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TACHPLUS+

ENGINE DISPLAY AND MONITORING SYSTEM
MODELS: TPA400, TPA420, TPA450

FIRE RESEARCH CORPORATION
www.fireresearch.com
26 Southern Blvd., Nesconset, NY11767
TEL (631) 724-8888 FAX (631) 360-9727 ***TOLL FREE 1-800-645-0074***

CONTENTS

Table of Contents

List of Tables

List of Figures

INTRODUCTION

Overview

The **TACH*PLUS*+** is an all-in-one instrument panel with integrated monitoring and display capabilities that saves valuable pump panel space. It combines up to thirteen (13) different instruments in one waterproof unit. It will and provide both audible and visual warning alarms if specified parameters go out of norm.

The **TACH*PLUS*+** has a 4 digit LED display for engine RPM, and 2 LED bar graphs to display the engine oil pressure and engine temperature. A dot-matrix message display will show battery voltage during normal operation and warning messages as they occur. When selected by the operator stored data and monitored input information is shown.

The **TACH*PLUS*+** receives input information over the J1587 data link, hardwired sensors, or the power-on condition of a monitored system.

TPA400 Engine inputs are from the J1587 datalink.

TPA406 Engine inputs are from an alternator input or RPM sensor, oil pressure, and coolant temperature sensors.

TPA420 Engine inputs are from J1587 datalink and an oil pressure sensor.

TPA450 Engine inputs are from the alternator or RPM sensor, oil pressure, and coolant temperature sensors.

Features

Digital Engine RPM Display

LED Oil Pressure Display with Low Pressure Warnings

LED Engine Temperature Display with High Temperature Warnings

Battery Voltage Display with Low and Over Voltage Warnings

Acculmates Operational Hours for Multiple Systems

Audible and Visual Warnings for Monitored Parameters

Specifications

Display Module

Supply Power:	12 VDC
Supply Current:	1.5 Amps
Dimensions:	4.4" by 4.4" by 3.5"

Audible Alarm Buzzer

Voltage:	12 VDC
Volume:	95 dB

Sensors

Note: Sensors are used when information is not available on the J1587 data link. The sensors needed will vary with the specific engine.

Oil Pressure:	0 - 100 PSI, 1/8" NPTF, 240-33 Ohms
Coolant Temperature:	100 - 250 °F, 1/2"-14 NPT
	50 - 300 °F, 5/8" - 18 UNF (Ford 6.0 L)
Gen. Engaged Sensor:	120 VAC
Trans. Temp. Sensor:	140 - 320 °F, 1/8" NPTF, 240-33 ohm
Pump Overheat:	Close 130 °F; Reset 115 °F
RPM:	Input signal from alternator or flywheel

Note: For TPA406 Ford 6.0L engines it is best to pick up the RPM from the Clean Tachometer Signal (green/white) wire. If connecting to the alternator, ensure the signal is not a low level (less than 1.5 volts), if it is the flywheel or magnetic pick-up connection must be used.

GENERAL DESCRIPTION

The information available to the **TACH*PLUS*+** control module on the J1587 data link varies depending on the particular engine. The sensors supplied will vary wiht the engine type and options ordered.

Components

The **TACH*PLUS*+** consist of the following components:

Display Module

Buzzer

Cables

Oil Pressure Sensor (As Required)

Engine Coolant Temperature Sensor (As Required)

Transmission Fluid Temperature Sensor (Optional)

Pump Overheat Sensor (Optional)

Generator Engaged Sensor (Optional)

Controls and Indicators

All controls and indicators are located on the front of the control module. It contains the push button electronic controls, LED indicators, and digital displays. (Refer to Figure 1.)

MODE Button

The MODE button is used to select the information scroll mode and to scroll through the system and options information.

RPM Display

Engine RPM is shown in bright red LEDs with digits larger than ½" (0.56"). Display will flash fault warn codes.

Message Display

Battery voltage is shown in the display during normal operations. This display will flash warnings as they occur. When in the information scroll mode this display will show system and options information.

SILENCE Button

The SILENCE button is to activate or de-activate the audible warning alarm. It is also used to exit the information scroll mode

OIL Pressure LED Bar Graph

Oil Pressure display is a vertical bar graph in 10 psi increments.

COOLANT Temperature LED Bar Graph

Engine Coolant Temperature is a vertical bar graph in 10 degree increments.

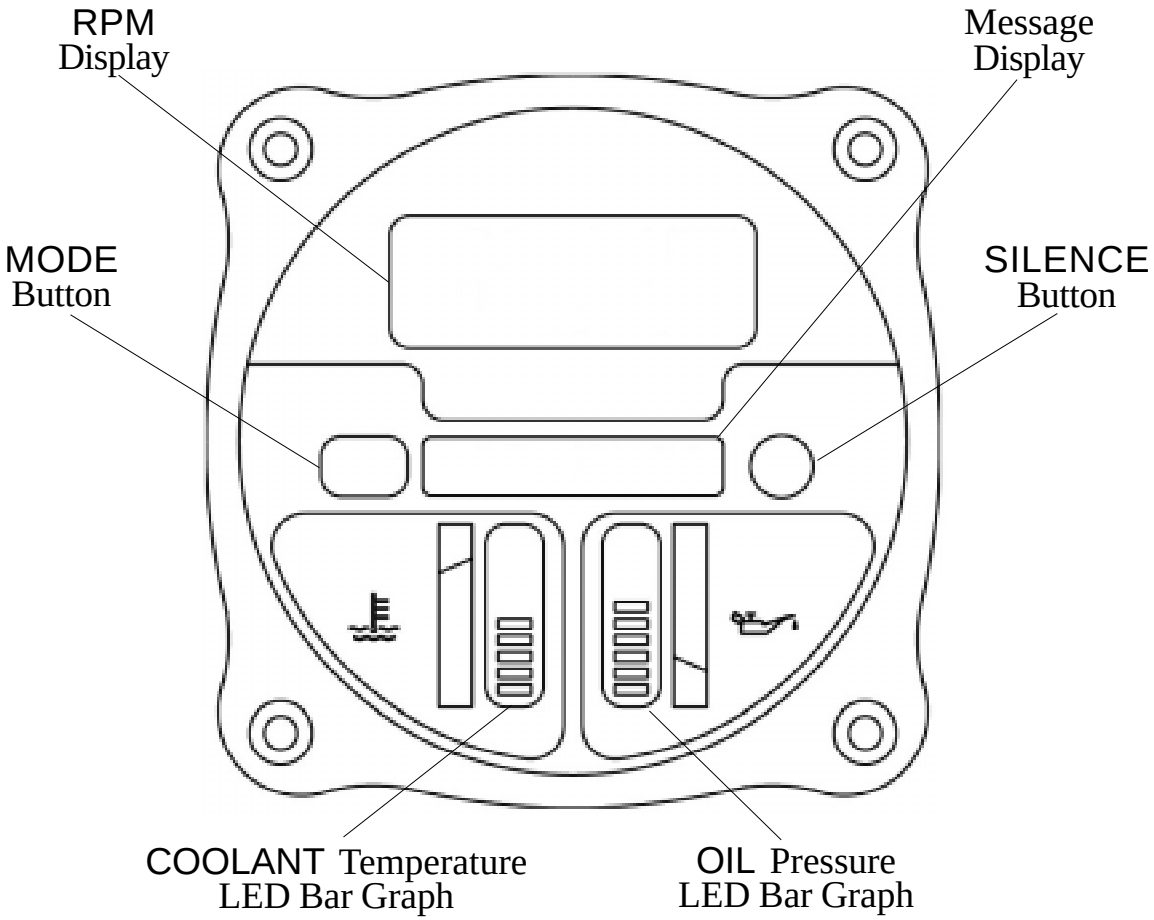


Figure 1. Controls and Indicators

INSTALLATION

For most electronic engines, the **TACH*PLUS*+** receives engine RPM, oil pressure, and coolant temperature information over the J1587 data link from the engine ECM. Some engines do not broadcast complete engine information over the data link and will require that seperate sensors are installed.

Install Control Module

1. Measure and mark mounting location for control module panel cutout and mounting screw holes. Make sure there is clearance behind the panel for the module and cables before cutting holes. Refer to Figure 2 for layout and dimensions.
2. Cut out a 3.75-inch diameter hole.
3. Drill four holes, clearance or tapped, for 10-32 mounting screws.
3. Place control module in position and secure with screws.
4. Connect cables at rear of the contol module. (Refer to Wiring section.)

Install Buzzer

A buzzer is supplied with the **TACH*PLUS*+**. Install the buzzer close to the control module so the audible warning is easily associated with the visual warning on the display. A cutout hole of 1-1/8" (1.125") is required on the pump panel. (Refer to Wiring section.)

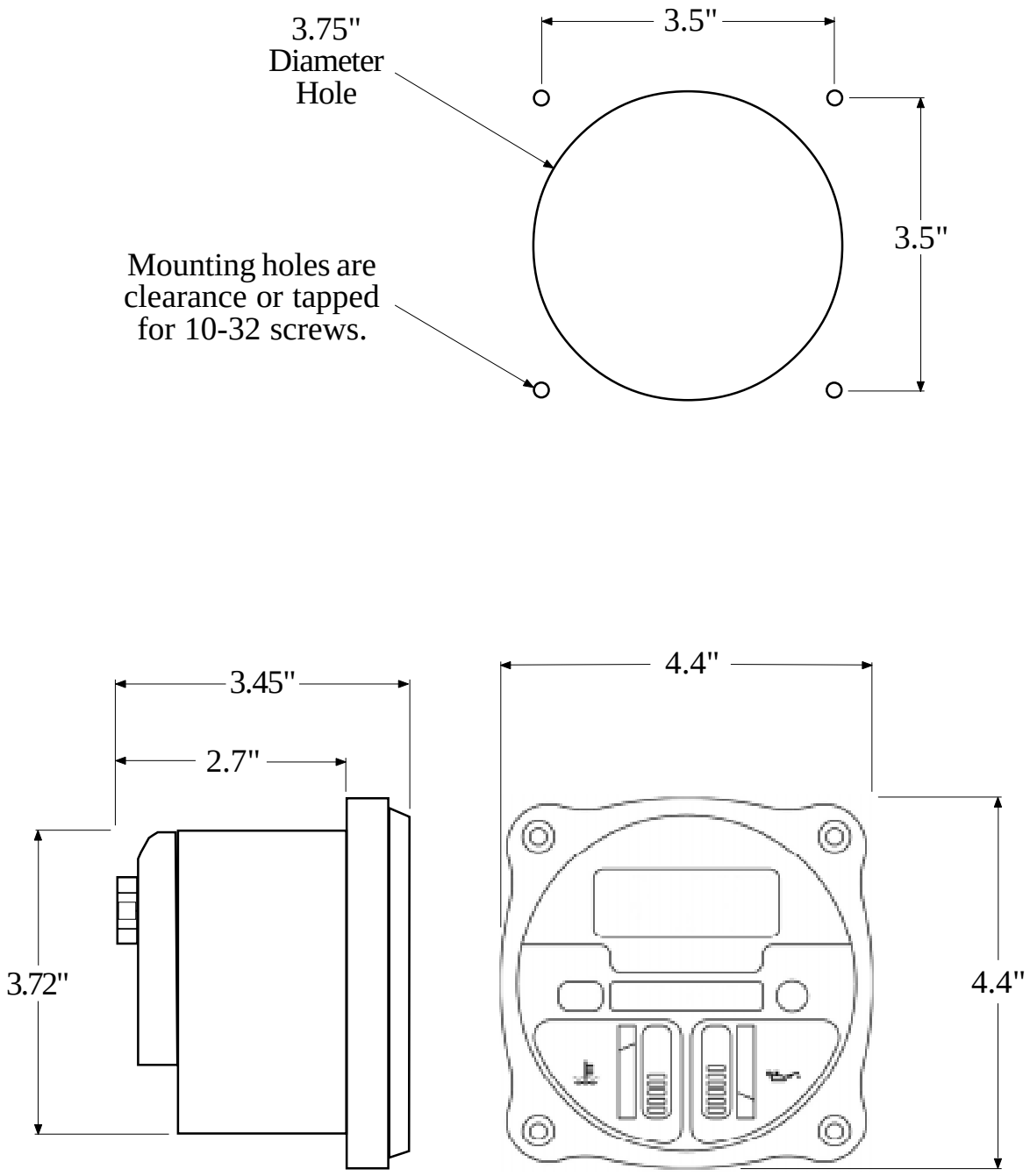


Figure 2. Control Module Mounting Dimensions

Install Oil Pressure Sensor

The oil pressure sensors has a single wire connection, the ground connection is made by the threads to the engine block. The thread size for this sensor is 1/8" NPTF. Install the sensor directly into the engine block oil pressure port. DO NOT USE A PIPE WRENCH ON THE SENSOR BODY. Tighten the sensor into the pressure port with a minimum of 5 turns. Check for leaks immediately on start-up. (Refer to Wiring section.)

Install Engine Coolant Temperature Sensor

The engine coolant temperature sensor (except Ford 6.0L) has a sealed, 2-wire connection which will eliminate corrosion and loss of ground return. This sensor is compatible with the non-conductive housings. The thread size for this sensor is 1/2" - 14 NPT thread with 1-1/16" (1.0625") hexagonal head.

The Ford 6.0L has two sensor options, a single wire connection with the ground connection made by the threads to the engine block and a two wire insulated ground type. The thread size for these sensosr is 5/8" - 18 UNF. (The single wire type sensor comes with a 16 mm adapter.)

DO NOT USE A PIPE WRENCH ON THE SENSOR BODY. Install the sensor directly into the engine block coolant port and tighten with the hexagonal head. Check for leaks immediately on start-up. (Refer to Wiring section.)

Install Transmission Temperature Sensor

The transmission fluid temperature sensor has a single wire connection, the ground connection is made by the threads to the transmission. The thread size for this sensor unit is 1/8" NPTF. Install the sensor directly into the transmission fluid pan. DO NOT USE A PIPE WRENCH ON THE SENDER BODY. Tighten the sensor into the pan with a minimum of 5 turns. Check for leaks immediately upon start-up. (Refer to Wiring section.)

Install Pump Overheat Sensor (Optional)

The pump overheat sensor is mounted onto the pump casing. Make sure the sensor is in direct contact with the surface of the pump body. (Refer to Wiring section.)

Install Generator Engaged Sensor (Optional)

Note: The AC generator engaged sensor is needed if a 12 VDC signal is not available to indicate that the generator is activate.

The AC generator engaged sensor should be mounted inside or near the circuit breaker box. This will avoid the need to run long wires with AC voltage. The sensor can be secured using 4 tie wraps.

DO NOT WIRE 240 VAC TO THE SENSOR.

Install RPM Sensor

For engines that do not provide RPM information on a data link, the RPM signal can be supplied by the alternator, or a magnetic pickup sensor. [For TPA450-6 Ford 6.0L engines it is best to pick up the RPM from the Clean Tachometer Signal (green/white) wire.] Refer the Wiring section. The RPM display will have to be calibrated for correct RPM measurement. Refer to the RPM Calibration section.

Install Hourmeters

The hourmeters are built into the control module. Inputs of 12 VDC must be provided to the control module when the generator and aerial are engaged. (Refer to Wiring section.)

OPERATION

The **TACH*PLUS*+** displays crucial engine information to the pump operator. The audible alarm is a clear distinctive warning that sounds when a monitored input exceeds normal parameters. Visual warnings for the two LED displays will flash to indicate warnings visually to the pump operator.

The Message Display will show all warning messages or other requested information.

Message Mode Operation

There are two buttons on the TachPlus: a MODE and a SILENCE button. In message mode, system messages are shown in the message display. To enter message mode, press the MODE button. Every push of the MODE button displays the next message. Each message remains in the window until the MODE button is pressed again. If there is any warning, the message will be shown in the message display in 10 second intervals. This message will flash to indicate that it is a warning. Press the SILENCE button to return to the normal display. Once exiting the message mode, pressing the MODE button again will show the last displayed message.

To scroll through the messages, press and hold the MODE button and press the SILENCE button. In scroll mode, the display will continuously scroll through all messages available. If there is any warning, it will be added to the bank of scrolling messages every 10 seconds. The warning message will flash to alert the operator. Pressing the SILENCE button will bring the display back to the normal mode.

Visual Alarm

Whenever there is a monitored failure or problem, the visual alarm will be activated. This alarm cannot be reset or cancelled manually. The alarm will stop automatically when the problem has been taken care of.

Audiable Alarm

The Tachplus has a very unique sound feature. The Audible Status Warning System gives a short clear distinctive signal as the pump is engaged. It sounds continuously if there is a monitored failure such as low oil pressure or high engine temperature. It sounds a dual burst for low fuel warning.

Silencing Audible Alarm

All audible alarms can be cancelled by pressing the SILENCE button. Pressing the SILENCE button for 2 seconds turns the buzzer or audible warning off. Pressing it for 2 seconds again will reactivate the audible warning. Pressing the SILENCE button will not change the visual warning.

Operation Displays

Refer to Table 1. Message Display Abbreviations for descriptions of message abbreviations.

Engine RPM

The engine RPM is displayed constantly under normal conditions. The engine RPM is shown steadly in 10 RPM increments.

Engine oil pressure

The 10 segment LED bar graph will display engine oil pressure from 10-100 PSI (each segment is equal to 10 PSI). Next to the readout is a color-coded graph for easy identification of the engine oil pressure status. The RED zone indicates that the engine oil pressure is low whereas the GREEN zone indicates that the pressure is normal. The visual and audible warnings are activated if the engine oil pressure drops below 8 PSI. The LED bar will flash and LOW OIL will flash in the message display. The audible alarm is a long solid tone and can be canceled by pressing and holding the SILENCE button until the sound goes away. For electronic engines, the LOW OIL activating point is determined by the engine ECM.

Coolant Temperature

The engine temperature is displayed from 150 to 240 °F in 10 °F increment. The GREEN zone indicates normal temperature condition and the RED zone indicates the engine is too hot. The visual warning will be activated when the temperature rises above 220°F. The LED bar will flash and HI TEMP will flash in the message display. The audible alarm is activated when the coolant temperature exceeds 230°F. The audible alarm can be silenced by pressing and holding the SILENCE button until the buzzer stops beeping.

Battery Voltage

Under normal conditions the battery voltage is shown in the message display. Visual and audible warnings are activated when the battery voltage drops below 11.5 VDC when the engine is not running, or below 11.8 VDC when the engine is running. If the voltage rises above 15.4 VDC, the high voltage warning will be activated. The low battery voltage warning is indicated by LOW BATT and the high battery voltage is indicated by "HI BATT", these will flash in the message display.

Low Fuel

Low engine fuel warning is activated when the fuel level drops below 25% of the tank level. LOW FUEL will flash in the message display.

Note: The Tachplus has to be calibrated in order to read the fuel level correctly, refer to the Calibration section.

Hourmeters

The Tachplus is designed with an internal timer to keep track of the various operating hours. The operating hours that the Tachplus is able to time are :

Engine hours - total operating hours of the engine (ENG. HRS)

Pump hours - total operating hours of the pump (PUMP HRS)

Current Incident hours - (INC. HRS)

Last Incident hours - (LAST INC)

Aerial hours - total operating hours of the aerial (AER. HRS)

Generator hours - total operating hours of the generator (GEN. HRS).

The hour information is displayed in decimals. Each tenth of a point is equal to 6 minutes or 1/10 of a minute (12.3 is 12 hours and 18 minutes).

Manifold Temperature

The manifold temperature information is supplied on the data link and is available on electronic engines only. For an over temperature condition MAN. TEMP will flash in the message display.

Pump Overheat (Option)

With this option, the Tachplus receives a signal from the pump overheat sensor. The pump overheat warning is activated when the pump temperature rises above 130°F. PUMP HOT will flash in the message display and audible alarm is activated.

Table 1. Message Display Abbreviations

Message Abbreviation	Description
AER. HRS	Aerial operating hours
ENG. HRS	Engine operating hours
FUEL %	Percent of fuel in tank
GEN. HRS	Generator operating
HI BATT	High battery voltage
HI TEMP	High engine coolant temperature warning
INC. HRS	Incident hours
LAST INC	Last incident hours
LOW BATT	Low battery voltage warning
LOW FUEL	Low fuel level warning (below 1/4 tank)
LOW OIL	Low oil presure warning
MAN. TEMP	Manifold temperature
PUMP HRS	Pump operating hours
PUMP HOT	High pump temperature warning
TRAN OIL	High transmission fluid temperature warning

Note: For TPA406 Ford 6.0L there is a three mminute delay after power is applied for the battery voltage warning.

CALIBRATION

RPM Calibration for Non-Electronic Engines

The RPM display has to be calibrated for all nonelectronic engines. No tools are required.

1. Run the engine at 1400 RPM. The RPM needs to be steady during the calibration process.
2. Press the SILENCE button twice.

   Result: The message display will show CAL RPM? .

Note: If no action is taken within 3 seconds, the calibration mode will be cancelled.

3. Press the SILENCE button twice again to proceed with the calibration process.

   Result: The message display will show WAIT. When the calibration is completed it will show DONE ! and 1400 will show in the RPM display.

Fuel Level Sender

In order to use the existing sender in the fuel tank, the Tachplus has to be set for the voltage level when the fuel tank is full and when it is empty. This adjustment is set at the factory but may need to be adjusted in the field. There is a cable with 2 adjustment pots behind the Tachplus, one of them is for adjusting the voltage level when the fuel tank is full and the other one is for adjusting the voltage level when the fuel tank is empty. When adjusting the pots, the message display will indicate which pot you are adjusting and the large readout above the display will show the voltage level thus eliminating the need of a voltmeter.

Note: The voltage levels set on the 2 pots (full and empty) have to be 1/2 the actual voltage sent by the fuel level sender to the fuel level gauge.

Since the Tachplus is able to use the existing fuel level sending unit that is mounted on the fuel tank, there is no fuel sensor supplied with the unit. The Tachplus will not affect the reading on other level gauges.

The Tachplus is factory calibrated to work with a 0-90 ohm fuel level sending unit that is driving a VDO fuel level gauge. If the truck you are working on has a different combination of sensor and gauge, you will have to recalibrate the Tachplus. Also, if the truck has multiple fuel gauges, you may need to recalibrate.

Please call FRC if you need any further technical assistance.

Fuel Level Calibration

Determine the voltage level from the sending unit when the fuel tank is full and the voltage level from the sending unit when the fuel tank is empty.

This information can be obtained from the gauge manufacturer or you can measure these voltages. To measure the voltages without actually filling and draining the tank, you will need:

A voltmeter, preferably a digital voltmeter, and a 250 or 1000 ohm potentiometer.

1. Disconnect the fuel level sending unit from the fuel level gauge at the signal terminal wire (refer to Figure 3).

2. Connect one lead from the test potentiometer to the signal terminal of the level gauge and connect the other leads to ground (or chassis).

3. Adjust the test potentiometer until the gauge shows full tank. Measure the voltage from the signal wire (TP-1) to ground, **divide the voltage by 2 and record it**.

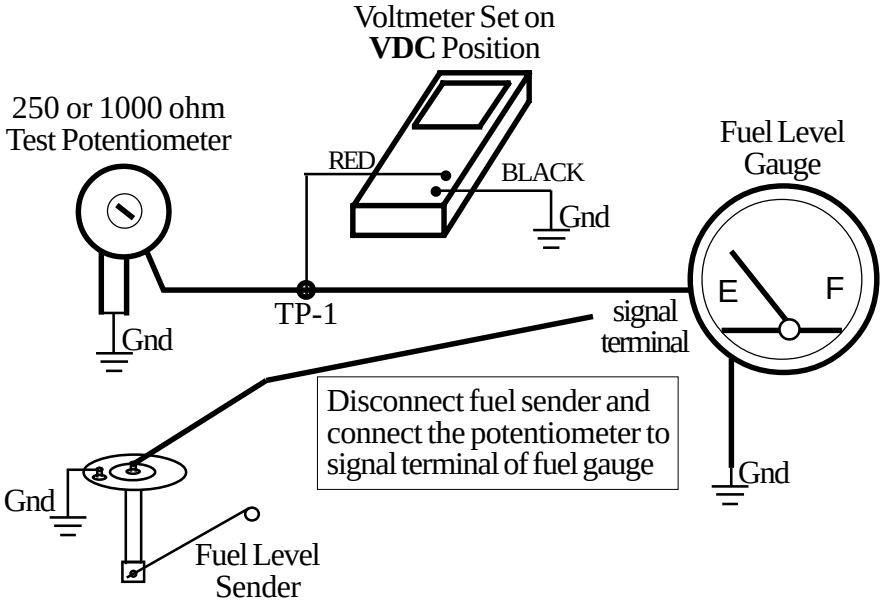
4. Adjust the test potentiometer until the gauge shows empty tank. Measure the voltage, **divide the voltage by 2 and record it.**

There is a cable at the rear of the Tachplus with 2 potentiometers. As each pot is adjusted the message display on the Tachplus will show "F- full" or "F- empty" and the RPM display will show the voltage level that was set at the factory. Use a small screwdriver to adjust each of the potentiometers slowly.

1. When the message display shows "F- full, adjust the potentiometer until the voltage shown in the display is equal to the recorded full tank voltage (make sure the voltage level was divided by 2).

2. When the message display shows "F- empty" adjust the potentiometer until the voltage shown in the display is equal to the recorded empty tank voltage (make sure the voltage level was divided by 2).

3. Connect the fuel level sending unit back to the fuel level gauge.



EXAMPLE
Set the Potentiometer so the fuel gauge pointer shows empty.

The voltmeter reads 8.00 VDC

Divide by two = 4.00 VDC
(this is the empty tank voltage)

Set the Potentiometer so the fuel gauge pointer shows full.

The volt meter reads 2.00 VDC

Divide by two = 1.00 VDC
(this is the full tank voltage)

Use the two values to set the two fuel calibration potentiometers on the tach plus display unit.

Figure 3. Fuel Level Calibration

DIAGNOSTICS

The information listed in Table 2 is to aid in troubleshooting a problem with the **TACH*PLUS*+.** The diagnostic code will be shown in the Message Display on the control module.

Table 2. Diagnostic Codes

Message Display	Problem	Probable Cause
E1	NO DATA	>Datalink cable not connected / connected to wrong port
		>Broken wire / bad connector contact on datalink cable
E2	BAD DATA	>Noise interference (radio frequency or electrical)
E3	NO RPM	>Datalink cable not connected / connected to wrong port
		>Engine not running / ignition key on
		>Broken wire / bad connector contact on alternator cable
E4	NO DATA	>No voltage at interlock input
	FROM ECM	>Internal datalink problem
		>Datalink shorted
E5	N/A	N/A
E6	N/A	N/A
E7	N/A	N/A
E8	MEMORY	>Contact FRC
	FAIL	
E9	OIL	>Sensor cable not connected
	PRESSURE	>Broken wire / bad connector contact on sensor cable
		>Defective pressure sensor
E10	ENGINE	>Sensor cable not connected
	TEMP	>Broken wire / bad connector contact on sensor cable
		>Defective temperature sensor

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WIRING

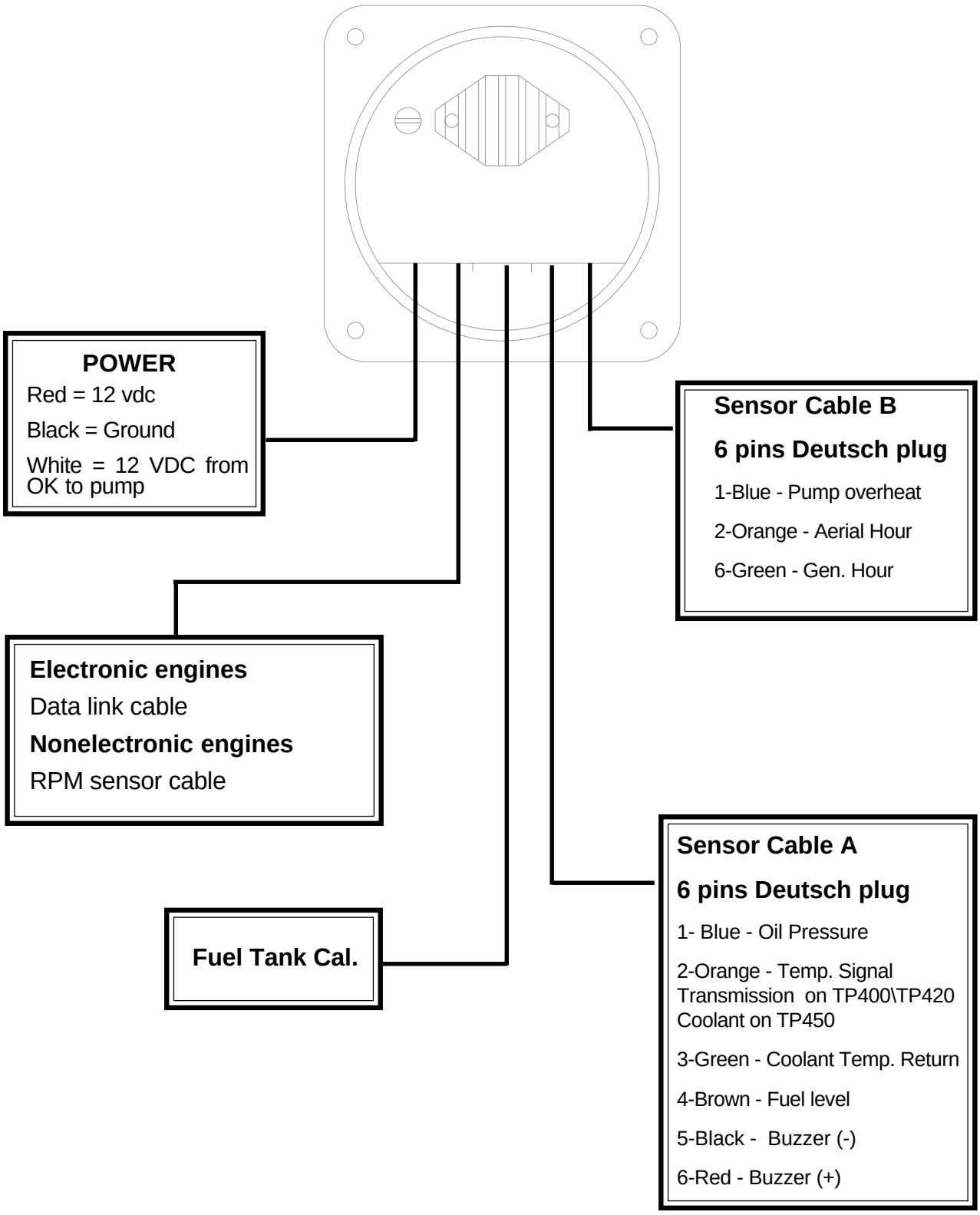

Figure 4. Common Wiring

TPA400 Wiring

Most Electronic Engines

NOTE: For Caterpillar 3116, 3126 engines use TP420 wiring refer to Figure 5.
For Ford 6.0L engines use TP450-6 wiring refer to Figure 6.

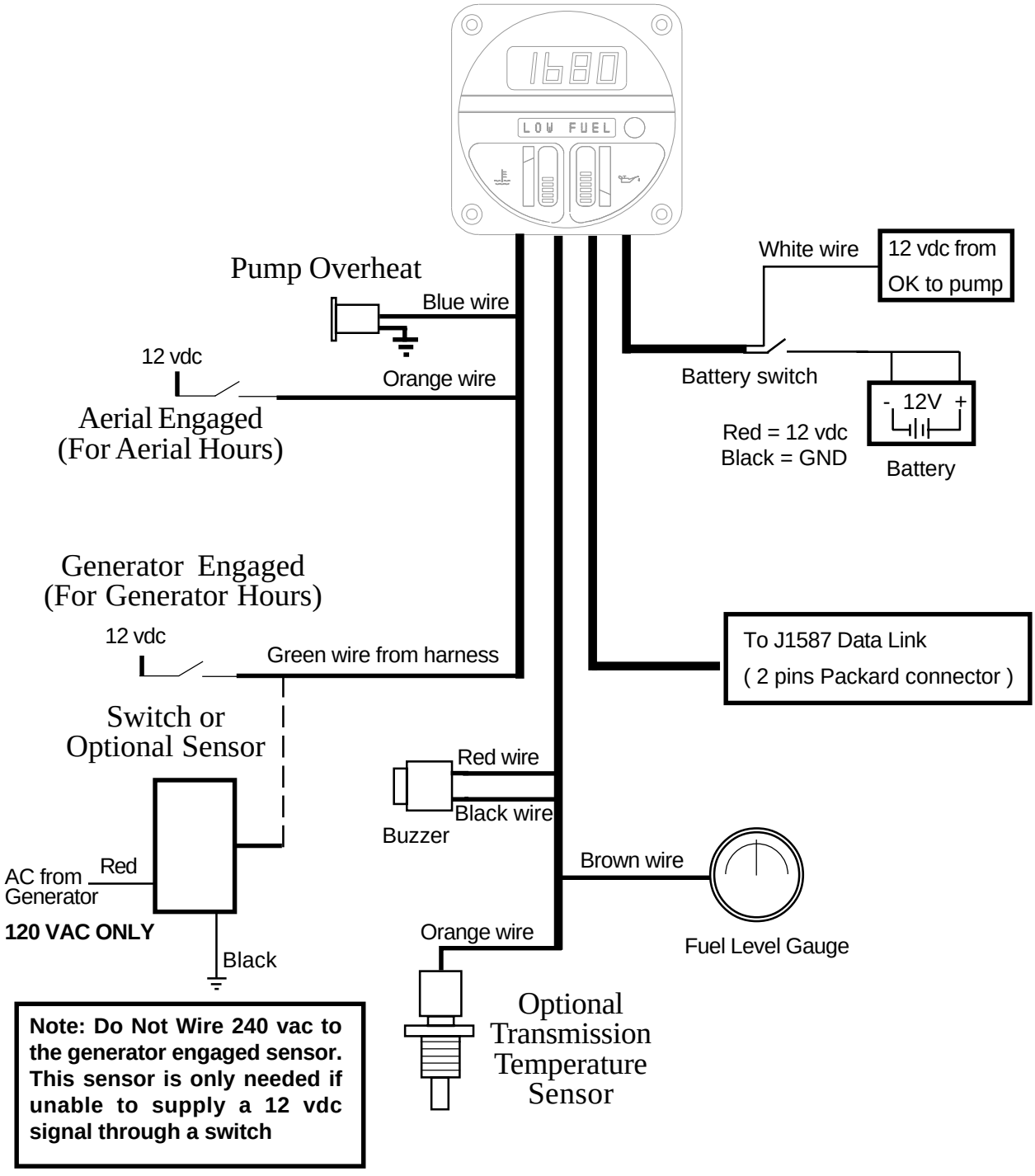

Figure 5. TPA400 Wiring

TPA420 Wiring

Caterpilar 3116, 3126

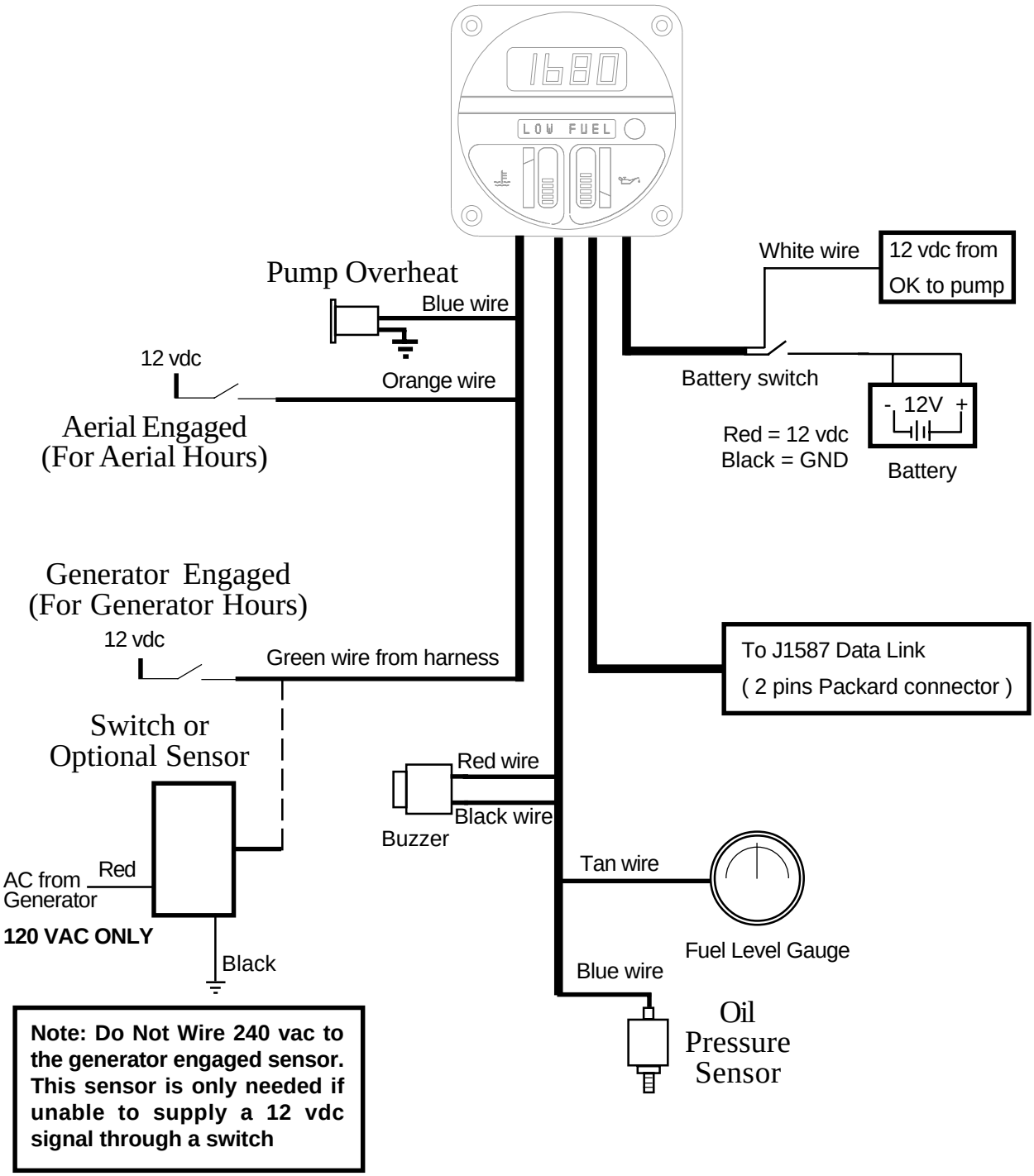

Figure 6. TPA420 Wiring

TPA406/TPA450 Wiring

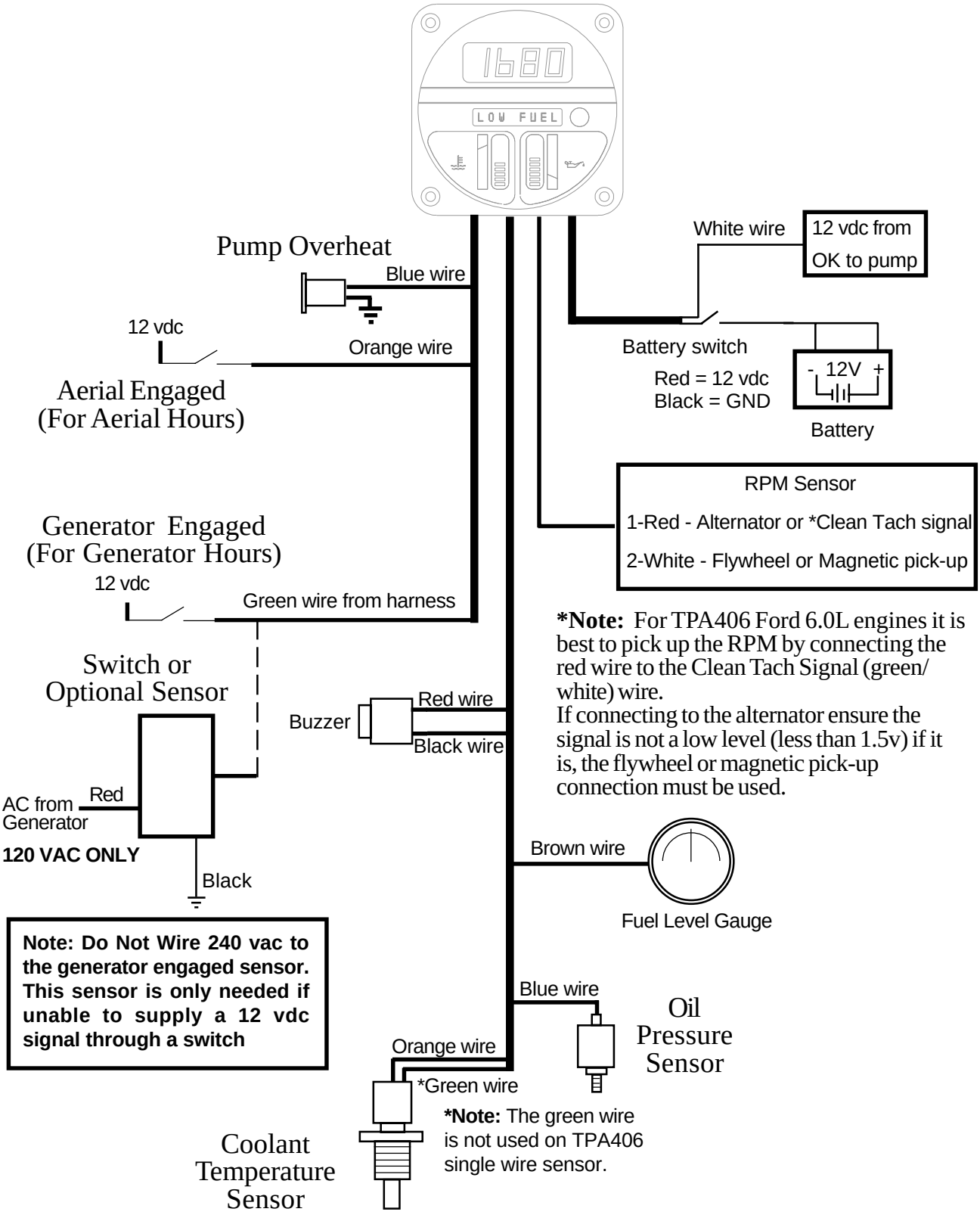

Figure 7. TPA406/TPA450 Wiring

FLYBACK DIODE INFORMATION

It is good engineering pratice to include a flyback diode when switching an inductive load (soleniod coil, relay coil, electric motor winding, etc.). It is recommended that a flyback diode be installed on inductive devices that share a common power source/ ground with a FRC governor.

Typical circuit showing a flyback diode installed across an inductive load. (Relay Coil, Solenoid, etc.)

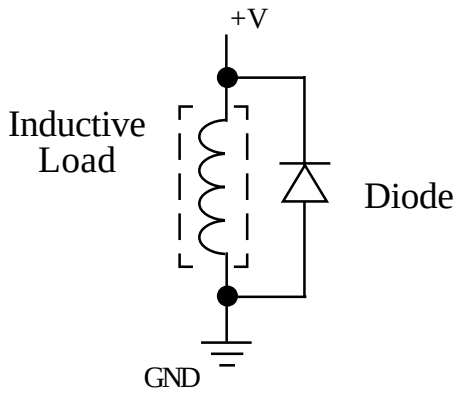

Diagram showing a flyback diode connected on a typical pump primer motor solenoid.

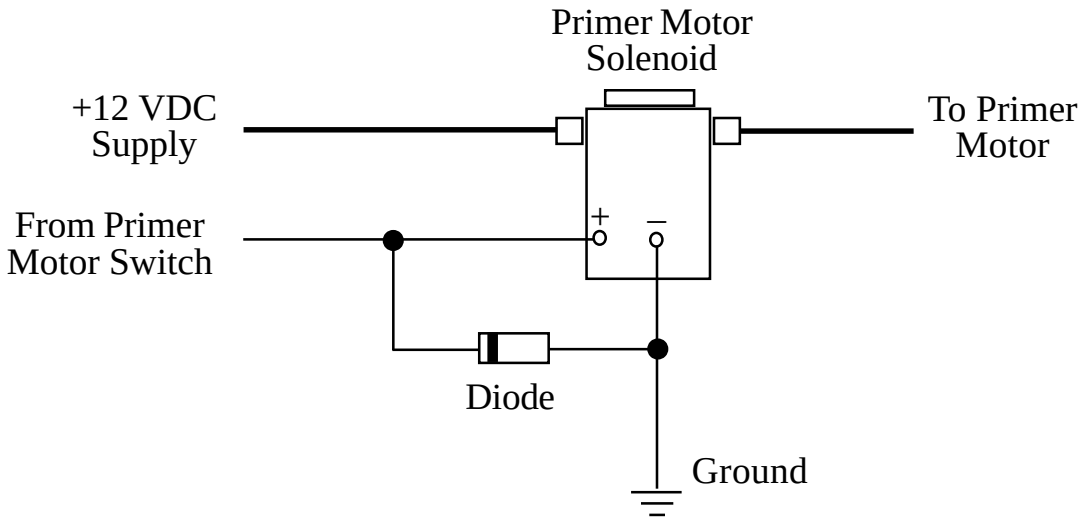

Figure 8. Flyback Diode