

AUTOMATIC SOLID STATE CONTROL (J86634A) FOR RESERVE DIESEL ENGINE-ALTERNATOR PLANTS TESTS AND INSPECTION

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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 The solid state control module is composed of a series of solid state logic circuit packages consisting of Flip Flop Memories, OR, NAND and NOR Gates, Timers, Analogue to Digital Converters, Inverters, and Power Amplifiers which function as a real time, asynchronous digital control system.

1.03 The control module functions either as an automatic or manual solid state control system which monitors commercial ac power and also monitors all functions of the engine-alternator set. If the commercial ac power in any phase drops below a predetermined level or fails completely while the control module is set for automatic operation, the control module begins a series of actions to replace the commercial power with engine alternator power. After commercial service is

reestablished, a routine course of events transfers the load to the commercial power and shuts the engine-alternator set down and again places it on a standby basis. In manual operation, the starting of the set, the transfer from commercial power to engine alternator power, the transfer back to commercial service, and shutdown are accomplished by manually operating pushbuttons on the engine set control panel. The control module monitors the engine-alternator set during its operation and should a major trouble develop in any mode of operation, such as failure of the engine to start properly, loss of oil pressure, overheating, or overspeeding, etc, the engine is automatically shut down and audible and visual alarms are operated. Audible and visual alarms are also provided for all modes of operation for conditions such as battery-charging rectifier failure, low cooling water temperature when an immersion heater is used, etc, however, the engine is not shut down with minor alarms.

1.04 The mode of operation of the control module is selected by operating the operation selector switch (OSS), a five 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. The engine-alternator set, in conjunction with the control module, can be operated in any one of the four modes and can be changed any time from one mode of operation to another without interrupting the operation of the set.

1.05 The solid state 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 routine testing, troubleshooting, and electrical alignment.

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1.06 The hinged cover 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.

Caution: Potentiometers on the circuit packs are manufacturer adjusted for their particular function in the control module. Adjustments should not be necessary on any of the potentiometers except for the VM1, 2, 3, voltage monitors, the RPD reverse power detector, and in the application where the CP3 is used as the DT, delay timer (equipment location 5), and the WUT, warmup timer (equipment location 7). In these cases, the operating companies may desire to vary the settings to satisfy their particular requirements. Adjustable circuit packs should not be interchanged between their respective equipment locations. Interchanging of any of these boards without readjustment may cause the unit to malfunction and could result in serious damage to the equipment.

1.07 A REVERSE POWER TEST switch 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 is closed and fastened in place, the switch will automatically restore to its normal operating position.

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

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

POWER DISTRIBUTION AND VOLTAGE REGULATOR

DESIGNATION	MEANING
VR	Voltage Regulator

LOGIC AND CONTROL

DESIGNATION	MEANING
BC	Breaker Control
BCC1, BCC2	Breaker Control Clamp One and Two
BCG1	Breaker Control Gate One
BCM1, BCM2	Breaker Control Memory One and Two
CN1	Coupling Network One
DT	Delay Timer
DTG1	Delay Timer Gate One
DTG2	Delay Timer Gate Two (Clamp)
DTI	Delay Timer Inverter
DTM1, DTM2, DTM3	Delay Timer Memory One, Two, and Three
DTMI	Delay Timer Memory Inverter
FC	Fuel Control
FCA	Fuel Control Amplifier
HOT	Hold Over Timer
HOTC	Hold Over Time Clamp
HOTG	Hold Over Timer Gate
MCG1	Memory Clear Gate One
MCI1, MCI2	Memory Clear Inverter One and Two
OSSG1	Operation Selector Switch Gate One (Clamp)
PF	Power Failure Switch
PFA	Power Failure Amplifier
RSG1	Remote Start Gate One
RSG2	Remote Start Gate Two (Clamp)
RT1, RT2, RT3	Run Timer One, Two, and Three
RTM	Run Timer Memory
SC	Start Control
SCA	Start Control Amplifier
VM1, VM2, VM3	Voltage Monitor One, Two, and Three
WUT	Warm Up Timer
WUTM	Warm Up Timer Memory

ALARM AND CONTROL

DESIGNATION	MEANING
ADM	Alarm Delay Memory
AO	Alarm Output
ATG	Alarm Test Gate
CCOG	Crank Cut Out Gate
CCOT	Crank Cut Out Timer
20CD	20 Cycle Detector
58CD	58 Cycle Detector
20CDM	20 Cycle Detector Memory
20CDMI	20 Cycle Detector Memory Inverter

DESIGNATION	ALARM AND CONTROL MEANING
58CDM	58 Cycle Detector Memory
CFA	Crank Fail Amplifier
CFG	Crank Fail Gate
CFLA	Crank Fail Lamp Amplifier
CFM1, CFM2	Crank Fail Memory One and Two
CFT	Crank Fail Timer
CN2	Coupling Network Two
HWTG	High Water Temperature Gate
HWTI	High Water Temperature Inverter
HWTLA	High Water Temperature Lamp Amplifier
HWTM	High Water Temperature Memory
LOPG	Low Oil Pressure Gate
LOPLA	Low Oil Pressure Lamp Amplifier
LOPM	Low Oil Pressure Memory
LOPT	Low Oil Pressure Timer
MAG	Major Alarm Gate
MIG	Minor Alarm Gate
MCG2	Memory Clear Gate Two
OSD	Overspeed Detector
OSLA	Overspeed Lamp Amplifier
OSM	Overspeed Memory
PS	Pulse Separator
RP	Reverse Power Detector
RPLA	Reverse Power Lamp Amplifier
RPM	Reverse Power Memory
SFG	Start Fail Gate
SFI	Start Fail Inverter
STLA	Shunt-Trip Lamp Amplifier
STM	Shunt-Trip Memory

1.09 For the purposes of this section, a power failure is defined as the decrease or loss of the 3-phase commercial power in any or all phases below 191±2 volts rms for the 208- or 240-volt ac commercial power or below 215±2 volts rms for 416- or 480-volt ac commercial power at the input to the voltage monitor circuits.

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

(a) A terminal voltage between the values of zero and -0.9 volt dc or no signal (float condition) is defined as a "0".

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

1.11 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.

Note: The volt-ohm-milliammeter should have a minimum internal resistance of 100,000 ohms per volt dc to prevent loading of the circuit.

1.12 The instructions are based on circuit schematic drawing SD-81692-01. For detailed description of the operation, see the corresponding circuit description.

2. LIST OF TOOLS, TEST APPARATUS, AND MATERIALS

CODE OR SPEC NO.	DESCRIPTION
TOOLS	
—	Fuse pullers 7-1/2 inches Ideal Industries (or equivalent)
—	Small Screwdriver
TEST APPARATUS	
—	Voltmeter, AC Weston Model 904, 300/150-V
KS-3008	Stopwatch
—	Oscilloscope, Tektronix Model 535A (or equivalent)
—	Volt-Ohm-Milliammeter Simpson Model 269-2 100,000 Ohm Per Volt Direct Current (or equivalent)
—	Tachometer
MATERIALS	
As Req'd	Insulated Tip Plugs H.M. Smith Type 201 solderless (or equivalent)
As Req'd	Insulated Alligator Clips, Mueller (or equivalent)
As Req'd	Test Prod Wire

3. INSPECTION

3.01 Visual inspection of the control unit should be made if there is a suspected trouble in the control unit. Improperly mounted circuit packs, loose connections, broken wiring, defective solder connections, or defective components are possible causes of troubles.

Caution: Hazardous voltages are present on some circuit packs in the control module.

3.02 The circuit packs should be checked for the proper identification code to determine that the circuit packs have been inserted in the proper slots. The circuit packs should be at a uniform height. If a circuit pack is extending slightly higher than the other circuit packs, press the circuit pack firmly into its connector. This may correct the trouble condition. Intermittent continuity between the connector and circuit pack can occur if the circuit pack is not inserted properly.

Caution: Operate the OSS to the OFF position to remove power from the control module before removing or inserting circuit packs.

3.03 If a circuit pack is suspected of not making contact with the connector, the circuit pack should be removed and the gold contacts examined for a damaged or scratched condition. If the contacts are dirty, they should be cleaned with a suitable solvent. Examine the connector for bent or broken contacts.

3.04 Continuity checks of the circuit packs shall be made using the Simpson Model 269 volt-ohm-milliammeter. Do not use a buzzer as this may damage the semiconductor devices. The circuit packs should be maintained in accordance with Section 032-173-301.

Caution: In making continuity checks, use the ohmmeter portion of the volt-ohm-milliammeter. Do not use the X10,000 or X100,000 position for testing semiconductors as the higher voltage used may damage them.

3.05 It is recommended that defective circuit pack(s) be removed and repaired or new or reconditioned circuit pack(s) be installed. The defective circuit pack can be returned to the Western Electric Company for repair and/or reconditioning.

BINARY OUTPUT

3.06 Binary output charts are given in 3.07 and 3.08 to aid in isolating trouble conditions to a few possible faulty circuit packs. Since some unsatisfactory conditions will damage more than one circuit pack or component, the associated circuit packs should be checked for proper binary output.

3.07 The binary output of the various circuits, with the engine-alternator set not operating, is checked as follows.

- (1) Operate the OSS to the MANUAL position.
- (2) The binary output is as follows:

CIRCUIT PACK	EQUIPMENT LOCATION	TEST POINT	BINARY SIGNAL
START AND FUEL CONTROL			
VM1	EL1	TP2	"1"
VM2	EL2	TP2	"1"
VM3	EL3	TP2	"1"
DTG1	EL29	TP1	"0"
DTI	EL4	TP4	"1"
PFA	EL4	TP2	"1"
PF	EL37	Terminal 8	"1" (-26V)*
DT	EL5	TP2	"0"
DTM1	EL13	TP1	"0"
		TP2	"1"
DTM2	EL13	TP4	"0"
		TP3	"1"
FCA	EL4	TP3	"1" (-26V)*

With
Commercial
Power
Available

ALSO SEE
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CIRCUIT PACK	EQUIPMENT LOCATION	TEST POINT	BINARY SIGNAL
START AND FUEL CONTROL			
FC	EL31	TP2	"0"
		TP1	"1" (-26V)*
DTM3	EL14	TP1	"0"
		TP2	"1"
DTMI	EL28	TP4	"1"
SCA	EL4	TP1	"1" (-26V)*
SC	EL32	TP1	"1" (-26V)*
		TP2	"0"
RSG1	EL8	TP1	"0"
ENGINE TIMER CIRCUIT			
WUT	EL7	TP2	"0"
WUTM	EL14	TP3	"1"
		TP4	"0"
RT1	EL34	TP2	"0"
RT2	EL35	TP1	"0" -
RT3	EL36	TP1	"0" -
RTM	EL16	TP1	"0"
		TP2	"1"
HOTG	EL6	TP3	"0"
HOT	EL6	TP2	"0"
CLAMP CIRCUIT			
OSSG1	EL39	TP1	"0"
DTG2	EL5	TP3	"0"
RSG2	EL9	TP1	"0"
BCC1	EL30	TP3	"0"
BCC2	EL30	TP2	"0"
HOTC	EL37	TP1	"0"
BREAKER CONTROL			
BCM2	EL15	TP3	"1"
		TP4	"0"
BCM1	EL15	TP1	"0"
		TP2	"1"
BCG1	EL30	TP1	"0"
MEMORY CLEAR CIRCUITS (SHUTDOWN)			
MCG1	EL29	TP2	"1" -
MCG2	EL37	TP3	"1"
MCI1	EL29	TP3	"0" -
MCI2	EL29	TP4	"0" -
ENGINE MONITOR CIRCUIT			
CFA	EL23	TP4	"0"
CFM1	EL17	TP2	"0"
		TP5	"1"
20CD	EL22	TP1	"0"
20CDM	EL17	TP3	"0"
		TP4	"1"
58CD	EL20	TP2	"0"

} See Note

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CIRCUIT PACK	EQUIPMENT LOCATION	TEST POINT	BINARY SIGNAL
ENGINE MONITOR CIRCUIT			
58CDM	EL17	TP4	"1"
		TP1	"0"
		TP6	"1"
OSD	EL21	TP2	"0"
CFT	EL9	TP3	"0"
CFG	EL27	TP2	"0"
CCOT	EL8	TP3	"0"
CCOG	EL27	TP1	"0"
LOPT	EL39	TP3	"0"
ADM	EL16	TP3	"1"
		TP4	"0"
LOPG	EL28	TP3	"0"
SFG	EL28	TP1	"1"
SFI	EL37	TP2	"0"
Z HWTI	EL28	TP2	"1"
<u>Y 20CDMI</u>	EL28	TP2	"0"
Z HWTG	EL7	TP3	"0"
Y HWTG	EL27	TP3	"0"
RP	EL25	TP1	"0"
ALARMS			
Z ATG	EL27	TP3	"0"
Y ATG	EL7	TP3	"0"
STM	EL12	TP1	"0"
		TP2	"1"
STLA	EL19	TP1	"1" (-26V)*
CFM2	EL10	TP1	"0"
		TP2	"1"
CFLA	EL18	TP1	"1" (-26V)*
LOPM	EL11	TP4	"0"
		TP3	"1"
LOPLA	EL19	TP2	"1" (-26V)*
RPM	EL12	TP4	"0"
		TP3	"1"
RPLA	EL19	TP3	"1" (-26V)*
HWTM	EL11	TP1	"0"
		TP2	"1"
HWTLA	EL18	TP2	"1" (-26V)*
OSM	EL10	TP4	"0"
		TP3	"1"
OSLA	EL18	TP3	"1" (-26V)*
MAG	EL26	TP1	"0"
* MLG	EL26	TP3	"0" 1
* AO	EL24	TP2	"0" 1 (-26V)
		TP1	"0"

* The voltage given will vary with control battery voltage.

(CORRECTED) - SEE ADD.

Note: These test points will indicate a "0" since they are connected to outputs of circuit packs which have a "0" output. Therefore, this check will not indicate that the clamp circuit is functioning properly.

3.08 The binary output of the various circuit packs, with the diesel engine-alternator operating, is checked as follows.

- (1) Operate the OSS to the FULL AUTO position.
- (2) Remove fuses or open circuit breakers, as necessary, to open the circuit paths to pins W, V, and X of P1 on the J86634A control unit.
- (3) The binary output is as follows:

CIRCUIT PACK	EQUIPMENT LOCATION	TEST POINT	BINARY SIGNAL
START AND FUEL CONTROL			
VM1	EL1	TP2	"0"
VM2	EL2	TP2	"0"
VM3	EL3	TP2	"0"
DTG1	EL29	TP1	"1"
DTI	EL4	TP4	"0"
PFA	EL4	TP2	"0"
PF	EL37	Terminal 8 Terminal 15	"0"

Note: In case of a power failure, the monitor voltage is removed only from the phase in which the power failure occurred. Therefore, only the voltage monitors associated with that phase will indicate a "0" signal. The other voltage monitors will indicate a "1" signal.

- (a) The DT, EL5 delay time interval after power failure (10±5 seconds or customer selected time interval)

CIRCUIT PACK	EQUIPMENT LOCATION	TEST POINT	BINARY SIGNAL
DT	EL5	TP2	**"1" (pulse)
DTM1	EL13	TP1	"1"
		TP2	"0"
DTM2	EL13	TP3	"0"
		TP4	"1"
FCA	EL4	TP3	"0"
FC	EL31	TP1	"0"
		TP2	"1" (-26V)*
DTM3	EL14	TP1	"1"
		TP2	"0"
DTMI	EL28	TP4	"0"
SCA	EL4	TP1	"0"
SC	EL32	TP1	"0"
		TP2	"1" (-26V)*

- (b) Engine starter is engaged. The CCOT, EL8 (crank cutout timer) and CFT, EL9 (crank fail timer) begin timing.

- (c) Engine accelerates to approximately 100 rpm.

Note: If engine fails to accelerate to 100 rpm in approximately 3 seconds, the engine is shut down.

CIRCUIT PACK	EQUIPMENT LOCATION	TEST POINT	BINARY SIGNAL
CFA	EL23	TP4	**"1"
CFM	EL17	TP2	"1"
		TP5	"0"
MCG2	EL37	TP3	"0"

- (d) Engine accelerates to approximately 600 rpm.

Note: If engine fails to accelerate to 600 rpm within 30 seconds from start, the engine is shut down.

CIRCUIT PACK	EQUIPMENT LOCATION	TEST POINT	BINARY SIGNAL
20CD	EL22	TP1	"1"***
20CDM	EL17	TP3	"1"
		TP4	"0"

- (e) The DTM3, EL14 cleared, engine start motor is disengaged. The LOPT, EL39 (low oil pressure timer) begins timing.

CIRCUIT PACK	EQUIPMENT LOCATION	TEST POINT	BINARY SIGNAL
DTM3	EL14	TP1	"0"
		TP2	"1"
DTMI	EL28	TP4	"1"
SCA	EL4	TP1	"1" (-26V)*
SC	EL32	TP1	"1" (-26V)*
		TP2	"0"

Note: The LOPT, EL39 times out (11±1 seconds) and applies a "1" pulse signal to the ADM, EL16 resulting in a "1" signal at TP3 on ADM, EL16 and terminal 14 of the LOPG, EL28. If a low oil pressure condition exists, a "0" signal (open) on pin Y of P1 will result in a shutdown. A normal oil pressure results in a "1" signal at pin Y of P1. See Part 4, TESTS.

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(f) Engine accelerates to 1800 rpm (rated speed). Alternator output voltage applied to terminals 1 and 3 on BC, EL33.

CIRCUIT PACK	EQUIPMENT LOCATION	TEST POINT	BINARY SIGNAL
58CD	EL20	TP2	"1"***
		TP4	"0"***
58CDM	EL17	TP1	"1"
		TP6	"0"

(g) The WUT, EL7 warmup time interval (4±1 minutes or customer selected time interval)

CIRCUIT PACK	EQUIPMENT LOCATION	TEST POINT	BINARY SIGNAL
WUT	EL7	TP2	"1" (pulse)
WUTM	EL14	TP3	"0"
		TP4	"1"

(h) The breaker control circuit is energized.

CIRCUIT PACK	EQUIPMENT LOCATION	TEST POINT	BINARY SIGNAL
BCM2	EL15	TP3	"1"
		TP4	"0"
BCG1	EL30	TP1	"1"***
BCM1	EL15	TP1	"1"
		TP2	"0"
BC	EL33	Terminal 12	"0"

Note: The load is automatically transferred to diesel engine-alternator at the end of the warmup time interval.

(i) The run timer circuit is energized with S1 switch on RT1, EL34 operated to the IN position (run timer interval is approximately, 46).

CIRCUIT PACK	EQUIPMENT LOCATION	TEST POINT	BINARY SIGNAL
RT1	EL34	TP2	"1" (pulse)
RTM	EL16	TP1	"1"
		TP2	"0"

Note: With S1 switch on RT1, EL34 operated to the OUT position, RT1 gives an output the instant the WUTM, EL30 is set.

(j) Install fuses or close circuit breakers, as necessary, to close the circuit path to pins W, V, and X of P1 on the J86634A control unit.

CIRCUIT PACK	EQUIPMENT LOCATION	TEST POINT	BINARY SIGNAL
HOTG	EL6	TP3	"1"

(k) The HOT, EL6 holdover delay time interval (approximately 3 minutes)

CIRCUIT PACK	EQUIPMENT LOCATION	TEST POINT	BINARY SIGNAL
HOT	EL6	TP2	"1" (pulse)
MCG1	EL29	TP2	"0" (pulse)
MCI1	EL29	TP3	"1" (pulse)
MCI2	EL29	TP4	"1" (pulse)

(l) The load is transferred to commercial power. Shutdown occurs, circuits are as indicated in 3.08.

* The voltage given will vary with battery voltage

** Use an oscilloscope to monitor this signal.

4. TROUBLES AND TESTS

4.01 For a list of control module malfunctions and troubleshooting procedures, refer to the troubleshooting flow charts in CD-81692-01.