

A91 Series MURPHYMATIC® Engine Microcontroller Installation and Operation Manual Models A91, A91-S, A91-WC, and A91-S-WC Option -LC (less case)



Please read the following information before installing. A visual inspection for any damage which may have occur during shipping is recommended. It is your responsibility to have a qualified person install the unit and make sure it conforms with applicable codes.

GENERAL INFORMATION

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.



Description

The A91 Series is a state-of-the-art, automatic engine controller. It is used to automatically start and stop internal combustion engine driven equipment.

It includes features like, crank and rest cycles, sensing circuit for crank disconnect and overspeed, lockouts, first-out shutdown indication LED's for overcrank, overspeed, high temperature and low lube oil. (Murphy SWICHGAGE® instruments are ideal end devices to monitor these functions.)

The A91 can operate from either 12 or 24 VDC.

With all the A91 models the customer **MUST** provide a magnetic pick-up switch 0.6 Vrms minimum, such as Murphy's **MP3298** magnetic sensor.

The A91-WC model, can operate automation devices such as our: **AT67207** throttle actuator, or the **CO3** clutch operator.

A91 Series Designation

MODELS	DESCRIPTION
A91	For less than 5 amp. up to 24V electric run output*.
A91-S	For 10 amp. up to 240 V electric run output**.
A91-WC	Same A91 with warmup/cooldown relay.
A91-S-WC	Same A91-S with warmup/cooldown relay.
All of the above	Less weatherproof (NEMA 3) enclosure

*Run output is the voltage and current required for an ignition system, fuel valve, or solenoid actuator that allows the engine to run.

**For grounding ignitions.

Specifications

Power Input: 12 or 24 VDC nominal (specify).

Magnetic Pickup Input: Requires 2 V rms minimum.

Input Polarity: Negative (-).

Sensor Outputs: Six (6) open collector transistor 125 mA sink;

Two (2) 5A @ 24 VDC normally open relay contacts.

Reverse Polarity Protection: 200 volt peak reverse voltage.

On-board Memory: 8k PROM (programmable, read only memory).

Operating Temperature Range: -20 to 140°F (-25 to 60°C).

Operating Humidity Range: 0-95% Non-Condensing

User Trip point Adjustments: Five (5) on-board potentiometers (320° turn).

Test-Off-Automatic Toggle Switch: Three position switch for:

- Test: Starts engine in automatic mode and runs until switched "off" or emergency shutdown occurs.
- Off: Disconnects all power to control circuits, Stop/disables engine from starting and resets shutdown indicators.
- Auto: Automatic start/stop sequencing is initiated by external switches and signals.

Cycle Crank Timer: 5 crank attempts 7 seconds each; 4 rest periods 15 seconds each, before overcrank.

Overspeed Trip Point Setting: From 2500-9000 Hz.

Crank Disconnect Speed Setting: From 400-2500 Hz.

Shutdown Time Delay: 15 seconds after engine start; locks out low lube oil and high temperature.

Engine Run LED: Turns "on" when crank disconnect occurs.

Shutdown Output: Removes D.C. output operates dry relay contacts for engine shutdown.

Start/Stop: SPDT or SPST switches.

Warmup Time Delay: Field adjustable from 0-300 seconds to load the engine after warmup (model -WC only).

Cooldown Time Delay: Field adjustable from 0-300 seconds (model -WC only).

Enclosure: Weatherproof NEMA 3R.

Enclosure Coating: Red enamel.

Subpanel Coating: White enamel.

MOUNTING



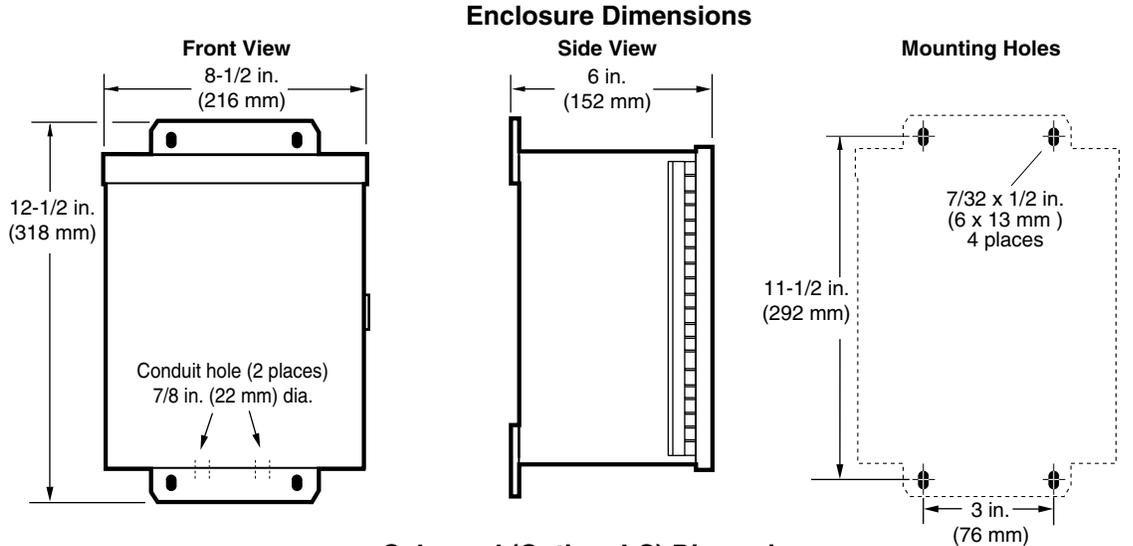
CAUTION: THE A91 SHOULD BE MOUNTED OFF ENGINE (ON A WALL OR PEDESTAL). USE A JUNCTION BOX TO WIRE THE ENGINE SENSORS/CONTROLS (SUCH AS FUEL VALVE, MAGNETIC PICK-UP, SWICHGAGE® AND THROTTLING DEVICE).

Mounting the A91 Panel

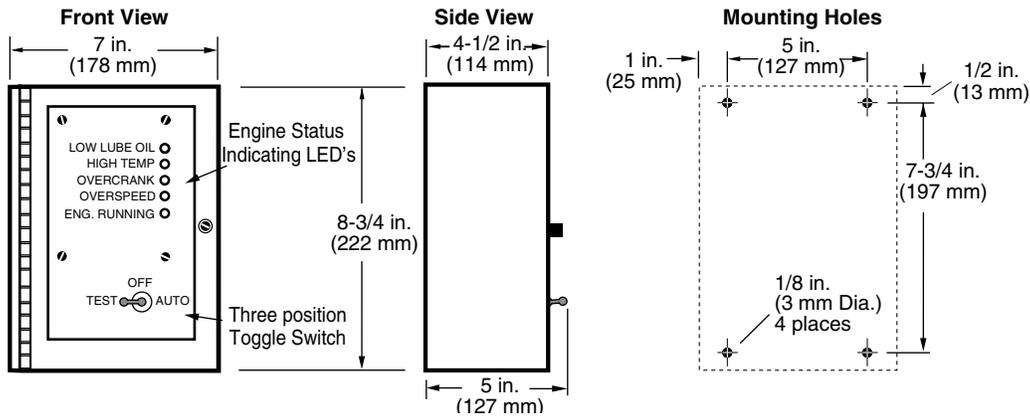
Select a suitable mounting location for the A91 that provides easy access to the panel. The A91 should be mounted away from the engine to avoid shock and vibration. Never mount the A91 on top of the engine.

A wall or a pedestal are recommended mounting location for the A91.

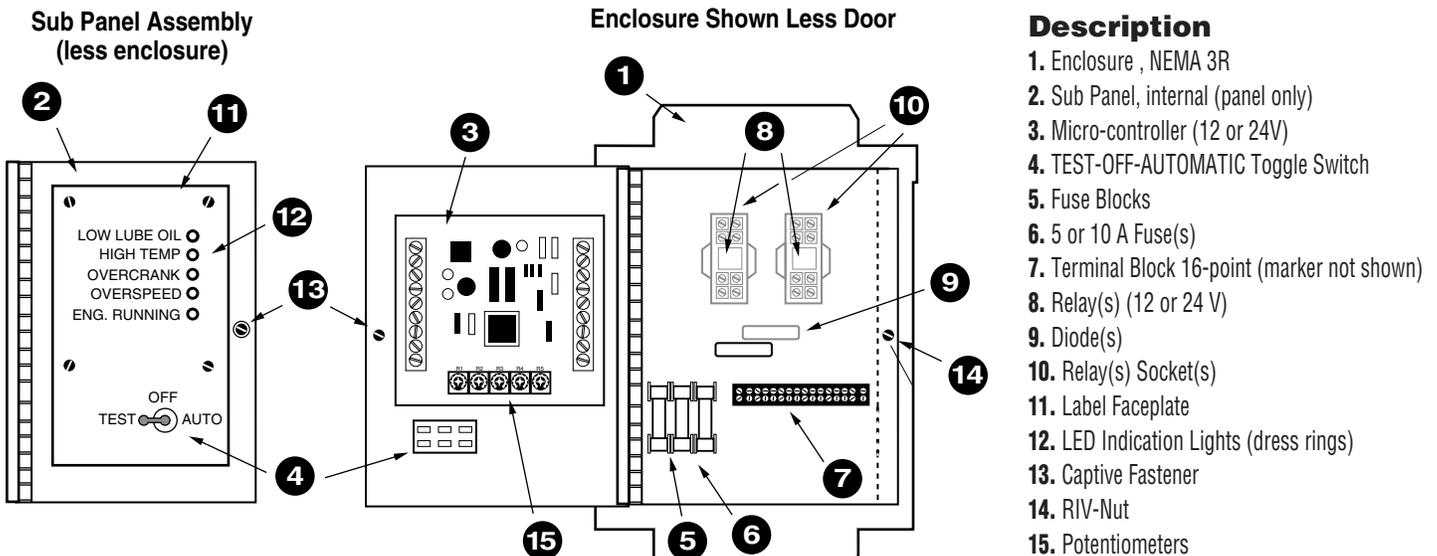
To secure the A91 in place, 4 mounting screws are required (not included). Mounting screws size should be 1/4-20 (recommended) or larger. Refer to the Dimensions schematic, below.



Subpanel (Option -LC) Dimensions



A91 INTERNAL SCHEMATIC



WIRING INFORMATION



WARNING: STOP THE MACHINE AND DISCONNECT ALL ELECTRICAL POWER BEFORE BEGINNING INSTALLATION. DISCONNECT BATTERY'S GROUND CABLE DURING WIRING.

Wiring diagram on pages 6/7 show typical engine installations, and the following is terminal by terminal explanation of that wiring.

Terminal 1 must be connected to the ungrounded side of the battery (+).

Terminal 2 must be connected to a good engine ground (-).

Terminals 3 and 4 are to be connected to the magnetic pick-up. It is good practice to use a shielded two conductor cable for these connections. Ground the shield to a good engine ground, or connect to terminal 3.

Terminal 5 is an optional connection to the low lube oil shutdown SWICHGAGE® or other device. (Pressure, level, etc.)

Terminal 6 is an optional connection to the high engine temperature shutdown SWICHGAGE® or other device. (Temperature, level, etc.)

Terminal 7 is an optional connection for battery charging alternator excitation.

Terminals 8 - 9 must be connected to the start and stop inputs. These terminals can be connected for two different type of circuits. (See drawings, p-6/7.)

Single Pole Single Throw (close to run, open to stop)

- Connect terminal 8 to a good engine ground.
- Connect terminal 9 to the start contact. Start contact should be grounded.

Single Pole Double Throw (on-off-on, or on-off)

- Connect terminal 8 to the normally closed (stop).
- Connect terminal 9 to the normally open (start).
- Connect common to a good engine ground.

Terminal 10 - 11 - 12 are reserved for the A91-S option, and are used to power up, or ground out higher voltage or current ignition systems, or higher current solenoid operators. See supplement drawing on pages 6 and 7.

Terminal 12 must be connected to an energized-to-run device, not to exceed 5 amps in current. This device can be:

- An ignition coil, or ignition module.
- A fuel solenoid valve.
- A solenoid operator.
- A pilot relay for any of the above.

Terminal 13, 14, and 15 are reserved for the A91-WC option, and are used to operate throttle, or clutch engagement devices. See supplement drawing, p-6 and 7.

Terminal 16 must be connected to starter solenoid pilot relay.

TO SELECT THE TYPICAL WIRING DIAGRAM FOR YOUR APPLICATION, SEE TYPICAL WIRING DRAWINGS ON PAGES 6 AND 7.

SEQUENCE OF OPERATIONS



CAUTION: BEFORE PERFORMING THE SEQUENCE OF OPERATION, MAKE SURE THE COMPLETE A91 IS PROPERLY MOUNTED AND INSTALLED. CHECK ALL ELECTRICAL WIRING CONNECTIONS. REPLACE ALL COVERS, LIDS AND ENCLOSURES BEFORE APPLYING POWER TO THE A91. STAND CLEAR OF MACHINE AT ALL TIMES WHEN IT IS OPERATING.

Toggle Switch Functions

TEST: When in the TEST position, the automatic start and run sequences initiate. The A91 will perform its operations as though an automatic start signal was received. The engine will remain in operation until the selector is moved to the OFF position and will shut down immediately.

OFF: Disconnects control power to prevent the engine from starting/running. Provides an immediate shutdown when the selector is placed to OFF.

AUTO(matic): As described in the sequence of operations.

TO RESET: Turn the selector switch to OFF, and wait for 10 seconds. Return to the AUTO or TEST position.

To Start the Engine

NOTE: The A91 features a field adjustable time delay (from 2 to 180 sec.) that delays both, the start and stop periods equally.

- Move the toggle switch to the AUTO position.
- When a momentary start signal is applied to the A91 start input (0.5 sec. approx.), an automatic start sequence will occur.
 - Battery (+) is supplied to terminal 7 for alternation excitation.
 - Ignition or fuel valve power is supplied to terminal 12, ready for engine start, for magneto/ignition, terminal 10 is ungrounded (-S models only).
 - The overspeed shutdown circuit is armed immediately.
 - Cycle cranking begins: battery (+) is alternately supplied to terminal 16 to crank the engine for 7 seconds and rest for 15 seconds until engine starts or the overcrank circuit operates.

NOTE: If engine refuses to start after 5 cranking attempts, the Overcrank LED will light, and the A91 will shut down and lock out. The LED and lock-out circuits must be manually reset by turning toggle switch to OFF, then back to AUTO or TEST, before the A91 resumes normal operation.

- When the engine speed rises above the adjustable crank disconnect speed setting, the automatic run sequence begins.
 - Cycle cranking is discontinued immediately and is indicated by the Engine running green LED.
 - Two timer periods begin.
 - The oil pressure and engine temperature shutdown lockout time delay begins. If the engine dies before the 15 second time delay expires, the A91 will wait 15 seconds before attempting to restart.

- The warm up time delay begins (field adjustable from 0 to 300 sec. on -WC models only.)

- When the time delay expires, the oil pressure and engine temperature shutdowns are armed. If engine dies after the 15 sec. time delay expires, the A91 will shut down/lock out turning ON both the overcrank and overspeed LED's indicating loss of speed/speed signal, requiring manual reset.

Shutdown and Lockout

When a SWICHGAGE® senses low oil pressure or high temperature, it signals the A91 to shut down immediately. An LED will indicate the shutdown. Manual reset is required before resuming normal operation.

Overspeed

A91 overspeed sensing circuit will trip the overspeed LED and shutdown the engine. Manual reset is required before resuming normal operation.

- When the warm up time delay expires: (model -WC only).
 - An SPDT contact, connected to terminals 13, 14 and 15 operates the loading device (throttle control, clutch actuator, etc).
- When a stop relay signal is received at the A91 (for approx. 0.5 sec.), an automatic stop sequence begins:
 - The SPDT contact connected to terminals 13, 14, and 15 resets to actuate loading devices to unload the engine and reduce the speed to a cooldown condition. (Model -WC only.)
 - Cooldown time delay begins: (field adjustable 0-300 sec. Model -WC).

After the cooldown time delay expires (Model-WC only.)

- All shutdown circuits are locked out.
- Ignition or fuel valve power is removed from terminal 12 to stop the engine. For magneto ignitions the terminal 10 is grounded (Model -S).
- Control circuits automatically reset for next start sequence.

LED's: Light Emitting Diodes indicate the cause of shutdown and lockout for:

**LOW LUBE OIL
HIGH TEMPERATURE
OVERCRANK
OVERSPEED**

NOTE: When both the overspeed and the overcrank LED's are lit, the engine died for some unknown reason, or the engine reference speed signal (magnetic pick-up) was lost.

FIELD ADJUSTMENTS



WARNING: REMOVE POWER BEFORE OPENING THE ENCLOSURE ACCESS DOOR AND THE SUB PANEL HINGED. DO NOT ATTEMPT TO ADJUST THE POTENTIOMETERS WHILE THE MACHINE IS RUNNING. IT IS YOUR RESPONSIBILITY TO HAVE A QUALIFIED PERSON ADJUST THE UNIT, AND MAKE SURE IT CONFORMS WITH NEC AND LOCAL CODES AND ORDINANCES.

The Potentiometers

The (5) potentiometers are mounted on the ASM-200 printed circuit board, behind the hinged internal subpanel, at the bottom of the PCB. See the *A91 Internal Schematic* (page 2).

Potentiometers are assigned as follows:

R1– Warm up delay: Adjustable from 0–300 sec.

R2–Cooldown delay: Adjustable from 0–300 sec.

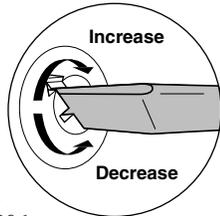
R3–Crank disconnect: Adjustable from 400–2,500 hertz.

Turn the potentiometer fully clockwise, loosen the crank wire at terminal 16 (causes the engine to start and immediately disconnects the crank wire to prevent further cranking). Slowly turn potentiometer counterclockwise until the green LED (RUN) turns “on”. This adjustment must be completed within 90 seconds, or the engine will shut down and indicate OVERCRANK. Simply enable starter circuit, manually reset the A91, and try again.

R4–Overspeed: Adjustable from 2,500 - 9,000 hertz.

R5–Start and Stop delays: Adjustable from 0–180 sec., (both delays).

ADJUSTMENT DETAIL



Adjusting the Potentiometers

To make adjustments, turn the potentiometer clockwise to increase the value and counterclockwise to decrease it. See the *Adjustment Detail* (left) and the *Factory Setting schematic* (below).

To Obtain Frequency (Hertz) Value

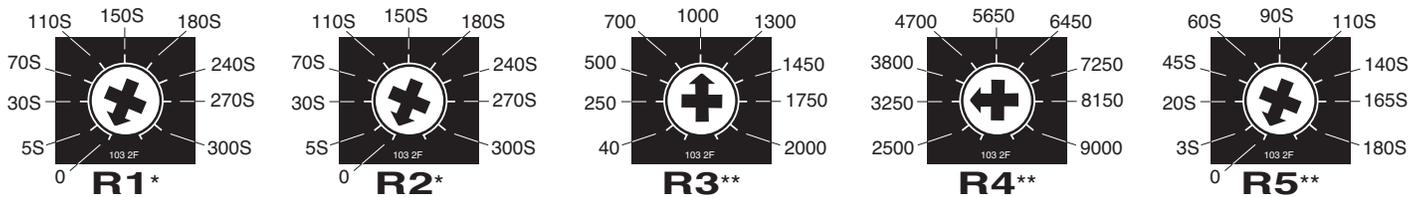
To obtain the frequency (Hertz) value, multiply the number of teeth on the starter ring gear, times the RPM value, and divide the result by 60 seconds.

Example: If the starter is to disconnect at 500 RPM, and the ring gear has 120 teeth, use the formula:

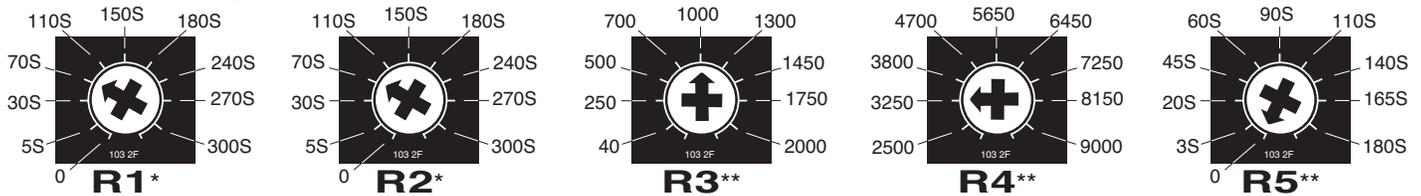
$$\frac{500 \times 120}{60} = 100 \text{ Hertz}$$

NOTE: Follow the same formula for the overspeed settings.

Factory settings for A-91 and A-91-S models



Factory settings for A-91-WC and A-91-S-WC models



*The dial calibrations are in seconds and are approximate

**The dial calibrations are in hertz and are approximate

TESTING THE A91 WITHOUT RUNNING THE ENGINE

Tools Needed:

2 small lights with wire leads and bulbs rated the same voltage as the starting battery. 1 screwdriver (medium). 1 AC signal generator or a plug-in transformer with a maximum secondary voltage of 15 VAC (such as a RADIO SHACK 273-1610, or 272-1611). 1 jumper wire 12 inches (305 mm) long.

Connections

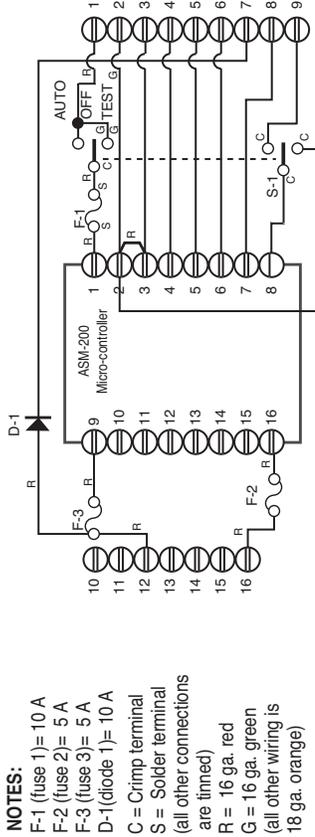
1. Turn the A91 toggle switch to OFF.
2. Set potentiometer R3 to its lowest setting (fully counterclockwise).
3. Disconnect wires from terminals 3 and 4 and connect the signal generator/plug-in transformer instead.
5. Disconnect the wire from terminal 16 and connect one wire from one of the lights instead. Ground the other lead and label crank.
6. Disconnect the wire to terminal 12 and connect one wire from the other light instead. Ground the other lead and label ignition.
7. Disconnect shutdown switches from terminals 5 and 6.
8. Ground one end of your 12 inch (305 mm) jumper.

Testing

1. Turn toggle switch to TEST. Ignition light should turn ON.
2. Crank light should turn ON for 7 seconds, and OFF for 15 seconds and repeat this sequence for 5 tries. The OVERCRANK LED should turn ON, and turn OFF the ignition light.
3. Reset OVERCRANK lockout. Move toggle switch to TEST.
4. Sequence “2” will begin. After one or two crank cycles adjust your signal generator to 60 hertz, or plug-in the transformer. The crank light should turn OFF, and ignition light should turn ON.
5. Wait for 15 seconds, then with your jumper ground-out, terminal 5 the ignition LED should turn OFF, and the low lube oil LED should stay ON.
6. Reset and repeat. This time ground out terminal 6 to test the high engine temperature lockout.
7. Repeat “2” and “3”. Move the selector to OFF. The ignition light should turn OFF.
8. All other devices should operate as if the engine was running.
9. Re-connect your original wiring.

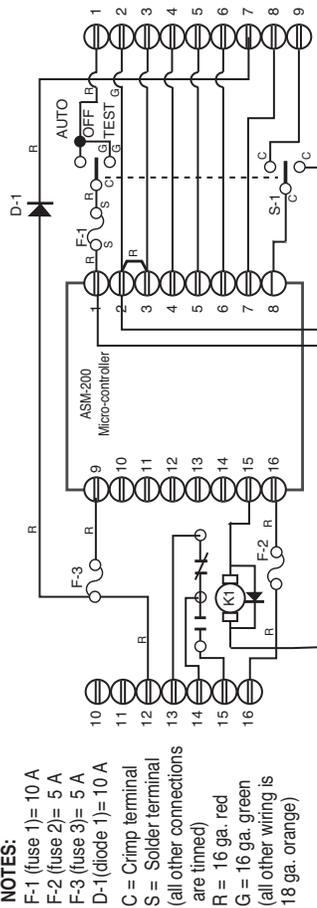
A91 INTERNAL WIRING DIAGRAMS

A91



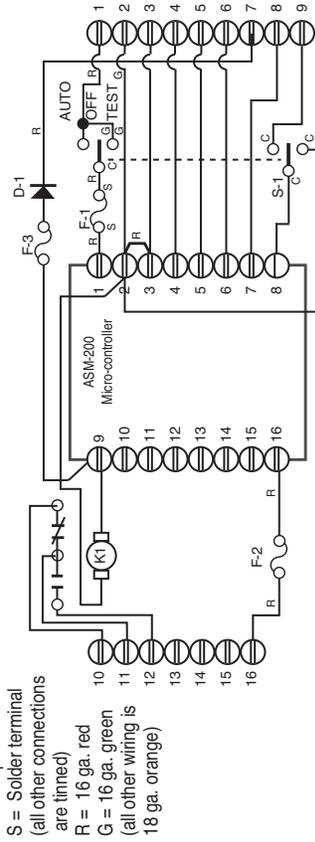
- NOTES:**
 F-1 (fuse 1)= 10 A
 F-2 (fuse 2)= 5 A
 F-3 (fuse 3)= 5 A
 D-1(diode 1)= 10 A
 C = Crimp terminal
 S = Solder terminal
 (all other connections are tinned)
 R = 16 ga. red
 G = 16 ga. green
 (all other wiring is 18 ga. orange)

A91-WC



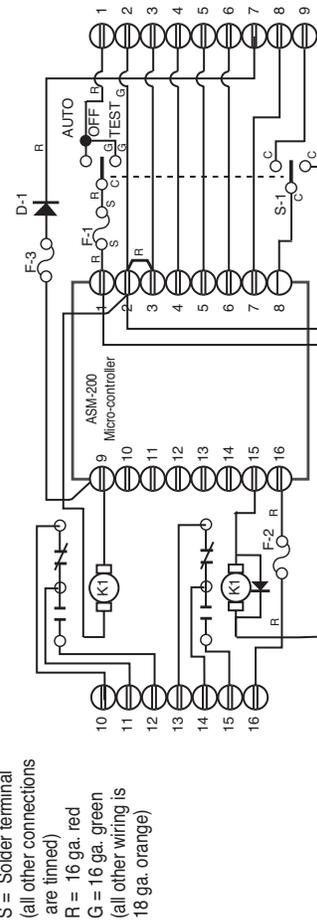
- NOTES:**
 F-1 (fuse 1)= 10 A
 F-2 (fuse 2)= 5 A
 F-3 (fuse 3)= 5 A
 D-1(diode 1)= 10 A
 C = Crimp terminal
 S = Solder terminal
 (all other connections are tinned)
 R = 16 ga. red
 G = 16 ga. green
 (all other wiring is 18 ga. orange)

A91-S



- NOTES:**
 F-1 (fuse 1)= 10 A
 F-2 (fuse 2)= 5 A
 F-3 (fuse 3)= 5 A
 D-1(diode 1)= 10 A
 C = Crimp terminal
 S = Solder terminal
 (all other connections are tinned)
 R = 16 ga. red
 G = 16 ga. green
 (all other wiring is 18 ga. orange)

A91-S-WC



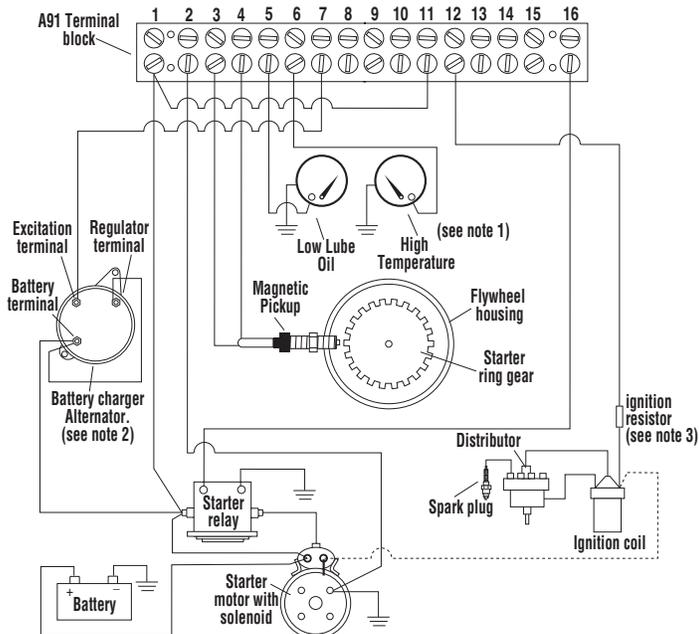
- NOTES:**
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 F-2 (fuse 2)= 5 A
 F-3 (fuse 3)= 5 A
 D-1(diode 1)= 10 A
 C = Crimp terminal
 S = Solder terminal
 (all other connections are tinned)
 R = 16 ga. red
 G = 16 ga. green
 (all other wiring is 18 ga. orange)

TYPICAL WIRING DIAGRAMS



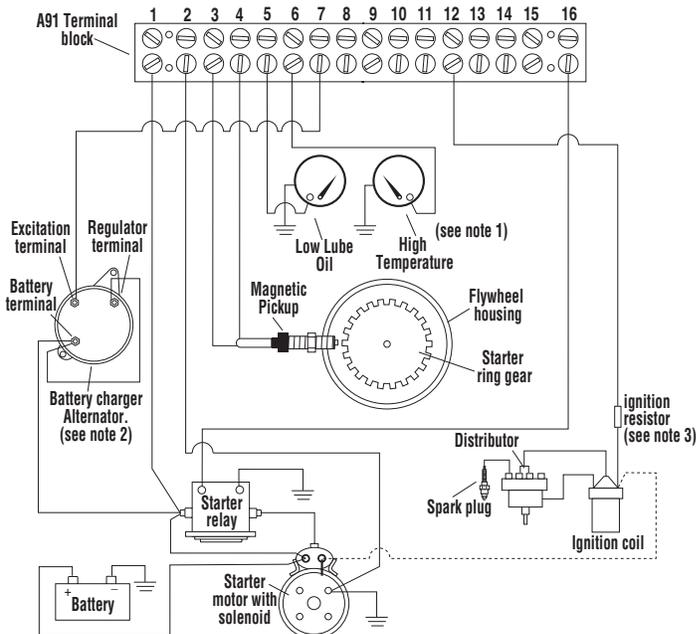
WARNING: STOP THE Engine AND DISCONNECT ALL ELECTRICAL POWER BEFORE BEGINNING the wiring installation. DISCONNECT BATTERY'S GROUND CABLE DURING WIRING. Do not bundle sensor inputs wiring with any other wiring.

For Spark Ignition Engines with high current, battery powered distributor, less than 10 A.



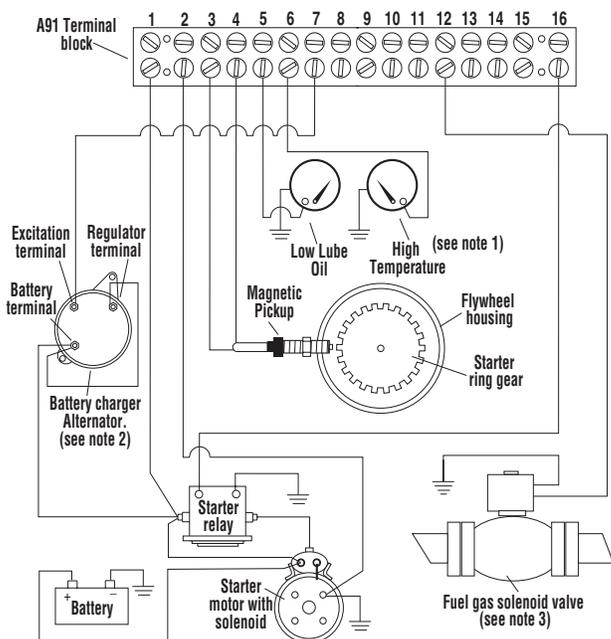
1. Oil pressure and water temperature SWICHGAGE® instruments are shown for simplicity. Any sensor for oil pressure, or level, or water or oil temperature can be used, as long as its contacts are open to run, and close to ground for shutdown lockout.
2. A Delco brand alternator is shown for illustrative purposes. All alternators will operate with the A91 series microcontroller. The A91 terminal 7 provides excitation current for ALL alternators.
3. Leave ignition resistor or resistor wire in place, and only wire to these resistive devices.

For Spark Ignition Engines with low current electronic module and battery powered distributor, less than 5 A.



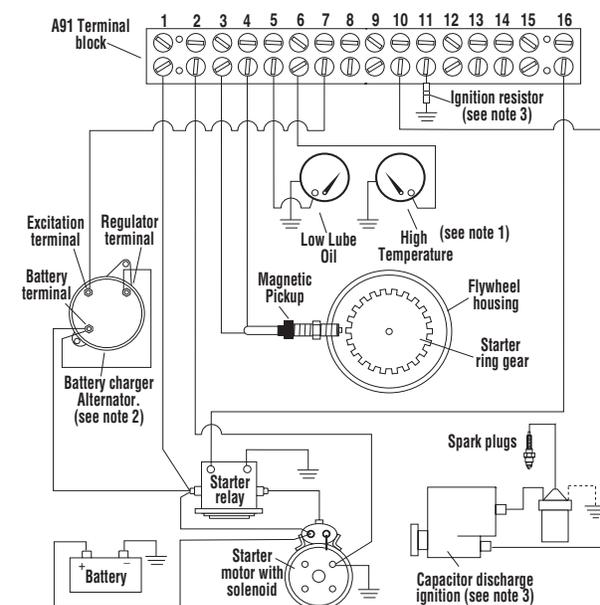
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2. A Delco brand alternator is shown for illustrative purposes. All alternators will operate with the A91 series microcontroller. The A91 terminal 7 provides excitation current for ALL alternators.
3. Leave ignition resistor or resistor wire in place, and only wire to these resistive devices.

For Spark Ignition Engines with Magneto Ignition, break point type, high or low tension.



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2. A Delco brand alternator is shown for illustrative purposes. All alternators will operate with the A91 series microcontroller. The A91 terminal 7 provides excitation current for ALL alternators.
3. A fuel gas solenoid valve can be installed in the fuel gas line for all gas fire spark ignition engines.

For Spark Ignition Engines with Capacitor Discharge (CD) type breakerless ignitions.



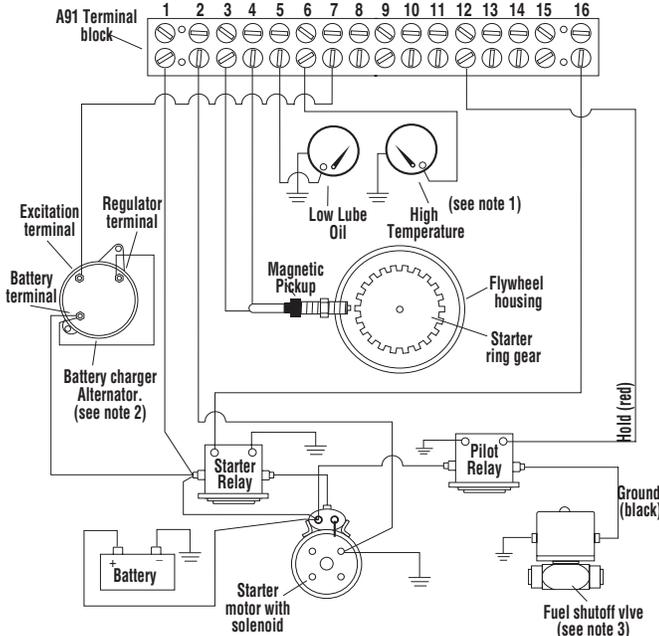
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2. A Delco brand alternator is shown for illustrative purposes. All alternators will operate with the A91 series microcontroller. The A91 terminal 7 provides excitation current for ALL alternators.
3. A high and low tension magnetos can be killed by grounding directly as shown. Capacitor discharge ignition systems also called solid-state and breakerless, can be killed by grounding through a 100 ohm, 2 watt resistor as shown.

TYPICAL WIRING DIAGRAMS



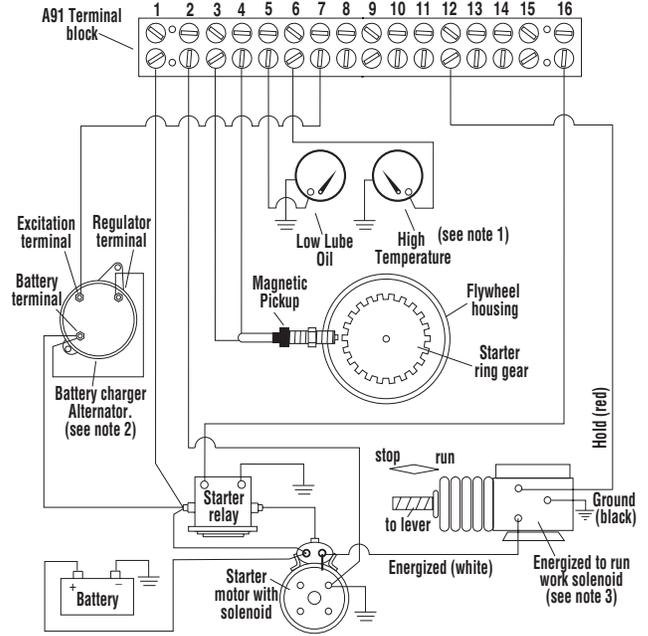
WARNING: STOP THE Engine AND DISCONNECT ALL ELECTRICAL POWER BEFORE BEGINNING the wiring installation. DISCONNECT BATTERY'S GROUND CABLE DURING WIRING. Do not bundle sensor inputs wiring with any other wiring.

For Diesel Engines with Fuel Solenoid Valve, low current below 5A, external or built-in injection pump



1. Oil pressure and water temperature SWICHGAGE® instruments are shown for simplicity. Any sensor for oil pressure, or level, or water or oil temperature can be used, as long as its contacts are open to run, and close to ground for shutdown lockout.
2. A Delco brand alternator is shown for illustrative purposes. All alternators will operate with the A91 series microcontroller. The A91 terminal 7 provides excitation current for ALL alternators.
3. Fuel shutoff can be separate valve installed in fuel line or energized to run solenoid built into injection

For Diesel Engines with energized to run work solenoid, (3) wire.

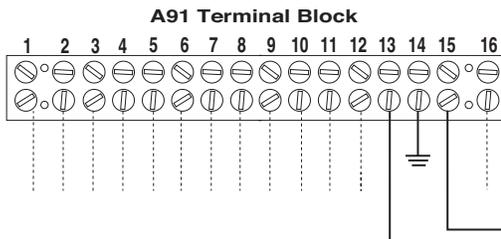


1. Oil pressure and water temperature SWICHGAGE® instruments are shown for simplicity. Any sensor for oil pressure, or level, or water or oil temperature can be used, as long as its contacts are open to run, and close to ground for shutdown lockout.
2. A Delco brand alternator is shown for illustrative purposes. All alternators will operate with the A91 series microcontroller. The A91 terminal 7 provides excitation current for ALL alternators.
3. Work solenoid can be installed on diesel engines to work-to-run lever for automatic control.

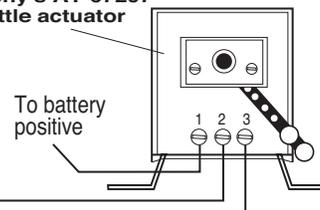
TYPICAL WIRINGS FOR ALL -WC (WARMUP /COOLDOWN) MODELS



WARNING: STOP THE Engine AND DISCONNECT ALL ELECTRICAL POWER BEFORE BEGINNING the wiring installation. DISCONNECT BATTERY'S GROUND CABLE DURING WIRING. Do not bundle sensor inputs wiring with any other wiring.

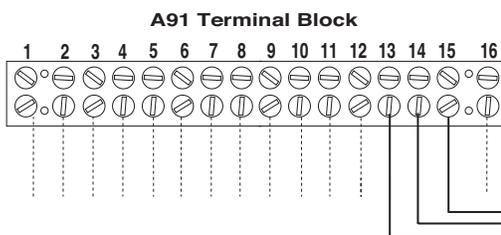


Murphy's AT-67207 Throttle actuator

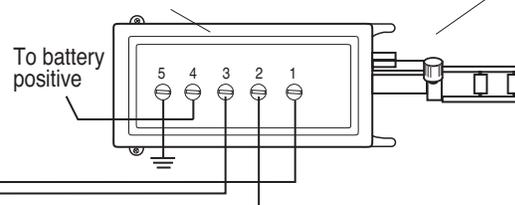


NOTE: The throttle actuator increases the engine speed at the end of the warmup period, and decreases the speed at the start of the cooldown period. If the throttle controller moves in the opposite direction than desired, reverse wires at terminal #13 and #15 on the A91 terminal block, or terminals #2 and #3 at the throttle actuator. The dotted line represents the (typical) basic wiring shown on the installation drawings, pages 6/7.

Only one device is required. Contact Murphy for details



Murphy's CO-3 Clutch operator



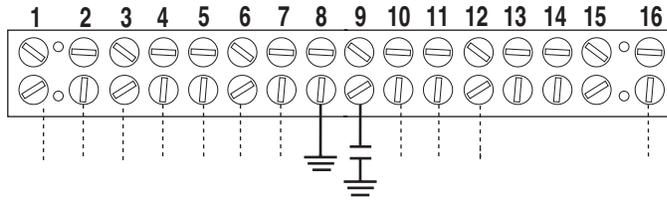
NOTE: The clutch operator engages the clutch at the end of the warmup period, and dis-engages at the start of the cooldown period. The dotted line represents the (typical) basic wiring shown on the installation drawings, pages 6/7.

TYPICAL WIRINGS FOR REMOTE START AND STOP CIRCUITS



WARNING: STOP THE Engine AND DISCONNECT ALL ELECTRICAL POWER BEFORE BEGINNING the wiring installation. DISCONNECT BATTERY'S GROUND CABLE DURING WIRING. Do not bundle sensor inputs wiring with any other wiring.

A91 Terminal Block

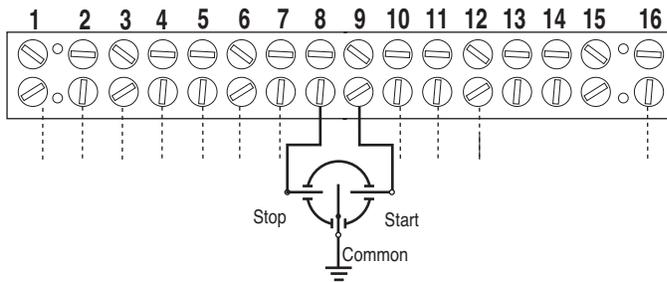


Single Start and Stop contact

Contact closes to start and run.
Contact opens to stop.

Dotted wiring is the wiring shown on the typical wiring diagrams (p-6/7)

A91 Terminal Block



Dual Start and Stop contact (SPDT)

Momentary close one contact to start and run.
Momentary close other contact to stop.

Dotted wiring is the wiring shown on the typical wiring diagrams (p6/7)

A91 SERVICE PARTS

A91, A91-S, A91-WC, and A91-S-WC

PART NO.	DESCRIPTION	PART NO.	DESCRIPTION
40-05-0436	Enclosure, NEMA 3R	00-00-3434	Terminal block 16-point
40-00-0097	Sub panel, internal (panel only)	00-00-3435	Marker, terminal block
00-00-3430	Micro-controller ASM-200-P-A91043-2 (12 V)	00-00-2952	12V relay
00-00-3438	Micro-controller ASM-200-P-A91043-2 (24 V)	00-00-2953	24V relay
00-00-3431	TEST - OFF - AUTO(matic) toggle switch	65-01-0087	Diode
00-00-3432	Fuse blocks	00-00-2378	Relay socket
00-00-3433	5A fuse	40-05-0421	Label faceplate
00-00-2157	10A fuse	00-00-3436	LED dress ring
		00-00-2380	Captive fastener
		00-00-2379	RIV nut

Warranty

A limited warranty on materials and workmanship is given with this FW Murphy product.
A copy of the warranty may be viewed or printed by going to www.fwmurphy.com/support/warranty.htm



FW Murphy
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