PHOTOELECTRIC STIMULUS ISOLATION UNIT

MODEL PSIU6

INTENDED USE

An accessory constant current unit for isolating stimulating electrodes in nerve and muscle research stimulation procedures. NOT FOR USE ON HUMANS.

INSTRUCTION MANUAL

GRASS INSTRUMENT COMPANY Tel. 617-773-0002
101 Old Colony Avenue • PO Box 516 • Quincy, MA 02269-0516

SERIAL # 95L0025G

PLEASE
DO NOT LOSE
THIS MANUAL

ONE MANUAL IS SHIPPED with each instrument.

No "shortages" recognized.

Additional copies may be purchased at cost by owners of the instrument, but it is necessary to give the exact model and serial numbers.

The cost $_____

®*GRASS* MODEL PSIU6 PHOTOELECTRIC STIMULUS ISOLATION UNIT

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WARNINGS

READ THIS BEFORE OPERATING PSIU6

The GRASS PSIU6 Stimulus Isolation Unit is not designed nor intended for use on HUMANS.

DO NOT USE ON HUMANS

The available output voltage and current of the PSIU6, when connected to a GRASS Stimulator may be sufficient under some conditions to be lethal or cause burns, especially with high duration and/or high voltage/current settings. Exercise caution when using this unit so that the stimulus is not delivered to the user.

The state of the art is such that the potential danger to humans, animals and tissue preparations from sustained stimulation, even at low levels, is still not completely understood.

Grass Instrument Company waives any responsibility whatsoever for any injuries incurred to the operator of this instrument or to any human, animal or tissue preparation as a result of its improper use or abuse

TAKE CARE NOT TO EXPOSE USER TO POSSIBLE HIGH OUTPUT LEVELS

INTENDED USE

The GRASS PSIU6 Stimulus Isolation Unit is designed and intended for use ONLY on animals and excised tissue preparations.

MODEL PSIU6 PHOTOELECTRIC STIMULUS ISOLATION UNIT
Table of Contents

M528D94

PSIU6 Stimulus Isolation Unit

featuring new ®*GRASS SAFELEAD*™ protected terminals

®*GRASS* MODEL PSIU6 SPECIFICATIONS

FOR USE ONLY ON ANIMALS – NOT FOR USE ON HUMANS

FOR PULSE & DC LOW CURRENT STIMULUS ISOLATION WITH HIGH IMPEDANCE ELECTRODES

ISOLATION – impedance to ground

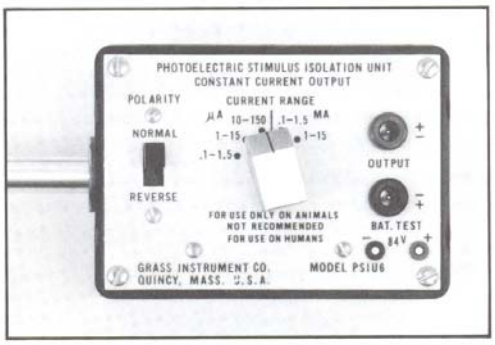
- Compact probe minimizes effects of capacitance (less than 5 pF to ground). For maximum reduction of stimulus artifact, the probe should be located as close to the preparation as possible.

INPUT

- Compatible with all Grass Stimulators without built-in stimulus isolation units, including the S4, S8, S44, S48, S88, S11 and S8800 square pulse Stimulators.

OUTPUT

- **The output terminals on this unit are recessed male 1.5 mm diameter (0.059-inch) *GRASS SAFELEAD*™ connectors conforming to the latest requirements of UL, CSA and FDA.** Only recessed 1.5 mm diameter female leads will provide proper connection. These are available from Grass Instrument Company. Adaptors are provided with each unit to aid in altering existing leads.
- Constant current output from 0.1 micro-amperes to 15 milliamperes with excellent isolation from ground, thus reducing stimulus artifact to a minimum.
- Output current of PSIU6 tracks numbers on stimulator volts dial within 20%.*
- Off duty leakage current less than one nanoampere.



- Current ranges*

0.1 μA	to	1.5 μA
1.0 μA	to	15.0 μA
10.0 μA	to	150.0 μA
0.1 mA	to	1.5 mA
1.0 mA	to	15.0 mA

POWER

- Powered by replaceable batteries with approximate lab life of 2 years when used under normal conditions at low duty cycle. Polarity reversing switch included.

OTHER STIMULUS ISOLATION UNITS

- SIU5: general purpose, RF coupled constant voltage output
- SIU7: same as PSIU6 except capacity coupled for extra safety in clinical applications
- SIU8T: transformer isolated, constant voltage

PHYSICAL SIZE

- 3" W x 4" H x 2" D (7.6 cm x 10.2 cm x 5.1 cm)
- Weight: 2 lbs. (0.9 kg)

* When used with S4, S8, S44, S48, S88, S11 or S8800 Grass Stimulators.

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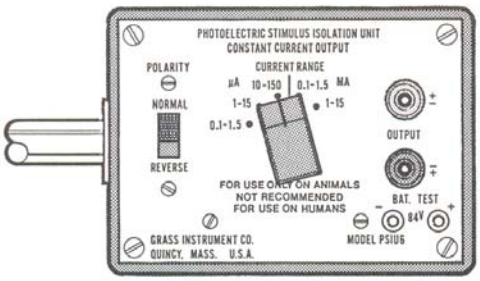
S178D94

2 GENERAL CONSIDERATIONS

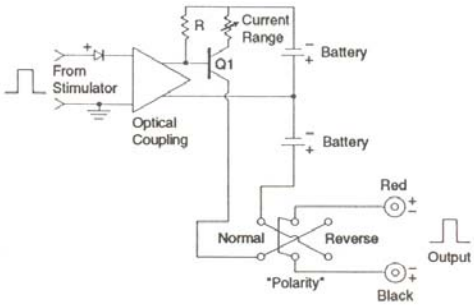
2.1 Design and Principle of Operation

2.1.1 The Grass Photoelectric Stimulus Isolation Unit is a transistorized optically-coupled circuit designed to be connected in series with the output of an S44, S48, S88, S11, S8800 and other compatible Stimulators and the stimulating electrodes to isolate the stimulus from ground, thus reducing stimulus artifact and provide constant current to the preparation. The source of energy for stimulus current is self-contained batteries. Because the unit is battery operated, it should be considered only for low energy applications in contrast to the Grass SIU5 and SIU8T series of isolation circuits which obtain the stimulus energy from the Stimulator itself. The PSIU6 does reproduce DC currents of any duration like the Grass SIU and in contrast to transformers which are limited to a few milliseconds duration.



MODEL PSIU6 PHOTOELECTRIC STIMULUS ISOLATION UNIT
FIGURE 2.1.1

2.1.2 The light emitting diode, driven directly from the output voltage of the Stimulator, causes a current to flow through the photo-sensitive diode which is isolated from ground. The current, proportional to the stimulus voltage, appears as an input signal to the constant current transistor Q_1. Output current, which is controlled by the CURRENT RANGE switch and the Stimulator VOLTS dial, is taken from the collector circuit of the constant current transistor. A POLARITY switch is also included. Refer to Figure 2.1.2.



OUTPUT CIRCUIT
FIGURE 2.1.2

3 CONNECTION OF THE PSIU6 TO STIMULATORS

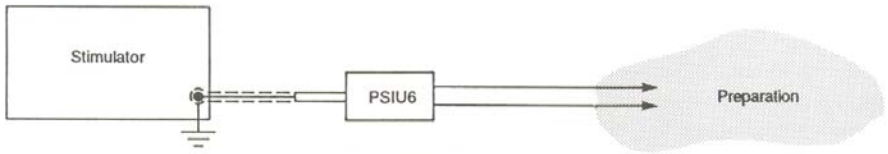
3.1 Power for PSIU6 Operation

3.1.1 The PSIU6 receives operating power from two sources. Modulating signal power for the INPUT circuit (optical-coupling) is obtained from the stimulator square wave output. Power for the OUTPUT circuit and stimulus current is obtained from two 42-volt batteries located within the PSIU6 case. Test jacks are provided for checking battery voltages. See Section 6.1.1a.

3.1.2 The PSIU6 connects to the S8800, S88, S44 and S48 Stimulators directly with the cable provided. Refer to Figure 3.1.2. The PSIU6 can be wired for use with the S11 Stimulator.

3.1.3 On all Grass Stimulators, it is necessary to set the VOLTS MULTIPLIER switch to the X10 (SIU) position.

NOTE: ***DO NOT connect either of the PSIU6 terminals to ground if stimulus isolation is desired.***



STIMULATOR CONNECTION
FIGURE 3.1.2

CONNECTION OF THE PSIU6 TO STIMULATORS
Sections 3.2 - 3.3

3.2 PSIU6 Connection to Grass S8800, S88, S44 and S48 Stimulators

3.2.1 ***NOTE: When using the PSIU6 for DC stimulation or pulsatile stimulation with long durations, the handle may become warm. This does not indicate instrument malfunction. A current limiting resistor is located within the PSIU6 handle.***

3.2.2 Connect the Amphenol PL259 coaxial connector of the PSIU6 cable to the stimulus OUTPUT connector on the Stimulator front panel. Set the VOLTS MULTIPLIER switch to the X10 (SIU) position. ***NOTE: DO NOT connect the PSIU6 to the S_1 S_2 MONITOR connector on the S88 Stimulator.***

3.3 PSIU6 Connection to Grass S11 Stimulators

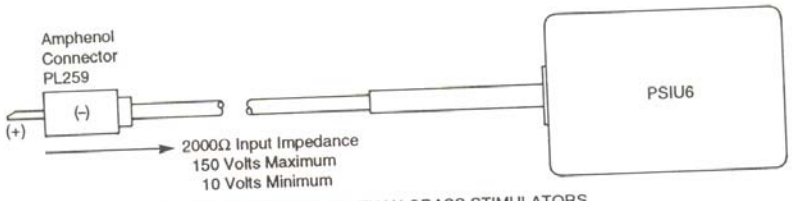
3.3.1 When specified with the order the PSIU6 can be wired for use with the Grass S11 Stimulator. The S11 has a 4-terminal connector at each output with two of the terminals being used as a safety interlock. Refer to Section 4 of the S11 Instruction Manual.

3.4 PSIU6 Connection to Other than Grass Stimulators

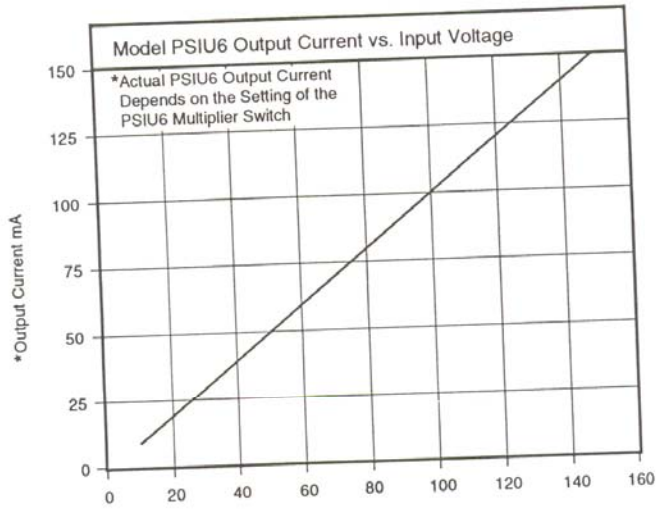
3.4.1 Proper polarity of the input voltage must be observed when driving the PSIU6 with other than Grass Stimulators. The center pin of the Amphenol PL259 input connector is positive with respect to the shell. Voltages less than 10 volts will not supply sufficient current to the light source to provide meaningful output currents. 150 volts maximum rating. Apply only DC or pulses with a rise time not exceeding 10 µS. Pulse amplitudes should be in the range of 10 to 150 volts.

3.4.2 The PSIU6 input impedance is about 2000 ohms. Instruments driving the PSIU6 should have an output impedance 5 to 10 times less than this. Refer to Figure 3.4.2.

3.4.3 Refer to Figure 3.4.3 for PSIU6 Output Current vs. Input Voltage.



CONNECTION TO OTHER THAN GRASS STIMULATORS
FIGURE 3.4.2



PSIU6 OUTPUT CURRENT VS. INPUT VOLTAGE
FIGURE 3.4.3

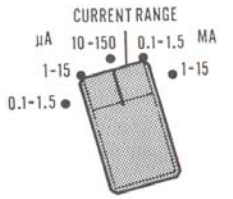
4 OPERATION OF THE PSIU6

4.1 Output Voltage/Current Polarity

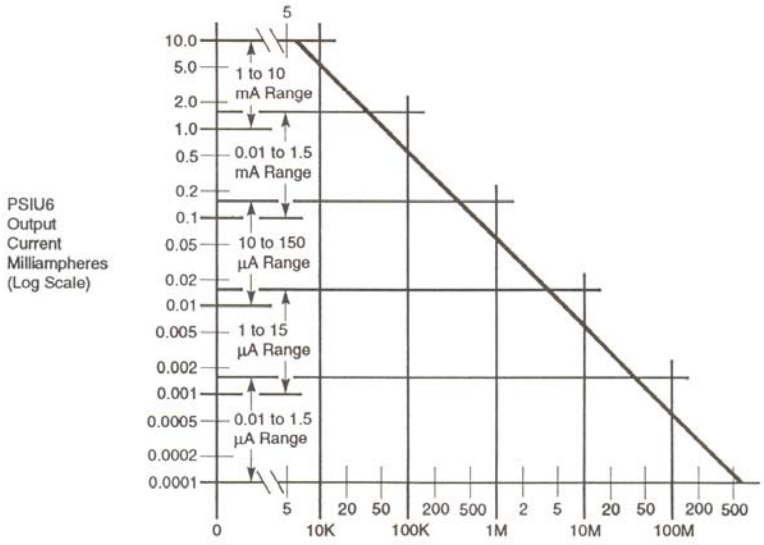
4.1.1 The POLARITY switch determines the polarity of the PSIU6 output, independent PSIU6 output, independent of a ground reference, providing no grounds have been attached to the stimulating electrodes or their leads. In the NORMAL position, the red output terminal is positive with respect to the black output terminal. In the REVERSE position, the black output terminal is positive with respect to the red output terminal.

4.2 Current Range

4.2.1 The CURRENT RANGE switch on the PSIU6 is similar in operation to the MULTIPLIER switch on the Grass Stimulus Isolation Unit, Model SIU5.



4.2.2 There are five overlapping constant current ranges available on the PSIU6, spanning 0.1 microamperes to 15 milliamperes. Control of current on any range is made with the VOLTS dial on the Stimulator. See Figure 4.2.2.



PSIU6 MAXIMUM OUTPUT CURRENT VS. ELECTRODE RESISTANCE WITH GRASS MODEL S44, S48, S88, S8800 AND S11 STIMULATORS
FIGURE 4.2.2

4.2.3 The PSIU6 output is essentially constant current which means a high output impedance. If the electrode impedance is reasonably stable during an experiment, a constant voltage source produces constant current. However, certain types of electrodes and/or experimental conditions can provide a significant variation in electrode resistance. Under these conditions, a constant current source is more desirable. Refer to the Appendices in the S44, S48, S88, S11 and S8800 Instruction Manuals and Section 8, Appendix in this Instruction Manual for a detailed discussion on Constant Voltage vs. Constant Current Sources for Pulse Stimulation.

4.3 Output Binding Posts

4.3.1 The miniature output binding posts on the PSIU6 will accept either standard 0.081-inch (2 mm) diameter pin plugs or bare wires.

The PSIU6E output terminals are designed to accept only 0.059-inch (1.5 mm) diameter female connectors. This change was made to conform to the latest safety requirements of the FDA and other regulatory agencies to provide protected electrode terminals having no exposed conductors. So users can alter existing leads, Grass provides adaptors for converting leads to mate with this new connector. The adaptor number is F-059.

4.4 Leakage Current

4.4.1 The design of the PSIU6 constant current circuit is such that there is always some small value of leakage current circulating in the output circuit with zero input voltage. The amount of leakage current is a function of the characteristics of the constant current transistor Q_1 and the photosensitive diode. The transistor used for this application has been carefully chosen to limit this current to less than one nanoampere (10^{-9} amps).

4.5 Biphasic Constant Current Stimulation

4.5.1 Symmetrical biphasic, constant current pulses may be delivered to a preparation as follows:

a. Connect one PSIU6 to the S_1 output of a S11, S88 or S8800 Stimulator. See Figure 4.5.1.

b. Connect a second PSIU6 to the S_2 output of a S11 or S88 Stimulator.

c. Connect one electrode lead to the red (+) output binding post of one PSIU6.

d. Connect the second electrode lead to the black (-) binding post of the second PSIU6.

e. Connect the black (-) output binding post on the first PSIU6 to the black (-) binding post of the second PSIU6.

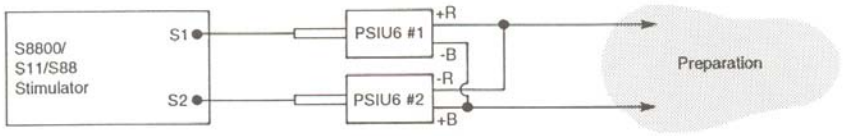
f. Connect the red (+) output binding post on the first PSIU6 to the red (+) output binding post of the second PSIU6.

g. Set the POLARITY switch on the first PSIU6 to NORMAL.

h. Set the POLARITY switch on the second PSIU6 to REVERSE.

NOTE: To avoid current cancellation, the S_1 and S_2 pulses should not overlap.

4.5.2 **Note:** When stimulating with low currents through high impedance electrodes, the use of two PSIU6 Units together at one preparation site is not recommended. Intervening tissue will affect the capacitance between electrode pairs and thus will divide the output current. Therefore, a discrepancy between the amount of current preset in each PSIU6 and actually delivered may result.



CONNECTION FOR BIPHASIC STIMULATION
FIGURE 4.5.1

5 ACCURACY, WAVEFORM AND REGULATION

5.1 Accuracy

5.1.1 The PSIU6 output current will track within ±20% of the numbers on the VOLTS dial of the Grass S11, S44, S48, S88 and S8800 Stimulators providing the maximum electrode resistance is not exceeded for a given range. (See Figure 4.2.2.)

5.2 Waveform

5.2.1 Both the rise and fall time constants of the output pulse of the PSIU6 (when measured with a CRO across a 1.0 kΩ resistor placed across the output terminals of the PSIU6) are nearly identical to that of the Stimulator alone. However, in use, with electrodes of approximately one megohm or higher, constant current with accurate square waves are difficult to achieve because the total current is significantly divided among stray parallel resistances and capacitances shunting the electrodes and leads.

5.3 Regulation

5.3.1 The current deviation from a preset value, on any current range of the PSIU6, is less than 5% for electrode impedance from zero to the maximum electrode impedance as shown in Figure 4.2.2.

6 SERVICE AND MAINTENANCE

6.1 Service

6.1.1 The PSIU6 is completely solid-state and, except for periodic battery replacement, should not require frequent service. However, factory service is available and recommended if adjustments are necessary on the instrument. Make certain, however, that the defect is in the PSIU6 and not in the Stimulator or other accessory equipment. Checking procedure is as follows:

a. If a defect in the PSIU6 assembly is suspected, first check the two 42V batteries within the PSIU6 by connecting a voltmeter across the battery test jacks. (The test jacks are wired across the two 42V batteries in series yielding a total open circuit voltage of 84 volts.) ***NOTE: USE CAUTION WHEN SERVICING PSIU6 – HIGH VOLTAGE (84V).*** To determine battery condition, however, it is best to measure the voltage while current is being drawn from the battery. To do this, proceed thru Step e and measure across the battery test jacks. See Section 6.2 for battery replacement information.

b. If the batteries read NORMAL, connect the output of the stimulator directly to the input of the CRO. Observe the waveform. (If the output from the Stimulator meets stated specifications, proceed to Step c).

c. Connect the PSIU6 to the Stimulator being used and set the Stimulator to 1 millisecond duration (or any other convenient duration). Set the VOLTAGE dial to 10 and the MULTIPLIER to the X10 (SIU) position.

d. Connect a 100 kilohm resistor across the output binding posts of the PSIU6 and set the current range switch to the 10 to 150 microampere position.

e. Connect an oscilloscope with a high impedance probe across the 100 kilohm resistor. The peak pulse voltage across the resistor should be 10 volts ±20%.

f. If difficulty is encountered, contact the Repair Service Department of Grass Instrument Company for further information.

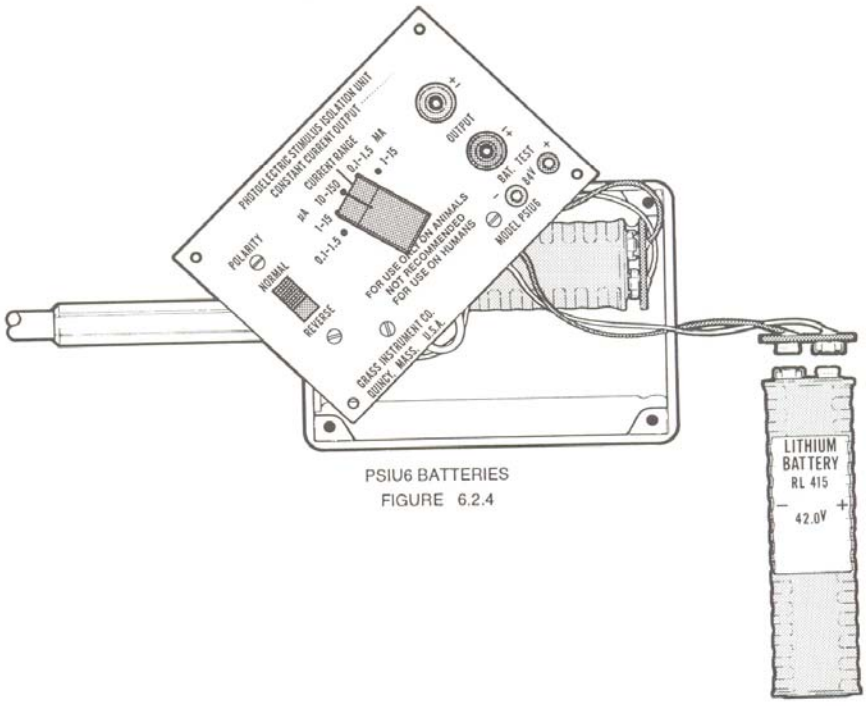
6.2 Battery Life and Replacement

6.2.1 The batteries in the PSIU6 are two 42V cells Type RL415. Replacement batteries may be obtained from Grass Instrument Company.

6.2.2 The PSIU6 battery life is a function of duty cycle and output current. DC stimulation reduces battery life considerably. Therefore, whenever possible, use short durations and low output currents.

6.2.3 Batteries should be replaced when the voltage measured at the test jacks reads 70 volts. The PSIU6 will, however, continue to operate with reduced maximum output current with battery voltages as low as 54 volts.

6.2.4 When replacing batteries, disconnect the PSIU6 from the Stimulator, remove the four 6-32 screws securing the panel, and carefully lift the panel from the PSIU6 case exposing the batteries. Replace the batteries, making sure that the polarized connectors are seated firmly on the batteries. Replace the panel. Refer to Figure 6.2.4 for further information.

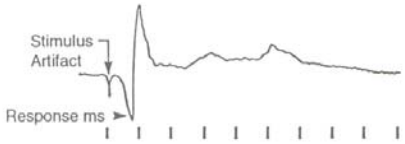


PSIU6 BATTERIES
FIGURE 6.2.4

7 ARTIFACTS, STIMULUS ISOLATION, CONSTANT CURRENT AND MIXING

7.1 Stimulus Artifact

7.1.1 When a stimulus pulse is introduced to a preparation to evoke a response, an electrical artifact appears in the recording instrumentation as the result of the spread of the stimulus current to the recording electrodes. This artifact preceeds the evoked response in time as indicated in the CRO record of Figure 7.1.1. The delay between stimulus artifact and the evoked response is dependent upon stimulation parameters and the characteristic properties of the preparation.

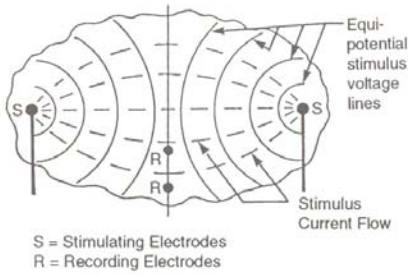


STIMULUS ARTIFACT
FIGURE 7.1.1

7.1.2 Some stimulus artifact is desirable to establish the time of stimulation. However, excessive stimulus artifact may obliterate the display of the desired response as is often the case when small evoked potentials are sought after a stimulus pulse of excessive amplitude or duration.

7.2 Sources and Reduction of Stimulus Artifacts

7.2.1 Excessive stimulus artifact results when the recording electrodes unavoidably measure the field distribution of the stimulus voltage through the preparation. The size of the stimulus and the proximity of the recording and stimulating electrode pairs contribute to the artifact amplitude. See Figure 7.2.1.



STIMULUS VOLTAGE FIELD DISTRIBUTION
FIGURE 7.2.1

NOTE: For optimum recording results, use independent stimulating and recording electrodes and keep recording electrodes perpendicular to stimulus current flow, if possible.

7.2.2 To alleviate stimulus artifact:

a. Isolate the stimulus pulse from ground and thereby reduce the circulating ground currents between the stimulator, preparation and recording instrument.

b. Space stimulating and recording electrodes as far from each other as possible and position them for maximum cancellation of field effects.

c. Use as small a stimulator pulse with as short a duration as is possible (approximately 0.1 milliseconds).

7.2.3 If the field distribution pattern of stimulus current causes substantial stimulus voltage between the recording electrodes, the resulting artifact cannot be avoided.

7.3 Stimulus Isolation

7.3.1 The S11, S44, S48, S88 and S8800 are compatible with Grass Stimulus Isolation Units Models SIU5, PSIU6, SIU7 and SIU8T.

7.3.2 Isolation of the signal from ground is most effective in the reduction of those artifacts due to ground currents arising from the stimulating and recording systems which are conductively joined by the preparation. When stimulus isolation is used during cortical stimulation, and in similar instances when a large volume of tissue surrounds closely spaced stimulating electrodes, the stimulus current sets up a three-dimensional field pattern, wherein the strength of the field usually decreases with the cube of the distance from the stimulating electrode. Isolation of the stimulus from ground in this instance is particularly effective because it reduces ground currents. Stimulus isolation is particularly necessary with multi-channel recording. It is also valuable from the standpoint of safety, because it isolates the stimulating electrodes from ground, a condition which is particularly desirable in the operating room. It has the further advantage of permitting direct addition of stimuli of either algebraic sign.

7.3.3 The high quality, general purpose Stimulators, S11, S44, S48, S88 and S8800 do not have "built-in" isolation and constant current circuits because these are not always desirable. The more limited Grass S9 series do have built-in isolation but not constant current output. In many applications, a very low output impedance of high power is required and is featured in the S11, S44, S48, S88 and S8800. Such an output will stimulate in solutions, will drive a long lead line or other capacitive loads without degrading the stimulus pulse. This is not possible with a high impedance source (constant current). It is possible and economical to drive isolated and high impedance circuits, but it is not economical to build low impedance outputs from high impedance sources. Furthermore, it is most often desirable to have the isolating and constant current circuits as close to the preparation as possible to preserve the isolation and fidelity of the stimulus. Thus, separate cabinets for these circuits are preferred. Furthermore, not all applications require SIUs and/or CCUs. The argument for this system is like that for high impedance probes for amplifiers.

The characteristics of the Grass SIUs permit the shielding of stimulating and recording electrode leads, thus reducing the capacitive coupling between recording and stimulus leads. For maximum reduction of artifact, the SIU should be placed as close to the preparation as is possible. Ideally, short unshielded leads to the electrodes should be used and every attempt should be made to reduce conduction and capacitance between the output leads, recording leads and ground to a minimum. If it is not possible to use short electrode leads, use 2-wire shielded low capacitance cable.

8 APPENDIX

8.1 Constant Voltage vs. Constant Current Sources for Pulse Stimulation

8.1.1 While the principal factor responsible for electrical stimulation is current, the amount of voltage required to produce this current is a function of the impedance presented by the electrodes and the surrounding tissue. This varies widely. Some procedures, such as the production of massive seizures in animals, utilize large, low impedance electrodes and yet require relatively high voltage. In the stimulation of single cells with microelectrodes, however, even though the current is in microamps or less, the electrode impedance is high and consequently a high voltage is also required. In other cases, both voltage and current may be low.

8.1.2 "CONSTANT VOLTAGE" inherently means a low impedance source. In this case, the voltage waveform is preserved to the electrode. Current waveform and phase are only dependent on the load impedance. A low source impedance can be relied on to provide the source voltage at the electrode metal-liquid interface independent of cable and similar shunt capacitances.

8.1.3 "CONSTANT CURRENT" on the other hand infers a very high source impedance. Its drawback is that it is difficult if not impossible to preserve either current or voltage waveform values when cable, lead or similar shunt capacities are in the "real circuit". This is particularly true with currents below 10 microamperes and gets worse with smaller currents and consequently higher source and load impedances. On the other hand, "Constant Current" sources offer the advantage of being able to "preset" currents for higher currents and lower impedances, and to provide currents more independent of tissue and electrode impedances. "Constant Current" sources are especially practical with large currents (over 100 microamperes). For DC stimulation "Constant Current" is most advantageous and shunt capacities have no effects.

8.1.4 Everything is relative though, and ratio of source and load impedances (including the resistive and capacitive components) need to be evaluated for proper understanding of "Constant Voltage/Constant Current". What is more important to recognize is that frequently the current or voltage that is measured in the lead wires is hardly the same as it appears at the interface of the tissue and electrode because of diffusion. Furthermore, it should be remembered that the important stimulus parameter is current density, i.e., amperes per unit area at the specific responding tissue.

$$\frac{\text{Amperes}}{\text{mm}^2}$$

APPENDIX
Sections 8.1 - 8.2

A general purpose Stimulator, such as the S11, S44, S48, S88 or S8800 must satisfy the greatest number of applications and represent the most desirable compromise between voltage and current requirements. A low source impedance is also required to drive such accessories as the SIU and CCU. The output, therefore, is a low impedance "constant voltage" emitter follower type. The output source impedance of the S11, S44, S48, S88 and S8800 Stimulators is 250 ohms on the X.01, X.1 and X1 positions of the VOLTAGE MULTIPLIER switch and can be selected to be 250 ohms, 100 kilohms or 25 ohms in one of the three X10 positions. The X10 (SIU) position is used in conjunction with all Stimulus Isolation Units and for most direct stimulating applications. The X10 (100 KΩ) position is used to provide a constant current output in the range of 0.15 to 1.5 MA, providing electrode impedances are 10 kilohms or less. The X10 (25 Ω) position is useful when electrode impedances are low and/or when large stimulating currents are required. The S11, S44, S48, S88 and S8800 Stimulators can deliver up to 150 MA to the preparation. Currents over 150 MA are possible with a slight modification to the appropriate plug-in printed circuit board. Consult the factory for details.

8.1.5 Accessory units are available for connection to the output of the S11, S44, S48, S88 and S8800 Stimulators. ***The SIU5*** is a radio frequency (RF) type of isolation unit with an output impedance of approximately 1000 ohms. ***The SIU8T*** is a transformer coupled constant voltage isolation unit for clinical procedures. No DC component will appear in the output. Maximum duration is about one millisecond as a near square wave. ***The PSIU6*** is an optically isolated Constant Current Unit providing currents from 0.1 microamperes to 10 milliamperes. ***The SIU7*** is an optically isolated Constant Current Unit having a maximum pulse duration of 5 milliseconds. It is intended for clinical procedures. ***The CCU1*** is a Constant Current Unit providing currents from 50 microamperes to 50 milliamperes but does not isolate the stimulator output from ground reference. However, the CCU1 can be used in conjunction with the SIU5 in which case the stimulus would be isolated from ground.

8.2 References

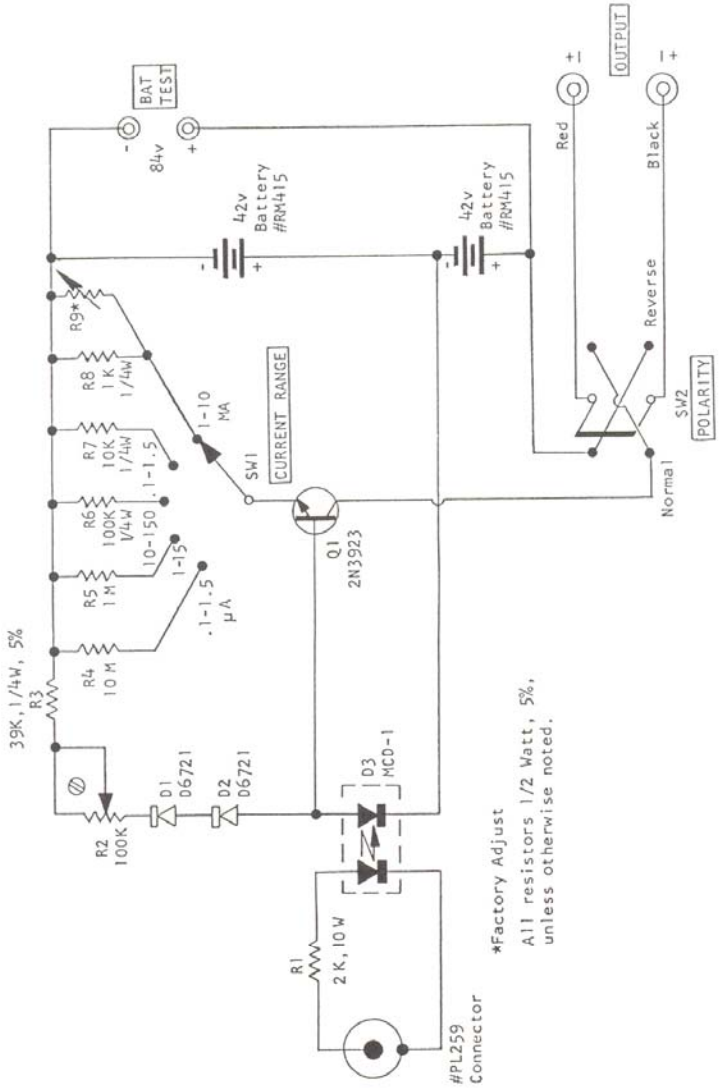
Gerken, G.M. A calibrated system for electrical stimulation of the brain. *Electroencephal. clin. Neurophysiol., 35:* 652-653, 1973.

9 CIRCUIT DIAGRAMS

9.1 Explanation of Circuit Diagrams

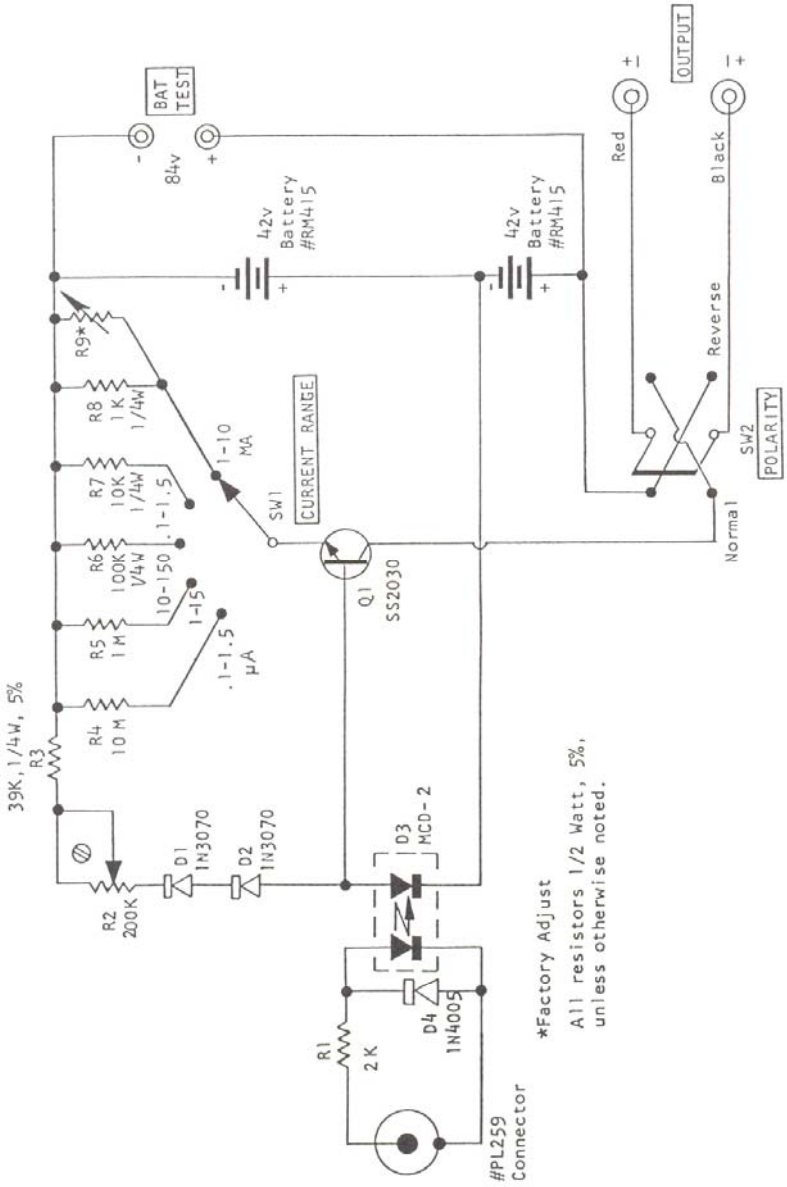
9.1.1 This manual contains all of the circuit diagrams with values of components for all models which have evolved from the basic design. The succession of design changes are indicated by the last letter subscript and are in alphabetical order. For instance, the basic design 7P1 is followed with a letter subscript such as A, B, C, D, etc. as in 7P1F which represents a change from the 7P1E. There may have been minor changes in a few components within any model with the same subscript letter. The circuit presented here with a certain subscript letter would be the last one prior to the introduction of a more substantial change such as when the 7P1F supercedes the 7P1E. The last subscript circuit in this manual is the latest one available at the date of publication.

To identify the appropriate circuit, check the last letter subscript of your instrument model number and identify with the circuit print with exactly the same model number.

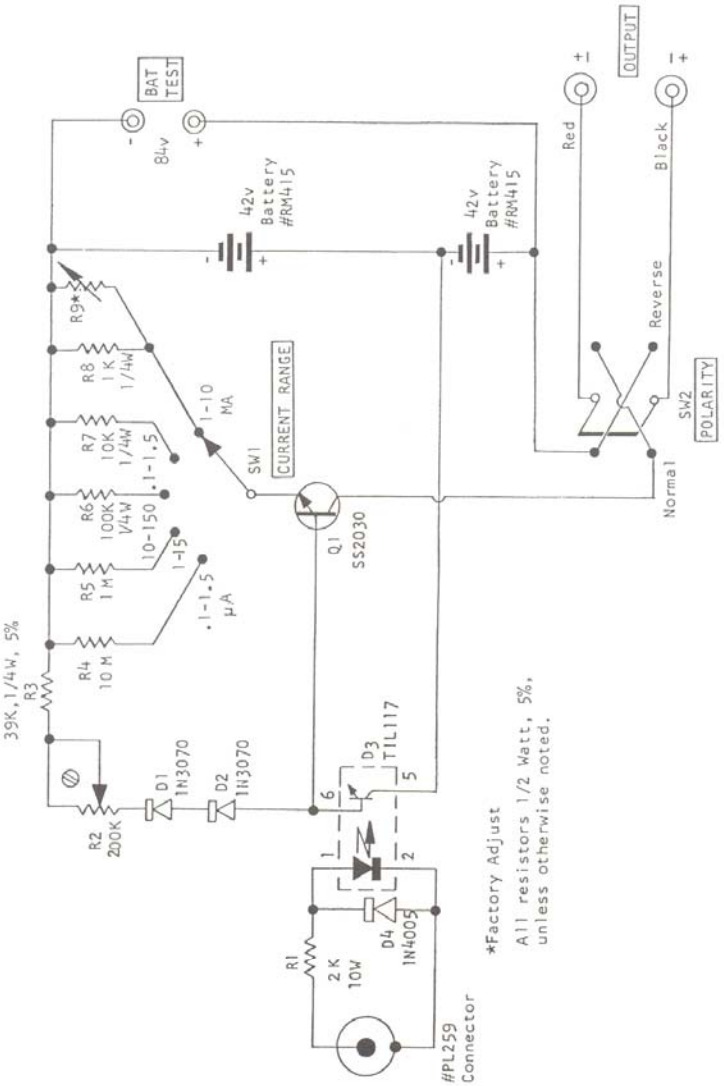


MODEL PSIU6A PHOTOELECTRIC STIMULUS ISOLATION UNIT CIRCUIT DIAGRAM - #50433

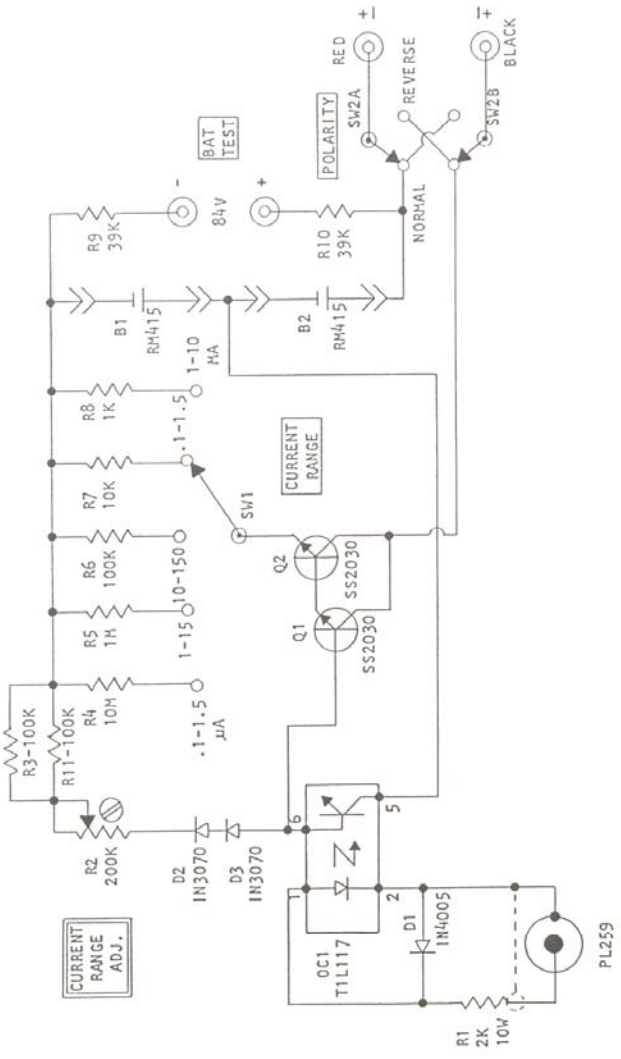
CIRCUIT DIAGRAMS
Section 9.1



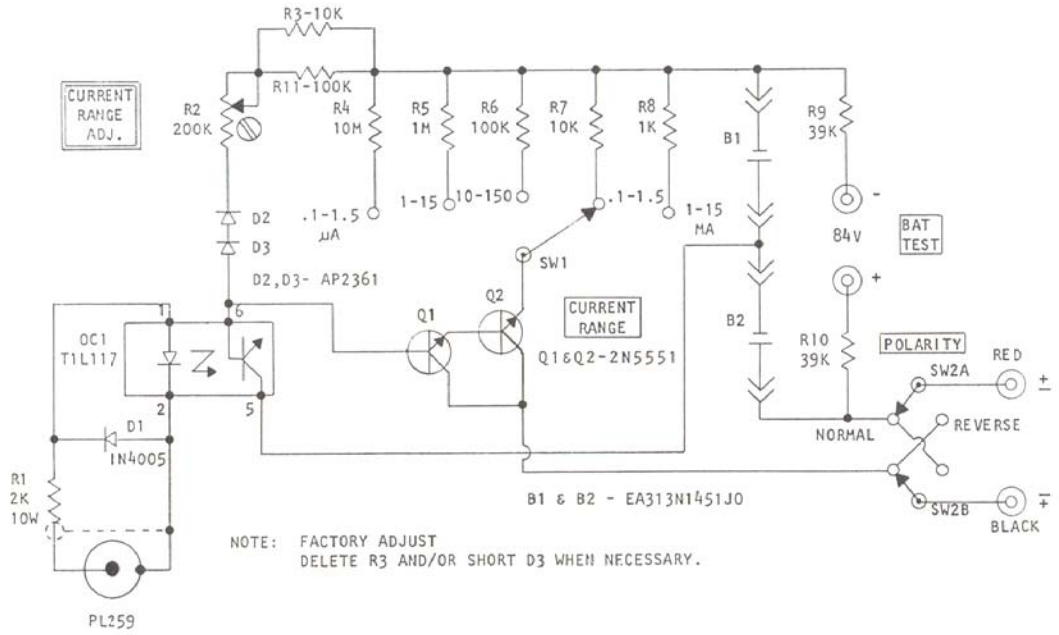
MODEL PSIU6B PHOTOELECTRIC STIMULUS ISOLATION UNIT CIRCUIT DIAGRAM - #50433-2



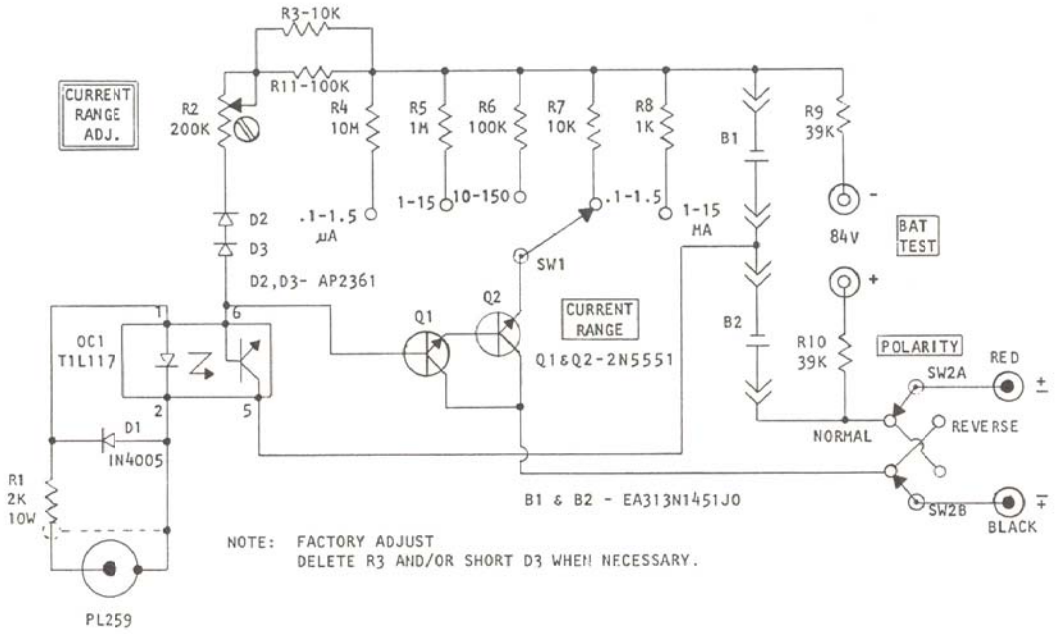
MODEL PSIU6C PHOTOELECTRIC STIMULUS ISOLATION UNIT CIRCUIT DIAGRAM - #50433-3



MODEL PSIU6D PHOTOELECTRIC STIMULUS ISOLATION UNIT CIRCUIT DIAGRAM - #50433-8



MODEL PSIU6E PHOTOELECTRIC STIMULUS ISOLATION UNIT CIRCUIT DIAGRAM - #50433-14



MODEL PSIU6E PHOTOELECTRIC STIMULUS ISOLATION UNIT CIRCUIT DIAGRAM - #50433-15