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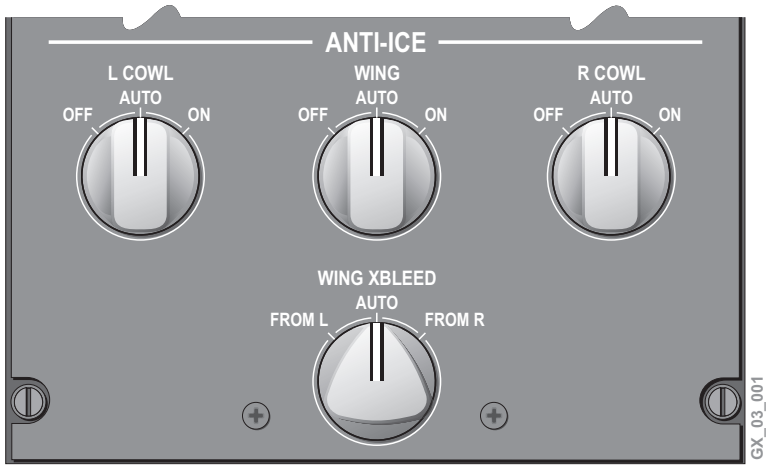
INTRODUCTION

The Global incorporates a fully automatic system for ice and rain protection. It will recognize icing conditions and alert the appropriate Bleed Management Controllers. The BMCs will then activate the wing anti-ice systems and alert the stall protection system. The ice detection system will operate a relay in the anti-ice control panel to activate cowl anti-ice. The system will also recognize single-engine conditions or system failures and configure all appropriate valves to ensure sufficient heat for anti-icing. All systems can also be activated manually. Built-in initiated tests are continuously monitoring the system.

GENERAL

Thermal anti-icing, electrical anti-icing, and ice detection and alerting systems are provided for airplane ice and rain protection. Selections for anti-ice functions are made on the ANTI-ICE panel located on the overhead panel.



ICE DETECTION

Independent ice detection probes (2), located on the fuselage, sense the formation of ice. If ice is detected, the ice detectors automatically turn on the electrical heat to the ice detection probe and signal the Bleed Management Controllers to activate wing anti-ice. The ice detection system will operate a relay in the ANTI-ICE Control panel to activate cowl anti-ice.

PNEUMATIC ANTI-ICING

Hot air anti-icing provided by engine bleed air prevents the formation of ice on the wing leading edge, slats and the engine intake cowls.

ELECTRICAL ANTI-ICING

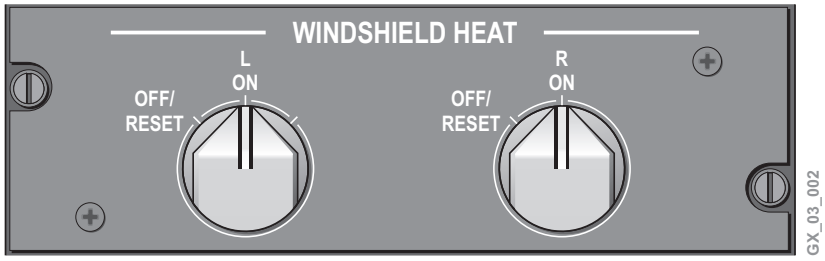
Electrical anti-icing is provided for Pitot Static Probes, Ice Detectors, Total Air Temperature (TAT) Probes, Heater/Brake Temperature Monitoring Units (HBMUs) and Angle of Attack (AOA) Vanes.

The heaters are automatically turned ON after engine start.

NOTE

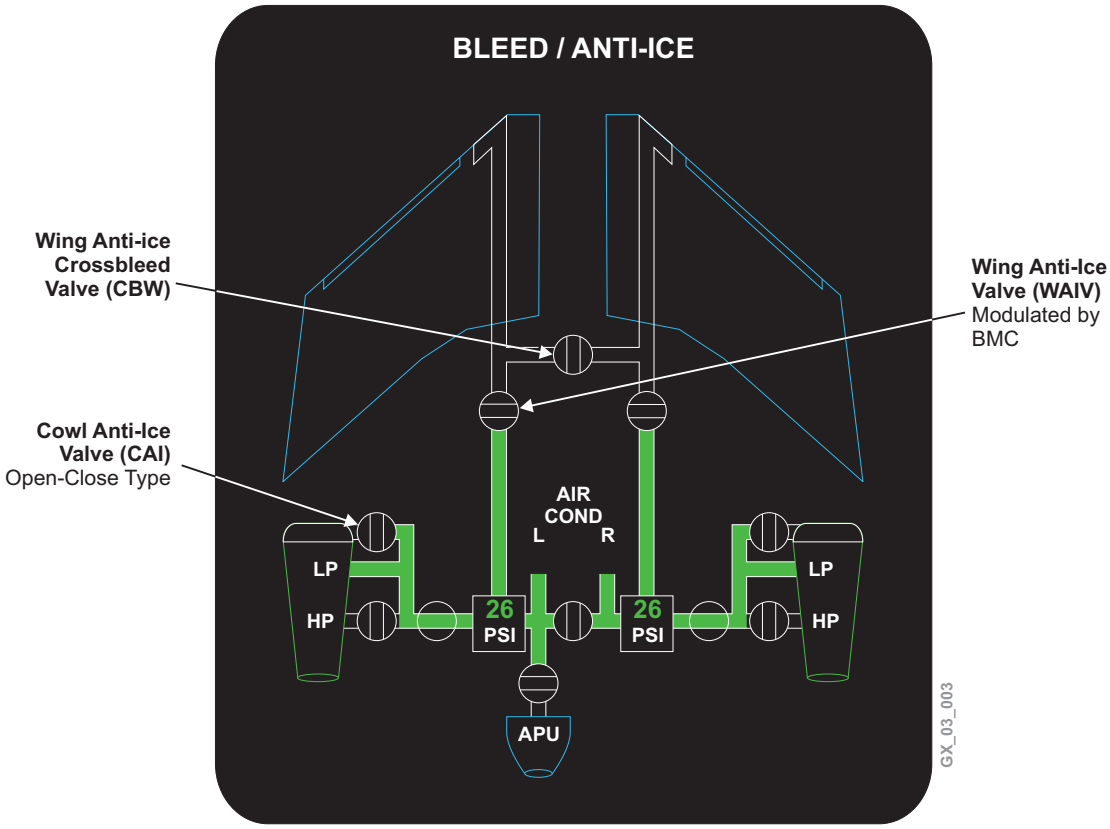
All heaters are tested ON when AC power is applied. It is recommended to remove all probe covers prior to starting APU or connecting external power.

Selections for the Pilot's and Copilot's Windshield and Side Window heating are made on the WINDSHIELD HEAT panel located on the overhead panel.



Anti-ice system data is displayed on the BLEED/ANTI-ICE synoptic page and any faults or failures are displayed on the EICAS and recorded by the CAIMS.

BLEED/ANTI-ICE SYNOPTIC

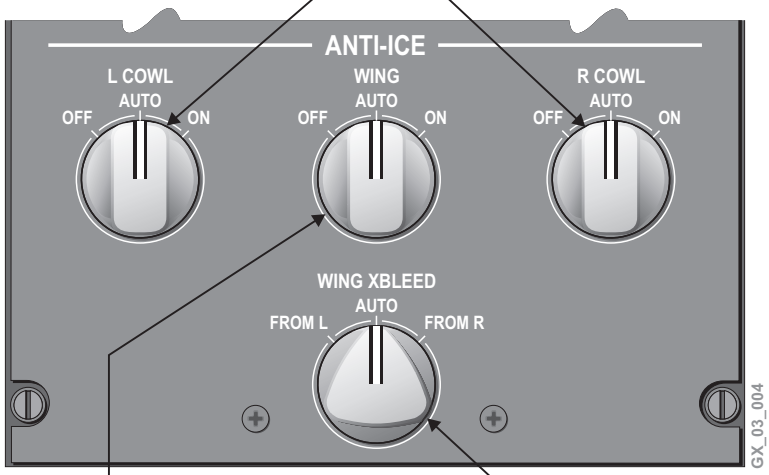


For more information on BLEED System, refer to Chapter 13, IAMS.

ANTI-ICE PANEL

Controls are provided on the ANTI-ICE panel located on the overhead panel.

L & R COWL Selectors
• **OFF** – Disarms the cowl anti-ice system and closes the associated valves.
• **AUTO** – Arms the cowl anti-ice system to enable automatic operation when ice is detected.
• **ON** – Activates cowl anti-ice system independently of ice detector signals.



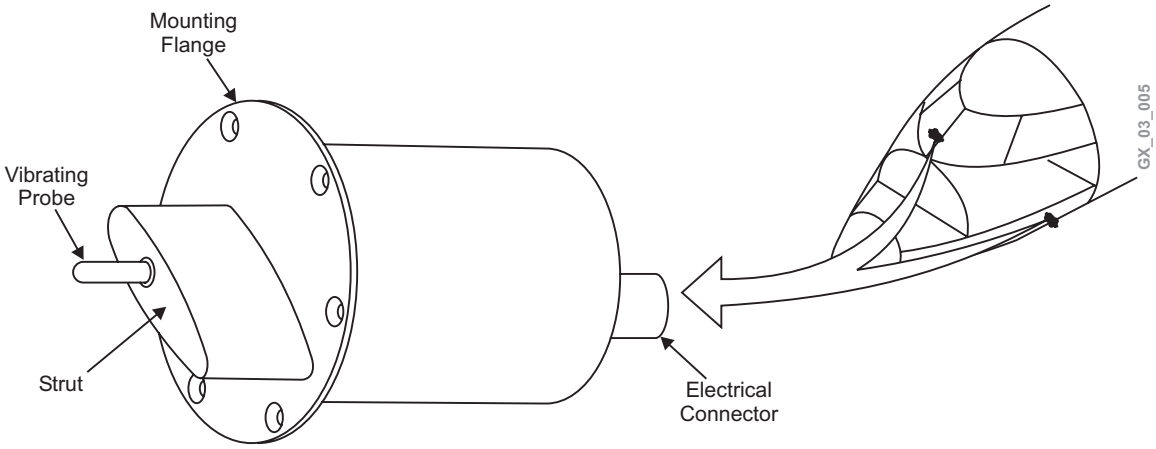
WING Selector
• **OFF** – Disarms the wing anti-ice system and closes the associated valves.
• **AUTO** – Arms the wing anti-ice system to enable automatic operation when ice is detected. System inhibited on the ground until 400 feet above field elevation.
• **ON** – Activates wing anti-ice system independently of ice detector signals.

WING XBLEED Selector
• **FROM L** – Closes the RH WAIV and opens the CBW independently of the BMC.
• **AUTO** – Arms the CBW to enable automatic opening by the BMC in the event of a failure in one WAIV.
• **FROM R** – Closes the LH WAIV and opens the CBW independently of the BMC.

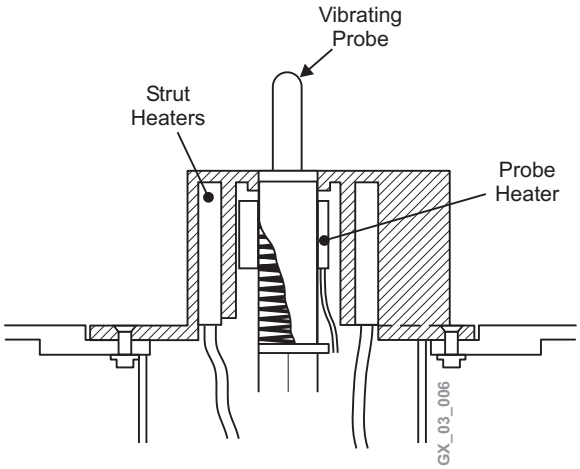
DESCRIPTION

ICE DETECTION

The airplane is fitted with two ice detectors, one on each side of the front fuselage.



The ice detector incorporates a vibrating probe that maintains a preset frequency (40 kHz) to detect icing conditions. As the ice detector enters an icing environment, ice collects on the vibrating probe. The added mass of ice causes the frequency of the probe to decrease. A 0.010 inch thickness of ice equals a 65 Hz decrease and immediately the ice detector de-ices the strut and the probe through internal heaters. Heater power is applied until the frequency rises to a predetermined level, plus a time delay factor (60+/-5 seconds) to ensure complete de-icing. If an additional icing/de-icing cycle occurs during that time interval, the 60 seconds cowl and wing anti-ice activation period is begun again.



SECTIONAL VIEW

The Ice detectors emit icing signals to the following:

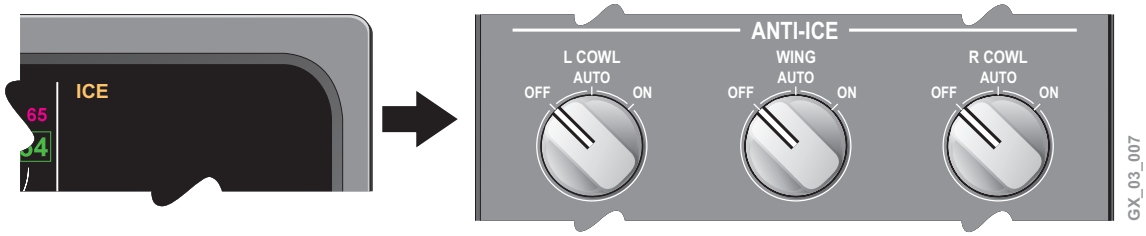
- Anti-Ice panel (cowl anti-ice relay) for activation of the cowl anti-icing system (AUTO)
- BMC for activation of the wing anti-icing system (AUTO). The AUTO operation of WING ANTI-ICE is inhibited during takeoff until the airplane is > 400 feet above field elevation
- Stall protection system, to change stick shaker control. Stick shaker control will only be adjusted if an ice detector has failed and icing is detected. For more information on Stall Protection, refer to Chapter 10, FLIGHT CONTROLS

Once de-iced, the probe cools within a few seconds and is ready to sense ice build-up again. This cycling process is repeated as long as the ice detector remains in an icing environment.

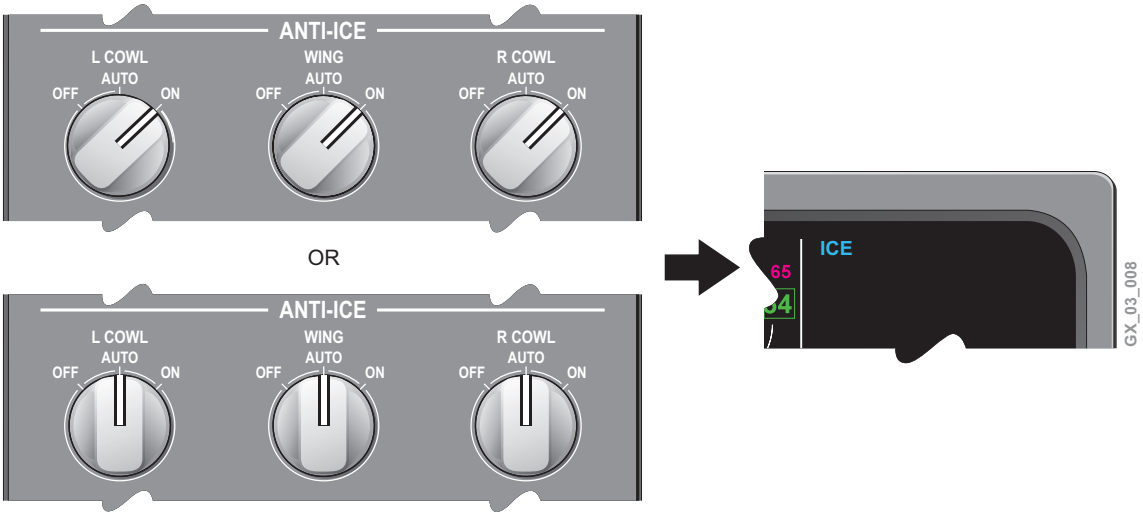
The ice detection system will detect and indicate icing when the airplane is on the ground. However due to the sensitivity of the ice detector probes, the ice detection system should be considered ineffective at airspeeds less than 30 knots IAS.

ICE DETECTION INDICATION

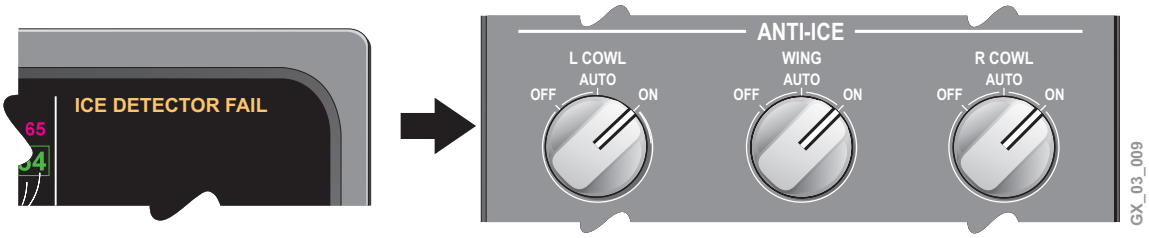
If ice is detected while the ANTI-ICE system is turned OFF, a caution message is displayed on EICAS.



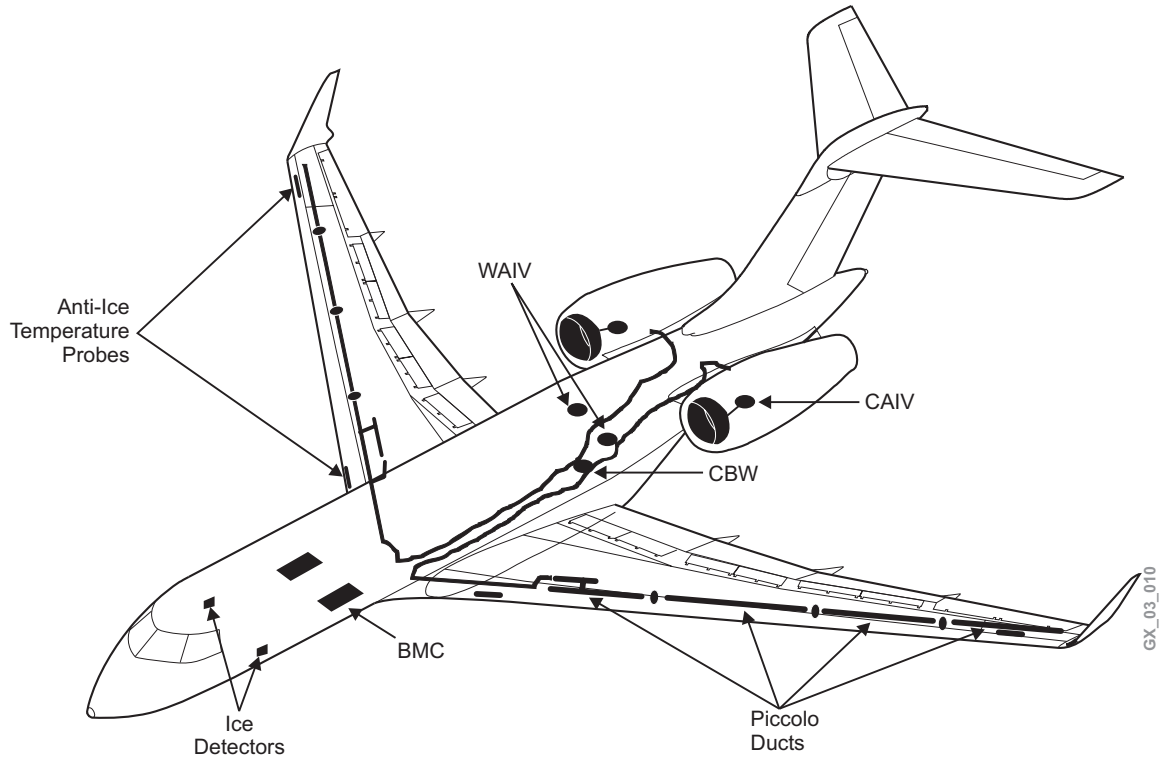
If ice is detected while the ANTI-ICE system is turned ON or AUTO, the following advisory message is displayed on EICAS.



If both ice detectors have failed, a caution message is displayed on the EICAS. The crew must revert to manual selection of cowl and wing anti-ice.



COMPONENTS


Anti-Ice
Temperature
Probes
WAIV
CAIV
CBW
BMC
Ice
Detectors
Piccolo
Ducts
GX_03_010

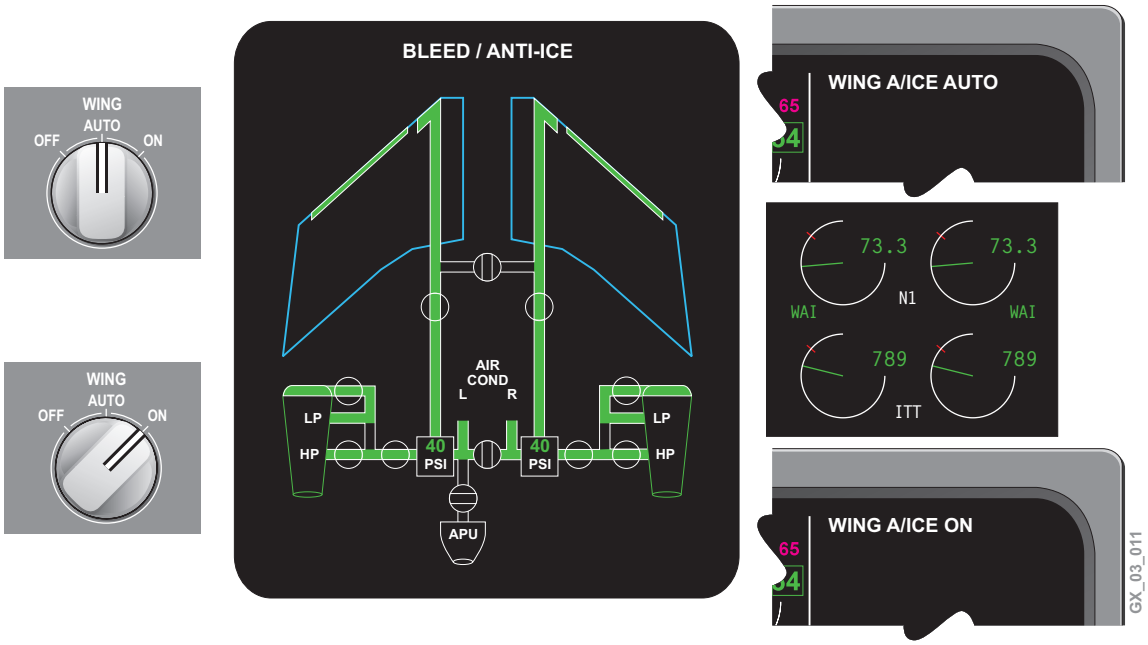
WING ANTI-ICE VALVE (WAIV)

Two wing anti-ice valves are electrically controlled, pneumatically operated, spring loaded closed, modulating shutoff valves. The ice detector system will send a signal to the BMC to activate the wing anti-ice system.

One temperature sensor, located in the fixed leading edge, provides a signal to the control channel of the BMC which drives the WAIVs open or closed. A second temperature sensor, located in the fixed leading edge, provides a signal to a monitoring channel in the BMC. One channel controls while the other channel acts as a monitor which can assume control in the event of a failure of the first sensor. In the event of complete failure of the sensors on one side the serviceable control sensor on the opposite side will control the WAIVs.

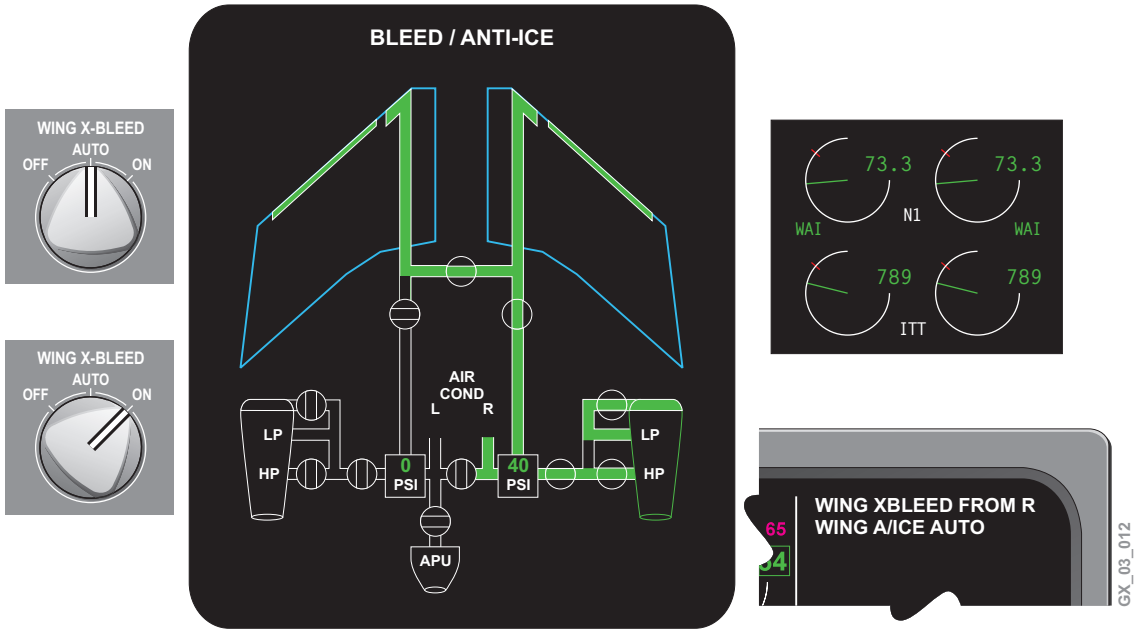
WAI OPERATION

When selected to AUTO, the ice detectors will send a signal to the BMC to activate the wing anti-ice system. Wing anti-ice can be manually selected to ON in which case the WAIVs will open independently of the ice detection system. Whenever wing anti-ice is activated (AUTO or ON), a WAI icon will be displayed on the EICAS page. The ICON color will vary from amber, green, or white, depending on the temperature in the wing or its status.



WING CROSS BLEED VALVE (CBW)

The left and right hand anti-ice systems normally operate independently. In the event of a single engine failure, bleed failure, or a failure of wing anti-ice air supply on one side, the left and right systems are interconnected by a CBW. This allows both wings to be fed from a single engine. In the case of a failure in AUTO position, the CBW will automatically be opened and the affected WAIV will automatically be closed by the BMC. Manual operation of the CBW is provided on the ANTI-ICE panel.



SLAT ANTI-ICING

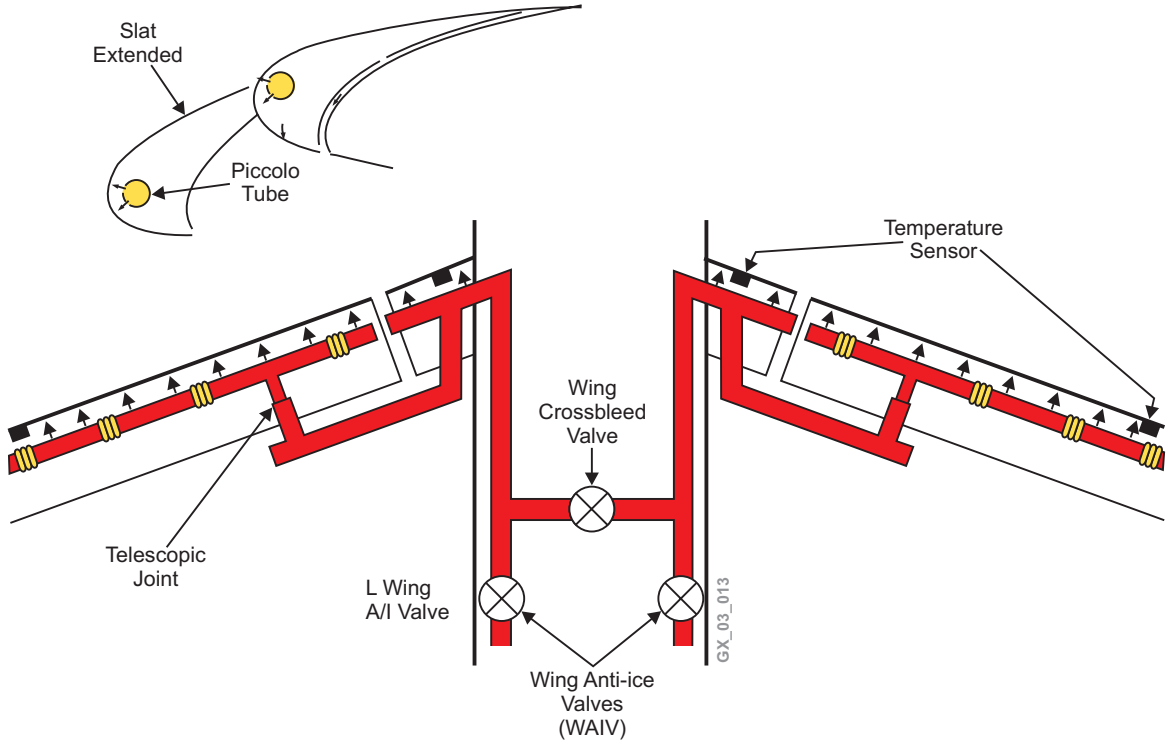
The sections of wing leading edge that are heated are as follows:

- Inboard fixed leading edge
- Slats 1, 2, 3 and 4

The short fixed leading edge section outboard of slat 4 on each wing, and the leading edge of the winglet are not heated.

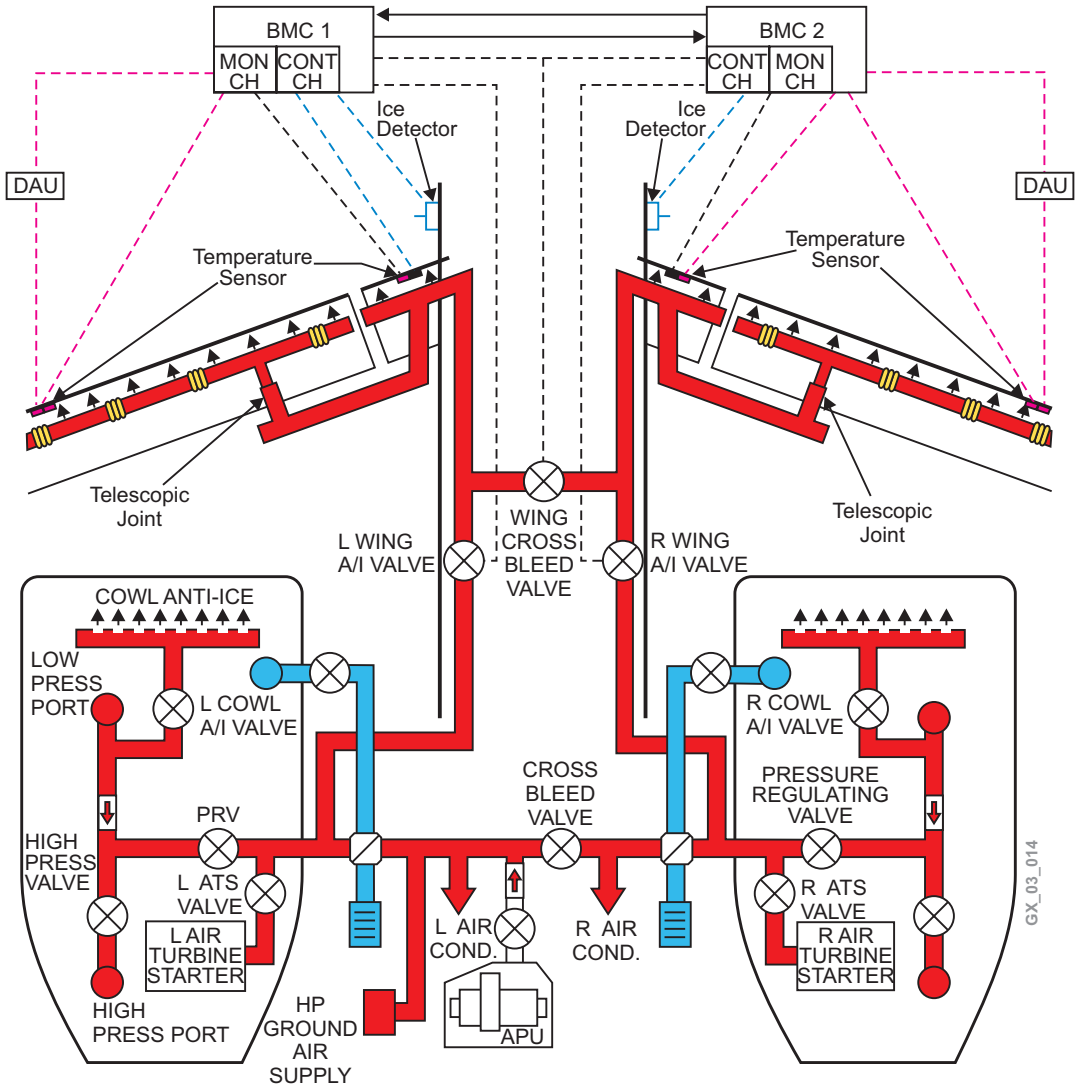
SLAT ANTI-ICE OPERATION

Air is ducted into the fixed section of the wing leading edge from the forward part of the wing root. From there it is directed into the wing leading edge slats via a telescopic duct which extends as the slats move to the extend position. Piccolo tubes in both inboard fixed leading edges and outboard in each slat distribute the air into the inside surface of the wing leading edge for ice protection. Air is then extracted overboard between the slat and the main wing.



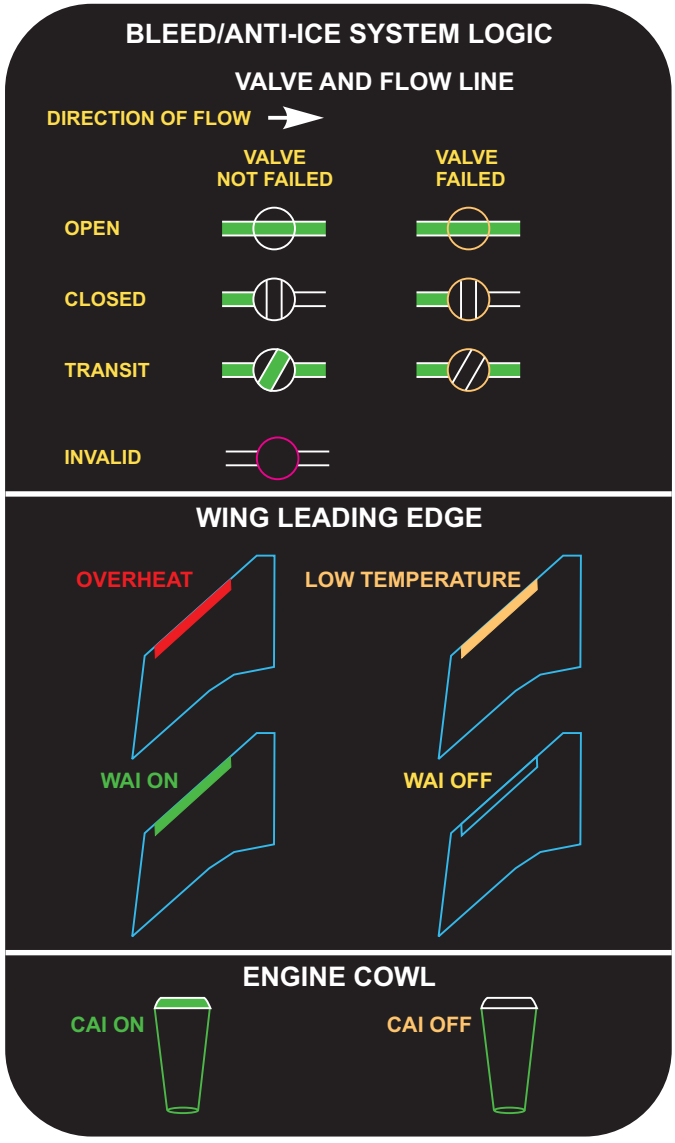
WING ANTI-ICING (WAI)

The wing anti-icing system is used to prevent formation of ice on the leading edge of the wing. The wing leading edge uses hot engine bleed air from either the 5th stage or the high pressure compressor 8th stage of the bleed air system.



EICAS PHILOSOPHY

The following represents the EICAS symbols and logic for the BLEED/ANTI-ICE synoptic page. The symbols are shown in serviceable and failure conditions.

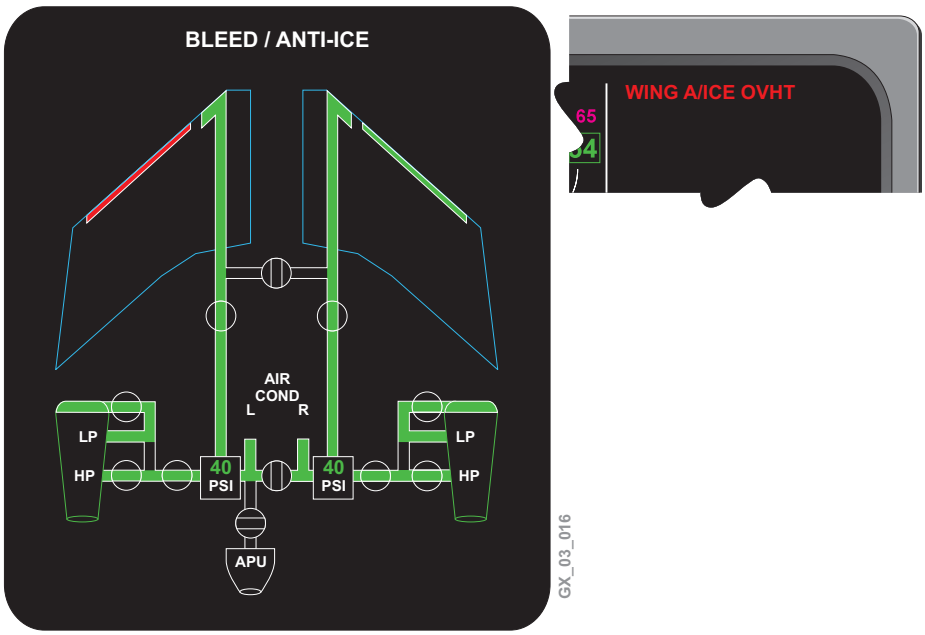


WAI FAILURE INDICATIONS

The WAI failure indications are as follows:

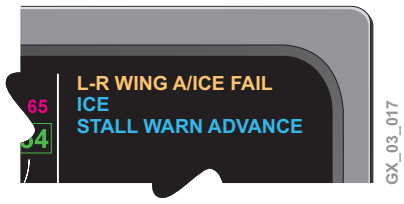
WING ANTI-ICE OVERHEAT

If there is an overheat in the wing anti-ice system, a message is displayed on the EICAS.



WING ANTI-ICE FAIL

If the wing anti-ice has failed, a message is displayed on the EICAS. If ice is detected during this failure condition, the stall warning trigger points are advanced automatically. Ensure rpm (N2) is above 76% prior to going to the QRH. Increasing rpm above 76% may fix this amber message.



NOTE

If ice is detected, the stall warning trigger points are advanced automatically. For more information on stall protection refer to Chapter 11, FLIGHT CONTROLS.

PNEUMATIC ANTI-ICING

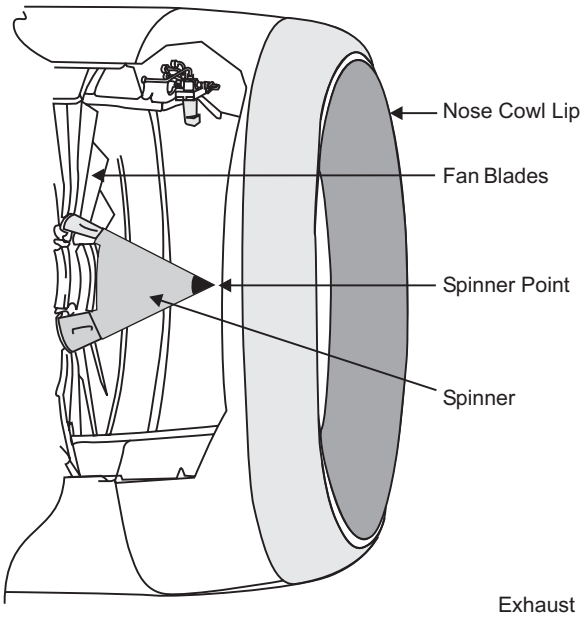
Engine bleed air is used for the pneumatic anti-icing systems.

COWL ANTI-ICING (CAI)

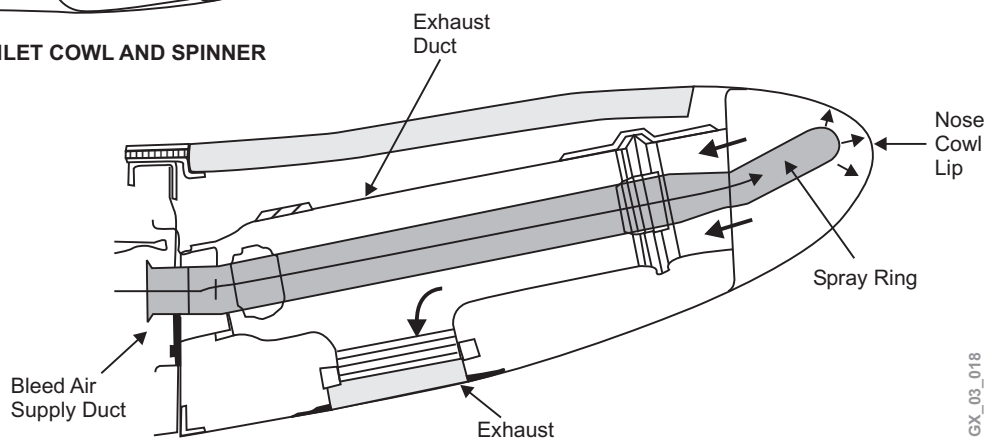
The cowl anti-icing system is used to prevent formation of ice on the nose cowl of the engine. The cowl leading edge uses hot engine bleed air from the low pressure port (5th stage) to heat the nose cowl. The bleed air is ducted through a spray ring and exhausts to the atmosphere through an exit grill.

ENGINE SPINNER

The engine spinner point is made of soft rubber which will distort during engine operation thus shedding any ice accumulation. The rear of the spinner and the fan blades use centrifugal force to prevent ice accumulation during engine operation.



AIR INLET COWL AND SPINNER

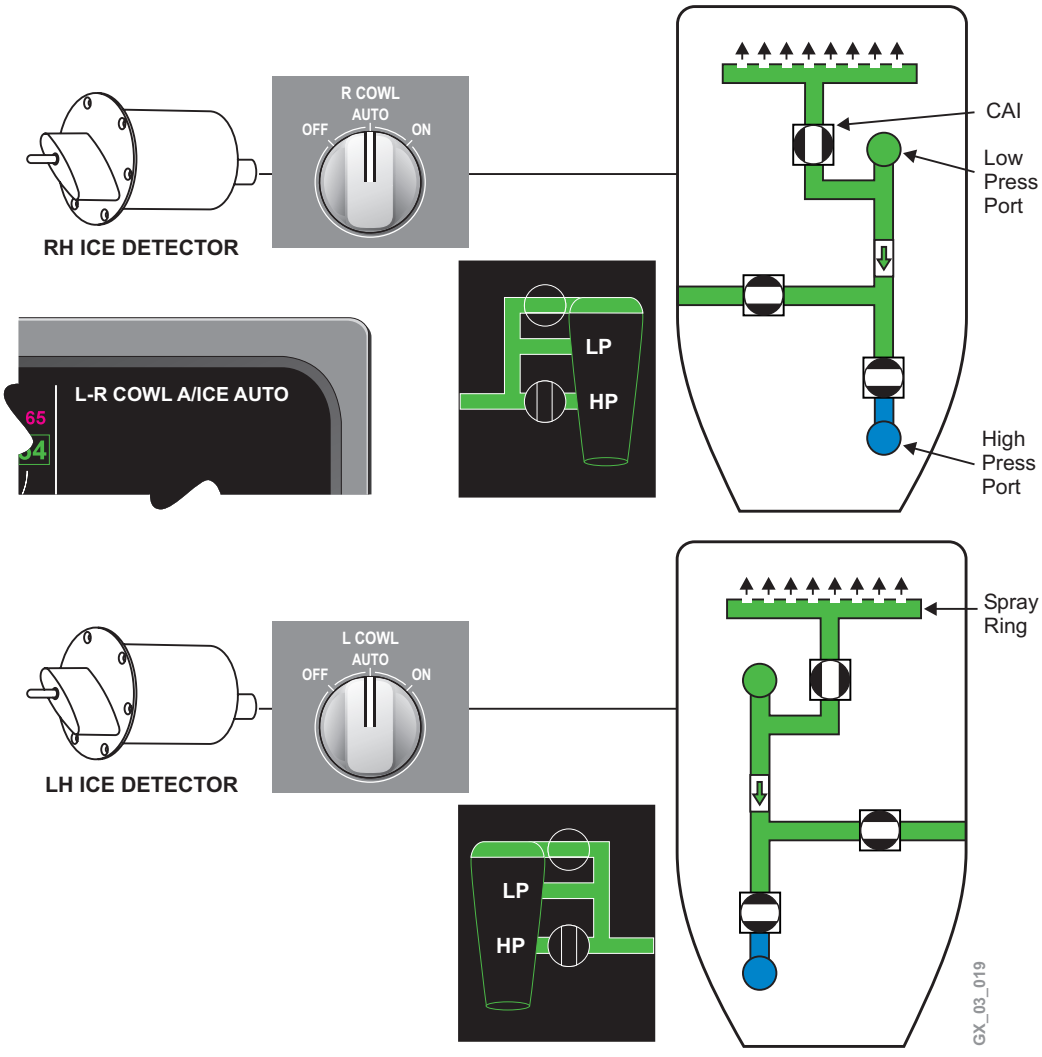


COWL ANTI-ICE VALVES

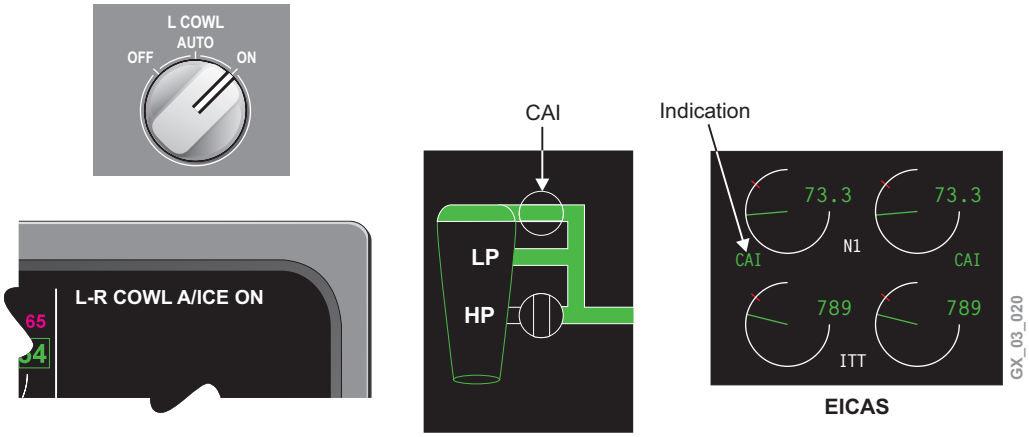
There are two Cowl Anti-Ice Valves (CAIV) which control the flow of engine bleed air to the cowl ducting. The CAIVs are spring-loaded open, pneumatically operated, electrically controlled, pressure regulating and shutoff valves that are controlled by signals from the ice detection system. They are either fully open or fully closed.

CAI OPERATION

When the L and/or R COWL selector is selected to AUTO and ice is detected, the ice detection system sends a signal to a relay in the ANTI-ICE panel that commands the anti-ice valves open. If an ice detector fails during icing conditions, the other detector will activate both cowl anti-ice valves in AUTO mode. A status message is displayed on the EICAS.



Cowl anti-icing can be manually selected to ON. This will open the CAI valves independent of the ice detection system and display a status message. Whenever cowl anti-ice is activated (AUTO or ON), a CAI icon will be displayed on the EICAS page.



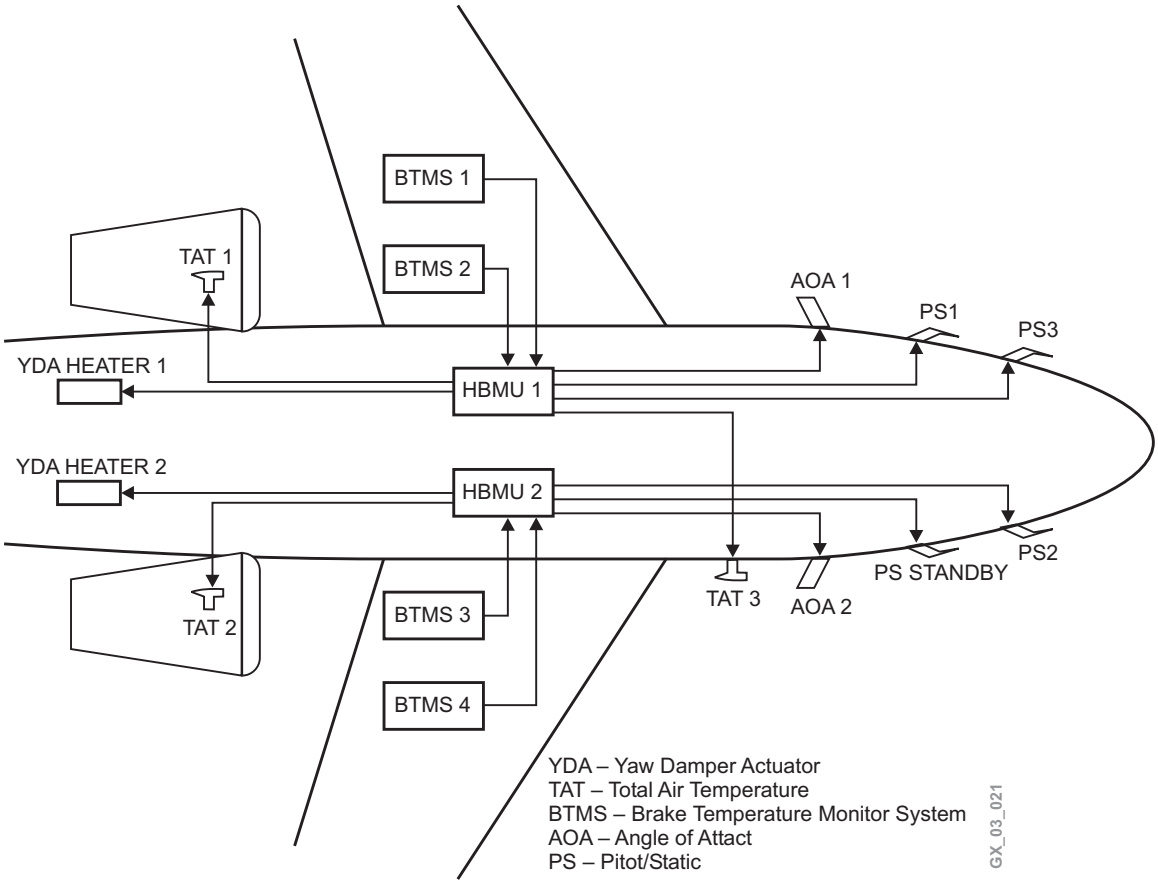
ELECTRICAL ANTI-ICING

Electrical power is used to operate the following:

AIR DATA PROBES AND SENSORS

The air data probes and sensors anti-ice system prevents ice accumulation on the probes and sensors which could lead to incorrect data transmission to the Air Data Computers (ADC).

The air data probes and sensors anti-ice system is controlled automatically by two Heater/Brake Temperature Monitoring Units (HBMU).



HBMU

HBMU1 controls AOA 1, PS 1, PS 3 and TAT 1 and YD Heater 1 and monitors BTMS 1 and BTMS 2.

HBMU 2 controls AOA 2, PS 2, PS Standby, TAT 2, TAT 3 and YD Heater 2 and monitors BTMS 3 and BTMS 4.

The HBMUs also monitor brake temperature data. The data sent by the Brake Temperature Monitoring System (BTMS), which incorporates four sensors installed in the brake housings, provides excessive brake temperature warning to the EICAS Refer to Chapter 14, LANDING GEAR for more information. The HBMU also controls heat to Yaw Damper (YD) actuators to ensure that the standby YD actuator is heated. Refer to Chapter 10, FLIGHT CONTROLS.

The HBMU receives data from various airplane systems via the Data Acquisition Units (DAU) to control the heaters. The systems that send data to the DAUs are:

- Electronic Engine Controllers (EEC) for the “all heaters off logic and for TAT probe on/off logic
- Fault Warning Computer (FWC) regarding which ADC is selected for cockpit display
- Automatic Flight Control System (AFCS) regarding which Yaw Damper is in use for YD heater control logic
- Air Data Computers (ADC) to provide TAT information to control heat to the Yaw Dampers and airspeed information for all heaters off logic
- Electrical Load Management System (EMS) provides BUS status and ADG information for heater control logic
- Weight-On-Wheels (WOW) for all heaters off logic and for TAT probe on/off logic

The heaters are driven to the indicated ON state based on the following logic:

GROUND / PARK LOGIC	ENGINE START	INFLIGHT
ALL HEATERS ARE POWERED "OFF" WHEN: LEFT ENGINE: OFF (AND) RIGHT ENGINE: OFF (AND) CAS: < 50 KTS (AND) MGWOW: GROUND	AOA 1 AOA 2 PS 1 PS 2 PS 3 PS STBY } ON YD 1 ON/OFF Note (1) YD 2 ON/OFF Note (1) TAT 1 ON/OFF Note (2) TAT 2 ON/OFF Note (2) TAT 3 OFF	AOA 1 AOA 2 PS 1 PS 2 PS 3 PS STBY } ON YD 1 ON/OFF Note (1) YD 2 ON/OFF Note (1) TAT 1 ON TAT 2 ON TAT 3 ON
Note: HBMU IBIT All heaters are tested "ON" when AC power is applied. It is recommended to remove all pitot/AOA covers prior to starting APU or connecting external power.	Note (1): YD 1 and 2 turn ON with TAT < -40°C and YD not engaged. Note (2): TAT 1 and 2 turn ON by respective engine run.	Note (1): YD 1 and 2 turn ON with TAT < -40°C and YD not engaged.

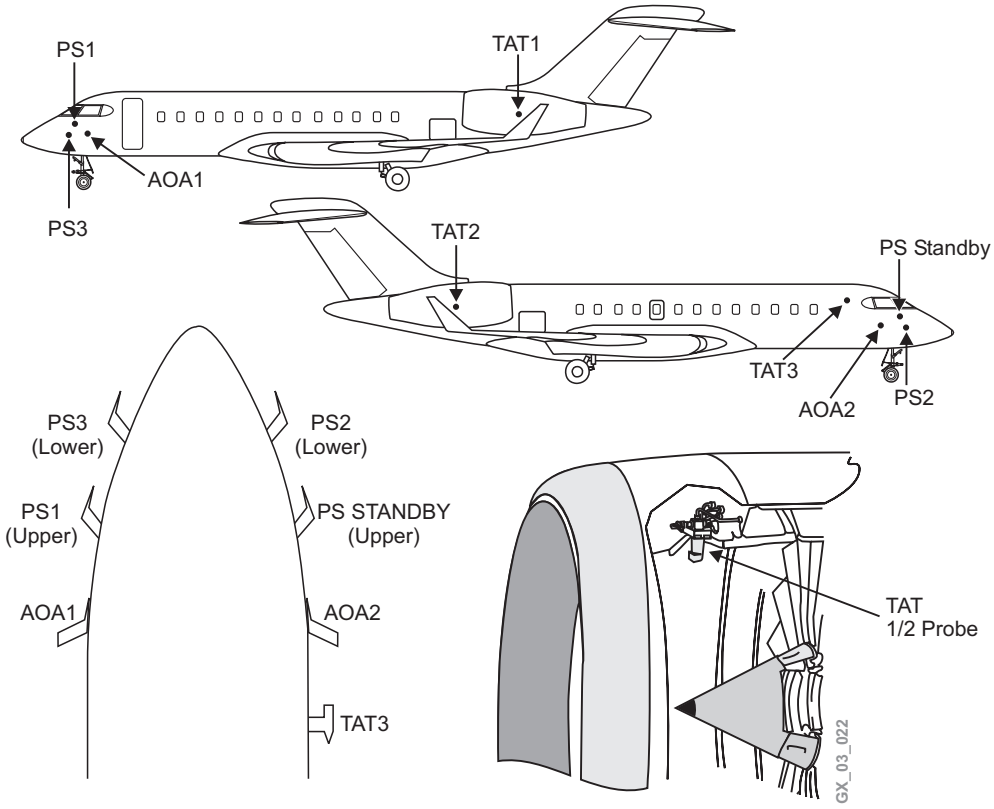
GX_03_030

PROBES

There are four Pitot-Static (PS) probes on the side of the fuselage. They supply pitot and static pressure to the Air Data Computers and standby instruments. Heater elements are installed in the PS heads and mounting bases.

There are three Total Air Temperature (TAT) Probes, one on the fuselage and one in each engine inlet.

There are two AOA probes mounted on the fuselage, one on either side.



The current being drawn by the heater is measured and a heater fault is generated if the current drawn is less than the minimum required by the particular probe. The fault is then transmitted to the EICAS.

WINDSHIELD HEAT

The Windshield Temperature Control System provides defog and anti-icing for the Pilot's and Copilot's windshield and side window. The system continuously monitors the temperature of each windshield and side window and maintains the temperature within specified limits.

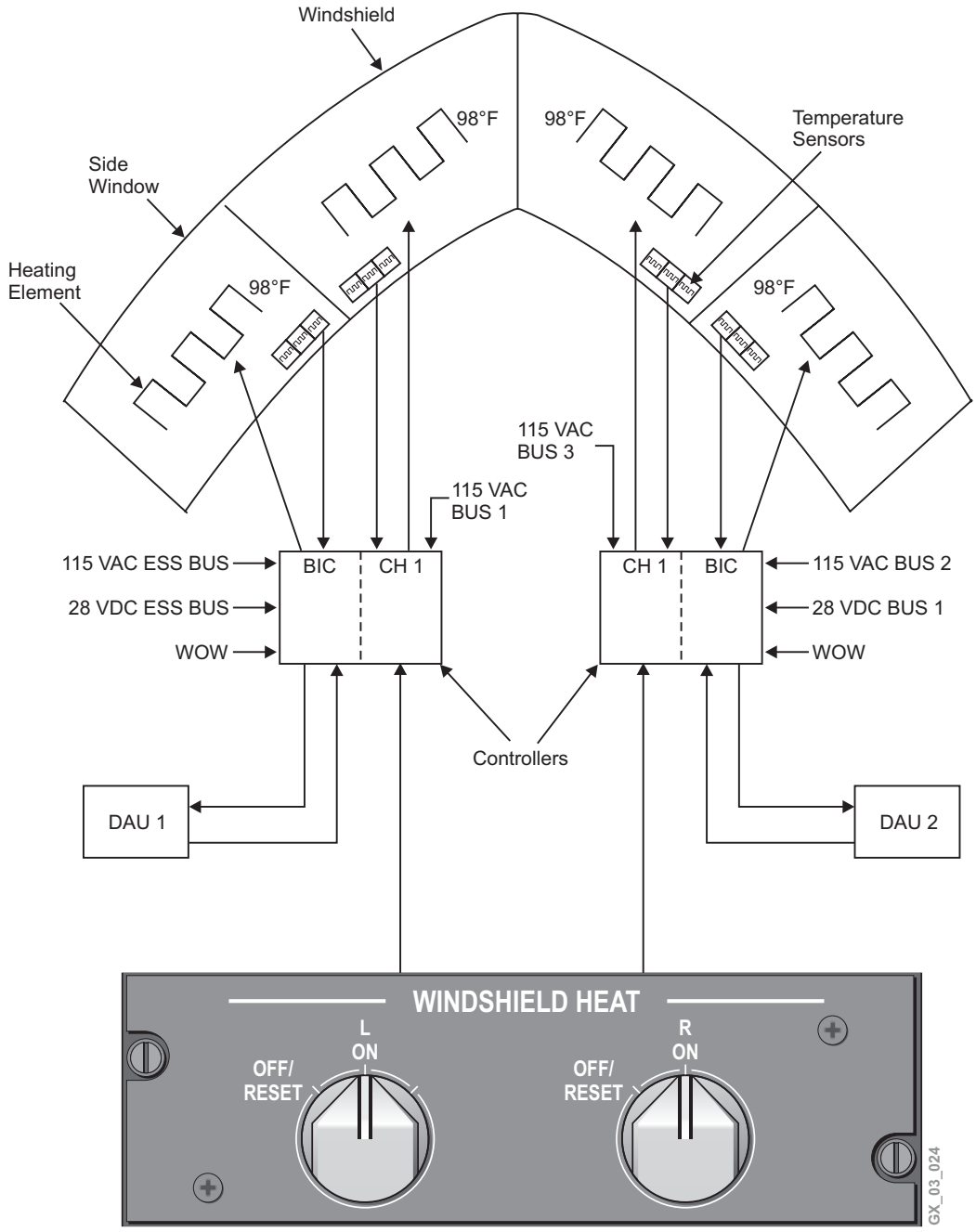
WINDSHIELD TEMPERATURE CONTROLLER

There are two dual channel Windshield Temperature Controllers (WTC). The left hand WTC controls the left windshield heater and the left side window heater. The right hand WTC controls the right windshield heater and the right side window heater. Both WTCs are interfaced with the EICAS via different DAUs. The controllers automatically control the power supplied to the heaters when electrical power is applied to the system.

The WTC has two totally independent channels. Channel 1 (CH1) monitors and regulates windshield heating and manages the Channel 1 Built-In-Test (BIT).

The BITE Interface Channel (BIC) monitors and regulates the side window temperature and manages the BIC Built-In-Test. Also, it communicates to EICAS and stores faults in a Non-Volatile Memory (NVM) for later retrieval by CAIMS.

The left and right switches on the Windshield Heat panel, independently control power to the left and right windshield and side window temperature controllers.



WINDSHIELD HEAT PANEL

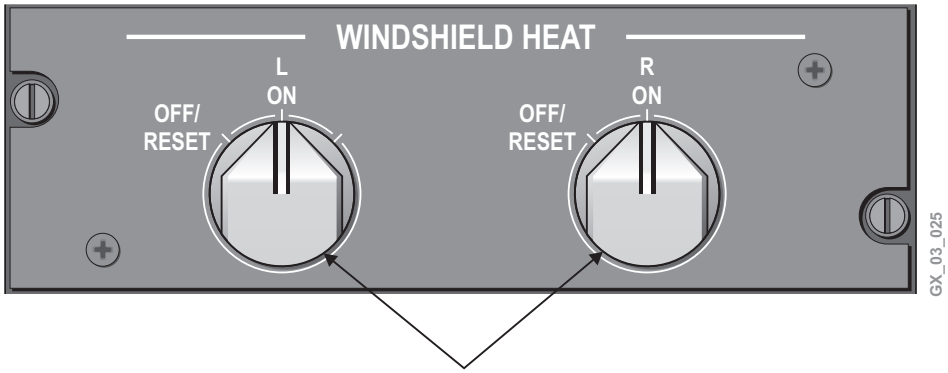
The heat for the windshields and side windows is supplied by electrical heaters.

The windshield is a laminated transparency comprising two acrylic mainplies and an outer glass faceply. A conductive film is deposited on the interior surface of the faceply except for a half-inch wide zone along its periphery. The conductive film acts as the windshield heating element.

The side window construction is similar to that of the windshield, except that the laminated transparency comprises only two acrylic mainply layers. On the side window, the conductive film is deposited on the interior surface of the outer mainply.

WINDSHIELD HEAT PANEL

Selections for the pilot's and copilot's windshield and side window heating are made on the WINDSHIELD HEAT panel located on the overhead panel.



LEFT and RIGHT WINDSHIELD HEAT Selectors
- **OFF/RESET** – Turns windshield/window heat OFF
  – Resets the system in the event of a failure
  – Inhibits all windshield and window fail messages
- **ON** – Activates the windshield/window temperature control system.

Modes of Operation

The windshield modes of operation are as follows:

Warm-Up Mode

The warm-up mode is provided to avoid the effect of thermal shock on the windshield. While in the warm-up mode, the windshield heater generates only 33% of nominal heat for approximately 4 minutes. The warm-up mode is activated on WTC power-up under the following conditions:

- Heat was not applied to the windshield for more than 5 seconds
- The airplane is weight-on-wheels

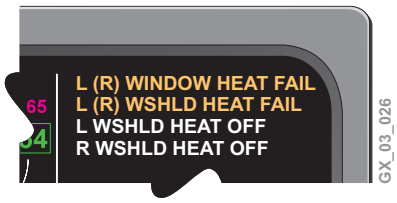
If the airplane is weight-off-wheels, the warm-up mode is terminated. Once the warm-up mode is terminated, it automatically switches to normal regulating mode.

Normal Regulating Mode

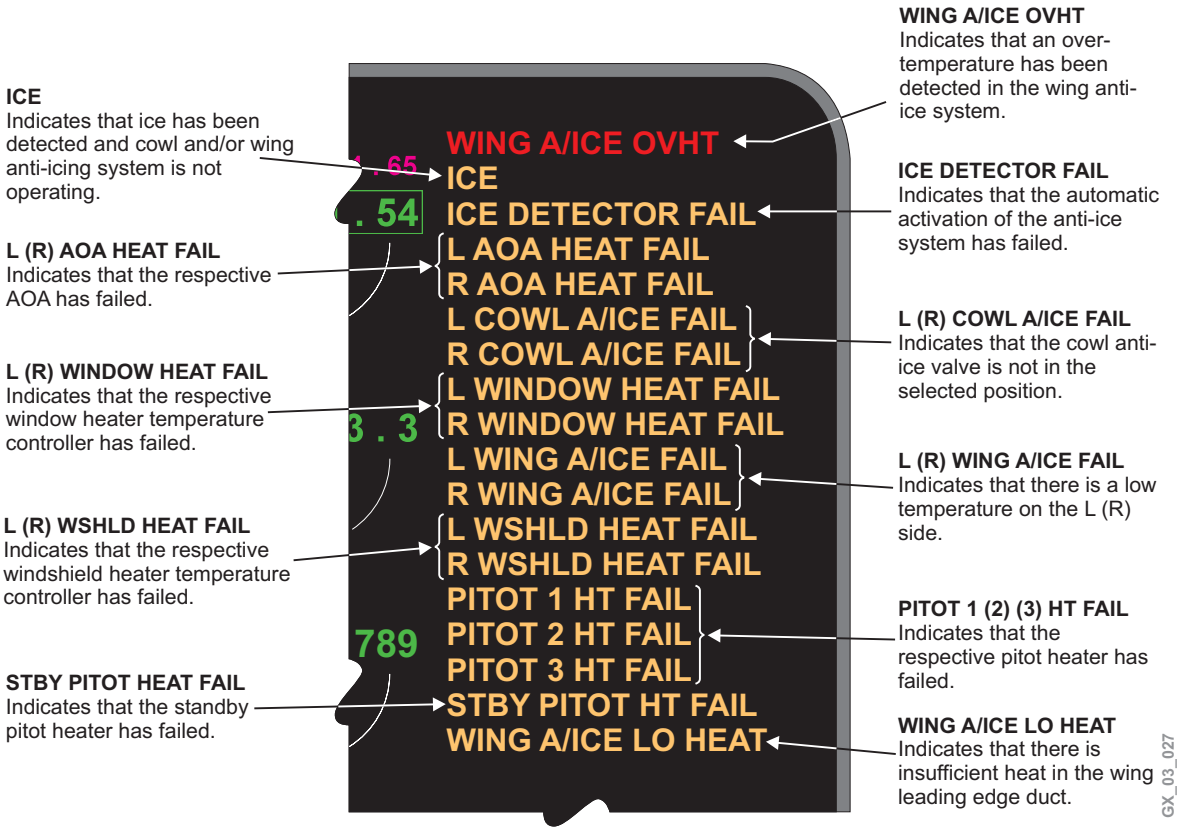
On WTC power-up, both channels controlling the windshield and respective side window are energized. Each channel continuously monitors the temperature through its sensor element. If the temperature decreases below a specified limit, the heater is turned on. If the temperature exceeds a specified limit, the heater is turned off.

WINDSHIELD/WINDOW FAILURE INDICATION

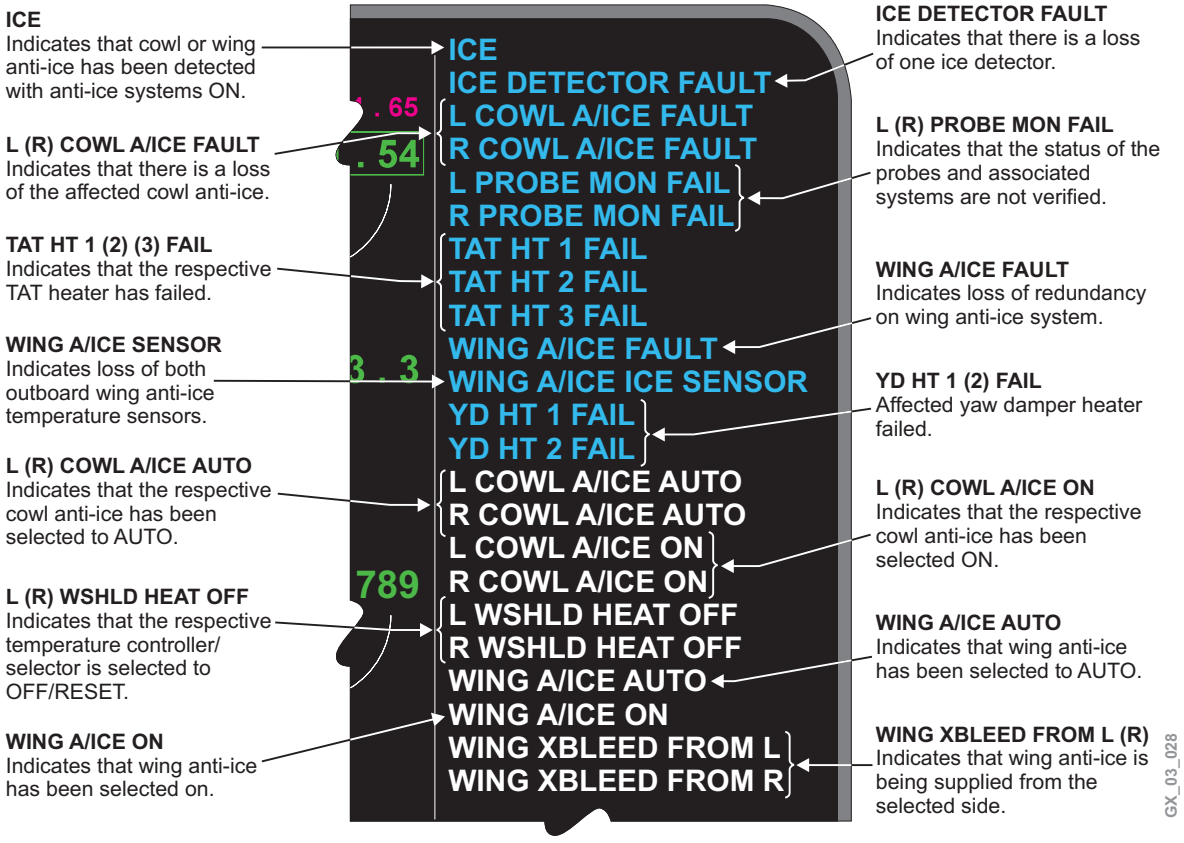
In the event of a system failure or being turned off, a message is displayed on the EICAS.



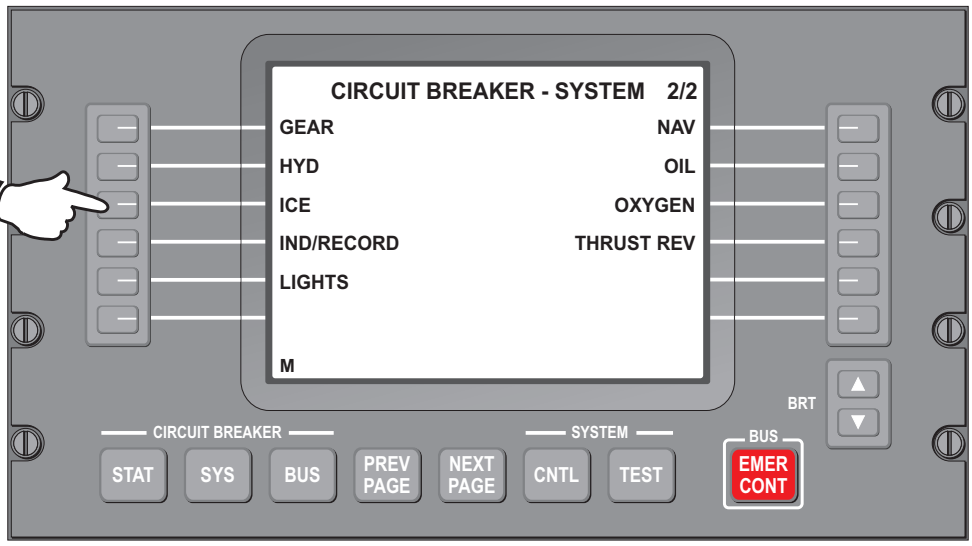
ICE AND RAIN EICAS MESSAGES



ICE AND RAIN EICAS MESSAGES (Cont)



EMS CIRCUIT PROTECTION



CB - ICE SYSTEM 1/5

HBMU 1	BATT		IN
HBMU 2	DC ESS		IN
L AOA HEAT	AC ESS	CCBP	IN
L COWL A/ICE VLV	BATT		IN
L ICE DETECTOR	AC ESS	CCBP	IN
L WINDOW HEAT	AC ESS	CCBP	IN

CB - ICE SYSTEM 2/5

L WINDOW HEAT CTL	DC ESS		IN
L WING A/ICE CTL	DC ESS		IN
L WSHLD HEAT 1	AC 1	CCBP	IN
L WSHLD HEAT 2	AC 1	CCBP	IN
PITOT 1 HT A	AC 1		IN
PITOT 1 HT B	AC ESS	CCBP	IN

CB - ICE SYSTEM 3/5

PITOT 2 HT	AC 1	CCBP	IN
PITOT 3 HT	AC ESS	CCBP	IN
R AOA HEAT A	AC 1	CCBP	IN
R AOA HEAT B	AC ESS	CCBP	IN
R COWL A/ICE VLV	BATT		IN
R ICE DETECTOR	AC 1	CCBP	IN

M

CB - ICE SYSTEM 4/5

R WINDOW HEAT	AC 2	CCBP	IN
R WINDOW HEAT CTL	DC 1		IN
R WING A/ICE CTL	DC ESS		IN
R WSHLD HEAT 1	AC 3	CCBP	IN
R WSHLD HEAT 2	AC 3	CCBP	IN
STBY PITOT HT	AC ESS	CCBP	IN

CB - ICE SYSTEM 5/5

TAT HT 1	AC ESS	CCBP	IN
TAT HT 2	AC ESS	CCBP	IN
TAT HT 3	AC 3	CCBP	IN
WAI XBLEED CTL	DC ESS		IN
WAI XBLEED VLV	DC ESS		IN

M

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