

# **Application Note**

GET-8558

## **RESIDUAL BUS MAIN-TIE-MAIN AUTOMATIC TRANSFER SCHEME USING THREE GE 850 RELAYS**

REVISION 01

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## **DECLARATION**

The breaker operations described in this document do not take into account of source overloading or loss of power on one or more buses, problems which may be encountered in the field. It is the operator's responsibility to fully understand the system operation principles and sequence of operation during daily operations; therefore, functional breaker operations will take place in either auto or manual mode providing uninterrupted power to the load without any source overloading. To avert this problem, the operator may need to manually shed some load on one or more buses prior to doing main or tie breaker switching operations.

The mechanical breaker operation mechanism for main breakers and the tie breaker should never be used during the factory acceptance test. The mechanical close of these breakers, which bypasses all relay internal logic for voltage permissive, sync check 25 function, close blocking, etc. should also not be used in the field. However, a mechanic emergency trip pushbutton or a mechanical trip/open pushbutton, may also be provided on a breaker mechanism and be used if it is necessary and available, which can be treated as an additional means to open the breaker in true emergency situations in the field if all other methods are failed.

## **1. INTRODUCTION**

A Main-Tie-Main (MTM) automatic transfer scheme has been designed and implemented by using three GE 850 relays. This application note is intended to assist users in the design, test and safe operations of the transfer scheme.

The MTM transfer scheme has the following features:

Manual breaker operations

Manual transfer and retransfer (Open-Transition or Closed-Transition)

Automatic transfer (Open-Transition, Break-Before-Make)

Optional Automatic retransfer (Closed-Transition, Make-Before-Break)

The GE three-relay scheme described in this document is a secondary selective residual bus based automatic transfer scheme. Refer to GE 850 manual for detailed automatic transfer scheme descriptions, features and limitations. The 850 automatic transfer scheme is implemented by using hard coded logic inside of three 850 relays with hardware inter-relay connections. Communication network and FlexLogic programming are not required for configurations and operations of the scheme.

In this document, main incoming breakers 1 and main incoming breaker 2 are referred as 52-1 and 52-2 breakers, respectively. Tie breaker is referred as 52-3 breaker. Relay for 52-1 is referred as 850-1, relay for 52-2 is referred as 850-2 and relay for 52-3 is referred as 850-3. These breaker and relay designations may be cross referenced with the specific names in the real projects. Accordingly, 86-1, 86T1, 86L1, 86B1, 86-2, 86T2, 86L2, 86B2 and 86-3 may also be cross referenced with the specific names in the real projects.

The GE three-relay based automatic transfer scheme may be implemented by using three 850 relays in different ways, thanks to the high level of flexibility with different connections and setup configurations inside each 850 relay. The highlighted features, the default settings and the typical wiring connections used in this application note are not the only way to make the scheme work properly but used as a general guideline for end user convenience. It does not discourage end users from using different ways with different connections or different configurations to make a revised scheme in order to achieve the same or similar functionality per each job's specific requirements.

## **2. RELAY ORDER CODE**

The default order code for all three 850 relays used for automatic transfer scheme is:  
850-E-P5-NN-G5-H-N-N-A-A-N-G-S-P-C-B-SE-N-N-B-N

Control power:	125VDC
CTs:	CT 5A for phase and 5A for ground
SLOT F:	7 Contact Inputs and 5 Output Relays (2 form A, 3 form C)
SLOT G:	7 Contact Inputs and 5 Output Relays (2 form A, 3 form C)
Protection:	Basic overcurrent protection plus voltage elements and built in auto transfer scheme
Ports:	One rear RS485 port and one rear RJ45 port
Protocol:	Modbus TCP/IP, DNP3, IEC60870-5-103
Coating:	Built-in Conformal Coating

It provides basic functions for doing automatic transfer scheme and provides protections described in this document. It also provides one RS485 and one RJ45 port for basic communication needs. Consult factory for other order code options if more advanced features of protection, control and communication, or different requirements, are needed for any specific project.

The above-mentioned scheme is for MTM configuration but it may be adjusted to fit a Main-Working Tie-Dummy Tie-Main (MTTM) configuration with some appropriate program changes and minor wire connection modifications. Consult factory for details when such situation arises.

### 3. RELAY IO CONNECTIONS

Per current setup, for main relays, incoming line voltage is sensed by using single-phase PT input and bus voltages are sensed by three-phase PT input. For the tie relay, Bus 1 and Bus 2 voltages are both sensed by their respective three-phase PT inputs.

Either Delta or Wye can be used for PT three-phase connections. For delta connected three-phase PTs, the corresponding phase of single-phase PT for the same relay should be connected to Vab, where for Wye connected three-phase PTs, the corresponding phase of single-phase PT on the same relay could be either Van or Vab.

Features of Loss of Potential (LOP, or VT fuse failure) and Negative Sequence Overvoltage 59-2 for the line are not currently in place due to only single-phase PT on the line side by the default PT connection method.

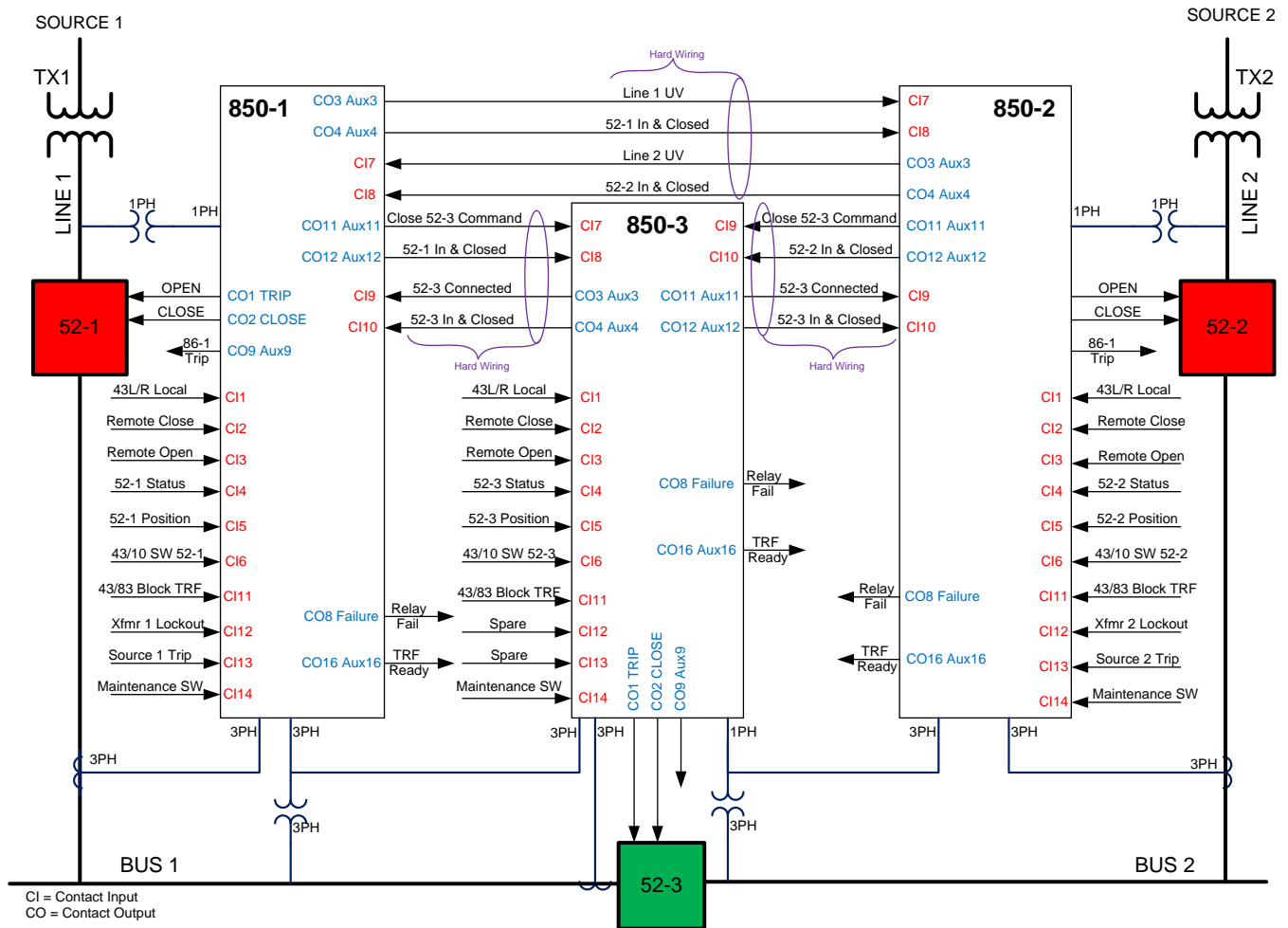


Figure 1. MTM Transfer Scheme Layout

Three phase currents are sensed to each individual relay for phase overcurrent protection, automatic transfer blocking and metering. Line and bus ground current can be sensed by adding a dedicated zero sequence CT at each incoming line or at the incoming power transformer neutral. Alternatively, they can be summed from phase current utilizing the neutral current by relay internal calculations without adding zero sequence CTs. These ground or neutral currents are used for protection only.

Table 1. Shows the recommended contact input connections.

**Table 1. Contact Input Connections**

Input	Contact	850-1	850-2	850-3
1	CI1	Local Mode	Local Mode	Local Mode
2	CI2	Remote Close	Remote Close	Remote Close
3	CI3	Remote Open	Remote Open	Remote Open
4	CI4	52-1 Status	52-2 Status	52-3 Status
5	CI5	52-1 Position	52-2 Position	52-3 Position
6	CI6	52-1 Selected To Trip	52-2 Selected To Trip	52-3 Selected To Trip [1]
7	CI7	UV Other Source	UV Other Source	Close From 52-1
8	CI8	52-2 Closed	52-1 Closed	52-1 Closed from 52-1
9	CI9	52-3 Connected	52-3 Connected	Close From 52-2
10	CI10	52-3 Closed	52-3 Closed	52-2 Closed from 52-2
11	CI11	Block Transfer	Block Transfer	Block Transfer
12	CI12	Xfmr 1 Lockout (86T1)	Xfmr 2 Lockout (86T2)	
13	CI13	Source 1 Trip (86L1)	Source 2 Trip (86L2)	
14	CI14	Maintenance Mode [2]	Maintenance Mode [2]	Maintenance Mode [2]

[1] A 52a of the tie breaker contact needs to be placed in series with the 43/10 Switch contact to reduce the effect of a time race between the anti paralleling and the auto transfer components of the scheme.

[2] Optional connection.

The following are general recommendations for contact output connections:

Relay normally open Contact Output 1 (F1-F2) is used for open command. See figure below.

Relay normally open Contact Output 2 (F4-F5) is used for close command. See figure below.

Relay normally open Contact Output 3 (F8-F9) is use for interconnection between relays.

Relay normally open Contact Output 4 (F11-F12) is used for interconnect between the relays.

Relay Contact Output 8 (F22-F23-F24) is for relay self-test only

Relay normally open Contact Output 9 (G1-G2) is reserved for trip 86 command.

Relay normally open Contact Output 10 (G4-G5) is reserved for spare.

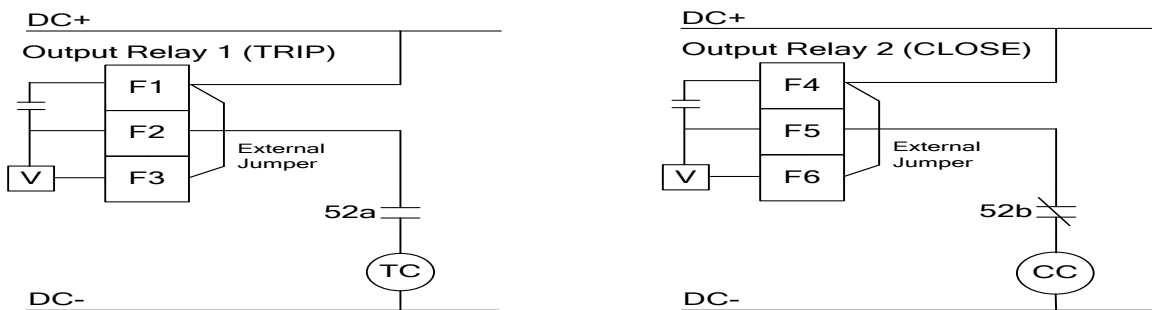
Relay normally open Contact Output 11 (G8-G9) is use for interconnection between relays.

Relay normally open Contact Output 12 (G11-G12) is used for interconnect between relays.

Relay normally open Contact Output 16 (G22-G23-G24) is used for indication of auto transfer ready.

### Breaker Trip Coil Monitoring (TCM) and Close Coil Monitoring (CCM)

Trip coil monitoring (TCM) and Close Coil Monitoring (CCM) may be programmed into the functionality of the transfer scheme through Output Relay 1 and Output Relay 2 connections illustrated as below:



For 850-1 Relay:

**Table 2. 850-1 Output Connections**

Output	Name	Terminal	To	Note
1	Trip	F1-F2	52-1 Bkr Trip Coil	Direct Connection to Trip Coil
2	Close	F4-F5	52-1 Bkr Closing Coil	TOC, Permissive and Block in Supervision
3	Aux3	F8-F9	850-2 CI7, F19	Line 1 Under voltage
4	Aux4	F11-F12	850-2 CI8, G13	52-1 In and Closed
8	Failure	F22-F23-F24	Light/Annunciator	Relay Fail[1]
9	Aux9	G1-G2	86-1 Lockout Coil	Trip and Block 52-1
10	Aux10	G4-G5		Spare
11	Aux11	G8-G9	850-3 CI7, F19	Close 52-3 Command
12	Aux12	G11-G12	850-3 CI8, G13	52-1 In and Closed
16	Aux16	G22-G23-G24	Light/Annunciator	52-1 Transfer Ready[1]

[1] Optional connection.

For 850-2 Relay:

**Table 3. 850-2 Output Connections**

Output	Name	Terminal	To	Note
1	Trip	F1-F2	52-2 Bkr Trip Coil	Direct Connection to Trip Coil
2	Close	F4-F5	52-2 Bkr Closing Coil	TOC, Permissive and Block in Supervision
3	Aux3	F8-F9	850-1 CI7, F19	Line 2 Under voltage
4	Aux4	F11-F12	850-1 CI8, G13	52-2 In and Closed
8	Failure	F22-F23-F24	Light/Annunciator	Relay Fail[1]
9	Aux9	G1-G2	86-2 Lockout Coil	Trip and Block 52-2
10	Aux10	G4-G5		Spare
11	Aux11	G8-G9	850-3 CI9, G14	Close 52-3 Command
12	Aux12	G11-G12	850-3 CI10, G15	52-2 In and Closed
16	Aux16	G22-G23-G24	Light/Annunciator	52-2 Transfer Ready[1]

[1] Optional connection.

For 850-3 Relay:

**Table 4. 850-3 Output Connections**

Output	Name	Terminal	To	Note
1	Trip	F1-F2	52-3 Bkr Trip Coil	Direct Connection to Trip Coil
2	Close	F4-F5	52-3 Bkr Closing Coil	TOC, Permissive and Block in Supervision
3	Aux3	F8-F9	850-1 CI9, G14	52-3 Connected
4	Aux4	F11-F12	850-1 CI10, G15	52-3 In and Closed
8	Failure	F22-F23-F24	Light/Annunciator	Relay Fail[1]
9	Aux9	G1-G2	86-3 Lockout Coil	Trip and Block 52-3
10	Aux10	G4-G5		Spare
11	Aux11	G8-G9	850-2 CI9, G14	52-3 Connected
12	Aux12	G11-G12	850-2 CI10, G15	52-3 In and Closed
16	Aux16	G22-G23-G24	Other applications	52-3 Transfer Ready [1]

[1] Optional connection.





### Maintenance Switch

If desired, an optional Maintenance Switch (MS) may be incorporated in to the scheme. This switch sometimes is activated by switchgear door movement called door switch. There may be two setting groups in the program. The normal protection settings are achieved in Setting Group 1 (SG1). The other optional setting group, Setting Group 2 (SG2), may be used for reducing arc flash impact purpose during a scheduled maintenance period; therefore, this allows for manual breaker operations only. Automatic transfer and automatic retransfer functions are disabled in maintenance mode. So, in order to have automatic transfer scheme in place, maintenance mode must not be activated. The maintenance mode may be activated by using a maintenance switch (or a switchgear door switch) to turn on Contact Input 14 of each relay. Alternatively, the relay front custom programmable pushbutton 3 (PB03) may be programmed to act as a maintenance switch.

### 43L/R Local/Remote Selection Switch

Contact arrangement of 43L/R Local/Remote Selection Switch is as shown below in Table 5:

**Table 5. 43L/R Switch Selection Table**

OPERATION MODE	LOCAL MODE	REMOTE MODE
Handle Position		
NO Contact 1	X	
NO Contact 2	X	
NO Contact 3	X	

43L/R Switch's NO Contact 1 is wired to 52-1 relay's Contact Input 1 (Terminal F13), NO Contact 2 is wired 52-3 relay's Contact Input 1 (Terminal F13), and NO Contact 3 is wired to 52-2 relay's Contact Input 1 (Terminal F13).

This switch is only needed when local breaker operations are required.

## 5. RELAY FRONT PANEL INTERFACE

There are total seventeen LEDs and three user custom pushbuttons at the relay front panel, arranged as below. Except LED1 and LED4, all other LEDs and all three pushbuttons are user programmable.

**Table 6. LED Labels**

LED1	IN SERVICE	LED8	BREAKER OPEN
LED2	TRIP	LED9	BREAKER CLOSED
LED3	ALARM	LED10	AUX3 STATUS
LED4	PICK UP	LED11	AUX4 STATUS
LED5	TEST MODE	LED12	AUX11 STATUS
LED6	MESSAGE	LED13	AUX12 STATUS
LED7	LOCAL MODE	LED14	AUTO TRF READY

LED "ON" Meaning

**Table 7. LED Status when ON**

LED #	LED LABEL	LED "ON" MEANING
1	IN SERVICE	Relay passed self test and in service (green)
2	TRIP	Relay trip operand operated
3	ALARM	Relay alarm operand operated
4	PICK UP	Relay at least one element is picked up
5	TEST MODE	Relay in test mode
6	MESSAGE	Relay target message detected
7	LOCAL MODE	Breaker manual operation in local mode
8	BREAKER OPEN	Breaker in open state
9	BREAKER CLOSED	Breaker in closed state
10	AUX3 STATUS	Relay Contact output Aux3 status
11	AUX4 STATUS	Relay Contact output Aux4 status
12	AUX11 STATUS	Relay Contact output Aux11 status
13	AUX12 STATUS	Relay Contact output Aux12 status
14	AUTO TRF READY	Scheme auto TRF ready for this relay

Relay custom programmable pushbuttons:  
 PB01, Local breaker manual open command  
 PB02, Local breaker manual close command  
 PB03, Spare

The associated LEDs for PB01 and PB02 are labeled as "OPEN" and "CLOSE", respectively.

## 6. SETTINGS

The following are default setting values in the scheme. These settings should be reviewed and modified carefully according to individual project. The transfer delay timing in main relays need to be modified carefully to match motor relay settings and protection coordination between main, tie relays and feeder/motor relays need to be setup properly. The transfer delay time settings may also need to be coordinated properly with the other automatic transfer schemes if multiple level transfer schemes are employed in the same location. CT, PT ratio and connection groups need to match the real project conditions. They are all users' responsibility to review, coordinate and adjust to meet job specific requirements.

### **System Sensing Settings:**

Normal frequency = 60Hz

Phase rotation = ABC

Frequency tracing = Enabled

Phase PT connection = Wye

Phase PT secondary = 68.6V [Assumed 4160V system]

Phase PT ratio = 35

Aux PT connection = Vab

Aux PT secondary = 118.9V [Assumed 4160V system]

Aux PT ratio = 35 [Assumed 4160V system]

Phase CT primary = 2000A

Ground CT primary = 1A [Assumed no zero sequence CT connected]

### **Control Settings:**

Contact input threshold = 84VDC

43/10 Switch breaker-selected trip delay: 0.2s

Local mode pushbutton 1 breaker manual open command holding time: 0s

Local mode pushbutton 2 breaker close command holding time: 0.5s

Aux UV1 for main relays is used for healthy line voltage set at 0.90pu/1s definite time, minimum 0V

Aux UV2 for main relays is used for transfer initiate voltage set at 0.75pu/1.2s definite time, minimum 0V

Sync check 25 function for main relays 850-1 and 850-2 is set at:

Bus voltage input = J2-3VT

Line voltage input = J2-Vx

Dead source permissive = LL&DB

Live bus minimum voltage = 0.80pu

Live line minimum voltage = 0.80pu

Dead bus maximum voltage = 0.25pu

Dead line maximum voltage = 0.25pu

Maximum voltage difference = 0.10pu

Maximum angle difference = 9degrees

Maximum frequency difference = 0.50Hz

No output relay for sync check 25 signaling

Sync check 25 function for the tie relay 850-3 is set at:

Bus 1 voltage input = J2-3VT

Bus 2 voltage input = J2-Vx

Dead source permissive = DLXDB

Live bus minimum voltage = 0.80pu

Live line minimum voltage = 0.80pu

Dead bus maximum voltage = 0.25pu

Dead line maximum voltage = 0.25pu  
Maximum voltage difference = 0.10pu  
Maximum angle difference = 9degrees  
Maximum frequency difference = 0.50Hz  
No output relay is used for sync check 25 signaling  
Bus residual voltage = 0.25pu

**UV Restoration Settings for 850-1 and 850-2:**

Auto retransfer restore voltage = 0.9pu/1s if enabled  
Auto retransfer synchrocheck supervision = Sync 1 Cls Perm  
Auto retransfer incomplete sequence = 10000minutes if enabled

**Protection Settings:**

Active setting group = 1  
Trigger to other setting group = None

TOC1 function for the main relays 850-1 and 850-2 is set at:  
Trip, 1.05pu, extremely reverse, time dial 1.00, Output relay to trip: Relay 9 (used for 86-1 or 86-2)

IOC2 function for the main relays 850-1 and 850-2 is set at:  
Configurable (block auto transfer only, no tripping), 6.00pu/0s delay/5s drop off

TOC1 function for the tie relay 850-3 is set at:  
Trip, 1.05pu, extremely reverse, time dial 0.50, Output relay to trip: Relay 9 (used for 86-3)

NTOC1 function for the main relays 850-1 and 850-2 is set at:  
Trip, 1.05pu, extremely reverse, time dial 1.00, Output relay to trip: Relay 9 (used for 86-1 or 86-2)

NTOC1 function for the tie relay 850-3 is set at:  
Trip, 1.05pu, extremely reverse, time dial 0.5, Output relay to trip: Relay 9 (used for 86-3)

59\_2 negative sequence overvoltage function is enabled for main relays and is set at:  
Trip, 0.25xVT, 0.5s, Output relay to trip: Relay 9 (used for 86-1 or 86-2 for phase reversal or loss)

All current and voltage elements related settings mentioned above are resided in Setting Group 1 and all other protection elements are disabled. No maintenance switch related connection and settings.

**Communications Settings:**

850-1 main breaker 1 relay default IP address= 192.168.xxx.101  
850-2 main breaker 2 relay default IP address= 192.168.xxx.102  
850-3 tie breaker relay default IP address= 192.168.xxx.103  
Default subnet mask= 255.255.255.0  
Default gateway= 192.168.XXX.254  
Default slave address for each relay= 254  
RS485 port setting= 115200, none, Modbus

Relay factory default values are all kept for all other settings not mentioned above.

## 7. TRANSFER SCHEME SETUP

The GE 3X850 transfer scheme can be set to both auto transfer and auto retransfer. Auto retransfer is optional.

A break-before-make open-transition auto transfer is initiated by any of the following two triggers:

1. Undervoltage. When voltage from one of the line sources drops down lower than the main relays Aux UV 2 setting threshold and time delay while the other source is healthy and no fault in the system.
2. 86T (transformer lockout). When 86T from one of incoming lines energizes while the other source is healthy and no fault in the system.
3. 86L (Source lockout 94). When 86L from one of incoming lines energizes while the other source is healthy and no fault in the system.

86L1 (86L on Source 1 side) or 86L2 (86L on Source 2 side) may be energized by any of the following or combination of them: Upstream breaker trip, upstream overcurrent protection operated, emergency trip.

86T1 (86T on Source 1 side) or 86T2 (86T on Source 2 side) may be energized by any of the following or combination of them: Transformer sudden pressure, transformer temperature second level high, transformer liquid second level low, transformer differential element operated, transformer neutral/ground overcurrent element operated.

If 86T is driven by 87T as an automatic transfer trigger, the location of the CT on the transformer low side needs to be carefully considered. Improper CT location on the transformer low side may cause auto transfer into a fault situation. Refer to the drawing below for an explanation on how transformer low side CT at Source 1 side of CT makes an impact.

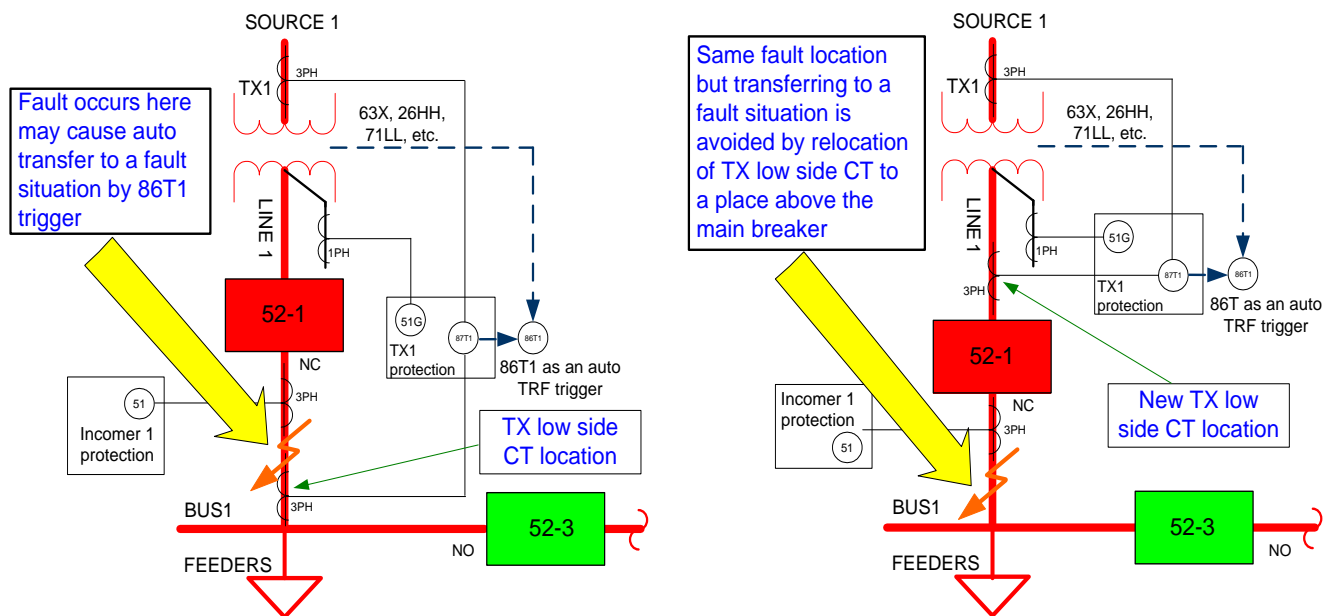


Figure 2. Transformer Low Side CT Placement

An optional auto retransfer is a make-before-break closed-transition process initiated by previously lost incoming source returns back to normal while no fault in the system and the other source is healthy. When previously lost main incoming source returns back to normal, the currently open main breaker closes first and then the tie breaker opens.

Indication of auto transfer ready is by Output 16 of each MAIN relay.

Tripping from each relay goes to Contact Output Aux9 of each relay and is supposed to be used to drive an 86 lockout switch to trip its corresponding breaker and block it from closing.

An optional 43L/R Local/Remote Selection Switch may be set to suit the application for local mode breaker operations. Local is defined as the two breaker operation pushbuttons (PB01 for open and PB02 for close) built in the relay front operation panel. Remote is defined as the breaker operation commands going through the relay contact inputs or through communication Modbus protocol. A physical local/remote switch may be needed in the switchgear for this purpose and connect its contact in each Relay's Contact Input 1 as indicated in Table 5 earlier.

## **8. DOUBLE SOURCE LOSS SITUATION**

- In Case of Two Incoming Sources Get Lost at the Same Time When Blocking is Disabled

In case both incoming sources get lost at the same time while the two main breakers are closed, both main breakers would open.

If two incoming sources recover at the same time, both main breakers will get closed.

In the event of a double source loss two main breakers will get open if the tie breaker was open or stay in their current states if the tie breaker was closed.

- In Case of Two Incoming Sources Get Lost at the Same Time When Blocking is Enabled

In case both incoming sources get lost at the same time, both the breakers will remain in the same state as they were when they lost the power.

If two incoming sources recover at the same time, both main breakers will remain in their current state.

- In Both Cases

Unless specifically requested, the transfer scheme will be set to auto retransfer disabled.

Regardless of definite time or inverse time, it is recommended that the Aux UV2 delay be set to 200ms more than the time delay for Aux UV1 to ensure that the double source loss blocking works properly.

## 9. LIVE SOURCE SEEKING LOGIC

The Live Source Seeking (LSS) logic described below is only available when the optional auto retransfer is enabled. The following description assumes that auto transfer is enabled.

- **In Case of Two Incoming Sources Get Lost at the Same Time & Blocking is Disabled**

When a double source loss situation happens at a normal condition, two main breakers will get open.

If two incoming sources return back at the same time, two incoming breakers will get closed at the same time.

If one of the two incoming sources returns back first, an automatic transfer will execute to transfer the load from its bus to the healthy source.

If another incoming source comes back later, an automatic retransfer will occur to get another main breaker closed first and then to get the tie breaker open.

- **In Case of Two Incoming Sources Get Lost at Different Time**

A live source seeking logic is included in the transfer scheme that allows the load automatically be recovered to the first returning-back healthy incoming source, and then back to normal two sources by an automatic retransfer operation if the second incoming source comes back later.

For example, if Source 2 gets lost first, resulting in 52-2 open and 52-3 closed by an automatic transfer operation, then Source 1 gets lost at a later time, 52-1, at this time, will remain closed because it has nowhere to transfer its load to. Depending on which source returns back first, the live source seeking logic will perform the following operation:

---When Source 1 returns first and Source 2 returns second

When Source 1 comes back first, 52-1 will remain closed to get the entire load fed by Source 1. After that when Source 2 comes back later, an automatic retransfer will occur resulting in 52-2 closed and 52-3 open if automatic retransfer is enabled. Everything is back to normal.

---When Source 2 returns first and Source 1 returns second

When Source 2 comes back first, 52-1 will open and 52-2 will be closed (This means shifting the entire load from Source 1 to Source 2 automatically). After that when Source 1 comes back later, an automatic retransfer will occur resulting in 52-1 closed and 52-3 open if automatic retransfer is enabled. Everything is back to normal.



## 10. 43/83 TRANSFER MODE SELECTION SWITCH

A two-position 43/83 Transfer Mode Selection Switch is used for operators to set at what transfer mode the scheme should be set at. When the 43/83 Switch is set to AUTO position, it allows breaker manual and auto operations. When the 43/83 Switch is set to OFF position, it allows breaker manual opening operations only but does not allow breaker manual closing and any auto operations. This means the transfer function is blocked. It is important to note that manual operations cannot be separated from the auto operations by the current automatic transfer scheme logic design.

43/83 Transfer Mode Selection Switch

Table 8. 43/83 Transfer Mode Selection Switch Table

TRF MODE SELECTION	OFF (BLOCK TRF ON)	AUTO (BLOCK TRF OFF)
Handle Position	↙	↑
NO Contact 1	X	
NO Contact 2	X	
NO Contact 3	X	

43/83 Switch's NO Contact 1 is wired to 52-1 relay's Contact Input 11 (Terminal G16), NO Contact 2 is wired 52-3 relay's Contact Input 11 (Terminal G16), and NO Contact 3 is wired to 52-2 relay's Contact Input 11 (Terminal G16).

When needed, a user may use a third position of "BYPASS" to combine it into the switch to make a three-position 43/83 switch. In bypass mode breakers are operated by direct hardwire connections to the breaker closing and tripping coils; therefore, this bypasses the relay internal logic. If the bypass mode has to be set, all three relays must be set to the bypass mode at the same time. The bypass mode may be used in situations when the relay fails to produce correct logical breaker operations, but the protection features from other relays are still in place.

**NOTE: In the bypass mode, voltage permissive and sync check functions for breaker closing operations are no longer in place; therefore, closing a breaker in the bypass mode may pose great danger, and extreme caution should be taken while operating breakers in this mode. While in this mode there is also potential to have the undesired result of three breakers closed at the same time. Due to the loss of system protection, bypass mode should not be used if a relay has experienced a total failure. In this case, before the affected relay is repaired /replaced and scheme fully tested, the scheme should not be in service.**

Due to the above reasons, the use of a bypass/normal switch is not a recommended practice in the scheme, but may be incorporated in relay hardwire connection drawings per each customer's specific request. It would be customer's full responsibility for breaker operations while in the bypass mode.

As a good practice, it is recommended that all three relays be set in the same transfer mode, either all OFF or all AUTO, all local or all remote. This will alleviate unnecessary confusion or complication on the part of the operator that may arise from inconsistent selection.

Operators need to be aware that although the Transfer Mode Switch is placed to "AUTO" position, it does not mean the automatic transfer and/or automatic retransfer feature is actually enabled. All of the other necessary conditions must be completely met.

## 11. 43/10 SWITCH OPERATIONS

A regular physical three-position maintained 43/10 Switch, usually mounted on the switchgear door, is incorporated in the program and is used to let an operator to set which racked-in breaker is selected to trip when three racked-in breakers are closed at the same time in breaker manual operations. 43/10 Switch assisted breaker operations are used to aid manual make-before-break closed-transition load transfers without power interruption. After manually closing a currently-open racked-in breaker where the other two racked-in breakers are already closed, the selected-to-trip breaker will open after a short time delay of parallel two sources together. When three racked-in breakers are closed at the same time, two incoming transformers, or two incoming lines, are paralleled together that cause the short circuit current magnitude doubled if a fault occurs at a feeder side during that time. The increased short circuit current may exceed the breaker interrupt rating. For this reason, the paralleling time should be set as short as possible. Refer to section 6 for the default setting value for this parameter. The switch should be wired as below:

### Three-Position 43/10 Switch

**Table 9. Three-Position 43/10 Switch Table**

BREAKER TRIP SELECTION	TRIP 52-1	TRIP 52-3	TRIP 52-2
Handle Position	↙	↑	↗
NO Contact 1	X		
NO Contact 2		X	
NO Contact 3			X

43/10 Switch's NO Contact 1 is wired to 52-1 relay's Contact Input 6 (Terminal F18), NO Contact 2 is wired 52-3 relay's Contact Input 6 (Terminal F18) with a tie breaker status 52a as the permissive between them, and NO Contact 3 is wired to 52-2 relay's Contact Input 6 (Terminal F18).

The scheme is also programmed in a way that when any two racked-in breakers are already closed and the associated 43/10 Switch is selected to trip the third racked-in and currently-open breaker, the close command for closing the currently-open third breaker is blocked inside the logic and cannot go through to the breaker closing coil. This prevents the third breaker from receiving a close and an open command at the same time causing excessive breaker operations.

## 12. SYNC CHECK

When breakers are racked in, the closing command for each breaker is supervised by their associated voltage permissive and sync check conditions, either for manual or auto operations.

Sync check 25 function for breakers 52-1, 52-3, and 52-2:

Sync check 25 function for breakers 52-1, 52-3, and 52-2 is passed when both sources across the breaker are alive and meet the 25 default setting parameters described in Section 4. The breaker closing command is blocked if the related two sources across the breaker are both alive but not synced together within the preset limits.

For each main breaker, 52-1 or 52-2, sync check is also passed when its associate line source is alive and its associated bus source is dead as voltage permissive condition to prevent voltage from feeding back to the system.

For each main breaker, 52-1 or 52-2, closing command is blocked when its associate line source and its associate bus source are both dead, or when its associate line source is dead and its associated bus source is alive.

For the tie breaker 52-3, sync check is also passed when one of its associate bus sources is live and the other bus source is dead. The breaker 52-3 closing command is blocked when both buses are dead.

This can be described as a 2/3 rule summarized in the following table, i.e. for main breakers, 2 conditions would allow each main breaker be closed but three conditions would block each main breaker from closing; for the tie breaker, 3 conditions would allow the breaker be closed but two conditions would block it from closing.

**Table 10. Sync-Check 2/3 Rule**

Condition\Breaker	Main Breaker 52-1 or 52-2	Tie Breaker 52-3
Allow Breaker Closing	Live Line & Live Bus & In Sync	Live Bus 1 & Live Bus 2 & In Sync
	Live Line & Dead Bus	Live Bus 1 & Dead Bus 2
		Dead Bus 1 & Live Bus 2
Block Breaker Closing	Live Line & Live Bus & Out of Sync	Live Bus 1 & Live Bus 2 & Out of Sync
	Dead Line & Dead Bus	Dead Bus 1 & Dead Bus 2
	Dead Line & Live Bus	

### 13. PROTECTION AND 86 LOCKOUT SWITCH FUNCTIONS

Protection elements inside of each 850 relay may be used to drive Contact Output 9. Consequently, it energizes an 86 lockout switch (86-1 for incomer 1 breaker circuit, 86-2 for incomer 2 breaker circuit and 86-3 for tie breaker circuit) to trip its associated breaker and block it from closing. These protection elements could be phase, neutral or ground overcurrent, either instantaneous or timed, 59-2 elements or others if needed. 86-3 lockout switch may not be needed if dedicated bus differential relays are used in junction with the scheme. The following explains the typical setup for 86 switches used in junction of an automatic MTM transfer scheme.

Functions of 86 lockout switches in MTM configuration:

- 86-1 and 86-2
  - Driven by overcurrent element in the associated main relay
  - Trip the associated main breaker
  - Block the associated main breaker and tie breaker from closing
  - Disable automatic transfer function
- 86-3
  - Driven by overcurrent element in tie relay
  - Trip tie breaker and block two main breakers from closing
  - Disable automatic transfer function
- 86T1 and 86T2 (only when needed. They are also called transformer lockout relays.)
  - Trip the associated main breaker
  - Block the associated main breaker from closing
  - Trigger automatic transfer
- 86B1 and 86B2 (when dedicated bus differential relays are equipped in the switchgear)
  - Trip every breaker in the zone and block them from closing
  - Disable automatic transfer
- 86L1 and 86L2 (only when needed, usually from the upstream switchgear with 86F designations. They are also called as source trip 94)
  - Trip the associated main breaker
  - Block the associated main breaker from closing
  - Trigger automatic transfer

Quantities of 86 lockout switches for a typical MTM configuration:

Without dedicated bus differential relays:

FUNCTION \ BREAKER	52-1	52-3	52-2
Overcurrent	86-1	86-3	86-2
Transformer fault	86T1		86T2
Upstream fault [1]	86L1		86L2

With dedicated bus differential relays:

FUNCTION \ BREAKER	52-1	52-3	52-2
Overcurrent	86-1		86-2
Transformer fault	86T1		86T2
Bus fault	86B1[2]		86B2[2]
Upstream fault [1]	86L1		86L2

[1] Only when needed; 86L1 and 86L2 normally are mounted on the upstream switchgear with feeder 86F designations.

[2] They can be mounted anywhere in the switchgear, do not necessarily have to be mounted in 52-1 and 52-2 cubicle location.

#### **14. BREAKER OPERATIONS AT TEST POSITION**

By switchgear wiring arrangement, any breaker may be operated in its test position without disturbing the operations of the other two racked-in breakers. Breaker operations in its test position should only be performed by using CS/C and CS/T contacts of the control switch mounted on the switchgear. Relay pushbuttons PB01 and PB02, as well as remote points, should not be used and are not programmed for any breaker operations in breaker test position. Wiring arrangement should, and must, be made in such a way that when a breaker is in its test position, its associated TOC contact must be closed, any 86 contacts where they are wired in the breaker closing circuit in order to block closing is bypassed and the associated CS/C and CS/T contacts are connected to the breaker closing and opening coil directly.

The scheme is pre-programmed in a way that when any breaker is in its test position, closing the breaker from CS/C will bypass its internal voltage permissive condition and bypass the sync check function for that particular breaker. In order to avoid possible production loss when doing a breaker test, 43/10 Switch logic is also disabled inside the scheme logic so it will not cause one of the other racked-in and closed breakers to trip after a CS/C command is issued for currently open and at-test-position breaker.

## **15. DEFINITION OF NORMAL CONDITION**

The system normal is defined as the following conditions are all met at the same time:

- Both incoming sources have balanced healthy voltages.
- Two main breakers, 52-1 and 52-2, are racked in and closed.
- The tie breaker, 52-3, is racked in and open.
- The operation is set as remote mode.
- No 86 lockout switch is activated.
- No Bell Alarm is activated (only for LV breakers equipped with trip unit).
- No fault exists in the system.

## **16. DESCRIPTION OF OPERATIONS**

The Main-Tie-Main transfer scheme proposed here provides manual, automatic transfer and automatic retransfer breaker operations. All three breakers must be racked in except operations of breakers at breaker test position described in Section 14.

Transferring the load manually from two sources to a single source can be performed either by an open-transition or a closed-transition operation manually. Open-transition is similar to normal manual breaker operations. This is achieved by opening one of the main breakers first then closing the tie breaker either through the relay front-panel pushbuttons or breaker control switches on the switchgear. A more desirable operation is to perform a closed-transition manual transfer operation by using PB02 on the tie breaker relay, or the tie breaker's CS/C mounted on the switchgear; therefore, the tie breaker closes first, and after it gets closed, one of the previously selected to trip and currently closed main breakers will open. No load loss will occur when the above described closed-transition manual transfer operation is used.

Transferring the load manually from one source back to two sources can also be performed either by an open-transition or a closed-transition operation manually. Open-transition is similar to normal manual breaker operations. This is achieved by opening the tie breaker first, and then closing the racked-in and currently open main breaker either through the relay front-panel pushbuttons, or breaker control switches on the switchgear. A more desirable operation is to perform a closed-transition manual retransfer operation by placing the 43/10 Switch to trip the tie breaker position and using PB02 on the main breaker relay, or the main breaker control switch's CS/C mounted on the switchgear. After the racked-in and currently open main breaker is closed, the tie breaker will open. No load loss will occur when the above described closed-transition manual retransfer operation is used.

The automatic transfer scheme described in this document provides complete control logic for automatic transfer and automatic retransfer via automatic breaker operations with protection elements in place. If all automatic transfer conditions are met and automatic transfer is enabled, upon receiving one of preset automatic transfer triggers from one of the incoming sources, the scheme automatically transfers the load through an open-transition operation to the other healthy source by opening the related main breaker first and then closing the tie breaker. The available preset triggers are three-phase voltage loss, or the phase(s) the actual line PT connected to, on one of the incoming lines, optional 86T or 86L, or both, connected to main relay's contact input. If automatic retransfer is also enabled and all automatic retransfer conditions are met, it also provides an automatic, hot-bus, synchronization supervised closed-transition retransfer operation after the previously lost main source is recovered by automatically closing the currently open main breaker first and then opens the tie breaker accordingly.

Automatic retransfer is optional. It can be enabled by setting appropriate parameters in the voltage restoration section of the two main relays. Automatic retransfer can only be achieved when an automatic transfer happened first with all other required conditions are met. It cannot get a manually opened main breaker back to close state when its associated line voltage comes back to normal. Auto retransfer would only occur during the period from the moment at accomplish of a successful auto transfer to the time specified by auto restoration incomplete sequence time. If at the moment when line voltage comes back but auto restoration incomplete sequence time has been already expired then a manual breaker operation is needed to restore system to normal condition.

As an enhanced safety feature, the switchgear wiring should be arranged in such a way that an open breaker command from its associated breaker control switch should neither be supervised by transfer mode switch status nor supervised by local/remote status.



## 16.1 Breaker Manual Operations

The Transfer Mode Switch 43/83 must be placed to "AUTO" position.

### Breaker Manual Operations at Breaker Racked-in Position

The main breakers and the tie breaker can be manually closed by using the PB02 pushbutton by press and hold it to a certain amount of time specified in Section 6 on the relay front-panel when scheme is set to local mode, or through each breaker's associated CS/C of breaker control switch mounted on the switchgear when scheme is set to remote mode.

Any breaker can be opened anytime in any mode through its associated CS/T of the breaker control switch mounted on the switchgear. Any breaker can also be opened anytime in local mode through the custom configurable pushbutton PB01 at its associated relay front panel.

The following describes how breakers are manually operated and under what conditions the operations can go through:

#### Main Breaker Manual Close Operation:

Step 1. Ensure the correct main breaker is in need to be closed.

Ensure the main breaker is racked in.

Ensure closing the selected breaker is not going to affect the other breakers' normal operation. It is important to remember that closing a racked-in main breaker may cause another breaker to open if the tie breaker and the other main breaker are both racked in and closed.

Step 2. Place the Transfer Mode Switch to "AUTO" position.

Step 3. Initiate closing of the main breaker by doing any of the following:

- On the main breaker relay, in local mode, using the PB02 pushbutton by press and hold it to a certain amount of time specified in Section 6 on the relay front-panel on the selected main breaker relay.
- On the main breaker relay, in remote mode, momentarily turn its related breaker control switch to CLOSE position.

The logic will verify that 52-1, or 52-2, has not tripped due to a fault, and no external blocking signals exist, and any one of the following voltage permissive and sync check conditions is present:

- Its related source has voltage and its value is higher than the preset healthy voltage threshold and its related bus voltage is less than the preset minimum bus threshold.
- Both source and bus have voltages and are synced together.

Step 4. The main breaker will then close.

#### Tie breaker Manual Close Operation:

Step 1. Ensure closing the tie breaker is not going to affect the other breakers' normal operation. It is important to remember that closing the racked-in tie breaker may cause one of the previously selected-to-trip racked-in main breakers to open if both main breakers are racked in and closed.

Ensure the tie breaker is racked in.

Step 2. Place the Transfer Mode Switch to "AUTO" mode.

Step 3. Initiate closing of the tie breaker by doing any of the following:

- On the tie breaker relay, in local mode, press and hold pushbutton PB02 for a certain amount of time specified in Section 6 on the tie breaker relay.
- On the tie breaker relay, in remote mode, momentarily turn its related breaker control switch to CLOSE position.

The logic will verify that 52-3 has not been tripped due to a fault, no external blocking signals are exist, and any one of the following voltage permissive and sync check condition is present:

- Bus 1 and Bus 2 both have voltages and are in synchronism.
- Bus 1 has voltage, and Bus 2 has no voltage.
- Bus 1 has no voltage, and Bus 2 has voltage.

Step 4. The tie breaker will then close.

### **Main and the Tie Breaker Manual Open Operation:**

Step 1. Ensure the correct breaker is in need to be opened.

Step 2. Initiate opening of the breaker by doing any of the following:

- Momentarily press pushbutton PB01 on the selected breaker relay when in local mode.
- Momentarily turn its related breaker control switch to TRIP position.

Step 3. The breaker will then open.

### **Manual Transfer Operations**

All breakers must be racked in and the Transfer Mode Switch 43/83 must be placed to "AUTO" position.

The load may be manually transferred via a closed-transition through 43/10 Switch assisted operations or an open-transition operation.

### **Closed-Transition Manual Transfer**

A closed-transition manual transfer may be performed as follows:

Step 1. Use the physical 43/10 Switch mounted on the switchgear to select which racked-in main breaker is going to trip after the currently open and racked-in tie breaker closes (the other racked-in breakers remain closed). Only one main breaker can be selected at a time. Selecting one main breaker to trip will automatically deselect the other main breaker.

Step 2. Initiate closing of the tie breaker by press and hold pushbutton PB02 for a certain amount of time specified in Section 6 on the tie breaker relay in local mode. Or, in remote mode, closing the tie breaker by turning its associated breaker control switch to CLOSE position.

The logic will verify that 52-1, 52-2 and 52-3 have not tripped due to a fault and the corresponding line and bus both have voltages and are in synchronism.

Step 3. The tie breaker will then close, and the main breaker that was previously selected to trip will open.

### **Open-Transition Manual Transfer**

An open-transition transfer may be performed as follows:

Step 1. Open 52-1 or 52-2 by either pressing pushbutton PB01 in local mode on the appropriate relay or turning the breaker control switch to TRIP on the appropriate main breaker.

Step 2. Initiate closing of 52-3 by using either PB02 on the tie relay when in local mode or turning the tie breaker control switch to CLOSE in remote mode.

The logic will verify that 52-3 has not tripped due to a fault and that either of the following conditions is present:

- Bus 1 has voltage, and Bus 2 has no voltage.
- Bus 1 has no voltage, and Bus 2 has voltage.

Step 3. The tie breaker 52-3 will then close.

## Manual Retransfer Operations

To restore the system back to normal operation configuration with both 52-1 and 52-2 closed and 52-3 open, either a closed-transition or an open-transition manual retransfer can be performed.

### Closed-Transition Manual Retransfer

A closed-transition manual retransfer may be performed as follows:

Step 1. Verify two incoming sources have balanced healthy voltage, the tie breaker is racked in and closed, one racked-in main breaker is open and the other racked-in main breaker is closed.

Step 2. Using either the physical 43/10 Switch to select the tie breaker as the breaker to trip when all three racked-in breakers are closed at the same time.

Step 3. Initiate closing of the currently open rack-in main breaker by pressing and hold pushbutton PB02 to a certain amount of time specified in Section 6 on the main breaker relay in local mode or turning the main breaker control switch to CLOSE in remote mode. The logic will verify that the main breaker has not tripped due to a fault and the following condition is present:

- The associated source and the associated bus have voltages and are in synchronism.

Step 3. The currently open and racked-in main breaker will close, and then the tie breaker will open.

### Open-Transition Manual Retransfer

An open-transition manual retransfer may be performed as follows:

Step 1. Open 52-3 by either pressing PB01 on the tie breaker relay or turning the tie breaker control switch to TRIP.

Step 2. Initiate closing of 52-1 or 52-2 by pressing and holding pushbutton PB02 for a certain amount of time specified in Section 6 on the main breaker relay in local mode or turning the tie breaker control switch to CLOSE in remote mode. The logic will verify that 52-1, 52-2 or 52-3 has not tripped due to a fault and that the following condition is present:

- The associated source has voltage, and the associate bus has no voltage.

Step 3. The main breaker 52-1 or 52-2 will then close

## 16.2 Automatic Transfer Operations

The 43/83 Transfer Mode Switch must be placed to "AUTO" position to set the scheme in auto mode.

### Automatic Transfer Ready and Automatic Transfer Enable

Automatic transfer will occur, when one of the automatic transfer triggers comes, only when the automatic transfer function is ready and enabled.

Automatic transfer function can only be enabled after all the following automatic transfer conditions are met, which can be verified by observation of the TRF READY output of Aux16 of the all three relays are closed. The output will be turned on for each relay when the following conditions are all met.

For Incomer 1 main breaker relay,

- The "Incomer 1" setting is selected under the TRANSFER FUNCTION setpoint
- The transfer scheme is not blocked from the "Block Transfer" input
- Tie Breaker is racked-in
- Incomer 1 Breaker is racked-in and closed
- Incomer 2 Breaker is racked-in and closed

- No transformer lockout 86T1 or source trip 86L1 is present
- No undervoltage is detected on any of the two sources
- No faults on the load side of the circuit breaker.

For incomer 2 main breaker relay,

- The “Incomer 2” setting is selected under the TRANSFER FUNCTION setpoint
- The transfer scheme is not blocked from the “Block Transfer” input
- Bus Tie Breaker is racked-in and open
- Incomer 1 Breaker is racked-in and closed
- Incomer 2 Breaker is racked-in and closed
- No transformer lockout 86T2 or source trip 86L2 is present
- No undervoltage is detected on any of the two sources
- No faults on the load side of the circuit breaker.

For tie breaker Relay,

- The “Bus Tie” setting is selected under the TRANSFER FUNCTION setpoint
- The transfer is not blocked from the “Block Transfer” input
- Bus Tie Breaker is racked-in and open
- Incomer 1 breaker is racked-in and closed
- Incomer 2 breaker is racked-in and closed.

It is recommended to serially connect these three outputs together to drive a common light or annunciator as an overall indication of auto transfer is enabled/disabled status.

### **Automatic Transfer Initiation**

Automatic transfer is initiated when all of the following conditions are true:

- Automatic transfer function is ready and enabled.
- Affected main breaker is closed and racked in at the time when one of the automatic transfer triggers comes from the associated incoming source.
- The other incoming source has healthy voltage and the main breaker for the other incoming source is closed and racked in.
- The tie breaker is open and racked in.

And with any one of the automatic transfer triggers comes:

- The voltage on an incoming source, either three-phase voltage loss, or the phase(s) the actual line PT connected to, on one of the incoming lines falls below the transfer initiate voltage threshold for a period of time defined by a preset time delay setting and the loss of voltage is not caused by blocking overcurrent element pick up for incoming line.
- (Optional) 86T or 86L on the main breaker relay trips

In addition to trip the transformer low side breaker, 86T should always trip the transformer high side breaker also, this can be done by hard wiring or through additional GOOSE message communication to the transformer high side relay (not in transfer scheme scope. A different 850 relay order code and additional programming are needed).

### **Automatic Transfer Execution**

When automatic transfer is initiated, the affected main breaker opens first and sends an automatic transfer initiate signal to the other relays. The automatic transfer signal is sealed-in by the main breaker logic until the automatic transfer process is finished, an automatic retransfer signal occurs or the automatic transfer scheme is disabled. This prevents repeated attempts at a transfer process.

Upon receipt of the automatic transfer initiate signal, the tie breaker closes if all of the following is true:

- 52-1 is open and the voltage on Bus 1 below the Residual Bus Voltage setting;

Or

52-2 is open and the voltage on Bus 2 below the Residual Bus Voltage setting;

- Automatic transfer scheme is enabled.
- A predefined automatic transfer time delay has expired.

If an automatic trigger returns after the affected main breaker opens but before the tie breaker closed, the tie breaker will not be closed. The result is the other main breaker with the healthy source remains closed, but the other two breakers are open. If this happens, operator needs to set the scheme back to manual transfer mode and then close the currently opened tie breaker manually.

### **Automatic Retransfer Ready and Automatic Retransfer Enable**

Automatic retransfer of the load from one source back to two normal sources can be enabled and disabled by turning on or off voltage restoration feature in the main relays. Unless specifically requested, the transfer scheme will be set to auto retransfer disabled. In order to be able to enable automatic retransfer function, the automatic transfer function must be enabled first. When automatic retransfer function is enabled, the load will automatically be retransferred back to two normal sources after the previously lost source voltage is recovered and a predefined auto retransfer time delay has expired. The automatic retransfer feature is only available during the period from the moment of automatic transfer is successfully executed to auto retransfer incomplete sequence time programmed in the main relays.

If automatic retransfer function is disabled, the load remains connected through the tie breaker after an automatic transfer but it does not retransfer back to two normal sources automatically when the previously lost source gets restored for a period of time set by the program. In this case, it must be retransferred back through manual breaker operations.

Automatic retransfer function is in place when all of the following conditions are true:

- All breakers are racked in.
- Automatic retransfer function is enabled and properly configured.
- An automatic transfer function happened before; resulting in one of the main breakers to open and its associate source is lost, the tie breaker is closed and the other main is closed with healthy source.

Automatic retransfer function is disabled if automatic transfer function is disabled or when the tie breaker is closed manually. This prevents automatic retransfers from occurring with repeat attempts if the buses have been intentionally tied by closing the tie breaker.

### **Automatic Retransfer Initiation and Execution**

If automatic retransfer function is enabled, the scheme will perform a closed-transition automatic retransfer of the load from a single source back to two normal sources by allowing the currently open and racked-in main breaker to be closed first. The racked-in tie breaker is then forced to open after a preset short time delay when both racked-in main breakers and the racked-in tie breaker are closed simultaneously.

A main breaker can automatically be closed in an automatic retransfer process if all of the following conditions are true:

- All three breakers are racked in.
- Automatic retransfer function is enabled.
- The currently racked-in open main breaker was opened earlier by an automatic transfer process.
- Three phase voltage on the associated source has been healthy for a predefined time delay.
- The tie breaker is closed.

- The tie breaker has not detected a fault on the bus.
- The bus has normal voltage and is in synchronism with the source.

After the currently open main breaker is closed first, the tie breaker will then open after a preset short time delay.

## 17. METERING

Metering information can be accessed at the relay front-panel or through a relay communication port with an appropriate available communication protocol provided from the relay. The scheme provides the following metering information.

### **For each incoming line, Line 1 and Line 2:**

(Access from the main breaker relays)

- Current: magnitude and angle for each phase, current values for zero sequence, positive sequence and negative sequence
- Voltage: magnitude and angle for the phase that the bus PT is connected to.
- Power: each phase and three-phase values of P, Q and S
- Power factor: each phase and three-phase values
- Frequency

### **For Bus 1:**

(Access from the tie breaker relay)

- Current: magnitude and angle for each phase, current values for zero sequence, positive sequence and negative sequence
- Voltage: magnitude and angle for each phase, voltage values for zero sequence, positive sequence and negative sequence
- Power: each phase and three-phase values of P, Q and S
- Power factor: each phase and three-phase values
- Frequency

### **For Bus 2:**

(Access from main 2 breaker relay)

- Voltage: Voltage: magnitude and angle for each phase, voltage values for zero sequence, positive sequence and negative sequence
- Frequency

Refer to the specific relay brochure or manual (not included in this document) for the accuracy of each piece of metering information the relays provide.

## **18. CONVERTING SR750/SR760 RELAY FILES TO 850 RELAY FORMAT**

A conversion tool is provided in GE 8Series setup program to let users conveniently to convert a previously programmed GE SR relay setting file to an 8Series relay setup program format. Refer to GE 850 Instruction Manual's Offline Settings File Conversion section for the details of how to use this tool with needed steps and attention.

To be specific for automatic transfer scheme related applications, cautions must be taken for the following:

1. After conversion, the following parameters need to be manually inputted or adjusted:  
Programmed LEDs  
Programmed pushbuttons  
Reassign breaker 52a, 52b (if needed) and breaker connect position TOC contact  
IP address  
All parameters in Bus Transfer section if the original file has auto transfer enabled
2. It is important to note, if an original SR750/SR760 setting file does not have transfer scheme enabled, the converted 850 relay file will not show "Bus Transfer" section at in the 850 relay setup program. In this case, it has to be created from beginning.
3. Since 850 relay automatic transfer scheme considers breaker connect/disconnect position (usually by TOC contact of each involved breaker), if an original SR750/SR760 transfer scheme setting is based on Scheme 1, user needs to be aware the new scheme takes TOC account into consideration. The contact input to reflect TOC status must be correctly setup.
4. In SR750/SR760 transfer scheme, automatic retransfer feature is enabled by setup as "Control" in UV restoration function; the converted file will show "Configurable" in 850 relay setup program as an equivalent to "Control" in SR/750/SR760. However, the correct setup for automatic retransfer enabling feature in 850 relay is "Close" in UV restoration function. User needs to make a manual adjustment.
5. It may not be necessary but would be a good idea, after conversion, all CT, PT ratios, protection and sync check elements should be verified for setting accuracy to meet the project specific requirements.



## 19. TRANSFER SCHEME SCOPE

- The two incoming sources from Line 1 and Line 2 are always of three phase balanced systems, no single or two phasing voltage coming from the upstream sources.
- Third voltage source is not considered in transfer scheme work.
- Relay coordination work related to the upstream and feeder/motor protection devices as well as related coordination of the main breaker and the tie breaker is out of the transfer scheme scope.
- Work related to relay communication and integration, including DCS, is out of the transfer scheme scope.
- Work related to load shedding for feeder/motor breakers/contactors is out of the transfer scheme scope.
- Work related to event setup and waveform trigger is out of the transfer scheme scope.
- Work related to custom target setup is out of the transfer scheme scope.
- Any special setup or logic development not related to transfer scheme requirement is out of the transfer scheme scope.

## **20. USER RESPONSIBILITY**

It is the users' responsibility to:

- Verify if the default values are acceptable. If not, provide appropriate setting values 3 weeks before FAT date.
- User may provide their own relay protection settings based on user relay coordination study results or other system operation scenarios before factory testing or user may load the relay settings themselves during commissioning. However, these settings must not conflict with the transfer program described in this document.
- User may write a specific plant operation procedure based on their final relay settings and their own operation guidelines. The project FAT procedure in associated with this document may be used as a reference or a guideline but should not be used as a direct replacement of the plant operation procedure. However, the plant procedure must not conflict with the described MTM transfer program in this document.
- Properly select all needed components and wire all connections correctly in the MTM involved switchgear.