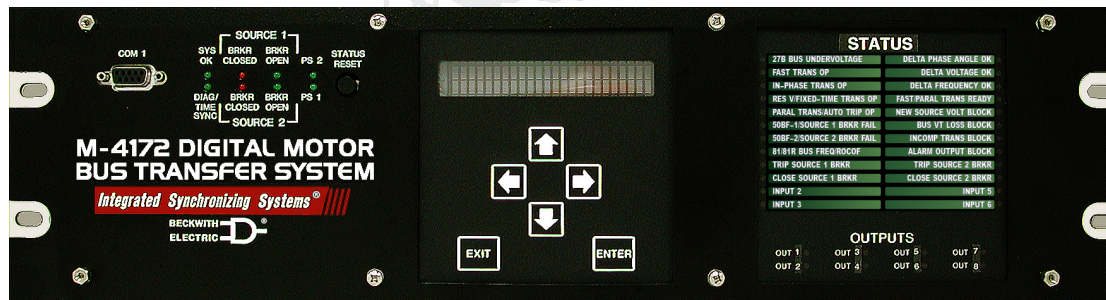


Digital Motor Bus Transfer System M-4172

Integrated Synchronizing System®



- Provides Automatic and Manual transfers of motor bus systems on Low Voltage Switchgears in power plants and industrial processing plants to ensure process continuity
- Automatically selects Fast, In-Phase, Residual Voltage, and Fixed Time motor bus transfers, based on varying system conditions
- Applicable for one way and bi-directional Manual transfers
- Can be expanded to accommodate multiple breaker configurations
- 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 protective relay transfer is not initiated.
- Fast Transfer with adjustable phase angle limit, delta voltage limit and delta frequency limit
- 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 is not possible
- Fixed Time Transfer after an adjustable time delay
- Programmable load shedding prior to initiating In-Phase Residual Voltage Transfer and Fixed Time Transfer
- 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, In-Phase Transfer and Residual Voltage Transfer (if the Hot Parallel Transfer is disabled)
- Programmable load shedding prior to initiating 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-4172 devices
- Breaker status supervision
- Breaker failure monitoring

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 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 lockout/blocking output contact, and 3 programmable output contacts (2 Form "a" and one Form "c")
- Two Breaker Status 52b (or 52a) inputs for the Source 1 and Source 2 breakers, four 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-3976 Status Module
- IRIG-B time synchronization
- Oscillographic recording
- Two RS-232 ports (front and rear) and one RS-485 port* (rear)
*When using M-3871 ISScom V10.02.XX to communicate with M-4172 units with Firmware version V03.00.XX and higher, the RS-485 port (COM 3) is not available.
- M-3871 ISScom® Communications and Oscillographic Analysis Software

Optional Features

- 5 A or 1 A models available
- 60 Hz or 50 Hz models available
- Available in vertical panel mount
- Redundant Power Supply
- External TCM and CCM available
- Ethernet Port RJ-45 10/100 Base-T (MODBUS over TCP/IP)
- Ethernet Port RJ-45 10/100 Base-T (IEC 61850 Protocol)

The M-4172 Digital Motor Bus Transfer System provides Automatic and Manual Transfers. The Fast Transfer, 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 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 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 and [Figure 3](#) for Open Transition Transfer methods.

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, 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, 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, Fast In-Phase and Residual Voltage Transfer methods 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 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 Sequential Transfer Mode.

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

Simultaneous Transfer Mode

Alternatively, once a transfer is initiated, and if the Simultaneous Mode is selected, within 10 ms of transfer initiate, Fast, In-Phase, and Residual Voltage Transfer methods 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 to trip and the new source* breaker to 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 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 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 5](#) for Timing Sequence of Transfer Logic in Simultaneous Transfer Mode.

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

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, 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.

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

The Output 8 Lockout/Blocking Output is energized when any Lockout/Blocking condition as mentioned above is active except Transfer In Process Blocking and Blocking After Transfer.

TRANSFER SETTINGS

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
Automatic 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).

In-Phase Transfer

Delta Voltage Limit	0 to 120 V	1 V	±0.5 V or ±2%
Delta Frequency Limit*	0.10 to 15.00 Hz	0.05 Hz	±0.02 Hz (±0.1 Hz)***
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); ±0.4 Hz(single phase).

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

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

For In-Phase Transfer, phase angle accuracy at first phase coincidence is 10.0 degrees with up to 15.0 Hz slip frequency.

Residual Voltage Transfer

Residual Voltage Limit	5 to 60 V	1 V	±0.5 V or ±2%
Load Shedding Time Delay*	0 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*	0 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 Fixed Time delay has timed out. The Close command for the Fixed Time Transfer is sent after the programmed load shedding time delay.

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

TRANSFER SETTINGS (cont.)

Device Number	Function	Setpoint Ranges	Increment	Accuracy [†]
Manual 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).

In-Phase Transfer

Delta Voltage Limit	0 to 120 V	1 V	±0.5 V or ±2%
Delta Frequency Limit*	0.10 to 15.00 Hz	0.05 Hz	±0.02 Hz (±0.1 Hz)***
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); ±0.4 Hz (single phase).

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

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

For In-Phase Transfer, phase angle accuracy at first phase coincidence is 10.0 degrees with up to 15.0 Hz slip frequency.

Residual Voltage Transfer

Residual Voltage Limit	5 to 60 V	1 V	±0.5 V or ±2%
Load Shedding Time Delay*	0 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.

Hot Parallel 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 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).

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

TRANSFER SETTINGS (cont.)

Device Number	Function	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

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

⁽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 + or - this value.

	Incomplete Transfer Lockout Time ⁽³⁾	50 to 3000 Cycles	1 Cycle	±1 Cycle or ±1%
	Local Manual Transfer Initiate Time Delay ⁽⁴⁾	0 to 8160 Cycles	1 Cycle	1 Cycle or 1%
	Remote Manual Transfer Initiate Time Delay ⁽⁶⁾	0 to 8160 Cycles	1 Cycle	1 Cycle or 1%
	Blocking After Transfer Time ⁽⁵⁾	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

⁽³⁾ 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.

⁽⁴⁾ This time delay is only applicable when the manual transfer is initiated from the local front panel via the HMI or Com1 port.

⁽⁵⁾ This timer is used to block any additional transfer after a transfer has been completed.

⁽⁶⁾ This time delay is only applicable when manual transfer is initiated from the Control/Status input, Com2 Port, Com3 Port or Ethernet Port.

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

FUNCTIONS

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
Auto Trip				
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 Undervoltage Automatic transfer initiate function that is used for Automatic Transfer from S1 to S2 direction.

27B #2 is the Bus Undervoltage Automatic transfer 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 voltage input is applied.

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-4172 output contacts or programmable inputs.

* Value in parentheses apply to 1A Secondary Rating

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-4172 output contacts or programmable inputs.

* Value in parentheses apply to 1A Secondary Rating

Source 1 Breaker Failure (Using breaker status)

Time Delay	0 to 30 Cycles	1 Cycle	1 Cycle
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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.

Source 2 Breaker Failure (Using breaker status)

Time Delay	0 to 30 Cycles	1 Cycle	1 Cycle
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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

Device Number	Function	Setpoint Ranges	Increment	Accuracy†
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81 Bus Frequency

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); ±0.4 Hz(single phase).

The 81 #1 Function can be used to initiate Load Shedding. The 81 Function is automatically disabled when the bus 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 parentheses applies to single phase bus frequency.

81R Bus Rate of Change of Frequency

81R	Pickup #1, #2	0.10 to 20.00 Hz/Sec.	0.01 Hz/Sec.	±0.05 Hz/Sec. or ±5%
	Time Delay #1, #2	3 to 8160 Cycles	1 Cycle	+20 Cycles
	Negative Sequence Voltage Inhibit	0 to 99%	1%	±0.5%
	Increasing ROCOF	Enable/Disable		

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

60FL	Delta Voltage Pickup*	5 to 25 V	1 V	±.05 V or ±2%
	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 initiated from internally generated logic.

ISSLogic®

ISSL	ISSLogic uses control/status input status, system status, function status, output contact close signals to develop 6 programmable logic schemes.			
	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%

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

Metering

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

Metering accuracies are:

Voltage: ± 0.5 V or $\pm 0.5\%$, 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 $\pm 0.75\%$, 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 $\pm 3\%$, whichever is greater
1 A rating, ± 0.02 A or $\pm 3\%$, 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 $\pm 0.5\%$, 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.

▲ CAUTION: Oscillograph records are not retained if power to the control is interrupted.

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.

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

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-3871 ISScom Communications Software.

Sequence of Events Recording

In addition to the Transfer Event Log the Digital Fast 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. 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-3871 ISScom® Communications Software.

▲ CAUTION: Sequence of Events records are not retained if power to the control is interrupted.

Calculations

Current and Voltage Values: The Digital Fast 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-4172.

Power Input Options

Nominal 110/120/230/240 Vac, 50/60 Hz, or nominal 110/125/220/250 Vdc. UL Rating 85 Vac to 265 Vac and from 80 Vdc to 288 Vdc. Burden 20 VA at 120 Vac/125 Vdc. Withstands 315 Vdc or 300 Vac for 1 second.

Nominal 24/48 Vdc, operating range from 18 Vdc to 56 Vdc. Burden 20 VA at 24 Vdc and 20 VA at 48 Vdc. Withstands 65 Vdc for 1 second.

An optional redundant power supply is available.

Sensing Inputs

Nine Voltage Inputs – Rated for a nominal voltage of 60 Vac to 140 Vac (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-4172 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.

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 52a or 52b breaker contacts must be connected to inputs 1 and 4. The default programming of **INPUT1** is S1 52a. The default programming of **INPUT4** is S2 52a. The remaining inputs are left unprogrammed and can be programmed to initiate the transfer or block the transfer operation, trigger the Oscillograph recorder, or to operate one or more outputs.

The four inputs, INPUT2, INPUT3, INPUT5 and INPUT6 are fully programmable to any of the following functions:

- None
- S1 52 SP (service position)
- S2 52 SP (service position)
- Automatic Transfer Block
- 86P-S1 Initiate (S1 to S2)
- 86P-S2 Initiate (S2 to S1)
- 27-S1 Initiate (S1 to S2)
- 27-S2 Initiate (S2 to S1)
- Transfer Block #1
- Transfer Block #2
- Transfer Block #3
- External Status Reset
- Manual Transfer Initiate
- Manual Transfer Block

The control/status inputs are designed to be connected to dry contacts and are internally wetted with a 24 Vdc power supply. The minimum current value to initiate/pickup an input is ≥ 25 mA.

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 predefined.

The three programmable output contacts OUTPUT5 through OUTPUT7 (two form "a" and one form "c"), the Lockout/Block alarm output contact OUTPUT8 (form "c"), the power supply alarm output contact (form "b") and the self-test alarm output contact (form "c"), are all rated as per IEEE C37.90 (see Tests and Standards section for details).

Any of the MBTS functions can be individually programmed to activate any one or more of the programmable output contacts (Outputs 5 to 7). Any output contact can also be selected as pulsed or latched. ISSLogic can also be used to activate an output contact.

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.

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

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 52b contact is open). The **SOURCE 1 BRKR OPEN** and **SOURCE 2 BRKR OPEN** green LEDs illuminate when the breaker is open (when the 52b contact is closed). The 52 contact input can be configured for either "a" or "b" inputs. The appropriate **status** LED will illuminate when corresponding 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** (if a redundant power supply is installed) 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.

Communication

Communication ports include rear RS-232 and RS-485 ports (see NOTE), 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-3871 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

■ **NOTE:** When using M-3871 ISScom V10.02.XX to communicate with M-4172 units with Firmware version V03.00.XX and higher, the RS-485 port (COM 3) is not available.

Optional Ethernet Port

The RJ-45 Ethernet port supports 10/100 Base-T fast Ethernet standard with auto negotiable speed. Additionally, MDI-X capability is provided to eliminate the need of a crossover cable when two similar devices are connected. The optional RJ-45 Ethernet port may be purchased with the following communication protocols:

- MODBUS/BECO2200 over TCP/IP
- IEC 61850: up to 4 concurrent sessions, to monitor all metering values, change settings and generate unsolicited reports. Refer to M-4172 Instruction Book, Section 4.1 Unit Setup for detailed information.

The M-3871 ISScom Communications and Oscillographic Analysis Software enables the plotting and printing of M-4172 waveform data downloaded from the unit to any Windows® compatible computer. The ISScom 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-4172 accepts either modulated (B-122) using the BNC Port, or demodulated (B-002) using the RS-232 Port, 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-4172 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-3976 Status Module provides 24 status and 8 output LEDs. Appropriate status LEDs illuminate when the corresponding M-4172 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.

ISSLogic®

This feature can be programmed utilizing the M-3871 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 ISSLogic Functions. The ISSLogic Function Diagram is illustrated in [Figure 1](#).

Tests and Standards

M-4172 Digital Fast Transfer System complies with the following type tests and standards:

Voltage Withstand

Dielectric Withstand

IEC 60255-5 2,000 Vac / 3,500 Vdc for 1 minute applied to each independent circuit to earth
 2,000 Vac / 3,500 Vdc for 1 minute applied between each independent circuit
 1,500 Vdc for 1 minute applied to IRIG-B circuit to earth
 1,500 Vdc for 1 minute applied between IRIG-B to each independent circuit
 1,500 Vdc 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 μ s, 500 ohms impedance, three surges at 1 every 5 seconds

Insulation Resistance

IEC 60255-5 > 100 Megaohms

Voltage Interruptions Immunity

IEC 60255-11 (AC) 5 cycles, (DC) 30 ms - max

Electrical Environment

Emissions

EN 55022 Class A Limits
 Conducted Emissions 150 kHz-30 MHz
 Radiated Emissions 30 MHz-1000 MHz

Electrostatic Discharge Test

EN 60255-22-2 Class 4 (8 kV)—point contact discharge
 EN 60255-22-2 Class 4 (15 kV)—air discharge

Fast Transient Disturbance Test

EN 60255-22-4 Class A (4 kV, 2.5 kHz)
 Ethernet Port (2 kV, 2.5 kHz)

Surge Withstand Capability

ANSI/IEEE 2,500 V pk-pk oscillatory applied to each independent circuit to earth
 C37.90.1-1989 2,500 V pk-pk oscillatory 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

ANSI/IEEE 2,500 V pk-pk oscillatory applied to each independent circuit to earth
 C37.90.1-2002 2,500 V pk-pk oscillatory applied between each independent circuit
 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

■ **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.

M-4172 Digital Motor Bus Transfer System – Specification

Radiated Immunity

IEEE C37.90.2	80-1000 Mhz @ 35 V/m
IEC 61000-4-3	1000-6000 MHz @ 10 V/m

Conducted Immunity

EN 60255-22-6	10 V _{emf} 150 kHz-80 MHz
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Output Contacts

IEEE C37.90	30 A make for 0.2 seconds at 250 Vdc Resistive
UL 508	8 A carry at 120 Vac, 50/60 Hz
CSA C22.2 No. 14	6 A break at 120 Vac, 50/60 Hz 0.5 A break at 48 Vdc, 24 VA 0.3 A break at 125 Vdc, 37.5 VA 0.2 A break at 250 Vdc, 50 VA

Atmospheric Environment

Temperature

IEC 60068-2-1	Cold, -20° C (-4° F) Operating
IEC 60068-2-2	Dry Heat, +70° C (+158° F) Operating
IEC 60068-2-78	Damp Heat, +40° C @ 95% _{RH} Operating
IEC 60068-2-30	Damp High Heat Condensation Cycles +25° C, +55° C (131° F) @ 95% _{RH} Operating

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, 5.0 g Shock Withstand Class 1, 15.0 g Bump Response Class 1, 10.0 g

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 5.21" high x 10.20" deep (48.3 cm x 13.2 cm x 25.9 cm)

Mounting: The unit is a standard 19", semi flush, 3-unit high, rack-mount panel design, conforming to ANSI/EIA RS-310C and DIN 41494 Part 5 specifications. Optional mounting is available.

Environmental: For flat surface mounting on a Type 1 enclosure, UL rated to 70°C surrounding air ambient.

Approximate Weight: 17 lbs (7.7 kg)

Approximate Shipping Weight: 25 lbs (11.3 kg)

Recommended Storage Parameters

Temperature: 5° C to 40° C

Humidity: Maximum relative humidity 80% for temperatures up to 31° C, decreasing to 31° C linearly to 50% relative humidity at 40° C.

Environment: Storage area to be free of dust, corrosive gases, flammable materials, dew, percolating water, rain and solar radiation.

See M-4172 Instruction Book, Appendix G, Layup and Storage for additional information.

Disposal and Recycling

Disposal of E-Waste for Beckwith Electric Products

The customer shall be responsible for and bear the cost of ensuring all governmental regulations within their jurisdiction are followed when disposing or recycling electronic equipment removed from a fixed installation.

Equipment may also be shipped back to Beckwith Electric for recycling or disposal. The customer is responsible for the shipping cost, and Beckwith Electric shall cover the recycling cost. Contact Beckwith Electric for an RMA # to return equipment for recycling.

Patent & Warranty

The M-4172 Digital Fast Transfer System is covered by U.S. Patent 7,468,593.

The M-4172 Digital Fast Transfer System is covered by a ten year warranty from date of shipment.

External Connections

M-4172 external connection points are illustrated in [Figure 6](#) & [Figure 7](#), External Connections.

TRADEMARKS

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Specification subject to change without notice. Beckwith Electric has approved only the English version of this document.

ISSLogic Functions

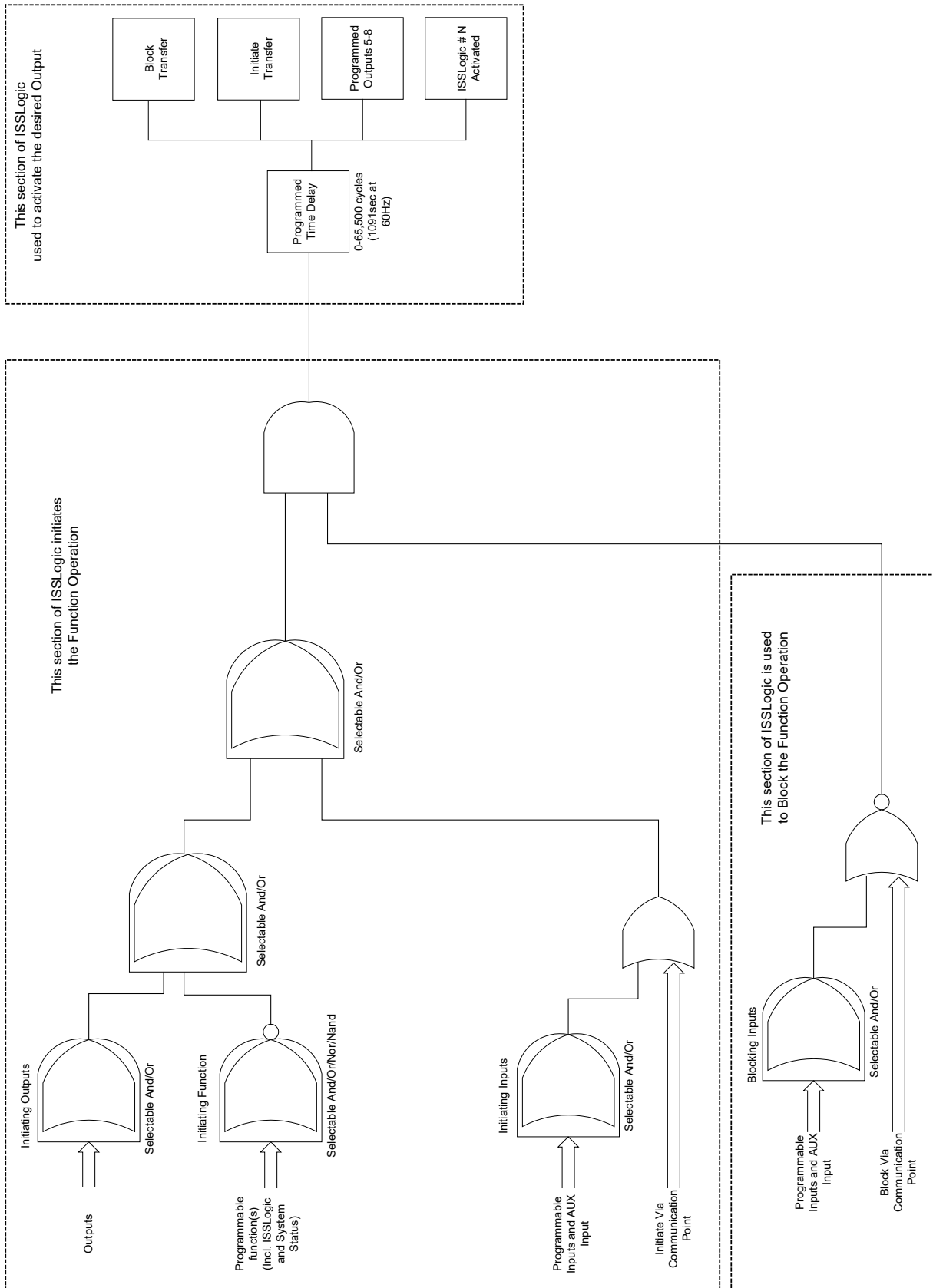
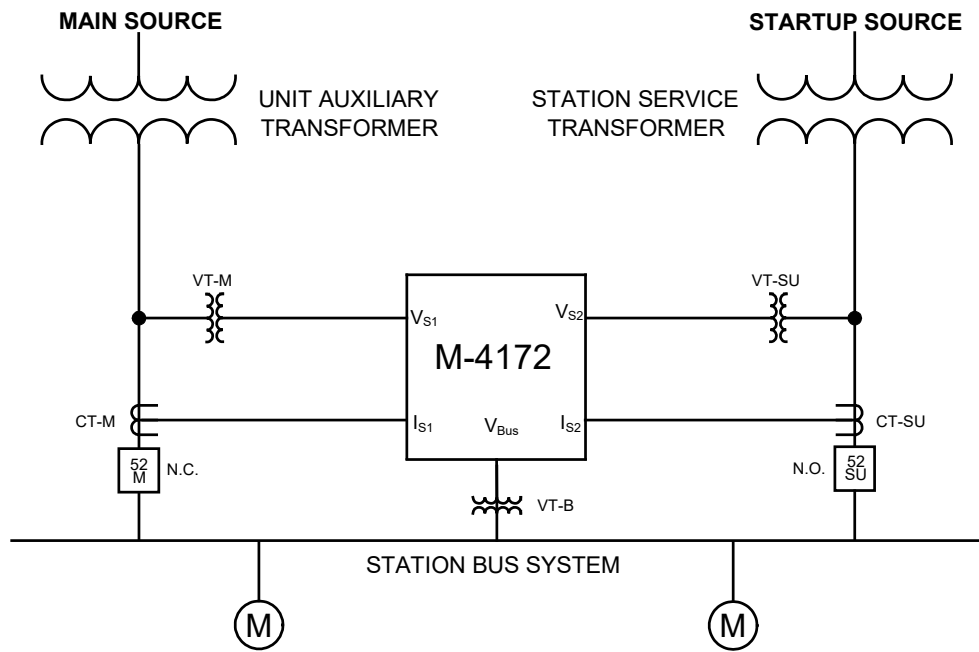
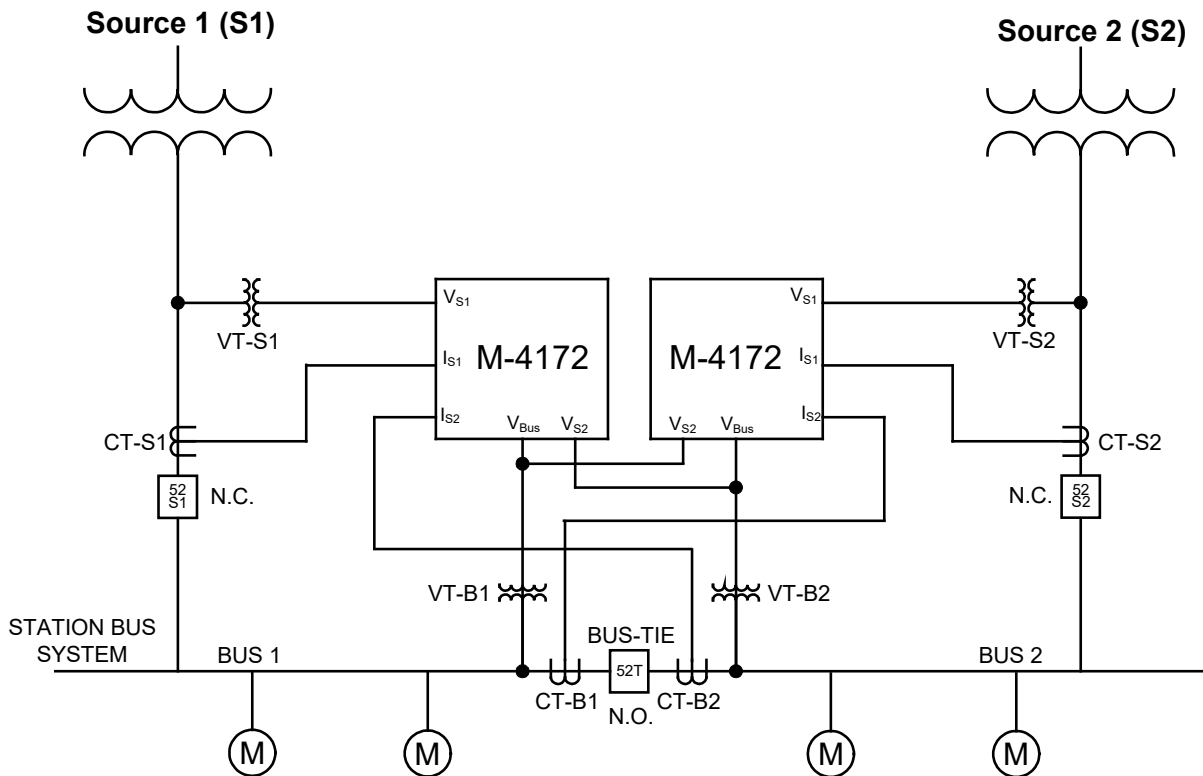


Figure 1 ISSLogic® Function Diagram



TWO-BREAKER CONFIGURATION

TWO-BREAKER CONFIGURATION



THREE-BREAKER CONFIGURATION

■ **NOTE:** Current Transformers are used for the M-4172's 50BF Function metering and oscillography, they are not required for transfer operation.

Figure 2 Typical Applications of Motor Bus Transfer Systems

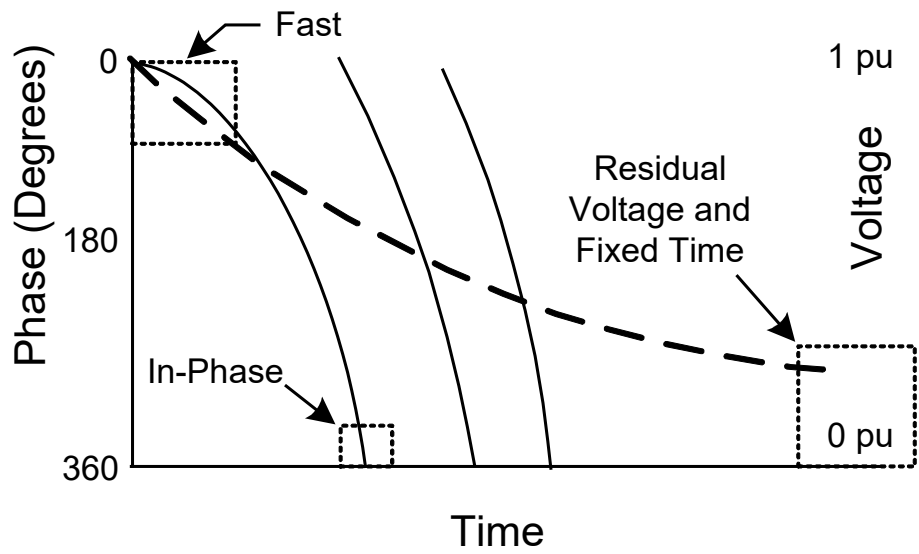


Figure 3 Open Transition Transfer Methods

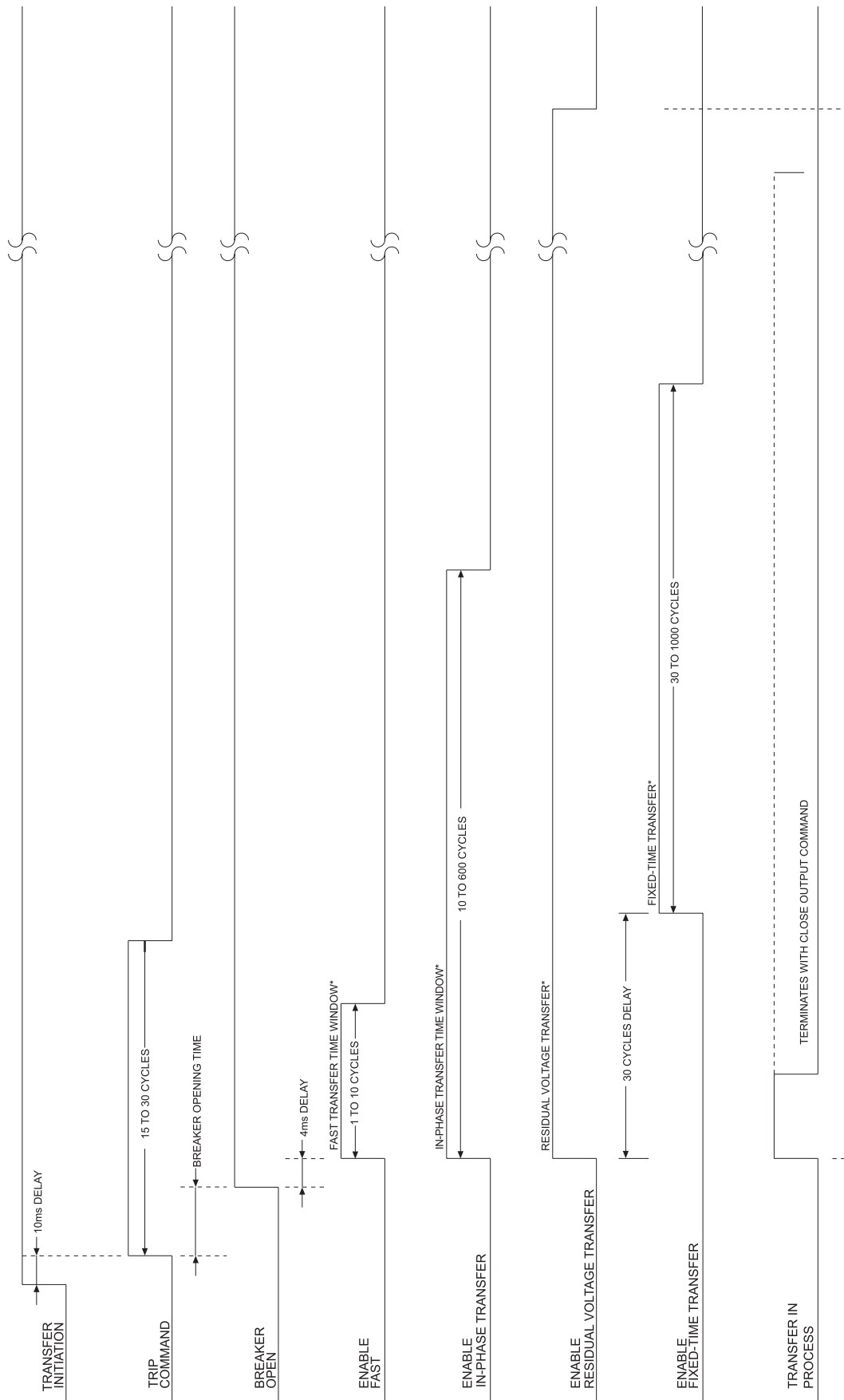


Figure 4 Time Sequence of Transfer Logic in Sequential Transfer Mode

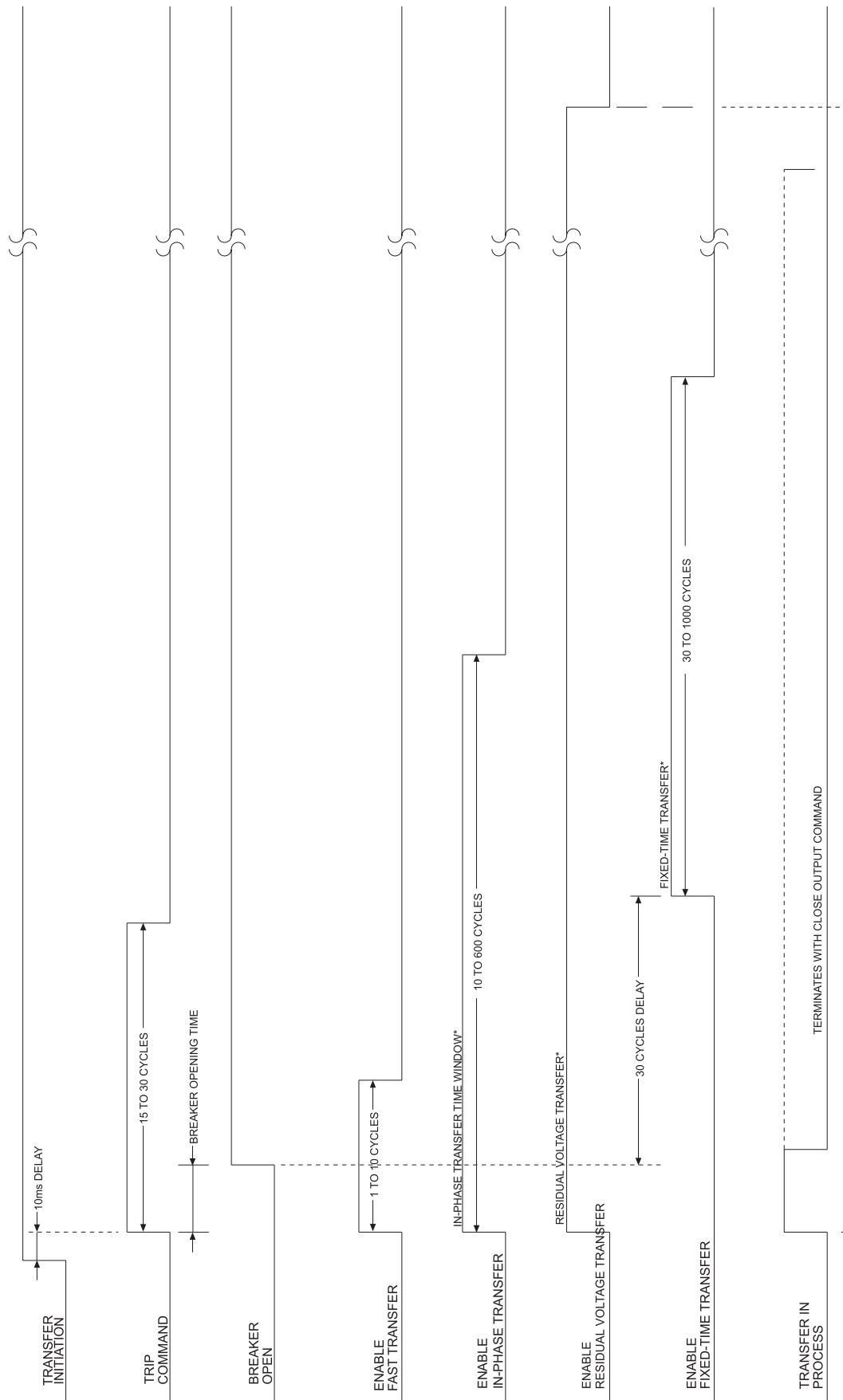
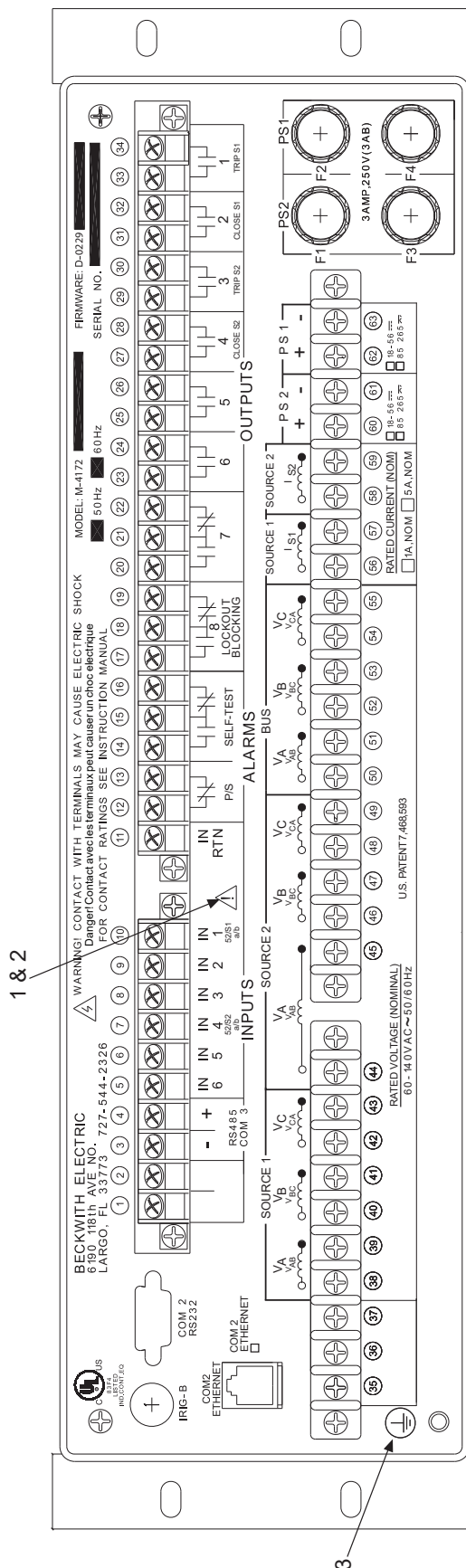


Figure 5 Time Sequence of Transfer Logic in Simultaneous Transfer Mode



1. **WARNING: ONLY DRY CONTACTS must be connected to inputs (terminals 5 through 10 with 11 common) because these contact inputs are internally wetted with 24 Vdc. Application of external voltage on these inputs may result in damage to the units.**

2. **CAUTION:** The 52a or 52b Breaker Status contact can be connected to Input 1 52/S1 and Input 4 52/S2. The M-4172 must be programmed to agree with the 52a or 52b contact connections respectively.

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

NOTE: All relays are shown in the de-energized state, and without power applied to the relay.

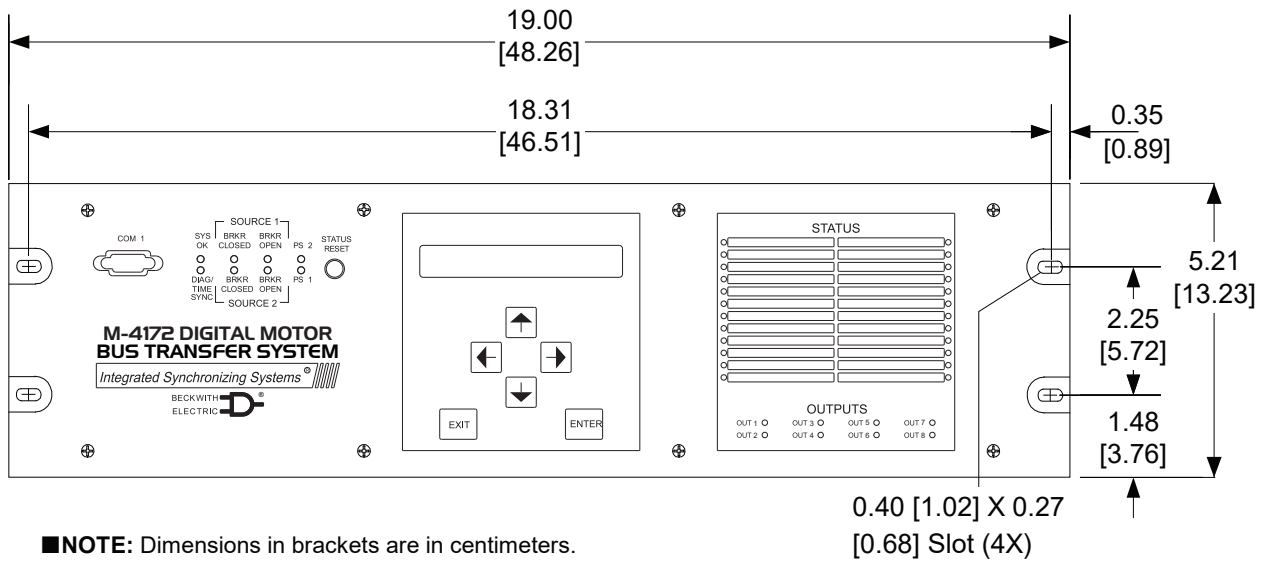
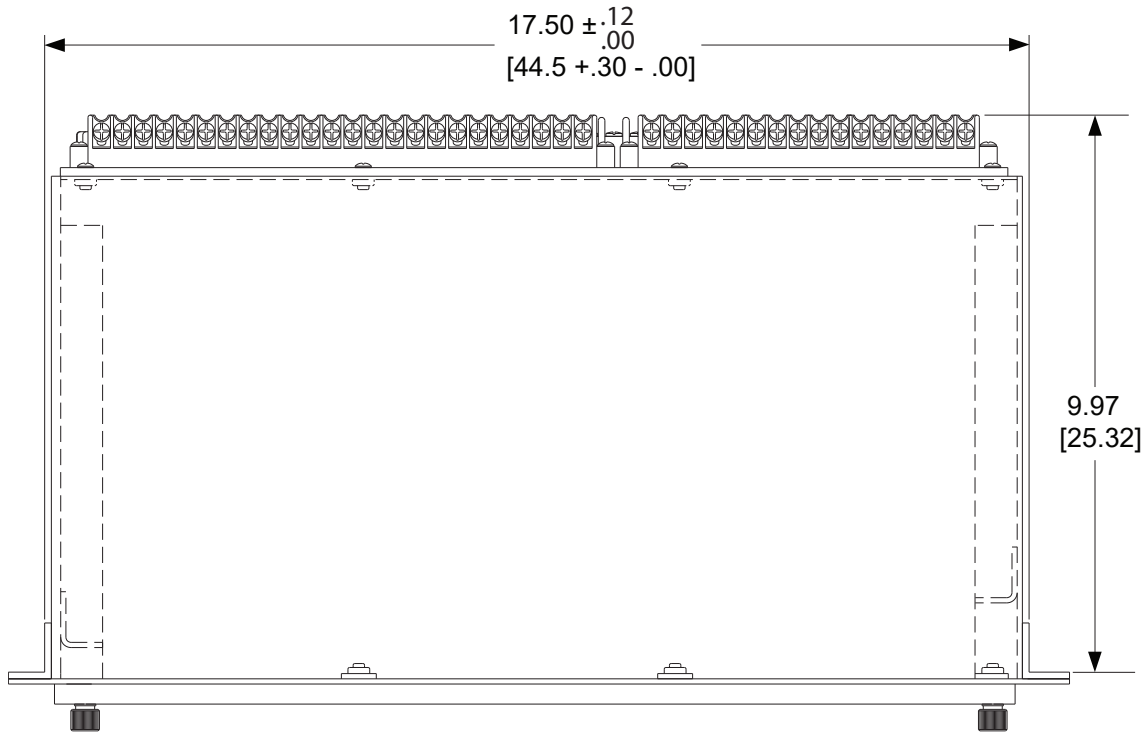
NOTE: The self-test relay is energized when the relay has performed all self-tests successfully.

NOTE: The Lockout Blocking Output is energized when any Lockout/Blocking condition occurs. See Lockout/Blocking section for details.

NOTE: The power supply relay (P/S) is energized when the power supply is functioning properly.

Figure 6 External Connections (Horizontal Mount)

M-4172 Digital Motor Bus Transfer System – Specification

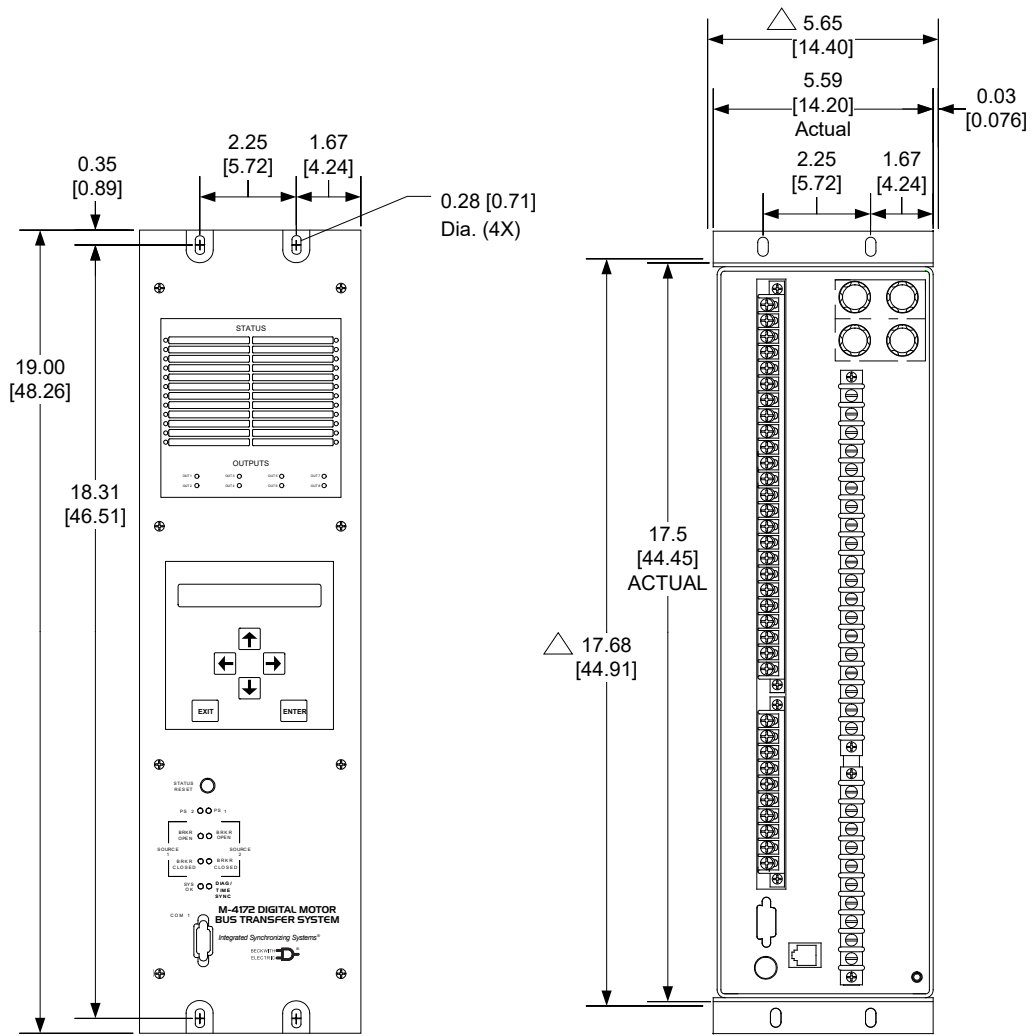


■NOTE: Dimensions in brackets are in centimeters.

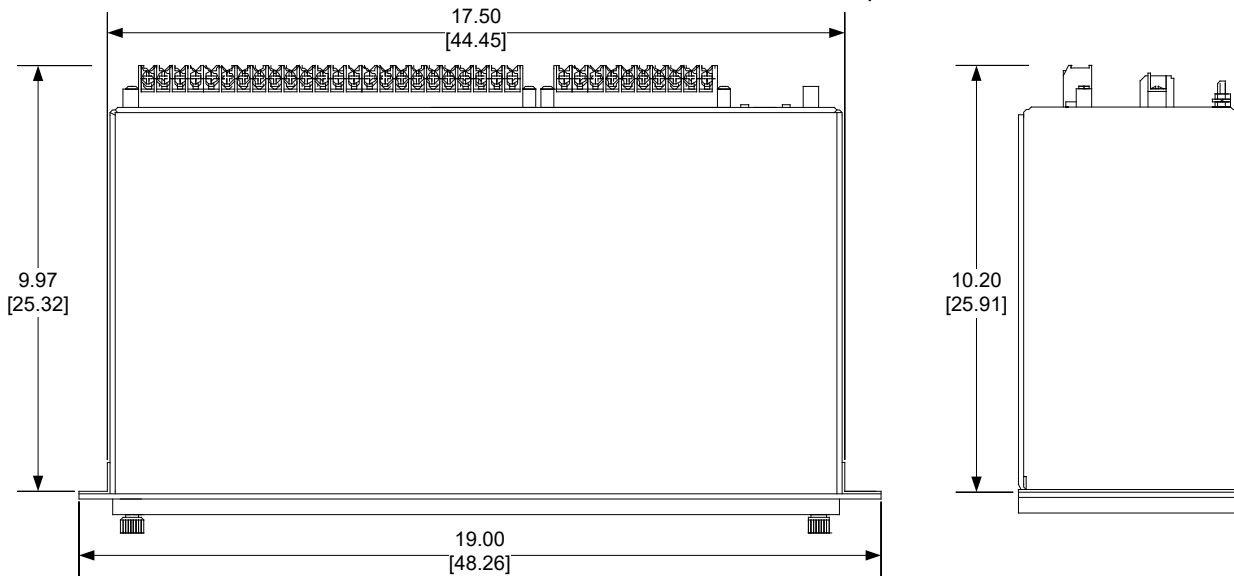
Standard 19" Horizontal Mount Chassis

Figure 8 Horizontal Mounting Dimensions

M-4172 Digital Motor Bus Transfer System – Specification



△ Recommended cutout when relay is not used as standard rack mount and is panel cut out mounted.



■ **NOTE:** Dimensions in brackets are in centimeters.

Figure 9 Vertical Mounting Dimensions



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