DC-TO-DC CONVERTER

J87294

OPERATING METHODS

1. GENERAL

1.01 The J87294 dc-to-dc converter provides a nominal −24 volt, 1 to 13 amperes direct current from a nominal +24 volt dc input. The converter is initially intended for use in the No. 101 Electronic Switching System power supply reserve plant.

1.02 This section is reissued to revise Part 3, OPERATION, Part 4, ROUTINE CHECKS, and Part 5, TROUBLES. Since this reissue is a general revision, marginal arrows ordinarily used to indicate changes have been omitted. This reissue does not affect the Equipment Test List.

1.03 The instructions given in this practice are based on circuit schematic drawing SD-81820-01. For a detailed description of operation, see the corresponding circuit description. For the connecting circuit, see circuit schmatic drawing SD-81825-01—Power Supply Control Circuit.

1.04 Keep the ventilating passage open and the unit free from excessive dust to ensure adequate cooling during operation.

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

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

2. LIST OF TEST APPARATUS

CODE OR SPEC NO.	DESCRIPTION
KS-14510	Volt-Ohm-Milliammeter
—	Oscilloscope, Type 535A, Tektronix (or equivalent)
—	Current Probe, Type P6016, Tektronix (or equivalent)
179A	Extender Board
—	Resistor, 1000 Ohm, 2W Pigtail
—	Resistor, 2500 Ohm, 2W Pigtail
—	ED-82354 Test Circuit

3. OPERATION

Preparing to Start

3.01 When preparing to put the converter in service, check the following.

(a) All external connections are made in accordance with the SD- drawings covering the associated circuit of which the converter is a part.

(b) The DC POWER switch is operated to the OFF position.

(c) The +24V, B supply fuse is installed.

(d) The +24V, A supply fuse is installed.

(c) The START PROT fuse F1 is installed.

(d) Ensure there is nothing in, on, or above the converter to interfere with operation or prevent free ventilation.

Starting

3.02 To place the J87294 dc-to-dc converter in service, operate the DC POWER switch to the START position and then to the RUN position. The converter is self regulating and should require no adjustment for normal operation.

Stopping

3.03 To remove the J87294 dc-to-dc converter from service, operate the DC POWER switch to the OFF position. If the converter is to remain out of service, remove the +24V, A fuse and +24V, B fuse.

Caution: Under no circumstances should the +24V, B fuse or circuit packs be removed with the DC POWER switch in the RUN or START position. Failure to observe this restriction can result in damage to components in the converter.

Adjustments

Caution: When using any portable instrument, the leads should be carefully examined to make sure the insulation is undamaged. The leads should be properly connected to the instrument before making any contact with the circuit to be tested. If connections are to be changed from one instrument range to another, first remove test picks from the equipment under test. Do not allow a test pick to touch two metal parts at the same time as destructive and dangerous short circuits may occur.

3.04 ***Output Voltage:*** The REG VOLTS ADJ potentiometer is provided to trim the regulated output voltage. This potentiometer is factory adjusted. However, should readjustment of the output voltage be necessary, rotating the REG VOLTS ADJ potentiometer cw will increase and ccw will decrease the output voltage. The voltage may be monitored by connecting a KS-14510 volt-ohm-milliammeter, set to the 60 VOLTS DC range, at the DC POWER (S1) switch and the P1 plug. Connect the positve lead to the P1 plug terminal A (GRD) and the negative lead to terminal 7 of the S1 switch. The output voltage of the converter should be between −22.7 and −26.5 volts.

3.05 ***High-Voltage Shutdown:*** The HV ADJ (R13) potentiometer, located on the control circuit board, adjusts the voltage at which the high-voltage shutdown circuit operates, shutting down the converter. The HV ADJ (R13) potentiometer has been factory adjusted to shut down the converter should the output voltage exceed −30 volts. Should a readjustment of the high-voltage shutdown circuit be necessary, proceed as follows.

(1) Operate the DC POWER switch to the OFF position.

(2) Remove the +24V, B fuse and the +24V, A fuse.

(3) Using No. 10 wire, strap the Q1 transistor and Q3 transistor from emitter to collector (terminal 1 to terminal 3).

(4) Disconnect the load to the converter and connect a dummy load, variable from 2 to 13 amperes, at the output of the converter (on the terminal board located at the bottom of power cabinet No. 2).

(5) Connect a KS-14510 volt-ohm-milliammeter, set to the 60 VOLTS DC range, across the dummy load to monitor the output voltage.

(6) Unlock and rotate the HV ADJ (R13) potentiometer fully cw.

(7) Install the +24V, B fuse and the +24V, A fuse.

(8) Adjust the dummy load for approximately 13 amperes at 24 volts and operate the DC POWER (S1) switch to the START and then to the RUN position.

(9) Monitor the output voltage and slowly decrease the load to the converter until the output voltage is 30 volts.

(10) Slowly rotate the HV ADJ (R13) potentiometer ccw until the converter shuts down. Lock the potentiometer, being careful not to disturb the setting.

(11) Operate the DC POWER (S1) switch to the OFF position.

(12) Repeat (8).

(13) Repeat (9). The converter should shut down at 30±0.5 volts.

(14) Operate the DC POWER (S1) switch to the OFF position.

(15) Remove the +24V, B fuse and the +24V, A fuse.

(16) Remove the strap wire installed in (3) from the Q1 and Q3 transistor.

(17) Disconnect the dummy load and the KS-14510 volt-ohm-milliammeter.

(18) Reconnect the load to the converter.

(19) Install the +24V, B fuse and the +24V, A fuse.

(20) Restore the converter to service (see 3.01 and 3.02).

4. ROUTINE CHECKS

4.01 Periodically check the converter as follows.

(a) The nominal input voltages may be checked with a KS-14510 volt-ohm-milliammeter set to the 60 VOLTS DC range. To test the +24V, A supply, the common lead should be connected to the P1 plug, terminal A (GRD) and the positive lead to the S1 switch terminal 1. To test the +24V, B supply, the common lead should be connected to the B ground, on the negative side of the C10 capacitor and the positive lead should be connected to the CR9 diode terminal 1. The meter should indicate between +21.7 and +26.0 volts.

(b) The output voltage may be checked at the DC POWER switch S1 and the P1 plug, using the KS-14510 volt-ohm-milliammeter set to the 60 VOLTS DC range. The positive lead should be connected to the P1 plug terminal A (GRD) and the common lead to terminal 7 of the S1 switch. The output of the converter should be between −22.7 and −26.5 volts.

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

4.03 Circuit packs and semiconductor devices should be maintained in accordance with Section 032-173-301.

5. TROUBLES

5.01 Failure of the J87294 converter will usually be characterized by one of two conditions: operated input fuses and consequent loss of output, or loss of output power without operation of input fuses. If the input fuses are operated, refer to 5.04 and the trouble chart in 5.05. If the input fuses are non-operated, but no output is present, the dynamic tests in 5.06 should be consulted. Figures 1 through 3 show component and test point location as outlined in the dynamic tests in 5.06 for the various circuit boards in the control section of the converter. Figure 4 shows the ED-82354 test circuit required for the control circuit test in 5.06.

Caution: The following precautions should be observed prior to and during the interval of detecting and clearing trouble of a faulty converter.

(a) The 24-volt converter output should be disconnected from the switch unit to eliminate the possibility of damage to that unit.

(b) Under no circumstances should fuses of higher rating than those specified or "slow blow" fuses be used.

(c) Under no circumstances should the +24V, B fuse or circuit packs be removed or installed with the DC power switch in the RUN or START position. Failure to observe this restriction can result in damage to components in the converter.

5.02 When the converter is not operating or is shut down for any reason, a closed path is provided through contact 2 of the ST1 relay to the power supply control circuit. No other alarms or indications are provided.

5.03 An oscilloscope may be used to help localize a trouble. Typical waveforms are given in the circuit schematic drawing SD-81820-01 and trouble charts.

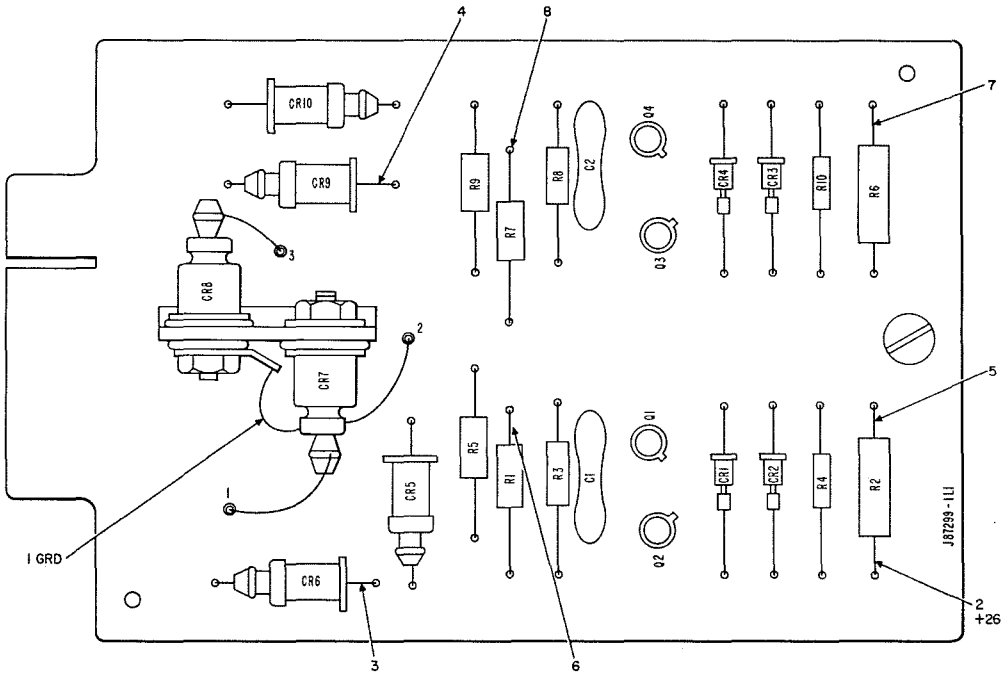


Fig. 1—CP3 Level Detector Circuit—Component Designation and Test Points

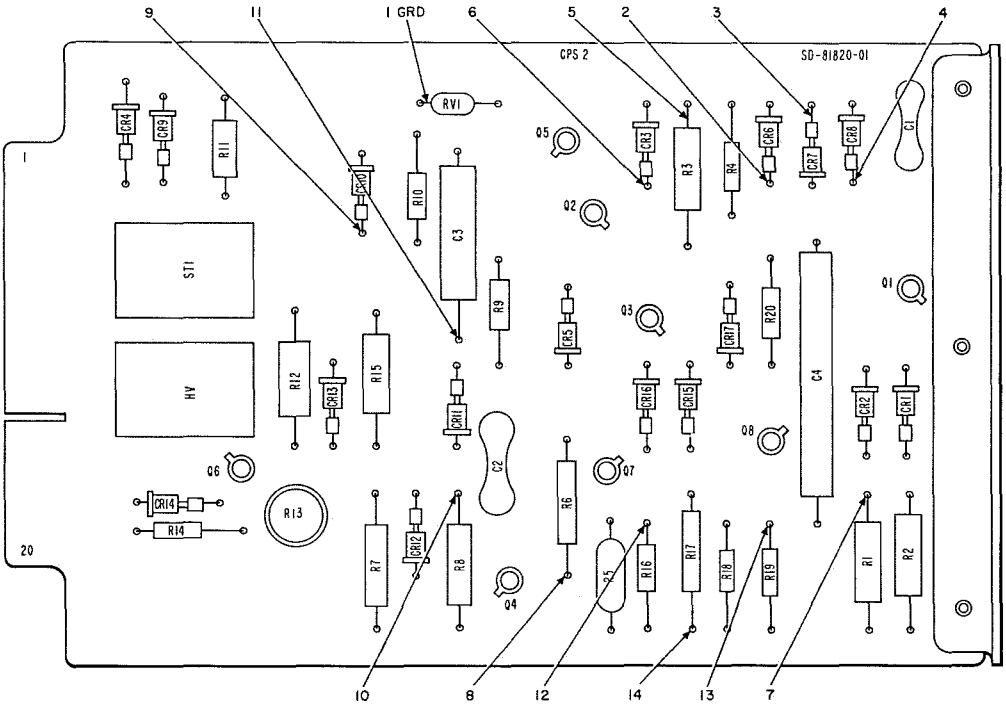


Fig. 2—CP2 Gate Pulse Control Circuit—Component Designation and Test Points

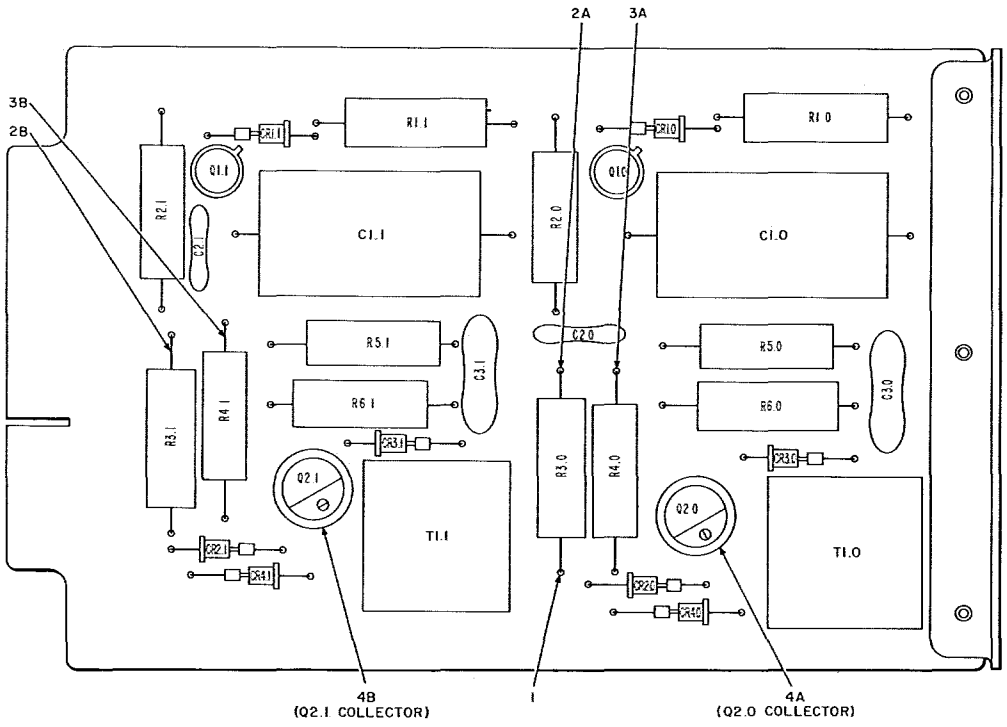


Fig. 3—CP1 Blocking Oscillator Circuit—Component Designation and Test Points

5.04 ***Operated INPUT Fuse or F1 START PROT Fuse:*** The simultaneous conduction of CR1 and CR2 or CR4 and CR5 SCRs, due to a transient in the power circuit or control circuit, may be the cause of an operated INPUT fuse or F1 START PROT fuse. If this is the suspected cause, proceed as follows.

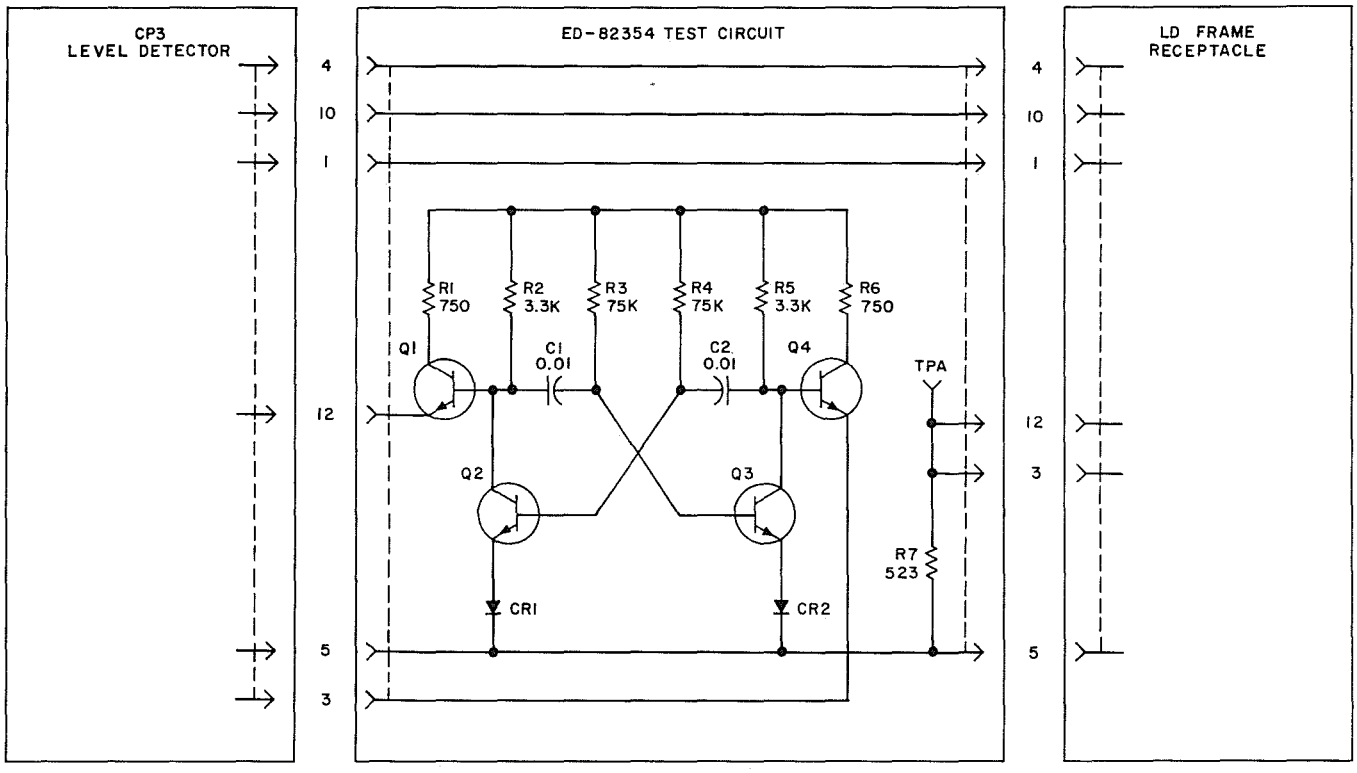
(1) Operate the DC POWER switch to the OFF position and remove the input and control fuses.

(2) Discharge capacitors C1.1 through C1.4 with a 100-ohm pigtail resistor.

(3) Install fuses and operate the DC POWER switch to the START position while monitoring the output voltage across C9.1, C9.2, as shown on FS1 of SD-81820-01.

(a) If either the INPUT fuse or F1 START PROT fuse operates, refer to the trouble chart in 5.05.

(b) If the INPUT fuse or F1 START PROT fuse does not operate and there is no output voltage, proceed to the dynamic test in 5.06.



NOTES:
1. ALL RESISTORS ARE 0.5 WATT
2. ALL TRANSISTORS ARE 16J TYPE
3. CR1 AND CR2 ARE 446A DIODES

Fig. 4—ED-82354 Test Circuit

5.05 ***Trouble Chart:*** The troubles and possible causes listed are not necessarily all-inclusive but are merely indicative of some of the difficulties encountered when the converter is not operating properly. If the trouble is not found with the assistance of the trouble chart and 5.06, reference must be made to SD-81820-01 and the corresponding circuit description.

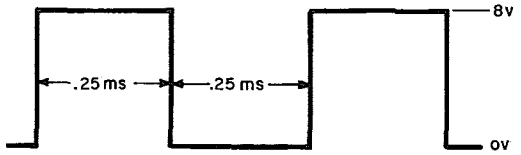
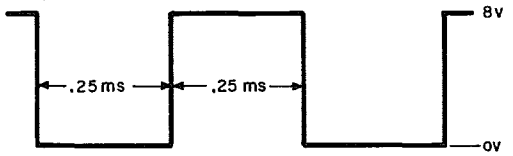
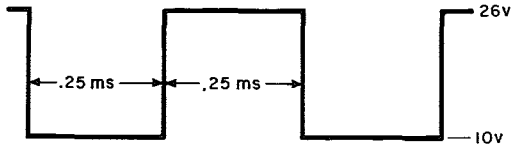
TROUBLE	POSSIBLE CAUSE
(a) Operated INPUT fuse or F1 START PROT protection fuse	(1) Simultaneous conduction of CR1 and CR2 or CR4 and CR5 SCRs due to transient in power circuit or control circuit.
	(2) Faulty wiring between DC POWER (S1) switch terminal 2 and anode of CR1 or CR4 to ground.
	(3) Shorted C1.1 through C1.4 capacitor.
	(4) Short circuit in CR1, 2, 4 or 5 SCRs or CR3, 6, or 7 diodes.
	(5) Short circuit in C8.1 or C8.2 capacitor or R14 or R18 resistor or connecting circuitry.
	(6) Short-circuited output of the converter.
(b) Loss of output voltage (INPUT fuse not operated)	(1) Loss of battery voltage to power frame; faulty P1 connector; open circuit wiring to S1 switch.
	(2) Loss of input battery voltage to control circuit (LD, GP, BO1, and BO2 circuit boards).
	CP3 LEVEL DETECTOR
	(a) Open wiring from control circuit supply filter to terminal 1.
	(b) Open ground return from terminal 5.
	(c) Faulty LD frame receptacle.
	CP2 GATE PULSE
	(a) Open wiring from control circuit supply filter to terminal 20.
	(b) Open ground return from terminal 5.
	(c) Faulty GP frame receptacle.
	BO1, BO2 BLOCKING OSCILLATOR
	(a) Open wiring from control circuit supply filter to terminal 1.
	(b) Open ground return to terminal 11.
	(c) Faulty BO1 or BO2 frame receptacle.
	(3) Loss of input battery voltage from DC POWER (S1) switch terminal 1 to anode of CR1 and CR4 SCRs.
	(a) Open S1 switch between terminals 1 and 2.
	(b) Open R9 starting resistor.
	(c) Operated or defective F1 START PROT fuse; defective F1 fuse holder or defective wiring.

TROUBLE	POSSIBLE CAUSE
(b) (Cont)	(d) Open wiring from R9 to anode of CR1 and CR4.
	(4) Failure of Q1 and/or Q3 series regulator transistor.
	Note: Transistors Q1 and Q3 on FS-1 of SD-81820-01 must both be replaced should either become defective.
	(5) High-voltage shutdown adjustment incorrectly set.
	Note: An operated HV relay indicates a possible misadjusted HV sensing circuit. Adjustments should be made in accordance with 3.05. If it is not possible to make adjustments, refer to TROUBLE (d).
	(6) Open or shorted gate on CR1, CR2, CR4, or CR5 SCRs.
	(7) Open CR3, CR6, or CR7 diode.
	(8) Open output terminal wiring, or faulty P1 connector.
	(9) No start pulse produced by GATE PULSE control circuit. Refer to TROUBLE (c).
(c) CP2 GATE PULSE control circuit does not produce a start pulse; no output voltage	(1) R19 (FS1) open.
	(2) Open wiring from S1 DC POWER switch terminal 2 to GP frame receptacle, terminal 2 (lead 17).
	(3) CR15, CR16, or Q7 defective; C3 shorted; or R16 open.
	(4) CR4 open; Q9 defective; CR17 open; or R19 open.
	(5) R20, R10 resistor open; Q5 defective; or RV1 open.
(d) High-voltage shutdown fails to function correctly.	(1) HV ADJ (R13) potentiometer incorrectly set. Refer to 3.05.
	(2) Defective Q6 transistor or CR14 diode.
	(3) Defective HV relay.

5.06 ***Dynamic Test:*** The CP4, ED-82354 test circuit is provided as a tool to aid in the maintenance of the converter. The test circuit is inserted between the CP3 level detector and its LD frame receptacle and provides the necessary waveforms to check the complete control circuit. Before performing the tests, determine that the 24-volt input battery voltage and the +24V, B supply voltage are at their nominal values. Disconnect the 24-volt converter output from the switch unit to eliminate possible damage to that unit.

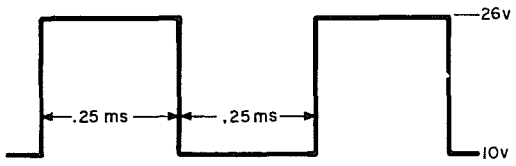
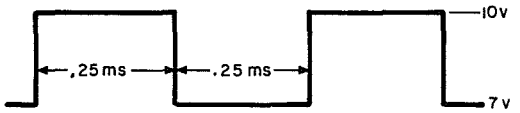
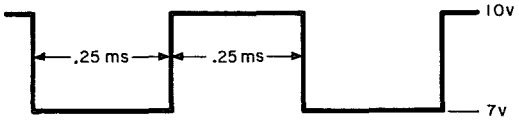
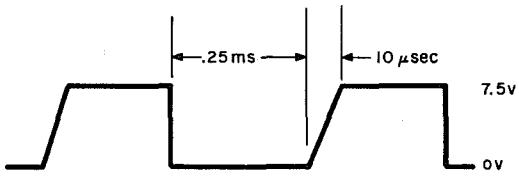
DYNAMIC TEST

(OPERATION OF CONVERTER WITH ED-82354 TEST CIRCUIT)

TEST PROCEDURE	CORRECT INDICATION	REASON FOR INCORRECT INDICATION
(1) Operate the DC POWER (S1) switch to the OFF position. (2) Remove the CP3 Level Detector and insert the ED-82354 test circuit in the CP3 LD frame receptacle. (3) Insert the LD circuit board in the receptacle on the test circuit. (4) Perform A through D as required.		
A. Possible Fault in CP3 Level Detector (Refer to Fig. 1.)		
(1) Refer to Fig. 1 for test point location. Connect the ground of the oscilloscope to test point 1. Connect the vertical input of the oscilloscope to test point 3.		Open CR5; shorted CR6, CR7.
(2) Connect the vertical input of the oscilloscope to test point 4.		Open CR10; shorted CR9, CR8.
(3) Connect the vertical input of the oscilloscope to test point 5.		Q2, CR2, R5, R2, or R4 defective.

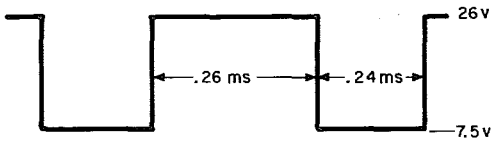
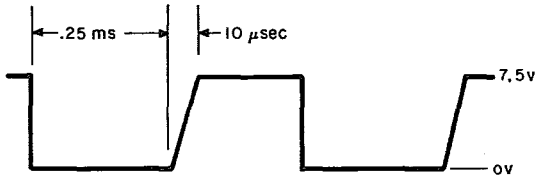
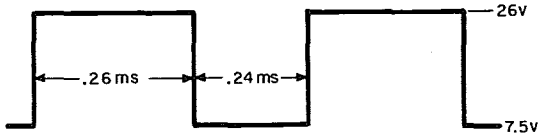
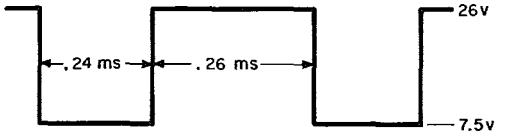
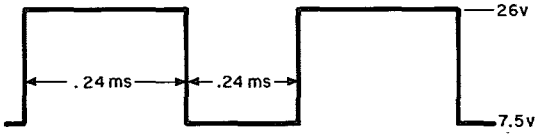
DYNAMIC TEST

(OPERATION OF CONVERTER WITH ED-82354 TEST CIRCUIT) (Cont)

TEST PROCEDURE	CORRECT INDICATION	REASON FOR INCORRECT INDICATION
(4) Connect the vertical input of the oscilloscope to test point 7.		Q3, CR3, R9, R6, or R10 defective.
(5) Connect the vertical input of the oscilloscope to test point 6.		Q1, CR1, R1, or R3 defective. CR4 on CP2 shorted or open.
(6) Connect the vertical input of the oscilloscope to test point 8.		Q4, CR4, R7, or R8 defective. CR9 on CP2 shorted or open.
B. Possible Fault in CP2 Gate Pulse Control Circuit (Refer to Fig. 2.)		
(1) Using the KS-14510 volt-ohmmeter, measure the voltage from test points 4, 3, and 2 to test point 1 placing the negative of the voltmeter at test point 1. (Refer to Fig. 2 for test point location.)	Voltage measured at test point 4, 3, and 2 should be approximately 6.3, 12.6 and 19 volts, respectively.	CR8, CR7, or CR6 defective. R5 open.
(2) Connect the ground of the oscilloscope to test point 1. (3) Connect the vertical input of the oscilloscope to test point 8.		Q3, Q4, CR12, CR13 defective; Q5, C2 shorted. If 10 μsec ramp is not present, C2 or associated printed wiring may be open. Open wiring between LD and GP circuit boards.

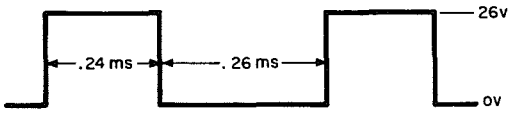
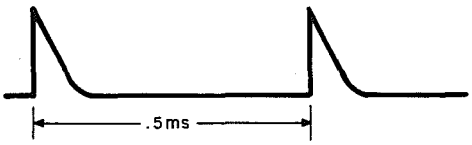
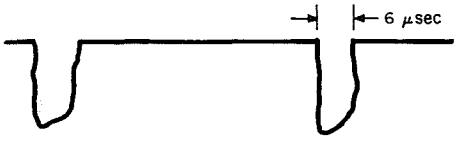
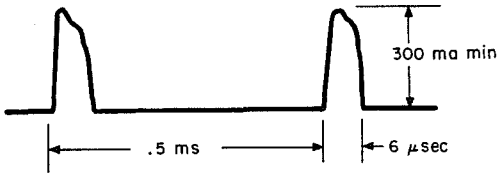
DYNAMIC TEST

(OPERATION OF CONVERTER WITH ED-82354 TEST CIRCUIT) (Cont)

TEST PROCEDURE	CORRECT INDICATION	REASON FOR INCORRECT INDICATION
(4) Connect the vertical input of the oscilloscope to terminal 18 of the GP frame receptacle.		Q4 defective, open from Q4 to GP frame receptacle. Open in GP frame receptacle.
(5) Connect the vertical input of the oscilloscope to test point 5.		Q2, Q1, CR1, CR2 defective; C1 shorted. If the 10 μsec ramp is not present, C1 or associated printed wiring may be open. Open wiring between LD and GP circuit boards.
(6) Connect the vertical input of the oscilloscope to terminal 19 of the GP frame receptacle.		Q1 defective, open from Q1 to GP frame receptacle. Open in GP frame receptacle.
C. Possible Fault in CP1 Blocking Oscillator Circuit (Refer to Fig. 3.)		
(1) Connect the vertical input of the oscilloscope to terminal 2 of the BO1 frame receptacle.		Open wiring from GP frame receptacle, terminal 18, to BO1 frame receptacle, terminal 2.
(2) Connect the vertical input of the oscilloscope to terminal 2 of the BO1 frame receptacle.		Open wiring from GP frame receptacle, terminal 19, to BO2 frame receptacle, terminal 2.

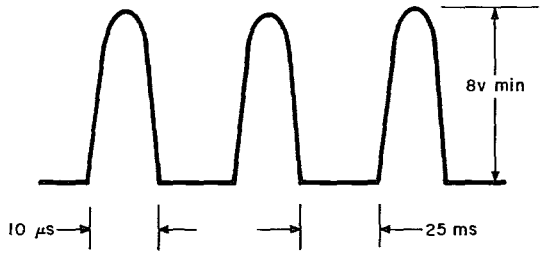
DYNAMIC TEST

(OPERATION OF CONVERTER WITH ED-82354 TEST CIRCUIT) (Cont)

TEST PROCEDURE	CORRECT INDICATION	REASON FOR INCORRECT INDICATION
(3) Connect the BO1 blocking oscillator to the converter using the 179A extender board. Refer to Fig. 3 for test point locations. Connect the ground of the scope to test point 1. Connect the vertical input of the scope to test point 2A.		Q1, CR1 defective. R2 open.
(4) Connect the vertical input of the oscilloscope to test point 3A.		C2 open; R4, CR2 shorted.
(5) Connect the vertical input of the oscilloscope to test point 4A.		Q2 defective. If pulse width is not approximately 6 μsec, R6 or C3 may be defective.
(6) Using a Tektronix P6016 current probe or equivalent, observe the gate pulses in the leads from terminals 20 and 5 on the BO frame receptacle.		T1 defective. Open contacts on BO frame receptacle. Open gate wiring to SCRs. Open gate resistors.
(7) Repeat (3) through (6) at test points 2B through 4B for other half of BO1. (8) Repeat (3) through (7) for BO2 blocking oscillator.		

DYNAMIC TEST

(OPERATION OF CONVERTER WITH ED-82354 TEST CIRCUIT) (Cont)

TEST PROCEDURE	CORRECT INDICATION	REASON FOR INCORRECT INDICATION
D. Possible Fault in FS1 Power Circuit		
(1) With test circuit ED-82354 installed and all other control cards and fuses in place, rotate the DC POWER (S1) switch to the START position. Place the ground of the scope on test point 1 of the LD CP3 circuit board (Fig. 1) ; place the vertical input of the scope on test point A of the ED-82354 test circuit.		Open T1 current transformer; open lead(s) from T1 transformer to LD frame receptacle.
(2) Using the KS-14510 volt-ohmmeter, measure the voltage across C8.1 — C8.2 being careful to observe polarity. The S1 switch must be in the START position for this test.	30 volts to 48 volts dc	Converter not operating due to any one of the problems described in the previous steps. A recheck will be required.
(3) Using the KS-14510 volt-ohmmeter, measure the voltage cathode (+) to anode of CR8 zener diode.	Approximately 27 volts dc, depending upon position of R15 REG VOLT potentiometer	CR8 defective.
(4) Operate the DC POWER (S1) switch to the RUN position and measure the voltage using the KS-14510 volt-ohmmeter across C9.1 and C9.2. Observe polarity on C9 electrolytic capacitor.	20 volts to 26 volts dc	Q2 defective.