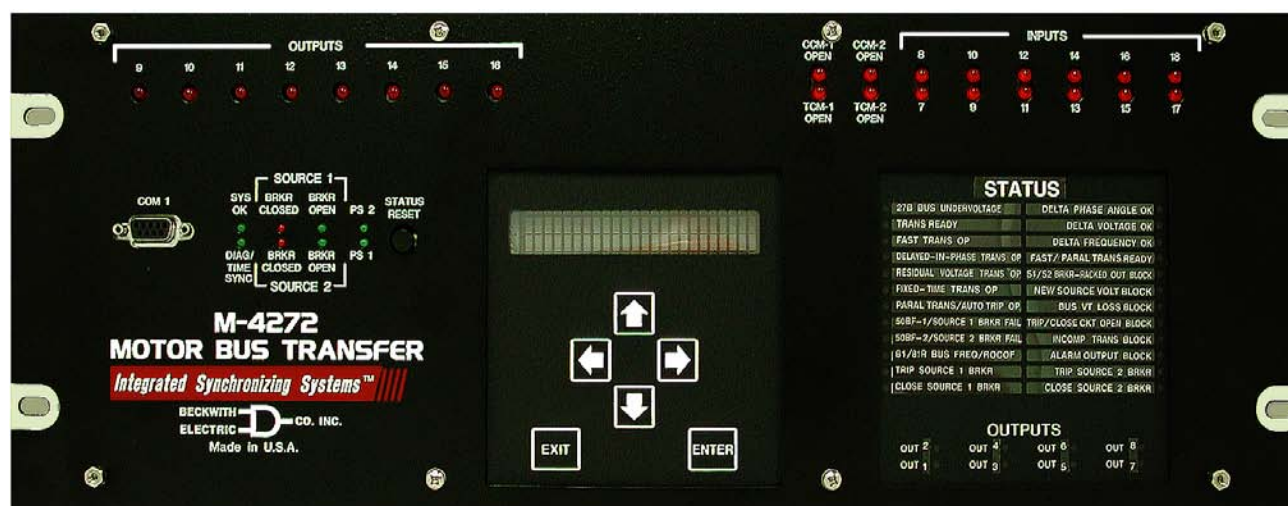# Digital Motor Bus Transfer System M-4272

Integrated Synchronizing System™

- **Provides Automatic and Manual transfers of motor bus systems in power plants and industrial processing plants to ensure process continuity**

- **Automatically selects Fast, Delayed In-Phase, Residual Voltage, and Fixed Time motor bus transfers, based on varying system conditions**

- **Applicable for one way and bi-directional Manual and Automatic transfers**

- **Can be expanded to accomodate multiple breaker configurations**

- **Multiple setpoint profiles for various application requirements**

- **Integrated control, supervisory functions, sequence of events, and oscillograph recording in one device**

- **Extensive commissioning tools, including ringdown analysis**

Standard Features

Automatic Transfer: The digital Motor Bus Transfer System (MBTS) provides the following Automatic Transfer logic and features:

- Transfer initiated by protective relay external to the MBTS
- Automatic Transfer after a loss of the motor bus supply voltage based on the programmable undervoltage element. This provides a selectable backup feature if a manual or protective relay transfer is not initiated.
- Fast Transfer with adjustable phase angle limit
- Delayed In-Phase Transfer at the first phase coincidence if Fast Transfer is not possible
- Residual Voltage Transfer at an adjustable low residual voltage limit if Fast Transfer and Delayed In-Phase Transfer are not possible
- Fixed Time Transfer after an adjustable time delay
- Programmable Load Shedding with no time delay for Fast Transfer
- Programmable load shedding prior to initiating Delayed-in-Phase Transfer, Residual Voltage Transfer, and Fixed Time Transfer
- Adjustable setpoints for delta voltage limit and delta frequency limit
- Verify the new source (the source to which the bus is being transferred) is healthy and within acceptable upper and lower voltage limits

Manual Transfer. When a Manual Transfer is initiated the digital MBTS provides the following:

- Sync check functions with adjustable parameters
- Hot Parallel Transfer if enabled (make-before-break)
- Fast Transfer, Delayed In-Phase Transfer, and Residual Voltage Transfer (if the Hot Parallel Transfer is disabled)
- Programmable Load Shedding with no time delay for Fast Transfer
- Programmable load shedding prior to initiating Delayed In-phase Transfer and Residual Voltage Transfer
- Verify the new source (the source to which the bus is being transferred) is healthy and within acceptable upper and lower voltage limits

Circuit Breaker Control: The digital Motor Bus Transfer System includes the following Circuit Breaker Control features:

- Control of two circuit breakers with two individual programmable breaker closing times
- Three-breaker configuration can be provided by two M-4272 devices
- Breaker status supervision
- Breaker failure monitoring
- Four trip and close circuit monitoring inputs

Additional Standard Features

- Sequential or Simultaneous Transfer Mode
- Bus Phase Undervoltage (27B)
- Frequency (81) and Rate of Change of Frequency (81R) for load shedding
- Breaker Failure (50BF), Source 1 and Source 2
- Bus VT Fuse-Loss Detection (60FL)
- Auto Trip
- Auto Close
- Four dry output contacts (two trip and two close) for Source 1 and Source 2, one lock-out/blocking output contact, and 11 programmable output contacts (10 Form 'a' and one Form 'c')
- Six Breaker Status inputs (a, b, and service position) for the Source 1 and Source 2 breakers, twelve programmable digital inputs
- All functions can be enabled or disabled
- Remote/Local control selection
- Device ON/OFF Control Selection
- M-3931 Human-Machine Interface (HMI) Module
- M-3972 Status Module
- IRIG-B time synchronization
- Oscillographic recording
- Two RS-232 ports (front and rear) and one RS-485 port (rear)
- M-3872 ISScom™ Communications and Oscillographic Analysis Software

Optional Features

- RJ45 Ethernet Port Utilizing MODBUS over TCP/IP
- 5 A or 1 A models available
- 60 Hz or 50 Hz models available

The M-4272 Digital Motor Bus Transfer System provides Automatic and Manual Transfers. The Fast Transfer, Delayed In-Phase Transfer, and Residual Voltage Transfer methods are activated at the same time, if enabled. If the conditions for the Fast Transfer are not met, then the Delayed In-Phase Transfer or the Residual Voltage Transfer will be attempted. The Fixed Time Transfer is also provided if during a transfer operation, it is not possible to monitor the motor bus voltage (due to Bus VT fuse loss, for example). The Delayed In-Phase Transfer, Residual Voltage Transfer, and Fixed Time Transfer methods can be selectively disabled. The Automatic or Manual Transfer operation can be blocked by control/status input or remote serial communications. See Figure 2 for Typical Application of Motor Bus Transfer Systems.

Automatic Transfer

Automatic Transfer can be initiated by an external protection trip signal (86P) or an external undervoltage function (27) using control/status input to the Motor Bus Transfer System (MBTS) device or triggered by a sudden loss of motor bus supply voltage using the internal bus undervoltage relay (27B Function). Automatic Transfer allows transfer operation in both directions: from Source 1 to Source 2, and vice-versa. The Automatic Transfer provides Fast Transfer, Delayed In-Phase Transfer, Residual Voltage Transfer and Fixed Time Transfer. The Automatic Transfer is blocked when any lockout/blocking condition occurs. The MBTS will not respond to any transfer command and will not send the trip command while in the lockout/blocking condition.

Manual Transfer

Manual transfer can be initiated by using the local Human-Machine Interface (HMI), from a control/status input or through remote serial communications. The Manual Transfer allows transfer operation in either direction: from Source 1 to Source 2, and vice versa. Manual Transfer provides Hot Parallel Transfer or a combination of Fast Transfer, Delayed In-Phase Transfer and Residual Voltage Transfer. The Manual Transfer is blocked when any lockout/blocking condition occurs. The MBTS will not respond to any transfer command and will not send the trip command while in the lockout/blocking condition.

Transfer Modes

There are two transfer modes, Sequential and Simultaneous, in the open transition transfer operation.

Sequential Transfer Mode

Once a transfer is initiated, and if the Sequential Mode is selected, the old source breaker is tripped within 10 ms and closure of the new source* breaker is attempted only upon confirmation by the breaker status contact that the old source breaker has opened. Within 4 ms of receipt of this confirmation, all three methods, Fast, Delayed In-Phase and Residual Voltage Transfer are enabled to supervise closure of the new source* breaker, and the Fixed Time Transfer is enabled 30 cycles later. The new source* breaker is then closed by the Fast Transfer Method if the phase angle between the motor bus and the new source* is within the delta phase angle limit immediately after the old source breaker opens.

If the phase angle between the motor bus and the new source* is not within the delta phase angle limit, the old source breaker is still tripped. When the four methods of transfer are enabled, the new source* breaker then closes either as a result of a subsequent movement into the delta phase angle limit within the Fast Transfer Time Window, a movement through a predicted zero phase coincidence within the Delayed In-Phase Transfer Time Window, or by a drop in the motor bus voltage below the Residual Voltage Transfer limit, or after the fixed time delay of the Fixed Time Transfer. Transfer is completed and the new source* breaker is closed by any of the above methods whose criteria is first satisfied.

Refer to Figure 3 for Timing Sequence of Transfer Logic in Sequential Transfer Mode.

Simultaneous Transfer Mode

Alternatively, once a transfer is initiated, and if the Simultaneous Mode is selected, within 10 ms of transfer initiate, all three methods of transfer, Fast, Delayed In-Phase and Residual Voltage Transfer are immediately enabled to supervise closure of the new source* breaker without waiting for the breaker status contact confirmation that the old source breaker has opened. At the same instant, the commands for the old source breaker and the new source* breaker to trip and close are sent simultaneously if and only if the phase angle between the motor bus and the new source* is within the delta phase angle limit for the Fast Transfer Method immediately upon transfer initiation. However only the Fixed Time Transfer is enabled 30 cycles after the old source breaker has opened.

If the phase angle between the motor bus and the new source* is not within the delta phase angle limit, the old source breaker is still tripped. When the four methods of transfer are enabled, the new source* breaker then

* **NOTE**: The 'new source' is defined as the source to which the bus is being transferred.

closes either as a result of a subsequent movement into the delta phase angle limit within the Fast Transfer Time Window, a movement through a predicted zero phase coincidence within the Delayed In-Phase Transfer Time Window, or by a drop in the motor bus voltage below the Residual Voltage Transfer limit, or after the fixed time delay of the Fixed Time Transfer. Transfer is completed and the new source* breaker is closed by any of the above methods whose criteria is first satisfied.

Refer to Figure 4 for Timing Sequence of Transfer Logic in Simultaneous Transfer Mode.

Bus VT Fuse-Loss Detection (60FL)

A Bus VT Fuse-Loss condition is detected by comparing either the three-phase voltage of the motor bus to the three-phase voltage of the connected source (VT's in three-phase connection) or single phase voltage of the motor bus to a single phase voltages of the connected source (VT's in single phase connection): phase a to phase a, phase b to phase b, and phase c to phase c.

Auto Trip

If an external operation closes the second breaker while leaving the first one closed, and if the Auto Trip feature is enabled, there is a breaker trip option: the MBTS will trip the breaker that was originally closed or the breaker that has just been closed within an adjustable time delay (0 to 50 Cycles in increments of 0.5 Cycle) after the second breaker is closed. This Auto Trip operates to transfer in either direction. The purpose is to allow external parallel transfer but prohibits inadvertent parallel operation. It must be noted that the external operation that closed the second breaker must be supervised by means external to the motor bust transfer system.

Auto Close

If an external operation opens the second breaker while leaving the first one open, and if the Auto Close feature is selected, the MBTS will close the breaker that was originally opened. The originally opened breaker will be closed using the Fast Transfer, Delayed In Phase Transfer, Residual Voltage Transfer or Fixed Time Transfer method depending upon the bus voltage decayed condition. This Auto Close operates to transfer in either direction. The purpose is to permit a transfer when the normally-closed breaker is accidentally/inadvertently tripped resulting in two open breakers. This operation is very similar to the regular transfer process except it does not send out the trip command, since the second breaker is already opened.

Lockout/Blocking

A transfer is blocked when any lockout/blocking condition described below is active:

- Voltage Blocking – If prior to a transfer, the new source* voltage exceeds the Upper or Lower voltage limits, all transfers are blocked as long as the voltage remains outside these limits.

- External Blocking – When this control input contact is closed, all transfers are blocked.

- Incomplete Transfer Lockout – Blocks any transfer initiated by a protective relay initiate or an automatic initiated transfer or manual transfer if the last transfer has not been completed within the time delay. A time delay can be set from 50 to 3000 Cycles. The MBTS remains in the lockout condition until manually reset.

- Bus VT Fuse Loss Blocking – Transfer is blocked if the Bus VT fuse loss is detected and the customer has selected to block transfers when this occurs.

- "Both Breakers Same State" Blocking – If both breaker status contacts are in the open state, due to an external operation that opens the second breaker while leaving the first one open, and if the Auto Close feature is not selected, no transfer sequence is initiated. Furthermore, any subsequent initiation of a transfer sequence while the breakers are in this state is inhibited. Also, if both breaker status contacts are closed due to an external operation that closes the second breaker while leaving the first one closed, and if the auto trip feature is disabled, no transfer sequence is initiated.

- Transfer in Process Blocking – Once a transfer is in process, any other transfer initiate inputs will be ignored until the original transfer is complete.

- Blocking After Transfer – After a transfer has been completed, any additional transfers are blocked for 0 to 8160 cycles, as selected by the user.

- Trip/Close Circuit Open Blocking – Transfer is blocked if the Trip or Close Circuit Open is detected.

- 52a and 52b Position Disagreement Blocking – Transfer is blocked when the 52a and 52b status input positions disagree (applicable when both 52a and 52b status inputs are used).

* **NOTE**: The 'new source' is defined as the source to which the bus is being transferred.

TRANSFER SETTINGS

	Setpoint Ranges	Increment	Accuracy†
Automatic Transfer			

Fast Transfer

Delta Phase Angle Limit*	0.0 to 90.0 Degrees	0.1 Degree	±0.5 Degree
Delta Voltage Limit	0 to 60 V	1 V	±0.5 V or ±2%
Delta Frequency Limit	0.02 to 2.00 Hz	0.01 Hz	±0.01 Hz or 5%
Time Window**	1 to 10 Cycles	0.5 Cycle	±1 Cycle
Closing Command Time Delay***	0 to 10 Cycles	0.5 Cycle	1 Cycle

* Accuracy defined at a constant frequency with a delta frequency of zero (0).

** This timer is used to limit the time window during which a Fast Transfer may be initiated.

*** This time delay is only used for Fast Transfer in Simultaneous. The trip and close commands are normally issued at the same time. This time delay allows the flexibility to delay the closing command to accomplish the break-before-make mode of operation (open transition).

Delayed In-Phase Transfer

Delta Voltage Limit	0 to 120 V	1 V	±0.5 V or ±2%
Delta Frequency Limit*	0.10 to 10.00 Hz	0.05 Hz	±0.02 Hz (±0.1Hz)***
Time Window**	10 to 600 Cycles	1 Cycle	±1 Cycle or ±1%

* The pickup accuracy applies to the 60 Hz model at a range of 57 to 63 Hz, and to the 50 Hz model at a range of 47 to 53 Hz. Beyond these ranges, the accuracy is ±0.1 Hz (3-phase); ±0.4Hz(single phase).

** This timer is used to limit the time window during which an in-phase transfer may be initiated.

*** Value in parenthese applies to single phase unit.

For Delayed In-Phase Transfer, phase angle accuracy at first phase coincidence is 10.0 degrees with up to 10.0 Hz slip frequency.

Residual Voltage Transfer

Residual Voltage Limit	5 to 60 V	1 V	±0.5 V or ±2%
Load Shedding Time Delay*	2 to 100 Cycles	1 Cycle	±1 Cycle or ±1%

Enabling the Load Shedding option allows the user to assign an output contact to shed load.

* The load shedding command is issued when bus voltage drops below residual voltage limit. The close command for the Residual Voltage Transfer is sent after the programmed load shedding time delay.

Fixed Time Transfer

Fixed Time Delay	30 to 1000 Cycles	1 Cycle	±1 Cycle or ±1%
Load Shedding Time Delay*	2 to 100 Cycles	1 Cycle	±1 Cycle or ±1%

This method is based on time delay only, and does not use the voltage, phase angle, frequency or current to supervise the closing of the new source breaker. The 'new source' is defined as the source to which the bus is being transferred.

Enabling the Load Shedding option allows the user to assign an output contact to shed load.

* The load shedding command is issued when the FixedTime delay has timed out. The Close command for the Fixed Time Transfer is sent after the programmed load shedding time delay.

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†Select the greater of these accuracy values. Accuracy applies to sinusoidal voltage with constant amplitude and frequency.

TRANSFER SETTINGS

	Setpoint Ranges	Increment	Accuracy†
Manual Transfer			

Fast Transfer

Delta Phase Angle Limit*	0.0 to 90.0 Degrees	0.1 Degree	±0.5 Degree
Delta Voltage Limit	0 to 60 V	1 V	±0.5 V or ±2%
Delta Frequency Limit	0.02 to 2.00 Hz	0.01 Hz	±0.01 Hz or ±5%
Time Window**	1 to 10 Cycles	0.5 Cycle	± 1 Cycle
Closing Command Time Delay***	0 to 10 Cycles	0.5 Cycle	1 Cycle

* Accuracy defined at a constant frequency with a delta frequency of zero (0).

** This timer is used to limit the time window during which a Fast Transfer may be initiated.

*** This time delay is only used for Fast Transfer in Simultaneous mode. The trip and close commands are normally issued at the same time. This time delay allows the flexibility to delay the closing command to accomplish the break-before-make mode of operation (open transition).

Delayed In-Phase Transfer

Delta Voltage Limit	0 to 120 V	1 V	±0.5 V or ±2%
Delta Frequency Limit*	0.10 to 10.00 Hz	0.05 Hz	±0.02 Hz (±0.1Hz)***
Time Window**	10 to 600 Cycles	1 Cycle	±1 Cycle or ±1%

* The pickup accuracy applies to the 60 Hz model at a range of 57 to 63 Hz, and to the 50 Hz model at a range of 47 to 53 Hz. Beyond these ranges, the accuracy is ±0.1 Hz (3-phase); ±0.4Hz (single phase).

** This timer is used to limit the time window during which an in-phase transfer may be initiated.

*** Value in parenthese applies to single phase unit.

For Delayed In-Phase Transfer, phase angle accuracy at first phase coincidence is 10.0 degrees with up to 10.0 Hz slip frequency.

Residual Voltage Transfer

Residual Voltage Limit	5 to 60 V	1 V	±0.5 V or ±2%
Load Shedding Time Delay*	2 to 100 Cycles	1 Cycle	±1 Cycle or ±1%

* The load shedding command is issued when bus voltage drops below residual voltage limit. The close command for the Residual Voltage Transfer is sent after the programmed load shedding time delay.

Enabling load shedding option allows the user to assign an output contact to shed load.

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†Select the greater of these accuracy values. Accuracy applies to sinusoidal voltage with constant amplitude and frequency.

TRANSFER SETTINGS

	Setpoint Ranges	Increment	Accuracy†
Manual Transfer (cont.)			

Hot Parallel Transfer

	Setpoint Ranges	Increment	Accuracy†
Delta Phase Angle Limit*	0.0 to 90.0 Degrees	0.1 Degree	±0.5 Degree
Delta Voltage Limit	0 to 60 V	1 V	±0.5 V or ±2%
Delta Frequency Limit	0.02 to 0.50 Hz	0.01 Hz	±0.01 Hz or ±5%
Time Window	1.0 to 50.0 Cycles	0.5 Cycle	±1 Cycle
Tripping Command Time Delay**	0.0 to 30.0 Cycles	0.5 Cycle	1 Cycle

Accuracy defined at a constant frequency with a delta frequency of zero (0).

** This time delay is only used in the Manual Transfer to implement a Hot Parallel Transfer (make-before-break).*

	Setpoint Ranges	Increment	Accuracy†
Auto Trip			
Trip Originally Closed Breaker	Enable/Disable	____	____
Trip Breaker Just Closed	Enable/Disable	____	____
Tripping Command Time Delay	0.0 to 50.0 Cycles	0.5 Cycle	1 Cycle

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†Select the greater of these accuracy values. Accuracy applies to sinusoidal voltage with constant amplitude and frequency.

TRANSFER SETTINGS

	Setpoint Ranges	Increment	Accuracy†
Common Function Settings			
Upper Voltage Limit New Source	5 to 180 V	1 V	±0.5 V or ±2%
Lower Voltage Limit New Source	5 to 180 V	1 V	±0.5 V or ±2%
Breaker Closing Time #1 (Source 1 Breaker)[1]	0.0 to 12.0 Cycles	0.1 Cycle	0.3 Cycle
Breaker Closing Time #2 (Source 2 Breaker)[1]	0.0 to 12.0 Cycles	0.1 Cycle	0.3 Cycle
Breaker Closing Time Deviation #1 [2]	0.0 to 6.0 Cycles	0.1 Cycle	0.3 Cycle
Breaker Closing Time Deviation #2 [2]	0.0 to 6.0 Cycles	0.1 Cycle	0.3 Cycle
52a and 52b Position Disagreement Pickup Time Delay[3] (Source 1 Breaker)	0 to 30 Cycles	1 Cycle	1 Cycle
Dropout Time Delay[3] (Source 1 Breaker)	0 to 30 Cycles	1 Cycle	1 Cycle
Pickup Time Delay[3] (Source 2 Breaker)	0 to 30 Cycles	1 Cycle	1 Cycle
Dropout Time Delay[3] (Source 2 Breaker)	0 to 30 Cycles	1 Cycle	1 Cycle
Incomplete Transfer Lockout Time[4]	50 to 3000 Cycles	1 Cycle	±1 Cycle or ±1%
Local Manual Transfer Initiate Time Delay[5]	0 to 8160 Cycles	1 Cycle	1 Cycle or 1%
Blocking After Transfer Time[6]	0 to 8160 Cycles	1 Cycle	1 Cycle or 1%
Trip Command Pulse Length	15 to 30 Cycles	1 Cycle	±1 Cycle
Close Command Pulse Length	15 to 30 Cycles	1 Cycle	±1 Cycle

[1] This is the time it takes the breaker to close from the issue of a close command to when the breaker status contact closes. The selectable adaptive breaker closing time is also provided.

[2] An alarm is activated if the actual Breaker Closing Time exceeds the programmed closing time by ± this value.

[3] The Time Delays are only applicable when both 52a and 52b Status Inputs of the S1 and S2 breakers are used. The Pickup Time Delay is used to block transfer when the 52a and 52b Status Input positions diagree.

[4] This timer is used for situations where the transfer was not completed. Response to a breaker failure is considered a complete transfer, and resets this timer.

[5] This time delay is only applicable when the manual transfer is initiated from the local front panel via the HMI or Com1 port.

[6] This timer is used to block any additional transfer after a transfer has been completed.

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†Select the greater of these accuracy values. Accuracy applies to sinusoidal voltage with constant amplitude and frequency.

FUNCTIONS

		Setpoint Ranges	Increment	Accuracy[†]
	27B Bus Phase Undervoltage			
27B	Pickup #1,#2,#3,#4	5 to 120 V	1 V	± 0.5 V or ± 2%
	Inhibit Setting**	5 to 120 V	1 V	± 0.5 V or ± 2%
	Time Delay	1 to 8160 Cycles	1 Cycle	-1 to +3 Cycles or ± 0.5%*

The pickup and time delay accuracies apply to 60 HZ models at a range of 57 to 63 Hz, and to 50 Hz models at a range of 47 to 53 Hz. Beyond these ranges, the time delay accuracy is 6 Cycles or 0.75% for the bus frequency down to 25 Hz. The time delay accuracy is ≤ 20 Cycles or 1% for the bus frequency at a range of 5 to 25 Hz.

** The Voltage Inhibit setting can be enabled or disabled.*

27B #1 is the Bus Phase Undervoltage initiate function that is used for Automatic Transfer from S1 to S2 direction.

27B #2 is the Bus Phase Undervoltage initiate function that is used for Automatic Transfer from S2 to S1 direction.

27B #3 can be used for load shedding.

27B #4 can be used for alarm or trip function.

The 27B functions are applicable only when the bus phase voltage input is applied.

		Setpoint Ranges	Increment	Accuracy[†]
	50BF-1 Breaker Failure (Source 1)			
50 BF1	Pickup Current	0.10 to 10.00 A (0.02 to 2.00 A)*	0.01 A	± 0.1 A or ± 2% (± 0.02 A or ± 2%)
	Time Delay	1 to 30 Cycles	1 Cycle	± 1 Cycle

50BF-1 can be initiated from designated M-4272 output contacts or programmable inputs.

** Value in parentheses apply to 1A Secondary Rating*

		Setpoint Ranges	Increment	Accuracy[†]
	50BF-2 Breaker Failure (Source 2)			
50 BF2	Pickup Current	0.10 to 10.00 A (0.02 to 2.00 A)*	0.01 A	± 0.1 A or ± 2% (± 0.02 A or ± 2%)
	Time Delay	1 to 30 Cycles	1 Cycle	± 1 Cycle

50BF-2 can be initiated from designated M-4272 output contacts or programmable inputs.

** Value in parentheses apply to 1A Secondary Rating*

		Setpoint Ranges	Increment	Accuracy[†]
	Source 1 Breaker Failure (Using breaker status)			
	Time Delay	0 to 30 Cycles	1 Cycle	1 Cycle

The breaker failure time delay is used to monitor breaker failure when using the breaker status inputs only. The breaker is considered failed when the breaker status has not changed state within this programmable time delay after a trip command is issued. A separate time delay is provided for breaker failure function (50BF) when current is present.

		Setpoint Ranges	Increment	Accuracy[†]
	Source 2 Breaker Failure (Using breaker status)			
	Time Delay	0 to 30 Cycles	1 Cycle	1 Cycle

The breaker failure time delay is used to monitor breaker failure when using the breaker status inputs only. The breaker is considered failed when the breaker status has not changed state within this programmable time delay after a trip command is issued. A separate time delay is provided for breaker failure function (50BF) when current is present.

[†]Select the greater of these accuracy values. Accuracy applies to sinusoidal voltage with constant amplitude and frequency. Values in parentheses apply to 1 A CT secondary rating.

FUNCTIONS (Cont.)

		Setpoint Ranges	Increment	Accuracy[†]

		81 Frequency (bus voltage)		
81	Pickup #1, #2	50.00 to 67.00 Hz 40.00 to 57.00 Hz*	0.01 Hz	± 0.02 Hz (± 1.0 Hz)**
	Time Delay #1, #2	5 to 65,500 Cycles	1 Cycle	± 3 Cycles or ± 1%

The pickup accuracy applies to 60 Hz models at a range of 57 to 63 Hz, and to 50 Hz models at a range of 47 to 53 Hz. Beyond these ranges, the accuracy is ± 0.1 Hz (3-phase); ± 0.4Hz(single phase).

The 81 #1 Function can be used to initiate Load Shedding. The 81 Function is automatically disabled when the bus phase voltage input is less than 5 to 15 V (Positive Sequence) based on the frequency, or less than 5 V (Single Phase).

* This range applies to 50 Hz nominal frequency model.

** Value in parenthese applies to single phase bus voltage frequency.

		81R Rate of Change of Frequency (bus voltage)		
	Pickup #1, #2	0.10 to 20.00 Hz/Sec.	0.01 Hz/Sec.	± 0.05 Hz/Sec. or ± 5%
81R	Time Delay #1, #2	3 to 8160 Cycles	1 Cycle	+20 Cycles
	Negative Sequence Voltage Inhibit	0 to 99%	1%	± 0.5%

The 81R #1 Function can be used to initiate Load Shedding. 81R function can only be used when the bus voltage input is three-phase, and for load shedding.

		Bus VT Fuse-Loss Detection		
	Delta Pickup*	5 to 25 V	1 V	± .05 V or ± 2%
60FL	Time Delay**	1 to 8160 Cycles	1 Cycle	3 Cycles or 1%****
	Blocking Drop Out Time Delay***	1 to 300 Cycles	1 Cycle	3 Cycles or 1%****

* Mismatched voltage of the motor bus in respect to the connected source.

** This time delay is for the programmable alarm output.

*** This is the time it takes to drop out (reset) the block transfer after no Bus VT fuse-loss is detected.
**** The pickup and time delay accuracies apply to 60 HZ models at a range of 57 to 63 Hz, and to 50 Hz models at a range of 47 to 53 Hz. Beyond these ranges, the time delay accuracy is 6 Cycles or 0.75% for the bus frequency down to 25 Hz. The time delay accuracy is ≤ 20 Cycles or 1% for the bus frequency at a range of 5 to 25 Hz.

If the bus VT fuse-loss is detected, the user must either select block transfer or initiate the Fixed Time Transfer.

Bus VT fuse-loss output is intiated from internally generated logic.

[†]Select the greater of these accuracy values. Accuracy applies to sinusoidal voltage with constant amplitude and frequency.

FUNCTIONS (Cont.)

	Setpoint Ranges	Increment	Accuracy†
Trip and Close Circuit Monitor			
Trip Circuit Monitor			
TCM-1 Time Delay	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%
TCM-1 Dropout Time Delay	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%
TCM-2 Time Delay	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%
TCM-2 Dropout Time Delay	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%
Close Circuit Monitor			
CCM-1 Time Delay	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%
CCM-1 Dropout Time Delay	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%
CCM-2 Time Delay	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%
CCM-2 Dropout Time Delay	1 to 8160 Cycles	1 Cycle	±1 Cycle or ±1%

(TCM)

(CCM)

The CCM/TCM inputs are provided for monitoring the continuity of the Source 1 and Source 2 trip and close circuits. The inputs can be used for nominal trip/close coil voltages of 24 V dc – 250 V dc. Trip and closing circuit monitoring are performed in the active breaker status only (trip circuit supervision when breaker is closed and close circuit supervision when breaker is open.) Both the DC supply and continuity for each of the circuits are monitored.

ISSLogic

(ISSL)

ISS Logic uses control/status input status, system status, function status, output contact close signals to develop 6 programmable logic schemes.

	Setpoint Ranges	Increment	Accuracy†
Time Delay #1-#6	0 to 65500 Cycles	1 Cycle	1 Cycle or 1%
Dropout/Reset Time Delay			
#1-#6	0 to 65500 Cycles	1 Cycle	1 Cycle or 1%

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†Select the greater of these accuracy values. Accuracy applies to sinusoidal voltage with constant amplitude and frequency.

Multiple Setpoint Profiles (Groups)

The system supports four setpoint profiles. This feature allows multiple setpoint profiles to be defined for the type of transfer initiated (Automatic , Manual or Hot Parallel) and the direction of the next transfer.

Metering

The Digital Motor Bus Transfer System provides metering of voltage, current, and frequency of the Source 1, Source 2, and Motor Bus.

Metering accuracies are:

Voltage: ±0.5 V or ±0.5%, whichever is greater (from 57 to 63 Hz for 60 Hz models; from 47 to 53 Hz for 50 Hz models)
±1.0 V or ±0.75%, whichever is greater (below 57 Hz or beyond 63 Hz for 60 Hz models; below 47 Hz or beyond 53 Hz for 50 Hz models)

Current: 5 A rating, ±0.1 A or ±3%, whichever is greater
1 A rating, ±0.02 A or ±3%, whichever is greater

Frequency: ±0.02 Hz (from 57 to 63 Hz for 60 Hz models; from 47 to 53 Hz for 50 Hz models)
±0.1 Hz (below 57 Hz or beyond 63 Hz for 60 Hz models; below 47 Hz or beyond 53 Hz for 50 Hz models)

Phase Angle: ±0.5 degree or ±0.5%, whichever is greater

Oscillographic Recorder

The oscillographic recorder provides comprehensive data recording of all monitored waveforms, and status inputs storing up to 248 cycles of data. The total record length is user-configurable from 1 to 16 partitions. The number of samples per cycle used to store the data is user selectable. The number of samples per cycle that can be selected is 16 or 32 (50 or 60 Hz). The number of samples selected effects the length of the data that can be saved and its resolution. The lower the number of samples, the longer the record length that can be stored (but at a lower resolution).

The oscillographic recorder is triggered by a designated control/status input (usually a protective relay initiate input), an automatically initiated signal, a trip output, a manual transfer signal or from serial communications.

When untriggered, the recorder continuously stores waveform data, thereby keeping the most recent data in memory. When triggered, the recorder stores pre-trigger data, then continues to store data in memory for a user-defined, post-trigger delay period. The records may be analyzed using Beckwith Electric ISScom™ Communications and Oscillographic Analysis Software, and are also available in COMTRADE file format.

Transfer Event Log

A transfer event log is considered complete when one of following occurs:

1. When the breaker from the old source opens and the breaker to the new source* closes.
2. When a breaker failure occurs.
3. When the incomplete transfer timer times out.

Depending on transfer type, up to four transfers will be stored. When 16 events are stored, any subsequent event will cause the oldest event to be lost. Each Transfer Event Log parameter is time stamped with the date and time in 1 ms increments.

The trigger and complete events are used to define the time frame during which the transfer event log is storing information. A reset feature is provided to clear this log through the serial communications. The Transfer Event Log is available for viewing utilizing the M-3872 ISScom Communications Software.

Sequence of Events Recording

In addition to the Transfer Event Log the Digital Motor Bus Transfer System provides Sequence of Events Recording. The Sequence of Events Recording stores every change in the input status, trip commands, close commands, any signal to initiate a transfer, type of transfer, change in any breaker status, and status reset.

***NOTE**: The 'new source' is defined as the source to which the bus is being transferred.

Each of these Running Events are time stamped with the date and time in 1 ms increments. The Running Event Log stores the last 512 events, when a new event occurs the oldest event is removed. A reset feature is provided to clear this log through the serial communications. The events and the associated data are available for viewing utilizing the M-3872 ISScom Communications Software.

Calculations

Current and Voltage Values: The Digital Motor Bus Transfer System uses discrete Fourier Transform (DFT) and RMS calculation algorithm on sampled voltage and current signals to extract fundamental amplitude, phase and frequency for the M-4272.

Power Input Options

Nominal 110/120/230/240 V ac, 50/60 Hz, or nominal 110/125/220/250 V dc. Operates properly from 85 V ac to 265 V ac and from 80 V dc to 312.5 V dc. Withstands 315 V dc or 300 V ac for 1 second. Burden 20 VA at 120 V ac/125 V dc.

Nominal 24/48 V dc, Operates properly from 18 V dc to 56 V dc. Withstands 65 V dc for 1 second. Burden 46 VA at 24 V dc and 30 VA at 48 V dc.

This unit includes two power supplies which are not redundant.

Sensing Inputs

Nine Voltage Inputs – Rated for a nominal voltage of 50 V ac to 140 V ac (user configurable) at 60 Hz or 50 Hz. Will withstand 240 V continuous voltage and 360 V for 10 seconds. Voltage transformer burden is less than 0.2 VA at 120 V. Source voltage may be phase-to ground or phase-to-phase connected. For proper operation of M-4272 MBTS, the connections for the Source 1, Source 2 and Bus voltages must match each other. The unit may have up to three voltage inputs for each of the Source 1, Source 2, and Bus Voltages. Typical connection diagrams are illustrated in Figures 10 through 15.

One Source 1 Current Input – Rated for a current (I_R) of 5.0 A or 1.0 A (optional) at 60 Hz or 50 Hz. Will withstand 4 I_R continuous current and 100 I_R for 1 second. Current transformer burden is less than 0.5 VA at 5 A (5 A option), or 0.3 VA at 1 A (1 A option).

One Source 2 Current Input – Rated for a current (I_R) of 5.0 A or 1.0 A (optional) at 60 Hz or 50 Hz. Will withstand 4 I_R continuous current and 100 I_R for 1 second. Current transformer burden is less than 0.5 VA at 5 A (5 A option), or 0.3 VA at 1 A (1 A option).

Control/Status Inputs

To provide proper operation and breaker status LED indication on the front panel, the INPUT1 through INPUT 6 status inputs must be connected to the 52a, 52b, 52a/b and 52SP (service position) breaker status contacts. The control/status inputs, INPUT7 through INPUT18, can be programmed to initiate the transfer or block the transfer operation, trigger the oscillographic recorder, or to operate one or more outputs. The control/status inputs are designed to be connected to dry contacts and are internally wetted with a 24 V dc power supply. The four Aux Inputs must be connected to the trip and close circuit monitoring.

Output Contacts

Output contacts OUTPUT1 through OUTPUT4 are available to Trip and Close the Source 1 and Source 2 breakers and are closed for a defined pulse length (pulse length can be programmed from 15 to 30 Cycles). The power supply alarm output contact (form 'b') and the self-test alarm output contact (form 'c'), and one output contact for lockout or blocking status (form 'c'). These outputs are pre-defined.

The eleven programmable output contacts (ten form 'a' and one form 'c'), the Lockout/Block alarm output contact (form 'c'), the power supply alarm output contact (form 'b') and the self-test alarm output contact (form 'c'), are all rated as per ANSI/IEEE C37.90-1989 for tripping. (Make 30 A for 0.2 seconds, carry 8 A, break 6 A @ 120 V ac, break 0.5A @ 48 V dc; 0.3A @ 125 V dc; 0.2A @ 250 V dc with L/R = 40 mSec.)

Any of the MBTS functions can be individually programmed to activate any one or more of the programmable output contacts (Outputs 5 to 16). Any output contact can also be selected as pulsed or latched. ISSLogic can also be used to activate an output contact.

*****NOTE**: The 'new source' is defined as the source to which the bus is being transferred.

Breaker Closing Time and Breaker Failure Monitoring

The Breaker Closing Time Monitoring feature measures the breaker closing time each time a transfer occurs. If this time varies by more than a selectable breaker closing time deviation of the programmed time, an alarm is activated. The breaker closing time is measured from the time the close command is sent until the breaker status indicates that the breaker is closed.

The selectable Adaptive Breaker Closing Time is provided. If it is enabled, a new setpoint of the breaker closing time will be automatically updated to an average value of 8 breaker closing time's measurements; however the setpoints of the breaker closing time are not permitted to write and change unless this feature is disabled.

The breaker status inputs are also monitored for breaker failure. The breaker is considered failed when the breaker status has not changed state within a programmable time after a trip command is issued. When Simultaneous Transfer mode is selected and a breaker failure occurs on the breaker that should have tripped, the breaker that was just closed will be tripped. This prevents the new source* from being continuously connected with the failed breaker, which could have a fault.

In addition to using the breaker status in determining when a breaker has failed, the current through the breaker can also be used to determine if the breaker has operated. The loss of current after a trip can be selected to provide a more positive indication of breaker operation. An instantaneous overcurrent breaker failure element with a time delay (50BF) is provided to minimize breaker failure coordination margins.

Power up Self-Test and Continuous On-Line Testing

The system performs self test verifications when power is first applied to the unit. These include verifying the operation of the multiplexer, programmable gain amplifier, analog to digital converter, DSP chip, Host processor and all RAM chips. After the initial self test is complete and the system is operating normally, continuous self check verification continues to check for correct operation of the system. The continuous self check verification tests are performed in the background and do not effect the response time of the unit to emergency conditions. In addition to the background tests, there are tests that can be performed in the diagnostic mode during periodic off line system testing. These additional tests can exercise the relay outputs, check front panel LED operation, verify input status operation, check pushbutton operation and communication operation.

Target/Status Indicators and Controls

The **SYS OK** LED reveals proper cycling of the microcomputer; it can be programmed to flash or to be illuminated continuously. The **SOURCE 1 BRKR CLOSED** and **SOURCE 2 BRKR CLOSED** red LEDs illuminate when the breaker is closed (when the 52a contact is closed). The **SOURCE 1 BRKR OPEN** and **SOURCE 2 BRKR OPEN** green LEDs illuminate when the breaker is open (when the 52a contact is open). The 52 contact input can be configured for either "a", "b" or "a/b" inputs. The corresponding **BRKR status** LED will illuminate when any of the conditions, events or unit functions activate.

Pressing and releasing the **STATUS RESET** pushbutton resets the **STATUS** LEDs if the conditions causing the operation have been removed. Pressing and holding the **STATUS RESET** pushbutton will allow conditions, events or functions that are picked up to be displayed. The **PS1** and **PS2** LEDs will remain illuminated as long as power is applied to the unit and the power supply is operating properly. **TIME SYNC** LED illuminates when a valid IRIG-B signal is applied and time synchronization has been established. The **TRIP SOURCE 1, CLOSE SOURCE 1, TRIP SOURCE 2** and **CLOSE SOURCE 2** status indicators are latched due to the pulsed nature of these commands. To provide information about which outputs were operated during the last transfer the appropriate **TRIP SOURCE 1, CLOSE SOURCE 1, TRIP SOURCE 2** or **CLOSE SOURCE 2** LEDs in the **Status** module are latched until reset or the next transfer.

*****NOTE**: The 'new source' is defined as the source to which the bus is being transferred.

Communication

Communication ports include rear RS-232 and RS-485 ports, a front RS-232 port, a rear IRIG-B port, and an Ethernet port (optional). The communications protocol implements serial, byte-oriented, asynchronous communication, providing the following functions when used with the Windows™-compatible M-3872 ISScom™ Communications and Oscillographic Analysis Software. MODBUS protocol is supported, providing:

- Interrogation and modification of setpoints and configuration
- Time-stamped status information for the 4 most recent Transfer Event logs
- Time-stamped status information for the 512 most recent events in the Sequence of Events log
- Real-time metering of all measured quantities, control status inputs, and outputs
- Downloading of recorded oscillographic data and Sequence of Events recorder data
- Initiate manual transfer and Sequence of Events recorder

The M-3872 ISScom Communications and Oscillographic Analysis Software enables the plotting and printing of M-4272 waveform data downloaded from the unit to any IBM-PC compatible computer. The ISScom Communications and Oscillograph Analysis Software can also be used to analyze the operation of the system, determine timing of the trip and close commands, breaker times and to evaluate "bus ringdown" test data. The evaluation of "bus ringdown" data eliminates the requirement for separate recording equipment during commissioning.

IRIG-B

The M-4272 accepts either modulated or demodulated IRIG-B time clock synchronization signals. The IRIG-B time synchronization information is used to correct the local calendar/clock and provide greater system wide synchronization for status and oscillograph time tagging.

HMI Module

Local access to the M-4272 is provided through the M-3931 Human-Machine Interface (HMI) Module, allowing for easy-to-use, menu-driven access to all functions using a 6-pushbutton keyboard and a 2-line by 24 character alphanumeric display. The M-3931 module includes the following features:

- User-definable access codes providing three levels of security
- Real-time metering of all measured quantities, control status inputs, and outputs
- Initiate Manual Transfer
- Remote/Local control
- Device On/Off control

Status Module

An M-3972 Status Module provides 24 status and 8 output LEDs. Appropriate status LEDs illuminate when the corresponding M-4272 conditions, event or function activates. The status indicators can be reset with the **STATUS RESET** pushbutton if the activated conditions have been removed. The **OUTPUT** LEDs indicate the status of the programmable output contacts. There are an additional 4 status LEDs, 8 output LEDs and 12 input LEDs located on the front panel.

ISSLogic

This feature can be programmed utilizing the M-3872 ISScom Communications Software. ISScom takes the control/status input status, system status and function status, and by employing (OR, AND, NOR and NAND) boolean logic and timers, can activate an output, change active setting profiles, initiate transfer, or block transfer.

There are six ISS Logic Functions per setting profile, depending on the number of different MBTS settings defined, the scheme may provide up to 24 different logic schemes. The ISSLogic Function Diagram is illustrated in Figure 1.

*NOTE: The 'new source' is defined as the source to which the bus is being transferred.
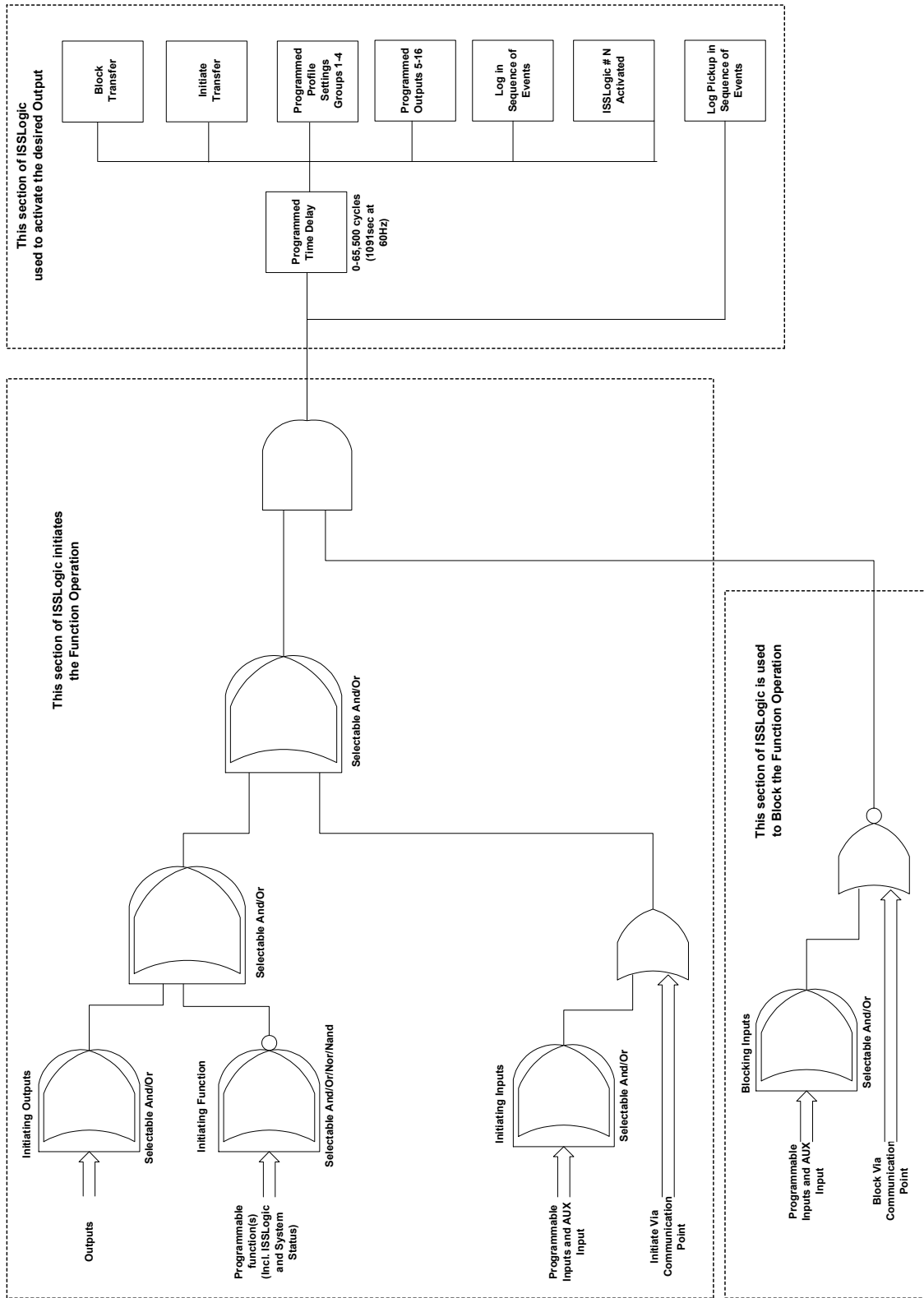
ISSLogic Functions

This section of ISSLogic used to activate the desired Output

Block Transfer

Initiate Transfer

Programmed Profile Settings Groups 1-4

Programmed Outputs 5-16

Log in Sequence of Events

ISSLogic # N Activated

Log Pickup in Sequence of Events

Programmed Time Delay

0-65,500 cycles (1091sec at 60Hz)

This section of ISSLogic initiates the Function Operation

Selectable And/Or

Selectable And/Or

Initiating Outputs

Selectable And/Or

Outputs

Initiating Function

Selectable And/Or/Nor/Nand

Programmable function(s) (Incl. ISSLogic and System Status)

Initiating Inputs

Selectable And/Or

Programmable Inputs and AUX Input

Initiate Via Communication Point

This section of ISSLogic is used to Block the Function Operation

Blocking Inputs

Selectable And/Or

Programmable Inputs and AUX Input

Block Via Communication Point

Figure 1   ISSLogic Function Diagram

Tests and Standards

M-4272 Digital Motor Bus Transfer System complies with the following type tests and standards:

Voltage Withstand

Dielectric Withstand

IEC 60255-5   3,500 V dc for 1 minute applied to each independent circuit to earth
3,500 V dc for 1 minute applied between each independent circuit
1,500 V dc for 1 minute applied to IRIG-B circuit to earth
1,500 V dc for 1 minute applied between IRIG-B to each independent circuit
1,500 V dc for 1 minute applied between RS-485 to each independent circuit

Impulse Voltage

IEC 60255-5   5,000 V pk, +/- polarity applied to each independent circuit to earth
5,000 V pk, +/- polarity applied between each independent circuit
1.2 by 50 μs, 500 ohms impedance, three surges at 1 every 5 seconds

IEC 60255-5   > 100 Megaohms

Electrical Environment

Electrostatic Discharge Test

EN 60255-22-2   Class 4 (8 kV)—point contact discharge

EN 60255-22-2   Class 4 (15kV)–air discharge

Fast Transient Disturbance Test

EN 60255-22-4   Class A (4 kV, 2.5 kHz)

ANSI/IEEE   2,500 V pk oscillatory applied to each independent circuit to earth
C37.90.1-   2,500 V pk oscillatory applied between each independent circuit
2002   4,000 V pk Fast Transient burst applied to each independent circuit to earth
4,000 V pk Fast Transient burst applied between each independent circuit
5,000 V pk Fast Transient applied to each independent circuit to earth
5,000 V pk Fast Transient applied between each independent circuit

■ **NOTE**: The signal is applied to the digital data circuits (RS-232, RS-485, IRIG-B, Ethernet communication port coupling port) through capacitive coupling clamp.

ANSI/IEEE   80-1000 Mhz @ 35 V/m
C37.90.2

Output Contacts

ANSI/IEEE   Make 30 A for 0.2 seconds, off for 15 seconds for 2,000 operations, per Section 6.7.1,
C37.90.0   Tripping Output Performance Requirements

Atmospheric Environment

Temperature

IEC 60068-2-1	Cold, −20° C
IEC 60068-2-2	Dry Heat, +70° C
IEC 60068-2-78	Damp Heat, +40° C @ 93% RH

Mechanical Environment

Vibration

IEC 60255-21-1	Vibration response Class 1, 0.5 g
	Vibration endurance Class 1, 1.0 g
IEC 60255-21-2	Shock Response Class 1, 5.0g
	Shock Withstand Class 1, 15.0g
	Bump Response Class 1, 10.0g

Compliance

cULus-Listed per 508 – Industrial Control Equipment

– Industrial Control Equipment Certified for Canada CAN/CSA C22.2 No. 14-M91

cULus-Listed Component per 508A Table SA1.1 Industrial Control Panels

European Safety - EN 61010-1:2001, CAT II, Pollution Degree 2

Physical

Size: 19.00" wide x 6.96" high x 10.20" deep (48.3 cm x 17.7 cm x 25.9 cm)

Mounting: The unit is a standard 19", semiflush, 4-unit high, rack-mount panel design, conforming to ANSI/EIA RS-310C and DIN 41494 Part 5 specifications. Optional mounting is available.

Approximate Weight: 20 lbs (9.1 kg)

Approximate Shipping Weight: 30 lbs (13.6 kg)
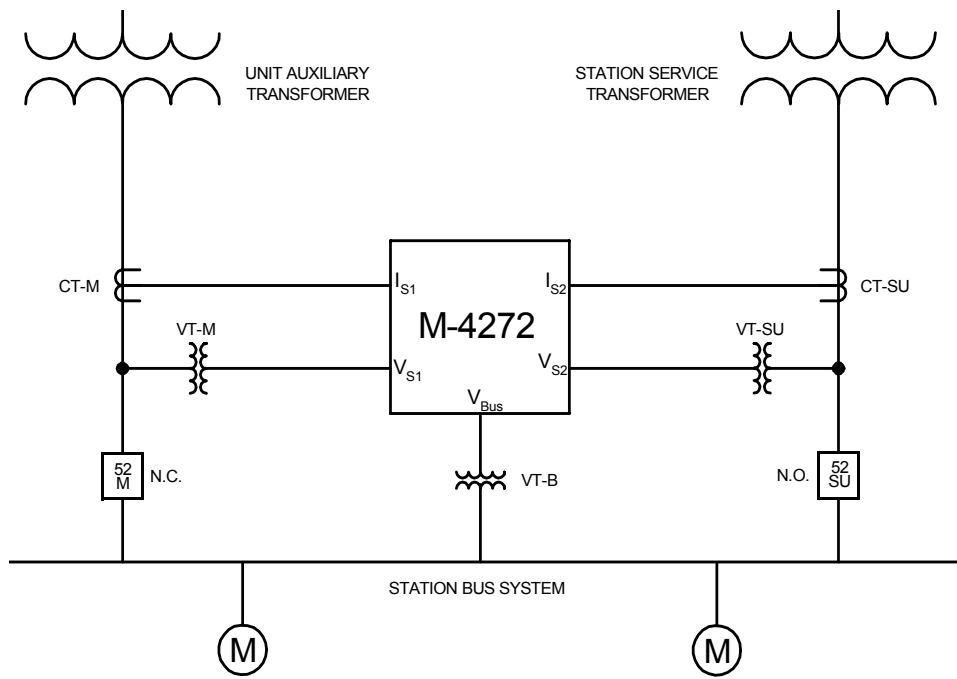
Patent & Warranty

The M-4272 Digital Motor Bus Transfer System has patents pending.

The M-4272 Digital Motor Bus Transfer System is covered by a five year warranty from date of shipment.
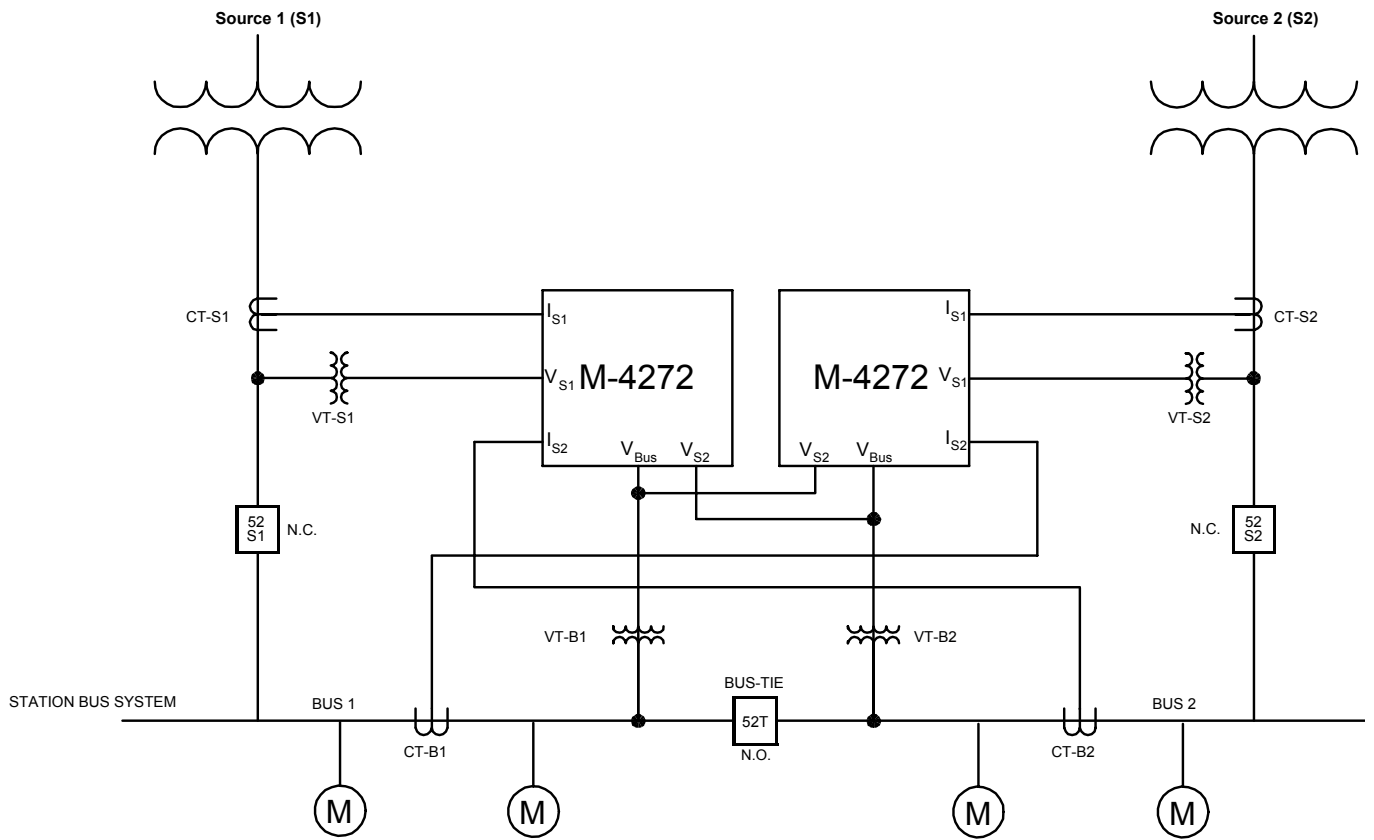
External Connections

M-4272 external connection points are illustrated in Figure 5, External Connections.

Specification subject to change without notice.

UNIT AUXILIARY TRANSFORMER

STATION SERVICE TRANSFORMER

CT-M

M-4272

CT-SU

I_{S1} I_{S2}

VT-M V_{S1} V_{S2} VT-SU

V_{Bus}

52 M N.C.

VT-B

N.O. 52 SU

STATION BUS SYSTEM

M M

TWO-BREAKER CONFIGURATION

TWO-BREAKER CONFIGURATION

Source 1 (S1)

Source 2 (S2)

CT-S1

I_{S1}

M-4272 V_{S1}

I_{S2} V_{Bus} V_{S2}

VT-S1

I_{S1}

V_{S1} M-4272

V_{S2} V_{Bus} I_{S2}

CT-S2

VT-S2

52 S1 N.C.

N.C. 52 S2

VT-B1

VT-B2

STATION BUS SYSTEM

BUS 1

CT-B1

BUS-TIE
52T
N.O.

CT-B2

BUS 2

M M M M

THREE-BREAKER CONFIGURATION

■ **NOTE**: Current Transformers are used for the M-4272, 50BF Function, they are not required for transfer operation.

Figure 2   Typical Applications of Motor Bus Transfer Systems
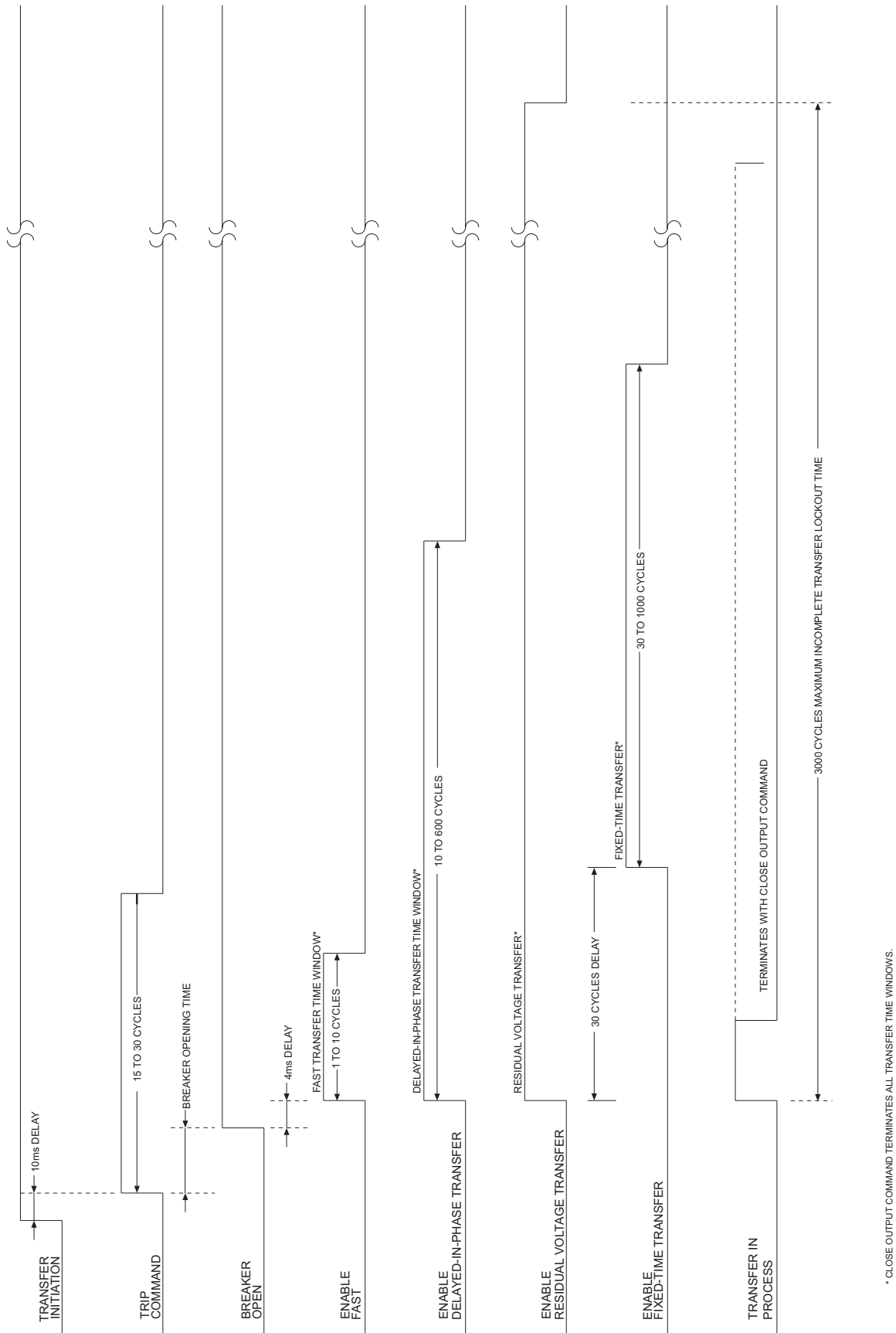
Figure 3   Time Sequence of Transfer Logic in Sequential Transfer Mode
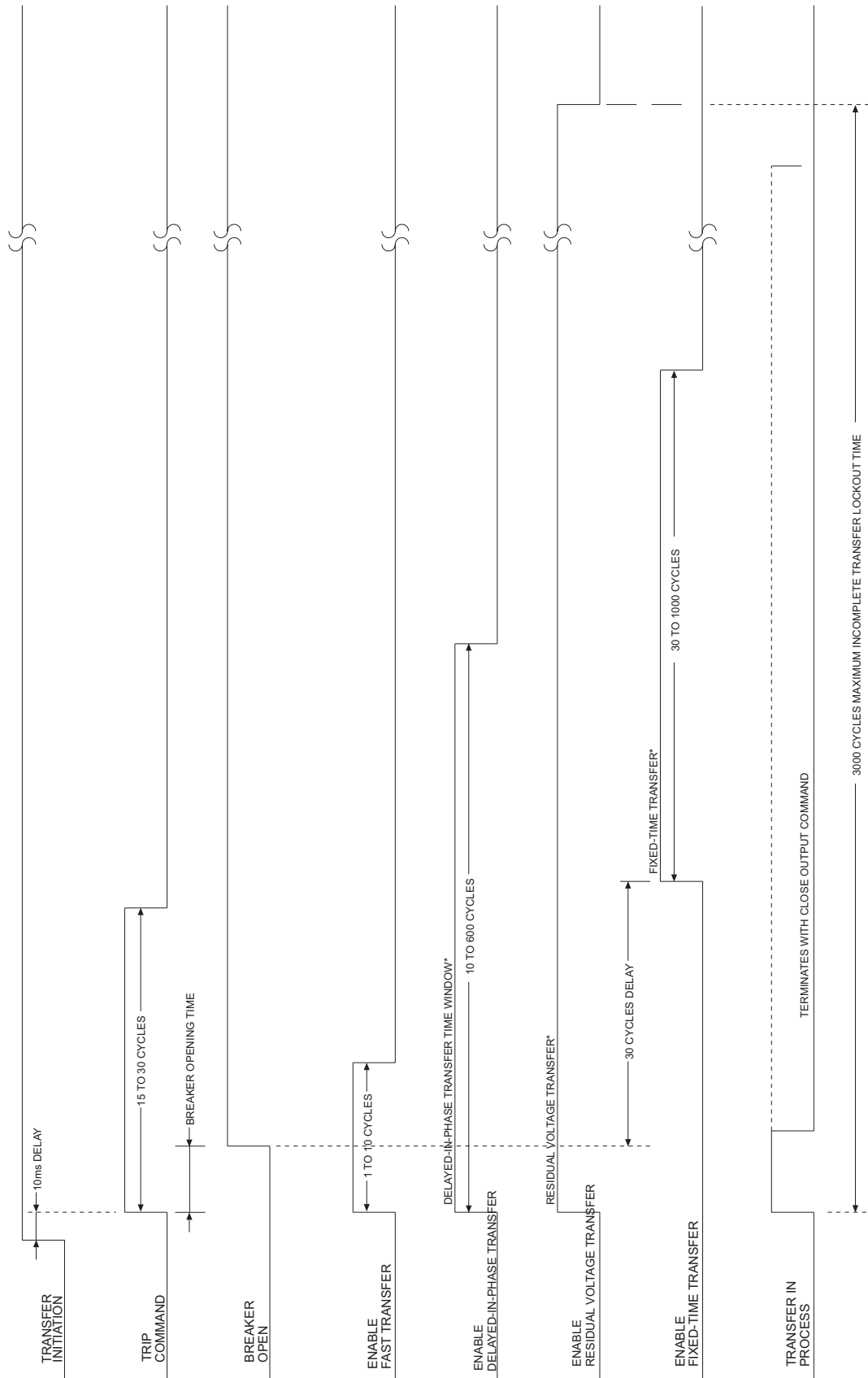
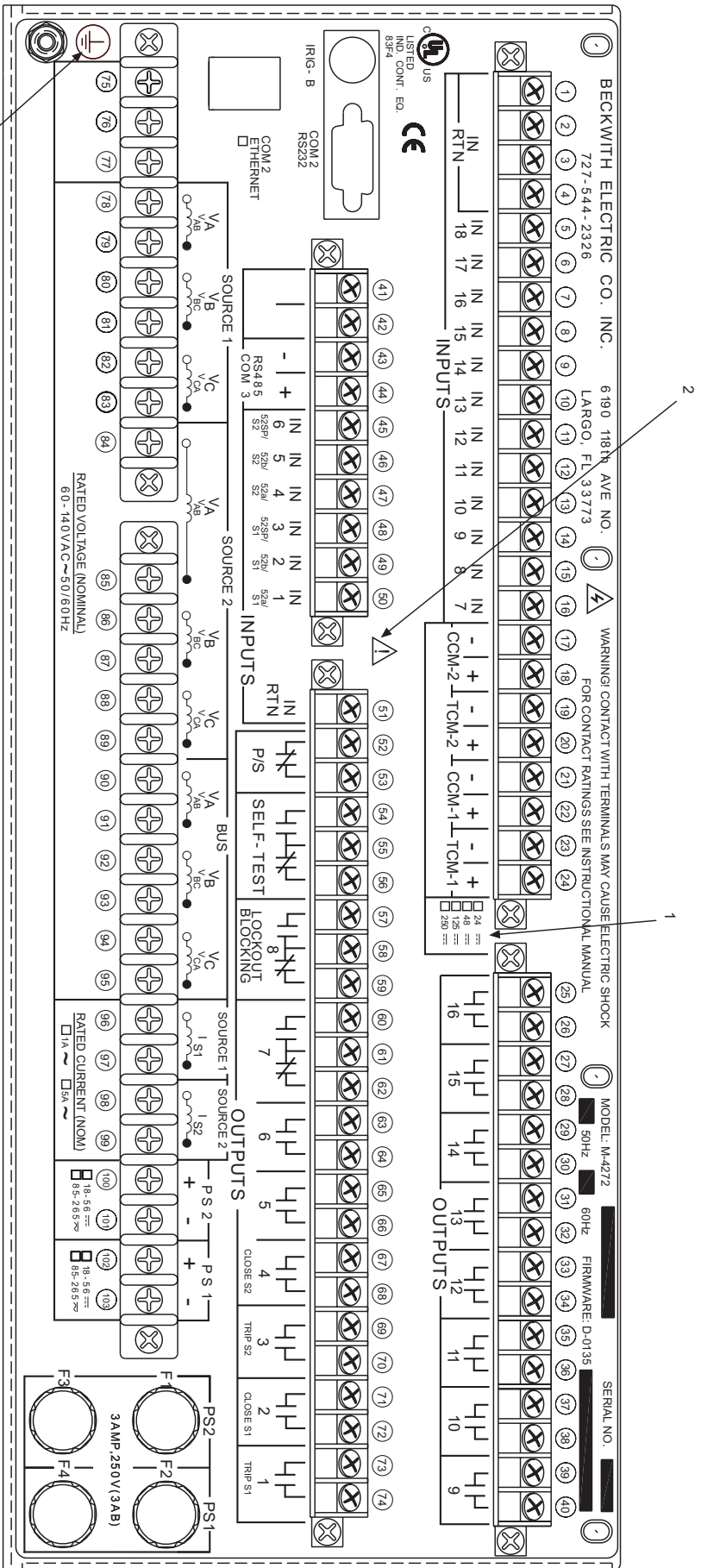*Figure 4   Time Sequence of Transfer Logic in Simultaneous Transfer Mode*

Figure 5   External Connections

■ NOTES:

1. Before making connections to the Trip/Close Circuit Monitoring input, see M-4272 Instruction Book Section 5.5, Circuit Board Switches and Jumpers, for the information regarding setting Trip/Close Circuit Monitoring input voltage. Connecting a voltage other than the voltage that the unit is configured to may result in mis-operation or permanent damage to the unit.

2. ● WARNING: ONLY DRY CONTACTS must be connected to inputs (terminals 45 through 50 with 51 common and terminals 5 through 16 with 1 through 4 common) because these contact inputs are internally wetted with 24 V dc. Application of external voltage on these inputs may result in damage to the units.

3. ● WARNING: The protective grounding terminal must be connected to an earthed ground any time external connections have been made to the unit.

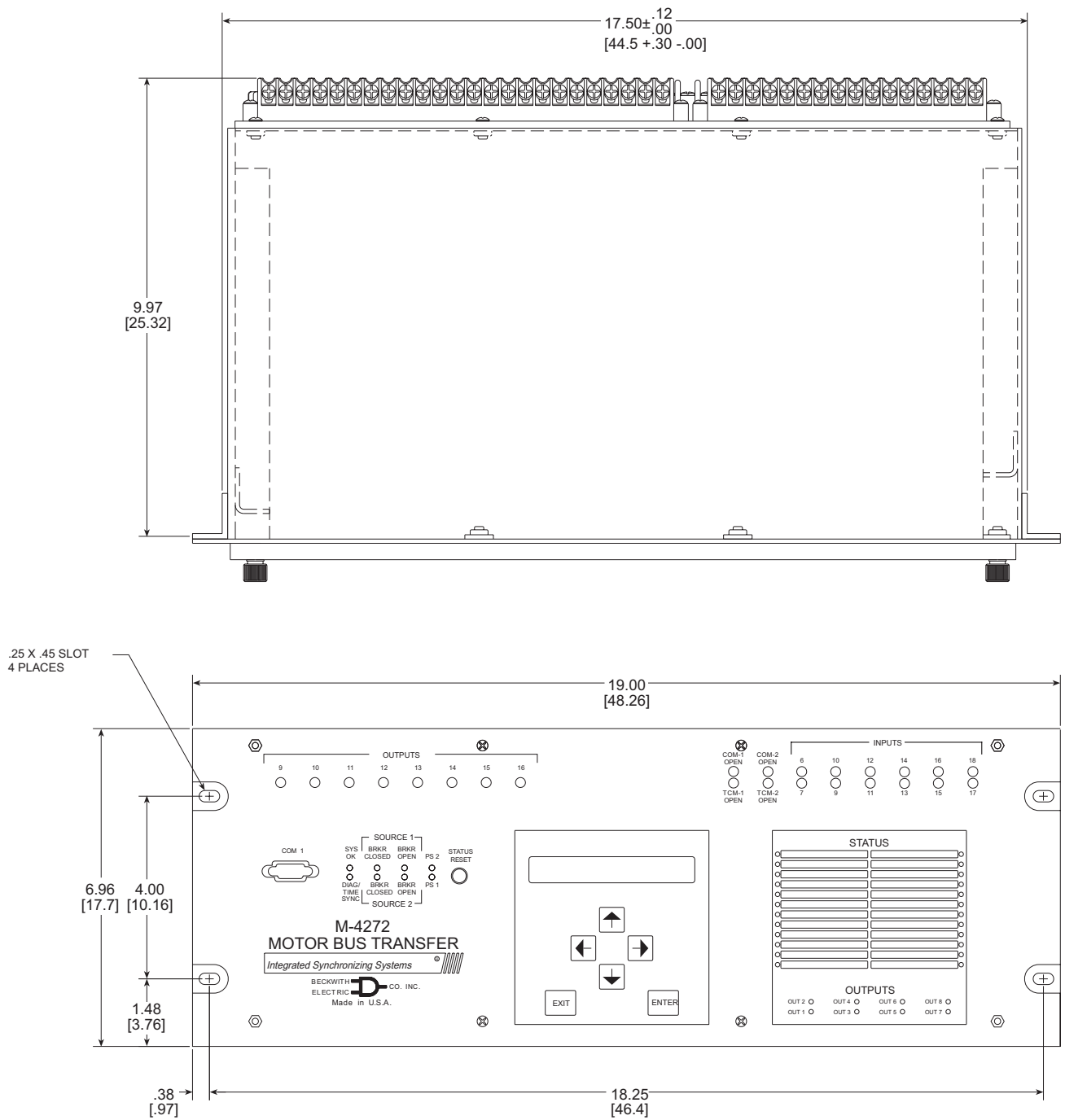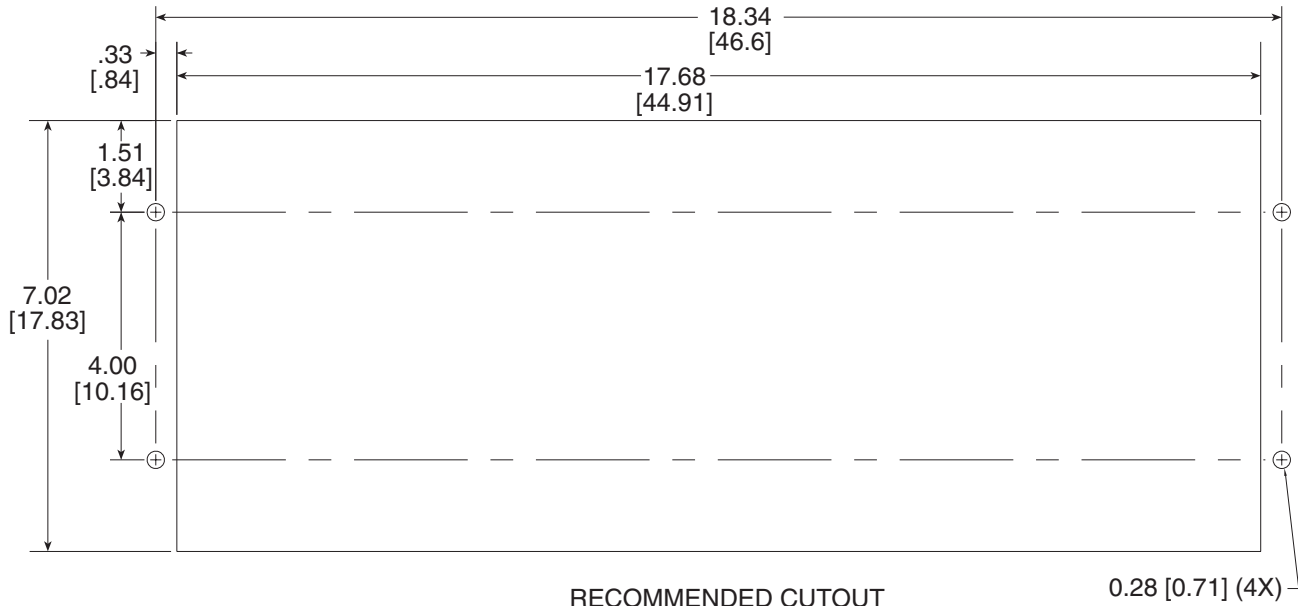*Figure 6 Horizontal Mounting Dimensions*

RECOMMENDED CUTOUT
4 UNIT PANEL M-4272

TOLERANCE: .XX±.015

Figure 7   Panel Mount Cutout Dimensions