INSTRUCTION MANUAL

FOR

SOLID STATE

AUTO-SYNCHRONIZING RELAY

Models: PRS210
PRS220
PRS230

Basler Electric

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INTRODUCTION

The addendum to this Instruction Manual (9 0754 00 99X) is to provide the user with information concerning a change in the manual. The change to Section 1.1.2 on Page 1 is as follows:

From: "FREQUENCY CORRECTION PICKUP POINT: ±6 Hz from bus frequency."

To: "FREQUENCY CORRECTION PICKUP POINT: ±6 Hz from bus frequency. This device is not intended for correction of frequencies beyond the ±6 Hz of the rated bus frequency. Frequency correction outside this range may be unpredictable."

WARNING

TO AVOID PERSONAL INJURY OR EQUIPMENT DAMAGE, ONLY QUALIFIED PERSONNEL SHOULD PERFORM THE PROCEDURES PRESENTED IN THIS MANUAL.

It is not the intention of this manual to cover all details and variations in equipment, nor does this manual provide data for every possible contingency regarding installation or operation. The availability and design of all features and options are subject to modification without notice. Should further information be required, contact Basler Electric Company, Highland, Illinois.

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SECTION 1

INTRODUCTION

1.1 GENERAL

1.1.1 This manual contains a description, principles of operation, installation, operation and maintenance pertaining to the Auto-Synchronizing Relay part number 90 75400-100, -101 and -102 rated 120 VAC, and the -103, -104 and -105 rated 208 VAC, manufactured by Basler Electric Company, Highland, Illinois.

1.1.2 The following table lists the leading particulars of the unit.

TABLE 1-1 LEADING PARTICULARS

INPUT POWER:	Incoming (machine)	Running (bus)
Voltage	See Table 1-2	Same as Incoming
Frequency	50/60 Hertz (nominal)	Same as Incoming
Phase	3	3
Burden (operating, per phase)	20 VA	3 VA
Burden Power Factor	0.9 Minimum	0.9 Minimum

VOLTAGE ACCEPTANCE BANDWIDTH: Adjustable, ±0.5% to ±4.5% bus voltage.

BREAKER CLOSURE TIME COMPENSATION: Adjustable, 0.1 to 0.5 seconds.

PHASE ANGLE INITIATION: Adjustable, 5° to 40°.

SLIP FREQUENCY ACCEPTANCE: See Figure 2-3.

FREQUENCY CORRECTION "ON" TIME: See Figure 2-4.

VOLTAGE CORRECTION "ON" TIME (Model PRS210 only): Continuous.

FREQUENCY CORRECTION PICKUP POINT: ±6 Hz from bus frequency.

VOLTAGE CORRECTION PICKUP POINT (Model PRS210 only): ±35% from bus voltage.

OPERATING TEMPERATURE RANGE: -40°F (-40°C) to +158°F (+70°C)

TEMPERATURE DRIFT:

Phase & Frequency: Negligible.
Voltage Acceptance: Less than 1% for 50°C change.

MOUNTING: Designed for either horizontal or vertical mounting with hinged cover for easy access.

VIBRATION: Withstands up to 5 G's at 70 Hz in any plane.

SHOCK: Withstands 15 G's in any plane.

CONTACT RATING: Breaker Closure Relay - Make 30 Amps, Break 2 Amps at 250 VDC;
Matching Motor Relay(s) - Make and Break 10A at 125 VAC, 0.75A at 110 VDC, 5.0A at 48 VDC.

FINISH: Dark brown, lusterless, textured, baked enamel.

MAXIMUM WEIGHT: Net 32 pounds; Shipping 36 pounds.

TABLE 1-2 MODEL-PART NUMBER CROSS REFERENCE

Autosynchronizing Relay	Model Number	Part Number	
		120 VAC $\pm$10% Input	208 VAC $\pm$10% Input
Without Voltage Frequency Matching	PRS230	90 75400-100	90 75400-103
With Frequency Matching	PRS220	90 75400-101	90 75400-104
With Frequency and Voltage Matching	PRS210	90 75400-102	90 75400-105

1.2 PURPOSE

1.2.1 The auto-synchronizer is designed to automatically furnish the breaker closing signal when two generating systems are being paralleled. The breaker closure signal is applied in advance of the zero phase position to achieve breaker closure near the zero phase position. The amount of advance is automatically determined by the synchronizer through the setting of the breaker time adjustment and the slip rate between the two generating systems.

1.2.2 Slip rates sufficiently high to require signal advance in excess of the phase angle setting will not allow synchronization unless the slip rate is reduced.

1.2.3 Should the incoming generator achieve synchronous speed before the units are synchronized, a pulsing circuit will pulse the speed matching relay to cause sufficient slip to allow synchronization, if the unit is equipped with Frequency Matching.

1.3 DESCRIPTION

1.3.1 The basic synchronizer is composed of the circuits and circuit functions as indicated in the block diagram of Figure 1-1.

1.3.2 The inputs from the generator and bus are applied to the primary of the input transformers. Portions of the secondary voltage are combined, rectified and filtered in the mixing circuit to form a half wave envelope with a period that reflects exactly the slip frequency of the incoming generator and bus.

1.3.3 The envelope from the mixing circuit is utilized in the phase sensing circuit to determine the phase position of the two units. The rate of change of the envelope is utilized in the anticipation circuit to advance or retard the triggering of the breaker closure circuit to achieve breaker closure near the zero phase position.

1.3.4 The sequence circuit insures that the incoming generator and bus phase positions are within acceptable limits before the anticipation circuit is allowed to close the breaker. If the anticipation circuit attempts to close the breaker before the units are in the correct phase position, synchronization will not occur. It should be noted that this is actually a limit on the maximum slip rate or frequency for synchronization.

1.3.5 The voltage acceptance circuit compares the incoming generator voltage with the bus voltage. If the difference between the two is too great, synchronization will not occur. The voltage acceptance circuit functions on the difference of the incoming generator and bus voltage over a range of approximately $\pm$10% of nominal.

1.3.6 A logic "and" circuit is utilized to monitor the phase, anticipation and voltage circuits. All three of the circuits must provide a "go" signal before the synchronization will be allowed to close the breaker.

1.3.7 The synchronizer has its own zener regulated power supply. The power for the unit is derived from the incoming generator; this generator, therefore, must be energized before the synchronizer will function.

1.3.8 Units furnished with voltage matching and frequency or speed matching circuits will automatically adjust the voltage and frequency to within limits acceptable to the synchronizer. Both frequency matching and voltage matching readouts are through relay contacts.

1.3.9 Synchronizer models with frequency matching circuits (see Table 1-2, Figures 1-2 and 1-3) utilize a ring demodulator circuit to sense the phase position of the incoming generator voltage vector with respect to a bus voltage vector. A pulse gating signal is obtained from the mixing circuit each time the generator and bus pass through the zero phase position. The frequency

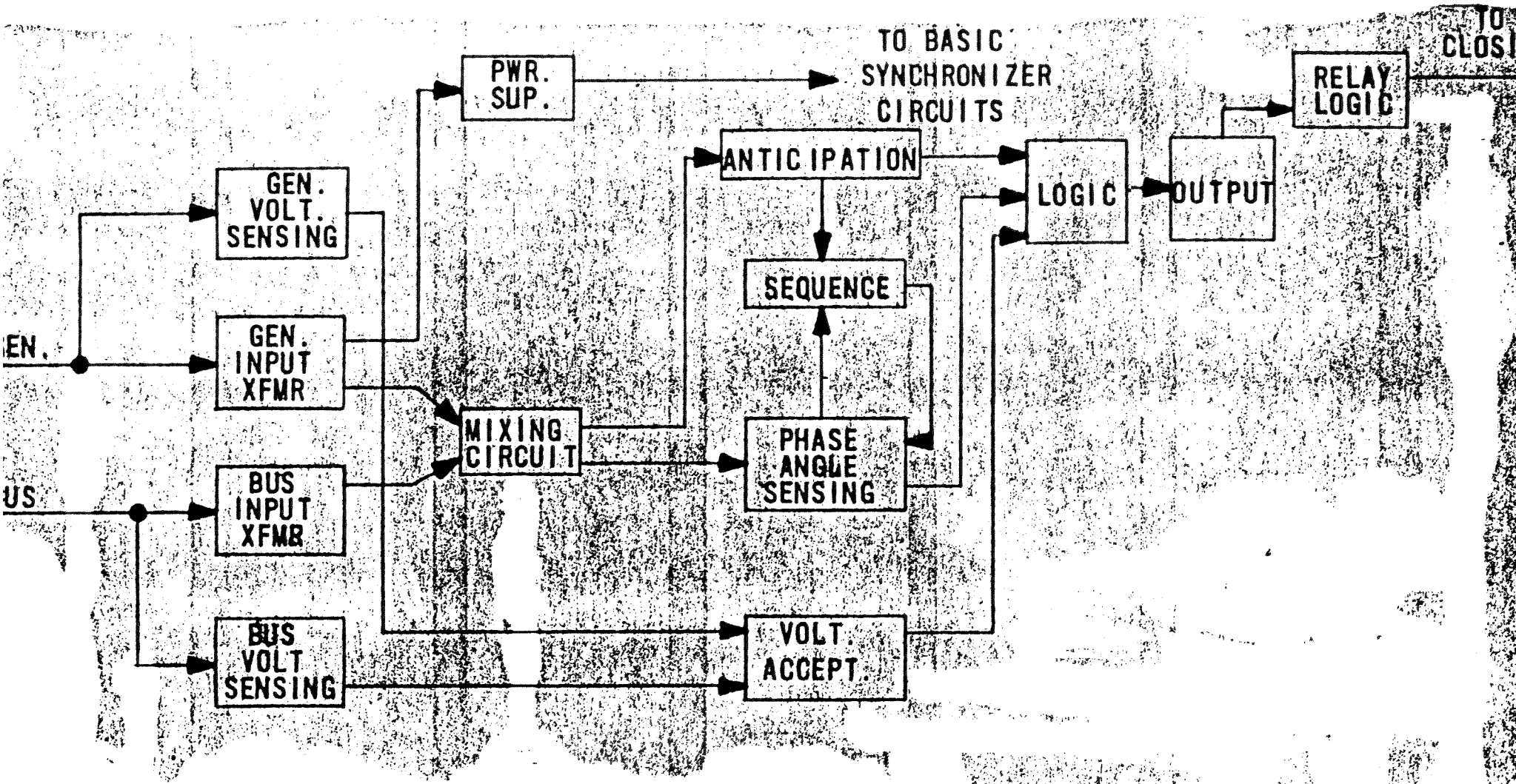


FIGURE 1-1
FUNCTIONAL BLOCK DIAGRAM
(90 75400-100)
(90 75400-103)

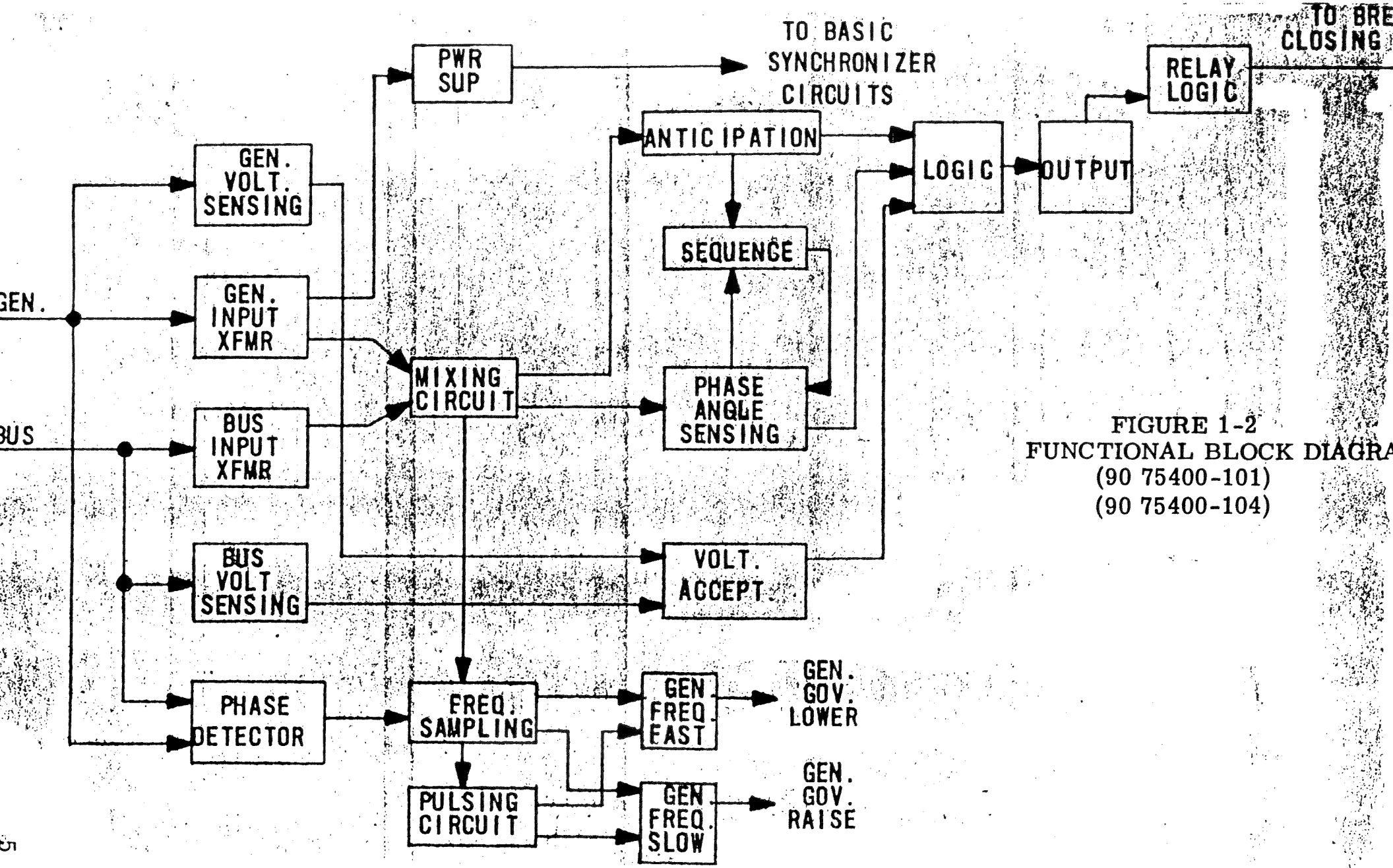
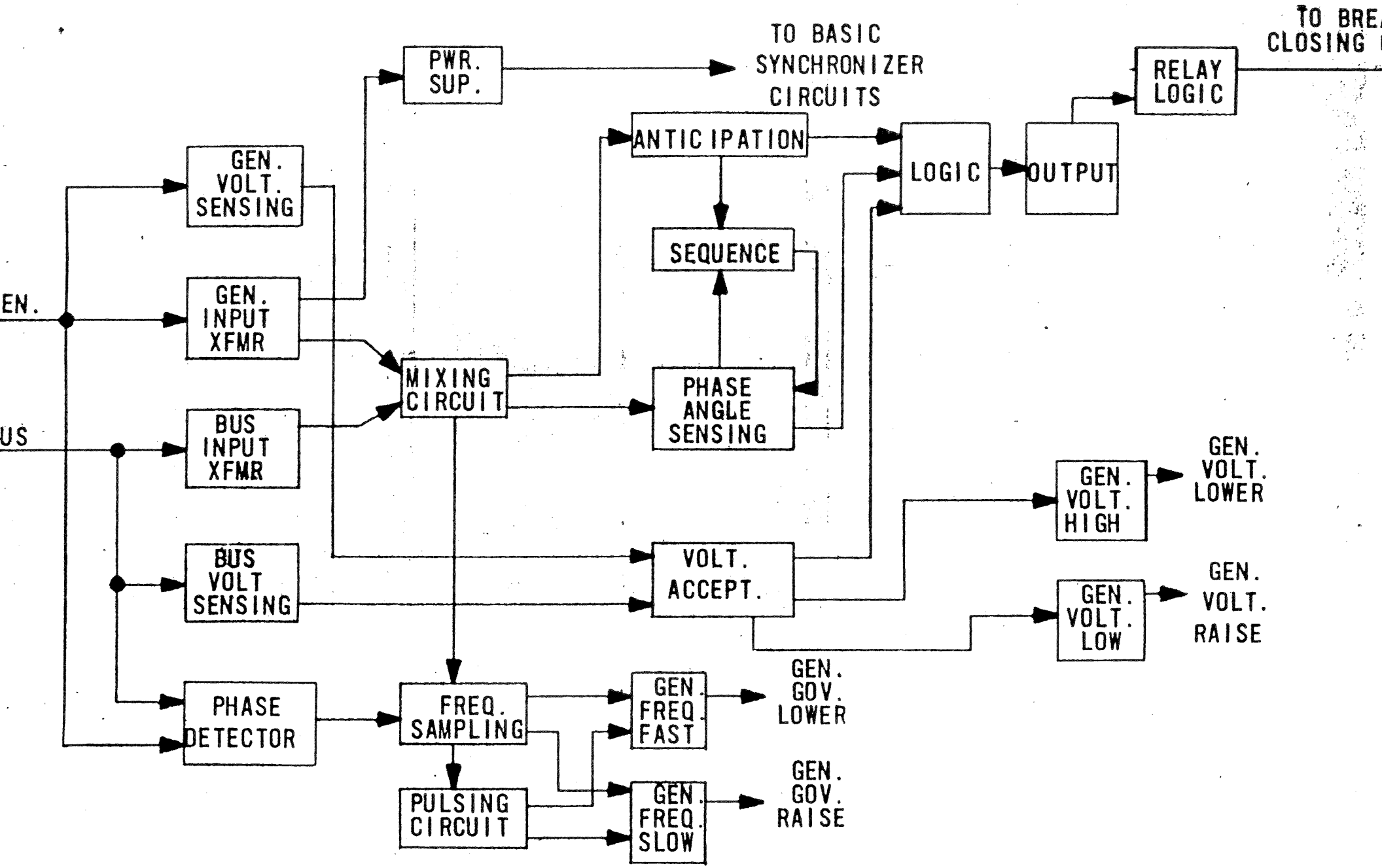


FIGURE 1-2
FUNCTIONAL BLOCK DIAGRA
(90 75400-101)
(90 75400-104)


PWR. SUP.
TO BASIC SYNCHRONIZER CIRCUITS
TO BRE
CLOSING
RELAY LOGIC
ANTICIPATION
LOGIC
OUTPUT
GEN. VOLT. SENSING
SEQUENCE
EN.
GEN. INPUT XFMR
MIXING CIRCUIT
PHASE ANGLE SENSING
US
BUS INPUT XFMR
GEN. VOLT. HIGH
GEN. VOLT. LOWER
BUS VOLT SENSING
VOLT. ACCEPT.
GEN. VOLT. LOW
GEN. VOLT. RAISE
PHASE DETECTOR
FREQ. SAMPLING
GEN. FREQ. FAST
GEN. GOV. LOWER
PULSING CIRCUIT
GEN. FREQ. SLOW
GEN. GOV. RAISE

sampling circuit then determines whether the generator frequency is "ahead" of the bus or "behind" it and corrections are given to the prime mover frequency control to correct the condition. Differences in excess of approximately 2 Hz cause a constant correction signal to be applied to the governor, less than 2 Hz the corrections are pulsed.

1.3.10 The pulse gating signal is derived from the rate of change of the mixing envelope and no speed corrections are given after the generator and bus come within approximately 0.06 slip speed. If, however, the generator should reach synchronous speed, but at an improper phase position, a pulsing circuit in the frequency matcher will pulse the governor control at approximately 3-second intervals to move the generator to the zero phase position. The direction of pulsing will always be in the direction of the smallest angle between the generator and bus. The pulsing circuit begins to operate if there have been no frequency corrections for approximately 17 seconds.

1.3.11 In synchronizer models having voltage matching (see Table 1-2 and Figure 1-3), the voltage acceptance circuit supplies correction signals to the voltage regulator to bring the generator voltage to within acceptable limits. The voltage correcting signals are continuous and cease when the voltage reaches the limits.

1.3.12 Systems with breakers having different closing speeds require a means of equalizing the breaker closing time to utilize the same synchronizer for all breakers. To accomplish this, an Equalizer is used in conjunction with the fastest closing breakers to delay their closure to the same amount of time as the slowest closing breaker. The synchronizer is then set for one breaker closure time and all breakers will close in the same amount of time. The Basler Electric Company Equalizer (part number 90 68200-100) is a time delay circuit, which is continuously adjustable from 0 to 0.5 seconds.

SECTION 2

INSTALLATION & OPERATION

2.1 GENERAL

2.1.1 This section contains information concerning installation and operation of the auto-synchronizer. It is extremely important that the interconnection and initial operation be done with care to insure correct operation of the unit.

2.1.2 The synchronizer is packed in accordance with the best commercial practices. Carefully remove all inserts, liners and packing from around the unit.

2.1.3 When the unit has been removed from the container, it should be visually inspected for physical damage.

2.2 MOUNTING

2.2.1 The synchronizer is intended for back of the panel mounting. It must be located in an ambient temperature of 70°C or lower.

2.2.2 All data necessary for mounting the Synchronizing Relay is contained in Figure 2-1.

2.3 INTERCONNECTION

2.3.1 The auto-synchronizer must be connected as shown in the interconnection diagram, Figure 2-2. Care must be taken to insure proper connection of the auto-synchronizer, especially important to watch polarity of step down transformers utilized with the synchronizer since the synchronizer operation is based on the signals presented to it. These signals must accurately reflect proper generator line condition. PHASE ROTATION MUST BE A-B-C.

2.3.2 Voltage Matching (PRS210 only)

2.3.2.1 When the incoming generator voltage exceeds the bus voltage, relay K3 energizes to provide a "lower voltage" command to the generator regulator. Relay K2 operates alternately to "raise voltage".

2.3.2.2 The relay contacts can be arranged to operate the Basler Model MOC2-Motor Operated Control and other motorized controls.

2.3.3 Frequency Matching (PRS-210 and PRS-220 Only)

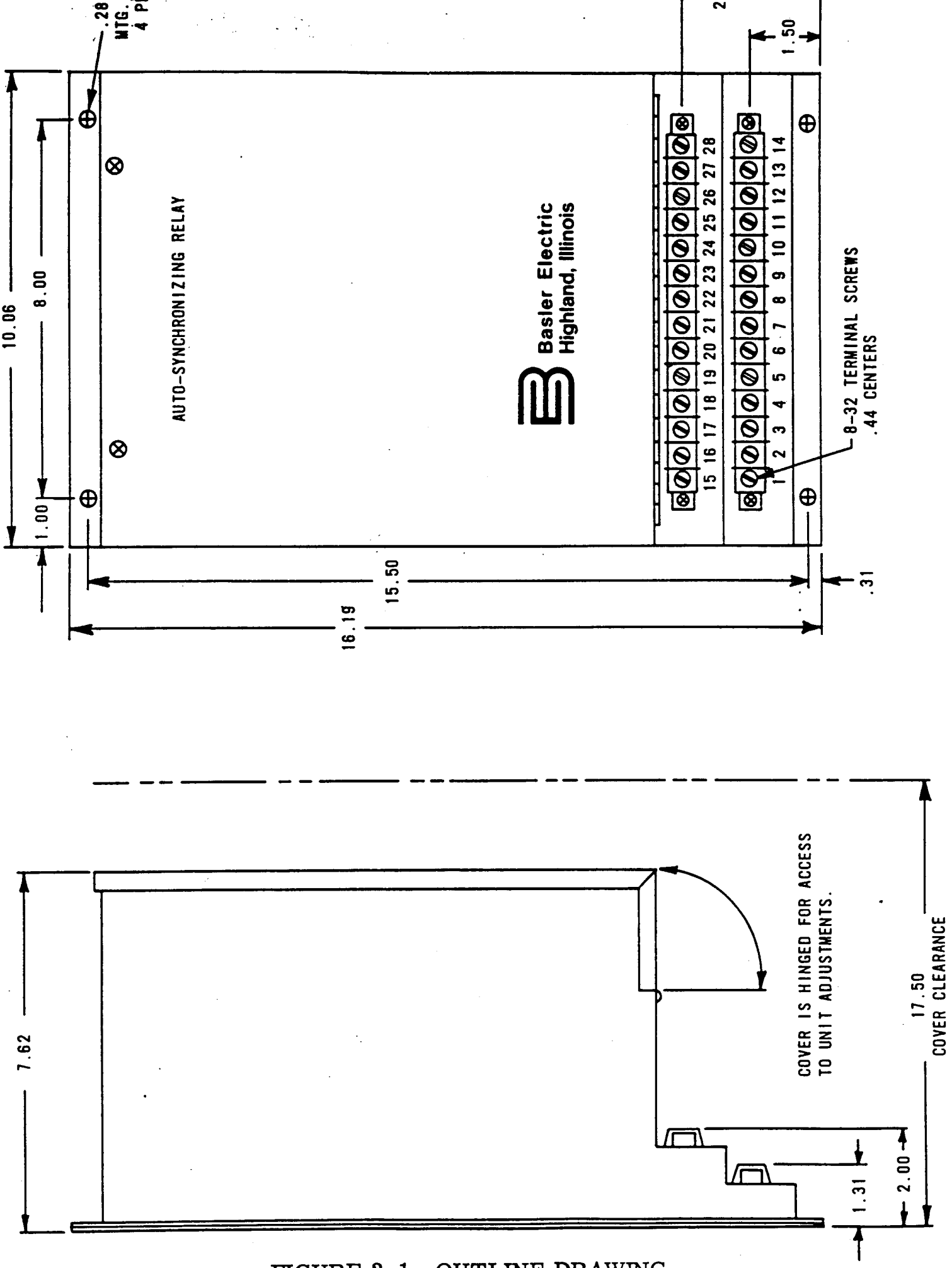
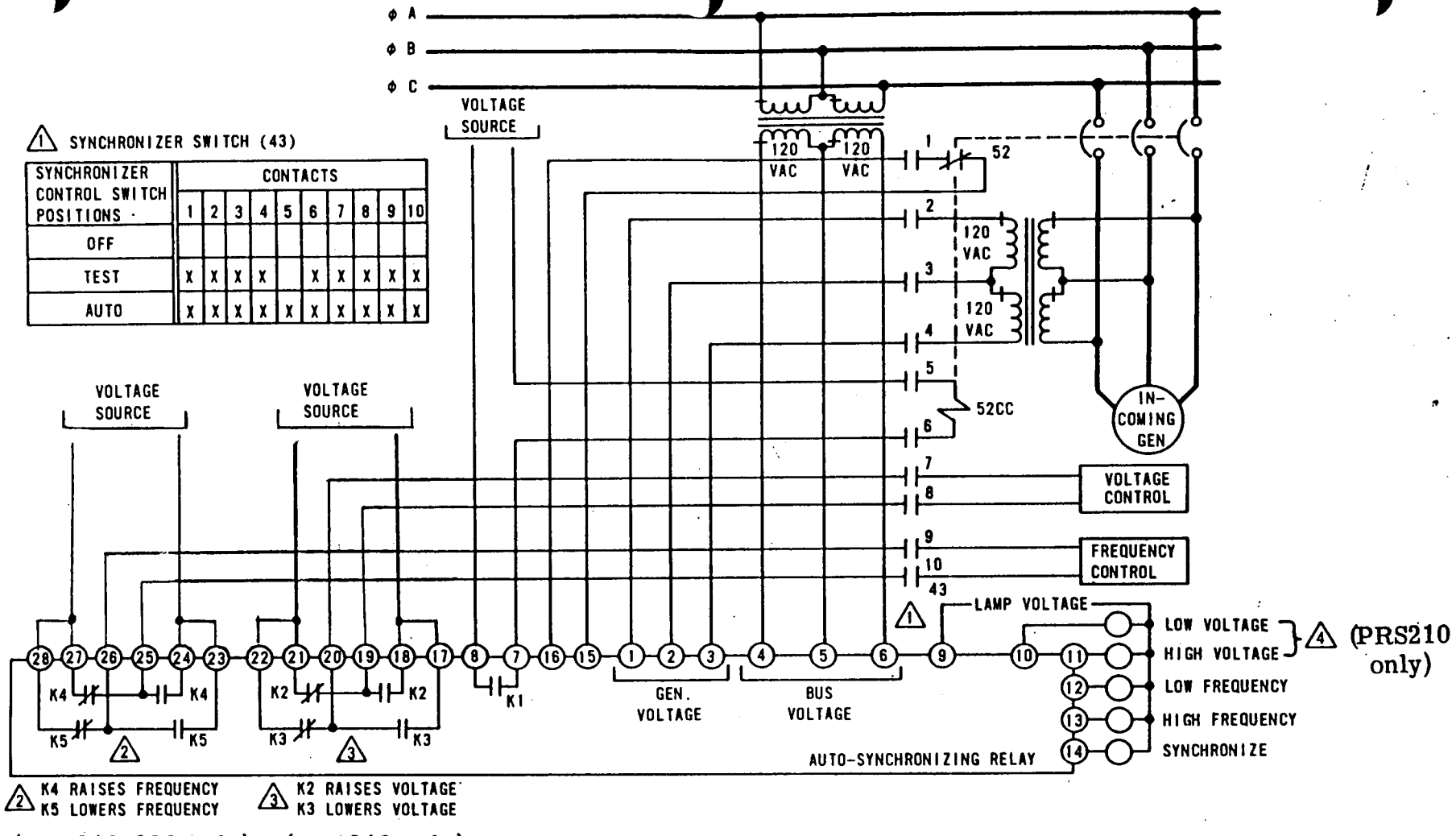


FIGURE 2-1: OUTLINE DRAWING



1 SYNCHRONIZER SWITCH (43)

SYNCHRONIZER CONTROL SWITCH POSITIONS	CONTACTS									
	1	2	3	4	5	6	7	8	9	10
OFF										
TEST	X	X	X	X		X	X	X	X	X
AUTO	X	X	X	X	X	X	X	X	X	X

2 K4 RAISES FREQUENCY
K5 LOWERS FREQUENCY
(PRS210, 220 only)

3 K2 RAISES VOLTAGE
K3 LOWERS VOLTAGE
(PRS210 only)

4 (PRS210 only)

NOTE: PHASE ROTATION MUST BE A-B-C.

FIGURE 2-2: INTERCONNECTION DIAGRAM

2.3.3.1 When the incoming generator frequency exceeds the bus frequency, relay K5 energizes to provide a "lower frequency" command to the generator. Relay K4 operates alternately to "raise frequency".

2.3.3.2 The relay contacts can be arranged to operate the Basler Model MOC2-Motor Operated Control and other motorized controls.

2.4 ADJUSTMENTS

2.4.1 Preliminary tests should be conducted with the breaker connected to the synchronizer, with the breaker in the "test" position. This allows test without circuit breaker closure. If the breaker has no test position, the tests should be performed without the bus or generator connected to the breaker. The breaker closing time and the setting of the breaker closing time adjust determine the accuracy with which the unit will synchronize; therefore, the breaker closing time should be determined from the manufacturer and the synchronizer set accordingly. If this information is not available, follow the procedure outlined in initial operation (paragraph 2.6).

2.4.2 Voltage Adjustment

2.4.2.1 The voltage adjustment dials are calibrated in precent bandwidth. With the dial set at 1.0%, the unit will allow synchronization, when the generator voltage differs by as much as $\pm$1% from the bus.voltage. Paralleling will be permitted if the voltage difference is less than 1%. The maximum voltage difference that can be tolerated should be determined from system requirements. The voltage difference should then be converted to precent of bus voltage and the voltage acceptance bandwidth dial set to that value.

2.4.3 Breaker Closing Time Adjustment

2.4.3.1 The approximate breaker closing time should be determined and the breaker closing time adjustment set for that value. This information should be available from the manufacturer as the closing time in cycles or seconds. If the closing time is given in cycles, it can be converted to closing time in seconds by multiplying by a .0166 for a 60 hertz system or .02 for a 50 hertz system.

EXAMPLE

Closing time given as 10 cycles on a 60 hertz system 10 cycles X .0166=.166 seconds closing time.

2.4.4 Phase Angle.

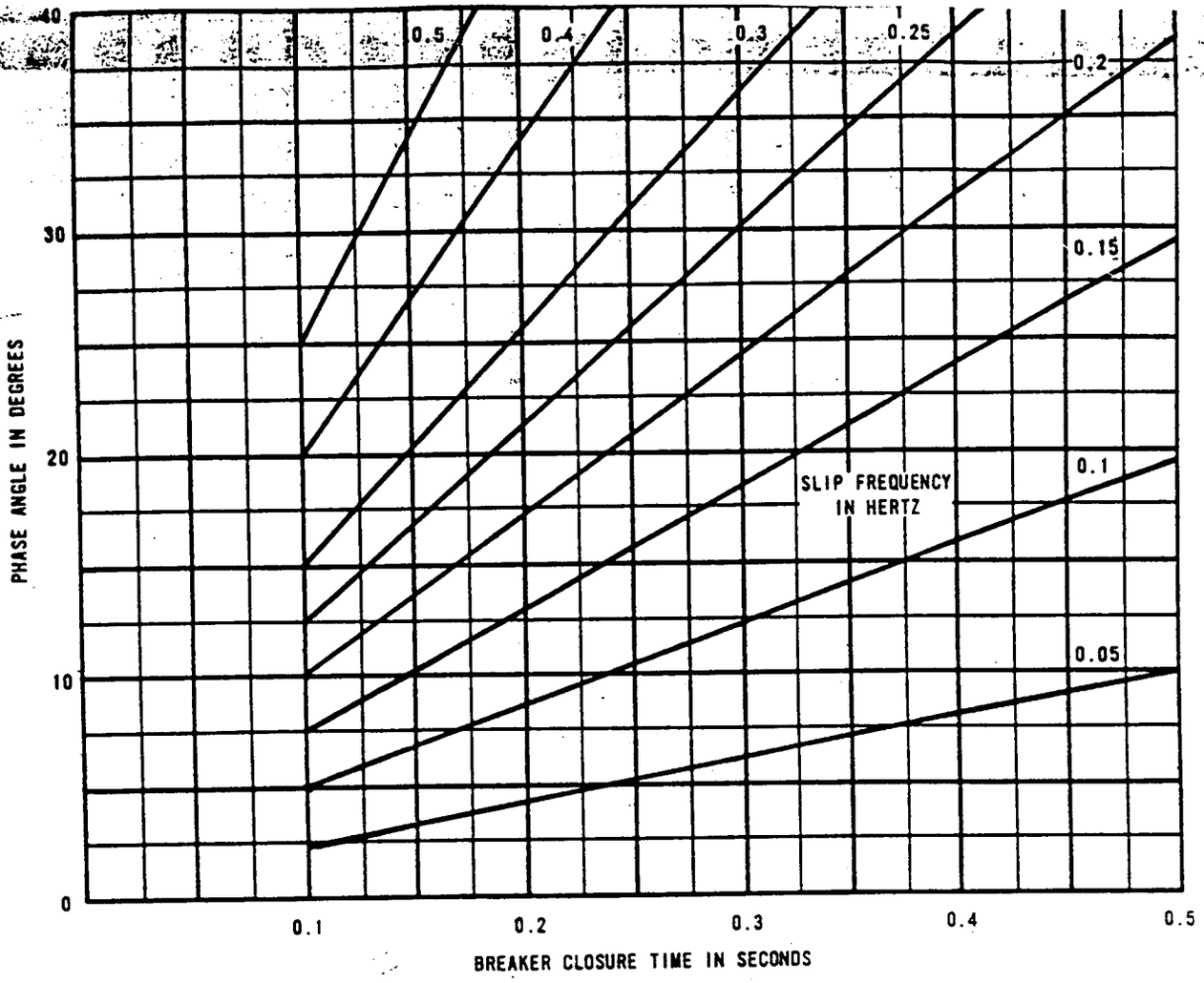


FIGURE 2-3: SLIP FREQUENCY ACCEPTANCE AT VARIOUS PHASE ANGLES AND CIRCUIT BREAKER CLOSURE TIMES

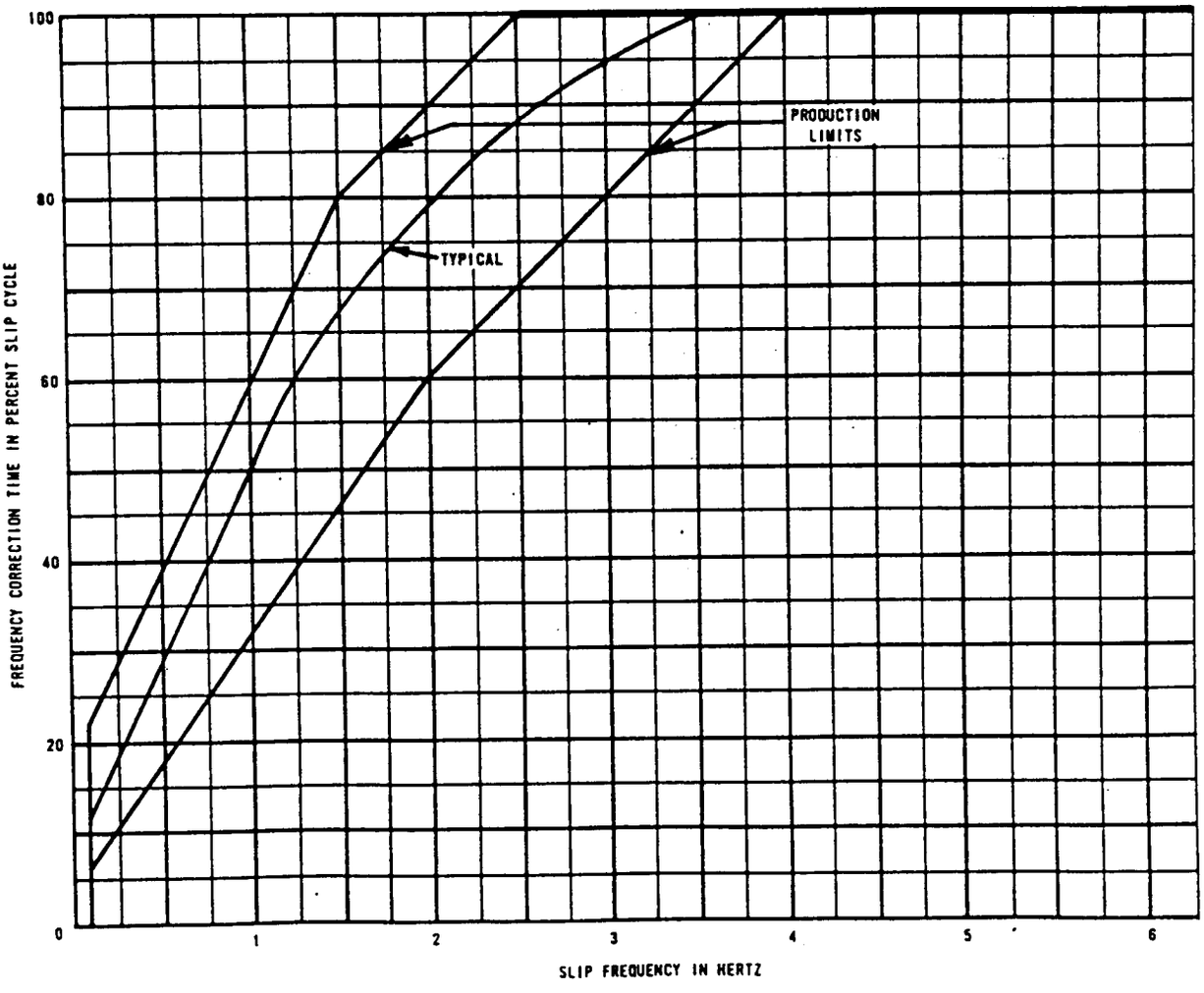


FIGURE 2-4: TYPICAL FREQUENCY CORRECTION

2. 4. 4. 1 The maximum slip frequency acceptable for synchronizing should be determined from system requirements. By referring to Figure 2-3, locate the intersection of the maximum slip frequency and the breaker closing time. From the graph, determine the phase angle setting.

EXAMPLE

GIVEN: Breaker Closing Time.....0. 2 Seconds
Max. Slip Freq. Acceptable.....0. 35 Cycles

From the graph, phase angle setting is 30 degrees.
The phase angle dials should be set for 30 degrees.

2. 4. 4. 2 Note that decreasing the phase angle settings decreases the allowable slip frequency and increasing the phase angle setting allows an increase in the slip frequency.

2. 4. 5 Figure 2-4 shows the production tolerances on Frequency Correction "On" time.

2. 5 INITIAL OPERATION (Breaker Closing Time Known)

2. 5. 1 Phase Rotation--PHASE ROTATION CONNECTIONS TO THE AUTO SYNCHRONIZER MUST BE A-B-C.

2. 5. 1. 1 It is important that the phase rotation of the generator be identical to that of the Bus at the input terminals (1 thru 6) of the Autosynchronizing Relay.

2. 5. 1. 2 A sample test for correct phase rotation is to connect two AC voltmeters (±3% accuracy is acceptable) as shown in Figure 2-5, and observe that both meters indicate increasing or decreasing voltage simultaneously. If one meter reading increases while the other decreases, the phase rotation is incorrect and the connections must be changed.

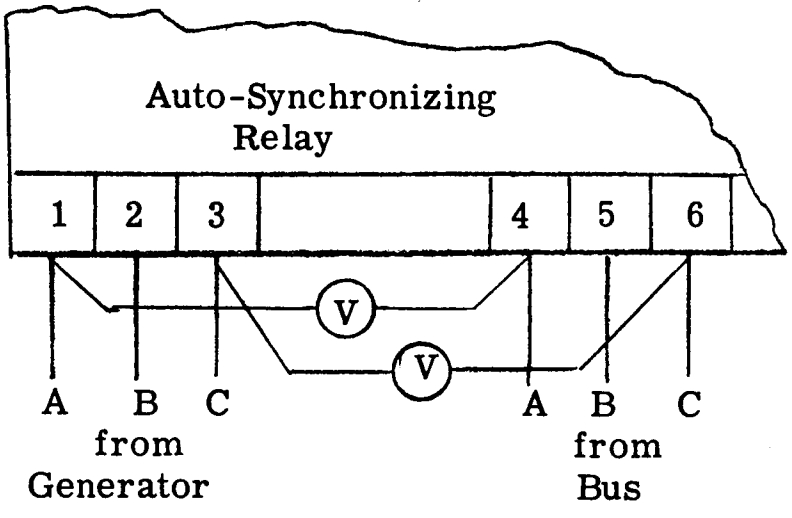


FIGURE 2-5: PHASE ROTATION TEST SET-UP

2.5.1.3 Observe that both meters read approximately zero at the instant the synchroscope (when provided) reads "zero" phase (the 12 o'clock position). This test assumes that the synchroscope is correctly monitoring an "in-phase" condition.

2.5.2 To check out the Autosynchronizing Relay prior to incorporating it in the power generating system, it is important that the main generator circuit breaker be temporarily cranked or set to its non-operating or test position.

2.5.3 Set the Voltage and Breaker Closing Time Adjustments as described in paragraphs 2.4.2 and 2.4.3. Then adjust the phase angle for the maximum desired slip frequency from the characteristic curves, Figure 2-3 as described in paragraph 2.4.4.

2.5.4 Temporarily disconnect the breaker closing circuit from the synchronizer by removing either the lead connected to terminal 7 or terminal 8. Energize the synchronizer and observe the generator status lights, if connected to synchronizer terminals 9 through 14.

2.5.5 If the incoming generator voltage and the bus voltage differ by more than the acceptable levels, the voltage lights should indicate the generator voltage status (generator voltage too high or too low). If the voltage matching function is being utilized, the generator voltage should be changing in the direction necessary to correct the status.

2.5.6 If the generator and bus voltages differ by more than the acceptable bandwidth and the synchronizer is not correcting this condition, it will be necessary to check the balance of the voltage acceptance circuit. This is accomplished in the following manner:

-Connect two high quality (1/2% accuracy) AC Voltmeters from line to line on both the generator and bus (on low voltage equipment) or across the secondary of the potential transformers (on high voltage equipment).

-Adjust the incoming generator voltage to match, exactly the bus voltage.

-Connect a 20,000 ohm/volt meter or equivalent (set to the 50 volt DC scale) to the balance pin jacks on the front of the synchronizer circuit board panel.

-Connect the leads for an up scale reading.

-Adjust the voltage bandwidth knob to 0.5%.

-Adjust the balance potentiometer with a small screwdriver until a zero reading is obtained on the meter.

-Set the meter for 2.5 volts DC full scale and trim the adjustment again for zero volts.

2.5.7 If the generator frequency differs by more than 2 hertz from the bus, the proper frequency matching light should be on continuously. For example, if the generator is at 57 hertz, the frequency "low" light should be lit. If the frequency matching circuits are being utilized, the generator governor should be changing in the direction to correct the status (increasing frequency). If the generator frequency is within approximately 2 hertz, the proper frequency light should be pulsing once each slip cycle immediately after the generator passes through the zero phase position.

2.5.8 When the voltage lights are out and the generator frequency is within the slip frequency set up in the adjustment section, the "synchronize" light should signal just prior to the zero phase position.

2.5.9 If a "synchronize" light is signalling at the proper time and all circuits appear to function normally, raise or lower the generator voltage until the voltage light comes on. Under this condition, no "synchronize" signal should be obtained until the voltage is returned to acceptable limits.

2.5.10 After the conclusion of the tests above, reconnect the breaker closing lead.

2.5.11 Recycle the generator through a paralleling operation and note the point on the synchroscope where the breaker closure takes place.

2.5.12 Breaker closure should occur at approximately the zero phase position if the unit is properly adjusted. Note that when the breaker closure occurs, the synchronizer ceases to function since the auxiliary contact on the breaker has deactivated the synchronizer.

2.5.13 After the successful completion of the above tests, the breaker can be placed in the operate position or the bus and generator leads can be connected to the breaker and the unit paralleled.

2.6 INITIAL OPERATION (Breaker Closing Time Unknown)

2.6.1 In installations where the breaker closing time may not be known, it will be necessary to adjust the synchronizer while the system is in operation. To accomplish this safely, the following procedure should be followed.

-Connect the synchronizer as stated in section 2.3.1.

-Follow the adjustment procedures as given in section 2.4 adjusting the breaker adjust knob to approximately 0.25 seconds and the phase angle to 10 degrees.

-Check for proper phase rotation per paragraph 2.5.1

-Disconnect one lead of the breaker closing circuit temporarily.

-Energize the synchronizer and adjust the generator frequency to less than 0.1 Hz (synchroscope should take 10 seconds or longer to complete on revolution). Check operation of synchronizer by noting whether a synchronize light is being obtained at approximately the zero phase position on the synchroscope.

-If the operation is correct, de-energize the system and reconnect the breaker closing circuit.

-Re-energize the system and gradually adjust the generator to within 0.1 Hz slip.

-Observe the point on the synchroscope at which the breaker contacts are closing. (If the contacts are closing before the zero phase position, the breaker is faster than the setting on the synchronizer panel. If the contacts are closing after the zero phase position, the breaker closing time is longer than the setting.)

-Readjust the setting of the breaker closing time by about 0.05 seconds as necessary from the test above.

-Repeat synchronizing operation as above and readjust as necessary until synchronization is taking place at approximately the zero phase position.

-The breaker closing time adjustment will be properly set at the actual breaker closing time when this point is reached.

2.6.2 Repeat the operation with the phase angle at 15° and turn the breaker closing time knob again as necessary to maintain the zero phase closing position.

2.6.3 Repeat the operation moving the phase angle knob 5 degrees each time until the desired phase angle is reached.

2.6.4 After the conclusion of the tests above, reconnect the breaker closing lead.

2.7 USE OR EQUALIZER (Basler P/N 90 68200-100)

2.7.1 In installations with breakers having different closing times, but utilizing the same synchronizer for each breaker, an equalizer must be installed to equalize the closing time of all breakers. For example, an installation with two breakers, one with 0.2 second closing time and one with 0.3 second closing time, will require an equalizer set for 0.1 second to be used in conjunction with 0.2 second breaker to extend its closing time to 0.3 seconds. The synchronizer is then set for 0.3 second breaker closing time to close both breakers.

SECTION 3

MAINTENANCE

3.1 GENERAL

3.1.1 The components in the synchronizer are extremely rugged and have operational limits well in excess of the stresses encountered during normal operation.

3.2 CLEANING

3.2.1 Remove dust and dirt from the synchronizer with a soft bristle brush and compressed air from a filtered source at a maximum of 15 pounds per square inch pressure. Insure that the dust and dirt is completely removed.

3.3 REPAIR SERVICE

3.3.1 Basler Electric maintains a stock of circuit boards and/or complete synchronizing relays for replacement if necessary. It, therefore, is not recommended that any attempts to repair components be made. Contact Basler Electric Company, Highland, Illinois for further information.

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