

## AUTOMATIC SOLID-STATE CONTROL (J86634A) FOR RESERVE DIESEL ENGINE-ALTERNATOR PLANTS REQUIREMENTS AND ADJUSTING PROCEDURES

### 1. GENERAL

**1.01** This circuit is designed to provide a control system for a reserve diesel engine-alternator. The solid-state control module monitors and provides control signals for the diesel engine-alternator sets. These sets furnish 208- to 240-volt, 3-phase, 4-wire, 60-Hz power to telephone plants when commercial power fails. The control module is used with the KS-19587, KS-19583, KS-19584, KS-19585, and KS-19586 diesel engine-alternator sets.

**1.02** This section is reissued to correct errors and to incorporate technical changes to the equipment in Parts 2 and 3 of the section.

**1.03** The mode of operation of the control module is selected by operating the OPERATION SELECTOR SWITCH (OSS), a 5-position switch with positions of OFF, MANUAL, AUTO NO LOAD, FULL AUTO, and AUTO MANUAL RESTORE. The switch is located on the main control panel, external to the control module.

*Note:* Nomenclature of controls and lamps on the main control panel will vary slightly between the sets of various manufacturers.

**1.04** The control module functions either as an automatic or manual control system which monitors commercial ac power and also monitors necessary functions of the engine-alternator set. Audible and visual major and minor alarms are provided for all modes of operation.

**1.05** The control module is mounted on drawer slides in the control cabinet. The slides permit the module to be extended outside the control cabinet while electrically connected to the engine-alternator set. The drawer slides are

equipped with a locking mechanism so the control module can be locked in place whether extended or in its normal position. The control module is moved to the extended position for testing, troubleshooting, and electrical alignment.

**1.06** A hinged cover on the control unit can be opened to expose the printed circuit packs. Equipment information and equipment locations are displayed on the inside face of the cover. Jacks, potentiometers, and switches are available on the various circuit packs for test and electrical alignment. An extender test board is provided with the control unit as well as a board extractor tool to aid in testing procedures.

**Warning:** *AC voltages of 208, 230, or 240 volts, 60 Hz, are supplied to wiring and terminals located in the main control cabinet and on the back of the main control panel. The control module has commercial and alternator ac output voltages of 208, 230, or 240 volts, 60 Hz, applied through P1 connector to the terminals on the under side of the control module chassis. Contact with these voltages is hazardous. Use caution while performing checks and adjustments on this equipment.*

**1.07** A reverse power test switch (S1) is provided in the control module. This switch is provided only for use during test runs of the control module and engine-alternator set. It has a pull-push action and is mounted so that when the cover of the control module is closed and fastened in place, the switch will automatically restore to its normal operating position.

**1.08** For the purpose of this practice, the following abbreviations are used:

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**ABBREVIATION**

**TERM**

**GENERAL**

CW	Clockwise
CCW	Counterclockwise
EL(1)	Equipment Location (One)
CP	Circuit Pack
OSS	Operation Selector Switch

**POWER DISTRIBUTION AND VOLTAGE REGULATOR**

VR	Voltage Regulator
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**LOGIC AND CONTROL**

BC	Breaker Control
BCM1	Breaker Control Memory One
DTM1	Delay Timer Memory One
HOT	Hold Over Timer
PF	Power Failure
RT1,RT2,RT3	Run Timer One, Two, and Three
VM1,VM2,VM3	Voltage Monitor One, Two, and Three
WUT	Warm Up Timer
WUTM	Warm Up Timer Memory

**ALARM AND CONTROL**

CCOT	Crank Cut Out Timer
CFT	Crank Fail Timer
20CD	20-Cycle Detector
58CD	58-Cycle Detector
20CDM	20-Cycle Detector Memory
58CDM	58-Cycle Detector Memory
LOPT	Low Oil Pressure Timer
OSD	Over Speed Detector
PS	Pulse Separator
RP	Reverse Power Detector

**1.09** Binary language shall be used to indicate signals applied or measured at test points with respect to ground. The definitions are as follows.

(a) A terminal voltage between the values  $-0.6$  and  $-0.9$  volt direct current, ground, or no signal, is defined as a "0".

(b) A terminal voltage or pulse signal of  $-6.0$  volts or more negative is defined as a "1".

**1.10** Circuit packs and semiconductor devices shall be maintained in accordance with Section 032-173-301.

**1.11** Whenever the statement "monitor TP-" is used, it shall mean to connect the positive terminal of the volt-ohm-milliammeter or oscilloscope to TP3 on VR, EL38 (ground) and the negative terminal of the volt-ohm-milliammeter or oscilloscope to the test point specified.

**1.12** This issue of the section is based on drawing SD-81692-01, Issue 12AC. If this section is to be used with equipment or apparatus reflecting later issue(s) of the drawing(s), reference should be made to the SDs and CDs to determine the extent of the changes and the manner in which the section may be affected.

**1.13** If the requirements given in the adjusting procedures in Part 3 cannot be met, the equipment should be shut down and the defective circuit pack replaced. The adjusting procedures should then be performed on the new circuit pack.

**1.14** Information in both Part 2, Requirements and Part 3, Adjustment Procedures, is arranged under the following headings:

HEADING	PART 2 PAR.	PART 3 PAR.
List of Tools, Test Apparatus, and Materials		3.001
Voltage Regulator (CP22)	2.01	3.01
Voltage Monitor (CP1)	2.02	3.02
20-Cycle Detector (CP9)	2.03	3.03
58-Cycle Detector (CP8)	2.04	3.04
Over Speed Detector (CP8)	2.05	3.05
Reverse Power Detector (CP12)	2.06	3.06
Crank Cut Out Timer (CP4)	2.07	3.07
Crank Fail Timer (CP4)	2.08	3.08
Delay Timer (Option W, CP3, or Option V, CP23)	2.09	3.09
Hold Over Timer (CP3)	2.10	3.10
Low Oil Pressure Timer (CP4)	2.11	3.11
Warm Up Timer (CP3)	2.12	3.12
Breaker Control (CP18)	2.13	3.13

## 2. REQUIREMENTS

**2.01 Voltage Regulator (CP22):** With an input voltage at TP1 (terminal 4) on VR, EL38 between  $-20$  and  $-28.6$  volts direct current ( $-26$  volts nominal), the output voltage at TP4 (terminal 11) on VR, EL38 is between  $-0.6$  and  $-0.9$  volt direct current ( $0.7$  volt nominal) and the output voltage at TP2 (terminal 16) on VR, EL38 is between  $-9.8$  and  $-13$  volts direct current ( $-12.0$  volts nominal). Both output voltages are with respect to TP3 on VR, EL38 (ground).

### 2.02 Voltage Monitor (CP1):

(a) **208-Volt RMS Operation**—The voltage monitors (VM1, EL1; VM2, EL2; and VM3, EL3) furnish a "1" signal at TP2 (terminal 19) with an increasing rms input voltage of  $200 \pm 2$  or more volts at input terminals 6 and 8 or a "0" signal at TP2 (terminal 19) with a decreasing rms voltage of  $191 \pm 2$  volts or less at input terminals 6 and 8.

(b) **230- or 240-Volt RMS Operation**—The voltage monitors (VM1, EL1; VM2, EL2; and VM3, EL3) are initially adjusted at the time of installation to furnish a "1" signal at TP2 (terminal 19) with an increasing rms input voltage of  $224 \pm 2$  or more volts at input terminals 6 and 8 or a "0" signal at TP2 (terminal 19) with a decreasing rms voltage of  $215 \pm 2$  volts or less at input terminals 6 and 8.

**2.03 20-Cycle Detector (CP9):** The 20CD, EL22 furnishes a "1" signal pulse at TP1 (terminal 14) when the pulsed signal at the input to the PS, EL23 (pins g and x of P1) reaches or exceeds a repetition rate of  $10$  Hz (see Fig. 1 and 2). This signal input consists of a series of positive and negative pulses which are approximately  $2.5$  volts in amplitude and approximately  $1$  millisecond in pulse width. The  $10 \pm .5$  Hz repetition rate of this input signal corresponds to an engine speed of  $600 \pm 30$  rpm.

**2.04 58-Cycle Detector (CP8):** The 58CD, EL20 furnishes a "1" signal pulse at TP2 (terminal 2) and a "0" signal at TP4 (terminal 19) when the pulsed signal at the input to the PS, EL23 (pins g and x of P1) reaches or exceeds a repetition rate of  $28.5 \pm .5$  Hz (see Fig. 3 and 4). This signal input consists of a series of positive and negative pulses which are approximately  $7$  volts in amplitude

and approximately  $0.4$  millisecond in pulse width. The  $28.5$ -Hz repetition rate of this input signal corresponds to an engine speed of  $1710 \pm 30$  rpm.

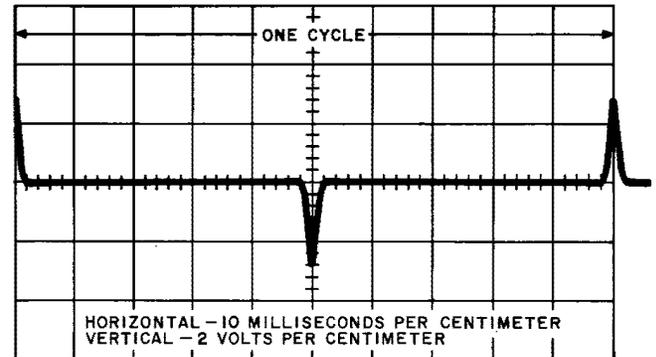


Fig. 1—Reluctance Pickup—9.5- to 10.5-Hz Output

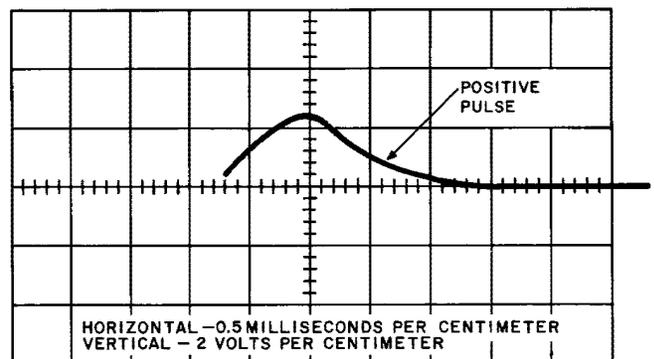


Fig. 2—Reluctance Pickup—9.5- to 10.5-Hz Output

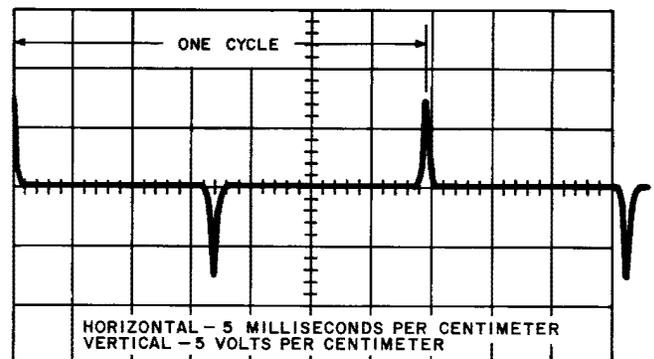


Fig. 3—Reluctance Pickup—28.0- to 29.0-Hz Output

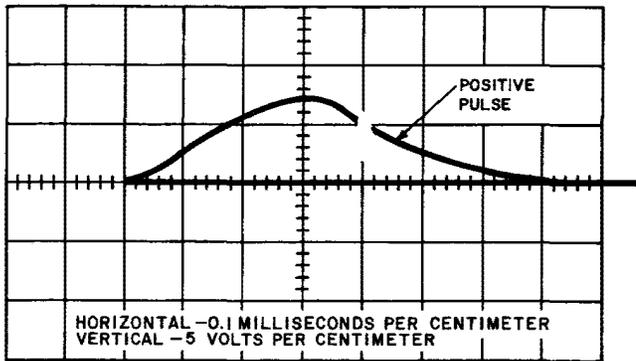


Fig. 4—Reluctance Pickup—28.0- to 29.0-Hz Output

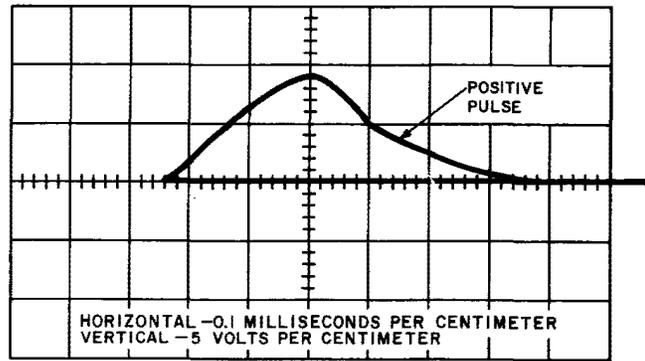


Fig. 6—Reluctance Pickup—34.5- to 35.5-Hz Output

**2.05 Over Speed Detector (CP8):** The OSD, EL21 furnishes a "1" signal pulse at TP2 (terminal 2) when the pulsed signal at the input to the PS, EL23 (pins g and x of P1) reaches or exceeds a repetition rate of  $35 \pm .5$  Hz (see Fig. 5 and 6). The signal input consists of a series of positive and negative pulses which are approximately 9 volts in amplitude and approximately 0.4 millisecond in pulse width. The  $35 \pm .5$  Hz repetition rate of this input signal corresponds to an engine speed of  $2100 \pm 30$  rpm.

**Note:** The circuit pack CP8 (ED82157) is factory adjusted for a repetition rate of  $28.5 \pm .5$  Hz. If the OSD, EL21 is replaced, the new circuit pack CP8 must be adjusted to  $35 \pm .5$  Hz.

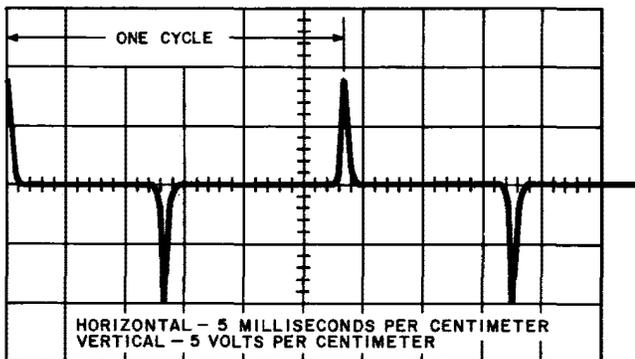


Fig. 5—Reluctance Pickup—34.5- to 35.5-Hz Output

**2.06 Reverse Power Detector (CP12):** The RP, EL25 is initially adjusted to furnish a "1" signal pulse at TP1 (terminal 2) with the REVERSE POWER TEST switch operated (pulled up) and with the load to the engine-alternator adjusted as follows:

ENGINE-ALTERNATOR FULL-LOAD RATING	ADJUST LOAD TO
115 kW	$20 \pm 2$ kW
75 kW	$20 \pm 2$ kW
45 kW	$20 \pm 2$ kW
30 kW	$15 \pm 2$ kW

In normal operation, the RP, EL25 furnishes a "1" signal pulse at TP1 (terminal 2) if the engine-alternator is motorized.

**2.07 Crank Cut Out Timer (CP4):** The CCOT, EL8 furnishes a "1" signal pulse at TP3 (terminal 19)  $30 \pm 3$  seconds after a "1" signal is applied to terminal 18.

**2.08 Crank Fail Timer (CP4):** The CFT, EL9 furnishes a "1" signal pulse at TP3 (terminal 19)  $3 \pm 0.3$  seconds after a "1" signal is applied to terminal 18.

**2.09 Delay Timer Option W, CP3, or Option V, CP23:** The DT, EL5 furnishes a "1" signal pulse at TP2 (terminal 2)  $10 \pm 5$  seconds after a "1" signal is applied to terminal 5. A "0" signal applied to terminal 6 during the timing

interval or after it has timed out will cause the timer to reset.

**2.10 Hold Over Timer (CP3):** The HOT, EL6 furnishes a "1" signal pulse at TP2 (terminal 2) 10  $\pm$ 1 minutes after a "1" signal is applied to terminal 5.

**2.11 Low Oil Pressure Timer (CP4):** The LOPT, EL39 furnishes a "1" signal pulse at TP3, (terminal 19) 11  $\pm$ 1 seconds after a "1" signal is applied to terminal 18.

**2.12 Warm Up Timer (CP3):** The WUT, EL7 furnishes a "1" signal pulse at TP2 (terminal 2) 4  $\pm$ 1 minutes after a "1" signal is applied to terminal 5.

**2.13 Breaker Control (CP18):** Terminal 12 on BC, EL33 is open-circuited or grounded depending on the following circuit conditions.

(a) A "0" signal applied to terminal 5 causes terminal 12 to be open-circuited.

(b) A "1" signal applied to terminal 5 causes terminal 12 to remain open-circuited or to be grounded, depending on the alternator voltage applied at terminals 1 and 3 on BC, EL33 as follows. When the rising alternator voltage initially reaches or exceeds 191  $\pm$ 2 volts line-to-line, terminal 12 becomes grounded. Terminal 12 remains grounded provided the alternator voltage does not drop below 100  $\pm$ 2 volts line-to-line. If the alternator voltage decreases below 100  $\pm$ 2 volts, terminal 12 reverts to an open-circuited condition and the alternator voltage must rise to 191  $\pm$ 2 volts line-to-line to again provide a ground on terminal 12.

**3. ADJUSTING PROCEDURES**

**3.001 LIST OF TOOLS, TEST APPARATUS, AND MATERIALS:**

CODE OR SPEC NO.	DESCRIPTION
<b>TOOLS</b>	
—	Fuse Pullers, 7-1/2 Inches, Ideal Industries (or equivalent)
—	3-Inch C Screwdriver

CODE OR SPEC NO.	DESCRIPTION
<b>TOOLS</b>	
R-1005	Jewelers Screwdriver
<b>TEST APPARATUS</b>	
—	AC Voltmeter, Weston, Model 904, 300/150-Volt or equivalent
KS-3008	Stopwatch
—	Oscilloscope, Tektronix Model 545A, with CA Type Plug-in Unit (or equivalent)
KS-20538	Volt-Ohm-Milliammeter or
—	Volt-Ohm-Milliammeter, Simpson, Model 269-2, 100,000 Ohms Per Volt direct current (or equivalent)
—	Variac, General Radio Company, Model W5H (or equivalent)
—	Tachometer
<b>MATERIALS</b>	
—	Insulated Tip Plugs, H. M. Smith, Type 201 Solderless (or equivalent) (as reqd)
—	Insulated Alligator Clips, Mueller (or equivalent) (as reqd)
—	Test Prod Wire (as reqd)
—	Resistor, 511-Ohm, 1-Watt
—	Red Glyptol, General Electric Co, No. 1201 (or equivalent)

**Caution:** The printed wire board assemblies of CP1, CP36, CP37, CP38, and CP39 have their respective equipment location number stamped on the upper right-hand corner of the apparatus side. When more than

*one of the same coded circuit packs are removed from the unit, care should be taken to reinsert the circuit packs into their respective equipment location. These printed wire boards are equipped with potentiometers which have been adjusted for a specific function in their respective location. Interchanging of any of these boards may cause malfunctioning of the unit.*

**3.01 Voltage Regulator** (Reqt 2.01): No adjustment is required.

**3.02 Voltage Monitor (CP1)** (Reqt 2.02): The VM1, EL1; VM2, EL2; and VM3, EL3 are manufacturer adjusted for a nominal 208-volt, 60-Hz, ac power. In the following procedures, use the voltages in parentheses for voltage monitor circuit packs that are used for 230- or 240-volt operation. If adjustment is required, proceed as follows.

- (1) Operate the OSS to OFF.
  - (2) Operate the circuit breakers or remove the fuses that complete the path for voltages to pins V, W, and X of P1.
  - (3) Elevate VM1, EL1, using the extender card.
  - (4) On VM1, EL1, rotate potentiometers R2 and R7 fully cw.
  - (5) Apply 200 (224) volts, 60 Hz, alternating current through a Variac to terminals 6 and 8 on VM1, EL1.
  - (6) Connect the volt-ohm-milliammeter, set to the 40 VOLT DC range, between TP2 on VM1, EL1 and TP3 on VR, EL38.
  - (7) Operate the OSS to MANUAL.
  - (8) Allow the module to operate for two minutes.
  - (9) Rotate potentiometer R2 on VM1, EL1 slowly ccw until a "1" signal is measured at TP2 on VM1, EL1.
  - (10) Adjust potentiometer R2 slowly cw (approximately one turn every 30 seconds) until a "0" signal appears at TP2 on VM1, EL1.
  - (11) Readjust potentiometer R2 slowly ccw (approximately every 30 seconds) until a "1" signal appears at TP2 on VM1, EL1.
  - (12) Readjust the input voltage to 191 (215) volts rms. Check that a "1" signal remains at TP2 on VM1, EL1.
  - (13) Adjust potentiometer R7 ccw until a "0" signal appears at TP2 on VM1, EL1.
- Note:** If a "0" signal cannot be obtained in (13), readjust potentiometer R7 fully cw. Increase the input voltage to 200 (224) volts rms and repeat (13).
- (14) Increase the input voltage gradually to 200 (224)  $\pm 2$  volts. A "1" signal appears at TP2 on VM1, EL1 only after the input voltage reaches 200  $\pm 2$  volts.
  - (15) Seal potentiometer R2.
  - (16) Decrease the input voltage gradually to 191 (215)  $\pm 2$  volts. A "0" signal appears at TP2 on VM1, EL1 only after the input voltage reaches 191  $\pm 2$  volts.
  - (17) Seal potentiometer R7.
- Note:** If this requirement is not met for the 230- or 240-volt system, operate the OSS to OFF and substitute a new VM circuit pack and repeat the adjustment.
- (18) Operate the OSS to OFF.
  - (19) Remove the ac voltage from terminals 6 and 8 on VM1, EL1.
  - (20) Disconnect the volt-ohm-milliammeter.
  - (21) Restore VM1, EL1 to its normal position.
  - (22) Elevate the voltage monitor to be adjusted and repeat (3) through (22) for VM2, EL2 and VM3, EL3.
  - (23) Close the circuit breakers operated in (2) or replace the fuses removed in (2).
  - (24) Operate the OSS to the desired standby position.

**3.03 20-Cycle Detector (CP9) (Reqt 2.03):** The 20CD, EL22 is adjusted as follows.

**Note:** The following check is made with the engine-alternator set operating. The starting and operating of the diesel engine-alternator set shall be in accordance with the appropriate Bell System Practice. All procedures and precautions given in the engine-alternator section shall be observed. For convenience and safety, the services of two technicians are recommended to accomplish the adjustment. Use a tachometer to measure the engine speed.

- (1) Operate the OSS to MANUAL.
- (2) Monitor TP3 on 20CDM, EL17, using the volt-ohm-milliammeter.
- (3) Depress the ENGINE START pushbutton located on the main control panel.

**Requirement:** A "1" signal is measured at TP3 on 20CDM, EL17 the instant the engine speed reaches  $600 \pm 30$  rpm.

**Note:** The engine will accelerate to 1800 rpm; therefore, the  $600 \pm 30$  rpm engine speed will be reached shortly after the ENGINE START pushbutton is depressed.

- (4) Operate the OSS to OFF.
- (5) If the requirement in (3) is met, proceed to (6). If the requirement in (3) is not met, slightly change the adjustment of potentiometer R4 on 20CD, EL22 (rotate potentiometer R4 cw for increased speed or ccw for decreased speed) and repeat (1) through (4) until the requirement in (3) is met.
- (6) Lock and seal potentiometer R4 on 20CD, EL22.
- (7) Operate the OSS to the desired standby position.

**3.04 58-Cycle Detector (CP8) (Reqt 2.04):** The 58CD, EL20 is adjusted as follows.

**Note:** The following check is made with the engine-alternator set operating. The starting and operating of the diesel engine-alternator

set shall be in accordance with the appropriate Bell System Practice. All procedures and precautions given in the engine-alternator section shall be observed. For convenience and safety, the services of two technicians are recommended to accomplish the adjustment. Use a tachometer to measure the engine speed.

- (1) Operate the OSS to MANUAL.
- (2) Monitor TP1 on 58CDM, EL17 using the volt-ohm-milliammeter.
- (3) Depress the ENGINE START pushbutton located on the main control panel.

**Requirement:** A "1" signal shall be measured at TP1 on 58CDM, EL17 the instant the engine speed reaches  $1710 \pm 30$  rpm.

- (4) Operate the OSS to OFF.
- (5) If the requirement in (3) is met, proceed to (6). If the requirement in (3) is not met, change the adjustment of potentiometer R4 on 58CD, EL20 slightly (rotate potentiometer R4 cw for increased speed or ccw for decreased speed) and repeat (1) through (4) until the requirement in (3) is met.
- (6) Lock and seal potentiometer R4 on 58CD, EL20.
- (7) Operate the OSS to the desired standby position.

**3.05 Over Speed Detector (CP8) (Reqt 2.05):**

**Note:** The following adjustments are made with the engine-alternator set operating. The starting and operating of the diesel engine-alternator set shall be in accordance with the appropriate Bell System Practice. All procedures and precautions given in the engine-alternator section shall be observed. For convenience and safety, the services of two technicians are recommended to accomplish these adjustments. Use a tachometer to measure the engine speed. The OSD, EL21 is adjusted as follows.

- (1) Operate the OSS to OFF.

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- (2) Rotate potentiometer R4 on OSD, EL21 fully cw.
- (3) Connect the oscilloscope to TP2 on OSD, EL21.
- (4) Remove OSM, EL10 from the control module.
- (5) Operate the OSS to MANUAL.
- (6) Monitor TP2 on OSD, EL21 using the volt-ohm-milliammeter.
- (7) Depress the ENGINE START pushbutton located on the main control panel.

**Requirement:** The engine cranks and accelerates to rated speed.

**Note:** The OVER SPEED and CRANK FAIL lamps light. The engine is not shut down.

- (8) Manually operate the speed control lever to increase the engine speed to 2100  $\pm$ 30 rpm as indicated on the tachometer.

**Requirement:** When the engine speed reaches 2100  $\pm$ 30 rpm, "1" signal pulses are monitored at TP2 on OSD, EL21.

- (9) If the requirement in (8) is not met, maintain the engine speed at 2100 rpm as indicated on the tachometer.

- (10) Adjust potentiometer R4 on OSD, EL21 until "1" signal pulses are monitored at TP2 on OSD, EL21.

- (11) Manually operate the speed control lever to decrease the engine speed to approximately 2000 rpm.

**Requirement:** TP2 on OSD, EL21 indicates a "0" signal.

- (12) Lock and seal potentiometer R4 on OSD, EL21.

- (13) Manually operate the speed control lever to increase the engine speed to 2100  $\pm$ 30 rpm.

**Requirement:** TP2 on OSD, EL21 indicates "1" signal pulses at 2100  $\pm$ 30 rpm.

- (14) Reset the engine speed control lever for normal operation (1800 rpm).
- (15) Operate the OSS to OFF.
- (16) Install CP6, EL10 in the control module.
- (17) Operate the OSS to the desired standby position.

**3.06 Reverse Power Detector (CP12)(Req't 2.06):**  
The RP, EL25 is adjusted as follows.

**Note:** Ensure that there is sufficient office load to meet the minimum requirements of the engine-alternator or that a dummy load is connected in accordance with Section 171-123-101. Operation of the engine-alternator should be in accordance with the appropriate Bell System Practice.

- (1) Operate the OSS to OFF.
- (2) Operate the OSS to MANUAL.
- (3) Depress the ENGINE START pushbutton.

**Requirement:** The engine cranks and accelerates to rated speed and voltage.

- (4) Depress the BREAKER CLOSE pushbutton and adjust the load to the different engine-alternator sets as follows.

ENGINE-ALTERNATOR FULL-LOAD RATING	ADJUST LOAD TO
115 kW	20 $\pm$ 2 kW
75 kW	20 $\pm$ 2 kW
45 kW	20 $\pm$ 2 kW
30 kW	15 $\pm$ 2 kW

**Caution:** The engine-alternator set should not be operated at less than 30 percent of rated full load any longer than necessary, in accordance with operating instructions.

**Note:** This procedure applies a simulated reverse power, equivalent to the adjusted load, to the reverse power detector without

actually forcing reverse power into the alternator from a parallel source.

- (5) On the control module, operate (pull up) the REVERSE POWER TEST switch located at the right rear corner of the control module chassis.

**Requirement:** The REVERSE POWER, SWITCH OFF NORMAL, and EMERGENCY STOP lamps light, the engine shuts down, the horn sounds, and a major alarm is given.

- (6) Operate the OSS to OFF.

**Note:** On the diesel engine-alternator, reset the air damper.

- (7) Depress the REVERSE POWER TEST switch.
- (8) If the requirement in (5) is met, proceed to (14). If the requirement is not met, proceed with (9).
- (9) Rotate potentiometer R8 on RP, EL28 fully ccw.
- (10) Repeat (1) through (5).
- (11) Rotate potentiometer R8 on RP, EL28 slowly cw (approximately one turn every 30 seconds) until the REVERSE POWER lamp just lights. The SWITCH OFF NORMAL and EMERGENCY STOP lamps light, the engine shuts down, and the horn sounds.
- (12) Seal potentiometer R8 on RP, EL28.
- (13) Operate the OSS to OFF.
- (14) Disconnect the dummy load, if connected.
- (15) Depress the REVERSE POWER TEST switch.
- (16) Operate the OSS to the desired standby position.

**3.07 Crank Cut Out Timer (CP4) (Reqt 2.07):** The CCOT, EL8 is adjusted as follows.

- (1) Operate the OSS to OFF.
- (2) Remove SC, EL32 from the control module.

- (3) Remove CFT, EL9 from the control module.
- (4) Operate the OSS to MANUAL.
- (5) Depress the ENGINE START pushbutton.
- (6) Monitor the time interval from the instant the ENGINE START pushbutton is depressed until the CRANKING FAILURE, SWITCH OFF NORMAL and EMERGENCY STOP lamps light and the horn sounds.

**Requirement:** The time interval shall be  $30 \pm 3$  seconds.

- (7) Operate the OSS to OFF.

**Note:** It will be necessary to reset the air damper on the diesel engine-alternator before the engine can be restarted.

- (8) If the requirement in (6) is met, proceed to (11). If the requirement is not met, proceed with (9).
- (9) Adjust potentiometer R3 on the CCOT, EL8 cw for increased time or ccw for decreased time and repeat (4) through (7) until the time interval is  $30 \pm 3$  seconds.
- (10) Lock and seal potentiometer R3 on CCOT, EL8.
- (11) Install CFT, EL9 and SC, EL32 in the control module.
- (12) Operate the OSS to the desired standby position.

**3.08 Crank Fail Timer (CP4) (Reqt 2.08):** The CFT, EL9 is adjusted as follows:

- (1) Operate the OSS to OFF.
- (2) Remove SC, EL32 from the control module.
- (3) Operate the OSS to MANUAL.
- (4) Depress the ENGINE START pushbutton on the main control panel.
- (5) Monitor the time interval from the instant the ENGINE START pushbutton is depressed until the CRANKING FAILURE, SWITCH OFF

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NORMAL, and EMERGENCY STOP lamps light and the horn sounds.

**Requirement:** The time interval shall be  $3 \pm 0.3$  seconds.

(6) Operate the OSS to OFF.

**Note:** It will be necessary to reset the air damper on the diesel engine-alternator before the engine can be restarted.

(7) If the requirement in (5) is met, proceed to (9). If the requirement in (5) is not met, repeat (3) through (6) and adjust potentiometer R3 on CFT, EL9 cw for increased time or ccw for decreased time until the time interval is  $3 \pm 0.3$  seconds.

(8) Lock and seal potentiometer R3 on CFT, EL9.

(9) Install SC, EL32 in the control module.

(10) Operate the OSS to the desired standby position.

**3.09 Delay Timer (Option W, CP3 or Option V, CP23) (Reqt 2.09):** The DT, EL5 is adjusted as follows.

(1) Operate the OSS to AUTO NO LOAD.

(2) Monitor the time interval from the instant the OSS is operated to AUTO NO LOAD until the engine begins to crank.

**Requirement:** The time interval is  $10 \pm 5$  seconds or the customer selected time interval.

(3) Operate the OSS to OFF.

(4) If the requirement in (2) is met, proceed to (5). If the requirement in (2) is not met, repeat (1), (2), and (3) and adjust potentiometer R4 on DT, EL5 cw for increased time or ccw for decreased time until the time interval is  $10 \pm 5$  seconds or the customer selected time interval.

(5) Operate the OSS to the desired standby position.

**3.10 Hold Over Timer (CP3) (Reqt 2.10):** The HOT, EL6 is adjusted as follows.

(1) Operate the OSS to AUTO.

(2) Momentarily connect TP2 on VR, EL38 through a 511-ohm resistor to TP2 on RT, EL34.

(3) Monitor the time interval from the instant TP2 on VR, EL38 is connected to TP2 on RT, EL34 until a "1" signal pulse appears at TP2 on HOT, EL6.

**Requirement:** The time interval is  $10 \pm 1$  minutes.

(4) Operate the OSS to OFF.

(5) If the requirement in (3) is met, proceed to (7). If the requirement in (3) is not met, repeat (1) through (4) and adjust potentiometer R4 on HOT, EL6 cw for increased time or ccw for decreased time until the time interval is  $10 \pm 1$  minutes.

(6) Seal potentiometer R4 on HOT, EL6.

(7) Operate the OSS to the desired standby position.

**3.11 Low Oil Pressure Timer (CP4) (Reqt 2.11):** The LOPT, EL39 is adjusted as follows:

(1) Operate the OSS to MANUAL.

(2) Remove PF, EL37 from the control module.

(3) Using a test lead, momentarily connect TP4 on VR, EL38 through a 511-ohm resistor to TP4 on 20CDM, EL17.

(4) Monitor the time interval from the instant TP4 on VR, EL38 is connected to TP4 on 20CDM, EL17 until the LOW OIL PRESSURE, SWITCH OFF NORMAL, and EMERGENCY STOP lamps light and the horn sounds.

**Requirement:** The time interval is  $11 \pm 1$  seconds.

(5) Operate the OSS to OFF.

(6) Install PF, EL37 in the control module.

**Note:** It will be necessary to reset the air damper on the diesel engine-alternator before the engine can be restarted.

(7) If the requirement in (4) is met, proceed to (9). If the requirement in (4) is not met, repeat (1) through (6) and adjust potentiometer R3 on LOPT, EL39 cw for increased time or ccw for decreased time until the time interval is  $11 \pm 1$  seconds.

(8) Lock and seal potentiometer R3 on LOPT, EL39.

(9) Operate the OSS to the desired standby position.

**3.12 Warm Up Timer (CP3)** (Reqt 2.12): The WUT, EL7 is adjusted as follows.

(1) Operate the OSS to MANUAL.

(2) Remove DTM1, EL13 from the control module.

(3) Using a test lead, momentarily connect TP4 on VR, EL38 through a 511-ohm resistor to TP6 on 58CDM, EL17.

(4) Monitor the time interval from the instant TP4 on VR, EL38 was connected to TP6 on 58CDM, EL17 until a "1" signal is measured, using the volt-ohm-milliammeter, at TP4 on WUTM, EL14.

**Requirement:** The time interval shall be  $4 \pm 1$  minutes (or customer selected time interval).

(5) Operate the OSS to OFF.

(6) If the requirement in (4) is met, proceed to (8). If the requirement in (4) is not met, repeat (1), (3), (4), and (5) and adjust potentiometer R4 on WUT, EL7 cw for increased time or ccw for decreased time until the time interval is  $4 \pm 1$  minutes (or customer selected time interval).

(7) Seal potentiometer R4 on WUT, EL7.

(8) Install DTM1, EL13 in the control module.

(9) Operate the OSS to the desired standby position.

**3.13 Breaker Control (CP18)** (Reqt 2.13): The BC, EL33 is adjusted as follows:

(1) Operate the OSS to OFF.

(2) Unsolder terminals 1 and 3 on the extender board.

**Note:** Care should be taken not to damage the extender board when unsoldering terminals 1 and 3.

(3) Elevate BC, EL33 using the extender board.

(4) Connect a 208-volt rms source through a Variac to terminals 1 and 3 on BC, EL33. Adjust the Variac for minimum voltage at terminals 1 and 3 on BC, EL33.

(5) Operate the OSS to MANUAL.

(6) Momentarily connect TP4 on VR, EL38 through a 511-ohm resistor to TP2 on BCM1, EL15.

(7) Adjust the Variac to gradually increase the voltage applied to terminals 1 and 3 on BC, EL33 to  $191 \pm 2$  volts rms, 60 Hz.

**Requirement:** Relay A on BC, EL33 operates and the breaker control relay in the control cabinet operates when the voltage at terminal 1 and 3 on BC, EL33 reaches  $191 \pm 2$  volts rms, 60 Hz.

(8) Decrease the voltage applied to terminal 1 and 3 on BC, EL33 to  $100 \pm 2$  volts rms, 60 Hz.

**Requirement:** Relay A on BC, EL33 and the breaker control relay in the control cabinet releases when the voltage at terminal 1 and 3 on BC, EL33 reaches  $100 \pm 2$  volts rms, 60 Hz.

(9) If the requirements in (7) and (8) are met, proceed to (17). If the requirements are not met, proceed to (10).

(10) On BC, EL33, rotate potentiometer R7 fully ccw and rotate potentiometer R2 fully cw.

(11) Adjust the Variac for 191 volts rms, 60 Hz at terminals 1 and 3 on BC, EL33.

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- (12) Rotate potentiometer R2 ccw until relay A on BC, EL33 and the breaker control relay in the control cabinet operates.
- (13) Decrease the voltage applied to terminal 1 and 3 on BC, EL33 to 100 volts rms, 60 Hz.
- (14) Rotate potentiometer R7 on BC, EL33 cw until relay A on BC, EL33 and the breaker control relay in the control cabinet releases.
- (15) Repeat (7) and (8) to determine that the adjustment is correct.
- (16) Seal potentiometers R7 and R2 on BC, EL33.
- (17) Operate the OSS to OFF.
- (18) Disconnect the Variac from terminals 1 and 3 on BC, EL33.
- (19) Install BC, EL33 in its normal position.
- (20) Operate the OSS to the desired standby position.
- (21) Resolder terminals 1 and 3 on the extender board.

**Note:** Care should be taken not to damage the extender board when resoldering terminals 1 and 3.