KeyTek
508-658-0880 x26

SURGE GENERATOR

MODELS 587, 587-PLUS AND 801-PLUS

-OPERATING INSTRUCTIONS-

KeyTek Instrument Corporation

260 Fordham Road
Wilmington, MA 01887

April, 1992

KPS-221

Table of Contents

List of Illustrations

WARNING!

DO NOT DEFEAT THE SAFETY INTERLOCKS AS THEY ARE PROVIDED TO PREVENT INJURY TO PERSONNEL. FAILURE TO COMPLY WITH THIS WARNING COULD RESULT IN INJURY TO PERSONNEL.

WARNING!

1. AC POWER-LINE VOLTAGE WILL BE PRESENT AT THE OUTPUT TERMINALS WHEN THE SURGE LINE BREAKER IS ON.

2. WHEN THE SURGE IS GENERATED, TRANSIENT VOLTAGES TO 10KV AND CURRENTS TO 10KA WILL BE PRESENT IN THE EQUIPMENT UNDER TEST.

3. PROPER SAFETY PRECAUTIONS MUST BE TAKEN TO PREVENT INJURY TO PERSONNEL AND DAMAGE TO ASSOCIATED EQUIPMENT.

4. SURGE AND POWERLINE VOLTAGES AND CURRENTS CAN BE LETHAL!

WARNING!

IN PARTICULAR, DISCONNECT OR SURGE FILTER ALL OTHER LINES, INCLUDING GROUND AND OTHER POWER, FROM/TO THE EQUIPMENT UNDER TEST.

WARNING!

SURGE TEST EQUIPMENT IS DESIGNED TO TEST DEVICES AND CIRCUITS FOR PROTECTION AGAINST HIGH-VOLTAGE, HIGH-ENERGY ELECTRICAL SURGES. SUCH SURGES OCCUR IN FIELD USE OF EQUIPMENT, AND RESULT FROM NATURAL PHENOMENA SUCH AS LIGHTNING DISCHARGES AND POWER-LINE DISTURBANCES. THE ONLY SURE WAY TO TEST FOR WITHSTAND AND SUSCEPTIBILITY PROTECTION AGAINST THESE PHENOMENA IS TO STIMULATE SURGE WAVEFORMS KNOWN TO RESULT FROM THEM.

THE PULSES INVOLVED CAN INCLUDE VOLTAGE PEAKS OF OVER 10,000 VOLTS AND CURRENT PEAKS TO THOUSANDS OF AMPERES; WITH ENERGY DISCHARGES RANGING FROM TENS TO HUNDREDS OF JOULES.

SURGES AT THE ABOVE LEVELS ARE POTENTIALLY DANGEROUS AND EVEN LETHAL. HENCE EVEN THOUGH ALL REASONABLE DESIGN PRECAUTIONS HAVE BEEN TAKEN VIA INTERLOCKS, DUAL-SWITCH OPERATION AND SO ON, SURGE TEST INSTRUMENTATION SHOULD BE USED ONLY BY OR UNDER THE DIRECT SUPERVISION OF QUALIFIED PERSONNEL, AND ONLY AFTER THOROUGH UNDERSTANDING, VIA THE OPERATING INSTRUCTIONS IN THE MANUAL, OF THE RECOMMENDED CONNECTIONS AND METHODS OF OPERATION.

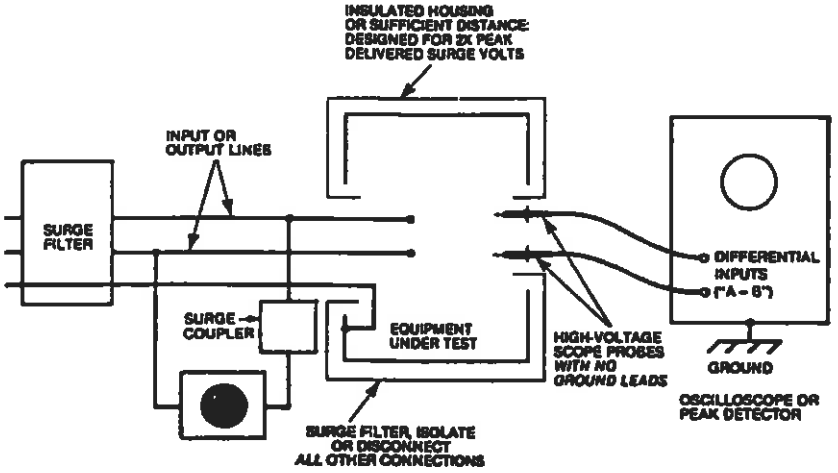
IN ISOLATED SITUATIONS, COMPONENTS BEING SURGED MAY FRAGMENT IF THEY ARE IMPROPERLY MANUFACTURED, OR ARE MISAPPLIED FOR THE SURGE ENERGIES INVOLVED. FOR THIS REASON, COMPONENTS AND CIRCUITS BEING SURGE-TESTED SHOULD BE COVERED TO PREVENT PERSONNEL HAZARD.

WARNING!

SURGING CIRCUITS

1. THE EQUIPMENT UNDER TEST MUST BE ISOLATED FROM ALL OTHER LINES, EQUIPMENT GROUNDS, AND CIRCUITS.

2. MEASUREMENTS WITH AN OSCILLOSCOPE, OR OTHER TEST EQUIPMENT, MUST BE MADE IN A DIFFERENTIAL MODE WITH NO GROUND CONNECTIONS BETWEEN THE TEST EQUIPMENT AND THE CIRCUIT UNDER TEST. DO NOT "FLOAT" THE TEST EQUIPMENT BY REMOVING CHASSIS GROUND.



Monitoring Within Surged Equipment

3. THE FIGURE ABOVE, TAKEN FROM KEYTEK APPLICATION NOTE AN106, SHOWS THE CORRECT METHOD FOR MONITORING WITHIN SURGED EQUIPMENT. REFER TO AN106 (ENCLOSED) FOR FURTHER, DETAILED APPLICATION INFORMATION.

WARRANTY

KeyTek Instrument Corp. warrants each instrument manufactured by it to be free from defects in material and workmanship for a period of one year from the date of delivery to the original purchaser, provided the instrument is used in accordance with the instructions in this manual. KeyTek's obligation under this warranty is limited to servicing or adjusting an instrument returned to the factory, transportation charges prepaid, for that purpose. This is the only warranty offered in connection with the sale of this instrument, no other warranty is implied. KeyTek is not liable for consequential damages.

If a fault in operation occurs, the following steps should be taken:

1. Notify KeyTek Instrument Corp. giving full details of the faulty operation, the model number and serial number of the instrument. On receipt of this information, service data or shipping instructions will be provided.

2. On receipt of the shipping instructions, forward the instrument prepaid and repairs will be made at the factory.

If it is necessary to return this instrument to the factory, it should be shipped in the original packing carton. If it is not available, contact KeyTek to obtain suitable shipping materials.

SAFETY

THIS EQUIPMENT GENERATES HIGH VOLTAGES AND SHOULD BE USED BY TRAINED PERSONNEL ONLY. ALWAYS WEAR SAFETY GOGGLES WHEN USING THIS EQUIPMENT. DO NOT DEFEAT INTERLOCK OPERATION. ALL EUT CONNECTIONS AND THE EUT SHOULD BE ISOLATED FOR AT LEAST 2X THE EXPECTED TEST VOLTAGE. NO USER SERVICEABLE PARTS ARE INSIDE THIS EQUIPMENT. REFER SERVICING TO AN AUTHORIZED KEYTEK REPRESENTATIVE. NOTE THAT THIS EQUIMENT IN THE COURSE OF NORMAL OPERATION PRESENTS DANGER OF LETHAL ELECTRICAL SHOCK IF INTERLOCK CIRCUITRY IS DEFEATED.

1. General Introduction

1.1 Introduction

The Model 587 and 587-PLUS Mainframe with an S1/S3 Surge Network, are a family of surge generators primarily intended to meet or exceed the ANSI/IEEE C62.41-1980 (also IEEE-587) surge recommendation and to test to 6kV for the IEC Pub. 664 test standard. Modifications convert the 587-PLUS Mainframe to an 801-PLUS Mainframe and, when combined with an M801-5 Surge Network, will meet the surge requirements of IEC 801-5 and the related requirements of VDE 0878 Part 200.

The Model 587, Model 587-PLUS Mainframe, and Model 801-PLUS Mainframe are virtually identical in function and features. For this reason, this document will refer to the Model 587, Model 587-PLUS Mainframe and Model 801-PLUS Mainframe as simply "Mainframe" and will specify the model when appropriate. Some differences will be pointed out below.

1.2 Model 587 Surge Generator Description

The Model 587 is a self-contained, dedicated surge generator for testing to both Categories A and B of ANSI/IEEE C62.41-1980 (formerly IEEE Std 587-1980) and IEC Pub. 664. The Model 587 is designed to test powered equipment for the effects of 100 kHz damped cosine or ring waves, as well as the classic 1.2/50 voltage and 8/20 current, power line surge transients. The Model 587 generates the Bi-Wave™, which provides the correct wave as a function of instantaneous load impedance: i.e., 1.2/50 open-circuit voltages and 8/20 short-circuit current waves as the load requires. See KeyTek Application Note 111 in Section 12. The 587 Surge Generator has a built-in ac line coupler/filter, as well as accurate line synch circuits for placement of single surges at any desired ac voltage phase angle. Front-panel switching is provided for surge wave selection and for choice of coupling mode. Earlier versions of the Model 587 provided NORMAL MODE and COMMON MODE surge coupling only. Two additional coupling modes were later added - HIGH TO GND, LOW TO GND and are now standard. Additional features include front panel surge polarity switching and digital peak delivered open circuit voltage metering. A complete safety interlock system continuously monitors various interlock conditions and separate LED annunciators provide status of each interlock circuit.

Output monitor capabilities include BNC coax voltage monitor ports for oscilloscope viewing of the actual surge voltage at an attenuated level. These output ports supply a low-voltage replica of the output surge voltage sensed at a pair of independent front panel terminals. The terminals are designated as V MON INPUT A (V MON HIGH) and V MON INPUT B (V MON LOW). This allows accurate oscilloscope measurement of the surge voltage delivered to the load, with optimum measurement locations selected by the user for each test situation and surge coupling mode.

Additional output monitor capabilities include a current monitor output port. A replica of the current delivered by the surge generator is provided at the I MON output BNC coax connector. Some earlier Model 587's were not equipped with the current monitor. Option I-587 is available for these earlier generators.

Auxiliary outputs include surge synch for triggering, ac line synch signals which include a -180° pre-trigger pulse on the ac voltage wave and an ac line voltage replica at a reduced amplitude to allow convenient viewing of the surge verses ac power line phase.

The coupler/filter is built-in unlike most surge generator systems. The "back-filter" is required for attenuating the surge upstream from the equipment under test. The standard coupler/filter is rated for 277 Vrms at a current of 10 Arms. Options are available which increase the voltage and current specifications.

1.3 Model 587-PLUS Mainframe Description

The Model 587-PLUS Mainframe is electrically identical to the Model 587, except the Model 587-PLUS Mainframe is designed to except modular plug-in surge networks. This modular approach allows surge testing not only to ANSI/ IEEE C62.41 and IEC 664, but also to CCITT and UL 1449 surge specifications, and other standards as they are developed.

Refer to Section 1.2, above, for a functional description of the Model 587-PLUS Mainframe.

The Model 587-PLUS will NOT except the M801-5 Surge Network designed for the Model 801-PLUS Mainframe. The 587-PLUS Mainframe requires Option 801-587 which will allow it to operate with the M801-5 Network.

1.4 Model 801-PLUS Mainframe Description

The Model 801-PLUS Mainframe is virtually identical to the Model 587-PLUS Mainframe in that it will accept all S-prefix surge networks in addition to the M801-5 Surge Network and other surge networks as they are developed.

The functional description of the Model 587 can be used for the Model 801-PLUS Mainframe.

The Model 801-PLUS Mainframe has a jumper selection which changes the coupling capacitor from 18uF to 9 uF in HIGH TO GND or LOW TO GND surge coupling mode.

The jumper is factory set to the 18uF position and can be accessed by removing the right side cover from the 801-PLUS Mainframe or the 587-PLUS Mainframe with Option 801-587.

1.5 Summary

In summary, the only difference between the Model 587 and Models 587-PLUS Mainframe and 801-PLUS Mainframe is the lack of modular construction in the Model 587. The difference between the Model 587-PLUS Mainframe and Model 801-PLUS Mainframe is the jumper selection for a coupling capacitance of 9 uF or 18 uF in HIGH TO GND or LOW TO GND surge coupling mode.

Because of the similarity between the Model 587, 587-PLUS, and 801-PLUS, the term "mainframe" will be used throughout this manual to describe the three models.

2. Mainframe Operation

2.1 Introduction

To effectively use the Mainframe, the operation and capabilities of this surge generating test equipment must be known. This section provides preliminary operating instructions and describes operation of controls and connectors.

This equipment is to be operated by qualified personnel only.

2.2 AC Power Sources

2.2.1 System AC Power

This equipment is intended to be operated from a single-phase, earth-referenced power source having one current carrying conductor (the Neutral Conductor) near earth potential. It is not recommended to operate this equipment from power sources where both conductors are live with respect to earth because only the HOT or Line Conductor is fused against over-current conditions within this Mainframe.

Should an attempt be made to operate this equipment from an ac power source that does not have a Neutral Conductor near earth potential, an open interlock condition will occur prohibiting the equipment from generating high voltage. This will be discussed later.

The Mainframe is equipped with a three-conductor power cord for connection to an ac power source and safety-earth. The safety-earth terminal is connected directly to the Mainframe chassis. This is required for electrical-shock prevention. Install the power cord into an outlet with a safety-earth contact or otherwise connect the Mainframe chassis to a suitable safety-earth system.

2.2.2 Operating Voltage

The Mainframe can be operated from either a 120 VRMS or a 220 Vrms nominal line-voltage source. In addition, the Mainframe can be operated at other line voltages. Follow the procedure outlined in Section 2.4 to obtain correct instrument operation from other line voltages available.

2.2.3 Surge Line Input Power Source

The SURGE LINE INPUT can be a separate, totally independent, power source used for providing power to the Equipment Under Test (EUT), connected to the front panel output terminals. This power source can be single phase, as described above, or a power source where both current-carrying-conductors are live with respect to earth (such as phase-to-phase on a three wire system).

The voltage and current limitations of the SURGE LINE INPUT can be determined from the original shipping paper work sent with the equipment. Alternately, the SURGE LINE INPUT voltage is specified on a label placed above the SURGE LINE INPUT connector located on the rear-panel.

The Mainframe requires the System AC power to operate, but does not require the SURGE LINE INPUT power source, unless conducting powered surge testing at the EUT.

2.3 Controls and Connectors

The major controls for operating the Mainframe are located on the front panel of the instrument. These are illustrated in Figure 2-1. Figure 2-2 shows the location of rear panel controls and connectors for early versions of the Mainframe with 277 Vrms maximum SURGE LINE INPUT capability. Figure 2-3 shows rear panel controls and connectors for early versions of the Mainframe with 480 Vrms maximum SURGE LINE INPUT voltage capability. This rear panel is now standard on ALL Mainframes.

The following is a description of the controls and connectors shown in Figures 2-1, 2-2 and 2-3.

2.3.1 Front Panel Controls and Connectors

The following descriptions are referenced to Figure 2-1.

1. SURGE LINE INPUT - Circuit breaker used to provide power to the EUT (Mainframe output terminals) when conducting ac powered surge testing.

2. SURGE NETWORK - S1/S3 Surge Network in Model 587-PLUS or Model 801-PLUS Mainframe. Other networks available. Non-modular version of S1/S3 Surge Network for Model 587.

3. WAVEFORM SELECTOR - Switch used to select desired waveform.

4. HIGH VOLTAGE - Indicator light illuminates as charge voltage increases. Light intensity also increases as voltage increases. Light should always turn OFF when CHARGE switch is released.

5. V MON OUTPUT A - Voltage MONitor output providing a 200:1 attenuation of the surge applied to V MON INPUT A terminal. A 6 kV surge provides 30 V to the oscilloscope (1 Meg ohm input impedance). V MON A output impedance is 50 ohms. See Section 6 for additional information regarding voltage monitoring.

6. V MON OUTPUT B - Voltage MONitor output providing a 200:1 attenuation of the surge applied to V MON INPUT B terminal. A 6 kV surge provides 30 V to the oscilloscope (1 Meg ohm input impedance). V MON B output impedance is 50 ohms. See Section 6 for additional information regarding voltage monitoring.

7. SURGE ANGLE VS LINE PHASE - Control adjusts placement of surge on AC SURGE LINE INPUT voltage with respect to the phase angle (0-360°) selected.

8. I MON OUTPUT - Surge current MONitor output with scale factor 100:1, or a 3 kA surge provides 30 V to the oscilloscope; output impedance is 50 ohms. Some surge networks have built-in I MON outputs, see operating instructions for specific surge networks to be used.

9. SURGE SYNCH - A positive going trigger pulse occurring simultaneously with the surge pulse. See individual surge network operating instructions for further details.

10. SURGE LINE ON AND SELECT ANGLE - Indicator light illuminates when the SURGE LINE INPUT breaker is ON and SELECT angle is selected. Note, SURGE LINE INPUT voltage must be present.

11. SELECT/RANDOM - Switch used to chose method in which surge is to be applied to the AC line. RANDOM mode will cause the surges to be applied with in random phase sequence, where SELECT mode allows selection of the phase angle at which the surge will be applied.

12. AUTO LINE FREQuency - The frequency of the SURGE LINE INPUT voltage is automatically measured and is indicated by illuminating the appropriate light.

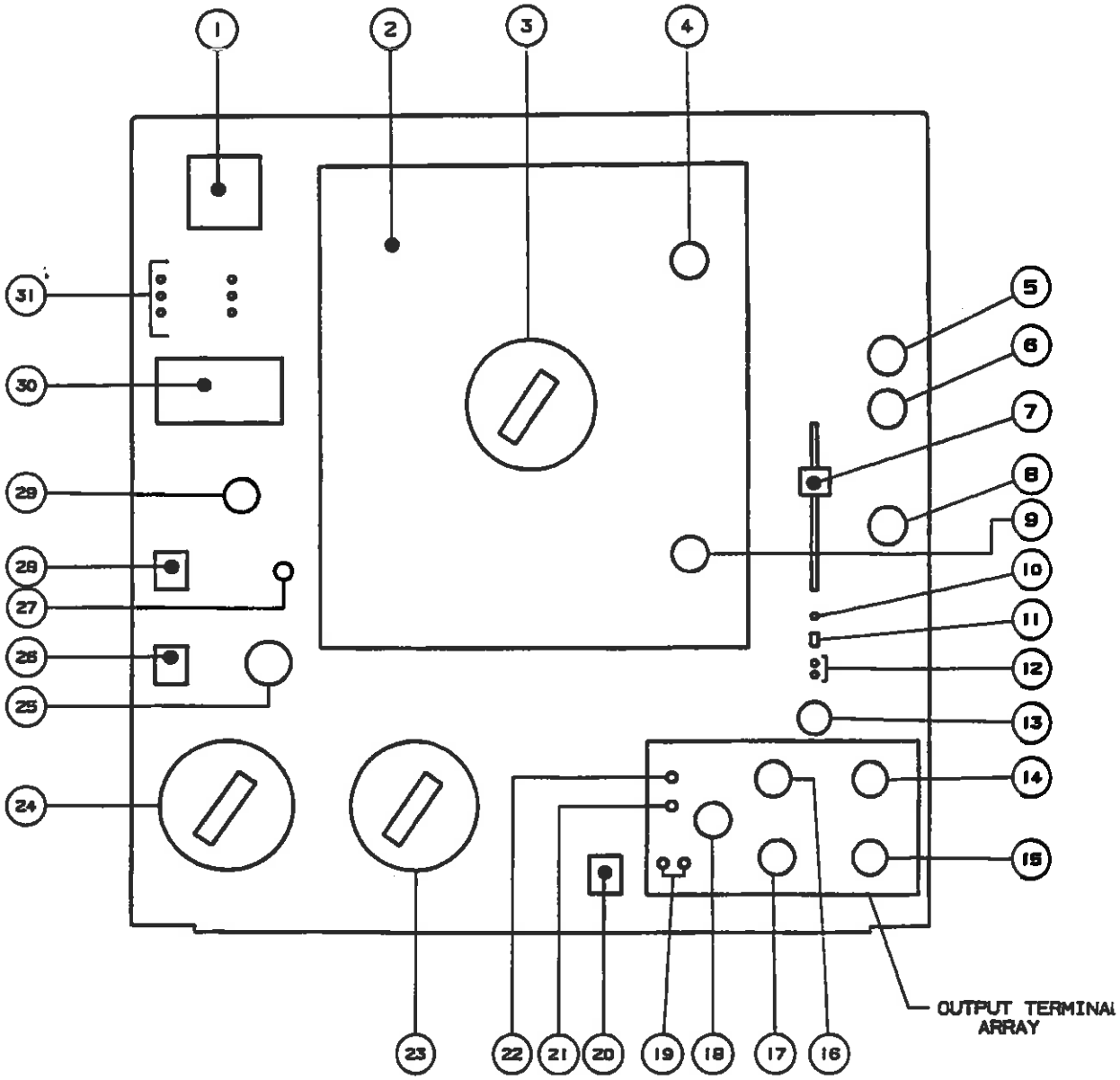


Figure 2-1 Mainframe Front-Panel Controls and Connectors

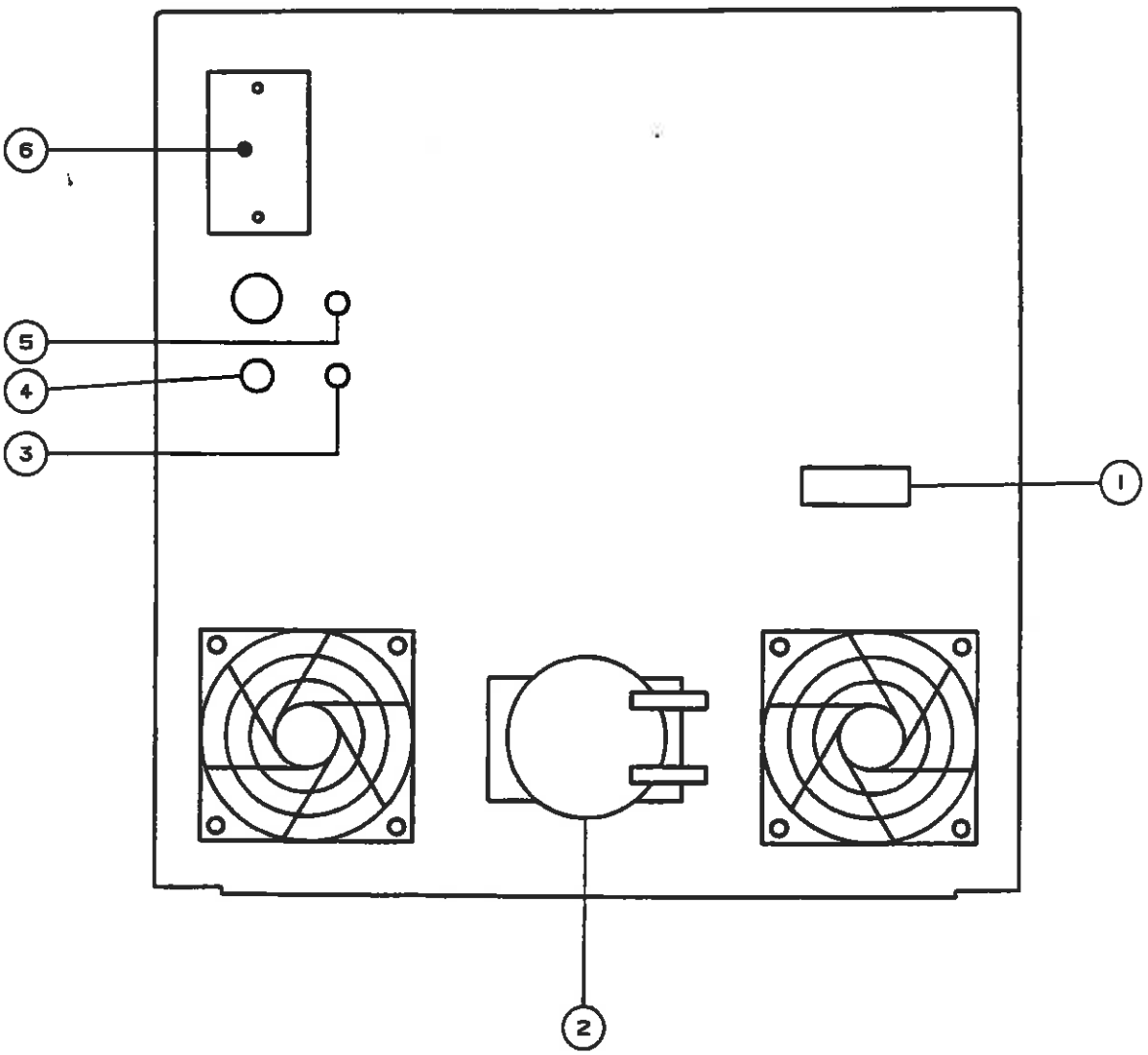


Figure 2-2 Mainframe Rear-Panel Connectors (early, 277V SURGE LINE INPUT, Version)

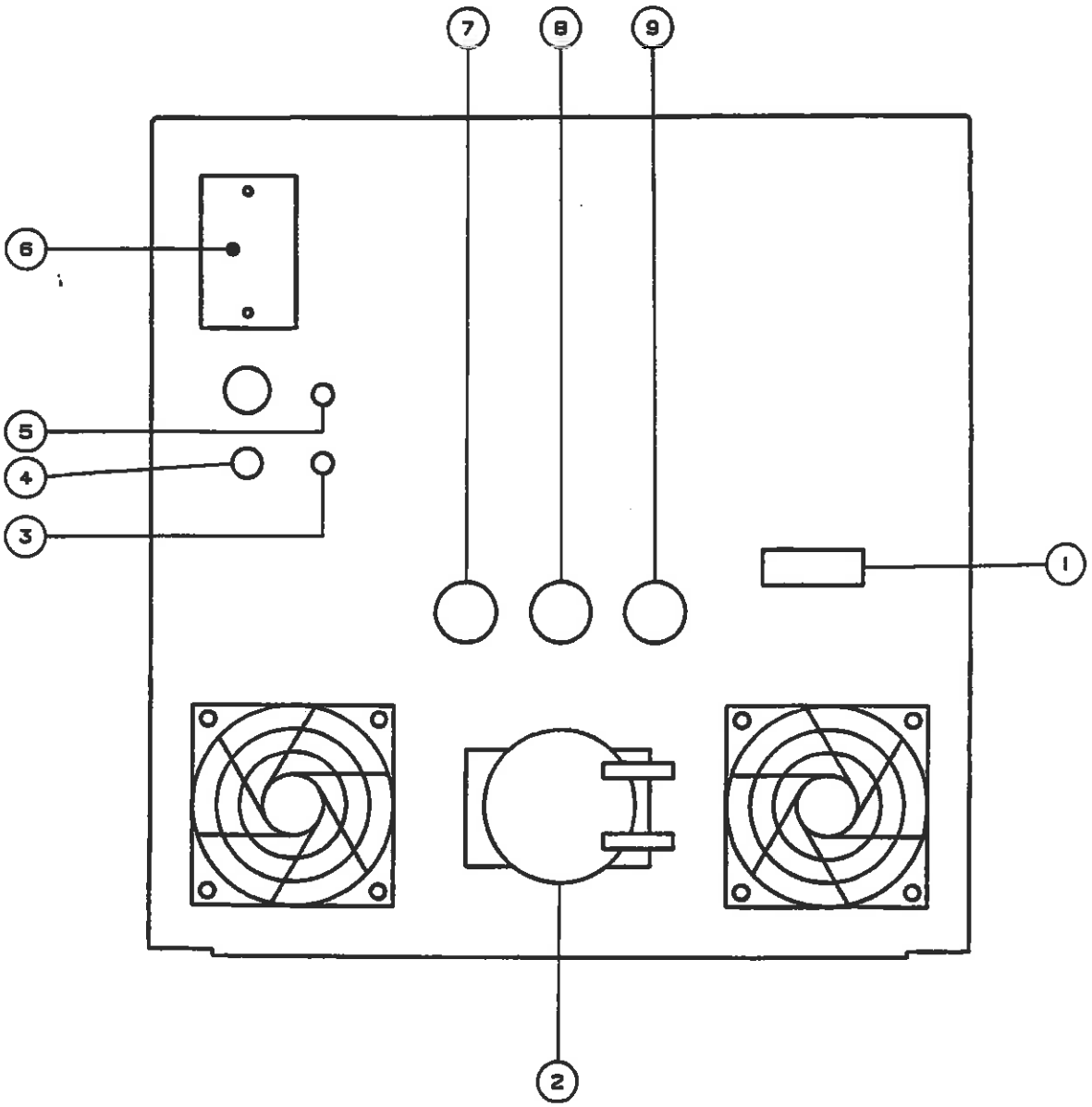


Figure 2-3 Mainframe Rear-Panel Connectors (early, 480V SURGE LINE INPUT-NOW STANDARD on 277V, Version)

13. EXTERNAL INTERLOCK - An external interlock jack is provided for instances where the safety interlock circuit is to be connected to an external test fixture or device. See Section 2.6 for additional information and wiring diagram.

OUTPUT TERMINAL ARRAY:

14. SURGED HIGH - Output terminal, normally HOT conductor when surging AC lines. Also SURGED HIGH connects to surge network output when appropriate coupling mode selected.

15. SURGED LOW - Output terminal, normally Neutral conductor when surging AC lines. Also, the SURGED LOW connects to the surge network output when the appropriate coupling mode is selected.

16. V MON INPUT A (V MON HIGH) - Input terminal, for monitoring the surge voltage at the SURGED HIGH terminal, SURGED GND terminal or at some remote location within the EUT. Input impedance is 10 k ohms.

17. V MON INPUT B (V MON LOW) - Input terminal, for monitoring the surge voltage at the SURGED LOW terminal, SURGED GND terminal or at some remote location within the EUT. Input impedance is 10 K ohms.

18. SURGED GND - Output terminal, connects to chassis (normally safety earth connection). Also, SURGED GND connects to the surge network output when surging in any COMMON MODE coupling.

19. COUPLER/FILTER IN/OUT - Indicator lights used to indicate whether the coupler/filter portion of the Mainframe is in place (IN) or removed for the surge circuit (OUT). The coupler/filter is normally IN when the AC SURGE LINE INPUT breaker is turned ON, and OUT when the AC SURGE LINE INPUT breaker is turned OFF.

    When a surge network is used which produces waves NOT intended to be coupled to live AC lines, (such as the S21 Surge Network, or the telecom waves produced by the S3/S21) the coupler/filter is locked OUT, regardless of the position of the AC SURGE LINE INPUT breaker.

20. PULSE - Switch used to generate surge at output terminals. CHARGE switch must be depressed and SET VOLTAGE adjusted to the desired level.

21. LOW LINE NOT GND - Indicator light illuminates when SURGED LOW terminal is not near earth potential. When the AC SURGE LINE INPUT is connected to an AC power source, normally the HOT conductor of the line is connected to the SURGED HIGH terminal, Neutral is connected to the SURGED LOW terminal and safety ground is connected to the SURGED GND terminal. Under these conditions, Neutral and safety earth should be near the same potential, since they are typically tied together at the building service entrance.

    If, however, Neutral is NOT tied to safety earth, or HOT and Neutral lines become inverted as a result of a wiring error external to the surge generator, the SURGED LOW terminal will NOT be at safety earth. This condition will illuminate the LOW LINE NOT GND indicator. Note, the indicator will flash momentarily in some instances when the surge generator is generating surges. This is not uncommon and should be expected.

22. AC AT OUTPUT - Indicator light illuminates when LIVE AC mains voltage is present between the SURGED HIGH, SURGED LOW and SURGED GND output terminals.

23. COUPLER/FILTER MODE - Switch selection of NORMAL MODE (line-to-line) or COMMON MODE (both lines to ground). Option M-587 adds HIGH TO GND and LOW TO GND coupling modes to mainframes not originally equipped with these modes.

24. SURGE POLARITY - Switch selection of surge polarity, for either positive (+) or negative (-) output surges.

25. CHARGE/PULSE CONTROL, LOCAL/REMOTE - Keyswitch, for user safety, to allow remote charge and pulse control by external circuits. LOCAL control permits only front-panel charge and pulse operation. Option RC-587 is available for Mainframes not originally equipped with this feature. See Section 8 for more details on this option.

26. POWER - System ON/OFF power switch. Supplies system AC power for equipment operation.

27. CHARGE/IL READY - Indicator light illuminates when ALL safety interlock circuits are closed and internal time delay circuits are reset. This time delay occurs after the PULSE switch has been depressed and varies with the surge network installed.

28. CHARGE - Switch used to charge the internal energy storage capacitor. The Charge switch must be released before the time delay circuits begin counting, see CHARGE/IL READY description above. Also, releasing the CHARGE switch before depressing the PULSE switch will discharge the energy storage capacitor very quickly.

29. SET VOLTAGE - Controls the charge voltage level stored on the energy storage capacitor. Rotate the control clockwise to increase the peak delivered open-circuit voltage to the desired level.

30. PEAK OPEN CIRCUIT KILOVOLTS - Digital display of the peak delivered open-circuit voltage determined by the position of the SET VOLTAGE control.

31. OPEN INTERLOCK - Indicator lights used to display the status of the safety interlock circuit, see Section 2.5 for details concerning interlock operation.

2.3.2 Rear Panel Connectors

The following descriptions are referenced to Figure 2-2 and Figure 2-3.

1. SYSTEM AC POWER - Connector, power entry module, fused, refer to Sections 2.2 and 2.4 for further details. Mainframe requires power at this connector to operate. Voltage ranges selectable from 100 Vrms to 240 Vrms.

2. SURGE LINE INPUT - Connector, EUT power source entry before being filtered. Not required to operate the Mainframe. See Section 2.2.3 for additional information. Options are available which will increase the voltage of the filter up to 480 Vrms and current levels up to 30 Arms, see Section 8.1.

3. PHASE REFerence 5/10 VAC - Output, provides a floating (ungrounded) replica of the 50 Hz or 60 Hz AC SURGE LINE INPUT voltage, at an attenuated level: approximately 5 Vrms out for a SURGE LINE INPUT voltage of 120 Vrms and approximately 10 Vrms out for a SURGE LINE INPUT voltage of 240 Vrms.

4. REMOTE CHARGE/PULSE - Input jack for generating remote charging and pulsing when the front panel REMOTE CHARGE/PULSE keyswitch is in the REMOTE position. See Section 8.1.11 for further details concerning wiring details.

5. -180° SYNCH - Output, provides a floating (ungrounded), positive-going trigger signal for an oscilloscope, which will occur at 180 degrees prior to the cycle at which the surge is to be placed.

6. OPTION COVER - Pull securing latches to the OUT position and remove option cover, revealing Option G33-587 (G33-801) signal cable connector if Mainframe is equipped with this option. See Section 8 for further details concerning these options.

The following descriptions are referenced to Figure 2-3, only.

7. SURGE LINE HIGH, F1 - Fuse, SURGE LINE INPUT HIGH (HOT) Line. Replace with type FNQ-30.

8. SURGE LINE LOW, F2 - Fuse, SURGE LINE INPUT LOW (Neutral) Line. Replace with type FNQ-30.

9. SURGE LINE REFERENCE, F3 - Fuse in series with Surge Line Input reference transformer.

2.4 Operation at Other AC Line Voltages

The Mainframe may be operated from an ac power source of 100, 120, 220, or 240 volts (± 10%), 50/60 Hertz. The following procedure is referenced to Figure 2-4. Selection of the desired voltage is made prior to connecting the instrument to the power source in the following way:

1. Make sure line cord is removed from rear panel.

2. Slide clear plastic protector cover from right to left, viewed from rear, covering the line receptacle and uncovering the fuse.

3. Pull fuse ejector out and all the way to the left, ejecting the fuse and providing access to the voltage selector board.

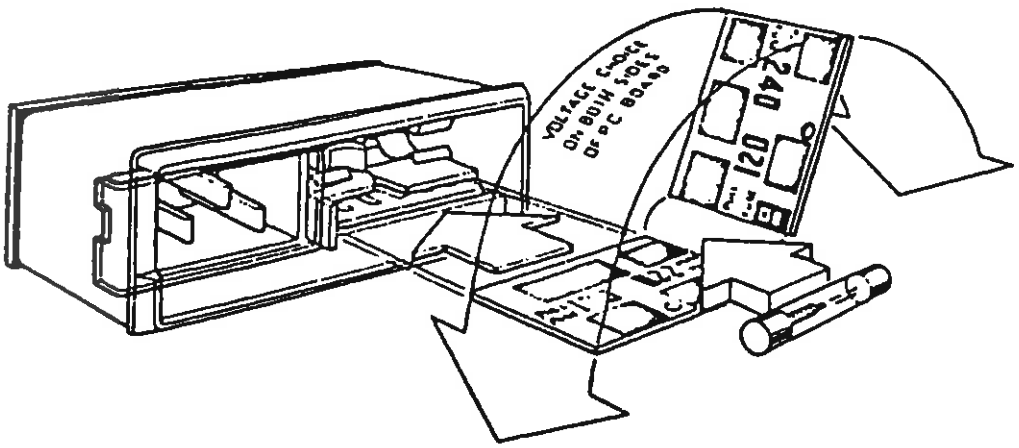
4. Using a pair of long nose pliers, remove the voltage selector board, replacing it in one of the four possible positions with desired voltage designation showing after it is re-installed.

5. Install the covered fuse: 3A Slow-Blow for 100 and 120V operation, 1.5A Slow-Blow for 220 and 240V operation.

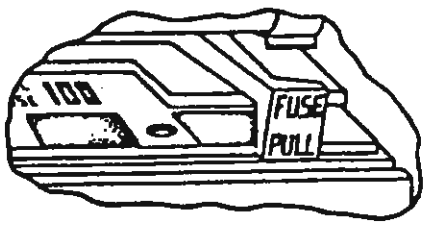
6. Push fuse ejector to the right and all the way back in, slide the clear plastic protector plate back in place over the fuse, and install the line cord in the now-uncovered receptacle.

Power dissipation is approximately 50 watts average, 200 watts maximum. During the capacitor charge, peak line current reaches 15A for about 0.1 second, in 120V AC operation; 7-8A for the same duration in 220-240V operation.

A three-conductor power cable is provided; when it is connected to a standard three-wire outlet, the instrument chassis is connected to power system ground. This prevents the instrument case from assuming voltages hazardous to personnel. In the event an adapter is used to connect the three wire cable to a two-wire outlet the green adapter terminal should be connected to the power system ground.



Operating voltage is shown in module window.



SELECTION OF OPERATING VOLTAGE

1. Open cover door and rotate fuse-pull to left.

2. Select operating voltage by orienting PC board to position desired voltage on top-left side. Push board firmly into module slot.

3. Rotate fuse-pull back into normal position and re-insert fuse in holders, using caution to select correct fuse value.

Figure 2-4 Selection of Operating Voltage

2.5 Unit Interlocks

Safety interlocks are provided in the Mainframe for operator safety. An open interlock condition will be annunciated by one of the OPEN INTERLOCK LED's located just below the SURGE LINE INPUT breaker. If any of these LED's are ON, surge generator operation will be inhibited, and the open interlock in the system must be located and corrected before the unit can be operated.

Interlock conditions and indicators are as follows:

1. HI-V SWITCHES - SURGE POLARITY OR COUPLER/FILTER MODE switch not seated properly.

2. OUTPUT COVER - Plastic output cover missing or not properly seated.

3. SURGE NETWORK - In the 587-PLUS™ or 801-PLUS Mainframes only, the Surge Network is not properly seated in the mainframe, or the WAVE SELECTION switch not properly seated.

4. WAVE SELECTOR - In the Model 587 only , the WAVE SELECTION switch is not properly seated.

5. NO AC LINE GND - Internal circuitry tests for the presence of third-wire ac line (green) ground. If ac line ground is not present, this interlock light will be activated. NEVER ATTEMPT TO OPERATE THE MAINFRAME FROM AN UNGROUNDED AC RECEPTACLE.

6. THERMAL - Internal thermal interlocks are provided to prohibit generator operation if overheating occurs.

7. EXTERNAL - An external interlock is open.

8. SET VOLTAGE > 7kV OR EXTERNAL IL - With S21H Surge Network only , the charge switch has been activated and the PEAK OPEN-CIRCUIT VOLTAGE CONTROL is set > 7 kV or an EXTERNAL INTERLOCK is open. When this interlock opens due to the SET VOLTAGE > 7 kV condition, operation of the interlock is momentary and will reset after approximately 10 seconds allowing Mainframe to charge again. When this condition exists, reduce the charge voltage by turning the SET VOLTAGE control counter-clockwise.

2.6 External Interlocks

The interlock circuit can be extended to a remote test fixture or enclosure.

If the External Interlock is in use, the interlock switch must be closed in whatever auxiliary external equipment is connected to it. Note that if the External jack is not in use, then internal terminals in the jack automatically short out this interlock, so that normal operation of the instrument will not be inhibited. Only if the jack is interfaced with an external interlock system -- such as a door on a test chamber or fixture, can the jack interrupt operation.

The special Type 482 jack is used in order to guarantee that there is no intermediate position for the plug, between fully removed and fully inserted, that will allow the unit to drop back into the "plug removed" situation. The Type 482 has a dead-contact ring that holds the internal telephone jack connections open once they have been opened, unlike standard plugs and jacks.

The Type 482 and its mating jack mounted on the Surge Network front panel are both military-type, heavy-duty units, with high mechanical stability and the connection advantages of gold-plating.

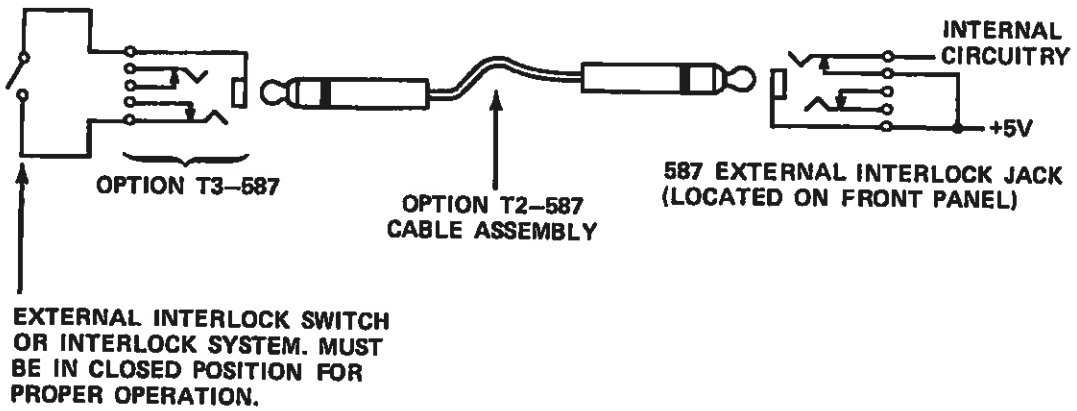


Figure 2-5 External Interlock Wiring

3. Coupler/Filter Operation - G33

3.1 Introduction

To effectively use the Model G33 Coupler/Filter the operation and capabilities of this surge generating test equipment must be know. This section provides preliminary operating instructions and describes operation of controls and connectors.

This equipment is to be operated by qualified personnel only.

3.2 AC Power Sources

3.2.1 System AC Power

This equipment is intended to be operated from a single-phase, earth-referenced power source having one current carrying conductor (the Neutral Conductor) near earth potential. It is not recommended to operate this equipment from power sources where both conductors are live with respect to earth because only the HOT or Line Conductor is fused against over-current conditions within this equipment.

Should an attempt be made to operate this equipment from an ac power source that does not have a Neutral Conductor near earth potential, an open interlock condition will occur prohibiting the equipment from generating high voltage, see Section 2.5.

The Model G33 is equipped with a three-conductor power cord for connection to an ac power source and safety-earth. The safety-earth terminal is connected directly to the Model G33 chassis. This is required for electrical-shock prevention. Install the power cord into an outlet with a safety-earth contact or otherwise connect the Model G33 chassis to a suitable safety-earth system.

3.2.2 Operating Voltage

The Model G33 can be operated from either a 120 Vrms or a 220 Vrms nominal line-voltage source. In addition, the Model G33 can be operated at other line voltages. Follow the procedure outlined in Section 2.4 to obtain correct instrument operating from other line voltages available.

3.2.3 Surge Line Input Power Source

The SURGE LINE INPUT is a separate, totally independent, power source used for providing power to the Equipment Under Test (EUT), connected to the front panel output terminals. This power source is intended to be a three-phase, five wire ac source with up to 480 Vrms maximum line-to-line voltage. Maximum line-to-neutral voltage is up to 277 Vrms.

The Model G33-(277/480)-20 is capable of supplying a maximum continuous AC surge line current of 20 Arms. While, the Model G33-(277/480)-30 is rated for a maximum continuous current of 30 Arms.

The Model G33 requires the System AC power to operate, but does not require the SURGE LINE INPUT power source, unless conducting powered surge testing at the EUT.

3.3 Controls and Connectors

The major controls for operating the Model G33 are located on the front panel of the instrument. These are illustrated in Figure 3-1. Figure 3-2 shows the location of rear panel controls and connectors.

The following is a description of the controls and connectors shown in Figures 3-1 and 3-2.

3.3.1 Front Panel Controls and Connectors

The following descriptions are referenced to Figure 3-1.

1. SURGE LINE INPUT - Circuit breaker used to provide power to the EUT (Model G33 output terminals) when conducting ac powered surge testing.

2. AC MAINS VOLTAGE - Indicator lights used to indicate the presence of AC mains voltage on each phase or the Neutral conductor.

SURGE PHASE ANGLE REFERENCE:

3. L1 - Switch/Indicator, surge impulse will be synched with respect to Line 1 of the AC power source. Phase angle is selected at the Mainframe. Indicator light turns ON when switch is depressed.

4. L2 - Switch/Indicator, surge impulse will be synched with respect to Line 2 of the AC power source. Phase angle is selected at the Mainframe. Indicator light turns ON when switch is depressed.

5. L3 - Switch/Indicator, surge impulse will be synched with respect to Line 3 of the AC power source. Phase angle is selected at the Mainframe. Indicator light turns ON when switch is depressed.

SURGE COUPLING MODE:

6. N - Switch/Indicator, used to connect the surge network output or "SURGE HIGH" to the Neutral Output Terminal.

   L1 - Switch/Indicator, used to connect the surge network output or "SURGE HIGH" to the L1 Output Terminal.

   L2 - Switch/Indicator, used to connect the surge network output or "SURGE HGIH" to the L2 Output Terminal.

   L3 - Switch/Indicator, used to connect the surge network output or "SURGE HIGH" to the L3 Output Terminal.

   Note, any one line or all lines may be selected and surged simultaneously.

7. GND - Switch/Indicator, used to connect the surge network output or "SURGE LOW" to the GrouND Output Terminal.

   N - Switch/Indicator, used to connect the surge network output or "SURGE LOW" to the Neutral Output Terminal.

   L1 - Switch/Indicator, used to connect the surge network output or "SURGE LOW" to the L1 Output Terminal.

   L2 - Switch/Indicator, used to connect the surge network output or "SURGE LOW" to the L2 Output Terminal.

   L3 - Switch/Indicator, used to connect the surge network output or "SURGE LOW" to the L3 Output Terminal.

   Note, only ONE line may be selected at any time. Also, the SURGE HIGH Coupling Mode selected is automatically turned off when the simliar SURGE LOW

line is selected. For example, given the following Surge Coupling Mode selection:

SURGE HIGH -		N	L1	L2	L3
		ON	ON	ON	ON
SURGE LOW -	GND	N	L1	L2	L3
	ON	OFF	OFF	OFF	OFF

Selecting, SURGE LOW, L1, would result in the following:

SURGE HIGH -		N	L1	L2	L3
		ON	OFF	ON	ON
SURGE LOW -	GND	N	L1	L2	L3
	OFF	OFF	ON	OFF	OFF

OUTPUT TERMINAL ARRAY (SURGED AC OUTPUTS):

8. L1 - Output terminal, normally HOT conductor when surging AC lines. Also L1 connects to surge network output when appropriate coupling mode selected.

9. L2 - Output terminal, normally L2 conductor when surging AC lines. Also, L2 connects to the surge network output when the appropriate coupling mode is selected.

10. L3 - Output terminal, normally L3 conductor when surging AC lines. Also, L3 connects to the surge network output when the appropriate coupling mode is selected.

11. N - Output Terminal, normally Neutral conductor when surging AC lines. Also, Neutral connects to the surge network output when the appropriate coupling mode is selected.

12. GND - Output terminal, connects to chassis (normally safety earth connection). Also, GND connects to the surge network output when surging in any COMMON MODE coupling.

13. REMOTE/LOCAL - Indicator lights used to indicate whether the coupler/filter and Mainframe are in manual (LOCAL) or automatic (REMOTE) mode, as determined by the LOCAL/REMOTE keyswitch on the Mainframe front panel.

14. OPEN INTERLOCK - Indicator light illuminates when open interlock condition exists. Check output covers, HV cable, or turn POWER switch ON.

15. AC AT OUTPUT - Indicator light illuminates when LIVE AC mains voltage is present at the Model G33 output terminals.

SURGE INPUT:

16. ALIGNMENT - Terminal used for cable alignment. Connected to CHASSIS in some cases.

17. SURGE LOW - Input terminal, connects with SURGED LOW terminal on Mainframe, via, HV Surge Cable.

18. SURGE HIGH - Input terminal, connects with SURGED HIGH terminal on Mainframe, via, HV Surge Cable.

19. POWER - System ON/OFF power switch. Supplies system AC power for G33 operation.

3.3.2 Rear-Panel Connectors

The following descriptions are referenced to Figure 3-2.

1. SYSTEM AC POWER - Connector, power entry module, fused, refer to Sections 3.2 and 2.4 for further details. Model G33 requires power at this connector to operate. Voltage ranges selectable from 100 Vrms to 240 Vrms.

2. SURGE LINE INPUT - Connector, EUT power source entry before being filtered. Not required to operate the Model G33. See Section 3.2.3 for additional information.

3. LOW VOLTAGE INTERFACE Cover - Pull securing latches OUT and remove cover, revealing the LOW VOLTAGE INTERFACE signal cable connector. Low voltage control signals, coming from Mainframe, interface with Model G33 here.

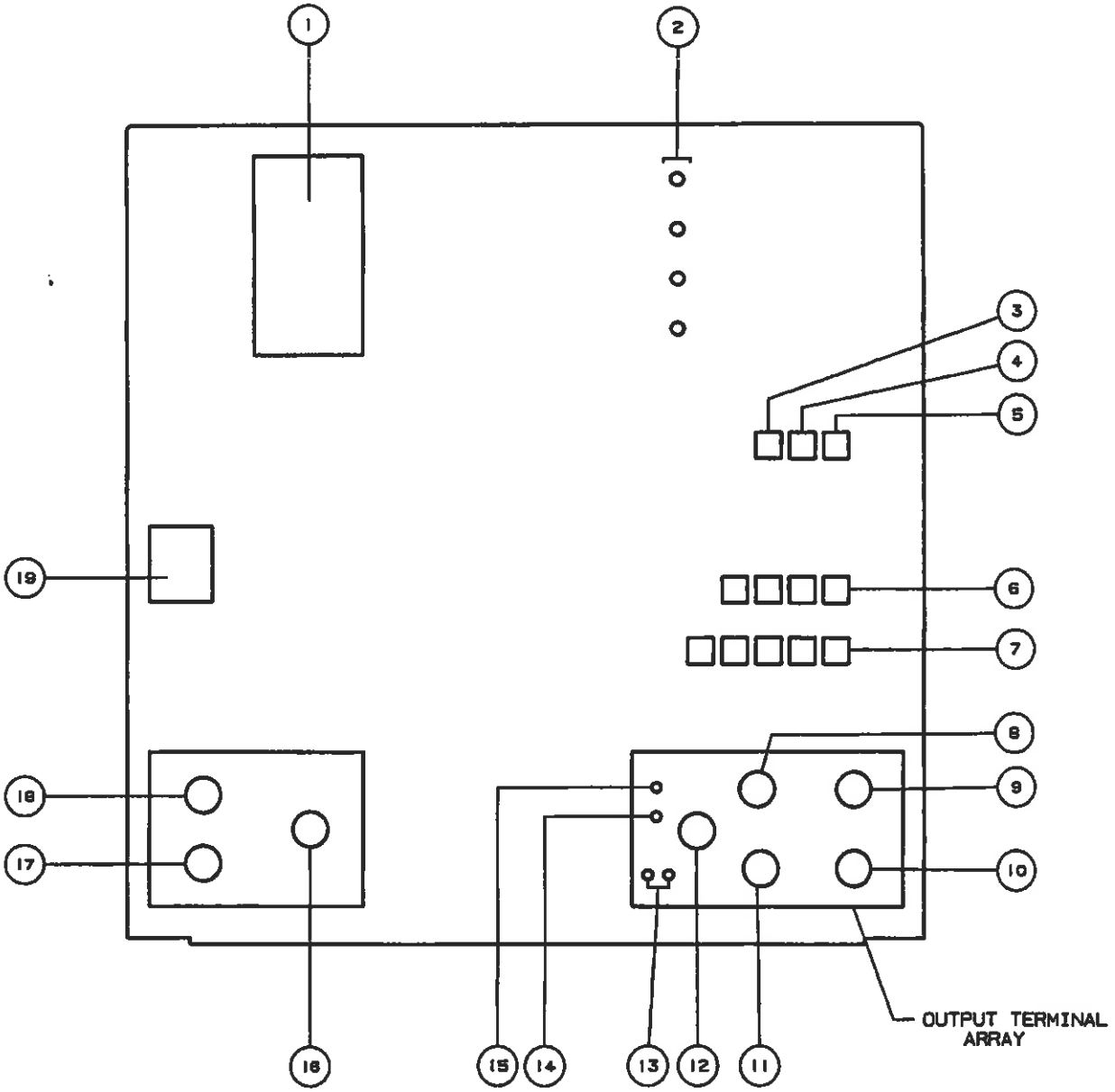


Figure 3-1 Model G33 Front-Panel Controls and Connectors

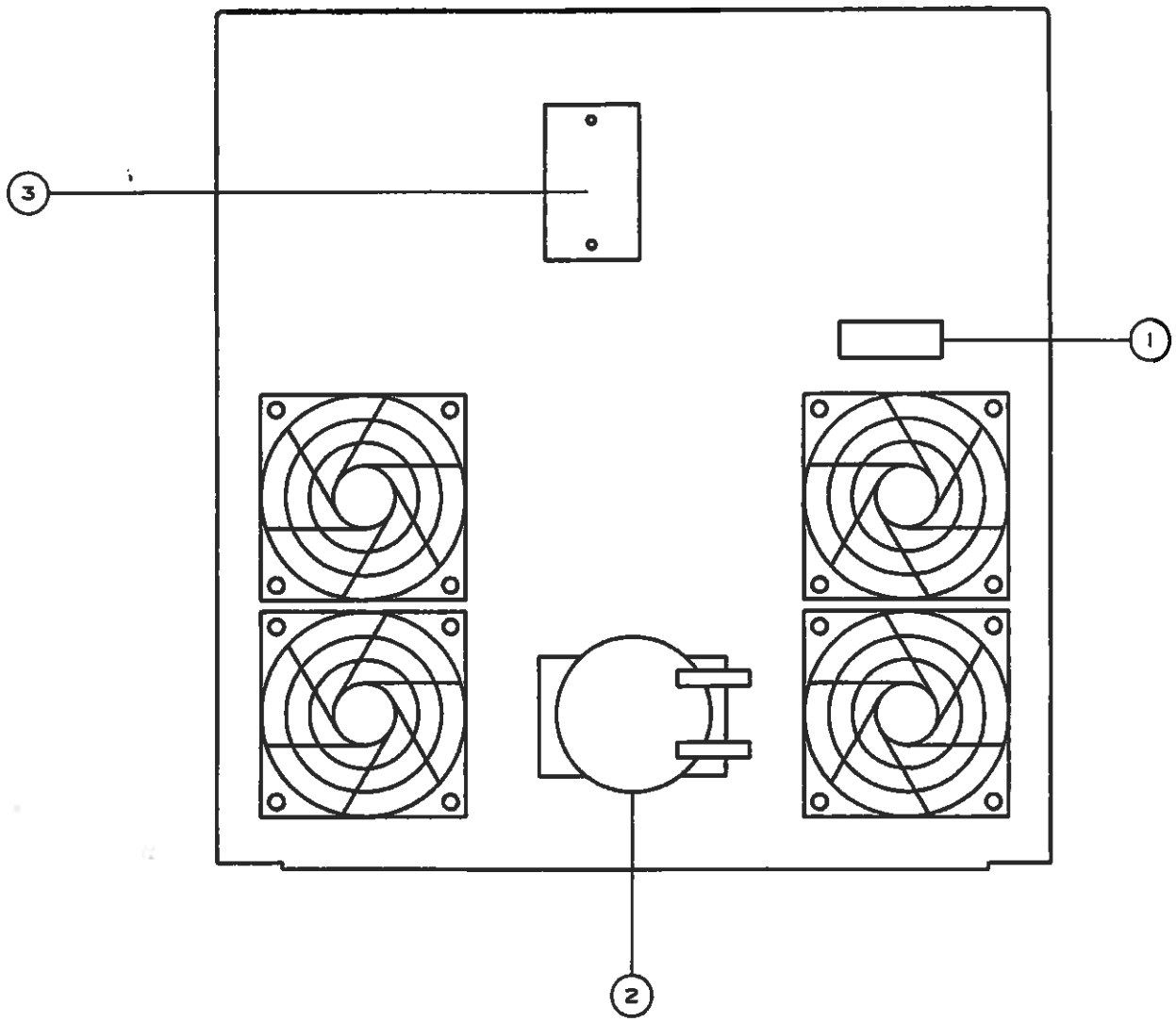


Figure 3-2 Model G33 Rear-Panel Connectors

3.4 Setup Procedure

1. Before interfacing the Model G33 with the Mainframe, turn the Mainframe POWER switch OFF. See Section 2.3.1, Item 26 and Figure 2-1.

2. Turn the G33 POWER switch OFF. See Section 3.3.1, Item 19, and Figure 3-1.

3. Connect the LOW VOLTAGE SIGNAL CABLE, end marked "Conn. To 587/801", to the Mainframe, via the OPTION COVER. See Section 2.3.2, Item 6, and Figure 2-2.

4. Connect the LOW VOLTAGE SIGNAL CABLE, end marked "Conn. To G33", to the G33, via the LOW VOLTAGE INTERFACE COVER. See Section 3.3.2, Item 3, Figure 3-2.

5. Connect the HV SURGE CABLE to the Mainframe Output Terminal Array and the G33 SURGE INPUT.

6. Set the Coupler/Filter Mode switch on the Mainframe to the NORMAL MODE position.

7. Connect the SYSTEM AC POWER and the SURGE LINE INPUT to the G33. See Section 3.3.2, Items 1 and 2, and Figure 3-2.

8. Turn ON the POWER switches to both the Mainframe and G33. See steps 1 and 2 above.

9. Install the Output Cover over the SURGED AC OUTPUTS terminals.

Setup procedure is complete. The G33 defaults to the following parameters.

SURGE ANGLE PHASE REFERENCE	-	L1
SURGE COUPLING MODE (surge high)	-	N
(surge low)	-	GND

With the HV SURGE CABLE installed, the Mainframe filter cannot be turned ON. This prevents the possibility of damaging the Mainframe or G33.

To switch back to single phase surging, using the Mainframe, remove the HV SURGE CABLE from the Mainframe and G33, remove the Output Cover from the G33 and install at the Mainframe Output Terminal Array. Removal of the LOW VOLTAGE SIGNAL CABLE is not necessary.

4. Theory of Operation

1. Installation and Initial Turn-On

1.1 Connections

1. Make sure the power ON-OFF switch and SURGE LINE INPUT breaker switch (Fig. 1-1) are in the OFF position.

2. For MODEL 587-PLUS™ ONLY: Insert the desired Surge Network into the Model 587-Plus™ mainframe and make sure the retaining screws on the front panel are screwed in finger tight.

3. Cover the Output Terminals with the plastic safety cover provided. NOTE: This cover is interlocked to prevent surge generator operation if it is removed.

4. Connect the ac power line cord from the ac input connector located on the rear panel to an appropriate ac source.* (See Fig. 1-2.)

*The Model 587 Mainframe is normally shipped to operate from 220 Vac (±10%), 60Hz (for units shipped to U.S. or Canadian locations) or 240 Vac (±10%) 50Hz (for units shipped overseas). For operation at other ac line voltages, refer to Appendix A, "Operation at Other AC Line Voltages".

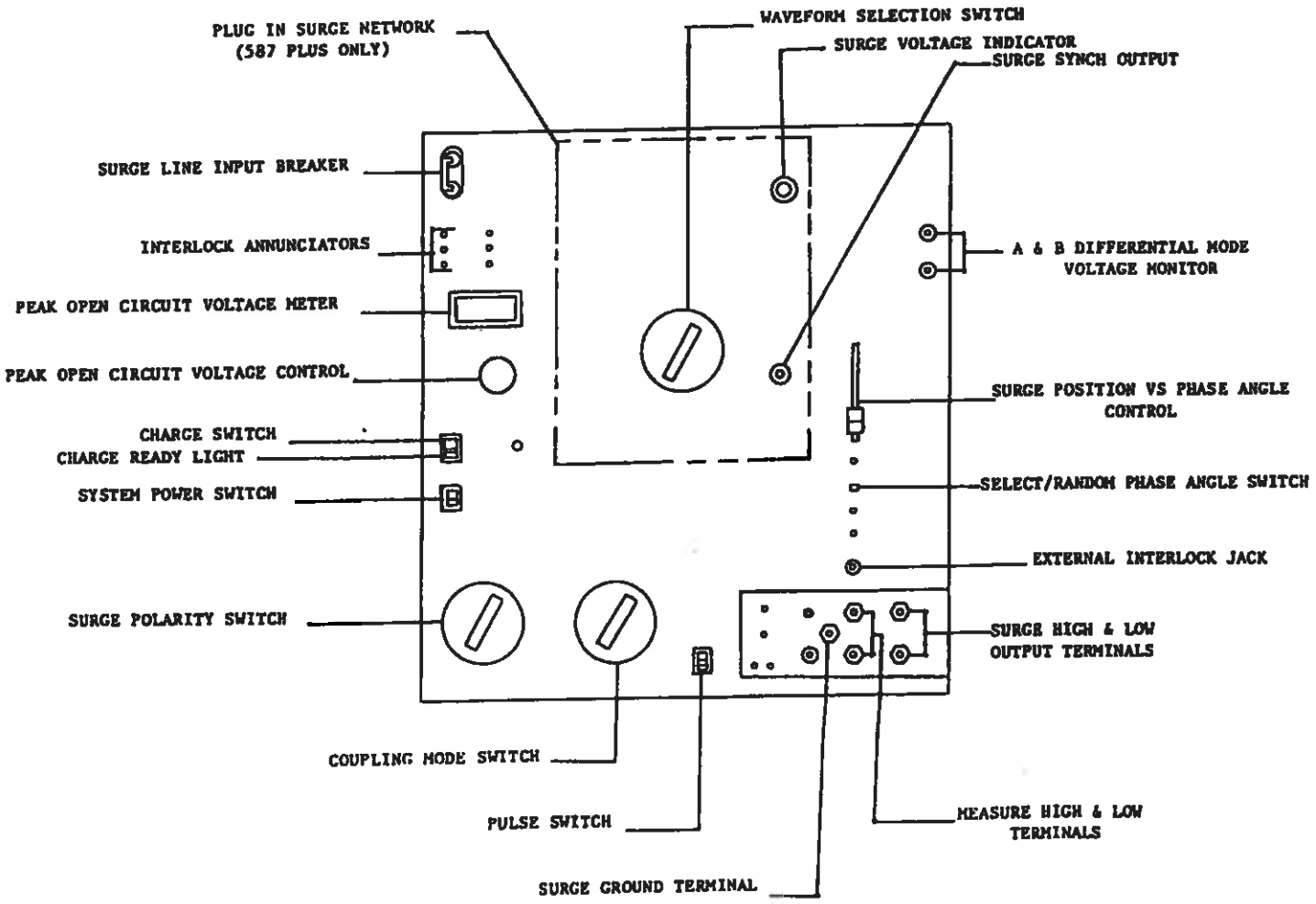


Figure 1-1

Model 587 Front Panel

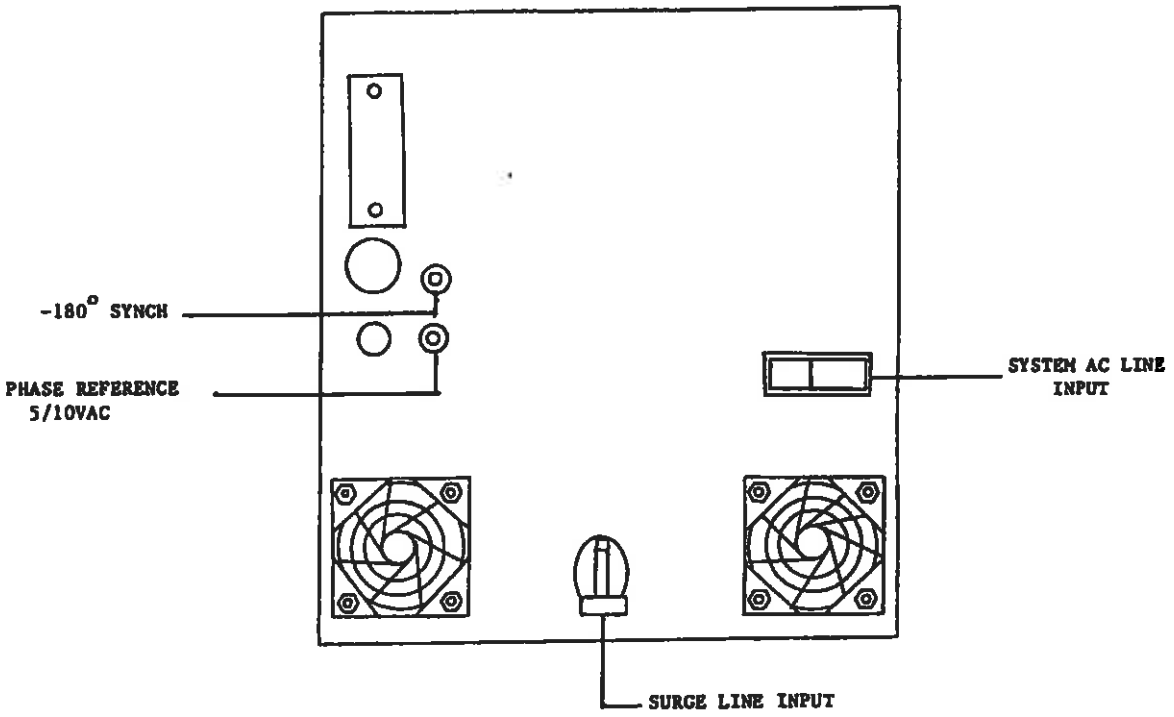


Figure 1-2

Model 587 Rear Panel

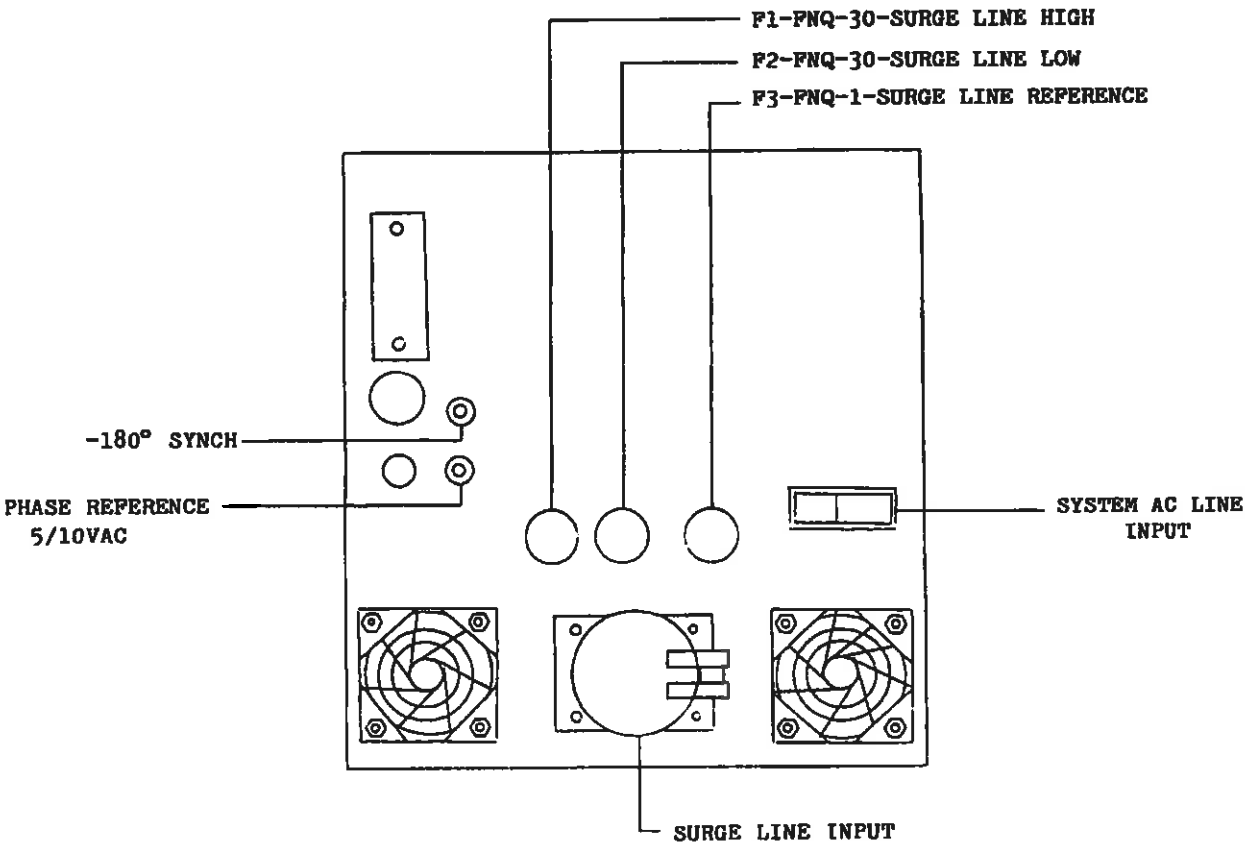


Figure 1-3

Model 587 Rear Panel With Option F2
480V Surge Line Input

1.2 Initial Turn-On (Refer to Fig. 1-1 for location of controls and indicators.)

1. Turn the power ON-OFF switch to the ON position. After a short delay, the READY light (located next to the CHARGE switch), will be ON. The Open Interlock lights should all be OFF. (If any of the interlock lights are on, refer to Section 2, "Interlocks".)

2. Select CHARGE + or - operation by pulling the SURGE POLARITY switch towards you. (An INTERLOCK light will turn on as the switch is loosened.) The switch itself is captive and spring loaded, and cannot be fully removed from its socket. Turn the switch to select the desired polarity. Reseat the switch firmly into the unit, until the interlock light goes out.

3. Using the COUPLER/FILTER MODE switch, select NORMAL MODE. This switch operates like the SURGE POLARITY switch in 2. above.

4. Remove any jumpers or cables from the Output Terminals.

5. Turn the SET VOLTAGE knob fully counter-clockwise.

6. Depress the CHARGE switch. The green CHARGE/READY light will turn OFF. While holding the CHARGE switch depressed, turn the SET VOLTAGE control clockwise. The digital charge meter will indicate the peak open-circuit output voltage that will be delivered when the Pulse Switch is subsequently depressed. If the CHARGE switch is released without depressing the PULSE switch, the charge voltage, as indicated on the digital meter, will fall quickly to zero.

7. While holding the CHARGE switch depressed, set the digital meter to the desired voltage. During charge, the amber HIGH VOLTAGE light will turn on. A surge can now be initiated by depressing the PULSE switch, while still holding the CHARGE switch depressed. Releasing the CHARGE switch at any time will cause the voltage to drop to zero, and prevent the unit from firing.

8. When the PULSE switch is depressed, a pulse will appear between the SURGE HIGH and SURGE LOW output teminals. The amber HIGH VOLTAGE light in the Surge Network will go off, and the digital charge meter will drop to zero.

WARNING: If the amber HIGH VOLTAGE light on the Surge Network does not go OFF, High Voltage is still present, possibly on the output terminals. The unit is malfunctioning; it should be turned off and the factory contacted immediately.

This completes the initial installation and operation of the Model 587. For output connections, see the appropriate Operating Instruction Section.

2. Unit Interlocks

Interlocks are provided in the 587 mainframe as a safety measure. An open interlock condition will be annunciated by one of the OPEN INTERLOCK lights located just below the SURGE LINE INPUT breaker. If any of these LED's are on, surge generator operation will be inhibited, and the open interlock in the system must be located and corrected before the unit can be operated.

Interlock conditions and indicators are as follows:

1. HI-V SWITCHES - SURGE POLARITY OR COUPLER/FILTER MODE switch not seated properly.

2. OUTPUT COVER - Plastic output cover missing or not properly seated.

3. SURGE NETWORK - In the 587-PLUS™ only, the Surge Network is not properly seated in the mainframe, or the WAVE SELECTION switch not properly seated.

4. WAVE SELECTOR - In the Model 587 only, the WAVE SELECTION switch not properly seated.

5. NO AC LINE GND - Internal circuitry tests for the presence of third-wire ac line (green) ground. If ac line ground is not present, this interlock light will be activated. NEVER ATTEMPT TO OPERATE THE MODEL 587 OR MODEL 587-PLUS™ FROM AN UNGROUNDED AC RECEPTACLE.

6. THERMAL - Internal thermal interlocks are provided to prohibit generator operation if overheating occurs.

7. EXTERNAL* - An external interlock is open

*The interlock circuit can be extended to a remote test fixture or enclosure. For interlock plug information, see Section 3, "External Interlocks".

3. External Interlocks

If the External Interlock is in use, the interlock switch must be closed in whatever auxiliary external equipment is connected to it. Note that if the External Jack is not in use, then internal terminals in the Jack automatically short out this interlock, so that normal operation of the instrument will not be inhibited. Only if the Jack is interfaced with an external interlock system -- such as a door on a test chamber or fixture, can the Jack interrupt operation.

The special Type 482 jack is used in order to guarantee that there is no intermediate position for the plug, between fully removed and fully inserted, that will allow the unit to drop back into the "plug removed" situation. The Type 482 has a dead-contact ring that holds the internal telephone jack connections open once they have been opened, unlike standard plugs and jacks.

The Type 482 and its mating jack mounted on the Surge Network front panel are both military-type, heavy-duty units, with high mechanical stability and the connection advantages of gold-plating.

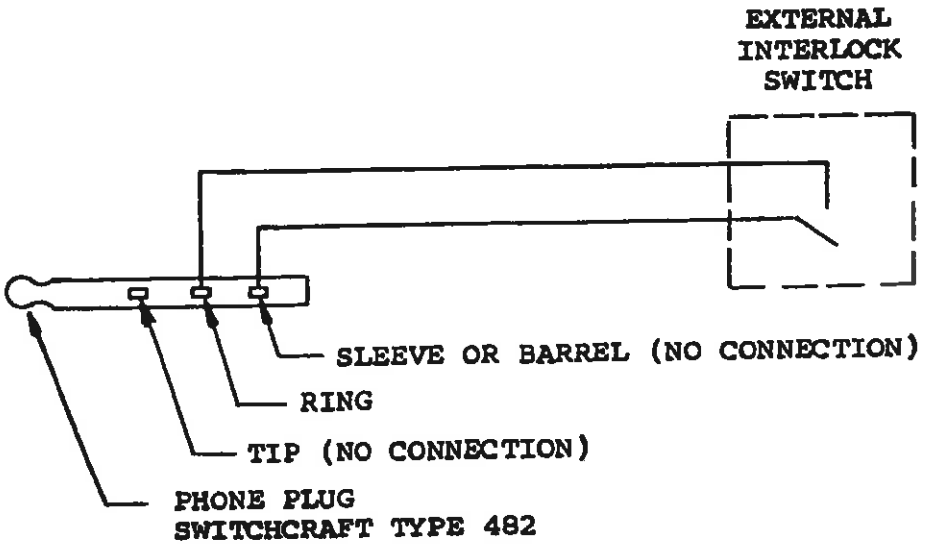


Figure 3-1

4. Output Terminal Array and Indicators

4.1 Indicators

4.1.1 AC AT OUTPUT

Indicates LIVE AC is present between the SURGE HI and SURGE LO terminals.

4.1.2 LOW LINE NOT AT GROUND

When the AC surge line is connected to an AC source, normally the "hot" side of the line is connected to the SURGE HI terminal, neutral is connected to the SURGE LO terminal, and ground to the GND terminal. Under these conditions, neutral and ground should both be at ground potential, since neutral and ground are normally tied together at the ac service entrance.

If, however, neutral is NOT tied to ground, or high and neutral lines become inverted as the result of a wiring error external to the surge generator, the SURGE LO (normally neutral at ground potential) will NOT be at ground. This will be annunciated via the LOW LINE NOT AT GROUND LED.

4.1.3 COUPLER/FILTER IN/OUT

Two LEDs exist to annunciate whether the coupler/filter portion of the Model 587 is in place (IN) or removed from the surge circuit (OUT). The coupler/filter is normally IN when the AC SURGE LINE BREAKER is turned ON, and OUT when the AC SURGE LINE BREAKER is turned OFF.

When a Surge Network is used which produces waves NOT intended to be coupled to live ac lines, (such as the S21, or the telecom waves produced by the S3/S21) the coupler/filter is locked OUT, regardless of the position of the AC SURGE LINE BREAKER.

4.2 Output Terminals

4.2.1 The ouput terminal array consists of 5 terminals as follows:

SURGED GND - Chassis Ground (Normally third wire "green" ground when surging live ac lines)

SURGED HI - Connects to the surge generator high ouput (Normally ac high when surging live ac lines)

SURGED LO - Connects to the surge generator low outputs (Normally ac neutral when surging live ac lines)

V MON HI* - For monitoring the surge voltage, connects to one side of ac line, or the circuit input to be monitored.

V MON LO* - For monitoring the surge voltage, connects to the opposing side of the ac line, or circuit input to be monitored.

*See Secton 6. Voltage Monitoring

5. Line-Synch Operation

Placement of the surge wave with respect to the ac voltage phase is accomplished via front panel slide control, and is continuously variable from 0 to 360 degrees. Line synch operation on 50Hz or 60Hz lines is automatically selected and annunciated via LEDs.

The SURGE LINE ON AND SELECT indicates that all conditions for LS operation have been met:

a. Surge line AC is connected to an AC source and Surge Line Breaker is turned on.

b. SELECT/RANDOM Switch is in the SELECT position.

NOTE: If LS light is not on, check before proceeding as surge will not be synched with the line.

5.1 Outputs

The Mainframe has two outputs which are available from rear panel BNC connectors. Refer to Fig. 2-2 and 2-3 Mainframe Rear Panel, for location.

1. -180° SYNCH

Provides a floating (i.e., ungrounded) positive trigger signal for an oscilloscope, which will occur at 180 degrees prior to the cycle in which the surge is to be placed.

2. PHASE REFERENCE 5/10 VAC

Provides a floating (i.e., ungrounded) replica of the 50Hz or 60Hz ac surge line voltage, at an attenuated level: approximately 5 Vrms out for a surge line voltage of 120 Vrms, 10 Vrms out for a 240 Vrms surge line.

5.2 Oscilloscope Display of Line-Synch Operation

For oscilloscope display, because of problems associated with scope writing speed, it is ordinarily difficult simultaneously to show both the narrow surge and the comparatively long, ac power-line frequency sine wave on which it is superimposed and to which it is synchronized in phase. In addition to the difference

in writing speeds for the two waves, there is usually the problem of grounds as well; the ac line is a dangerous and uncertain place on which to connect the scope, and the surge itself may be ungrounded.

For the above reasons, the MAINFRAME provides a scope synch output, at -180° on the ac line and a reduced -- 5% of input--phase-accurate version of the ac line to which the output is synched. Both of these auxiliary output signals are floating, so that when they are grounded at the scope no ground loops will be introduced. (The coax connectors on the Mainframe rear panel are insulated from the panel on which they are mounted.)

Equally important, it is possible with many scopes to intensify a small portion of a large wave, with the intensified portion under position control of an external synch signal. (If it is not, the intensification location can still be controlled via a delay adjust on the scope, but with less precision than a few microseconds out of many milliseconds -- desirable to see a narrow surge on an ac line wave.) NOTE: To take full advantage of the external-synch feature for the intensified portion of the sweep, it is necessary to obtain a pre-trigger from the Mainframe front panel. (See fig. 2-1; SURGE SYNCH output.)

Using the scope's intensification mode makes it possible to display the surge and the ac line sine wave at the same time, with reasonably good intensity balance for both.

Settings are provided for several popular Tektronix oscilloscope configurations, which can easily be transposed for any other oscilloscope having equivalent capabilities. Table 5-1 shows scope connections; Tables 5-2, 5-3 and 5-4 describe the scope control settings for the Tektronix 7834, 7633 and 466 respectively. Scope connections and settings are also provided for the Tektronix 7603 with 7D20 Digitizer.

Using the connections and settings from the tables will make possible displays similar to those of Fig. 5-1. Surges at 0, 90, 180, 270 and 360 degrees, Figs. 5-1 (a) through (e) respectively, are shown for a 100KHZ Ring Wave, superimposed on a 60 Hz line.

For the photos of Fig. 5-1 the scope synch output was changed at the factory to occur at 0° for display purposes.

Table 5-1

SCOPE CONNECTIONS FOR LS OPTION DISPLAY
(Tektronix 7834, 7633, 466 or equivalent)

	From	Location	To	Signal
1.	Model 587 A & B Differential Mode Voltage Monitor, A coax (B coax no connection)	Model 587 front panel	Scope CH1 input	Scaled version of Model 587 output pulse: 5V full range (i.e.,5V=10kV for P1,P3).
2.	Phase Reference 5/10 VAC output coax from 587 (Replica)	Model 587 Rear Panel Coax	Scope CH2 input	AC: scaled version of line to which the LS circuitry is synched(i.e., surge line input). NOTE: front panel surge line input breaker must be ON to obtain this signal.
3.	Surge Synch output	587 Front panel coax (ungrounded)	Scope DLY'D TRIG IN	Pre-surge, quasisquare wave trigger, lasting beyond 5 usec. +5 to +8V amplitude.
4.	-180° Synch Output	Model 587 Rear Panel Coax	Scope MAIN TRIG IN	Synch at -180° with respect to ac line to which the LS circuitry is synched (i.e., surge line input). NOTE: front panel surge line input breaker must be ON to get signal.

Table 5-2

SCOPE SETTINGS FOR LS DISPLAY
(Tektronix 7834 with 7A18 and 7B92A or equivalent)

	CONTROL	SETTING
1.	MAIN TRIGGERING	
	A. MODE	SINGLE SWEEP
	B. COUPLING	AC HF REJ
	C. SOURCE	EXT
	D. SLOPE	+
	E. LEVEL	Approximately 1 o'clock position
2.	TIME/DIV	5msec/div
3.	Gray/black "PULL FOR ALT" knob	pull out and set at 10 usec for the ring wave, .1msec for the impulse wave.
4.	TRACE SEP	Full CCW
5.	Time base INTENSITY	Approximately 3 o'clock position
6.	DELAY TIME MULT	0
7.	DELAY TRIGGERING	
	A. SLOPE	+
	B. COUPLING	DC
	C. SOURCE	EXT
	D. LEVEL	Approximately 1 o'clock position
8.	External Trigger Input	50
9.	DISPLAY MODE	Add
10.	TRIGGER SOURCE	MODE
11.	CHANNEL 1	
	A. VOLTS/DIV	1 Volt/div
	B. COUPLING	DC
12.	CHANNEL 2	
	A. VOLTS/DIV	5 Volts/div
	B. COUPLING	DC
13.	Storage mode	VAR PERSIST

Table 5-3

SCOPE SETTINGS FOR LS DISPLAY
(Tektronix 7633 with 7A18 and 7B53A or equivalent)

	CONTROL	SETTING
1.	MAIN TRIGGERING	
	A. MODE	SINGLE SWEEP
	B. AMPLIFIER SOURCE	DC, EXT
	C. SLOPE	+
	D. LEVEL	Approximately 1 o'clock position
2.	TIME/DIV	5msec/div
3.	DLY'D TRIG LEVEL	Full CCW
4.	DLY TIME MULT	Full CCW
5.	Gray/black VARIABLE knob	Pull and set a 1 usec for the ring wave, 10 usec for the impulse wave
6.	Red CAL knob	Pull
7.	DISPLAY MODE	Add
8.	TRIGGER SOURCE	MODE
9.	CHANNEL 1	1 Volt/div
10.	CHANNEL 2	5 Volts/div

Table 5-4

SCOPE SETTINGS FOR LS DISPLAY
(Tektronix 466 or equivalent)

	CONTROL	SETTING
1.	MAIN TRIGGERING	
	A. MODE	SINGLE SWEEP
	B. COUPLING	AC HF REJ
	C. SOURCE	EXTERNAL
	D. SLOPE	+
	E. LEVEL	Approximately 1 o'clock position
2.	DELAY TRIGGER	
	A. MODE	SINGLE SWEEP
	B. SOURCE	EXTERNAL
	C. COUPLING	HF REJECT
	D. SLOPE	+
	E. LEVEL	Approximately 1 o'clock position
3.	DELAY TIME POSITION	FULL CCW
4.	MAIN SWEEP	5msec/div
5.	DELAY SWEEP	Pull and set at 2 usec for the ring wave, 20 usec for the impulse wave
6.	HORIZONTAL DISPLAY MODE	A INTENSIFY
7.	VERTICAL DISPLAY MODE	ADD
8.	CHANNEL 1	.5 Volt/div DC
9.	CHANNEL 2	5 Volts/div DC
10.	STORAGE MODE	VARIABLE PERSIST.

Table 5-5

SCOPE CONNECTIONS FOR LS DISPLAY
(Tektronix 7D20 Digitizer* or equivalent)

	From	Location	To	Signal
1.	Model 587 A & B Differential Mode Voltage Monitor, A coax (B coax no connection).	Model 587 front panel	Scope CH1 input	Scaled version of Model 587 output pulse: 5V full range (i.e., 5V=10kV).
2.	Phase Reference 5/10V AC output coax from 587 (Replica)	Model 587 Rear Panel Coax	Scope CH2 input	AC: scaled version of line to which the LS is synched (i.e., rear surge line input.) NOTE: front panel surge line breaker must be ON to obtain this signal.
3.	-180° Synch Output	Model 587 Rear Panel Coax	Scope MAIN TRIG IN	Synch at -180° with respect to ac line to which the LS circuitry is synched(i.e., rear surge line input.) NOTE: front panel surge line input breaker must be ON to obtain this signal.

* For 1.2 x 50us voltage; 8 x 20us current event capture only. The 7D20 sample interval at 2ms/div is 20us. The Ring Wave is a damped 100kHz cosine wave, resulting in too short an event for repeatable and easily interpreted event capture at 20us/sample.

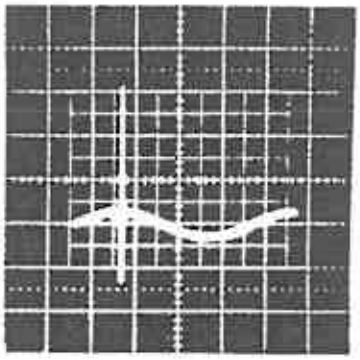
Table 5-6

SCOPE SETTINGS FOR LS DISPLAY*
(Tektronix 7603 and 7D20)

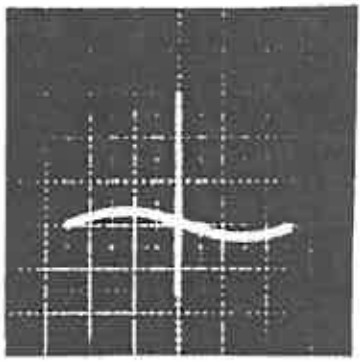
	CONTROL	SETTING
1.	MAIN TRIGGERING	
	A. MODE	HOLD NEXT
	B. COUPLING	AC HF REJ
	C. SOURCE	EXT
	D. SLOPE	+
	E. LEVEL	Approximately 1 o'clock position
	F. TRIG POS	0
2.	TIME/DIV	5msec/div
3.	AQR MODE	ADD 1
4.	CHANNEL 1	
	A. VOLTS/DIV	1 volt/div
	B. COUPLING	DC
5.	CHANNEL 2	
	A. VOLTS/DIV	5 volts/div
	B. COUPLING	DC

* For 1.2 x 50us voltage; 8 x 20us current event capture only.

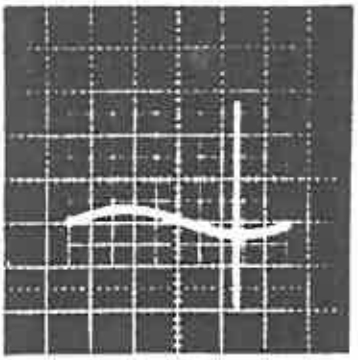
(a) 0°



(b) 90°



(c) 180°



(d) 270°

(d) 360°

Fig. 5-1

LS OPTION DISPLAYS: 0, 90, 180, 270, 360°

6. Surge/Voltage Monitoring

The Mainframe is designed to provide the user with a means for making high voltage, differential surge measurements, via an appropriate storage oscilloscope, across the circuit or component under test. Because these terminals are differential and floating they can be connected directly across the ac line, either at the front panel or at the input to the equipment under test. An oscilloscope having a differential vertical amplifier or A and B inputs capable of being used in a differential mode, is then connected via 50 ohm coaxial cable to the front panel V MONITOR BNC ports. (The attenuation is a factor of 200:1.)

6.1 Monitoring at the Mainframe front panel

To monitor the surge voltage at the Mainframe front panel, connect the V MON HIGH terminal to the SURGED HIGH output terminal, and the V MON LOW to the SURGED LOW terminal. (NOTE: If the surge coupling switch is in the COMMON MODE position, SURGED HIGH and SURGED LOW will be at the same potential with respect to ground. In this case, V MON LOW should be connected to the SURGED GND terminal to measure the surge voltage).

6.2 Monitoring at the load

The V MON HIGH and V MON LOW terminals provide the means for making a surge voltage measurement across a component, or at the input of a circuit, some distance from the generator.

CAUTION

Surge voltages WILL be present on any lines connected between a surged load and the V MON HIGH and V MON LOW terminals. Use ONLY wires with sufficient insulation to handle twice the anticipated surge voltage.

7. Surge Network Operating Instructions

7.1 Introduction

This section contains the operating instructions for surge networks used in the Model 587, 587-PLUS and 801-PLUS Mainframes.

The Model 587 includes a non-modular version of the Model S1/S3 Surge Network. Refer to the Model S1/S3 Operating Instructions for a functional description of the network.

The Model 587-PLUS Mainframe has an expanding library of surge networks designed to meet various standard and custom surge requirements. The Model M801-5 and Model S1/S3 with Option 801-S1/S3 are not compatible in the Model 587-PLUS Mainframe. Option 801-587 consists of modifications to the 587-PLUS Mainframe required in order to use the M801-5 and Option 801-S1/S3 Surge Networks.

The Model 801-PLUS Mainframe will accept all the surge networks designed for the 587-PLUS Mainframe including the M801-5 and S1/S3 Network with Option 801-S1/S3, as well as any additional networks which may be developed. Should the M801-5 or Option 801-S1/S3 Networks be used in a standard 587-PLUS Mainframe, an open interlock condition will occur and be annunciated by the SURGE NETWORK LED turning ON.

7.2 OPERATING INSTRUCTIONS - Model S1/S3 Surge Network

7.2.1 Introduction

The Model S1/S3 Surge Network is designed to provide all necessary waveforms as specified by ANSI/IEEE C62.41-1980 (Formerly IEEE Std. 587-1980). The S1/S3 Surge Network is intended for protectors and equipment which can be powered from the AC power-line during the test. Consult the document listed above for a more comprehensive overview concerning specifications and test configurations.

7.2.1.1 Specifications

BI-WAVE

Open-Circuit Voltage	0-6 kV
Voltage Front Time	1.2 us
Voltage Duration	50 us
Short-Circuit Current	0-3 kA
Current Front Time	8 us
Current Duration	20 us

NOTE:
1. The voltage front time is the time interval between the 30 percent and 90 percent of peak points, on the leading edge, multiplied by 1.67.
2. The current front time is the time interval between the 10 percent and 90 percent of peak points, on the leading edge, multiplied by 1.25.
3. The voltage and current duration is the time interval between the virtual origin point and the 50-percent-of-peak point on the trailing edge.

   Virtual origin is defined as the intersection with the zero axis of a straight line drawn through points on the front of the voltage wave at 30 percent and 90 percent of peak, or through points on the front of the current wave at 10 and 90 percent of peak.

RING WAVE

Open-Circuit Voltage	0-6 kV
Voltage Risetime	0.5 us
Ring Frequency	100 kHz
Short-Circuit Current	200 A (Category A) 500 A (Category B)

NOTE: 1. The voltage risetime is defined as the time interval between the 10 percent and 90 percent of peak points, on the leading edge, of the waveform.

2. The ring frequency is calculated from the first and third zero-crossing after the initial peak.

3. The nominal rate of decay of amplitude is 60 percent between adjacent peaks of opposite polarity.

7.2.2 Installation

1. Make sure the POWER switch and SURGE LINE INPUT BREAKER switch are in the OFF position.

2. Remove the surge network from the mainframe by unscrewing the retaining screws on the front panel and firmly pulling on the surge network's handle. Slide it out of the mainframe, while supporting the bottom of the surge network. Insert the Model S1/S3 Surge Network, making sure that it is seated all the way into the mainframe and the retaining screws on the front panel are screwed in finger tight.

3. Place the OUTPUT FIXTURE over the mainframe Output Terminal Array and exit all output wires to the right for safety.

7.2.3 Operation

7.2.3.1 Introduction

After following the INSTALLATION procedure outlined above, the mainframe may now be turned ON. Use the CHARGE and PULSE switches in the normal manner and sequence to produce an output pulse.

7.2.3.2 Surge Network After Pulse Delay

A built-in time delay circuit is used to limit power dissipation in the S1/S3 Surge Network. The RING WAVE delay time was 2.5 seconds on earlier S1/S3 Surge Networks and is now 10 seconds. The Bi-Wave™ delay time was 10 seconds on earlier S1/S3 Surge Networks and is now 30 seconds. The CHARGE/IL READY light, located to the right of the CHARGE switch, will turn OFF after the CHARGE switch has been released. The mainframe can't be charged until the light turns back ON after the delay time.

7.2.3.3 Synch Output

A unidirectional sync pulse, which occurs simultaneiously with the surge, is available at the SURGE SYNCH output and is approximately +7V for either positive or negative polarity surges. The trailing edge may have a number of transitions, hence if the SURGE SYNCH pulse is used for counting, it should be buffered by a one-shot multivibrator with sufficient duration.

7.2.3.4 Output Terminal Array

Refer to Section 2 which defines the operation of each output terminal.

7.2.3.5 High Voltage Indication

A high voltage indicator, identified as HIGH VOLTAGE, is illuminated when high voltage is present inside the surge network. Lamp intensity will increase with increasing SET VOLTAGE. The HIGH VOLTAGE indicator should extinguish completely when the PULSE switch is depressed, except when selecting the 200A or 500A Ring Wave.

Some residual charge is still present on the Surge Network energy storage capacitor. Releasing the CHARGE switch will remove this residual charge and the HIGH VOLTAGE indicator will go OFF.

WARNING: If the amber HIGH VOLTAGE indicator on the surge network does not go OFF, when the CHARGE switch is released, HIGH VOLTAGE is still present within the surge network and possibly at the output terminals. The unit is malfunctioning and should be turned OFF. Contact factory immediately.

7.2.4 VOLTAGE AND CURRENT MONITORING

7.2.4.1 Introduction

Refer to Section 6 which describes the proper connection of V MON INPUT A (V MON HIGH) and V MON INPUT B (V MON LOW) terminals.

7.2.4.2 Current Monitoring

The mainframe has a built in current monitor which measures the current delivered by the surge network. The scale factor is 100:1, or a 100A surge provides 1V to the oscilloscope. The current monitor is located on the mainframe front panel, to the right of the SURGE ANGLE VS LINE PHASE control, and is identified as I MON. It is calibrated for a 1 Mega ohm oscilloscope input.

7.2.5 Schematics

7.2.5.1

Schematic Title	Document Number
Schematic, S1/S3 Surge Network, H.V., 587	58-730-000-00
Schematic, S1/S3 PCB, 587	58-730-110-00

7.3 OPERATING INSTRUCTIONS - Model S3B Surge Network

7.3.1 Introduction

The Model S3B Surge Network is designed to deliver high-energy surges to protectors and equipment which can be powered from the AC line during the test.

7.3.1.1 Specifications

Open Circuit Voltage	0-6 kV
Voltage Front Time	1.2 us
Voltage Duration	50 us
Short-Circuit Current	0-5 kA
Current Front Time	8 us
Current Duration	20 us

NOTE:

1. The voltage front time is the time interval between the 30 percent and 90 percent of peak points, on the leading edge, multiplied by 1.67.

2. The current front time is the time interval between the 10 percent and 90 percent of peak points, on the leading edge, multiplied by 1.25.

3. The voltage and current duration is the time interval between the virtual origin point and the 50-percent-of-peak point on the trailing edge.

   Virtual origin is defined as the intersection with the zero axis of a straight line drawn through points on the front of the voltage wave at 30 percent and 90 percent of peak, or through points on the front of the current wave at 10 and 90 percent of peak.

7.3.2 Installation

1. Make sure the POWER switch and SURGE LINE INPUT BREAKER switch are in the OFF position.

2. Remove the surge network from the mainframe by unscrewing there retaining screws on the front panel and firmly pulling on the surge network's handle. Slide it out of the mainframe, while supporting the bottom of the surge network. Insert the Model S3B Surge Network, making sure that it is seated all the way into the mainframe and the retaining screws on the front panel are screwed in finger tight.

3. Place the OUTPUT FIXTURE over the mainframe Output Terminal Array and exit all output wires to the right for safety.

4. Connect the Model 587-PLUS ATTENUATOR, supplied, to the mainframe I MON output. A BNC type angle adapter is provided for ease of installation.

5. A retrofit attenuator, identified as 5 OHM ATTENUATOR, is provided for mainframes not originally purchased with an S3B Surge Network. To install the 5 OHM ATTENUATOR, first remove the mainframe right side cover. Next, locate the existing (blue) attenuator box, which is mounted behind the front panel to the I MON connector, and replace with 5 OHM ATTENUATOR. Replace the mainframe right side cover.

7.3.3 Operation

7.3.3.1 Introduction

After following the INSTALLATION procedure outlined above, the mainframe may now be turned ON. Use the CHARGE and PULSE switches in the normal manner and sequence to produce and output pulse.

7.3.3.2 Surge Network After Pulse Delay

A built-in time delay circuit is used to limit power dissipation in the S3B Surge Network and is factory set to 10 seconds. The CHARGE/IL READY light, located to the right of the CHARGE switch, will turn OFF after the CHARGE switch has been released. The mainframe can't be charged until the light turns back ON 10 seconds later. It is not recommended to reduce this delay time as excessive power dissipation in the network will result.

7.3.3.3 Synch Output

A unidirectional sync pulse, which occurs simultaneously with the surge, is available at the SURGE SYNCH output and is approximately +7V for either positive or negative polarity surges. The trailing edge may have a number of transitions, hence if the SURGE SYNCH pulse is used for counting, it should be buffered by a one-shot multivibrator with sufficient duration.

7.3.3.4 Output Terminal Array

Refer to Section 2 which defines the operation of each output terminal.

7.3.3.5 High Voltage Indication

A high voltage indicator, identified as HIGH VOLTAGE, is illuminated when high voltage is present inside the surge network. Lamp intensity will increase with increasing SET VOLTAGE. The HIGH VOLTAGE indicator should extinquish completely when the PULSE switch is depressed.

WARNING: If the amber HIGH VOLTAGE indicator on the surge network does not go OFF, when the CHARGE switch is released, HIGH VOLTAGE is still present within the surge network and possibly at the output terminals. The unit is malfunctioning and should be turned OFF. Contact factory immediately.

7.3.4 Voltage and Current Monitoring

7.3.4.1 Introduction

Refer to Section 6 which describes the proper connection of V MON INPUT A (V MON HIGH) and V MON INPUT B (V MON LOW) terminals.

7.3.4.2 Current Monitoring

See Section 7.3.2, steps 4 and 5, which describes the installation of the 5 OHM ATTENUATOR and MODEL 587-PLUS I MON ATTENUATOR boxes. The current monitor measures the current delivered by the surge network with a scale factor of 1000:1, or a 1kA surge provides 1V to the oscilloscope. This is measured at the output of the MODEL 587-PLUS I MON ATTENUATOR.

The MODEL 587-PLUS I MON ATTENUATOR should be removed when not using the S3B Surge Network. Also, it is not necessary to change the 5 OHM ATTENUATOR inside the mainframe. Operation and scale factor of the I MON output returns to 100 A/V.

7.3.5 Schematics

7.3.5.1 Schematic Title	Document Number
Schematic, S3B Surge Network, H.V. 587	58-706-000-00
Schematic, S3B PCB, 587	58-706-110-00

7.4 OPERATING INSTRUCTIONS - S4/5/6 Surge Network

7.4.1 Introduction

THE MODEL S4/5/6 Surge Network is designed to provide the three additional waveforms as specified by UL 1449, Transient Voltage Surge Suppressers. The S4/5/6 surge Network is intended for suppressers and equipment which can be powered from the AC power-line during the test. Consult the document listed above for a more comprehensive overview concerning specifications and test configurations.

7.4.1.1 Specifications

BI-WAVES (ALL WAVEFORMS)

Open-Circuit Voltage	0-6 kV
Voltage Front Time	1.2 us
Voltage Duration	50 us
Short-Circuit Current	750 A 500 A 125 A
Current Front Time	8 us
Current Duration	20 us

NOTE: 1. The voltage front time is the time interval between the 30 percent and 90 percent of peak points, on the leading edge, multiplied by 1.67.

2. The current front time is the time interval between the 10 percent and 90 percent of peak points, on the leading edge, multiplied by 1.25.

3. The voltage and current duration is the time interval between the virtual origin point and the 50-percent-of-peak point on the trailing edge.

   Virtual origin is defined as the intersection with the zero axis of a straight line drawn through points on the front of the voltage wave at 30 percent and 90 percent of peak, or through points on the front of the current wave at 10 and 90 percent of peak.

7.4.2 Installation

1. Make sure the POWER switch and SURGE LINE INPUT BREAKER switch are in the OFF position.

2. Remove the surge network from the mainframe by unscrewing the retaining screws on the front panel and firmly pulling on the surge network's handle. Slide it out of the mainframe, while supporting the bottom of the surge network. Insert the Model S4/5/6 Surge Network, making sure that it is seated all the way into the mainframe and the retaining screws on the front panel are screwed in finger tight.

3. Place the OUTPUT FIXTURE over the mainframe output terminal array and exit all output wires to the right for safety.

7.4.3 Operation

7.4.3.1 Introduction

After following the INSTALLATION procedure outlined above, the mainframe may now be turned ON. Use the CHARGE and PULSE switches in the normal manner and sequence to produce and output pulse.

7.4.3.2 Surge Network After Pulse Delay

A built-in time delay circuit is used to limit power dissipation in the S4/5/6 Surge Network and is factory set to 5 seconds. The CHARGE/IL READY light, located to the right of the CHARGE switch, will turn OFF after the CHARGE switch has been released. The mainframe can't be charged until the light turned back ON 5 seconds later. It is not recommended to reduce this delay time as excessive power dissipation in the network will result.

7.4.3.3 Synch Output

A unidirectional sync pulse, which occurs simultaneously with the surge, is available at the SURGE SYNCH output and is approximately +7V for either positive or negative polarity surges. The trailing edge may have a number of transitions, hence if the SURGE SYNCH pulse is used for counting, it should be buffered by a one-shot multivibrator with sufficient duration.

7.4.3.4 Output Terminal Array

Refer to Section 2 which defines the operation of each output terminal.

7.4.3.5 High Voltage Indication

A high voltage indicator, identified as HIGH VOLTAGE, is illuminated when high voltage is present inside the surge network. Lamp intensity will increase with increasing SET VOLTAGE. The HIGH VOLTAGE indicator should extinguish completely when the PULSE switch is depressed.

WARNING: If the amber HIGH VOLTAGE indicator on the surge network does not go OFF, when the CHARGE switch is released, HIGH VOLTAGE is still present within the surge network and possibly at the output terminals. The unit is malfunctioning and should be turned OFF. Contact factory immediately.

7.4.4 Voltage and Current Monitoring

7.4.4.1 Introduction

Refer to Section 6 which describes the proper connection of V MON INPUT A (V MON HIGH) and V MON INPUT B (V MON LOW) terminals.

7.4.4.2 Current Monitoring

The mainframe has a built in current monitor which measures the current delivered by the surge network. The scale factor is 100:1, or a 100A surge provides 1V to the oscilloscope. The current monitor is located on the mainframe front panel, to the right of the SURGE ANGLE VS PHASE control, and is identified as I MON. It is calibrated for a 1 Mega ohm oscilloscope input.

7.4.5 Schematics

7.4.5.1 Schematic Title	Document Number
Schematic, S4/5/6 Surge Network, H.V. 587	58-715-000-00
Schematic, S4/5/6 PCB, 587	58-715-110-00

7.5 OPERATING INSTRUCTION - S7 Surge Network

7.5.1 Introduction

The Model S7 Surge Network is designed to deliver high-energy surges to protectors and equipment which can be powered from the AC line during the test. The Model S7 provides AC power-line surging in line-to-line coupling mode only. Output is taken at the Model S7 Surge Network front panel and NOT at the mainframe Output Terminal Array. A keeper cover must be placed over the mainframe output terminals.

7.5.1.1 Specifications

Open Circuit Voltage	0-6 kV
Voltage Front Time	1.2 us
Voltage Duration	50 us
Short-Circuit Current	0-10 kA
Current Front Time	8 us
Current Duration	20 us

NOTE:

1. The Voltage front time is the time interval between the 30 percent and 90 percent of peak points, on the leading edge, multiplied by 1.67.

2. The current front time is the time interval between the 10 percent and 90 percent of peak points, on the leading edge, multiplied by 1.25.

3. The voltage and current duration is the time interval between the virtual origin point and the 50-percent-of-peak point on the trailing edge.

   Virtual origin is defined as the intersection with the zero axis of a straight line drawn through points on the front of the voltage wave at 30 percent and 90 percent of peak, or through points on the front of the current wave at 10 and 90 percent of peak.

7.5.2 Installation

1. Make sure the POWER switch and SURGE LINE INPUT BREAKER switch are in the OFF position.

2. Remove the Surge Network from the mainframe by unscrewing the retaining screws on the front panel and firmly pulling on the surge network's handle. Slide it out of the mainframe, while supporting the bottom of the surge network. Insert the Model S7 Surge Network, making sure that it is seated all the way into the mainframe and the retaining screws on the front panel are screwed in finger tight.

3. Place the mainframe OUTPUT KEEPER over the mainframe Output Terminal Array. The keeper automatically connects the V MON INPUT A (V MON HIGH) to SURGED HIGH, and V MON INPUT B (V MON LOW) to SURGED LOW terminals of the Model S7.

4. Place the OUTPUT FIXTURE over the MODEL S7 Output Terminal Array. Exit all output wires to the right and clamp wires, to the top of the OUTPUT KEEPER, using the cable clamps provided for additional safety.

7.5.3 Operation

7.5.3.1 Introduction

After following the INSTALLATION procedure outlined above, the mainframe may now be turned ON. Use the CHARGE and PULSE switches in the normal manner and sequence to produce an output pulse.

7.5.3.2 Surge Network After Pulse Delay

A built-in time delay circuit is used to limit power dissipation in the S7 Surge Network and is factory set to 30 seconds. The CHARGE/IL READY light, located to the right of the CHARGE switch, will turn OFF after the CHARGE switch has been released. The mainframe can't be charged until the light turns back ON 30 seconds later. It is not recommended to reduce this delay time as excessive power dissipation in the network will result.

7.5.3.3 Synch Output

A unidirectional sync pulse, which occurs simultaneously with the surge, is available at the SURGE SYNCH output and is approximately +7V for either positive or negative polarity surges. The trailing edge may have a number of transitions, hence if the SURGE SYNCH pulse is used for counting, it should be buffered by a one-shot multivibrator with sufficient duration.

7.5.3.4 Model S7 Output Terminal Array

The output terminals are used to interface the surge network with the device or EUT to be surged and are designated as follows:

SURGED HIGH - Connects with the HIGH side of the surge network output. Also, connects with the HIGH (or HOT) side of the AC line when the SURGE LINE INPUT BREAKER is turned ON.

SURGED LOW - Connects with the LOW side of the surge network output. Also, connects with he LOW (or NEUTRAL) side of the AC line when the SURGE LINE INPUT BREAKER is turned on.

SURGED GND - Connects with chassis Ground (normally third wire "green" ground when surging AC lines.)

7.5.3.5 High Voltage Indicator

A high voltage indicator, identified as HIGH VOLTAGE, is illuminated when high voltage is present inside the surge network. Lamp intensity will increase with increasing SET VOLTAGE. The HIGH VOLTAGE indicator should extinguish completely when the Pulse switch is depressed.

WARNING: If the amber HIGH VOLTAGE indicator on the surge network does not go OFF, when the CHARGE switch is released, HIGH VOLTAGE is still present within the surge network and possibly at the output terminals. The unit is malfunctioning and should be turned OFF. Contact factory immediately.

7.5.3.6 AC At Output Indicator

The AC AT OUTPUT indicator, located to the left of the Model S7 output terminals, is illuminated when AC line voltage is present between the SURGED HIGH and SURGED LOW terminals.

7.5.4 Voltage and Current Monitoring

7.5.4.1 Introduction

Refer to Section 6 which describes surge/voltage monitoring.

7.5.4.2 Current Monitoring

The S7 Surge Network has a built in current monitor which measures the current delivered by the surge network. The scale factor is 1000:1, or a 1kA surge provides 1 V to the oscilloscope. The current monitor output is located on the Model S7 front panel, identified as I MON, and is calibrated for a 1 Mega ohm oscilloscope input.

The I MON output, located on the mainframe front panel, is not functional when operating the Model S7 and should not be used.

7.5.5 Schematics

7.5.5.1

Schematic Title	Document Number
Schematic, S7 Surge Network H.V. 587	58-707-000-00
Schematic, S7 PCB, 587	58-707-110-00
Schematic, AC AT OUTPUT, PCB	58-707-140-00

7.6 OPERATING INSTRUCTIONS - S9 Surge Network

7.6.1 Introduction

The Model S9 Surge Network is primarily designed to meet FCC Docket 19528, Part 68, surge requirements. Part 68 is intended to test the "Connection of Terminal Equipment to the Telephone Network". Specifically, SUBPART D-Section 68.302, Environment Simulation, provides a more comprehensive description of the application of the surge waveforms to the equipment under test.

7.6.1.1 Specifications

Metallic Voltage Surge

Open-Circuit Voltage	Waveform Time to Crest/Duration	Short-Circuit Current
0-800V	<10us/>560us	>100A max

Longitudinal Voltage Surge

Open-Circuit Voltage	Waveform Time to Crest/Duration	Short-Circuit Current
0-1500V	<10us/>160us	>200A max
0-2500V	<2us x >10us	>1000A max

1. The waveform time to crest is the maximum time interval between virtual wave zero and the actual crest or peak of the waveform. This appears to be an easy measurement, but determination of the actual crest position is difficult since it is so broad a peak when compared to the front of the wave.

2. The waveform duration is the minimum decay time interval between virtual wave zero and the 50 percent-of-peak point on the trailing edge.

7.6.1.2 Waveform Selection

Any of the three waveforms listed in Section 7.6.1.1 may be selected by rotating the VOLTAGE WAVE selector switch located on the S9 Surge Network front panel. First, pull handle of selector switch OUT (towards you). The SURGE NETWORK open interlock indicator will illuminate, signifying an open interlock condition. Then rotate the selector switch to the desired waveform and firmly push into position. If not seated properly the SURGE NETWORK open interlock indicator will remain ON.

The <2 us x >10 us Waveform is the only waveform intended for AC power-line surging. The SURGE LINE INPUT BREAKER will NOT enable the COUPLER/FILTER when selecting the other two surge waveforms.

7.6.2 Installation

1. Make sure the POWER switch and SURGE LINE INPUT BREAKER switch are in the OFF position.

2. Remove the surge network from the mainframe by unscrewing the retaining screws on the front panel and firmly pulling on the surge network's handle. Slide it out of the mainframe, while supporting the bottom of the surge network. Insert the Model S9 Surge Network, making sure that it is seated all the way into the mainframe and the retaining screws on the front panel are screwed in finger tight.

3. Place the OUTPUT FIXTURE over the mainframe Output Terminal Array and exit all output wires to the right for safety.

4. The S9 Surge Network is compatible only with mainframes beginning with serial number 8810285. Mainframes with serial numbers below this will require Option S9-587 factory retrofit which includes modifications to all existing customer plug-in surge networks and mainframe.

7.6.3 Operation

7.6.3.1 Introduction

After following the INSTALLATION procedure outlined above the mainframe may now be turned ON. Use the CHARGE and PULSE switches in the normal manner and sequence to produce an output pulse.

7.6.3.2 Surge Network After Pulse Delay

A built-in time delay circuit is used to limit power dissipation in the S9 Surge Network. The delay is factory set to 10 seconds. The CHARGE/IL READY light, located to the right of the CHARGE switch, will turn OFF after the CHARGE Switch has been released. The mainframe can't be charged until the light turns back On 10 seconds later. It is not recommended to reduce this delay time as excessive power dissipation in the network will result.

7.6.3.3 Synch Output

A unidirectional sync pulse, which occurs simultaneously with the surge, is available at the SURGE SYNCH output and is approximately +7V for either positive or negative polarity surges. The trailing edge may have a number of transitions, hence if the SURGE SYNCH pulse is used for counting, it should be buffered by a one-shot multivibrator with sufficient duration.

7.6.3.4 Output Terminal Array

Refer to Section 2 which defines the operation of each output terminal.

7.6.3.5 High Voltage Indication

A high voltage indicator, identified as HIGH VOLTAGE, is illuminated when high voltage is present inside the surge network. Lamp intensity will increase with increasing SET VOLTAGE. The HIGH VOLTAGE indicator should extinguish completely when the PULSE switch is depressed.

WARNING: If the amber HIGH VOLTAGE indicator on the surge network does not go OFF, when the CHARGE switch is released, HIGH VOLTAGE is still present within the surge network and possibly the output terminals. The unit is malfunctioning and should be tuned OFF. Contact factory immediately.

7.6.4 Voltage and Current Monitoring

7.6.4.1 Current Monitoring

The mainframe has a built in current monitor which measures the current delivered by the surge network. The scale factor is 100:1, or a 100A surge provides 1V to the oscilloscope. The current monitor is located on the mainframe front panel, to the right of the SURGE ANGLE VS LINE PHASE control, and is identified as I MON. It is calibrated for a 1 Mega ohm oscilloscope input.

7.6.4.2 Voltage Monitoring

Refer to Section 6, Surge/Voltage Monitoring, for proper connection of V MON INPUT A (V MON HIGH) and V MON INPUT B (V MON LOW) terminals.

7.6.5 Schematics

7.6.5.1 Schematic Title	Document Number
Schematic, S9 Surge Network, H.V. 587	58-709-000-00
Schematic, S9 PCB, 587	58-709-110-00

7.7 OPERATING INSTRUCTIONS - S9A/B Surge Network

7.7.1 Introduction

The Model S9 A/B Surge Network is a true three-terminal output network, designed to meet Bellcore's LSSGR surge requirements. It is primarily intended for surge testing telecommunications eqiupment and NOT intended for AC power-line surging.

This surge network delivers high-energy surges to protectors and equipment. The Model S9 A/B furnishes separate, resistor-isolated output insuring that arrester operation or flashover on one line will not eliminate availability of the surge on the other. Thus, Tip and Ring inputs of telecom lines will each be fully and realistically tested for protection.

The surge output is taken at the Model S9 A/B Surge Network front panel and NOT at the mainframe Output Terminal Array. A keeper cover must be placed over the mainframe output terminals.

7.7.1.1 Specifications

OPEN-CIRCUIT VOLTAGE	SHORT-CIRCUIT CURRENT	WAVEFORM RISETIME X DURATION
0-2500V	500A/Output	< 2 us x > 10us
0-5000V	500A/Output	< 2 us x > 10us

NOTE:
1. The waveform risetime is the time interval between the 10 percent and 90 percent of peak points, on the leading edge, multiplied by 1.25.
2. The waveform duration is the time interval between the 10-percent-of-peak point on the leading edge and the 50-percent-of-peak point on the trailing edge.

7.7.2 Installation

1. Make sure the POWER switch and SURGE LINE INPUT BREAKER switch are in the OFF position.

2. Remove the surge network from the mainframe by unscrewing the retaining screws on the front panel and firmly pulling on the surge network's handle. Slide it out of the mainframe, while supporting the bottom of the surge network. Insert the Model S9 A/B Surge Network, making sure that it is seated all the way into the mainframe and the retaining screws on the front panel are screwed in finger tight.

3. Place the OUTPUT KEEPER over the Output Terminal Array of the mainframe.

4. Place the Surge Network OUTPUT FIXTURE over the MODEL S9 A/B Output Terminal Array. Exit all output wires to the right and clamp wires, to the top of the OUTPUT KEEPER, using the cable clamps provided for additional safety.

7.7.3 Operation

7.7.3.1 Introduction

After following the INSTALLATION procedure outlined above, the mainframe may now be turned ON. Use the CHARGE and PULSE switches in the normal manner and sequence to produce and output pulse.

7.7.3.2 Surge Network After Pulse Delay

A built-in time delay circuit is used to limit power dissipation in the S9 A/B Surge Network and is factory set to 10 seconds. The CHARGE/IL READY light, located to the right of the CHARGE switch, will turn OFF after the CHARGE switch has been released. The mainframe can't be charged until the light turns back ON 10 seconds later. It is not recommended to reduce this delay time as excessive power dissipation in the network will result.

7.7.3.3 Synch Output

A unidirectional sync pulse, which occurs simultaneously with the surge, is available at the SURGE SYNCH output and is approximately +7V for either positive or negative polarity surges. The trailing edge may have a number of transitions, hence if the SURGE SYNCH pulse is used for counting, it should be buffered by a one-shot multivibrator with sufficient duration.

7.7.3.4 Model S9 A/B Output Terminal Array

The output terminals are used to interface the surge network with device or EUT to be surged and are as follows:

Output 1 - taken between OUT 1 HIGH and OUT 1 LOW

Output 2 - taken between OUT 2 HIGH and OUT 2 LOW

OUT 1 LOW and OUT 2 LOW are common connections within the surge network, but are separated at the output terminal array to facilitate connection of components or wires to the output terminals. A ground connection is available for terminating the output of the surge network to chassis ground and is identified as CHASSIS. Shorting links are provided to help with these terminations.

7.7.3.5 High Voltage Indication

A high voltage indicator, identified as HIGH VOLTAGE, is illuminated when high voltage is present inside the surge network. Lamp intensity will increase with increasing SET VOLTAGE. The HIGH VOLTAGE indicator should extinguish completely when the PULSE switch is depressed.

WARNING: If the amber HIGH VOLTAGE indicator on the Surge Network dies not go OFF, when the CHARGE switch is released, HIGH VOLTAGE is still present within the surge network and possible at the output terminals. The unit is malfunctioning and should be turned OFF. Contact factory immediately.

7.7.3.6 Open-Circuit Voltage Selection

The maximum open-circuit voltage is switch selectable from 2.5kV to 5kV by depressing the MAX OPEN-CIRCUIT VOLTAGE selector switch. The 0-2.5kV range is selected when the switch is in the depressed or IN position. The 0-5kV range is selected when the switch is in the released or OUT position.

7.7.4 Voltage and Current Monitoring

7.7.4.1 Introduction

Refer to Section 6, which describes Surge/Voltage Monitoring.

7.7.4.2 Current Monitoring

The S9 A/B Surge Network has a built in current monitor which measures the current delivered by the surge network. The scale factor is 100:1, or a 100A surge provides 1 V to the oscilloscope. The current monitor output is located on the Model S9 A/B front panel, identified as I MON, and is calibrated for a 1 Mega ohm oscilloscope input.

The I MON output, located on the mainframe front panel, is not functional when operating the Model S9 A/B and should not be used.

7.7.4.3 Voltage Monitoring

The internal voltage monitors of the mainframe can be used to monitor the surge voltage at the S9 A/B Surge Network OUT 1 or OUT 2 terminals. First, set the Coupler/Filter mode switch to the Normal Mode position and place the OUTPUT KEEPER over the Output Terminal Array of the mainframe. The OUTPUT KEEPER has internal connections to automatically connect the V MON INPUT A (V MON HIGH) and V MON INPUT B (V MON LOW) monitor terminals to the S9 A/B Surge Network. Remove any links from the output terminal array before installing the OUTPUT KEEPER. Next, select which output is to be monitored by depressing OUT 1 or OUT 2 of the V MONITOR SELECTION switch located on the S9 A/B Surge Network front panel. Only one output can be selected at one time.

7.7.5 Schematics

7.7.5.1

Schematic Title	Document Number
Schematic, S9 A/B Surge Network, H.V. 587	58-709-000-00
Schematic, S9 A/B PCB, 587	58-709-110-00

7.8 OPERATING INSTRUCTIONS - S29 Surge Network

7.8.1 Introduction

The Model S29 Surge Network is a true three terminal output network, designed to meet Bellcore's LSSGR surge requirements. It is primarily intended for surge testing telecommunications equipment and NOT intended for AC power-line surging.

This surge network delivers high-energy surges to protectors and equipment. The Model S29 furnishes separate, resistor-isolated outputs insuring that arrester operation or flashover on one line will not eliminate availability of the surge on the other. Thus, Tip and Ring inputs of telecom lines will each be fully and realistically tested for protection.

The surge output is taken at the Model S29 Surge Network front panel and NOT at the mainframe Output Terminal Array. A keeper cover must be placed over the mainframe output terminals.

The S29 has an internal energy storage capacitor which requires approximately 15 seconds to charge, before depressing the PULSE switch. The After Pulse Delay is factory set for 10 seconds (see Section 7.8.3.2 for more details). The maximum surge repetition rate is thus one surge per 25 seconds.

7.8.1.1 Specifications

OPEN-CIRCUIT VOLTAGE	SHORT-CIRCUIT CURRENT	WAVEFORM RISETIME X DURATION
0-1000V	100A/Output	10us x 1000us
0-1500V	100A/Output	10us x 1000us

NOTE: 1. The waveform risetime is the time interval between the 10 percent and 90 percent of peak points, on the leading edge, multiplied by 1.25

2. The waveform duration is the time interval between the 10-percent-of-peak point on the leading edge and the 50-percent-of-peak point on the trailing edge.

7.8.2 Installation

1. Make sure the POWER switch and SURGE LINE INPUT BREAKER switch are in the OFF position.

2. Remove the surge network from the mainframe by unscrewing the retaining screws on the front panel and firmly pulling on the surge network's handle. Slide it out of the mainframe, while supporting the bottom of the surge network. Insert the Model S29 Surge Network, making sure that it is seated all the way into the mainframe and the retaining screws on the front panel are screwed in finger tight.

3. Place the OUTPUT KEEPER over the mainframe Output Terminal Array.

4. Place the Surge Network OUTPUT FIXTURE over the MODEL S29 Output Terminal Array. Exit all output wires to the right and clamp wires, to the top of the OUTPUT KEEPER, using the cable clamps provided for additional safety.

7.8.3 Operation

7.8.3.1 Introduction

After following the INSTALLATION procedure outlined above, the mainframe may now be turned ON. Use the CHARGE and PULSE switches in the normal manner and sequence to produce an output pulse.

7.8.3.2 Surge Network After Pulse Delay

A built-in time delay circuit is used to limit power dissipation in the S29 Surge Network and is factory set to 10 seconds. The CHARGE/IL READY light, located to the right of the CHARGE switch, will turn OFF after the CHARGE switch has been released. The mainframe can't be charged until the light turns back ON 10 seconds later. It is not recommended to reduce this delay time as excessive power dissipation in the network will result.

7.8.3.3 Synch Output

A unidirectional sync pulse, which occurs simultaneously with the surge, is available at the SURGE SYNCH output and is approximately +7V for either positive or negative polarity surges. The trailing edge may have a number of transitions, hence if the SURGE SYNCH pulse is used for counting, it should be buffered by a one-shot multivibrator with sufficient duration.

7.8.3.4 Model S29 Output Terminal Array

The output terminals are used to interface the surge network with the device or EUT to be surged and are as follows:

Output 1 - taken between OUT 1 HIGH and OUT 1 LOW

Output 2 - taken between OUT 2 HIGH and OUT 2 LOW

OUT 1 LOW and OUT 2 LOW are common connections within the surge network, but are separated at the output terminal array to facilitate connection of components or wires to the output terminals. A ground connection is available for terminating the output of the surge network to chassis ground and is identified as CHASSIS. Shorting links are provided to help with these terminations.

7.8.3.5 High Voltage Indication

A high voltage indicator, identified as HIGH VOLTAGE, is illuminated when high voltage is present inside the surge network. Lamp intensity will increase with high increasing SET VOLTAGE. The HIGH VOLTAGE indicator should extinguish completely when the PULSE switch is depressed.

WARNING: If the amber HIGH VOLTAGE indicator on the Surge Network does not go OFF, when the CHARGE switch is released, HIGH VOLTAGE is still present within the surge network and possible at the output terminals. The unit is malfunctioning and should be turned OFF. Contact factory immediately.

7.8.3.6 Open-Circuit Voltage Selection

The maximum open-circuit voltage is switch selectable from 1.0kV to 1.5kV by depressing the MAX OPEN-CIRCUIT VOLTAGE selector switch. The 0-1.0kV range is selected when the switch is in the depressed or IN position. The 1.5kV range is selected when the switch is in the released or OUT position.

7.8.4 Voltage and Current Monitoring

7.8.4.1 Introduction

Refer to Section 6, which describes Surge/Voltage Monitoring.

7.8.4.2 Current Monitoring

The S29 Surge Network has a built in current monitor which measures the current delivered by the surge network. The scale factor is 100:1, or a 100A surge provides 1V to the oscilloscope. The current monitor output is located on the Model S29 front panel, identified as I MON, and is calibrated for a 1 Mega ohm oscilloscope input.

When operating the Model S29, the I MON output, located on the mainframe front panel, is not functional and should not be used.

7.8.4.3 Voltage Monitoring

The internal voltage monitors of the mainframe can be used to monitor the surge voltage at the S29 Surge Network OUT 1 or OUT 2 terminals. First, set the Coupler/Filter mode switch to the Normal Mode position and place the OUTPUT KEEPER over the output terminal array of the mainframe. The OUTPUT KEEPER has internal connections to automatically connect the V MON LOW monitor terminals to the S29 Surge Network. Remove any links from the Output Terminal Array before installing the OUTPUT KEEPER. Next, select which output is to be monitored by depressing OUT 1 or OUT 2 of the V MONITOR SELECTION switch located on the S29 Surge Network front panel. Only one output can be selected at one time.

7.8.5 Schematics

7.8.5.1 Schematic Title	Document Number
Schematic, S29 Surge Network, H.V. 587	58-729-000-00
Schematic, S29 PCB, 587	58-729-110-00

7.9 OPERATING INSTRUCTIONS - S3HV Surge Network

7.9.1 Introduction

The Model S3HV Surge Network can be operated in Mainframes equipped with Option HV-587 or HV-801 ONLY! Consult factory for details. Option HV modifications include 400:1 internal, differential, high-voltage probes (replacing the standard 200:1 probes), as well as, a current monitor with a scale factor of 1000:1 (in addition to the standard 100:1 current monitor).

The S3HV has an internal energy storage capacitor which requires approximately 15 seconds to charge, before depressing the PULSE switch. The After Pulse Delay is factory set for 10 seconds (see Section 7.9.3.2 for more details). The maximum surge repetition rate is thus one surge per 25 seconds.

When using the S3HV Surge Network, the PEAK OPEN CIRCUIT KILOVOLTS display must be multiplied by 2 to obtain the actual peak open circuit voltage desired. For example, a 10 kV surge will result when the SET VOLTAGE is adjusted for a 5 kV output.

An internal limiting circuit is used to limit the maximum peak open circuit voltage to 10.5 kV (SET VOLTAGE displayed will be 5.25 kV, see previous paragraph). This limiting circuit will open a unit interlock, see Section 2 for further details describing the operation of this interlock.

The Model S3HV Surge Network is designed to deliver high-energy surges to protectors and equipment which can be powered from the AC line during the test.

7.9.1.1 Specifications

Open Circuit Voltage	0-10 kV
Voltage Front Time	1.2 us
Voltage Duration	50 us
Short-Circuit Current	0-5 kA
Current Front Time	8 us
Current Duration	20 us

NOTE: 1. The voltage front time is the time interval between the 30 percent and 90 percent peak points, on the leading edge, multiplied by 1.67.

2. The current front time is the time interval between the 10 percent and 90 percent of peak points, on the leading edge, multiplied by 1.25.

3. The voltage and current duration is the time interval between the virtual origin point and the 50-percent-of-peak point on the trailing edge.

Virtual origin is defined as the intersection with the zero axis of a straight line drawn through points on the front of the voltage wave at 30 percent and 90 percent of peak, or through points on the front of the current wave at 10 and 90 percent of peak.

7.9.2 Installation

1. Make sure the POWER switch and SURGE LINE INPUT BREAKER switch are in the OFF position.

2. Remove the surge network from the mainframe by unscrewing the retaining screws on the front panel and firmly pulling on the surge network's handle. Slide it out of the mainframe, while supporting the bottom of the surge network. Insert the Model S3HV Surge Network, making sure that it is seated all the way into the mainframe and the retaining screws on the front panel are screwed in finger tight.

3. Place the OUTPUT FIXTURE over the mainframe Output Terminal Array and exit all output wires to the right for safety.

4. Connect the MODEL 587-PLUS I MON ATTENUATOR, supplied, to the mainframe I MON output. A BNC type angle adapter is provided for ease of installation.

5. A retrofit Attenuator, identified as 5 OHM ATTENUATOR, is provided for mainframes not originally purchased with an S3HV Surge Network. To install the 5 OHM ATTENUATOR, first remove the mainframe right side cover. Next, locate the existing (blue) Attenuator box, which is mounted behind the front panel to the I MON connector, and replace with 5 OHM ATTENUATOR. Replace the mainframe right side cover.

7.9.3 Operation

7.9.3.1 Introduction

After following the INSTALLATION procedure outlined above, the mainframe may now be turned ON. Use the CHARGE and PLUS switches in the normal manner and sequence to produce an output pulse.

7.9.3.2 Surge Network After Pulse Delay

A built-in time delay circuit is used to limit power dissipation in the S3HV Surge Network and is factory set to 10 seconds. The CHARGE/IL READY light, located to the right of the CHARGE switch, will turn OFF after the CHARGE switch has been released. The mainframe can't be charged until the light turns back ON 10 seconds later. It is not recommended to reduce this delay time as excessive power dissipation in the network will result.

7.9.3.3 Synch Output

A unidirectional sync pulse, which occurs simultaneously with the surge, is available at the SURGE SYNCH output and is approximately +7V for either positive or negative polarity surges. The trailing edge may have a number of transitions, hence if the SURGE SYNCH pulse is used for counting, it should be buffered by a one-shot multivibrator with sufficient duration.

7.9.3.4 Output Terminal Array

Refer to Section 2 which defines the operation of each output terminal.

7.9.3.5 High Voltage Indication

A high voltage indicator, identified as HIGH VOLTAGE, is illuminated when high voltage is present inside the surge network. Lamp intensity will increase with increasing SET VOLTAGE. The HIGH voltage indicator should extinguish completely when the PULSE switch is depressed.

WARNING: If the amber HIGH VOLTAGE indicator on the surge network does not go OFF, when the CHARGE switch is released, HIGH VOLTAGE is still present within the surge network and possibly at the output terminals. The unit is malfunctioning and should be turned OFF. Contact factory immediately.

7.9.4 Voltage and Current Monitoring

7.9.4.1 Introduction

Refer to Section 6, which describes the proper connection of V MON INPUT A (V MON HIGH) and V MON INPUT B (V MON LOW) terminals.

7.9.4.2 Current Monitoring

See Section 7.9.2, steps 4 and 5, which describes the installation of the 5 OHM ATTENUATOR and MODEL 587-PLUS I MON ATTENUATOR boxes.

The current monitor measures the current delivered by the surge network with a scale factor of 1000:1, or a 1kA surge provides 1V to the oscilloscope. This is measured at the output of the MODEL 587-PLUS I MON ATTENUATOR. The I MON output is calibrated for a 1 ohm oscilloscope input.

The MODEL 587-PLUS I MON ATTENUATOR should be removed when not using the S3HV Surge Network. Also, it is not necessary to change the 5 OHM ATTENUATOR inside the mainframe. Operation of the I MON output returns to 100 A/V.

7.9.4.3 Voltage Monitoring

The internal, differential, high-voltage probes have a scale factor of 400:1 or a 10kV surge provides 25V to the oscilloscope.

7.9.5 Schematics

7.9.5.1 Schematic Title	Document Number
Schematic, S3HV Surge Network, H.V. 587	58-748-000-00
Schematic, S3HV PCB, 587	58-748-110-00

7.10 OPERATING INSTRUCTIONS - Model S53A Surge Network

7.10.1 Introduction

The Model S53A Surge Network is designed to meet Bellcore's LSSGR surge requirements. It is primarily intended for surge testing telecommunications equipment and NOT intended for AC power-line surging.

The surge output is taken at the Model S53A Surge Network front panel and NOT at the mainframe Output Terminal Array. A keeper cover must be placed over the mainframe output terminals.

7.10.1.1 Specifications

OPEN-CIRCUIT VOLTAGE	SHORT-CIRCUIT CURRENT	WAVEFORM RISETIME X DURATION
0-800V	25A	0.1us x 560us
0-600V	20A	0.1us x 1000us

NOTE: 1. The waveform risetime is the time interval between the 10 percent and 90 percent of peak points, on the leading edge, multiplied by 1.25.

2. The waveform duration is the time interval between the 10 percent-of-peak point on the leading edge and the 50 percent-of-peak point on the trailing edge.

7.10.2 Installation

1. Make sure the POWER switch and SURGE LINE INPUT BREAKER switch are in the OFF position.

2. Remove the surge network from the mainframe by unscrewing the retaining screws on the front panel and firmly pulling on the surge network's handle. Slide it out of the mainframe, while supporting the bottom of the surge network. Insert the Model S53A Surge Network, making sure that it is seated all the way into the mainframe and the retaining screws on the front panel are screwed in finger tight.

3. Place the OUTPUT KEEPER over the mainframe Output Terminal Array.

4. Place the mainframe OUTPUT FIXTURE over the MODEL S53A Output Terminal Array. Exit all output wires to the right and clamp wires, to the top of the OUTPUT KEEPER, using the cable clamps provided for additional safety.

7.10.3 Operation

7.10.3.1 Introduction

After following the INSTALLATION procedure outlined above, the mainframe may now be turned ON. Use the CHARGE and PULSE switches in the normal manner and sequence to produce an output pulse.

7.10.3.2 Surge Network After Pulse Delay

A built-in time delay circuit is used to limit power dissipation in the S53A Surge Network and is factory set to 10 seconds. The CHARGE/IL READY light, located to the right of the CHARGE switch, will turn OFF after the CHARGE switch has been released. The mainframe can't be charged until the light turns back ON 10 seconds later. It is not recommended to reduce this delay time as excessive power dissipation in the network will result.

7.10.3.3 Synch Output

A undirectional sync pulse, which occurs simultaneously with the surge, is available at the SURGE SYNCH output and is approximately +7V for either positive or negative polarity surges. The trailing edge may have a number of transitions, hence if the SURGE SYNCH pulse is used for counting, it should be buffered by a one-shot multivibrator with sufficient duration.

7.10.3.4 Model S53A Output Terminal Array

The output terminals are used to interface the surge network with the device or EUT to be surged and are as follows:

Output 1 - taken between OUT 1 HIGH and OUT 1 LOW

Output 2 - taken between OUT 2 HIGH and OUT 2 LOW

OUT 1 LOW and OUT 2 LOW are common connections within the surge network, but are separated at the Output Terminal Array to facilitate connection of components or wires to the output terminals. A ground connection is available for terminating the output of the surge network to chassis ground and is identified as CHASSIS. Shorting links are provided with the mainframe to help with these terminations.

7.10.3.5 High Voltage Indication

A high voltage indicator, identified as HIGH VOLTAGE is illuminated when high voltage is present inside the surge network. Lamp intensity will increase with

increasing SET VOLTAGE. The HIGH VOLTAGE indicator should extinquish completely when the PULSE switch is depressed.

WARNING: If the amber HIGH VOLTAGE indicator on the Surge Network does not go OFF, when the CHARGE switch is released, HIGH VOLTAGE is still present within the surge network and possible at the output terminals. The unit is malfunctioning and should be turned OFF. Contact factory immediately.

7.10.3.6 Voltage Waveform Selection

The output voltage waveform is switch selectable by depressing the switch located on the surge network front panel. OUT 1 selects the 0.5/560 us, 0-800V, voltage wave. OUT 2 selects the 0.5/1000 us, 0-600V, voltage wave. An OPEN INTERLOCK condition will occur if both OUT 1 and OUT 2 are not selected. Should this condition exist, the SURGE NETWORK annunciator will turn ON. Selecting OUT 1 or OUT 2 will close the open interlock.

7.10.4 Voltage and Current Monitoring

7.10.4.1 Introduction

Refer to Section 6 which describes Surge/Voltage Monitoring.

7.10.4.2 Current Monitoring

The S53A Surge Network has a built in current monitor which measures the current delivered by the surge network. The scale factor is 1:1, or a 1A surge provides 1V to the oscilloscope. The current monitor output is located on the Model S53A front panel, identified as I MON, and is calibrated for a 1 Mega ohm oscilloscope input.

When operating the Model S53A, the I MON output, located on the mainframe front panel, is not functional and should not be used.

7.10.4.3 Voltage Monitoring

The internal voltage monitors of the mainframe can be used to monitor the surge voltage at the S53A Surge Network OUT 1 or OUT 2 terminals. First, set the Coupler/Filter mode switch to the Normal Mode position and place the OUTPUT KEEPER over the Output Terminal Array of the mainframe. The OUTPUT KEEPER has internal

connections to automatically connect the V MON INPUT A (V MON HIGH) and V MON INPUT B (V MON LOW) monitor terminals to the S53A Surge Network output selected, see Section 7.10.3.6. Remove any links from the Output Terminal Array before installing the OUTPUT KEEPER.

7.10.5 Schematics

7.10.5.1	Schematic Title	Document Number
	Schematic S53A Surge Network H.V. 587	58-753-000-00
	Schematic, S53A PCB, 587	58-753-110-00

7.11 OPERATING INSTRUCTIONS - S29B Surge Network

7.11.1 Introduction

The Model S29B Surge Network is a true three terminal output network, designed to meet Bellcore's LSSGR surge requirements. It is primarily intended for surge testing telecommunications equipment and NOT intended for AC power-line surging.

This surge network delivers high-energy surges to protectors and equipment. The Model S29B furnishes separate, resistor-isolated outputs insuring that arrester operation or flashover on one line will not eliminate availability of the surge on the other line. Thus, Tip and Ring inputs of telecom lines will each be fully and realistically tested for protection.

The surge output is taken at the Model S29B Surge Network front panel and NOT at the mainframe Output Terminal Array. A keeper cover must be placed over the mainframe output terminals.

The S29B has an internal energy storage capacitor which requires approximately 15 seconds to charge, before depressing the PULSE switch. The After Pulse Delay is factory set for 10 seconds (see Section 7.11.3.2 for more details). The maximum surge repetition rate is thus one surge per 25 seconds.

7.11.1.1 Specifications

OPEN-CIRCUIT VOLTAGE	SHORT-CIRCUIT CURRENT	WAVEFORM RISETIME X DURATION
0-1000V	100A/Output	10us X 1000us
0-1000V	10A/Output	10us x 1000us

NOTE: 1. The waveform risetime is the time interval between the 10 percent and 90 percent of peak points, on the leading edge, multiplied by 1.25.

2. The waveform duration is the time interval between the 10-percent-of-peak point on the leading edge and the 50-percent-of-peak point on trailing edge.

7.11.2 Installation

1. Make sure the POWER switch and SURGE LINE INPUT BREAKER switch are in the OFF position.

2. Remove the surge network from the mainframe by unscrewing the retaining screws on the front panel and firmly pulling on the surge network's handle. Slide it out of the mainframe, while supporting the bottom of the surge network. Insert the Model S29B Surge Network, making sure that it is seated all the way into the mainframe and the retaining screws on the front panel are screwed in finger tight.

3. Place the OUTPUT KEEPER over the mainframe Output Terminal Array.

4. Place the Surge Network OUTPUT FIXTURE over the Model S29B Output Terminal Array. Exit all output wires to the right and clamp wires, to the top of the OUTPUT KEEPER, using the cable clamps provided for additional safety.

7.11.3 Operation

7.11.3.1 Introduction

After following the INSTALLATION procedure outlined above, the mainframe may now be turned ON. Use the CHARGE and PULSE switches in the normal manner and sequence to produce an output pulse.

7.11.3.2 Surge Network After Pulse Delay

A built-in time delay circuit is used to limit power dissipation in the S29B Surge Network and is factory set to 10 seconds. The CHARGE/IL READY light, located to the right of the CHARGE switch, will turn OFF after the CHARGE switch has been released. The mainframe can't be charged until the light turns back ON 10 seconds later. It is not recommended to reduce this delay time as excessive power dissipation in the network will result.

7.11.3.3 Synch Output

A unidirectional sync pulse, which occurs simultaneously with the surge, is available at the SURGE SYNCH output and is approximately +7V for either positive or negative polarity surges. The trailing edge may have a number of transitions, hence if the SURGE SYNCH pulse is used for counting, it should be buffered by a one-shot multivibrator with sufficient duration.

7.11.3.4 Model S29B Output Terminal Array

The output terminals are used to interface the surge network with the device or EUT to be surged and are as follows:

Output 1 - taken between OUT 1 HIGH and OUT 1 LOW

Output 2 - taken between OUT 2 HIGH and OUT 2 LOW

OUT 1 LOW and OUT 2 LOW are common connections within the surge network, but are separated at the output terminal array to facilitate connection of components or wires to the output terminals. A ground connection is available for terminating the output of the surge network to chassis ground and is identified as CHASSIS. Shorting links are provided to help with these terminations.

7.11.3.5 High Voltage Indication

A high voltage indicator, identified as HIGH VOLTAGE, is illuminated when high voltage is present inside the surge network. Lamp intensity will increase with high increasing SET VOLTAGE. The HIGH VOLTAGE indicator should extinguish completely when the PULSE switch is depressed.

WARNING: If the amber HIGH VOLTAGE indicator on the Surge Network does not go OFF, when the CHARGE switch is released, HIGH VOLTAGE is still present within the surge network and possible at the output terminals. The unit is malfunctioning and should be turned OFF. Contact factory immediately.

7.11.3.6 Short-Circuit Current Selection

The maximum short-circuit current is switch selectable from 100A/SIDE to 10A/SIDE by depressing the MAX SHORT-CIRCUIT CURRENT selector switch. The 0-100A range is selected when the switch is in the depressed or IN position. The 0-10A range is selected when the switch is in the released or OUT position.

7.11.4 Voltage and Current Monitoring

7.11.4.1 Introduction

Refer to Section 6, which describes Surge/Voltage Monitoring.

7.11.4.2 Current Monitoring

The S29B Surge Network has a built in current monitor which measures the current delivered by the surge network. The scale factor is 100:1, or a 100A surge provides 1V to the oscilloscope. The current monitor output is located on the Model S29B front panel, identified as I MON, and is calibrated for a 1 Mega ohm oscilloscope input.

When operating the Model S29B, the I MON output, located on the mainframe front panel, is not functional and should not be used.

7.11.4.3 Voltage Monitoring

The internal voltage monitor of the mainframe can be used to monitor the surge voltage at the S29B Surge Network OUT 1 or OUT 2 terminals. First, set the Coupler/Filter mode switch to the Normal Mode position and place the OUTPUT KEEPER over the Output Terminal Array of the mainframe. The OUTPUT KEEPER has internal connections to automatically connect the V MON INPUT A (V MON HIGH) and V MON INPUT B (V MON LOW) monitor terminals to the S29B Surge Network. Remove any links from the Output Terminal Array before installing the OUTPUT KEEPER. Next, select which output is to be monitored by depressing OUT 1 or OUT 2 of the V MONITOR SELECTION switch located on the S29B Surge Network front panel. Only one output can be selected at one time.

7.11.5 Schematics

7.11.5.1 Schematics Title	Document Number
Schematic, S29B Surge Network H.V. 587	58-728-000-00
Schematic, S29B PCB, 587	58-728-110-00

7.12 OPERATING INSTRUCTIONS - Model M801-5 Surge Network

7.12.1 Instructions

The Model M801-5 Surge Network is designed to provide the necessary waveforms as specified by IEC 801-5. The M801-5 is intended for surging both power and I/O (Input/Output) lines.

Note, the M801-5 Surge Network was formerly called the S3/S21 (IEC) Surge Network.

Consult the IEC 801-5 document for a more comprehensive overview concerning specifications and test configurations.

7.12.1.1 Specifications

	COMBINATION WAVE	COMBINATION WAVE (+10 ohm resistor)
Open-Circuit Voltage	0-6kV	0-6kV
Voltage Front Time	1.2us	1.2us
Voltage Duration	50us	50us
Short-Circuit Current	0-3kA	0-500A
Current Front Time	8us	undefined
Current Duration	20us	undefined

NOTE:

1. The voltage front time is the time interval between the 30 percent and 90 percent of peak points, on the leading edge, multiplied by 1.67.

2. The current front time is the time interval between the 10 percent and 90 percent of peak points, on the leading edge, multiplied by 1.25.

3. The voltage and current duration is the time interval between the virtual origin point and the 50-percent-of-peak point on the trailing edge.

   Virtual origin is defined as the intersection with the zero axis of a straight line drawn through points on the front of the voltage wave at 30 percent and 90 percent of peak, or through points on the front of the current wave at 10 and 90 percent of peak.

	Surge Network Outputs	
Open-Circuit Voltage	0-6kV	0-6kV
Voltage Front Time	0.5us	10us
Voltage Duration	700us	700us
Output Damping Resistor Selections	0 ohm - OUT HIGH 25 ohm - OUT 1 HIGH 25 ohm - OUT 2 HIGH	

Three-terminal Output Configuration with additional 0 ohm output.

Short-Circuit Waveform - undefined.

NOTE:
1. The open-circuit voltage front time is the time interval between the 30 percent and 90 percent of peak points, on the leading edge, multiplied by 1.67.
2. The voltage duration is the time interval between the virtual origin and the 50 percent-of-peak point on the trailing edge. The virtual origin is defined as the intersection with the zero axis of a straight line drawn through points on the front of peak on the leading edge of the waveform.
3. The short-circuit current waveform is undefined. The three output damping resistance selections effectively limit the peak short-circuit current.

7.12.2 Installation

1. Make sure the POWER switch SURGE LINE Input BREAKER switch are in the OFF position.

2. Remove the surge network from the mainframe by unscrewing the retaining screws on the front panel and firmly pulling on the surge network's handle. Slide it out of the mainframe, while supporting the bottom of the surge network. Insert the Model M801-5 Surge Network, making sure that it is seated all the way into the mainframe and the retaining screws on the front panel are screwed in finger tight.

3. Place the K1-801-5 KEEPER FIXTURE over the surge network Output Terminal Array when selecting the Combination Waves. The surge output will be at the mainframe Output Terminal Array.

4. Place the C1-801-5 OUTPUT FIXTURE over the mainframe Output Terminal Array to close the interlock circuit. Exit all output wires to the right, for safety.

5. When selecting the surge network outputs, place the C1-801-5 OUTPUT FIXTURE over the surge network Output Terminal Array and the K1-801-5 KEEPER FIXTURE over the mainframe Output Terminal Array. The surge will be present at the surge network output only.

7.12.3 Operation

7.12.3.1 Introduction

After following the INSTALLATION procedure outlined above, the mainframe may now be turned ON. Use the CHARGE and PULSE switches in the normal manner and sequence to produce an output pulse.

7.12.3.2 Surge Network After Pulse Delay

A built-in time delay circuit is used to limit power dissipation in the M801-5 Surge Network and is factory set to 10 seconds. The CHARGE/IL READY light, located to the right of the CHARGE switch, will turn OFF after the CHARGE switch has been released. The mainframe can't be charged until the light turns back ON after the delay time.

7.12.3.3 Synch Output

A undirectional sync pulse, which occurs simultaneously with the surge, is available at the SURGE SYNCH output and is approximately +7V for either positive or negative polarity surges. The trailing edge may have a number of transitions, hence if the SURGE SYNCH pulse is used for counting, it should be buffered by a one-shot multivibrator with sufficient duration.

7.12.3.4 Output Terminal Array

Refer to Section 2 which defines the operation of each output terminal.

The surge network output has a common terminal called OUT LOW. The surge can be measured between OUT HIGH (0 ohm) and OUT LOW or between OUT 1 HIGH (25 ohm) and OUT LOW, or between OUT 2 HIGH (25 ohm) and OUT LOW. For true-three terminal surging use OUT 1 HIGH and OUT 2 HIGH. A 0 ohm output is provided in the event that more than two lines are needed to be surged.

7.12.3.5 High Voltage Indication

A high voltage indicator, identified as HIGH VOLTAGE, is illuminated when high voltage is present inside the surge network. Lamp intensity will increase with increasing SET VOLTAGE. The HIGH VOLTAGE indicator should extinquish completely when the PULSE switch is depressed.

WARNING: If the amber HIGH VOLTAGE indicator on the surge network does not go OFF, when the CHARGE switch is released, HIGH VOLTAGE is still present within the surge network and possibly at the output terminals. The unit is malfunctioning and should be turned OFF. Contact factory immediately.

7.12.4 Voltage and Current Monitoring

7.12.4.1 Introduction

When selecting the Combination Waves, refer to Section 6 which describes the proper connection of V MON INPUT A (V MON HIGH) and V MON INPUT B (V MON LOW) terminals.

Voltage monitoring the surge network output waveforms can be achieved by connecting the V MON INPUT A (V MON HIGH) and V MON INPUT B (V MON LOW) terminals to the appropriate surge network output terminals using the properly insulated wire. A slot is provided in the K1-801-5 Fixture for accessing the V MON terminals.

7.12.4.2 Current Monitoring

The mainframe has a built in current monitor which measures the current delivered by the surge network when selecting the Combination Waves. The scale factor is 100:1, or a 100A surge provides 1V to the oscilloscope. The current monitor is located on the mainframe front panel, to the right of the SURGE ANGLE VS LINE PHASE control, and is identified as I MON. It is calibrated for a 1 Mega ohm oscilloscope input.

When selecting the surge network outputs, the current monitor output is located on the surge network front panel and is identified as Surge Network I MON. The scale factor is 100A/V and is calibrated for a 1 Mega ohm oscilloscope input. Note, the current monitor output is the sum of the OUT 1 and OUT 2 outputs.

7.12.5 Schematics

7.12.5.1 Schematic Title	Document Number
Schematic, M801-5 Surge Network, H.V., 587	58-725-000-00
Schematic, M801-5 PCB, 587	58-725-110-00

7.13 OPERATING INSTRUCTIONS - Model S1 Surge Network

7.13.1 Introduction

The Model S1 Surge Network is designed to provide the necessary Ring Waves as specified by ANSI/IEEE C62.41-1980. The S1 Surge Network is intended for protectors and equipment which can be powered from the AC power-line during the test. Consult the document listed above for a more comprehensive overview concerning specifications and test configurations.

7.13.1.1 Specifications

RING WAVE

Open-Circuit Voltage	0-6kV
Voltage Risetime	0.5us
Ring Frequency	100kHz
Short-Circuit Current	200A (Category A) 500A (Category B)

NOTE:
1. The voltage risetime is defined as the time interval between the 10 percent and 90 percent of peak points, on the leading edge, of the waveform.
2. The ring frequency is calculated from the first and third zero-crossing after the initial peak.
3. The nominal rate of decay of amplitude is 60 percent between adjacent peaks of opposite polarity.

7.13.2 Installation

1. Make sure the POWER switch and SURGE LINE INPUT BREAKER switch are in the OFF position.

2. Remove the surge network from the mainframe by unscrewing the retaining screws on the front panel and firmly pulling on the surge network's handle. Slide it out of the mainframe, while supporting the bottom of the surge network. Insert the Model S1 Surge Network, making sure that it is seated all the way into the mainframe and the retaining screws on the front panel are screwed in finger tight.

3. Place the OUTPUT FIXTURE over the mainframe Output Terminal Array and exit all output wires to the right for safety.

7.13.3 Operation

7.13.3.1 Introduction

After following the INSTALLATION procedure outlined above, the mainframe may now be turned ON. Use the CHARGE and PULSE switches in the normal manner and sequence to produce an output pulse.

7.13.3.2 Surge Network After Pulse Delay

A built-in time delay circuit is used to limit power dissipation in the S1 Surge Network and is factory set to 10 seconds. The CHARGE/IL READY light, located to the right of the CHARGE switch, will turn OFF after the CHARGE switch has been released. The mainframe can't be charged until the light turns back ON after the delay time.

7.13.3.3 Synch Output

A unidirectional sync pulse, which occurs simultaneously with the surge, is available at the SURGE SYNCH output and is approximately +7V for either positive or negative polarity surges. The trailing edge may have a number of transitions, hence if the SURGE SYNCH pulse is used for counting, it should be buffered by a one-shot multivibrator with sufficient duration.

7.13.3.4 Output Terminal Array

Refer to Section 2 which defines the operation of each output terminal.

7.13.3.5 High Voltage Indication

A high voltage indicator, identified as HIGH VOLTAGE, is illuminated when high voltage is present inside the surge network. Lamp intensity will increase with increasing SET VOLTAGE.

WARNING: If the amber HIGH VOLTAGE indicator on the surge network does not go OFF, when the CHARGE switch is released, HIGH VOLTAGE is still present within the surge network and possibly at the output terminals. The unit is malfunctioning and should be turned OFF. Contact factory immediately.

7.13.3.6 Waveform Selection

For Category A testing, select the SHORT-CIRCUIT CURRENT range switch labeled 200A.

For Category B testing, select the SHORT-CIRCUIT CURRENT range switch labeled 500A.

7.13.4 Voltage and Current Monitoring

7.13.4.1 Introduction

Refer to Section 6 which describes the proper connection of V MON INPUT A (V MON HIGH) and V MON INPUT B (V MON LOW) terminals.

7.13.4.2 Current Monitoring

The mainframe has a built in current monitor which measures the current delivered by the surge network. The scale factor is 100:1, or a 100A surge provides 1V to the oscilloscope. The current monitor is located on the mainframe front panel, to the right of the SURGE ANGLE VS LINE PHASE control, and is identified as I MON. It is calibrated for a 1 Mega ohm oscilloscope input.

7.13.5 Schematics

7.13.5.1 Schematic Title	Document Number
Schematic S1 Surge Network, H.V., 587	58-731-000-00
Schematic S1 PCB, 587	58-731-110-00

7.14 OPERATING INSTRUCTIONS - Model S1/S3 Surge Network with Option 801-S1/S3

7.14.1 Introduction

The Model S1/S3 Surge Network with Option 801-S1/S3 is designed to provide all necessary waveforms as specified by ANSI/IEEE C62.41-1980 (formerly IEEE Std. 587-1980), along with the ac mains waveforms specified by IEC 801-5, specifically the Combination Wave and Combination Wave plus the 10 ohm series resistor waveform. The S1/S3 Surge Network is intended for protectors and equipment which can be powered from the AC powerline during the test. Consult the document listed above for a more comprehensive overview concerning specifications and test configurations.

7.14.1.1 Specifications

	COMBINATION WAVE	COMBINATION WAVE (+10 OHM RESISTOR)
Open-Circuit Voltage	0-6kV	0-6kV
Voltage Front Time	1.2us	1.2us
Voltage Duration	50us	50us
Short-Circuit Current	0-3kA	500A
Current Front Time	8us	undefined
Current Duration	20us	undefined

NOTE:

1. The voltage front time is the time interval between the 30 percent and 90 percent of peak points, on the leading edge, multiplied by 1.67.

2. The current front time is the timer interval between the 10 percent and 90 percent of peak points, on the leading edge, multiplied by 1.25.

3. The voltage and current duration is the time interval between the virtual origin point and the 50-percent-of-peak point on the trailing edge.

   Virtual origin is defined as the intersection with the zero axis of a straight line drawn through points on the front of the voltage wave at 30 percent and 90 percent of peak, or through points on the front of the current wave at 10 and 90 percent of peak.

RING WAVE

Open-Circuit Voltage	0-6 kV
Voltage Risetime	0.5 us
Ring Frequency	100 kHz
Short-Circuit Current	200 A (Category A) 500 A (Category B)

NOTE: 1. The voltage risetime is defined as the time interval between the 10 percent and 90 percent of peak points, on the leading edge, of the waveform.

2. The ring frequency is calculated from the first and third zero-crossing after the initial peak.

3. The nominal rate of decay of amplitude is 60 percent between adjacent peaks of opposite polarity.

7.14.2 Installation

1. Make sure the POWER switch and SURGE LINE INPUT BREAKER switch are in the OFF position.

2. Remove the surge network from the mainframe by unscrewing the retaining screws on the front panel and firmly pulling on the surge network's handle. Slide it out of the mainframe, while supporting the bottom of the surge network. Insert the Surge Network, making sure that it is seated all the way into the mainframe and the retaining screws on the front panel are screwed in finger tight.

3. Place the OUTPUT FIXTURE over the mainframe Output Terminal Array and exit all output wires to the right for safety.

7.14.3 Operation

7.14.3.1 Introduction

After following the INSTALLATION procedure outlined above, the mainframe may now be turned ON. Use the CHARGE and PULSE switches in the normal manner and sequence to produce an output pulse.

7.14.3.2 Surge Network After Pulse Delay

A built-in time daily circuit is used to limit power dissipation in the Surge Network and is factory set to 10 seconds. The CHARGE/IL READY light, located to the right of the CHARGE switch, will turn OFF after the CHARGE switch has been released. The mainframe can't be charged until the light turns back ON after the delay time.

7.14.3.3 Synch Output

A unidirectional sync pulse, which occurs simultaneously with the surge, is available at the SURGE SYNCH output and is approximately +7V for either positive or negative polarity surges. The trailing edge may have a number of transitions, hence if the SURGE SYNCH pulse is used for counting, it should be buffered by a one-shot multivibrator with sufficient duration.

7.14.3.4 Output Terminal Array

Refer to Section 2 which defines the operation of each output terminal.

7.14.3.5 High Voltage Indication

A high voltage indicator, identified as HIGH VOLTAGE, is illuminated when high voltage is present inside the surge network. Lamp intensity will increase with increasing SET VOLTAGE. The HIGH VOLTAGE indicator should extinguish completely when the PULSE switch is depressed, except when selecting the 200A or 500A Ring Wave.

Some residual charge is still present on the Surge Network energy storage capacitor. Releasing the CHARGE switch will remove this residual charge and the HIGH VOLTAGE indicator will go OFF.

WARNING: If the amber HIGH VOLTAGE indicator on the surge network does not go OFF, when the CHARGE switch is released, HIGH VOLTAGE is still present within the surge network and possibly at the output terminals. The unit is malfunctioning and should be turned OFF. Contact factory immediately.

7.14.3.6 Waveform Selection

Select the desired waveform by pulling the waveform selector switch , located in the center of the surge network, to the out position. Rotate the switch to the desired waveform and push the selector switch in making sure it is seated properly. The SURGE NETWORK interlock LED will be ON if the selector switch is not seated all the way in.

7.14.4 Voltage and Current Monitoring

7.14.4.1 Introduction

Refer to Section 6 which describes the proper connection of V MON INPUT A (V MON HIGH) and V MON INPUT B (V MON LOW) terminals.

7.14.4.2 Current Monitoring

The mainframe has a built in current monitor which measures the current delivered by the surge network. The scale factor is 100:1, or a 100A surge provides 1V to the oscilloscope. The current monitor is located on the mainframe front panel, to the right of the SURGE ANGLE VS LINE PHASE control, and is identified as I MON. It is calibrated for a 1 Mega ohm oscilloscope input.

7.14.5 Schematics

7.14.5.1 Schematic Title	Document Number
Schematic, S1/S3 Surge Network, H.V., 587, with Option 801-S1/S3	58-732-000-00
Schematic, S1/S3 PCB, 587, with Option 801-S1/S3	58-732-110-00

7.15 OPERATING INSTRUCTIONS - Model S7B Surge Network with S0 Interface Network

WARNING! 6,000 VOLTS - 20,000 AMPS

This equipment has LETHAL ENERGY PRESENT AT THE OUTPUT TERMINALS and should be operated by TRAINED PERSONNEL ONLY!! DO NOT DISABLE ANY INTERLOCK as this will present a potentially dangerous situation. Both EYE and EAR safety protection are required when operating this equipment. All connections to the output terminals should be tightened SECURELY. Care should be exercised when surging components and equipment as components may become flying projectiles when surged with this equipment. The Equipment Under Test (EUT) MUST BE CONTAINED IN AN EXPLOSION PROOF CONTAINER TO PREVENT INJURY. Wires exiting from output terminals may be at 6,000 Volts and should be insulated for TWO TIMES maximum output voltage to avoid electrical shock hazard.

7.15.1 Introduction

The Model S7B Surge Network is designed to provide the waveforms as specified by Bellcore Technical Advisory TA-NWT-001011, Issue 1, April 1991. Consult this document for a more comprehensive overview concerning specifications and test configurations.

The S7B is a remote surge network and must be used in conjunction with the Model S0 Interface Network only. The S0 network is the interface between the Mainframe and the S7B.

7.15.1.1 Specifications

	COMBINATION WAVE	COMBINATION WAVE
Open-Circuit Voltage	0-6kV	0-6kV
Voltage Front Time	1.2us	1.2us
Voltage Duration	50us	50us
Short-Circuit Current	0-10kA	0-20kA
Current Front Time	8us	8us
Current Duration	20us	20us

NOTE:

1. The voltage front time is the time interval between the 30 percent and 90 percent of peak points, on the leading edge, multiplied by 1.67.

2. The current front time is the time interval between the 10 percent and 90 percent of peak points, on the leading edge, multiplied by 1.25.

3. The voltage and current duration is the time interval between the virtual origin point and the 50-percent-of-peak point on the trailing edge.

   Virtual origin is defined as the intersection with the zero axis of a straight line drawn through points on the front of the voltage wave at 30 percent and 90 percent of peak, or through points on the front of the current wave at 10 and 90 percent of peak.

7.15.2 Installation

1. Make sure the Mainframe POWER switch, SURGE LINE INPUT BREAKER switch and S7B POWER switch are in the OFF position.

2. Remove the surge network from the Mainframe by unscrewing the retaining screws on the front panel and firmly pulling on the surge network's handle. Slide it out of the mainframe, while supporting the bottom of the surge network. Insert the S0 Surge Network, making sure that it is seated all the way into the mainframe and the retaining screws on the front panel are screwed in finger tight.

3. Install the S0 Surge Cable from the rear of the S0/Mainframe to the rear of the S7B Surge Network. Note that the cable ends are marked to show which end connects with which unit. This cable MUST be removed before installing any surge network other than the S0 into the Mainframe.

4. Place the OUTput FIXTure S7B over the S7B Output Terminal Array and exit all output wires to the right for safety.

7.15.3 Operation

7.15.3.1 Introduction

After following the INSTALLATION procedure outlined above, the Mainframe may now be turned ON. Use the CHARGE and PULSE switches in the normal manner and sequence to produce an output pulse.

7.15.3.2 Surge Network After Pulse Delay

A built-in time delay circuit is used to limit power dissipation in the S7B Surge Network and is factory set to 30 seconds. The CHARGE/IL READY light, located to the right of the CHARGE switch, will turn OFF after the CHARGE switch has been released. The Mainframe can't be charged until the light turns back ON 30 seconds later. It is not recommended to reduce this delay time as excessive power dissipation in the network will result. The S7B has an internal energy storage capacitor which requires approximately 15 seconds to charge before depressing the pulse switch. The maximum surge repetition rate is one surge per 45 seconds.

7.15.3.3 Synch Output

A unidirectional sync pulse, which occurs simultaneously with the surge, is available at the SURGE SYNCH output and is approximately +7V for either positive or negative polarity surges. The trailing edge may have a number of transitions, hence if the SURGE SYNCH pulse is used for counting, it should be buffered by a one-shot multivibrator with sufficient duration.

7.15.3.4 Output Terminal Array

The output terminals are as follows:

SURGED HIGH - Output terminal, normally HOT conductor when surging AC lines. Also SURGED HIGH connects to surge network output when appropriate coupling mode selected.

SURGED LOW - Output terminal, normally Neutral conductor when surging AC lines. Also, the SURGED

LOW connects to the surge network output when the appropriate coupling mode is selected.

SURGED GND - Output terminal, connects to chassis (normally safety earth connection). Also, SURGED GND connects to the surge network output when surging in any COMMON MODE coupling.

7.15.3.5 High Voltage Indication

A high voltage indicator, identified as HIGH VOLTAGE, is illuminated when high voltage is present inside the surge network. Lamp intensity will increase with increasing SET VOLTAGE. The HIGH VOLTAGE indicator should extinguish completely when the PULSE switch is depressed.

WARNING: If the amber HIGH VOLTAGE indicator on the surge network does not go OFF, when the CHARGE switch is released, HIGH VOLTAGE is still present within the surge network and possibly at the output terminals. The unit is malfunctioning and should be turned OFF. Contact factory immediately.

7.15.3.6 Short Circuit Current Selection

The current waveform from the S7B Surge Network is an 8/20 us surge with switch selectable maximum peak currents as follows:

1. 10kA MAX - Switch, used to set the maximum short circuit current to 10kA.

2. 20kA MAX - Switch, used to set the maximum short circuit current to 20kA.

7.15.3.7 Coupler/Filter Mode Selection

The surge can be applied to the S7B output terminals in any of four different coupling configurations. The Mode switches are identified as follows:

1. HIGH TO LOW - Switch, used to connect the surge network between the SURGED HIGH and SURGED LOW output terminals.

2. HIGH TO GND - Switch, used to connect the surge network between the SURGED HIGH and SURGED GND output terminals.

3. LOW TO GND - Switch, used to connect the surge network between the SURGED LOW and SURGED GND output terminals.

4. HIGH AND LOW TO GND - Switch, used to connect the surge network between the SURGED HIGH and SURGED GND terminals, as well as between the SURGED LOW and SURGED GND terminals, simultaneously. Note, this mode is allowed when the 20kA MAX current range is selected. In this mode, the maximum current available is 20kA (10kA from SURGED HIGH to SURGED GND, and 10kA from SURGED LOW to SURGED GND).

7.15.3.8 Indicators

1. AC AT OUTPUT - Indicator light illuminates when LIVE AC mains voltage is present at the S7B output terminals.

2. SELECT ONE (Short Circuit Current) - Indicator light illuminates when BOTH 10kA MAX and 20kA MAX range selections are in the unselected or out position. This condition will also open the interlock system, see OPEN INTERLOCK below.

3. SELECT ONE (Coupler/Filter Mode) - Indicator light illuminates when ALL the coupling mode switches are in the unselected or out position. This condition will also open the interlock system, see OPEN INTERLOCK below.

4. SELECT 20kA (Coupler/Filter Mode) - Indicator light illuminates when HIGH AND LOW TO GND mode is selected in conjunction with the 10kA MAX current range. Select 20kA MAX to correct. Note, this does not open the interlock system as this does not present a safety hazard.

5. OPEN INTERLOCK - Indicator light illuminates when an open interlock condition exists at the S7B. The following conditions will show an open interlock:

   a. OUTput FIXTure S7B is removed or not seated properly.

   b. Short Circuit Current selection not made (See Step 2 above).

c. Coupler/Filter Mode selection not made (See Step 3 above).

7.15.4 Voltage and Current Monitoring

7.15.4.1 Introduction

Refer to Section 6, which describes the proper connection of V MON INPUT A(V MON HIGH) and V MON INPUT B (V MON LOW) terminals.

7.15.4.2 Current Monitoring

The S7B Surge Network has two built in current monitors which measure the current delivered by the surge network. The BNC connectors are located above the Output Terminal Array and are identified as follows:

1. SURGED HIGH - Connector, BNC, provides measurement of delivered surge current from the SURGED HIGH output connector. The scale factor is 1000:1, or 1000A surge provides 1V to the oscilloscope.

2. SURGED LOW - Connector, BNC, provides measurement of delivered surge current from the SURGED LOW output connector. The scale factor is 1000:1, or a 1000A surge provides 1V to the oscilloscope.

The I MONITOR outputs are calibrated for a 1 Megohm oscilloscope input. The monitored short circuit current waveform will be slightly reduced in duration when measuring a 20kA current pulse.

Note, when surging in HIGH TO LOW mode, the I MONITOR SURGED HIGH output will be in the positive direction; while, the I MONITOR SURGED LOW output will be in the negative direction (for a positive surge polarity).

7.15.5 Schematics

7.15.5.1 Schematic Title	Document Number
Schematic, S0-S7B Surge Network, H.V.	58-713-000-00
Schematic, S0-S7B Surge Network, PCB.	58-713-110-00

7.16 OPERATING INSTRUCTIONS - Model M801-5A Surge Network

7.16.1 Introduction

The Model M801-5A Surge Network is designed to provide waveforms as specified by IEC 801-5. The M801-5A is intended for surging both power and I/O(Input/Output) lines.

Consult the IEC 801-5 document for a more comprehensive overview concerning specifications and test configurations.

7.16.1.1 Specifications

	COMBINATION WAVE	COMBINATION WAVE (+10 ohm resistor)
Open-Circuit Voltage	0-6kV	0-6kV
Voltage Front Time	1.2us	1.2us
Voltage Duration	50us	50us
Short-Circuit Current	0-3kA	0-500A
Current Front Time	8us	undefined
Current Duration	20us	undefined

NOTE:

1. The voltage front time is the time interval between the 30 percent and 90 percent of peak points, on the leading edge, multiplied by 1.67.

2. The current front time is the time interval between the 10 percent and 90 percent of peak points, on the leading edge, multiplied by 1.25.

3. The voltage and current duration is the time interval between the virtual origin point and the 50-percent-of-peak point on the trailing edge.

   Virtual origin is defined as the intersection with the zero axis of a straight line drawn through points on the front of the voltage wave at 30 percent and 90 percent of peak, or through points on the front of the current wave at 10 and 90 percent of peak.

	Surge Network Outputs	
Open-Circuit Voltage	0-6kV	0-6kV
Voltage Front Time	0.5us	10us
Voltage Duration	700us	700us
Output Damping Resistor Selections	0 ohm - OUT HIGH 25 ohm - OUT 1 HIGH 25 ohm - OUT 2 HIGH	

Three-terminal Output Configuration with additional 0 ohm output.

Short-Circuit Waveform - undefined.

NOTE:
1. The open-circuit voltage front time is the time interval between the 30 percent and 90 percent of peak points, on the leading edge, multiplied by 1.67.

2. The voltage duration is the time interval between the virtual origin and the 50 percent-of-peak point on the trailing edge. The virtual origin is defined as the intersection with the zero axis of a straight line drawn through points on the front of the peak on the leading edge of the waveform.

3. The short-circuit current waveform is undefined. The three output damping resistance selections effectively limit the peak short-circuit current.

The COMBINATION WAVES are also present at the surge network Output Terminal Array. When using the surge network Output Terminal Array, the Back/Filter may be turned ON to provide power to the EUT. The COMBINATION WAVES will not appear at the Mainframe Output Terminal Array when using the surge network output.

7.16.2 Installation

1. Make sure the POWER switch and SURGE LINE INPUT BREAKER switch are in the OFF position.

2. Remove the surge network from the mainframe by unscrewing the retaining the screws on the front panel and firmly pulling on the surge network's handle. Slide it out of the mainframe, while supporting the bottom of the surge network. Insert the Model M801-5A Surge Network, making sure that it is seated all the way into the mainframe and the retaining screws on the front panel are screwed in finger tight.

3. Place the SURGE NETWORK OUTPUT KEEPER over the surge network Output Terminal Array when selecting the Combination Waves intended for powerline surging. The surge output will be at the mainframe Output Terminal Array.

4. Place the C1-801 OUTPUT FIXTURE over the mainframe Output Terminal Array to close the interlock circuit. Exit all output wires to the right, for safety.

5. When selecting the surge network outputs, place the SURGE NETWORK OUTPUT FIXTURE over the surge network Output Terminal Array with the C1-801 OUTPUT FIXTURE over the mainframe Output Terminal Array. The surge will be present at the surge network output only.

Note, the EUT may still be powered through the Back/Filter, while using the surge network output, Combination Waves or Telecom Waves, to surge I/O or communication lines.

7.16.3 Operation

7.16.3.1 Introduction

After following the INSTALLATION procedure outlined above, the mainframe may now be turned ON. Use the CHARGE and PULSE switches in the normal manner and sequence to produce an output pulse.

7.16.3.2 Surge Network After Pulse Delay

A built-in time delay circuit is used to limit power dissipation in the M801-5A Surge Network and is factory set to 10 seconds. The CHARGE/IL READY light, located to the right of the CHARGE switch, will turn OFF after the CHARGE switch has been released. The mainframe can't be charged until the light turns back ON after the delay time.

7.16.3.3 Synch Output

A undirectional sync pulse, which occurs simultaneously with the surge, is available at the SURGE SYNCH output and is approximately +7V for either positive or negative polarity surges. The trailing edge may have a number of transitions, hence if the SURGE SYNCH pulse is used for counting, it should be buffered by a one-shot multivibrator with sufficient duration.

7.16.3.4 Output Terminal Array

Refer to Section 2 which defines the operation of each Mainframe output terminal.

The surge network output has a common terminal called OUT LOW. The surge can be measured between OUT HIGH (0 ohm) and OUT LOW or between OUT 1 HIGH (25 ohm) and OUT LOW, or between OUT 2 HIGH (25 ohm) and OUT LOW. For true-three terminal surging use OUT 1 HIGH and OUT 2 HIGH. A 0 ohm output is provided in the event that more than two lines are needed to be surged.

The COMBINATION WAVES are available between the COMBINATION WAVE output terminal and OUT LOW. Note, the COMBINATION WAVES are not present at the Mainframe Output Terminal Array when the SURGE NETWORK OUTPUT FIXTURE is used at the surge network output.

7.16.3.5 High Voltage Indication

A high voltage indicator, identified as HIGH VOLTAGE, is illuminated when high voltage is present inside the surge network. Lamp intensity will increase with increasing SET VOLTAGE. The HIGH VOLTAGE indicator should extinguish completely when the PULSE switch is depressed.

WARNING: If the amber HIGH VOLTAGE indicator on the surge network does not go OFF, when the CHARGE switch is released, HIGH VOLTAGE is still present within the surge network and possibly at the output terminals. The unit is malfunctioning and should be turned OFF. Contact factory immediately.

7.16.4 Voltage and Current Monitoring

7.16.4.1 Introduction

When selecting the Combination Waves, refer to Section 6 which describes the proper connection of V MON INPUT A (V MON HIGH) and V MON INPUT B (V MON LOW) terminals.

Voltage monitoring the surge network output waveforms can be achieved by connecting the V MON INPUT A (V MON HIGH) and V MON INPUT B (V MON LOW) terminals to the appropriate surge network output terminals using properly insulated wire. A slot is provided in the Mainframe Output Fixture for accessing the V MON terminals.

7.16.4.2 Current Monitoring

The mainframe has a built in current monitor which measures the current delivered by the surge network when selecting the Combination Waves. The scale factor is 100:1, or 100A surge provides 1V to the oscilloscope. The current monitor is located on the mainframe front panel, to the right of the SURGE ANGLE VS LINE PHASE control, and is identified as I MON. It is calibrated for 1 Mega ohm oscilloscope input.

When selecting the surge network outputs, the current monitor output is located on the surge network front panel and is identified as Surge Network I MON. The scale factor is 100A/V and is calibrated for a 1 Mega ohm oscilloscope input. Note, the current monitor output is the sum of the OUT 1 and OUT 2 outputs.

7.16.5 Schematics

7.16.5.1 Schematic Title	Document Number
Schematic, M801-5A Surge Network, H.V.	58-726-000-00
Schematic, M801-5A PCB	58-726-110-00

7.17 OPERATING INSTRUCTIONS - Model S21 and S21H Surge Networks.

7.17.1 Introduction

The Model S21 and Model S21H Surge Networks are virtually identical in features and performance and as a result this manual will refer to these networks as Model S21 or simply S21. Any differences will be pointed out below.

The Model S21 Surge Network is designed to provide waveforms as specified by CCITT Rec K.17 and are intended for surging telecom networks.

The S21 is a "circuit specified" surge network as defined by CCITT Rec K.17, Figure 1/K.17 of that document, with the exception of an additional waveform: 0.5us/700us, 0-6kV.

Output damping resistors (2.5 ohm and 25 ohm) can be selected as required by Rec K.17. A 0 ohm resistor is available that will allow the S21 Surge Network, with optional external coupling network, to generate the 10/700us, 0-6kV, 2 x 25 ohms waveform as specified in CCITT Rec K.20 and Rec K.21.

Note, the S21 is not intended for AC power-line surging and as a result will not allow the COUPLER/FILTER to be enabled (IN) when the SURGE LINE INPUT BREAKER is turned ON.

7.17.1.1 Specifications

Model S21 Waveforms -

Open-Circuit Voltage	0-6kV	0-6kV	0-5kV
Voltage Front Time	0.5us	10 us	100us
Voltage Duration	700us	700us	700us

Model S21H Waveforms -

Open-Circuit Voltage	0-7kV	0-7kV	0-6kV
Voltage Front Time	0.5us	10 us	100us
Voltage Duration	700us	700us	700us

Short-Circuit Current	undefined
Output Damping Resistor Selections -	0 ohm 2.5 ohm 25 ohm

NOTE:

1. The voltage front time is the time interval between the 30 percent and 90 percent of peak points, on the leading edge, multiplied by 1.67.

2. The voltage duration is the time interval between the virtual origin point and the 50-percent-of-peak point on the trailing edge.

   Virtual origin is defined as the intersection with the zero axis of a straight line drawn through points on the front of the voltage wave at the 30 percent and 90 percent of peak.

3. The short-circuit current waveform is undefined. The three output damping resistance selections effectively limit the peak short-circuit current.

7.17.1.2 Model S21H Required Options

The S21H Surge Network can only be used in Mainframes equipped with Options S21H-587 or S21H-801 (see Section 8.1.10).

7.17.1.3 Model S21 Open Interlock

The maximum Open-Circuit Voltage for the S21H Surge Network is limited to 7.2kV. Should the SET VOLTAGE be adjusted to greater than this limit, an open interlock condition will occur. The Interlock is momentary and will reset after approximately 10 seconds, allowing the Mainframe to charge again. When this condition exists, reduce the charge voltage by turning the SET VOLTAGE control counter-clockwise.

7.17.2 Installation

1. Make sure the POWER switch and SURGE LINE INPUT BREAKER switch are in the OFF position.

2. Remove the surge network from the Mainframe by unscrewing the retaining screws on the front panel and firmly pulling on the surge network's handle. Slide it out of the Mainframe, while supporting the bottom of the surge network. Insert the Model S21 Surge Network, making sure that it is seated all the way into the Mainframe and the retaining screws on the front panel are screwed in finger tight.

3. Place the C1-587 OUTput FIXTure over the Mainframe Output Terminal Array to close the interlock circuit. Exit all output wires to the right for safety.

4. If the SURGE NETWORK Open Interlock indicator is ON,

   - be sure the network is seated all the way into the Mainframe.

   - firmly seat the Waveform and Damping resistor selection switches.

7.17.3 Operation

7.17.3.1 Introduction

After following the INSTALLATION procedure outlined above, the Mainframe may now be turned ON. Use the CHARGE and PULSE switches in the normal manner and sequence to produce an output pulse.

7.17.3.2 Surge Network After Pulse Delay

A built-in time delay circuit is used to limit power dissipation in the S21 Surge Network and is factory set to 10 seconds. The CHARGE/IL READY light, located to the right of the CHARGE switch, will turn OFF after the CHARGE switch has been released. The Mainframe can't be charged until the light turns back ON after the delay time.

7.17.3.3 Synch Output

A unidirectional sync pulse, which occurs simultaneously with the surge, is available at the SURGE SYNCH output and is approximately +7kV for either positive or

negative polarity surges. The trailing edge may have a number of transitions, hence if the SURGE SYNCH pulse is used for counting, it should be buffered by a one-shot multivibrator with sufficient duration.

7.17.3.4 Output Terminal Array

Refer to Section 2 which defines the operation of each Mainframe output terminal. With the COUPLER/FILTER MODE switch set to the NORMAL MODE position, the surge will appear at the SURGED HIGH and SURGED LOW output terminals.

7.17.3.5 High Voltage Indication

A high voltage indicator, identified as HIGH VOLTAGE, is illuminated when high voltage is present inside the surge network. Lamp intensity will increase with increasing SET VOLTAGE. The HIGH VOLTAGE indicator should extinguish completely when the PULSE switch is depressed.

WARNING: If the amber HIGH VOLTAGE indicator on the surge network does not go OFF, when the CHARGE switch is released, HIGH VOLTAGE is still present within the surge network and possibly at the output terminals. The unit is malfunctioning and should be turned OFF. Contact factory immediately.

7.17.3.6 Waveform and Damping Resistor Selection

The Waveform selection can be performed by pulling the selector switch to the OUT position. Next, rotate the switch to the desired selection and firmly seat the switch by pushing it into position. Note, the SURGE NETWORK Open Interlock indicator will turn ON when this switch is not seated properly.

The Damping Resistor selection is made in the same manner as described above. If this switch is opened or is not seated properly the SURGE NETWORK Open Interlock indicator will turn ON as described above.

7.17.4 Voltage and Current Monitoring

7.17.4.1 Introduction

Refer to Section 6 which describes the proper connection of the V MON INPUT A (V MON HIGH) and V MON INPUT B (V MON LOW) terminals.

7.17.4.2 Current Monitoring

The Mainframe has a built-in current monitor which measures the current delivered by the surge network. The scale factor is 100:1, or a 100A surge provides 1V to the oscilloscope. The current monitor is located on the Mainframe front panel, to the right of the SURGE ANGLE VS LINE PHASE control, and is identified as I MON. It is calibrated for a 1 Mega ohm oscilloscope input.

7.17.5 Schematics

7.17.5.1 Schematic Title	Document Number
Schematic, S21 Surge Network, H.V.	58-721-000-00
Schematic, S21 Surge Network, PCB.	58-721-110-00
Schematic, S21H Surge Network, H.V.	58-722-000-00
Schematic, S21H Surge Network, PCB.	58-722-110-00

7.18 OPERATING INSTRUCTIONS - Model S3/S21A Surge Network.

7.18.1 Introduction

The Model S3/S21A Surge Network is designed to provide the Combination Wave (+10 ohm additional series resistor) for surge testing as specified in IEC 801-5.

The Surge Network also provides waveforms as specified by CCITT Rec K.17 and are intended for surging telecom networks.

The S21 is a "circuit specified" surge network as defined by CCITT Rec K.17, Figure 1/K.17 of that document, with the exception of an additional waveform: 0.5us/700us, 0-6kV.

Output damping resistors (2.5 ohm and 25 ohm) can be selected as required by Rec K.17. A 0 ohm resistor is available that will allow the Surge Network, with optional external coupling network, to generate the 10/700us, 0-6kV, 2 x 25 ohms waveform as specified in CCITT Rec K.20 and Rec K.21.

When selecting the Combination Wave, the COUPLER/FILTER is allowed to be enabled (IN) for AC power-line surging. Note, the 700us waves are not intended for AC power-line surging and as a result will not allow the COUPLER/FILTER to be enabled (IN) when the SURGE LINE INPUT BREAKER is turned ON.

7.18.1.1 Specifications

Output Waveforms -

Open-Circuit Voltage	0-6kV	0-6kV	0-6kV	0-5kV
Voltage Front Time	1.2us	0.5us	10 us	100us
Voltage Duration	50us	700us	700us	700us

Short-Circuit Current: undefined

Output Damping Resistor Selections -: 0 ohm, 2.5 ohm, 25 ohm

NOTE: 1. The voltage front time is the time interval between the 30 percent and 90 percent of peak points, on the leading edge, multiplied by 1.67.

2. The voltage duration is the time interval between the virtual origin point and the 50-percent-of-peak point on the trailing edge.

   Virtual origin is defined as the intersection with the zero axis of a straight line drawn through points on the front of the voltage wave at the 30 percent and 90 percent of peak.

3. The short-circuit current waveform is undefined. The three output damping resistance selections effectively limit the peak short-circuit current for the 700us duration waves. The short-circuit current waveform of the Combination Wave is approximately 500Apk.

7.18.2 Installation

1. Make sure the POWER switch and SURGE LINE INPUT BREAKER switch are in the OFF position.

2. Remove the surge network from the Mainframe by unscrewing the retaining screws on the front panel and firmly pulling on the surge network's handle. Slide it out of the Mainframe, while supporting the bottom of the surge network. Insert the Model S3/S21A Surge Network, making sure that it is seated all the way into the Mainframe and the retaining screws on the front panel are screwed in finger tight.

3. Place the C1-587 OUTput FIXture over the Mainframe Output Terminal Array to close the interlock circuit. Exit all output wires to the right for safety.

4. If the SURGE NETWORK Open Interlock indicator is ON,

   - be sure the network is seated all the way into the Mainframe.

   - firmly seat the Waveform and Damping Resistor selection switches.

7.18.3 Operation

7.18.3.1 Introduction

After following the INSTALLATION procedure outlined above, the Mainframe may now be turned ON. Use the CHARGE and PULSE switches in the normal manner and sequence to produce an output pulse.

7.18.3.2 Surge Network After Pulse Delay

A built-in time delay circuit is used to limit power dissipation in the S3/S21A Surge Network and is factory set to 10 seconds. The CHARGE/IL READY light, located to the right of the CHARGE switch, will turn OFF after the CHARGE switch has been released. The Mainframe can't be charged until the light turns back ON after the delay time.

7.18.3.3 Synch Output

A unidirectional sync pulse, which occurs simultaneously with the surge, is available at the SURGE SYNCH output and is approximately +7V for either positive or negative polarity surges. The trailing edge may have a number of transitions, hence if the SURGE SYNCH pulse is used for counting, it should be buffered by a one-shot multivibrator with sufficient duration.

7.18.3.4 Output Terminal Array

Refer to Section 2 which defines the operation of each Mainframe output terminal. Set the COUPLER/FILTER MODE switch to the NORMAL MODE position, the surge will appear at the SURGED HIGH and SURGED LOW output terminals for the 700us duration waves.

7.18.3.5 High Voltage Indication

A high voltage indicator, identified as HIGH VOLTAGE, is illuminated when high voltage is present inside the surge network. Lamp intensity will increase with increasing SET VOLTAGE. The HIGH VOLTAGE indicator should extinguish completely when the PULSE switch is depressed.

WARNING: If the amber HIGH VOLTAGE indicator on the surge network does not go OFF, when the CHARGE switch is released, HIGH VOLTAGE is still present within the surge network and possibly at the output terminals. The unit is malfunctioning and should be turned OFF. Contact factory immediately.

7.18.3.6 Waveform and Damping Resistor Selection

The Waveform selection can be performed by pulling the selector switch to the OUT position. Next, rotate the switch to the desired selection and firmly seat the switch by pushing it into position. Note, the SURGE NETWORK Open Interlock indicator will turn ON when this switch is not seated properly.

To select the Combination Wave, rotate the Damping Resistor Selector switch to the Combination Wave position. Then, rotate the Waveform Selector switch to the Combination Wave position. Note, BOTH selector switches must be set to Combination Wave for proper operation.

7.18.4 Voltage and Current Monitoring

7.18.4.1 Introduction

Refer to Section 6 which describes the proper connection of the V MON INPUT A (V MON HIGH) and V MON INPUT B (V MON LOW) terminals.

7.18.4.2 Current Monitoring

The Mainframe has a built-in current monitor which measures the current delivered by the surge network. The scale factor is 100:1, or a 100A surge provides 1V to the oscilloscope. The current monitor is located on the Mainframe front panel, to the right of the SURGE ANGLE VS LINE PHASE control, and is identified as I MON. It is calibrated for a 1 Mega ohm oscilloscope input.

7.18.5 Schematics

7.18.5.1	Schematics Title	Document Number
	Schematic, S3/S21 Surge Network, H.V.	58-724-000-00
	Schematic, S3/S21 Surge Network, PCB.	58-724-110-00

7.19 OPERATING INSTRUCTIONS - S9C Surge Network

7.19.1 Introduction

The Model S9C Surge Network is primarily designed to meet FCC Docket 19528, Part 68, (Revised Edition 10-1-90) surge requirements. Part 68 is intended to test the "Connection of Terminal Equipment to the Telephone Network". Specifically, SUBPART D-Section 68.302, Environment Simulation, provides a more comprehensive description of the application of the surge waveforms to the equipment under test.

7.19.1.1 Specifications

Metallic Voltage Surge

Open-Circuit Voltage	Waveform Time to Crest/Duration	Short-Circuit Current
0-800 V	<10 us/>560 us	>200 A max

1. The waveform time to crest is the maximum time interval between virtual wave zero and the actual crest or peak of the waveform. This appears to be an easy measurement, but determination of the actual crest position is difficult since it is so broad a peak when compared to the front of the wave.

2. The waveform duration is the minimum decay time interval between virtual wave zero and the 50 percent-of-peak point on the trailing edge.

7.19.2 Installation

1. Make sure the POWER switch and SURGE LINE INPUT BREAKER switch are in the OFF position.

2. Remove the surge network from the mainframe by unscrewing the retaining screws on the front panel and firmly pulling on the surge network's handle. Slide it out of the mainframe, while supporting the bottom of the surge network. Insert the Model S9C Surge Network, making sure that it is seated all the way into the mainframe and the retaining screws on the front panel are screwed in finger tight.

3. Place the OUTPUT FIXTURE over the mainframe Output Terminal Array and exit all output wires to the right for safety.

4. The S9C Surge Network is compatible only with mainframes beginning with serial number 8810285. Mainframes with serial numbers below this will require Option S9-587 factory retrofit which includes modifications to all existing customer plug-in surge networks and mainframe.

7.19.3 Operation

7.19.3.1 Introduction

After following the INSTALLATION procedure outlined above the mainframe may now be turned ON. Use the CHARGE and PULSE switches in the normal manner and sequence to produce an output pulse.

7.19.3.2 Surge Network After Pulse Delay

A built-in time delay circuit is used to limit power dissipation in the S9C Surge Network. The delay is factory set to 10 seconds. The CHARGE/IL READY light, located to the right of the CHARGE switch, will turn OFF after the CHARGE Switch has been released. The mainframe can't be charged until the light turns back ON 10 seconds later. It is not recommended to reduce this delay time as excessive power dissipation in the network will result.

7.19.3.3 Synch Output

A unidirectional sync pulse, which occurs simultaneously with the surge, is available at the

SURGE SYNCH output and is approximately +7V for either positive or negative polarity surges. The trailing edge may have a number of transitions, hence if the SURGE SYNCH pulse is a number of counting, it should be buffered by a one-shot multivibrator with sufficient duration.

7.19.3.4 Output Terminal Array

Refer to Section 2 which defines the operation of each output terminal.

7.19.3.5 High Voltage Indication

A high voltage indicator, identified as HIGH VOLTAGE, is illuminated when high voltage is present inside the surge network. Lamp intensity will increase with increasing SET VOLTAGE. The HIGH VOLTAGE indicator should extinguish completely when the PULSE switch is depressed.

WARNING: If the amber HIGH VOLTAGE indicator on the surge network does not go OFF, when the CHARGE switch is released, HIGH VOLTAGE is still present within the surge network and possibly the ouput terminals. The unit is malfunctioning and should be turned OFF. Contact factory immediately.

7.19.3.6 Mainframe COUPLER/FILTER MODE Switch

Place the COUPLER/FILTER MODE switch to the NORMAL MODE position. The surge output will be available at the SURGED HIGH and SURGED LOW terminals. The S9C is not intended to be operated in a coupling mode other than NORMAL MODE.

7.19.4 Voltage and Current Monitoring

7.19.4.1 Current Monitoring

The mainframe has a built in current monitor which measures the current delivered by the surge network. The scale factor is 100:1, or 100A surge provides 1V to the oscilloscope. The current monitor is located on the mainframe front panel, to the right of the SURGE ANGLE VS LINE PHASE control, and is identified as I MON. It is calibrated for a 1 Mega ohm oscilloscope input.

7.19.4.2 Voltage Monitoring

Refer to Section 6, Surge/Voltage Monitoring, for proper connection of V MON INPUT A (V MON HIGH) and V MON INPUT B (V MON LOW) terminals.

7.19.5 Schematics

7.19.5.1	Schematic Title	Document Number
	Schematic, S9C Surge Network H.V.	58-719-000-00
	Schematic, S9C PCB	58-719-110-00