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The D.C. Scout

D.C. BATTERY DISTRIBUTION SYSTEM GROUND LOCATOR

When minutes matter—

Operations Manual

(Available Online)

To order parts or for assistance, call or email:

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THE D.C. SCOUT

D.C. Battery Distribution System Ground Locator

OPERATION MANUAL

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Illustrations

I. Description

The D.C. Scout is used for locating resistive or non-resistive current paths from D.C. battery distribution systems to building ground, without de-energizing components or loads in the system. The D.C. Scout has been engineered to withstand the rigors of a hostile environment and to provide a long service life. The instrument consists of two basic functional parts, which are:

A) The Pulser Unit, used to pulsate current through the D.C. battery – D.C. Scout – Building ground loop; and

B) The Pulse Detector Unit, used to detect pulses generated by the Pulser Unit in the D.C. battery – D.C. Scout -- building ground loop.

The D.C. Scout is shipped as a complete unit and includes the Pulser Unit, the Pulse Detector Unit, Pulse Detector Current Transformer Probe, External Pulse Indicator Lamp, spare fuses, operation manual, and Carrying case.

II. Operational Overview

Figure 1a, below, shows an isolated D.C. battery supplying current to a load through wires. If, for whatever reason, one of the wires became connected to the building ground, the D.C. Scout can locate the point where this connection has occurred.

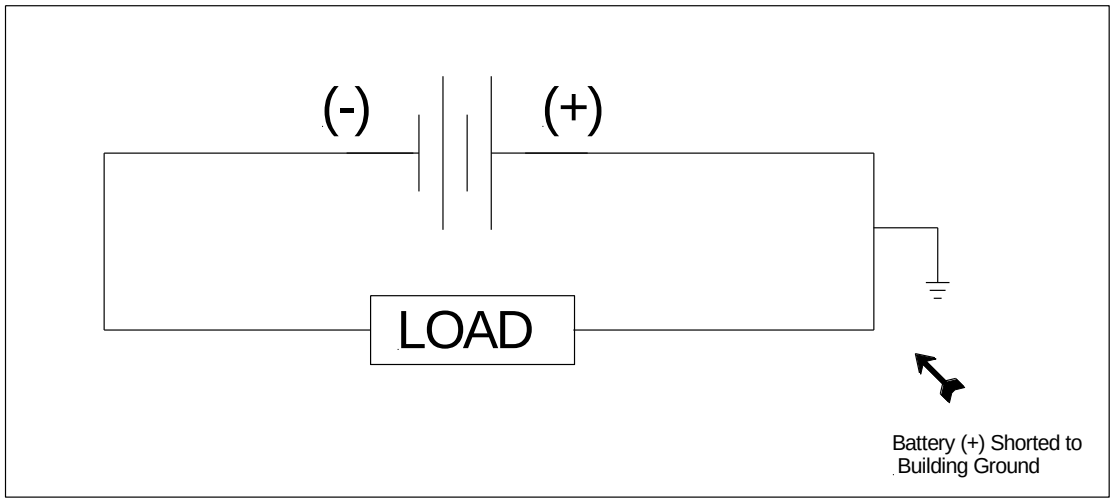

Figure 1a*: D.C. System with a Ground Fault*

If the D.C. Scout is connected as shown in Fig. 1b, below, then a close circuit is established. This closed circuit current flows from the plus (+) battery pole, through the wire shorted to building ground, through the D.C. Scout building ground lead, then back through the D.C. Scout +/- battery lead to the negative battery post. Note that the ground detection system battery is the source of the current flow. The scout does not contribute any current.

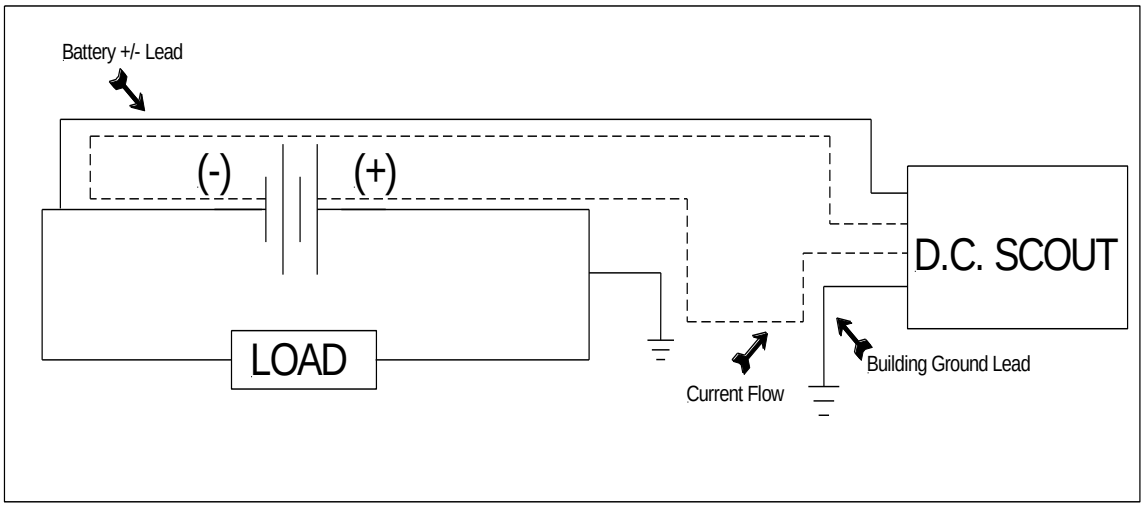

Figure 1b ***Basic Operation: Pulser Connections***

The D.C. Scout repeatedly opens and closes (pulses) this closed circuit's current flow. The D.C. Scout detector Unit can then detect and show these pulses on the Detector Unit Meter when the Pulse Detector Current Transformer Probe is clipped over a wire in the current path.

Figure 2 shows if the Detector Probe is clipped over the current path at points A and B, pulses will be detected and shown on the Detector Meter. If the Detector Probe is clipped over the wire at point C, no pulses will be detected since point C is not in the D.C. Scout closed circuit current path. This systematic approach of noting where pulses have been detected, then moving down the wire to where pulses are ***not*** detected, pinpoints the ground fault location.

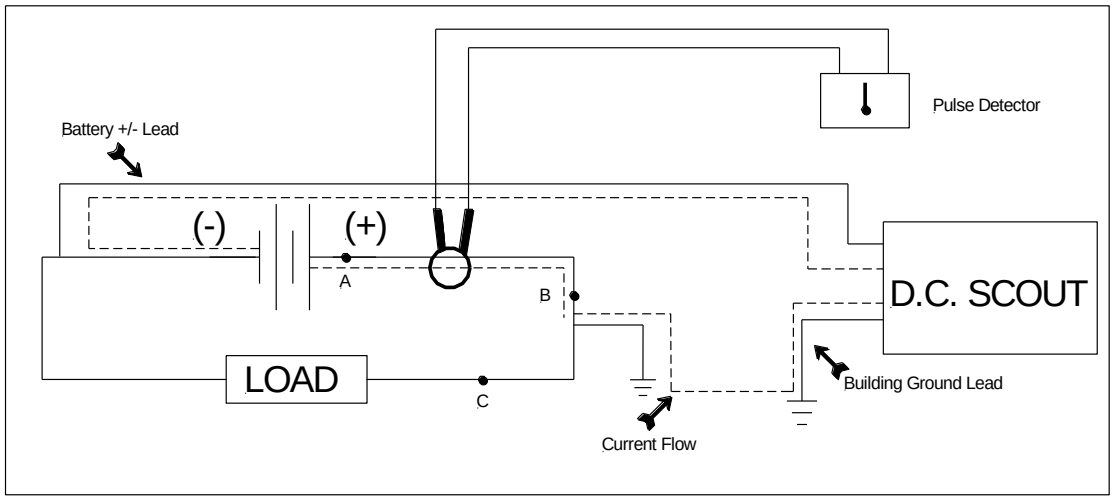

Figure 2 ***Basic Operation: Detector Probe Connections***

III. "Real World" Operation

Nuclear power plants are prime examples of industrial use of D.C. battery distribution systems. Most of these systems have ground detector circuits to indicate a positive (+) or negative (-) ground, but these circuits will not tell where the ground is located so that it can be isolated and cleared. A ground can be very difficult, in complex systems, to isolate. De-energizing various pieces of equipment can case or inhibit a plant shutdown.

Figure 3 describes one typical D.C. System used. This system has both a positive (+) and negative (-) ground detector light and shows a solid "zero" resistance positive ground at load "X." NOTE: In Figure 3 meters, relays, etc., may be used in place of or with the ground indicating lights, but lights are shown here for simplicity.

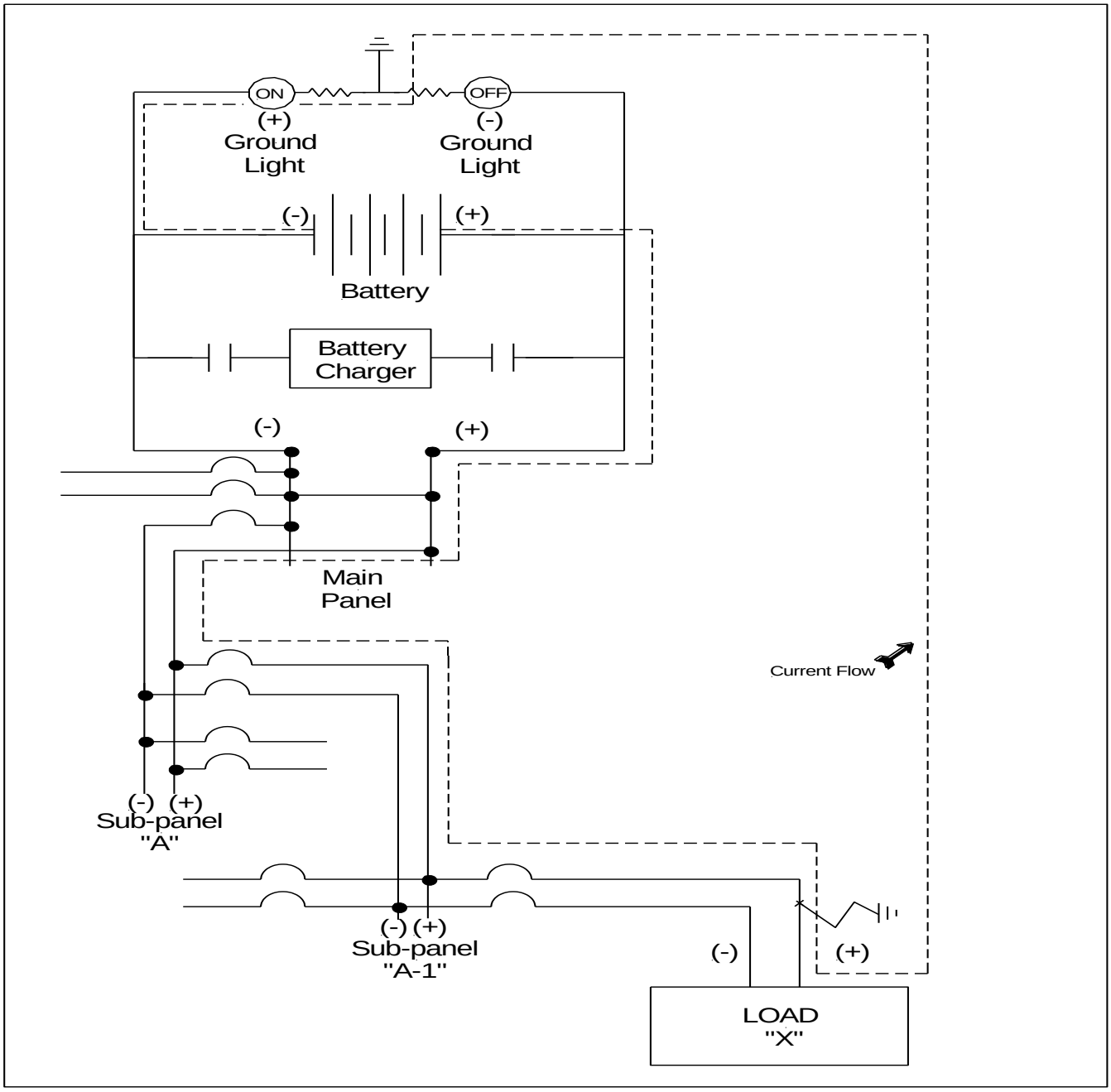

Figure 3: ***Typical D.C. Battery Ground Detection Circuit***

With no D.C. ground in the Figure 3 circuit, both lights will have one-half of the battery voltage across them and thus will display equal brightness. With a positive ground (see load "X"), the negative (-) ground light is shorted out (zero voltage across it), and the positive (+) light burns bright (full voltage across it), thus indicating a positive ground. The reverse is true for a negative ground. The dashed line indicates ground current flow with a positive ground.

Next, we need to follow this ground path between the battery (+) terminal and out into the field, in this case, to load "X." We do this by establishing an additional pulsating ground current that will flow along with the existing ground current between battery (+) and the load "X" ground point. This will be done as shown in Figure 4.

The D.C. Scout Pulser Unit is connected as shown, the red "Battery +/-" lead to the negative buss at the main panel and the black "Bldg. Ground" lead to the building ground. In essence, the Pulser Unit is connected in parallel with the (+) ground light. It will have full battery voltage across it for a resistive ground. This pulsating current will flow as the dashed line shows in Figure 4. The pulse amplitude will be set for a minimum of 5mA to a maximum of 200mA D.C.

In order to follow this pulsating ground current path between the main panel (+) buss and the (+) positive ground in the field, we use the D.C. Scout Pulse Detector Unit, which is fed a signal from the clamp-on Pulse Detector Current Transformer Probe. The following procedure is a guide to setting up the equipment and locating the ground.

A. Connecting the D.C. Scout Pulser Unit.

1) Identify the D.C. system with the ground, the system voltage (24, 48, 125, or 250 volts DC), and if the ground is a positive or a negative one. This will be indicated by your system's lights, meters, relays, or other indicating devices.

2) Determine if the ground is a solid short (zero resistance to ground) or has resistance to ground. **Note**: A resistive ground will show up on both positive and negative indicators, but one will show more strongly than the other.

3) Set the controls on the Pulser Unit as follows:

   a) Set Switch "A" OFF

   b) Set Switch "B" OFF

   c) Set Meter Switch "C" to (-) for a negative ground or to (+) for a positive ground.

   d) Set 5 K / 55 K Switch to 55 K position.

   e) Set 30mA / 300mA switch 300mA position.

   f) Set the "Pulse Amplitude Adjust" control to the minimum current position.

   g) Set "Pulser ON/OFF" Switch to OFF.

   h) Plug in the D.C. Switch Pulser Unit 120 VAC power cord.

CAUTION!

Before proceeding with step 4, we recommend the use of safety glasses, face shield, and rubber gloves for your protection.

4) Connect the D.C. Scout Pulser Unit as shown in Figure 4 for a (+) ground. Connect the Pulser Unit's leads in the following sequence.

   a) Connect the black "BLDG. GROUND" lead to the building ground wire.

   b) Connect the red "BATT. +/-" lead to the (-) D.C. buss for a positive ground. Connect the lead as close as possible to the incoming feeder buss on the main distribution panel.

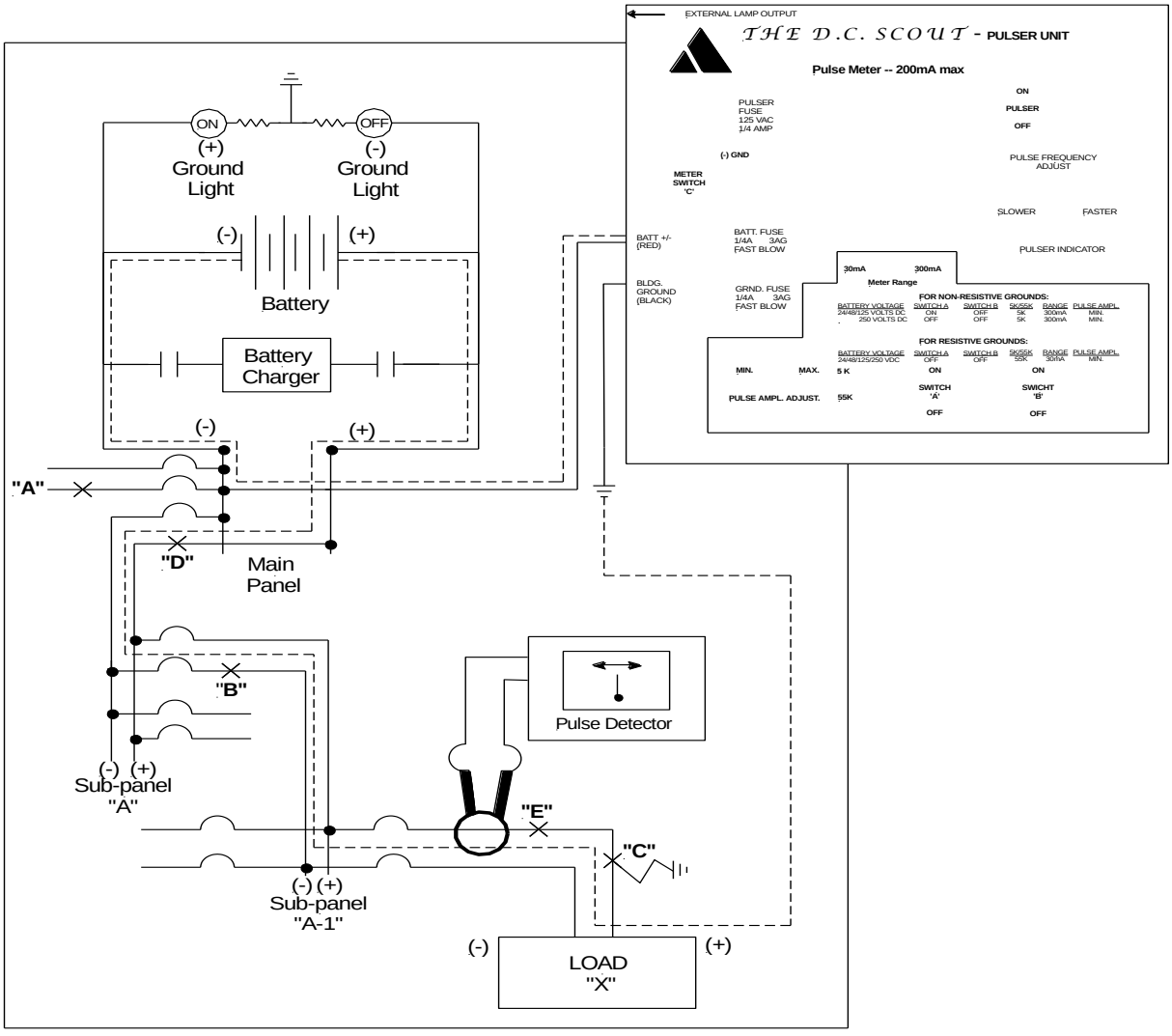

Figure 4: ***D.C. Scout Connection to D.C. System with Positive Ground***

CAUTION!

Before proceeding with step 5, we recommend the use of safety glasses, face shield, and rubber gloves for your protection.

5) Connect the D.C. Scout Pulser Unit as shown in Figure 5 for a (-) ground. Connect the Pulser Unit's leads in the following sequence.

a) Connect the black "BLDG. GROUND" lead to the building ground wire.

b) Connect the red "BATT. +/-" lead to the (+) D.C. buss for a negative ground. Connect the lead as close as possible to the incoming feeder buss on the main distribution panel.

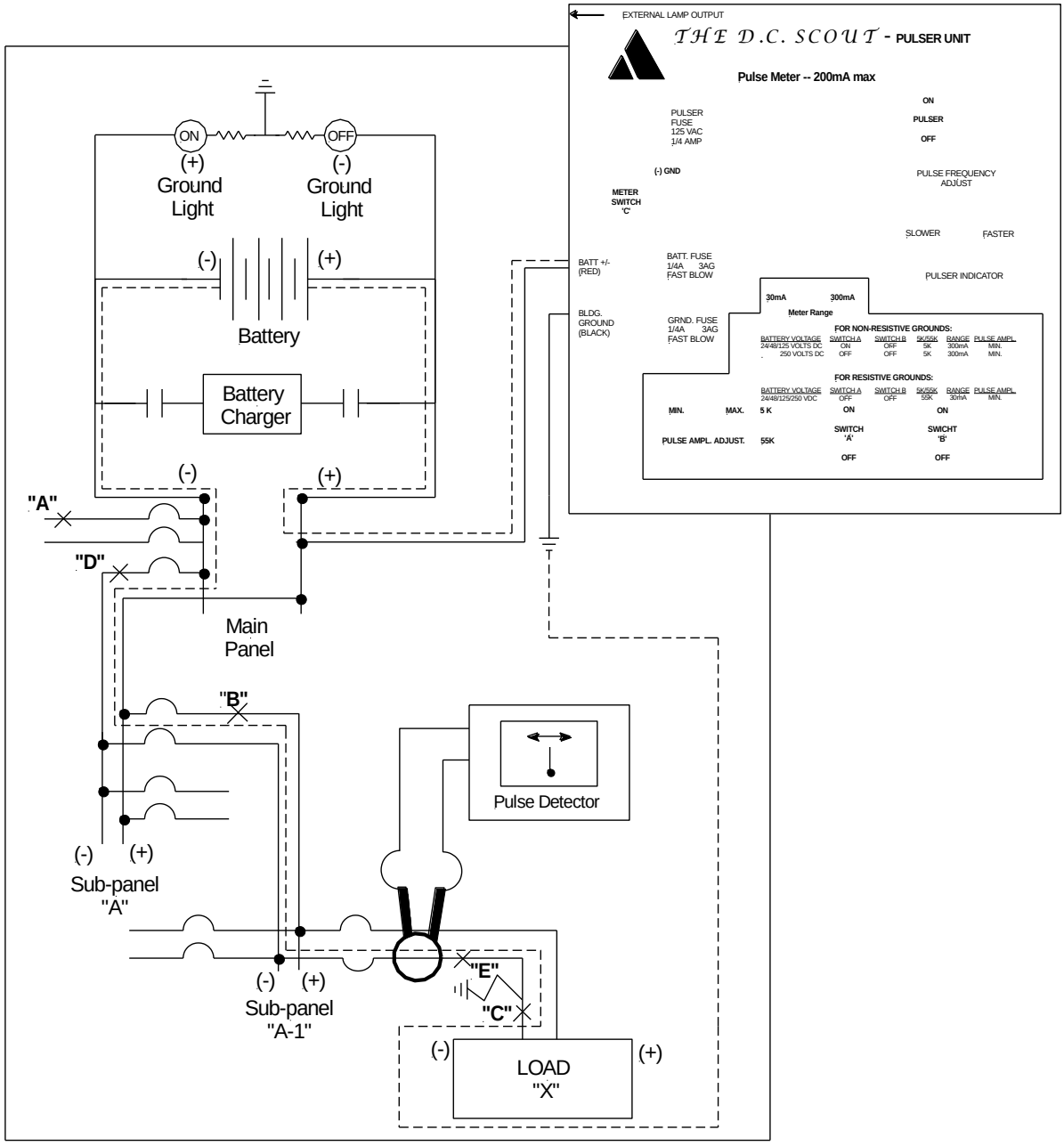

Figure 5: ***D.C. Scout Connection to D.C. System with Negative Ground***

B. Adjusting the D.C. Scout Pulser Unit

CAUTION!!

Under no circumstances should a fuse rating of more than 250mA be installed in the "BATT FUSE" or "GRND FUSE" fuse holders.

The D.C. Scout Pulser Unit has two in-line fuses to insure protection of the D.C. Scout and the system it is analyzing. If more sensitive protection is desired, a lower amperage quick-blow fuse may be substituted. This, of course, depending on the fuse size, would limit the output capacity of the D.C. Scout.

1) **24, 48, 125 Volt** D.C. System with solid ground

   a) Set Switch "A" ON (closed)
   b) Set Switch "B" OFF
   c) Set 5 K / 55 K Switch to 5 K position.
   d) Using the "Pulse Amplitude Adjust" control, the following current amplitudes are available for pulse detection:

      24 volt system – 4mA minimum to 40mA maximum
      48 volt system – 8mA minimum to 80mA maximum
      125 volt system –20mA minimum to 200mA maximum

2) **250 Volt** D.C. System with solid ground

   a) Set Switch "A" OFF
   b) Set Switch "B" OFF
   c) Set 5 K / 55 K Switch to 5 K Position
   d) Using the "Pulse Amplitude Adjust" control, the following current amplitudes are available for pulse detection:

      250 volt system –40mA minimum to 200mA maximum

3) **24, 48, 125, or 250 Volt** D.C. System with resistive ground

   a) Set Switch "A" OFF
   b) Set Switch "B" OFF
   c) Set 5 K / 55 K Switch to 55 K position.
   d) Set Pulse Meter Switch to 30mA position.

CAUTION!!

With a resistive ground, we suggest starting with a minimum detectable current of 4 to 5mA, even though a higher pulse current may be attainable. Please refer to section A, Usage Tips (page 11) before proceeding.

   e) Adjust the "Pulse Amplitude Adjust" control from Min. to Max. to see if the Pulse Meter will register a minimum detectable current of 4 to 5mA. If that much current cannot be obtained, then return the "Pulse Amplitude adjust: control to Min. and set both switches "A" and "B" to the "ON" position. **CAREFULLY** adjust the "PULSE AMPLITUDE ADJUST" control from Min. toward Max to get the 4 to 5mA of Pulse meter current.

NOTE: Care must be taken when performing this step. With both switches "A" and "B" ON, there are no current limiting resistors in the circuit and it is possible to quickly blow the D.C. Scout Pulser Unit's "BATT FUSE" or "GRND FUSE."

IMPORTANT

In some cases the D.C. Scout Pulser Unit Pulse Meter will not register the minimum detectable ground current 4 to 5mA, as with a highly resistive ground. For this reason, H.J. Arnett Industries L.L.C. specifies the D.C. Scout's effective use only for ground currents that generate 4 to 5mA or more on the Pulser Unit Pulse Meter. In order to generate 5mA or more of ground current, a 125 VDC system should have a ground resistance of 25 K ohms or less. Likewise, a 250 VDC system should have a ground resistance of 50 K ohms or less.

C. Setting the D.C. Scout Pulse Detector Unit

1) Plug the Pulse Detector Unit Current Transformer Probe into the banana jacks on the back of the Pulse Detector Unit.

2) Turn on the Pulse Detector Unit by pulling out the Balance control knob. Adjust this balance control until the meter needle is centered on the meter.

3) Do a battery check by pressing the red button on the back of the unit. The meter needle should deflect to the "Battery O.K." position on the meter face. If this does not occur, replace the 9-volt battery inside the Detector Unit.

4) Clamp the Probe around the red "Battery +/-"lead of the Pulser Unit.

5) Turn on the Pulser Unit ON-PULSER-OFF Switch. Adjust the "Pulse Frequency Adjust" control for the desired pulse rate – the slowest rate is a good place to start. Refer to section B of Usage Tips (page 11) for more information on pulse rates.

6) The Pulse Detector Unit meter needle should now be deflecting right then left of meter center for each Pulser Unit pulse. If the meter needle deflects to the left on each pulse, then reverse the clamp on direction of the Detector Unit Probe.

   Adjust the sensitivity knob; on the back of the Pulse Detector Unit, for a wide deflection both ways from zero center on meter scale. Note that as the sensitivity knob is adjusted, the balance knob may have to be re-adjusted to make the meter needle come back to zero (center) after each pulse.

D. Locating a D.C. System Ground

1) The D.C. Scout package includes an External Pulse Indicator Lamp. This lamp is handy for seeing when each pulse from the Pulser Unit occurs, even though the user may be 40 yards or more away from the Pulser Unit.

   Plug the External Pulser Lamp jack into the Pulser Unit External Lamp Output plug. The lamp box has a Velcro backing on it. The mating Velcro piece is in the lid of the D.C. Scout carrying case. Press the two Velcro pieces together to mount the lamp. (After each use; remove and place the lamp in the accessory tray.)

2) The dashed line in Figures 4 and 5 represents the pulsed ground current path. If the Pulse Detector Probe is placed around a wire that is in this ground current path, the Pulse Detector meter will indicate a pulse at the frequency the Pulser Unit is pulsing. Looking at Figures 4 and 5, points "A", "B", and "C" will not have any pulses, but points "D" and "E" will have pulses.

3) Expose the load wire in the distribution panels, using caution to avoid tripping any circuit breakers or disconnecting switches.

4) Clamp the Detector Probe around each load wire and note the wire or wires, which have pulses that coincide with the generated pulses. Determine the locations of the panels or devices these circuits feed. Continue to follow the pulses until the grounded device or wire is found. ***BE SYSTEMATIC AND USE YOUR PRINTS.***

Note: At times there can be difficulty discerning between the desired pulses on the Pulse Detector Meter and random spikes or pulses (noise). Section B of Usage Tips (below) shows methods to effectively deal with this "noise".

IV. Usage Tips

A. Resistive Ground Considerations

The resistance of a ground can be caused by wire insulation, terminals, electrical/electronic device breakdown, or a combination of all these. A resistive ground could also be due to a good relay in series with a solid (zero resistance) ground.

It is possible for the current generated by the ground detector circuit, in combination with the current flowing through the D.C. Scout, to flow through a device and create a voltage drop large enough to cause activation. Devices of particular concern are high impedance HFA relays.

In order to minimize the occurrence of activation, two precautionary steps can be taken. The first is to remove the D.C. ground detection current by temporarily disabling the ground detection system. The second is to start with a minimum detectable D.C. Scout current of 4 to 5mA. This 5mA is well below the current required to activate the "worst case" relays we have seen.

In order to detect 4 to 5mA D.C. Scout pulses, the sensitivity on the Pulse Detector Unit must be turned to maximum. If this increased sensitivity causes the pulse detector to detect random spikes or noise on the D.C. System, then refer to section B that follows.

B. Getting Through Noise

The following methods can be used to eliminate or reduce the effect noise has on the Pulse Detector Unit.

1) For those pulses/spikes, which are circulating from (-) to (+) in the circuit, clamp the D.C. Scout's Pulse Detector Probe around both (-) and (+) wires at the same time. The circulating pulses will cancel out and you should see only the D.C. Scout's pulse, which is not circulating on both the (+) and (-) wires.

2) For those pulses/spikes that are radiating down a wire and are not circulating, move down the wire, if possible, to get away from noisy systems such as choppers, and inverters. It may be necessary to decreases the sensitivity of the Pulse Detector and increase the amplitude of the D.C. Scout's pulse in order to override the remaining interference.

3) The "Pulse Frequency Adjust" control on the D.C. Scout Pulser Unit can be adjusted so that the frequency of the Scout's pulses stand out from the existing noise.

C. Pulse Detector Sensitivity Settings

The following chart shows the minimum D.C. Scout pulsing current required for the given Pulse Detector sensitivity setting.

Pulse Detector Sensitivity Setting in % Rotation	Minimum Pulsing Current Required, mA DC
0	150
10	75
25	40
50	20
75	10
100	5

Note that as the Pulse Detector sensitivity is increased this also increases the chance of detecting random spikes/pulses (noise). Section B, above, suggests methods to effectively deal with "noise."

V. Additional Applications

A. Locating A.C. Grounds

The D.C. Scout can be used to locate grounds on A.C. system up to 480 volts, *provided the following conditions are met.*

1) The A.C. circuit must be totally de-energized and disconnected from its source. This means all phase leads and the neutral lead, if used.

2) A 130 Volt D.C power supply must be available that is capable of supplying 200mA of current. This D.C. voltage must be isolated from ground. This means that the (+) and (-) leads each read zero (0) volts to ground when energized.

3) The above D.C. supply will be connected in series with the D.C Scout to supply the current for pulsing. The D.C. Scout will control the current amplitude and generate the pulses for detection.

4) Procedure for locating A.C. Grounds – refer to Figure 6 below, and follow these steps:

   a) Connect one lead of the D.C. power supply to the grounded conductor at the point of disconnection.

   b) Connect the other D.C. power supply lead to one of the Pulser Unit leads of the D.C. Scout.

   c) Connect the remaining Scout Pulser Unit lead to the building ground.

   d) Set Pulser Unit switches "A" and "B" to OFF, 30mA / 300mA switch to 300 mA 5 K / 55 K switch to 55 K, Pulser ON/OFF switch to OFF, and "Pulse Amplitude Adjust" to minimum.

   e) Plug in the A.C. power cords for the D.C. power supply and the D.C. Scout Flip the D.C. power supply ON / OFF switch ON and the Pulser Unit ON / OFF switch ON.

f) Increase the current flowing through the Scout by adjusting "Pulse Amplitude Adjust" and / or by flipping switches "A" or "B" or both ON. Do this until you can see a discernable pulse on the Pulse Detector Meter.

g) Proceed as you would for locating a D.C. ground fault until the fault is found.

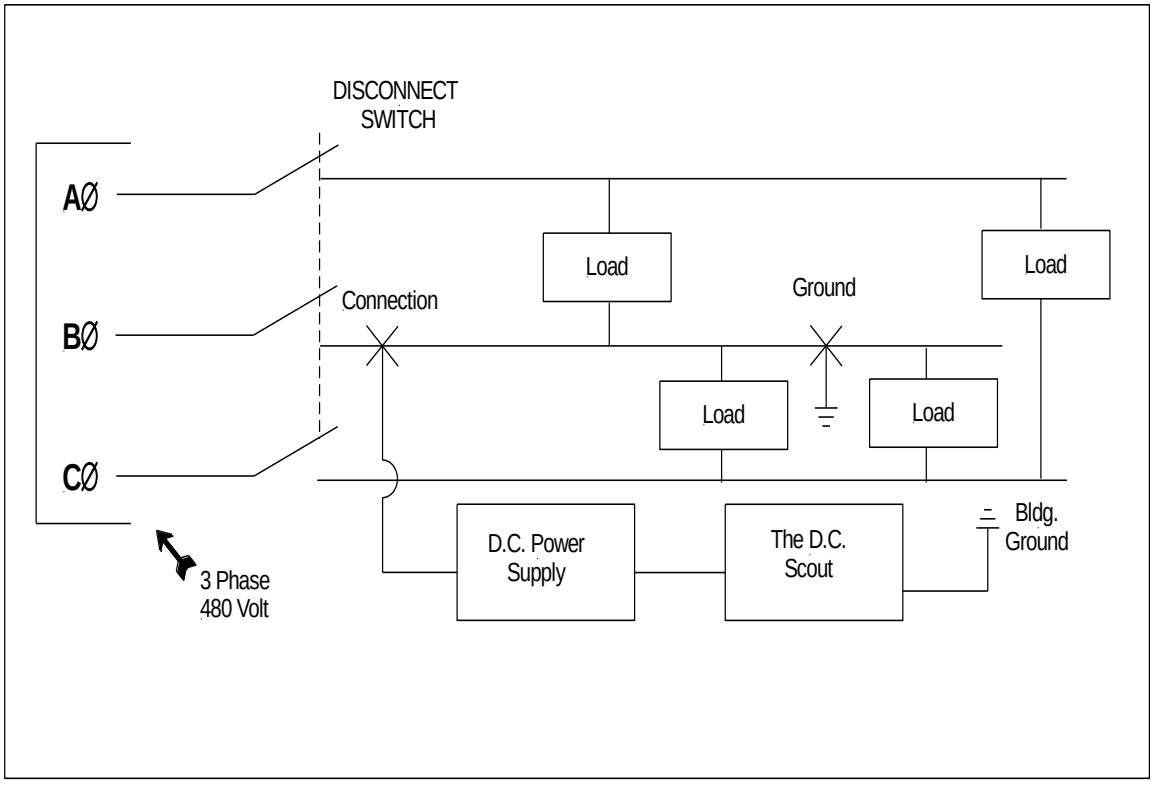

Figure 6: ***A.C. System with a Ground Fault***

B. Ground Locating On Fire Alarm And Marine Systems

The D.C. Scout has been used successfully to locate grounds on fire alarm systems, using the procedures outlined in this manual. We believe these procedures will be useful for marine systems as well. We welcome comments, reports, and questions from users.

VI. D.C. Scout Pulser Unit Internals

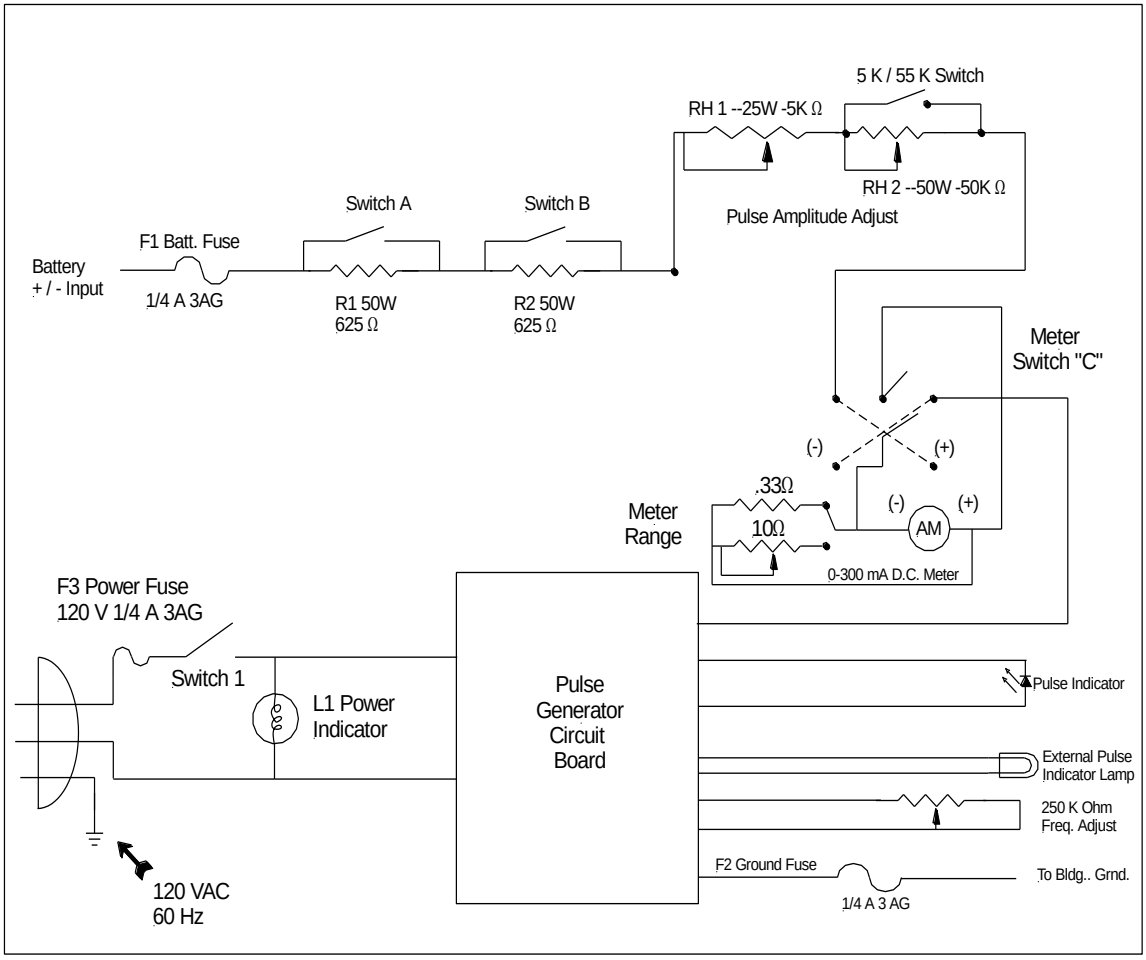

Figure 7: ***D.C. Scout Pulser Unit Internal Diagram***

- The two 625 ohm resistors are used for current limiting in case the rheostat combination is turned to "0" resistance.
- For 125 volt D.C. applications (zero resistance to ground) only one of the 625 ohm resistors are shunted out.
- For 250 volt D.C. applications (zero resistance to ground) no resistors are shunted out.
- For resistive grounds (either 125 or 250 VDC) one or both 625 ohm resistors may be shunted out in order to obtain the desired 5 to 200 milliamp ground current on the Pulser Unit Pulse Meter.
- The 5 K / 55 K switch allows either the 5 K rheostat or both the 5 K and 50 K rheostats to control the pulse amplitude. These rheostats are ganged as the "Pulse Amplitude Adjust" control.
- Switch "C" is used to assure an up-scale meter deflection for either a POSITIVE or a NEGATIGE ground.

⁂ The Pulse Generator consists of a circuit board, a relay, and digital circuitry and components used to vary the rate at which the relay opens and closes, and to power the pulse indicator lamps.

VII. Troubleshooting the D.C. Scout

PROBLEM	PROBABLE CAUSE	REMEDY
No Pulser unit meter deflection with voltage applied to Pulser Unit leads.	1) Blown battery or Ground fuse. 2) Meter Switch set to wrong polarity. 3) Too much ground circuit resistance to indicate current flow. 4) Bad 625 ohm resistor, 5 K ohm or 55 K rheostat, Meter Switch, D.C. ammeter, Pulse Generator Board, or faulty Pulser Unit cables.	1) Replace fuse or fuses. 2) Toggle meter switch to opposite polarity. 3) Review Step III.B.3 4) Do continuity checks on listed components. If check out O.K., then order new Pulser Generator Board.
Pulser unit won't pulse with Pulser ON-OFF Switch ON	1) Pulser fuse blown. 2) Blown circuit board fuse. 3) Bad Pulse Generator Board. 4) Pulser Unit not plugged into 120 VAC. 5) Bad Pulser ON/OFF Switch.	1) Replace pulser fuse. 2) Check External Lamp leads to see if shorted together and replaced circuit board fuse. 3) Order new Pulse Generator Board. 4) Plug unit into 120 VAC outlet. 5) Bad switch if power indicator lamp does not light when switch is ON.
Detector Unit Meter unresponsive	1) Detector ON/OFF switch not ON. 2) Dead 9-volt battery.	1) Pull Balance control knob out. 2) Press battery test button on back of detector unit. If meter does not deflect to "Battery OK" then replace battery.

Detector Unit won't register pulses	1) Sensitivity turned too low on detector.	1) Turn up the Sensitivity knob on the back of the Detector.
	2) Detector Probe not clamped around wire in ground current loop.	2) Review manual section III.D.2
	3) Too little ground current being pulsed.	3) Review top of page 10.
	4) Detector unit banana jack dirty.	4) Clean Detector banana jacks.

VIII. The D.C. Scout Part List

Pulser Unit	----------
HJA-2525	D.C Scout complete
HJA-2525-MAN	D.C. Scout Operating Manual
HJA-2525-R1	625 ohm, 50 W, current limiting resistor
HJA-2525-R2	625 ohm, 50 W, current limiting resistor
HJA-2525-RH1	5 K ohm, 25 W, Pulse Amplitude Adjust rheostat
HJA-2525-RH2	50 K ohm, 50 W, Pulse Amplitude Adjust rheostat
HJA-2525-SW-A	SPST, 250 VDC, resistor shunt switch
HJA-2525-SW-B	SPST, 250 VDC, resistor shunt switch
HJA-2525-SW-C	DPDT, ON-OFF-ON 250 VDC, meter switch
HJA-2525-SW-5K/55K	SPST, 250 VDC, 50 K rheostat bypass switch
HJA-2525-SW-1	SPST, 250 VAC Pulser ON/OFF switch
HJA-2525-M1	0-300 mA D.C. Pulser Meter
HJA-2525-SW-30/300mA	SPDT, miniature Meter Range Switch
HJA-2525-CBL1	12' 120 VAC power cord
HJA-2525-L1	120 VAC Power Indicator Lamp
HJA-2525-L2	External Pulse Indicator Lamp assembly
HJA-2525-P1	250 K ohm Pulse Frequency Adjust Pot
HJA-2525-PGB	Pulse Generator Circuit Board complete
HJA-2525-CBL3A	Pulser Unit red cable assembly
HJA-2525-CBL4A	Pulser Unit black cable assembly
Pulse Detector Unit	----------
HJA-2525-110	Pulse Detector complete
HJA-2525-111	ON/OFF Switch and balance pot
HJA-2525-112	Sensitivity Potentiometer
HJA-2525-113	Red, 5-way, banana jack

HJA-2525-114	Black, 5-way, banana jack
HJA-2525-115	Pulse Detector Unit meter
HJA-2525-116	Current Transformer Probe 80i-600 complete
HJA-2525-117	Current Transformer Probe Y8101 complete
HJA-2525-118	Detector Preamplifier Board complete

IX. Specifications

D.C. Scout Pulser Unit

120 VAC Operating Voltage	Panel mounted 0.25 Amp protection fuse
Output Relay Rating	250 VDC maximum. Fuse protected with two panel mounted 250 mA fuses.
Relay Pulse Rate	User adjustable from approximately 2 pulses/sec. to 8 pulses/sec.
External Pulse Indicator Lamp	12 VDC, bayonette style.
Pulse Generator Circuit Board	External Lamp short circuit protected with 0.5 Amp fuse on PCB.
Pulse Amplitude Meter	Pivot and jewel style, 0-300 mA DC.
Dimensions	18” L x 9” H x 8” D
Weight	12 lbs.

Pulse Detector Unit
(galvanometer, hangs from neck)

9VDC Transistor battery powered
Taut-band, zero-center, meter
Battery test feature
Meter sensitivity & balance adjustments

Meter and probe sensitivity	5 mA min. pulse amplitude (for detectable meter movement)
Dimensions	3-38” W x 3” H 5-1/8” D
Weight	2 lbs.

Detector Probe

Fluke 80i-600 current transformer	
2” circular jaws	
Weight	.75 lbs

Accessory Tray

For spare fuses, Detector Probe,	
External Pulse Lamp, Manual, etc.	
Weight	2 lbs.

Total Unit Dimensions	18” x 9” x 8”
Total Shipping Weight	17 lbs.