



# SAI-340 Pilot Guide



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### Record Of Revision

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1-ER	5/19/2015	Initial release for internal/DER review	Jeff Bethel
1	20150817	DRN 485	CLH
2	20160121	ECN 4147 – Updates for V15 Software. Updated system description. Added default baro configuration options (STD, LAST, AUTO). Added airspeed units (KTS or MPH). Clarified degraded mode of operation, initial stabilization and other operations.	CLH
3	20160825	ECN 4173 Changed minimum airspeed from 20 to 30 to reduce flutter when stationary. Add IVSI and Altitude Bug	BWG

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# Section 1 - System Overview

## 1.1 Introduction

This manual describes the operation of the SANDIA aerospace SAI 340 Attitude Indicator. It is intended for use by pilots operating the SAI 340 in normal and abnormal operating conditions.

## 1.2 SAI 340 Product Description

The SAI 340 Attitude Indicator is a panel mounted attitude, airspeed, altitude, vertical speed and slip instrument. The instrument is self-contained and directly incorporates all of the sensors required to measure and display the listed flight parameters.

All information is displayed on a color 3.5" diagonal LCD display in traditional aerospace symbology. The unit also contains a rechargeable battery capable of providing continued operation in the event of aircraft electrical failure.



Figure 1 - SAI 340 Overview

### 1.2.1 Functions

The SAI 340 performs the following functions:

- Display of Indicated Airspeed (Knots or Mph)
- Display of Barometric Altitude (Feet)
- Display of Roll & Pitch (Fixed Pointer Format, Degrees)
- Display of Slip Indication (Degrees)
- Display of Vertical Speed Indication (feet per minute)
  
- Pilot Entered Baro Correction (mb or inHg – Configurable Default Value)
- Automatic and Manual Backlight Control (%)
- Display of Battery Charge Status (% Remaining)
- Display of V-Speed Limitations (Colored Bands)
- Altitude Bug (Pilot Adjustable)

Various parameters can be configured by the installer (not pilot accessible):

- Configuration of Roll & Tilt Offsets
- Configuration of Airspeed and Altitude Trim
- Configuration of Airspeed Units
- Configuration of V-Speeds
- Configuration of Baro Units
- Configuration of Baro Default Value
- Configuration of Battery Type
- IVSI Filter Lag

### 1.2.2 System Interfaces

Airspeed and altitude are derived from internal pressure sensors that are connected to the aircraft's pitot and static lines. Airspeed is determined by the pressure difference between the pitot and static ports, while altitude is determined by the pressure on the static port. Altitude is barometrically corrected by the pilot entered baro value prior to being displayed.

Attitude is aided by airspeed to provide better pitch performance during takeoffs and in-flight accelerations and decelerations. TSO performance levels are maintained with or without this additional aiding.

Aircraft power is the only electrical interface present. No communication or data interfaces are provided to other avionic systems in the aircraft.

## Section 2 - Normal Operation

### 2.1 Initial Power On

Upon initial power-on, the unit will display the company logo, battery status and software version. If the battery is not installed, has failed self-test, or is in a low-temperature state, the battery life will show 0%.



Figure 2 - Power On Screen

### 2.2 Thermal Stabilization

On initial power-on, the various internal sensors must thermally stabilize. While this is occurring, the corresponding indicator area will be covered by a red X. At room temperature, this process takes approximately 1 minute. At colder temperatures, this may take longer.

If the ambient temperature is below 10°C, the battery will enter a heating cycle and the battery status icon will be red-X'ed with a BAT HEATING indication as follows:



Figure 3 – Sensor & Battery Stabilization

## 2.3 Alignment

On power-up, the unit will perform an initial alignment. The aircraft should not be subjected to taxiing or excessive motions during this process. Alignment is not normally performed during flight.

**During alignment, the aircraft should not be subjected to taxiing or excessive motions.**

During alignment, the following message will be presented on the screen:

**ALIGNING**

Figure 4 – Aligning Message

## 2.4 Pilot Display and Controls

The following shows the on-screen functions and pilot controls once the system has stabilized:

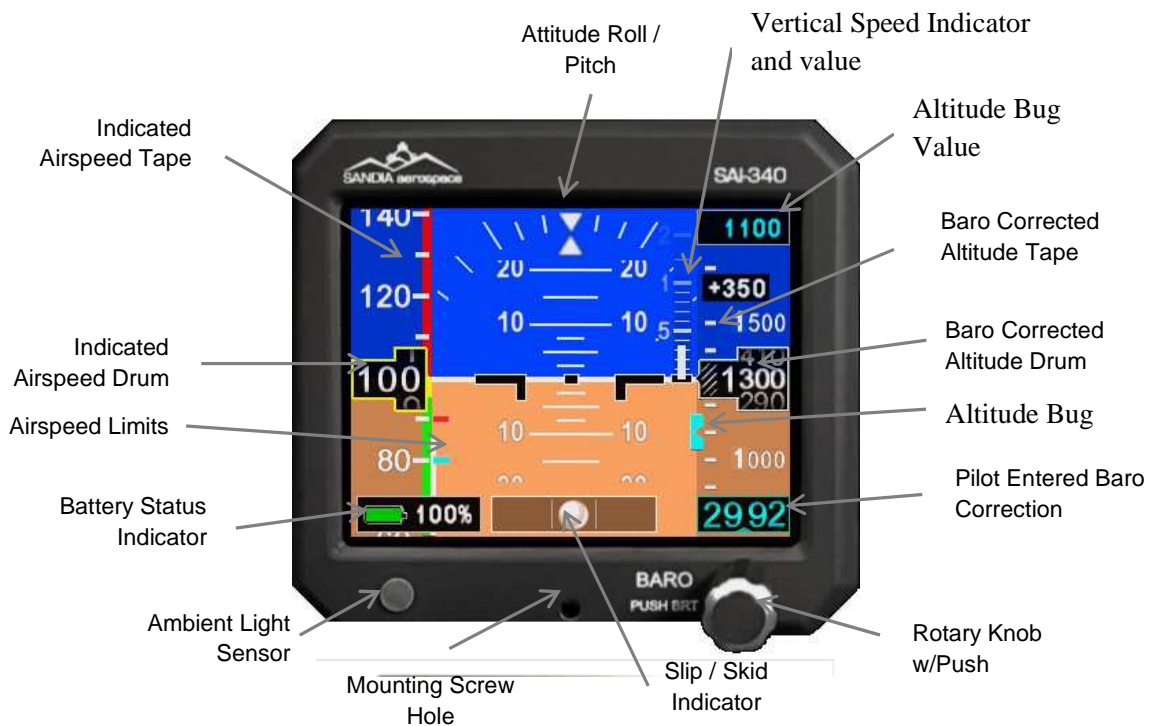


Figure 5 – Pilot Display & Controls

The Rotary Knob with pushbutton provides the pilot access to all of the interactive functions of the SAI-340. Figure 6 depicts the pushbutton selection of various functions and Table 1 describes the role of the Rotary Knob in each function

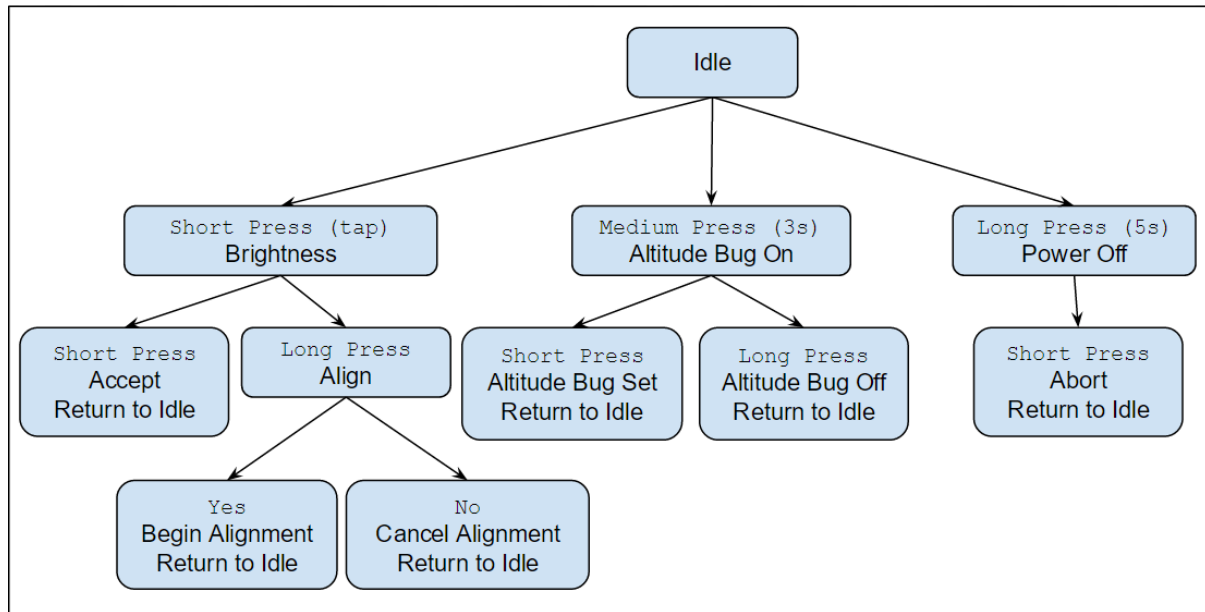


Figure 6 - Pushbutton Controls

Mode	Rotary Knob Function
Idle	Increase/Decrease Baro Setting
Brightness	Increase/Decrease Brightness
Align	n/a
Altitude Bug On	Increase/Decrease Altitude Bug

Table 1 - Rotary Knob Controls

## 2.5 Indicated Airspeed

Indicated Airspeed is shown on the left side tape and drum. Airspeeds between 30 to 400 kts (30 to 460 mph) are displayable. If the airspeed exceeds the maximum value, the tape area will be Red-X'ed. If the airspeed is below 30, the drum display will dash and the tape will settle to 0.

The units for Indicated Airspeed (kts or mph) are set during the installation procedure, and will match the operating units of the aircraft. Airspeed units can only be configured by approved personnel and is not pilot adjustable.



### 2.5.1 Indicated Airspeed Limits

Airspeed limits are indicated by means of colored bands and radial lines as follows:

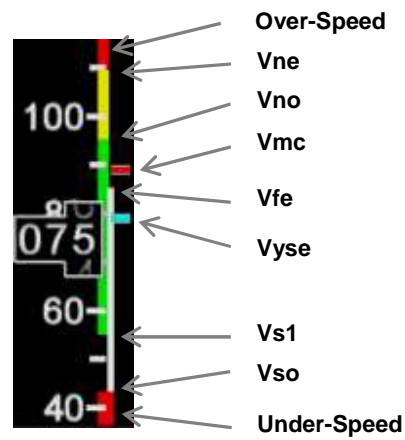


Figure 7 - IAS Limits

The Vmc and Vyse are applicable to multi-engine aircraft only and will not be shown in single engine installations.

### 2.5.2 Over and Under Speed Indications

If operation occurs between Vno and Vne, the white surround around the numerical readout will turn amber. If operation occurs over Vne, or below Vso, the surround will turn red.

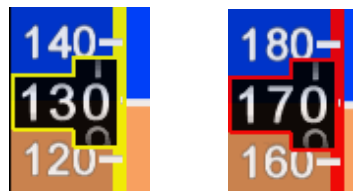


Figure 8 - Over and Under Speed Indications

The Under-Speed band and surround coloring is only shown if the aircraft has previously exceeded Vso. Under-Speed indication is disabled prior to take-off.

Airspeed limits can only be configured by an approved mechanic and are not pilot adjustable.

## 2.6 Barometric Altitude

Baro Corrected Altitude is shown on the right side tape and drum. The altitude presented is pressure altitude as measured on the static port, corrected by the currently set baro value.

Altitudes between -1,500 feet and 35,000 feet are displayable. If the aircrafts altitude exceeds this range, the tape area will be Red-X'ed.

### 2.6.1 Baro Adjustment

Baro adjustment is performed by rotating the control knob left or right when no menu is selected (default screen state). The value shown will be in the units that are configured during installation. Units of inches mercury (inHg), and millibars (mb) are both supported. Baro Correction from 28.00 inHg to 31.00 inHg, or 948 mb to 1050 mb can be set.

### 2.6.2 Default Baro

The default baro can be selected between Standard (STD), Automatically estimated (AUTO), or last pilot set value (LAST).

- STD will default to 29.92 InHg (or 1013 Mb).
- AUTO will utilize the airport elevation on the last power-down to estimate a current baro setting.
- LAST will retain the last pilot entered value.

The default baro behavior adjustable to owner preference and can be configured by an approved mechanic. This setting is not pilot adjustable.

## 2.7 Instantaneous Vertical Speed Indication (IVSI)

The IVSI is presented to the pilot using a growing and shrinking bar that gradually appears as the magnitude of the vertical speed grows. The bar will not appear until the vertical rate exceeds  $\pm 100$  Feet/Min. A digital value is also presented to the pilot. The IVSI in the SAI-340 uses both the rate of altitude change and the internal accelerometer to provide vertical speed with very little delay. The black area of the box is used for trimming vertical rate and the boundaries represent  $\pm 50$  ft/min. The tape itself does not appear until  $\pm 100$  ft/min is exceeded. The IVSI can be enabled or disabled during the installation configuration. The display filtering can be adjusted in the installation configuration pages to slow down the responsiveness.

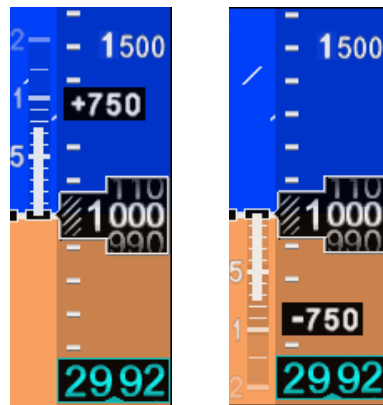


Figure 9 - Climbing and Descending IVSI

## 2.8 Altitude Bug

The Altitude Bug is enabled, disabled and adjusted using the Rotary Knob with Pushbutton.

Figure 6 provides an overview of the pushbutton functionality.

Pressing the pushbutton for 3 seconds allows editing the Altitude Bug (Figure 10.b). The digital Altitude bug value will appear in the upper right corner of the display while editing the Altitude Bug. Rotating the knob while editing the altitude bug will modify the Altitude Bug in increments of 50 feet.

When done adjusting the altitude bug, a short press of the pushbutton will set the bug (Figure 10.c). If the altitude bug is not adjusted for 7 seconds while in the editing mode, the bug will become set at the current value.

While editing the Altitude Bug, holding the pushbutton down for 3 seconds will disable the altitude bug (Figure 10.a).

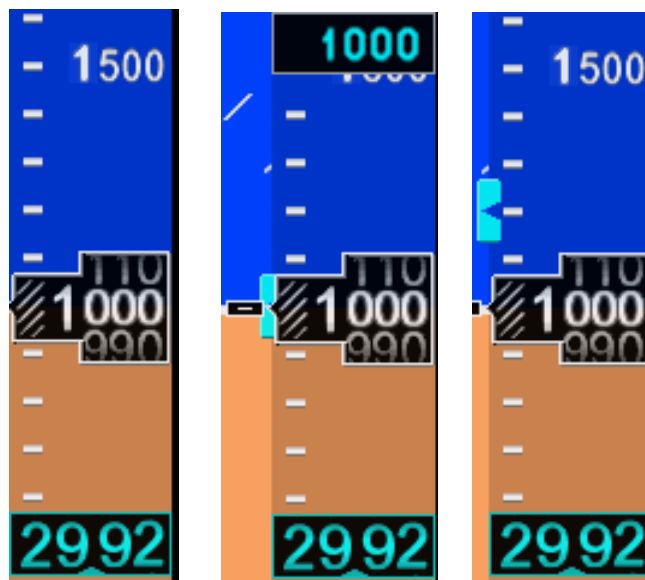


Figure 10- Altitude Bug Modes (a) Disabled, (b) Adjusting/Editing, (c) Enabled)

## 2.9 Roll & Pitch

Roll is shown in fixed pointer format - the pointer remains in a fixed location relative to the instrument housing and the roll scale rotates with the horizon. The background blue/brown horizon is limited such that some ground or sky reference always remains present on the screen. The pitch ladder and heavy white horizon line will “detach” from the background horizon in these cases.

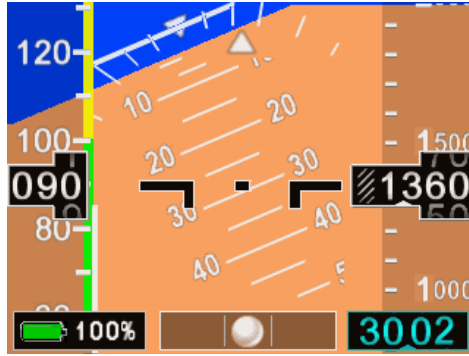


Figure 11 - Example of Detached Horizon Line

Roll and pitch rates are limited to 400 degrees per second and operation throughout all roll/pitch angles is supported. If attitude is invalid, the center area will be Red-X'ed. No excessive angle presentations are provided.

## 2.10 Slip Indication

Slip is shown in a format that mimics the mechanical inclinometer (white ball in a glass tube). The left and right stops represent  $\pm 7$  degrees. If the internal slip sensor fails, the area will be Red-X'ed.



Figure 12 - Slip Indicator

## 2.11 Brightness Adjustment

The screen's brightness is either manually or automatically controlled. By default after power-on, the automatic mode is selected. In the automatic mode, the brightness will be adjusted based on the ambient light detected by the bezel-mounted light sensor.

Pushing the rotary knob displays the brightness adjustment menu. Once displayed, rotating the control knob left or right will place the unit into manual mode and increase or decrease the brightness level. Once adjusted, pushing the knob will clear the menu.



**Figure 13 - Backlight Adjust Menu**

After displaying the brightness menu, pushing the rotary knob again without rotating the knob will leave the unit in the previous operating mode (automatic or manual). Once placed in the manual mode, automatic mode cannot be re-entered until a power-cycle occurs.

## Section 3 - Abnormal Operation

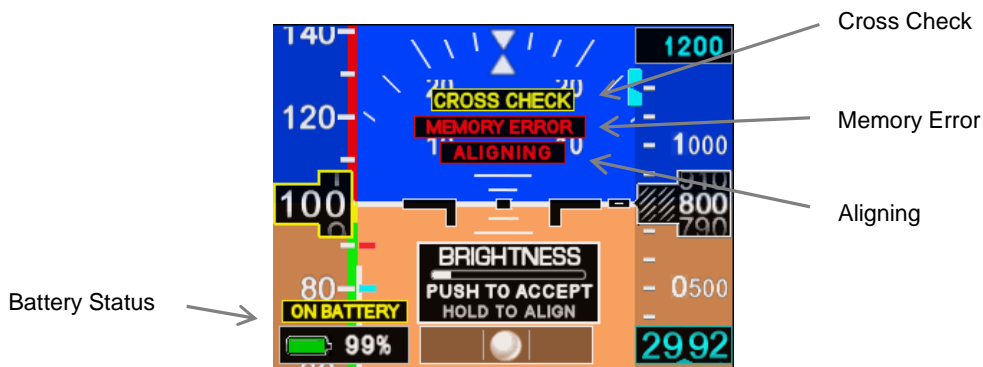


Figure 14 – Abnormal Operation Indicators

### 3.1 Abnormal Annunciation

Abnormal operating modes and conditions are annunciated by a variety of on-screen indications, as shown in Figure 14 – Abnormal Operation Indicators.

### 3.2 Attitude Re-Alignment

In certain abnormal operations, such as aerobics, a manual attitude alignment may be required.

Attitude (roll & pitch) alignment may be performed by momentarily pressing the rotary knob to present the brightness adjust menu, then pressing and holding the knob in for a few seconds. This will initiate a re-alignment cycle.

**During alignment the aircraft should be held wings-level.**

During alignment, the following message will be presented on the screen:

**ALIGNING**

Figure 15 – Aligning Message

## Memory Error

On power-on, the unit performs a self-test of the calibration and setup parameters stored in non-volatile memory. If this test fails, a red MEMORY ERROR message is displayed and the instrument becomes inoperable. If this occurs, the unit must be returned to the factory for service.



Figure 16 - Memory Error Message

## 3.3 Degraded Attitude

Air-data is utilized to help refine the attitude solution during specific operational maneuvers. If air-data is lost, a Degraded Mode of operation is automatically entered.

During this mode, errors in pitch may be observed during long accelerations or decelerations, however attitude information is always available - it is never removed or made un-available.

Errors will not exceed TSO limit specifications. Degraded Mode maintains basic attitude performance and is sufficient to maintain positive aircraft control for VFR and IFR operations.

When operating in the Degraded Mode, a yellow CROSS CHECK message may be displayed on the screen.



Figure 17- Cross Check Message

Cross Check may occur during extended periods of extreme turbulence or maneuvering. Reestablishing straight and level flight allows the unit to reacquire TSO criteria performance. The Cross Check message will automatically clear once normal operations are resumed.

## 3.4 Transition To and From Battery

The unit will automatically transition to internal battery if the aircraft power drops below approximately 7 VDC. At this point, one of two operational sequences will occur, depending on if the aircraft is on the ground or in the air. This logic is tied to the current indicated airspeed as follows:

- In Flight: If airspeed is above 40 knots, transition will occur to battery with no pilot action required. Only the yellow ON BATTERY indication will be shown – no other popup menus or messages will be presented.
- On Ground: If airspeed is below 30 knots, a shutdown timer will be displayed. If the pilot takes no action, the unit will automatically shut-down in approximately 45 seconds. This is the normal on-ground shutdown sequence.

If the rotary knob is pushed to cancel the count-down timer, the unit will remain on and continue to operate from battery power. The yellow ON BATTERY indication will be shown.

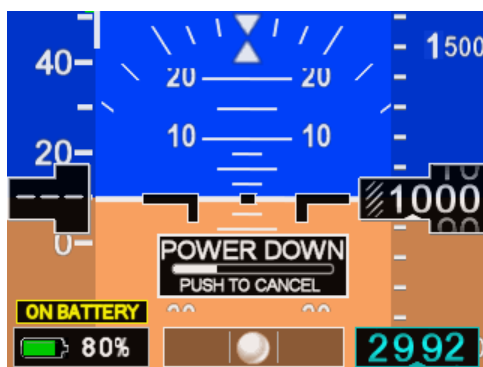


Figure 18 - On Battery Indication & Shutdown Timer

If aircraft power returns, the unit will automatically switch back to aircraft power and start a battery charge cycle (if all conditions are satisfied).

### 3.5 Battery Status

Internal battery status is shown in the lower left corner of the screen. When operating on the internal battery, the colored icon will transition from green, to yellow, to red as the battery drains. Charge levels above 50% are shown in green, between 25% and 50% is shown in amber, and levels below 25% are shown in red. The charge is also shown numerically in percent.

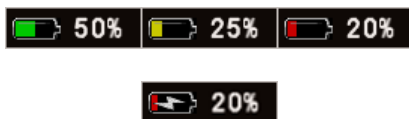


Figure 19 - Charge Status Icon

If the battery is charging, a charge indicator will be shown over the colored icon as a small white lighting bolt. There is a power-on delay of several minutes prior to the charger being internally enabled. Charging will occur only if the following conditions are detected:

- The battery has passed the power-on self-test
- The battery is sufficiently low that a charge cycle is required
- The ambient temperature is between 0°C and 40°C
- The aircraft supplied voltage is > 10 VDC



If the battery fails the power-on self-test (or is in a heating cycle), it will be Red-X'ed and no backup battery capability will exist:



Figure 20 - Battery Not Available Indication

**If the battery status icon is Red-X'ed, the battery is not available for use and loss of aircraft power will result in the unit turning off.**

**Prior to departure or entry into IFR conditions, verify that the battery is not faulted (no red-X over the battery icon), and that a charge level of at least 80% is shown.**

### 3.6 Battery Duration

Battery duration is dependent on several factors; including age of the battery pack, display intensity setting and ambient operating temperature. With a healthy battery, a minimum of 30 minutes of operation is guaranteed. Typical durations when operating at room temperature and a reduced display brightness will be approximately 2 hours.

Note that the charge level indicated is an approximation of the remaining capacity of the battery, and will dynamically adjust based on operating environment and conditions. For example, dimming of the display will extend the battery duration, and thus increase the percent charge shown. Correspondingly, increasing the display brightness will reduce the battery duration and thus decrease the percent charge shown.

### 3.7 Cold Temperature Startup

At operating temperatures below 10° C, the battery pack requires a pre-heating cycle prior to being brought on-line. The heating time period will depend on the ambient temperature and will range from a few moments to up to a maximum of 15 minutes (cold-soaked at -20°C).

During the battery heating cycle, the BAT HEATING message is shown in red and the battery icon is Red-X'ed, indicating battery operation is currently not supported:



Figure 21 - Battery Heating Message

**While the battery is heating, operation from battery power is inhibited.**

**Loss of power will result in the unit shutting down.**

**Prior to departure or entry into IFR conditions, verify that the battery is NOT in a heating cycle.**

### 3.8 Sensor Failure

If any internal sensor fails, the corresponding parameter on the display will remain in the Red-X'ed state. If this occurs, the unit must be returned to the factory for service.

### 3.9 Emergency Shutdown Procedure

In the event that the unit requires shutdown in-flight due to improper operation or other failure mode, perform the following sequence:

1. Remove power from the unit by opening the corresponding circuit breaker.
2. Push and hold the rotary knob for several seconds - this will initiate a manual power-down sequence.
3. Do not cancel the power-down timer – when the timer expires, the unit will internally disable the battery and the unit will shut down.

Re-applying external power to the unit will turn the unit back on.

# Section 4 - Operational Limitations

## 4.1 Operational Limitations

The following operational limitations apply:

- Geographic limitation: None
- Magnetic field sensitivity: None
- Lightning direct effects sensitivity: None
- Lightning indirect effects sensitivity: Approved for catastrophic functions
- HIRF Susceptibility: Approved for catastrophic functions
- Viewing Angle Limitations: 60° Left / Right, 45° Up / Down
  
- Displayable Vspeeds: Vne, Vno, Vfe, Vs1, Vso (Vmc, Vyse ME Only)
- Maximum displayable airspeed: 400 Knots / 460 Mph
- Minimum displayable airspeed: 30 Knots / 30 Mph
- Maximum displayable vertical speed range: -5,000 to 5,000 Feet/Min
- Minimum displayable vertical speed range: -100 to 100 Feet/Min
- Maximum displayable altitude: 35,000 Feet
- Minimum displayable altitude: -1,500 Feet
- Maximum configurable baro correction: 1050 mb / 31.00 inHg
- Minimum configurable baro correction: 948 mb / 28.00 inHg
- Minimum operational duration on battery: 30 Minutes
- Maximum roll rate: 400 degrees / second
- Maximum operating G force: 6 G
  
- Battery operation may be inhibited for up to 15 minutes during cold-starts.
- No operational capability on internal battery is possible if the battery is faulted, as shown by a Red-X over the battery icon.
- Battery charging is disabled below approximately 0°C and above 40°C, or when power input is below approximately 11 volts DC.
- In-Flight alignment must be performed with wings-level non-accelerated flight conditions.
- Airspeed and altitude are derived from internal pressure sensors that are connected to the aircraft's pitot and static lines. Airspeed is determined by the pressure difference between the pitot and static ports, while altitude is determined by the pressure on the static port. Altitude is barometrically corrected by the pilot entered baro value prior to being displayed.
- Attitude is aided by airspeed to provide better pitch performance during takeoffs and in-flight accelerations and decelerations. TSO performance levels are maintained with or without this additional aiding.

NOTE: Approximately nine percent of the population has some sort of color vision deficiency (what is commonly called “color blindness”). It should also be noted that the FAA does not test for all potential color deficiencies. (Source TSO-C113a / AS8034)