AVTM6514J
Rev. A
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Instruction Manual AVTM6514J
for
Impulse Generator

Catalog Nos. 651403 and 651404

High-Voltage Equipment
Read the entire manual before operating.

Aparato de Alto Voltaje
Antes de operar este producto lea este manual enteramente.

Megger

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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. Specifications are subject to change without notice.

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FIGURE LIST

SECTION 1

Introduction

RECEIVING INSTRUCTIONS

Check the equipment received against the packing list to ensure that all materials are present. Notify Megger of any shortage. Telephone (610) 676-8500.

Examine the instrument for possible damage received in transit. If any damage is discovered, file a claim with the carrier at once and notify Megger or its nearest authorized sales representative, giving a detailed description of the damage.

This instrument has been thoroughly tested and inspected to meet rigid specifications before being shipped. It is ready for use when set up as indicated in this manual.

GENERAL INFORMATION

This instruction manual describes the operation and maintenance of Impulse Generators having Catalog No. 651403 and 651404. Catalog No. 651403 is the 120 V, 50/60 Hz, 300 VA model, and Catalog No. 651404 is the 240 V, 50/60 Hz, 300 VA model.

The Impulse Generator produces periodic pulses up to 15 kV for locating faults in cables by the high-voltage, impulse-tracing method. No larger than a medium-sized suitcase and weighing only 41 pounds, the Impulse Generator is contained in a fiberglass carrying case that is rugged and durable to withstand transportation from site to site. See Figure 1.

The Impulse Generator uses low-voltage storage capacitors on the primary side of a pulse transformer. Every six seconds, a solid-state switch discharges the capacitors into the pulse transformer, which steps the voltage up to the required level. The resultant output is a high-voltage impulse with a steep front and an exponentially decaying "tail" — an ideal waveform for cable fault location. The waveform travels along the cable until it reaches the fault, where a sparkover occurs. High-voltage sparkover causes a significant current to flow, and the fault is located by detecting this current or the noise made by the sparkover.

An ammeter on the Impulse Generator displays peak fault current in percentage of the available output. When the meter indicates a cable fault, its location is pinpointed by tracing the fault current with a detector carried along the cable path. Two such detectors are available from Megger:

Figure 1: Impulse Generator

Catalog No. 653000	Surge Detector (for direct buried cable)
Catalog No. 651113	Electromagnetic Impulse Detector (for ducted and buried cable)

A rotary switch allows the selection of 3, 6, 9, 12, or 15 kV. The switch also has a ZERO START position which discharges the capacitors and provides a zero-voltage start-up for safety. Input and output cables are permanently attached; storage for cables is provided in the lid of the carrying case. An integral fan provides cooling.

Section 2

Safety

This equipment and the cable to which it is connected are sources of high-voltage electrical energy. All persons performing or assisting in tests must use all practical safety precautions to prevent contact with energized parts of the test equipment and related circuits. Persons actually engaged in the test must stand clear, by at least 3 ft (0.91 m), of all parts of the complete high-voltage circuit unless the system is de-energized and all parts of the test circuit are grounded. Persons not directly involved with the work must be kept away from test activities by suitable barriers, barricades or warnings. Be aware that impulses applied to the cable will be present at the remote end(s) and any other exposed part of the cable, usually out of sight of the operator. To avoid inadvertent contact with hazardous live parts, always ensure that access to all exposed parts of the cable or connected equipment is restricted, by using suitable barriers or barricades.

- Safety is the responsibility of the user.
- Misuse of this high-voltage equipment can be extremely dangerous.
- The purpose of the test equipment is limited to use as described in this manual. Do not use the equipment or its accessories with any device other than specifically described.
- Never connect the test equipment to energized equipment.
- Never use the test equipment if there is any possibility that the test equipment or cable under test is in an explosive atmosphere.
- A qualified operator should be in attendance at all times while the test equipment is in operation.
- The safety ground jumpers and surge ground must be properly connected (refer to Section 5).
- Refer to IEEE 510-1983 "IEEE Recommended Practices for Safety in High-Voltage and High-Power Testing," and follow the applicable safety recommendations.
- Observe the safety warnings marked on the equipment.

Treat all terminals of high-voltage power equipment as a potential electric shock hazard. There is always the potential of voltages being induced at these terminals because of proximity to energized high-voltage lines or equipment. Always use a safety grounding stick to ground the high-voltage conductor. A safety ground jumper must then be installed between the high-voltage conductor and ground of the cable under test. The ground connection must be the first made and the last removed.

Systems of this type should not be used to locate faults on direct-buried unshielded or secondary cable. Dangerously high differences in potential may be developed in the current return path to the system.

Systems of this type should not be used to locate faults on any cable that is likely to be near enough to an energized cable to allow a burn through of the insulation of the energized cable. This situation may occur when the cables are located in a common trench, duct, or tray.

On completion of a test, even after power has been removed from the system, energy can still be stored in the impulse capacitor and cable under test. To discharge the cable and capacitor, immediately after use, set the OUTPUT KILOVOLTS switch to ZERO START. This places a solid ground on the output cable, power supply, and impulse capacitor.

WARNING

Never assume that the coaxial output cable or the cable under test is completely discharged, even after following the above procedures. Always use a safety grounding stick to ground any conductive part of the circuit and then apply safety ground jumpers before touching any connections.

This system operates from a single-phase power source. It has a three-wire power cord and a two-pole, three-terminal grounding type connector. The voltage to ground from either pole of the power source must not exceed the maximum rated operating voltage, 120 V ac for Catalog No. 651403 and 240 V ac for Catalog No. 651404. Before making connection to the power source, determine that the system is suitable for the voltage of the power source, and has a suitable two-pole, three-terminal grounding type connector. The power source must have a high rupture fuse or circuit breaker rated no higher than 15 A.

The power input plug must be inserted only into a mating receptacle with a ground contact. Do not bypass the grounding connection. Any interruption of the grounding connection can create an electric shock hazard. Determine that the receptacle is correctly wired before inserting the plug.

To avoid electric shock hazard, operating personnel must not remove the system protective covers. Component replacement and internal adjustments must be made by qualified service personnel only.

Users of high-voltage equipment should note that high-voltage discharges and other sources of strong electric or magnetic fields may interfere with the proper functioning of heart pacemakers. Personnel using heart pacemakers should obtain expert advice on the possible risks before operating this equipment or being close to the equipment during operation.

If the system is operated in accordance with the safety precautions in this manual and if all grounds are correctly made, rubber gloves are not necessary. As a routine safety procedure, however, some users require that rubber gloves be worn, not only when making connections to the high-voltage terminals, but also when manipulating controls. Megger recommends this excellent safety practice.

The following warning and caution notices are used in this manual where applicable and should be strictly observed.

WARNING

Warning, as used in this manual, is defined as a condition or practice which could result in personal injury or loss of life.

CAUTION

Caution, as used in this manual, is defined as a condition or practice which could result in damage to or destruction of the equipment or apparatus under test.

Megger has made formal safety reviews of the initial design and any subsequent changes. This procedure is followed for all new Megger products and covers areas in addition to those included in applicable ANSI standards. Regardless of these efforts, it is not possible to eliminate all hazards from electrical test equipment or to foresee every possible hazard that may occur. It is therefore essential that the user, in addition to following the safety rules in this manual, also carefully consider all safety aspects of the test before proceeding.

Section 3

Specifications

ELECTRICAL

Input voltage:	105 to 125 V ac (Cat. No. 651403) 210 to 250 V ac (Cat. No. 651404)
Input frequency:	50/60 Hz
Power consumption:	300 VA
Surge interval:	6 seconds
Surge generator equivalent capacitance:	2.5 µF at 15 kV
Stored energy:	300 joules
Surge output voltage:	3 to 15 kV (switch selected)
Surge output current:	Approximately 600 A into a short circuit
Output cable length:	20 ft (6 m)

PHYSICAL

Weight:	41 lb (18.6 kg)
Dimensions:	14.5 x 17.5 x 8.5 in. (D x W x H) (36.8 x 44.5 x 21.6 cm)

ENVIRONMENTAL

Temperature range:	-4 to 122°F (-20 to 50°C) (operating) -22 to 131°F (-30 to 55°C) (storage)
Altitude:	7500 ft (2286 m) maximum Voltage derates at higher altitudes
Humidity:	Operation and storage limits 5 to 95% rh noncondensing conditions
Climate:	Operation prohibited in rain or snow

Section 4

Description

CIRCUIT DESCRIPTIONS

The electronics of the Impulse Generator are described in the following and shown in the schematic diagram of Figure 2.

The Impulse Generator has a bank of energy storage capacitors, a high-voltage dc supply for charging the capacitors, a switch to discharge the capacitors, a damping resistor, and an output circuit. Capacitive energy storage and switching take place at a low voltage on the primary side of a pulse transformer, which in turn steps the voltage up as high as 15 kV for output to the cable under test. This means that the capacitors may be 800 to 1000 V devices, rather than the usual large 15,000 to 25,000 V type. The lower voltage allows use of a solid-state switch, an SCR.

The circuit schematic is divided into five functional parts:

1. Energy storage capacitor charging circuit: This circuit is composed of transformer T1 and diode CR8, which provides a rectified voltage to charge the main capacitor bank C7.

2. Solid-state switch SCR: This switch (Q7) is used to discharge the capacitor bank C7.

3. Discharge circuit: The energy in the capacitor bank is discharged into pulse transformer T3 through a damping resistor R19. T3 steps the voltage pulse up as high as 15 kV (open circuit) for output to the cable under test. The output voltage under load varies between 3 and 15 kV in five steps of 3 kV each, depending on which secondary tap of T1 is used to charge C7.

4. Pulse transformer and output metering circuit: A current transformer T4 monitors the output current and provides an input to meter M1, which indicates peak current. M1 has a 0 to 100 percent scale; it is calibrated to read approximately 100 percent with 15 kV into a short circuit. Lower output voltage taps provide a proportionately lower indication; e.g., 3 kV into a short circuit produces only 20 percent deflection.

5. Timing and firing circuits: The periodic pulse which gates the main SCR Q7 is developed in the following manner. Every six seconds a voltage pulse is discharged through transformer T2, gating pilot SCR Q6. In turn, Q6 switches the gating voltage to the main SCR Q7, thus completing the firing sequence for the high-voltage output pulses.

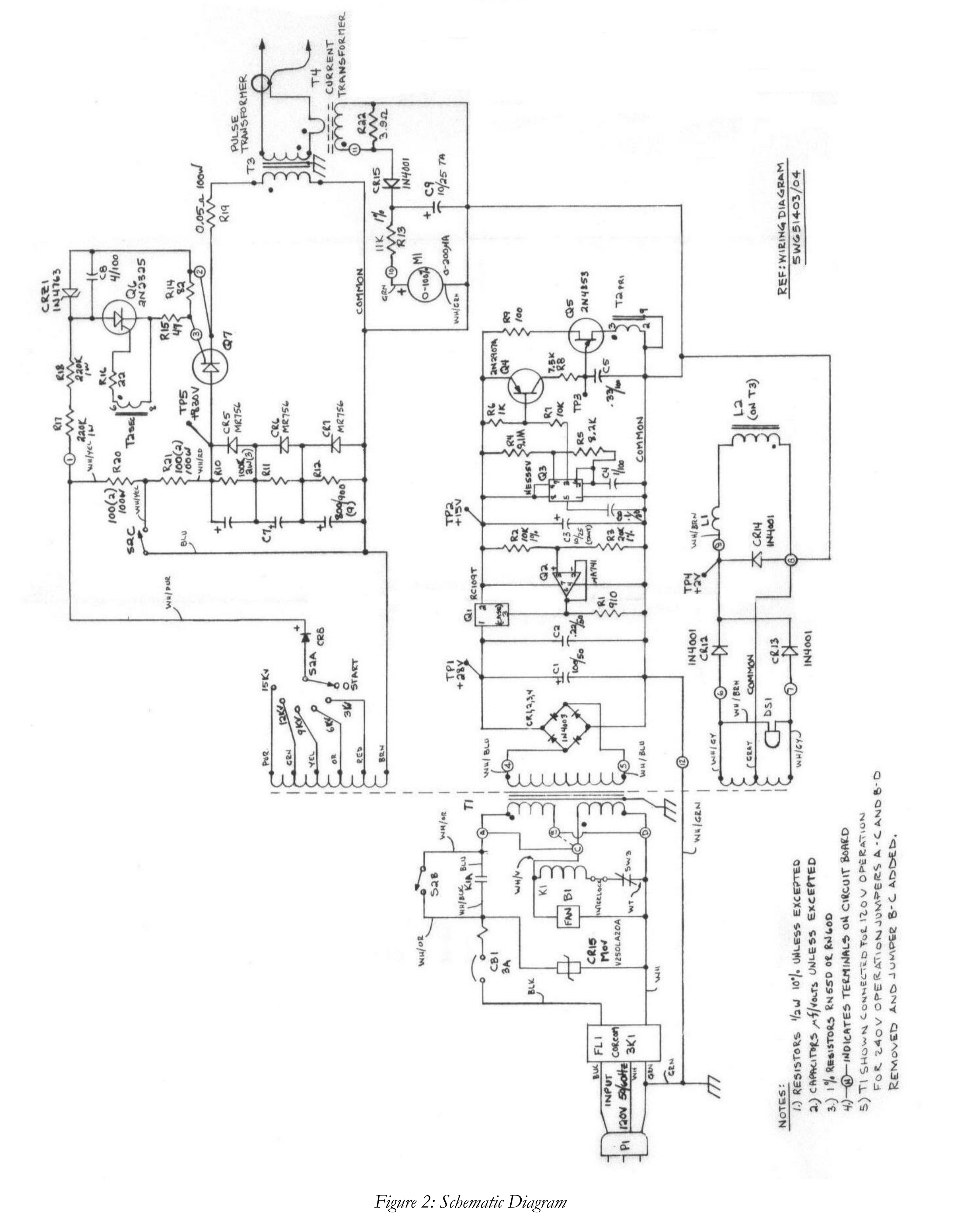


Figure 2: Schematic Diagram

A zero start circuit uses a latching (self-sealing) relay K1 in the primary of T1. A sixth position on the T1 secondary tap-changing switch discharges capacitor bank C7 and simultaneously shorts the latching contact of K1. This ensures that on start-up, no high-voltage pulses can be generated until the rotary switch is first turned to its (zero-output) position.

Line-voltage fan B1 cools the heat sink of the charge and discharge resistors. If the heat sink temperature rises excessively due to a fan failure or for any other reason, thermal switch SW3 shuts the unit down.

ON/OFF circuit breaker CB1 protects the Impulse Generator and provides immediate shutdown whenever required. FL1 and transient voltage suppressor CR15 are provided across the main line voltage input. Pilot light DS1, across a third secondary tap of T1, indicates that high-voltage output pulses are available.

CONTROLS AND CONNECTORS

AC INPUT:	10-ft (3 m), permanently attached line cord; two-pole, three-wire grounding plug mates with a standard NEC socket
HV OUTPUT:	20-ft (6 m), permanently attached output cable is terminated with two heavy duty copper spring clips, covered with rubber boots (one red, one black).
POWER lamp:	red pilot light on the panel indicates that the input circuits are working and the high-voltage output should be available.
ON/OFF switch:	3.5 A breaker provides circuit protection and acts as ON/OFF switch.
OUTPUT KILOVOLTS switch:	rotary switch selects the output voltage from 0 to 15 kV in steps of 3 kV and also provides the ZERO START feature.
OUTPUT CURRENT meter:	indicates percentage of the maximum peak output current: 600 A at 15 kV into a short circuit

Section 5

Setup

The following steps serve as a general guide for setting up operation. Before proceeding, read, understand, and observe all safety precautions contained in this manual. Refer to Section 2.

1. Observing all safety precautions, be sure all equipment is de-energized. Identify the faulted cables, obtain access to both ends, and erect barriers.

2. Discharge the cable under test by applying a ground using a safety grounding stick (not supplied). Connect a safety ground jumper (not supplied) from the high-voltage conductor of the cable under test to the specimen ground (the ground conductor of the cable under test).

WARNING

Failure to apply a safety ground jumper to the cable under test prior to system connection can be extremely dangerous.

3. Choose a location that meets the following conditions:
   a. Both the high-voltage conductor and shield of the cable to be tested must be accessible.
   b. An electrical service suitable for the system must be available within 10 ft (3 m) of the chosen location. The service ground wire must be connected to a secure low-resistance ground.
   c. The system must be within 20 ft (6 m) of the terminal of the cable under test.
   d. The test area should be as dry as possible.
   e. There should be no flammable material stored in the vicinity.
   f. There should be adequate ventilation in the test area.
   g. Warning lights or beacons are recommended.

4. Connect the output surge ground (low-voltage return lead of the HV OUTPUT cable, black boot) to the specimen ground (grounded shield of the cable under test).

WARNING

Do not extend the surge ground. Be sure that this connection is made to a secure low-resistance ground (less than 5O), usually the driven ground of the power system located in the vicinity of and connected to the specimen ground.

5. Connect the HV OUTPUT cable high-voltage lead (red boot) to the faulted high-voltage conductor of the cable under test. Be sure that the exposed conductor and clamp are sufficiently insulated to withstand the test voltage.

6. Connect any other conductors of the cable under test to the specimen ground.

7. Be sure that the ON/OFF switch is set to OFF and the OUTPUT KILOVOLTS switch is set to ZERO START.

WARNING

Use only a three-terminal grounded outlet; instrument is grounded through the line cord. Do not use a three-terminal to two-terminal adaptor.

8. Connect the AC INPUT cable to the service outlet.

9. For vehicles having a motor-driven generator:

   a. Make sure that the ground and neutral of the generator are securely tied to the machine frame and the chassis of the vehicle.

   b. Start the engine-generator and allow it to warm up sufficiently to ensure normal stable operation.

   c. Check the engine-generator voltage to ensure proper input voltage for the system.

10. Operation from a portable engine-generator:

The system can be operated from a portable engine-generator when a service line is not available. An engine-generator suitable for sustained operation must be rated at a minimum of 0.5 kVA. It must be equipped with a good governor that responds to load change rapidly but without excessive overshoot. The electrical output should be matched to the rated input voltage, frequency, and power.

   a. Locate the engine-generator in a well-ventilated area less than 10 ft (3 m) from the system.

   b. Store spare fuel in a suitable safety container well away from both the engine-generator and the system.

   c. Be sure that the green neutral wire is bonded to the engine-generator frame. This lead should be no longer than 10 ft (3 m) and should be equivalent to No. 12 AWG or larger.

   d. Start the engine-generator and allow it to warm up sufficiently to ensure normal stable operation.

   e. Check the engine-generator voltage to ensure proper input voltage for the system.

   f. Connect the test system to the motor-generator using the input cord.

WARNING

Do not refuel the engine-generator while it is running.

When these setup procedures have been completed, the test may be conducted in accordance with the procedures given in Section 6.

Section 6

Operation

OPERATING PROCEDURE

Be sure to read and understand Section 2, Safety, before operating.

1. Ensure that the setup procedures detailed in Section 5 have been performed. Remove the safety ground jumper from the cable under test.

2. Set the OUTPUT KILOVOLTS switch to ZERO START.

3. Set the ON/OFF switch to ON; the red POWER pilot lamp lights, and the fan starts.

WARNING

The high-voltage output circuits have now been enabled and high voltage will be present hereafter.

4. Set the OUTPUT KILOVOLTS switch to the first position (3 kV), and observe the OUTPUT CURRENT meter. The Impulse Generator applies a 3 kV pulse every six seconds to the cable under test; a significant deflection (at least 10 percent) observed at these intervals indicates either a sparkover has occurred, or that the cable has a short circuit. No deflection means the cable can withstand 3 kV.

5. If no sparkover occurs at 3 kV, set the OUTPUT KILOVOLTS switch to the next step (6 kV) and repeat. If the cable withstands 6 kV, continue through the other steps of the OUTPUT KILOVOLTS switch until sparkover occurs or the cable has withstood several 15 kV pulses. The highest possible output for the Impulse Generator is 15 kV; if there is no significant indication on the OUTPUT CURRENT meter when 15 kV impulses are applied, the breakdown voltage of the fault is greater than 15 kV.

6. To shut down, refer to "Shutdown Procedure."

INTERPRETING THE OUTPUT CURRENT METER

The most effective device on the Impulse Generator for detecting sparkover is the OUTPUT CURRENT meter, which displays peak fault current. To interpret these readings correctly, it is necessary to understand their meaning:

a. The meter is calibrated to produce full scale (approximately 100 percent) deflection with a 15 kV impulse into a short circuit. The reading is lower than

100 percent with a high resistance or an arcing fault, because the higher impedance of these faults allows less current than a short circuit. Deflection for voltage impulses below 15 kV is also lower than 100 percent as determined by a proportionality law: 3 kV impulses produce a maximum (short circuit) reading of 20 percent, 6 kV impulses produce 40 percent, etc.

b. A slight meter movement is produced with a capacitance as low as 0.1 μF in the cable under test. Since this is the capacitance of the cable, slight meter movements may occur when no fault is present.

Thus, as a general rule of thumb, the operator should ignore any meter deflections less than 10 percent of full scale and interpret the results as a fault only when the deflection is greater than 10 percent of full scale. As with most rules of thumb, ambiguities will occur from time to time, and experience with the instrument will aid interpretation. Increasing the output voltage to the next tap will usually resolve most questions.

SHUTDOWN PROCEDURE

1. When a test is complete, set the OUTPUT KILOVOLTS switch to ZERO START; this disables the high-voltage output. Set the ON/OFF switch to OFF.

2. To disconnect the setup, manually ground the HV OUTPUT cable high-voltage lead with a safety grounding stick and then apply safety ground jumpers.

WARNING

Never assume that the coaxial output cable or the cable under test is completely discharged, even after following the above procedures. Always use a safety grounding stick to ground any conductive part of the circuit and then apply safety ground jumpers before touching any connections.

3. Remove the test clips from the conductor and the shield.

WARNING

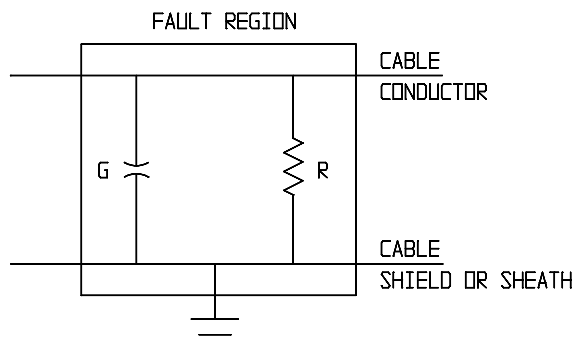
Leave the safety ground jumpers in place to drain any relaxation charge for a period of at least four times as long as the test voltage had been applied.

Section 7

Operation Notes

THEORY

All faults can be represented electrically by a gap shunted by a resistance as shown in Figure 3. Although the electrical circuit shown is simple, variations in the conditions of the two paths can cover an extremely wide range, with the resistance ranging from a dead short to many megohms, and the gap breakdown voltage varying from zero to many thousands of volts.



G = GAP IN THE INSULATION; MAY BE GAS OR LIQUID-FILLED

R = SURFACE RESISTANCE OF THE WALLS OF THE GAP BEFORE BREAK DOWN

Figure 3: Typical Fault Diagram

When the impulse voltage wave reaches the fault, it may dissipate either through the resistance path or by sparking over the gap. In either event, it releases energy in the return path, thereby providing a current that can be detected. If the cable is exposed, faults can usually be located by the sound of the arc discharge or by the flash itself. For more difficult cases where the cable is buried or the sheath is intact, an electromagnetic impulse detector or an acoustic impulse detector may be required. If energy passes through only the resistance path, no spark results and an electromagnetic impulse detector must be used. Even if the resistance of the fault is infinitely high, the fault can be located by the impulse method, provided that the peak value and time duration of the voltage wave are sufficient to cause sparkover. It is for this reason that the impulse method is so generally applicable.

Basically, sparkover is determined by three factors: the nature of the fault, the capacitance of cable, and the capacitance of the Impulse Generator. If the capacitance of the Impulse Generator is equal to or smaller than that of the cable to which the generator is connected, the fault may not break down on every closure of the impulse switch. This is a result of the voltage division between the cable and the Impulse Generator. The frequency of breakdown can be increased by increasing the applied voltage, but at the risk of applying overvoltage to the cable.

Information provided in this section is intended only as a guide for cable fault locating, not a complete study of the subject.

IMPULSE TESTING

The output voltage is slowly raised, in steps, to the test level without exceeding the recommended proof test rating of the cable. Once breakdown is achieved, the OUTPUT CURRENT meter momentarily deflects with each impulse. This means that there is an energy transfer with each impulse from the generator to the cable.

If the output voltage is held constant and the cable fault is not breaking down, the OUTPUT CURRENT meter does not move. This means the cable momentarily charges to the applied output voltage of the generator. Continue to increase the output voltage until it is high enough to cause the cable fault to break down. When this occurs the OUTPUT CURRENT meter momentarily deflects with each impulse. To ensure that the fault breakdown occurs with each impulse, the output voltage should be raised above the fault breakdown level. For some installations the available 15 kV impulse may be excessive. When such a limit exists, the operator is cautioned not to exceed the specified voltage limit.

OPERATION WITH AN ELECTROMAGNETIC IMPULSE DETECTOR

A common cable construction is three conductors bundled in a lead sheath and installed in a conduit or duct. In such a construction, a sheath ground bond is usually present at every manhole. For testing cables of this type, an electromagnetic impulse detector is very effective. Because the conductors are not concentric with respect to the sheath, an external magnetic field exists around the cable and the electromagnetic impulse detector may respond to this field or to the magnetic field due to current in the bonds.

When using an electromagnetic impulse detector, it is suggested that the pickup coil be applied to the cable at a point close to the system prior to patrolling the cable. The pickup should be applied to sense the current in the shield extension or at the first bond. This will confirm an established signal and check the detector prior to the test.

PROOF TESTING CABLE

After a cable fault is repaired, the Impulse Generator can be used to proof test the repair. Begin the test with the OUTPUT KILOVOLTS switch set to ZERO START, then advance to the output level at which sparkover occurred. Advance the OUTPUT KILOVOLTS switch one step at a time until the cable withstands several 15 kV impulses. The fault may then be considered repaired and proof tested.

Section 8

Service

MAINTENANCE

The Impulse Generator is constructed to withstand use normally encountered in field testing for public utilities and industrial plants. To maintain this equipment in proper condition, a planned program of routine maintenance should be carried out every six months.

WARNING

This is a high-voltage system which can produce and contain dangerous voltages. Any service or repair of this equipment should be performed only by qualified persons who are aware of high-voltage hazards and the necessary precautions routinely taken to prevent injury.

Before any inspection, service, or repair, the system must be completely disconnected from the power supply and from any cable under test. Set the OUTPUT KILOVOLTS switch to ZERO START. The OUTPUT KILOVOLTS switch must remain set to ZERO START for at least 15 minutes before access is gained to the interior of the chassis.

WARNING

When it is necessary to touch the terminals of any of the capacitors, all terminals of the capacitor should be grounded using a safety grounding stick and then bonded together with safety ground jumpers, before any connections are removed from the capacitor.

If company policy requires that a defect report be provided to those performing maintenance, this report should be consulted and the items noted on the report investigated at the appropriate point in the maintenance procedure.

Maintenance Procedure

1. Examine all cables to locate any loose or damaged terminals.

2. Inspect and clean the outer jacket of the HV OUTPUT cable; check for breaks in this jacket. As a temporary repair, and only if the shield is intact, apply at least four layers of vinyl tape over any such damage. Replace the damaged output cable as soon as practical.

WARNING

If the HV OUTPUT cable is not properly maintained, unexpected high voltages may be accessible to operating personnel.

3. Check all controls to be sure that they operate freely.
4. Wipe the entire case clean and check for damage.
5. Check the top panel for any damage to meters, switches, lamps, etc.

WARNING

The impulse capacitor may be charged to a lethal voltage. This capacitor should be discharged using a safety grounding stick before attempting repairs.

6. Clear a bench top work area, and remove the Impulse Generator electronics from its carrying case. This is done as follows:
   a. Remove the six screws holding the front panel into the case.
   b. Carefully remove the front panel and electronics from the case, and place it on the bench. The best position is with the front panel vertical and the unit resting on the two transformers and the bank of capacitors.
7. Apply a safety ground jumper across the terminals of the impulse capacitor.
8. Check that all screws and nuts are tight.
9. Examine all electrical connections for evidence of corrosion, fracture, or burning.
10. Clean all bushings and electrical insulating supports with a clean, soft cloth. Do not use solvents. Clean, low-pressure air may be used.
11. Inspect all resistor banks for burned sections or loose end bonds. Check the capacitors for leaks or evidence of case swelling.
12. When work on the Impulse Generator has been completed, replace the electronics in the carrying case, then run the Impulse Generator in accordance with the following Performance Check procedure.

PERFORMANCE CHECK

To verify that the Impulse Generator is operating properly, perform the following performance check. This procedure may be performed either in the shop after performing routine maintenance or in the field before fault locating. Fault characteristics can vary widely and in some cases can even temporarily clear themselves. The performance check can verify the proper performance of the Impulse Generator so that the fault can be isolated. Be sure to read and understand Section 2, Safety, before operating the Impulse Generator.

1. Choose a safe test site as described in Section 5.
2. Connect the low-voltage lead (black boot) of the HV OUTPUT cable to a secure low-resistance ground.
3. Connect the high-voltage lead (red boot) of the HV OUTPUT cable to the same ground as the output low-voltage lead.
4. Plug the AC INPUT cable into a standard 120/240 V ac socket. Set the OUTPUT KILOVOLTS switch to ZERO START, and turn on the circuit breaker. The fan starts and the POWER lamp lights.

WARNING

The high-voltage output circuits have now been enabled and high voltage will be present hereafter.

5. Set the OUTPUT KILOVOLTS switch to 15 kV, one step at a time. Note that the following OUTPUT CURRENT meter deflections occur every six seconds at each output position:

3 kV	20%	
6 kV	40%	
9 kV	60%	(percentages are approximate)
12 kV	80%	
15 kV	100%	

6. Return the OUTPUT KILOVOLTS switch to ZERO START, and set the ON/OFF switch to OFF.

TROUBLESHOOTING AND REPAIR

The Impulse Generator is designed for reliability and should give years of trouble-free operation. If a malfunction occurs, Megger maintains a complete repair service and recommends its customers take advantage of this service. However, the problem can often be located with a few simple checks made by a technician using only a VOM multimeter. Repairs may be made in the field using components available from Megger. Refer to Section 9, Replaceable Parts List.

If the Impulse Generator fails to operate properly, the following troubleshooting guide will be useful in determining the cause of the malfunction. It notes possible equipment malfunctions as observed during operation or checkout and suggests the possible cause and the means of identifying the defective component. See Figure 2 for help in locating and identifying the components. Special equipment required for servicing the system is identified where applicable. Refer to Section 2, Safety.

WARNING

This is high-voltage equipment and may contain dangerous voltages. Repairs must only be made by qualified personnel who are familiar with such hazards and the routine precautions required to prevent injury.

Before any service is attempted, the input and output must be completely disconnected and the OUTPUT KILOVOLTS switch must be set to ZERO START for at least 15 minutes. Any trouble reports should be reviewed. The troubleshooting guide does not suggest wiring or hardware defects as possible causes because these must be considered in every case and are not specific to this system.

1. Choose a safe test site as described in Section 5.

2. Connect the low-voltage lead (black boot) of the HV OUTPUT cable to a secure low-resistance ground.

3. Connect the high-voltage lead (red boot) of the HV OUTPUT cable to the same ground as the output low-voltage lead.

4. Isolate the fault to a major region of the circuit using the fan, POWER lamp, and OUTPUT CURRENT meter. Once this is done, systematically check test points in that region to determine the problem area, then locate and replace faulty components.

5. Plug the AC INPUT cable into a 120/240 V ac outlet, and set the OUTPUT KILOVOLTS switch to ZERO START. Make sure the HV OUTPUT cable is shorted. Set the ON/OFF switch to ON. Set the OUTPUT KILOVOLTS switch to 3 kV and check for the following symptoms, then proceed as indicated:

SYMPTOM	POSSIBLE CAUSE
Fan and POWER lamp do not come on and meter does not indicate current.	Unit is not receiving proper line voltage input. Check line socket. Check breaker CB1 and Filter FL1.
Fan does not come on, but POWER lamp is lit and/or meter indicates output.	Fan is bad, or it is not receiving voltage input.
POWER lamp does not light, but meter indicates current.	Light bulb is bad, or socket is not receiving voltage input.
Fan comes on but POWER lamp does not, and meter does not indicate current.	Input circuit malfunction. Check test points on next page.
Fan and POWER lamp come on, but no meter indication.	Fault meter, or malfunction in charging, firing, or output circuits. Check test points on next page.

If disassembly of the Impulse Generator is indicated, clear a bench top work area, and follow the procedure described in the Maintenance Procedure for removal of the electronics from the carrying case.

WARNING

In the following procedures, lethal voltages will be present at various points. Before touching any component in the Impulse Generator, remove power from the equipment, set the OUTPUT KILOVOLTS switch to ZERO START, use a safety grounding stick, and apply safety ground jumpers.

Input Circuit Test Points

1. Set the OUTPUT KILOVOLTS switch to ZERO START, and set ON/OFF switch to ON. If red POWER lamp does not light, check bulb and make sure socket is receiving proper voltage. If not, check contact S2B on the rotary output switch, and check transformer T1.

2. If the red POWER lamp lights with the OUTPUT KILOVOLTS switch set to ZERO START, turn to 3 kV. If the lamp goes out, check:
   a. Thermal switch SW3 is closed. (Fan failure could cause SW3 to open.)
   b. Relay K1 is operating properly.

Charging, Firing, and Output Circuit Test Points

1. Check connections to meter M1, and check the meter movement.

2. Check test points TP1 and TP2 for +28 V dc (unregulated) and +15 V dc (regulated) to ground, respectively. This checks the power supplies for the timing and firing circuits.

3. Connect the VOM across C5; use the lowest dc range. Every six seconds a meter deflection should occur, indicating that the initial part of the firing circuit is operating properly.

4. Connect the VOM across C8; use a range of at least 100 V dc. Turn the OUTPUT KILOVOLTS switch to 3 kV. The meter should read about 90 V, then drop back towards zero every six seconds. Return the OUTPUT KILOVOLTS switch to ZERO START. This checks the firing circuit for the main SCR switch in the high-voltage section.

5. Connect the VOM between circuit board terminal #1 and ground; use a range of at least 1000 V dc. Set the OUTPUT KILOVOLTS selector switch to 3 kV; the VOM should read approximately 200 V dc. Set the switch to the other output settings; the meter reading should increase by approximately 200 V dc at every step, up to approximately 900 V dc at 15 kV. Return the OUTPUT KILOVOLTS switch to ZERO START. This checks the dc supply to the high-voltage section.

6. Connect the VOM between TP5 (the top plate of Q7) and ground; use a range of at least 200 V dc. Set the OUTPUT KILOVOLTS switch to 3 kV. The meter should read approximately 170 V dc, then drop back towards zero every six seconds. Return the OUTPUT KILOVOLTS switch to ZERO START. A failure at this point is probably due to SCR Q7, resistor R19, or transformer T3; check for shorts and open circuits. The problem might also be in the capacitor bank C7; check for damaged components and replace as necessary.

7. Check the secondary of pulse transformer T3 for an open circuit or a short. Check current transformer T4, and check the circuitry feeding the meter.

Section 9

Replaceable Parts List

The following lists all the parts that may need replacement during the life of the Impulse Generator. They are normally available from Megger. The Schematic Designation column refers to Figure 2.

SCHEMATIC DESIGNATION	DESCRIPTION	Megger PART NO.
	Case Modified	15083
	Bracket	15080
B1	Fan	9741
	Hanger	15084
	Cord	9741-4
L1	Choke Assembly	15092
K1	Relay	3623
DS1	Light	15099
	Bulb	3612-3
CR15	Varistor	3384-1
CB1	Circuit Breaker	6807-7
M1	Meter	12805-1
S2 (A,B,C)	Switch	15093
	Knob	4690-20
P1	Input Cable	4127
T3	Pulse Transformer	15090
T1	Power Transformer	15089
	Output Cable Assembly	15104
R19,20,21	Resistor Assembly	15059
Q7	Rectifier Assembly	15073
	PC Board Assembly	15060
C7	Capacitor Assembly	15107
T4	Current Transformer	15106

GLOSSARY

	High-voltage warning
	Use only in accordance with Instruction Manual.
ground bond	A short, low-resistance conductor used to connect a point in a circuit to ground.
NEC	National Electrical Code
safety ground jumper	Temporary connection (not supplied) made between the high-voltage conductor of the cable under test to specimen ground.
safety grounding stick	An insulated stick (sometimes called a hot stick) with a hook type electrode connected to ground via an insulated cable. In some designs, frequently known as high-voltage discharge sticks, a resistor is connected between the electrode and the ground cable. Both are used to discharge capacitive specimens to ground. They must be suitably rated for the voltage and capacitance of the specimen to be discharged.
specimen ground	Ground conductor (sheath) of the cable under test. Assumed to be connected to the driven ground of the power system.
surge ground	The shield of the coaxial high-voltage output cable, this ground is connected to specimen ground before each test.
sparkover	A disruptive discharge in the form of an arc or spark between two electrical conductors or between a conductor and earth (also called arc-over or flashover).

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. This warranty does not include batteries, lamps, or similar 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.

APPENDIX

BRIEF OPERATING INSTRUCTIONS

These procedures are not intended to replace the Instruction Manual. Read and understand the entire manual before operating this instrument.

1. Follow all safety and operating procedures in Instruction Manual.
2. Ensure that cable under test is de-energized. Use safety grounding stick to discharge cable. Ground cable using a safety ground jumper.
3. Connect HV OUTPUT cable to cable under test — red boot to conductor, black boot to shield, sheath, or ground wire.
4. Remove safety ground jumper from cable under test.
5. Set ON/OFF switch to OFF and OUTPUT KILOVOLTS switch to ZERO START.

WARNING

Use only a three-terminal grounded outlet; instrument is grounded through the line cord. Do not use a three-terminal to two-terminal adaptor.

6. Plug in Impulse Generator and set ON/OFF switch to ON. Red POWER lamp will light.
7. Set OUTPUT KILOVOLTS switch to desired test voltage. Fault is located by patrolling length of cable and listening for sparkover.
8. To shut down, set OUTPUT KILOVOLTS switch to ZERO START and ON/OFF switch to OFF.
9. Use safety grounding stick to discharge cable. Ground cable using a safety ground jumper. Disconnect HV OUTPUT cable.