

**Application Guide**

**M-0193B  
Syncrocloser Unit**

**BECKWITH  
ELECTRIC**  **CO. INC.**

# Syncrocloser<sup>®</sup> Unit M-0193B



- **Accurate, independent controls require no additional instrumentation for field setting**
- **Various  $\Delta V$  and  $\Delta F$  limits available**
- **Breaker closing times are field programmable**
- **50 Hz operation available**

## Inputs

**Gen/Line Voltage**, nominal 120 V ac, 145 V ac maximum continuous. Will withstand 200 V ac for 1 sec.

**Bus Voltage**, nominal 120 V ac, 145 V ac maximum continuous. Will withstand 200 V ac for 1 sec.

**Supply Voltage**, minimum 100 V ac, maximum 140 V ac.

**Enable Auto-Sync** close.

**Breaker Closing Time**; field programmable from 20 to 800 ms.

■ **NOTE:** Gen/Line, Bus and Supply voltages are transformer-isolated to allow complete freedom in applications.

## Burden

**Gen/Line or Bus:** 0.5 VA maximum at 120 V ac

**Supply:** 7 VA maximum at 120 V ac

## Controls

**UPPER VOLTAGE LIMIT** (either input): 110 to 140 V ac, accuracy  $\pm 1\text{--}1/2\%$  of full scale

**LOWER VOLTAGE LIMIT** (either input): 90 to 120 V ac, accuracy  $\pm 1\text{--}1/2\%$  of full scale

**$\Delta V$  LIMIT** (MAXIMUM VOLTAGE DIFFERENCE LIMIT): 1 to 5 V ac, accuracy  $\pm 5\%$  of full scale. Multiples of this range are available. A  **$\Delta V$  LIMIT** of 4 to 20 V ac or lower must be specified if the M-0193B is to be used in conjunction with the M-0194 Generator Control Unit.

**$\Delta F$  LIMIT** (Maximum Frequency Difference Limit): 0.05 to 0.5 Hz, accuracy  $\pm 3\%$  of full scale. An additional range of 0.005 to 0.05 Hz is available.

## LED Indicators

These LEDs are lit when conditions are met to close the breaker:

**BUS UPPER VOLTAGE LIMIT OK**

**GEN/LINE UPPER VOLTAGE LIMIT OK**

**BUS LOWER VOLTAGE LIMIT OK**

**GEN/LINE LOWER VOLTAGE LIMIT OK**

**$\Delta V$  LIMIT OK**

**$\Delta F$  LIMIT OK**

**M-0193B READY**

## Breaker Close Relays

Dry output contacts rated to make and carry 20 A up to 250 V dc, interrupt 0.9 A, 120 V dc inductive load; 0.4 A, 250 V dc inductive load. Open contacts or contacts to ground will withstand 1500 V ac for one minute.

## Status Contacts

Relay contacts; closed indicates  $\Delta F$  conditions OK

Relay contacts; closed indicates  $\Delta V$  conditions OK

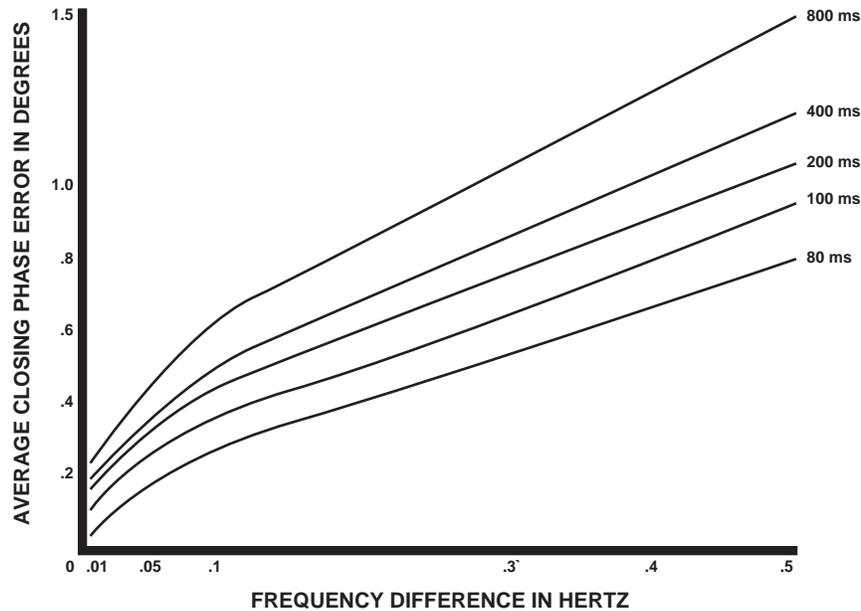
These are light duty contacts intended primarily for status interrogation by supervisory control. They can be used to light local lights with the following maximum restrictions: 1/2 A at 125 V dc resistive, 1 A 120 V ac, 250 V dc across open contacts

## Minimum Frequency Difference

The guaranteed minimum frequency difference for operation is 0.0005 Hz; however, typical units consistently operate with frequency differences of 0.0001 Hz.

## Zero Phase Prediction

The figure below illustrates the average closing phase error as a function of frequency difference for 80 ms, 100 ms, 200 ms, 400 ms, and 800 ms breaker closing times. This data was taken under lab conditions with a constant frequency difference.



## Anti-Motoring

The Anti-Motoring feature prevents closing of the breaker when the generator frequency is slower than the line frequency, thus preventing motoring power from flowing into the generator. This feature is enabled/disabled by a switch internal to the M-0193B. This default position is OFF (disabled).

## Operator Window Option

The Operator Window Option allows an operator to work in conjunction with the M-0193B. The operator's contact must be closed within a variable time and phase angle "window", otherwise the M-0193B will block closing of the breaker. The unit will then automatically reset for the next attempt to close.

## Anti-Pump Option

The breaker close contacts will close for approximately 0.5 sec. Power must be removed for approximately 10 sec. before another closure is possible, regardless of other inputs. A front panel LED (M-0193B Ready) indicates that the M-0193B is active and ready to operate, provided input conditions meet their respective limits. The M-0193B can be ordered without the Anti-Pump Option. In this case, the M-0193B will close once on each slip cycle when all input conditions are within their limits and the unit is enabled.

## Generator Control Unit Compatibility Option

This option must be ordered if the M-0193B is to be used in conjunction with the M-0194 Generator Control Unit. Please refer to the M-0193B Application Guide for further information.

## **50 Hz Option**

This option allows the M-0193B to operate with Gen/Line and Bus frequency at nominal 50 Hz.

## **Mounting Options**

Horizontal mounting is standard; vertical mounting or vertical General Electric GES21A Retrofit Panel mounting are available as options.

## **Syncrocloser® Unit cover Kit**

The M-0193B Syncrocloser Unit includes a transparent cover with associated mounting bracket to cover the dials and prevent accidental resetting.

## **Reliability**

The M-0193B Syncrocloser Unit is assembled on a single glass-epoxy printed circuit board, thereby eliminating the need for plug-in connectors. All semiconductor components are hermetically sealed and are of the highest and most reliable quality available. Highly stable, instrument grade capacitors and resistors are used in critical measurement circuits to minimize the possibility of error.

The output relay is picked up for approximately 0.5 sec. by a capacitor which also forms the time delay. No sela-in is required, because once the capacitor discharge into the relay is started, it cannot be stopped by input conditions.

## **Transient Protection**

Input and output circuits are protected against system transients. The M-0193B will pass requirements of ANSI/IEEE C37.90.1-1989, which defines oscillatory and fast transient surge withstand capability. All inputs and outputs will withstand 1500 V ac to chassis or instrument ground for one minute. Voltage inputs are electrically isolated from each other, from other circuits, and from ground.

## **Environmental**

**Temperature Range:** Stated accuracies are maintained from  $-40^{\circ}$  to  $+80^{\circ}$  C

**Humidity:** Stated accuracies are maintained under 95% relative humidity (non-condensing)

**Fungus Resistance:** A conformal printed circuit board coating inhibits fungus growth

## **Physical**

**Size:** 19" wide x 3-1/2" high x 13" deep (48.26 cm x 8.89 cm x 33.02 cm). Horizontal mounting requires two rack units space in a standard 19" rack.

**Approximate Weight:** 15 lb (6.8 kg)

**Approximate Shipping Weight:** 20 lb (9.1 kg)

## **Patents**

U.S. Patent 3,491,248

## **Warranty**

The M-0193B Syncrocloser Unit is covered by a five year warranty from date of shipment.

*Specification subject to change without notice.*

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**ISO 9001:2008**

# WARNING

**DANGEROUS VOLTAGES**, capable of causing death or serious injury, are present on the external terminals and inside the equipment. Use extreme caution and follow all safety rules when handling, testing or adjusting the equipment. However, these internal voltage levels are no greater than the voltages applied to the external terminals.

## **DANGER! HIGH VOLTAGE**



- This sign warns that the area is connected to a dangerous high voltage, and you must never touch it.

## **PERSONNEL SAFETY PRECAUTIONS**

*The following general rules and other specific warnings throughout the manual must be followed during application, test or repair of this equipment. Failure to do so will violate standards for safety in the design, manufacture, and intended use of the product. Qualified personnel should be the only ones who operate and maintain this equipment. Beckwith Electric Co., Inc. assumes no liability for the customer's failure to comply with these requirements.*



- This sign means that you should refer to the corresponding section of the operation manual for important information before proceeding.



### **Always Ground the Equipment**

To avoid possible shock hazard, the chassis must be connected to an electrical ground. When servicing equipment in a test area, the Protective Earth Terminal must be attached to a separate ground securely by use of a tool, since it is not grounded by external connectors.

### **Do NOT operate in an explosive environment**

Do not operate this equipment in the presence of flammable or explosive gases or fumes. To do so would risk a possible fire or explosion.

### **Keep away from live circuits**

Operating personnel must not remove the cover or expose the printed circuit board while power is applied. In no case may components be replaced with power applied. In some instances, dangerous voltages may exist even when power is disconnected. To avoid electrical shock, always disconnect power and discharge circuits before working on the unit.

### **Exercise care during installation, operation, & maintenance procedures**

The equipment described in this manual contains voltages high enough to cause serious injury or death. Only qualified personnel should install, operate, test, and maintain this equipment. Be sure that all personnel safety procedures are carefully followed. Exercise due care when operating or servicing alone.

### **Do not modify equipment**

Do not perform any unauthorized modifications on this instrument. Return of the unit to a Beckwith Electric repair facility is preferred. If authorized modifications are to be attempted, be sure to follow replacement procedures carefully to assure that safety features are maintained.

## **PRODUCT CAUTIONS**

*Before attempting any test, calibration, or maintenance procedure, personnel must be completely familiar with the particular circuitry of this unit, and have an adequate understanding of field effect devices. If a component is found to be defective, always follow replacement procedures carefully to that assure safety features are maintained. Always replace components with those of equal or better quality as shown in the Parts List of the Instruction Book.*

### **Avoid static charge**

This unit contains MOS circuitry, which can be damaged by improper test or rework procedures. Care should be taken to avoid static charge on work surfaces and service personnel.

### **Use caution when measuring resistances**

Any attempt to measure resistances between points on the printed circuit board, unless otherwise noted in the Instruction Book, is likely to cause damage to the unit.

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## 1.0 Introduction

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### The Syncrocloser® Line

This line of products is directed towards the problem of when to close a circuit breaker. In most cases, it is expected that the products will be used with a transmission rather than a distribution breaker. They may be used with generator breakers, line breakers, or breakers selectively used for either purpose.

The units are available with various alternatives giving a flexibility of application to a wide variety of conditions, yet with a cost proportional to the complexity of the application. Solid-state technology gives all units the following important features:

1. Each unit mounts in a standard 19" rack, thereby conserving valuable panel space for meters and frequently used controls. Each unit requires only 3-1/2" of vertical rack space.
2. The units are capable of meeting extreme shock, vibration and seismic requirements.

### The M-0193B Syncrocloser Unit

The M-0193B is an automatic synchronizer that looks at voltage transformer outputs from either side of a breaker and closes at a precise time, restricting the power flow during synchronizing to safe limits. The circuitry within the M-0193B *requires a rotating angle for closing*. The M-0193B will initiate closing in advance of zero phase angle at a time set equal to the breaker closing time. Proper voltage and frequency difference conditions must be met before closing is permitted.

### Use of Solid-State Technology Yields the Following Features

1. Accurate closing at zero phase angle with compensation for breaker closing time.
2. Programmable (by closing two circuits) for a variety of breaker closing times.
3. Highly stable Undervoltage, Overvoltage, and Voltage Difference functions set by accurately calibrated controls.
4. Frequency difference can be limited to as low as 0.005 Hz for protection of the largest generators in existence or those being contemplated for the future.
5. Operation only when generator speed is higher than system (Anti-Motoring feature).

6. Optional operator phase angle and time window to allow the M-0193B to work in conjunction with an operator (Operator Window Option).
7. Anti-Pump feature allows only one breaker closing operation until the M-0193B is reset by removing power. This feature can be deleted if not desired.

### This Unit is Intended for Two General Classes of Application

1. For initial connection of a generator to a power network.
2. As a network breaker where there is a possibility of a split of the system into two isolated networks having different frequencies.

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## 1.1 Syncrocloser System Packages

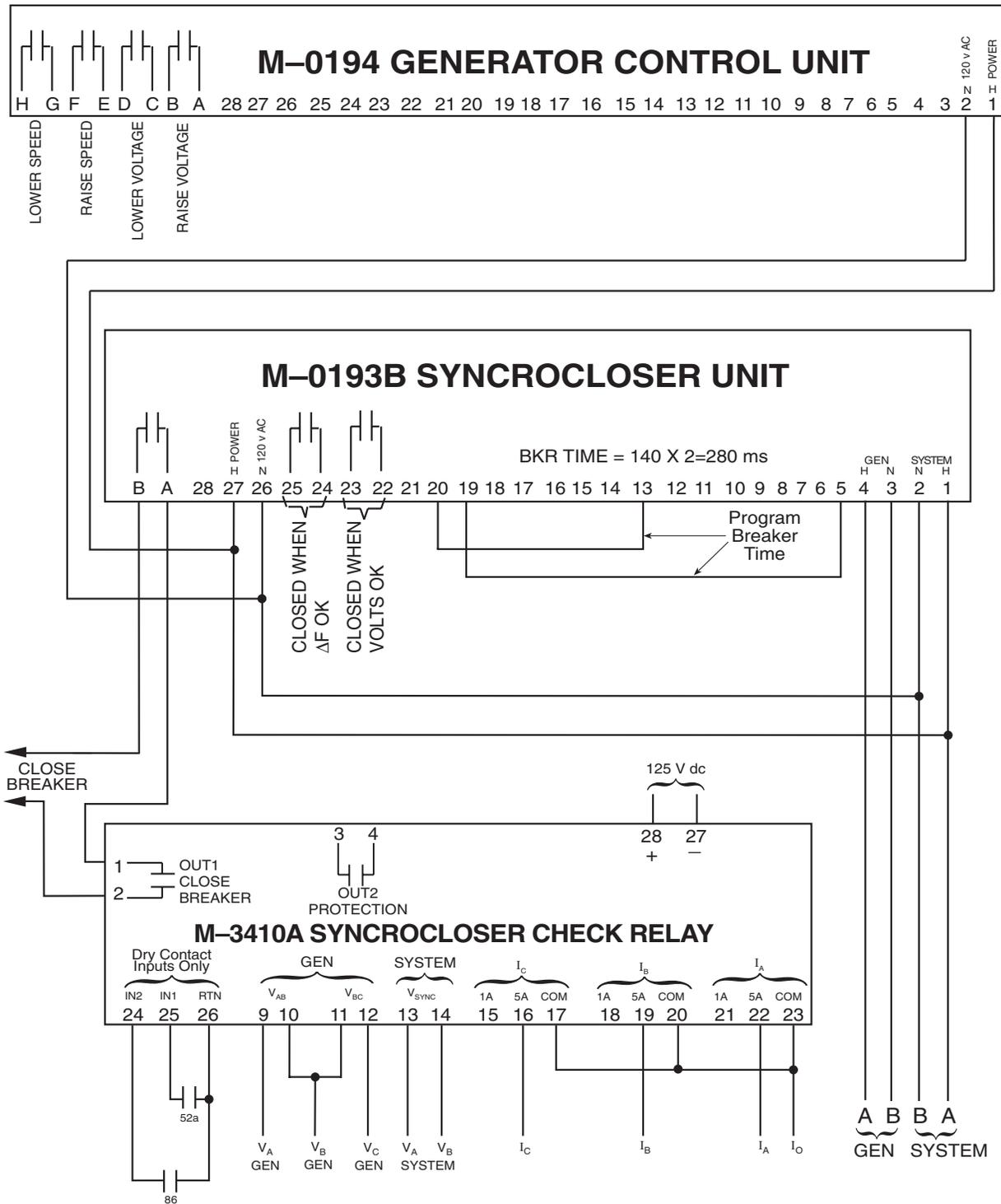
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To assure that closing will not take place at an extremely large angle, the M-0193B may be used in conjunction with either a Beckwith M-3410A Syncrocloser Check/Intertie/Generator Protection Relay or an M-0188 Syncrocloser Check Relay.

The M-0193B can also be used in conjunction with the Beckwith M-0194 Generator Control Unit, which provides speed and voltage "jogs" to bring a generator to proper conditions of matching voltage and frequency, prior to closing a breaker into a bus energized by an electric power network.

The M-0193B, M-0194, and either an M-3410A or M-0188 may be used together to assure safe, accurate connection of a generator to the power network. Figures 1 and 2 show the interconnections between units. Refer to the M-3410A Instruction Book, M-0188 or M-0194 Application Guides for further information.

# Syncrocloser® Interconnections



■ **NOTE:** See Notes on Figures 2 and 3 before making connections.

Figure 1 Syncrocloser® Interconnections (with M-3410A)

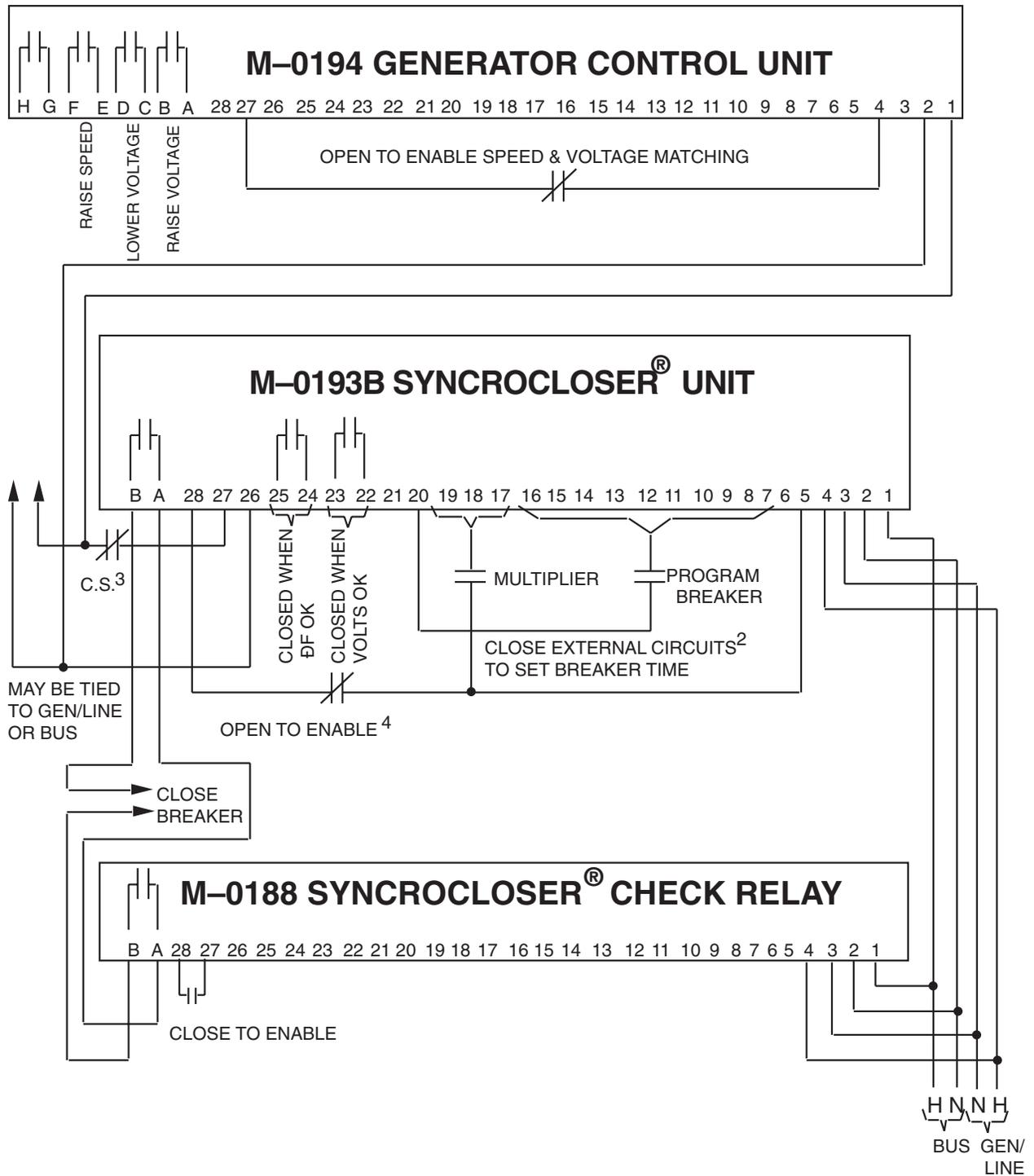


Figure 1A Syncrocloser<sup>®</sup> Interconnections (with M-0188)

## 2.0 Application

In designing a scheme for closing a circuit breaker, the consequences of incorrect closing should be carefully examined. These can vary from inflicting multimillion dollar damage to a generator or transformer, to merely retripping the breaker. Intermediate errors may cause other breakers to trip, creating no damage but propagating a service interruption.

The probability of damage due to breaker closing may be greatly reduced by using two independent devices with breaker closing contacts in series or by providing a breaker closing device and operator switch contacts in series.

Suppose that the probability of a device failing or an operator erring while closing a breaker is one time in 10,000 closings. By combining two devices or a device and an operator, the probability of an error becomes the product, or one time in 100 million closings. A redundant system may be inexpensive insurance compared to the potential cost of damage.

One method of breaker closing having considerable merit with regard to reliability is to have one of the operator control switch contacts in series with the M-0193B close contact and the other operator control switch contact between terminals TB1-28 and TB1-5, as shown in Figure 5. This method uses the Operator Window Option available on the M-0193B.

Secondly, an M-3410A Syncrocloser® Check/Intertie/Generator Protection Relay or an M-0188 Syncrocloser Check Relay can be used with the M-0193B to assure that closing will not take place at an extremely large angle. When this is done, the M-3410A/M-0188 close contacts should be connected in series with the M-0193B close contacts, as shown in Figures 1 and 1A. Refer to the M-3410A Instruction Book or the M-0188 Application Guide for a detailed description of these units.

An M-0188 having a 30° Phase Angle Limit and a 1.5 second TIME range would normally be used with the M-0193B  $\Delta F$  range of 0.005 to 0.05Hz. The acceptance angle should be set slightly higher than an angle calculated as:  $\Phi = 360 \times \Delta F(t_b + T)$ , where  $\Delta F$  is the  **$\Delta F$  LIMIT** setting on the M-0193B, " $t_b$ " is the breaker closing time, and "T" is the M-0188 **TIME (SEC)** setting. The M-0188 **TIME** control should be set to a minimum value of 0.1 to 0.5 seconds to minimize the **PHASE ANGLE LIMIT** setting required.

## 2.1 Setting Breaker Closing Time

Refer to Figure 2 which shows the External Connections. If the M-0193B is to be used for a single breaker, jumpers may be added to set the unit prediction time to equal the closing time of the breaker. One jumper goes from terminal TB1-20 to

one of terminals TB1-7 through TB1-16 to cover the range of most breaker closing times from 20 to 200 ms. For slower breakers, a second jumper can be tied from TB1-5 to TB1-17, TB1-18, or TB1-19 so as to multiply the time by 4, 3, or 2, respectively.

■ **NOTE:** Use multipliers only for breaker times greater than 200 ms.

■ **NOTE:** It is important to remember that, when making connections to the rear of the unit to program the breaker closing time, 20 ms must be added to the actual breaker closing time. This additional time is the average pickup time of the M-0193B output relay. For example, if the average closing time for the controlled circuit breaker is 100 ms, the M-0193B should be programmed for 120 ms.

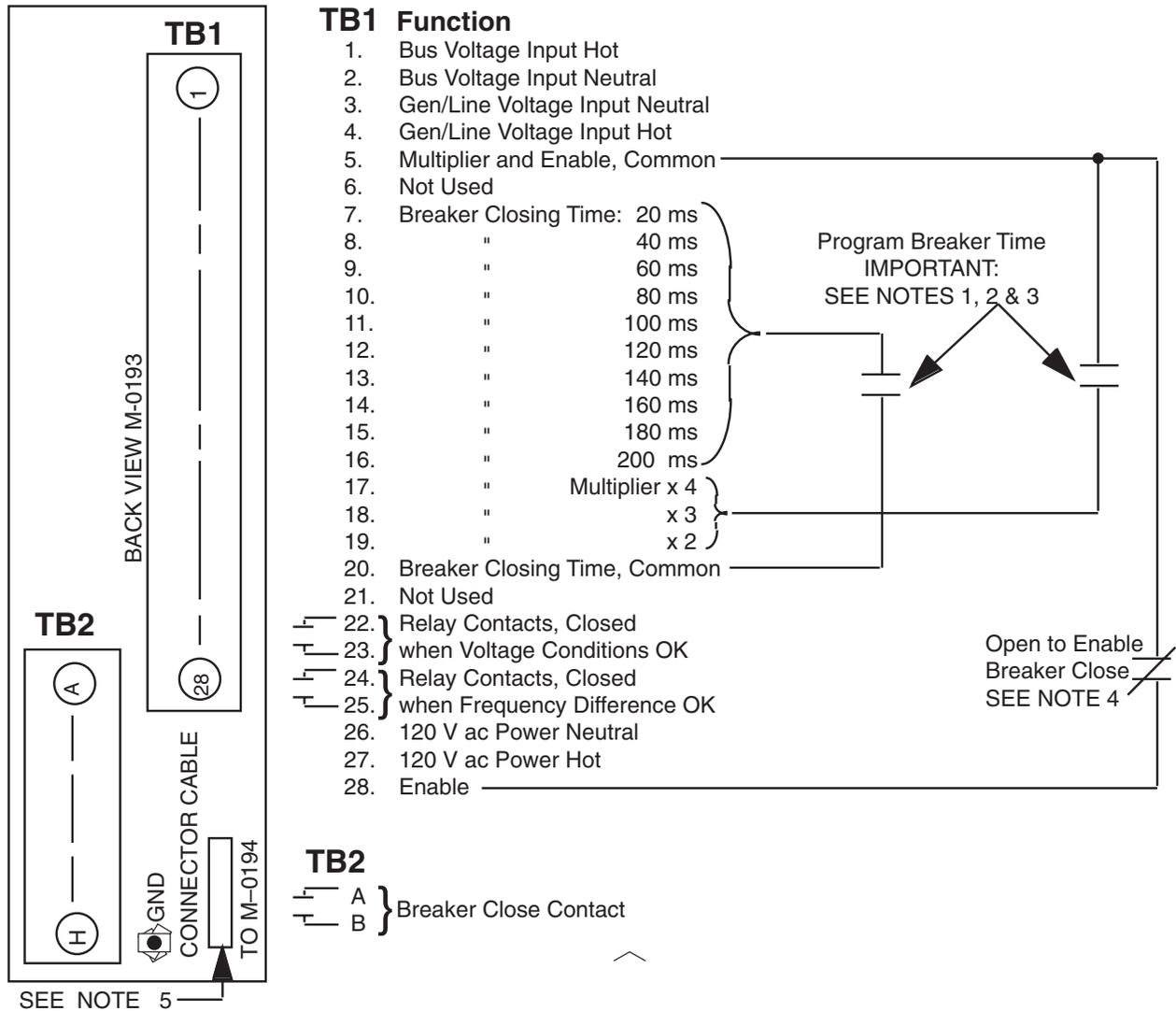
### Recommended Wiring to Breaker Closing Time and Multiplier Connections (TB1-7 through TB1-19)

When making the connections to the M-0193B for breaker closing time selection, connect wires only to the terminals required. When only one breaker speed is needed, then place short jumper(s) directly onto the M-0193B terminal block from terminal TB1-20 to TB1-(6 through 16), and, if breaker closing time is more than 200 ms, from terminal TB1-5 to TB1- (17, 18, 19), as required. When used in conjunction with several breakers that have different closing times, mount small auxiliary relays adjacent to the M-0193B to make the necessary selections at the time each breaker is selected for closing. Avoid using long wires to external disconnect devices. See Figure 3 for typical wiring. Do not connect wires to the unused terminals. The auxiliary relay(s) can then be energized by control wiring from the appropriate breaker select switches.

The auxiliary relays used to program the breaker closing time should have gold-plated, dry circuit contacts. The use of high voltage, high current contacts in this circuit may cause intermittent operation. The wiring between the M-0193B terminal block and the auxiliary relay contacts should be kept as short as possible (less than 2 feet). Twisted/shielded wire is recommended.

Note that most breakers have a time of less than 200 ms, and that only a single circuit may be closed at a time. (No damage will be done to the M-0193B if more than one circuit is closed simultaneously, but an incorrect prediction time will result.)

The breaker time programming contact or contacts should be closed at the same time (using the same switch or relay contacts) that the line or bus voltages (or both) are energized. Otherwise, closing with an incorrect time can result.

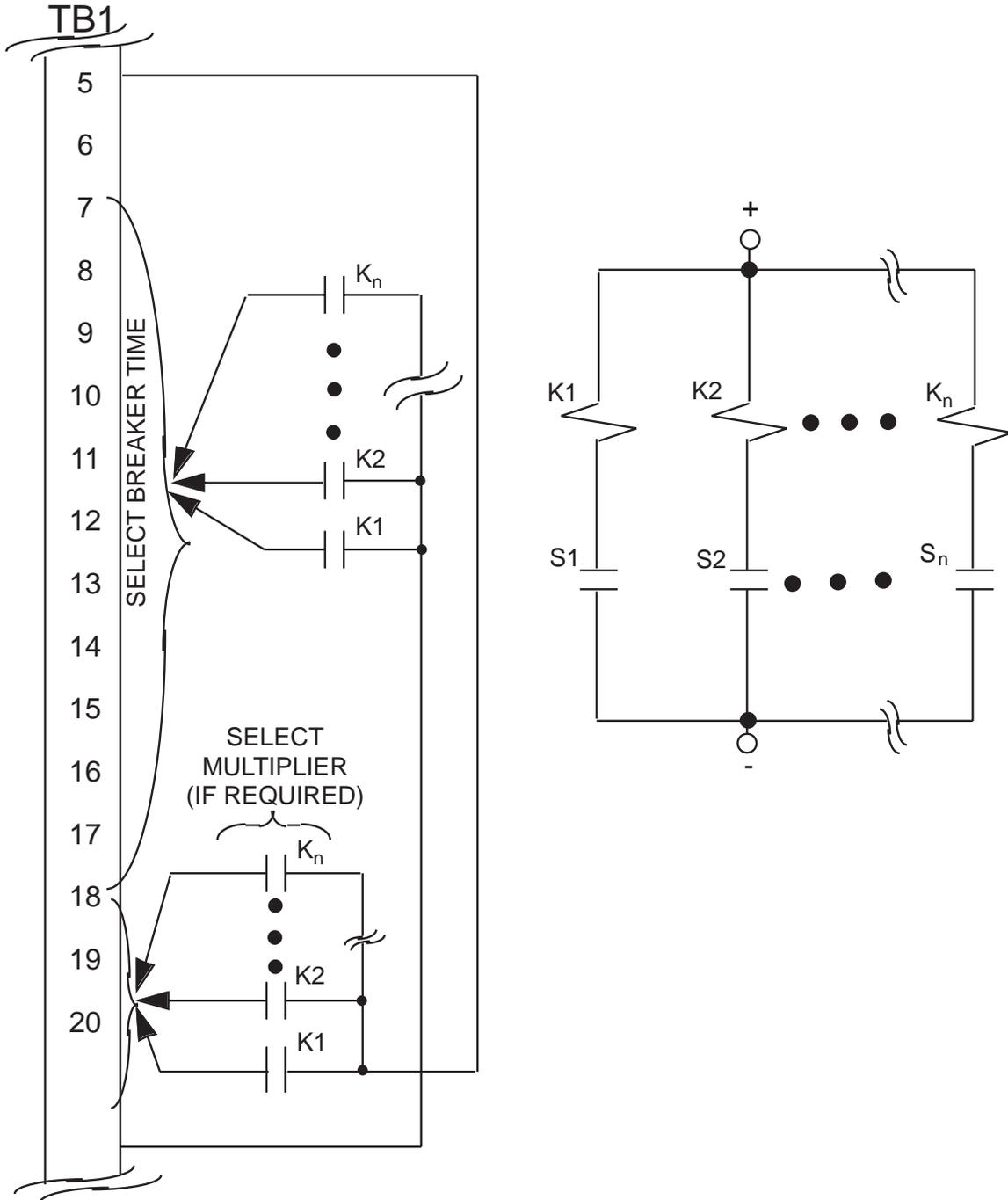


■ NOTES:

- When making connections to the rear of the unit to program the breaker closing time, 20 ms must be added to the actual breaker closing time. This additional time is the average pickup time of the M-0193B output relay. For example, if the average closing time for the circuit breaker is 100 ms, the M-0193B should be programmed for 120 ms. If only one breaker closing time would ever be required, a permanent jumper should be added here. **DO NOT MAKE CONNECTIONS TO UNUSED BREAKER CLOSING TIME TERMINALS.**
- Use multiplier only for breaker times greater than 200 ms.
- The contacts used to program the breaker closing time should be gold-plated, dry circuit contacts. The use of high voltage, high current contacts in this circuit may cause intermittent operation. The wiring between the M-0193B terminal block and these contacts should be kept as short as possible (less than 2 feet) and twisted/shielded wires are recommended. Refer to Figure 3 for wiring multiple breaker times. If only one breaker closing time is required, then place a short jumper on the rear of the M-0193B between the proper terminals.
- Terminal 28 is used for the Operator Window Option, in which case a closed contact enables breaker close.
- Refer to the M-0194 Generator Control Unit Application Guide for further details.

Figure 2 External Connections

**Breaker Time Select Contact Wiring (Two or More Breaker Closing Times)**



Where:

$S_1, S_2, \dots, S_n$  are the contacts from the breaker select control switches. Only one contact should be closed at any one time. If several breakers have identical closing times, the "S" contacts can be paralleled to energize one relay.

$K_1, K_2, \dots, K_n$  are auxiliary relays mounted close to the rear of the M-0193B. A separate relay is required for each different breaker closing time. One relay for each breaker is unnecessary, unless all breakers have different closing times. A multiplier contact is required for each breaker with a closing time greater than 200 ms.

Figure 3 External Connections for Multiple Breaker Time Programming

### Anti-Pump Option

The M-0193B is designed to prevent the reclosing of a breaker that trips after synchronizing. If the M-0193B is ordered with the Anti-Pump feature, then after a breaker close operation has occurred, it is necessary to remove the M-0193B power input to terminal TB1-27 for approximately 10 sec. in order to reset the unit for another operation. It makes no difference whether or not the line and bus inputs are removed at the same time.

■ **NOTE:** When the M-0193B is ordered with the Anti-Pump Option, a method *must* be provided, in the connections to terminal TB1-27, to easily remove the power from the M-0193B after each operation.

Alternatively, the M-0193B may be ordered without the Anti-Pump feature. In this case the 10 sec. reset after each close is not required. In a typical case involving several breakers, the bus input could be tied to a bus VT. The line and power supply terminals could be paralleled and connected to one appropriate line VT at a time, by a relay which also sets the breaker time.

▲ **CAUTION:** When the M-0193B is ordered without the Anti-Pump Option, a breaker that trips after synchronizing will be reclosed at the next zero phase coincidence, unless external means are provided to prevent the reclosure.

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## 2.2 Anti-Motoring Feature

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■ **NOTE:** Disabling/Enabling the Anti-Motoring feature, if desired, (default is OFF) should be done prior to installation of the M-0193B since the unit's top cover must be removed for access to the toggle switch on the printed circuit board.

An Anti-Motoring feature is included in the unit and before shipment from the factory, the toggle switch on the Anti-Motoring printed circuit board is set to customer specification or defaulted to OFF to disable this feature.

With the Anti-Motoring feature enabled (set to the ON position), the generator's frequency is required to be slightly higher than the system frequency in order to be synchronized online. The Anti-Motoring option for the M-0193B Syncrocloser Unit may be considered for steam turbine generators when necessary to help minimize turbine blade vibrations at the instant that the generator is connected to the power system. The Anti-Motoring feature may also help avoid tripping during synchronizing of large turbine generators with sensitive reverse power protection. Of course reducing the Maximum Allowable Frequency Difference for synchronizing can also address these concerns.

Unless Beckwith Electric Co. receives a specific request from the customer, the Anti-Motoring option will be turned OFF, allowing the machine to synchronize in both the FAST and SLOW direction. This will allow the machine to synchronize more rapidly than with the Anti-Motoring option turned ON. A more rapid synchronizing process is actually an advantage with thermal machines to prevent overheating under speed-no load conditions awaiting synchronizing, and must be weighed against the perceived advantage of permitting closing only in the FAST direction.

The fundamental operation difference of the M-0193B is depicted by Figure 4.

When Anti-Motoring is enabled (toggle switch is set to ON), the M-0193B  $\Delta F$  OK indicator will illuminate when the frequency enters the plus (generator fast) region of the  $\Delta F$  LIMIT setting. The M-0193B will only allow circuit breaker closure when the generator frequency is above the running bus frequency and the slip frequency is within the  $\Delta F$  LIMIT setting.

If the M-0193B is used in conjunction with a Generator Control Unit, M-0194, the M-0194 will issue error-based corrective “raise” pulses to the governor circuit when the generator frequency is below the running bus frequency. Kicker pulses will be issued if the generator frequency is within the plus  $\Delta F$  LIMIT setting and the kicker pulse time setting is exceeded without the circuit breaker closing.

When Anti-Motoring is disabled (toggle switch is set to OFF), the M-0193B  $\Delta F$  OK indicator will illuminate when the frequency enters either the plus (generator fast) or minus (generator slow) region of the  $\Delta F$  LIMIT setting. The M-0193B will allow circuit breaker closure when the slip frequency is within the  $\Delta F$  LIMIT setting.

If the M-0193B is used in conjunction with a Generator Control Unit, M-0194, the M-0194 will issue error-based corrective “raise” or “lower” pulses to the governor circuit when the generator frequency is either below or above the running bus frequency, respectively. Kicker pulses will be issued if the generator frequency is within the plus or minus  $\Delta F$  LIMIT setting and the KICKER PULSE RATE setting is exceeded without the circuit breaker closing.

**Operator Window Option**

An operator phase angle and time window has been designed which allows an operator to work in conjunction with the M-0193B. The interconnections for this feature are shown in Figure 5. The operator must close his contact before the breaker time, but not earlier than a variable time between 0.2 to 6.2 sec. At the same time, the operator must be within a variable phase angle “window” ( $0^\circ$  to  $30^\circ$  for  $\Delta F$  range 0.005 to 0.05 Hz,  $0^\circ$  to  $180^\circ$  for  $\Delta F$  range 0.05 to 0.5 Hz). Should the operator close his contact outside the above “windows,” the M-0193B will block closing of the breaker and the operator must reset his contact and make another attempt on the next slip cycle. Both the phase angle and time windows can be adjusted to suit a given system and operator; however, a phase angle setting below  $15^\circ$  is not recommended.

■ **NOTE:** The M-0193B will not close on any truly stationary angle. With an angle of  $0^\circ$ , the unit may or may not close as a result of phase jitter.

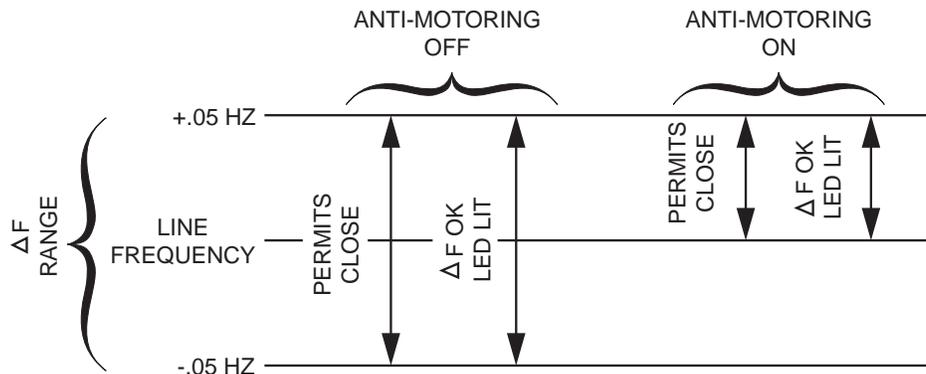


Figure 4 Anti-Motoring Option

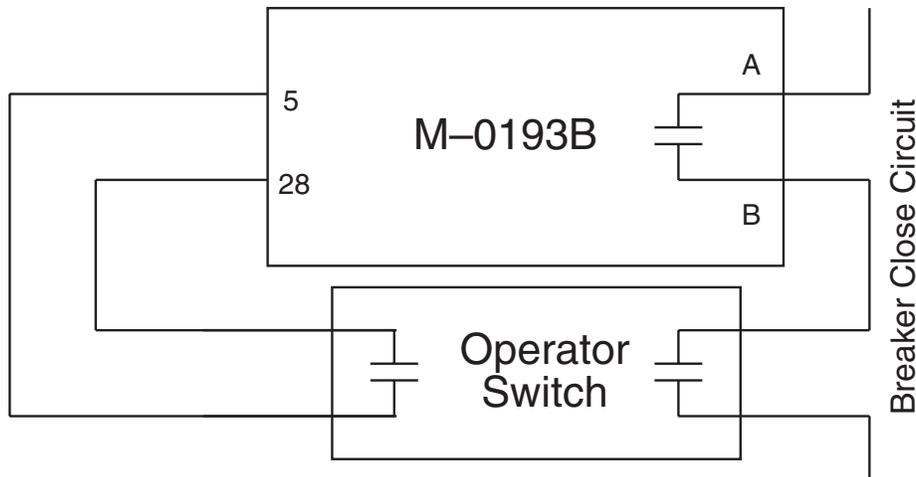


Figure 5 Operator Window Interconnections

### 3.0 Adjustment

#### Operator Window Option

■ **NOTE:** This is an internal adjustment on the printed circuit board and must be set prior to installation since the top cover must be removed.

1. Calculate the maximum allowable operator closing angle ( $\Phi_{max}$ ) from maximum  $\Delta F$  setting ( $\Delta F_{max}$ ), operator reaction time allowance ( $T_o$ ) and breaker time ( $T_b$ ):

$$\Phi_{max} = \Delta F_{max} (T_o + T_b) 360^\circ$$

■ **NOTE:**  $\Phi_{max}$  setting below  $15^\circ$  is *not* recommended.

2. Next, remove the top cover of the unit.
3. To set the Operator Phase Angle Window Control, refer to Figure 6.
  - a. Locate potentiometer R160 near the center of the interior printed circuit board, just above power relay K3. Also locate the small vertical wire hook (TB6) to the left of potentiometer R160.
  - b. Attach the positive lead of a high impedance digital voltmeter to the small wire hook; attach the negative lead of the voltmeter to the negative lead of the large electrolytic capacitor C14, located under power relay K3.
  - c. Apply power (120 V ac) to terminals TB1–26 and TB1-27, noting that terminal TB1-26 is NEUTRAL and terminal TB1-27 is HOT.

- d. Using Table 1, adjust R160 to the required voltage. Clockwise increases the voltage and therefore the angle ( $\Phi_{max}$ ).

*Example:* If desired  $\Phi_{max}$  is  $15^\circ$ , then Voltage = (15) (0.056) = 0.840 V. Therefore, R160 should be adjusted until the voltmeter reads 0.840 V.

4. Calculate the maximum time window ( $T_{w_{max}}$ ) from the lowest expected  $\Delta F$  ( $\Delta F_{min}$ ) and the maximum closing angle ( $\Phi_{max}$ ):

$$T_{w_{max}} = \frac{\Phi_{max}}{(\Delta F_{min}) 360^\circ}$$

5. To set the Operator Time Window Control R148, refer to Figure 6.

- a. Locate potentiometer R148, just above R160. Since the time setting is not a critical parameter, the Operator Time Window Control may be set visually.
- b. Adjust the screwdriver slot on potentiometer R148 to the positions indicated for the required time setting ( $T_{w_{max}}$ ). A Clockwise adjustment decreases the time setting ( $T_{w_{max}}$ ).

*Example:* If  $\Phi_{max}$  is  $15^\circ$ , and minimum expected  $\Delta F$  is 0.01 Hz,

$$\text{then } T_{w_{max}} = \frac{15}{(0.01) (360)} = 4.2 \text{ sec.}$$

Therefore, adjust R148 to approximately 5 sec.

■ **NOTE:** Maximum time setting for R148 is 6.2 sec.

$\Delta F$ Scale	Maximum Phase Angle Setting of R160	Voltage at Wire Hook as a Function of the Desired Phase Angle Setting
0.005 to 0.05 Hz	$30^\circ$	Voltage = $\phi_{max}$ (0.056)
0.05 to 0.5 Hz	$180^\circ$	Voltage = $\phi_{max}$ (0.056)

Table 1 Operator Window Phase Angle Limit

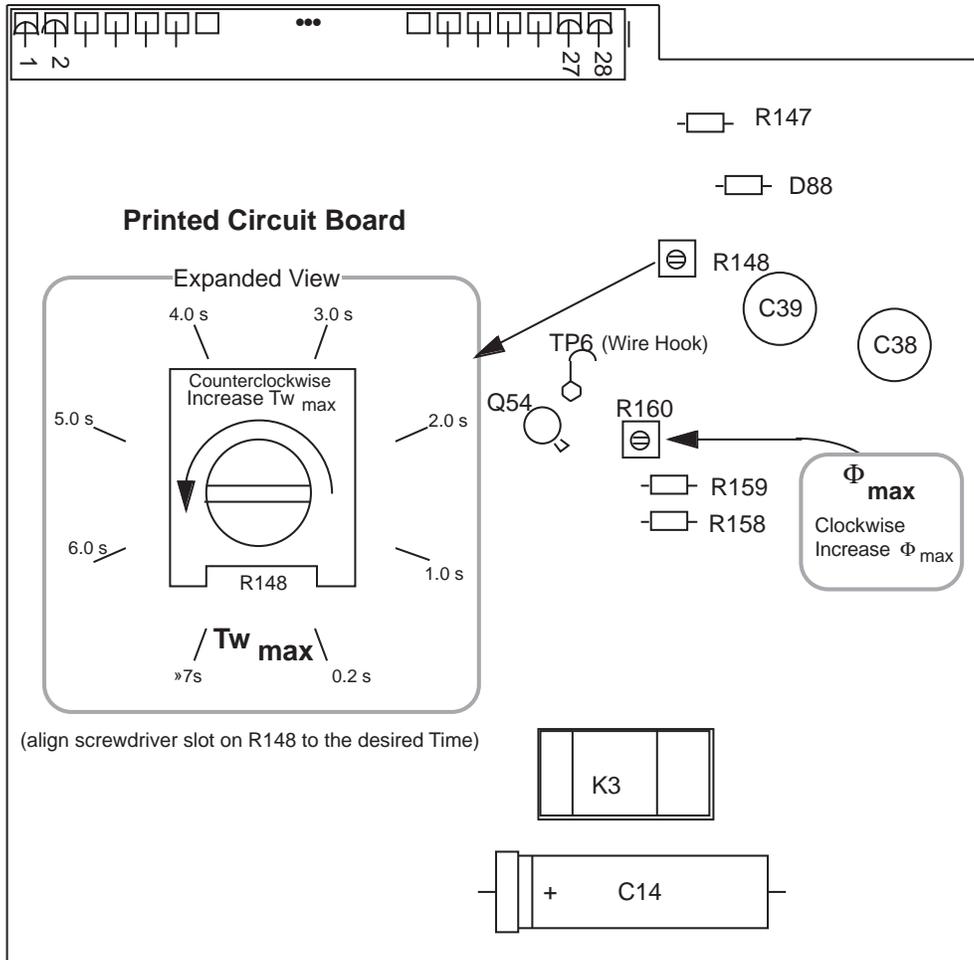


Figure 6 Component Location for Operator Window Adjustment

### 3.1 Front Panel Controls

■ **NOTE:** These adjustments may be set after installation of the unit.

Adjust the **UPPER VOLTAGE LIMIT** control to the limit voltage which *both* the line and bus voltages may not exceed, if breaker closing is to be permitted.

Adjust the **LOWER VOLTAGE LIMIT** control to the limit voltage which *both* the line and bus voltages must exceed, if breaker closing is to be permitted.

Adjust the **ΔV LIMIT** to the difference in voltage which, if exceeded, will block breaker closing.

Adjust the **ΔF LIMIT** to the value above which it is desired to block breaker closing. A power transient will flow due to the generator frequency error, even though the phase angle is precisely zero at the instant the breaker contacts close. The **ΔV LIMIT** should be set low enough to limit this component of the synchronizing power transient to a safe value.

The various LED indicators will light when the conditions indicated by each are proper for closing.

### 4.0 Mounting

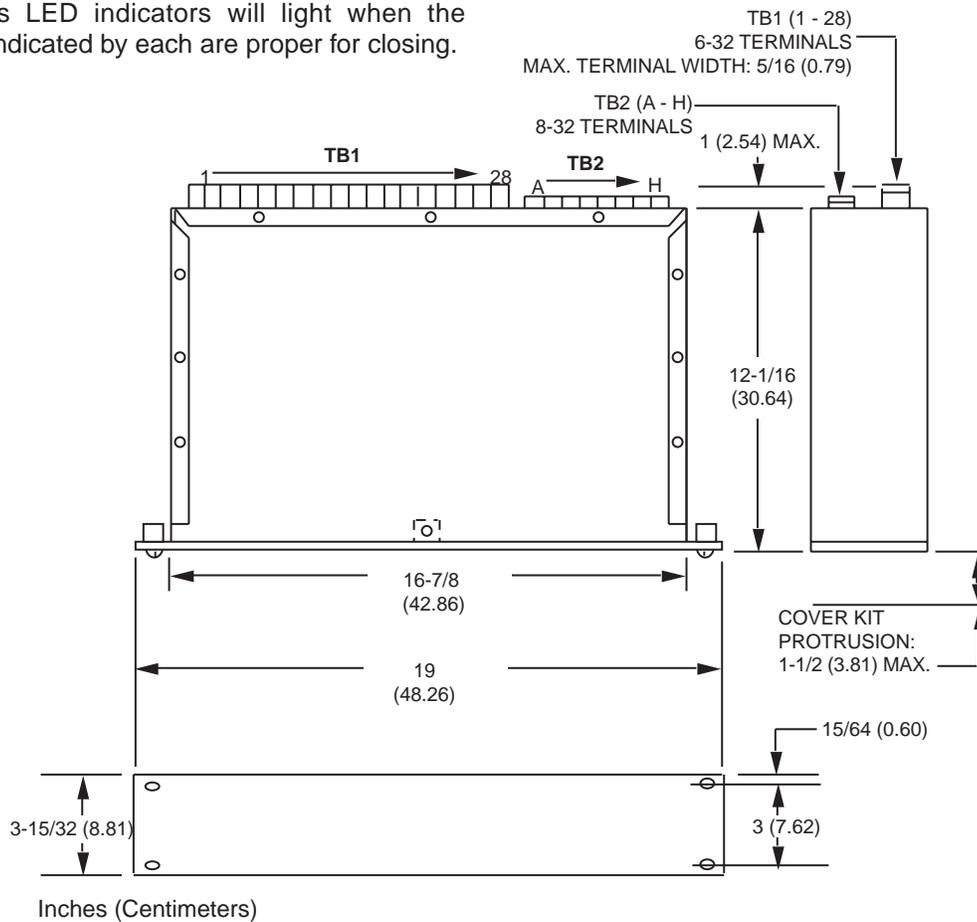
Figure 7 shows the outline dimensions for all of the standard units in the Syncrocloser® Line. Each unit fits a standard 19" rack mount and requires two rack units of height.

Figure 8 shows the cutout required for panel mounting. The unit can be mounted horizontally or vertically.

A transparent cover and mounting bracket set is available to cover the knobs and prevent accidental resetting.

A version of the M-0193B configured to physically retrofit a General Electric GES21A is available as an option.

There are no electrical or operation changes in the M-0193B; the only changes are the physical orientation, as shown in Figure 9.



■ **NOTE:** Shown with cover kit and top removed.

Figure 7 Outline Dimensions for All Syncrocloser Equipment Chassis

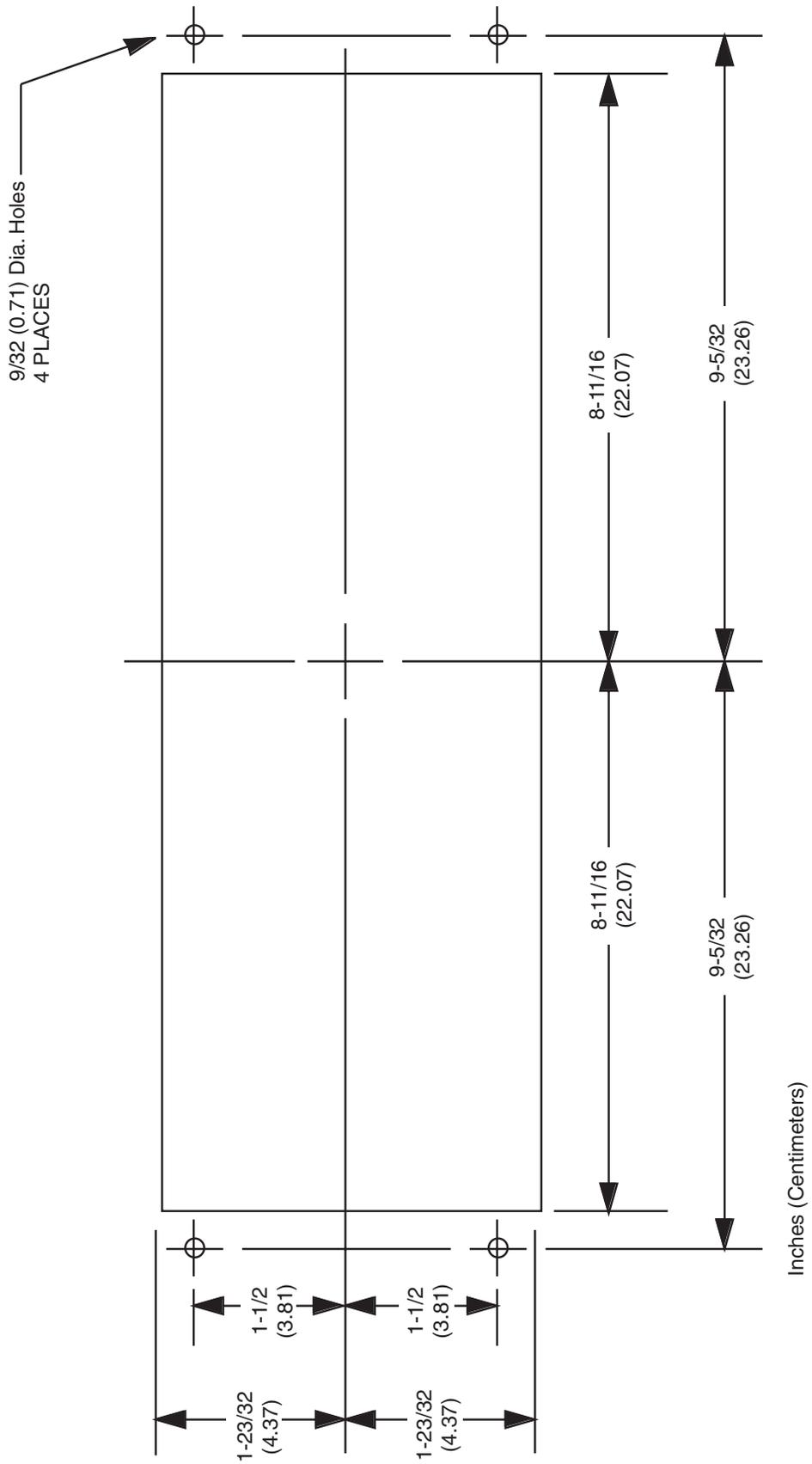
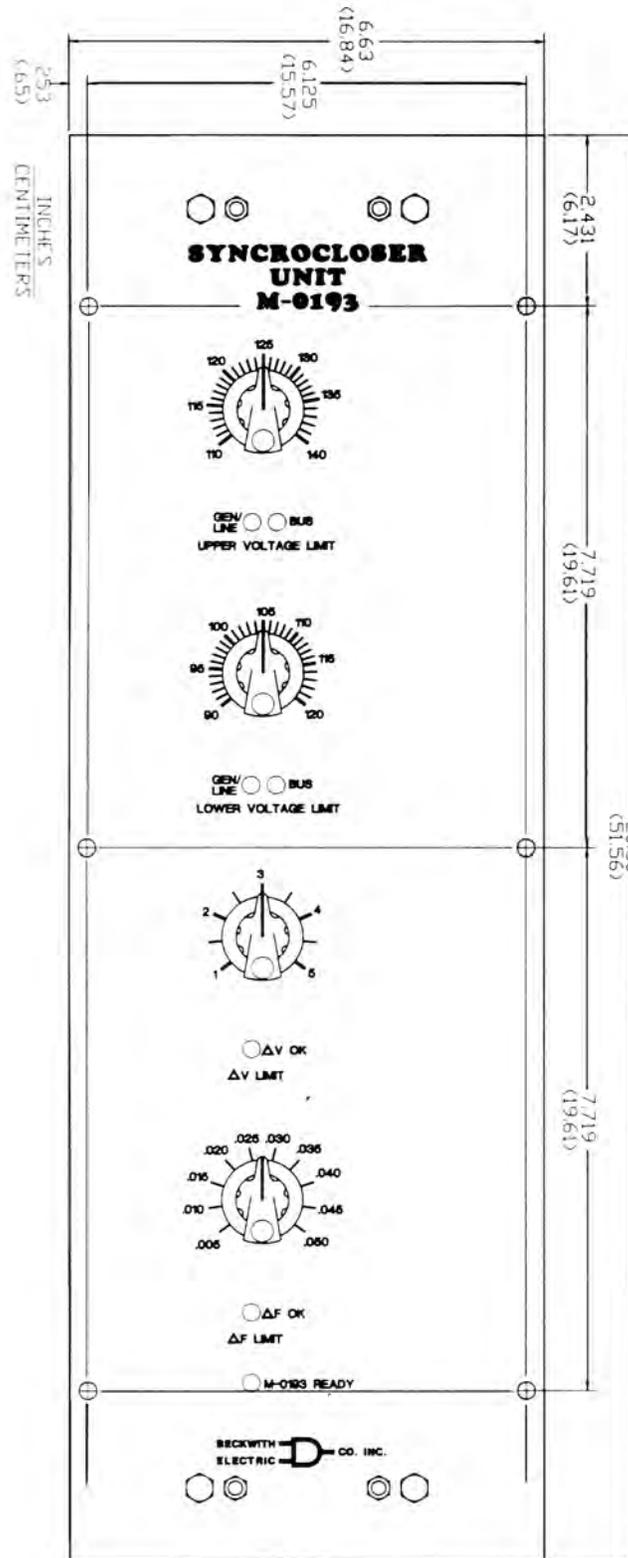


Figure 8 Hole Drill and Cutout Dimensions



■ **NOTE:** A version of the M-0193B configured to physically retrofit a General Electric GES21A is available as an option. There are no electrical or operation changes to the M-0193B for this configuration; the only change is the physical orientation, as shown.

Figure 9 Optional GES21A Configuration

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## 5.0 Design Changes

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Beckwith Electric maintains a system whereby our customers can be aware of design changes in any of our units. Full documentation on any unit is kept on file by Model Number and Serial Number.

All units have a Model Number, consisting of a letter and four numbers. Complex changes are recorded by adding a suffix letter. The rule is that it must be possible to use any later version as a replacement for an earlier version. The opposite may not be true because of features added. If later units are *not* interchangeable with older units, a change in the Model Number is made.

Some simple changes are recorded by Serial Numbers; for example, changes in the detailed rating or manufacturer of a component where either the new or old part will perform properly.

The following describes the changes that have taken place on the M-0193B Syncrocloser® Unit.

### I. M-0193B

This first version did not provide the Operator Window Option.

### II. M-0193A

This version included the Operator Window Option. Also, additional circuitry was added to reduce “worst case” phase angle error.

### III. M-0193B

This version added a noise filter on each input, modified the Generator Control Compatibility Option to provide an indication when the generator voltage is excessively high or low, increased the contact rating of the status relays and modified the mounting of the front panel control potentiometers.

## Patent

The units described in this manual are covered by U.S. Patents, with other patents pending.

Buyer shall hold harmless and indemnify the Seller, its directors, officers, agents, and employees from any and all costs and expense, damage or loss, resulting from any alleged infringement of United States Letters Patent or rights accruing therefrom or trademarks, whether federal, state, or common law, arising from the Seller's compliance with Buyer's designs, specifications, or instructions.

## Warranty

Seller hereby warrants that the goods which are the subject matter of this contract will be manufactured in a good workmanlike manner and all materials used herein will be new and reasonably suitable for the equipment. Seller warrants that if, during a period of five years from date of shipment of the equipment, the equipment rendered shall be found by the Buyer to be faulty or shall fail to perform in accordance with Seller's specifications of the product, Seller shall at his expense correct the same, provided, however, that Buyers shall ship the equipment prepaid to Seller's facility. The Seller's responsibility hereunder shall be limited to replacement value of the equipment furnished under this contract.

*Seller makes no warranties expressed or implied other than those set out above. Seller specifically excludes the implied warranties of merchantability and fitness for a particular purpose. There are no warranties which extend beyond the description contained herein. In no event shall Seller be liable for consequential, exemplary, or punitive damages of whatever nature.*

Any equipment returned for repair must be sent with transportation charges prepaid. The equipment must remain the property of the Buyer. The aforementioned warranties are void if the value of the unit is invoiced to the Seller at the time of return.

## Indemnification

The Seller shall not be liable for any property damages whatsoever or for any loss or damage arising out of, connected with, or resulting from this contract, or from the performance or breach thereof, or from all services covered by or furnished under this contract.

In no event shall the Seller be liable for special, incidental, exemplary, or consequential damages, including but not limited to, loss of profits or revenue, loss of use of the equipment or any associated equipment, cost of capital, cost of purchased power, cost of substitute equipment, facilities or services, downtime costs, or claims or damages of customers or employees of the Buyer for such damages, regardless of whether said claim or damages is based on contract, warranty, tort including negligence, or otherwise.

Under no circumstances shall the Seller be liable for any personal injury whatsoever.

It is agreed that when the equipment furnished hereunder are to be used or performed in connection with any nuclear installation, facility, or activity, Seller shall have no liability for any nuclear damage, personal injury, property damage, or nuclear contamination to any property located at or near the site of the nuclear facility. Buyer agrees to indemnify and hold harmless the Seller against any and all liability associated therewith whatsoever whether based on contract, tort, or otherwise. Nuclear installation or facility means any nuclear reactor and includes the site on which any of the foregoing is located, all operations conducted on such site, and all premises used for such operations.

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