Model CB-1000
Vacuum Circuit Breaker

April, 1995
Manual Part # 180-0181 rev. A

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4/28/99

VACUUM CIRCUIT BREADER

Model: CB-1000 Toshiba 600 AMP CONTACTOR

Scope: The purpose of this addendum is to notify factory personnel, installers and users of the AMR Vacuum Circuit Breaker of a revision change to AMR Schematic #218-0096H to #218-0096J.
In addition, drawing # 180-0229B has been added to this manual.

Reference: Schematic # 218-0096J
AMR Manual Part # 180-018B

Description: AMR schematic #218-0096H, installation of the Vacuum Circuit Breaker, was revised to 218-0096J pm 4/28/99. The purpose of the revision is to show the proper hookup of the new 600 amp contactor (AMR P/N 280-0092, Toshiba P/N CV1-JBU). A diode bridge module (AMR P/N 270-0179) is included with the contactor as shown in Drawing # 180-0029B. This module must be included with the hookup of the circuit breaker system, as shown in schematic. # 218-0096J. **FAILURE TO PROPERLY INSTALL THIS MODULE CAN CAUSE A CONTACTOR FAILURE!**

For further information or questions pertaining to this matter please contact your AMR representative or call our Service department at (276) 928-1712.

ADDENDUM

7/29/96

VACUUM CIRCUIT BREADER

Model: CB-1000 Joslyn Clark 300 AMP CONTACTOR

Scope: The purpose of this addendum is to notify factory personnel, installers and users of the AMR Vacuum Circuit Breaker of a revision change to AMR Schematic #218-0096G to # 218-0096H

Reference: Schematic # 218-0096G
AMR Manual Part # 180-0181

Description: AMR schematic #218-0096j, installation of the Vacuum Circuit Breaker, was revised to B on 7/29/96. The purpose of the revision is to show the proper terminal block jumper configuration for the Joslyn Clark 300 amp contactor. Contactors are shopped form Joslyn to AMR configured for 120 volt ac and with a jumper installed from Terminal 6 to 7. This jumper disables the EXTERNAL CONTROL used by the AMR Control unit to operate the contactor. THE JUMPER BETWEEN TERMINALS 6 AND 7 MUST BE REMOVED FOR THE VACUUM BREAKER TO FUNCTION PROPERLY. **FAILURE TO REMOVE THIS JUMPER RESULTS IN A UNSAFE CONDITION!** The breaker will immediately close when 120 volts as is applied if the jumper is not removed.

For further information or questions pertaining to this matter please contact your AMR representative or call our Service department at (276) 928-1712.

Model CB-1000 Description and Installation

I.A. Introduction

The vacuum bottle circuit breaker is designed for use in mining applications. It provides a safer and more reliable circuit control system than the mechanical circuit breaker new in us in power distribution centers. It also can be used as the belt or pump controller to replace the mechanical circuit breaker, controll contactor over-current relay.

Currently, there are three models available. They are:

- CB-1000-300, 300 amperes continuous current rating;
- CB-1000-450, 450 amperes continuous current rating;
- CB-1000-600, 600 amperes continuous current rating;
- CB-1000-800, 800 amperes continuous current rating.

I.B. General Description

The standard model vacuum bottle circuit breaker is packaged on a 14 inch wide panel commonly used in power distribution centers. This allows for easy retrofit of a mechanical breaker panel with a vacuum bottle breaker panel. Any custom designed package available. The vacuum breaker panel contains the following units:

- Vacuum Bottle Contactor with DC solenoid – switches three phase power to the load
- Current Limiting Fuses – limit three phase fault current and disconnect the load under extreme fault currents.
- Phase Current Transformers – monitor phase thermal and magnetic current levels.
- Ground Fault Current Transformer – monitors circuit form a phase conductor to ground conductor fault condition.
- Ground Monitor Current Transformer – monitors continuity of cable ground conductor.

- Auxiliary Contacts Interface – interfaces the vacuum contactor with the circuit control unit.
- Ground Monitor Phase Filter – couples ground monitor signals to the cable phase conductors.
- Cable Receptacle – provides three phase power to the load.
- Circuit Control Unit- consolidates in one package all of the electronic circuitry needed to monitor and control the three phase circuit.

I.C. Vacuum Bottle Contactor

The Vacuum Bottle Contactor provides the primary means for interrupting three phase fault currents. The unit consists of three vacuum bottle interrupters driven by a DC solenoid and insulating rod actuator assembly. The terminal block of the Contactor is connected to the CB-1000 circuit control unit as shown in Figure 6. Two normally open and normally closed contact modules are located on each side of the contactor and are used by the CB-1000 to determine the state of the vacuum bottles. The Auxiliary Contact Interface is connected to these contacts and to the CB-1000 circuit control unit according to Figure 6.

The Vacuum Bottle Contactor used on each model are:

- CB-1000-300, Joslyn Clark VC77U3515;
- CB-1000-450, Jennings RP133-2332-00;
- CB-1000-600, Toshiba CV212;
- CB-1000-800, Mitsubishi VZ8-PE-C

I.D. Current Limiters (Fuses)

Bussman Semitron SPJ-6E600, 1000 VAC, 600 Amp current limiters with indicators are used to interrupt the circuit for fault currents of 5000 amperes to 300,000 amperes on model CB-1000-300. Bussman Semitron SPJ-6E700, 1000 VAC, 700 Amp current limiters with indicators are used to interrupt the circuit for fault currents of 6000 amperes to 300,000 amperes.

On models CB-1000-450 and CB-1000-6000. Bussman Semitron SPJ-7E1000, 1000 VAC, 1000 Amp current limiters with indicators are used to interrupt the circuit for fault currents of 10,000 amperes to 300,000 amperes on model CB-1000-800. The fuses must be mounted directly to the load side tabs of the vocuum contactor with the indicators visible from the cutout window. An insulator assembly is used to isolate the fuses from each other. The fuse monitor wires(P6-7, P6-8, and P6-9 shown in Figure 6) should be attached to the receptacle bolts so that during fuse replacement they do not have to be disconnected.

Lastly, MSHA requies that a window be installed to allow the fuses to be viewed from outside the enclosure which contains the vacuum breaker. This is to insure the operator that the fuses are in place and have not been jumpered out.

I.E. Phase Current Transformer

An AMR current transformer (130-0079) is placed around each phase conductor as shown in Figure 6, The current transformer provides an output voltage which is a linear representation of the phase current. This output voltage is applied to the circuit control unit where electronic circuitry processes the voltage. Should the phase current exceed a preset long-term average level or a short-term peak level, the electronic circuitry causes the vacuum bottle breaker to interrupt the three phase circuit, and indicating an over-current.

I.F. Ground Fault Current Transformer

An AMR current transformer (130-0032) is placed around all three phase conductors as shown in Figure 1. Since the circuit is three phase and under normal conditions currents are balanced, the ground fault current transformer provides an output when an imbalance in the three phase current exists. A phase to ground fault produces a three phase current imbalance that is detected by the transformer. The transformer output voltage is applied to the circuit control unit where electronic circuitry processes the voltage and causes the vacuum bottle breaker to interrupt the three phase circuit, and indicating a ground fault.

I.G. Ground Monitor Current Transformer

An AMR current transformer (125-0003) is placed around the cable ground conductor before the conductor is connected to the enclosure center frame ground (see Figure 6). The transformer couples the ground monitor signal from the ground condoctor and applies this signal to the ground monitor circuitry in the circuit control unit. Should the ground monitor signal drop below a preset level, the ground monitor circuit will cause the vacuum bottle breaker to interrupt the three phase circuit, and indicating a ground monitor tripped.

I.H. Ground Monitor Phase Filter

The phase filter (270-0002) consists of an inductor and three capacitors. The capacitors couple the ground monitor signal to the cable phase conductors. An identical filter couples the signal from the cable phase conductors to the frame at the cable load end.

I.J. Circuit Control Unit

The circuit control unit is a removable assembly that contains all the controls, indicators, and plug-in printed circuit boards that are necessary to control the operation of the vacuum bottle circuit breaker. All indicators and controls are placed on the front panel for easy operator use. (See Table 1 for a description of the front panel controls and indications.

The circuit control unit contains six plug-in printed circuit boards. The following lists the PC boards and provides a brief functional description of each board;

I.J.1. Power Supply and Solenoid Driver(A1)

- Converts the incoming 24VAC to +30VDC, +24VDC, and +12VDC to power the circuit control unit's electronic circuitry.
- Contains a solid state DC switch that interrupts DC power to the vacuum bottle contactor DC solenoid

a fault signal is received from the fault detector PC board.

I.J.2. Cable Ground Monitor (A2)

- This board contains the ground monitor transmitter and receiver circuitry. The trans mitter generates the monitor signal that is applied to the cable phase conductors via the phase filter assembly. The receiver monitors the frequency and level of the signal from the ground monitor current transformer. If the signal frequency and level are not within preset limits, the ground monitor relay opens which interrupts the vacuum bottle contactor.

I.J.3. Interface (A3) –optional

- This board interfaces the circuit control unit to another controller, system, or monitor such as PLC and mine data acquisition system.
- When this optional board is used, two jumpers on the mother board sold side must be unjumped. After open the back cover of the circuit control unit enclosure, remove one jumper on the top of the board, and other jumper on the bottom of the board.

I.J.4. Phase Loss and Current Limit Monitor (A4)

- This board performs the dual function of monitoring the three phase circuit for loss of phase current and monitoring for an open fuse or frozen contactor.
- The setting of phase loss can be adjusted by R10 and R22 on this board (see Figure 1).

I.J.5. Fault Detector (A5)

- This board contains the circuitry which processes the input from the various fault transducers. Phase over-current signals from the current transformers are compared with preset, thermal and magnetic trip levels.

Thermal levels are set by a plug-in module on the front panel PC board, while magnetic levels are established from the front panel magnetic current trip adjust. Should the over current signals exceed the preset levels, the fault detector board will send a contactor interrupt signal to the solenoid driver PC board. Ground fault and under-voltage condition signals are processed in a manner similar to the phase over current signals.

- Ground fault trip level is adjustable by means of the front panel ground fault trip adjust potentiometer.

I.J.6. Test Voltage Generator (A6)

- This board contains the circuitry which performs the unit self-test function. It generates the signals used to test the fault detector PC board for proper operation. The test signals simulate fault conditions as received from the appropriate transducer, i.e., phase over current, ground fault, or under voltage. These test signals are periodically applied to the fault detection board and tested for proper processing. If the simulated fault conditions are not processed properly the contactor is interrupted and the unit fault LED is activated.

Model CB-1000 Operation

II.A Current Limiting Fuses

The Current Limiting Fuses are state of the art semiconductor protection type devices selected for their high current disconnect, high voltage rating, and fast disconnect time. They are Bussmann SEMITRON type with a voltage rating of 1000 VAC, a fault current disconnect to capability of 300,000 amperes, a continuous current carrying capability of 700 amperes (600 amperes for model CB-1000-300, 1000 amperes for model CB-1000-800). The fuses are supplied with fuse open indication devices.

The fuses function to interrupt the circuit faults above a perdetermined level (10,000 amperes, 6000 amperes or 5000 amperes). Since the vacuum bottle contactor is limited to disconnecting faults less than interrupting current (10,000 amperes, 6000 amperes or 5000 amperes), coordination of the disconnect time between the vacuum bottles and the fuses is crucial to the protection of the vacuum bottles and the prevention of nuisance fuse disconnects. The CB-1000 Circuit Control Unit is designed to always open the vacuum bottle contactor before the fuses open for faults below the contactor interrupting current. When fault currents above the contactor interrupting current, the fuses generate a disconnect time faster than the contactor disconnect time, thus protecting the vacuum contactor bottles. Figure 2, 3, 4, and Figure 5 shows the coordination of the disconnect times between the fuses and vacuum bottle contactor for various fault currents.

II.B Vacuum Bottle Contactor

The vacuum bottle contactor provides the primary means for interrupting phase currents. It consists of three vacuum bottle interrupters driven by a DC solenoid and insulating rod assembly. Control voltage is derived from rectified 120VAC through a diode bridge. The control line is driven on the DC side of the bridge by a solid state switch to achieve fast interrupt times.

II.C. Testing

The CB-1000 cable ground monitor circuitry and ground fault be easily tested periodically as required by simply pushing the appropriate front panel test switch button and verifying that the CB-1000 Circuit Breaker opened and the appropriate fault indicator came on.

A calibration verification and test of the CB-1000 Circuit Breaker should be performed every three months as described in Section III.C., CB-1000 Testing.

II.D. Troubleshooting

The CB-1000 Circuit Breaker has front panel indicators to point the operator in the direction of the problem with either the power source (phase undervoltage or loss); the load (phase overcurrent, ground fault, fuse open, phase loss or ground monitor); or circuit control unit (unit fault).

Before attempting to troubleshoot the CB-1000 Circuit Breaker, verify that the problem is not in the load, cable, or power source. After isolating the problem to the CB-1000 Circuit Breaker, use the flow sheet to locate the problem) see Figure 7).

II.E. Caution

- If "Frozen Contact" indicator is on, be sure to turn off the incoming power before troubleshooting.
- Turn off the incoming power, when checking fuse, current transformer, and vacuum contactor.

Table 1. Front Panel Controls and Indicators

Item	Description and Function
Open Switch	Red push-button with maintain contacts that open the vacuum bottle contactor AC drive solenoid circuit.
Open Indicator	Green LED that displays the OPEN vacuum bottle contactor state.
Close Switch	Green push-button with momentary contacts that closes the vacuum bottle contactor.
Close Indicator	Red LED that displays the CLOSE vacuum bottle contactor state.
Ground Monitor Test Switch	Push-button with momentary contacts that allow easy functional testing of the ground monitor circuitry by inserting a 45 ohm resistance in the ground monitor signal path.
Ground Fault Test Switch	Push-button with momentary contacts that allows easy functional testing of the phase to ground fault detection circuitry.
Fault Reset Switch	Push-button with momentary contacts that resets all circuit control unit fault indictors.
Phase Over Current Indictor	Red LED that indicates the over current circuitry has detected a thermal or a magnetic fault condition.
Ground Fault Indictor	Red LED that indicates the phase to ground fault circuitry has detected a fault condition.
Phase Under Voltage Ind.	Red LED that indicates the phase under voltage circuitry has detected a fault condition.
Unit Fault Indicator	Red LED that indicates the circuit control unit self-check circuitry has detected a problem with the fault detection circuitry operation.
Ground Monitor Trip Indicator	Red LED that indicates the cable ground monitor circuitry has detected a faulty cable ground conductor condition.
Fuse Open/Frozen Contact Indicator	Red LED that indicates that a current limiting fuse has opened, or a vacuum bottle is frozen.

Table 1. Front Panel Controls and Indicators (continued)

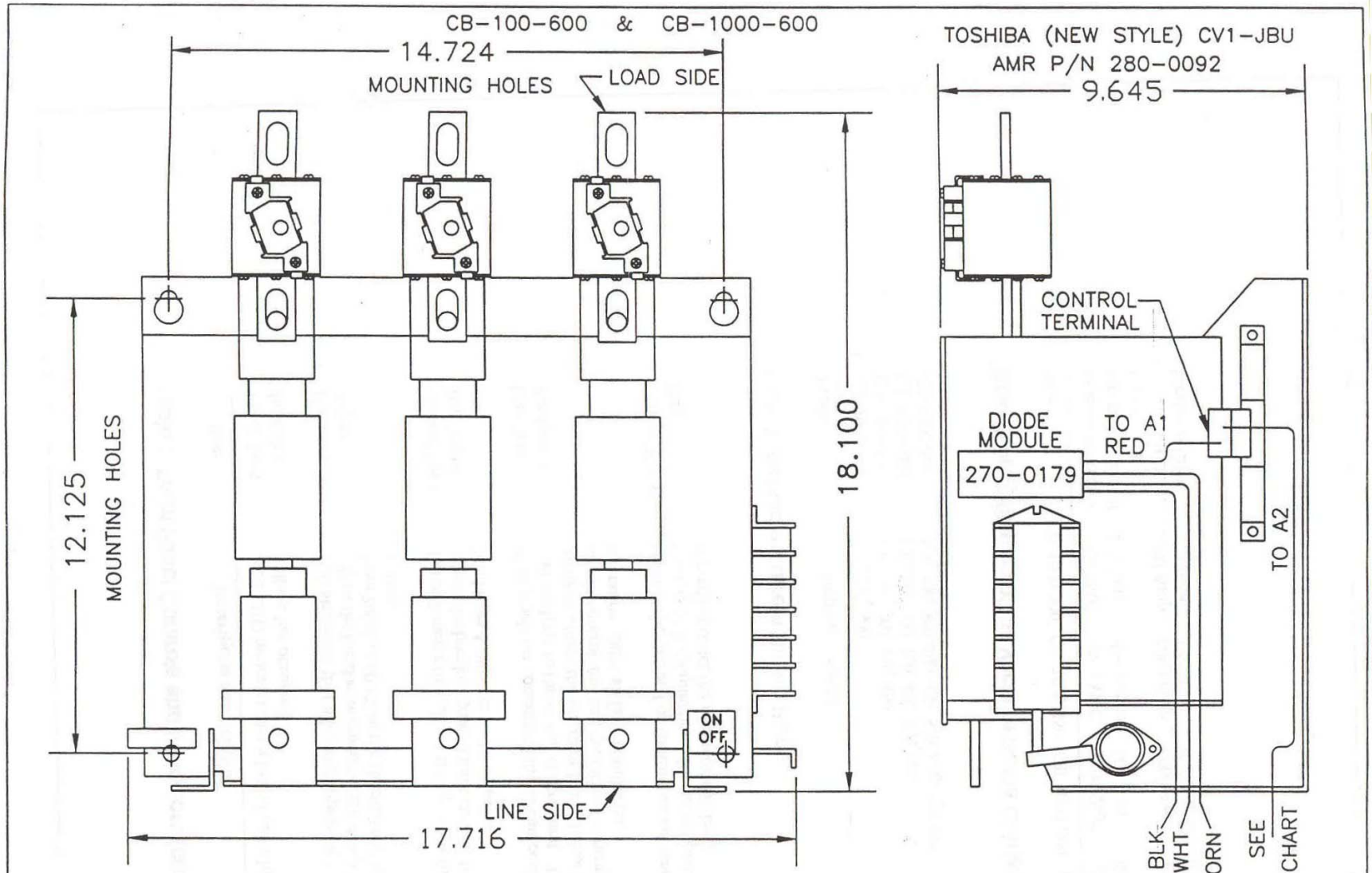
Item	Description and Function
Phase Loss Indicator	Red LED indicates that a loss of one phase voltage has occurred.
Magnetic Trip Adjust	Potentiometer that allows the operator to adjust the breaker magnetic current trip level from 200% to 600% of the thermal trip level setting
Ground Fault Trip Adjust	Potentiometer that allows the operator to adjust the breaker ground fault current trip level from 4 amperes to 7.5 amperes.
Unit Test Receptacle	Receptacle for connecting the circuit control unit analyzer to the circuit control unit. The analyzer allows the operator to easily test the circuit control unit and contactor for proper operation under al fault conditions.
Current Rating Plug	Defines the thermal or continuous current trip Level, used in conjunction with the magnetic trip adjust to set the magnetic trip level.

Table 2. Available Current Rating Plugs

Model	Amperage Rating
CB-1000-300	100, 200,300
CB-1000-450	100, 200,300, 400, 450
CB-1000-600	100, 200,300, 400, 450, 500, 600
CB-1000-800	100, 200,300, 400, 450, 500, 600, 700, 800

Table 3. Specification of the Vacuum Bottle Contactors

Item	CB-1000-300	CB-1000-450	CB1000-600	CB-1000-800
Operation voltage	1500 VAC	1500 VAC	1500 VAC	7200 VAC
Operation current	320 Amp	450 Amp	600 Amp	800 Amp
Interrupting Current	5000 Amp	6000 Amp	6000 Amp	11400 Amp
Electrical Life	1 Million	1 Million	.5 Million	.1 Million



NOTE: A CLEARANCE OF 1.5" ALL AROUND MUST BE MAINTAINED AT LOAD AND LINE SIDE CONNECTIONS

DWG. NO. 180-0229 REV B

270-0179 HOOKUP - CB-100 ONLY	270-0179 HOOKUP - CB-1000 ONLY
BLK TO CB-100 P4-20	BLK TO CB-1000 P6-13
WHT TO CB-100 P4-8	WHT TO CB-1000 P6-16
ORN TO CB-100 P4-14	ORN TO CB-1000 P7-11
RED TO CONTACTOR A1	RED TO CONTACTOR A1
CONTACTOR A2 TO CB-100 P4-24	CONTACTOR A2 TO CB-1000 P6-14

Figure 1. Phase Loss Setting

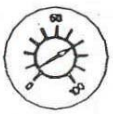
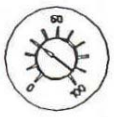
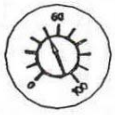
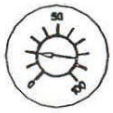
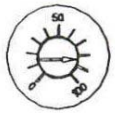
PHASE LOSS SETTING		
30%	20%	15%
R22  R10 	R22  R10 	R22  R10 

Figure 2. Clear Time vs Current (Model CB-1000-300)

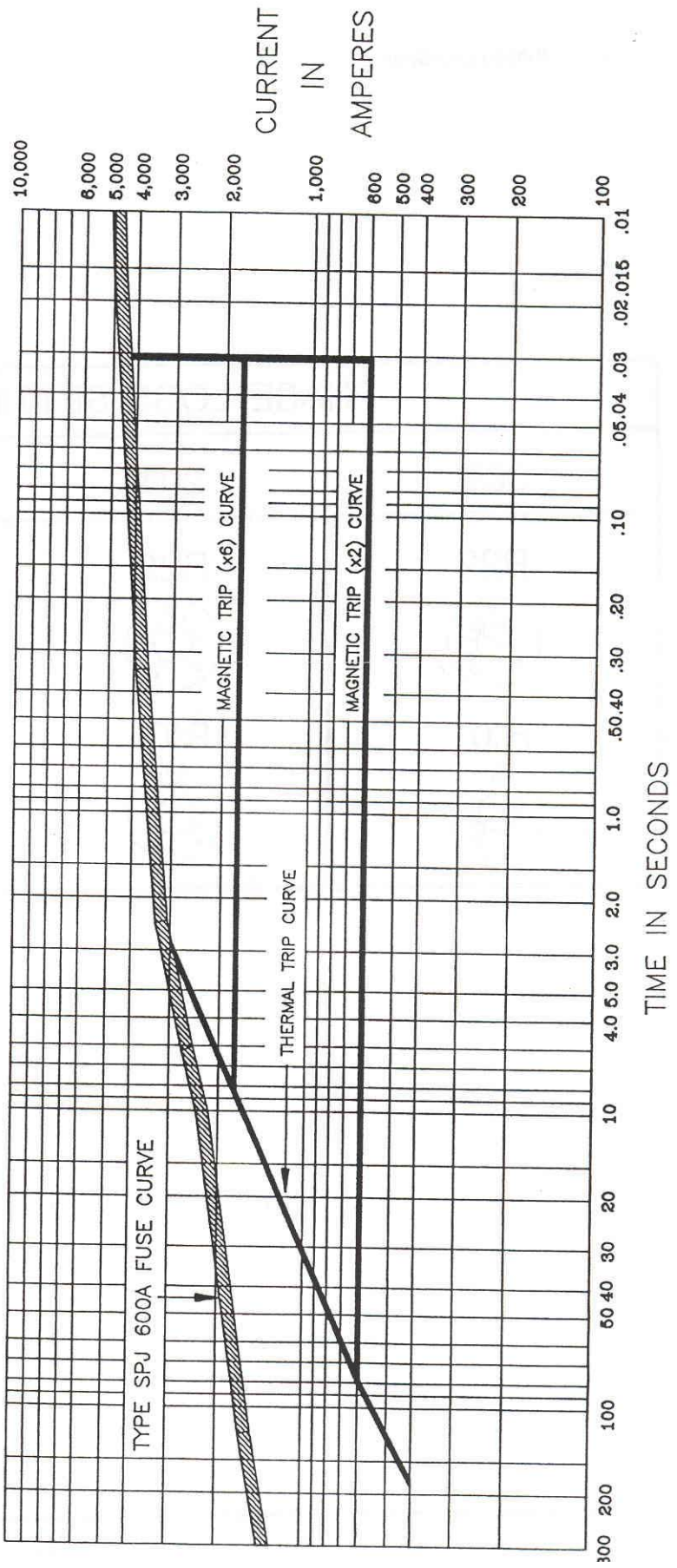


Figure 3. Clear Time vs. Current (Model CB-1000-450)

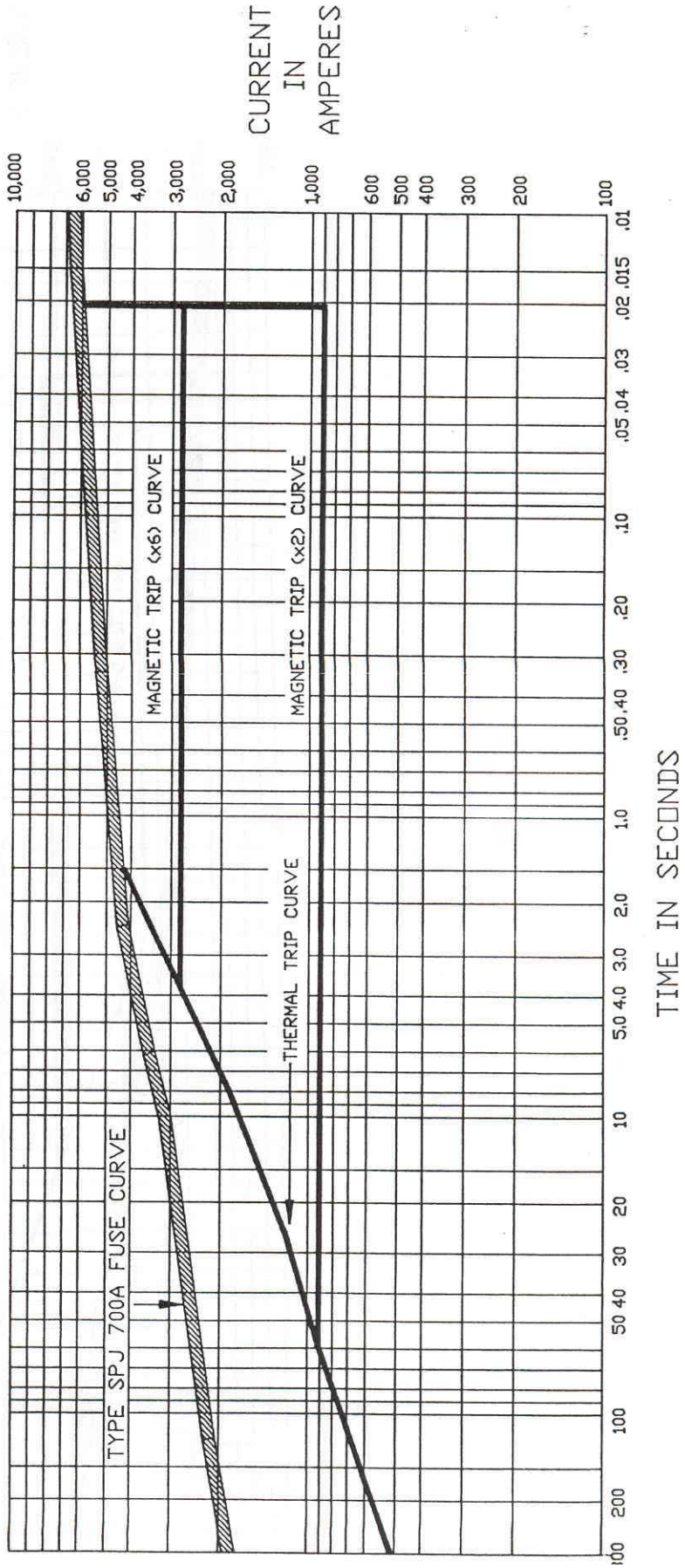


Figure 4. Clear Time vs. Current (Model CB-1000-600)

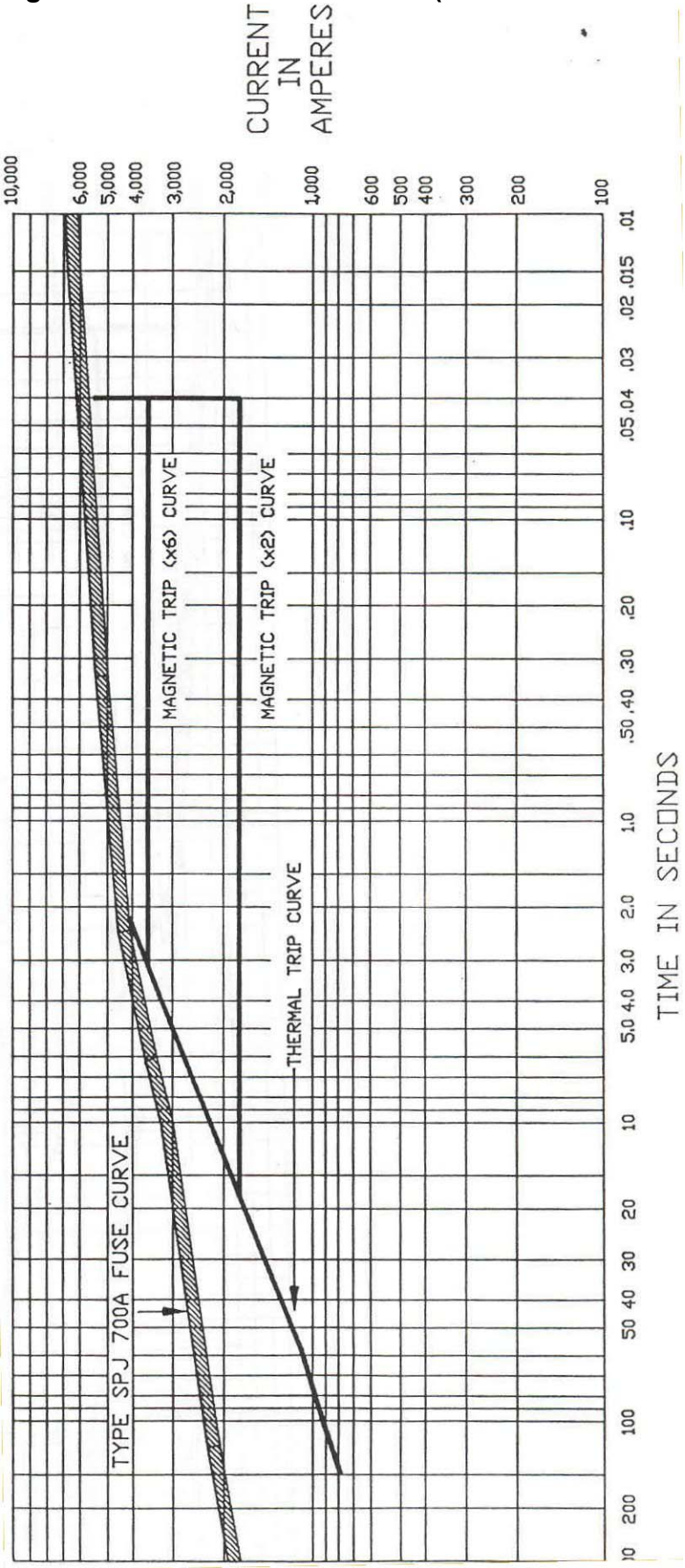
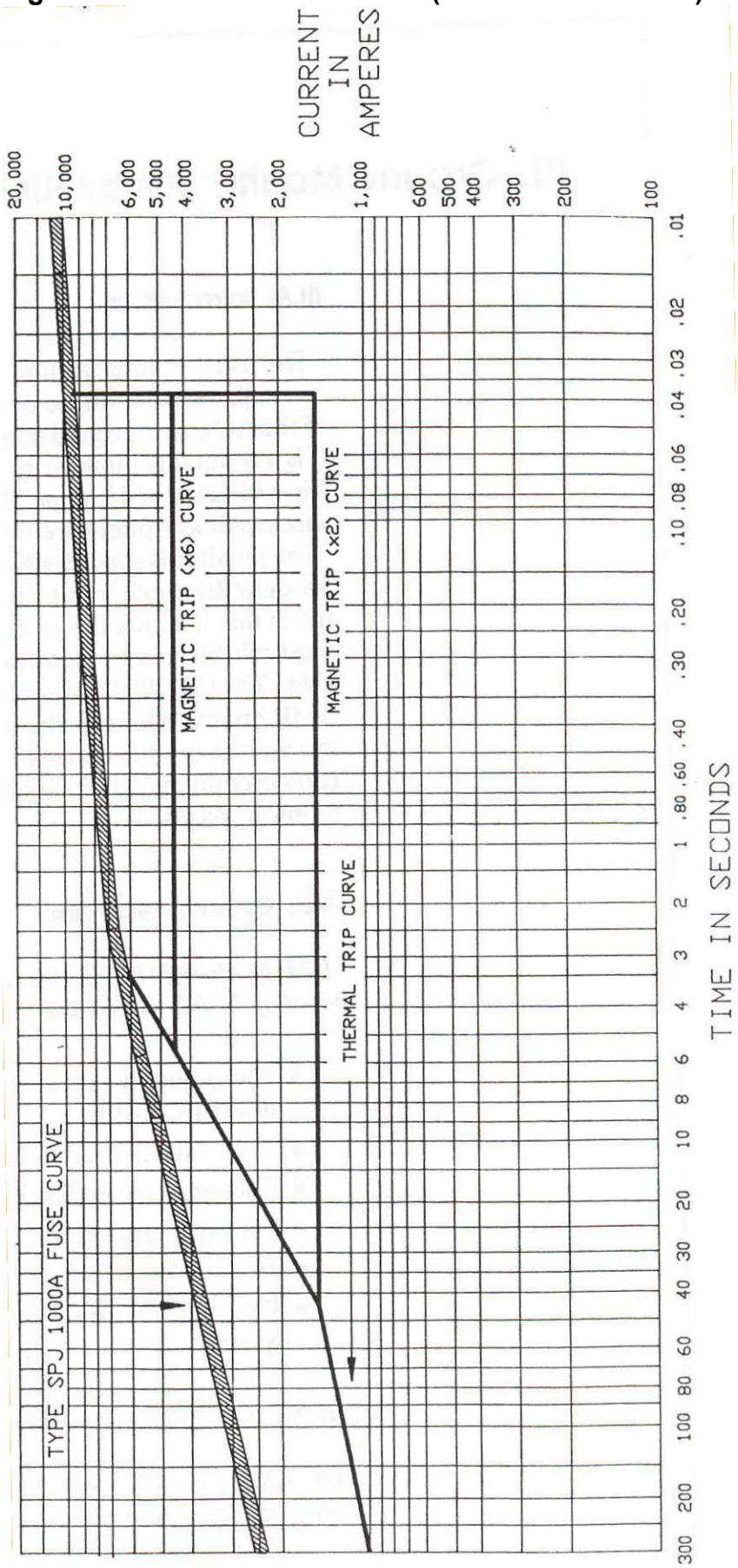


Figure 4. Clear Time vs. Current (Model CB-1000-800)



III.A. Introduction

The AMR Frame Ground Monitor is a solid state frequency controlled system whose purpose is to monitor the continuity of the AC frame ground conductor on three phase equipment. It is a continuity monitor system that has a maximum allowable trip resistance of 45 ohms. The monitor can be operated pilot wireless or as a pilot wire monitor.

The monitor is specifically designed for use in the CB-1000 Vacuum Breaker Circuit Control Unit. The unit is very versatile in that it allows the operator many options to provide the most reliable and economical ground monitoring system available. The CB-1000 contains all the features found on other AMR ground monitors that reduce nuisance tripping due to low voltage or intermittent conditions in the cables. The circuit descriptions and installation instructions are given in the following pages.

III.B. Circuit Description

III.B.1. The AMR CB-1000 Ground Check Monitor is composed of the following basic functional components:

- Power Supply – located on power supply and solenoid driver PCB (A1).
- Transmitter – located on Ground Monitor PCB (A2).
- Receiver – located on Ground Monitor PCB (A3).
- Current Transformer.
- Two – 3 Phase Filters (for the pilot wireless system).
- Two – Pilot Wire Filters, A and B (for the pilot wire system).

III.B.2. General Operation Description

The AMR CB-1000 Ground Monitor System utilizes an audio frequency signal to monitor the continuity of the grounding

conductor. An audio signal is generated by the transmitter section. This signal is coupled to the three phase power conductors going to the equipment being monitored by the first phase filter. The signal then travels up the three conductors to the monitored piece of equipment. The signal is then coupled from the three phase lines to the ground conductor by the second phase filter. The audio signal travels back to the CB-1000 System through the ground conductor and passes through the current transformer tot frame ground and the common side of the transmitter output. The current transformer couples the audio signal from the ground line to the receiver. The receiver then detects this signal and closes a relay which is part of the hold-in circuit for the three phases circuit breaker feeding the monitored equipment. If the audio signal is lost for any reason due to a broken grounding conductor or any open whatsoever in the above transmissions circuit, the relay is released and power is shut off to the machine being monitored.

III.C. Installation and Operational Testing

III.C.1. General Installation Directions

- All Installation wiring shall be performed according ot applicable codes.
- All hookup wiring should be at leas 18 awg. Type, THNN or equivalent insulations, except the transmitter output lead which should be at least 14 awg. It may be preferable to use a larger size wire for mechanical strength.
- All terminations and connection shall be made using approved termination and splice connectors.
- All power shall be disconnected, tagged, and locked out before this equipment is installed.

III.C.2. Installation Instructions for Low Voltage Pilotless System.

The installation of the AMR CB-1000 Ground Monitor unit consists mainly of the mounting and wiring of the following pieces of equipment:

- A receiver current transformer on the ground line of the AC outlet to be monitored.
- One Phase Filter on the CB-1000 Circuit Breaker.
- One Phase Filter on the piece of equipment to be monitored.

The wiring schematic for the CB-1000 Circuit Breaker Ground Monitor is shown in Figure 8. These schematics should be referred to while installing the CB-1000.

III.C.3. Installation of Receiver Current Transformers

The Receiver CT is installed on the grounding wire of the monitored AC output. The receptacle's grounding conductor should be disconnected from the frame ground and pushed through the CT.

Since it is essential that the grounding conductor not be connected to frame ground before it passes through the CT, check to see that the grounding conductor is isolated from frame ground at this time. Using an ohmmeter, check the resistance from the disconnected grounding wire to the frame ground. If a resistance less than 10 ohms is seen, an isolating board for the receptacle will have to be installed. These boards are available from the receptacle manufacturer.

In the same way, check the resistance between the grounding pin and the shell of the plug. If a low resistance is present, there is probably a shorting strap internally connecting the grounding pin to the shell. This strap must be removed. After completing these checks and modifications, reground the receptacle's grounding conductor. Both the plug and the receptacle shells must be grounded to the frame with conductive straps at least half the size of the phase conductor.

Two pieces of wire should be cut that are long enough to go from the CT lead to the CB-1000 enclosure. Each wire should be crimped to the CT output leads with the terminals that are already installed on the CT leads. The wire should then be neatly routed and connected to the circuit control unit Plug P7-2 and P7-7.

III.C.4. Installation of Phase Filter on Circuit Breaker Panel

The AMR 1000 VAC phase Filter (270-0002) should be used on circuits of 1000 VAC and less.

The phase filter should be mounted on the circuit breaker panel using the large cable ties to securely hold it in place. The three black phase wires should be connected to the phase lines as shown in Figure 8. This will allow monitoring of the current limiters with the ground monitor signal. The green phase filter wire should be connected to circuit control unit Plug P7-1.

III.C.5. Installation of Phase Filter on Equipment Being Monitored.

The Phase filter must be installed on the equipment being monitored. The unit should be securely mounted to the piece of equipment using large cable ties. The green wire of the phase filter should be connected to frame ground of the equipment being monitored. The three black wires should be connected to the power phase lines as shown in Figure 8. It is necessary for this connection to be made at a point on the line side of the equipment disconnect device, so that the monitor will be able to continue monitoring when the equipment is shut down. One phase filter must be installed on each piece of equipment that is to be monitored.

In installations where a large number of non-cable reel equipment is to be monitored, some nuisance tripping of high resistance machines (Example – shuttle cars and roof bolters with take up reels) may be experienced. This is caused by the excessive drain of transmitter current by the low resistance equipment with out cable reels. The problem can be solved by the installation of approximately 10 ohms of resistance in the green lead of each phase filter installed on non-cable reel equipment. This reduces transmitter current drain to these machines and completely eliminates this problem.

The installation of this resistance can be made either by the customer himself or by obtaining modification kit RK-1 from American Mine Research. This addition is shown on the schematic diagram in Figure 8.

III.C.6. Connection of Pilot Interlock Feature

The system also provides a pilot interlock feature that will satisfy MSHA regulations requiring the circuit breaker to open if the machine plug is accidentally removed while under load. This disconnected feature of the CB-1000 does not contain the time delay that is allowed in the approved monitor circuitry. This pilot interlock gives an inmmediate breaker trip upon removal of the three phase machine plug. To install the pilot interlock feature, connect P6-15 Circuit Control Unit Plug to the pilot pin on the back of the power receptacle on the panel. This connection is shown in Figure 8. Each three phase plug that is used in any of the monitored outlets must contain a jumper wire that connects the pilot pins in the plug to the ground pin. This connection allows the pilot interlock current to flow in to the frame ground of the power center. IF the pilot interlock is not used, the P6-15 Circuit Control Unit Plug must be connected to the frame ground.

III.C.7. Operational Testing

Verify that all wiring is connected as directed in the previous instruction. Apply voltage to the power center. Allow the monitor a five minute warn up period before continuing with operational tests.

The following procedure will functionally test the monitor and be an initial test of its calibration. Plug the machine plug into the receptacle and then press the small reset button on the circuit control unit panel. The trip indicator light for the circuit that has a machine plugged into it should now go out. If any problems are now apparent, refer to the Trouble Shooting Procedure in Section III.D. of this manual. Now press the test button. The circuit breaker should trip and the trip indicator light should come on. If any problems develop, refer to the Trouble Shooting Procedure in Section III.D.

The next checkout procedure on the monitor will test the single phase protection and insure that it will trip when the machine ground line is opened. At least five jumper cords or short pieces of wire will be required to perform this test. **At no time during this test should the circuit breaker under test ever be closed. The breaker should be locked out by pushing the OPEN switch on the circuit control unit panel.**

Using the jumpers, make the connections as shown in Figure 9. This should allow the monitor to pickup, and when the small reset button on the circuit control unit is pressed, the trip indicator light should go out.

Remove the ground jumper, which in Figure 9 is number 1. This should cause the monitor to trip after a time delay of 250 millisecond, and the trip indicator light for the circuit under test should come on. Reconnect the ground jumper to its original place. The monitor relay should again pickup and the trip indicator light should go off when the reset button is pressed. Now remove any one of the jumpers that are connecting the phases (Jumpuers 2,3,or 4 in Figure 9). Removal of any one of the phase jumpers should again cause the monitor to trip after a time delay of 250 milliseconds. The trip indicator light should again come on. This test insures that the monitor will trip if any phase conductor in the cable is opened for more than 250 millisconds. Return the phase jumper and reset the monitor trip indicators. Now remove the jumper that connects the pilot pin to ground (Jumper5 in Figure 9). The monitor should immediately trip with no time delay at all, and the trip indicator light should come on. Reconnect the pilot jumper, and again reset the trip indicator light. This completes the tests for this circuit and the above procedure should be repeated for every circuit that is to be monitored by the CB-1000 System. IF any problems are encountered, refer to the Trouble Shooting Procedure in Section III.D.

The pilot interlock feature can be tested by the following procedure. Set the breaker by pressing the reset button on the cir=cuit control unit panel. Go th machine plugged into the power center and turn the machine OFF so that it will draw the minimum possible amount of current from the power source. Return to the unit, slowly remove machine plug and wbserve if the cirren5t circuit breaker immediately trips when the pilot pin is disconnected. There should be no time delay in this tripping action. Perform this test on all the circuits monitored by the CB-1000 System. If any problems might occur during this procedure, refer to the Troubleshooting procedure in Section III.D. of this manual.

III.C.8. Installation as a Pilot Wire Monitor

The installation and checkout procedures described elsowhere in Section III.C. will apply to pilot wire installations. The major differences are explained in the following section.

The CB-1000 can monitor trailing cable ground using a pilot wire. Two methods are accepted at present.

The first method involves the use of a tuned filter pair (see Figure 10). The transmitter output is connected to a filter, AMR #PF-162-A. No polarity needs to be observed in the filter hookup. The other lead of this filter is connected to the pilot pin. The machine filter, AMR #PF-162-B is connected between the pilot wire and frame ground. Again, this filter is not polarized. These two filters in series create a tuned circuit having a low impedance to the monitor frequency while reducing induced 60 cycle current. This approach is preferred, since it is able to detect pilot-to-ground shorts in the cable.

If thereis not sufficient room to mount a machine filter (such as in pumps), the second approach is to simply run the monitor signal through the pilot wire directly to ground at the machine (see Figure 11). A 1000 VAC phase filter, AMR #PF-160 is placed in series with the pilot wire to reduce 60 cycle induced currents and to protect the ground monitor. This method is unable to detect pilot-to-ground shorts, as is the case with many impedance type monitors. When no filter pair is used, and the monitor is used on non-cable reel equipment with cables shorter that 250ft., a 10ohm resistor, AMR #RK-1 is inserted in series as in Figure 11.

III.C.9. Intermachine Arc Protection

The CB-1000 Ground Monitoring System can be used with any type of arc suppression device. The two common types of devices in use today are the diode suppressors and the inductance type suppressors. The signal of the CB-1000 will pass directly through the diode type device and the device will simply add an additional amount of resistance to the circuit. In most cases, the amount of additional resistance would not cause any nuisance tripping.

The inductance types are suppressors can be more of a problem because they often add a much larger value of resistance to the monitor signal. This feature can sometimes be used to our

Advantage to block the monitor signal from going where it shouldn't go. An example of application is that, a phase filter is placed in a distribution box to provide a return path for the ground monitor located in the power center. If a second ground monitoring system was installed in the distribution box for its circuits, this filter would provide a dead short in the transmitter. It is necessary to install a blocking inductor or an arc trap to prevent this drain on the distribution box's transmitter. The arc trap would block the signal flow of the distribution box's transmitter from going directly through the power center's return filter.

If it is necessary to install the inductor type of arc trap directly in the path of the monitor signal, an arc trap bypass filter, AMR #PF-170 (270-001) will have to be connected across the arc trap to allow the signal to get to frame ground. An standard phase filter can be used by connecting the three black leads of the filter to one side of the arc trap and the green lead of the filter to the other side. A 1uf capacitor with a voltage rating of at least 200 volts could also be used in place of the phase filter.

In any installation, it is best to do an initial test to determine the arcing potectial between the different machines of the section. This type of test is well described in the article "Intermachine Arcing Resulting From Induced Voltages In AC Mining Equipment Cables" by Ralph I. Krek and Robert A. Wolf, Mining Enforcement and Safety Administration. The arcing potential test should be repeated occasionally to be sure that no unsafe conditions have developed. If further engineering assistance is required, contact American Mine Research, Inc.

III.D. TROUBLESHOOTING

III.D.1. General Instructions

Experience indicates that the most common problem which is encountered is that of faulty wiring connections or broken or intermittent connections in the trailing cable. Before going into the detailed troubleshooting procedures outlined below, all wiring should be verified to be correct according to the eletrical schematics, and examined to insure proper electrical and mechanical integrity.

The troubleshooting procedure for the AMR Ground Monitoring System is a simple process of elimination. The idea is to eliminate as quickly as possible the different components of the system to pinpoint the problem area. The following procedure should quickly lead to the source of the trouble.

III.D.2. Precedure for CB-1000 Ground Monitoring Failure

III.D.2.a. Determine Location of Problem

- Remove power from the circuit under test by opening the circuit breaker.
- Remove the machine cable plug from the power center.
- Verify that the power has been removed by using a volt-ohm meter (VOM).
- Connect the three phase conductors to the ground conductor at the receptacle outlet. This can be done by using the phase filter found in the TK-150 Test Kit or a piece of bare wire that can be bent to connect the three phase terminals to ground terminal of the receptacle If the pilot interlock feature is being used, it will also be necessary to connect a jumper from the pilot pin to the ground pin.
- If the red ground monitor trip indicator light for this circuit now stays out when the reset button is pressed, this indicates that all the monitor equipement in the power center is working and the problem is limited to the following areas:
    - In the trailing cable or on the machine being monitored. (See Section III.D.2.c.)
    - The monitor is out of calibration. (Return to AMR for calibration.)
- If the red trip indicator light can not be reset after the jumpers are installed, this indicates the problem is within the CB-1000 System.

III.D.2.b. Location of Problem within the CB-1000 System

- Remove all the power to the CB-1000 System, and visually check all wiring connections from the ground monitor to the phase filter, current transformer (CT), and to the phase, ground, and pilot connections. If any

wiring errors are suspected, the following checks can be made with a volt-ohm meter to verify correct wiring.

- With the volt-ohm meter set to the lowest resistance scale, remove circuit control unit P7 Plug and place one probe on P7-7 and the other probe on the frame ground of the power center. This resistance should not be more than one or two ohms. If the resistance is greater, this indicates that the transmitter is not properly grounded.
- With the volt-ohm meter still set for the lowest resistance scale, place one probe in P6-15 of the circuit control unit and one probe on the frame ground of the power center. The meter should indicate a resistance of one or two ohms if the pilot interlock circuit is properly made.
- Leaving the volt-ohm meter set on the resistance scale, place one probe in P7-2 and one in P7-3 of the circuit control unit. The receiver current transformer (CT) can usually be assumed to be good if this resistance is less than five ohms. If the indicated resistance is found to be higher, check the wiring and replace the CT if necessary.
- Place one probe of the volt-ohm meter, still set on the lowest resistance scale, on the frame of the circuit breaker panel and the other probe on frame ground of the power center. If the resistance is less than one or two ohms, this indicates that a wire is correctly run from the frame ground bolt of the breaker panel to the frame ground of the power center.
- Apply power to the ground monitor unit. Check to make sure the circuit breaker going to the piece of equipment is still off.
- Install the jumpers again on the male receptacle as you did in Section III.D.2.a.
- Using a second jumper set, connect P7-1 on the circuit control unit to the three black phase filter leads located on the circuit of the power center panel.

Attempt to reset the monitor trip indicator light; if it stays out when reset, this indicates that the phase filter is defective and should be replaced.

If the ground monitor still has a problem, replace the circuit control unit ground monitor PCB (A5).

III.D.2.c. Location of Problem in the Trailing Cable or on the Machine

- Remove all power from the machine and leave the cable plug disconnected from the power center so as to have a visual disconnect. Lock out and tag the plug to insure safety during the following procedures.
- With an ohm meter set on the lowest ohms scale, check to see if the ground pin is isolated from the frame of the plug. This can be done by placing on probe on the ground pin and the other on the frame of the plug. Move the cable at the strain relief as much as possible and if the meter indicates a low resistance (less than 10 ohms), the plug must be taken apart and the ground wires isolated from the cable plug frame. When the pilot interlock feature is being used, place one probe on the ground pin and one probe on the pilot pin of the plug. There should be a low resistance short in this circuit (less than 10 ohms) indicating that the correct jumper has been installed in the plug between pilot and ground.
- On the newer pieces of distribution equipment, the entire power receptacle may be isolated from the frame of the equipment by mounting the receptacle on an insulated board. If this is the case with the unit you are working on, it will not be necessary to isolate the ground through the plug and the receptacle. Refer to Section III.C.5. for this procedure.
- Visually inspect the cable for cuts or bad splices. The probability is high that the problem will be in the cable.
- Remove the cover from the control box on the piece of equipment and visually check all connections.
- Leaving one person to observe the red trip indicator light on the monitor, connect the three phase conductors to the ground conductor at the receptacle outlet on the power center. This can be done by using the phase filter

found in the TK-150 Test Kit or a piece of bare wire that can be bent to connect the three phase terminals to the ground terminal of the receptacle. If the pilot interlock feature is being used, it will also be necessary to connect a jumper from the pilot pin to the ground pin.

- Return the cable plug to the CB-1000 System, and lock out the circuit breaker so that power cannot be placed on the machine.
- If the red trip indicator light now goes out when the reset button is pushed, this indicates that the machine filter is bad and should be replaced.
- If the red trip indicator light stays on when reset, this indicates that the problem is in the cable or the associated wiring on the machine.
- The cable or machine wiring can be checked by using a jumper to short on phase to ground at the three phase filter on the machine. Place the probe of a volt-ohm meter, set to the lowest resistance scale, or the ground pin of the machine cable plug at the power center end of the cable. With the other probe, find the phase pin in the plug which contains the short. This resistance should be less than 4 to 5 ohms on machines that do not have cable take-up reels. If the machine does have a take-up reel, hold the ohm meter on the phase to ground pins while another person slowly pulls the cable off the reel. This resistance should not exceed 25-35 ohms. If a higher resistance is measurer, the cable reel brushes should be serviced. All three phases should be checked in this manner to further isolate the problem.

Figure 8. Circuit Breaker Ground Monitor

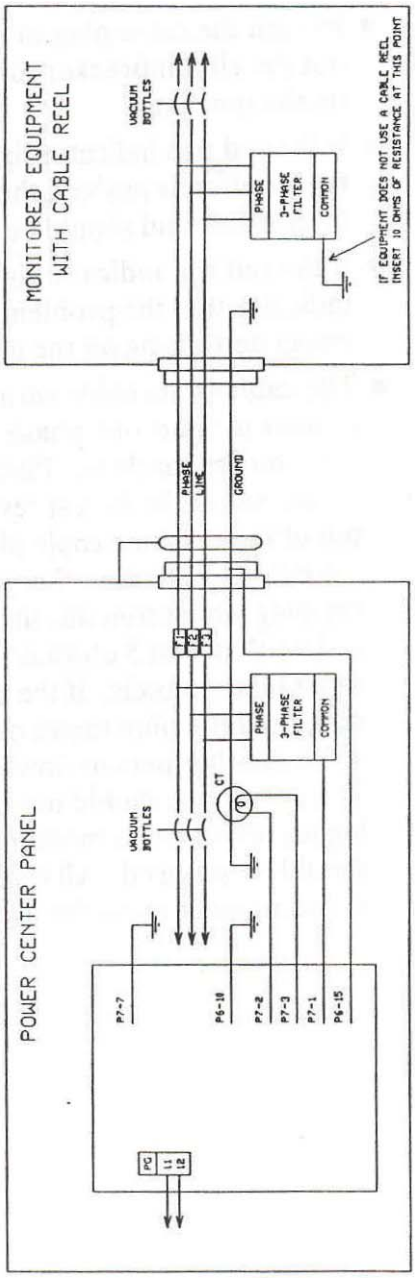


Figure 9. Operational Testing Jumpers

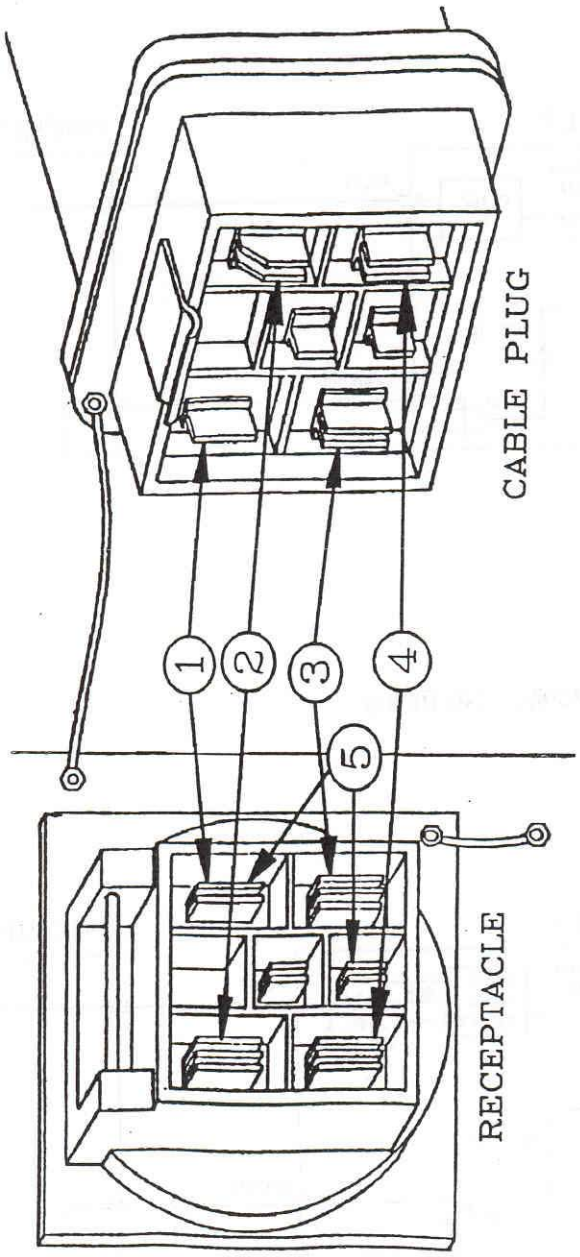


Figure 10. Pilot Wire Monitor – Tuned Jilter Pair

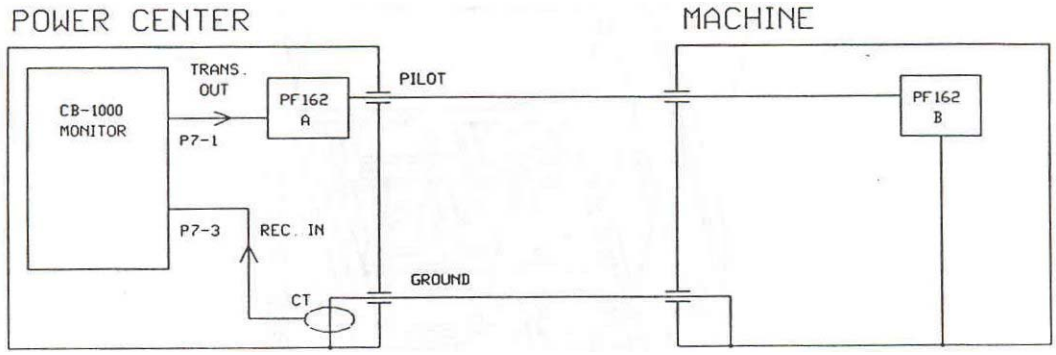
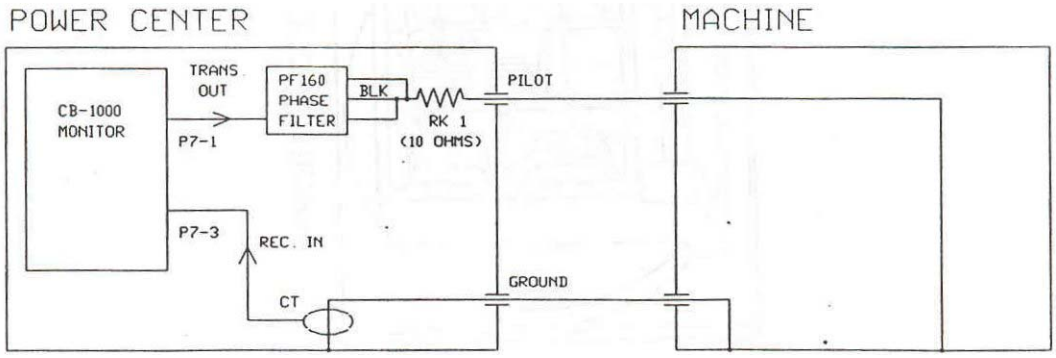


Figure 11. Pilot Wire Monitor – No Tuning



APPENDIX

A. RECOMMMENDED SPARE PARTS

Parts Number	Description	Quantity
253-0045	Power supply PCB (A1)	
253-0044	Ground monitor PCB (A2)	
253-0057	Phase loss PCB (A4)	
253-0033	Fault detector PCB (A5)	
253-0034	Test voltage PCB (A6)	
253-0123	Aux. contactor interface	
130-0079	Phase CT	
130-0032	Ground fault CT	
270-0002	Ground Monitor Phase filter	
125-0003	Ground monitor CT	
160-0024	Fuse, 1.5 Amp, slow blow	
162-0003	Relay, 24 VDC, 10 Amp	
For model CB-1000-300 only:		
160-0029	Fuse, 600 Amp, 1000V	3
011-0002-300	Rating plug, (300 Amp)	1
For model CB-1000-450 only:		
160-0022	Fuse, 700 Amp, 1000V	3
011-0002-450	Rating plug, (450 Amp)	1
For model CB-1000-600 only:		
160-0022	Fuse, 700 Amp, 1000V	3
011-0026	Rating plug, (600 Amp)	1
For model CB-1000-800 only:		
160-0038	Fuse, 1,000 Amp, 1000V	3
011-0002-800	Rating plug, (850 Amp)	1

B. RECOMMENDED TESTING UNITS

Model BT-1000 Circuit Breaker Tester

Model CST-1000 Contactor Simulator Tester

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