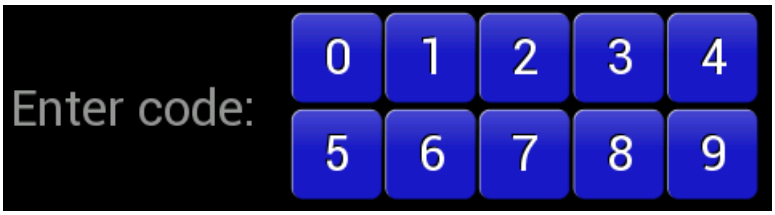
9 TFT Touch Display Operations

Above the left (pilot side) EFIS is a small TFT touch display, used to control and monitor various startup and running operations.

9.1 Power up and security

The display will “come alive” around ten seconds after the left side door is opened, and will stay alive (i) until around five minutes after the left door is closed with all other power switches off, or (ii) as long as either master power switch on the panel is in one of the “on” positions. When first powered up, the display will simply show the aircraft registration:

In general, this startup display will be active with the left door open during all pre-flight operations, passenger loading, and while the pilot is getting seated and the left door is closed. At any time, but generally after all of these actions are completed, if the pilot touches the screen, the following invitation will be displayed:



You won’t be flying this aircraft unless you have been issued with a security code. Codes are issued on a per-pilot basis, with other codes associated with maintenance and simulation. Until a correct security code is entered, the engine cannot be started.

9.2 Backup Battery/Power display

Once a correct security code is entered, focus shifts to the backup power display. One of the following screens will appear. The display will update as events occur to bring the backup battery and right system power online. Initially, neither will be online, and it may be that the backup selector may not be able to derive status:

Here is the backup power display as it would appear under normal circumstances, with both (a) the Right power system online, and (b) the backup battery adequately charged. In this normal configuration, the Right power system is the avionics backup power supply (and will take over if the Left power system fails or is switched off), and the backup battery is ready and available as the third tier avionics backup if *both* the Left and Right power systems fail or are switched off. This display is what would be considered the "normal" situation in flight.

If the front panel battery backup (BAT) switch is turned off, the battery system will be shown as inactive. The right power system will still be present as backup Avionics power:

If the right system power had been turned off instead of the battery backup system, the display will reflect the situation in the following manner. In this case, in the event of left electrical system switch off or failure, avionics backup power will come from the backup battery alone.

If both left and right electrical systems are off, avionics power will continue to come from the backup battery. However, as the backup battery voltage declines, the display will switch to red indicating eminent shutdown of the backup battery system.

The battery backup display will update whenever status of either systems change, as part of the normal sequence of pilot initiated power-up events. In this mode, the display can be sequenced to the next state (door annunciation) by one of two methods:

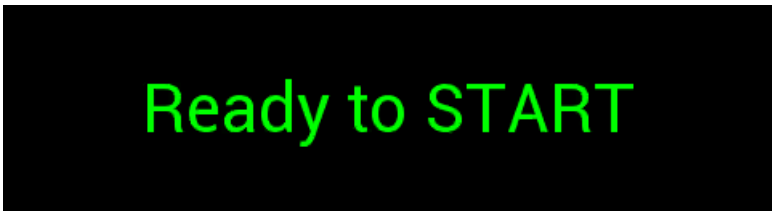
- Manually, by swiping the display left or right
- Automatically, if both the right and battery backup electrical systems have been on and stable for a period of five seconds.

9.3 Door Annunciation and engine start

This display is the door annunciations for the left and right doors, and baggage door. Green means the door is correctly closed and the pins are engaged. Red means the door is not properly closed. Here is the display when the pilot side door is still open:

It is not possible to progress past this point until all doors are properly closed. Once the pilot side door is closed and the lock pins are properly engaged, the display will update to all green:

With all doors properly closed, touching the display will move on to a series of items that are to be used in conjunction with engine start and checklists. The first of these displays will simply advise the pilot that engine start is now possible:



Various pilot actions would normally be taken at this time in order to start the engine. Once the engine is running, the display will transition to begin a series of checklist related items.

9.4 Checklist aids

During engine run-ups, various systems need to be ground tested. A series of three checklist displays allow disabling engine systems in order to test redundancy. Each system may be disabled and re-enabled any number of times, as engine checks occur. “Next” and “Previous” keys allow movement between the checklist items at will until all engine tests are done to the satisfaction of the pilot.

9.5 Left Coilpack checklist aid

These checks are analogous to the magneto LEFT/RIGHT/BOTH checks on a traditional aircraft.

To disable the left ignition system, simply press on the centre button labeled “Left Coilpack”. This corresponds to disabling all of the the *top* spark plugs. The Left ignition system uses dedicated power from the Left/Primary battery/alternator.

While the left ignition system is disabled, engine RPM will drop slightly, and the display will be highlighted as shown in the following screenshot:

In this mode, the *PREV* and *NEXT* keys are disabled – it is not possible to leave this display until the coilpack has been re-enabled, by pressing once on the centre key. This will restore power to the Left ignition system, the engine RPM drop should disappear, and the centre key will revert to its previous green colour.

With power restored to the Left Coilpack, pressing *NEXT* will progress to the next checklist item.

9.6 Right Coilpack checklist aid

The Right Coilpack corresponds to the *bottom* spark plugs. This ignition system uses dedicated power from the Right/Secondary battery/alternator.

Operation is identical to the previous example, and once the Right Coilpack is re-enabled, pressing *NEXT* will progress to the Injector power checklist item.

9.7 Injector power checklist aid

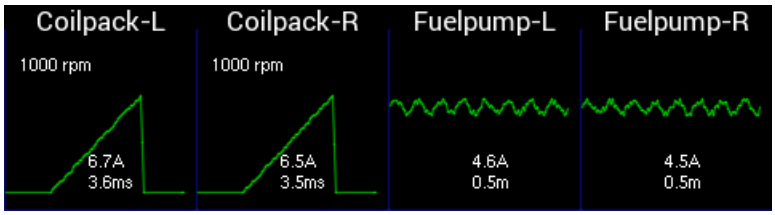
The Fuel Injector power check is different to the Coilpack checks. In the case of the Coilpack checks, there are two physically redundant ignition systems on the engine, and when one is disabled the other allows engine operation to continue. In the case of the fuel injectors, there is only one injector per cylinder, and what is being tested by this checklist item is the automatic switchover, on a per-injector basis, of the injector power itself. It is critically important that this check be performed on the ground, to guarantee that an in-flight failure of the Left/Primary electrical system cannot cause engine failure.

With *both* Left/Primary and Right/Secondary ECU Power switches in the ON position, and the engine running *at idle*, tape the *Injector Power* key, and verify that the engine continues operating. Tap once again to restore injector power to the normal Left/Primary position, and that once again the engine continues to operate.

With Injector Power restored to normal, the *NEXT* key may be pressed to exit the Checklist menus.

9.8 Coilpacks and Fuelpumps summary display

This is one of the two main engine monitoring displays, providing summary information for both Coilpacks and both Fuelpumps. In the following example, both ignition systems are on (as normal), and both fuelpumps are on, as would be the case for take-off and climb out.



For each of the left and right coilpacks, coilpack current pulses as sampled by the EFI redundant power system are plotted in green. These waveforms are refreshed approximately ten times per second, and should be very consistent between samples. They should be triangular in shape as shown, with a constant rate of current increase and a sudden collapse at the end of the pulse. Two numerical indicators below the waveforms summarize peak current (in Amps) and dwell time (in msec) for the Coilpack current pulses. At the top left of each plot window is a measurement of “derived” rpm. The EFI redundant power system samples *all* Coilpack pulses, and can therefore derive the implied engine RPM by counting the rate at which pulses occur. These two *implied* RPM measurements should closely match the *actual* engine RPM, as

measured by the aircraft's engine monitor. If they do not, the mismatch could indicate occasional missing sparks in the ignition system, which should be investigated.

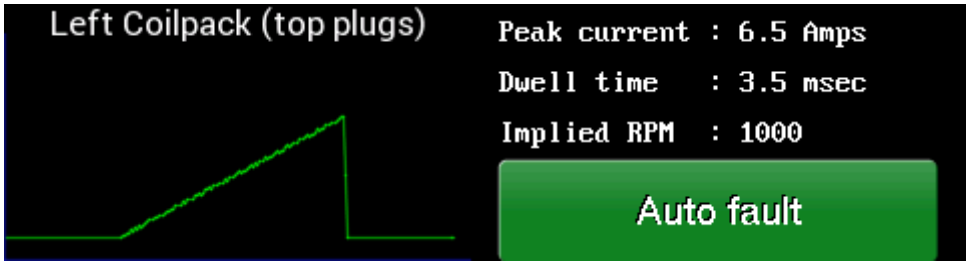
For each of the left and right Fuelpumps, sampled pump current waveforms are displayed. Although these are nominally DC pumps, the pump motors have commutators and the sampled waveforms can give a visual impression of the motor's electrical health. Excessive commutator noise or dropouts can provide an early indication of impending pump failure, even though the pump is still providing adequate fuel pressure. Below the pump waveforms are a measurement of the average pump current (in Amps) and the time that has elapsed since the pump was last started (in minutes).

Various anomalies and error conditions can be detected by the EFI redundant power system and presented on this summary display. These conditions are described in a later section of this Chapter.

Any of the four plotting sections on this page can be selected to produce a more detailed display. To do this, simply tap once on the corresponding plot. Alternatively, to move to the next or previous summary display, swipe your fingers either right-to-left or left-to-right respectively.

9.8.1 Coilpack detailed display

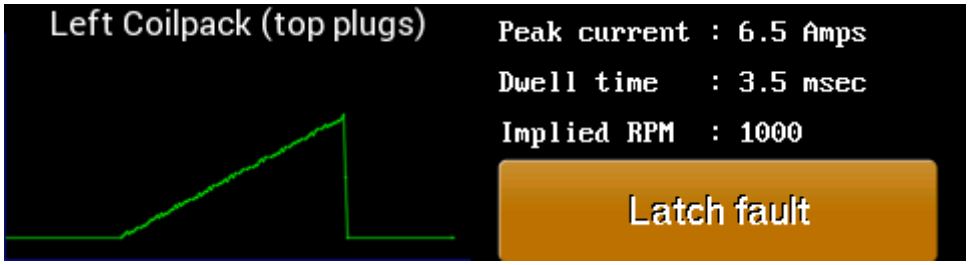
The Coilpack detailed display provides a larger waveform plot with more points, the same information as contained in the summary but with labels, and a push-button that can be used to disable automatic fault retries on a running system. The plot title also indicates which plugs this coilpack corresponds to, top or bottom.



To return to the previous summary display, tap the screen on the waveform. To change from "Auto fault" to "Latch fault", tap the green button. This is not a recommended action in flight, but is a capability provided for the Coilpacks and Fuelpumps only (not the injectors) as an advanced pilot capability.

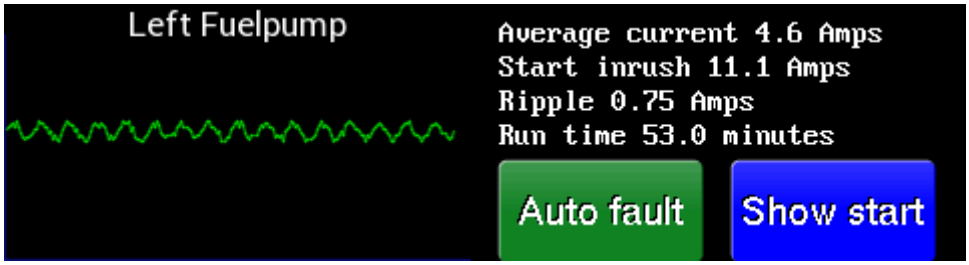
Normally, in the event of a circuit fault, the EFI redundant power system will automatically re-apply power (i.e. reset the electronic circuit breaker) in order to get the circuit running again. It can sense the fault condition extremely quickly and trip the circuit, and keep repeating the process indefinitely. This is completely normal and one of the key benefits of electronic circuit protection. If an intermittent or momentary fault occurred, the ignition system might stall momentarily but will automatically recover when the fault condition goes away.

If the pilot changes the mode to "Latch fault", then if/when a fault condition occurs, the electronic breaker will trip, and power can only be manually restored (by pressing the "Latch fault" button and thereby switching back to "Auto fault"). This mode is not recommended unless there is specific information available to the pilot that means the fault condition is permanent and cannot recover. Stopping the automatic retries stops the system from fruitlessly beating on a dead circuit, thereby stopping the large/narrow current spikes that can cause interference with other channels.



9.8.2 Fuelpump detailed display

The Coilpack detailed display provides a larger waveform plot with more points, more detailed information than the summary, a push-button that can be used to disable automatic fault retries on a running system, and a blue pushbutton that can be used to examine the current surge that occurred the last time the pump was started.



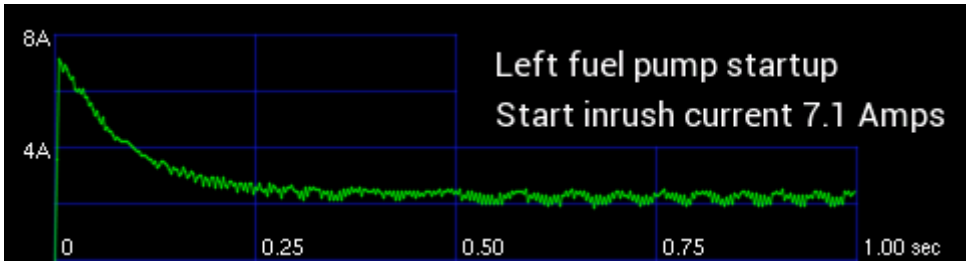
To return to the previous summary display, tap the screen on the waveform. To change from "Auto fault" to "Latch fault", tap the green button. This is not a recommended action in flight, but is a capability provided for the Coilpacks and Fuelpumps only (not the injectors) as an advanced pilot capability.

In addition to average current and run time, starting inrush peak current (in Amps) and peak-to-peak ripple current (in Amps) are shown in the details.

Pressing the blue button will lead to a new display, showing the inrush current across a one second interval after the last time the pump was turned on.

9.8.3 Fuelpump last start surge display

When a DC electric motor is turned on, it is stationary and a large current surge occurs in the instant after switch-on. As the motor builds up speed, the current drops down to the normal operating level for that motor. The characteristic of this switch-on current surge can be useful for monitoring both the electrical health of the pump motor, and overall condition of the hydraulic system that the pump drives.[9]



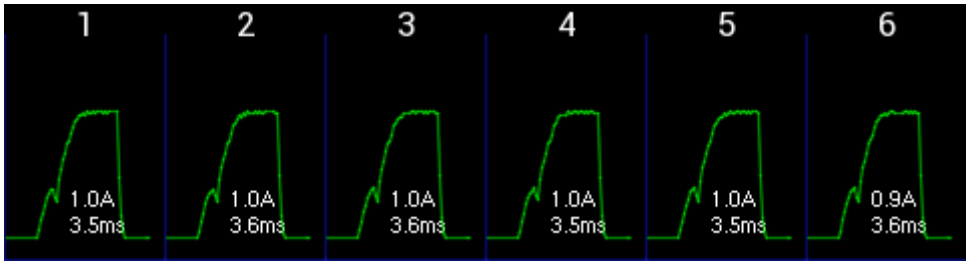
9 Note: the inrush current plot shown is *not* from an SDSEFI Walbro fuel pump. It is from a cheap DC blower.

While this display is active, it is automatically refreshed if a new pump start event occurs. That way, if there is some question about the integrity of the system and how the pump is starting up, the pump can be cycled multiple times while viewing this display. Under normal conditions, the starting inrush characteristic should be consistent across multiple standing starts. If it is not, the cause should be investigated on the ground.

Tap the screen to return to the previous Fuelpump detail display. Tap the plot once again to return to the Coilpack/Fuelpump summary display.

9.9 Fuel Injectors summary display

The fuel injectors summary display provides waveform data, peak current and duration for injector pulses, for each of the six fuel injectors. Pulses are scaled in both duration (x direction) and amplitude (y direction) in order to fit onto the display; however, the scaling applied is consistent across the six injector plots so that anomalous behavior for any injector can be observed.

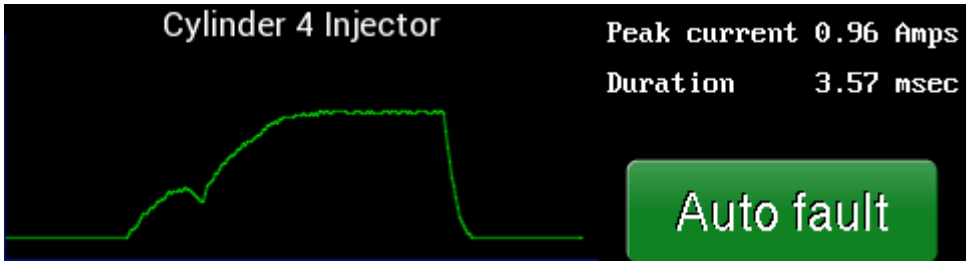


Various anomalies and error conditions can be detected by the EFI redundant power system and presented on this summary display. These conditions are described in a later section of this Chapter.

Any of the six plotting sections on this page can be selected to produce a more detailed display. To do this, simply tap once on the corresponding plot. Alternatively, to move to the next or previous summary display, swipe your fingers either right-to-left or left-to-right respectively.

9.9.1 Fuel Injectors detailed display

The fuel injectors detailed display provides a larger waveform plot, as well as peak current and opening duration information. The *"Auto fault"* button is present, but depressing it takes no action. It is present to note the fact that for each injector automatic retries for over-current faults will occur.

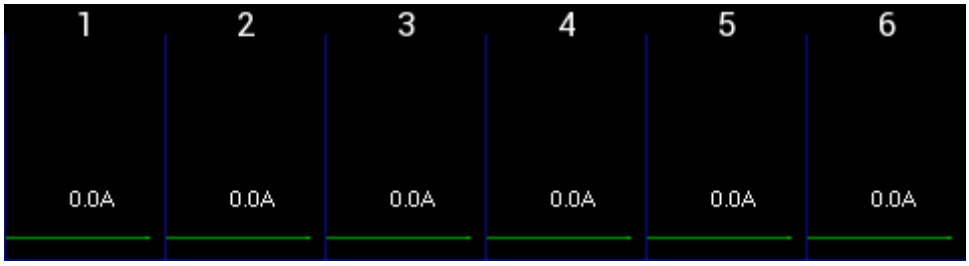


To go back to the Fuel Injectors summary display, press once anywhere near or on the waveform plot area.

9.9.2 Fuel Injectors – display when Left/Primary power is off

If the Left/Primary power is turned off, or has failed, the EFI redundant power system will almost instantaneously, under hardware control, switch all fuel injectors over to the Right/Secondary power system.

The engine will continue to run. The only indication on the TFT display that this has occurred will be that all fuel injector currents are zero:



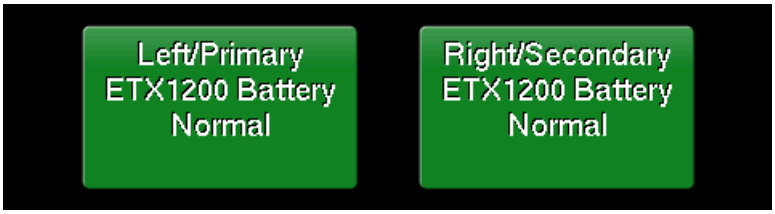
This is not considered a failure condition, from the standpoint of the TFT display. The display system has no way to determine that the injectors have been changed over to the backup supply. This is by design in the EFI Redundant Power system, where the fuel injector power changeover logic has been designed to be as rugged and reliable as possible. Hardware for fancy features beyond its basic function is deliberately not present.

If the pilot turned the Left/Primary power system off, then he/she will be fully aware that the fuel injectors are running off backup power. If the Left/Primary power system has failed, there will be lights and annunciation from the main Avionics display that will fully captivate the pilot’s attention. Again, the fact that the Left/Primary power system has failed will be obvious.

Note that the behavior described above is not the case for Coilpack and Fuel pump displays, since these devices have no redundant switchover function – there is one of each type of device on each physically separate power system.

9.10 ETX1200 Battery Fault Status display

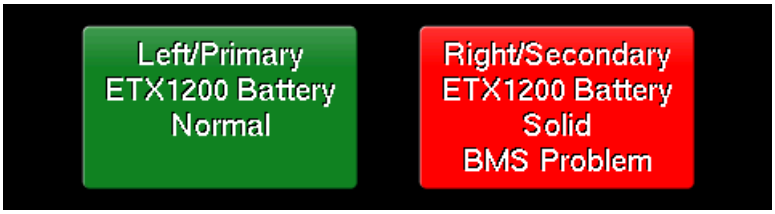
Each main battery has a fault output, which would normally turn on or blink an LED light. These outputs are interpreted by the system and presented to the Pilot in a decoded form on the TFT display. Here is the display when both batteries are operating normally, i.e. no fault status:



If the Left/Primary ETX1200 fault status was blinking at a slow (5 sec) rate, this would result:

If the Left/Primary ETX1200 fault status was blinking at a fast (2 sec) rate, it would be displayed as follows:

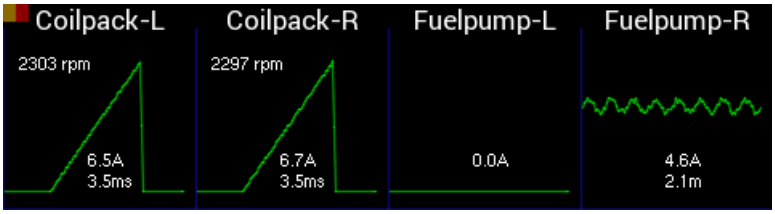
Finally, if the Right/Secondary ETX1200 fault status was on solid, the following would be displayed:

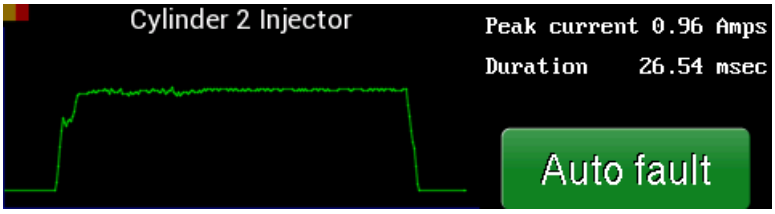


Refer to the EarthX ETX1200 battery manual for more details on the fault status and what actions should be taken. This information is repeated in Section 8.8 on page 34. A copy of the EarthX pilot information is included in the checklist.

9.10.1 ETX1200 Battery alarm notification on other screens

The Pilot would not normally have the ETX1200 battery status displayed during flight. In order to notify the pilot of an active fault status of either battery, a small indicator will appear, and blink, in the top left of the screen for any active Injector/Coilpack/Fuelpump summary or detailed display. There are two small indicators, the left for the left battery and to the right for the right battery. In addition, an audio message will be sent to the intercom system at the onset of any battery fault, and every 5 minutes thereafter. Here are some example displays where both left (amber) and right (red) battery fault notifications are active:





If a small amber or red rectangle in the top left of the display starts to blink, the normal Pilot action would be to swipe over to the ETX1200 Battery summary display and take note of the fault status, in conjunction with noting the electrical system voltage and charging status on the main EFIS display.

If there is no fault status for either main battery, these notification bars will not appear.

9.11 Air/Fuel ratio display

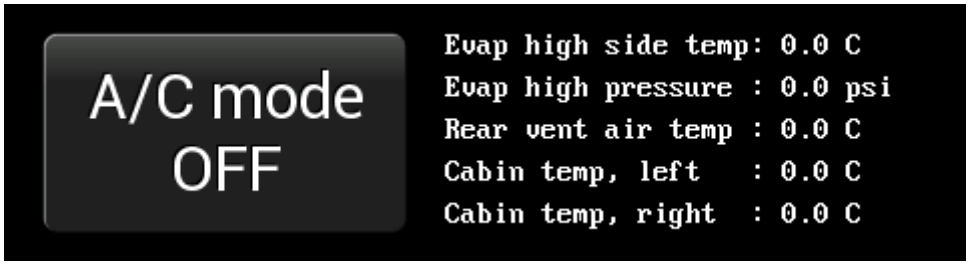
This display is primarily for use as an aid in EFI ECU tuning. It presents measured Air/Fuel ratio on a dial and in a large numerical form, independent from the ECU tuning interface. Note that this data is only reliable if the Air/Fuel monitor probe is working properly, and these probes are subject to failure after a period of operation with 100LL AvGas.

Also included are the Primary and Secondary rpm counts, these are derived from the pulse output of the ECU's, and reflect actual engine rotation.

Swipe the display left or right to move on to the next item.

9.12 A/C system display

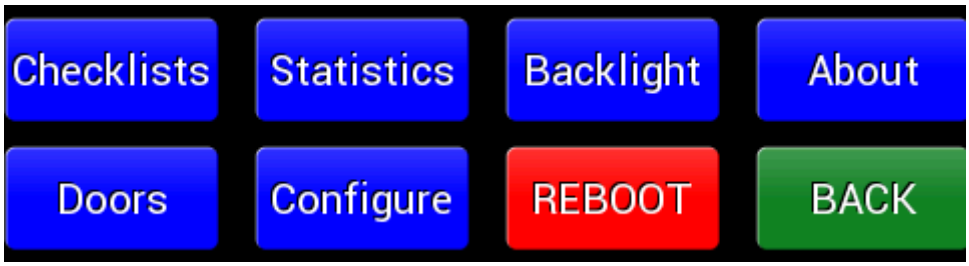
This display summarizes air conditioning status. It is not used for any sort of A/C control. Sensors present near the A/C evaporator measure high side temperature and pressure and can be used to confirm the A/C system performance. In addition, there are measurements of the rear vent air, left cabin and right cabin temperature.



Swipe the display left or right to move on to the next item.

9.13 Utilities display

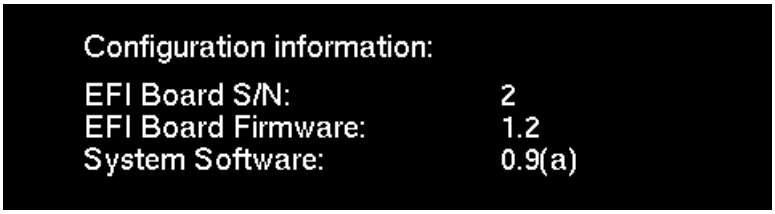
The Utilities display allows a number of auxiliary functions, not normally useful for flight, to be displayed. Each separate utility is entered by pressing the corresponding button. Exiting the top level Utilities display occurs via the **BACK** button, not by swiping.



A unique case is the REBOOT button. If this is pressed, then the entire system will reboot. The display will go blank for a while and return with the Initial display (aircraft registration). There is no confirmation, if you hit the button the system will REBOOT. This will not effect the engine or power system in any way.

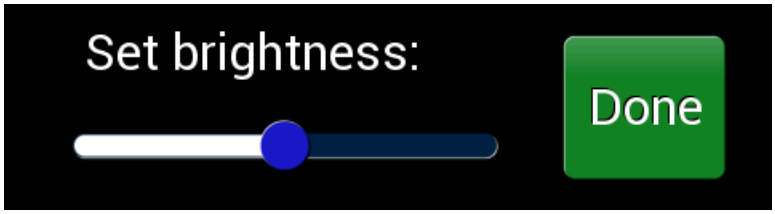
9.13.1 About display

The About display simply lists the EFI Redundant power board serial number, firmware revision, and host system software revisions. Tap the display anywhere to return to the top menu.



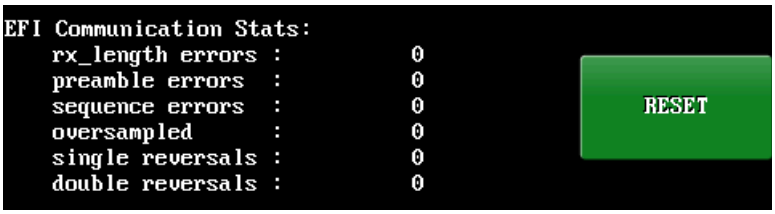
9.13.2 Backlight display

This utility allows setting the TFT display backlight level, i.e. setting the display brightness. A simple slider allows setting the backlight, which adjusts continuously along with actions on the slider. When the desired brightness has been set, press Done to return to the Utilities menu.

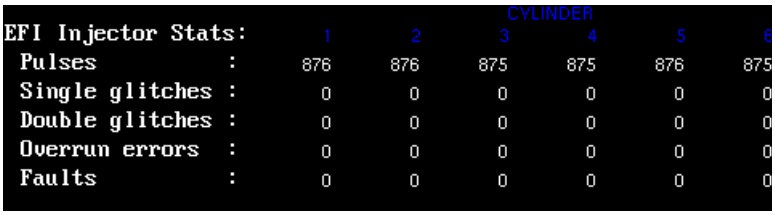


9.13.3 Statistics displays

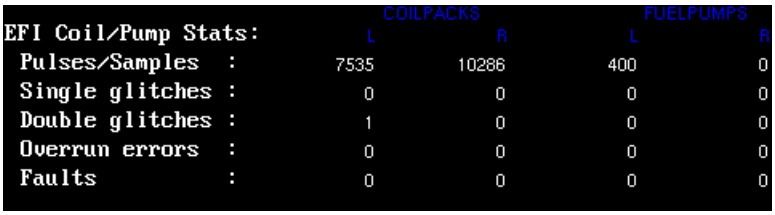
These displays are not useful to the pilot, they are present mainly as a system maintenance and/or development aid. There are various statistics counters maintained on the EFI Redundant Power board firmware, and they may be viewed and reset here. The first display is for EFI Communications statistics, and under normal circumstances all numbers should be zero. If they are not, it can indicate a communications problem between the CPU and the EFI Redundant Power board, which should be addressed. There is a single green RESET button, which resets all statistics on this and subsequent displays. Swipe this display right-to-left to proceed to the next screen (avoiding the RESET button).



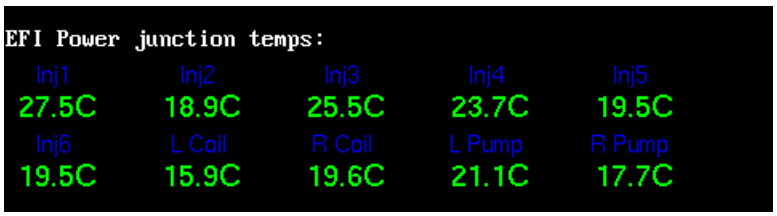
The next display shows EFI Injector statistics. For each injector, the number of pulses. Glitches refer to samples that were too narrow to constitute genuine injector pulses. The presence of these is not indicative of any sort of failure. Overrun errors refers to the EFI board's firmware and this should never occur. Faults counts the number of times over-current fault conditions were sampled, this should never occur either but as a troubleshooting aid for intermittent problems these are logged. Swipe this display right-to-left to proceed to the next screen.



The Coilpack and Fuelpump statistics display gives the same information for Coilpacks and Fuelpumps. Swipe this display right-to-left to proceed to the next screen.



The final statistics screen gives Junction temperatures for each of the Electronic Circuit Protection devices on the EFI Redundant Power board. These junction temperatures should never be high – the devices are never operated anywhere near their thermal limits.



Swipe this display right-to-left to return to the top level Utilities display.

9.13.4 Checklists entry point

This button enters the Checklist entry items, and they behave identically as described previously in Section 9.4 on page 38. Use the NEXT or PREV buttons to return to the top level Utilities menu.

9.13.5 Doors display

This simply shows the door annunciators, as previously described in section 9.3. Tap the display once to return to the top level utilities display.

9.13.6 Configure display

The contents of this item are beyond the scope of this manual. Refer to the maintenance manual for further details. Note that this item cannot be entered while the engine is running, and may not be available anyway depending on whether the user (as identified by the originally entered security code) has configuration privileges.