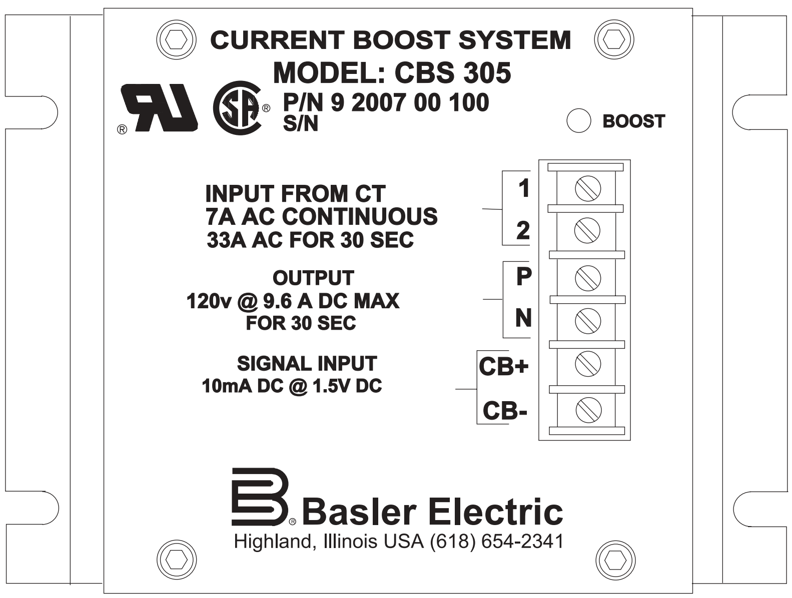
INSTRUCTION MANUAL

FOR

CURRENT BOOST SYSTEM

Model: CBS 305

Part Number: 9 2007 00 100



Basler Electric

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WARNING

To prevent personal injury or equipment damage, only qualified technicians/operators should install, operate, or service this device.

CAUTION

Meggers and high potential test equipment should be used with extreme care. Incorrect use of such equipment could damage components contained in the device.

CONFIDENTIAL INFORMATION

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

Manual Revision History

The following table of information provides a historical summary of changes made to this instruction manual.

Manual Version and ECO/ECA	Change
RevD/17075	Added UL and CSA marks to front panel drawings in the manual. Added UL and CSA information to the specifications portion of Section 1. Revised manual to new format.

TABLE OF CONTENTS

SECTION 1 • GENERAL INFORMATION

GENERAL DESCRIPTION

The Current Boost System (CBS 305) consists of a current boost module and a current transformer (CT). The system provides an additional current source along with the APR 63-5 voltage regulator which allows the field to receive full forcing during generator overloading and short circuits.

The CBS 305 allows three-wire and four-wire generators to provide current during sustained single-phase and multi-phase line-to-line faults. The CBS also permits four-wire generators to support phase A and C line-to-neutral faults (phase B line-to-neutral faults will have some fault sustaining capabilities since the APR 63-5 regulator input power is taken from the other two unshorted phases).

The Current Boost Module uses the CB+ and CB- outputs of the APR regulator as a control signal. Boost power to the module is supplied from a CT installed in phases A and C of the generator output. During short circuits, the CT is the source of all excitation current.

Because the APR 63-5 regulator sensing is the source for the Current Boost System control, the boost operating level is automatically adjusted to the nominal generator voltage. The CBS control signal also tracks the regulator~s underfrequency curve to allow the prime mover to pick up large loads in one step.

CURRENT BOOST MODULE DESCRIPTION

The Current Boost module contains the electronics mounted on a printed circuit board, a terminal strip for circuit connections and an LED indicator to annunciate when the boost is operating. All of the electronics are encapsulated in a metal enclosure.

CURRENT TRANSFORMER DESCRIPTION

The current transformer is connected to two phases of the generator to provide current for the Current Boost System. The CT provides several turns-ratios for tailoring the CBS 305 to a variety of generator systems. Refer to Paragraph 2-4 for appropriate turns-ratios.

The CT is available in two sizes:

1. Part Number BE 21331-001**:** for use on generators with rated line currents up to 800A.
2. Part Number BE 21432-001: for use on generators with rated line currents up to 2400A.

SPECIFICATIONS

Refer to Table 1-1 for the electrical specifications and to Table 1-2 for the physical specifications.

Table 1-1. Electrical Specifications

Input from CT:	7 A maximum continuous/33 A maximum for 30 seconds.
Input from Voltage Regulator:	10 mAdc @ 1.5 Vdc.
Output Power:	90 - 120 Vdc, 7.2 - 9.6 A maximum.
Power Dissipated:	
Current Boost Module:	24 W in non-boost mode.
CT BE 21331-001:	25 W maximum.
CT BE 21432-001:	70 W maximum.
Transient Response:	Less than 2 cycles from regulator's boost signal until boost output reaches 90 Vdc.

Field Resistance:	12.5 Ω minimum/50 Ω maximum.
CT Secondary Turns: **BE 21331-001:** **BE 21432-001:**	Terminals 1 and 2: 209 turns. Terminals 1 and 2: 208 turns/Terminals 1 and 3: 616 turns.
CT Secondary Insulation Rating:	2500 Vac Hi-pot.

Table 1-2. Physical Specifications.

Storage Temperature Range:	-65°C (-85°F) to +85°C (+185°F).
Operating Temperature Range:	-40°C (-40°F) to +60°C (+140°F).
Shock:	Withstands 15 G's in each of three mutually perpendicular planes.
Vibration:	Withstands the following: 1.2 G's over the frequency range of 5 to 26 Hz; 0.036 inch double amplitude over the frequency range of 27 to 52 Hz; 5.0 G's over the frequency range of 53 to 1000 Hz.
UL Recognition:	UL recognized per Standard 508, UL File Number E97033
CSA Certification:	CSA certified per Standard CAN/CSA-C22.2 Number 14-M91, CSA File Number LR23131.
Humidity:	Totally protected from humidity and condensation by encapsulation.
Current Boost Module Weight:	2.6 lbs. (1.2 kg) net, 3.6 lbs. (1.6 kg) shipping.
Current Transformer: **BE 21331-001:** **BE 21431-001:**	 15.5 lbs. (7.1 kg) net, 17 lbs. (8 kg) shipping; 44 lbs. (20 kg) net, 65 lbs. (25 kg) shipping.

SECTION 2 • INSTALLATION

CURRENT BOOST MODULE MOUNTING

The unit may be mounted in any position although mounting it with the fins in the vertical position will provide the best cooling. Refer to figure 2-1 for the outline drawing of the unit. The current boost module may be mounted directly to the generator set using 1/4" hardware. Hardware should be selected based on vibration and shock during shipping/transport and normal operation.

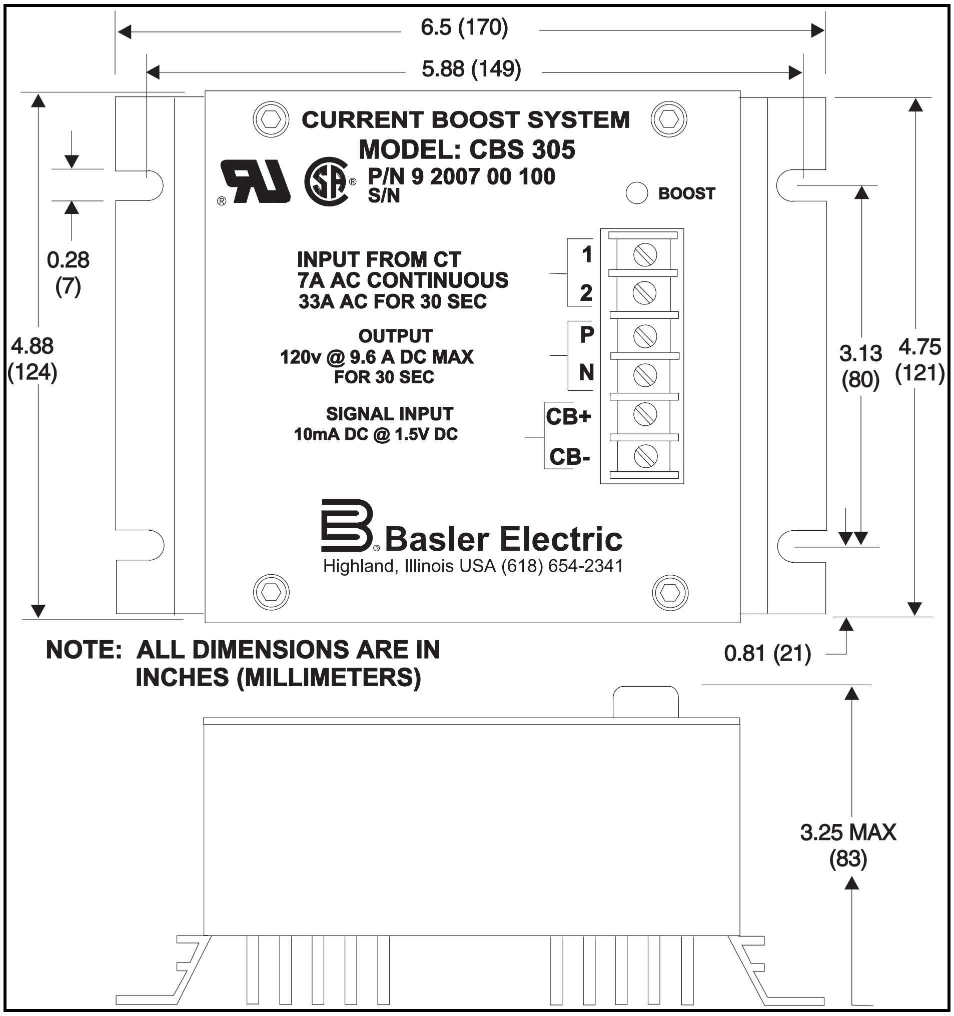


Figure 2-1. Outline Drawing - Current Boost Module.

CURRENT TRANSFORMER MOUNTING

Mount securely using 5/16" mounting bolts in six places. Ensure that the mounting structure is adequate to support the transformer weight during shipping/transport and operation of the system. Refer to Figures 2-2 and 2-3 for the current transformer.

> **NOTE**
>
> For selection of the CT turns-ratio, refer to paragraph 2.4.

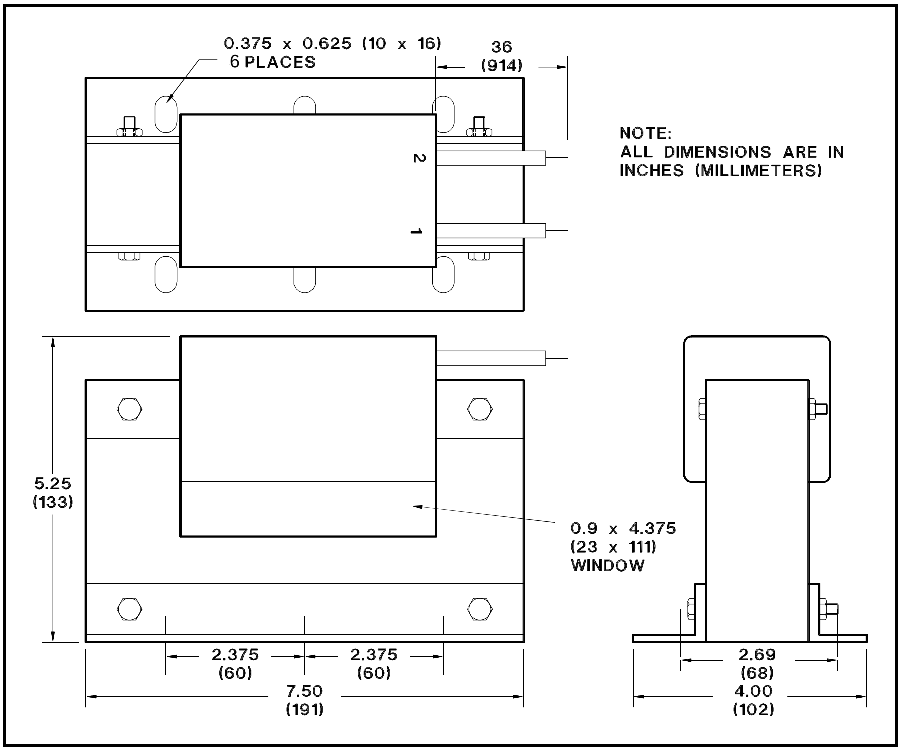


Figure 2-2. Outline Drawing - Current Transformer BE 21331-001

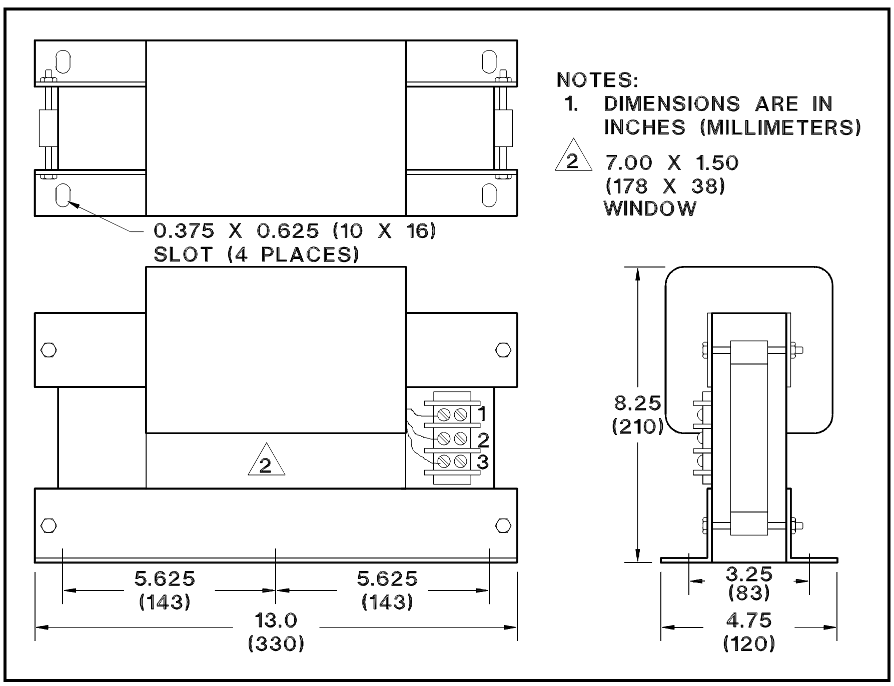


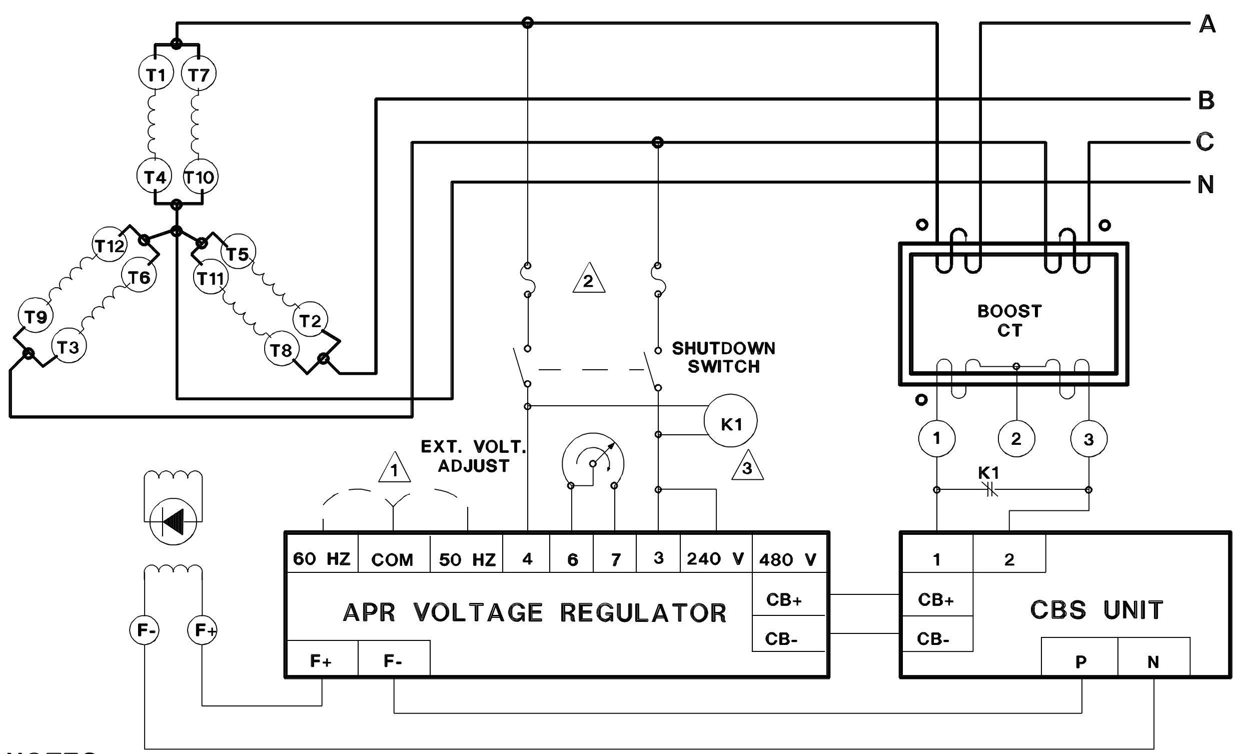
Figure 2-3. Outline Drawing - Current Transformer BE21432-001

INTERCONNECTION

a. Refer to Figures 2-4 through 2-8 for the interconnection diagrams and connect as shown therein.

> **NOTE**
>
> Be sure that the two power leads from the two phases pass through the CT window in opposite directions.

b. The generator leads must be provided with adequate insulation for the generator operating voltage. Insulated cables or insulated bus bar may be used. Proper support for the cables/bus bar during short circuit must be provided.



NOTES:

1. JUMPER FOR 50 HZ OR 60 HZ.
2. REFER TO VOLTAGE REGULATOR MANUAL FOR PROPER FUSE SIZE.
3. OPTIONAL TIME DELAY RELAY FOR OVER EXCITATION SHUTDOWN DURING BOOST CONDITIONS

Figure 2-4. CBS 305 Interconnection With 208 to 240 Vac Generators

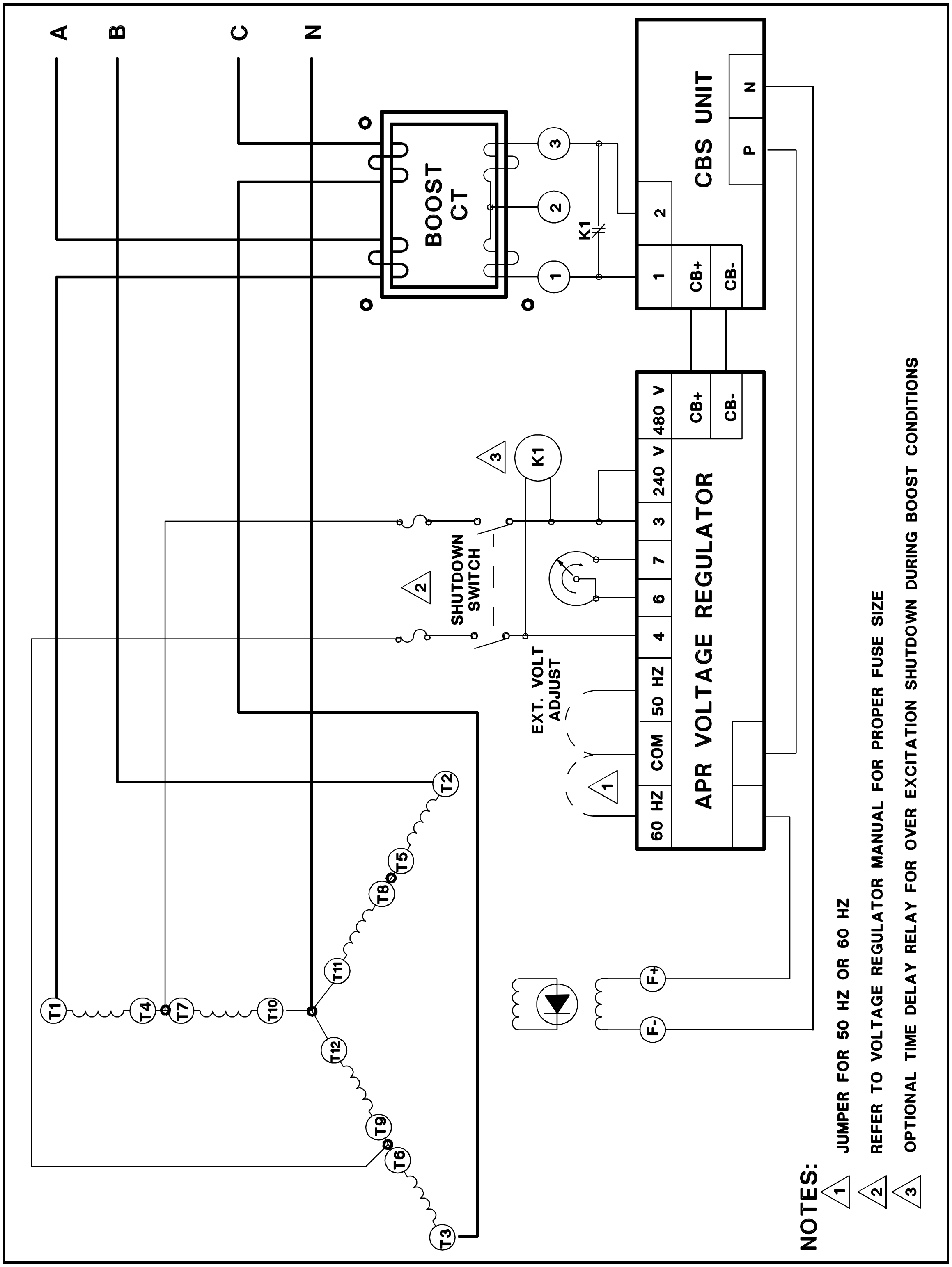


Figure 2-5. CBS Interconnection with 415 to 480 Vac Generators

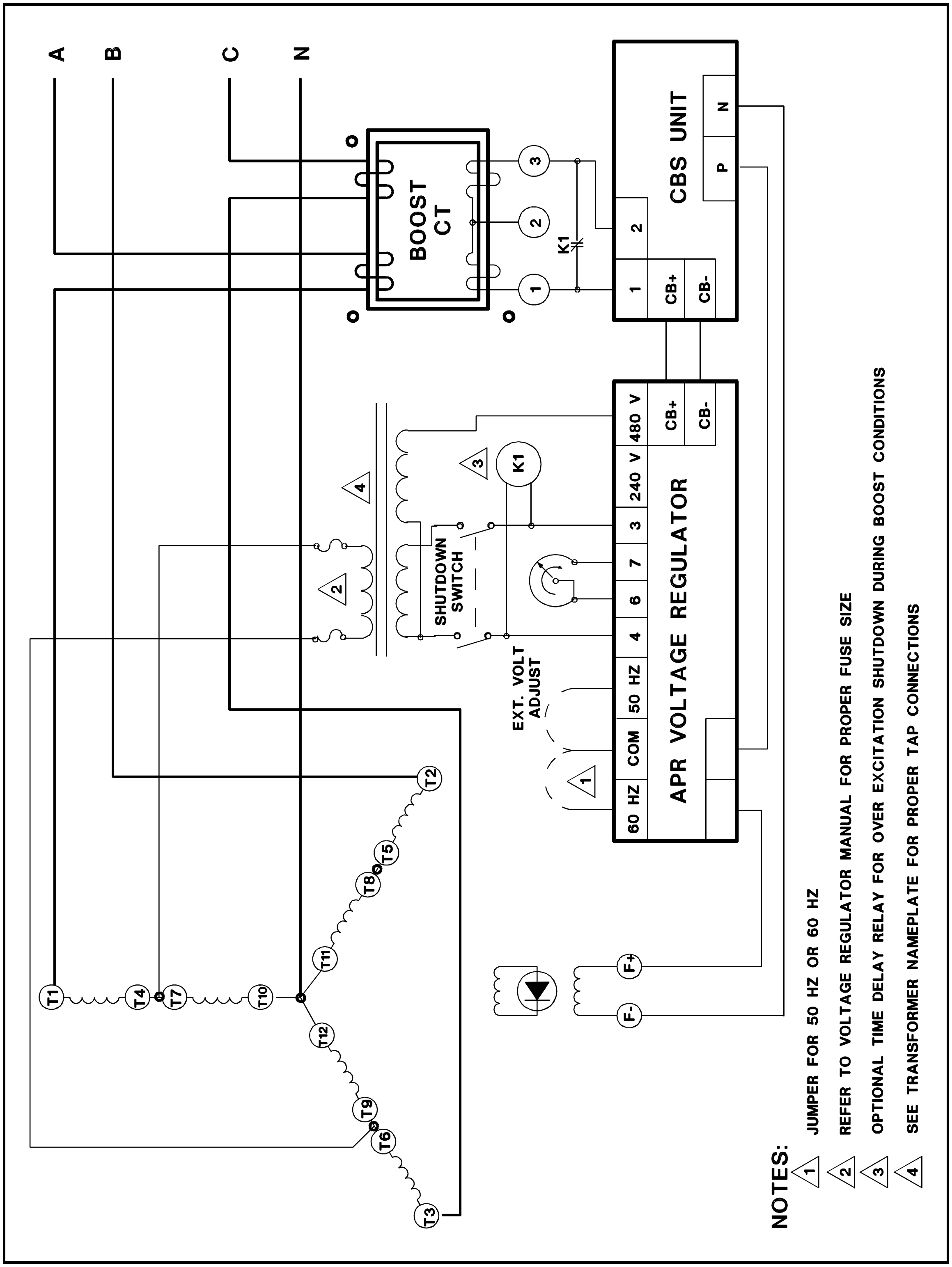


Figure 2-6. CBS Interconnection with Isolation Transformer

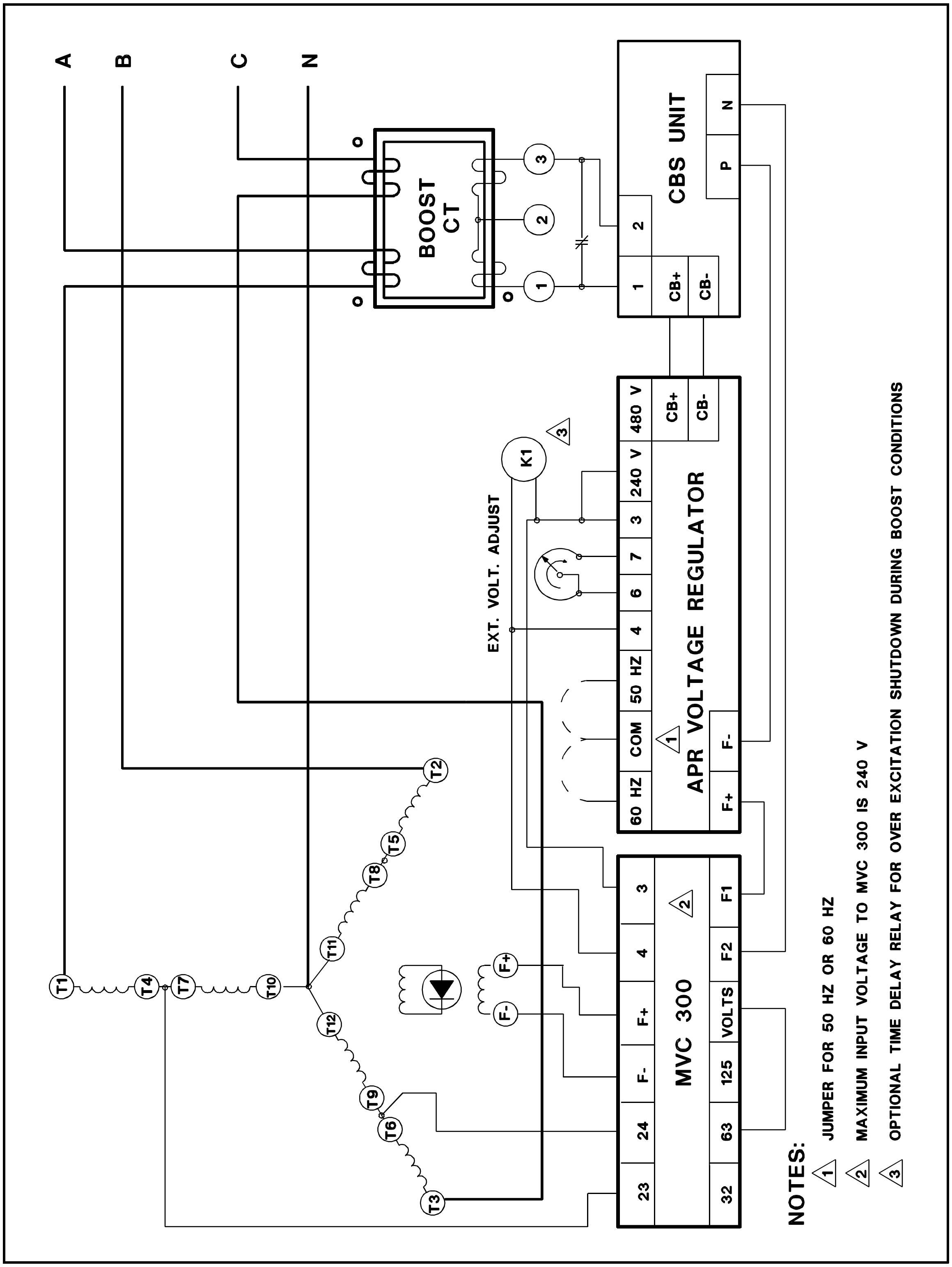


Figure 2-7. CBS Interconnection with MVC on a 480 Vac Generator

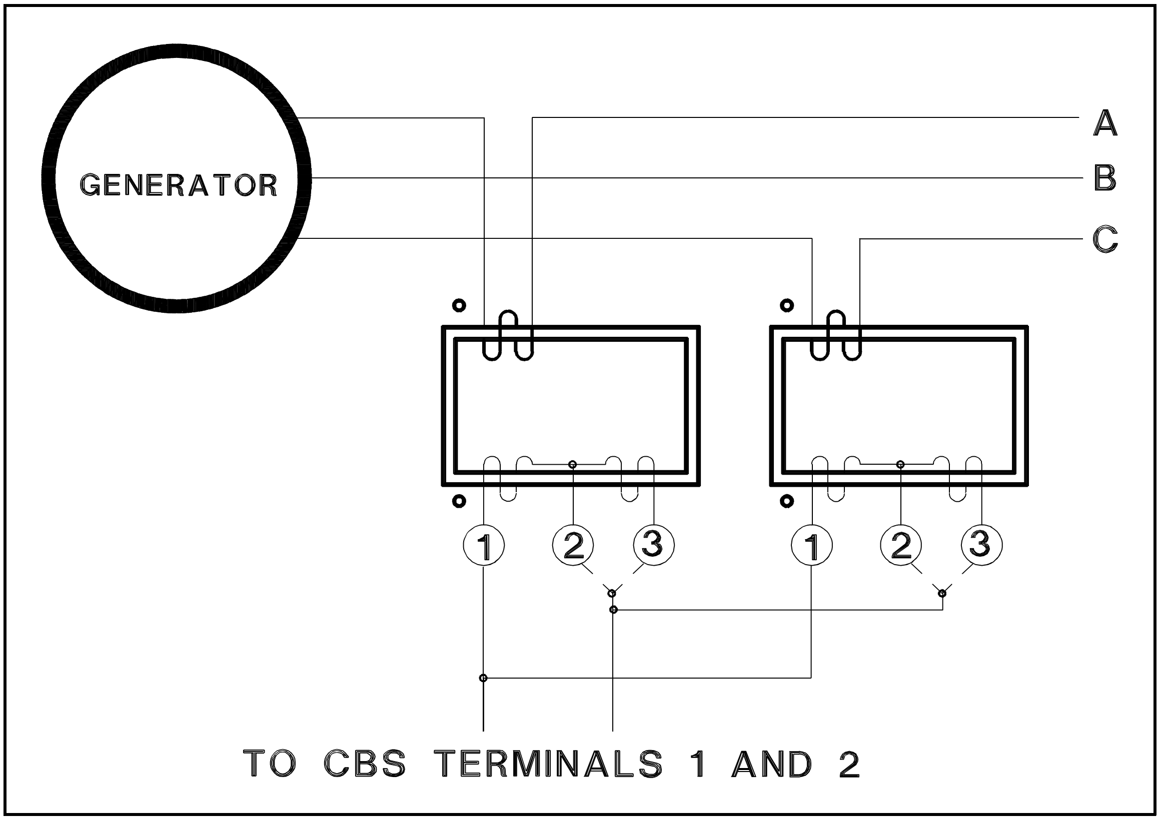


Figure 2-8. CBS Interconnection Using Two Current Transformer

SELECTION OF CT TURNS-RATIO

The boost system requires current from two phases of the generator output. The interconnect diagrams illustrate the use of one CT with two phases on the primary or two CT's with one phase on each primary. The following procedure is used to calculate the number of CT primary turns (generator output lines wound through the CT window by the installer) for each phase and the secondary turns required.

Step 1. Calculate the exciter field current during a generator short circuit:

$$I_{Field} = \frac{E}{R}$$

Where:

I_{Field}	=	Exciter field current at short circuit.
R	=	Exciter field resistance from generator data.
E	=	CBS field forcing voltage (90 Vdc for CBS 305).

Step 2. From the generator manufacturer's short circuit saturation data (plot of exciter field current versus line amps with generator output short circuited), determine the generator three phase line current during a short circuit that would result from the exciter field current calculated in Step 1.

If for your generator system:	Then proceed to:
This results in **excessive** generator line current.	Step 3A.
This results in **acceptable** generator line current.	Step 3B.

Step 3A.

a. Determine the desired acceptable generator three phase line current at short circuit (typically 300% of nominal). Refer to Table 2-1 or 2-2 (as appropriate) and locate the range that covers the value in Column 1.

b. Using the generator manufacturer's short circuit data (plot of exciter field current versus line amps with the generator short circuited), determine the exciter short circuit field current needed to generate the acceptable generator line current. Refer to Table 2-1 or 2-2 (as appropriate) and locate the current value equal to this value in column 3. If the field current desired is in between the column 3 values, go to the next higher value.

c. Check that the rated generator full load line current doesn't exceed the maximum continuous line current. If the generator full load line current does exceed the maximum continuous line current rating, consult the factory.

Table 2-1. Turns-Ratio Selection (3-Phase)

	Column 2	**Column 3**			
3-Phase Line Current @ Short Circuit	Maximum Continuous Line Current	Exciter Field Current at Rated CBS 305 Output Voltage (90 Vdc)			
		1.8 Adc	3.6 Adc	7.2 Adc	Transformer
35 - 70	25	8:209	16:209	32:209	BE 21331-001
70 - 140	50	4:209	8:209	16:209	
140 - 275	100	2:209	4:209	8:209	
275 - 550	200	1:209	2:209	4:209	
550 - 1100	400	1:209	1:209	2:209	
1100 - 2200	800	1:209	1:209	1:209	
1600 - 3200	1200	1:616	1:616	1:308	BE21432-001
3200 - 6400	2400	1:616	1:616	1:616	

Table 2-2. Turns-Ratio Selection (Single-Phase)

Column 1	**Column 2**	**Column 3**					
1-Phase Line Current @ Short Circuit (Zig-Zag)	Maximum Continu-ous Line Current	Exciter Field Current at Rated CBS Output Voltage (90 Vdc) (Transformer BE 21331-001)					
		1.8 Adc	3.6 Adc	7.2 Adc	2.38 Adc	3.16 Adc	6.3 Adc
23 - 37	10.8	8:209	16:209	32:209	16:209	22:209	44:209
37 - 60	17.6	4:209	8:209	16:209	10:209	14:209	27:209
60 - 100	28.6	2:209	4:209	8:209	6:209	8:209	16:209
100 - 203	53.4	1:209	2:209	4:209	3:209	4:209	9:209
203 - 604	163.2	1:209	1:209	2:209	1:209	1:209	3:209
604 - 802	216.8	1:209	1:209	1:209	1:209	1:209	2:209

d. To obtain a reduced field current, place a current limiting resistor in series with the exciter field. The value of this resistance is calculated as follows:

$$R_S = \frac{E}{I_2} - R_f$$

Where:

R_S = value of series field resistance to be added (ohms). This resistance must not be so great as to restrict normal forcing.

E = exciter field forcing voltage (from step 1).

I_2 = field current required to produce acceptable generator line current at short circuit.

R_f = exciter field resistance.

e. Proceed to step 4.

Step 3B**.**

a. In Table 2-1, Column 1, locate the range of the generator three-phase short circuit line current that covers the value determined in step 2.

b. In Table 2-1, Column 3, locate the exciter short circuit field current that is closest to the value determined in step 1. If the calculated field current is between the values in Column 3, go the next higher value.

c. Proceed to step 4.

Step 4.

a. Find the turns-ratio at the point of intersection of the values found in step 3.

b. The first numeral of the turns-ratio indicates the number of turns of each generator line that passes through the CT window. The second numeral indicates the CT secondary turns. Refer to Table 1-1 and to Figures 2-2 and 2-3 for the terminal numbers corresponding to the desired secondary turns.

Step 5. Verify that the CT "window" size is sufficient for the generator conductor by comparing the conductor cross-section (including insulation) with the CT window area.

EXAMPLE 1

Sample Generator Data:

100 kW, 125 KVA, 60 Hz, 3-phase, 480 Vac Line-Line
150 A at full rated load, 15 ohm field.
I_F = 5.14 Adc at 300% short circuit (450 A Line)
I_F = 6.0 Adc at 350% short circuit (525 A Line)

Step 1. Determine the field current that will be provided by a Basler CBS 305 during short circuit:

$$I_F = \frac{E}{R} = \frac{90Vdc}{15ohms} = 6.0A$$

Where:

I_F = Field current.

E = APR63-5/CBS 305 maximum dc voltage.

R = Exciter field resistance.

Step 2. From generator manufacturer's data, you determine that the exciter field current of 6.0A from the CBS 305 would result in a short circuit line current of 525 A - for your generator system you consider this to be:

Unacceptable - Proceed to Step 3A, and skip 3B.

Acceptable - Proceed to Step 3B.

Step 3A. You determine that 450 A would constitute an acceptable generator line current at short circuit. From the generator manufacturer's data, you determine that an exciter field current of 5.14 A is required for the generator system to deliver an acceptable 450 A at short circuit.

Determine the necessary resistance to be added to the exciter field to achieve the 5.14 A exciter field current as follows:

$$R_S = \left(\frac{90Vdc}{5.14} - 15\Omega\right) = (17.5 - 15\Omega) = 2.5\Omega$$

NOTE - The series resistance must not be so great as to restrict normal forcing.

In Table 2-1, Column 1, the value of 450 A is between the values of 275 to 55O A. Draw a horizontal line from this point across the chart.

In Table 2-1, Column 2, the maximum continuous line current of 200 A is greater than the full load line current of 150 A, therefore, the limits are not exceeded.

In Table 2-1, Column 3, the value of 7.2 A corresponds with the required value of 5.14 A (from step 3A). Draw a vertical line from this point down the chart.

Step 3B. In Table 2-1, Column 1, the value of 525 A (from Step 2) is between the value of 275 -550 A. Draw a horizontal line from this point across the chart.

In Table 2-1, Column 3, the closest value to 6.0 A (from Step l) is 7.2 A. Draw a vertical line from this point, down the chart.

Step 4. From Table 2-1, the intersection of the two lines (from Step 3B) is the turns-ratio, 4:209.

4 turns on the primary, 209 turns on the secondary

Step 5. The first numeral of the turns-ratio (4), the number of conductors per phase (1), and the number of phases (2), multiplied together results in: 8 conductors (through the CT window). From the generator manufacturer's data, 0.537 is the conductor diameter; therefore, for 8 conductors, the CT window must be at least 0.537 in. X 4.30 in. Basler CT P/N BE 21331-001 is 0.9 in. X 4.375 in. and meets the requirements. Selection is complete.

PRECISION SELECTION OF CT TURNS-RATIO

NOTE

This procedure is to be used only for determining the turns-ratio for the BE 21331-001 current transformer.

a. The turns-ratio indicated in Table 2-1 will provide the CBS with ample operating current. However, the number of primary turns through the CT may be reduced by using the steps in this paragraph to more precisely match the CBS to the generator system.

b. Perform steps 1, 2, and 3A or 3B from Example1 then proceed as follows:

Step 1. Using the exciter short circuit field current obtained from the generator manufacturer's short circuit data, calculate the required secondary current as follows:

$$I_{CT\ SEC} = (I_{FIELD} \times 1.25)$$

Where:

I_{FIELD}	=	Exciter field current at acceptable short circuit current.
$I_{CT\ SEC}$	=	Secondary current from the CT.

Step 2. Calculate the primary ampere-turns required by the CT to provide the secondary current as follows:

$$P_{AT} = (209 \times I_{CT\ SEC})$$

Where:

P_{AT}	=	Primary ampere-turns.
$I_{CT\ SEC}$	=	Secondary current from the CT.

Step 3. Calculate the number of Primary turns required as follows:

$$N_{PRI} = \frac{P_{AT}}{(1.73 \times I_{LINE})}$$

Where:

N_{PRI}	=	Number of primary turns.
P_{AT}	=	Primary ampere-turns.
I_{LINE}	=	3-phase line current at short circuit.

Step 4. Round the result to the next higher whole number. This result is the number of primary turns required per phase.

Example: If N_{PRI} = 1.72, round to 2.

Step 5. Verify that the maximum continuous line current rating has not been exceeded by calculating the following:

$$CONTINUOUS\ P_{AT} = N_{PRI} \times I_{LINE}(Continuous)$$

Where:

CONTINUOUS P_{AT}	=	Continuous primary ampere turns.
N_{PRI}	=	Number of primary turns per phase.
I_{LINE} (continuous)	=	3-phase continuous line current

If the result is less than 800 A-T (ampere-turns), the design is acceptable.
If the result is more than 800 A-T, consult the factory.

EXAMPLE 2

From steps 1, 2, and 3A of Example 1, it is determined that:

I_{FIELD} = 6.0 A

I_{LINE} = 525 A at short circuit

It is also determined the short circuit current is acceptable.

Step 4. Determine the CT secondary current required by the boost system as follows:

$$I_{CT\ SEC} = (I_{FIELD} \times 1.25) = 6.0A$$

Step 5. Calculate the primary ampere-turns required as follows:

$$P_{AT} = (209 \times I_{FIELD}) = (209 \times 7.5A) = 1568\ Ampere\text{-}Turns$$

Step 6. Calculate the number of primary turns as follows:

$$N_{PRI} = \left(\frac{P_{AT}}{1.73 \times I_{LINE}}\right) = \left(\frac{1568}{1.73 \times 525}\right) = 1.72\ turns$$

Which when rounded up, equals 2 turns.

TIME DELAY RELAY

A time delay relay, with delay upon dropout, can be added to provide over-excitation shutdown during boost conditions. The relay will also inhibit the boost output when operating in a manual mode of operation on systems containing a manual voltage control.

The relay shall be selected with a delay that is compatible with the generator/load overload time limits. The maximum allowable delay is 30 seconds.

The input coil voltage should be 208, 240, or 277 Vac as required by the particular generator system. The relay contact ratings required are 7 A at 240 Vac continuous and 45 A at 240 Vac momentarily during shutdown under fault conditions.

SECTION 3 • OPERATION

GENERAL

Operation of the Current Boost System is completely automatic and controlled by the APR63-5 voltage regulator.

INSTALLATION VERIFICATION

Preliminary

(1) Ensure that the prime mover is not turning.

(2) Verify the installation, the turns-ratio selection, and that the interconnection is in accordance with Section 2.

(3) Verify voltage regulator installation per the appropriate voltage regulator instruction manual.

Testing

(1) With the generator under a "no-load" condition, start-up the prime mover and the generator. Verify voltage regulator operation.

(2) Connect of a voltmeter configured to read 120Vdc to the current boos module terminals listed in Table 3-1.

Table 3-1. Voltmeter Connections

Voltmeter Lead	Current Boost Terminal
Positive (+)	P
Negative (-)	N

(3) Observe that the voltmeter indicates approximately -1.5 Vdc. (This small negative voltage will change to a large positive value during boost.)

(4) Connect a load to the generator to cause a 25% or greater dip in rated voltage output.

(5) Observe that the **BOOST** indicator on the Current Boost Module lights and the voltmeter indicates a positive voltage of less than or equal to 120 Vdc for the CBS 305.

(6) Remove voltmeter.

(7) With a balanced load applied to the generator, measure the generator line current (I_L) and the boost CT secondary current (I_{SEC}).

(8) Verify the calculated turns-ratio (paragraph 2-4) by using the following equation and then compare the calculated secondary current with the actual measured value

$$I_{SEC} = \frac{(1.73 \times N_P \times I_L)}{N_{SEC}}$$

Where:

I_{SEC}	=	CT secondary current
N_P	=	Number of primary turns per phase
N_{SEC}	=	Number of secondary turns
I_L	=	Generator line current

(9) Operate generator normally.

BENCH TEST

Step 1. Connect the CBS in accordance with Figure 3-1.

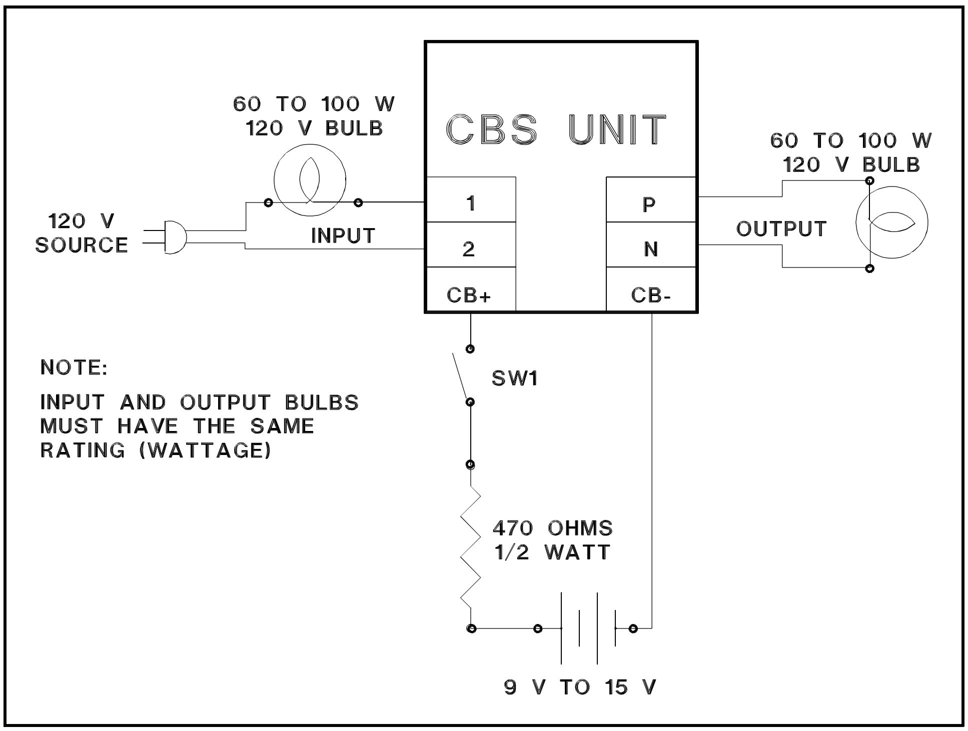


Figure 3-1. Bench Test Interconnection

Step 2. Energize the 120 Vac source.

Step 3. Close the switch (SWl). The Input light bulb should glow at full brilliance. The **BOOST** light and Output light bulb should be off.

Step 4. Open the switch (SWl). The Input light bulb should decrease in intensity and the **BOOST** light and Output light bulb should illuminate.

> **WARNING**
>
> High voltage is present on the terminal strip until the BOOST light is completely out.

Step 5. Remove the 120 Vac source.

Step 6. Disconnect the switches, light bulbs, and current boost module.