ACRONYMS

ADC	Air Data Computer
ADI	Attitude Director Indicator
ADS	Air Data System
ADSP	Air Data Smart Probe
AMM	Air Management Module
AMSAC	Air Management System Automatic Controller
A/I	Anti ice
AOA	Angle of Attack
ARINC	Aeronautical Radio Inc.
BIT	Built-In-Test
BLD	BLeeD
CAS	Crew Alerting System
CB	Circuit Breaker
EEC	Electronic Engine Controller
FADEC	Full Authority Digital Engine Control
HP	High Pressure
HPRSOV	High Pressure Regulation and Shut-Off Valve
IBIT	Initial Built-In Test
LH	Left handle
LP	Low Pressure
LRU	Line Replaceable Unit
LWPS	Left Windshield Power Supply module
MAU	Modular Avionics Unit
MDU	Multi-function Display Unit
MFP	Multi-Function Probe
OAT	Outside Air Temperature
PDU	Primary Display Unit
PRSOV	Pressure Regulating Shut Off Valve
R/H	Right hand side
RWPS	Right Windshield Power Supply Module
SP	SmartProbe
SSPC	Solid State Power Controller
SWPS	Spare Windshield Power Supply module
TAT	Total Air Temperature
TCV	Temperature control valve
WOW	Weight on Wheels

INTRODUCTION

The ice and rain protection system is intended to permit:

- Safe flight through intermittent or continuous maximum icing conditions,
- Improved visibility through windshield during taxi, take off, approach and landing in rain condition and during ground operation in dew conditions.

The system uses three ice and rain protection sources:

- Pneumatic source for:
  - Wings,
  - Engines air intake anti ice,
  - Engine 2 S-duct anti ice,
  - Brakes anti ice.
- Electrical source for:
  - Windshields and lateral windows,
  - Air data probes,
  - Waste water drain mast.
- Specific fluid for:
  - Windshield rain protection (rain repellent).

The ice and rain protection system is split into:

- ATA 30_1: Ice Detection,
- ATA 30_2: Probes, Windshield, Rain repellent,
- ATA 30_3: Engines, S-duct, Wing, Brakes Anti ice.

INTRODUCTION

Two ice detectors provide the following functions:

- Detect all types of in-flight icing condition (before unsafe ice accumulation),
- Provide an ice signal to the crew (through the avionics) when ice on the detector reaches a predetermined threshold,
- Provide health status of each detector to the crew (through the avionics).

This system is primary manual, which means:

- The crew is to rely on the ice detection warning provided by the ice detectors,
- When the warning is triggered, the crew must manually switch on the anti ice systems.

NOTE

After an ice detector failure, the system becomes advisory which means the crew is to use visual cues (visible moisture) and temperature indications.

FLIGHT DECK OVERVIEW

CONTROLS

Crew control of the ice detection system is performed via:
- The ICE soft key available in the TEST synoptic page.

INDICATIONS

Cockpit indications related to the ice detection system consist of:
- Displays on:
  - The pilot and copilot ADI,
  - The ENG-CAS window for CAS messages,
  - The STATus synoptic / FAULT tab for fault messages,
- And an aural warning "ICE".

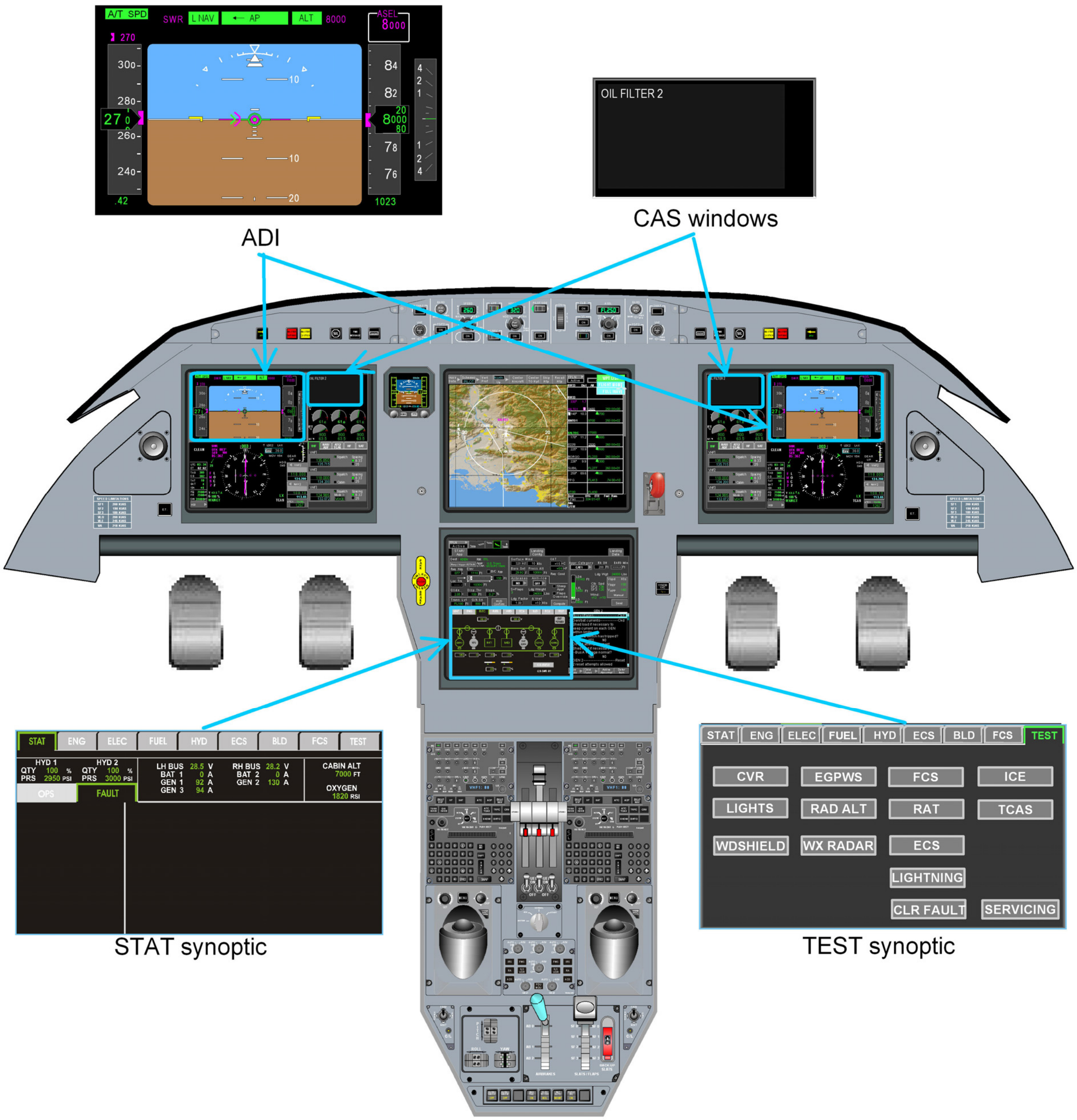


FIGURE 02-30_1-05-00 - FLIGHT DECK OVERVIEW

ICE DETECTION SYSTEM

The ice detection system consists of two ice detectors detecting all types of in-flight icing conditions prior to hazardous or unsafe ice accumulation on the airplane surfaces.

The ice detection system is a crew awareness system using CAS messages, ADI display and aural warning to inform the crew members.

Icing conditions are detected by the ice detector system. If at least one ice detector has failed, the icing conditions must be determined by the crew members.

Icing conditions exist when:

- The OAT on the ground and for take-off, or TAT in flight is 10°C or below, and visible moisture in any form is present (such as clouds, fog with visibility of one mile or less, rain, snow, sleet or ice crystals),

Or:

- The OAT on the ground and for take-off is 10°C or below when operating on ramps, taxiways or runways where surface snow, ice, standing water, or slush may be ingested by the engines or freeze on engines, nacelles or engine sensors.

➢ *Refer to DESCRIPTION SUPPLEMENTARY INFORMATION for additional information.*

DESIGN PRINCIPLES

The ice detection system was designed considering the followings design principles:

- With regard to flight safety:
  - Icing conditions are detected prior to unsafe ice accumulation on airplane surfaces (when ice accumulation reaches a predetermined threshold).
- With regard to reliability:
  - The two aircraft mounted ice detectors each provide two ICE signals to MAU1 and MAU2,
  - Each ice detector accrete ice independently on the probe,
  - Ice detector information is delivered to the MAU with discrete output,
  - The ice detectors provide, fault data to avionics for indication in CAS display.
- With regard to maintenance:
  - Since each ice detector is a single LRU incorporating a probe and a microcontroller, the on line maintenance is facilitated.

EQUIPMENT LOCATION

The ice detectors are symmetrically located on the forward fuselage in the pressurized area below the cockpit window.

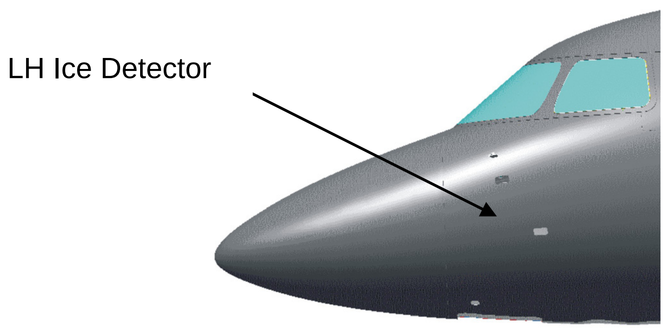


FIGURE 02-30_1-15-00 - LH ICE DETECTOR LOCATION

FIGURE 02-30_1-15-01 - ICE DETECTOR SENSING PROBE

ELECTRICAL POWER SUPPLY

The following paragraph describes the power supply of the different equipment of the ice detection system.

Electrical protection is provided either:

- By Solid State Power Controllers (SSPC),
- By Circuit Breakers (CB).

➢ *Refer to ATA 24 – ELECTRICAL for additional information.*

EQUIPMENT	POWER SUPPLY	TYPE OF PROTECTIONS
Ice detector 1	LH Main Bus	CB
Ice detector 2	RH Main Bus	CB

GENERAL SYSTEM ARCHITECTURE

The ice detector is a single LRU. There are two ice detectors mounted on the forward fuselage.

The main characteristics of the Ice Detection System are as follows:

- Two separate ice detectors perform the acquisition of ice accretion information,
- Each ice detector accretes ice independently on a probe,
- The ice detector information is delivered to the MAU with discrete outputs.

Ice detector 1 transmits ice detection information ("Ice Detector #1 sig1" and "Ice Detector #1 sig 2") to respectively:

- MAU1 and MAU2 along with ice detector status ("Ice Detector #1 Status") to MAU2.

Ice detector 2 transmits ice detection information ("Ice Detector #2 sig2" and "Ice Detector #2 sig 2") to respectively:

- MAU1 and MAU2 along with ice detector status (Ice Detector #2 Status) to MAU1.

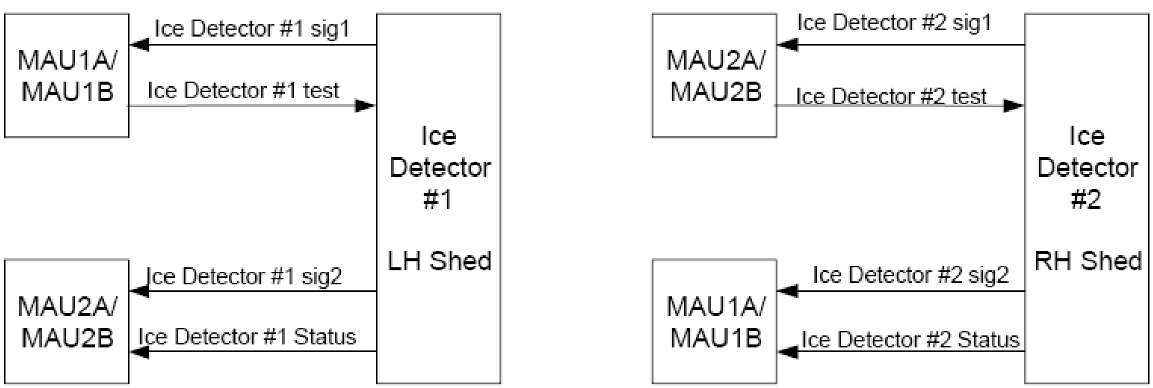


FIGURE 02-30_1-15-02 - ICE DETECTION ARCHITECTURE

SYSTEM COMPONENTS

ICE DETECTORS

The ice detector consists of a vibrating sensing element (probe) incorporated with a supporting strut that is exposed to the air stream. The primary purpose of the strut is to extend the probe far enough into the air stream to allow droplets to impinge on the sensing probe. As ice accumulates on the sensing element, ice accretion is detected by a change in the sensing element's resonant frequency.

The electronics primarily consist of a microcontroller with embedded software, signal conditioning and power supply hardware. The microcontroller calculates the sensor frequency, controls heater functions, regulates output signals, and performs the various Built-In-Test (BIT) functions. The internal software controls two discrete output signals that interface with the aircraft avionics in a manner suitable for display of any icing conditions encountered or failures for manual activation by the crew of aircraft ice protection systems.

Ice accretion measurement

The ice detector uses a sensing element (probe) which is driven to vibrate at its mechanical resonance by an oscillator circuit. The presence of ice on the sensing element increases the effective mass of the sensing element, which is detected by a shift in the measured resonant frequency. When a predetermined shift of the frequency is detected on the probe, the ice detector is designed to activate the ICE SIGNAL outputs. This shift corresponds to an ice thickness of approximately 0.02-inch (0.5 mm), depending on the actual icing conditions (i.e. temperature, Liquid Water Content (LWC), airspeed, etc).

Standard ice detection cycle

An icing cycle consists of ice accumulation, de-icing, and cool down of the probe .

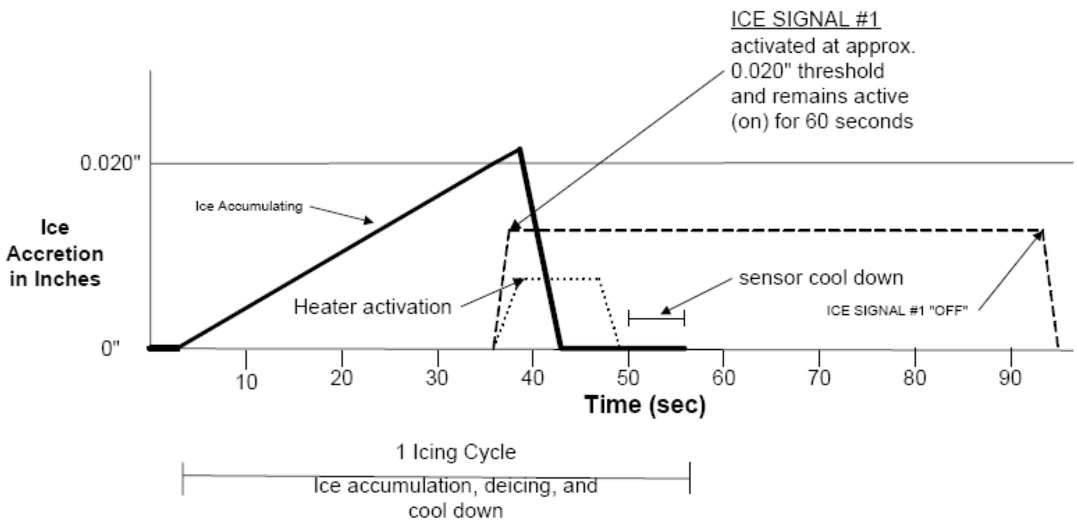


FIGURE 02-30_1-15-03 - ICE DETECTION SIGNAL 1 CYCLE (FOR SAMPLE)

When the threshold of approximately 0.02-inch of ice has accreted on the probe, the ICE SIGNAL outputs are activated and the probe heater is turned on. The ICE SIGNAL outputs will remain active for approximately 60 seconds. Once the ice accumulation de-bonds from the sensing element, the heater remains active for 5 seconds to allow the ice to be shed from the probe. The sensing element cools until it begins to accrete ice, starting a new icing cycle. The ice signals will deactivate when no additional ice is detected within the active 60 second time period.

CONTROLS

The crew control of the Ice Detection system is performed via:

- The ICE soft key available in the TEST synoptic page on the MDU (the ICE pushbutton is available on ground or in flight).

ICE TEST

The ICE soft key is designed to initiate an ice detector Initiated Built In Test (IBIT).

This feature provides the flight crew the capability to confirm if a fault is present or has been cleared.

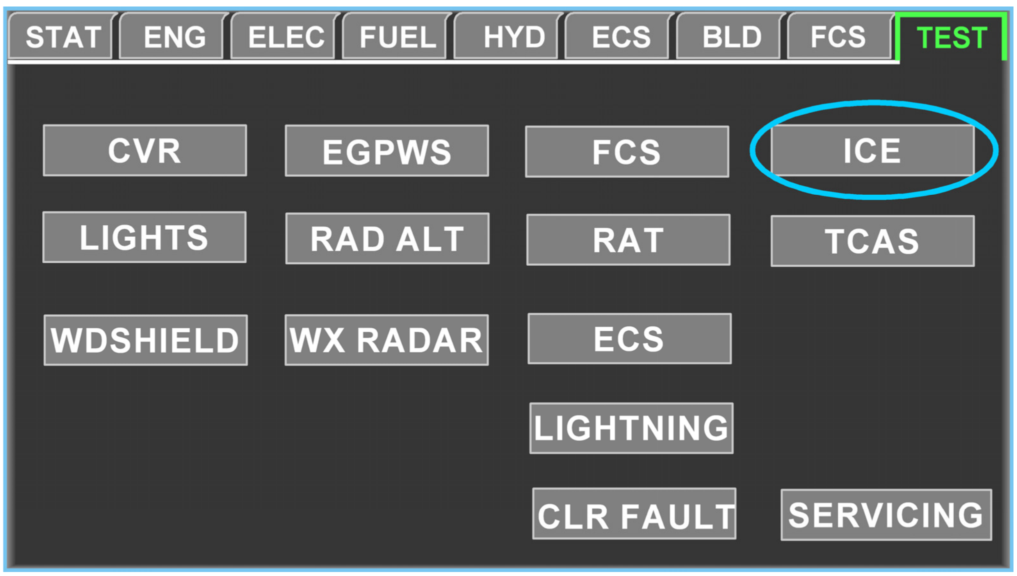


FIGURE 02-30_1-20-00 - TEST SYNOPTIC PAGE

INDICATIONS

Cockpit indications related to Ice Detection system consist of:

- Displays on:
  - The pilot and copilot ADI,
  - The ENG-CAS window for CAS messages,
  - The STATus synoptic / FAULT tab for fault messages,
- And an aural warning "ICE".

PILOT AND COPILOT ADI

The ICE flag on ADI is displayed amber when:

- Ice is detected and the wing or engines anti ice system is off,
- During ice detectors test.

The ICE flag on ADI is displayed white when:

- Ice is detected and wing and engines anti icing system is on,
- During ice detectors test,
- In transition phase from ice to no ice condition (flash for 5 seconds) with wing or engine anti icing system on.

The ICE flag amber or white is inhibited during the Take-off phase.

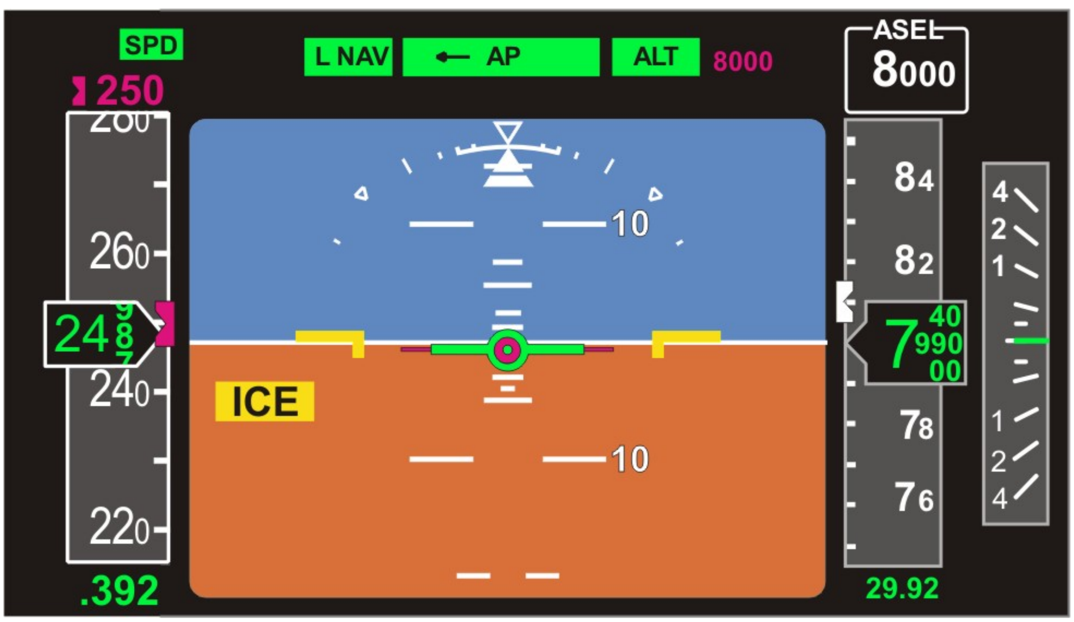


FIGURE 02-30_1-20-01 - PILOT ADI ICE INDICATION

ENG-CAS WINDOW FOR ICE DETECTION

When ice is detected, an amber CAS message is displayed (A/I: ICE DETECTED 1 . or A/I: ICE DETECTED 2 or A/I: ICE DETECTED 1+2).

This message is replaced by an advisory CAS message when the whole anti-icing system is turned on (A/I: ICE DETECTED 1 or A/I: ICE DETECTED 2 or A/I: ICE DETECTED 1+2).

This message is inhibited during takeoff phase.

➢ *Refer to CODDE 2 for a complete list of CAS messages.*

STATUS SYNOPTIC / FAULT TAB

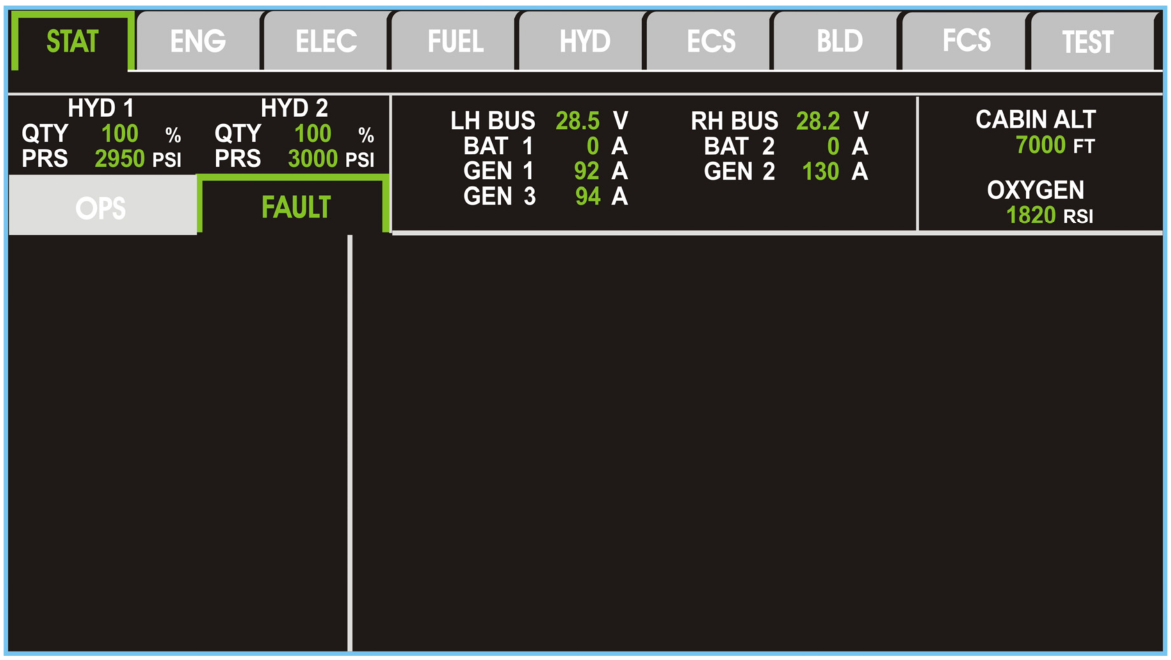


FIGURE 02-30_1-20-02 - STATUS SYNOPTIC

An Initiated Built In Test (IBIT) is triggered in response to a request from the ICE soft key.

For each ice detector the IBIT verifies:

- The heater signal outputs,
- The ice signal outputs,
- The status signal output,
- The Built In Test failure monitors.

The IBIT also performs a memory check of software designed into the ice detector.

If a fault is detected during IBIT, the corresponding A/I: ICE DETEC .. FAIL is displayed.

AURAL WARNING

Aural warning "ICE" events are triggered:

- When any ice detector is indicating the presence of ice and the wing or any engine anti-icing system is off,
- During ice detectors test (temporarily activated).

The alarm can be silenceable by pushing on the SIL pushbutton.

In addition, "ICE" is inhibited during take off phase.

No supplementary indication to be provided on controls and indications at present time.

SYSTEM MONITORING

The following parameters are monitored:

- Ice accretion level on sensing element,
- All signal whose faults that inhibit the detection and/or ice accretion:
  - Probe/oscillator frequency out of range,
  - Heater signal outputs,
  - Ice signal outputs,
  - Status signal outputs,
  - Power interruption.

Each ice detector incorporates:

- A Continuous Built In Test function,
- A Power-Up Built In Test function,
- An Initiated Built In Test function.

➢ *Refer to CODDE 2 for a complete list of CAS messages.*

ACTIVE PROTECTIONS

POWER INTERRUPTION RECOVERY

In case of power interruption a hardware circuit determines whether a Power Built In Test or a Power Interruption Recovery test will be executed.

All power interruption greater than 1500ms will cause a PBIT to be executed.

The Power Built In Test verifies:

- The heater signal outputs
- The ice signal outputs
- The status signal outputs
- The BIT failure monitors

The IBIT also performs a memory check of software designed into the ice detector.

No supplementary information to be provided on system protection at present time.

No information to be provided on ground operation at present time.

- *Refer to Ground Servicing Manual.*

INTRODUCTION

The 4 Multi-Function Probes (MFP) and the 2 TAT probes are electrically heated (ice protection).

The engines P1 probes are electrically heated when engine anti-ice is on.

The 2 front windshields and 2 lateral windows are electrically heated with a conductive coating (ice protection), and the 2 front windshields have a hydrophobic coating on their external panel, dry coat (rain protection).

In addition, the rain repellent system is used to improve visibility (no wiper system) through pilots' LH and RH front windshield during:

- Approach and landing phases in rainy condition,
- Ground operation in wet condition,
- And when dry coat is inefficient.

The Falcon 7X uses also a special windshield coating to maintain visibility in rainy condition.

An anti-fogging and demisting system is provided for the cabin and the flight deck windows.

The two water waste drain masts are electrically heated.

FLIGHT DECK OVERVIEW

CONTROLS

Crew control of probes, windshield, rain repellent system are performed from the Overhead Panel via:

- 3 Probe Pushbuttons for MFP heat and TAT probes heat,
- 3 Pushbuttons LH / RH / BACKUP for windshield deicing / defogging,
- 2 Rain RPLNT Pushbuttons for Rain repellent control.

In addition, a WDSHIELD soft Key in the TEST synoptic page for windshield anti-ice system test.

INDICATIONS

Cockpit indications related to probes, windshield, rain repellent system are displayed:

- With lights associated to each control pushbutton,
- On the ENG-CAS window for CAS messages,
- On the STATus synoptic / FAULT tab for fault messages.

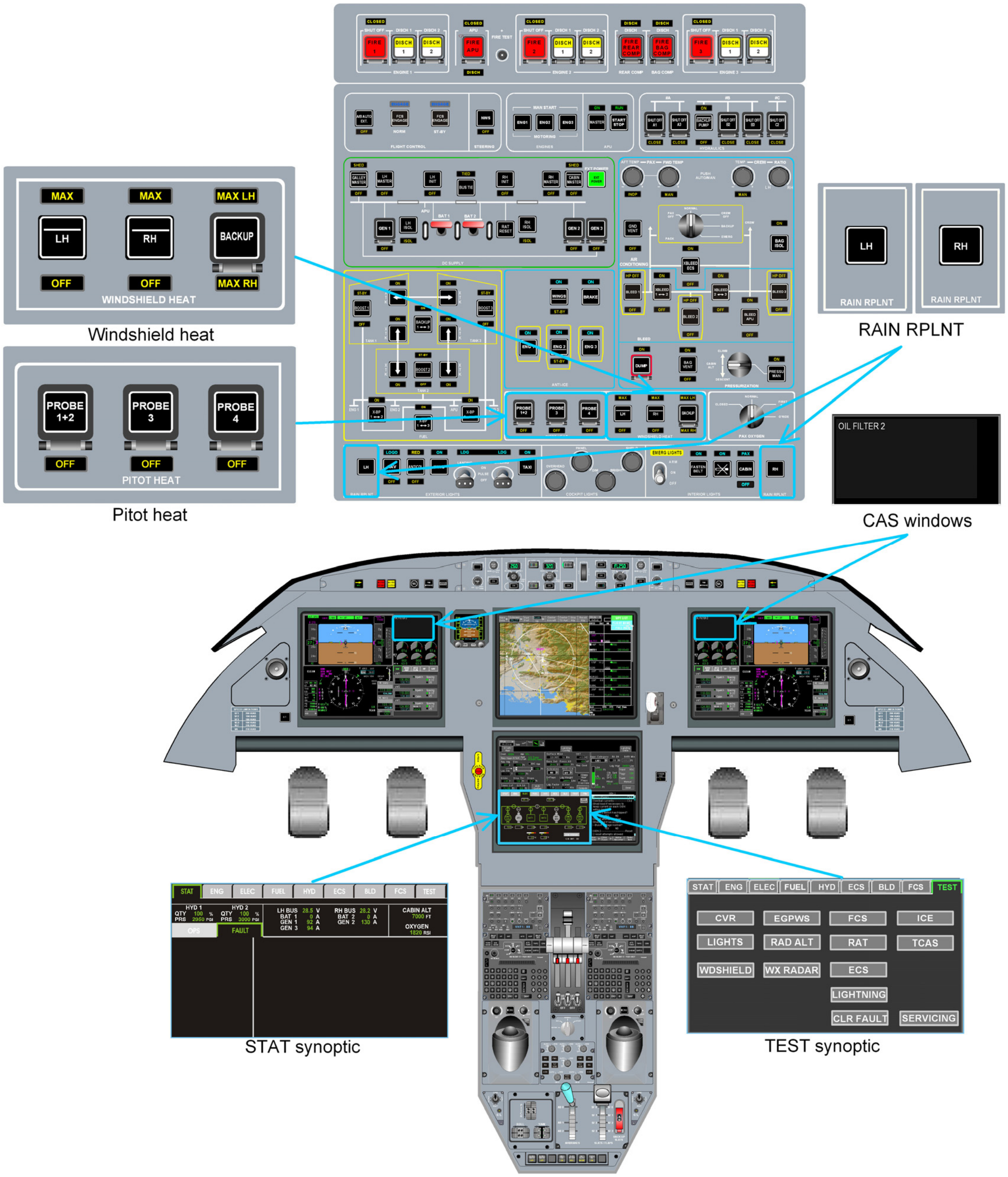


FIGURE 02-30_2-05-00 COCKPIT CONTROLS AND INDICATIONS

PROBES

MULTI-FUNCTION PROBES

The 4 MFP are ice protected (internal resistors) either manually or automatically.

The overhead panel probe pushbuttons are controlled both by automatic logic within the avionics and manual operation by the pilot.

At any time, the crew members can override the automatic logic by pressing the appropriate overhead panel probe heater pushbutton, in this case the ADS regulates the MFP heater power.

TOTAL AIR TEMPERATURE PROBES

The 2 TAT probes are ice protected in the same manner as the MFP, the same inputs that controls the MFP also controls the application of regulated heater power to the TAT.

ENGINES PROBES

The probes, located in each engine air intake, provide information about the airflow to the FADEC. Their heating is activated when the anti-icing ENG control is set to ON.

WASTE WATER DRAIN MASTS

The drain masts and the heating elements of the lines are automatically activated as soon as the airplane is electrically powered.

WINDSHIELDS

ICE PROTECTION

Front windshields and lateral windows are heated with a conductive coating incorporated in the transparent panels.

In normal mode, the LH frontal windshield and the LH window heating resistors are supplied by the LH module. Respectively for the RH side.

In MAX mode, only the LH and RH frontal windshields are heated. The lateral windows are no longer supplied by the modules.

If the LH or the RH module fails, a back up module allows to recover the heating of the failed side in MAX mode.

DEFOG AND DEMIST PROTECTION

Air from the cockpit air conditioning system helps to remove mist from:

- The front windshield panels,
- The LH and RH side windows.

➢ *Refer to DESCRIPTION SUPPLEMENTARY INFORMATION for supplementary information.*

RAIN PROTECTION

Windshield design

The cockpit includes two front windshields (LH and RH) and two lateral windows (L/H and RH).

The windshields are designed so that water can easily be shed along the window panel by the airflow. The phenomenon is improved with the airplane speed.

There is no dry coat on lateral windshield (as there is no wiper on lateral windows).

Dry Coat

Dry coat is a durable hydrophobic film with long term rain-shedding properties and laid over the front windshields.

RAIN REPELLENT

The rain repellent system is used to improve visibility through the windshields during approach in rain condition. It consists in a chemical, hydrophobic fluid sprayed on the front windshields.

- *Refer to DESCRIPTION SUPPLEMENTARY INFORMATION for supplementary information.*

DESIGN PRINCIPLES

DESIGN PRINCIPLES FOR PROBES ANTI ICE

The probe anti ice system was designed considering the following design principle:

With regard to reliability:

- Automatic heating controls leads the Air Data Smart Probes (ADSP) to monitor , activate and deactivate the MFP heating,
- The same input that controls the MFP also controls the application of regulated heater power to the TAT probes.

DESIGN PRINCIPLES FOR WINDSHIELDS ICE AND RAIN PROTECTION AND RAIN REPELLENT

The windshields ice and rain protection system was designed considering the following design principles:

With regard to reliability:

- The pilot's and copilot's ice and rain protection system are independent. Dry coat can be easily refurbished one line without window removal,
- In case of failure of LH or RH windshield power supply a spare power supply can be switched on LH or RH windshield (Backup operation),
- The LH and RH power supply modules are respectively supplied by LH ESS and RH ESS buses,
- The crew can perform a windshield de ice system test before flight.

With regard to efficiency:

- The heat distribution on the windshield heating film ensures a good visibility area and optimizes electrical consumption,
- There is no wiper system since windshields wipers add weight and drag and lose their effectiveness at high speed and with curved surfaces,
- Windshields are designed so that water can easily be drained along the window panel by the airflow,
- Dry coat is a durable hydrophobic film with long term rain shedding properties,
- A rain repellent spay on a windshield is supposed to be efficient during 15 flight/hours in the same flight.

With regard to maintenance:

- Wiper system malfunctions are eliminated,
- Dry coat can be easily refurbished one line without window removal.

EQUIPMENT LOCATION

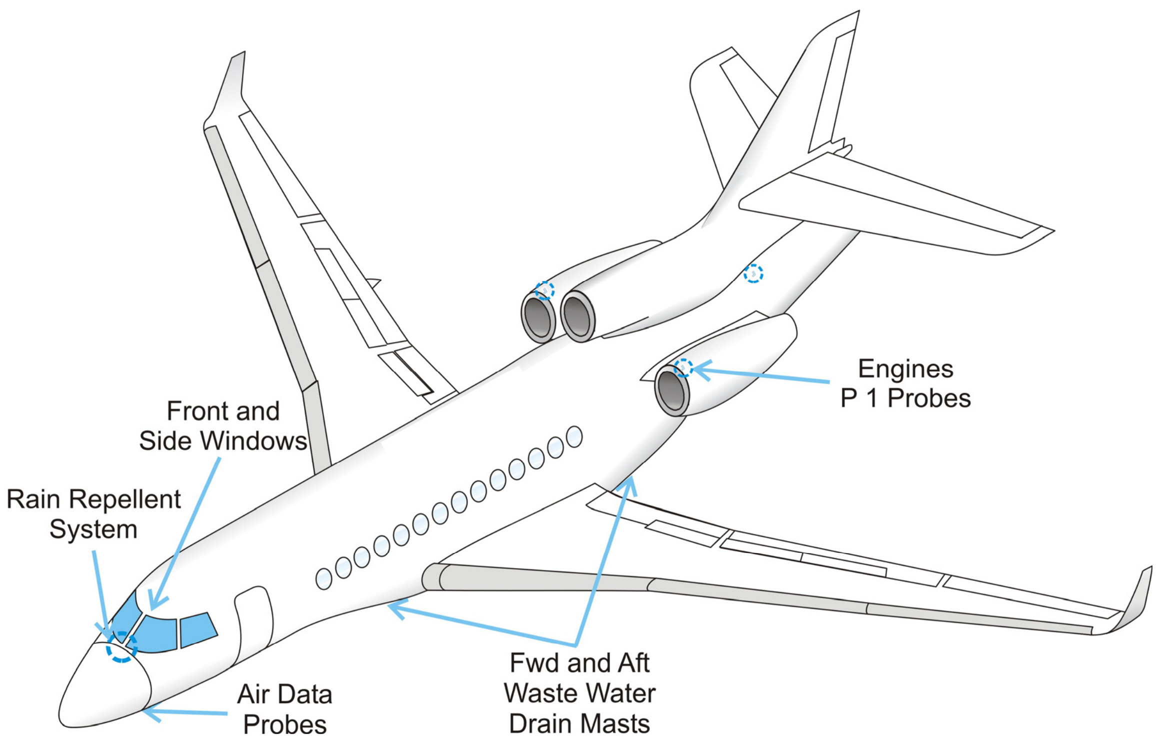


FIGURE 02-30_2-15-00 - PROBES, WINDSHIELD, RAIN REPELLENT SYSTEM

ELECTRICAL POWER SUPPLY

The following paragraph describes the power supply of the different equipment for probes anti- ice, windshields ice and rain protection and rain repellent systems.

Electrical protection is provided:

- By Solid State Power Controllers (SSPC) ,
- By Circuit Breakers (CB).

➢ *Refer to ATA 24 – ELECTRICAL POWER for additional information.*

EQUIPMENT	POWER SUPPLY	TYPE OF PROTECTION
ADSP 1A HEAT	LH Main bus	CB
ADSP 2A HEAT	LH Main bus	CB
ADSP 1B HEAT	RH Main bus	CB
ADSP 2B HEAT	RH Main bus	CB
ADSP 3A HEAT	LH ESS bus	CB
ADSP 4A HEAT	RH ESS bus	CB
ADSP 4B HEAT	RH ESS bus	CB
LH TAT Probe 1	LH Main bus	CB
RH TAT Probe 2	RH Main bus	CB
Engine 1 Probe	LH ESS bus	SSPC
Engine 2 Probe	RH ESS bus	SSPC
Engine 3 Probe	LH ESS bus	SSPC
Fwd drain mast heater	RH Main	CB
Aft drain mast heater	RH Main	CB
Drain valve	RH Main	CB
LH front windshield	LH ESS bus	Fuse
RH front windshield	RH ESS bus	Fuse
LH front windshield (backup) LH lateral window	LH Main bus	Fuse
RH front Windshield (backup) RH lateral window	RH ESS bus	Fuse
LH rain repellent system	LH ESS bus	CB
RH rain repellent system	RH ESS bus	CB

EQUIPMENT	POWER SUPPLY	TYPE OF PROTECTION
Dispatch box	LH ESS bus	CB
Dispatch box	RH Main	CB

GENERAL ARCHITECTURE

PROBES ANTI ICING PROTECTION

Monitoring and control of each MFP heating is supplied by dual-channel Air Data Computer (ADC) embedded into the corresponding Smart Probe.

The same input that controls the MFP also controls the application of regulated heater power to the TAT.

Channel A of ADSP1 controls heat to TAT probe 1.

Channel B of ADSP2 controls heat to TAT probe 2.

Drain masts and drain valve of the waste water system are electrically anti-iced.

Forward and rear drain masts are heated and controlled through a temperature sensor located inside each mast. In case of regulation failure leading to a permanent heating, the self-regulating capability of the heating element will protect from excessive internal heat.

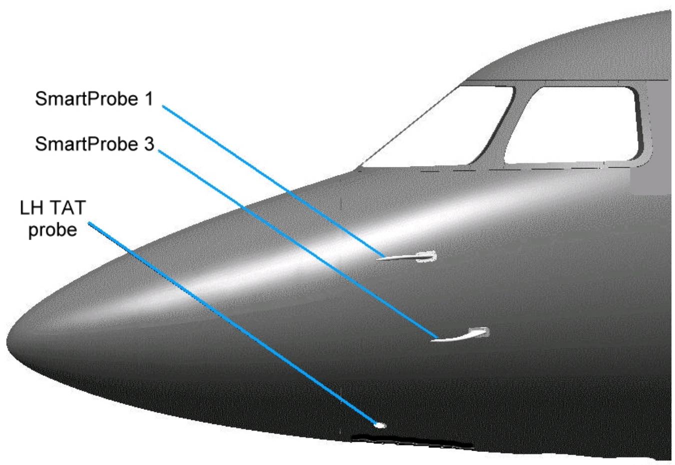


FIGURE 02-30_2-15-01 - MFP AND TAT PROBES LOCATION LH SIDE

WINDSHIELDS ICE AND RAIN PROTECTION

ICE PROTECTION

Front windshields and lateral windows are heated with a conductive coating incorporated in the transparent panels and located:

- On the internal face of the external ply of the windshields so they can be de-iced more effectively,
- On the external face of the internal ply of the lateral windows so they can be de-fogged more effectively.

For each windshield two different areas are de-iced and de-fogged as follow:

- A minimum-security area to have a sufficiently extensive view along the flight path in normal flight attitudes and powered to efficient level,
- A larger area, including the "comfort" area powered with a decreasing gradient from center to edges.

The electrical anti-ice system of the windshields is composed of two identical circuits, one pilot circuit and one copilot circuit including each a Windshield Power Supply (WPS) module.

In case of failure of the LH or RH windshield power supply module, a backup operation allows a Spare Windshield Power Supply (SWPS) module to power and sensor the LH or RH frontal windshield thanks to the dispatch box.

Back up direction is controlled through the dispatch box by the BACKUP pushbutton located on the overhead panel with the following states:

- OFF, (switch not lighted)
- LH, (switch lighted)
- RH, (switch lighted)

When Overhead Panel BACKUP pushbutton is depressed, one front windshield is supplied in MAX mode by SWPS, whatever is the state of its own control pushbutton.

If SWPS is switched on left front windshield:

- LWPS frontal power output and sensors are disconnected,
- LWPS stop supplying left lateral window in order to limit power on left 28 V bus,
- SWPS is powered by 28 V left Main bus.

If SWPS is switched on right front windshield:

- RWPS frontal power output and sensors are disconnected
- RWPS stop supplying right lateral window in order to limit power on right 28 V bus

SWPS is powered by 28 V right Main bus.

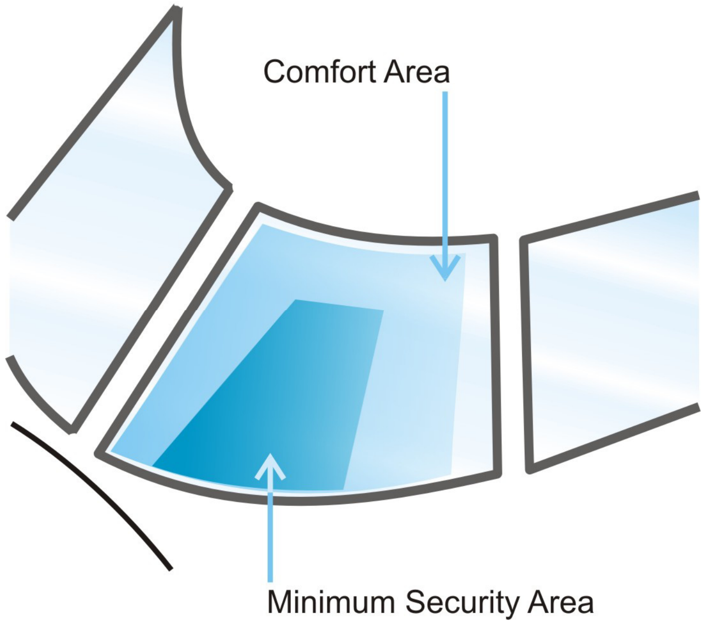


FIGURE 02-30_2-15-02 - WINDSHIELD ICE PROTECTION AREAS

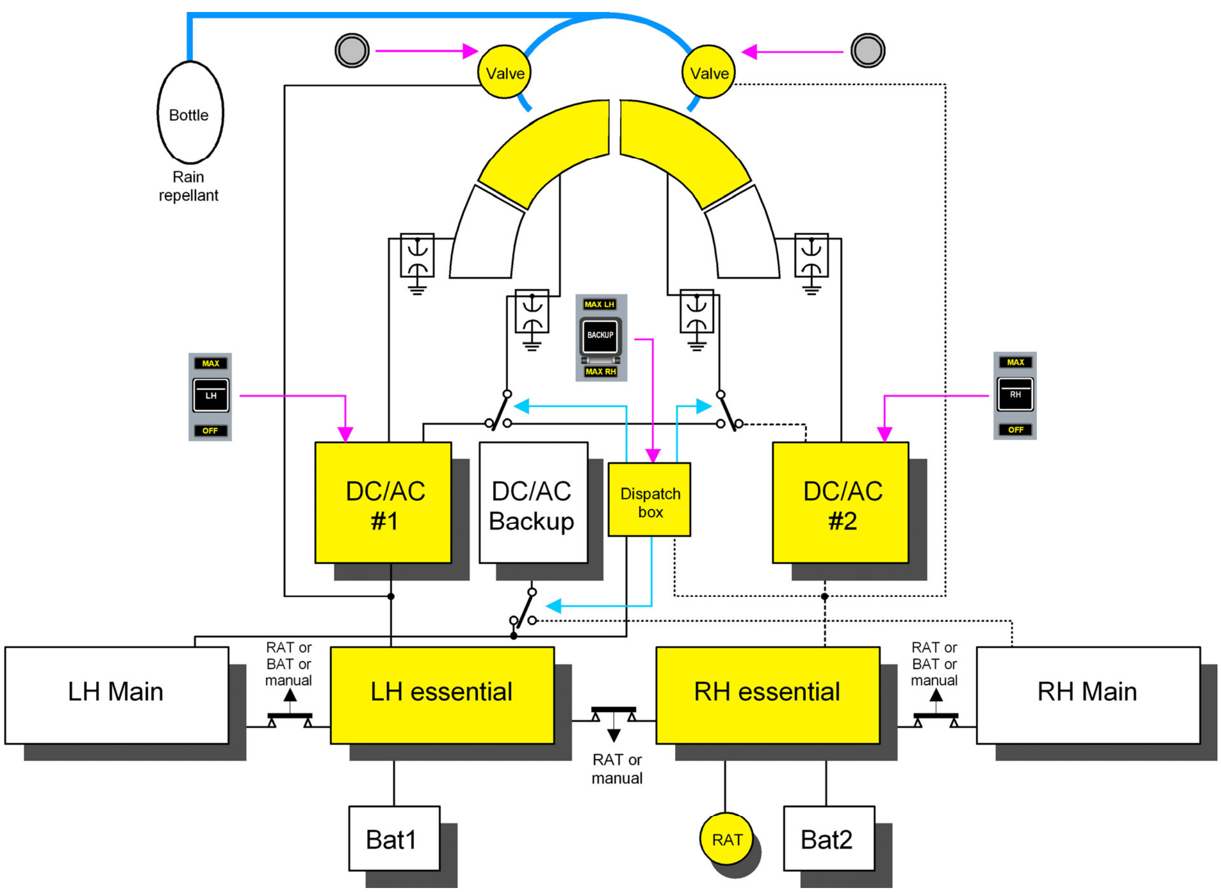


FIGURE 02-30_2-15-03 - WINDSHIELDS ANTI ICING SYSTEM ELECTRICAL DIAGRAM

RAIN PROTECTION

Dry coat

Due to the great affinity of water for the hydroxyl groups of the glass material, an ideally clear windshield should be covered under the rain by a continuous film of water. Actually, the glass easily absorbs all carbonated pollutants, which modify the surface tension, and it is rather observed that water gathers in drops and rivulets, with dry areas in between; Such an irregularly wet surface is optically poor and results in a blurred vision, making a rain removal system necessary.

Windshield wipers are commonly employed as primary rain removal system, however, furthermore to add weight and drag, they have a propensity to lose their effectiveness at high speed and with curved windshields.

Therefore on the Falcon 7X, dry coat has been applied on to the windshields to form a thin hydrophobic film.

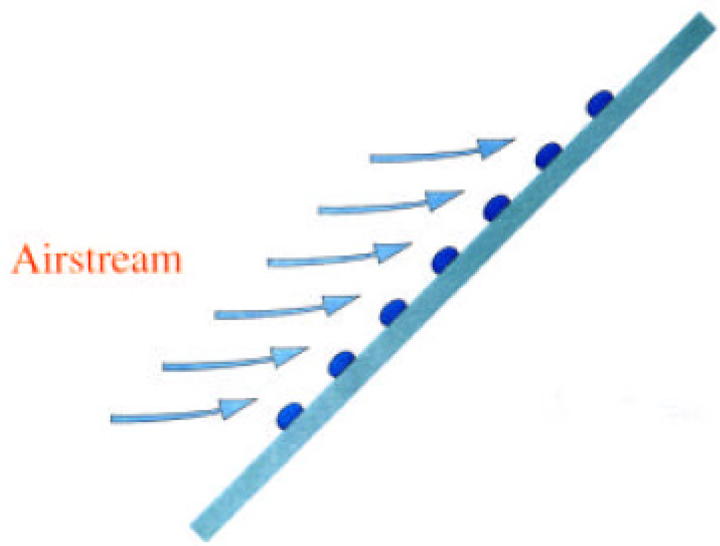


FIGURE 02-30_2-15-04 - EFFECT OF THE AIRFLOW ON DROPLETS

RAIN REPELLENT

The rain repellent system consists of a pressurized container of rain repellent fluid (called CAN assembly), a container receptacle (called GAGE assembly including a visual reservoir and a pressure gauge), two solenoid valves (including a time delay device), two nozzles assemblies, plumbing and two pushbuttons. The CAN assembly and the GAGE assembly are installed in the cockpit. A visual reservoir and a pressure gauge indicate the level of rain repellent fluid.

The system is controlled independently for each window (LH and RH front windshield) by two pushbutton located on the Overhead Panel.

Each time the left or the right pushbutton is pressed, approximately 10cc of rain repellent fluid is sprayed onto the windshield. A rain repellent fluid spray on a windshield is supposed to be efficient during 15 flight hours (in a same flight).During approach the fluid is spread over the window by airflow and rain. During ground operation, the fluid washes out the dew by gravity.

A visual reservoir and a pressure gauge, located in the cabinet behind the pilot, indicate the level of rain repellent fluid.

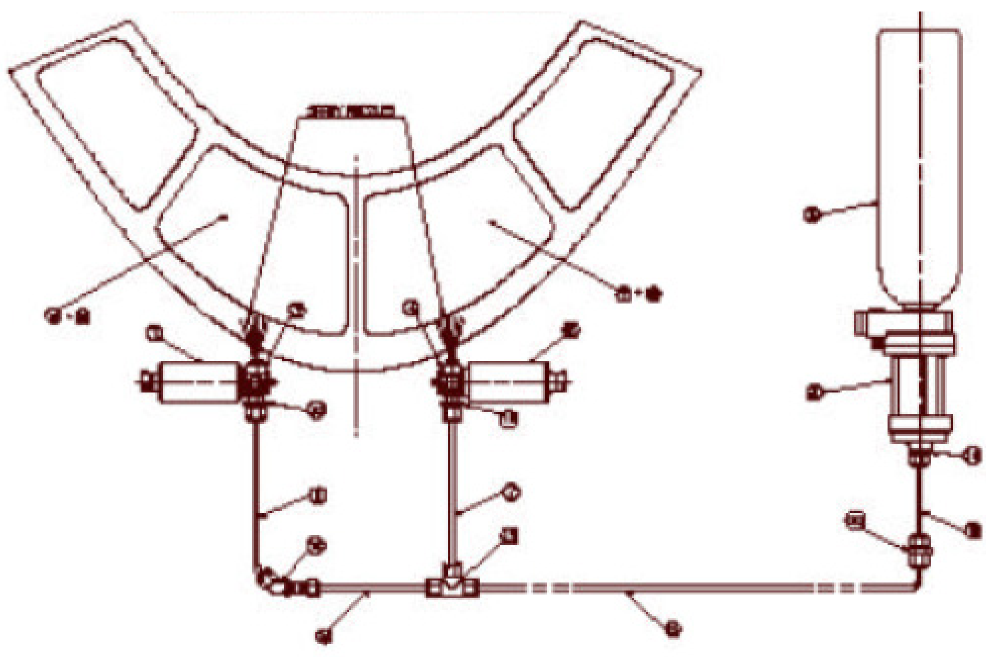


FIGURE 02-30_2-15-05 - RAIN REPELLENT SYSTEM SCHEMATIC

CONTROLS

Crew control of probes, windshield, rain repellent system is performed from the Overhead Panel via:

- 3 pushbuttons PROBE for MFP heating and TAT probe heating,
- 3 pushbuttons LH / RH / BACKUP for windshield de icing,
- 2 pushbuttons RAIN RPLNT for rain repellent control.

In addition, a WDSHIELD soft Key in the TEST synoptic page for windshield anti-ice system test.

OVERHEAD PANEL

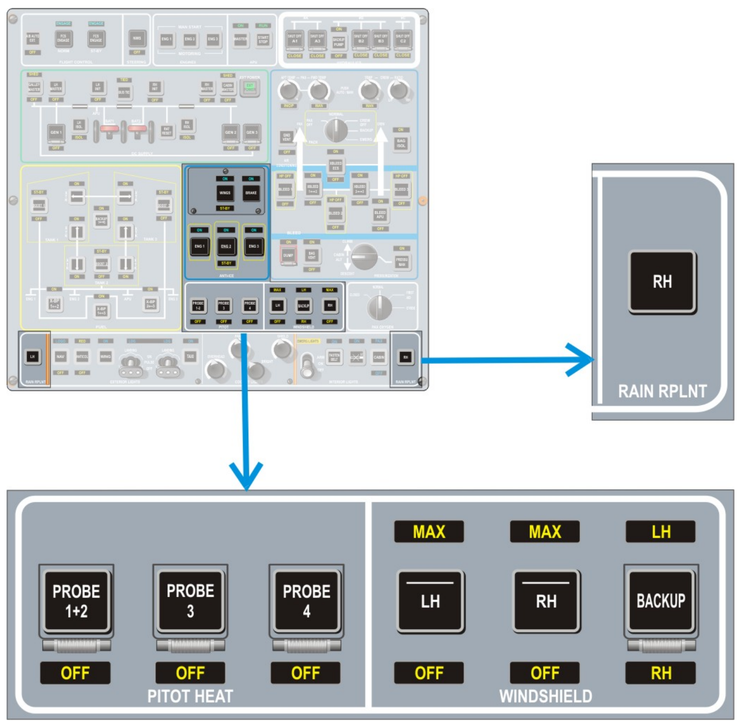


FIGURE 02-30_2-20-00 -PROBES WINDSHIELD, RAIN REPELLENT CONTROLS

MULTI FUNCTION AND TAT PROBES CONTROLS

At initial airplane power on, the overhead panel configuration is:

- PROBE 1-2 in OFF mode,
- PROBE 3 in OFF mode,
- PROBE 4 in OFF mode.

These controls are automatically set to On (unlighted) when in the configuration WOW, park brake pulled and two engines running.

They are automatically set to OFF mode when in the configuration WOW, park brake pulled and two engines stopped.

The pilot can always manually control the MFP and TAT heater power through the PROBE 1+2, PROBE 3, PROBE 4 pushbuttons on the Overhead Panel.

CONTROL	FUNCTION	TO ACTIVATE / TO DEACTIVATE		SYNOPTIC
	PROBE HEAT 1+2 pushbutton actuates: LH and RH MFP resistors And LH and RH TAT resistors.	Manual push On commands probe anti-icing		No synoptic
		Manual push OFF deselects probe anti-icing		
	PROBES HEAT 3 pushbutton actuates: LH MFP resistor	Manual push On commands probe anti-icing		No synoptic
		Manual push OFF deselects probe anti-icing		
	PROBES HEAT 4 Pushbutton actuates: RH MFP resistor	Manual push On commands probe anti-icing		No synoptic
		Manual push OFF deselects probe anti-icing		

WINDSHIELD CONTROLS

After all generators are operating, the windshield deicing system is automatically powered and set to Normal mode.

If the crew members pushed a long push on the LH / RH pushbutton, the windshield deicing system will switch to MAX mode.

If the crew members pushed a short push, the windshield deicing system will be deactivated (OFF mode).

If the crew pushes the BACKUP pushbutton, the SWPS will be set to LH front windshield. If the pushbutton is depressed again, the SWPS will set to the RH front windshield.

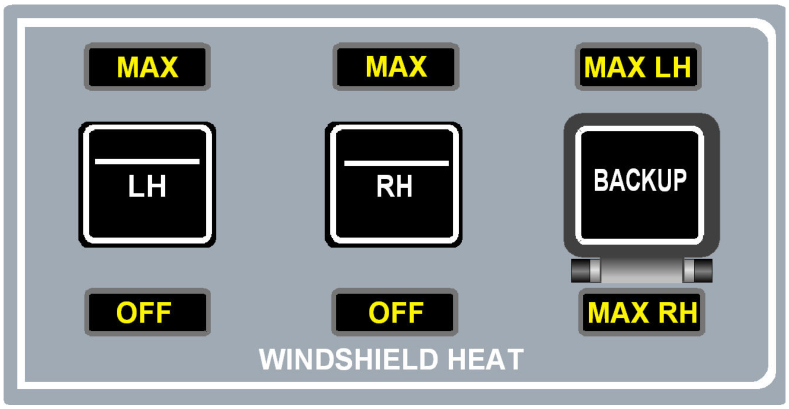
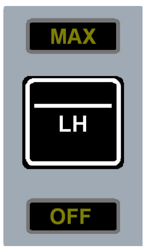


FIGURE 02-30_2-20-01 - WINDSHIELD DE ICING CONTROL PANEL

<table>
<tr><th>CONTROL</th><th>FUNCTION</th><th colspan="2">TO ACTIVATE
TO DEACTIVATE</th><th>SYNOPTIC</th></tr>
<tr>
<td rowspan="3">


</td>
<td rowspan="3">Allows three modes activated by pushing the pushbutton.

Pressing the LH or RH pushbutton for less than 2 sec. switches between:
- OFF,
- Normal.

Pressing the LH or RH pushbutton for more than 2 sec. switches to:
- MAX.

In Normal mode, the following heating circuits are supplied:
- LH or RH corresponding front windshield panel,
- LH or RH corresponding side window.
In mode MAX: front windshield panel only.</td>
<td>Automatic mode</td>
<td>
</td>
<td rowspan="3">No synoptic</td>
</tr>
<tr>
<td>OFF</td>
<td>
</td>
</tr>
<tr>
<td>MAX
mode</td>
<td>
</td>
</tr>
<tr>
<td>
</td>
<td>BACKUP mode: activates the MAX mode on the selected front windshield
First push: MAX LH side selected in BACKUP.
Second push: MAX LH side selected in BACKUP.</td>
<td>MAX LH side selected in BACKUP</td>
<td>
</td>
<td>No synoptic</td>
</tr>
</table>

PUSH TO TEST WDSHIELD SOFT KEY

The WDSHIELD soft key in the TEST synoptic page allows the crew members to initiate a self-test before flight.

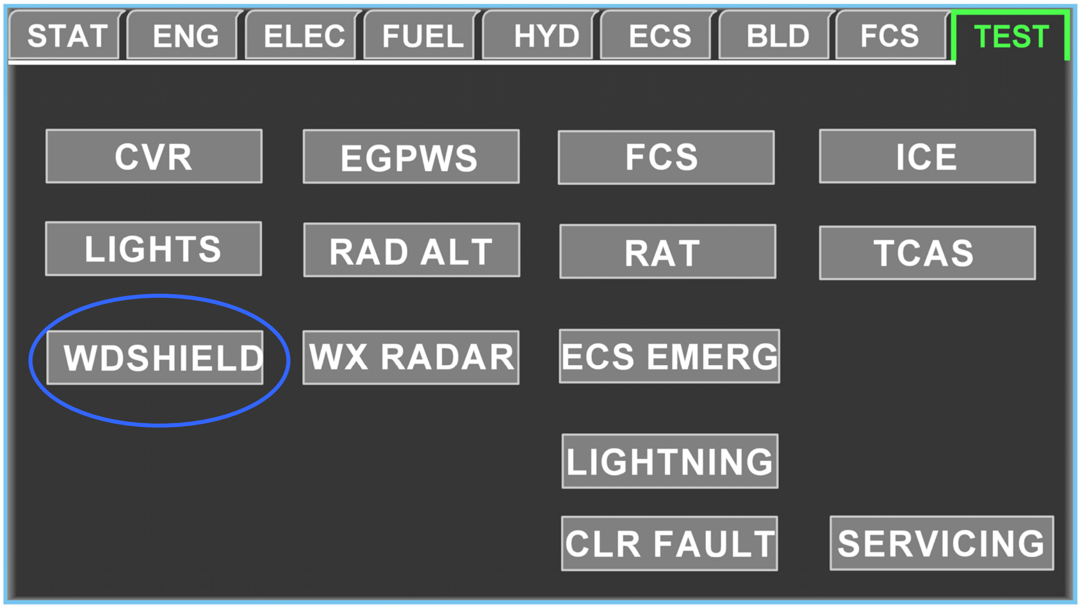


FIGURE 02-30_2-20-02 - WINDSHIELD SOFT KEY

This soft key allows the crew members to initiate windshield pre flight test.

If one windshield side has failed, the crew members can select the backup converter to this side and test it.

RAIN REPELLENT CONTROLS

The system is controlled independently for each window (L/H and R/H front windshield) by two pushbutton switches located on the overhead panel.

CONTROL	FUNCTION	TO ACTIVATE		SYNOPTIC
	Each time the LH or RH RAIN RPLNT switch is pressed, approximately 10 cc of fluid is sprayed on-to the corresponding windshield.	Push On commands fluid spray		No synoptic

INDICATIONS

Cockpit indications related to probes, windshield, rain repellent system are displayed:

- With lights associated to each control pushbutton,
- On the ENG-CAS window for CAS messages,
- On the STATus synoptic / FAULT tab for fault messages.

No supplementary information to be provided on control and indication at present time.

PROBES SYSTEM PROTECTIONS

SYSTEM MONITORING

The following parameters are monitored:
- MFP heater elements current and voltage for failure or power off.

➢ *Refer to CODDE 2 for a complete list of CAS messages.*

ACTIVE PROTECTIONS

Active protections consist of:
- Regulation of MFP temperature:
  - The duty cycle of MFP heater power is adapted to regulate the MFP temperature.
  - The duty cycle is 100% or full on when the airplane speed is above 60 knots.
- Smart Probe Built-in Test:
  - The SmartProbe Built-In Test perform a continuous test for MFP and TAT heater and TAT sensor.

➢ *Refer to PROTECTION SUPPLEMENTARY INFORMATION for additional information.*

WINDSHIELDS PROTECTIONS

SYSTEM MONITORING

The following parameters are monitored:

- Loss of pilot or copilot windshield de-icing protection in normal mode.
- Loss of pilot or copilot windshield de-icing protection in Backup mode.
- Failure of normal or backup test.

➢ *Refer to CODDE 2 for a complete list of CAS messages.*

ACTIVES PROTECTIONS

Active protection consists of:

- Sensing elements and power controller determining when to switch on or off power.
- Electrical power limitation for:
  - Front windshields in MAX mode,
  - Front windshields and lateral windows in Normal mode.
- Backup operation in case of failure of the LH or RH windshield power supply module.

➢ *Refer to PROTECTION SUPPLEMENTARY INFORMATION for additional information.*

RAIN REPELLENT SYSTEM PROTECTIONS

The rain repellent system has no specific protections and is not monitored by the crew alerting system.

A leak is characterized by an odor of pine.

PROBES

HEATING PROTECTION

When MFP heater power is unregulated, the MFP can reach excessive temperatures when in still air. This excessive heat decreases the life of the MFP heater element. The SmartProbe ADC regulates the temperature of the MFP by cycling the heater on and off to improve the service life of the MFP.

The MFP heater control is accomplished by monitoring the probe temperature.

The temperature of the MFP is obtained by measuring the MFP heater element current and voltage applied.

The MFP heater element resistance is then calculated, and from that resistance value, the MFP temperature is approximated as the MFP heater element resistance changes with temperature.

The duty cycle of MFP heater power is modified to regulate the MFP temperature. For failsafe design assurance, the MFP heater power duty cycle is 100%, or full-on, when the airspeed is above 60 knots.

PROBE HEAT LOGIC – AIRCRAFT IS WEIGHT-ON-WHEELS WITH THE PARK BRAKE ON	
CONDITION	**PUSHBUTTON INDICATION**
The PITOT switches ‘power-up’ to the OFF position. The multi-function probes and TAT probes are unheated	OFF
At transition from one engine running to two engines running.	On (unlighted)
At transition from two engines running to one engine running	OFF

AUTOMATIC 100% HEATING:	
MFP	Airspeed > 60 kts.
TAT	Engine 1 and 3 power lever angle > 30° and the airspeed > 60 kts
TAT	Heating removed with engine 1 and 3 power lever angle < 30° and airspeed < 45 kts.

WINDSHIELD

HEATING PROTECTION

WINDSHIELD HEAT LOGIC – AIRCRAFT IS WEIGHT-ON-WHEELS WITH THE PARK BRAKE ON	
CONDITION	**PUSHBUTTON INDICATION**
The windshield switches 'power-up' to the OFF position. The windshield probes are unheated	OFF
At transition from one engine running to two engines running.	On (unlighted)
At transition from two engines running to one engine running	OFF

TEMPERATURE MONITORING

Temperature sensing elements are used to monitor windshield temperatures and (in accordance with the power controller) determine when to switch on or off.

They consist of a fine resistant wire with a positive temperature variation coefficient. They are composed of fine long wires.

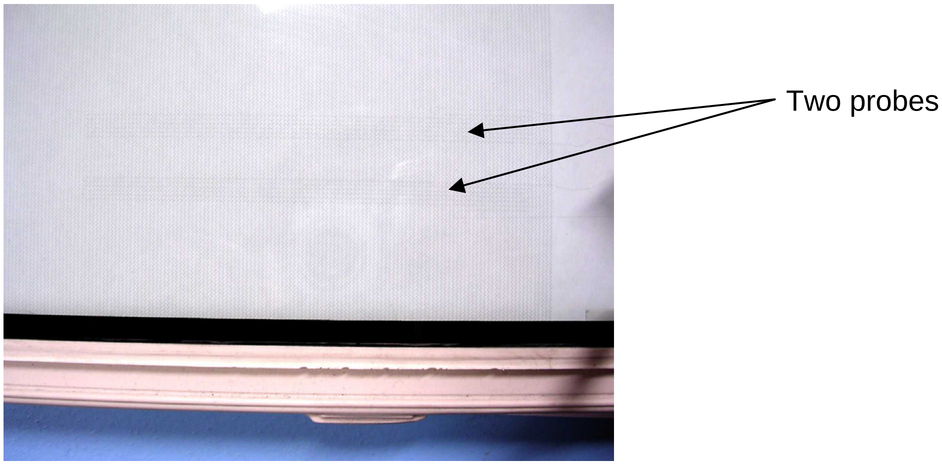


FIGURE 02-30_2-35-00 - WINDSHIELD TEMPERATURE SENSING

RAIN REPELLENT

No supplementary information to be provided on rain repellent system protection at present time.

PROBES

No information to be provided on probes Ground Operation at present time.

WINDSHIELDS

CLEANING

Soft enwove cloths soaked with ethyl or isopropyl alcohol are recommended to clean the external surfaces of windshields treated by dry coat.

CAUTION

The use of abrasive pads or materials and/or concentrated acids or bases must be avoided, failing to do so might seriously degrade the hydrophobic properties

REFURBISHMENT

Unless inadequate cleaning procedures and/or failing to do so might seriously degrade the hydrophobic properties.

The coat is expected to remain effective in service for not less than 6 months and for about 1500 F/H expected on Falcon 7X. It shall be then refurbished to recover its original properties.

Dry coat is easy to refurbish in-situ. Removing the windshield from the airplane is not necessary and no more than one operator is required. The time to refurbish a dry coat film does not exceed one hour.

RAIN REPPELENT

The CAN must be changed when the visual level or the pressure is too low.

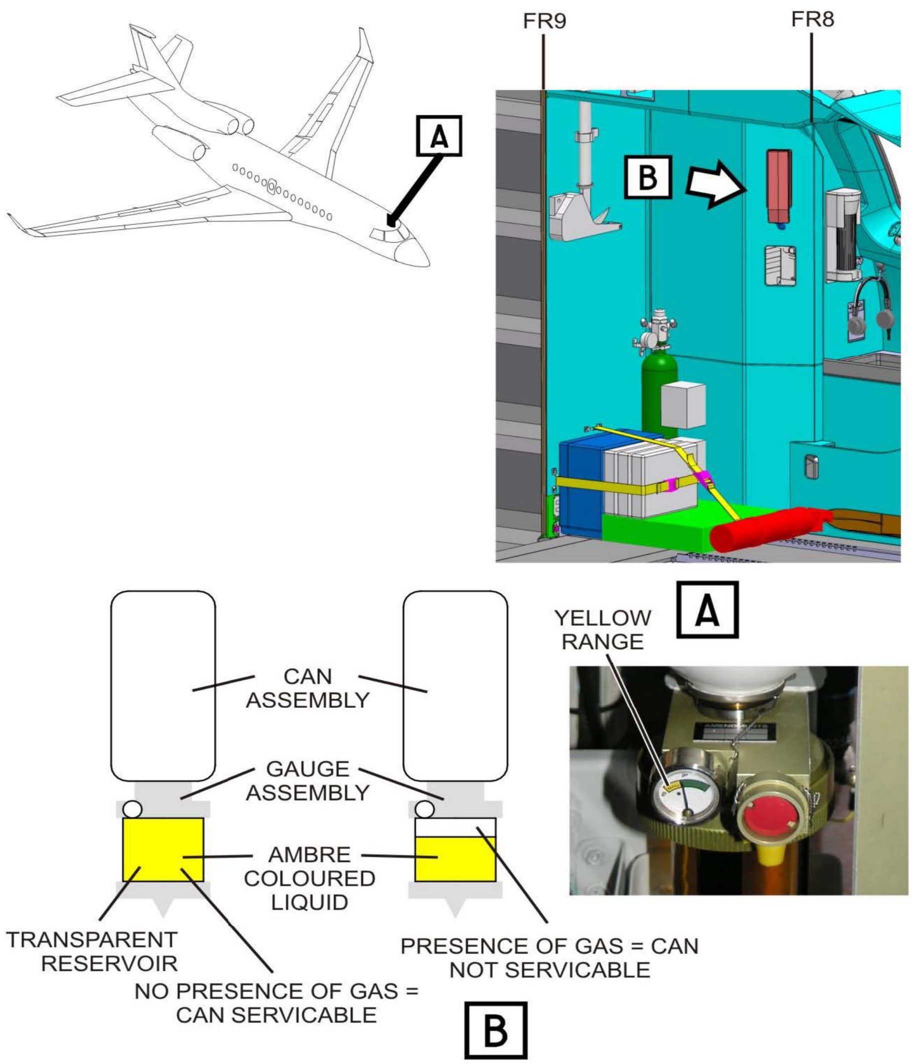


FIGURE 02-33_2-40-00 - RAIN REPELLENT GAUGE

➢ *Refer to GROUND SERVICING manual.*

INTRODUCTION

The most critical parts of the airplane with respect to icing, such as engine air intakes and S-duct, wing leading edges slats, and brakes (option) are protected by an anti-ice system commanded manually by the crew.

FLIGHT DECK OVERVIEW

CONTROLS

Crew control of engines anti-ice, S-duct anti-ice, wings anti-ice and brakes anti-ice system is performed from the Overhead Pnel via:

- Three anti ice pushbutton for engines 1 & 3 and engine 2 S-duct,
- One pushbutton for both wings,
- One pushbutton for brakes anti-ice (optional).

NOTE

Engines 1 & 3 nacelles anti ice and Engine 2 S-duct also command the engines probe heaters.

INDICATIONS

Cockpit indications related to engines anti-ice, S-duct anti-ice, wings anti-ice and brakes anti-ice systems are displayed:

- In the BLD (bleed air) synoptic page for bleed anti ice systems status (engines, S-duct, wings and brakes),
- In the ENG-CAS window for CAS messages,
- In the ENG-CAS window for indication of minimum N1 required with Wing Anti ice on.

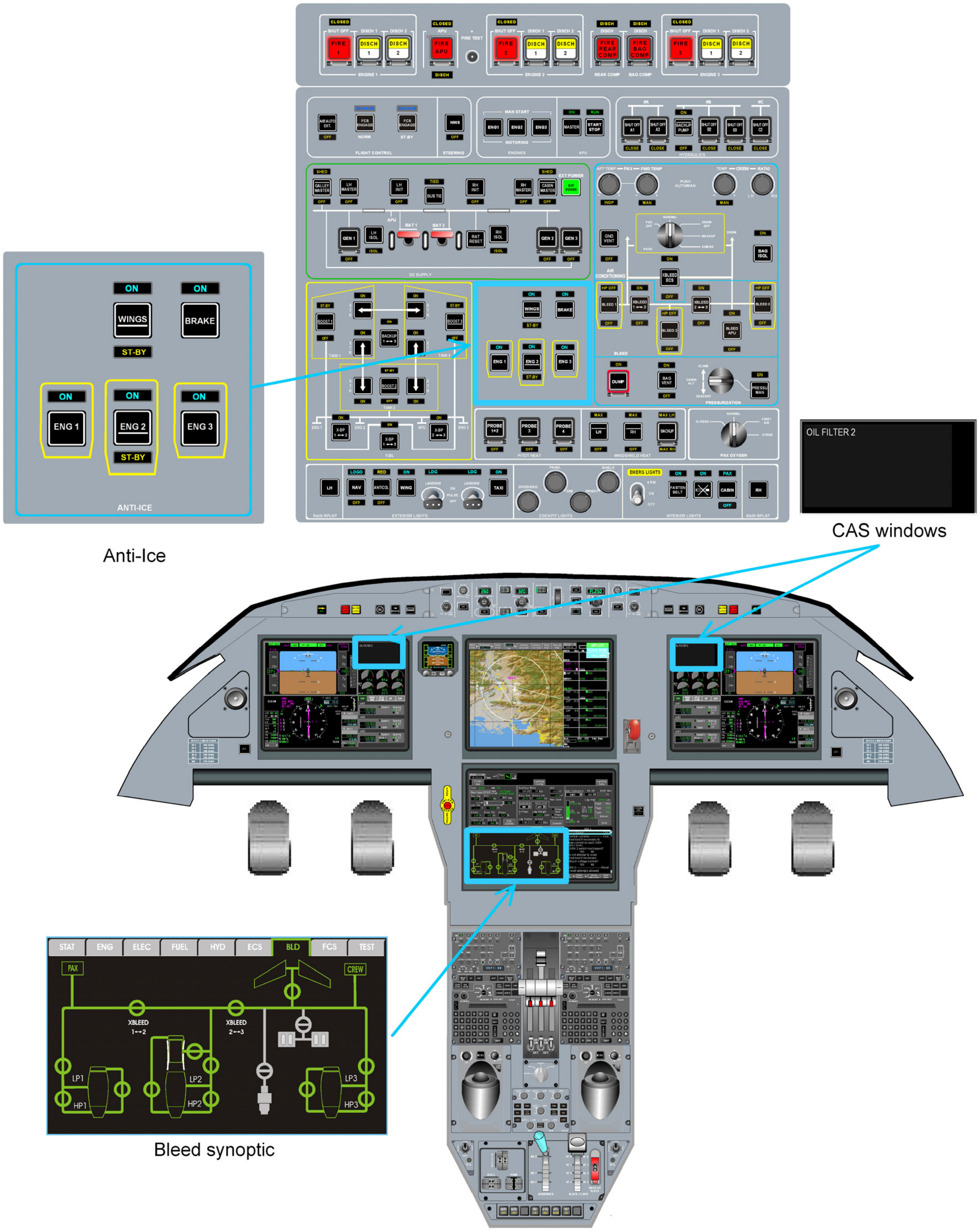


FIGURE 02-30_3-05-01 FLIGHT DECK OVERVIEW

GENERAL ARCHITECTURE

The pneumatic system relies on LP and HP bleed air bled from the three engines.

Mixed air is distributed to wing slats, engine 2 S-duct and brakes anti ice.

HP bleed air is distributed to engines air intakes.

Two crossbleed (XBLEED 1↔2 and XBLEED 2↔3) valves can separate the distribution assembly into three independent circuits.

The Air Management System Auto Controller (AMSAC) regulates and powers wing, S-duct and brakes anti-ice.

➢ *Refer to ATA 36 PNEUMATIC SYSTEM for additional information.*

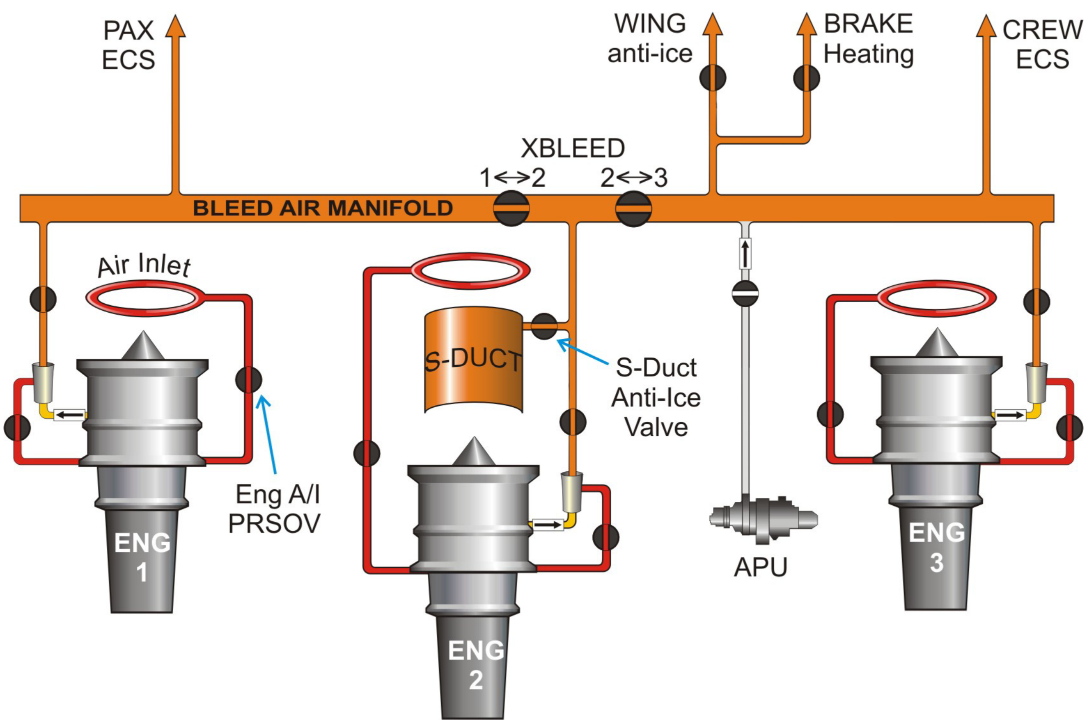
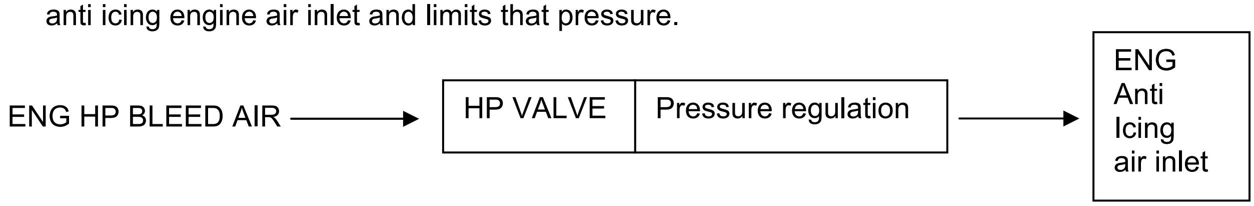


FIGURE 02-30_3 -10-00 - GENERAL SCHEMATIC SUPPLY

ENGINES ANTI ICE

The air intake anti-ice systems of all three engines are fully independent.

The HP valve modulates the supply of HP bleed air to maintain adequate pressure in the anti icing engine air inlet and limits that pressure.



S-DUCT ANTI ICE

The air supply for the S-duct anti-ice is a HP / LP mix from the bleed-air manifold interconnecting all three engines.

The S-duct anti-Ice system is controlled and monitored by the Air Management System Automatic Controller (AMSAC):

- Air Management Module 1 (AMM) in normal mode,
- Air Management Module 2 in standby mode.

If wing anti-ice is off:

- The XBLEED 1↔2 and XBLEED 2↔3 valves remain closed and engine 2 S-duct is anti-iced by engine 2 bleed air only.

If wing anti-ice is running (on or standby):

- The XBLEED 1↔2 and XBLEED 2↔3 valves are opened in order to provide sufficient flow to the wing and to the S-duct.

WING ANTI-ICE

The air supply for the wing slats ice protection is a HP / LP mix from the bleed-air manifold interconnecting all three engines.

On each wing, a distribution line supplies:

- The fixed leading edge root,
- The inboard, median and outboard slats via three telescopic ducts.

The wing anti icing system is controlled and monitored by AMSAC:

- Air Management Module 1 (AMM) in normal mode,
- Air Management Module 2 in standby mode.

With wing anti-ice system on, the XBLEED 1↔2 and XBLEED 2↔3 valves are opened in order to feed wings and S-duct by all three engines.

NOTE

Wings anti-ice should not be operated with engines anti-ice off.

BRAKES ANTI ICE

The brake anti ice system heats the braking system after take off in order to remove any potential water or dirt from brakes system that could freeze on brakes during flight.

Therefore the main landing gear compartments are heated by air tapped upstream of the wing anti ice valve and mixed with ambient air in order to limit the temperature.

The system is fitted with a single anti ice brakes valve.

The brake anti icing system is controlled and monitored by the AMM 1 of the AMSAC.

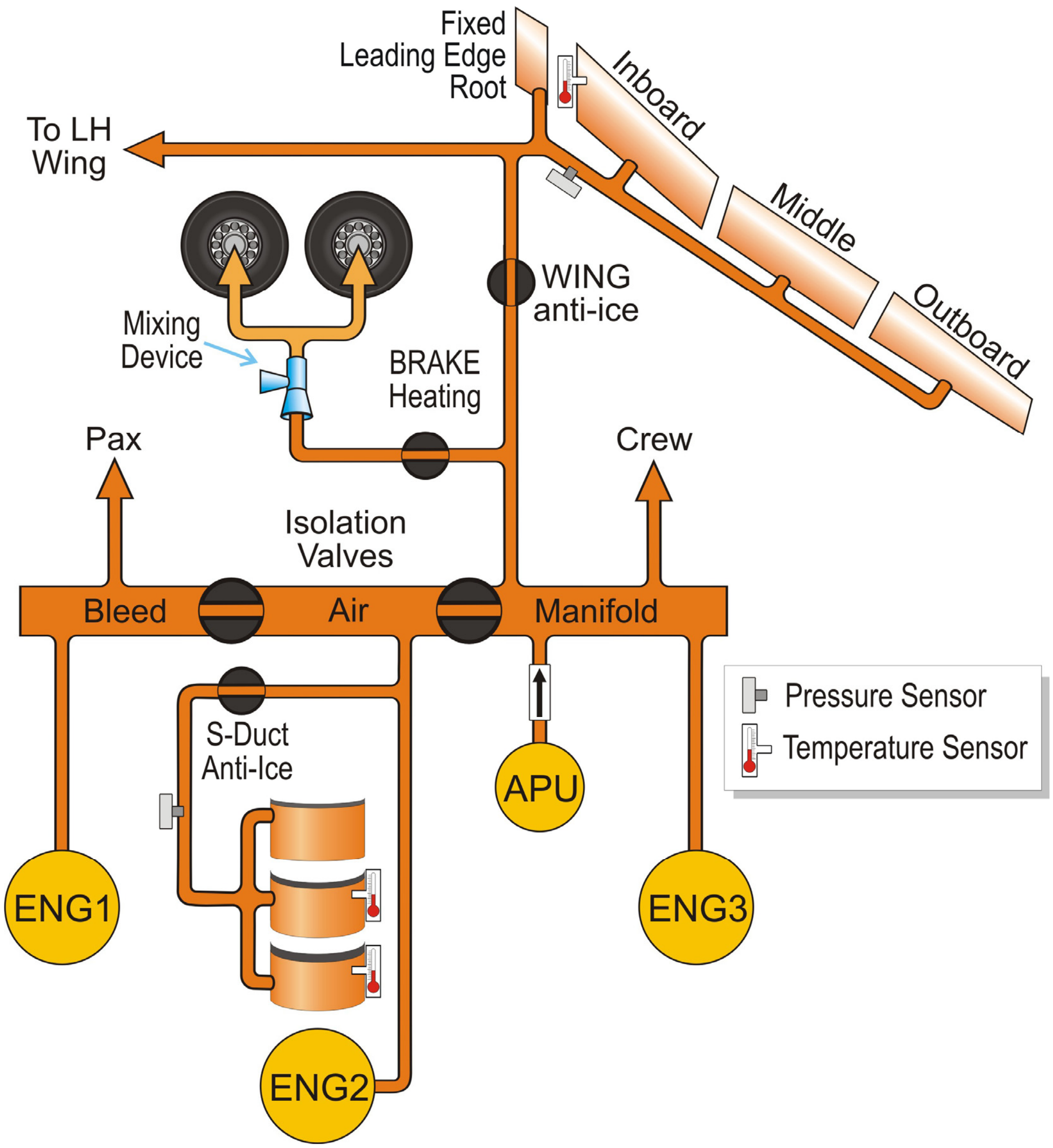


FIGURE 02-30_3-10-01 - S-DUCT, WINGS AND BRAKES ANTI ICE

DESIGN PRINCIPLES

ENGINE ANTI-ICE SYSTEM

The engine anti-ice system was designed considering the followings design principles:

With regard to efficiency:

- The system (with sufficient engine N1%) can provide full evaporation of all impinging water on the engine intake in maximum continuous icing condition,
- The amount of runback water (with no sufficient engine N1%) will be limited, thus the maximum quantity of ice forming will not result in an ice slab greater than the ice ingestion capacity of the engine.

With regard to Safety:

- The system is partially located within engine fire zone 1 (this zone is protected by fire extinguisher),
- The system is protected against overpressure and duct burst.

With regard to maintenance:

- The system has integrated maintenance capability; the failures are recorded in a maintenance message.

ENGINE 2 S-DUCT ANTI-ICE SYSTEM

The engine 2 S-duct anti-ice system was designed considering the followings design principles:

With regard to efficiency:

- The system ensures a sufficient anti-ice protection of the S-duct with direct control of the skin temperature.

With regard to safety:

- The system is protected against controller failure, overtemperature, overpressure.

With regard to maintenance:

- The system has integrated maintenance capability, the failures are recorded in a maintenance message.

WING ANTI-ICE SYSTEM

The engine wing anti-ice system was designed considering the followings design principles:

With regard to efficiency:

- The system ensure a sufficient anti-ice protection of the wings with direct control of the skin temperature,
- The system displays the minimum engine N1% required for anti-ice efficiency,
- The system detects the anti-ice low power.

With regard to safety:

- The system is protected against controller failure, overtemperature, overpressure,
- The system detect the overheat for material protection and to improve the life cycle of slats,
- The system limits the bleed pressure in order to limits the slats distortions.

With regard to maintenance:

- The system have integrated maintenance capability, the failures are recorded in a maintenance message.

BRAKES ANTI-ICE

The brakes anti-ice system was designed considering the following design principle:

With regard to safety:

- In order to limit temperature in the main landing gear compartment the bleed air is mixed with ambient air.

EQUIPMENT LOCATION

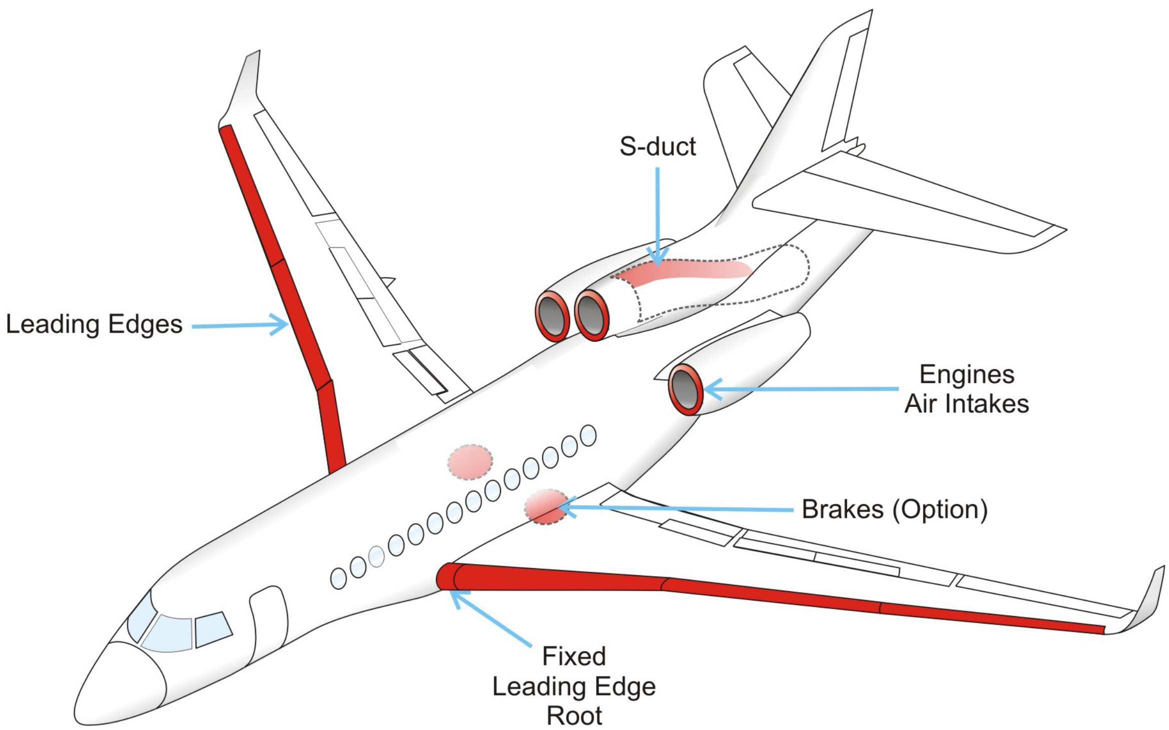


FIGURE 02-30_3-15-00 - ENGINES, S-DUCT, WINGS, BRAKES ANTI-ICE

ELECTRICAL POWER SOURCE

The following paragraph describes the power supply of the different equipment of the engines, S-duct, wings and brakes anti-ice systems.

Electrical protection is provided:

- By Solid State Power Controllers (SSPC) ,
- By Circuit Breakers (CB).

➢ *Refer to ATA 24 – ELECTRICAL POWER for additional information.*

EQUIPMENT	POWER SUPPLY	TYPE OF PROTECTION
ENGINE 1 ANTI-ICE VALVE	LH ESS bus	SSPC
ENGINE 2 ANTI-ICE VALVE	RH ESS bus	SSPC
ENGINE 3 ANTI-ICE VALVE	LH ESS bus	SSPC
AMSAC AMM 1	LH Main bus	CB
AMSAC AMM 2	RH Main bus	SSPC

The S-duct anti-ice valve, wings anti-ice vale and brake anti-ice valve are electrically powered by the AMSAC.

DETAILLED ARCHITECTURE

ENGINE ANTI-ICE SYSTEM

The engine anti-ice system is based on hot air jet impingement design. The air enters the anti-ice system at its interface with the engine's high-pressure bleed port.

Engine HP bleed air is regulated via a Pressure Regulating Shut Off Valve (PRSOV) which is electrically controlled in the open/closed position by the pilot via the pushbutton on the Overhead Panel.

When the valve is open, the HP compressor bleed air flows through a supply pipe to heat the inlet lip by means of a piccolo distribution pipe.

The supply pipe interfaces with the distribution ring (the piccolo pipe) which runs circumferentially within the forward D-chamber region of the inlet.

The piccolo pipe is drilled with small holes that direct the hot air to impinge on the inner surface of the lip skin.

The hot air is discharged from the D-chamber through:

- An exhaust duct attached to the forward bulkhead, then overboard through an exhaust panel in the outer barrel for the side engine inlet.
- The forward and then the rear bulkhead into the S-duct compartment for the center engine inlet.

The anti-ice system is partially located within engine fire zone I (Fan Compartments).

The equipment items of the side and centre engine inlet anti-icing systems are located as follows:

- The side engine inlet anti-ice venturi is located upstream of the anti-icing system PRSOV in the fan compartment zone,
- The PRSOV is located in the fan compartment zone,
- The pressure transducer is located downstream of the PRSOV in the fan compartment zone for the side engine and near the engine inlet for the centre engine.

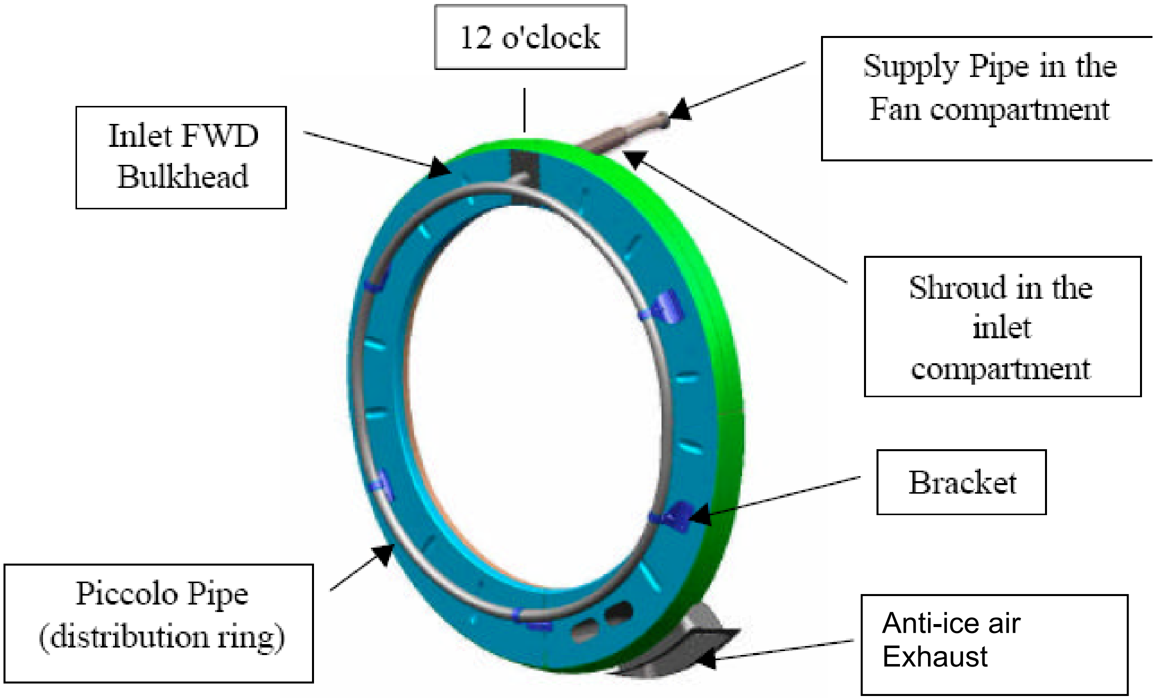


FIGURE 02-30_3-15-01 - SUPPLY PIPE AND PICCOLO PIPE INSTALLATION

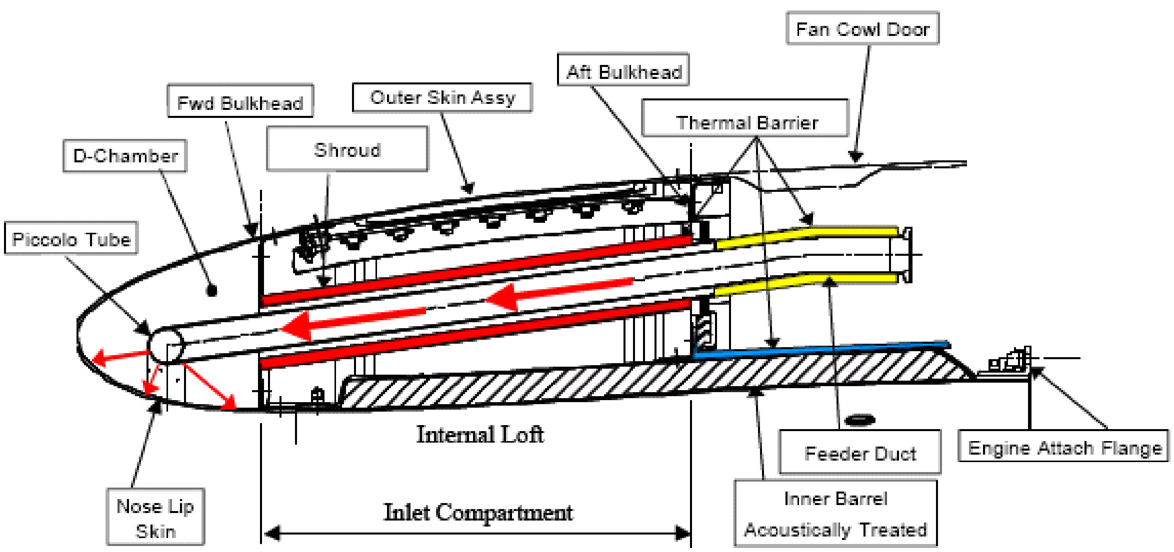


FIGURE 02-30_3-15-02 - CROSS-SECTION OF THE SIDE ENGINE AIR INLET WITH ANTI-ICE SYSTEM COMPONENTS

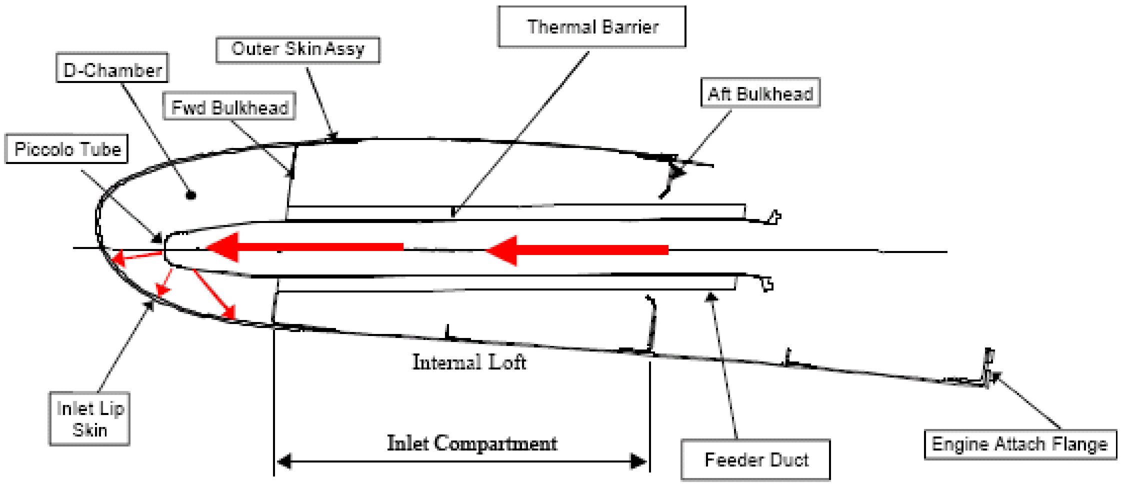


FIGURE 02-30_3-15-03 - CROSS-SECTION OF THE CENTER ENGINE AIR INLET WITH ANTI-ICE SYSTEM COMPONENTS

S-DUCT ANTI-ICE SYSTEM

The S-duct is physically divided in four sections, from section 1 (S1) after the engine air inlet to section 4 (S4) before the engine interface.

The first three sections are heated by the S-Duct anti-icing system, whereas the fourth one is unheated.

The first three sections are heated on their upper half (-95° to +95° from the vertical axis) thanks to a double-skin heat exchanger.

The exchanger is fed by hot air, result of a mixing between air bled from the low pressure port and the high pressure port of the engine HP compressor.

This mixing is then routed through pipes up to distribution piccolos located on top of the S-duct inside a plenum chamber.

HP/LP mixing is controlled and monitored by the AMSAC Controller.

If Wings Anti-Ice is OFF, engine 2 S-duct is anti-iced by engine 2 bleed air only and the XBLEED 1↔2 and XBLEED 2↔3 valves remain closed.

The AMSAC regulates the S-duct skin temperature by modulating the S-duct anti-ice control valve.

In case of failure of the normal S-duct anti-ice mode, the second channel of the AMSAC is able to control the S-duct anti-ice with the same control laws and limitations:

This is achieved by the crew members when selecting ENG 2 STBY anti-icing mode on the overhead panel.

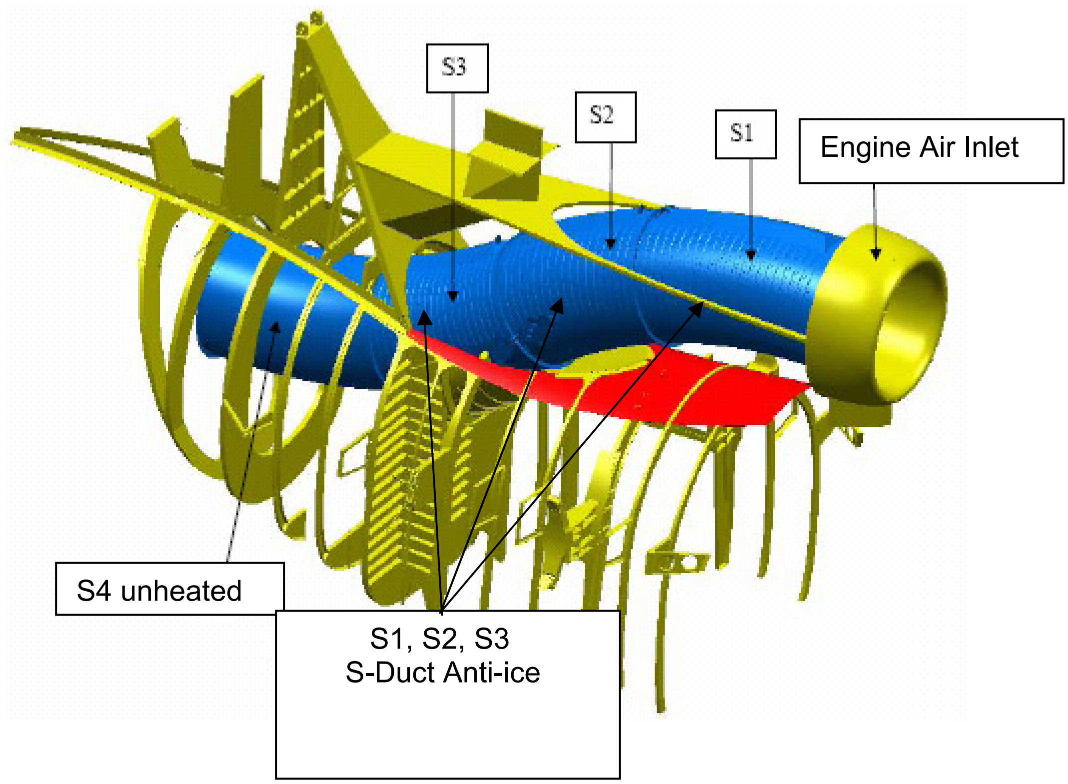


FIGURE 02-30_3-15-04 - S-DUCT ANTI-ICE SYSTEM VIEW

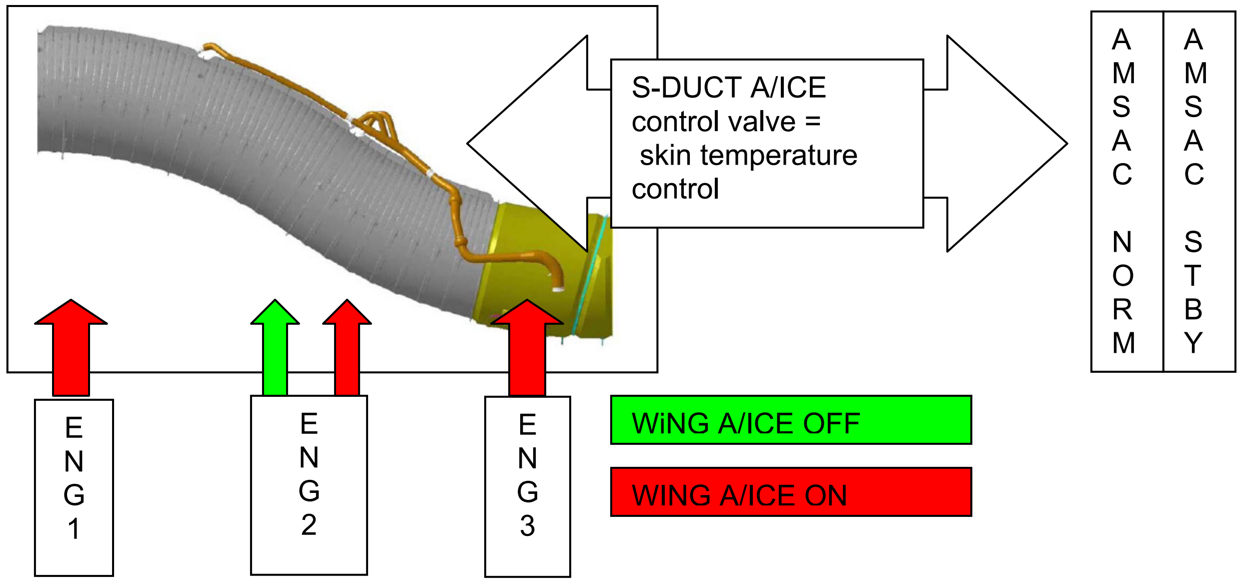


FIGURE 02-30_3-15-05 - S-DUCT ANTI-ICE SYSTEM

WING ANTI-ICE SYSTEM

The wing anti-ice system covers the air anti-ice of the mobile leading edge which is divided into four parts:

- One inboard slat,
- One median slat,
- One outboard slat,
- The fixed leading edge root.

The wing slats are heated on the whole span by hot air, result of a mixing between air bled from the low pressure port of the engine and air bled from the high pressure port. The anti-ice hot air is low pressure air, preferably and it is completed with high pressure air if necessary.

HP/LP mixing is controlled and monitored by the AMSAC.

This mixing is then routed through pipes up to distribution piccolo tubes inside the leading edge of the slats.

The fixed leading edge root of each wing is uncovered when the inboard slat is extended.

The fixed leading edge roots are heated by hot air bled from wing slats pipe feeding.

Two pressure switches detect the leak pipes or the disconnected pipes.

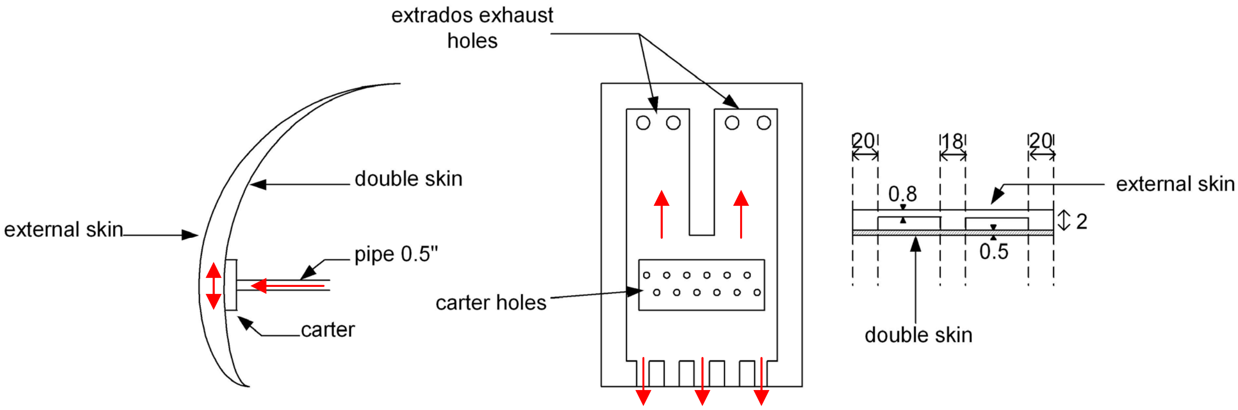


FIGURE 02-30_3-15-06 - CIRCULATION INSIDE THE FIXED LEADING EDGE ROOT

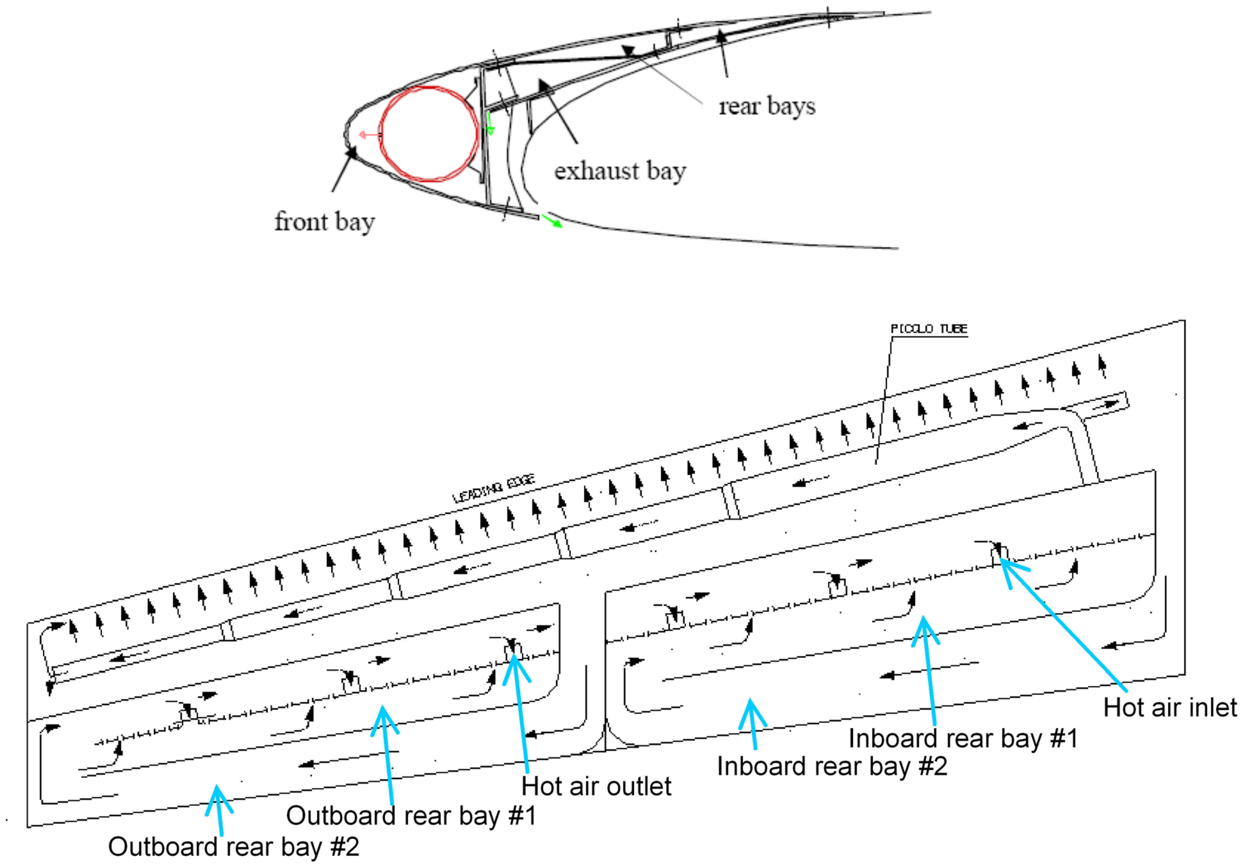


FIGURE 02-30_3-15-07 - CIRCULATION INSIDE THE SLATS

The hot air arrives inside the slat from telescopic duct by the piccolo tube. The air flow is distributed in the front bay by the piccolo tube. The main direction of air circulation is spanwise.

Downstream the piccolo tube, the air circulation is as following:

- A part of the airflow passes into the outboard rear bays.
- The other part of the airflow passes into the inboard rear bays.

The airflow passes in first by the rear bay #2 and then in the rear bay #1.

Then the air flow from the rear bay #1 goes into the exhaust bay.

MAIN COMPONENTS

ENGINES ANTI-ICE SYSTEM

PRSOV (Pressure Regulating Shut off Valve)

Power applied energizes the solenoid to open the valve, which regulates compressor bleed air pressure. No power applied closes the valve.

Once the solenoid is excited, the PRSOV will open and regulate the downstream static pressure in the anti-icing supply pipe to 100±5 psig during normal system operation.

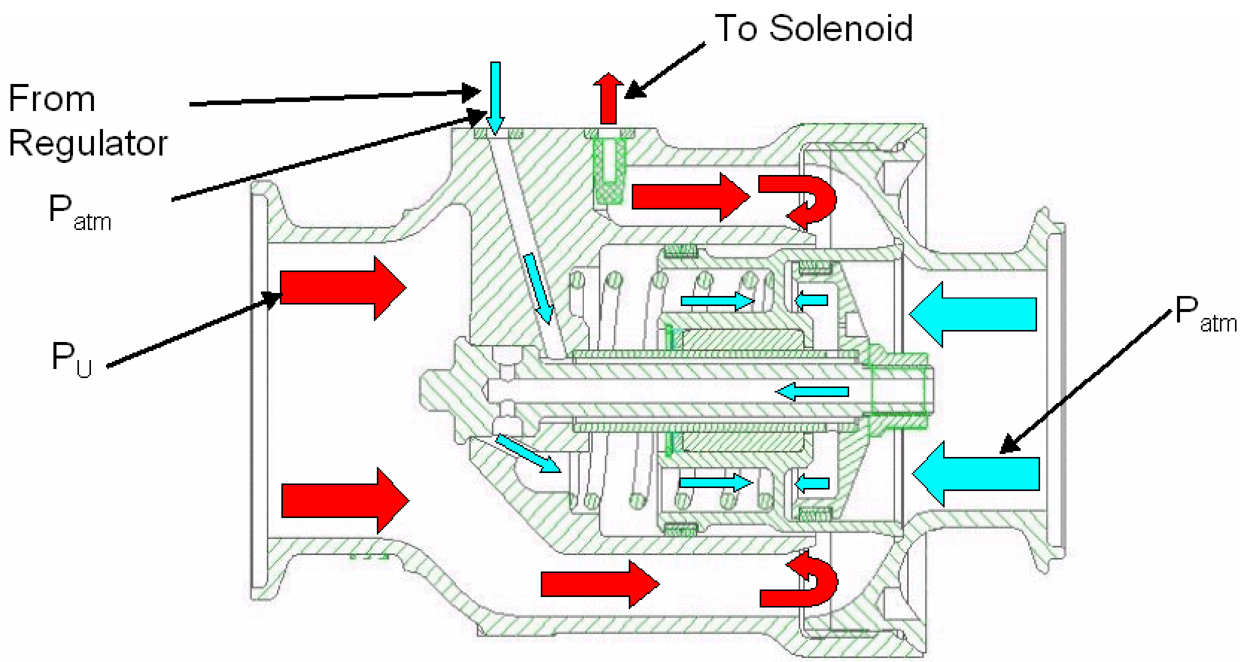


FIGURE 02-30_3-15-08 - PRSOV

Pressure sensing device

The pressure-sensing device - a pressure transducer - is positioned between the anti-icing PRSOV and the piccolo tube (It monitors the static pressure downstream of the PRSOV).

Within the MAU, the pressure signal of the pressure sensing device is compared to the acceptable upper and lower limits (established as a function of engine P3 and ambient pressure).

The limits are computed by the EEC and sent to the MAU. Based on this approach, the logic can detect a PRSOV regulation failure and a transducer failure.

These faults generate CAS messages and Maintenance messages.

S-DUCT ANTI-ICE

S-duct anti-ice temperature control valve

The S-duct anti-icing Temperature Control Valve (TCV) is a 3 in. diameter butterfly valve.

It is composed of two electric actuators fixed on a stainless steel butterfly valve.

The valve has a switch (index) to visualize the butterfly position: CLOSED or NOT CLOSED.

This valve is controlled by the AMSAC. It controls the airflow to regulate the skin temperature measured by the sensors located on the S-duct.

In all cases except a failure, the TCV limits the air pressure measured by the pressure sensor.

In case of electrical power supply failure, the valve remains closed.

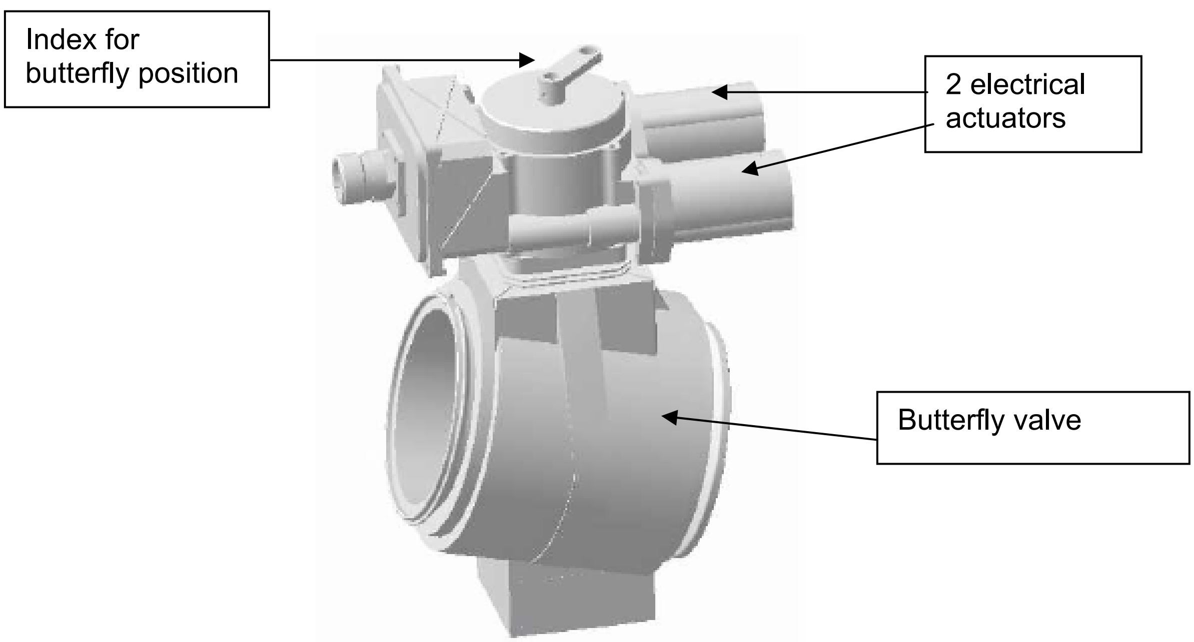


FIGURE 02-30_3-15-09 - S-DUCT ANTI-ICE TEMPERATURE CONTROL VALVE

Anti-ice pressure sensor

Two pressure sensors are located on the hot air feeding pipe and connected in parallel on the same tapping. They allow to control the pressure downstream of the temperature control valve. One pressure sensor is linked to the AMM1 card, the other one is linked to the AMM2 card.

Anti-ice dual bead skin temperature sensor

Two dual bead skin temperature sensors measure the temperature of the outer skin of the S-duct:

- The skin temperature sensor 1 is located at the end of the section 2, at 84° angle from the plenum line,
- The skin temperature sensor 2 is located on the section 3 upstream of the frame 41, at 18° angle from plenum line.

One sensitive part of the sensor is linked to the AMSAC, the other sensitive part is linked to the MAU.

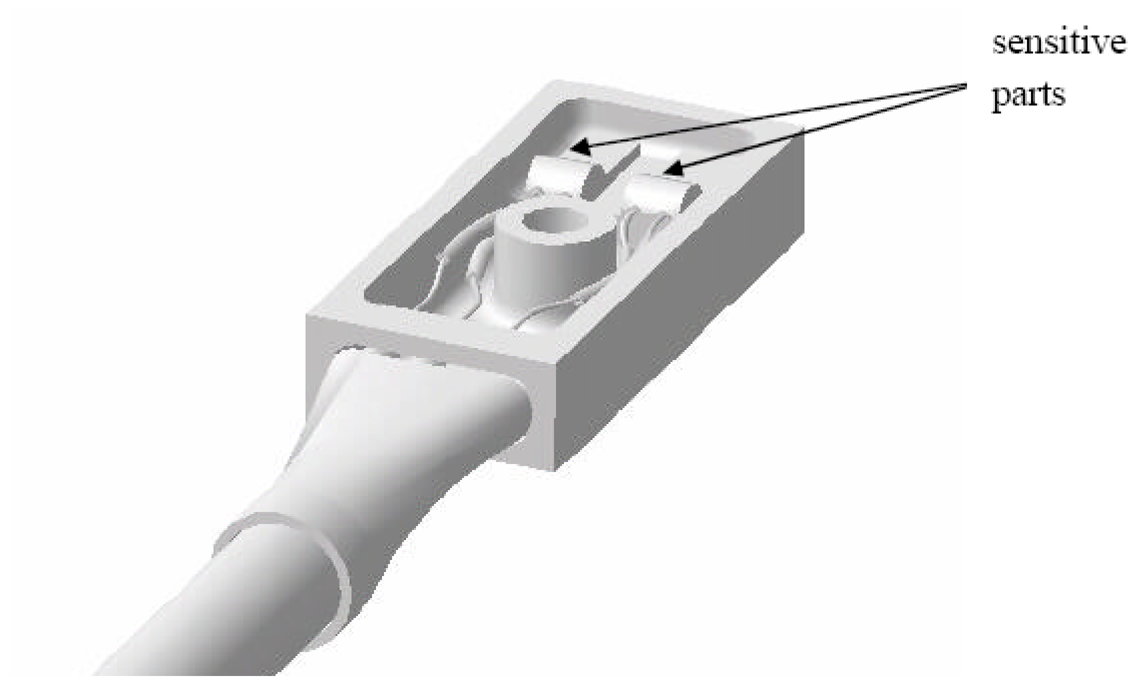


FIGURE 02-30_3-15-10 - ANTI-ICE DUAL BEAD SKIN TEMPERATURE SENSORS

WING ANTI-ICING

Wing anti-icing temperature control valve

The wing anti icing system is controlled by the first Air Management Module (AMM 1) of the Air Management System Automatic Controller (AMSAC). In case of failure of the first Wing Anti-Ice System, the second Air Management Module (AMM 2) of the AMSAC is able to control the system with the same control laws and limitations (this is achieved by the crew when selecting STBY anti-ice mode on the overhead panel). The AMSAC regulates the slats leading edge temperature by modulating the wing anti-ice control valve position/flow.

If the pressure increases above a limit (58 psig max) determined by AMSAC with look up tables, the wing anti-ice control valve regulates pressure at the limit and the AMSAC uses the High Pressure Regulation and Shut-Off Valve (HPRSOV) to limit the skin temperature.

When the Wings Anti-Ice system is ON, the XBLEED 1↔2 and XBLEED 2↔3 valves are opened in order to feed wings and S-Duct by all three engines.

The wing anti-icing temperature control valve is a butterfly type made of stainless steel and fitted with two actuators.

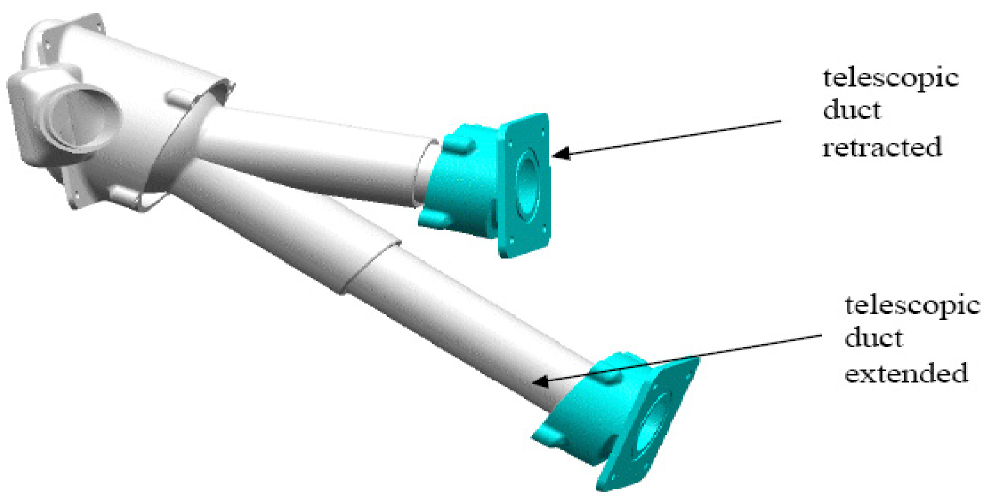
The valve is fitted with two switches: open and closed positions.

The valve, controlled by the AMSAC, regulates the airflow in accordance with the slats position.

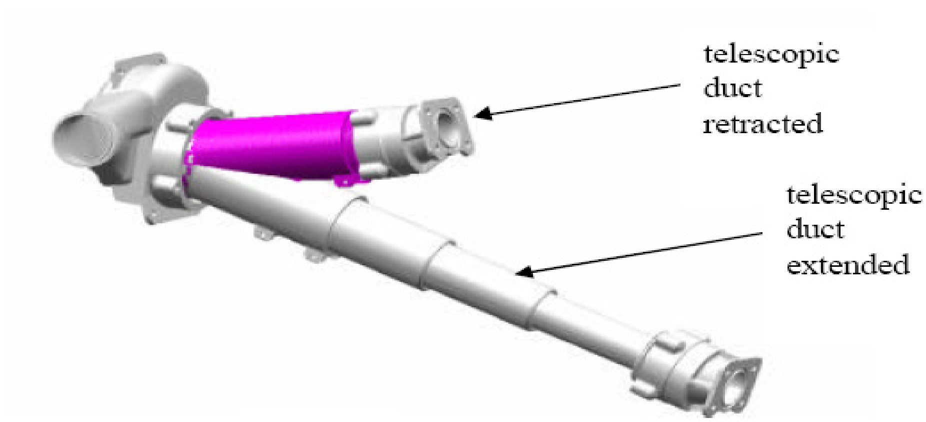
Skin temperature is measured by the skin temperature sensors on the inboard slats.
If an electrical power supply failure occurs, the valve remains in the last position.

Telescopic tubes

The telescopic tubes allow feeding the slats with hot air, whatever the position of the slats.



Inboard telescopic duct



Median telescopic duct

FIGURE 02-30_3-15-11 - INBOARD AND MEDIAN TELESCOPIC DUCTS

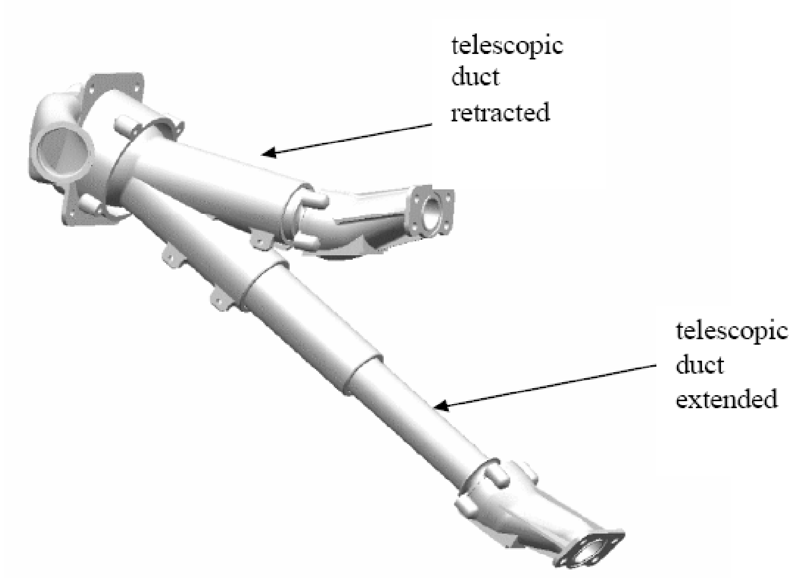


FIGURE 02-30_3-15-12 - OUTBOARD TELESCOPIC DUCT

Anti-ice pressure sensor

A pressure sensor is located on the left and right wings anti-icing feeding pipes inside the fairing.
These pressure sensors allow to control the hot air pressure in the wings anti- icing circuit and slats.

FIGURE 02-30_3-15-13 - PRESSURE SENSOR

Anti-ice dual bead skin temperature sensor

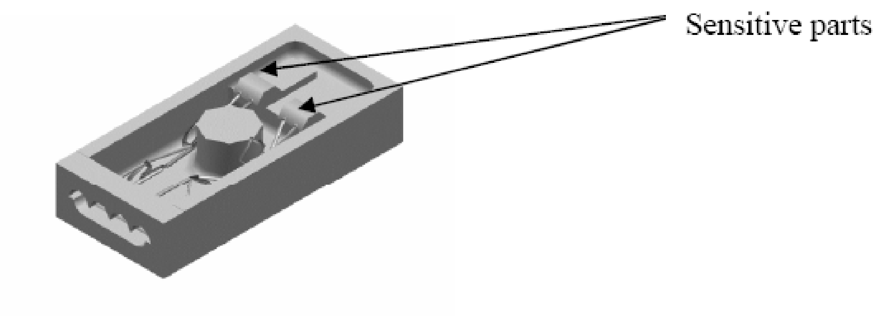
A dual bead skin temperature sensor allows measuring the skin temperature on each inboard slat. This sensor location in the inboard slat is chosen in order to minimize the engine ice ingestion risks because the inboard slats are in front of lateral engines.

One sensitive part of the sensor is linked to AMSAC, while the other sensitive part is linked to MAU for monitoring.

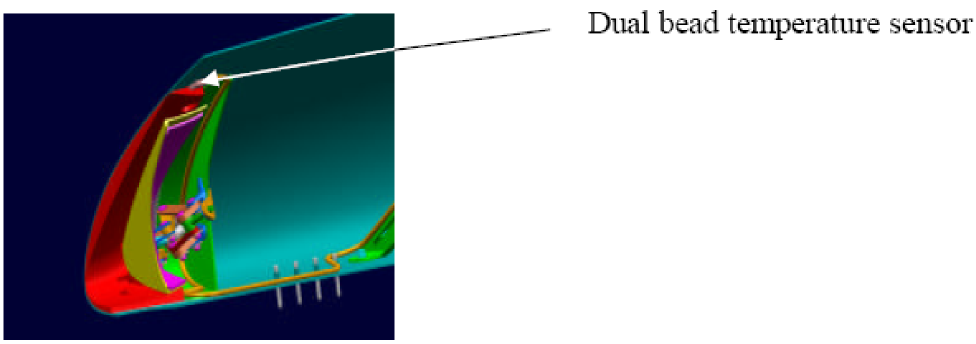
The AMSAC detects the minimum measured temperature between the LH and RH wing and maintains a skin temperature at the level of the sensor to have sufficient anti-ice power overall slats.

This sensor temperature is used to control the anti icing valve flow.

The MAU displays the minimum sensor skin temperature elaborated from the minimum measured temperature between the LH and RH wings. This minimum sensor skin temperature is used to warn the crew in case of overheat or in case of temperature too low.



Dual bead skin temperature sensor



Dual bead skin temperature sensor location on the inboard slat

FIGURE 02-30_3-15-14 - DUAL BEAD SKIN TEMPERATURE SENSOR

PRESSURE SWITCH

The anti ice pipes are fitted with one pressure switch. These pressure switches detect the leak pipes or the disconnected pipes.

The principle of the leak detection is:

- A pressure of 0.6 bar relative is detected by the left hand pressure switch and the wing A/I temperature control valve is full open,

and / or

- A pressure of 0.6 bar relative is detected by the right hand pressure switch and the wing A/I temperature control valve is full open.

The amber **A/I: WINGS LEAK** CAS message is triggered. The crew put off the wings A/I system and leaves or avoids the icing conditions.

FIGURE 02-30_3-15-15 - PRESSURE SWITCH

BRAKES ANTI-ICE

No supplementary information to be provided on brakes anti-ice system at present times.

CONTROLS

Crew control of engines anti-ice, S-duct anti-ice, wings anti-ice and brakes anti-ice system is performed from the Overhead Panel via:

- Three anti ice pushbutton for engines 1 & 3, engine 2 and S-duct,
- One pushbutton for both wings,
- One pushbutton for brakes anti-ice.

NOTE

Anti-ice pushbutton for Engines 1 & 3 nacelles and Engine 2 S-duct also command the Engines TT0 probe heater.

Engine 2 pushbutton commands both S-duct and engine 2 air intake anti-ice.

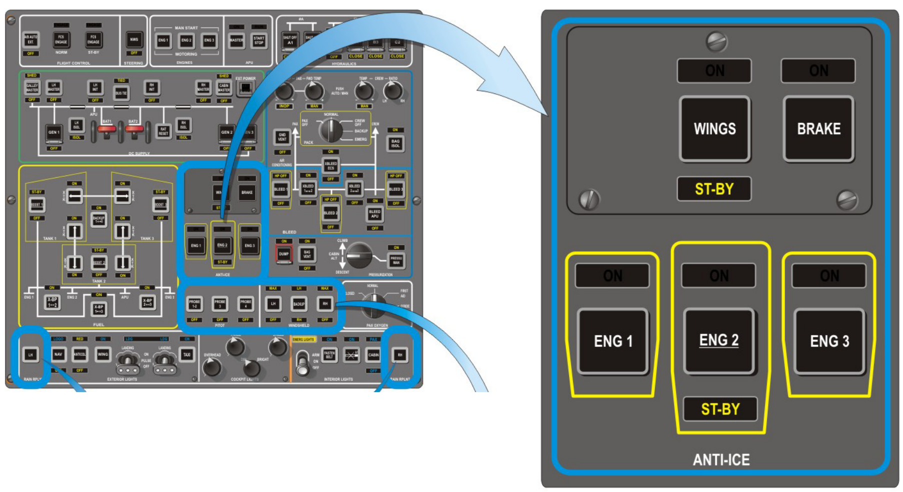
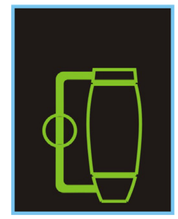
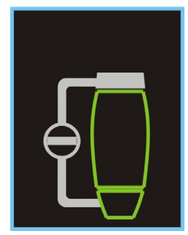
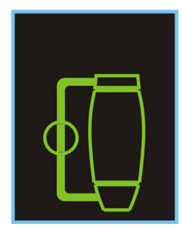
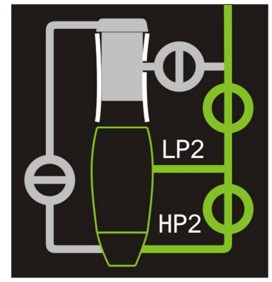
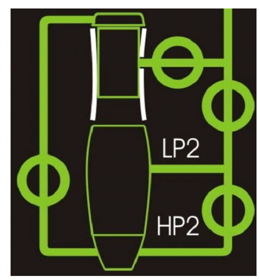


FIGURE 02-30_3-20-00 - ENGINES ANTI-ICE, S-DUCT ANTI-ICE, WING ANTI-ICE AND BRAKES ANTI-ICE CONTROL PANEL

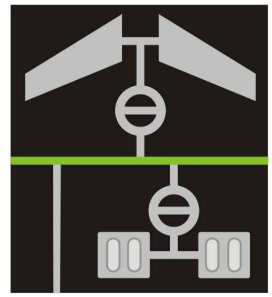
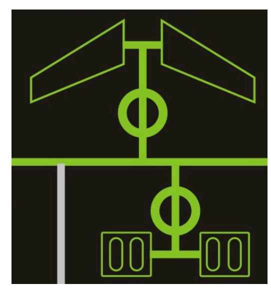
CONTROLS ENGINE 1 AND 3 ANTI-ICE

CONTROL	FUNCTION	TO ACTIVATE TO DEACTIVATE		SYNOPTIC
	Controls hot air supply to No 1 engine air intake lips. Engines air intake lips are directly anti-iced by HP air of the corresponding engine	Push ON commands air intake anti-icing		
		Push Off commands air-intake anti-icing valve closing		
	Controls hot air supply to No 3 engine air intake lips. Engines air intake lips are directly anti-iced by HP air of the corresponding engine	Push ON commands air intake anti-icing		
		Push Off commands air-intake anti-icing valve closing		

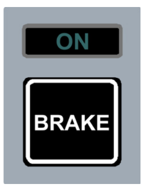
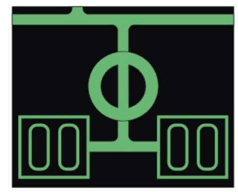
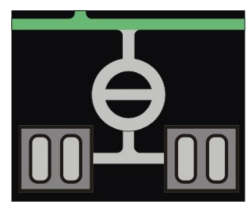
CONTROLS ENG2 ANTI ICE AND S-DUCT ANTI ICE

CONTROL	FUNCTION	TO ACTIVATE TO DEACTIVATE		SYNOPTIC
	Manually controls to ON, ST-BY or Off the engine 2 anti-ice. Engine air intake lip is directly anti-iced by HP air of engine 2. In ON mode, AMSAC opens the S-duct anti-icing control valve and controls HP valves to provide, if necessary, the correct air temperature and pressure. In ST-BY mode, the S-duct anti-icing control is provided by the second channel of the AMSAC	Short puh: unlighted Off		
	Pressing the ENG 2 puhbutton for less than 2 seconds switches between: - ON - Off	Short push: ON		
	Pressing the ENG 2 puhbutton for more than 2 seconds selects: - ST-BY	Long push: ST-BY		

CONTROLS WING ANTI ICE

CONTROL	FUNCTION	TO ACTIVATE / TO DEACTIVATE		SYNOPTIC
	Controls hot air supply to the wings. In ON mode, AMSAC opens the wings anti-icing control valve and controls HP valves to provide the correct slat skin temperature. In ST-BY mode, the wings anti-icing control is provided by the second channel of the AMSAC. Short push: Normal/ON. Long push ST-BY.	First push: wings anti-icing in ON mode		
		Second push: wings anti-icing in ST-BY mode		
		Third push: wings anti-icing valve closing		

CONTROLS AND INDICATION BRAKES ANTI-ICE

CONTROL	FUNCTION	TO ACTIVATE / TO DEACTIVATE		SYNOPTIC
	Manually controls the brakes anti-icing valve: - Unlighted Off: brakes anti-ice valve is closed. - ON: brakes anti-ice valve is open.	First push brakes Anti ice ON		
		Second push brakes anti ice OFF		

INDICATIONS

Cockpit indications related to engines anti-ice, S-duct anti-ice, wings anti ice and brakes anti-ice are displayed:

- On the BLD (Bleed air) synoptic page for bleed anti ice systems status (engines, S-duct wings and brakes),
- ON ENG-CAS window for CAS messages,
- On ENG -CAS window for indication of minimum N1 required with wing anti-ice on.

BLEED AIR SYNOPTIC PAGE

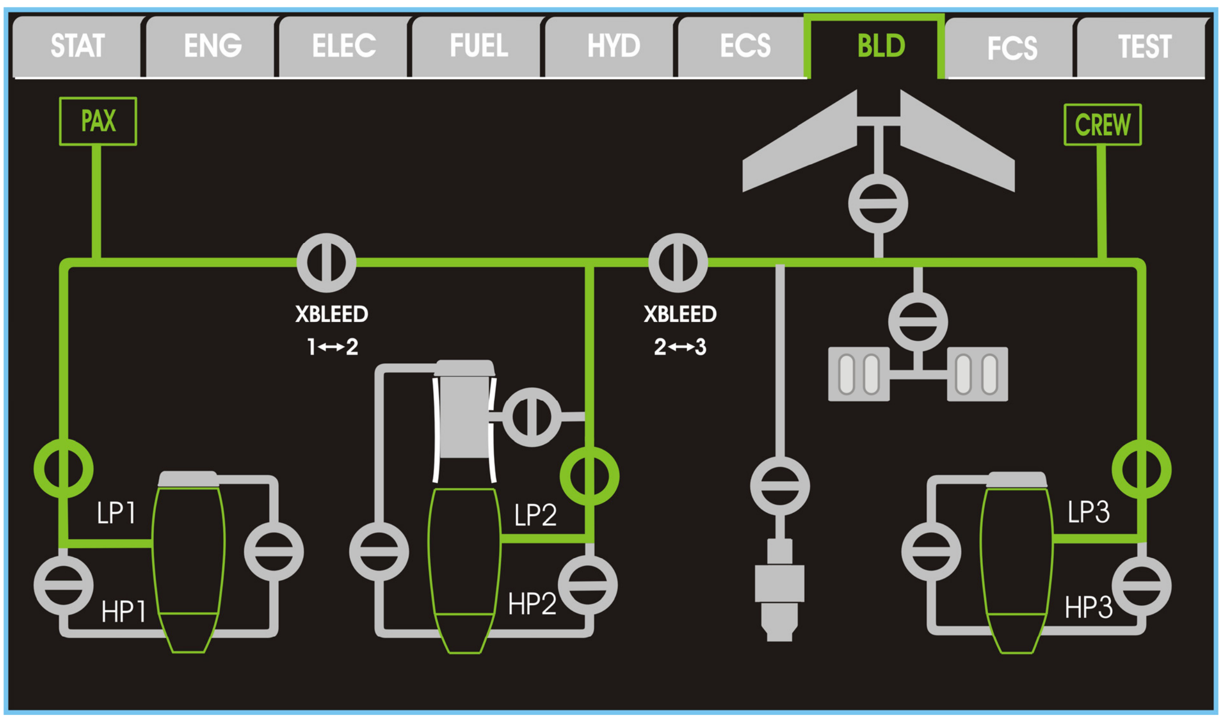


FIGURE 02-30_20-01 - ENGINES ANTI-ICE, S-DUCT ANTI-ICE, WINGS ANTI ICE AND BRAKES HEAT SYSTEM OFF

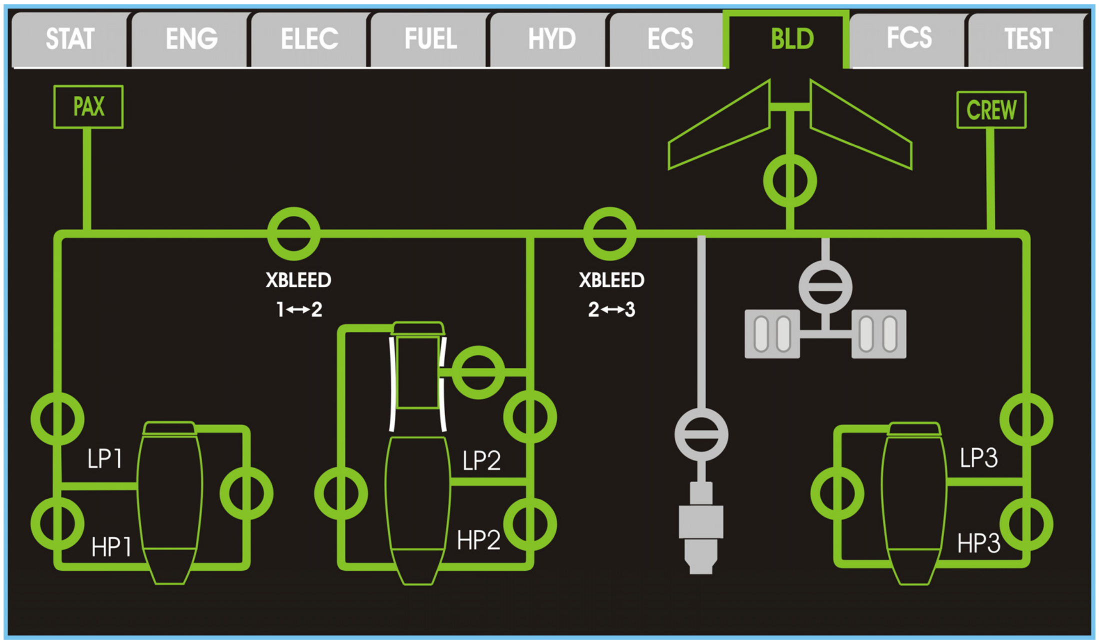
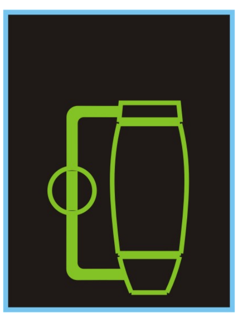
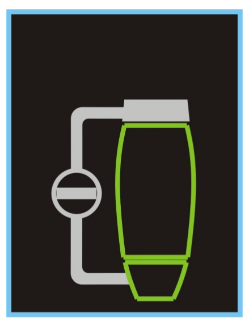


FIGURE 02-30_20-02 - ENGINES ANTI-ICE, S-DUCT ANTI-ICE, WINGS ANTI ICE AND BRAKES HEATING SYSTEM ON

ENGINE 1 and 3 anti-icing symbols



Engine anti-icing command ON



Engine anti-icing command OFF

Engine stopped

LOW PRESSURE

Engine anti-icing command ON and low pressure

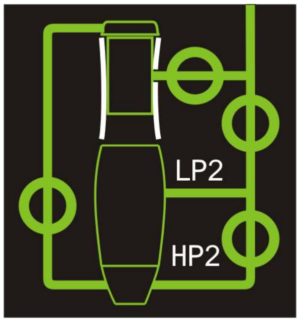
High PRESSURE

Engine anti-icing command ON and high pressure

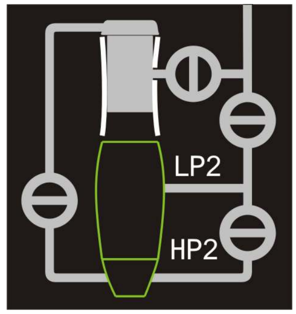
RESIDUAL PRESSURE

Engine anti-icing command OFF and residual pressure

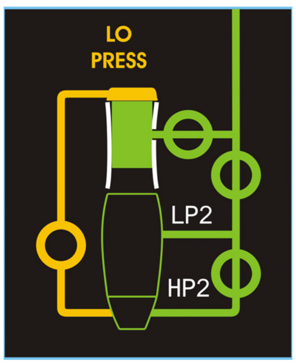
ENGINE 2 and S-DUCT anti-icing symbols



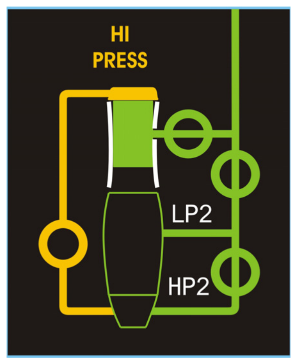
Engine 2 anti-icing
command ON



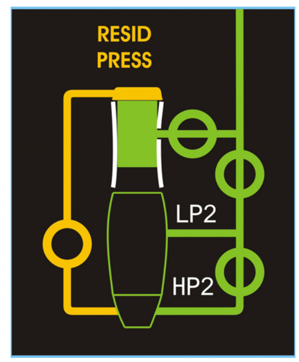
Engine 2 anti-icing
command OFF



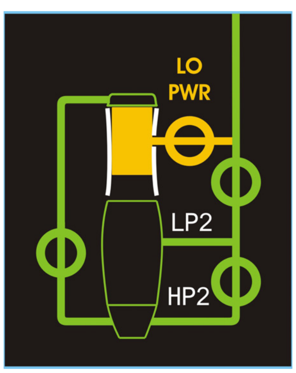
Engine 2 anti-icing command
ON with low pressure



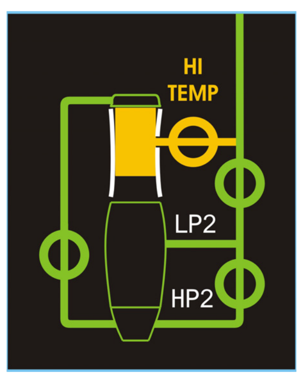
Engine 2 anti-icing command
ON with high pressure



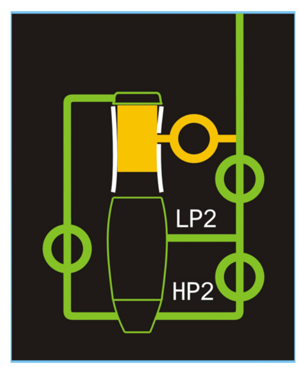
Engine 2 anti-icing
command OFF with engine
2 residual pressure



Engine 2 anti-icing ON with
S-duct low power

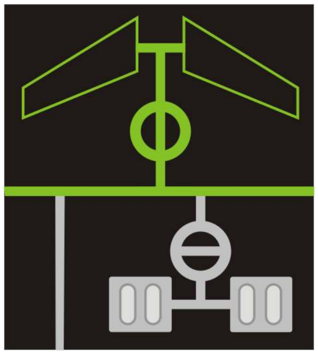


Engine 2 anti-icing ON with
S-duct high temperature

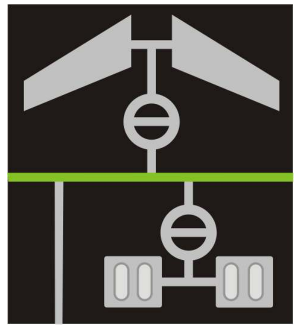


Engine anti-icing ON
with S-duct valve
in abnormal position

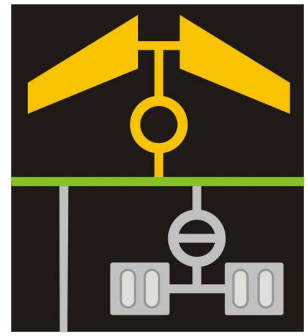
WINGS anti-icing symbol



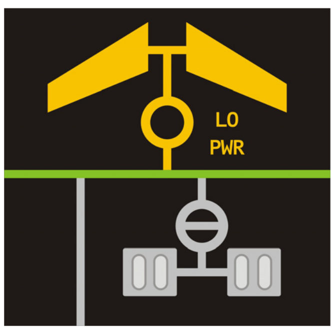
Wing anti-icing command AUTO (wing anti-iced)



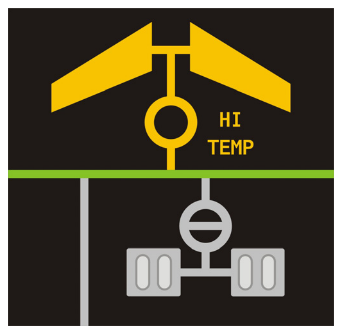
Wing anti-icing command OFF



Wing anti-icing ON with valve in abnormal position

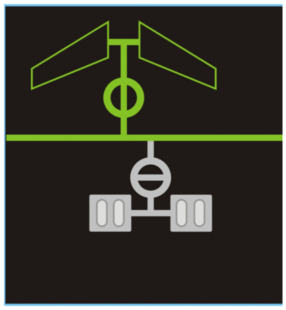


Wing anti-icing command ON and low power

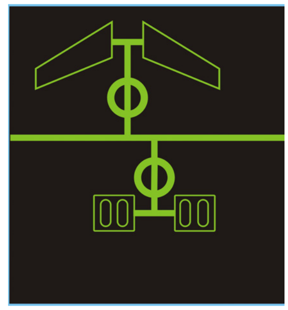


Wing anti-icing command ON and high temperature

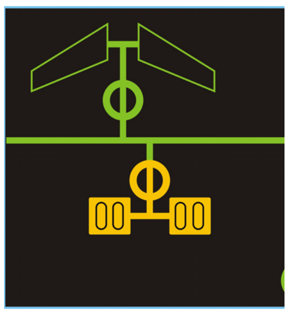
BRAKES anti-icing symbol (option)



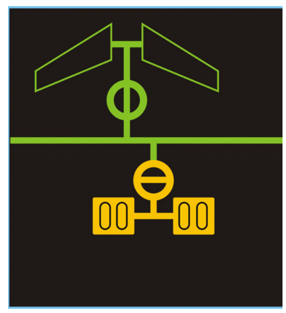
Brake heating Off



Brake heating On



Brake heating failure with brake heating On



Brake heating failure with brake heating Off

ENG-CAS WINDOW MINIMUM N1

The minimum engine N1 required for correct operation of the wings anti-ice system is represented by an amber tick mark (the N1 arc below this tick mark is amber).

It is only displayed with the WINGS pushbutton on ON or ST-BY.

With Engine N1 above N1 mini, the N1 needle is green,

With Engine N1 below N1 mini, the N1 needle is amber.

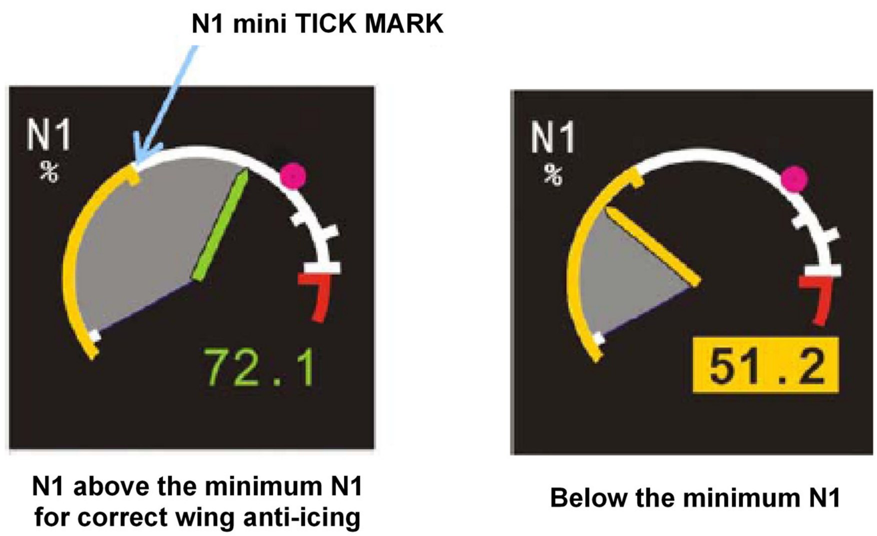


FIGURE 02-30_3-20-03 - MINIMUM N1 FOR WINGS ANTI ICE SYSTEM

CONTROLS AND INDICATIONS

ENGINE ANTI-ICE SYSTEM

When the engine anti icing is activated, the FADEC receives the information relative to the selection pushbutton position via ARINC 429 data bus between MAU and FADEC, and uses the information to apply the required corrections in the thrust setting logic.

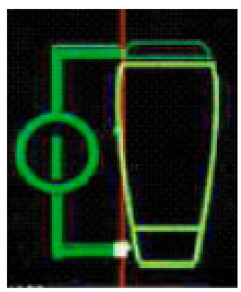
A pressure sensor allows the monitoring of system operation and fault detection by sending the pressure information downstream of the PRSOV to the MAU.

The logic within the MAU allows to monitor the PRSOV operation, ducting and anti icing pressure sensor allows to monitor the PRSOV operation, ducting and anti icing pressure sensor integrity by comparison with other pressure signals provided by the FADEC.

Anti ice system is ON

The solenoid within the PRSOV is energized and opens the PRSOV.

If the static pressure downstream of the PRSOV is between a lower and an upper limit (computed by the FADEC) the synoptic display shows a green flow line symbol and an open green valve symbol:



If the static pressure downstream of the PRSOV is below the lower limit of the system logic, the synoptic display an amber flow line and an amber valve symbol without valve position and the corresponding **A/I: ENG .. LO PRESS** message is displayed in CAS area.

This indication means the pressure is lower than the minimum required for operation within design limits, or PRSOV is failed closed and there is no anti icing protection:

If the static pressure downstream of the PRSOV is above the upper limit of the system logic, the synoptic displays an amber flow line and an amber valve symbol without valve position and the corresponding **A/I: ENG .. HI PRESS** message is displayed in CAS area.

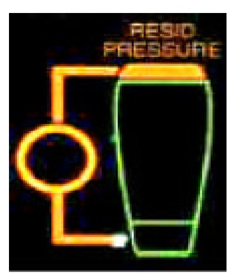
The PRSOV is failed open and the valve is not regulating the anti icing flow:

Anti ice system is Off

The solenoid within the PRSOV is not energized and the PRSOV is closed.

If the static pressure downstream of the PRSOV is less than the lower limit, below a threshold providing confidence that the valve is closed, the synoptic displays a grey flow line symbol and a closed grey valve symbol, with the meaning that anti icing is closed.

If the static pressure downstream of the PRSOV is greater than the residual pressure limit (mentioned above) (Pamb+5 psia) the synoptic display shows an amber flow line and an amber valve symbol without valve position and the corresponding **A/I: ENG .. RESID PRESS** message is displayed in CAS area. The PRSOV is not closed properly.



S-DUCT ANTI ICE SYSTEM

S-DUCT A/I TCV temperature control valve AMSAC

The parameters used by the AMSAC for S-duct A/I TCV control are as follows:

- Input :
  - S-duct A/I command (ON/STBY/Off) from the Overhead Panel
  - Two S-duct skin temperatures from both temperature sensors sensitive parts linked to the AMSAC
  - Two S-duct skin temperatures from both temperature sensor sensitive parts linked to the MAU (by the ARINC 429 bus)
  - CLOSED / NOT CLOSED discrete information of the S-duct A/I TCV
  - One pressure sensor located downstream of the S-duct A/I TCV
  - Ps, Ts, Mach number, N1 of each engine and slat position transmitted by the ARINC 429 BUS
- Output :
  - Order for the S-duct A/I TCV to maintain a skin temperature of:
    - 44°c +/- 2.5°c if TAT > -20°c
    - 50°c +/- 2.5°c if TAT ≤ -20°c

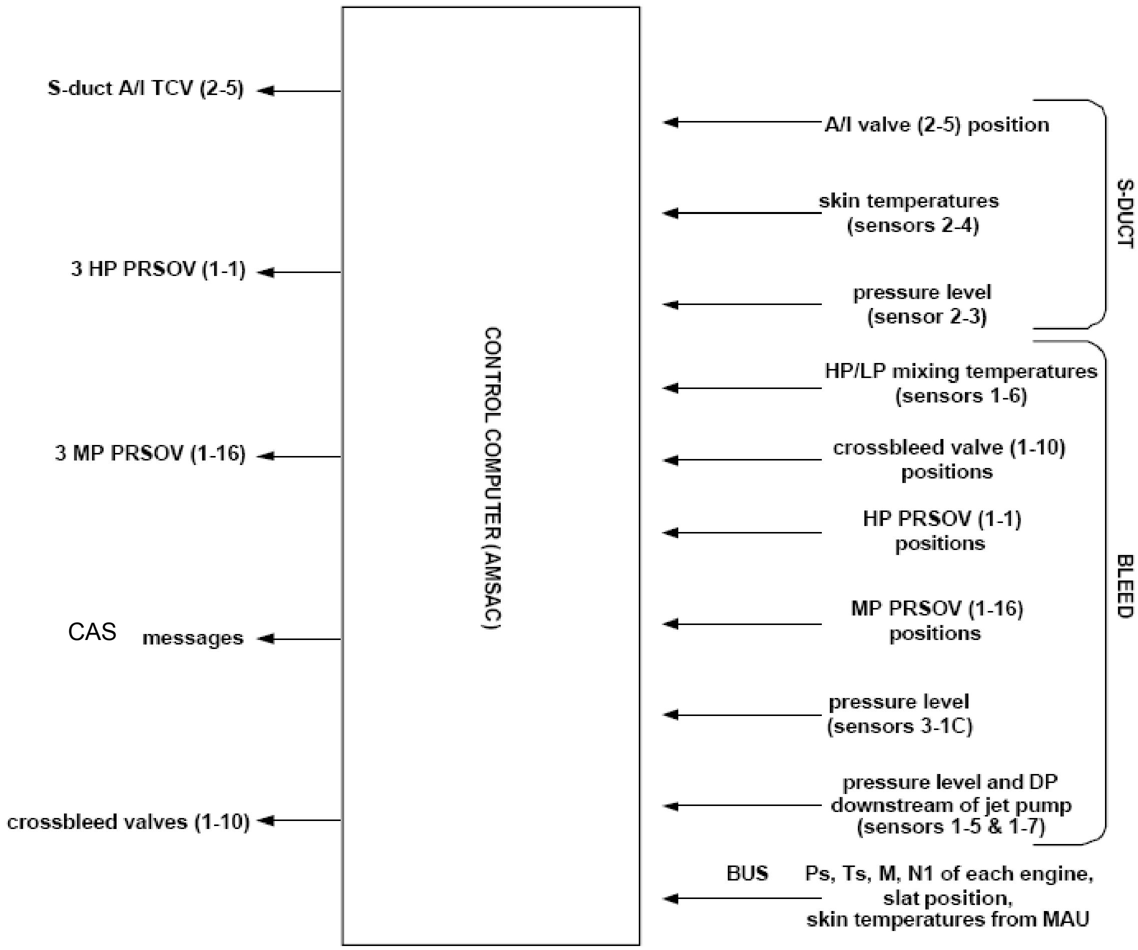


FIGURE 02-30_3-25-00 - AMSAC INPUT/OUTPUT PARAMETERS

S-DUCT A/I TCV TEMPERATURE CONTROL VALVE MONITORING

Concerning the skin temperature monitoring, skin temperatures are provided by both dual bead sensors.

The skin temperature sensor 1 is used for the low power monitoring.

The skin temperature sensor 2 is used for the overheat monitoring.

On ground and in flight, the controller checks the difference between the sensitive part linked to the AMSAC and the sensitive part linked to the MAU for the same sensor).

If this difference is greater than 6°C, the controller considers the sensor in failure; a maintenance message is sent: "A/I: S-duct skin temperature sensor (i) failed".

If the sensor 1 is registered in failure, the low power monitoring is done using the minimum temperature measurement between both sensitive parts.

This sensor is also considered in failure if one of both sensitive parts gives a temperature out of range.

If the temperature measured by the sensor 1 sensitive part linked to the MAU is out of range, the low power monitoring is done by the sensitive part linked to the AMSAC.

If the temperatures measured by both sensor 1 sensitive parts are out of range, the low power monitoring is done by the sensor 2 sensitive part linked to the MAU.

If the sensor 2 is registered in failure, the overheat monitoring is done using the maximum temperature measurement between both sensitive parts.

If the temperature measured by the sensor 2 sensitive part linked to the MAU is out of range, the overheat monitoring is done by the sensitive part linked to the AMSAC.

If the temperatures measured by both sensor 2 sensitive parts are out of range, the overheat monitoring is lost.

On ground only, the following checklist message “A/I: S-duct skin temperature sensors failed” warns the pilot when a skin temperature sensor is registered in failure.

The failure must be registered by a maintenance message too.

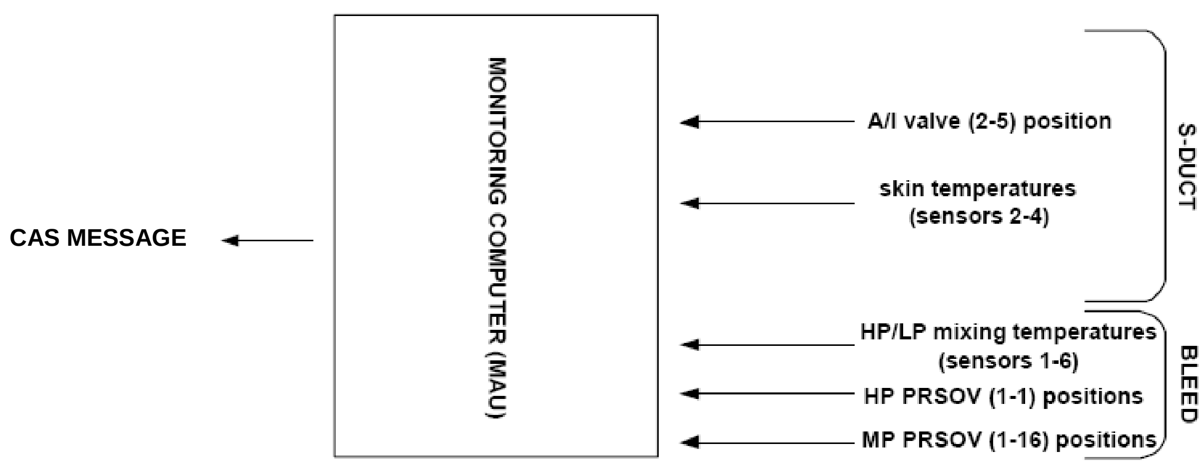


FIGURE 02-30_3-25-01 - MAU MONITORING

WINGS ANTI ICE MONITORING

The parameters for the MAU controller are the following:

- Input: NO CLOSE/CLOSE discrete information of wings A/I TCV, two slats skin temperatures from temperature sensors sensitive part linked to MAU. Theses temperature sensors (2-4) have dual beads and are installed on outboard slat queue for each inboard slat, Ps, Ts, Mach number, three engine N1, slats position and the flap / slat lever Position, wings leakage detection.
- Output: CAS messages.

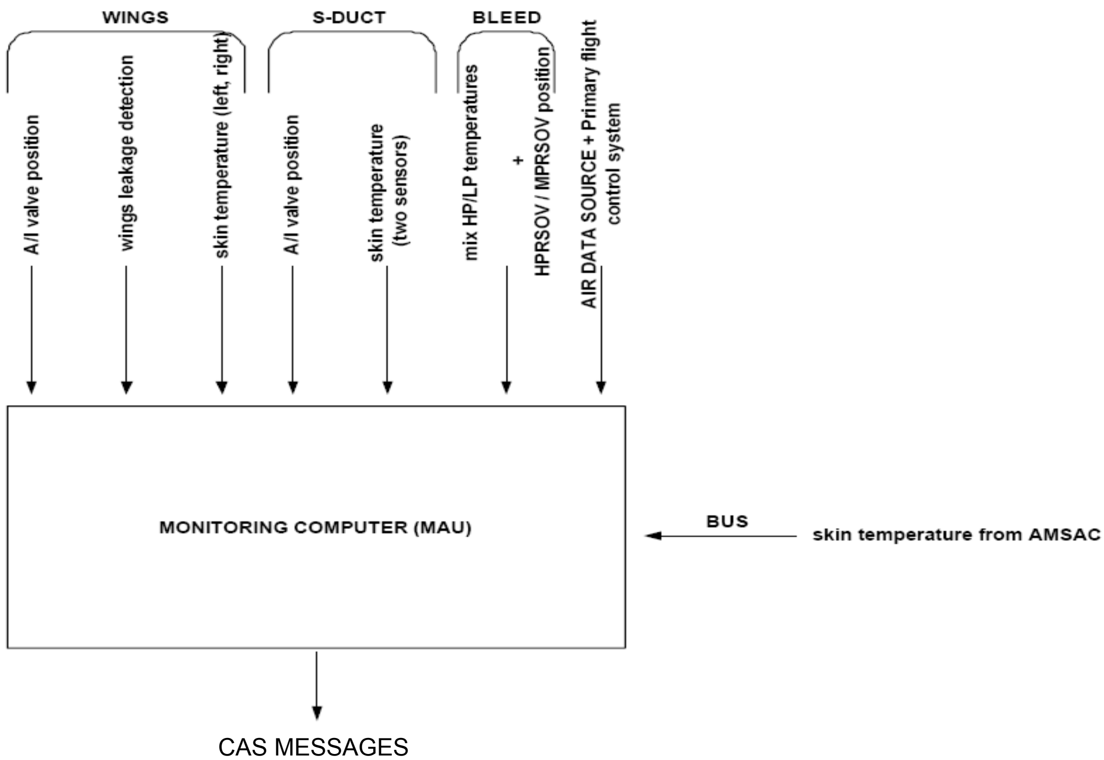


FIGURE 02-30_3-25-02 - MAU MONITORED PARAMETERS FOR CAS MESSAGES

ENGINE ANTI ICE SYSTEM PROTECTIONS

SYSTEM MONITORING

The following parameters are monitored:
- Loss of nacelle anti icing pressure monitoring,
- Anti ice pressure under or over limits,
- Residual pressure high with nacelle anti icing OFF,
- Nacelle Anti-icing On with TAT ≥ 10°C.

➢ *Refer to CODDE 2 for a complete list of CAS messages.*

ACTIVE PROTECTIONS

Active protection consists of:
- The pressure regulating shut off valve which regulate and limit airflow pressure,
- The side engines flow limiter (Venturi) which limit the airflow in the event of a duct burst.

NOTE

The Engine FADEC receives the nacelle anti icing selection status to avoid engine ITT exceedance with respect to the rating when anti icing is selected.

S-DUCT ANTI ICE SYSTEM PROTECTIONS

SYSTEM MONITORING

The following parameters are monitored:

- Skin temperature,
- Anti-ice pressure,
- Temperature control valve failure,
- Temperature sensor failure,
- S-duct anti-icing On with TAT ≥ 10°C.

➢ *Refer to CODDE 2 for a complete list of CAS messages.*

ACTIVE PROTECTIONS

Active protection consists of:

- The S-duct temperature control valve which controls and limits the airflow (skin Temperature regulation).

NOTE

In case of loss of electrical power, the valve remains in the last position

WING ANTI ICE SYSTEM PROTECTIONS

SYSTEM MONITORING

The following parameters are monitored:

- Anti-ice pressure,
- Anti-ice temperature,
- Leak in the wings,
- System sensors failure (temperature , pressure),
- Wing anti-icing On with TAT ≥ 10°C.

➢ *Refer to CODDE 2 for a complete list of CAS messages.*

ACTIVE PROTECTIONS

Active protection consists of:

- The wing temperature control valve which regulates and limit the airflow in accordance with the slats skin temperature.

NOTE

In case of loss of electrical power, the valve remains in the last position.

BRAKES ANTI-ICE

SYSTEM MONITORING

The following parameters are monitored:

- Air Management Module 1 failure,
- Brakes valve position no corresponding to command in case of:
  - Brakes valve failure,
  - ECS Emergency mode with brakes command ON.

➢ *Refer to CODDE 2 for a complete list of CAS messages.*

ACTIVE PROTECTIONS

Bleed air is mixed with ambient air in order to limit brakes compartment overheating.

ENGINES

- *Refer to SUPPLEMENTARY INFORMATION Controls and INDICATIONS for detailed system protections*

ENG2 S-DUCT

S-DUCT A/I VALVE TCV LOSS

In case of controller failure, the privileged position of the S-duct A/I valve TCV is the last position.

If the valve is jammed open or closed, the pilot is warned by **A/I: SDUCT FAULT** CAS message and therefore he switches the “ENG 2” pushbutton on the Overhead Panel to the “STBY” mode. If the CAS message still remains, the pilot avoids or leaves the icing condition.

SKIN TEMPERATURE SENSOR LOSS

On ground and in flight, the controller checks the difference between the sensitive part linked to the AMSAC and the sensitive part linked to the MAU for the same sensor.

If this difference is greater than 6°C, the controller considers the sensor in failure; a maintenance message is sent: “A/I: S-duct skin temperature sensor (i) failed”. The sensor is also considered in failure if one of both sensitive parts gives a temperature out of range.

If the temperature measured by the sensor 1 sensitive part linked to the AMSAC is registered in failure, the S-duct temperature control is done by the sensor 2 sensitive part linked to the AMSAC. In that case, the skin temperature measured by the sensor 2 is regulated at:

- 57°c with TAT > -20°c
- 69°c with TAT ≤ -20°c

On ground only, the **A/I: S-DUCT TEMP SENS FAIL** CAS message warns the pilot when a skin temperature sensor (2-4) is registered in failure.

PRESSURE SENSOR LOSS

If the pressure measured through the pressure sensor is greater than 3.5 bars during 10 seconds consecutively, an overpressure maintenance message is sent.

If the pressure is out of range, a maintenance message is sent: "A/I: S-duct pressure sensor failed".

If the pressure sensor failed, the pressure given by the MP PRSOV is suitable for the system and the S-duct A/I TCV regulates the temperature without pressure limitation.

ANTI-ICE FUNCTIONS PRIORITY FOR AMSAC

The A/I system functions priority managed by the AMSAC is the following:

- 1. HP/LP mix bleed temperature limitation
- 2. A/I pressure level limitation
- 3. Skin temperature regulation
- 4. HP bleed minimization
- 5. Bleed flow balancing

S-DUCT INSUFFICIENT POWER

When the temperature measured by the sensor 1 is lower than Tlow1 (see table hereafter), during more than 30 seconds consecutively below the altitude of 22,000 ft and during more than 1 minute consecutively above the altitude of 22,000 ft, the following CAS message **A/I: S-DUCT LO PWR**

The low power threshold is function of the total air temperature and is linearly interpolated from the following table (nominal value with a ± 2.5°C tolerance):

TAT (°C)	-40	-30	-20	-15	-10	-5	0	5	10
Tlow1 (°C)	41	37	31	26	19	15	10	12	21

In case of loss of the TAT value, the low1 threshold is 31°C.

If the temperatures measured by both sensor 1 sensitive parts are out of range, the low power monitoring is done by the sensor 2 sensitive part linked to the MAU. Then the warning threshold is Tlow2 (see table below) with the same logic as above.

TAT (°C)	-40	-30	-20	-15	-10	-5	0	5	10
Tlow2 (°C)	54	47	43	40	36	31	15	24	34

In case of loss of the TAT value, the Tlow2 threshold is 43°C.

To prevent an untimely message being displayed after the selection of the S-duct A/I, the **A/I: S-DUCT LO PWR** CAS message has a time lag of:

- 5 minutes after the first “ICEx” label has occurred on PDU if the S-duct A/I is put on in the meantime,
- 4 minutes after the selection of the S-duct A/I if it has been put on before an "ICEx" label occurs on PDU.

S-DUCT OVERHEAT:

If the sensor 2 measures a temperature greater than 72°C ± 2.5°C if TAT > -20°C or 84°C ± 2.5°C if TAT ≤ -20°C during more than 15 seconds consecutively and the S-duct A/I TCV is not closed, the following CAS message **A/I: S-DUCT HI TEMP** is displayed.

In case of loss of the TAT value, the overheat threshold is 84°C ± 2.5°C.

WING ANTI-ICE

No supplementary information to be provided on wing anti-ice protection at present time.

No information to be provided on ground operation at present time.

- *Refer to Ground Servicing Manual.*