

DC POWER SUPPLY
J86835A
OPERATING METHODS

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Every precaution should be observed to avoid any contact with exposed metal parts or terminals when the power supply is in operation. Do not allow a test pick to touch two metal parts at the same time, as dangerous and destructive short circuits may occur.

1. GENERAL

1.01 The J86835A dc-to-dc converter power supply is designed primarily to provide four dc voltages for the elements of the 461A traveling wave tube (TWT), used in the TD3 radio relay system. The J86835A dc-to-dc converter consists of the J86835B, INVERTER AND HEATER REGULATOR section, and the J86835C, RECTIFIERS AND HELIX REGULATOR section, which are mated and serialized. However, if the F option is provided, the J86835B and J86835C sections are not paired and serialized. The J86835D, TEST LOAD, is the associated test load for the J86835A converter.

Danger: Voltages inside the power supply are higher than those usually encountered in telephone power plants.

1.02 This section is reissued to:

- (a) Add information on the KS-19592, L2 time delay relay
- (b) Update the admonishments to the latest standards

Change arrows are used to emphasize the more significant changes. This issue does not affect the Equipment Test List.

1.03 The J86835A converter is arranged for mounting in the TD3 T/R bays.

1.04 Keep the ventilating passages clean. This is essentially important to prevent excessive heating during operation.

1.05 Routine checks should be made during a period when they will not interfere with service.

1.06 These instructions are based on schematic drawing SD-81660-01. The associated circuit description gives working limits, functions, and complete details on how the circuit operates.

1.07 This circuit will function with the following TD3 circuits:

- (a) SD-50544-01—Application Schematic Transmitter Receiver Bay.

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(b) SD-50557-01—Transmitter Receiver Common Alarm Circuit.

1.08 The abbreviations cw and ccw refer to clockwise and counterclockwise, respectively.

1.09 For more detailed information on the operation and maintenance of individual equipment or apparatus, refer to the appropriate Bell System Practice.

2. LIST OF TOOLS AND TEST APPARATUS

**CODE OR
SPEC NO.**

DESCRIPTION

TOOLS

— 3-Inch C Screwdriver

TEST APPARATUS

KS-14510 Volt-Ohm-Milliammeter

3. OPERATION

Description

3.01 The power input requirement for the J86835A converter is a dc power source that is positive grounded with a normal -24 volt, 5-ampere output. The J86835A converter provides four filtered dc outputs for the 461A TWT. The four outputs supply the dc voltages for the anode, helix, cathode, and heater of the TWT. The cathode is -1420 volts from the collector which is at ground potential. The voltages and currents in reference to the cathode are listed in Table A.

TABLE A

| OUTPUT | VOLTAGE | CURRENT |
|-----------|----------------|---------|
| Anode | 2560 to 3400V | 1 MA |
| Helix | 2500V to 2900V | 4 MA |
| Collector | 1420V | 40 MA |
| Heater | -7.5V | 0.95A |

Note: The HELIX CURRENT may rise to 6 mA during the starting of a "cold" TWT.

3.02 Overcurrent protection is provided in the J86835A converter by a circuit breaker and a fuse.

(a) The circuit breaker, CB1-B, is used to protect against the excessive current drawn from the battery power plant due to a failure of the J86835A converter or the TWT.

(b) The helix and anode circuits are protected by the circuit breaker, CB1-A, against excessive current due to failure in the helix or anode circuit of the J86835A converter or the TWT.

(c) A slow-blow type fuse, F1, is used in the heater circuit to protect the heater transformer and the semiconductor components in the regulator circuit.

3.03 Operation is facilitated by an ANODE TO CATHODE VOLTAGE voltmeter, HELIX CURRENT milliammeter, CATHODE CURRENT milliammeter, ANODE VOLTAGE ADJUST control, HELIX ADJUST control, INPUT circuit breaker, and INPUT VOLTAGE jacks, all of which are mounted on the front panel of the power supply. If the F option is provided, the HEATER ADJUST potentiometer (R13) is located on the front panel. Careful observation of the panel instrument readings during operation will alert the operator to required adjustments or impending troubles.

Mating of J86835B and J86835C Sections

3.04 The J86835B, INVERTER AND HEATER REGULATOR section, and the J86835C, RECTIFIERS AND HELIX REGULATOR section, are tested as mated pairs, serialized and shipped together with the intent of never becoming separated. In the event that a mated pair of sections must be broken up, follow the procedure in Part 5 for the correct heater adjustment. If the F option is provided, the J86835B and J86835C sections are not mated and serialized. The heater voltage must be adjusted when the J86835A converter is installed and whenever the J86835B and/or J86835C sections are replaced. Refer to Part 4 for the heater voltage adjustment procedure.

Preparing to Start

3.05 Before putting the J86835A into service, check that:

- (a) The INPUT circuit breaker (CB1) is in the OFF position.
- (b) The internal F1 fuse, of the proper type and rating, is installed in the J86835A converter.

Note: Since F1 is at -1420 volts from ground, it is located inside the converter as a safety precaution.

- (c) The pointer of the time delay relay, K1, is set at 180 seconds.

Note: ♦On those units that employ a KS-19592, L2 relay, the delay time is not adjustable.♦

- (d) The TWT WARM UP light bulb of the proper type is installed.
- (e) All external connections are made in accordance with the SD drawings covering the associated circuits of which the J86835A converter is a part.
- (f) There is nothing in, on, or above the power supply to interfere with operation or prevent free ventilation.
- (g) The normal battery power plant voltage is between -24 and -26 volts, (12-cell plant). The maximum allowable line drop to terminals 1 and 2 of TS1 of the TWT converter is 1.0 volt.

Note: If the normal battery power plant voltage is between -22 and -24 volts, (11-cell plant), refer to schematic drawing SD-81660-01 for changing transformer taps.

- (h) The ANODE VOLTAGE ADJUST (T1) and HELIX ADJUST (R22) are set at approximately midposition.
- (i) Where serial numbers are used, check that the J86835B and J86835C sections have matched serial numbers. J86835A converters with matched and serialized J86835B and J86835C sections have potentiometer R13 factory set for

a heater voltage of -7.5 ± 0.01 volts, and no field adjustment should be necessary. If no serial numbers are used, the heater voltage should be adjusted in accordance with Part 4. Where serial numbers are provided but are mismatched, refer to 5.05.

- (j) Ensure that the output connector P3 is connected to the TWT.

Note: The J86835A converter is provided with a safety interlock. If the output connector P3 is not connected to the TWT, the -24 volt input lead is not connected to the inverter; thus, the inverter will not operate and no high voltage will appear on the output connector.

- (k) Ensure that the INVERTER AND HEATER REGULATOR section and RECTIFIERS AND HELIX REGULATOR section are securely fastened in their case.

♦Danger: If a converter has been stored for an extended period, refer to Section 032-110-701 to check capacitors and disconnect any source of circuit current.♦

Starting and Stopping the J86835A Converter

3.06 To start the J86835A converter, proceed as follows.

- (1) Switch the J86835A converter to a protection channel. Refer to the appropriate Bell System Practice.
- (2) Operate the INPUT circuit breaker to the ON position. The TWT WARM UP lamp lights and after 180 ± 22 seconds is extinguished.

Note: During the time the TWT WARM UP lamp is lighted, there will be no anode or helix voltages applied to the TWT.

- (3) After the TWT WARM UP lamp is extinguished, rotate the ANODE VOLTAGE ADJUST control for an indication of 3000 volts on the ANODE TO CATHODE VOLTAGE meter.
- (4) Rotate the HELIX ADJUST control for an indication of 40 milliamperes on the CATHODE

CURRENT milliammeter. The HELIX CURRENT milliammeter indicates less than 1.5 milliamperes.

- (5) Place the inverter in service in accordance with the appropriate Bell System Practice.

3.07 To stop the J86835A converter, proceed as follows.

- (1) Switch the J86835A converter to a protection channel. Refer to the appropriate Bell System Practice.
- (2) Operate INPUT circuit breaker (CB1) to the OFF position.

4. ROUTINE CHECKS

4.01 Routine checks should be made periodically to determine that the J86835A converter is operating properly. These checks are performed at the transmitter site and use the built-in meters on the RECTIFIER and HELIX REGULATOR panel and the TEST LOAD panel. A portable meter is used to check the input voltage. Differences may exist in values and/or tolerances as given in the CD and this section. The figures given in this section are the maximum allowable considering the accuracy of the test equipment usually available in the field. Where more accurate test equipment is available, the figures given in the CD should be used. The meters of the J86835D test load should be checked often enough to ensure their accuracy. This is especially important for heater voltage measurements. A heater voltage which is set inaccurately can reduce the life of the associated 461A TWT.

4.02 To check the TWT power supply using the J86835D TEST LOAD, the channel under test must be switched to a protection channel to avoid service interruptions. Refer to the appropriate Bell System Practice for the procedure of switching a regular channel to a protection channel.

- (1) Operate INPUT circuit breaker (CB1) to the OFF position.
- (2) Remove INVERTER AND HEATER REGULATOR section from the J86835A converter enclosure.

- (3) Disconnect the TWT from P3; mount the TEST LOAD on the enclosure; and connect J5 on the TEST LOAD to P3.

Note: The J86835A converter is provided with a safety interlock. If the output connector P3 is connected to neither the TWT nor the TEST LOAD, the -24 volt input lead is not connected to the inverter. The inverter will not operate. Thus, no high voltage will appear on the output connector P3.

- (4) Install the INVERTER AND HEATER REGULATOR section in the enclosure. If serial numbers are provided, ensure that the INVERTER AND HEATER REGULATOR and the RECTIFIERS AND HELIX REGULATOR sections have matched serial numbers. If the F option is provided, these two sections are not matched and serialized.

- (5) Ensure that the VOLTAGE SELECTOR switch (S1) on the TEST LOAD is in the OFF position.

- (6) Rotate the ANODE VOLTAGE ADJUST and HELIX ADJUST controls to their approximate midpositions.

- (7) Operate INPUT circuit breaker (CB1) to the ON position.

Requirement: The TWT WARM UP lamp lights. There will be no anode-to-cathode voltage or helix current. If the G option is furnished, the HEATER VOLTAGE meter will indicate 9.1 ± 0.4 volts. If the F option is furnished, the heater voltage may not be adjusted and will be approximately 9.1 volts. After 180 ± 22 seconds the TWT WARM UP lamp will extinguish. There will be anode-to-cathode voltage and also helix current indicated. For the G option, the heater voltage will be 7.5 ± 0.1 volts. For the F option, the heater voltage will be approximately 7.5 volts.

- (8) Adjust the HEATER ADJUST potentiometer (R13) (see Note) so that the HEATER VOLTAGE meter indicates exactly 7.5 volts.

Note: If the G option is furnished, HEATER ADJUST potentiometer (R13) is located inside

the J86835B section. Should heater adjustment be necessary, refer to 5.05.

- (9) Connect the KS-14510 meter to the INPUT VOLTAGE jacks.

Requirement: For battery plants with a normal voltage of 24 volts at the battery, (11-cell plant), the meter should indicate between 21.2 and 25.6 volts. For battery power plants with a normal voltage of 26 volts at the battery, (12-cell plant), the meter should indicate between 23.3 and 27.7 volts.

- (10) Disconnect the KS-14510 meter.
- (11) Operate the VOLTAGE SELECTOR switch to the COLLECTOR position.

Requirement: For battery power plants with a normal voltage of 24 volts at the battery, (11-cell plant), the VOLTAGE MONITOR on the TEST LOAD indicates between 134 and 152 volts. For battery power plants with a normal voltage of 26 volts at the battery, (12-cell plant), the VOLTAGE MONITOR indicates between 136 and 150 volts.

Note: When the switch is in the COLLECTOR position, the actual voltage is the VOLTAGE MONITOR meter indication multiplied by 10.

- (12) Operate the VOLTAGE SELECTOR switch to the HELIX 0.6 MA position and rotate the HELIX ADJUST potentiometer cw until the VOLTAGE MONITOR indicates 148 volts.

Note: When the switch is in the HELIX 0.6 MA, HELIX 6 MA (earlier models may be designated HELIX 10 MA), or ANODE position, the actual voltage is the VOLTAGE MONITOR meter indication multiplied by 20.

- (13) Operate the VOLTAGE SELECTOR switch to the HELIX 6 MA position.

Requirement: The VOLTAGE MONITOR indicates 148 volts.

- (14) Rotate the HELIX ADJUST potentiometer ccw until the VOLTAGE MONITOR indicates 122 volts.

- (15) Operate the VOLTAGE SELECTOR switch to the HELIX 0.6 MA position.

Requirement: The VOLTAGE MONITOR indicates 122 volts.

- (16) Rotate the HELIX ADJUST potentiometer cw until the VOLTAGE MONITOR indicates 135 volts.

Requirement: The HELIX CURRENT meter on the TEST LOAD indicates 0.6 ± 0.03 mA and the HELIX CURRENT meter on the power supply indicates 0.6 ± 0.3 mA.

- (17) Operate the VOLTAGE SELECTOR switch to the HELIX 6 MA position.

Requirement: The VOLTAGE MONITOR indicates 135 ± 0.5 volts. If the VOLTAGE SELECTOR position reads HELIX 10 MA, (VOLTAGE MONITOR indicates 135 ± 5.0 volts), the CATHODE CURRENT meter on the TEST LOAD and the CATHODE CURRENT meter and the HELIX CURRENT meter on the J86835A converter may indicate over-scale. No damage will occur when these meters are over-scale. No over-scale indications should be noted on any of the meters provided when the VOLTAGE SELECTOR is in the HELIX 6 MA position.

- (18) Operate the VOLTAGE SELECTOR switch to the ANODE position and rotate the ANODE VOLTAGE ADJUST fully ccw.

Requirement: The VOLTAGE MONITOR indicates 136 volts maximum.

- (19) Rotate the ANODE VOLTAGE ADJUST fully cw.

Requirement: The VOLTAGE MONITOR indicates 162 volts minimum.

- (20) Rotate the ANODE VOLTAGE ADJUST ccw until the VOLTAGE MONITOR indicates 150 volts.

Requirement: The ANODE TO CATHODE VOLTAGE meter on the J86835A converter indicates 3000 ± 120 volts. The CATHODE CURRENT meter on the TEST LOAD indicates 42.3 ± 4.1 mA. The CATHODE CURRENT

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meter on the J86835A converter indicates within ± 2 mA of the indication on the CATHODE CURRENT meter on the TEST LOAD.

- (21) Operate the VOLTAGE SELECTOR switch to the OFF position.
- (22) Operate the INPUT circuit breaker (CB1) to the OFF position.
- (23) Remove the INVERTER AND HEATER REGULATOR from the enclosure.
- (24) Disconnect P3 from J5 and remove the TEST LOAD. Connect P3 to the TWT.
- (25) Install the INVERTER AND HEATER REGULATOR section in the enclosure.

4.03 Electrolytic capacitors should be maintained in accordance with Section 032-110-701.

5. TROUBLES

5.01 In general, the only components likely to become defective with use are electrolytic capacitors and semiconductors (rectifying, regulating, and reference diodes or transistors).

5.02 Troubles may result from a faulty TWT at times. When a TWT or J86835A converter failure occurs, the TEST LOAD should be used to determine which has failed.

5.03 If a heater overcurrent condition causes internal fuse F1 to blow, the HEATER VOLTAGE meter on the J86835A converter will read zero, indicating TWT or TWT converter failure.

5.04 When replacing defective transistors or diodes, no code substitutions should be made other than those specified in SD-81660-01.

5.05 The following heater adjustment procedure is to be used if either the J86835B or J86835C sections of a pair which are mated and serialized have to be replaced, resulting in a mismatched pair.

Warning: Do not adjust the heater voltage of a mated (serialized) pair of sections.

(1) Operate the INPUT circuit breaker to the OFF position.

(2) Remove the inoperative section of the power supply.

(3) If the J86835B section is being replaced, ensure that the INPUT circuit breaker on the replacement is in the OFF position and the time delay relay, K1, is set at 180 seconds.

(4) Mount the TEST LOAD on the enclosure, and connect J5 on the TEST LOAD to P3.

(5) Install both sections in the enclosure.

(6) Operate the INPUT circuit breaker to the ON position. The TWT WARM UP lamp lights and after 180 ± 22 seconds is extinguished. The HEATER VOLTAGE meter on the TEST LOAD should indicate 7.5 ± 0.05 volts. If the HEATER VOLTAGE meter indication is not correct, perform (7) through (11).

(7) Operate the INPUT circuit breaker to the OFF position.

(8) Pull the J86835B section out of the enclosure far enough to expose the shaft of HEATER ADJUST potentiometer (R13).

(9) Adjust the HEATER ADJUST potentiometer (R3) to raise or lower the heater voltage as required.

Note: Rotating the HEATER ADJUST potentiometer (R13) cw raises the heater voltage, and rotating it ccw lowers the heater voltage.

(10) Push the J86835B section back into the enclosure.

(11) Repeat (6).

Note: Normally, three trial adjustments will be necessary before the heater voltage is 7.5 ± 0.05 volts.

5.06 Should any of the following troubles develop, it is suggested that the possible causes listed be checked. If the trouble is not found, inspect for loose or open connections or short circuits due to foreign matter lying across wiring terminals.

Any one of the following troubles may be caused by an open or short circuit or by aging or drift in the values of some faulty component. If one of the possible causes listed does not lead to the location of the trouble, it is advisable to make individual component resistance measurements with the circuit completely de-energized, and compare the measurements with the values shown on the circuit drawing.

| TROUBLE | POSSIBLE CAUSE |
|--|---|
| (a) INPUT circuit breaker (CB1) operates | (1) Short in inverter circuit. (2) Defective filter capacitors C2 through C8, C19. (3) Inverter transistor Q1 or Q4 shorted collector to emitter. (4) Overload in collector supply. (5) Intermittent short in transformer T3, T4, T5, or T6. (6) Shorted helix-to-cathode or anode-to-cathode outputs. (7) Defective CR17, CR18, or CR42. (8) Defective K1, time delay relay. (9) Heater regulator transistor Q5 shorted. |
| (b) No anode, helix, collector, or heater voltage; (CB1 does not operate, fuse F1 not blown) | (1) Open path in inverter circuit. (2) Collector supply shorted. (3) Open switching capacitor C18. (4) Open or shorted primary or secondary of switching transformer T2. (5) Open diode CR1. (6) Faulty starting resistor R7. (7) Faulty switching component C1, C7, R2, R8, R82, R83, or R84. (8) Open inverter transistor Q1 or Q4. (9) INPUT circuit breaker (CB1) defective. |
| (c) No cathode current | (1) Milliammeter M2 defective. (2) Open path in collector supply. (3) Resistor R88 defective. (4) Varistor RV5 shorted. |
| (d) Collector-to-cathode voltage out of limits (see Note 1) | (1) Q1 or Q4 defective. (2) Incorrect selection of secondary taps on transformer T5. (3) Resistor R24, R85, or R86 defective. |
| (e) Collector output ripple voltage high (1 volt RMS max) | (1) Defective filter capacitor C9. (2) Bleeder resistor R24, R85, or R86 open or shifted in value. |

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| TROUBLE | POSSIBLE CAUSE | TROUBLE | POSSIBLE CAUSE |
|---|---|---|--|
| (f) No heater voltage | (1) Internal fuse F1 blown. (2) Heater output shorted. (3) Filter capacitor C10 shorted. (4) Open path in heater circuit. (5) Diode CR8, CR9, CR33, CR34, or CR39 defective. | (k) Helix-to-cathode voltage out of limits, possible loss of control (see Note 4) | (1) Circuit package CP1 faulty. (2) CR2, CR3, CR39, Q2, or Q3 defective. (3) Open path in feedback loop. (4) R21, R23, R25, or R44 through R47 defective. (5) Potentiometer R22 defective. (6) CR11 through CR16 defective. (7) C14 or R43 defective. (8) R16 defective. (9) Faulty heater supply. (10) CR3, R3, R4, or R5 defective. |
| (g) Heater voltage out of limits (see Note 2 and 3) | (1) Open path in control circuit consisting of R12, R13, or R15. (2) Q5, Q6, CR10, CR39, RV1, RV2, or RV3 defective. (3) One or more of the following resistors are defective: R10, R11, and R14. (4) Open path in regulator circuit. (5) Diode CR8 or CR9 defective. | (l) Helix-to-cathode output ripple voltage high (150 mv RMS max) | (1) Filter component C7, C8, R19, or R20 defective. (2) R43 or C14 defective. (3) C19 or C20 defective. |
| (h) Heater output ripple high (75mv RMS max) | (1) Filter capacitor C10 defective. (2) Resistor R27 open or shifted in value. | (m) No anode-to-cathode voltage | (1) Open path in anode supply. (2) Helix-anode section (CB1-A) of INPUT circuit breaker defective. (3) Resistors R48 through R55 defective. (4) Voltmeter M3 defective. (5) CR17 defective. (6) Variable autotransformer T1 defective. |
| (i) No helix-to-cathode voltage | (1) Open path in helix supply. (2) Helix-anode section (CB1-A) of INPUT circuit breaker defective. | | |
| (j) No helix current | (1) Milliammeter M1 defective. (2) Resistor R87 defective. (3) Varistor RV4 shorted. (4) Open path in helix supply. | | |

| TROUBLE | POSSIBLE CAUSE |
|---|---|
| | (7) Faulty helix supply. |
| (n) Anode-to-cathode voltage out of limits; possible loss of control (see Note 5) | (1) Faulty helix supply. (2) Variable autotransformer T1 defective. (3) Filter capacitor C3 or C4 defective. (4) Diode CR40, CR41, CR42, CR44, or CR45 defective. (5) Filter capacitor C15 defective. (6) Resistor R17, R18, or R81 defective. |
| (o) Anode-to-cathode output ripple voltage high (300 mv RMS max) | (1) Filter component C3, C4, C15, R17, or R81 defective. (2) R18 open or shifted in value. |

Note 1: The collector-to-cathode voltage is factory adjusted. The input voltage is measured at TS1. The voltage limits with respect to input voltage and load current conditions are listed in Table B.

Note 2: For power supplies manufactured prior to issue 5B of SD-81660-01, the heater voltage is factory adjusted, and no field adjustment should be necessary. The input voltage is measured at TS1. The heater voltage limits of the factory-adjusted power supply with respect to input voltage and load current are listed in Table C.

Danger: The positive side of the heater output is connected to the cathode which is -1420 volts from ground.

Note 3: If the F option is provided, the heater voltage must be adjusted in the field to 7.5 volts. Regulation is ± 0.15 volt within the stated range of the load current and for line inputs of 21.5 to 26.0 volts dc.

Note 4: Helix-to-cathode voltage is continuously adjustable from 2500 to 2900 volts with load currents of 0 to 4 mA. Regulation is ± 12 volts within the stated range of voltage and load currents for line inputs of 21.5 to 26 volts direct current.

Note 5: Anode-to-cathode voltage is continuously adjustable from 2560 to 3400 volts with load currents of 0 to 1 mA. Regulation is ± 60 volts within the stated range of voltage and load currents for line inputs of 21.5 to 26 volts direct current.

TABLE B

| | | INPUT VOLTAGE (VOLTS DC) | LOAD CURRENT (MA DC) | COLLECTOR TO CATHODE VOLTAGE (VOLTS) |
|-------------------|-------------------------|--------------------------|----------------------|--------------------------------------|
| Normal | } Tap 11 of T5 Not Used | 25.25 | 40 | 1420 \pm 10 |
| Max | | 26.0 | 36 | 1550 approx |
| Min | | 21.5 | 44 | 1185 approx |
| Tap 11 of T5 Used | | 23.0 | 35 | 1420 \pm 30 |

TABLE C

| | INPUT VOLTAGE (VOLTS DC) | LOAD CURRENT (AMPS DC) | HEATER VOLTAGE (VOLTS) |
|--------|--------------------------------|------------------------------|---------------------------|
| Normal | 25.25 | 0.875 | 7.5 ± 0.010 |
| Max | 26.0 | 0.800 | $7.5 + 0.15$ |
| Min | 21.5 | 0.950 | $7.5 - 0.15$ |