BGFS

Ground Fault Simulator

USER MANUAL

The information presented in this manual is believed to be adequate for the intended use of the product. If the product or its individual instruments are used for purposes other than those specified herein, confirmation of their validity and suitability must be obtained from Megger. Refer to the warranty information below. Specifications are subject to change without notice.

Warranty

Products supplied by Megger are warranted against defects in material and workmanship for a period of one year following shipment. Our liability is specifically limited to replacing or repairing, at our option, defective equipment. Equipment returned to the factory for repair must be shipped prepaid and insured. Contact your MEGGER representative for instructions and a return authorization (RA) number. Please indicate all pertinent information, including problem symptoms. Also specify the serial number and the catalog number of the unit. This warranty does not include batteries, lamps or other expendable items, where the original manufacturer's warranty shall apply. We make no other warranty. The warranty is void in the event of abuse (failure to follow recommended operating procedures) or failure by the customer to perform specific maintenance as indicated in this manual.

Megger

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Phoenixville, PA 19460

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Table of Contents

1 Introduction

Thank you for purchasing the Ground Fault Simulator, from Megger.

If you find any discrepancies in the product or its accessories or have any comments, please send them to Megger via fax, e-mail or phone.

Megger

400 Opportunity Way

Phoenixville, PA 19460

U.S.A.

Attn: Customer Service

Fax: (214) 331 7397

e-mail: june.crossland@megger.com

Customer service / Technical Support 1-800-723-2861 ext. 3519

For more information please visit our web site at: www.megger.com

Contents Received:

Qty	Part No.	Description
1		Ground Fault Simulator
1		Manual Operator Responsibility

When your Megger product arrives, check the equipment received against the packaging list to ensure that all materials are present. Notify Megger of any shortages.

Examine the contents for damage received during transit. If any damage is discovered, file a claim with the carrier at once and notify Megger or it's nearest authorized sales representative, giving a detailed description of the damage.

3 Overview of Product

Intended Use

The ground fault simulator is used to create simulated battery ground faults. The simulated ground fault can then be characterized and traced using either the Megger Battery Ground Fault Tracer (BGFT) or the Megger Battery Ground Locator (BGL) battery ground fault. Multiple resistive faults as well as phantom capacitive faults can be simulated using the battery ground fault simulator.

Applications

Applications Include:

- TRAINING FOR CHARACTERIZING AND LOCATING BATTERY GROUND FAULTS WITH THE MEGGER BGFT.
- TRAINING FOR CHARACTERIZING AND LOCATING BATTERY GROUND FAULTS WITH THE MEGGER BGL.

Definitions

Term	Definition
Battery Ground Fault	A resistive short circuit between one side of a battery string and earth. This short circuit can be anywhere from 0 ohms through 399K ohms.
Phantom Fault	A perceived short from one side of the battery string to earth caused by high capacitance. This presents a false ground fault.
Characterizing a fault	Determining through various means how much of the fault current is being drawn due to the resistive fault and how much of the current is being drawn due to a phantom fault.
BGFT	Battery Ground Fault Tracer – A two part instrument consisting of a transmitter and a receiver. Will locate ground faults up to 399K ohms. Incorporates an on board Wheatstone bridge for characterizing faults.
BGL	Battery Ground Locator – A one piece instrument with a combined transmitter and receiver. Will locate ground faults up to 100K ohms. Directly measures capacitance and resistance for characterizing faults.
Ground Fault Monitor	An on-site monitor used to indicate the presence of either a positive or negative ground fault.

Test Current	Supplied by BGFT or BGL
Input Power Rating	None
Fault Ranges	50 ohm to 330K ohm
Phantom Faults	1μF to 4.4 μF
Accuracy	Approximate Only
Physical size (Lid OFF)	30cm W x 55cm L x 14cm H 11.8” W x 21.6” L x 5.5” H
Physical size (Lid ON)	30cm W x 55cm L x 21cm H 11.8” W x 21.6” L x 8.3” H
Weight	6.3Kg (13.9lbs)
Operating Temperature	0C to +40°C (32 to 104°F)
Storage Temperature	-20C to +55°C (-5 to 131°F)
Operating Humidity	20 to 90% non-condensing
Altitude	2000 meters
EMF	IEC 61326:2002
Safety	IEC61010
IP Rating	51
CAT Rating	CAT IV @ 600V

5 Safety

Warnings and Safety Precautions

WARNING

When testing high-voltage transformers, caution must be used at all times and all safety precautions followed. Read, understand, and employ all safety precautions and circuit connections described in Section 2 - Safety.

Installation of this instrument MUST be performed in compliance with the National Electric Code and any additional safety requirements applicable to your installation.

Installation, operation and maintenance of this instrument MUST be performed by qualified personnel only. The National Electrical Code defines a qualified person as one familiar with the construction and operation of the equipment and the hazards involved.

Do not leave the instrument connected to the system under test when not in use.

Always use extreme caution when connecting the instrument around bare conductors, under fault conditions, high voltage or currents may be present and may pose a shock hazard.

Do not touch circuit connections or any metal that is exposed due to damaged insulation.

Do not use the instrument or connect it to any external system if it shows any visible signs of damage, malfunction or if it has been stored in unfavorable conditions.

Always inspect the instrument prior to use.

Replace any defective parts or return the instrument to an authorized center for repair.

Do not use the instrument or connect it to any external system if the enclosure is open or any parts of the enclosure are missing.

Only use specified batteries as described by this document, if applicable.

The instrument shall not be used if any parts are damaged.

Always connect the probe to the instrument prior to connecting to the source.

This instrument is not intrinsically safe and must not be used in hazardous atmospheres.

The following safety precautions MUST be taken whenever this product is installed.

- Wear safety glasses and insulated gloves when making connections to power circuits
- Hands, shoes, floor/ground must be dry when making any connection to a power line

These warnings and safety precautions are to be used where appropriate when following instructions in this manual.

CAUTION!

If this equipment is used in the manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Safety and Warning Symbols

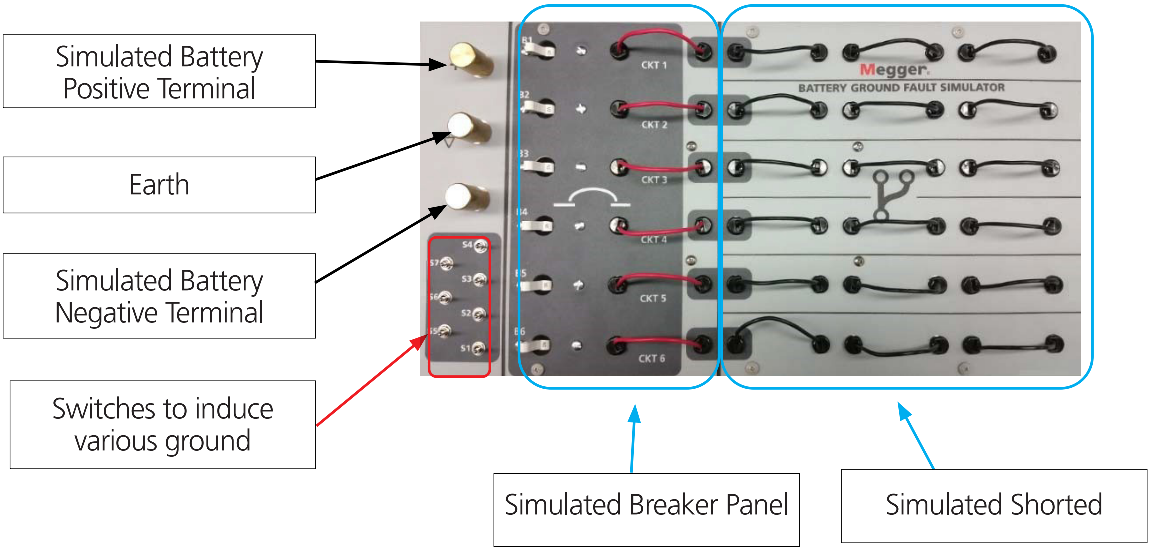
Symbol	Description	Notes
~	Alternating Current	Alternating current is present on these terminals when the unit is in operation. The voltage will not exceed 50VAC in normal operation.
	Warning	WARNING is defined as a condition or practice which could result in personal injury or loss of life.
	Caution	CAUTION is defined as a condition or practice which could result in damage to or destruction of the equipment or apparatus under test.

6 Product Connections

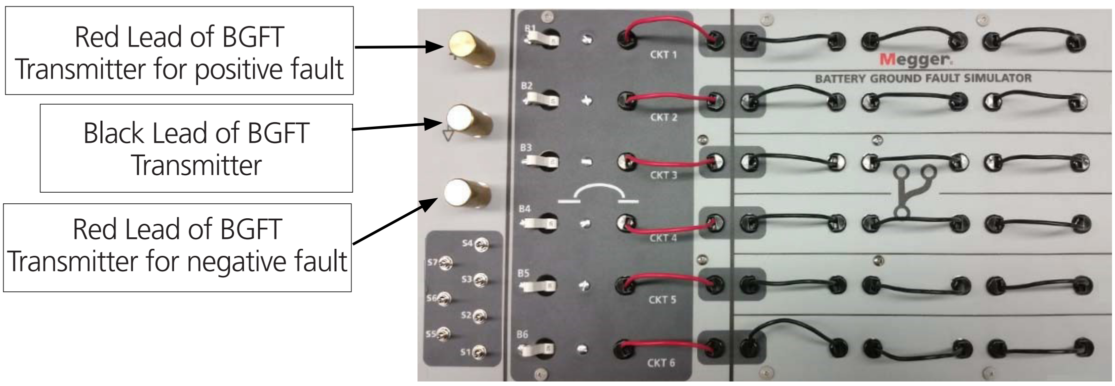
Connector Layout / Interconnect

Testing a Single-Phase Transformer

Single-Winding Test



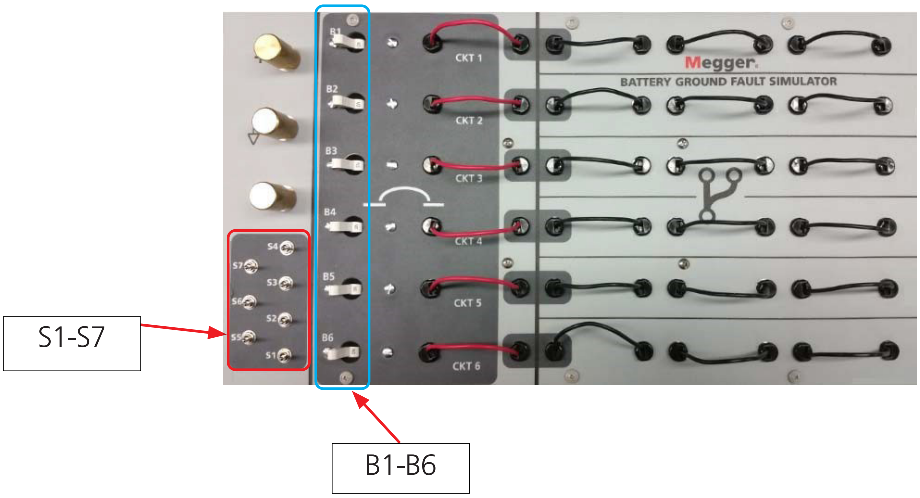
Interconnections for operation



The following section describes the operation of the Ground Fault Simulator. This section will describe in a step by step manner how to operate the unit.

Operation Controls and Modes

Define switch and control functions



Control	Function
B1 – B6	Breaker Switches Used to simulate a breaker panel.
S1 – S7	Fault switches. Used to induce various ground faults.

7 Operation with the BGFT

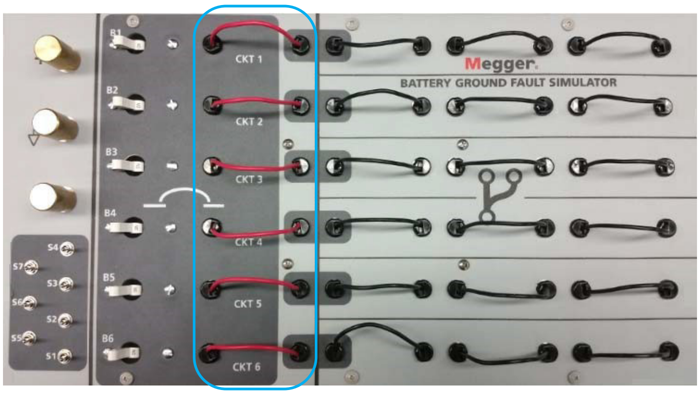
Operation with the BGFT

TEST # 1 - *Simulated Simple Positive Ground Fault*

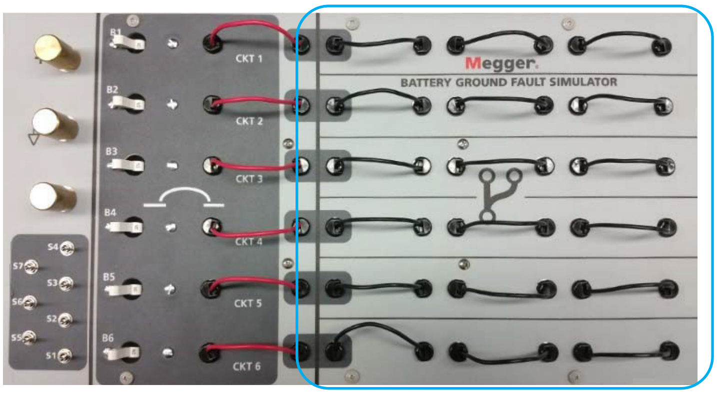
1. Set all the breaker switched (B1 – B6) on the battery ground fault simulator to the ON position.
2. Set all the fault switched (S1 – S7) on the battery ground fault simulator to the OFF position. (To the right)
3. Since it is a positive ground fault the BGFT will be connected across the positive battery terminal and earth.
4. Set the ground fault simulator fault switch S1 to ON.
5. Connect the black lead of the BGFT to the earth terminal of the ground fault simulator.
6. Connect the red lead of the BGFT to the positive terminal of the ground fault simulator
7. Verify the BGFT is configured as follows.
    a. All Wheatstone bridge dials are set to the "blue" position.
    b. The output voltage knob is set fully counter-clockwise.
    c. The output switch is off.
    d. If this is a model 246100C then the 15V / 50V switch is set to 15V.
    e. The power switch is turned ON.
8. Place the BGFT receiver's current clamp around the red lead of the BGFT transmitter. This is done to measure and characterize the total fault current.
9. Set the BGFT receivers gain to 100.
10. Turn on the BGFT and set the output voltage to 15V.
11. If the receiver is displaying an over current then lower the gain until a stable reading is achieved.
12. Characterize the fault using the Wheatstone bridge using the flow chart in appendix A.

NOTE: The current value on the receiver will increase when the capacitive values on the bridge is increased, in either direction. This indicates there is very little current going to any capacitance. The majority of the fault current drops to near zero at 2K. Since the majority of fault current drops when the resistance portion of the bridge is increased this indicates the fault is resistive. (2KΩ).

13. Once the fault capacitance and resistance is determined locate the circuit that has the fault. This is done by placing the receiver CT on each breaker circuit one at a time, until the fault current is located.



14. Once the faulted circuit is located trace the fault. This is done by moving the receiver's CT down the circuit until the fault current disappears. The point at which the fault current disappears is the location of the fault.



Results for Test #1 Switch S1 ON Circuit Characterization

Capacitance = 0μF (Minimal capacitance)

Resistance = Approximately 2K Faulty Circuit = 1

Location of Short = Between loop 2 and 3

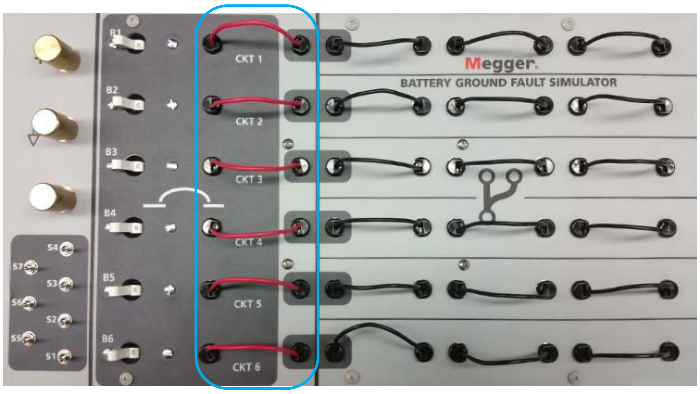
TEST # 2 - ***Simulated Positive Low Resistive Ground Fault***

1. Set all the breaker switched (B1 – B6) on the battery ground fault simulator to the ON position.
2. Set all the fault switched (S1 – S7) on the battery ground fault simulator to the OFF position. (To the right).
3. Since it is a positive ground fault the BGFT will be connected across the positive battery terminal and earth.
4. Set the ground fault simulator fault switch S2 to ON.
5. Connect the black lead of the BGFT to the earth terminal of the ground fault simulator.
6. Connect the red lead of the BGFT to the positive terminal of the ground fault simulator.
7. Verify the BGFT is configured as follows.
    a. All Wheatstone bridge dials are set to the "blue" position.
    b. The output voltage knob is set fully counter-clockwise.
    c. The output switch is off.
    d. If this is a model 246100C then the 15V / 50V switch is set to 15V.
    e. The power switch is turned ON.
8. Place the BGFT receiver's current clamp around the red lead of the BGFT transmitter. This is done to measure and characterize the total fault current.
9. Set the BGFT receivers gain to 100.
10. Turn on the BGFT and set the output voltage to 15V.
11. If the receiver is displaying an over current then lower the gain until a stable reading is achieved.
12. Characterize the fault using the Wheatstone bridge using the flow chart in appendix A.

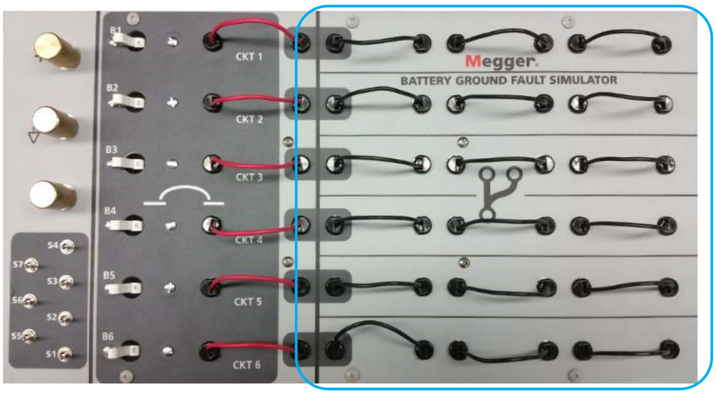
NOTE: The current value on the receiver will hardly drop when the bridge values are increased. This is because the ground fault value is so close to ground it cannot be nearly zeroed out. When the ground fault value cannot be nearly zeroed out this indicates the fault is less than 1K. Since this fault is so near to ground no further characterization is required.

7 Operation with the BGFT

13. Once the fault capacitance and resistance is determined locate the circuit that has the fault. This is done by placing the receiver CT on each breaker circuit one at a time, until the fault current is located.



14. Once the faulted circuit is located trace the fault. This is done by moving the receiver's CT down the circuit until the fault current disappears. The point at which the fault current disappears is the location of the fault.



Results for Test #2 Switch S2 ON Circuit Characterization

Capacitance = 0μF (Minimal capacitance)

Resistance = Less than 1K (Actually 50Ω)

Faulty Circuit = 2

Location of Short = Between loop 1 and 2

TEST # 3 - *Simulated Multiple Positive Ground Fault*

1. Set all the breaker switched (B1 – B6) on the battery ground fault simulator to the ON position.
2. Set all the fault switched (S1 – S7) on the battery ground fault simulator to the OFF position. (To the right).
3. Since it is a positive ground fault the BGFT will be connected across the positive battery terminal and earth.
4. Set the ground fault simulator fault switch S1, S4 to ON.
5. Connect the black lead of the BGFT to the earth terminal of the ground fault simulator.
6. Connect the red lead of the BGFT to the positive terminal of the ground fault simulator.
7. Verify the BGFT is configured as follows.

a. All Wheatstone bridge dials are set to the “blue” position.

b. The output voltage knob is set fully counter-clockwise.

c. The output switch is off.

d. If this is a model 246100C then the 15V / 50V switch is set to 15V.

e. The power switch is turned ON.

8. Place the BGFT receiver’s current clamp around the red lead of the BGFT transmitter. This is done to measure and characterize the total fault current.

9. Set the BGFT receivers gain to 100.

10. Turn on the BGFT and set the output voltage to 15V.

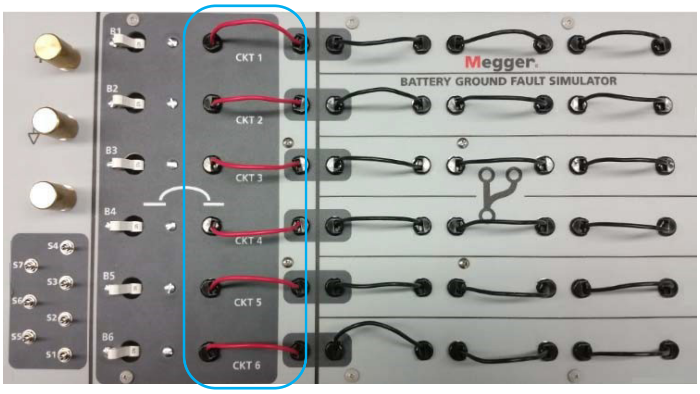
11. If the receiver is displaying an over current then lower the gain until a stable reading is achieved.

12. Characterize the fault using the Wheatstone bridge using the flow chart in appendix A.

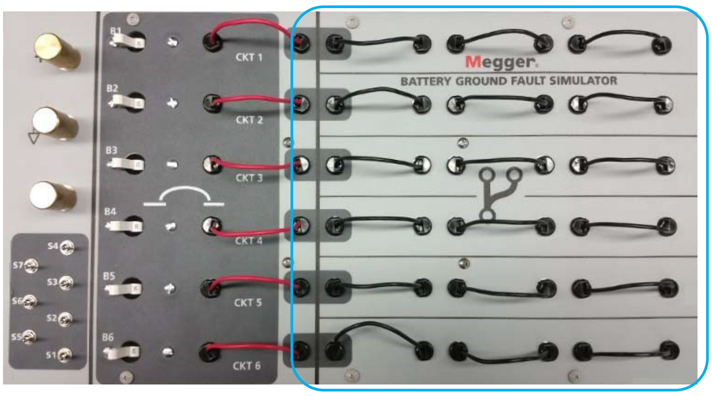
NOTE: The current value on the receiver will hardly drop when the capacitive bridge values are increased. This indicates little to no capacitance. When the resistor bridge values are adjusted again you will see the ground fault value cannot be nearly completely zeroed out. This is because the ground fault value is so close to ground. So we know the fault is less than 1K.

Since the majority of the current dropped when the resistive values were adjusted we know the fault is primarily resistive. No further characterization is required.

13. Once the fault capacitance and resistance is determined locate the circuit that has the fault. This is done by placing the receiver CT on each breaker circuit one at a time, until the fault current is located. **Trace the circuit that draws the most fault current first.**



14. Once the faulted circuit is located trace the fault. This is done by moving the receiver’s CT down the circuit until the fault current disappears. The point at which the fault current disappears is the location of the fault.



15. Once the first fault is found, remove it by opening the breaker. (This is only for training purposes. This is never done in the real world.) Now trace the second fault.

    Results for Test #3 Switch S4 ON

    Circuit Characterization

    Capacitance = 0μF (Minimal capacitance)

    Resistance =Approximately <1K on CKT 2 between loop 1 and 2

    Faulty Circuit = CKT 3 between loops 2 and 3 = 1K fault

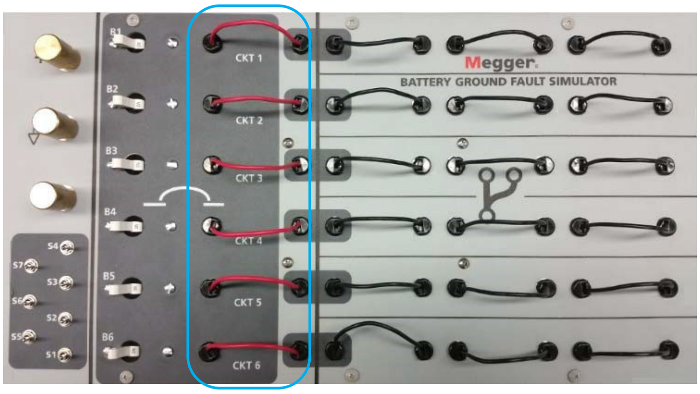
    Faulty Circuit = CKT 1 between loops 2 and 3 = 1K fault

TEST # 4 - *Simulated Negative Ground Fault with phantom short*

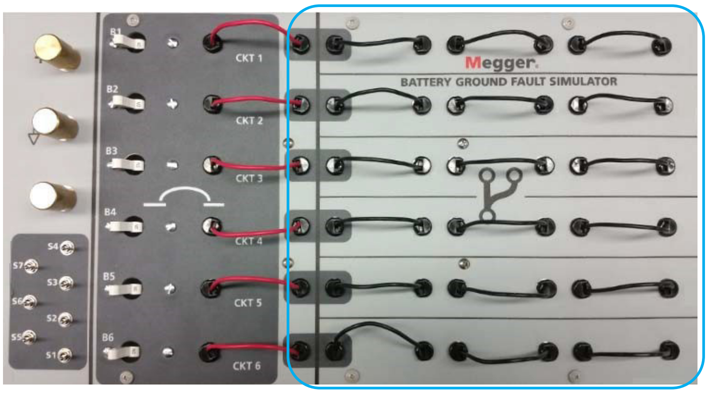
1. Set all the breaker switched (B1 – B6) on the battery ground fault simulator to the ON position.
2. Set all the fault switched (S1 – S7) on the battery ground fault simulator to the OFF position.
3. Since it is a positive ground fault the BGFT will be connected across the positive battery terminal and earth.
4. Set the ground fault simulator fault switch S5, S6 to ON.
5. Connect the black lead of the BGFT to the earth terminal of the ground fault simulator.
6. Connect the red lead of the BGFT to the positive terminal of the ground fault simulator.
7. Verify the BGFT is configured as follows.
    a. All Wheatstone bridge dials are set to the "blue" position.
    b. The output voltage knob is set fully counter-clockwise.
    c. The output switch is off.
    d. If this is a model 246100C then the 15V / 50V switch is set to 15V.
    e. The power switch is turned ON.
8. Place the BGFT receiver's current clamp around the red lead of the BGFT transmitter. This is done to measure and characterize the total fault current.
9. Set the BGFT receivers gain to 100.
10. Turn on the BGFT and set the output voltage to 15V.
11. If the receiver is displaying an over current then lower the gain until a stable reading is achieved.
12. Characterize the fault using the Wheatstone bridge using the flow chart in appendix A.

NOTE: The current value on the receiver will drop considerably when the capacitive value on the bridge is increased. This indicates there is a great deal of current going to a capacitance load. Since the majority of the current drop tunes out when the capacitance is adjusted we know the current being drawn by the phantom short is higher than the current being drawn by the actual resistive fault. Therefore we must characterize each circuit drawing fault current in order to determine which on has the real resistive fault.

13. Once the fault capacitance and resistance is determined locate the circuit that has the fault. This is done by placing the receiver CT on each breaker circuit one at a time, until the fault current is located.



14. Characterize the two circuits using the Wheatstone bridge using the flow chart in appendix A. Locate which one has the resistive fault.
15. Once the faulted circuit is located trace the fault. This is done by moving the receiver's CT down the circuit until the fault current disappears. The point at which the fault current disappears is the location of the fault.



NOTE: This is one of the most difficult faults to locate because the impedance of the capacitance of the circuit is lower than the impedance of the fault.

Results for Test #4 Switch S5 and S6

Circuit Characterization

Capacitance = 4.5μF

Resistance =Approximately 10K

Faulty Circuit = 4, between loops 2 and 3 (Circuit 6 has the phantom fault)

TEST # 5 - ***Simulated Negative Very High Resistive Ground Fault***

1. Set all the breaker switched (B1 – B6) on the battery ground fault simulator to the ON position.
2. Set all the fault switched (S1 – S7) on the battery ground fault simulator to the OFF position. (To the right)
3. Since it is a positive ground fault the BGFT will be connected across the positive battery terminal and earth.
4. Set the ground fault simulator fault switch S7 to ON.
5. Connect the black lead of the BGFT to the earth terminal of the ground fault simulator.
6. Connect the red lead of the BGFT to the positive terminal of the ground fault simulator.
7. Verify the BGFT is configured as follows.

a. All Wheatstone bridge dials are set to the "blue" position.

b. The output voltage knob is set fully counter-clockwise.

c. The output switch is off.

d. If this is a model 246100C then the 15V / 50V switch is set to 15V.

e. The power switch is turned ON.

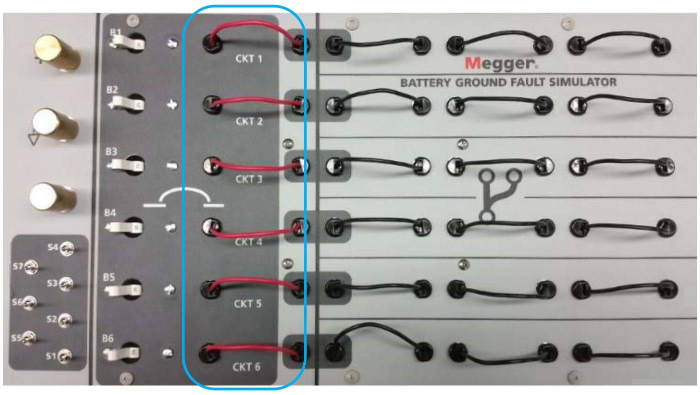
8. Place the BGFT receiver's current clamp around the red lead of the BGFT transmitter. This is done to measure and characterize the total fault current.
9. Set the BGFT receivers gain to 100.
10. Turn on the BGFT and set the output voltage to 15V.

NOTE: The receiver does not display any current. This is because the voltage is too low to generate enough current through such a high impedance fault.

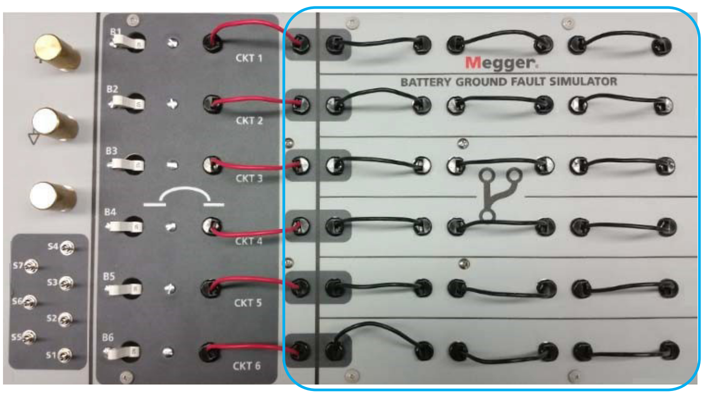
11. Set the current to zero.
12. If using a 246100C model set the 15V / 50V switch to 50.
13. Turn up the voltage to 50V and note the current displayed on the receiver.
14. Characterize the fault using the Wheatstone bridge using the flow chart in appendix A.

NOTE: The current value on the receiver will increase when the capacitive bridge is used. This indicates there is very little current going to any capacitance. The majority of the fault current drops when the resistance is adjusted. This indicates the fault is mainly resistive. Since this fault does not contain phantom short no further characterization is required.

15. Once the fault resistance is determined locate the circuit that has the fault current. This is done by placing the receiver CT on each breaker circuit one at a time, until the fault currents is located.



16. Once the faulted circuit is located trace the fault. This is done by moving the receiver's CT down the circuit until the fault current disappears. The point at which the fault current disappears is the location of the fault.



Results for Test #5 Switch S5 ON

Circuit Characterization

Capacitance = 0μF (Minimal capacitance)

Resistance = Approximately >300K

Faulty Circuit = 5

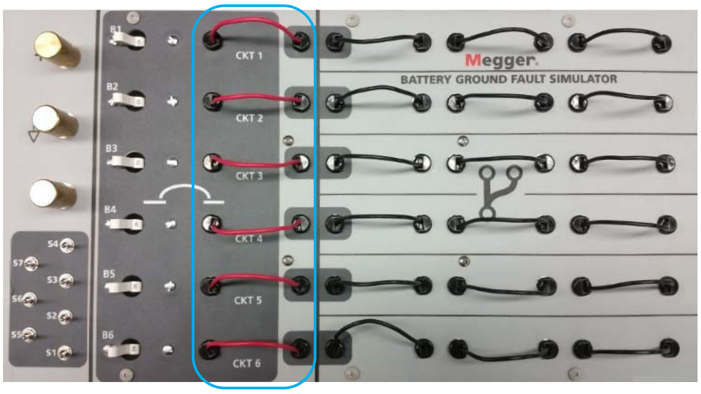
Location of Short = Between loop 1 and 2

TEST # 6 - *Simulated Positive Multiple Ground Fault with a Phantom Fault*

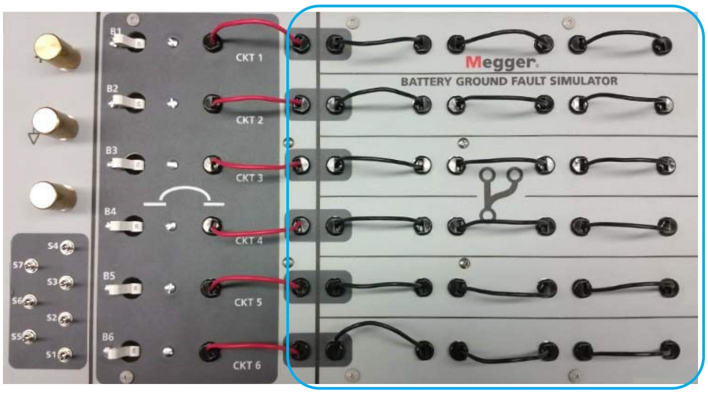
1. Set all the breaker switched (B1 – B6) on the battery ground fault simulator to the ON position.
2. Set all the fault switched (S1 – S7) on the battery ground fault simulator to the OFF position. (To the right)
3. Since it is a positive ground fault the BGFT will be connected across the positive battery terminal and earth.
4. Set the ground fault simulator fault switches S1, S3 & S4 to ON.
5. Connect the black lead of the BGFT to the earth terminal of the ground fault simulator.
6. Connect the red lead of the BGFT to the positive terminal of the ground fault simulator.
7. Verify the BGFT is configured as follows.
    a. All Wheatstone bridge dials are set to the “blue” position.
    b. The output voltage knob is set fully counter-clockwise.
    c. The output switch is off.
    d. If this is a model 246100C then the 15V / 50V switch is set to 15V.
    e. The power switch is turned ON.
8. Place the BGFT receiver’s current clamp around the red lead of the BGFT transmitter. This is done to measure and characterize the total fault current.
9. Set the BGFT receivers gain to 100.
10. Turn on the BGFT and set the output voltage to 15V.
11. If the receiver is displaying an over current then lower the gain until a stable reading is achieved.
12. Characterize the fault using the Wheatstone bridge using the flow chart in appendix A.

NOTE: The current value on the receiver does decrease when capacitance is applied. This indicates that there is a phantom fault caused by capacitance. However the majority of the current drops when the resistance is adjusted. This means the majority of the fault is resistive. Since we cannot get the value close to zero we know the resistive fault current is below 1KΩ. Since this fault does contain a phantom short we need to characterize the circuits that are drawing the fault current. This way we do not chase the fault down the circuit with the phantom fault.

13. Once the fault capacitance and resistance is determined locate the circuits that has the fault current. This is done by placing the receiver CT on each breaker circuit one at a time, until the fault currents is located. **Characterize them and locate the circuits with the resistive faults.**



14. Notice that circuit 3 contains both the capacitive phantom fault as well as a resistive fault. You can use the bridge one the secondary side of the circuit to find where the capacitive phantom fault is and where the resistive real fault is.c



15. Once you have identified where the capacitive phantom faults and the real resistive faults are, turn off breaker 3. (This is never done in the real world.) Now check the fault current from the BGFT transmitter.

16. Note there is still fault current. There is a second fault. Try to characterize and locate it

Results for Test #6 Switches S1, S3 & S4 ON

Circuit Characterization

Capacitance = 4.6μF on Circuit #3 (Between loops 1 and 2)

Resistance = Approximately 2KΩ on Circuit #1 (Between loops 2 and 3)

Resistance = Approximately 1KΩ on Circuit #3 (Between loops 2 and 3)

Unit Maintenance

The equipment is a very low maintenance device. All that is required is a periodic cleaning.

Instructions for cleaning and decontamination

The unit should not be cleaned with anything more than a clean dry cloth.

9 Spare Parts

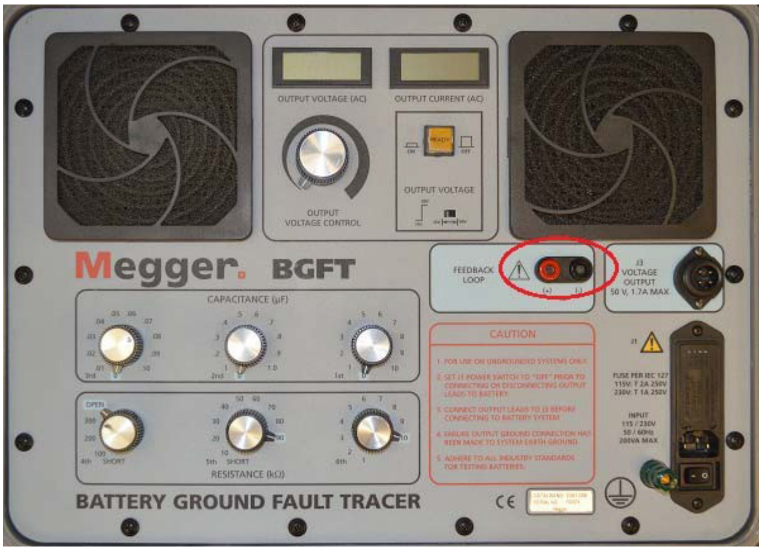
There are no user replaceable parts in the ground fault simulator.

Instructions for cleaning and decontamination

The unit should not be cleaned with anything more than a clean dry cloth.

Appendix A Characterizing a circuit

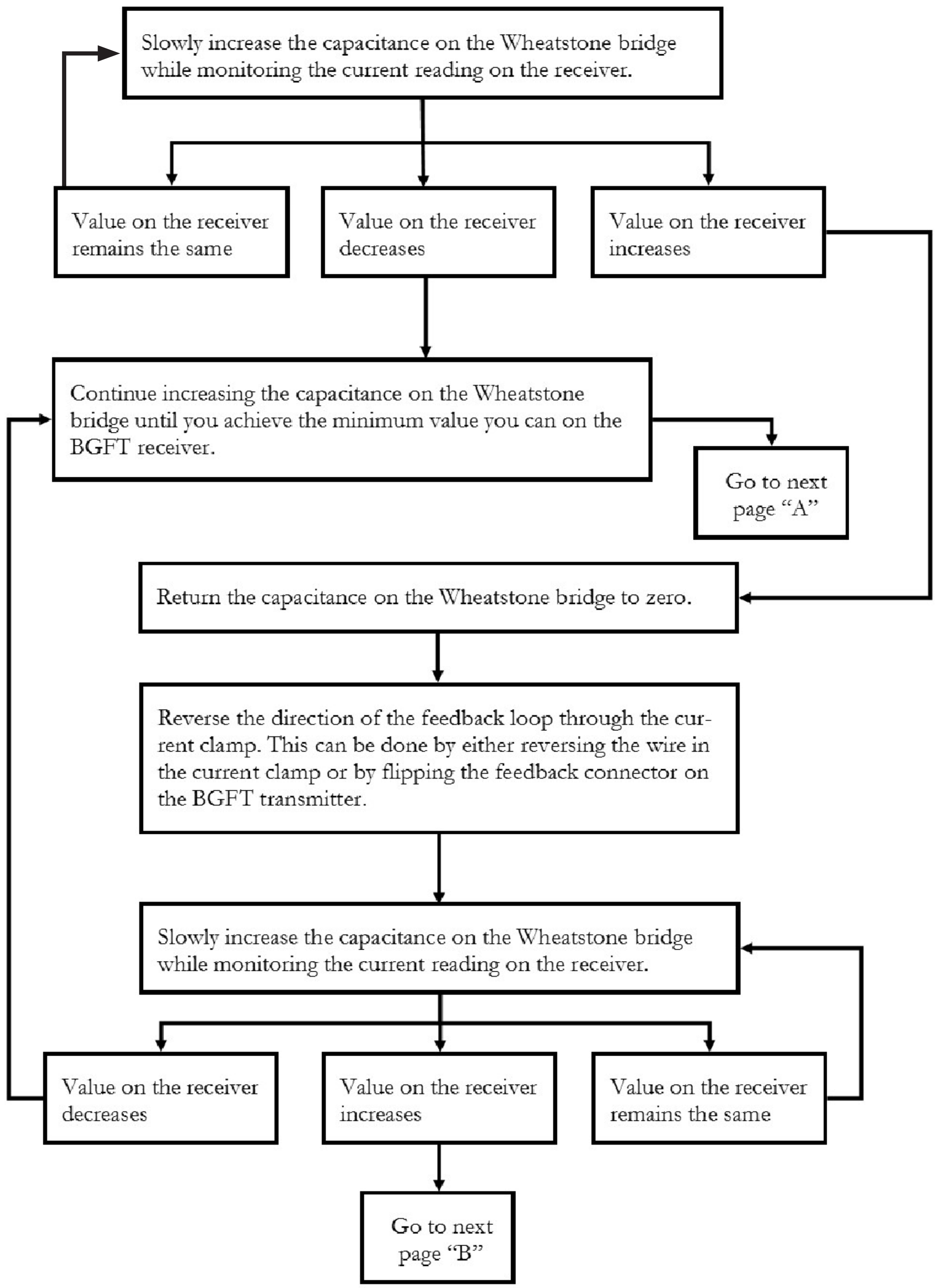
1. Connect the feedback loop to the BGFT transmitter.

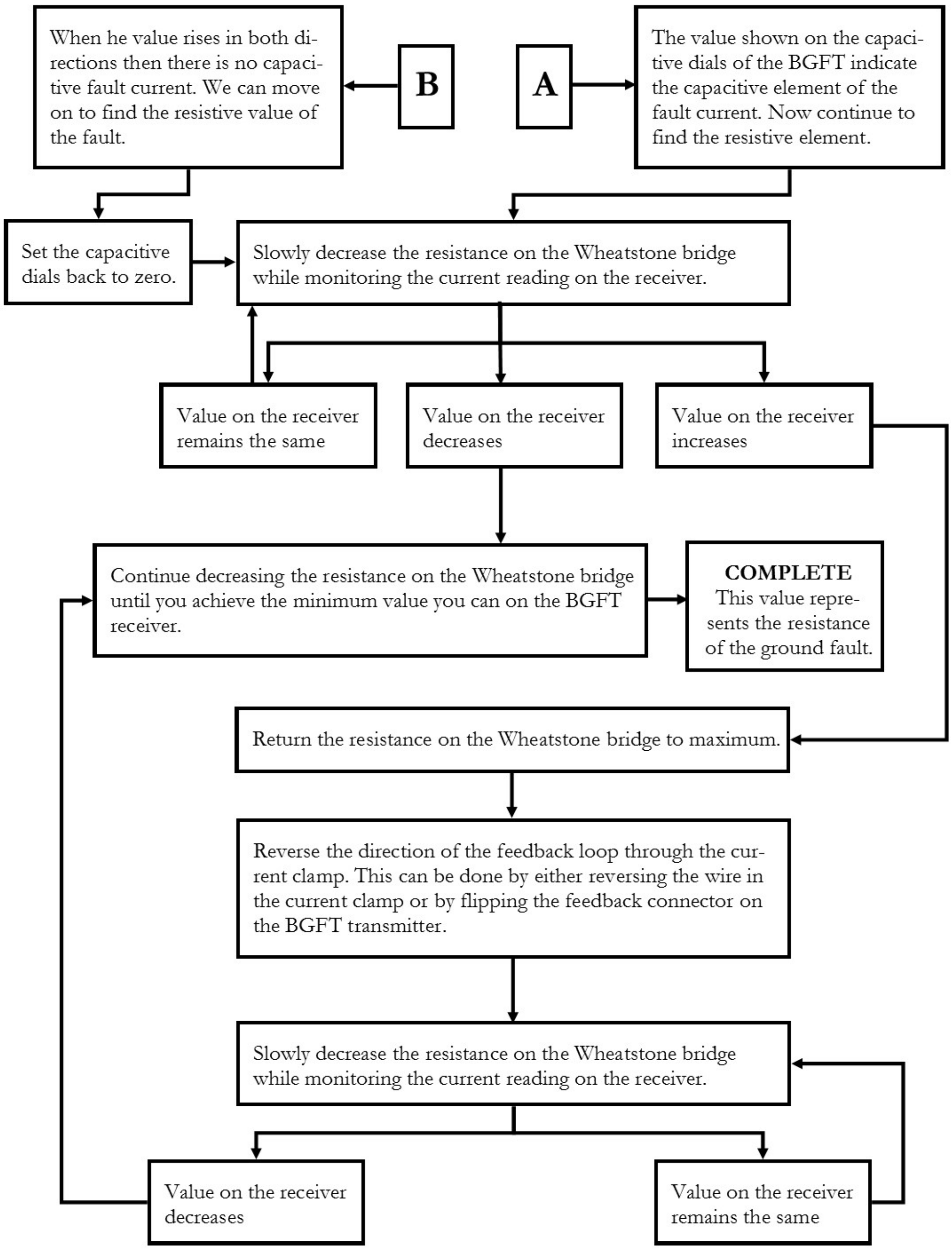


2. Place the feedback loop through the receivers CT in parallel with the circuit to be characterized.

Characterizing

3. Place the feedback loop through the receivers CT in parallel with the circuit to be characterized.




When he value rises in both directions then there is no capacitive fault current. We can move on to find the resistive value of the fault.
B
A
The value shown on the capacitive dials of the BGFT indicate the capacitive element of the fault current. Now continue to find the resistive element.
Set the capacitive dials back to zero.
Slowly decrease the resistance on the Wheatstone bridge while monitoring the current reading on the receiver.
Value on the receiver remains the same
Value on the receiver decreases
Value on the receiver increases
Continue decreasing the resistance on the Wheatstone bridge until you achieve the minimum value you can on the BGFT receiver.
COMPLETE
This value represents the resistance of the ground fault.
Return the resistance on the Wheatstone bridge to maximum.
Reverse the direction of the feedback loop through the current clamp. This can be done by either reversing the wire in the current clamp or by flipping the feedback connector on the BGFT transmitter.
Slowly decrease the resistance on the Wheatstone bridge while monitoring the current reading on the receiver.
Value on the receiver decreases
Value on the receiver remains the same

Appendix B Fault Configurations

Switch	Positive / Negative	Type	Value	Circuit	Location
S1	Positive	Resistive	2K	1	Between loop 2 and 3
S2	Positive	Resistive	50Ω	2	Between loop 1 and 2
S3	Positive	Capacitive	4.5µF	3	Between loop 1 and 2
S4	Positive	Resistive	1K	3	Between loop 2 and 3
S5	Negative	Resistive	10K	4	Between loop 1 and 2
S6	Negative	Capacitive	4.5µF	6	Between loop 1 and 2
S7	Negative	Resistive	330K	5	Between loop 2 and 3

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