

## INVERTER

### KS-19951

## REQUIREMENTS AND ADJUSTING PROCEDURE

### 1. GENERAL

**1.01** This section covers requirements and adjusting procedures for the KS-19951 dc-to-ac inverter. For final inverter output voltage adjustment, refer to Section 167-678-301 (523A Power Plant Operating Methods).

**1.02** This issue does affect the Equipment Test List.

**1.03** Refer to Section 020-010-711, covering general requirements and definitions, for additional information necessary for the proper application of the requirements listed in this practice. For operating methods, refer to Section 161-234-301.

**1.04** The inverter is intended for use as a source of 117-volt ac power in the 523A power plant. It consists essentially of two dc-to-ac 59.5-Hz square-wave power stages using thyristors as switching elements. The outputs of the power stages are connected in series to produce a quasi-square wave. The quasi-square wave is passed through tuned filters which pass the fundamental and suppress all harmonics, producing a 117-volt, 59.5-Hz, single-phase, sine-wave output. A voltage-regulator circuit maintains the output voltage within the required limits for battery voltage, load, and temperature variations. A current droop circuit limits the output current during an overload up to and including a short circuit. During short-circuit conditions the output current is limited to 40 amperes. A frequency and voltage-regulator circuit controls the output frequency and voltage. This circuit consists essentially of an oscillator which sets the frequency of operation of the inverter, two transistor drivers which power the gates of the thyristors in the inverter power stages, the voltage regulator, and a dc supply which furnishes power to the oscillator, gate drivers, and voltage-regulator circuits.

**1.05** Schematic drawing for the KS-19951 inverter is SD-81852-01, and the schematic drawing for the frequency control and voltage-regulator circuit is SD-81860-01. The associated circuit descriptions (CDs) give working limits, functions, and complete details on how the circuit functions.

### 2. REQUIREMENTS

#### 2.01 Voltage:

(a) **DC Input Voltage:** For normal operation, the inverter requires a dc input which is between 42 and 55 volts.

(b) **AC Output Voltage:** The output sine-wave voltage of the inverter is 117 volts rms  $\pm 5$  percent, single phase.

**2.02 Ambient Temperature:** The ambient temperature in the vicinity of the inverter shall not be less than 32°F nor more than 122°F for continuous and reliable operation.

**2.03 Frequency Stability:** The output frequency is  $59.5 \pm 0.5$  Hz for all conditions of line, load, and temperature as specified in 2.01(a), 2.02, and 2.05.

**2.04 AC Output Current:** The rated output current of the inverter is 16.0 amperes.

**2.05 Output Power:** The inverter is capable of delivering 1500 volt-amperes and handling loads having power factors of unity to less than 0.8 lagging when operated within the limits specified in 2.01(a), 2.02, and 2.04.

**2.06 Adjustment Range:** The output voltage can be adjusted between 100 volts and 120 volts rms when the inverter is delivering full load and dc input is 52.5 volts.

**2.07 Short-Circuit Capability:** The inverter is capable of handling overloads up to and including a short circuit. In the overload region, the voltage is reduced as the current is increased. With a short circuit, the output current is limited to 40 amperes.

**2.08** If any of the inverter requirements cannot be met, the unit is out of adjustment. Refer to the applicable adjustment procedure in Part 3.

### 3. ADJUSTING PROCEDURES

**Caution:** Adjustment of R2, R19, R24, R25, R33, and R49 potentiometers is very critical. Indiscriminate tampering with these controls will result in maladjustment of the inverter.

#### 3.01 List of Tools and Test Apparatus:

CODE OR SPEC NO.	DESCRIPTION
<b>TOOLS</b>	
—	3-Inch C Screwdriver
<b>TEST APPARATUS</b>	
KS-8039	DC Volt-Milliammeter
KS-14510	Volt-Ohm-Milliammeter
—	Hewlett-Packard 5211B Electronic Counter
—	Oscilloscope, Tektronix 535A Equipped With G Plug-In Unit and a One-to-One Probe
—	Weston Model 528 Ammeter, Capable of Carrying 50 Amperes or More
—	Single-Pole, Single-Throw Switch, Capable of Carrying 50 Amperes or More
KS-19951 L5	Circuit Test Cable
—	Hewlett-Packard Model 302A Wave Analyzer

**Note:** Equivalents may be substituted.

#### 3.02 Initial Start:

(a) Battery voltage must be between 42 and 55 volts. Read this voltage at the INPUT DC VOLTS (+) and (-) jacks with the KS-8039 dc volt-milliammeter set to the 75 VOLTS DC range.

**Caution:** The inverter must not be started with the load connected. Make sure the input fuses to the connecting circuit are removed, or that the OPERATION SELECTOR switch in the AC Power Supply Circuit is in the COML PWR mode.

(b) Remove the KS-8039 dc volt-milliammeter. Connect the KS-14510 volt-ohm-milliammeter, set to the 300 VOLTS AC range, to the OUTPUT AC VOLTS ( $\pm$ ) and (NEUT) jacks. Operate the S1 INPUT SWITCH to the START position. Observe that the ac output voltage will be approximately 117 volts within 5 seconds. Operate the S1 INPUT SWITCH to the RUN position.

**Note:** For output voltage and frequency adjustments, the ambient temperature of the inverter must be between 20°C and 25°C (68°F and 77°F); the inverter shall be delivering power to its connected load; the battery plant must be at its specified float voltage; and the inverter must have been operating under these conditions for at least 15 minutes.

**3.03** The inverter output voltage, as indicated on the 300-volt scale of the KS-14510 meter, should now be 117 volts  $\pm$ 5 percent. If the output is not 117 volts, adjust to this value by rotating the VOLTS ADJ (R2) potentiometer clockwise to raise, and counterclockwise to lower, the output voltage. Insert the input fuses to the connecting circuit. The inverter is now in its normal operating state.

**3.04 Frequency Adjustment:** The output frequency is set during manufacture and normally does not require field adjustment. However, if field adjustment is required, connect the Hewlett-Packard 5211B Electronic Counter, or equivalent, to the OUTPUT AC VOLTS ( $\pm$ ) and (NEUT) jacks of the inverter. Adjust the frequency to 59.5 Hz by rotating the FREQ ADJ (R24) potentiometer clockwise to increase or counterclockwise to decrease the output frequency.

**3.05 Delayed Pulse Generator Adjustment:** The delayed pulse generator is set during

manufacture and should not need adjusting. In the event that a circuit pack or other component is replaced in the voltage regulator or frequency-control circuit, it may be necessary to adjust the delayed pulse generator by proceeding as follows.

**Caution:** *When making adjustments on the delayed pulse generator, do not confuse R24 potentiometer located on the VOLTAGE REGULATOR board with the FREQ ADJ R24 potentiometer which is located on the FREQ CONTROL board. The delayed pulse generator should be set after the frequency has been set in accordance with 3.04. This adjustment is made with the frequency control unit energized, but with the NONDELAYED and DELAYED power stages de-energized. The INPUT DC VOLTS measured at the (+) and (-) jacks must be between 47 and 53 volts.*

- (1) Disconnect the load by operating the OPERATION SELECTOR switch to the COML PWR position and by removing the input fuses to the connecting circuit.
  - (2) Disable the DELAYED and NONDELAYED power stages by connecting a jumper across C21.
  - (3) Remove the FREQUENCY CONTROL and VOLTAGE REGULATOR units from the inverter and reconnect it with a KS-19951 L5 adapter cable.
  - (4) Connect a one-to-one oscilloscope probe to TP3 (J3) which is located on the FREQUENCY CONTROL and VOLTAGE REGULATOR unit. Connect the common lead of the probe to the INPUT DC VOLTS (-) jack. Do not ground the oscilloscope.
  - (5) Operate the INPUT SWITCH (S1) to the START position and observe that a positive pulse waveform appears on the oscilloscope. If the dwell time of the waveform is not 0.50 milliseconds, rotate R24 (see preceding **Caution**) clockwise to decrease or counterclockwise to increase the dwell time.
  - (6) Operate the INPUT SWITCH (S1) to the OFF position.
  - (7) Disconnect the oscilloscope probes from the INPUT DC VOLTS (-) jack and TP3 (J3).
  - (8) Remove the KS-19951 L5 adapter cable and replace the FREQUENCY CONTROL and VOLTAGE REGULATOR units.
  - (9) Remove the jumper from C21.
  - (10) Restore the inverter to normal operation as covered in 3.02.
- 3.06 Short-Circuit Current Adjustment:** The short-circuit current setting is set during manufacture and normally does not require field adjustment. However, if components are replaced and field adjustment is required, proceed as in (1) through (8).
- Note:** In order for this adjustment to be made, the voltage at the input terminals must be in the range of 45 to 55 volts as measured in 3.02(a).
- (1) Operate the INPUT SWITCH (S1) to the OFF position. Disconnect the load by operating the OPERATION SELECTOR switch to COML PWR and by removing the input fuses to the connecting circuit.
  - (2) Connect a single-pole, single-throw switch and a Weston model 528 ammeter, each capable of carrying 50 amperes or more, in series across terminals 1 and 2 on TB2.
  - (3) Operate the single-pole, single-throw switch to the OFF position and start the inverter as covered in 3.02(b).
  - (4) Operate the single-pole, single-throw switch to the ON position and observe that the short-circuit current, as indicated on the ammeter, is 38 amperes. If the short-circuit current is 38 amperes, proceed to (6); if not, proceed to (5).
  - (5) Operate the INPUT SWITCH (S1) to the OFF position. Adjust the slide wire resistor, R22, on CP1 in 1/16-inch increments until the short-circuit current is 38 amperes. Increasing the value of R22 decreases and decreasing the value of R22 increases the short-circuit current. Make sure to turn the inverter OFF each time R22 is adjusted.

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**Note:** If the setting of R22 causes unstable current, turn R19 on CP1 clockwise until the output current reaches a stable value, then turn R19 approximately 10° more, clockwise.

- (6) Operate the INPUT SWITCH (S1) to the OFF position.
- (7) Remove the single-pole, single-throw switch and ammeter.
- (8) Restore the inverter to normal operation as covered in 3.02.

**3.07 Voltage Limit Adjustment:** The voltage limit is set during manufacture and does not normally require field adjustment. However, if field adjustment is required, proceed as follows.

- (1) Operate the INPUT SWITCH (S1) to the OFF position and disconnect the load by operating the OPERATION SELECTOR switch to the COML PWR position and by removing the input fuses to the connecting circuit.
- (2) Disable the voltage regulator by disconnecting the lead to L10 inductor at terminal 2 of TB2.
- (3) Connect the KS-14510 volt-ohm-milliammeter, set to the 300 VOLTS AC range, to the OUTPUT AC VOLTS ( $\pm$ ) and (NEUT) jacks.
- (4) Start the inverter as described in 3.02.
- (5) Adjust VOLT LIMIT ADJ (R25) potentiometer until the output voltage is above 132 volts rms.
- (6) Connect a one-to-one oscilloscope probe to the OUTPUT AC VOLTS ( $\pm$ ) jack, and connect the common lead of the probe to the (NEUT) jack.
- (7) Observe the output voltage on the oscilloscope and slowly rotate R25 counterclockwise until a low frequency hunt appears. The hunt should begin as the voltage reaches  $130\pm 2$  volts as

measured with the KS-14510 volt-ohm-milliammeter. If oscillation begins at  $130\pm 2$  volts, proceed to (12); if oscillation begins above 132 volts, proceed to (8); if oscillation begins below 128 volts, proceed to (10).

- (8) Operate the INPUT SWITCH (S1) to the OFF position. Move the tap on transformer T4 to a lower number. Operate the INPUT SWITCH (S1) to the ON position.
- (9) Repeat (7) and (8) until hunt begins in the range of  $130\pm 2$  volts. Proceed to (12).
- (10) Operate the INPUT SWITCH (S1) to the OFF position. Move the tap on transformer T4 to a higher number. Operate the INPUT SWITCH (S1) to the ON position.
- (11) Repeat (7) and (10) until hunt begins in the range of  $130\pm 2$  volts. Proceed to (12).
- (12) Start the inverter as described in 3.02. Adjust R25 so that the output voltage corresponds to the input voltage as shown in Fig. 1.
- (13) Lock the adjustment bushing on R25.
- (14) Operate the INPUT SWITCH (S1) to the OFF position. Disconnect all test equipment; connect the lead to inductor L10 to terminal 2 of TB2.
- (15) Restore the inverter to normal operation as covered in 3.02.

**3.08 Voltage Band Adjustment:** The VOLTS ADJ potentiometer will allow the output voltage to be adjusted over a band of 98 to 124 volts. If for any reason the band needs to be shifted either up or down, proceed as follows:

- (1) To shift the band upwards, increase the resistance of R2 slide wire resistor.
- (2) To lower the band, decrease the resistance of R2 slide wire resistor.

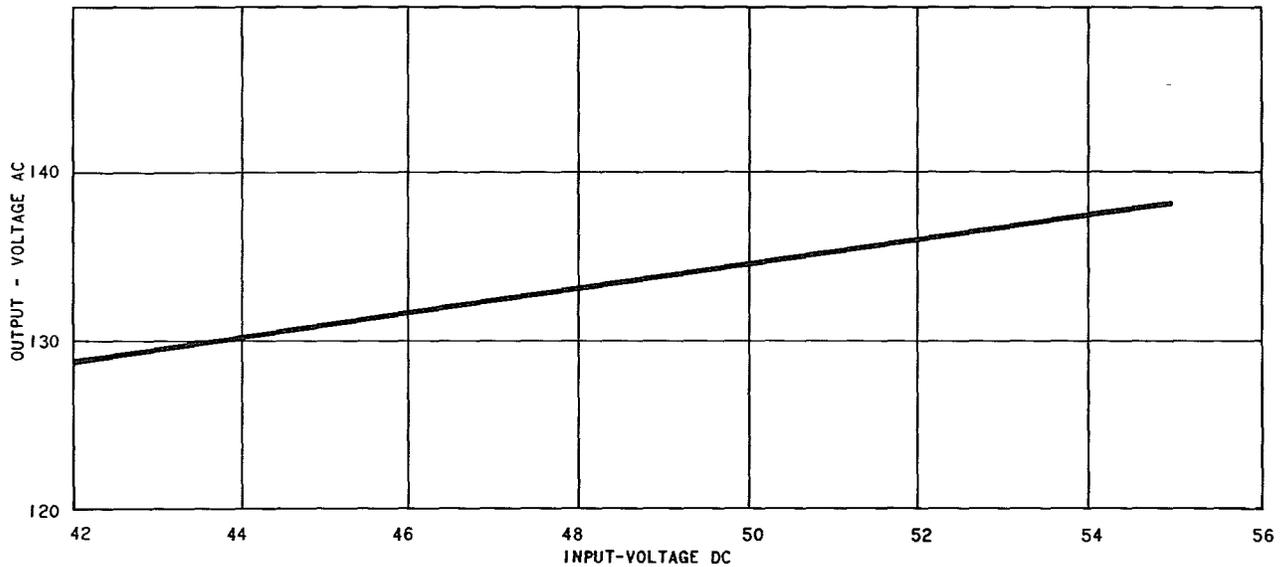


Fig. 1—Input Voltage Versus Output Voltage

**3.09 Harmonic Trap Adjustment:** The harmonic traps are adjusted at the factory and should never need adjusting. In the event that a component in any of the harmonic traps must be replaced, it will be necessary to retune that particular trap. A list of trap circuit designations and their respective trap frequency is given in the TRAP FREQUENCIES table.

#### TRAP FREQUENCIES

CIRCUIT DESIGNATION	HARMONIC	FREQUENCY
L6-C11	3	180 Hz
L7-C12	5	300 Hz
L8-C13	7	420 Hz
L9-C14	9	540 Hz

- (1) Start the inverter and run at no load as covered in 3.02.
- (2) Connect the Hewlett-Packard model 302A wave analyzer, or equivalent, to the OUTPUT

AC VOLTS ( $\pm$ ) and (NEUT) jacks. Set the wave analyzer to the required harmonic frequency, and read the harmonic voltage.

- (3) Using insulated jumpers, clip in a 1.0  $\mu$ f trim capacitor across the trim terminals. The harmonic voltage should decrease. If it does not decrease, substitute a 0.25  $\mu$ f trim capacitor for the 1.0  $\mu$ f.
- (4) Add trim capacitors as necessary until the output harmonic voltage decreases to a minimum.
- (5) Stop the inverter and solder the capacitors into the circuit.
- (6) Repeat (1), (2), and (3) to make sure the output harmonic voltage is minimum. Disconnect the wave analyzer and return the inverter to normal operation.