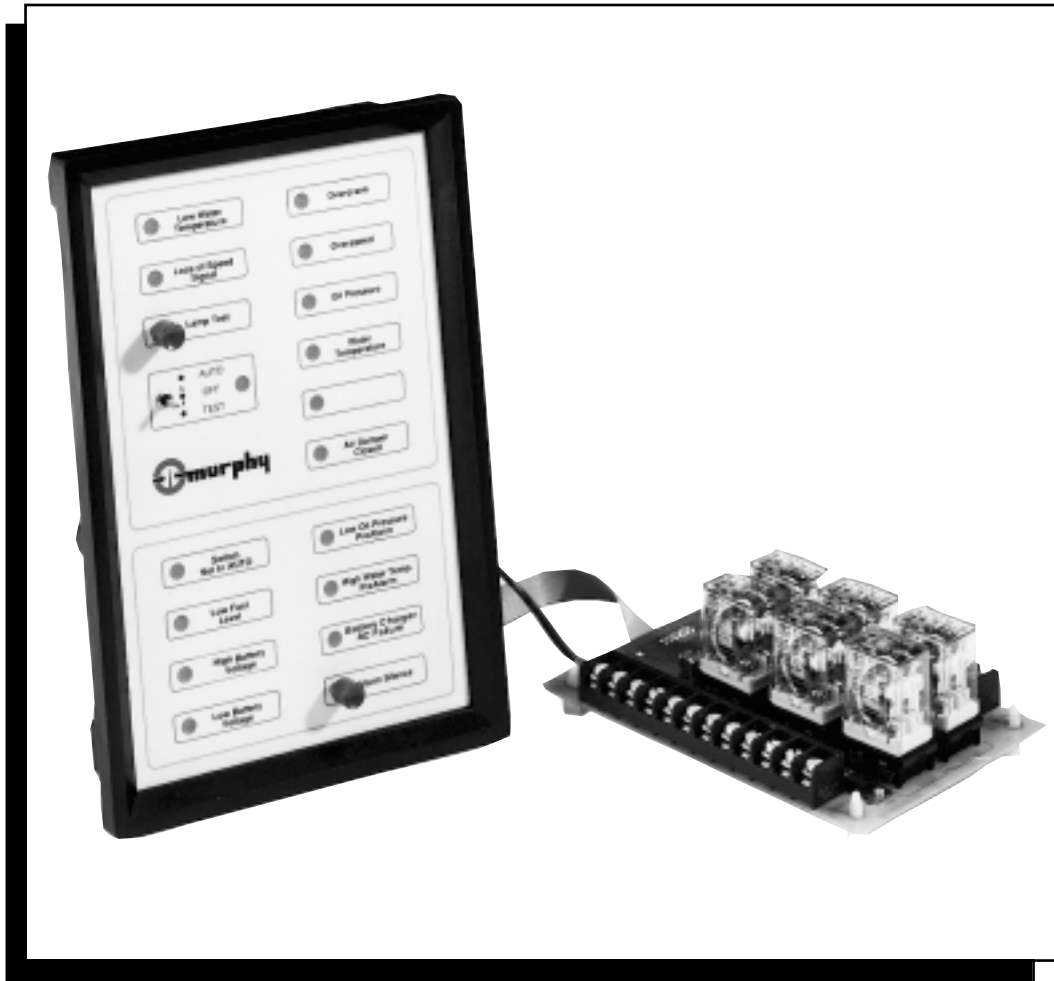




**SERIES A900
MURPHYMATIC® GENERATOR
ENGINE CONTROL SYSTEM
DESIGN, INSTALLATION
AND OPERATING MANUAL**





Certain danger to human safety and to equipment may occur if some equipment is stopped without pre-warning. It is recommended that monitored functions be limited to alarm-only or to alarm before shutdown.

WARNING

BEFORE BEGINNING INSTALLATION OF THIS MURPHY PRODUCT

- ✓ **Disconnect all electrical power to the machine.**
- ✓ **Make sure the machine cannot operate during installation.**
- ✓ **Follow all safety warnings of the machine manufacturer.**
- ✓ **Read and follow all installation instructions.**

Table of Contents

Section 1: Introduction	<i>page 1</i>
1-1 System	1
1-2 Models	1
1-3 Purpose	1
1-4 Definitions	1
1-5 How To Use This Manual	1
Section 2: Specifications	1
2-1 Enclosure Type	1
2-2 Power Requirements	1
2-3 Input Ratings	1
2-4 Output Ratings	1
2-5 Field Wiring Connections	1
2-6 Operating Temperature	1
Section 3: Model Identification	1
3-1 Model Numbers	1
3-2 A901	2
3-3 A901-2	5
3-4 A902	7
3-5 A902-2	8
3-6 A903	10
3-7 A903-2	12
Section 4: Installation	14
4-1 Location	14
4-2 Wiring	14
4-3 Crank Disconnect	19
4-4 Pre-Operational Check-Out	19
Section 5: Operation	21
5-1 Operator Controls	21
5-2 Operating Modes	21
Section 6: Routine Maintenance and Operational Tests	21
6-1 Routine Maintenance	21
6-2 Operational Tests	21
Section 7: Troubleshooting and Repair	21
7-1 Tools Required	21
7-2 A900 SELECTRONIC® Control Operation and Shutdown	21
7-3 A900 SELECTRONIC® Control Alarm Circuit Operation	23
Section 8: Service Parts	24
8-1 Table 8-1: Replacement Components of the A900 Series Generator Controls	24
8-2 Table 8-2: Replacement Components of the A900 Controls for Detroit Diesel	24

Section 1: Introduction

1-1 System.

1-1.1 The MURPHYMATIC® Generator Engine Control System, Series A900 is designed to meet the requirements of the engine control, shutdown and alarm section of NFPA-110 “Emergency And Standby Power Systems” specification. The controller also meets the minimum requirements of NFPA99 “Health Care Facilities” and the Canadian standard CAN/CSA-C282-M89 “Emergency Electrical Power Supply for Buildings” for engine control, shutdown and alarm systems. By combining one of the A900 series controls with generator instruments, a complete engine generator control panel meeting the above specifications can be provided.

1-2 Models.

1-2.1 The Series A900 is available in three basic configurations:

1-2.1.1 Model A901 for automatic start and stop generator sets which includes the minimum shutdowns and alarms per NFPA-110 Level 1.

1-2.1.2 Model A902 for automatic start and stop generator sets which includes the minimum shutdowns and alarms per NFPA-110 Level 2.

1-2.1.3 Model A903 for automatic start and stop generator sets which includes the minimum shutdowns and alarms per NFPA-110 Level 2 and seven unlabeled alarm lights for additional customer specified alarms.

1-2.2 All models are available for 12 or 24 V DC operation.

1-2.3 All models are available for use on either two cycle or four cycle engines. Models for two cycle engines include an alarm light for “Air Damper Closed” and an “Overspeed Relay” to operate the air shutoff solenoid for overspeed shutdown.

1-2.4 Each model is made up of two parts, a Control/Display module and a Relay module.

1-3 Purpose.

1-3.1 This manual is directed to the installation, maintenance and operating personnel who will be in day to day contact with the A900 system. However the basic knowledge gained with this material will allow those personnel to easily adjust to special circumstances.

1-4 Definitions.

1-4.1 Throughout this manual, reference is made to organizations, trade names and trademarks which may not be familiar to the reader. Some of these are:

1-4.1.1 CSA: Canadian Standards Association.

1-4.1.2 CAN/CSA-C282-M89: The standard for Emergency Electrical Power Supply for Buildings, 1989 Edition.

1-4.1.3 NFPA: National Fire Protection Association.

1-4.1.4 NFPA-70: The National Electrical Code.

1-4.1.5 NFPA-99-1990: The standard for Health Care Facilities, 1990 Edition.

1-4.1.6 NFPA-110-1988: The standard for Emergency And Standby Power Systems, 1988 Edition.

1-4.1.7 Several terms used in this manual are registered trademarks of Frank W. Murphy Mfr.

(a) MURPHYMATIC®: Refers to all Murphy automatic controls.

(b) SELECTRONIC®: A name that is applied to all electronic controls manufactured by Murphy.

(c) SWICHGAGE®: A combination indicating gauge and switch.

(d) TATTLETALE®: A term that refers to a shutdown indicating device or circuit in the control panel.

1-5 How to use this manual.

1-5.1 Section 1, 2, 4, 5, 6 and 7 contain general information that applies to all A900 models.

1-5.2 Section 3, Model Identification, is broken into seven sub sections. Section 3-1 allows you to chose the model that best fits your requirements and Section 3-2 through 3-7 explain each models features in detail.

Section 2: Specifications

2-1 Enclosure Type.

2-1.1 The A900 Series enclosure is designed to be mounted in a standard electrical enclosure for indoor use.

2-2 Power Requirements.

2-2.1 The engine controls, shutdown circuits, alarm and shutdown indicators are powered from the engine starting battery. The A900 series is available in either 12 or 24 V, negative ground.

2-2.2 The A900 is fused for 3 A maximum current.

2-3 Input Ratings.

2-3.1 All input switches should be dry contact type, maximum current is 2 mA, 8 V DC or less.

2-3.2 Frequency signal for the speed sensing circuit requires a minimum input of 2 V rms from a magnetic pickup (preferred) or from the tachometer terminal of the battery charging alternator.

2-3.2.1 Frequency range of the speed sensing circuits is 25 Hz to 10,000 Hz.

2-4 Output Ratings.

2-4.1 The A900 Control / Display Module has outputs for remote indication of alarm and shutdowns. These outputs are transistors that close to the negative supply (sink) and are rated at 1 amp, 30 V DC maximum.

2-4.2 The Control / Display Module also has an output for an auxiliary starter contactor which is rated 1 A, 30 V DC maximum. This is a transistor that closes to the positive supply (source).

2-4.3 The Relay Module includes 3 engine control relays with contact ratings of 7 A, 30 V DC inductive. These powered contacts must be supplied from an 8 A fuse or circuit breaker (customer supplied). The 3 alarm relays have dry contacts, also rated at 7 A, 30 V DC maximum.

2-5 Field Wiring Connections.

2-5.1 All field wiring connections are barrier terminal blocks, UL rated for 15 A, 300 V.

2-6 Operating Temperature.

2-6.1 The operating temperature range of the A900 is -4°F to 158°F (-20°C to 70°C.)

Section 3: Model Identification

3-1 Model Numbers.

3-1.1 A901-12 and A901-24: These models are designed for an automatic start four cycle engine driven generator, and include the shutdown and alarm points recommended in NFPA-110-1988 “Emergency and Standby Generator Systems” for Level 1 installations. These controllers also meet or exceed the minimum requirements of NFPA99-1990 “Health Care Facilities” and with the addition of a Low Water Level alarm, the Canadian standard CAN/CSA-C282-M89 “Emergency Electrical Power Supply for Buildings”. The suffix numbers -12 and -24 indicate the engine starting battery voltage.

3-1.2 A901-2-12 and A901-2-24: These models are designed for

an automatic-start, two-cycle, engine-driven generator, and include the shutdown and alarm points recommended in NFPA-110-1988 “Emergency and Standby Generator Systems” for Level 1 installations. These controllers also meet or exceed the minimum requirements of NFPA-99-1990 “Health Care Facilities” and with the addition of a Low Water Level alarm, the Canadian standard CAN/CSA-C282-M89 “Emergency Electrical Power Supply for Buildings”. The suffix numbers -12 and -24 indicate the engine starting battery voltage.

3-1.2.1 The A901-2 series control includes an “Air Damper Closed” light and “Overspeed Relay” to trip the air shut-off solenoid on overspeed of a two-cycle engine.

3-1.3 A902-12 and A902-24: These models are designed for an automatic-start, four-cycle, engine-driven generator, and include the shutdown and alarm points recommended in NFPA-110-1988 “Emergency and Standby Generator Systems” for Level 2 installations. The suffix numbers -12 and -24 indicate the engine starting battery voltage.

3-1.4 A902-2-12 and A902-2-24: These models are designed for an automatic-start, two-cycle, engine-driven generator, and include the shutdown and alarm points recommended in NFPA-110-1988 “Emergency and Standby Generator Systems” for Level 2 installations. The suffix numbers -12 and -24 indicate the engine starting battery voltage.

3-1.4.1 The A902-2 series control includes an “Air Damper Closed” light and “Overspeed Relay” to trip the air shut-off solenoid on overspeed of a two-cycle engine.

3-1.5 A903-12 and A903-24: These models are designed for an automatic-start, four-cycle, engine-driven generator, and include the shutdown and alarm points recommended in NFPA-110-1988 “Emergency and Standby Generator Systems” for Level 2 installations plus seven unlabeled alarms that the user may specify and an “Alarm Silence Switch”. The suffix numbers -12 and -24 indicate the engine starting battery voltage.

3-1.6 A903-2-12 and A903-2-24: These models are designed for an automatic-start, two-cycle, engine driven generator, and include the shutdown and alarm points recommended in NFPA-110-1988 “Emergency and Standby Generator Systems” for Level 2 installations plus seven unlabeled alarms that the user may specify and an “Alarm Silence Switch”. The suffix numbers -12 and -24 indicate the engine starting battery voltage.

3-1.6.1 The A903-2 series control includes an “Air Damper Closed” light and “Overspeed Relay” to trip the air shut-off solenoid on overspeed of a two-cycle engine.

3-1.7 Table 3-1.7 illustrates the alarm and shutdown requirements of NFPA-110, NFPA99 and CAN/CSA-C282-M89 and compares the features of the A900 series controls to those requirements.

3-2 A901.

3-2.1 Control / Display Module. The Control / Display Module, figure 3-2.1, includes the control and test switches, the solid state logic elements, shutdown and alarm TATTLETALE® lights that make up the generator engine control for a four-cycle engine.

3-2.1.1 Mode Selector Switch, OFF-AUTO-TEST:

- (a) OFF; turns off the control system and resets any shutdown circuits.
- (b) AUTO; turns on the engine controls and shutdown circuits. System is on standby waiting for a contact closure to start engine.

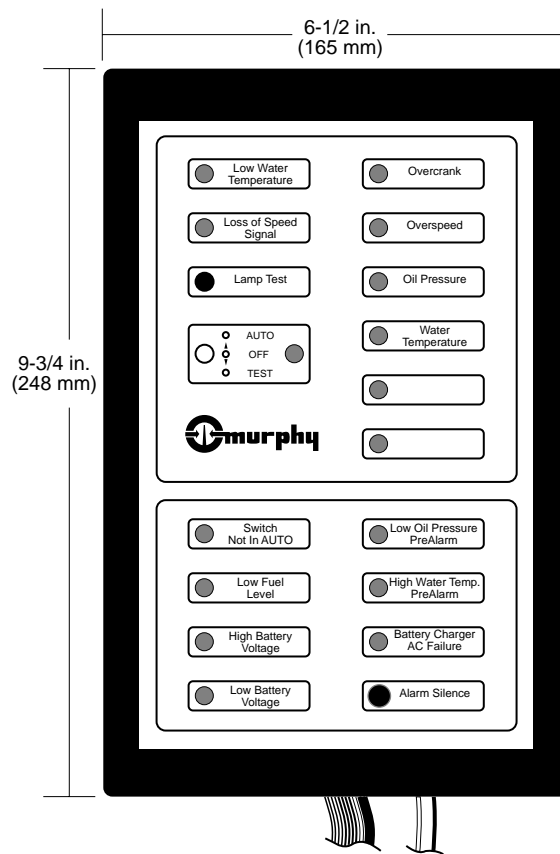


Figure 3-2.1

- (c) TEST; turns on the engine controls and shutdown circuits. A start signal is applied to the automatic control and the engine start sequence begins.

3-2.1.2 Lamp Test Pushbutton: Tests the lights on the A901 module.

3-2.1.3 Alarm Silence Pushbutton: Turns off any audible alarm that is connected to the Local or Remote Audible Alarm Relays. The indicating light will remain on as long as the condition exists. If the Alarm Silence pushbutton is not operated, the audible alarm will turn off when the alarm contact clears.

3-2.1.4 The A901 SELECTRONIC® Control Module includes the following engine control features:

- (a) Cycle crank circuit; will crank the engine for 15 seconds then rest for 15 seconds until the engine starts. The crank/rest time can be selected for either 10, 15, 20, 25 or 30 seconds. If the engine false starts, goes above crank disconnect speed then drops below that speed, the control will rest for a fixed 10 second period before cranking again.
- (b) Crank Disconnect Speed Switch; this circuit detects engine speed and terminates cranking when engine speed rises above the speed switch setting. The speed switch is adjustable, 25 Hz to 2000 Hz, and is factory set at 1180 Hz. This would be 600 RPM on an engine with 118 teeth on the flywheel ring gear.
- (c) Auxiliary Crank Disconnect Circuit; this circuit, required by NFPA-110, is provided as a back up for the Crank Disconnect Speed Switch. It is operated by an external switch sensing either speed, generator voltage or some other variable that could be used to terminate cranking. Either circuit will disconnect the starter when the engine starts.

Table 3-1.7

	NFPA-110										NFPA99			CAN/CSA C282-M89			A901			A902			A903																						
	Level 1					Level 2					C.V.	S	L.A.	R.A.	R.V.	C.V.	S	L.A.	R.A.	R.V.	C.V.	S	L.A.	R.A.	R.V.	C.V.	S	L.A.	R.A.	R.V.															
	C.V.	S	L.A.	R.A.	R.V.	C.V.	S	L.A.	R.A.	R.V.																					C.V.	S	L.A.	R.A.	R.V.	C.V.	S	L.A.	R.A.	R.V.	C.V.	S	L.A.	R.A.	R.V.
a. Overcrank	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
b. Low Water Temperature	X	—	X	X	X	X	—	X	X	X	X	—	X	X	X	X	—	X	X	X	X	—	X	X	X	X	—	X	X	X	X	—	X	X	X	X	—	X	X	X	X	—	X	X	X
c. High Engine Temp. Prealarm	X	—	X	X	X	X	—	X	X	X	X	—	X	X	X	X	—	X	X	X	X	—	X	X	X	X	—	X	X	X	X	—	X	X	X	X	—	X	X	X	X	—	X	X	X
d. High Engine Temperature	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
e. Low Lube Oil Pressure Prealarm	X	—	X	X	X	X	—	X	X	X	X	—	X	X	X	X	—	X	X	X	X	—	X	X	X	X	—	X	X	X	X	—	X	X	X	X	—	X	X	X	X	—	X	X	X
f. Low Lube Oil Pressure	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
g. Overpeed	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
h. Low Fuel Main Tank	X	—	X	X	X	X	—	X	X	X	X	—	X	X	X	X	—	X	X	X	X	—	X	X	X	X	—	X	X	X	X	—	X	X	X	X	—	X	X	X	X	—	X	X	X
i. Control Switch not set in Auto	X	—	X	X	X	X	—	X	X	X	X	—	X	X	X	X	—	X	X	X	X	—	X	X	X	X	—	X	X	X	X	—	X	X	X	X	—	X	X	X	X	—	X	X	X
j. High Battery Voltage	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X
k. Low Voltage/Battery	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X
l. Lamp Test	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X
m. Audible Alarm Silencing switch	—	—	X	X	—	—	—	X	X	—	—	—	X	X	—	—	—	X	X	—	—	—	X	X	—	—	—	X	X	—	—	—	X	X	—	—	—	X	X	—	—	—	X	X	—
n. Low Starting Air Pressure	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X
o. Low Starting Hydraulic Pressure	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X
p. Air shutdown dampner when used	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
q. Remote Emergency Stop	—	X	—	—	—	—	X	—	—	—	—	X	—	—	—	—	X	—	—	—	—	X	—	—	—	—	X	—	—	—	—	X	—	—	—	—	X	—	—	—	—	X	—	—	—
r. Low Coolant Level	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
s. Battery Charger AC Failure	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X	X	—	X	—	X

KEY

- C.V.: Control panel-mounted Visual indication.
- S: Shutdown of EPS
- L.A.: Local Audible contacts.
- R.A.: Remote Audible contacts.
- R.V.: Remote Visual contacts.
- X: Required
- O: Optional
- ①: Items “N” or “O” apply only when applicable as a starting method.
- ②: NFPA99 requires an audible alarm for all alarm and shutdown functions. May be connected to L.A. contacts.
- ③: Air Damper Closed and is available on -2 models only.
- ④: R.A. and R.V. relays not supplied in model A902 or A903, optional.
- ⑤: Circuits and indicators supplied without labels.

- (d) Overcrank circuit; will stop automatic cranking and indicate overcrank if engine fails to start after 3 attempts. The number of cranks are selectable for 1, 2, 3, 4 or 5 cycles before shutdown. The overcrank circuit may also be turned off so no overcrank shutdown occurs.
- (e) Shutdown Time Delay Bypass; this delay prevents the oil pressure, water temperature and loss of speed signal shutdown circuits from operating for 15 seconds after the engine starts as detected by the crank disconnect circuit. This same delay also locks out the Low Oil Pressure Pre-alarm and High Water Temperature Pre-alarm circuits when the engine is not running.
- (f) Overspeed Speed Switch;
 1. Provides a signal to the overspeed shutdown circuit if the engine exceeds the preset speed. The factory setting is approximately 3894 Hz, or 1980 RPM on an engine with 118 teeth on the flywheel ring gear. The adjustment range is 300 Hz to 10,000 Hz.
 2. A push-to-test switch is provided to allow testing of the overspeed circuit without overspeeding the engine. When switch is depressed, the set point of the speed switch is lowered approximately 10%.
 3. The push-to-test switch can also be used to set the overspeed switch at approximately 110% of running speed. Hold the switch depressed while adjusting the setting until the overspeed trips. When switch is released, the set point will be 10% above normal running speed. This is the method used to make the factory setting. With engine speed at 1800 RPM or 3540 Hz.
- (g) Cooldown circuit; this circuit keeps the engine running for five minutes after the transfer switch has removed the load from the generator and signaled the A901 to stop the engine. This feature may be selected (turned On, standard setting is Off) with a switch on the back of the Control / Display Module.

3-2.1.5 Seven (7) First-out Shutdown Circuits; provide first-out indication of cause of shutdown. These circuits deactivate the fuel relay and lockout the A901 until reset. Shutdown circuits are activated by the crank disconnect circuit and are not active when the engine is stopped. Six (6) Red Shutdown Indicating Lights are provided. The Remote Shutdown circuit does not have an indicator light.

- (a) Overcrank; tripped by the overcrank sensing circuit which counts the number of cranking attempts.
- (b) Overspeed; tripped by overspeed switch when engine exceeds a preset speed.
- (c) Oil Pressure; tripped by the oil pressure SWICHGAGE® if pressure drops below preset point while the engine is running.
- (d) Water Temperature; tripped by the water temperature SWICHGAGE® if engine coolant temperature exceeds the switch setting.
- (e) Spare Shutdown; tripped by an external switch. This circuit is provided for an additional shutdown that may be recommended by the engine supplier.
- (f) Loss of Speed Signal; tripped by an internal sensing circuit that detects the loss of the Magnetic Pickup frequency signal for the speed switches while the engine is still running. Since the Overspeed shutdown circuit is

activated by the frequency input, it prevents the engine from running without overspeed protection.

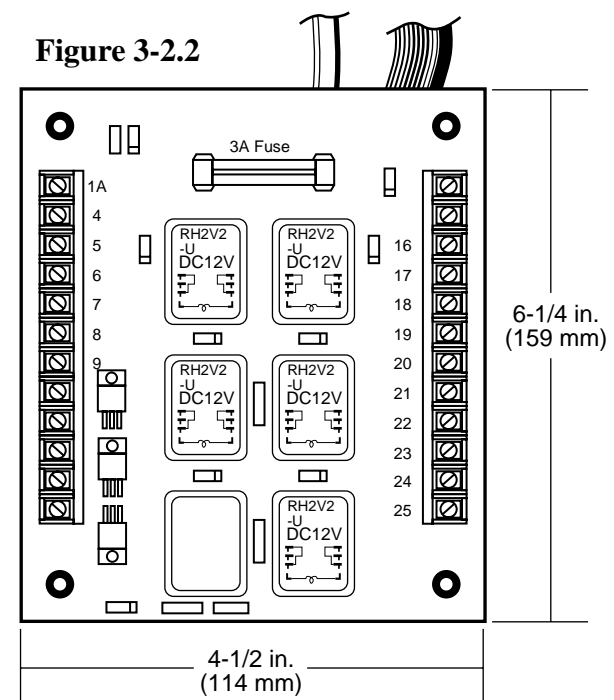
- (g) Remote Shutdown; this circuit is provided to shutdown the engine generator from a remote location. No indicating light is provided.

3-2.1.6 Nine (9) Alarm Indicating Circuits; provide indication of cause of alarm. These circuits activate the alarm relays. Alarm circuits are active as long as power is applied to the A901. All are active when the engine is running, shutdown or on standby except Low Oil Pressure Pre- alarm and High Water Temperature Pre-alarm. Nine (9) Amber Alarm Indicating Lights are provided.

- (a) Low Water Temperature; operated by low water temperature SWICHGAGE®.
- (b) Spare Alarm; operated by an external switch. This circuit is provided for an additional alarm that may be required by the user.
- (c) Switch Not In Automatic; operated by the OFF-AUTO-TEST mode selector switch.
- (d) Low Fuel Level; operated by level switch on fuel tank.
- (e) High Battery Voltage; operated by relay contact in battery charger.
- (f) Low Battery Voltage; operated by low voltage sensing device in battery charger.
- (g) Low Oil Pressure Pre-alarm; operated by pre-alarm switch in oil pressure SWICHGAGE®.
- (h) High Water Temperature Pre-alarm; operated by pre alarm switch in water temperature SWICHGAGE®.
- (i) Battery Charger AC Failure: operated by a relay contact in the Battery Charger.

3-2.2 Relay Module. The Relay Module, figure 3-2.2, includes all of the control, alarm and shutdown relays that are required to make up the generator engine control. Relays are available for operation on either 12 or 24 volt battery systems. Five (5) relays are included for:

3-2.2.1 Fuel Relay; this relay provides two outputs, one to energize the engine fuel solenoid and a separate circuit to



energize the battery charging alternator field.

3-2.2.2 Shutdown Relay; this relay is operated by the shutdown circuits of the Control / Display Module and provides an output that can be used to trip the generator circuit breaker on an emergency shutdown.

3-2.2.3 Local Audible Alarm Relay; provides a contact closure to operate a local audible alarm as required by NFPA-110, Level 1 and Level 2.

3-2.2.4 Remote Audible Alarm Relay; provides a contact closure to operate a remote audible alarm as required by NFPA-110, Level 1.

3-2.2.5 Remote Visual Alarm Relay; provides a contact closure to operate a remote visual alarm as required by NFPA-110, Level 1.

3-2.3 Status Signals. The relay module also includes three outputs that can be used with external circuits for signaling or control functions.

3-2.3.1 The Control On function at terminal 12 is on (closed to negative) as long as the Mode Selector Switch is in either Auto or Test. When the Mode Selector is turned Off, the Control On signal is open. This can be used to signal switch position or to reset an external circuit when the Mode Selector is turned Off.

3-2.3.2 The System Ready signal at terminal 13 is on (closed to negative) as long as the Mode Selector Switch is in either Auto or Test and no shutdown Tattletale circuit is latched on. This can be used to signal that the generator engine is ready to automatically start or is running in Test.

3-2.3.3 The Control On function at terminal 14 is on (closed to positive) as long as the Mode Selector Switch is in either Auto or Test. When the Mode Selector is turned Off, the Control On signal is open. This can be used to signal switch position or to reset an external circuit when the Mode Selector is turned Off.

3-3 A901-2.

3-3.1 Control / Display Module. The Control / Display Module, figure 3-3.1, includes the control and test switches, the solid state logic elements, shutdown and alarm TATTLETALE® lights that make up the generator engine control for a two-cycle engine.

3-3.1.1 Mode Selector Switch, OFF-AUTO-TEST:

- (a) OFF; turns off the control system and resets any shutdown circuits.
- (b) AUTO; turns on the engine controls and shutdown circuits. System is on standby waiting for a contact closure to start engine.
- (c) TEST; turns on the engine controls and shutdown circuits. A start signal is applied to the automatic control and the engine start sequence begins.

3-3.1.2 Lamp Test Pushbutton: Tests the lights on the A-901-2 module.

3-3.1.3 Alarm Silence Pushbutton: Turns off any audible alarm that is connected to the Local or Remote Audible Alarm Relays. The indicating light will remain on as long as the condition exists. If the Alarm Silence pushbutton is not operated, the audible alarm will turn off when the alarm contact clears.

3-3.1.4 The A901-2 SELECTRONIC® Control Module includes the following engine control features:

- (a) Cycle crank circuit; will crank the engine for 15 seconds then rest for 15 seconds until the engine starts. The

crank/rest time is selectable for either 10, 15, 20, 25 or 30 seconds. If the engine false starts, goes above crank disconnect speed then drops below that speed, the control will rest for a fixed 10 second period before cranking again.

- (b) Crank Disconnect Speed Switch; this circuit detects engine speed and terminates cranking when engine speed rises above the speed switch setting. The speed switch is adjustable, 25 Hz to 2000 Hz, and is factory set at 1180 Hz. This would be 600 RPM on an engine with 118 teeth on the flywheel ring gear.

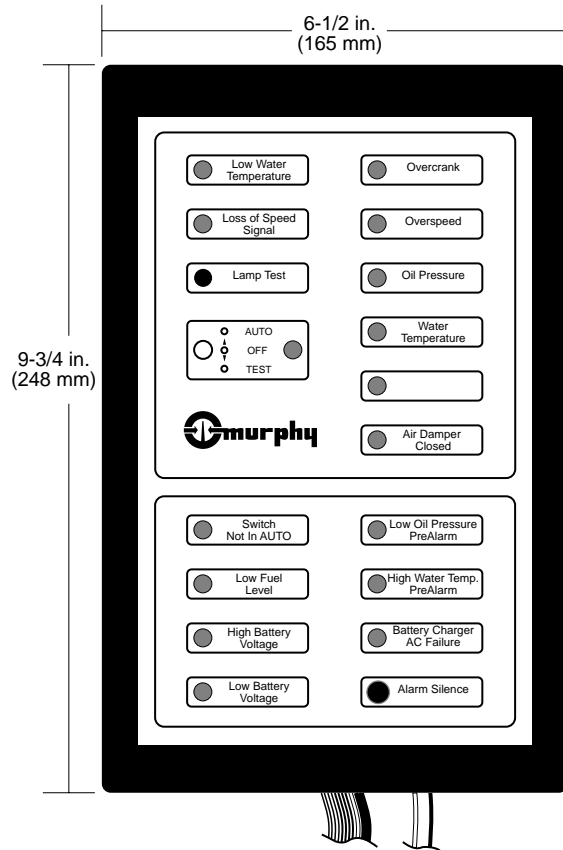


Figure 3-3.1

- (c) Auxiliary Crank Disconnect Circuit; this circuit, required by NFPA-110, is provided as a back up for the Crank Disconnect Speed Switch. It is operated by an external switch sensing either speed, generator voltage or some other variable that could be used to terminate cranking. Either circuit will disconnect the starter when the engine starts.
- (d) Overcrank circuit; will stop automatic cranking and indicate overcrank if engine fails to start after 3 attempts. The number of cranks are selectable for 1, 2, 3, 4 or 5 cycles before shutdown. The overcrank circuit may also be turned off so no overcrank shutdown occurs.
- (e) Shutdown Time Delay Bypass; this delay prevents the oil pressure, water temperature and loss of speed signal shutdown circuits from operating for 15 seconds after the engine starts as detected by the crank disconnect circuit. This same delay also locks out the Low Oil Pressure Pre-alarm and High Water Temperature Pre-alarm circuits when the engine is not running.

- (f) Overspeed Speed Switch;
 1. Provides a signal to the overspeed shutdown circuit if the engine exceeds the preset speed. The factory setting is approximately 3894 Hz, or 1980 RPM on an engine with 118 teeth on the flywheel ring gear. The adjustment range is 300 Hz to 10,000 Hz.
 2. A push to test switch is provided to allow testing of the overspeed circuit without overspeeding the engine. When switch is depressed, the set point of the speed switch is lowered approximately 10%.
 3. The push to test switch can also be used to set the overspeed switch at approximately 110% of running speed. Hold the switch depressed while adjusting the setting until the overspeed trips. When switch is released, the set point will be 10% above normal running speed. This is the method used to make the factory setting. With engine speed at 1800 RPM or 3540 Hz.
- (g) Cooldown circuit; this circuit keeps the engine running for five minutes after the transfer switch has removed the load from the generator and signaled the A901-2 to stop the engine. This feature may be selected (turned On, standard setting is Off) with a switch on the back of the Control / Display Module.

3-3.1.5 Seven (7) First-out Shutdown Circuits; provide first-out indication of cause of shutdown. These circuits deactivate the fuel relay and lockout the A901-2 until reset. Shutdown circuits are activated by the crank disconnect circuit and are not active when the engine is stopped. Six (6) Red Shutdown Indicating Lights are provided. The Remote Shutdown circuit does not have an indicator light.

- (a) Overcrank; tripped by the overcrank sensing circuit which counts the number of cranking attempts.
- (b) Overspeed; tripped by overspeed switch when engine exceeds a preset speed.
- (c) Oil Pressure; tripped by the oil pressure SWICHGAGE® if pressure drops below preset point while the engine is running.
- (d) Water Temperature; tripped by the water temperature SWICHGAGE® if engine coolant temperature exceeds the switch setting.
- (e) Spare Shutdown; tripped by an external switch. This circuit is provided for an additional shutdown that may be recommended by the engine supplier.
- (f) Loss of Speed Signal; tripped by an internal sensing circuit that detects the loss of the Magnetic Pickup frequency signal for the speed switches while the engine is still running. Since the Overspeed shutdown circuit is activated by the frequency input, it prevents the engine from running without overspeed protection.
- (g) Remote Shutdown; this circuit is provided to shutdown the engine generator from a remote location. No indicating light is provided.

3-3.1.6 Nine (9) Alarm Indicating Circuits; provide indication of cause of alarm. These circuits activate the alarm relays. Alarm circuits are active as long as power is applied to the A901-2. All are active when the engine is running, shutdown or on standby except Low Oil Pressure Pre- alarm and High Water Temperature Pre-alarm. Nine (9) Amber Alarm Indicating Lights are provided.

- (a) Low Water Temperature; operated by low water temperature SWICHGAGE®.

- (b) Air Damper Closed; operated by an external switch or by the Overspeed Relay circuit. This circuit is provided with a selector switch to allow the user to determine the source of the signal.
- (c) Switch Not In Automatic; operated by the OFF-AUTO-TEST mode selector switch.
- (d) Low Fuel Level; operated by level switch on fuel tank.
- (e) High Battery Voltage; operated by relay contact in battery charger.
- (f) Low Battery Voltage; operated by low voltage sensing device in battery charger.
- (g) Low Oil Pressure Pre-alarm; operated by pre-alarm switch in oil pressure SWICHGAGE®.
- (h) High Water Temperature Pre-alarm; operated by pre-alarm switch in water temperature SWICHGAGE®.
- (i) Battery Charger AC Failure; operated by relay contact in Battery Charger.

3-3.2 Relay Module. The Relay Module, figure 3-3.2, includes all of the control, alarm and shutdown relays that are required to make up the generator engine control. Relays are available for operation on either 12 or 24 volt battery systems. Six (6) relays are included for:

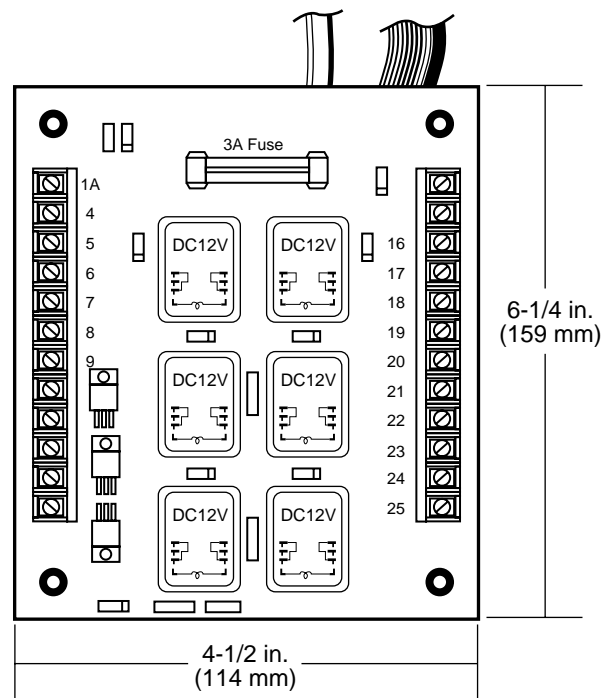


Figure 3-3.2

3-3.2.1 Fuel Relay; this relay provides two outputs, one to energize the engine fuel solenoid and a separate circuit to energize the battery charging alternator field.

3-3.2.2 Shutdown Relay; this relay is operated by the shutdown circuits of the Control / Display Module and provides an output that can be used to trip the generator circuit breaker on an emergency shutdown.

3-3.2.3 Overspeed Relay; operates only on an Overspeed shutdown. This relay provides an output to trip an air shut off solenoid to close the air damper on a two-cycle engine.

3-3.2.4 Local Audible Alarm Relay; provides a contact closure

to operate a local audible alarm as required by NFPA- 110, Level 1 and Level 2.

3-3.2.5 Remote Audible Alarm Relay; provides a contact closure to operate a remote audible alarm as required by NFPA-110, Level 1.

3-3.2.6 Remote Visual Alarm Relay; provides a contact closure to operate a remote visual alarm as required by NFPA- 110, Level 1.

3-3.3 Status Signals. The relay module also includes three outputs that can be used with external circuits for signaling or control functions.

3-3.3.1 The Control On function at terminal 12 is on (closed to negative) as long as the Mode Selector Switch is in either Auto or Test. When the Mode Selector is turned Off, the Control On signal is open. This can be used to signal switch position or to reset an external circuit when the Mode Selector is turned Off.

3-3.3.2 The System Ready signal at terminal 13 is on (closed to negative) as long as the Mode Selector Switch is in either Auto or Test and no shutdown Tattletale circuit is latched on. This can be used to signal that the generator engine is ready to automatically start or is running in Test.

3-3.3.3 The Control On function at terminal 14 is on (closed to positive) as long as the Mode Selector Switch is in either Auto or Test. When the Mode Selector is turned Off, the Control On signal is open. This can be used to signal switch position or to reset an external circuit when the Mode Selector is turned Off.

3-4 A902.

3-4.1 Control / Display Module. The Control / Display Module, figure 3-4.1, includes the control and test switches, the solid state logic elements, shutdown and alarm TATTLETALE® lights that make up the generator engine control for a four-cycle engine.

3-4.1.1 Mode Selector Switch, OFF-AUTO-TEST:

- OFF; turns off the control system and resets any shutdown circuits.
- AUTO; turns on the engine controls and shutdown circuits. System is on standby waiting for a contact closure to start engine.
- TEST; turns on the engine controls and shutdown circuits. A start signal is applied to the automatic control and the engine start sequence begins.

3-4.1.2 Lamp Test Pushbutton: Tests the lights on the A902 module.

3-4.1.3 The A902 SELECTRONIC® Control Module includes the following engine control features:

- Cycle crank circuit; will crank the engine for 15 seconds then rest for 15 seconds until the engine starts. The crank/rest time is selectable for either 10, 15, 20, 25 or 30 seconds. If the engine false starts, goes above crank disconnect speed then drops below that speed, the control will rest for a fixed 10 second period before cranking again.
- Crank Disconnect Speed Switch; this circuit detects engine speed and terminates cranking when engine speed rises above the speed switch setting. The speed switch is adjustable, 25 Hz to 2000 Hz, and is factory set at 1180 Hz. This would be 600 RPM on an engine with 118 teeth

on the flywheel ring gear.

- Auxiliary Crank Disconnect Circuit; this circuit, required by NFPA-110, is provided as a back up for the Crank Disconnect Speed Switch. It is operated by an external switch sensing either speed, generator voltage or some other variable that could be used to terminate cranking. Either circuit will disconnect the starter when the engine starts.
- Overcrank circuit; will stop automatic cranking and indicate overcrank if engine fails to start after 3 attempts. The number of cranks are selectable for 1, 2, 3, 4 or 5 cycles before shutdown. The overcrank circuit may also be turned off so no overcrank shutdown occurs.

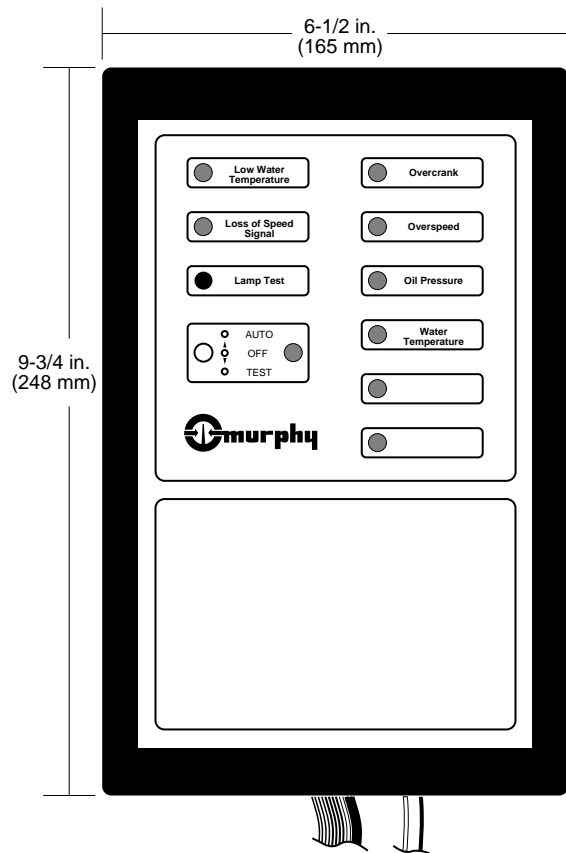


Figure 3-4.1

- Shutdown Time Delay Bypass; this delay prevents the oil pressure, water temperature and loss of speed signal shutdown circuits from operating for 15 seconds after the engine starts as detected by the crank disconnect circuit.
- Overspeed Speed Switch;
 - Provides a signal to the overspeed shutdown circuit if the engine exceeds the preset speed. The factory setting is approximately 3894 Hz, or 1980 RPM on an engine with 118 teeth on the flywheel ring gear. The adjustment range is 300 Hz to 10,000 Hz.
 - A push to test switch is provided to allow testing of the overspeed circuit without overspeeding the engine. When switch is depressed, the set point of the speed switch is lowered approximately 10%.
 - The push to test switch can also be used to set the overspeed switch at approximately 110% of running speed. Hold the switch depressed while adjusting the

setting until the overspeed trips. When switch is released, the set point will be 10% above normal running speed. This is the method used to make the factory setting. With engine speed at 1800 RPM or 3540 Hz.

- (g) Cooldown circuit; this circuit keeps the engine running for five minutes after the transfer switch has removed the load from the generator and signaled the A902 to stop the engine. This feature may be selected (turned On, standard setting is Off) with a switch on the back of the Control / Display Module.

3-4.1.4 Seven (7) First-out Shutdown Circuits; provide first-out indication of cause of shutdown. These circuits deactivate the fuel relay and lockout the A902 until reset. Shutdown circuits are activated by the crank disconnect circuit and are not active when the engine is stopped. Six (6) Red Shutdown Indicating Lights are provided. The Remote Shutdown circuit does not have an indicator light.

- (a) Overcrank; tripped by the overcrank sensing circuit which counts the number of cranking attempts.
- (b) Overspeed; tripped by overspeed switch when engine exceeds a preset speed.
- (c) Oil Pressure; tripped by the oil pressure SWICHGAGE® if pressure drops below preset point while the engine is running.
- (d) Water Temperature; tripped by the water temperature SWICHGAGE® if engine coolant temperature exceeds the switch setting.
- (e) Spare Shutdown; tripped by an external switch. This circuit is provided for an additional shutdown that may be recommended by the engine supplier.
- (f) Loss of Speed Signal; tripped by an internal sensing circuit that detects the loss of the Magnetic Pickup frequency signal for the speed switches while the engine is still running. Since the Overspeed shutdown circuit is activated by the frequency input, it prevents the engine from running without overspeed protection.
- (g) Remote Shutdown; this circuit is provided to shutdown the engine generator from a remote location. No indicating light is provided.

3-4.1.5 Two (2) Alarm Indicating Circuits; provide indication of cause of alarm. These circuits activate the alarm relay. Alarm circuits are active as long as power is applied to the A902. All are active when the engine is running, shutdown or on standby. Two (2) Amber Alarm Indicating Lights are provided.

- (a) Low Water Temperature; operated by low water temperature SWICHGAGE®.
- (b) Spare Alarm; operated by an external switch. This circuit is provided for an additional alarm that may be required by the user.

3-4.2 Relay Module. The Relay Module, figure 3-4.2, includes all of the control, alarm and shutdown relays that are required to make up the generator engine control. Relays are available for operation on either 12 or 24 volt battery systems. Three (3) relays are included for:

- 3-4.2.1 Fuel Relay;** this relay provides two outputs, one to energize the engine fuel solenoid and a separate circuit to energize the battery charging alternator field.
- 3-4.2.2 Shutdown Relay;** this relay is operated by the shutdown circuits of the Control / Display Module and provides an output

that can be used to trip the generator circuit breaker on an emergency shutdown.

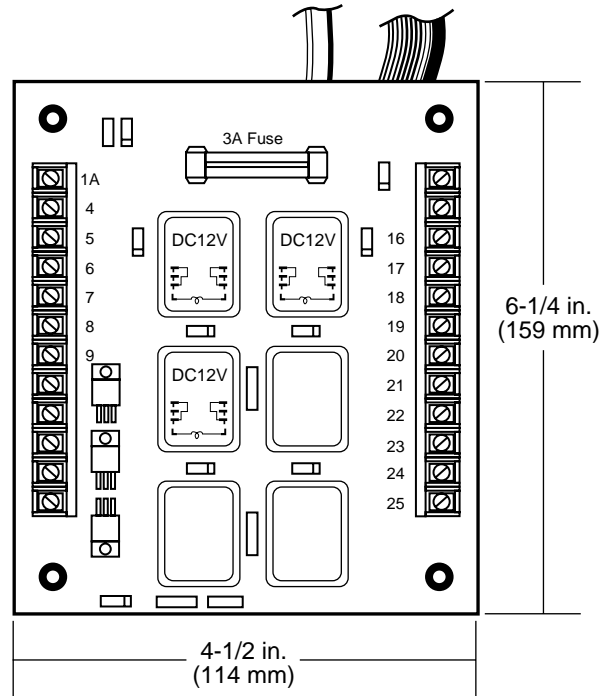


Figure 3-4.2

3-4.2.3 Local Audible Alarm Relay; provides a contact closure to operate a local audible alarm as required by NFPA- 110, Level 1 and Level 2.

3-4.3 Status Signals. The relay module also includes three outputs that can be used with external circuits for signaling or control functions.

3-4.3.1 The Control On function at terminal 12 is on (closed to negative) as long as the Mode Selector Switch is in either Auto or Test. When the Mode Selector is turned Off, the Control On signal is open. This can be used to signal switch position or to reset an external circuit when the Mode Selector is turned Off.

3-4.3.2 The System Ready signal at terminal 13 is on (closed to negative) as long as the Mode Selector Switch is in either Auto or Test and no shutdown TATTLETALE® circuit is latched on. This can be used to signal that the generator engine is ready to automatically start or is running in Test.

3-4.3.3 The Control On function at terminal 14 is on (closed to positive) as long as the Mode Selector Switch is in either Auto or Test. When the Mode Selector is turned Off, the Control On signal is open. This can be used to signal switch position or to reset an external circuit when the Mode Selector is turned Off.

3-5 A902-2.

3-5.1 Control / Display Module. The Control / Display Module, figure 3-5.1, includes the control and test switches, the solid state logic elements, shutdown and alarm TATTLETALE® lights that make up the generator engine control for a two-cycle engine.

3-5.1.1 Mode Selector Switch, OFF-AUTO-TEST:

- (a) OFF; turns off the control system and resets any shutdown circuits.
- (b) AUTO; turns on the engine controls and shutdown circuits. System is on standby waiting for a contact closure to start engine.

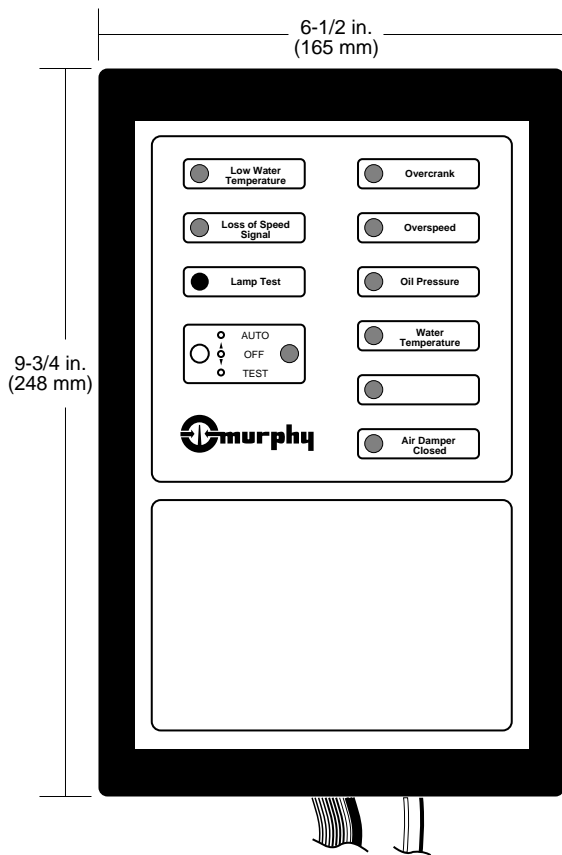


Figure 3-5.1

- (c) TEST; turns on the engine controls and shutdown circuits. A start signal is applied to the automatic control and the engine start sequence begins.

3-5.1.2 Lamp Test Pushbutton: Tests the lights on the A- 902-2 module.

3-5.1.3 The A902-2 SELECTRONIC® Control Module includes the following engine control features:

- (a) Cycle crank circuit; will crank the engine for 15 seconds then rest for 15 seconds until the engine starts. The crank/rest time is selectable for either 10, 15, 20, 25 or 30 seconds. If the engine false starts, goes above crank disconnect speed then drops below that speed, the control will rest for a fixed 10 second period before cranking again.
- (b) Crank Disconnect Speed Switch; this circuit detects engine speed and terminates cranking when engine speed rise above the speed switch setting. The speed switch is adjustable, 25 Hz to 2000 Hz, and is factory set at 1180 Hz. This would be 600 RPM on an engine with 118 teeth on the flywheel ring gear.
- (c) Auxiliary Crank Disconnect Circuit; this circuit, required by NFPA-110, is provided as a back up for the Crank Disconnect Speed Switch. It is operated by an external switch sensing either speed, generator voltage or some other variable that could be used to terminate cranking. Either circuit will disconnect the starter when the engine starts.
- (d) Overcrank circuit; will stop automatic cranking and indicate overcrank if engine fails to start after 3 attempts. The number of cranks are selectable for 1, 2, 3, 4 or 5 cycles before shutdown. The overcrank circuit may also

be turned off so no overcrank shutdown occurs.

- (e) Shutdown Time Delay Bypass; this delay prevents the oil pressure, water temperature and loss of speed signal shutdown circuits from operating for 15 seconds after the engine starts as detected by the crank disconnect circuit.
- (f) Overspeed Speed Switch;
 1. Provides a signal to the overspeed shutdown circuit if the engine exceeds the preset speed. The factory setting is approximately 3894 Hz, or 1980 RPM on an engine with 118 teeth on the flywheel ring gear. The adjustment range is 300 Hz to 10,000 Hz.
 2. A push to test switch is provided to allow testing of the overspeed circuit without overspeeding the engine. When switch is depressed, the set point of the speed switch is lowered approximately 10%.
 3. The push to test switch can also be used to set the overspeed switch at approximately 110% of running speed. Hold the switch depressed while adjusting the setting until the overspeed trips. When switch is released, the set point will be 10% above normal running speed. This is the method used to make the factory setting. With engine speed at 1800 RPM or 3540 Hz.
- (g) Cooldown circuit; this circuit keeps the engine running for five minutes after the transfer switch has removed the load from the generator and signaled the A902-2 to stop the engine. This feature may be selected (turned On, standard setting is Off) with a switch on the back of the Control / Display Module.

3-5.1.4 Seven (7) First-out Shutdown Circuits; provide first-out indication of cause of shutdown. These circuits deactivate the fuel relay and lockout the A902-2 until reset. Shutdown circuits are activated by the crank disconnect circuit and are not active when the engine is stopped. Six (6) Red Shutdown Indicating Lights are provided. The Remote Shutdown circuit does not have an indicator light.

- (a) Overcrank; tripped by the overcrank sensing circuit which counts the number of cranking attempts.
- (b) Overspeed; tripped by overspeed switch when engine exceeds a preset speed.
- (c) Oil Pressure; tripped by the oil pressure SWICHGAGE® if pressure drops below preset point while the engine is running.
- (d) Water Temperature; tripped by the water temperature SWICHGAGE® if engine coolant temperature exceeds the switch setting.
- (e) Spare Shutdown; tripped by an external switch. This circuit is provided for an additional shutdown that may be recommended by the engine supplier.
- (f) Loss of Speed Signal; tripped by an internal sensing circuit that detects the loss of the Magnetic Pickup frequency signal for the speed switches while the engine is still running. Since the Overspeed shutdown circuit is activated by the frequency input, it prevents the engine from running without overspeed protection.
- (g) Remote Shutdown; this circuit is provided to shutdown the engine generator from a remote location. No indicating light is provided.

3-5.1.5 Two (2) Alarm Indicating Circuits; provide indication

of cause of alarm. These circuits activate the alarm relay. Alarm circuits are active as long as power is applied to the A902-2. All are active when the engine is running, shutdown or on standby. Two (2) Amber Alarm Indicating Lights are provided.

- (a) Low Water Temperature; operated by low water temperature SWICHGAGE®.
- (b) Air Damper Closed; operated by an external switch or by the Overspeed Relay circuit. This circuit is provided with a selector switch to allow the user to determine the source of the signal.

3-5.2 Relay Module. The Relay Module, figure 3-5.2, includes all of the control, alarm and shutdown relays that are required to make up the generator engine control. Relays are available for operation on either 12 or 24 volt battery systems. Four (4) relays are included for:

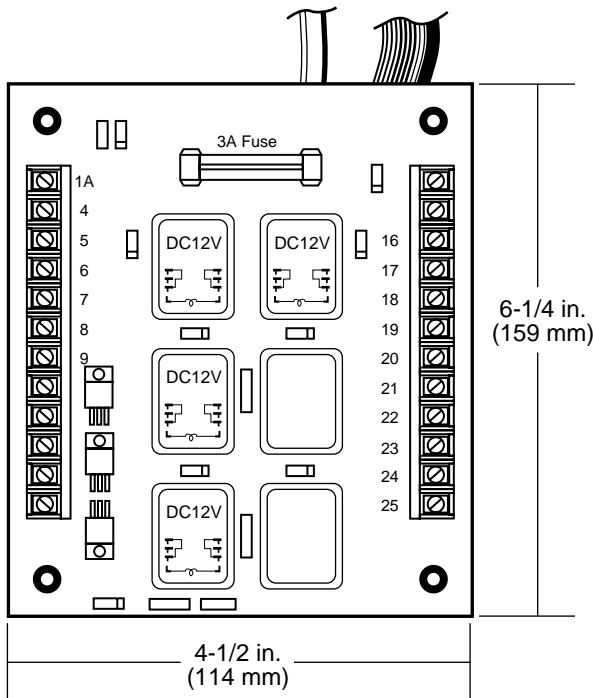


Figure 3-5.2

3-5.2.1 Fuel Relay; this relay provides two outputs, one to energize the engine fuel solenoid and a separate circuit to energize the battery charging alternator field.

3-5.2.2 Shutdown Relay; this relay is operated by the shutdown circuits of the Control / Display Module and provides an output that can be used to trip the generator circuit breaker on an emergency shutdown.

3-5.2.3 Overspeed Relay; operates only on an Overspeed shutdown. This relay provides an output to trip an air shut off solenoid to close the air damper on a two-cycle engine.

3-5.2.4 Local Audible Alarm Relay; provides a contact closure to operate a local audible alarm as required by NFPA- 110, Level 1 and Level 2.

3-5.3 Status Signals. The relay module also includes three outputs that can be used with external circuits for signaling or control functions.

3-5.3.1 The Control On function at terminal 12 is on (closed to negative) as long as the Mode Selector Switch is in either Auto or Test. When the Mode Selector is turned Off, the Control On signal is open. This can be used to signal switch position or to

reset an external circuit when the Mode Selector is turned Off.

3-5.3.2 The System Ready signal at terminal 13 is on (closed to negative) as long as the Mode Selector Switch is in either Auto or Test and no shutdown TATTLETALE® circuit is latched on. This can be used to signal that the generator engine is ready to automatically start or is running in Test.

3-5.3.3 The Control On function at terminal 14 is on (closed to positive) as long as the Mode Selector Switch is in either Auto or Test. When the Mode Selector is turned Off, the Control On signal is open. This can be used to signal switch position or to reset an external circuit when the Mode Selector is turned Off.

3-6 A903.

3-6.1 Control / Display Module. The Control / Display Module, figure 3-6.1, includes the control and test switches, the solid state logic elements, shutdown and alarm TATTLETALE® lights that make up the generator engine control for a four cycle engine. This module is the same as Model A- 901 except 7 of the alarm circuits are un-labeled. This allows the customer to specify labels other than those recommended in NFPA-110. This model has shutdown and alarm circuits labeled to meet the requirements of NFPA-110, Level 2.

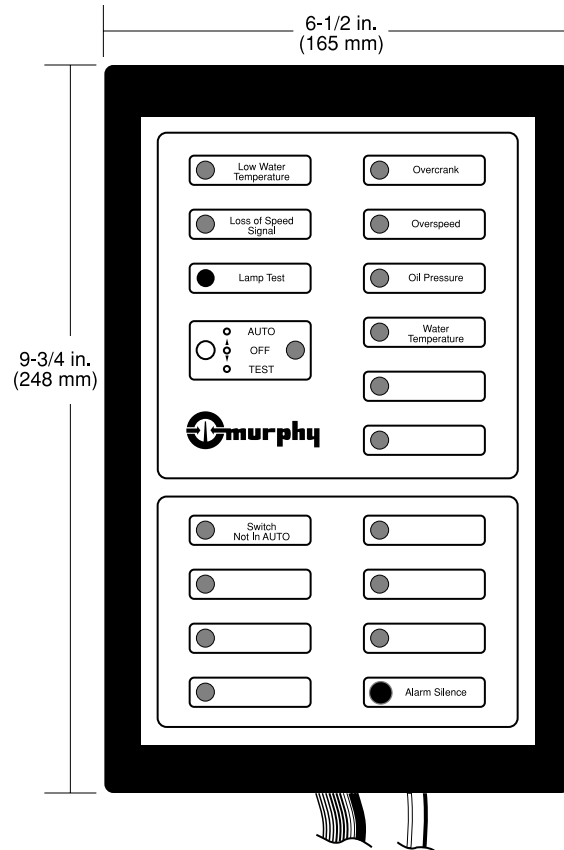


Figure 3-6.1

3-6.1.1 Mode Selector Switch, OFF-AUTO-TEST:

- (a) OFF; turns off the control system and resets any shutdown circuits.
- (b) AUTO; turns on the engine controls and shutdown circuits. System is on standby waiting for a contact closure to start engine.
- (c) TEST; turns on the engine controls and shutdown circuits. A start signal is applied to the automatic control and the engine start sequence begins.

3-6.1.2 Lamp Test Pushbutton: Tests the lights on the A903 module.

3-6.1.3 Alarm Silence Pushbutton: Turns off any audible alarm that is connected to the Local or Remote Audible Alarm Relays. The indicating light will remain on as long as the condition exists. If the Alarm Silence pushbutton is not operated, the audible alarm will turn off when the alarm contact clears.

3-6.1.4 The A903 SELECTRONIC® Control Module includes the following engine control features:

- (a) Cycle crank circuit; will crank the engine for 15 seconds then rest for 15 seconds until the engine starts. The crank/rest time is selectable for either 10, 15, 20, 25 or 30 seconds. If the engine false starts, goes above crank disconnect speed then drops below that speed, the control will rest for a fixed 10 second period before cranking again.
- (b) Crank Disconnect Speed Switch; this circuit detects engine speed and terminates cranking when engine speed rises above the speed switch setting. The speed switch is adjustable, 25 Hz to 2000 Hz, and is factory set at 1180 Hz. This would be 600 RPM on an engine with 118 teeth on the flywheel ring gear.
- (c) Auxiliary Crank Disconnect Circuit; this circuit, required by NFPA-110, is provided as a back up for the Crank Disconnect Speed Switch. It is operated by an external switch sensing either speed, generator voltage or some other variable that could be used to terminate cranking. Either circuit will disconnect the starter when the engine starts.
- (d) Overcrank circuit; will stop automatic cranking and indicate overcrank if engine fails to start after 3 attempts. The number of cranks are selectable for 1, 2, 3, 4 or 5 cycles before shutdown. The overcrank circuit may also be turned off so no overcrank shutdown occurs.
- (e) Shutdown Time Delay Bypass; this delay prevents the oil pressure, water temperature and loss of speed signal shutdown circuits from operating for 15 seconds after the engine starts as detected by the crank disconnect circuit. This same delay also locks out alarm circuit #7 and #8 when the engine is not running.
- (f) Overspeed Speed Switch;
 - 1. Provides a signal to the overspeed shutdown circuit if the engine exceeds the preset speed. The factory setting is approximately 3894 Hz, or 1980 RPM on an engine with 118 teeth on the flywheel ring gear. The adjustment range is 300 Hz to 10,000 Hz.
 - 2. A push to test switch is provided to allow testing of the overspeed circuit without overspeeding the engine. When switch is depressed, the set point of the speed switch is lowered approximately 10%.
 - 3. The push to test switch can also be used to set the overspeed switch at approximately 110% of running speed. Hold the switch depressed while adjusting the setting until the overspeed trips. When switch is released, the set point will be 10% above normal running speed. This is the method used to make the factory setting. With engine speed at 1800 RPM or 3540 Hz.
- (g) Cooldown circuit; this circuit keeps the engine running for five minutes after the transfer switch has removed

the load from the generator and signaled the A903 to stop the engine. This feature may be selected (turned On, standard setting is Off) with a switch on the back of the Control / Display Module.

3-6.1.5 Seven (7) First-out Shutdown Circuits; provide first-out indication of cause of shutdown. These circuits deactivate the fuel relay and lockout the A903 until reset. Shutdown circuits are activated by the crank disconnect circuit and are not active when the engine is stopped. Six (6) Red Shutdown Indicating Lights are provided. The Remote Shutdown circuit does not have an indicator light.

- (a) Overcrank; tripped by the overcrank sensing circuit which counts the number of cranking attempts.
- (b) Overspeed; tripped by overspeed switch when engine exceeds a preset speed.
- (c) Oil Pressure; tripped by the oil pressure SWITCHGAGE® if pressure drops below preset point while the engine is running.
- (d) Water Temperature; tripped by the water temperature SWITCHGAGE® if engine coolant temperature exceeds the switch setting.
- (e) Spare Shutdown; tripped by an external switch. This circuit is provided for an additional shutdown that may be recommended by the engine supplier.
- (f) Loss of Speed Signal; tripped by an internal sensing circuit that detects the loss of the Magnetic Pickup frequency signal for the speed switches while the engine is still running. Since the Overspeed shutdown circuit is activated by the frequency input, it prevents the engine from running without overspeed protection.
- (g) Remote Shutdown; this circuit is provided to shutdown the engine generator from a remote location. No indicating light is provided.

3-6.1.6 Nine (9) Alarm Indicating Circuits; provide indication of cause of alarm. These circuits activate the alarm relays. Alarm circuits are active as long as power is applied to the A903. All are active when the engine is running, shutdown or on standby except alarm circuit #7 and #8 which are locked out until the engine is running. Nine (9) Amber Alarm Indicating Lights are provided however only two circuits are labeled. The other 7 are for customer specified alarms.

- (a) Low Water Temperature; operated by low water temperature SWITCHGAGE®.
- (b) #2 Spare Alarm; operated by an external switch. This circuit is provided for an additional alarm that may be required by the user.
- (c) Switch Not In Automatic; operated by the OFF-AUTO-TEST mode selector switch.
- (d) #4 Spare Alarm; operated by an external switch. This circuit is provided for an additional alarm that may be required by the user.
- (e) #5 Spare Alarm; operated by an external switch. This circuit is provided for an additional alarm that may be required by the user.
- (f) #6 Spare Alarm; operated by an external switch. This circuit is provided for an additional alarm that may be required by the user.
- (g) #7 Spare Alarm; operated by an external switch. This circuit is provided for an additional alarm that may be required by the user.

- (h) #8 Spare Alarm; operated by an external switch. This circuit is provided for an additional alarm that may be required by the user.
- (i) #9 Spare Alarm; operated by an external switch. This circuit is provided for an additional alarm that may be required by the user.

3-6.2 Relay Module. The Relay Module, figure 3-6.2, includes all of the control, alarm and shutdown relays that are required to make up the generator engine control. Relays are available for operation on either 12 or 24 volt battery systems. Three (3) relays are included for:

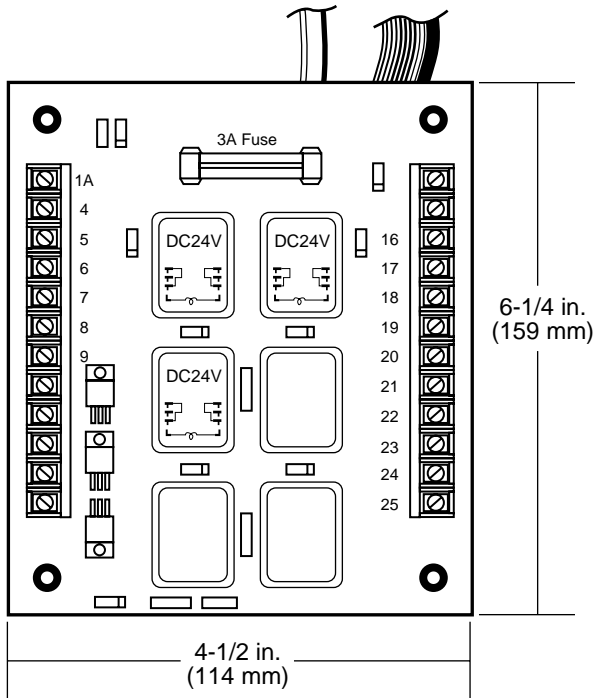


Figure 3-6.2

3-6.2.1 Fuel Relay; this relay provides two outputs, one to energize the engine fuel solenoid and a separate circuit to energize the battery charging alternator field.

3-6.2.2 Shutdown Relay; this relay is operated by the shutdown circuits of the Control / Display Module and provides an output that can be used to trip the generator circuit breaker on an emergency shutdown.

3-6.2.3 Local Audible Alarm Relay; provides a contact closure to operate a local audible alarm as required by NFPA- 110, Level 1 and Level 2.

3-6.3 Status Signals. The relay module also includes three outputs that can be used with external circuits for signaling or control functions.

3-6.3.1 The Control On function at terminal 12 is on (closed to negative) as long as the Mode Selector Switch is in either Auto or Test. When the Mode Selector is turned Off, the Control On signal is open. This can be used to signal switch position or to reset an external circuit when the Mode Selector is turned Off.

3-6.3.2 The System Ready signal at terminal 13 is on (closed to negative) as long as the Mode Selector Switch is in either Auto or Test and no shutdown TATTLETALE® circuit is latched on. This can be used to signal that the generator engine is ready to automatically start or is running in Test.

3-6.3.3 The Control On function at terminal 14 is on (closed to

positive) as long as the Mode Selector Switch is in either Auto or Test. When the Mode Selector is turned Off, the Control On signal is open. This can be used to signal switch position or to reset an external circuit when the Mode Selector is turned Off.

3-7 A903-2.

3-7.1 Control / Display Module. The Control / Display Module, figure 3-7.1, includes the control and test switches, the solid state logic elements, shutdown and alarm TATTLETALE® lights that make up the generator engine control for a two-cycle engine. This module is the same as Model A901-2 except 6 of the alarm circuits are un-labeled. This allows the customer to specify labels other than those recommended in NFPA-110. This model has shutdown and alarm circuits labeled to meet the requirements of NFPA-110, Level 2.

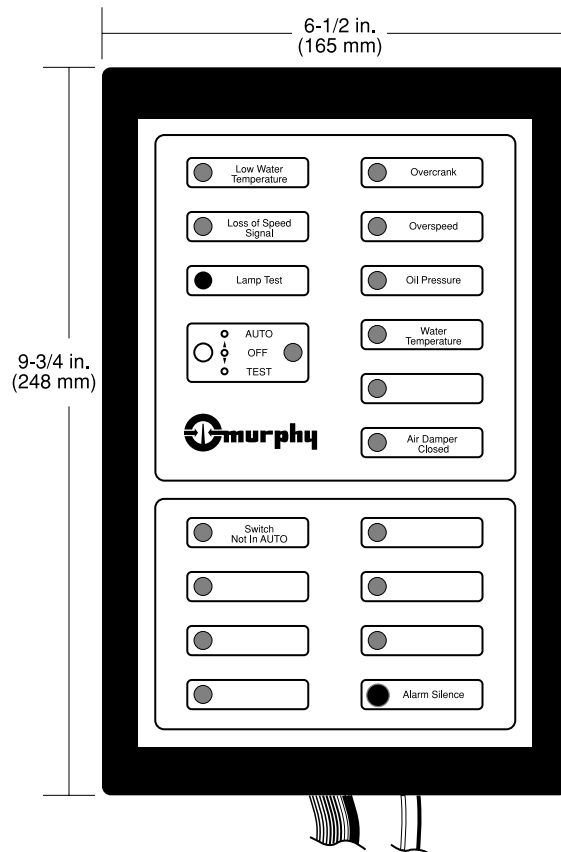


Figure 3-7.1

3-7.1.1 Mode Selector Switch, OFF-AUTO-TEST:

- (a) OFF; turns off the control system and resets any shutdown circuits.
- (b) AUTO; turns on the engine controls and shutdown circuits. System is on standby waiting for a contact closure to start engine.
- (c) TEST; turns on the engine controls and shutdown circuits. A start signal is applied to the automatic control and the engine start sequence begins.

3-7.1.2 Lamp Test Pushbutton: Tests the lights on the A- 903-2 module.

3-7.1.3 Alarm Silence Pushbutton: Turns off any audible alarm that is connected to the Local or Remote Audible Alarm Relays. The indicating light will remain on as long as the condition exists. If the Alarm Silence pushbutton is not operated, the

audible alarm will turn off when the alarm contact clears.

3-7.1.4 The A903-2 SELECTRONIC® Control Module includes the following engine control features:

- (a) Cycle crank circuit; will crank the engine for 15 seconds then rest for 15 seconds until the engine starts. The crank/rest time is selectable for either 10, 15, 20, 25 or 30 seconds. If the engine false starts, goes above crank disconnect speed then drops below that speed, the control will rest for a fixed 10 second period before cranking again.
- (b) Crank Disconnect Speed Switch; this circuit detects engine speed and terminates cranking when engine speed rises above the speed switch setting. The speed switch is adjustable, 25 Hz to 2000 Hz, and is factory set at 1180 Hz. This would be 600 RPM on an engine with 118 teeth on the flywheel ring gear.
- (c) Auxiliary Crank Disconnect Circuit; this circuit, required by NFPA-110, is provided as a back up for the Crank Disconnect Speed Switch. It is operated by an external switch sensing either speed, generator voltage or some other variable that could be used to terminate cranking. Either circuit will disconnect the starter when the engine starts.
- (d) Overcrank circuit; will stop automatic cranking and indicate overcrank if engine fails to start after 3 attempts. The number of cranks are selectable for 1, 2, 3, 4 or 5 cycles before shutdown. The overcrank circuit may also be turned off so no overcrank shutdown occurs.
- (e) Shutdown Time Delay Bypass; this delay prevents the oil pressure, water temperature and loss of speed signal shutdown circuits from operating for 15 seconds after the engine starts as detected by the crank disconnect circuit. This same delay also locks out alarm circuit #7 and #8 when the engine is not running.
- (f) Overspeed Speed Switch;
 - 1. Provides a signal to the overspeed shutdown circuit if the engine exceeds the preset speed. The factory setting is approximately 3894 Hz, or 1980 RPM on an engine with 118 teeth on the flywheel ring gear. The adjustment range is 300 Hz to 10,000 Hz.
 - 2. A push to test switch is provided to allow testing of the overspeed circuit without overspeeding the engine. When switch is depressed, the set point of the speed switch is lowered approximately 10%.
 - 3. The push to test switch can also be used to set the overspeed switch at approximately 110% of running speed. Hold the switch depressed while adjusting the setting until the overspeed trips. When switch is released, the set point will be 10% above normal running speed. This is the method used to make the factory setting. With engine speed at 1800 RPM or 3540 Hz.
- (g) Cooldown circuit; this circuit keeps the engine running for five minutes after the transfer switch has removed the load from the generator and signaled the A903-2 to stop the engine. This feature may be selected (turned On, standard setting is Off) with a switch on the back of the Control / Display Module.

3-7.1.5 Seven (7) First-out Shutdown Circuits; provide first-out indication of cause of shutdown. These circuits deactivate the fuel relay and lockout the A903 until reset. Shutdown circuits are activated by the crank disconnect circuit and are not active when the engine is stopped. Six (6) Red Shutdown Indicating Lights

are provided. The Remote Shutdown circuit does not have an indicator light.

- (a) Overcrank; tripped by the overcrank sensing circuit which counts the number of cranking attempts.
- (b) Overspeed; tripped by overspeed switch when engine exceeds a preset speed.
- (c) Oil Pressure; tripped by the oil pressure SWITCHGAGE® if pressure drops below preset point while the engine is running.
- (d) Water Temperature; tripped by the water temperature SWITCHGAGE® if engine coolant temperature exceeds the switch setting.
- (e) Spare Shutdown; tripped by an external switch. This circuit is provided for an additional shutdown that may be recommended by the engine supplier.
- (f) Loss of Speed Signal; tripped by an internal sensing circuit that detects the loss of the Magnetic Pickup frequency signal for the speed switches while the engine is still running. Since the Overspeed shutdown circuit is activated by the frequency input, it prevents the engine from running without overspeed protection.
- (g) Remote Shutdown; this circuit is provided to shutdown the engine generator from a remote location. No indicating light is provided.

3-7.1.6 Nine (9) Alarm Indicating Circuits; provide indication of cause of alarm. These circuits activate the alarm relays. Alarm circuits are active as long as power is applied to the A903-2. All are active when the engine is running, shutdown or on standby except alarm circuit #7 and #8 which are locked out until the engine is running. Nine (9) Amber Alarm Indicating Lights are provided however only three circuits is labeled. The other 6 are for customer specified alarms.

- (a) Low Water Temperature; operated by low water temperature SWITCHGAGE®.
- (b) Air Damper Closed; operated by an external switch or by the Overspeed Relay circuit. This circuit is provided with a selector switch to allow the user to determine the source of the signal.
- (c) Switch Not In Automatic; operated by the OFF-AUTO-TEST mode selector switch.
- (d) #4 Spare Alarm; operated by an external switch. This circuit is provided for an additional alarm that may be required by the user.
- (e) #5 Spare Alarm; operated by an external switch. This circuit is provided for an additional alarm that may be required by the user.
- (f) #6 Spare Alarm; operated by an external switch. This circuit is provided for an additional alarm that may be required by the user.
- (g) #7 Spare Alarm; operated by an external switch. This circuit is provided for an additional alarm that may be required by the user.
- (h) #8 Spare Alarm; operated by an external switch. This circuit is provided for an additional alarm that may be required by the user.
- (i) #9 Spare Alarm; operated by an external switch. This circuit is provided for an additional alarm that may be required by the user.

3-7.2 Relay Module. The Relay Module, figure 3-7.2, includes all of the control, alarm and shutdown relays that are required to

make up the generator engine control. Relays are available for operation on either 12 or 24 volt battery systems. Four (4) relays are included for:

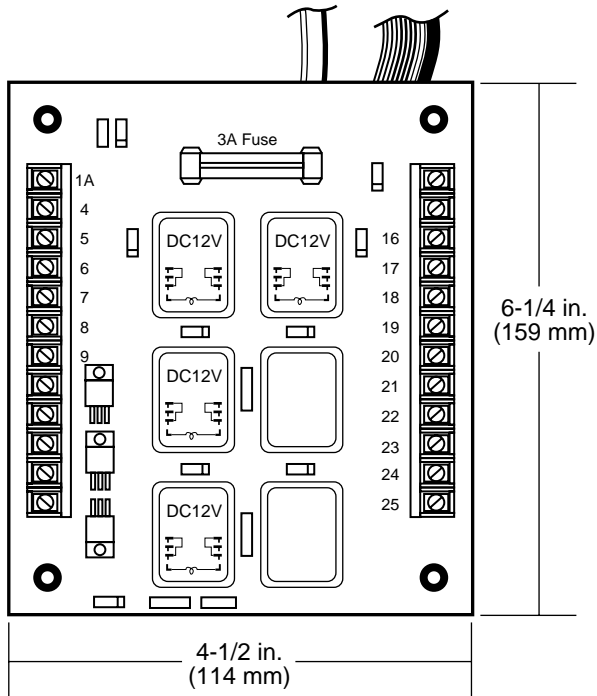


Figure 3-7.2

3-7.2.1 Fuel Relay; this relay provides two outputs, one to energize the engine fuel solenoid and a separate circuit to energize the battery charging alternator field.

3-7.2.2 Shutdown Relay; this relay is operated by the shutdown circuits of the Control / Display Module and provides an output that can be used to trip the generator circuit breaker on an emergency shutdown.

3-7.2.3 Overspeed Relay; operates only on an Overspeed shutdown. This relay provides an output to trip an air shut off solenoid to close the air damper on a two-cycle engine.

3-7.2.4 Local Audible Alarm Relay; provides a contact closure to operate a local audible alarm as required by NFPA- 110, Level 1 and Level 2.

3-7.3 Status Signals. The relay module also includes three outputs that can be used with external circuits for signaling or control functions.

3-7.3.1 The Control On function at terminal 12 is on (closed to negative) as long as the Mode Selector Switch is in either Auto or Test. When the Mode Selector is turned Off, the Control On signal is open. This can be used to signal switch position or to reset an external circuit when the Mode Selector is turned Off.

3-7.3.2 The System Ready signal at terminal 13 is on (closed to negative) as long as the Mode Selector Switch is in either Auto or Test and no shutdown TATTLETALE® circuit is latched on. This can be used to signal that the generator engine is ready to automatically start or is running in Test.

3-7.3.3 The Control On function at terminal 14 is on (closed to positive) as long as the Mode Selector Switch is in either Auto or Test. When the Mode Selector is turned Off, the Control On signal is open. This can be used to signal switch position or to reset an external circuit when the Mode Selector is turned Off.

Section 4: Installation

4-1 Location.

4-1.1 The A900 series is designed to mount in a MURPHYMATIC® Generator Control panel with the Control / Display module on the front panel and the Relay module on the inside bottom surface. Other types of installation is possible as long as the relationship of the two modules are maintained.

4-1.2 Clearance for Installation and Service; The modules must be accessible for wiring to the terminal blocks and adjustment of the user controls on the back of the Control / Display module. Figure 4-1.2 shows the mounting dimensions and the minimum clearances recommended for installation.

4-1.3 Wiring Terminals; Terminal blocks are provided on both sides of the Control / Display enclosure and the Relay Module. Torque all terminal screws to 12 inch pound maximum.

4-2 Wiring.

4-2.1 After the A900 has been located and installed, the wiring connections can be made. This work should be done with all electrical power disconnected from the engine. **BE SURE THAT THE BATTERY IS DISCONNECTED.**

4-2.2 All electrical installation work should be done in accordance with the National Electrical Code, NFPA-70, and all applicable local codes.

4-2.3 In general, the following connections will be made:

- Battery positive and negative. An 8 A fuse or circuit breaker must be provided to protect powered relay contact circuits.
- Engine run device, such as a fuel shutoff solenoid.
- Engine speed sensor, such as a magnetic pickup or the tachometer output of a battery charging alternator.
- Auxiliary crank disconnect device, such as a voltage sensing relay contact wired to the generator output.
- Engine starter circuit; an auxiliary starter solenoid is required to handle most starter solenoid requirements.
- Remote start contact. This is normally from the automatic transfer switch but other sources are possible.
- Alarm and shutdown sensing switches as required.

4-2.3.1 The complete wiring of a Model A901 control is shown in figure 4-2.3.1. Provision is made in the A900 series to operate remote lights for all of the alarm and shutdown circuits however these circuits do not have to be wired for the A900 to function. Alarm input switches are not required but the alarm circuits will not work without them.

4-2.3.2 Figure 4-2.3.2 is for wiring of the A902 control. The same provisions as for the A901 are made.

4-2.3.3 The A903 wiring is shown in figure 4-2.3.3.

4-2.3.4 Wire Termination; the terminal blocks that are supplied requires that all wires be terminated with #6 stud size forked spade solderless wire connectors or stripped and inserted under the captive terminal plates. Torque all terminal screws to 12 inch pound maximum.

4-2.3.5 All inductive loads (relays-solenoids-coils-etc.) that are connected to the A900 must have reverse diodes wired across the coil to suppress reverse voltage that is generated whenever the inductive load is de-energized. This will protect the electronic components in the A900 and should prevent operating malfunction due to noise. The "rule of thumb" for sizing the reverse diode is to use one with a PIV (Peak Inverse Voltage) rating equal to the operating voltage, or at least 100 volts and a

Figure 4-1.2.5: Mounting Dimensions

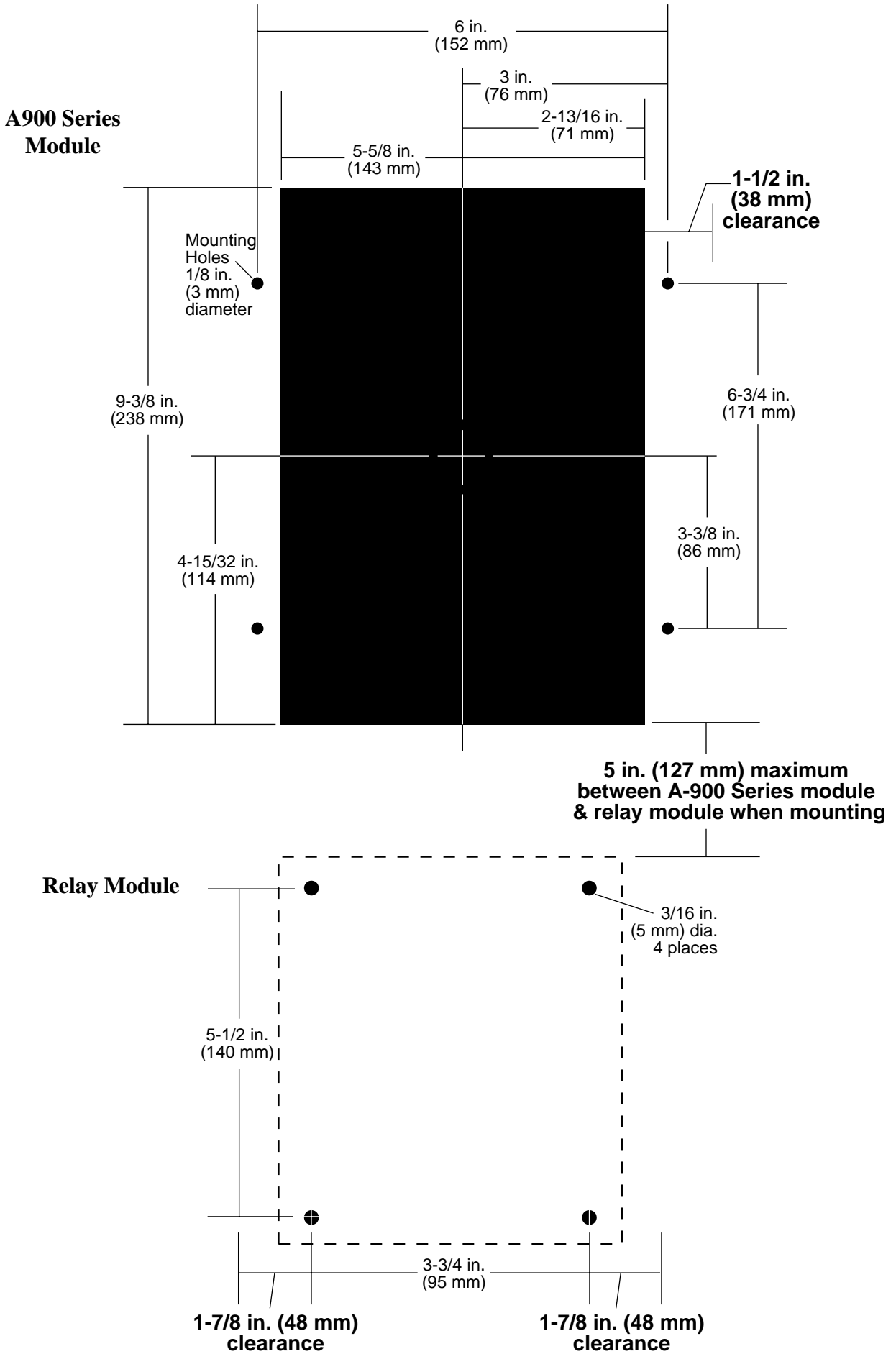


Figure 4-2.3.1: A901 wiring

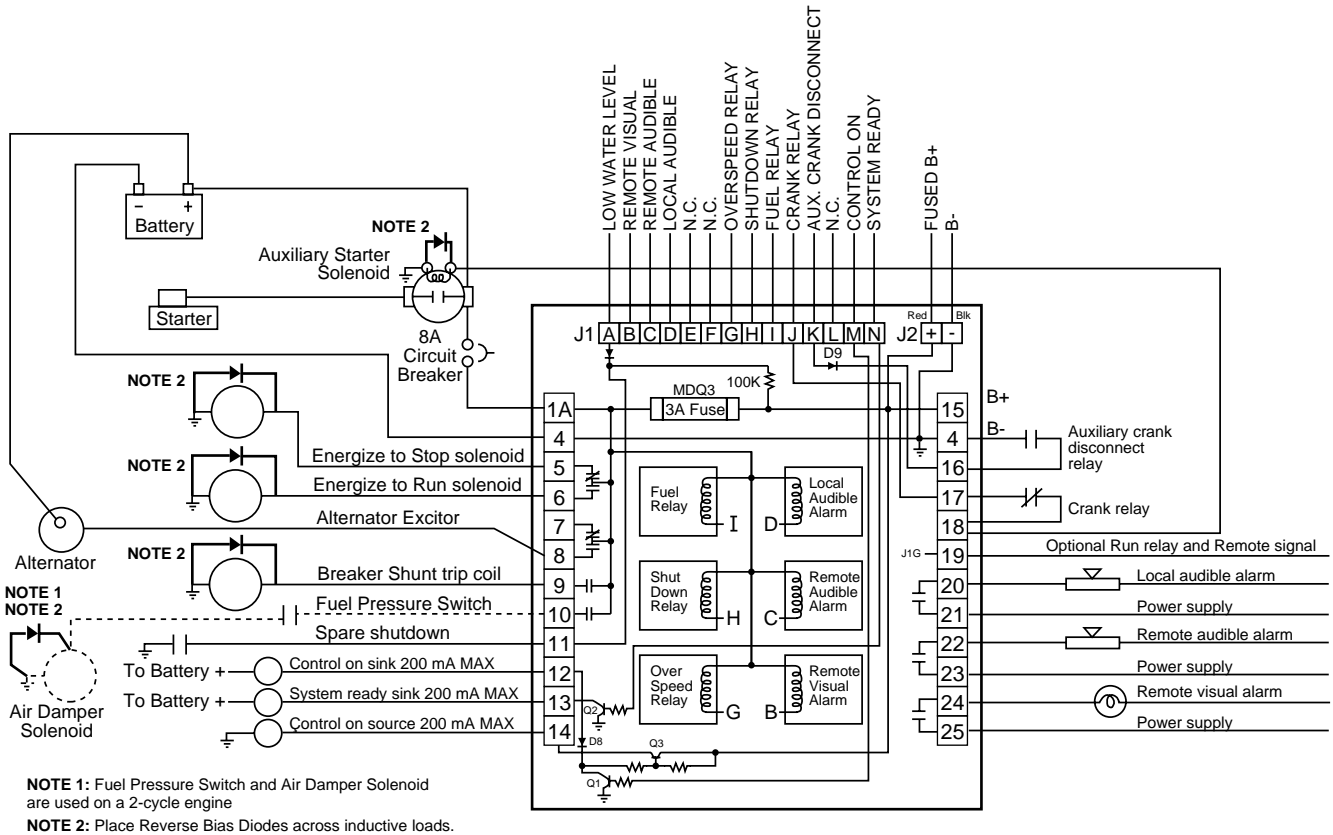
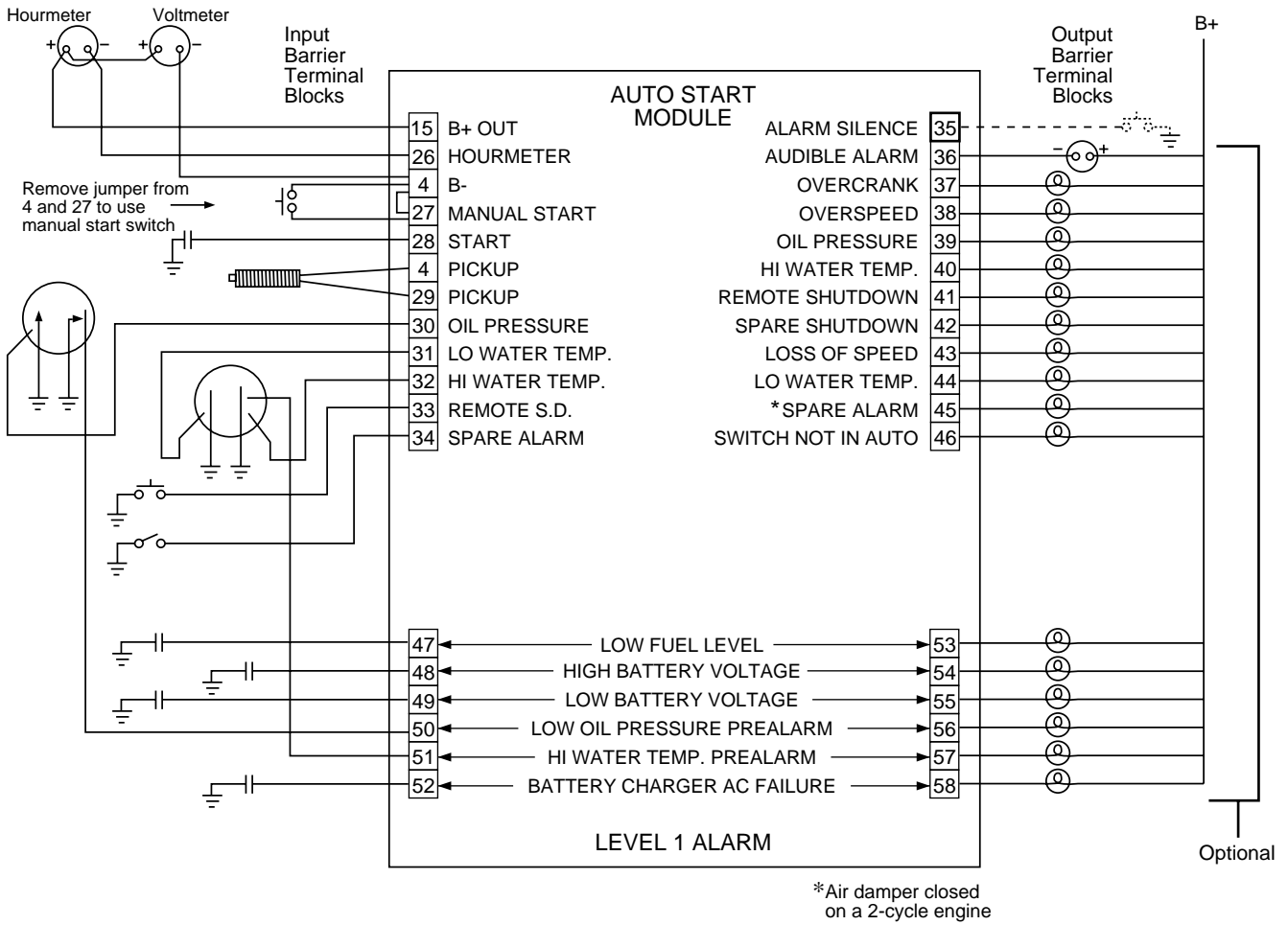
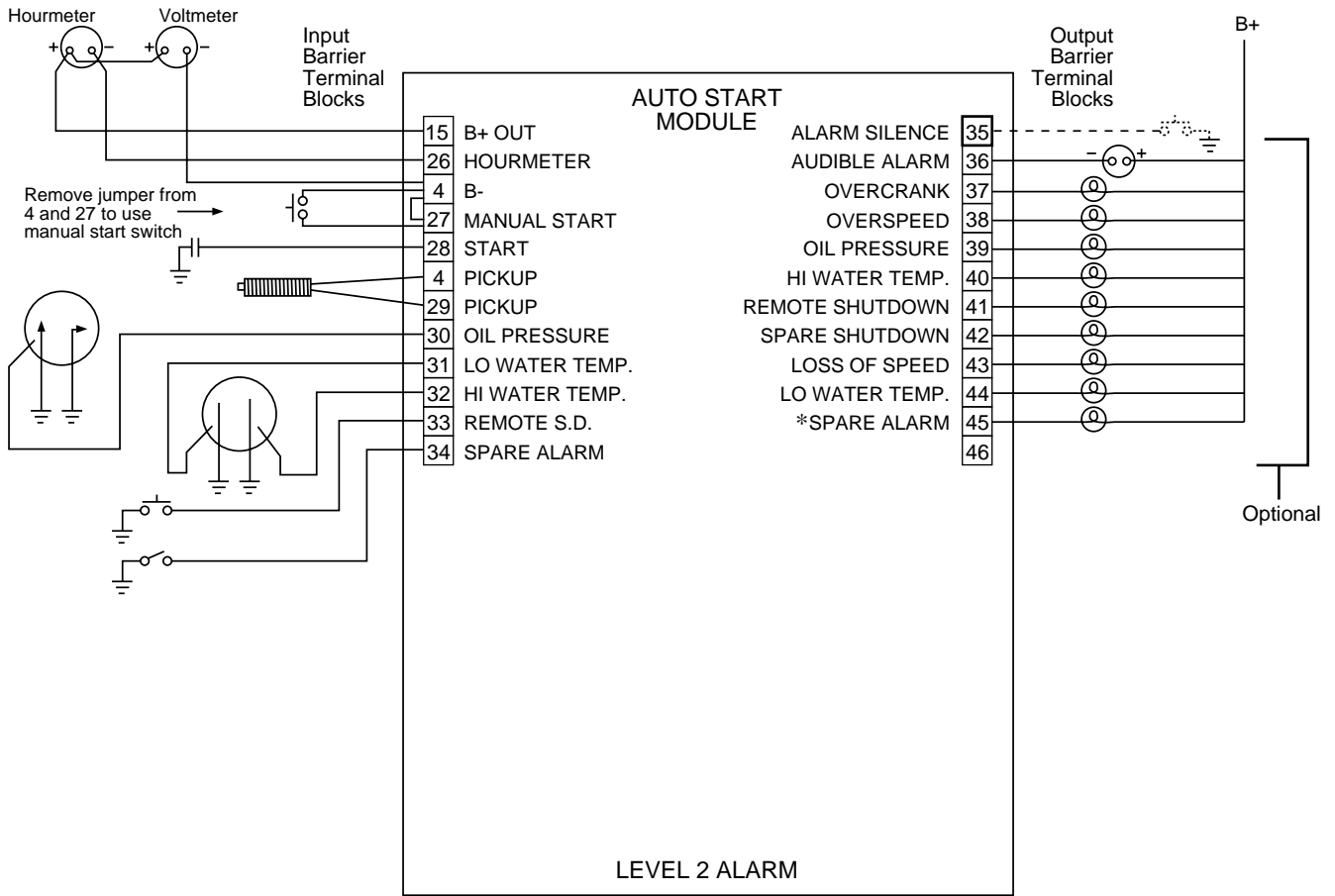
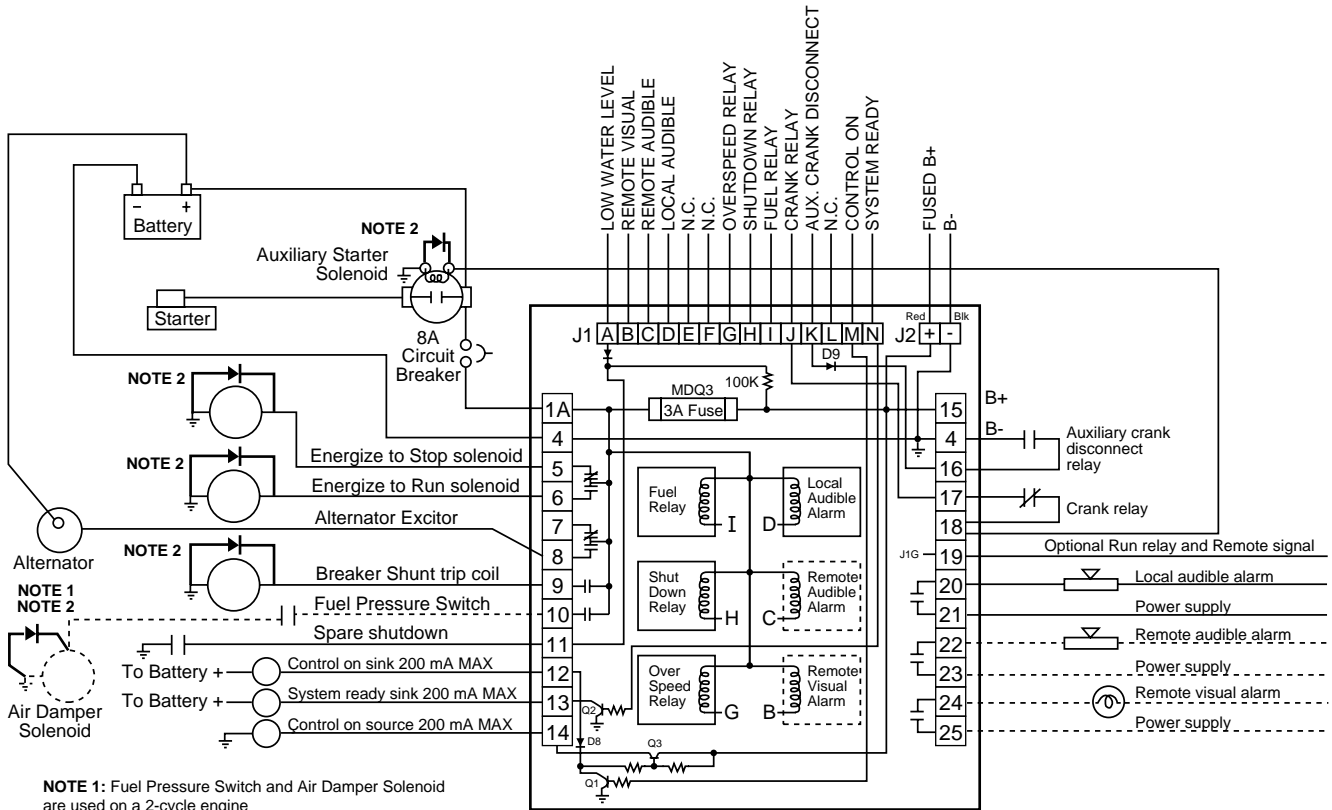


Figure 4-2.3.2: A902 wiring



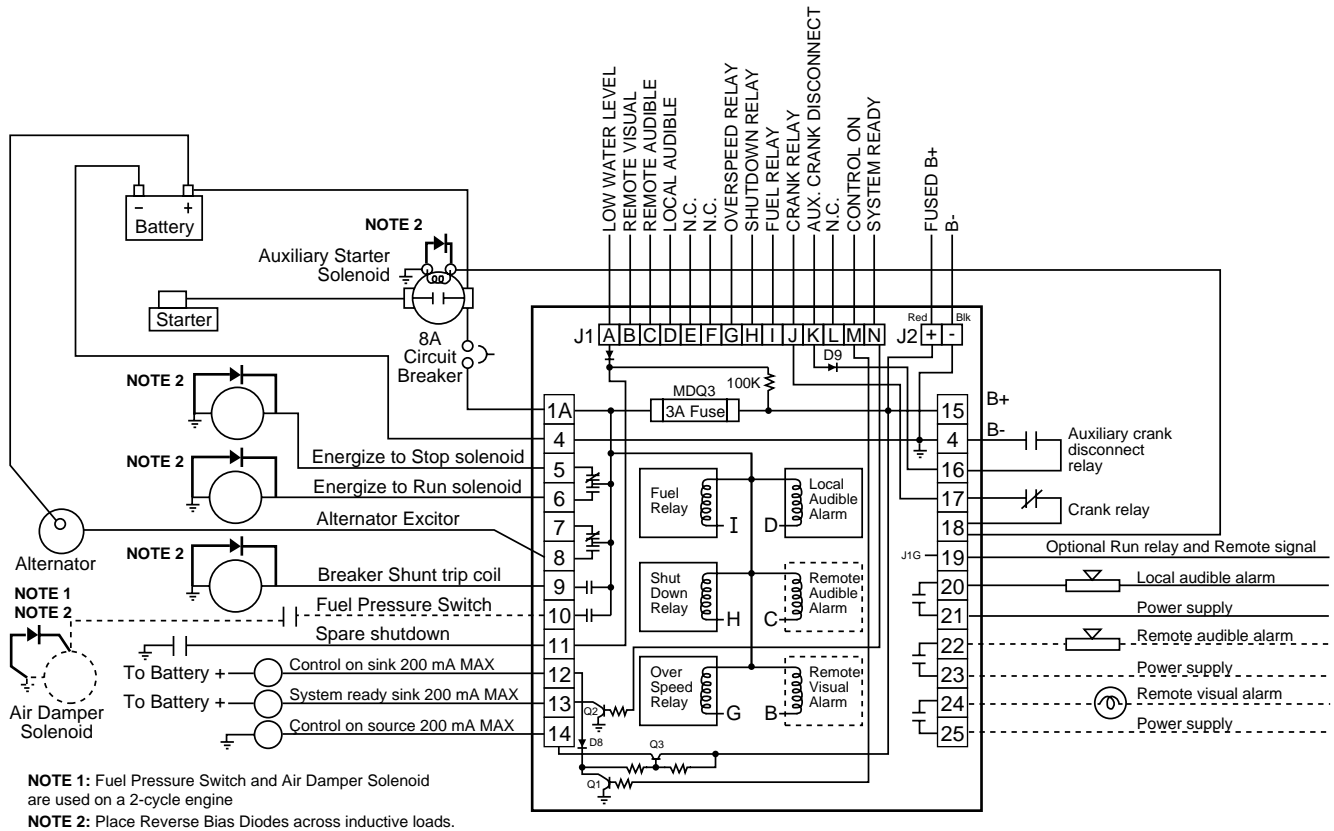
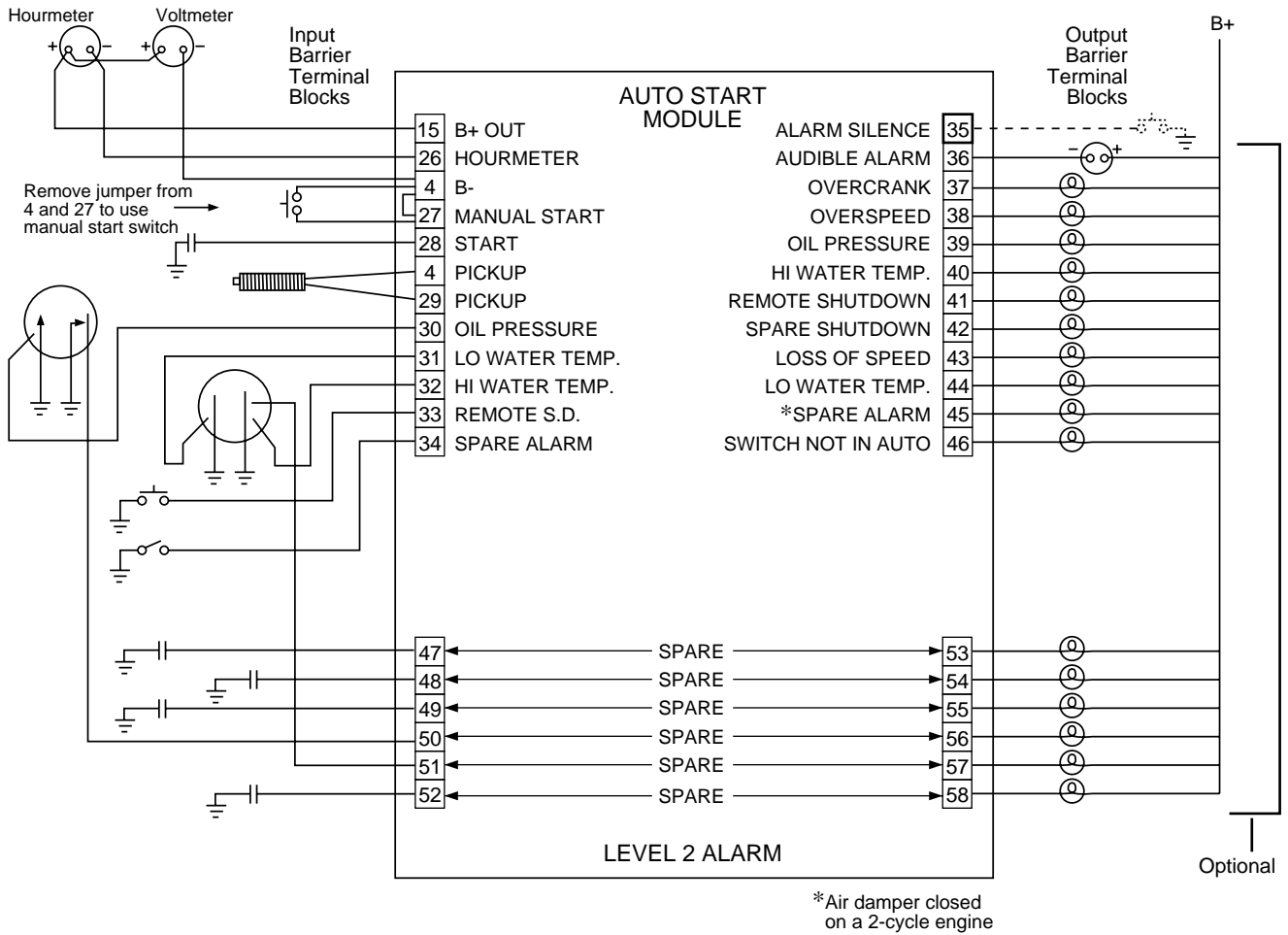
*Air damper closed on a 2-cycle engine



NOTE 1: Fuel Pressure Switch and Air Damper Solenoid are used on a 2-cycle engine
NOTE 2: Place Reverse Bias Diodes across inductive loads.

Drawing Revision C

Figure 4-2.3.3: A903 wiring



current rating that is equal to or greater than the forward current that the coil draws to operate. For example, a relay less than 1 A, use a 1 A diode since they are readily available. The wiring shown in Figures 4-2.3.1, 4-2.3.2 and 4-2.3.3 have examples of the places that a reverse diode is required.

4-3 Crank Disconnect.

4-3.1 A magnetic pickup is recommended to supply the speed signal for the A900 series primary crank termination circuit and for the overspeed switch. This pickup will be mounted in the flywheel housing in line with the ring gear on the flywheel and wired to the A900 using either a twisted pair or a shielded cable to reduce the possibility of electrical noise pickup in the wiring.

4-3.1.1 The tachometer terminal, of the battery charging alternator, may be used for the speed signal but a broken drive belt will disable this source and some alternators have electrical noise which will cause the speed switches to operate at speeds well below the desired RPM.

4-3.2 An auxiliary crank disconnect circuit, required by NFPA-110, is provided in the A900. Any signal that detects when the engine is running and provides a contact closure between Terminals 4 and 16 can be used. This circuit terminates cranking even if the speed signal fails. The “Loss Of Speed” shutdown / alarm on the A900 will indicate if the speed signal is lost while the engine is running by either shutdown of the engine or operation of the alarm circuit. “Loss Of Speed” alarm will only operate if the auxiliary crank disconnect circuit is used. Provision is also made for a second N.C. contact between Terminals 17 and 18 to interrupt the output to the auxiliary starter solenoid. This would disconnect cranking even if both crank disconnect circuits in the A900 should fail. If this contact is not provided, you must jumper Terminals 17 and 18 for the start signal to reach the auxiliary starter solenoid. A voltage sensing relay wired to one output phase of the generator is one way to provide both of these contacts.

4-4 Pre-operational Check-out.

4-4.1 After installation is complete, it is necessary to make some adjustments to the A900 SELECTRONIC® Control before the system is operational. All shutdown and alarm circuits also should be tested. Table 4-4.1 lists the standard factory setting of the adjustable functions on the A900 series control. To

determine if the frequency of the speed switches must be changed, calculate the required setting using the following formulas:

$$\text{Set point frequency in HZ} = \frac{\text{No. of Gear Teeth} \times \text{RPM set points}}{60}$$

OR

$$\text{Set point frequency in HZ} = \frac{\text{Pulley ratio} \times \text{No. of Alternator Poles} \times \text{RPM set points}}{60}$$

Refer to Table 4-4.1 to determine if the speed switch settings are below the factory settings listed. If required frequency will be higher than the standard, increase the setting before proceeding. Turn The Crank Disconnect Set and Overspeed Set pots clockwise to increase setting. The adjustments are 20 turn controls without stops at either end.

4-4.1.1 Be sure to have a fully charged battery to do these tests. Low battery voltage can cause improper results during the tests.

4-4.1.2 The “Air Damper Closed” alarm on A900 series for 2 cycle engines can be actuated by either an internal circuit that senses the output to the overspeed relay, from the “Overspeed” shutdown circuit or by an external switch wired to terminal 34 of the Control / Display Module. The “Air Damper Closed” switch, Table 4-4.1 must be turned On for internal sensing and Off for external switch. This circuit is a Spare alarm on A900 for 4 cycle engines and the switch must be turned Off to prevent this circuit from operating with the “Overspeed” shutdown.

4-4.1.3 All of the adjustments and controls shown in Table 4-4.1 are located on the rear of the control/display module. See Figure 4-4.1.3. Each light and switch is labeled for ease of identification. The LED's are supplied as an aid in installation and troubleshooting of the A900.

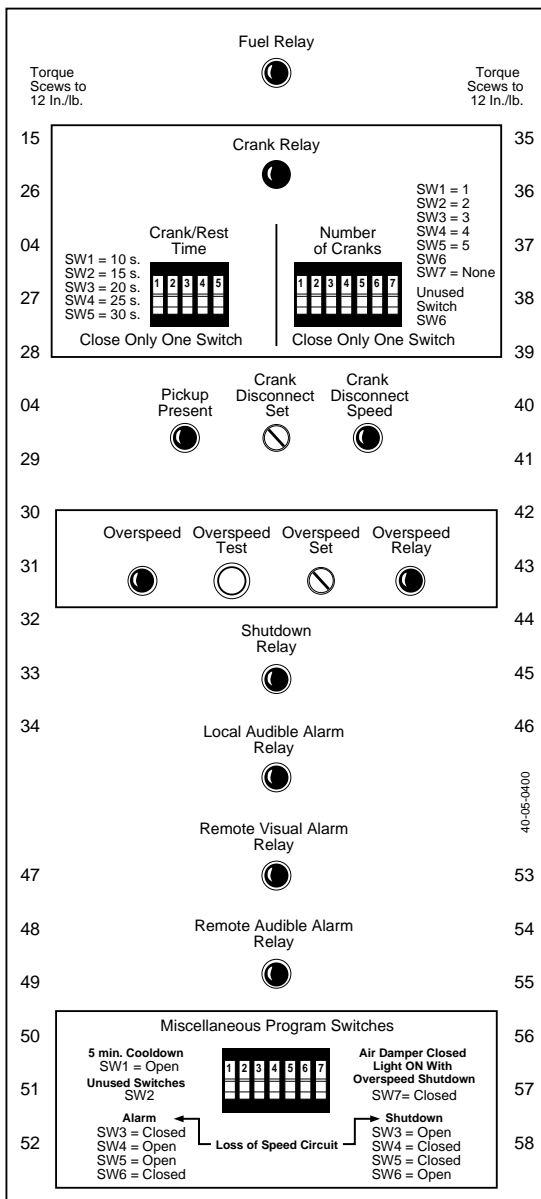
4-4.2 Crank Disconnect Speed Setting; to set this speed switch, proceed as follows:

- (a) Disconnect the run solenoid wire from terminal 6 on the Relay Module.
- (b) Check engine to be sure it is safe to crank.
- (c) Be sure Mode Selector switch is in OFF position.
- (d) Connect battery cables to a fully charged cranking battery.
- (e) Turn Mode Selector switch to TEST position and watch the lights on the A900 control module back panel.
 1. The engine should start cranking and the “Fuel Relay”, “Crank Relay”, and “Pickup Present” lights turn on.
 2. If engine does not crank, check the lights. If green light next to Mode Selector Switch on front panel is not on, check the DC power input wiring and fuse.
 3. If green light, “Fuel Relay” and “Crank Relay” lights are on, check wiring from A900 Terminal 18 to auxiliary start solenoid and than on to the starter on engine.
 4. With engine cranking, check “Pickup Present” light. It must be on. If off, check the wiring to magnetic pickup and check gap between pickup face and ring gear.
 5. If “Crank Disconnect Speed” light comes on and cranking stops, setting of Crank Disconnect Switch is still to low. Turn Mode Selector switch OFF and turn crank disconnect adjustment clockwise 1 or 2 turns and repeat test.

Table 4-4.1

Function	Standard Setting	Adjustment Range	Adjustment Type
Crank/Rest Time	15 seconds	10, 15, 20, 25 and 30 Seconds	Switch
Overcrank	3 cranks	1, 2, 3, 4, 5, 6 and No overcrank	Switch
Crank Disconnect	1180 Hz	25 to 2 KHz	Turn CW to increase
Overspeed	3894 Hz	300 to 10 KHz	Turn CW to increase
Cooldown	OFF	Fixed 5 minute	ON-OFF switch
Loss of speed Signal	Shutdown	Shutdown or Alarm	Switch
Air Damper Closed Alarm on 2 Cycle Engines only	ON with Overspeed shutdown	Internal switch ON External switch OFF	Switch

Figure 4-4.1.3



6. While engine is cranking, turn crank disconnect adjustment counter clockwise slowly until "Crank Disconnect Speed" light turns on and cranking stops.
7. Turn crank disconnect adjustment clockwise 1/4 turn. This sets crank disconnect speed at approximately 125 RPM above cranking speed.
8. Turn Mode Selector switch OFF.
- (f) Reconnect the run solenoid wire at terminal 6 on Relay Module.

4-4.3 Start and Stop Engine; to test the start and stop function, proceed as follows:

- (a) Double check all wiring to be sure it is connected.
- (b) Turn Mode Selector switch to the TEST position. This gives the A900 Controller a start signal.
- (c) Engine should crank, start and come up to governor speed.
 1. Check "Crank Disconnect Speed" light; it should be on and "Crank Relay" light should be off.
 2. If lights are not correct, turn Mode Selector switch OFF and review paragraph 4-4.2.
- (d) When engine has come up to speed and governor has been

adjusted for proper running speed, turn Mode Selector switch OFF. This gives the A900 Controller a stop signal.

- (e) All lights on the back of the A900 should go off and the engine stop. If engine does not stop, check run solenoid to be sure it has returned to the stop position.

4-4.4 Automatic Start and Stop; to test the automatic-start and stop function, proceed as follows:

- (a) Turn Mode Selector switch to the AUTO position. Short terminal 28 to 4 on the Control / Display module. This gives the A900 Controller a start signal.
- (b) Engine will crank, start and come up to governor speed.
- (c) When engine has come up to speed, open the circuit between terminal 28 and 4. This gives the A900 Controller a stop signal.
- (d) All lights on the back of the A900 should go off and the engine stop.

4-4.5 Overspeed Switch Setting; To set the speed switch, proceed as follows:

- (a) Turn Mode Selector switch to the TEST position.
- (b) Engine will crank, start and come up to governor speed.
- (c) With engine running, adjust governor to bring engine speed to normal RPM.
- (d) Depress and hold the Overspeed Test pushbutton.
- (e) Slowly turn the Overspeed Set adjustment counter-clockwise until the "Overspeed" and "Overspeed Relay" lights on the A900 come on and the engine shuts down.
- (f) Release pushbutton; check "Overspeed" light on front panel to be sure it is on.
- (g) Turn Mode Selector switch OFF to reset shutdown circuits; then back to TEST.
- (h) When engine starts, increase governor speed setting slowly until engine shuts down on overspeed. This should occur about 10% above governor speed.
- (i) Turn Mode Selector switch OFF.

4-4.6 Overcrank setting; to test number of cranks before system shuts down on overcrank;

- (a) Disconnect the run solenoid wire from terminal 6 of the Relay Module.
- (b) Check number set on the "Number Of Cranks" switch on A900 back panel. It is factory set at 3.
- (c) Turn Mode Selector switch to TEST.
 1. Engine will crank for 15 seconds.
 2. Then rest for 15 seconds
 3. This should repeat 3 times and then the "Overcrank" light on the A900 will come on and engine will not crank again.
- (d) Turn Mode Selector switch OFF.
- (e) Reconnect the run solenoid wire at terminal 6 of the Relay Module.

4-4.7 Oil Pressure; to test oil pressure shutdown circuit:

- (a) Turn Mode Selector switch to TEST. When engine starts, wait 30 seconds then,
- (b) Use a jumper wire and short from terminal 30 to 4.
- (c) "Oil Pressure" light will come on and engine will stop.
- (d) Turn Mode Selector switch OFF.

4-4.8 Water Temperature; to test the water temperature shutdown circuit:

- (a) Turn Mode Selector switch to TEST. When engine starts, wait 30 seconds then,
- (b) Use a jumper wire and short from terminal 32 to 4.

- (c) “Water Temperature” light will come on and engine will stop.
 - (d) Turn Mode Selector switch OFF.
- 4-4.9** Low Water Temperature; to test the low water temperature alarm circuit:
- (a) Engine does not have to be running.
 - (b) Use a jumper wire and short from terminal 31 to 4.
 - (c) “Low Water Temperature” alarm light will come on as long as the jumper maintains the circuit.
- 4-4.10** Other Alarm and/or Shutdowns; all other alarms and shutdowns would be tested in the same manner.
- (a) For shutdown circuits, the engine must be running for test.
 - (b) Most alarm only circuits can be tested without starting the engine. Low Oil Pressure Pre-alarm and High Water Temperature Pre-alarm are exceptions.
 - (c) To test other shutdowns or alarms, a jumper wire can be used to short out the switch contacts at the switch or if this is not possible, the test can be run by shorting the input terminal for that circuit, to ground, terminal 4.
 - (d) To test Low Oil Pressure Pre-alarm;
 1. Turn Mode Selector switch to TEST. When engine starts, wait 30 seconds then,
 2. Use a jumper wire and short from terminal 50 to 4; “Low Oil Pressure Pre-alarm” light will come on as long as the jumper maintains the circuit.
 - (e) To test High Water Temperature Pre-alarm;
 1. Turn Mode Selector switch to TEST. When engine starts, wait 30 seconds then,
 2. Use a jumper wire and short from terminal 51 to 4; “High Water Temperature Pre-alarm” light will come on as long as the jumper maintains the circuit.

Section 5: Operation

5-1 Operator Controls.

5-1.1 Mode Selector Switch; allows the operator to select either manual (TEST), automatic operation (AUTO), or no operation (OFF).

5-1.2 The OFF position on the mode selector also provides a reset function for the shutdown circuits. If the engine is shut down by the automatic control, the operator must turn selector off and back on to reactivate the system.

5-1.3 Push to Test Lamps; this pushbutton tests the alarm and shutdown indicator lights.

5-1.4 Alarm Silence Pushbutton; if so equipped, silences the local and remote audible alarm. Visual indicator remains on until reset or sensor switch contacts clear.

5-2 Operating Modes.

5-2.1 The A900 Generator Engine Control has two operating modes: manual and automatic.

5-2.2 Manual Operation is provided for testing of the generator set.

5-2.2.1 To initiate Manual Control, place the Mode Selector switch in the TEST position. This provides the automatic control a start signal.

5-2.2.2 To stop, turn selector switch to OFF. This removes start signal and the engine will stop.

5-2.3 Automatic operation is the normal mode.

5-2.3.1 To initiate Automatic Control, place the Mode Selector switch in the AUTOMATIC position. When a start signal is

received, the engine will start.

5-2.3.2 When the start signal is removed, the engine will stop. It is now ready to restart.

5-2.4 OFF or Not Operating; to prevent operation of the engine, turn selector switch OFF.

Section 6: Routine Maintenance and Operational Tests

6-1 Routine Maintenance.

6-1.1 Due to the design and types of components used, very little maintenance is required to the A900 Control.

6-1.2 Visual inspection of the internal wiring of the control panel, along with checking wire connections for tightness, should be done on a semiannual schedule for stand-by systems or quarterly for prime power. Check wire bundles for chafing and wear to the insulation of the wires where they contact the panel or engine.

6-1.4 Shutdown and Alarm Circuits should be tested on a monthly basis for prime power and quarterly for stand-by sets. The same tests run during pre-operation check out, Section 4-4, should be included.

6-2 Operational Tests.

6-2.1 No special operational tests are required. The routine operational tests for the generator set will exercise the control.

Section 7: Troubleshooting and Repair

7-1 Tools Required.

7-1.1 Some of the tools necessary for troubleshooting are built into the A900 Series controls.

7-1.1.1 By observing the lights on the front and rear of the control panel, clues to a problem and the possible source can be seen.

7-1.1.2 Operational problems with the automatic engine control will show up by looking at the input and output lights on the rear of the A900 ELECTRONIC® Control / Display Module.

7-1.2 Other tools which may be required are:

7-1.2.1 AC/DC Voltmeter for taking voltage readings and an Ohmmeter for testing resistance of wires and connections.

7-1.2.2 Jumper wires with alligator clips to bypass or simulate circuit closures.

DO NOT USE THESE JUMPER WIRES TO CHECK IF VOLTAGE IS PRESENT AT A TERMINAL BY DRAWING AN ARC TO GROUND. THIS WILL DAMAGE OR DESTROY EQUIPMENT IN THE A900 CONTROL PANEL.

7-2 A900 ELECTRONIC Control Operation And Shutdown.

7-2.1 The first step in troubleshooting any equipment is to understand its normal operation. Table 7-2.1 contains normal voltage readings taken at the terminals of the A901 with all equipment shown on the standard drawing, connected.

(a) All voltage readings are DC, except at terminal 29, and were taken with the negative lead of the meter connected to ground at terminal 4. Voltage reading at terminal 29 was taken with negative lead grounded and the meter on AC scale.

(b) The battery voltage, at the time readings were recorded, was 13.8 V and 27.6 V. All readings will vary depending on battery voltage, equipment supplied in the panel and external devices connected to the A900 control. See notes

Terminal Number	Mode Selector OFF		Mode Selector AUTO Stand-by		Mode Selector AUTO Cranking		Mode Selector AUTO Running		Mode Selector AUTO Shutdown		Mode Selector OFF		Mode Selector AUTO Stand-by		Mode Selector AUTO Cranking		Mode Selector AUTO Running		Mode Selector AUTO Shutdown			
	Input	Voltage	Input	Voltage	Input	Voltage	Input	Voltage	Input	Voltage	Input	Voltage	Input	Voltage	Input	Voltage	Input	Voltage	Input	Voltage	Input	Voltage
1	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	13.8	27.6	13.8	27.6	0	0	0	0	13.8	27.6	0	0	13.8	27.6	0	0	13.8	27.6	0	0	13.8	27.6
6	0	0	0	0	13.8	27.6	0	0	13.8	27.6	0	0	13.8	27.6	0	0	13.8	27.6	0	0	13.8	27.6
7	13.8	27.6	13.8	27.6	0	0	0	0	13.8	27.6	0	0	13.8	27.6	0	0	13.8	27.6	0	0	13.8	27.6
8	0	0	0	0	13.8	27.6	0	0	13.8	27.6	0	0	13.8	27.6	0	0	13.8	27.6	0	0	13.8	27.6
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6
12	13.8	27.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	13.8	27.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6
16	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
17	.3	.3	.3	.3	13.8	27.6	.3	.3	13.8	27.6	.3	.3	13.8	27.6	.3	.3	13.8	27.6	.3	.3	13.8	27.6
18	0	0	0	0	13.8	27.6	0	0	13.8	27.6	0	0	13.8	27.6	0	0	13.8	27.6	0	0	13.8	27.6
19	13.8	27.6	13.8	27.6	1.5	1.5	1.5	1.5	13.8	27.6	1.5	1.5	13.8	27.6	1.5	1.5	13.8	27.6	1.5	1.5	13.8	27.6
20	0	0	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6	13.8	27.6
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	13.8	27.6	13.8	27.6	0	0	0	0	13.8	27.6	0	0	13.8	27.6	0	0	13.8	27.6	0	0	13.8	27.6
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	5.5	5.5	.5	.5	.5	.5	0	0	.5	.5	0	0	.5	.5	0	0	.5	.5	0	0
29(1)	0	0	0	0	4	4	4	4	0	0	4	4	0	0	4	4	0	0	4	4	0	0
30(2)	0	0	0	0	0	0	0	0	6	6	6	6	6	6	6	6	6	6	6	6	6	6

Table 7-2.1

NOTES

- Note 1: AC voltage measured on AC scale of volt-ohmmeter.
- Note 2: Low Oil Pressure shut-down circuit. Oil pressure was the cause of shutdown on column 5.
- Note 3: Low Oil Pressure pre-alarm circuit. This circuit turned on before the Low Oil Pressure shutdown occurred in column 5.

to the table for examples.

- (c) Voltages less than battery also may vary due to tolerances of the electronic components in the A900. Minor variations, 1 or 2 volts, normally will have no effect on the A900 operation.
- (d) The AC voltage at terminal 29 must be a minimum of 2 VAC to drive the speed sensing circuits of the A900.

7-2.2 With power applied and the Mode Selector switch in AUTO, the following occurs when a switch is closed from terminal 28 to ground.

7-2.2.1 The fuel relay is energized, which opens the circuits at terminal 5 and 7, and closes the circuits at terminal 6 and 8. This applies battery power to the run solenoid and to the exciter terminal of the alternator.

7-2.2.2 At the same time, the crank relay driver provides battery voltage at terminal 17, thru the auxiliary crank disconnect relay contact to the auxiliary starter solenoid. This output is controlled by the crank and rest timer but it can be overridden by the crank disconnect speed switch and / or the auxiliary crank disconnect circuit. The output will remain on until the crank time expires or the crank disconnect circuits detect that the engine has started.

7-2.2.3 If the engine does not start during the crank time, the rest timer will prevent cranking until it has timed out. After the rest time, the engine will begin cranking again. This sequence will repeat until the engine starts or the overcrank shutdown circuit trips.

7-2.2.4 Engine speed is detected by an AC signal from a magnetic pickup wired to terminal 29. When this frequency exceeds the setting of the crank disconnect speed switch,

- (a) Cranking is terminated.
- (b) A time delay starts timing during which the oil pressure and water temperature shutdown circuits are locked out.
- (c) The overcrank counter is reset to zero.
- (d) The overspeed shutdown circuit is activated.

7-2.2.5 An engine run signal closes to ground at terminal 19 when the engine starts.

7-2.3 With the engine running, the six shutdown TATTLETALE® circuits are activated and will operate anytime a switch closes from ground to their inputs.

Circuit	Input	Output
(a) Remote Stop	Terminal 33	Terminal 41
(b) Oil Pressure	Terminal 30	Terminal 39
(c) Water Temp	Terminal 32	Terminal 40
(d) Overspeed	Int. Speed Switch	Terminal 38
(e) Loss of Speed Signal	Int. Circuit	Terminal 43
(f) Spare Shutdown	Terminal 11	Terminal 42

7-2.3.1 Each circuit has a indicating light and a transistor output that closes to ground to operate an individual remote indicating light.

7-2.3.2 When any of the six shutdown functions trip, the shutdown relay K-2, pulls in and applies battery power to terminal 9. At the same time, the fuel relay, K-1 drops out and if the shutdown was due to overspeed, the overspeed relay, K-3 pulls in to signal an air shut off solenoid, terminal 10 to close.

7-2.3.3 The six shutdown circuits, paragraph 7-2.3, are first out latching type TATTLETALE®. That is, only one of the six may trip at one time and it must be reset before the A900 will operate again.

7-2.3.4 If one of the TATTLETALE® circuits trip, the following occurs to shutdown the engine and generator.

- (a) The TATTLETALE® light for that function turns on.

- (b) Shutdown relay K-2 is energized, closing its contacts at terminal 9. These contacts can be wired to a shunt trip solenoid in the generator circuit breaker if required.
- (c) The fuel relay drops out, removing battery voltage from the run solenoid, terminal 6, and from the alternator exciter, terminal 8. The circuits at terminal 5 and 7 will close to reconnect the battery positive to these terminals.
- (d) The run signal, terminal 19 turns off.
- (e) If the shutdown is due to overspeed, the overspeed relay operates and applies battery positive to terminal 10 to close an air shutoff solenoid if the engine is so equipped.

7-2.3.5 If the engine is shutdown by the remote stop circuit, no TATTLETALE® light is provided. Otherwise a TATTLETALE® light will show the cause of shutdown.

7-2.3.6 In the A900, the Loss of Speed signal TATTLETALE® can be either a shutdown or an alarm. It is connected to a circuit that monitors the magnetic pickup input at terminal 29. If the input from the pickup fails, drops below the minimum voltage, or is disconnected while the engine is running, the Loss of Speed Signal TATTLETALE® circuit will activate and shutdown the engine or operate the alarm circuit. It is recommended that the shutdown circuit is used since this prevents the generator set from running without overspeed protection. If this circuit is used as an alarm, the auxiliary crank disconnect input MUST be supplied to prevent malfunction of the shutdown circuits.

7-2.3.7 To reset the circuits, the Mode Selector switch must be turned OFF and back on to either the AUTO or TEST position.

7-2.4 Normally, the engine will run until the start signal is removed from terminal 28.

7-2.4.1 When the signal is removed, the following occurs to stop the engine;

- (a) The fuel relay drops out, removing battery voltage from the run solenoid, terminal 6, and from the alternator exciter, terminal 8. The circuits at terminal 5 and 7 will close to reconnect the battery positive to these terminals.
- (b) The run signal, terminal 19 turns off.
- (c) The four engine function TATTLETALE® circuits are locked out as soon as the fuel relay drops out. This prevents any TATTLETALE® from tripping while the engine coasts to a stop.

7-3 A900 SELECTRONIC® Control Alarm Circuit Operation.

7-3.1 The A900 alarm circuits perform the following functions;

- (a) Turns on individual alarm lights based on input switch closures.
- (b) Provides lamp test function for all alarm and shutdown lights.
- (c) Activates either the local audible alarm relay, K-4, and remote visual alarm relay, K-6, or the local audible alarm relay, K-4, the remote audible alarm relay, K-5, and the remote visual alarm relay, K-6, depending on the requirements of NFPA-110 1988 paragraph 3-5.5.1 (d).
- (d) Provides the audible alarm silence circuit.

7-3.2 A contact closure to ground, at the alarm circuit input terminal, will cause the associated TATTLETALE® light to turn on and an output transistor to close to ground and turn on a remote indicating light.

7-3.2.1 The alarm circuits also operate the three relays for local audible alarm, remote audible alarm and remote visual alarm as required by NFPA-110. The normally open dry relay contacts,

local audible (K-4) terminal 20 and 21, remote audible (K-5) terminal 22 and 23 and remote visual (K- 6) terminal 24 and 25 close to operate the alarm devices wired to them.

7-3.3 An alarm silence pushbutton is wired between terminal 35 and ground. This switch is provided on the A901 and can be externally connected on the A902 series. When this switch is closed, the audible alarm relays K-4 and K-5 will drop out if they are closed. This turns off the audible alarms but does not affect the individual alarm lights on the panel. The lights will remain on until the input switches open. If no alarm silence switch is provided, the alarm relays will reset when the alarm and / or shutdown lights reset.

Section 8: Service Parts

8-1 Table 8-1 covers all of the replaceable components of the A900 Series Generator Engine Controls. The part numbers that are shown are Frank W. Murphy Mfr. numbers, and may not appear on the individual parts.

8-1.1 Each complete control is made up of a Control/Display

Module, a Relay Module and a number of Relays.

8-1.2 There are no field replacement parts in the Control/Display Module. The complete module must be replaced if it fails. All relays are individually replaceable in the Relay Module but the module must be replaced if a failure of the circuit board occurs.

8-2 Table 8-2 displays replaceable components for the A900 series controls manufactured for Detroit Diesel Corporation. These components have Murphy part numbers. In addition, they are OEM parts and are available only to Detroit Diesel and their distributors.

8-2.1 The A900-DDC parts are the same as the Murphy A900 series that has been covered throughout the A900 manual except the “Spare Shutdown” circuit is labeled “Low Water Level” and the DDC logo is printed on the face plate.

Table 8-1: Replacement Components for A900 Series Generator Engine Controls

Model Number	Part Number	Control/Display Module	Relay Module	Relay Part Number	Relay Qty
A901-12	40-02-0132	40-00-0077	40-00-0064	00-00-2952	5
A901-24	40-02-0137	40-00-0077	40-00-0064	00-00-2953	5
A901-2-12	40-02-0134	40-00-0078	40-00-0064	00-00-2952	6
A901-2-24	40-02-0140	40-00-0078	40-00-0064	00-00-2953	6
A902-12	40-02-0133	40-00-0079	40-00-0064	00-00-2952	3
A902-24	40-02-0145	40-00-0079	40-00-0064	00-00-2953	3
A902-2-12	40-02-0135	40-00-0080	40-00-0064	00-00-2952	4
A902-2-24	40-02-0148	40-00-0080	40-00-0064	00-00-2953	4
A903-12	40-02-0151	40-00-0081	40-00-0064	00-00-2952	3
A903-24	40-02-0152	40-00-0081	40-00-0064	00-00-2953	3
A903-2-12	40-02-0155	40-00-0082	40-00-0064	00-00-2952	4
A903-2-24	40-02-0156	40-00-0082	40-00-0064	00-00-2953	4

Table 8-2: Replacement Components for A900 Series Controls for Detroit Diesel Corporation

Model Number	Part Number	Control/Display Module	Relay Module	Relay Part Number	Relay Qty
A901-12-DDC	40-35-0020	40-00-0083	40-00-0064	00-00-2952	5
A901-2-24-DDC	40-35-0029	40-00-0084	40-00-0064	00-00-2953	6
A902-12-DDC	40-35-0022	40-00-0085	40-00-0064	00-00-2952	3
A902-2-24-DDC	40-35-0037	40-00-0086	40-00-0064	00-00-2953	4
A903-12-DDC	40-35-0024	40-00-0087	40-00-0064	00-00-2952	3
A903-2-24-DDC	40-35-0043	40-00-0088	40-00-0064	00-00-2953	4

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