IntelliSpark®

Ignition Systems

Operation Manual

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Section 40

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 http://www.fwmurphy.com/warranty

WARNING

BEFORE BEGINNING INSTALLATION OF THIS FW MURPHY PRODUCT:

- Read and follow all installation instructions.
- Please contact FW Murphy immediately if you have any questions.

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Product Description

Technical Overview

The IntelliSpark® 16/8 series ignition systems are capacitive discharge, low-tension type designs. The system is capable of generating precise spark timing that improves fuel economy, load balance and ignition stability. The controller design incorporates a state-of-the-art, 16-bit microcontroller. This technology provides users with a highly flexible solution to meet their ignition needs.

A unique feature of this product is the patented spark plug demand voltage measurement that is available through the use of any IntelliSpark smart coil. It allows the system to:

- Measure demand on each cylinder's plug for diagnostic purposes.
- Use the measured demand for automatic energy control.
- Use the measured demand in the unique camless crank method to determine the compression stroke, eliminating the need for a camshaft sensor.

WARNING: This system must be configured (programmed) for an engine prior to starting. Refer to the Programming Manual for complete instructions on setting up the system to run a specific engine.

Operational Requirements

Power Supply

The system runs on 12/24V DC. Refer to the **Specifications** section in the Installation Booklet for details. Note that the system also requires a few seconds after power is applied before it is able to start firing. If the system is being powered up at every start and the delay needs to be minimal, the system can remain powered up at all times, and it will start firing coils as soon as the crank signals are within spec.

Ignition Enable

This input can be accessed on the wiring terminal block or through the U-lead connection. To run the engine, the Ignition Enable input should be open, and the U-lead should not be grounded. With the Ignition Enable input shorted to the switch return, the system will shut down, and the Tank Capacitor power supply will shut down as well so the tank voltage will show between 0.0 v and battery voltage. The user can see the state of Ignition Enable on the main Operator Page of the display. The tank voltmeters are also on the same page.

Crank and Cam Signals

Once the starter engages, the system will start firing coils when the flywheel gear teeth are counted, and the count is found to be within spec. For 4-stroke engines using a camshaft sensor, the CAMREF signal also needs to be detected. For camless operation, the system needs to be able to distinguish the stroke sequence during the first four revs of test firing. The minimum RPM for firing is 30 RPM.

Operating

Display Functions: Main Menu

Figure 1.0 shows the Main Menu screen seen after power is applied. For approximately 8 seconds the screen displays “Initializing…” During this time, the display is establishing communications with the controller and its initializing parameters. The button labels along the left side show from top to bottom:

Operator Page:
This button changes the screen to the first page of the operation page section.

Off-Line Diag:
This button takes the user to the passcode screen and then to the off-line diagnostic testing page. The system must be in the Standby Mode for this button to be active. For example, if the engine is running, this button will not be active.

System Setup:
This button takes the user to the passcode screen and then to the setup menu. For details on what is available please refer to the programming section of this manual set.

Help Menu: This button takes the user to a page with a menu list of general help topics.

Figure 1.0 Main Menu Screen

Also included on the Main Menu page is the day/date and clock. Here the F/W (firmware version) is shown as 4.07, although your firmware version may be different. The brown color of the version parameter indicates that it is read from the controller.

The Display Rel (release) date is the date the program file for the display was released. As changes are made to the display program in the future, this date will be reset to the date of release.

The Display Communications Status LED indicates the display is properly communicating with the controller (green). If communications are interrupted, this LED will turn red. During initialization, this LED will be red until the communication test passes near the end of the initialization. Then it will turn green, and the message “Initialization Complete” will appear for a few seconds indicating everything is ready to go.

Engine Start Up.

When ready to start the engine, the user can press the Operator Page button and monitor the start up on the Operator Page. Figure 2.0 shows the Operator Page.

Figure 2.0 Operator Page

Figure 2.0 shows the page contents when the system is in the standby mode and is ready to start the engine. In this example, the timing schedule A is active, and the timing is set for 10.0 degrees (BTDC). The Tank voltage is 239.3, and the energy level is 78%. The Alarm and Shutdown relays are off indicating no alarms pending and no prior shutdowns. It also shows that Ignition Enable is enabled meaning the U-lead is not grounded and Ignition Enable input is open circuited.

As the engine starts to crank, the display will show the PIPs counted. If the PIPs are within specification, the Ign On Rly LED will turn green indicating the actual relay has activated. This also means the coil output drivers have started to fire. If the primary harness is connected the coils will be firing the plugs. If the primary harness is not connected, the user would see all “Open Primary” on the Spark Page.

Figure 3.0 shows the page contents during a typical cranking phase.

For this example, the PIP count is perfect at 207 teeth counted out of 207 programmed. The Ign On Relay LED is green indicating that it is firing the coil drivers and that the relay is on. When this relay turns on the fuel valve, the engine should start to pick up speed.

Figure 3.0 Cranking

Engine Run Mode

Once the engine RPM exceeds the Crank/Run RPM, the system will go into the normal run mode. Once there, the system will use different tolerances on the PIP count, typically the tolerance is tightened. The user has some latitude to change these tolerances, but the system also has limits that cannot be exceeded. Figure 4.0 shows the contents during a typical run mode.

Figure 4.0 Normal Running

Spark kV Page

Once the system has entered the normal running mode, the display offers some unique insight into the operation of an ignition system. As mentioned in the overview, one of the key features is the ability to display actual spark gap breakdown voltage. Since the voltages required to breakdown the gap are in the order of kilovolts, we refer to these parameters as kV values. Pressing the Spark Page button will take the user to the page that shows all of the plug's kV values. Figure 5.0 shows the spark page screen.

Figure 5.0 Spark Page

Figure 5.0 shows what a 16 cylinder engine spark kV page would look like. The leftmost vertical bar graph shows how much kV the coil is supplying. The individual cylinder graphs show what each plug requires for breakdown. Underneath each bar is the value in numeric form. At a glance, this page tells the user that all plugs are firing and that they are all firing with similar values. Plugs that are not firing near the average may need to be inspected. It may only be that the plug gap is different, but it may indicate something more serious.

There are diagnostics for each cylinder that tell the user if he has any one of the following conditions:

1. Open primary wire
2. Shorted primary wire
3. Open or disconnected plug wire

There is a button for displaying the average kV for each cylinder. The average is based on samples taken over a period of 10 seconds.

There is an energy mode selection, Auto or Manual. In the Manual mode, the tank voltage and energy stay fixed at the user programmed level. In the Auto mode, the tank voltage is adjusted to provide enough energy to fire all of the plugs but keeps it as low as possible. This helps reduce plug erosion and thus extend plug operating hours. As the tank voltage is reduced, it will settle to a value that will maintain all of the plugs firing. The energy gauge will drop to the level established by the tank voltage. As the plugs age, the kV demand will increase due to the ever-widening gaps, and the voltage will rise to meet the demand. The energy gauge will also rise tracking the tank voltage. The energy gauge can provide a good indication of the auto energy control loop operating and can also be used to help determine or predict the end of life for the plugs. A maintenance rule could be established to change the plugs whenever the energy exceeds 95% in the auto mode.

The Help button takes the user to a set of pages where these parameters are defined in greater detail.

Figure 6.0 Spark Page showing diagnostic messages

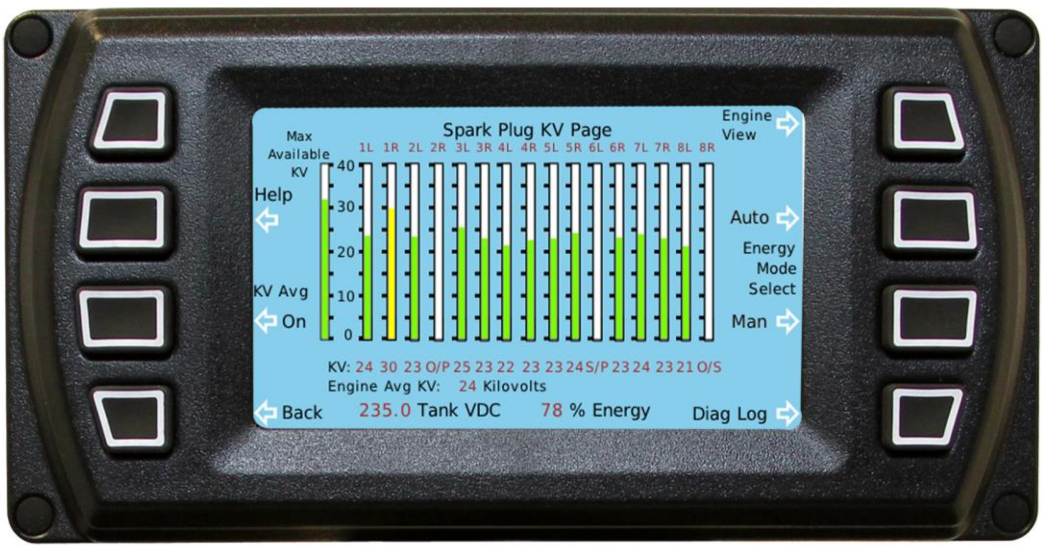


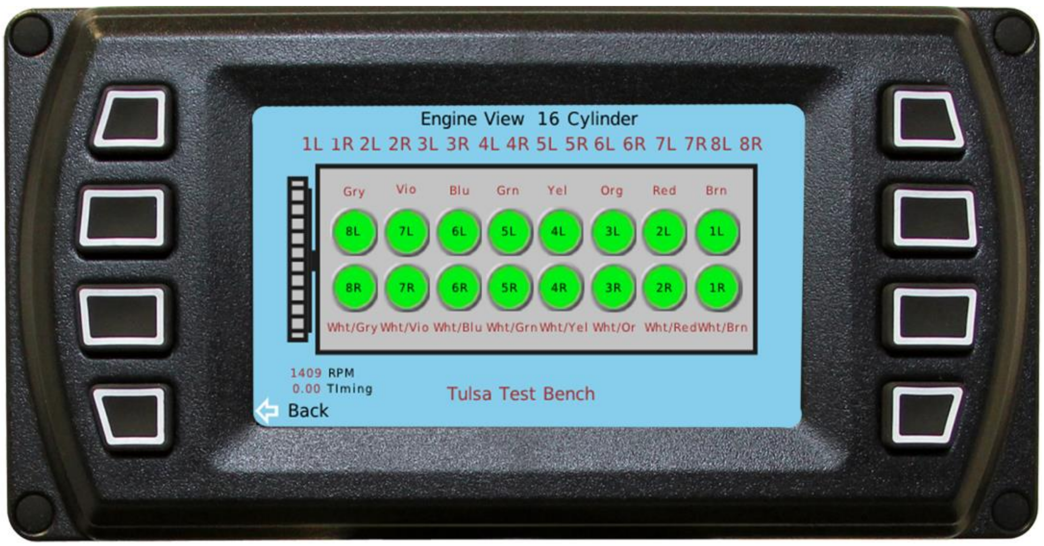
Figure 6.0 shows what would appear when there are abnormal conditions. Plug 1R shows a yellow graph indicating the demand is getting close to the available. Plug 2R has a broken primary wire therefore it shows an O/P (open primary). Plug 6L shows it has a shorted primary wire (S/P). Plug 8R shows open secondary (O/S), an indication that the plug wire is broken or the plug gap is excessively large.

Engine View Page

The Engine View button takes the user to a page that shows the engine block and each cylinder. The cylinders are color coded to show the status of the kV values. Figure 7.0 shows the 16 cylinder engine view.

In the engine block view page, the firing order is presented along the top of the page. The RPM and timing parameters are displayed. Each cylinder is color coded green, red or yellow. Green indicating the kV value is within normal range, yellow indicating a kV value that is getting near the end of available kV and Red if there is a diagnostic fault associated with the cylinder kV value.

Figure 7.0 Engine Block View



Another feature of the engine block page is the indication of the wire color of the primary lead that should be wired to the indicated cylinder. The primary harness color code indicates what pin it's connected to in the primary output connector. The firing sequence on the output is always:

Pin A, B, C, D, E, F, G, H, J, K, L, M, N, P, R, S, A, B, C…

Pin A should be wired to the first cylinder in the firing order. Pin B should be wired to the second cylinder in the firing order and so on.

The pins are wired according to the following color code:

Pin A-Brown, B-Wht/Brn, C-Red, D-Wht/Red, E-Orange, F-Wht/Or, G-Yellow, HWht/Yel
J-Green, K-Wht/Grn, L-Blue, M-Wht/Blu, N-Vio, P-Wht/Vio, R-Gray, S-Wht/Gray

Using the firing order example shown, pin A (Brown) should go to the coil on cylinder 1L. Pin B (Wht/Brn) goes to the coil on 1R and so on.

If the user selects an engine in the data base provided in the display, the firing order will be known and the wiring color code will be shown on this page. If the user provides a custom firing order, the display will still organize the wiring and show the proper wire by color code that should go to each cylinder, taking into account the user-entered firing order.

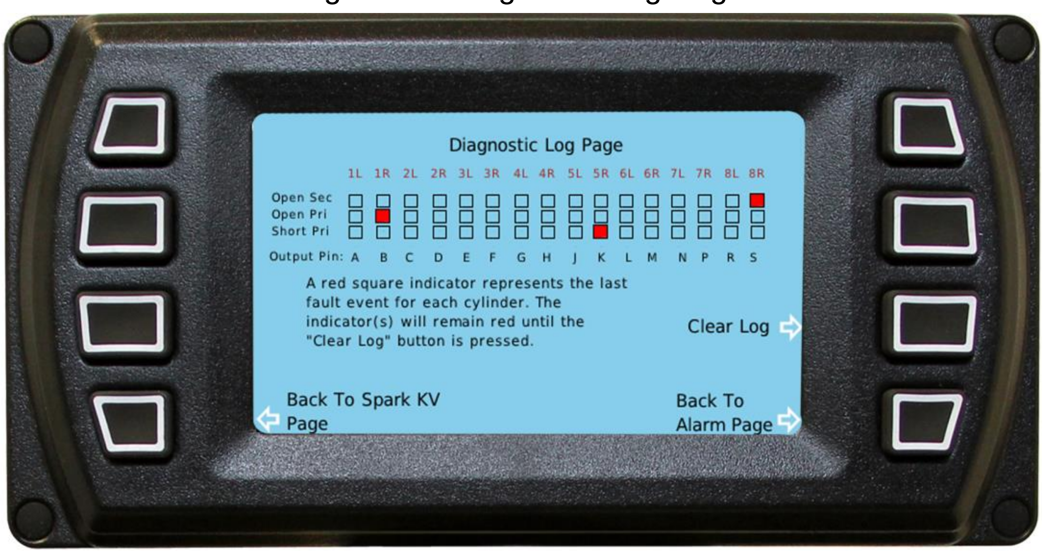
This page is useful to leave on the screen during operation. Anybody checking on the engine can view this page from several feet away and immediately see if all cylinders are firing normally.

The BACK button takes the user back to the Spark kV page.

Diagnostic Log Page

The Diagnostic Log button takes the user to a page that shows if any faults have occurred.

Figure 8.0 Diagnostic Log Page



The three possible diagnostic conditions for each cylinder are displayed in a table format. Any occurrence of one of the three fault conditions will cause the appropriate box to be filled in red, and this box will remain red until the Clear Log button is pressed. This page is useful to identify intermittent problems. The user can see what occurred, even if it only occurred once since the last clearing. In figure 8.0 it shows that cylinder 1R had at least one occurrence of an open primary since this page was cleared. Cylinder 5R had a shorted primary, and cylinder 8R had an open secondary.

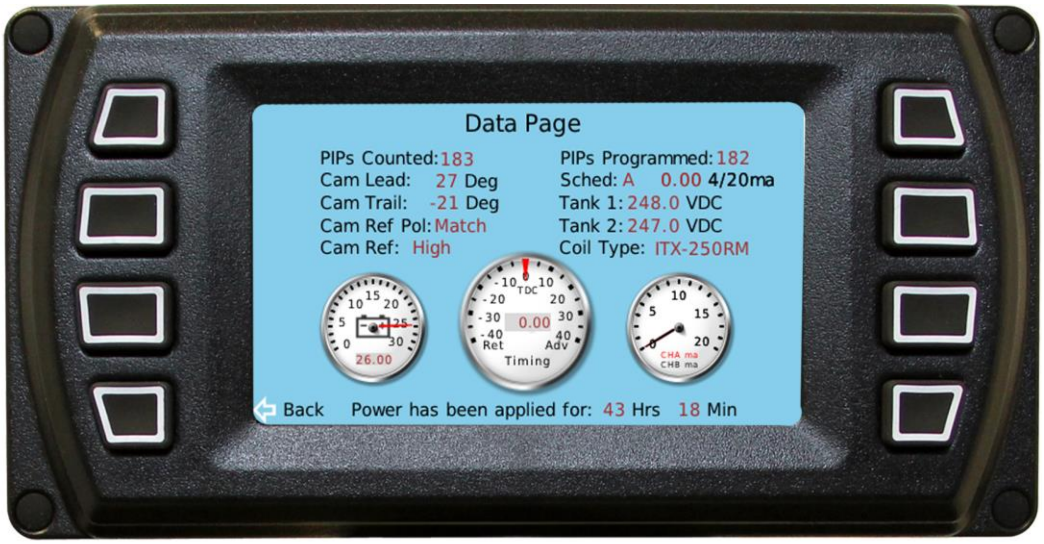
The user has the option to return to the Spark kV page or to the Alarm page.

A final comment on the diagnostic faults: Faults must occur for any two out of three consecutive revolutions for it to be registered. This filtering technique eliminates false reporting of faults. If any cylinder is detected to have a diagnostic condition that persists for two out of three revolutions in a row the condition is considered real.

Data Page

The Data Page shows a set of variables that are useful to know during operation. All of these parameters are explained in the help pages accessed from the main menu.

Figure 9.0 Data Page



In the example page shown in figure 9.0, the PIPs actually counted are 183, and PIPs that the user entered into the program are 182. This difference will generate an alarm, but as long as the PIP count tolerance is equal to or greater than 1, the system will continue to run. The CAM Lead and Trail parameters are typical. The lead value is positive indicating it is in advance of the 1/REV pulse, and the trailing edge is negative, indicating the trailing edge happened after the 1/REV pulse. These are normal values. The CAM parameters are grayed out if the unit is programmed to use one of the CAMLESS modes where no CAMREF signal is used.

CAMRef Pol indicates that the user-programmed polarity matches the measured value. The CAMRef: High indicates the CAMREF signal was detected during the period it is marking a logic high value, i. e. 10 volts. When the magnet passes under the sensor, the output will go to a low voltage (< 1.0v), and this is a logic low level. The CAMREF input is sampled every few degrees, and since during most of the revolution the target magnet is not under the sensor, a display of “High” will be shown most of the time.

The remaining parameters are self-explanatory.

The Power-Applied timer will stop after 48 hours since power was applied. This timer is useful when the unit is unattended and for some reason was shut down. The mechanic can check this timer, and if it shows 48 hours since power was applied and the engine went down within the last 48 hours, the mechanic can assume that a power cycle was not a cause of the shutdown. If for example, the timer shows 3 hours 23 minutes, this indicates that power was applied 3 hours and 23 minutes earlier. If the engine was running at that time, and power was cycled, the IntelliSpark will not fire the unit and will shutdown showing Speed > Reset fault. This means the system came out of the power up reset state and saw the engine had an RPM > crank/run and will shut down. The potential for having excess fuel in the system is the reason the system is designed not to fire the plugs if speed is detected after power up.

View/Edit Setpoint Page

The View /Edit Setpoints page allows the user to observe and change several operating parameters. In order to edit, the user must enter a passcode. These parameters can be set during standby or run mode.

Figure 10.0 View/Edit Setpoints Page

The three parameters shown in figure 10.0 can be changed by the user if the correct passcode is entered. The 1/Rev Position parameter is used to specify where the 1/REV signal actually occurs. This allows the displayed timing angle to agree with a timing light used on the flywheel. Changing this value does not change the displayed timing angle, but it does change the actual timing at which the unit fires the coils. Once the timing light and the displayed timing are the same, the user can rely on the displayed timing for the actual timing.

The Timing Adjust allows the user to change the timing plus or minus 3 degrees for any purpose. Changing this parameter will change the displayed timing and actual timing. This parameter can be used to take the engine out of a knocking condition due to any reason, or the user may want to see what possible fuel savings can be had by advancing this a few degrees.

The parameters can be saved in non-volatile memory so they remain after power is removed. If the engine is running at the time the SAVE button is pressed, the page will display “Save Pending…” meaning it must wait for the engine to be shut down before it reprograms the memory. It cannot reprogram memory during run mode, it must be in the standby mode. The new values will be used after they are changed.

Figure 11.0 Editing the 1/REV Position

Figure 11.0 shows the page the user will see after the correct passcode has been entered and the 1/REV Position parameter has been selected for editing. The Select arrows cause the gauge select pointer to scroll from gauge to gauge. In the example, the user has stopped it under the 1/REV Position gauge. The small digital gauge within the dial will show the same value as the analog gauge. The user would press the up or down arrow buttons adjacent to “Adjust” to increase or decrease the value. After the changes have been made, the user would press the Back button and then press the Save button on the home page to make them permanent. The user can also elect to just make the changes without saving to see the effect the changes have. All three parameters can be changed and saved as a group.

Once the passcode has been accepted and the user is on the editing page, there is a button labeled “More” which will bring him to another page that gives him access to two factory-set parameters.

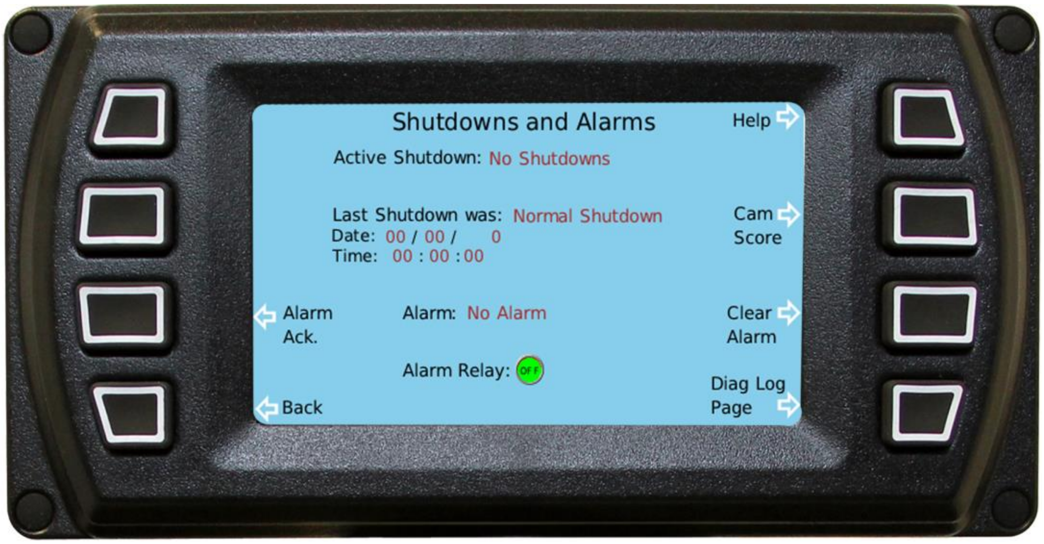
Figure 12.0 Factory Setpoints

These parameters are set during a final factory test. They affect the kV measurement sub-system. Details on these parameters are presented during the ignition class held at the factory in Tulsa, Oklahoma.

Shutdown and Alarms page

Selecting this page takes the user to the page depicted in Figure 13.0. The top area of the page is used to post shutdowns, and the lower part of the page is used to post alarms.

Figure 13.0 Shutdowns and Alarms Page



When the engine is running, the Active Shutdown will show "No Shutdowns." If something occurs that is serious enough to generate a shutdown such as overspeed or signal loss, a message to this effect would immediately post in this area on the screen. This event is also saved and time stamped. After the engine comes to a stop, the alarm message will remain posted until the engine is restarted, at which time the message will automatically clear. There is no need to cycle power or press any button to reset shutdowns. If the engine is shutdown normally, for example, the fuel is cutoff, the Active Shutdown would show normal shutdown, and it would be saved and time stamped below the Active Shutdown line.

The Alarms include some shutdowns as well as detected fault conditions that are not serious enough to cause a shutdown but should be addressed before the problem becomes more serious. The non-shutdown alarms include ignition diagnostics, 4/20 mA input errors, PIP counts not perfect but within acceptable limits and others. When an alarm occurs the Alarm relay will come on, the Alarm Relay LED indicator on the Operator page will turn red as well as the LED indicator on this page.

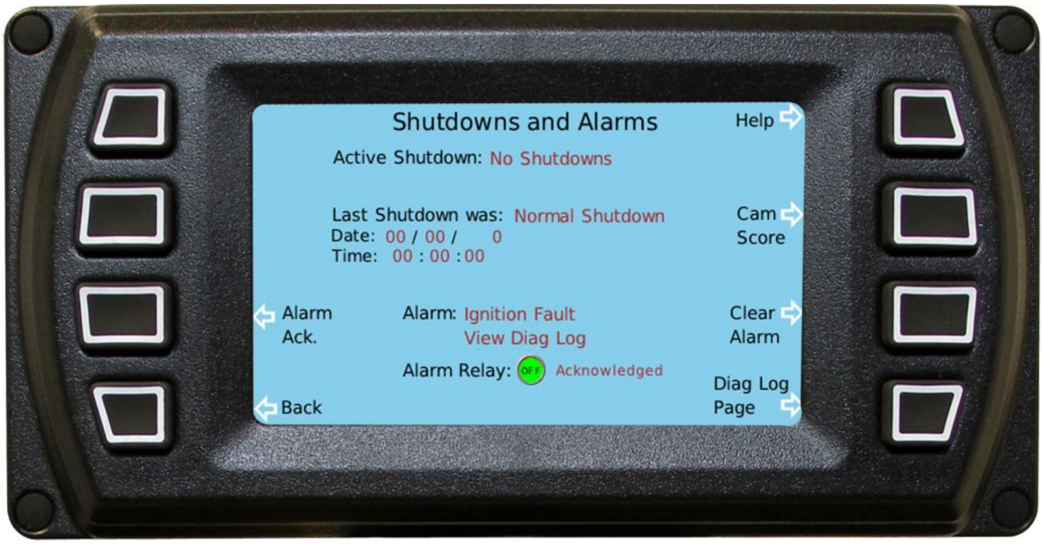
When an alarm occurs the user has several options:

1. Leave the Alarm Relay on
2. Press the Alarm Acknowledge button which turns off the Alarm Relay
3. Press the Clear Alarm Button

Pressing the Alarm Acknowledge button will turn off the Alarm Relay, but the Alarm will still remain posted on the page. If a new alarm occurs, the relay will turn on again. The purpose of the Alarm Acknowledge button is to turn off any device connected to the relay such as a horn or alarm bell. The alarm will remain posted until the source of it is fixed and the user presses the Clear Alarm button.

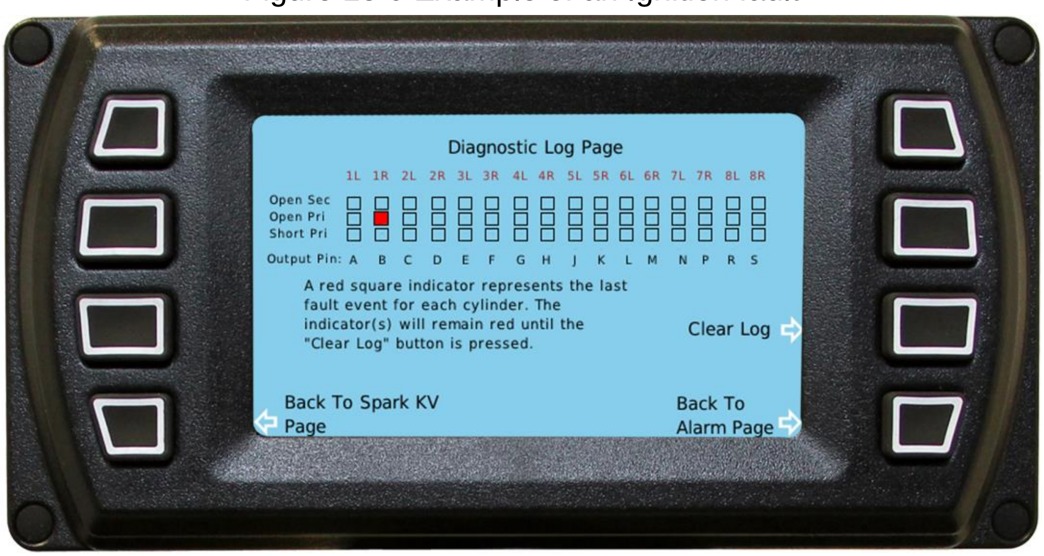
Figure 14.0 Ignition Fault shows the screen after the user pressed the Alarm Ack. Button.

Figure 14.0 Ignition Fault screen view



In the above example, the user is asked to view the Diagnostic Log Page. Figure 15.0 shows the Diagnostic Log page for this example.

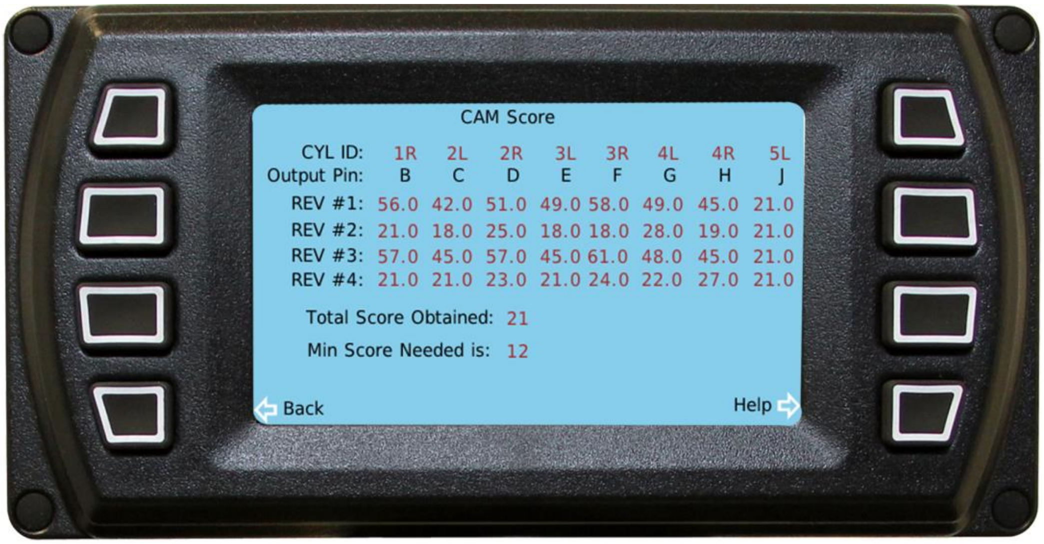
Figure 15.0 Example of an Ignition fault



The Shutdowns and Alarm page provide a button to take the user to the Cam Score page if one of the Camless methods is being used.

Figure 16 shows a typical display of data after the engine is started using one of the camless methods. The engine is a 16 cylinder; therefore, eight coils are used in the test firing phase. The cylinders used always start with the second cylinder in the firing order, which in this case is cylinder 1R according to the firing order. Each of the eight cylinders is fired once every revolution, and its timing is based on the Timing RPM schedule. The user would normally set the timing to 0.00 degrees, for example, TDC where the highest pressure is generated on the compression stroke.

Figure 16.0 Cam Score Page 3



For this example, cylinders 1R-4R show a good distinction between the strokes. These numbers are the time delay values that get used to calculate the kV value. Since the kV is directly proportional to the time delay, the time data can be used directly. This is further covered in the ignition class.

From this data, it appears that the first and third revolutions are the compression stroke due to the higher values on these firings than on the second and fourth revs. Cylinder 5L shows the same value so this is a case where there was no distinction made on this cylinder possibly due to a fouled plug or very small gap. But cylinder 5L will not prevent this engine from starting because the minimum required score was set to 12, and the score obtained reached 21. A perfect score would have been 24 if cylinder 5L provided higher readings on its compression stroke. If the compression in 5L was gone due to a mechanical malfunction, the engine would start but would exhibit poor performance due to a dead cylinder.

Another piece of information that can be deduced from this page is that the plug gaps may not be very uniform due to the large variation in the time delay values on the compression stroke between cylinders. This is not a major issue but one worth noting the next time the plugs are cleaned/regapped or replaced.

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