]). For distances exceeding 100 ft. (30m) consult Thomson Technology

3.5.2. Remote start contact wires should be run in a separate conduit.

3.5.3. Avoid wiring near AC power cables to prevent pick-up of induced voltages.

3.5.4. An interposing relay may be required if field-wiring distance is excessively long (i.e. greater than 100 feet (30m)) and/or if a remote contact has a resistance of greater than 5.0 ohms.

3.5.5. The remote start contact must be voltage free (i.e. dry contact). The use of a "powered" contact will damage the transfer controller.

3.6. *DIELECTRIC TESTING*

Do not perform any high voltage dielectric testing on the transfer switch with the TSC 800 controller connected into the circuit as serious damage will occur to the controller. All AC control fuses and control circuit isolation plugs connected to the TSC 800 must be removed if high voltage dielectric testing is performed on the transfer switch.

3.7. *INSTALLATION OF OPEN TYPE TRANSFER SWITCHES*

Please contact Thomson Technology for additional information.

4. GENERAL DESCRIPTION

Thomson Technology TS 880 series of Automatic Transfer Switches employ two mechanically interlocked enclosed contact power switching units and a microprocessor based controller to automatically transfer system load to a generator supply in the event of a utility supply failure. System load is then automatically re-transferred back to the utility supply following restoration of the utility power source to within normal operating limits.

The standard TS 880 series Automatic Transfer Switch is rated for 100% system load and requires upstream over current protection. The TS 880 Automatic Transfer Switch may be supplied with optional integral over current protection within the enclosed contact power switching units for applications such as Service Entrance Rated equipment. Refer to ***Section 6*** of this manual for detailed information on over current protection.

The TS 880 series transfer switches employs a TSC 800 microprocessor based controller which provides all necessary control functions for fully automatic operation. The TSC 800 controller is mounted on the door of the transfer switch enclosure and operating status is shown via LED lights and LCD display module. For further information on the TSC 800 Transfer Controller, refer to instruction manual PM049.

100A-1200A rated molded case power switching devices used for the utility and generator sources are operated by an electrically driven motor mechanism in the transfer switch. 800A-4000A rated insulated case power switching devices used for the utility and generator sources are operated by internal drive motor operators. The transfer switch mechanism utilizes the power from the source to which the electrical load is being transferred. The mechanism provides a positive mechanical interlock to prevent both power switching units from being closed at the same time, which allows an interrupted open transition “break-before-make” transfer sequence. For transfer switches supplied with Closed Transition transfer option, the mechanical interlock is removed thereby allowing a “make-before break” transfer sequence when both sources of power are available. The TSC 800 transfer controller provides a standard neutral position delay timer for open transition transfer sequences to allow adequate voltage decay during transfer operation to prevent out of phase transfers.

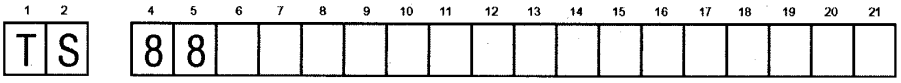
Note: For the purpose of this manual, the following standard nomenclature is utilized:

- Utility: to indicate the source of primary power

- Generator: to indicate the source of standby power
- Power switching device: to indicate the automatic transfer switch power switching device

4.1. *PRODUCT MODEL CODE*

The type of TS 880 series transfer switch supplied is identified by way of a 21 digit product code which appears on the equipment rating plate (MODEL) on the door of the transfer switch, and on the transfer switch drawings. The model code structure and definitions are as follows:



1-3. SERIES
TS – TRANSFER SWITCH

4 & 5. MODEL
88 – 880 SWITCH

6. POLES
2 – 2 POLE
3 – 3 POLE
4 – 4 POLE

7. CONFIGURATION TYPE
A – ATS
B – BYPASS/ISOLATION ATS
X – SPECIAL

8-11. AMPERAGE
0100
0150
0200
0250
0400
0600
0800
1000
1200
1600
2000
2500
3000
4000

12. APPLICATION
A – STANDARD
B – SERVICE ENTRANCE
C – DUAL SOURCE
X – SPECIAL

13. OPERATION TYPE
1 – OPEN TRANSITION
2 – MANUAL ELEC. OP.
3 – CLOSED TRANSITION (MOMENTARY)
X – SPECIAL

14. CERTIFICATION
A – UL 1008
B – CSA C22.2. No. 178
X – NOT APPLICABLE

15. VOLTAGE
1Ø 3 WIRE
D – 120/240

3Ø 4 WIRE (GROUNDED NEUTRAL)
(*=MULTI-VOLTAGE CAPABLE)
E – 120/208*
F – 127/220
G – 120/240*(DELTA)
H – 220/380**
J – 240/416
K – 254/440
M – 277/480*
N – 347/600*

3Ø 3 WIRE
P – 208
Q – 220
R – 240
S – 380**
U – 416
V – 480
W – 600
X – SPECIAL
** FOR 50HZ APPLICATION

16. CONTROLLER
2 – TSC 800
7 – NONE (MANUAL)

17. ENCLOSURE TYPE
A – NEMA 1, ASA #61 GREY
B – NEMA 2, ASA #61 GREY
C – NEMA 12, ASA #61 GREY
D – NEMA 3R SD, ASA #61 GREY
E – NEMA 3R DD, ASA #61 GREY
F – NEMA 4X, STAINLESS STEEL
G – NONE (OPEN STYLE)
X – SPECIAL

18. UTILITY SWITCHING DEVICE
K – MOLDED CASE SWITCH 100-1200A
M – MOLDED CASE SWITCH C/W THER-MAG TRIP 100-200A
N – MOLDED CASE SWITCH C/W ELECTRONIC TRIP 250-1200A
P – MOLDED CASE SWITCH C/W ELECTRONIC & GF TRIP 250-1200A
Q – INSULATED CASE, FIX MOUNT SWITCH (800A-4000A)
R – INSULATED CASE, FIX MOUNT SWITCH C/W ELECTRONIC TRIP (800A-4000A)
T – INSULATED CASE, FIX MOUNT SWITCH C/W ELECTRONIC & GF TRIP (800A-4000A)
U – INSULATED CASE, DRAW-OUT SWITCH (800-4000A)
V – INSULATED CASE, DRAW-OUT SWITCH C/W ELECTRONIC TRIP (800A-4000A)
W – INSULATED CASE, DRAW-OUT SWITCH C/W ELECTRONIC & GF TRIP (800A-4000A)
X – SPECIAL

19. GENERATOR SWITCHING DEVICE
K – MOLDED CASE SWITCH 100-1200A
M – MOLDED CASE SWITCH C/W THER-MAG TRIP 100-200A
N – MOLDED CASE SWITCH C/W ELECTRONIC TRIP 250-1200A
P – MOLDED CASE SWITCH C/W ELECTRONIC & GF TRIP 250-1200A
Q – INSULATED CASE, FIX MOUNT SWITCH (800A-4000A)
R – INSULATED CASE, FIX MOUNT SWITCH C/W ELECTRONIC TRIP (800A-4000A)
T – INSULATED CASE, FIX MOUNT SWITCH C/W ELECTRONIC & GF TRIP (800A-4000A)
U – INSULATED CASE, DRAW-OUT SWITCH (800-4000A)
V – INSULATED CASE, DRAW-OUT SWITCH C/W ELECTRONIC TRIP (800A-4000A)
W – INSULATED CASE, DRAW-OUT SWITCH C/W ELECTRONIC & GF TRIP (800A-4000A)
X – SPECIAL

20. POWER CONNECTIONS
A – STANDARD
X – SPECIAL

21. CONNECTION CONFIGURATION
(SEE DRAWING M-007450-00051)
A – STANDARD
B – ALTERNATE B (400-1200A)
C – ALTERNATE C (400-1200A)
D – ALTERNATE D (400-1200A)
E – ALTERNATE E (800-4000A)
F – ALTERNATE F (800-4000A)
G – ALTERNATE G (800-4000A)
X – SPECIAL

4.2. *TYPICAL COMMISSIONING PROCEDURES*

> ***CAUTION!!!***
>
> Commissioning procedures must be performed by qualified personnel only. Ensure the Automatic Transfer Switch (ATS) Isolation Plug is disconnected prior to energizing the supply sources. Manually place the transfer switch mechanism in the neutral position prior to applying power. Failure to do so may result in equipment failure or personal injury.

Note: The ***TYPICAL AUTOMATIC TRANSFER SWITCH COMMISSIONING PROCEDURES MODEL SERIES TS 880*** (attached as "**APPENDIX A**") is provided for general information only pertaining to typical site installations and applications. Contact Thomson Technology for further information as may be required.

5. GENERAL THEORY OF OPERATION

5.1. *STANDARD AUTOMATIC TRANSFER SWITCH*

5.1.1. NORMAL SEQUENCE OF OPERATION - OPEN TRANSITION TYPE TRANSFER SWITCHES

When utility supply voltage drops below a preset nominal value (adjustable from 70% to 99% of nominal) on any phase, an engine start delay circuit is initiated and the transfer to utility supply signal will be removed (i.e. contact opening). Following expiry of the engine start delay period (adjustable from 0 to 60 sec.) an engine start signal (contact closure) will be given.

Once the engine starts, the transfer switch controller will monitor the generator voltage and frequency. Once the generator voltage and frequency rises above preset values (adjustable from 70% to 99% of nominal), the engine warmup timer will be initiated. Once the warmup timer expires (adjustable from 0 to 60 min.), the transfer to Generator Supply signal (contact closure) will be given to the transfer switch mechanism. The load will then transfer from the utility supply to the generator supply via the motor operated mechanism. **Note:** A neutral delay timer circuit will delay the transfer sequence in the neutral position (i.e. both power-switching devices open) until the selected time expires (adjustable from 0 to 60 sec.).

The generator will continue to supply the load until the utility supply has returned. The retransfer sequence is completed as follows: when the utility supply voltage is restored to above the preset values (adjustable from 70% to 99% of nominal) on all phases, a utility return delay circuit will be initiated. Following expiry of the Utility Return Timer (adjustable from 0 to 60 min.), the Transfer to Generator Supply signal will be removed (contact opening), and then the Transfer to Utility Supply signal (contact closure) will be given to the transfer switch mechanism. The load will then retransfer the load from the generator supply back to the utility supply. **Note:** A neutral delay timer circuit will delay the transfer sequence in the neutral position (i.e. both power switching devices open) until the neutral delay time period expires (adjustable from 0 to 60 seconds).

An engine cooldown timer circuit will be initiated once the load is transferred from the generator supply. Following expiry of the cooldown delay period (adjustable from 0 to 30 minutes), the engine start signal will be removed (contact opening) to initiate stopping of the generator set.

5.1.2. NORMAL SEQUENCE OF OPERATION - CLOSED TRANSITION TYPE TRANSFER SWITCH OPTION

For transfer switches equipped with the Closed Transition transfer option, the ATS is configured to operate as follows:

Under normal closed transition operating conditions, the transfer switch operates automatically during a failure and restoration of utility power and does not require operator intervention.

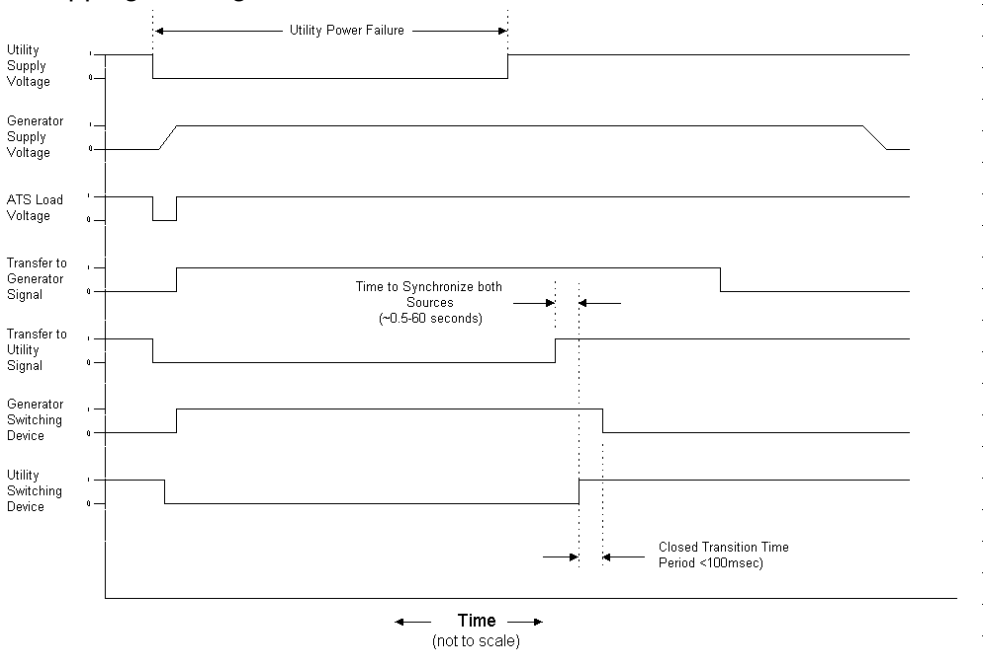
When utility supply voltage drops below a preset nominal value (70 - 99% of rated adjustable) on any phase, an engine start delay circuit will be initiated and the transfer to utility supply signal will be removed (i.e. contact opening). Following expiry of the engine start delay period (0 - 60 sec. adjustable) an engine start signal (contact closure) will be given.

Once the engine starts, the transfer switch controller will monitor the generators voltage and frequency levels. Once the generator voltage and frequency rises above preset values (70 – 99% nominal adjustable) a warmup time delay will be initiated. Once the warmup timer (0-60 Min adjustable) expires, the transfer to generator supply signal (contact closure) will be given to the transfer switch mechanism. The

load will then transfer from the utility supply (i.e. opening the utility power switching device) to the generator supply (closing the generator power switching device) via motor driven mechanism to complete a “break-before-make” open transition transfer sequence.

The generator will continue to supply the load until the utility supply has returned and the retransfer sequence is completed as follows: When the utility supply voltage is restored to above the present values (70 - 99% of rated adjustable) on all phases, a re-transfer sequence will be initiated once the Utility Return timer expires. The utility will close its power switching device when it is in synchronism with the generator supply via external logic device. The generator power switching device will immediately trip open approximately 50-100 milliseconds after the utility power switching device closes to complete the “make-before-break” re-transfer sequence.

An engine cooldown timer circuit will be initiated once the load is transferred from the generator supply. Following expiry of the cooldown delay period (0 - 60 min. adjustable) the engine start signal will be removed (contact opening) to initiate stopping of the generator set.



Closed Transition Operation Sequence Diagram

(Normal Power Failure & Return Sequence)

The following operating sequences and time delays are associated with closed transition type transfer switches which momentarily parallel two sources of supply for less than 100 milliseconds. For closed transition type transfer switches, which utilize extended parallel operation for soft-loading operating sequences, refer to separate instruction manual.

1. Transfer Control Switch (Open/Closed Transition): A two position selector switch is provided on the front of the transfer switch for operator section of desired operation. The 2 positions are as follows:
    - OPEN TRANSITION: The transfer switch will operate in a "break-before-make" open transition sequence during load transfers. A programmed neutral delay period will occur during the transfer sequence to ensure voltage decays on the load bus before load is re-applied. The two sources will not be paralleled at any time during operation in this mode.
    - CLOSED TRANSITION: When both sources of supply are available, the transfer switch will operate in a "make-before-break" closed transition sequence during load transfers. **Note:** If only one source of supply is available during an initiated transfer sequence, the control system will automatically revert to an open transition transfer sequence.
2. Synchronizing Protection: To ensure both sources are in synchronism prior to initiating a closed transition transfer sequence, a sync check relay is used (Device 25). The synch check relay is door mounted and proved a LED light Synchroscope to monitor phase angle of the two sources. The synch check relay will block a closed transition transfer sequence until both sources phase angle and voltages are within programmed limits. The synch check relay settings are field programmable (+-5 to 20 Deg Phase Angle ($\triangle\varphi$) and 1-10% voltage difference ($\triangle U$) and they must be set at time of final equipment commissioning for desired values. The factory settings are as follows:

Factory settings
When the product is delivered from the factory, the following basic settings will be set:

ΔU:	5% of $\pm U_{BB}$
t_R :	0.5 sec.
$\Delta\varphi$:	$\pm 10°$
Dead bus:	OFF

Note: The standard closed transition transfer switch does not contain an automatic synchronizer to control the generators frequency or voltage to bring it within limits of the sync check relay. For correct closed transition transfer operation, the system requires the generators frequency to be set within 0.25% of nominal frequency and the generators voltage to be set within 0.5% of nominal voltage.

3. Closed Transition Time Period: The time period in which both sources of supply are paralleled together during the closed transition transfer sequence is 50-100 milliseconds (maximum). The time period is inherently controlled by operation of auxiliary contacts from the power switching devices (i.e. when one switching devices closes, its aux contact closes to initiate tripping of the opposite switching device).
4. Closed Transition Failure Mode Operation: A control logic circuit and timer (CFT) continually monitors the closed transition operation time period. The CFT timer is factory set for 100 milliseconds that allows normal closed transition operation (i.e. both power switching devices remain closed for less than 100 milliseconds). The timer and alarm circuit is not activated under normal operation. Should the closed transition operation time exceed 100 milliseconds (i.e. both power switching devices remain closed for longer than the normal closed transition time period plus the setting of timer CFT), the following sequence of events will occur:
   - CFT time delay period will expire and will activate auxiliary trip relay.
   - If the transfer switch was transferring power from the generator source to the utility source and the generator switching device failed to open, an auxiliary trip relay will trip open the utility power switching device to immediately separate the two power sources. If the transfer switch was transferring power from the utility source to the generator source and the utility switching device failed to open, an auxiliary trip relay will trip open the generator power switching device to immediately separate the two power sources. **Note:** The maximum time period both sources will remain paralleled under this failure mode is 200 milliseconds.

- The original source (i.e. prior to the transfer sequence) will remain on load, separated from the other source. An alarm light and TSC 800 controller will indicate a failure condition which must be manually reset before the transfer switch will re-attempt subsequent transfers. For further information on the TSC 800 features and operation, refer to the separate product instruction manual.

Note: Two alarm contacts are provided for the Closed Transition Failure Mode (i.e. one for a failed generator power switching device and one for the utility power switching device. The contacts are wired to terminal blocks for customer use to remotely trip open upstream devices should an abnormal condition persist.

5. Transfer Fail Alarm (Switching Device Fail to Close): A control timer (TFT) is provided to detect and alarm abnormal operating conditions. Should a power switching device fail to close for any reason within a 5 minute time period, an alarm light and alarm relay contact will be activated. The TSC 800 transfer controller also includes a time delay and alarm feature. For further information on the TSC 800 features and operation, refer to the separate product instruction manual.

5.2. *SERVICE ENTRANCE AUTOMATIC TRANSFER SWITCH*

Note: This applies only to service entrance transfer switches

5.2.1. NORMAL OPERATION

Under normal conditions, the load is energized from the utility supply through the closed utility transfer power switching device. If the utility power fails, the generator will start and the load will be re-energized via the closed generator transfer power switching device.

In the normal operating mode, the Service Disconnect switch shall be in the “energized” position.

5.2.2. OVER CURRENT TRIP

Should the utility power switching device trip open due to an over current condition, the TSC 800 transfer controller will initiate an engine start signal and will permit transfer of the load to the generator supply. The utility source will be locked out and the load will remain on the generator supply until the TSC 800 alarm signal is manually reset.

Refer to the TSC 800 Instruction Manual for further details on Transfer Fail operation.

Should the generator power switching device trip open due to an over current condition, TSC 800 transfer controller will initiate transfer of the load to the utility supply. The generator source will be locked out and the load will remain on the utility supply until the TSC 800 alarm signal is manually reset.

5.2.3. SERVICE DISCONNECT PROCEDURE

To perform a service disconnect (i.e. to disconnect the utility and generator supplies), the following procedure is required:

1. Move the "Service Disconnect" control switch located on the door of the transfer switch to the "Disconnected" position.

2. Verify that the "Service Disconnected" pilot light is illuminated. *If the Light is illuminated, the service has been successfully disconnected and it is safe to perform any maintenance procedures as required*. In this condition, the transfer switch is in the neutral position, with both utility and generator transfer power switching devices open. The transfer switch will remain in this condition, regardless of condition of the utility and generator supplies (i.e. if the utility power fails, the generator will not receive a start signal, nor will the transfer switch move to the generator position). NOTE: *If the Service Disconnect Light is **not** illuminated, additional procedures are required (refer to the following procedure #4).*

3. Attach safety lockout padlock to the "Service Disconnect" control switch to prevent unauthorized change in operating condition and verify transfer switch door is locked closed. If the door is not locked, turn and remove door key.

> ***WARNING!***
>
> ***Close and lock the transfer switch enclosure door before connecting power sources.***

4. To reenergize the load, remove the padlock(s) from the service disconnect control switch, and move the switch to the energized position. The transfer switch will immediately return to the utility or generator supply if within normal operating limits.

5.2.4. ADDITIONAL PROCEDURES

If the "Service Disconnected" pilot light is **not** illuminated, the service will **not** have been successfully disconnected and therefore it is **not** safe to perform any maintenance until the following additional procedures are performed:

> ***WARNING!***
>
> ***Qualified personnel must undertake the following procedures only! Failure to do so may result in serious personal injury or death due to electrical shock.***

1. On 100A-1200A molded case power switching unit type transfer switches, open the door to the transfer switch using a suitable tool and open the door lock with the key.
2. Visually inspect the actual position of the transfer switch mechanism as follows:
   On 100A-1200A molded case power switching unit type transfer switches: *If the position of the transfer switch mechanism is clearly in the "neutral position", and the load bus is de-energized on all phases, the service has been successfully disconnected*. Proceed to Step. 4.
   - If the position of the transfer switch mechanism is not in the neutral position or the load bus is energized, further procedures are required.

   On 800A-4000A insulated case power switching unit type transfer switches, verify both power switching devices are in the OPEN position. *If* both power switching devices clearly indicate they are in the OPEN position*, the service has been successfully disconnected*.

   Note: If the position of the transfer switch mechanism is clearly in the "neutral position, the "service disconnected" pilot light may not have illuminated due to the following reasons:
   a) Utility and generator supply voltages are not present (the pilot light requires AC supply voltage to be present).
   b) The pilot light may be burnt out. The bulb should be immediately replaced with a suitably rated bulb.

   Failure of one or more of the sensing/logic contacts. A qualified service technician is required to trouble shoot this specific condition. Switch the utility

control circuit isolation switch to the de-energized position to remove utility control power. To isolate the generator supply, remove the control circuit isolation plug.

Note: The AC power conductors will still remain energized. Once all the control circuits are de-energized and isolated the "Service Disconnected" pilot light will not illuminate due to loss of control power.

Note: To return the transfer switch back to normal operation, the control circuit isolation plug must be re-connected first and then the utility control circuit disconnect switch can be switched back to the On position.

3. *If the position of the transfer switch mechanism is **not** in the "neutral position", manually operate the transfer switch mechanism as follows: Pull the manual release plunger on the mechanism, releasing the motor drive rod from motor drive arm and move the knob and yoke to the marked "neutral position".*

> ***WARNING!***
> ***Failure to move the mechanism to the Neutral Position may result in serious personal injury or death due to electrical shock.***

4. If the position of both power switching units (i.e. 800A-4000A insulated case power switching unit type transfer switch), are **not** in the "OPEN" position" the power switching units must be manually operated as follows. To operate manually, push the unit's OPEN pushbutton. The unit should then open. Repeat for the other power switching unit.
5. Close the transfer switch door securely using a suitable tool. Lock the door in the closed position and remove the key.

> ***WARNING!***
> ***Failure to open both power switching devices to the OPEN position may result in serious personal injury or death due to electrical shock.***

6. Attach a safety lockout padlock to the service disconnect control switch to prevent unauthorized change in operating condition and verify transfer switch door is locked closed.

7. To reenergize the load, remove the padlock(s) from the service disconnect control switch, and move the switch to the Energized position. The transfer switch will immediately return to the utility or generator supply if within normal operating limits.

5.3. *TEST MODES*

The transfer switch may be tested utilizing the TSC 800 controller push-buttons or optional four position test switch. A simulated utility power failure condition will be activated when the test mode is selected. The transfer switch will operate as per a normal utility power fail condition.

The transfer switch will remain on generator supply until the test mode is terminated. It will then immediately transfer back to the utility supply and then continue to operate the generator set for its cooldown period then stop. **Note:** The transfer switch will automatically return to the utility supply (if within nominal limits) if the generator set fails while in the test mode.

6. OVER CURRENT PROTECTION

Thomson Technology ***TS 880*** series of Automatic Transfer Switches may be supplied with or without integral over current protection as described below:

6.1. *STANDARD TS 880 AUTOMATIC TRANSFER SWITCH*

The standard TS 880 Automatic Transfer Switch does not contain any integral over current protection and requires upstream over current protection devices for both Utility and Generator sources. The Standard TS 880 is rated for 100% continuous loading and can withstand a maximum short circuit fault current as noted in ***Section 13*** of this manual. The standard TS 880 transfer switch model without integral over current protection is identified in the product model code. Refer to ***Section 4.1*** of this manual for further details on model coding.

6.2. *OPTIONAL TS 880 AUTOMATIC TRANSFER SWITCH WITH INTEGRAL OVER CURRENT PROTECTION*

TS 880 transfer switches will have integral over current protection supplied on the Utility source as standard. The type of over current protection utilized is dependent upon ATS amperage size and optional features specified. For transfer switches rated 100A through 200A, over current protection is non-adjustable thermal-magnetic type trip units. For transfer

switches rated 400A through 4000A over current protection is adjustable electronic type with long time & instantaneous trip unit elements with optional ground fault protection elements.

Note: Ground fault protection is supplied as standard on 1000A and 1200A transfer switches that are used on systems greater than 240V.
An upstream over current protection device is required on the generator source which feeds the TS 880 Transfer Switch if integral over current protection option is not specified on the ATS.

Note: For models of transfer switch with adjustable integral over current protection trip units, the over current protection must be set prior to operation. The equipment will be shipped from the factory with a long-time current setting of 100% (of the equipment rating) and maximum instantaneous/short-time current and time delay settings.

WARNING!
Do Not Energize this equipment until device settings have been verified to ensure proper system protection & coordination. Failure to do so may result in equipment failure.

Refer to ***Section 4.1*** Product Model Code for types of integral over current protection which are supplied with the transfer switch.

7. SERVICING TRANSFER SWITCH MECHANISMS

CAUTION!!!
All installation and/or service work performed must be done by qualified personnel only. Failure to do so may cause personal injury or death.

Failure to correctly maintain an automatic transfer switch may present a hazard to life and equipment. Full operational testing must be done prior to placing a transfer switch in service

subsequent to any maintenance or repair. Any service work involving electrical components requires high-potential testing to ensure that required insulation levels have been maintained.

7.1. *SERVICING –100A-250A TRANSFER SWITCH MECHANISMS*

7.1.1. GENERAL DESCRIPTION

The transfer mechanism consists of the transfer motor and drive assembly, which operates a common yoke which in turn operates both utility and generator power switching devices. Since the power switching devices are oriented opposite to each other, the action of turning one power switching device off will result in turning the other power switching device on. The geometry of the mechanism ensures that one power switching device always opens before the other closes, thus maintaining the required mechanical interlocking.

The motor operates the motor drive arm and rod assembly. The motor drive arm is normally held captive to the yoke via the manual release plunger assembly. A common yoke assembly operates both power-switching device toggles. There are two limit switches that are contacted by the yoke at its extremes of travel, which disconnects the motor circuit at the point of full power switching device toggle travel in the intended direction. Should adjustment be required, consult Thomson Technology for further information.

The transfer switch mechanism has three possible positions:

a) Utility power switching device closed and generator power switching device open;
b) Generator power switching device closed and utility power switching device open;
c) Both utility and generator power switching devices open, but NEVER both utility and generator power switching devices closed at the same time.

7.1.2. EQUIPMENT INSPECTION

To maintain mechanical integrity, ensure that;

- Both limit switches are correctly adjusted to provide full travel of the power switching device toggles *without* exerting unnecessary forces associated with excessive travel. Ensure the power switching device travels far enough to reset any internal trip unit. Note: It is more important for the toggle to go fully in the "off" direction, than in the "on" direction).

- Mechanical interlocking is correct (i.e. one power switching device must be well open before the other should close).
- All fasteners are adequately tightened.
- The operating linkages are not damaged or bent, and that all bearing points operate freely.

To maintain electrical integrity, ensure that:

- All electrical connections are clean and adequately tightened. Corroded or loose power connections will cause destructive heating, and may cause premature tripping.
- All insulating devices are in place and in good condition.
- No moisture or other contamination is present.
- Electrical conductors are adequately secured away from moving parts.

To maintain operational integrity, ensure that:

- All control devices are in good condition and correctly calibrated.
- All control devices are adequately secured in their plug-in fixtures.

Failure to correctly maintain an automatic transfer switch may present a hazard to life and equipment. Full operational testing must be done prior to placing a transfer switch in service subsequent to any maintenance or repair. Any service work involving electrical components requires high-potential testing to ensure that required insulation levels have been maintained.

7.1.3. MANUAL OPERATION

CAUTION!!!

Qualified personnel must perform manual operation of the transfer switch only. Failure to do so may cause personal injury or death.

Isolate the transfer switch from all sources of supply before opening the enclosure for manual operation. With all sources of power de-energized to the transfer switch, the control circuit isolation plug an be unplugged to prevent subsequent operation.

To operate manually, pull the manual release plunger, releasing the motor drive rod from the motor drive arm and push the yoke in the desired direction.

Automatic operation may be regained by replacing the isolation plug. With all sources of power de-energized to the transfer switch, the control circuit isolation plug can be re-connected. The drive system is self-engaging and will move the transfer switch mechanism to the required position. Refer to the manual operation instruction on front of transfer switch mechanism for further details.

7.1.4. RECOMMENDED MAINTENANCE

- DO NOT perform dielectric tests on the equipment with the control components in the circuit.
- Check if control components are tight in sockets.
- Periodically inspect all terminals (load, line and control) for tightness. Re-torque all bolts, nuts and other hardware. Clean or replace any contact surfaces, which are dirty, corroded or pitted.
- Transfer switches should be in a clean, dry and moderately warm location. If signs of moisture are present, dry and clean transfer switch. If there is corrosion, try to clean it off. If cleaning is unsuitable, replace the corroded parts. Should dust and/or debris gather on the transfer switch, brush, vacuum, or wipe clean. DO NOT blow dirt into power switching devices.
- Test the transfer switch operation. While the unit is exercising, check for freedom of movement, hidden dirt, corrosion or any excessive wear on the mechanical operating parts. Ensure that the power switching device travel is correct.
  - Verify all program settings on the TSC 800 controller are as per the programming sheet supplied with the transfer switch.
  - Confirm that the yoke operates freely on the yoke pivot bushings. Should lubrication be required, apply medium weight (SAE 20) oil sparingly at these points.
  - The motor and gearbox are permanently lubricated, and should not require attention under normal operating circumstances.

7.2. *SERVICING– 400A-1200A MOLDED CASE TYPE TRANSFER MECHANISMS*

7.2.1. GENERAL DESCRIPTION

The transfer mechanism consists primarily of the transfer motor, a hub assembly, two operating rods and two power switching device operating yokes.

The reversible transfer motor drives the hub assembly, which in turn moves the operating rods that are connected to the power switching device operating yokes. The power switching device toggles are set inside the yokes and are operated by the yoke. There are two limit switches, which are contacted by the operating yokes (one for each direction of travel), which disconnect the transfer motor power supply when the power switching devices have attained full travel. The adjuster screws located on the yokes determines the operating point of these limit switches. Should adjustment be required, consult Thomson Technology for further information.

The transfer switch mechanism has three possible positions:

a) Utility power switching device closed and generator power switching device open;

b) Generator power switching device closed and utility power switching device open;

c) Both utility and generator power switching devices open, but NEVER both utility and generator power switching devices closed at the same time.

7.2.2. EQUIPMENT INSPECTION

To maintain mechanical integrity, ensure that:

- All limit switches linkages are correctly adjusted to provide full travel of the power switching device toggles *without* exerting unnecessary forces associated with excessive travel. Ensure that power switching device travel far enough to reset any internal trip unit. Note: It is more important for the toggle to go fully in the "off" direction, than in the "on" direction.
- Mechanical interlocking is correct (i.e. one power switching device must be well open before the other should close.
- All fasteners are adequately tightened.
- The operating linkages are not damaged or bent, and that all bearing points operate freely.

To maintain electrical integrity, ensure that:

- All electrical connections are clean and adequately tightened. Corroded or loose power connections will cause destructive heating, and may cause premature tripping.
- All insulating devices are in place and in good condition.
- No moisture or other contamination is present.
- Electrical conductors are adequately secured away from moving parts.

To maintain operational integrity, ensure that:

- All control devices are in good condition and correctly calibrated.
- All control devices are adequately secured in their plug-in fixtures.
- Failure to correctly maintain an automatic transfer switch may present a hazard to life and equipment. Full operational testing must be done prior to placing a transfer switch in service subsequent to any maintenance or repair. Any service work involving electrical components requires high-potential testing to ensure that required insulation levels have been maintained.

7.2.3. MANUAL OPERATION

CAUTION!!!

Qualified personnel must perform manual operation of the transfer switch only. Failure to do so may cause personal injury or death.

Isolate the transfer switch from all sources of supply before opening the enclosure for manual operation. With all sources of power de-energized to the transfer switch, the control circuit isolation plug can be unplugged to prevent subsequent operation.

To operate manually, pull the release plunger and operate the handle in the desired direction.

Automatic operation may be regained by replacing the isolation plug. With all sources of power de-energized to the transfer switch, the control circuit isolation plug can be re-connected. The drive system is self-engaging and will operate the transfer switch to the required position. Refer to the manual operation instruction on front of transfer switch mechanism for further details.

7.2.4. RECOMMENDED MAINTENANCE

- DO NOT perform dielectric tests on the equipment with the control components in the circuit.

- Check if control components are tight in sockets.
- Periodically inspect all terminals (load, line and control) for tightness. Re-torque all bolts, nuts and other hardware. Clean or replace any contact surfaces, which are dirty, corroded or pitted.
- Transfer switches should be in a clean, dry and moderately warm location. If signs of moisture are present, dry and clean transfer switch. If there is corrosion, try to clean it off. If cleaning is unsuitable, replace the corroded parts. Should dust and/or debris gather on the transfer switch, brush, vacuum, or wipe clean. DO NOT blow dirt into power switching devices.
- Test the transfer switch operation. While the unit is exercising, check for freedom of movement, hidden dirt, corrosion or any excessive wear on the mechanical operating parts. Ensure that the power switching device travel is correct.
  - Verify all program settings on the TSC 800 controller as per the programming sheet as supplied with the transfer switch.
  - Ensure that the manual handle moves freely on the hub when the lock pin is disengaged. If lubrication is necessary, apply medium weight (SAE 20) oil sparingly.
  - Yoke pivot bearings and rod ends are permanently lubricated and do not require maintenance.
  - The motor and gearbox are permanently lubricated, and should not require attention under normal operating circumstances.

7.3. *SERVICING – 800A – 4000A INSULATED CASE TYPE TRANSFER MECHANISMS*

7.3.1. GENERAL DESCRIPTION

800A-4000A transfer switches consist of two insulated case power switching units mounted in a vertical stack configuration. Standard transfer switches have insulated case power switching devices, which are fix-mounted. Draw-out power switch devices are available as an option for additional service and maintenance benefits. The power switching devices are electrically and mechanically interlocked using a cable interlock mechanism. On Closed Transition type transfer switches, the mechanical interlock is removed. The power switching units are provided with an internal motor operator and open and close coils. Manual operation pushbuttons are provided on the face of the power switching units.

Should adjustment be required on the mechanical interlock, it is advisable to consult Thomson Technology for further information.

7.3.2. EQUIPMENT INSPECTION

To maintain mechanical integrity, ensure that:

- All linkages are correctly adjusted.
- Mechanical interlocking is correct - it should not be possible to close a power switching unit without first opening the other power switching unit.
- All fasteners are adequately tightened.
- The operating linkages are not damaged or bent, and that all bearing points operate freely.

To maintain electrical integrity, ensure that:

- All electrical connections are clean and adequately tightened. Corroded or loose power connections will cause destructive heating, and may cause premature tripping of the power switching devices that incorporate integral over current protection units.
- All insulating devices are in place and in good condition.
- No moisture or other contamination is present.
- Electrical conductors are adequately secured away from moving parts.

To maintain operational integrity, ensure that:

- All control devices are in good condition and correctly calibrated.
- All control devices are adequately secured in their plug-in fixtures

7.3.3. MANUAL OPERATION

A two-position “System Operation Mode” selector switch is provided to operate the transfer switch manually as follows:

AUTO: This selects automatic operation of the transfer switch. The power switching device will automatically open/close as detailed in the sequence of operation.

MAN: This position inhibits automatic operation and automatic engine starting. The power switching device must be manually operated via pushbuttons located on the face of the power switching devices to open/close them as required.

NOTE:

When the MANUAL Mode is selected the engine start output logic is disabled. Where generator voltage is required during manual operation the local generator controls must be set for manual operation.

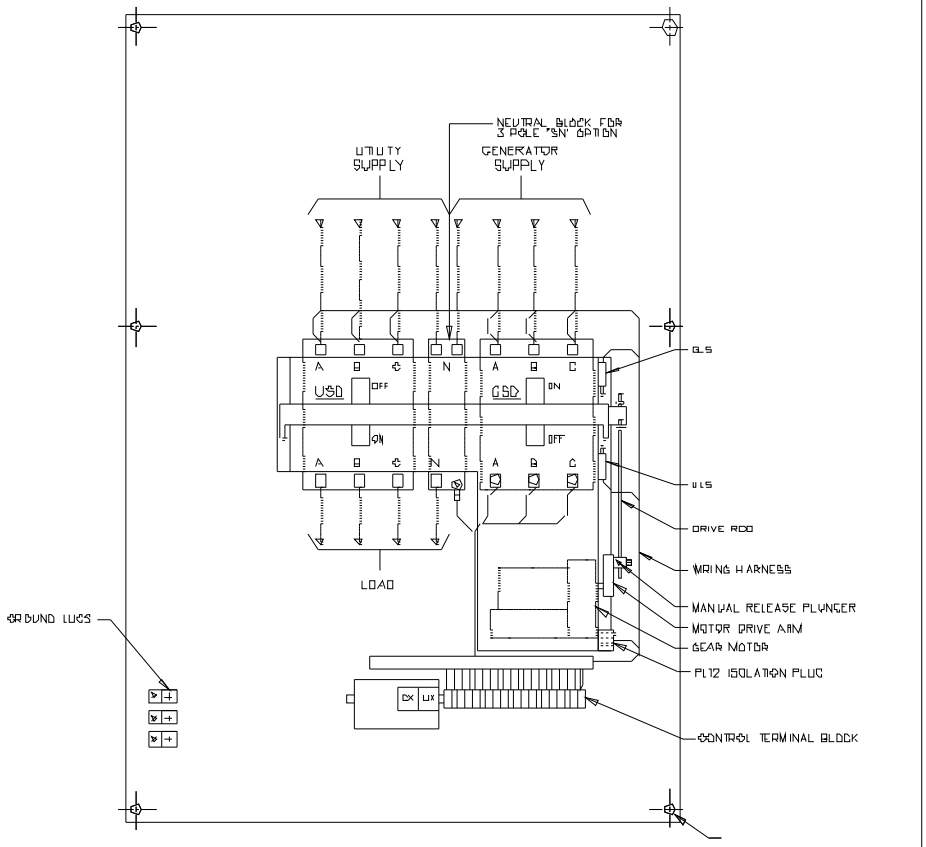
To transfer manually to generator - turn the System Operation Mode selector to MANUAL, manually start the generator, open the utility power switching device, close the generator power switching device, using open/close pushbuttons.

To transfer manually to utility – place the local generator controls in manual/run to ensure continued operation, turn the System Operation Mode selector to MANUAL, open the generator power switching device, close the utility power switching device, using open/close pushbuttons.

7.3.4. RECOMMENDED MAINTENANCE

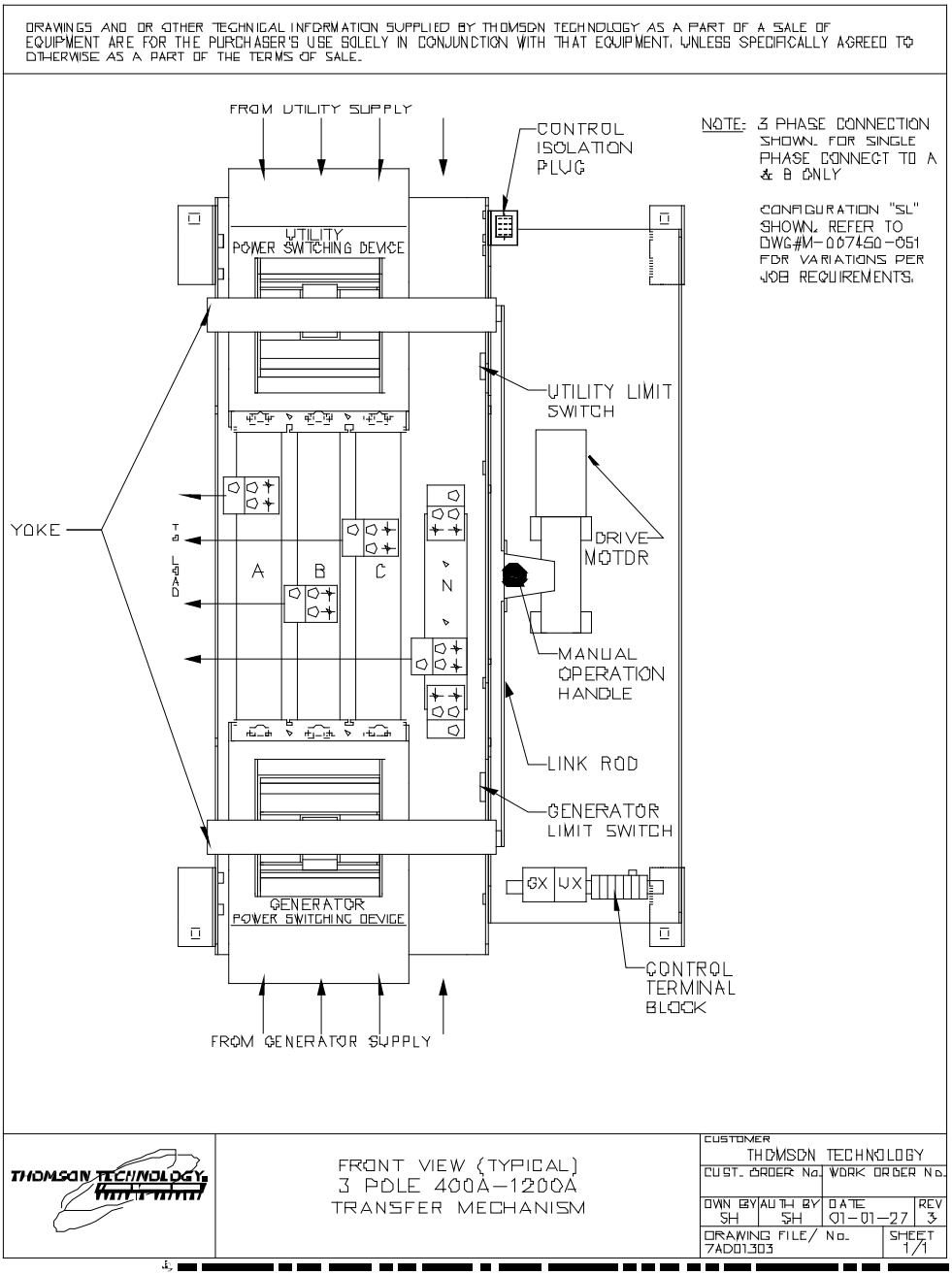
- DO NOT perform dielectric tests on the equipment with the control components in the circuit.
- Check if control components are tight in sockets.
- Periodically inspect all terminals (load, line and control) for tightness. Re-torque all bolts, nuts and other hardware. Clean or replace any contact surfaces which are dirty, corroded or pitted.
- Transfer switches should be in a clean, dry and moderately warm location. If signs of moisture are present, dry and clean transfer switch. If there is corrosion, try to clean it off. If cleaning is unsuitable, replace the corroded parts. Should dust and/or debris gather on the transfer switch, brush, vacuum, or wipe clean. DO NOT blow dirt into power switching devices.
- Test the transfer switch operation. While the unit is exercising, check for freedom of movement, hidden dirt, corrosion or any excessive wear on the mechanical operating parts. Ensure that the power switching device travel is correct.
- Verify all program settings on the TSC 800 controller are as per the programming sheet supplied with the transfer switch.

8. FRONT VIEW (TYPICAL) 3 POLE 100A-250A TRANSFER MECHANISM

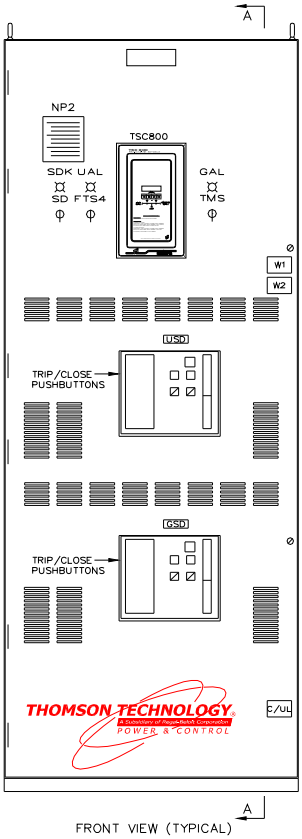


THOMSON TECHNOLOGY	FRONT VIEW (TYPICAL) 3 POLE 100A–250A TRANSFER MECHANISM	CUSTOMER: THOMSON TECHNOLOGY CUST. ORDER No. / WORK ORDER No. DWN BY: SH / AUTH BY: GS / DATE: 00-01-27 / REV: 4 DRAWING FILE/ No.: 7AGD1302 / SHEET: 1/1

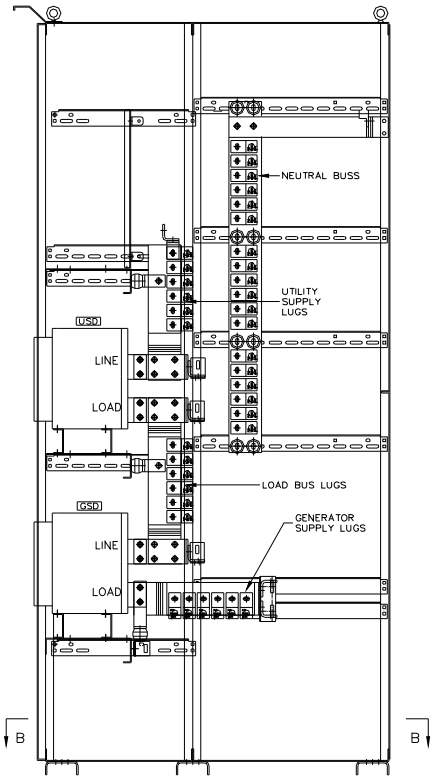
9. FRONT VIEW (TYPICAL) 3 POLE 400A-1200A TRANSFER MECHANISM



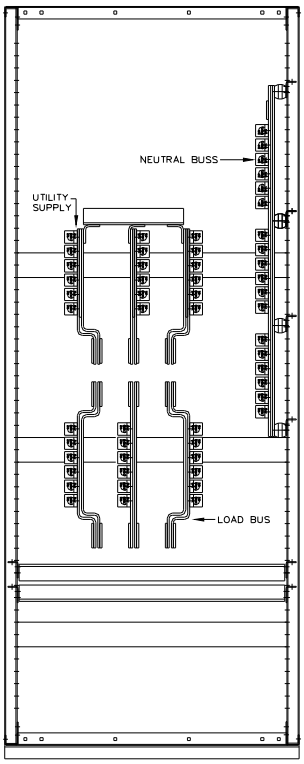
10. FRONT VIEW (TYPICAL) 3 POLE 800A-4000A INSULATED CASE TYPE TRANSFER MECHANISM



FRONT VIEW (TYPICAL)



RIGHT SIDE VIEW (TYPICAL)



REAR VIEW (TYPICAL)

11. CONNECTION CONFIGURATION OPTIONS

12. CABLE TERMINAL INFORMATION

BASIC MODEL	TERMINAL RATING		CONNECTION TIGHTNESS (In-lbs)	
	QTY PER PHASE	RANGE	TERMINAL MOUNTING SCREW	CABLE CLAMP
TS88xA-0100	1	#14-1/0	120	50
TS88xA-0150	1	#2–4/0	120	120
TS88xA-0200	1	#6–350MCM	150	275
TS88xA-0250	1	#6–350MCM	150	275
TS88xA-0400[1]	2	2/0–500MCM	72	275
TS88xA-0600[1]	2	2/0–500MCM	72	275
TS88xA-0800[1]	3	2/0–500MCM	110	375
TS88xA-1000/1200[1]	4	4/0–500MCM	375	375
TS88xA-0800/4000[2]	As Req'd	#2–600MCM	--	450

1. With molded case power switching units
2. With insulated case power switching units
3. For other model types not shown, contact Thomson Technology for further information.

13. REQUIREMENTS FOR UPSTREAM CIRCUIT PROTECTIVE DEVICES

13.1. *WITHSTAND CURRENT RATINGS (ALL MODELS WITHOUT INTEGRAL OVERCURRENT PROTECTION OPTION)*

BASIC MODEL	MAX. VOLTAGE	RATED CURRENT (A)	WITHSTAND CURRENT RATING AMPS (RMS) [1]				
			With Upstream Circuit Breaker Protection			With Upstream Fuse Protection	
			@240V	@480V	@600V	@ Up to 600V	Fuse Type
TS88xA-0100	600	100	65,000	25,000	18,000	100,000	T, J
TS88xA-0150	600	150	65,000	25,000	18,000	100,000	T, J
TS88xA-0200	240	200	65,000	N/A	N/A	N/A	T, J
TS88xA-0250	600	250	65,000	35,000	25,000	100,000	T, J
TS88xA-0400	600	400	65,000	50,000	35,000	100,000	T, J
TS88xA-0600	600	600	65,000	50,000	35,000	100,000	T, J
TS88xA-0800[1]	600	800	65,000	50,000	35,000	100,000	Consult Factory
TS88xA-1000/1200[1]	600	1000/1200	65,000	50,000	42,000	100,000	Consult Factory
TS88xA-0800[2]	600	800	100,000	100,000	85,000	100,000	Consult Factory
TS88xA-1200[2]	600	1200	100,000	100,000	85,000	100,000	Consult Factory
TS88xA-1600[2]	600	1600	100,000	100,000	85,000	100,000	Consult Factory
TS88xA-2000[2]	600	2000	100,000	100,000	85,000	100,000	Consult Factory
TS88xA-2500[2]	600	2500	100,000	100,000	85,000	100,000	Consult Factory
TS88xA-3000[2]	600	3000	100,000	100,000	85,000	100,000	Consult Factory
TS88xA-3200[4]	600	3200	100,000	100,000	85,000	100,000	Consult Factory
TS88xA-4000[2]	600	4000	100,000	100,000	85,000	100,000	Consult Factory

1. With molded case power switching units
2. With insulated case power switching units
3. For other ratings, contact Thomson Technology for further information
4. IEC Rating

Fuse ratings shown are maximum allowable to permit use of the transfer switch in application with available fault current not exceeding that shown. Consideration must be given to fuse sizing when fuses also provide overload protection.

13.2. *INTERRUPTING CAPACITY CURRENT RATINGS (ALL MODELS WITH INTEGRAL OVERCURRENT PROTECTION OPTION)*

BASIC MODEL	MAX. VOLTAGE	RATED CURRENT (A)	INTERRUPTING CAPACITY CURRENT RATING AMPS (RMS) [4] No Upstream Circuit Breaker Protection Required		
			@240V	@480V	@600V
TS88xA-0100	600	100	65,000	25,000	14,000
TS88xA-0150	600	150	65,000	25,000	14,000
TS88xA-0200	240	200	65,000	N/A	N/A
TS88xA-0250	600	250	65,000	35,000	22,000
TS88xA-0400	600	400	65,000	50,000	25,000
TS88xA-0600	600	600	65,000	50,000	25,000
TS88xA-0800[1]	600	800	65,000	50,000	25,000
TS88xA-1000/1200[1]	600	1000/1200	65,000	50,000	50,000
TS88xA-0800[2]	600	800	100,000	100,000	85,000
TS88xA-1200[2]	600	1200	100,000	100,000	85,000
TS88xA-1600[2]	600	1600	100,000	100,000	85,000
TS88xA-2000[2]	600	2000	100,000	100,000	85,000
TS88xA-2500[2]	600	2500	100,000	100,000	85,000
TS88xA-3000[2]	600	3000	100,000	100,000	85,000
TS88xA-3200[5]	600	3200	100,000	100,000	85,000
TS88xA-4000[2]	600	4000	100,000	100,000	85,000

1. With molded case power switching units
2. With insulated case power switching units
3. For other ratings, contact Thomson Technology for further information
4. With molded case/insulated case switching devices equipped with integral overcurrent protection. Typically supplied on service entrance automatic transfer switches.
5. IEC Rating

14. GROUND FAULT SITE TEST REQUIREMENTS

Per NEC and UL1008, a ground fault protected system shall be performance tested when first installed on site. A written record of this shall be made and be available to the authority having jurisdiction. A form is provided at the back of this manual for this purpose – see ***Section 24***.

Confirm and record actual trip setpoints in the form provided which is to be made available on request by the inspection authority.

14.1. *PERFORMANCE TEST*

Qualified Field Service technicians require a calibrated current injection test apparatus and must be knowledgeable in power switching unit testing to provide primary neutral CT injection up to or greater than the trip setpoint as selected by the responsible party. As indicated in the NEC, the maximum setting of the ground fault protection shall be 1200 amps, and the maximum time delay shall be 1 second for ground faults equal to or greater than 3000 amps.

The inspection authority should be contacted to confirm actual test requirements as these may vary by region or local code requirements.

The interconnected system shall be evaluated to ensure compliance with the appropriate schematic drawings. The proper location of sensors and power cabling shall be determined. The grounding points of the system shall be verified to determine that ground paths do not exist that would bypass the sensors. The use of high-voltage testers and resistance bridges may be required. A simulated fault current is to be generated by a coil around the sensors. The reaction of the circuit-interrupting device is to be observed for correct response. The results of the test are to be recorded on the test form provided.

15. TROUBLESHOOTING (100A-1200A MOLDED CASE SWITCH TYPE ATS)

CAUTION!!!

All troubleshooting/service work performed must be done by qualified personnel only. Failure to do so may cause personal injury or death.

Symptom	Possible Causes
Will not re-transfer to utility source upon restoration	- Isolation plug out - Utility disconnect switch is in the de-energized position (Service Entrance Rated ATS). Switch to the Energized position. - A test mode has been activated (check TSC 800 controller) - Utility voltage is below the pre-programmed limits (check utility source for adequate voltage) - A loose control connection - Faulty motor limit switch - Defective motor - TSC 800 has incorrect voltage programmed for correct system voltage

Symptom	Possible Causes
	- Defective TSC 800 controller (verify output signals with circuit board mounted diagnostic LED's) - TSC 800 has "Transfer Fail" alarm activated. Determine cause of alarm and rectify before TSC 800 is reset
Will not transfer to generator source upon failure of utility source	- Isolation plug out - Generator set not producing enough voltage/frequency or output circuit breaker is open - TSC 800 has incorrect voltage programmed for system voltage - Warmup time delay function has not timed out yet (verify TSC 800 timer setting) - A loose control connection - Faulty motor limit switch - Defective motor - Defective TSC 800 controller (verify output signals with circuit board mounted diagnostic LED's) - TSC 800 has "Transfer Fail" alarm activated Determine cause of alarm and rectify before TSC 800 is reset
Transfer to generator source without a power failure in the utility source	- A test mode has been activated (check TSC 800 controller) - Utility supply voltage is slightly below voltage sensing setpoints. Verify TSC 800 has incorrect voltage program setting for system voltage - Defective TSC 800 controller (verify output signals with circuit board mounted diagnostic LED's) - Utility power switching device has tripped due to an over current condition and TSC 800 "Transfer Fail" alarm activated. Determine cause of alarm and rectify before TSC 800 is reset.
Generator does not start up or stop when it should	- Verify remote engine control panel is set for automatic mode
No time delay when there should be	- Verify time delay function in the TSC 800 program setting as per programming sheets as supplied with the transfer switch
Power is not available at the load terminals but the utility or generator power switching device appears to be closed to a live source	- The power switching device's over current protection unit has opened due to a fault on the system. Correct the fault, and manually reset the power switching device in the transfer switch by moving it off and then on again with the manual operating handle - Limit switch incorrectly adjusted
The transfer switch has completed a transfer, but the motor has overheated and the internal thermal protector has opened	- Limit switch failure or improper adjustment has failed to disconnect motor - Binding or jamming of the transfer mechanism

NOTE:

There are no user serviceable components located on the TSC 800 printed circuit board. If the TSC 800 controller is deemed to be defective it must be returned to the Thomson Technology Factory for repair or replacement. Please refer to ***Section 22*** for further detailed on product return procedures required.

16. TROUBLESHOOTING (800A-4000A INSULATED CASE SWITCH TYPE ATS)

Symptom	Possible Causes
Will not re-transfer to utility source upon restoration	- Control wiring isolation plug is removed - A test mode has been activated (check TSC 800 status LCD display) Utility disconnect switch is in the de-energized position (Service Entrance Rated ATS). Switch to the energized position. - Transfer mode selector is not in “auto” position - Utility voltage or frequency is outside the pre-programmed limits (check utility source for adequate voltage & frequency) - Loose control connection - Faulty Power Switching Device (refer to Power Switching Device Troubleshooting Section) - Defective TSC 800 controller (verify output signals with circuit board mounted diagnostic LED’s) - TSC 800 has “Transfer Fail” alarm activated (if programmed as “Force Transfer). Determine cause of alarm and rectify before TSC 800 is reset
Will not transfer to generator source upon failure of utility source	- Control wiring isolation plug is removed - Generator set not producing enough voltage/frequency or output circuit breaker open - Warmup time delay function has not timed out yet (verify TSC 800 timer setting) - Transfer mode selector is not in “auto” position - A loose control connection

Symptom	Possible Causes
	- Faulty Power Switching Device (refer to Power Switching Device Troubleshooting Section) - Defective TSC 800 controller (verify output signals with circuit board mounted diagnostic LED's) - TSC 800 has "Transfer Fail" alarm activated (if programmed as "Force Transfer). Determine cause of alarm and rectify before TSC 800 is reset
Transfer to generator source without a power failure in the utility source	- A test mode has been activated (check TSC 800 status LCD display) - Utility supply voltage is slightly above or below voltage sensing setpoints. Compare TSC 800 program voltage setpoints with actual utility voltage displayed on the controller - Defective TSC 800 controller (verify output signals with circuit board mounted diagnostic LED's) - Utility Power Switching Device has opened due to an over current condition (Service Entrance type ATS) and TSC 800 "Transfer Fail" alarm activated. (**Note:** TSC 800 must be programmed as "Force Transfer for this to occur). Determine cause of alarm and rectify before TSC 800 is reset
Generator does not start up or stop when it should	- Verify remote engine control panel is set for automatic mode
No time delay when there should be	- Verify time delay function in the TSC 800 program setting as per programming sheets as supplied with the transfer switch
Power is not available at the load terminals but the utility or generator power switching unit appears to be closed to a live source	- The Power Switching Device (service entrance type ATS) has opened due to a fault on the system and TSC 800 "Transfer Fail" is programmed as "Disabled or Halt Transfer". Correct the fault, and manually reset the power switching unit.

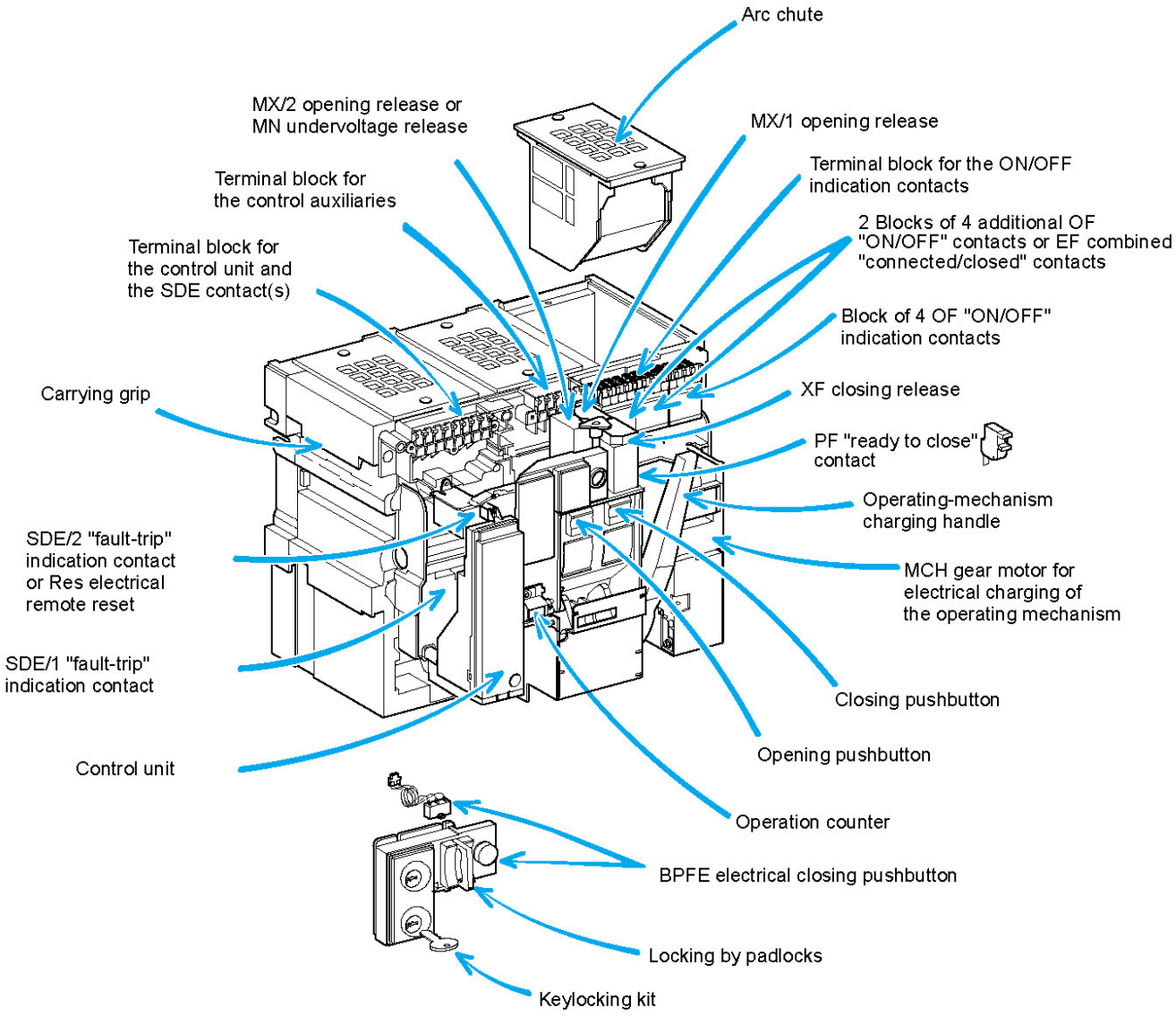
17. POWER SWITCHING DEVICE TROUBLESHOOTING (800A-4000A INSULATED CASE SWITCH TYPE ATS)

MALFUNCTIONS	PROBABLE CAUSES	CORRECTIVE ACTIONS
The power switching device cannot be opened locally.	- Open push-button locked. - Faulty mechanism or main circuits bonded.	- Remove the locking. - Contact Thomson Technology Service Department.
The power switching device cannot be manually closed.	- **power switching device** closing on short-circuit. - Fault trip indicator-on **power switching device** button not reset. (Service Entrance type ATS) - **power switching device** not fully connected. (draw-out type only) - Anti-pumping function. - **power switching device** not charged. - Closing coil is continuously supplied. - **power switching device** locked in “open” position. - **power switching device** interlocked.	- Clear the fault. Check **power switching device** condition before putting back into operation. - Reset fault trip indicator-button. - Connect **power switching device fully**. - Move transfer mode switch to the manual position, then back to the auto position to cycle the control signal. - Check the geared motor power supply is greater than 85% nominal voltage. Check the power supply circuit. Attempt a manual recharging. Replace the geared motor if necessary. (Contact Thomson Technology Service Department) - Move transfer mode switch to the manual position, then back to the auto position to cycle the control signal. - Remove the locking. - Check whether this refusal to close is not normal.
The power switching device does not recharge electrically.	- Charge motor supply voltage too low (less than 85% nominal voltage).	- Apply a voltage greater than 85% nominal voltage. Check the charge motor electrical circuit. Attempt to recharge manually. If problem: mechanism is faulty. Contact Thomson Technology Service Department. If okay: motor faulty. Replace it.
It is impossible to insert the racking handle to connect or to disconnect the power switching device.	- There is a padlock or a key-lock for connected or disconnected position. There is a racking interlock. - The extraction rails or the **power switching device** is not completely pushed in.	- Remove disabling. - Push the rails or the **power switching device** completely in.
It is impossible to extract the right side rail (on chassis alone) or the power switching device.	- The racking handle is remained inserted. - The **power switching device** is not completely disconnected. - There is a padlock or a key-lock	- Remove the racking handle and put it in its storage. - Disconnect the **power switching device** - Remove disabling.

MALFUNCTIONS	PROBABLE CAUSES	CORRECTIVE ACTIONS
	for connected or disconnected position. There is a racking interlock.	
It is impossible to extract the power switching device whenever it is charged.	- There is an extraction locking when **power switching device** is charged.	- Discharge the **power switching device** (open, close then open again the **power switching device**).
It is impossible to rack in the power switching device	- The chassis does not correspond with the **power switching device**. - The plastic ties which hold clusters during transport are not removed. - The clusters positions are not correct. - There is a safety shutters locking.	- Fit fouling-plate on your chassis and **power switching device** to avoid new mistakes. - Remove the plastic ties. - Put them in order again. - Remove this locking.

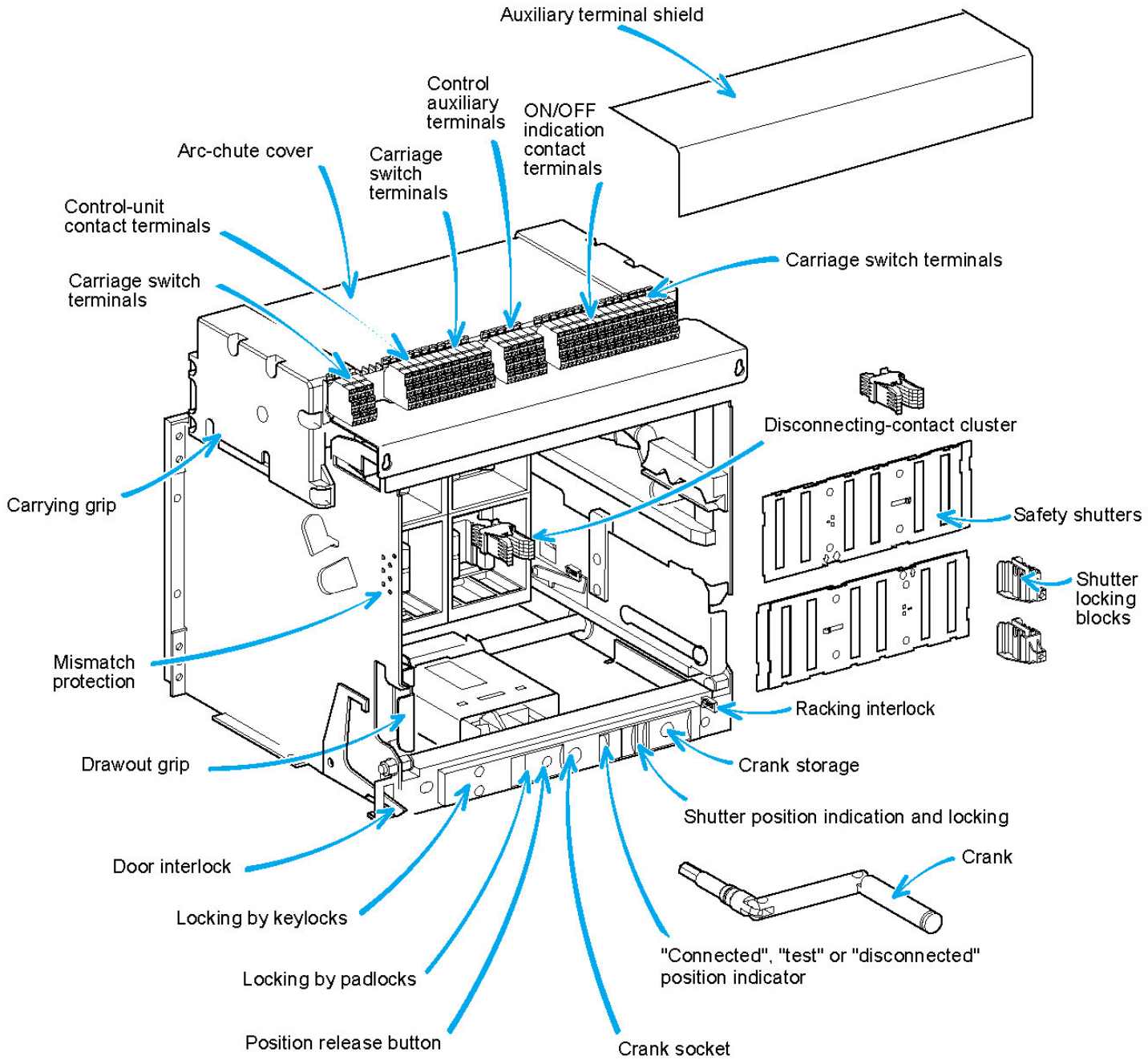
18. POWER SWITCHING DEVICE DRAWING

Power Switching Device



19. DRAWOUT CHASSIS ENGINEERING DRAWING

Chassis

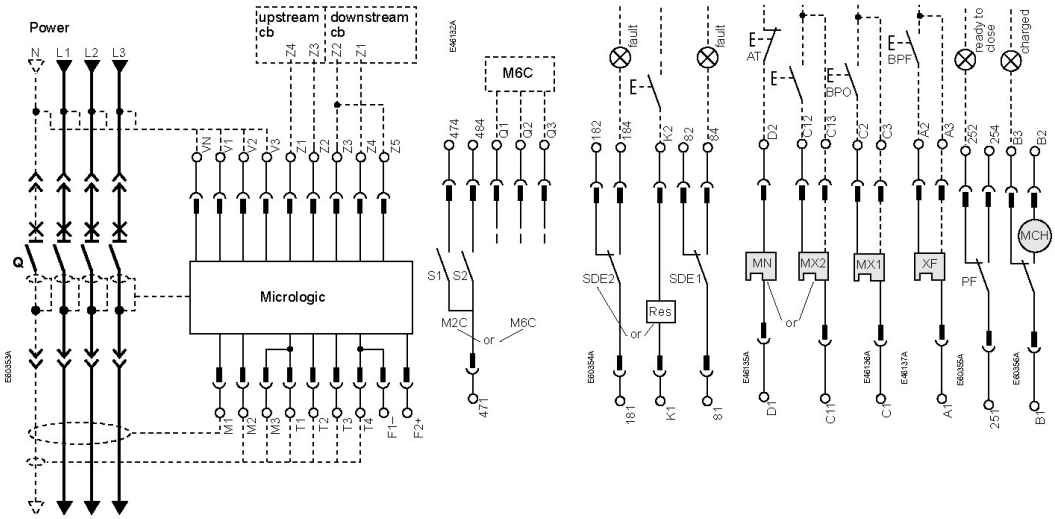


20. ELECTRICAL DIAGRAMS

Electrical diagrams
Fixed and drawout devices

The diagram is shown with circuits de-energised, all devices open, connected and charged and relays in normal position.

Power | **Control unit** | **Remote operation**



Control unit

Com	UC1	UC2	UC3	UC4	M2C / M6C
E5 E6	Z5 M1	M2 M3	F2+	V3	484 / Q3
E3 E4	Z3 Z4	T3 T4	VN	V2	474 / Q2
E1 E2	Z1 Z2	T1 T2	F1 –	V1	471 / Q1

Remote operation

SDE2 / Res	SDE1	MN / MX2	MX1	XF	PF	MCH
184 / K2	84	D2 / C12	C2	A2	254	B2
182	82		C3	A3	252	B3
181 / K1	81	D1 / C11	C1	A1	251	B1

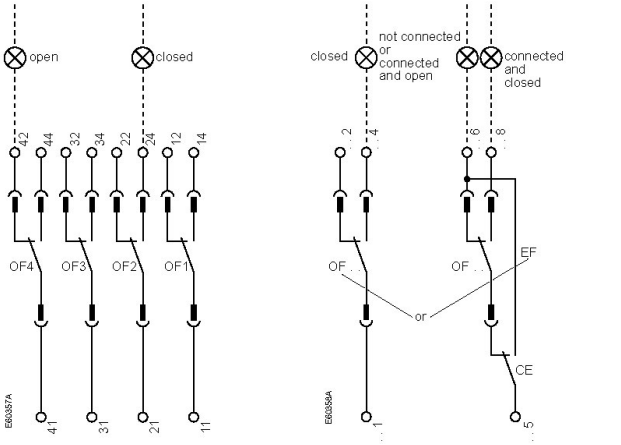
A	P	H	Control unit	Remote operation
■	■	■	**Com**: E1-E6 communication	**SDE2**: Fault-trip indication contact **or** **Res**: Remote reset
■	■	■	**UC1**: Z1-Z5 zone selective interlocking; Z1 = ZSI OUT SOURCE Z2 = ZSI OUT; Z3 = ZSI IN SOURCE Z4 = ZSI IN ST (short time) Z5 = ZSI IN GF (earth fault) M1 = Vigi module input (Micrologic 7)	**SDE1**: Fault-trip indication contact (supplied as standard)
■	■	■		**MN**: Undervoltage release **or** **MX2**: Shunt release
■	■	■	**UC2**: T1, T2, T3, T4 = external neutral;	
■	■	■	M2, M3 = Vigi module input (Micrologic 7)	**MX1**: Shunt release (standard or communicating)
				XF: Closing release (standard or communicating)
■	■	■	**UC3**: F2+, F1– external 24 V DC power supply VN external voltage connector	**PF**: "Ready to close" contact
	■	■		**MCH**: Gear motor.
	■	■	**UC4**: V1, V2, V3 optional external voltage protector	
	■	■	**M2C**: 2 programmable contacts (internal relay); ext. 24 V DC power supply required **or**	***Note:*** *When communicating MX or XF releases are used, the third wire (C3, A3) must be connected even if the communications module is not installed.*
	■	■	**M6C**: 6 programmable contacts (external relay); 24 V DC power supply required	

A *: Digital ammeter*
P *: A + power meter + programmable protection*
H *: P + harmonics*

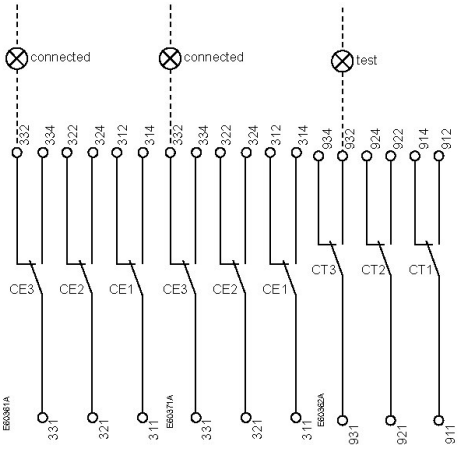
Identifying the electrical auxiliaries

Electrical diagrams

Indication contacts



Chassis contacts



Indication contacts

OF4	OF3	OF2	OF1
44	34	24	14
42	32	22	12
41	31	21	11

OF24	OF23	OF22	OF21	OF14	OF13	OF12	OF11
244	234	224	214	144	134	124	114
242	232	222	212	142	132	122	112
241	231	221	211	141	131	121	111

or

EF24	EF23	EF22	EF21	EF14	EF13	EF12	EF11
248	238	228	218	148	138	128	118
246	236	226	216	146	136	126	116
245	235	225	215	145	135	125	115

Chassis contacts

CD3	CD2	CD1	CE3	CE2	CE1	CT3	CT2	CT1
834	824	814	334	324	314	934	924	914
832	822	812	332	322	312	932	922	912
831	821	811	331	321	311	931	921	911

or

CE6	CE5	CE4
364	354	344
362	352	342
361	351	341

or

CE9	CE8	CE7
394	384	374
392	382	372
391	381	371

Indication contacts

OF4: ON/OFF
OF3 indication
OF2 contacts
OF1

OF 24 or EF 24 ON/OFF indication contacts Combined "connected/closed" indication contacts

OF 23 or EF 23

OF 22 or EF 22

OF 21 or EF 21

OF 14 or EF 14

OF 13 or EF 13

OF12 or EF12

OF11 or EF11

Chassis contacts

CD3: Disconnected **CD2** -position **CD1** contacts

CE3: Connected **CE2** -position **CE1** contacts

CT3: Test-position **CT2** contacts **CT1**

or

CE6: Connected **CE5** position **CE4** contacts

or

CE9: Connected **CE8** position **CE7** contacts

or

CD6: Disconnected **CD5** position **CD4** contacts

Key:

Drawout device only

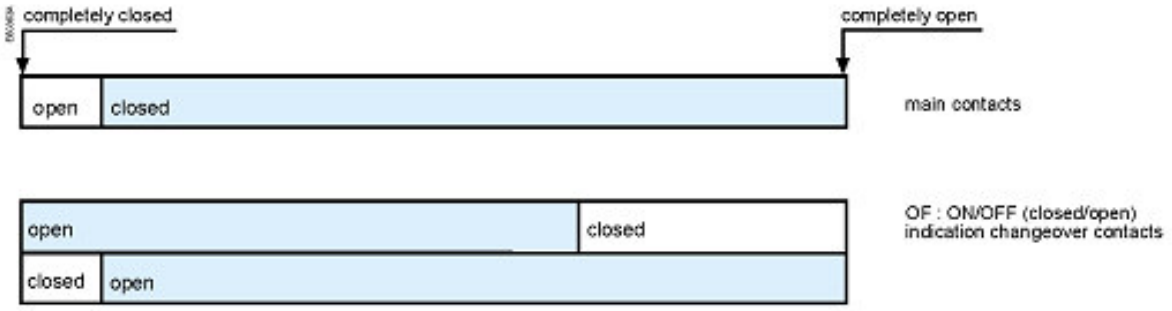
XXX *SDE1, OF1, OF2, OF3, OF4 supplied as standard*

Interconnected connections (only one wire per connection point)

Operation

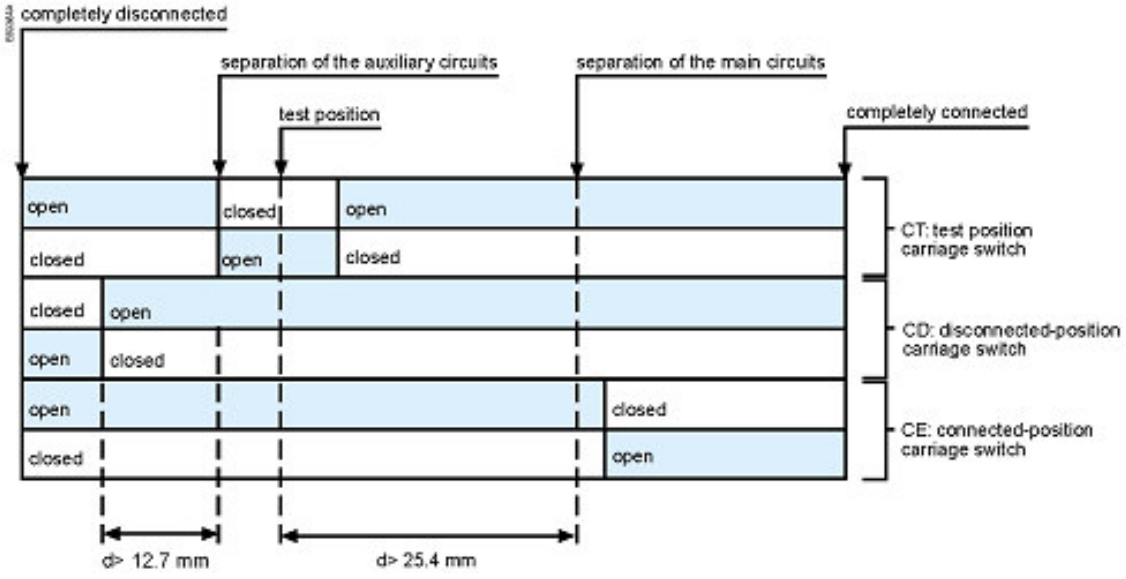
The ON/OFF indication contacts signal the status of the device main contacts.

Power Switching Device



The carriage switches indicate the "connected", "test" and "disconnected" positions.

Chassis



21. REPLACEMENT PARTS

Replacement parts are available for the transfer switch as follows:

NOTE

When ordering replacement parts please provide the following information:

-Transfer Switch Model code (e.g. TS 883AA0200AS)

-Transfer Switch Serial Number (e.g. W-022345)

The above information can be found on the transfer switch rating plate located on the outside of the ATS door.

Component Description	Thomson Technology Part Number	Comments
TSC 800 Service Replacement Controller Board	TSC 800SR	Must verify program settings prior to use. Refer to TSC 800 Instruction Manual.
TSC 800 LCD Display	LCDSR-T	Contact Thomson Technology Service Department for installation procedures.
Limit Switch 1 n/o, 1 n/c (100A-1200A molded case type ATS Models)	004929	Must install and adjust for proper operation before use. Contact Thomson Technology Service Dept for installation/adjustment procedures
Unidirectional** Transfer Switch Motor (100A-250A) 1 PH 120V	001077	Motor is supplied with gear box assembly. Contact Thomson Technology Service Department for installation procedures
OR Reversing** Transfer Switch Motor (100A-250A) 1 PH 120V	004565	Motor is supplied with gear box assembly and starting capacitor. Contact Thomson Technology Service Department for installation procedures
Transfer Switch Motor (400A-1200A molded case type) 120V 1/10 hp 1 PH	001075	Motor is supplied with gear box assembly. Contact Thomson Technology Service Dept for installation procedures
120VAC Auxiliary Plug-in Relay, 11 pin Square (UX/GX)	001278	Must ensure coil voltage is correct
120VAC Auxiliary Plug-in Timer	001515	Must ensure coil voltage is correct

Component Description	Thomson Technology Part Number	Comments
100VA Control Transformer	002159	
200VA Control Transformer	002162	

** Motor types used on 100A-250A transfer switches were changed during the first quarter of 2005 from unidirectional to reversing style motors.

Note: A reversing type motor cannot be used as a direct replacement for a unidirectional motor due to mechanical and electrical wiring differences therefore when ordering replacement motors, the same motor type must be specified to ensure it matches the original mechanism design.

To distinguish between the two different motor types, refer to the following product descriptions:

- Unidirectional Transfer Switch Motor: 2 wire leads extend from the motor. ATS Terminal block has number "M1" terminal which connects to this type of motor.
- Reversing Transfer Switch Motor: 3 wire leads extend from the motor. ATS Terminal block does not contain terminal number "M1". Reversing motor also uses a starting capacitor which is mounted above the motor under the ATS mechanism.

For other parts not listed, please contact Thomson Technology.

22. PRODUCT RETURN POLICY

Thomson Technology uses a Return Material Authorization (RMA) process. Please complete the Return Authorization Request Form (available on our web page) for return of goods, warranty replacement/repair of defective parts, or credit consideration and fax to the appropriate department.

Returns only: Sales Fax (604) 888-5606

Warranty replacement/Warranty Repair: Service Fax (604) 888-3370.

Upon receipt of your request, Thomson Technology will confirm with a copy of our Order Acknowledgement via fax advising the RMA number which should be used to tag the defective controller prior to shipment.

23. NOTES

24. PERFORMANCE TEST FORM

This form should be retained by those in charge of the building electrical installation in order to be available to the authority having jurisdiction.

Date	Personnel	Tests performed	Comments
		Interconnection evaluation	
		Grounding point evaluation	
		Fault current test:	
		Ground fault settings - _____	
		Simulated current - _____	
		Results - _____	

APPENDIX "A"

TYPICAL AUTOMATIC TRANSFER SWITCH COMMISSIONING PROCEDURES Model Series TS 880/TS 830

Note: The following commissioning procedures are provided for general information only pertaining to typical site installations and applications. Contact Thomson Technology for further information as may be required.

CAUTION

Commissioning procedures must be performed by qualified personnel only. Ensure the Automatic Transfer Switch (ATS) Isolation Plug is pulled prior to energizing the supply sources. Manually place the transfer switch mechanism in the neutral position prior to applying power. Failure to do so may result in equipment failure or personal injury.

Pre-Commissioning Checks Prior to Commissioning Agent On-Site (to allow loads to be supplied prior to final commissioning)

1) Verify supply source voltage to be applied to the transfer switch is of the correct nominal value. Confirm this to be the same as listed on the ATS drawings and the ATS equipment label. For other system voltages refer to the ATS instruction manual for re-configuring procedures prior to energization. **FAILURE TO RE-CONFIGURE ATS VOLTAGE TO MATCH SYSTEM VOLTAGE WILL RESULT IN EQUIPMENT MALFUNCTION AND DAMAGE.**
   If ATS voltage is changed, record the new voltage on the TSC 800 Component Calibration Label.

2) For 240V High Leg Delta systems refer to the ATS instruction manual for correct phasing required and re-configuring procedures. **FAILURE TO OBTAIN THE CORRECT ATS PHASING WILL RESULT IN EQUIPMENT MALFUNCTION AND DAMAGE.**

3) Confirm cable size is correct for the lugs supplied in the transfer switch (line and load). Confirm the cables were meggered by the electrical contractor to ensure no cross phase connections or conduction to ground.

4) Confirm cable lugs are properly torqued. Confirm cable installation; ensure the cables do not interfere with normal equipment operation or which may cause component damage.

5) Manually operate the transfer mechanism by opening or closing the utility or generator power switching device to the appropriate source of supply. Leave the Isolation Plug disconnected until final Transfer Switch Commissioning is to be completed.

Final Commissioning

1) Verify installation of the Automatic Transfer Switch as per installation manual and verify wiring (also see the Pre-Commissioning Checks). Confirm phase, neutral and grounding conductors are installed as per electrical code requirements***. Note***: Confirm neutral conductors of both sources are correctly installed and are solidly grounded for 3 phase 4 wire configurations.

2) Check for mechanical damage (shipping or installer).

3) Check for cable interference with mechanical moving parts or the motor brake on 100A-250A ATS mechanism.

4) Verify correct control wire interconnects to the engine/generator set auto start/stop circuitry. Ensure the engine controller automatic start circuit does not draw more than 5.0 amps (resistive) across the TSC 800 Engine Start contact. The TSC800 Engine Start contact is voltage free and the only voltage measured should result from the engine controllers internal control logic. **Note**: The ATS Engine Start contact CLOSES to start the engine and OPENS to stop the engine.

5) Place the generator engine controller in the "OFF" position and open the generator local circuit breaker.

6) Ensure the ATS isolation plug is disconnected prior to application of voltage of the supply sources.

7) Energize the utility supply and the generator supply sources and verify these meet the correct voltage, phasing and phase rotation for the ATS and system. Once these have been confirmed to be correct, de-energize both sources before installing the isolation plug.

8) Once the isolation plug is connected, the ATS and system load may be energized with utility power once the site electrical contractor and or owner (as required) give authorization to proceed.

9) If Utility power is within nominal limits, the ATS should transfer to the utility source. To determine correct operation, observe the following on the TSC 800 Display: UTIL NORMAL, GEN AUTO, Green LED above mimic bus for the Utility source is On.

APPENDIX "A"

10) To verify all LED's are operational, perform a "LAMP TEST" operation (lamp test is initiated by pressing and holding the INCREMENT & DECREMENT push buttons on the TSC 800 faceplate simultaneously On until all the LED's illuminate).Review TSC 800 program settings by entering the program menu. Select "Program Menu" on the display by scrolling with the forward arrow button (right button). Select "Yes" by using the up or down arrow then enter. Password will be displayed. Enter password "1" for read only access or password "2" for read /write access (select password 3 only if passwords are to be changed).

11) Set the TSC 800 time clock, as there is no battery installed on the circuit board. The time clock is a 7 day, 4 week, 24 hour clock. Refer to the TSC 800 manual for time clock programming instructions. The TSC 800 time clock is used for automatic exercise load testing.

12) TSC 800 AUTOMATIC PLANT EXERCISE PROGRAMMING (**OPTIONAL**): If an automatic plant exercise feature is desired, program the TSC 800 automatic plant exercise settings. Refer to the TSC 800 manual for detailed automatic exercise programming instructions.

13) Review the remainder of the TSC 800 program by using the enter key to navigate through the program. Verify each program value is the same as the value, which is entered on the program data sheets. If any of these values are modified to suit site conditions or requirements these should be noted on the data sheets for future reference.

14) UTILITY/LOAD VOLTAGE CALIBRATION: Near the end of the TSC 800 program loop are calibration menus for utility, generator and load voltages. If TSC 800 voltage display accuracy needs to be verified, measure actual voltages on the ATS power connections with an accurately calibrated meter. Verify that each phase-to-phase reading at the TSC 800 is within 0.5% accuracy. Refer to the TSC 800 instruction manual for complete details on Voltage calibration if required. Document any changes on the program data sheets. To exit the program, press and hold the exit key for a minimum of 2-3 seconds.

15) Prior to operating the generator, ensure it is ready to be energized and the site electrical contractor and/or owner (as required) give authorization to proceed. In preparation for operation, turn the generator's engine control switch to the "Automatic" start position.

16) To transfer the generator on load, perform a load test by entering the ATS MODE MENU, selecting "YES" on the TSC 800 display, then selecting "ON LOAD" test, then enter. The engine should start following the 3-second engine start delay period and the transfer switch will begin transferring to the generator supply once the 2-second engine warm-up timer expires. **Note:** the engine warm-up timer will only begin timing once the generator's output rises above 90% nominal voltage and 90% nominal frequency. Once the Utility power switching device opens, the transfer switch mechanism will pause in the neutral position for the 3-second neutral delay period, then the mechanism will complete the transfer and close the generator power switching device. To determine correct operation, observe the following on the TSC 800 Controller: DISPLAY –GEN NORMAL, Red LED above mimic bus for the generator source is On, Green LED above mimic bus for the Utility source is OFF.

17) With the generator operating, view the TSC 800 display and verify correct voltage is displayed. If TSC 800 generator voltage display accuracy needs to be verified, refer to item #15 as described above.

18) To terminate the test, enter the ATS MODE MENU, select "YES" on the TSC 800 display, then selecting "NONE", then enter. Once initiated, the transfer switch will begin transferring to the utility supply following the 2-minute utility return delay period. **Note:** the utility return delay timer will only begin timing if the utility voltage is above 90% nominal on all phases. Once the Generator power switching device opens, the transfer switch mechanism will pause in the neutral position for the 3-second neutral delay period, then the mechanism will complete the transfer and close the Utility power switching device to return the load to the Utility source. Once the load has transferred onto the utility source, the engine will continue to run for the 2-minute cool down time delay period and will then it will automatically stop.

19) Perform a power outage test by opening the upstream utility feeder breaker. The TSC 800 controller display will go blank; the generator set will start after the 3-second engine start delay has expired. The generator should transfer on load as described in item #17 above.

20) Return the transfer switch to utility power by re-closing the upstream utility breaker. The load should re-transfer back to the utility supply and the engine should stop as described in item #19 above.

21) Repeat tests #17 through #21 two (or more) times to ensure correct operation.

22) On completion of commissioning ensure all controls are left in automatic.

23) If required, forward document or drawing updates to Thomson Technology if revisions are required and provide the end user with a set of marked-ups to be retained on site.

24) Ensure copies of manuals for the equipment are on site.

25) Record and forward list of deficiencies to the appropriate parties where applicable.