MODEL EC120

ENGINE CONTROL

INSTRUCTION MANUAL

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SECTION 1. INTRODUCTION

The Model EC120 is an all solid state control, containing all of the logic, timing and annunciation required for the automatic control and protection of an engine. The unit consists of a single circuit card mounted in an iridited aluminum chassis with a stainless steel front panel, suitable for flush mount. Unit dimensions are 7" x 7" x 1.5" HWD. The internal power supply will operate from 8 - 30 VDC, allowing the EC120 to be used with 12 VDC or 24 VDC systems.

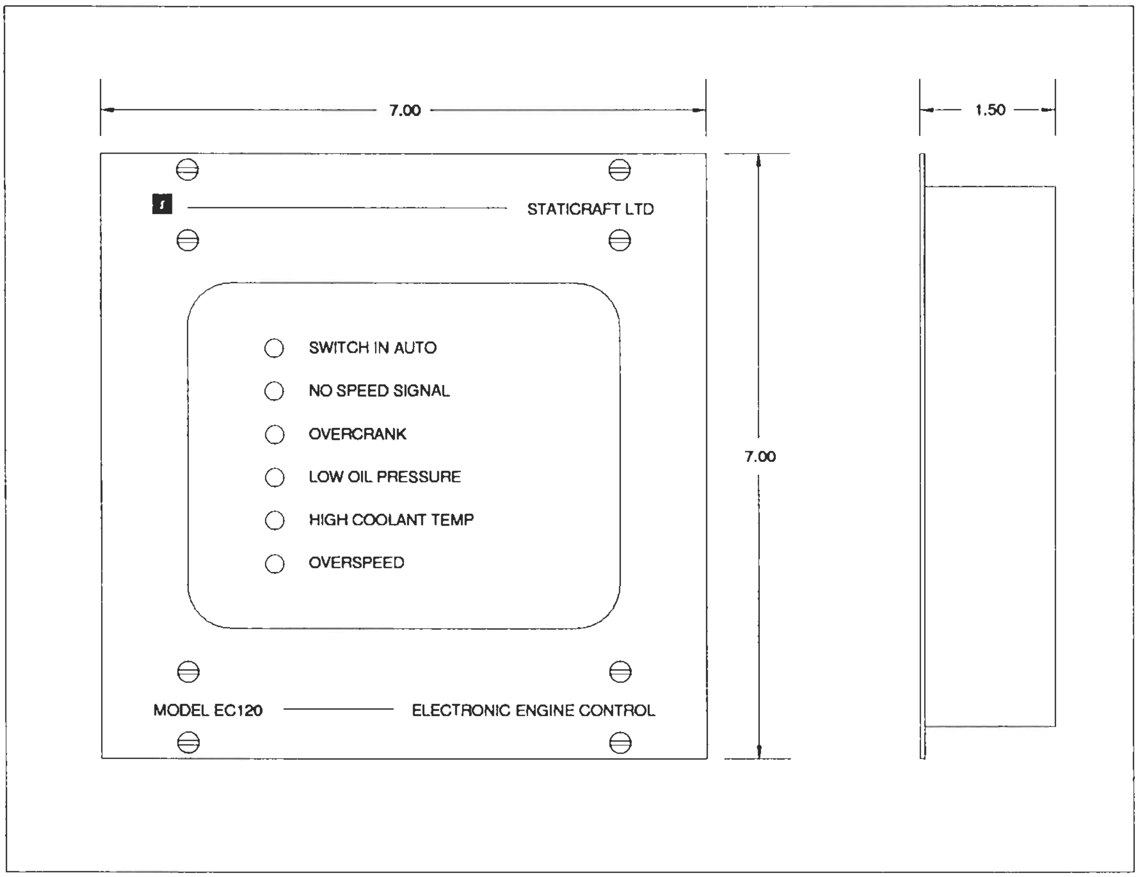

FIGURE 1-1 EC120 PHYSICAL LAYOUT

The EC120 has an internal electronic speedswitch to disconnect the starter motor and provide overspeed protection. In addition, a signal derived from the speedswitch circuitry is conditioned to provide a 0 - 1 mADC output suitable for driving a 0 - 1 mADC meter calibrated in RPM. The control also provides a crank timer (TDCR), user-adjustable from 6 - 60 seconds.

The overspeed setpoint, crank time and tachometer calibration are set with multi-turn potentiometers located in the top left corner of the circuit card when viewing the unit from the back. The potentiometers are accessed through a slot on the left side of the back cover, again viewing the unit from the back. A 12-pole terminal block is also located on the back of the circuit card to allow external wiring to be connected. Refer to figure 1-2.

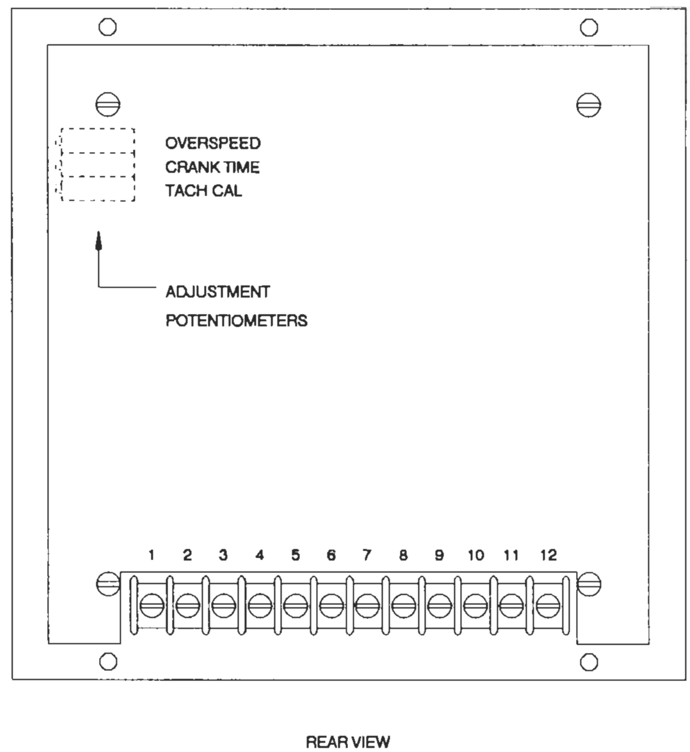

FIGURE 1-2 EC120 POTENTIOMETERS AND TERMINAL BLOCK

The EC120 has two modes of operation; manual and automatic. The mode is selected by grounding either terminal 1 (manual operation), or terminal 2 (automatic operation). If automatic operation is selected the "engine start contact" input (terminal 3) determines whether the control is to start or stop the engine. This is described in detail in section 3.1.

Protection is provided for the following alarm conditions;

- **No Speed Signal**
- **Overcrank**
- **Low Oil Pressure**
- **High Coolant Temperature**
- **Overspeed**

Individual panel lamps are provided to indicate the cause of the alarm, and a common alarm relay driver output is supplied for applications requiring a remote alarm.

SECTION 2. CIRCUITRY

In order to properly interface the Model EC120 with external wiring or devices, a clear understanding of the operation of specific sections of EC120 circuitry is required.

2.1 POWER SUPPLY

The EC120 power supply will operate from an 8 - 30 VDC source. Battery positive is applied to terminal 7, and battery negative to terminal 8. The power supply input is protected against reverse polarity, so accidentally reversing the polarity of the two terminals will not damage internal circuitry. The DC power is applied to a series pass voltage regulator to produce the +5 VDC used by internal components.

Noise protection and over-voltage protection are built in to the DC input. However, subjecting the input to extremely high DC or AC voltage can cause damage. Refer to section 6 for a more detailed coverage of this topic.

2.2 LOGIC INPUTS

This control is equipped with five high impedance logic inputs (terminals 1 - 5). The inputs are normally held high (+5 VDC) when open circuit. In order to activate the input, ground the input terminal to battery negative. This will pull the input to ground potential, and cause the downstream logic to switch state (refer to figure 2-1). Notice that an external relay contact (supplied by others) is used to ground the logic input.

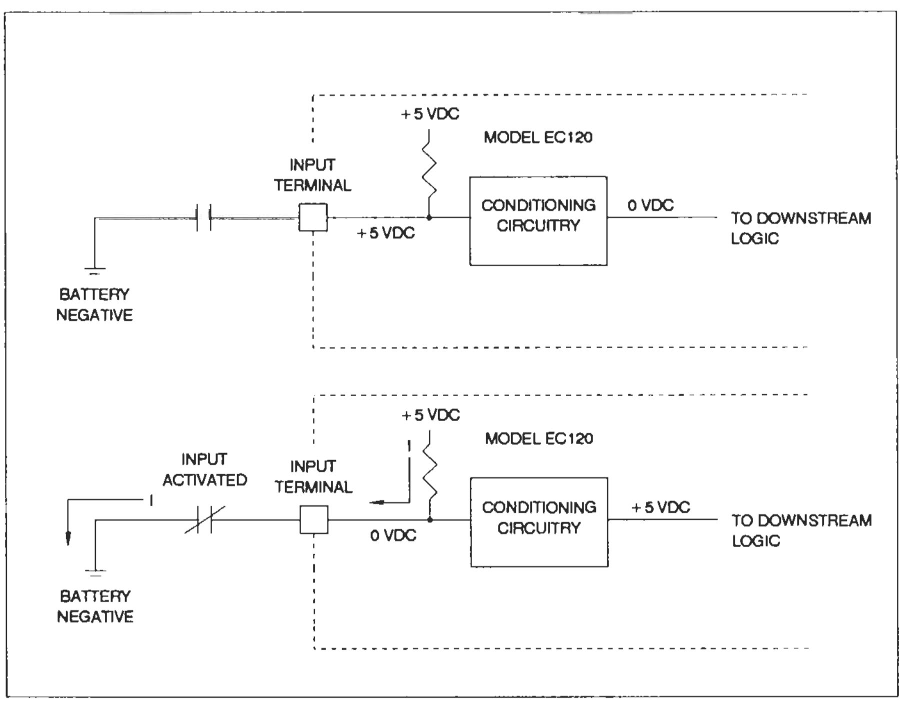

FIGURE 2-1 LOGIC INPUT

2.2.1 Manual

Terminal 1 is the connection point for the manual position of the control switch. This is described in detail in section 3.1.

2.2.2 Automatic

Terminal 2 is the connection point for the automatic position of the control switch. This is described in detail in section 3.1.

2.2.3 Start Contact

Terminal 3 is the connection point for the engine start contact. This is described in detail in section 3.1.

2.2.4 Oil Pressure

A contact from an engine mounted lube oil pressure switch (supplied by others) is connected from terminal 4 to battery negative. Switch operation should be contact closure on falling oil pressure.

2.2.5 Coolant Temperature

A contact from an engine mounted coolant temperature switch (supplied by others) is connected from terminal 5 to battery negative. Switch operation should be contact closure on rising coolant temperature.

2.3 RELAY DRIVER OUTPUTS

The EC120 is equipped with three relay driver outputs (terminals 9,10,11). The outputs are high current silicon transistors providing a current sink to battery negative. To use the outputs, connect a relay coil (supplied by others) from the output terminal to battery positive as illustrated in figure 2-2.

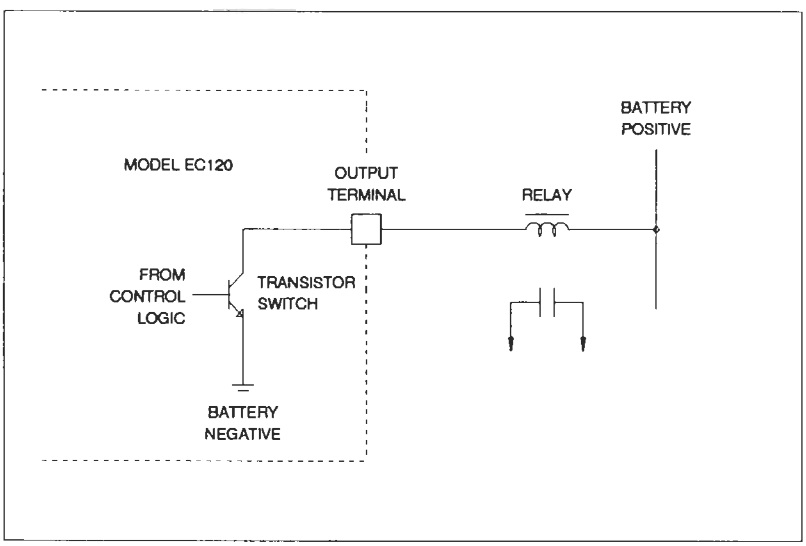

FIGURE 2-2 RELAY DRIVER OUTPUT

The transistor is controlled by internal logic. When the transistor is off, it behaves like an open switch, and no current flows through the relay coil (figure 2-3). When the transistor is turned on, it acts as a closed switch, and current flows through the relay coil and transistor to battery negative, completing the circuit and energizing the relay coil (figure 2-4).

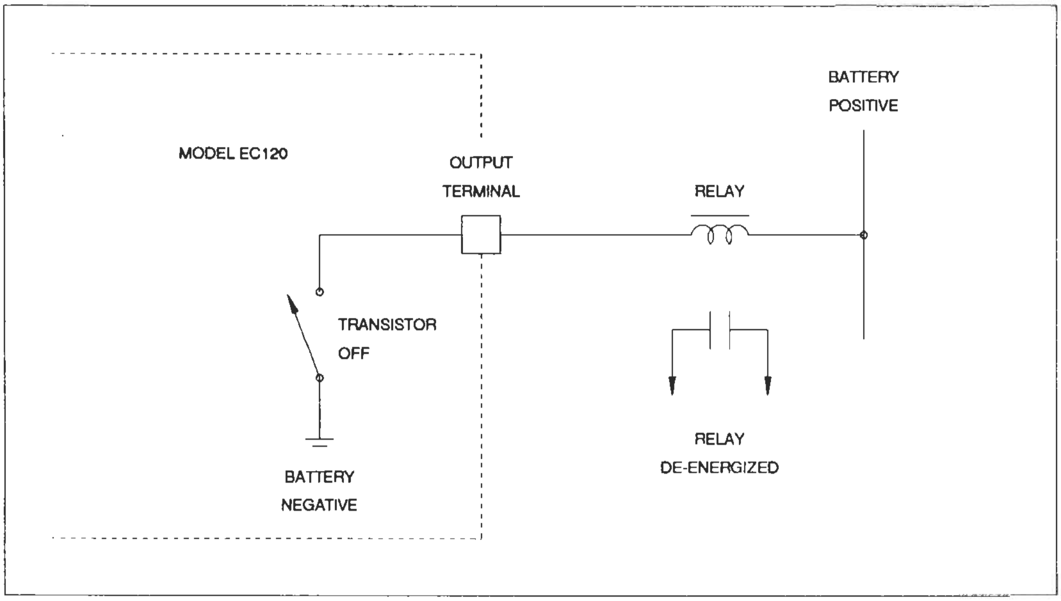

FIGURE 2-3 OUTPUT DE-ENERGIZED

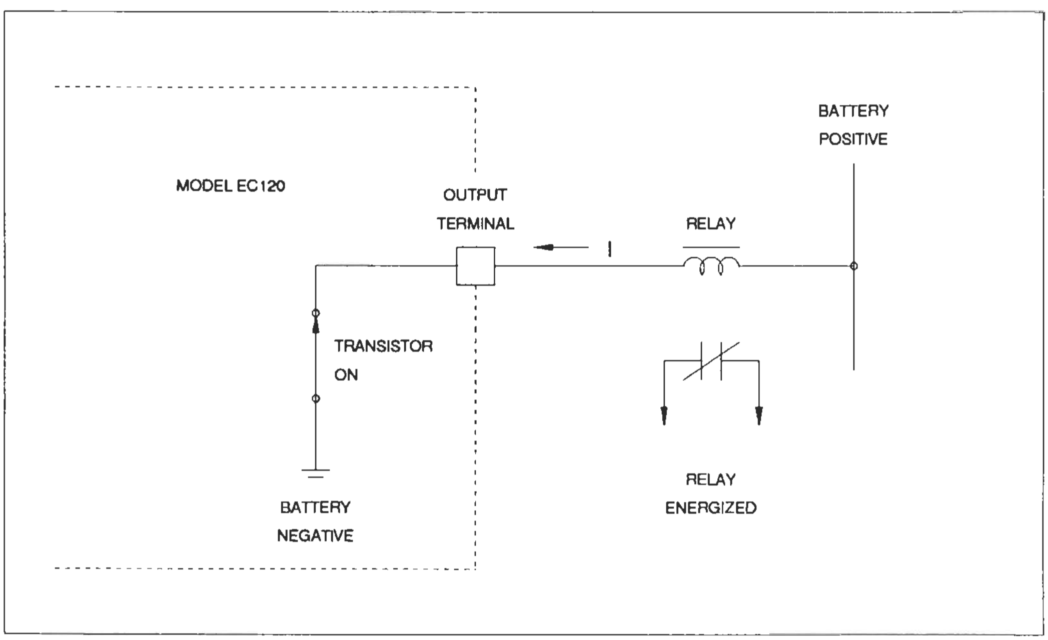

FIGURE 2-4 OUTPUT ENERGIZED

Note: the output transistors are rated at **1 ADC MAXIMUM @ 30 VDC**. Therefore, if relays or solenoids drawing more than 1 ADC (such as fuel or starter solenoids) are to be activated by the transistor output, slave relays **MUST** be used. Figure 2-5 illustrates a typical slave relay application.

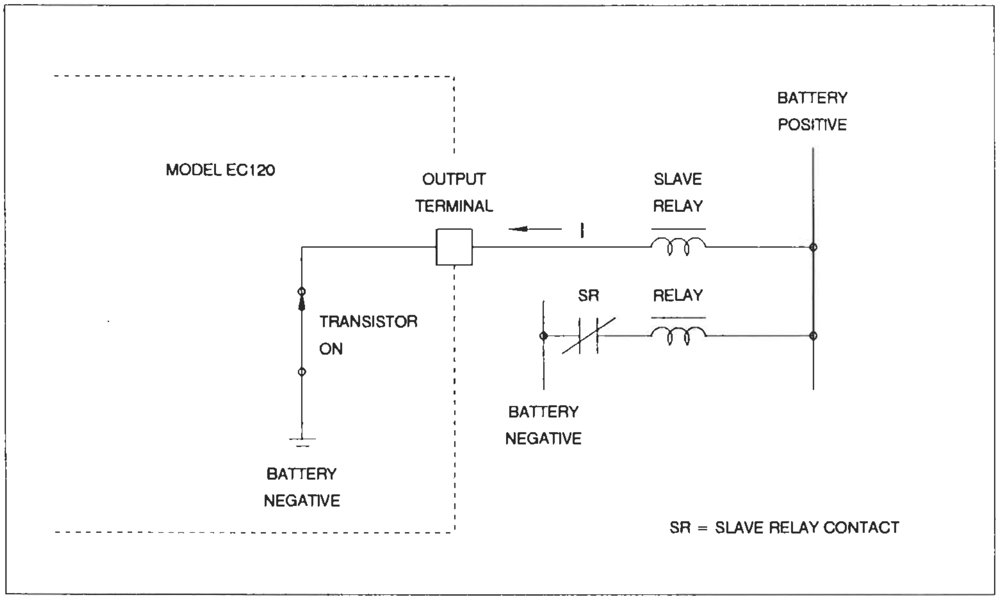

FIGURE 2-5 SLAVE RELAY CONNECTION

2.3.1 Fuel

The fuel output (terminal 9) is energized whenever the engine is to run. The output will remain energized until the engine is signalled to stop, or a shutdown occurs.

2.3.2 Crank

The crank output (terminal 10) is energized whenever the engine is to crank. The output is de-energized when engine speed exceeds the speedswitch low setpoint.

2.3.3 Alarm

This output (terminal 11) is energized when the engine is shut down on fault. The output will remain energized until the control is reset by placing the function switch in Off.

SECTION 3. OPERATION

3.1 OPERATING MODE

The EC120 has two operating modes, MANUAL and AUTOMATIC. The mode is selected by connecting battery negative to either terminal 1 (manual operation) or terminal 2 (automatic operation). Typically, this is done using a three-position function switch (supplied by others). The third position (OFF), will reset any alarms generated by the control following a shutdown. Figure 3-1 illustrates the recommended switch arrangement.

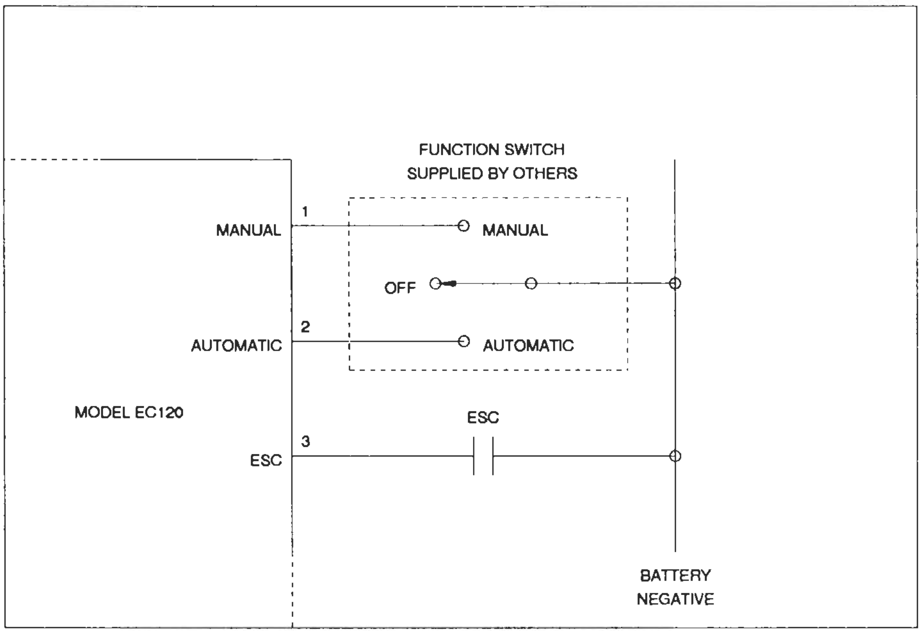

FIGURE 3-1 FUNCTION SWITCH AND ENGINE START CONTACT

3.1.1 Manual Operation

Shorting terminal 1 to battery negative will signal the engine to start and run. To stop the engine, remove battery negative from terminal 1.

3.1.2 Automatic Operation

Shorting terminal 2 to battery negative will select Automatic operation, but will not signal the engine to start. A "Switch In Auto" lamp located on the front panel is energized when the control is in this mode.

When Automatic operation is selected, the start signal is issued when the "engine start contact" (ESC) input (terminal 3) is grounded. To stop the engine, remove battery negative from terminal 3.

NOTE: The ESC input is not active unless the control is in the Automatic mode of operation.

3.2 ELECTRONIC SPEEDSWITCH

An electronic speedswitch is built in to the EC120. The speedswitch disconnects the starter motor when the engine fires, and provides overspeed protection. Two switchpoints—speedswitch low and speedswitch high—are provided to perform these functions.

Engine speed is derived from the frequency of the generator output voltage. A transformer (supplied by others) must be used to transform the generator output voltage to a nominal 24 VAC level before it is applied to terminals 6 and 8 of the control. It is extremely important to isolate the transformer wiring from other cabling. This is described in detail in section 5.1. The speedswitch will operate from a speed signal as low as 0.02 VAC or from a signal considerably greater than 24 VAC without damage.

The speedswitch circuit can be factory modified at nominal cost to operate from a magnetic pickup signal rather than generator frequency if required.

3.2.1 Speedswitch Low

Speedswitch low is used to disconnect the starter. When the engine fires and comes up to speed, speedswitch low opens and the starter output is de-energized. The switchpoint is then latched open to ensure that the starter does not re-engage if the speed signal is lost. Speedswitch low will operate when engine speed reaches 33% of the speedswitch high setting.

3.2.2 Speedswitch High

Speedswitch high is used for overspeed protection. If engine speed exceeds the switchpoint, the generator is immediately shut down and locked out on an overspeed fault. The setpoint is adjusted with a multi-turn potentiometer labeled OVERSPEED, located on the back of the control. To increase the overspeed setpoint, turn the potentiometer clockwise. Speedswitch high is factory preset to operate when engine speed reaches 110% of nominal (66 Hz.). A white sealing compound is then applied to the potentiometer.

Note: this adjustment affects the speedswitch low setpoint as well. Figure 3-2 illustrates the effect of the Overspeed potentiometer on both switchpoints.

3.2.3 Loss Of Speed Signal

The continuity of the speed signal is constantly checked by the speedswitch while the engine is cranking or running. If the speed signal is lost, "time delay loss of signal" (TDLS) is initiated. If the signal is not received before TDLS times out (approximately 5 seconds), the engine is shut down and locked out on a loss of signal fault.

3.3 TACHOMETER DRIVE

A signal derived from the speedswitch is conditioned to provide a 0 - 1 mADC current sink proportional to engine speed. The output is available from terminal 12, and is suitable for driving a 0 - 1 mADC meter calibrated in RPM. Figure 3-3 illustrates the proper method of connecting the tachometer. Note: this output will not operate with an AC meter movement.

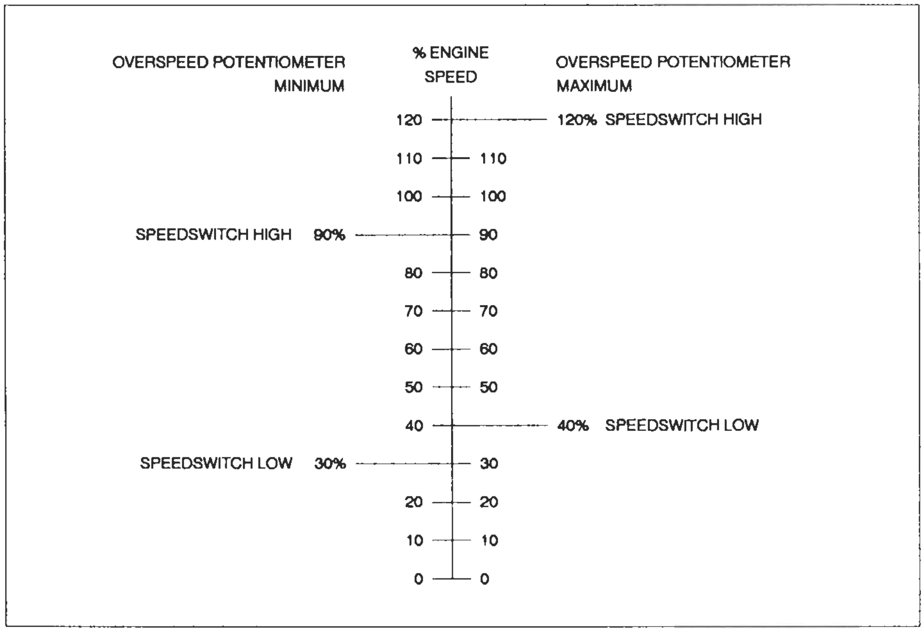

FIGURE 3-2 SPEEDSWITCH CALIBRATION SUMMARY

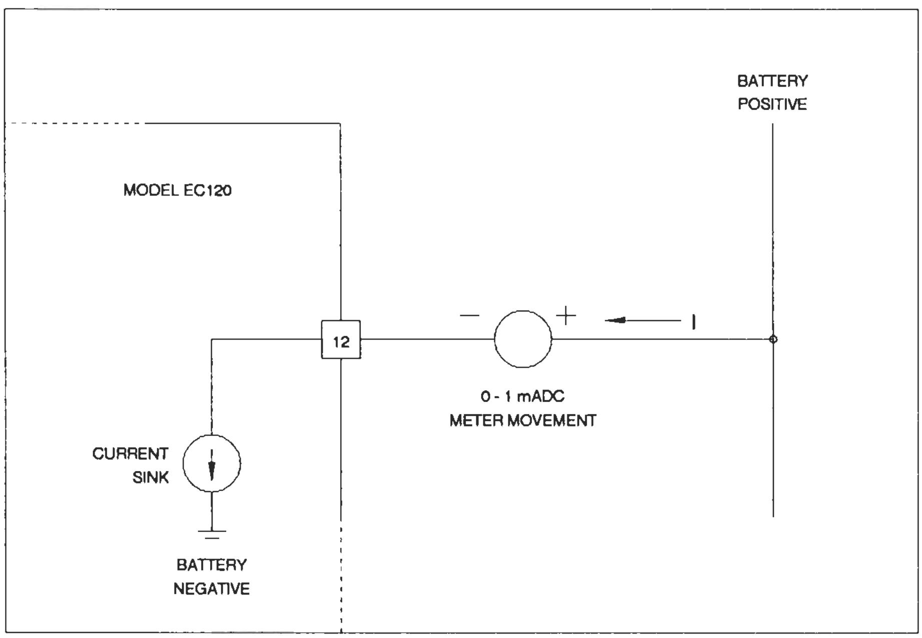

FIGURE 3-3 TACHOMETER CONNECTION

3.3.1 Tachometer Calibration

A single multi-turn potentiometer located on the back of the controller is provided to calibrate the tachometer. The potentiometer permits the current sink to be adjusted from 0.7 mADC to 1.2 mADC at 100% speed (clockwise to increase). This adjustment is done at the factory before the controller is shipped. However, if field adjustment is necessary, simply run the engine at nominal speed, and slowly turn the TACH CAL potentiometer until the tachometer displays actual engine speed.

3.4 ALARMS

The EC120 provides five alarms. If an alarm is received while the engine is running, the engine is shut down and locked out. A lamp on the front panel of the control will indicate which alarm occurred, and a common alarm output (terminal 11), is energized. In order to reset the alarm, place the function switch in the OFF position (no connection to terminals 1 or 2).

3.4.1 No Speed Signal

This fault occurs when the speed signal is lost for a period of five seconds while the engine is cranking or running. The No Speed Signal lamp will be energized following this fault.

3.4.2 Overcrank

This fault occurs if engine speed does not exceed the speedswitch low setpoint before the crank delay times out. The Overcrank lamp will be energized following this fault.

3.4.3 Low Oil Pressure

This fault occurs when terminal 4 is grounded to battery negative. The fault is inhibited on startup while time delay bypass (TDBP) times to allow oil pressure to reach prescribed limits. If the fault remains when TDBP times out, the engine is shut down, and the Low Oil Pressure lamp will be energized.

3.4.4 High Coolant Temperature

This fault occurs when terminal 5 is grounded to battery negative. This fault is also inhibited on startup. Operation is identical to low oil pressure described above.

3.4.5 Overspeed

This fault occurs if engine speed exceeds the speedswitch high setpoint. The Overspeed lamp will be energized following this fault.

3.5 TIME DELAYS

The EC120 is equipped with one adjustable and two fixed time delays.

3.5.1 Time Delay Crank (TDCR)

TDCR determines the length of time the engine will crank before an overcrank fault occurs, assuming the engine does not start. It is adjustable from 10 to 60 seconds, and is factory preset to 20 seconds. The delay is adjusted using a multi-turn potentiometer labeled CRANK TIME, located on the back of the control.

3.5.2 Time Delay Bypass (TDBP)

TDBP determines the length of time that low oil pressure and high coolant temperature faults are inhibited on startup. The delay is factory preset to 10 seconds and is not adjustable. TDBP is initiated when the engine begins to run, as determined by the opening of speedswitch low.

3.5.3 Time Delay Loss Of Signal (TDLS)

TDLS determines the length of time that the engine is permitted to crank or run when no speed signal is received. If the signal is restored while TDLS is timing, the delay is reset. If the delay times out, the engine is shut down and locked out. TDLS is factory preset to 5 seconds, and is not adjustable.

3.6 SEQUENCE OF OPERATION

When the EC120 receives a start signal (in either Manual or Automatic), the control initiates start up of the engine by energizing the fuel and crank outputs and monitoring the presence of the speed signal. As the engine fires and comes up to speed the starter is disconnected and TDBP is initiated. At the end of TDBP the oil pressure and coolant temperature circuits are armed. A subsequent closure of either contact will cause a shutdown and the appropriate lamp will be lit on the front panel. The EC120 shuts down the engine by de-energizing the fuel output. All shutdowns are reset by placing the function switch in OFF.

If the speed of the engine exceeds the speedswitch high setpoint, the engine is immediately shut down and locked out. If the engine has not started when the crank delay expires the engine is shut down on an Overcrank fault. If the speed signal is lost (or does not exceed 20 mV while cranking) for a period of 5 seconds, the unit is shut down on a loss of signal fault.

At the end of the required run period, removing the start signal will cause the fuel circuit to de-energize, stopping the engine.

NOTES:

SECTION 4. SPECIFICATIONS

Parameter	Specification
Logic Inputs	Terminals 1 to 5 Source Impedance: 680 Kohms Open Circuit Voltage: 5 VDC Short terminal to battery negative to activate input
Tachometer Drive	Terminal 12 0 - 1 mADC proportional to engine speed Suitable for driving 0 - 1 mADC meter calibrated in RPM Adjustable from 0.7 to 1.2 mADC at 100% speed
Speed Signal	Terminals 6 and 8 Input: 24 VAC (nominal) 1 VA or greater (typical)
Battery Voltage	Terminal 7 (positive) and 8 (negative) Input Range: 8 - 30 VDC @ 0.25 ADC
Relay Driver Outputs	Terminals 9 to 11 Rating: 1 ADC @ 30 VDC (maximum)
Chassis	Brushed stainless steel front panel Iridited aluminum rear chassis
Terminal Block	12 pole screw type
Dimensions	7" x 7" x 1.5" HWD
Weight	1.75 pounds
Operating Temperature	- 20 to +55 °C

NOTES:

SECTION 5. INSTALLATION

Connecting the EC120 to external circuitry or devices is a relatively simple procedure. The recommended connection diagram is presented in figure 5-4. Subsections 5-1 through 5-3 describe areas requiring particular attention.

5.1 SPEED SIGNAL WIRING

The speedswitch input has a high sensitivity, operating from a signal as small as 0.02 VAC. As a result, problems may arise if precautions are not taken when wiring the speed sensor input (terminal 6 and 8). For example, suppose the EC120 was mounted on a generator with a block heater powered by a commercial 60 Hz. line. If some of the speed sensor wiring was common with the block heater wiring, the IR drop along the common wiring may be interpreted by the EC120 as a speed signal. As a result, the starter would not engage, and the unit would fail to start. To eliminate this problem, it is recommended that the speed sensing wiring be completely isolated from any other wiring on the generator set.

Problems may also arise if the EC120 is used in conjunction with a poorly filtered battery charger. The 120 Hz. ripple voltage at the output of the battery charger may be interpreted as an overspeed condition, resulting in an engine shutdown. Again, this problem is solved by ensuring that the speed signal wiring is isolated from all other wiring on the generator set.

Lastly, the speedswitch input wiring should not be switched or interrupted in any manner.

5.2 LOGIC INPUTS

The logic inputs (terminals 1 to 5) are high impedance, and noise protection is fitted to each channel. However, if lead lengths exceed 50 feet, it is recommended that slave relays be used at the EC120 location, as illustrated in figure 5-1.

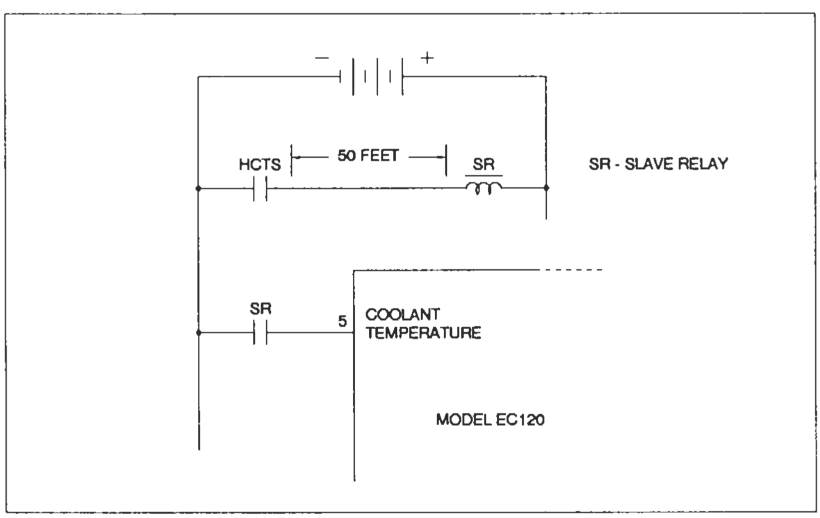

FIGURE 5-1 LOGIC INPUT WITH SLAVE RELAY

An alternate solution is to connect a 1 to 2 Kohm, 1 W resistor from the input terminal to battery positive. This provides a low impedance path shunting noise away from the input. This is illustrated in diagram 5-2.

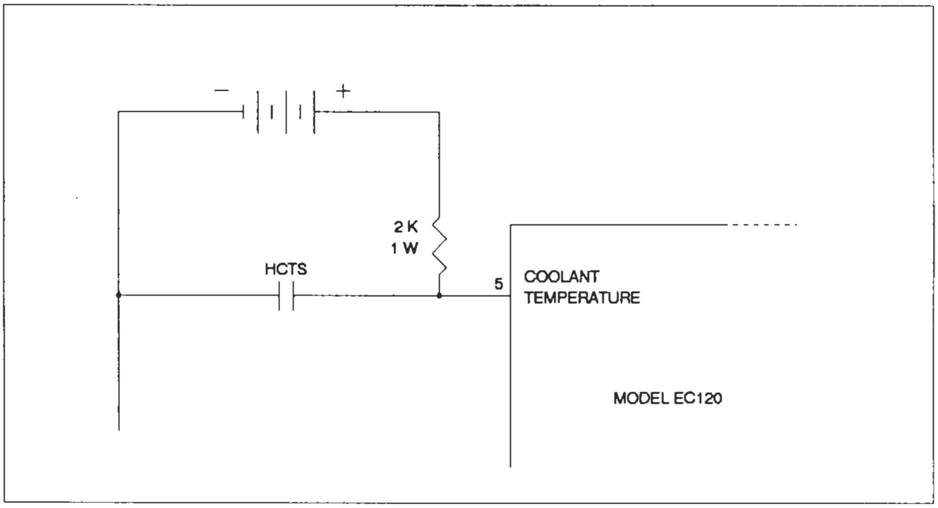

FIGURE 5-2 LOGIC INPUT WITH PULLUP RESISTOR

5.3 EXTERNAL RELAYS

It is a good practice to connect a diode across any relay or solenoid connected to the same DC source as the EC120 in order to eliminate the effects of counter-electromotive force (CEMF). The polarity of the diode is indicated in the following diagram.

The diode current rating should meet or exceed that of the coil, and the voltage rating must be adequate for the system. Typical diodes for this purpose are 1N4002, 1N4003 and 1N4004.

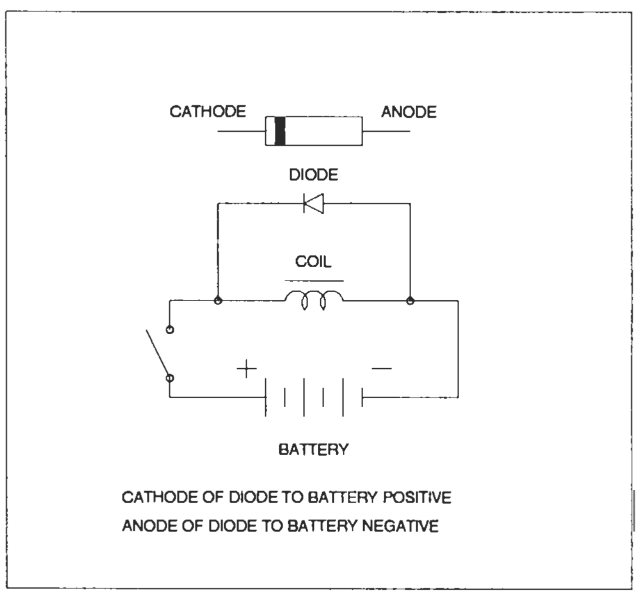

FIGURE 5-3 CEMF SUPPRESSION DIODE

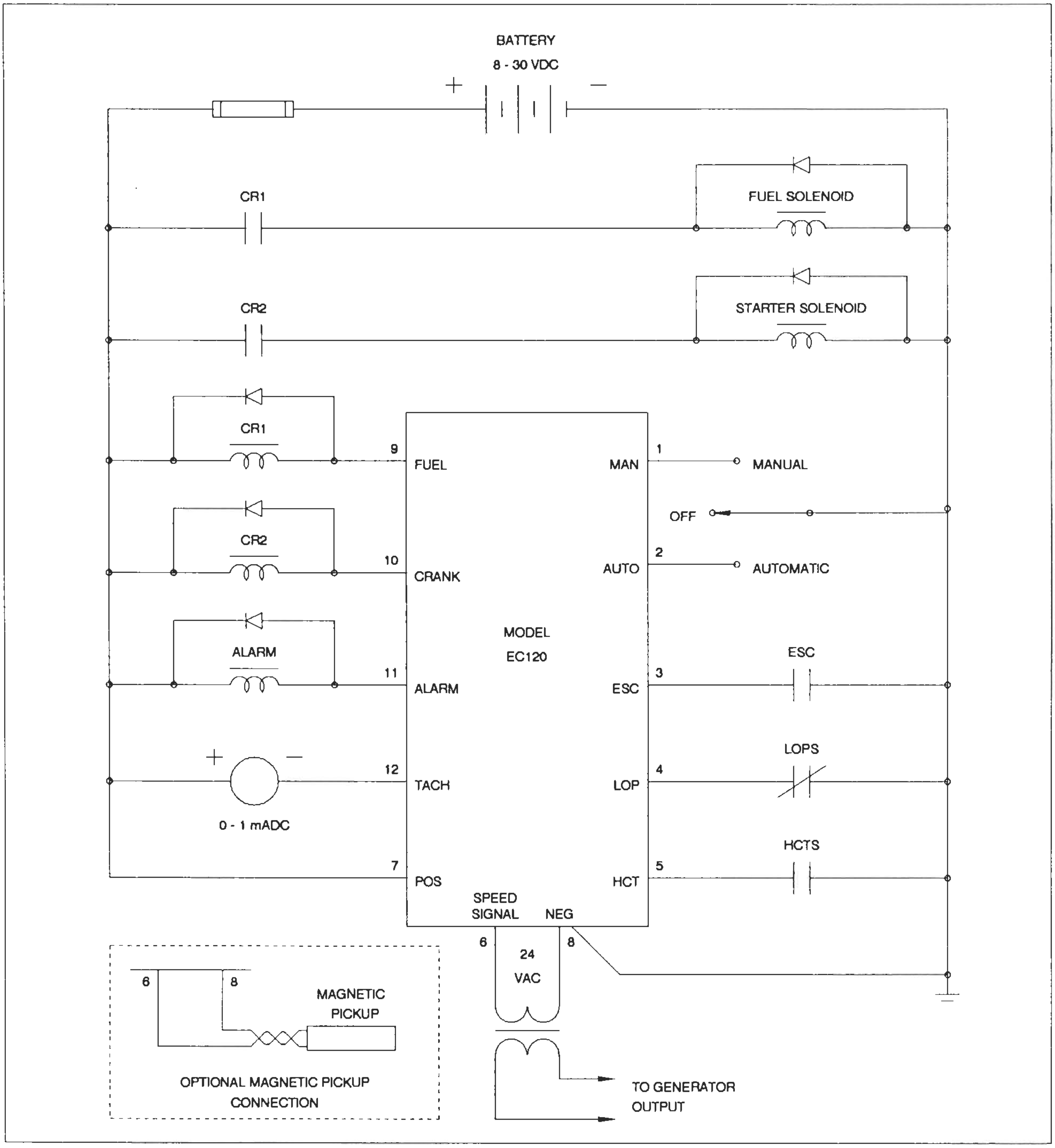

FIGURE 5-4 EC120 CONNECTION DIAGRAM

5.4 MOUNTING

The EC120 is intended to be flush mount in the relay panel door. Four 10-32 machine screws are required for this purpose. Hole spacing and cutout dimensions are detailed in the following diagram.

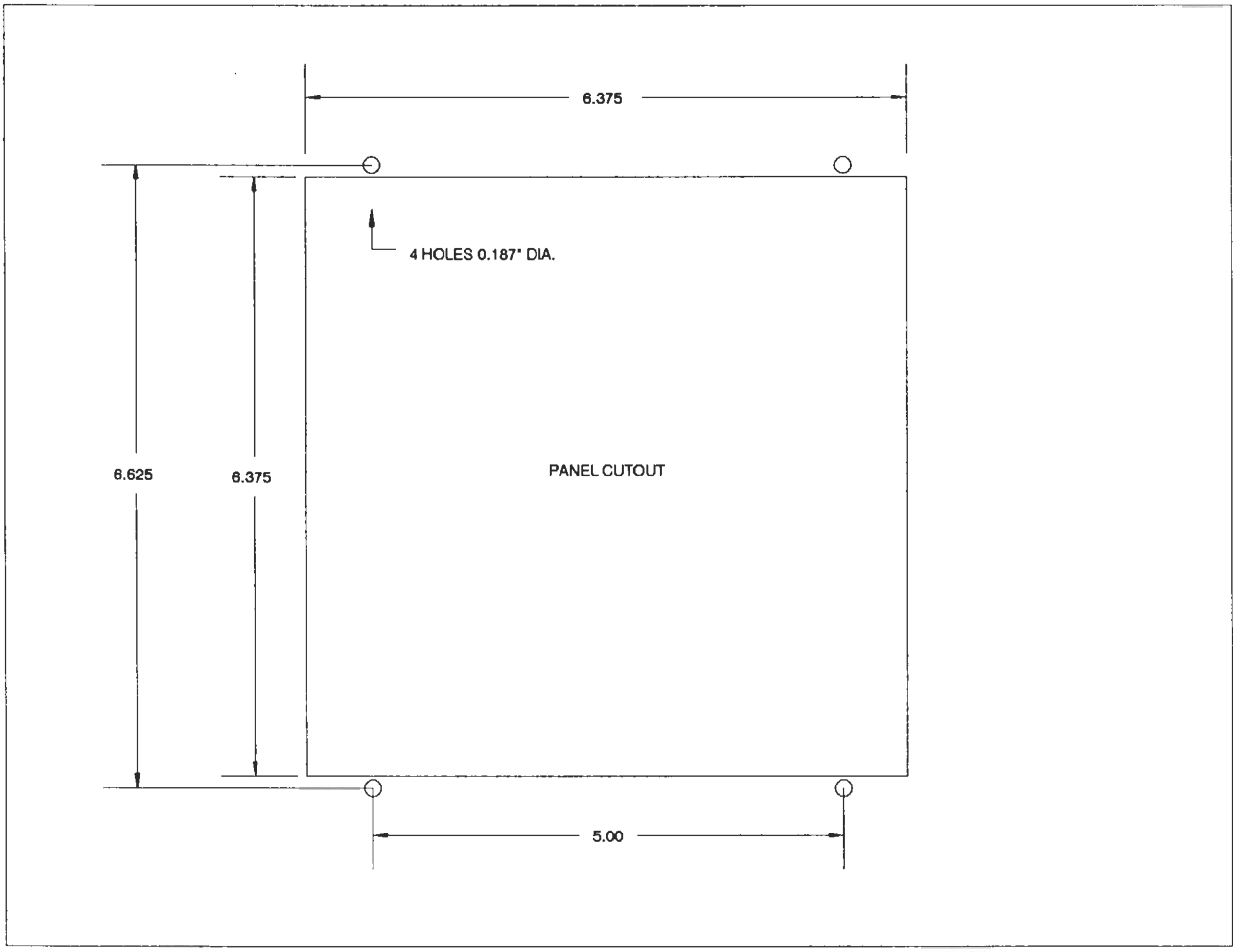

FIGURE 5-5 EC120 MOUNTING DIMENSIONS

SECTION 6. MAINTENANCE

The EC120 is a completely solid state device. The only recommended maintenance is periodic inspection for dust or heat buildup. If this occurs, disassemble the unit and remove the dust with a soft bristle brush.

6.1 BATTERY CHARGERS

A poorly filtered battery charger may produce a dangerous voltage surge at the DC input of the EC120 greater than the nominal 30 VDC maximum permitted. This occurs when the highly capacitive battery is removed from the DC bus for maintenance purposes. Therefore, it is strongly recommended the **BATTERY CHARGER ALWAYS BE TURNED OFF BEFORE REMOVING THE BATTERY FROM THE BUS.**

NOTE: random alarms may be generated by the EC120 when DC is reapplied to the control following maintenance. To reset the alarms, place the function switch in OFF.