



## Type AKD-8 Low-Voltage Switchgear

### High Resistance Pulsing Ground Detection System

#### GENERAL

##### Pulsing Current High Resistance Neutral Grounding System

The following paragraphs describe a high resistance neutral grounding system supplied with GE AKD-8 Low Voltage Switchgear. The system features an alarm system and utilizes a pulsing current to locate the first ground fault. The system has the following basic features:

1. Grounds the neutral of an ungrounded 3-phase power system, utilizing the "high resistance" method. This allows the system to operate as an "ungrounded" system but eliminates the danger of high transient over-voltage during certain types of ground faults.
2. Gives an immediate warning when the first ground fault occurs.
3. Provides a method for quickly locating and removing the fault before another fault develops on another phase, thereby preventing circuit outages due to double line to ground faults.

**Reference:** The high resistance grounding method is fully described in IEEE Transactions on Industry and

General Applications, Vol. IGA-1 No. 5, Sept./Oct. 1965 under High Resistance Grounding.

#### Fault Locating

The success of operating a high resistance grounded system relies heavily on a dependable method of searching out the ground fault location to allow the faulty system member to be removed with the least delay.

The two important innovations introduced in this equipment to take the uncertainty out of signal tracing include:

1. Use of repeating, cyclic, switching sequence by which the tracer current can be rhythmically switched to a slightly higher value. This gives unique character to the tracer signal by which it can be distinguished from steady state background noise.
2. Use of an extremely sensitive ground-fault-current sensing transformer such that extraneous noise will be ignored and only the current-carrying member which passes through the window will be registered on the meter.

#### EQUIPMENT DESCRIPTION AND GROUNDING SYSTEM OPERATION

During normal conditions, with no ground fault on the system, no voltage appears across the system and no voltage appears across the grounding resistors. (Refer to Fig. 1).

When a ground fault occurs, the resistors limit the ground current to a low value, adjustable between 0.9 and 3.6 amperes.

The voltage appearing across the resistors will be sensed by the voltage coil of the meter relay. Auxiliary contacts

of the meter relay, operated by the voltage coil, may be used for remote indications and annunciation.

A green indicating light on the equipment indicates that control voltage is available and that the system is normal. When a fault develops, a red indicating light on the equipment will remain lighted until the ground fault is removed. If no remote annunciator is available to notify the operator, an audible signal may be added to the equipment as an option. A rotating red signal beacon may be used in noisy or remote installations.

# EQUIPMENT DESCRIPTION AND GROUNDING SYSTEM OPERATION (CONT.)

To trace the ground fault, the operator turns the selector switch to the "pulse" position. This initiates cycle timing alternately energizing and deenergizing a shorting contactor at the secondary resistor, resulting in a rhythmic fluctuation in the magnitude of the ground current.

An optional current transformer and ammeter at the panel will allow the operator to determine the current fluctuations on the system. A portable hook-on detector is then used to trace the fluctuations in ground current through the system to the point of fault. After the ground point has been located and removed from the system, the operator then resets the selector switch to deenergize pulse cycle timing circuits, and depresses a reset button to reset indicating lights and annunciators.

Taps are provided on the resistor to adjust the magnitude of the ground current in the range of 0.9 to 7.3A., depending on the size of the system, so that the current through the resistor to a ground fault will be slightly greater than the system's natural capacitance charging current.

The capacitance charging current of most 480 volt systems is below one ampere, so that the resistor is usually set at 0.9 ampere, with an increase to 3.6 ampere during pulsing. For unusually large systems, taps are available for an initial ground current of 3.6 amps with pulsing to 7.3 amperes.

Refer to Fig. 2 for typical system circuit elementary.

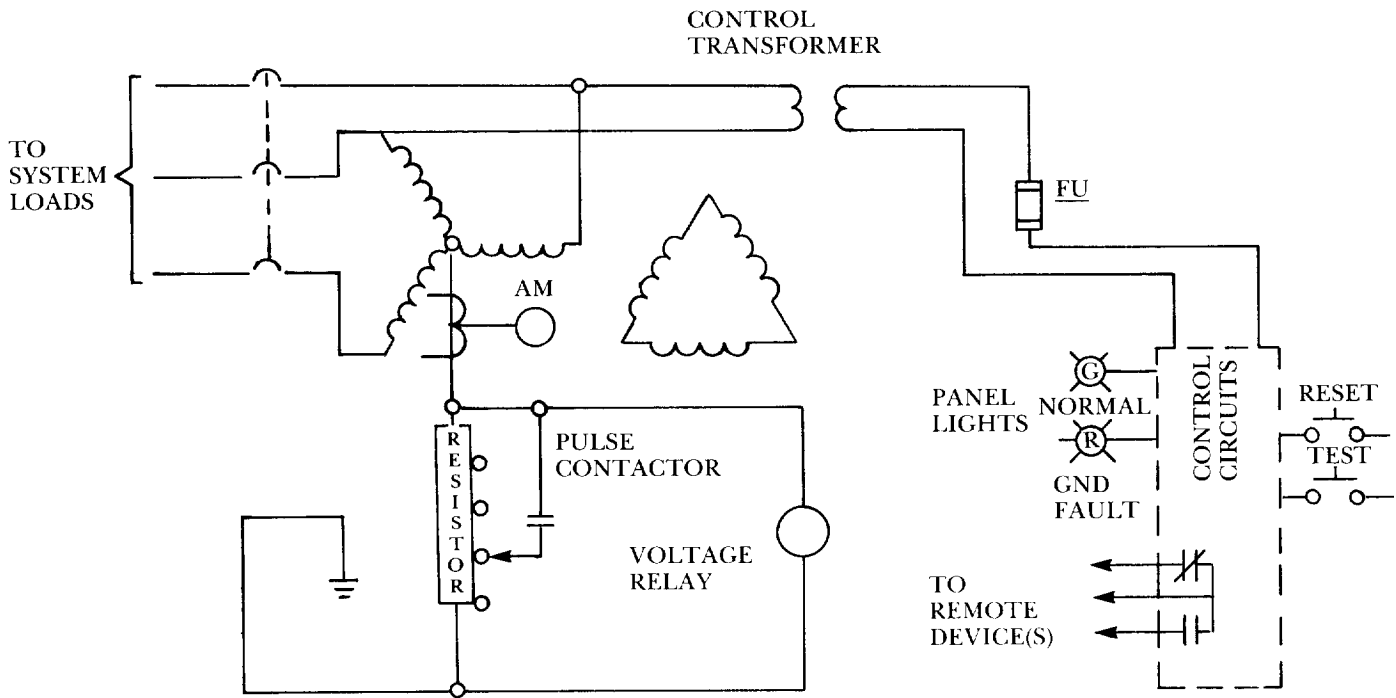


Figure 1. Basic System Operation

## EQUIPMENT DESCRIPTION AND GROUNDING SYSTEM OPERATION (CONT.)

### Grounding Resistors

Since ground current is limited by the resistors, the last section must never be shorted out by the shorting contactor during pulsing.

The resistor must be adjusted at installation so that the ground current with one ground fault is equal to or slightly greater than the maximum system capacitance charging current. (The value obtained with maximum connected load of the system). If maximum system capacitance current is not known, refer to "System Capacitance Charging Current" below for methods to determine the value.

### Operation of Equipment

The following instructions will appear on an engraved nameplate on the equipment door:

#### Normal

- 1 - Green light indicates normal condition and equipment energized.
- 2 - Red light indicates ground fault on system.

#### Ground Detection

- 1 - Press reset button. If red light goes out, there is no ground.
- 2 - Plug in portable pulsing unit.
- 3 - Trace pulsing ground current with portable detector.
- 4 - Remove ground.
- 5 - Press reset button to remove fault indication.
- 6 - Unplug portable pulser.

#### Test

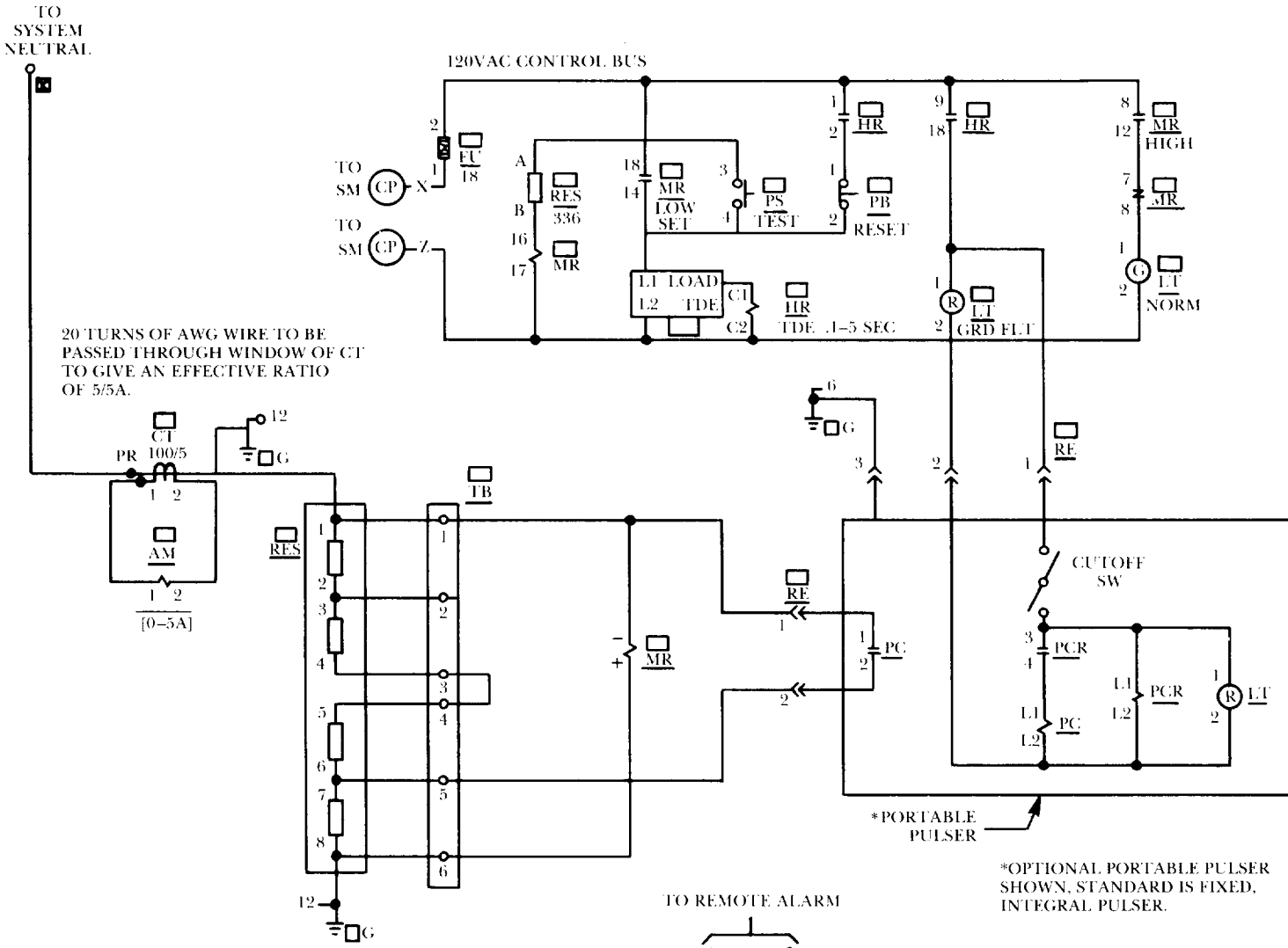
- 1 - Press test button to simulate ground and to operate alarm and control circuits. Hold for five seconds or until red light is lit.
- 2 - Press reset button after test to return to normal.

### Equipment Included In Standard 480V WYE System With System Neutral Available

- 1 - Neutral current transformer (optional) (CT)
- 1 - Meter relay (MR)
- 1 - Pulsing contactor, set to produce approx. 40 current pulsations per minute (fixed or portable) (PC)
- 1 - Neutral grounding resistors. (RES)
- 1 - Relay for pulsing contactor. (PCR)
- 1 - Holding relay, with extra interlocks for remote alarm. (HR)
- 1 - Neutral ammeter (optional). (AM)
- 1 - "Ground Fault" red indicating light. (LT/GRD FLT)
- 1 - "Normal" green indicating light. (LT/NORM)
- 1 - "Reset" pushbutton. (PB/RESET)
- 1 - "Test" pushbutton. (PB/TEST)
- 1 - Instruction plate on door.
- 1 - Portable clamp on detector (optional)

### System Capacitance Charging Current

The maximum system capacitance charging current must be known before the high resistance grounding system resistors can be set for the correct ground current during a fault. If the maximum system charging current is not known, the value may be established by the procedures detailed on pages 5 or 6, whichever is appropriate.



GRD FAULT AMPS	PULSE AMPS	TERMINAL BLOCK JUMPER
.9	3.6	3-4
1.2	3.6	1-2, 3-4
2.30	7.2	1-2, 3-5, 4-6
3.4	7.2	1-3, 2-5, 4-6

FACTORY CONNECTED FOR .9 AMPS GROUND FAULT CURRENT.

Figure 2 Typical High Resistance Pulsing Ground Detection Elementary

**(Using Accepted Normal Values of System Capacitance Charging Current)**

**High Resistance Pulsing Ground Detector  
480 Volt WYE**

1. Familiarize yourself with this instruction and with the grounding circuit.
2. Adjust the neutral ground resistance by moving jumpers on resistor terminal board such that the ground current with one ground fault is greater than the **System Capacitance Charging Current ( $I_c$ )**

**TABLE 5.1**

I <sub>c</sub> -Maximum Primary	Neutral Ground Resistor Data		Ground Fault Data		Pulsing Data		
	Jumper Connection On Resistor Terminal Board (See Note 2)	Resistance (OHMS)		Amps	Watts	Amps	Watts
		Normal	Pulsing				
0.8	3-4	304	76	0.91	252	3.65	556
1.1	1-2, 3-4	228	76	1.21	334	3.65	605
2.3	1-2, 3-5, 4-6	114	38	2.43	672	7.3	1213
3.5	1-3, 2-5, 4-6	76	38	3.65	1010	7.3	1417

3. Maximum normal expected ground fault for system  
kVA: kVA shown:

<u>TOTAL SYSTEM SIZE (kVA)</u>	<u>MAX NORMAL GROUND FAULT AMPS</u>
1000	0.9
1500	1.2
2000	2.4
3000	3.6

4. Set the meter relay (MR) such that the high-set pointer, "RED" is the maximum setting and the low-set pointer, "BLUE" is just higher than the voltage across the neutral ground resistor due to the system capacitance charging current.

**NOTE: 1.** The control voltage must be within 107-127 Volts, otherwise meter relay will not operate.

2. Refer to ground system elementary for resistor terminal board. Never short out resistors by connecting terminal 5 to 4 or 6.

## Testing For System Capacitance Charging Current, 480 Volt WYE

**WARNING:** Testing for capacitance charging current requires that the entire system be energized; hence, take all the necessary safety measures and employ all safety codes and practices.

The following instruction describes a high resistance neutral ground system supplied with Type AKD-8 Low Voltage Switchgear. The system features an alarm, and utilizes a pulsing current to locate the first ground fault.

This system is designed to:

1. De-energize grounding equipment by opening main circuit breaker, and by disconnecting hard wire connection to neutral bus. Be sure no other ground is connected to system. Remove neutral-ground link, if supplied.
2. Disconnect or open-circuit the resistors during test, and insert a 6-amp, 600V current limiting fuse as shown in Figure 1.
3. Connect a Variable Voltage Auto Transformer rated five (5) amps or more between equipment and ground as shown. Initially set at zero volts.
4. Connect a voltmeter as shown.
5. Use portable signal detector if furnished to read ground current. (1-amp scale for most systems.) Wire can be passed through detector window several times to produce greater sensitivity. (Test qual-

ity clamp-on ammeter may be used if portable signal detector is not supplied).

6. With maximum operating load equipment connected on system, re-energize the grounding equipment by re-connecting hard wire connection to neutral bus and closing main breaker. (Do Not re-install neutral-ground link, if supplied).
7. Energize the variable voltage auto transformer from an ungrounded, 110V, 60 Cyc. single-phase test source. (Use 1:1 isolation transformer rated (5) amps or more to obtain ungrounded voltage).
8. With maximum operating load equipment connected on the system, bring the voltage up slowly, recording neutral displacement voltage and current at selected test points until a linear variation of current with voltage is obtained.
9. Calculate system capacitance charging current,  $I_c$ , at rated voltage by extrapolation as follows:  
$$I_c = E \times I_a = \text{Amps system charging}$$
$$\frac{3}{V}$$
current, where  
 $E = \text{Rated system voltage, line to line}$   
(usually 480V)  
 $V = \text{Measured test voltage. (Neutral displacement).}$   
 $I_a = \text{Measured ground current corresponding to } V.$
10. Plot various test values to verify that linear relationship of current to voltage is being attained as system neutral is gradually displaced from ground potential.

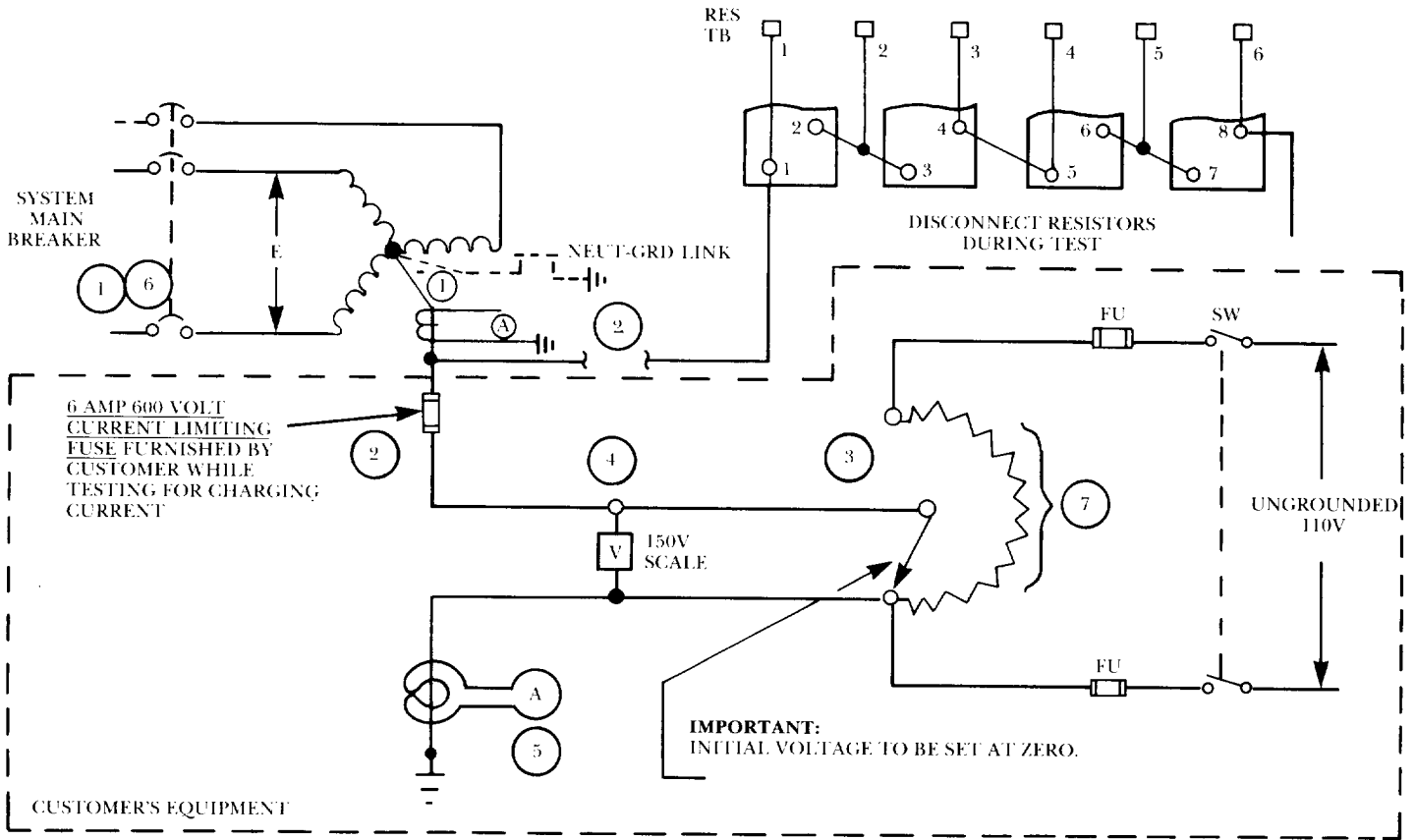


Figure 3. Testing Schematic



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