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Airbus
A318/A319/A320/A321

ATA 47
Inert Gas System

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ATA 47 INERT GAS SYSTEM

GENERAL INTRODUCTION

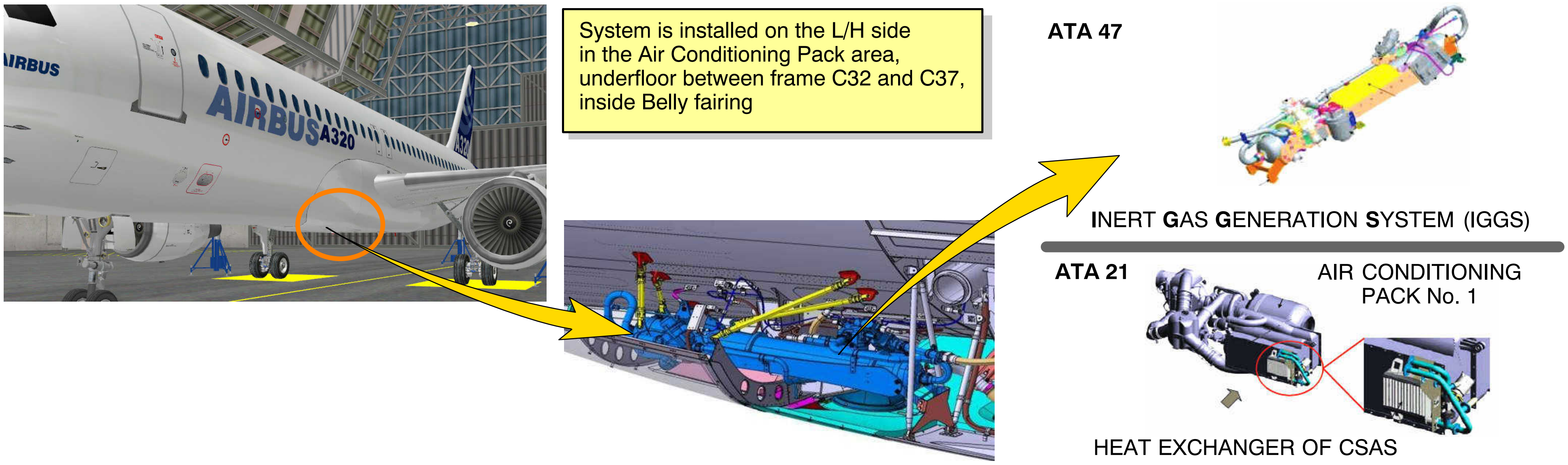
Within the framework of the fuel tank safety program the new DLH A320 family aircraft are now equipped with a system to reduce the flammability of aircraft fuel tanks.

After detailed research the FAA and EASA have released some rules in order to improve the flammability resistance of aircraft fuel tanks.

Based on these regulations Fuel Tank Safety Training has been initiated. Additionally, the following **F**uel **T**ank **I**nerting **S**ystem (FTIS) has been created.

Because the FTIS uses bleed air from the aircraft it is divided into two sub systems:

- the **C**onditioned **S**ervice **A**ir **S**ystem (CSAS) ATA 21 which provides air from the bleed system and is built by Liebherr
- the **I**nert **G**as **G**eneration **S**ystem (IGGS) ATA 47 which separates oxygen from nitrogen and is built by Parker



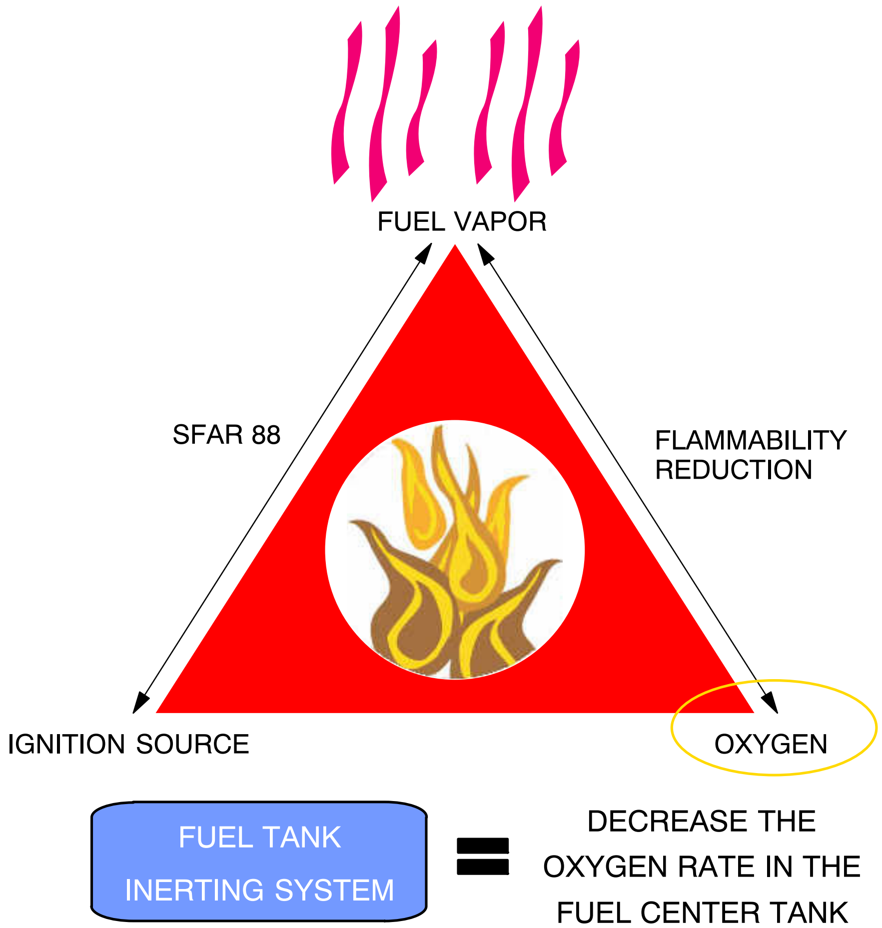
SYSTEM FUNCTION AND SAFETY

The fuel tank flammability is possible only if the three elements get together: fuel vapor, ignition source and oxygen.

To reduce the fuel tank flammability, the fuel tank inerting system reduces the rate of oxygen in the center tank only.

Because the system separates oxygen from nitrogen it is dangerous for Maintenance personnel to work close to an activated system.

The oxygen enriched flow is routed overboard. The nitrogen enriched flow is sent to the center tank.



WARNING:

DO NOT GO INTO THE WORK AREA UNTIL A MINIMUM OF 5 MINUTES AFTER YOU REMOVE THE ACCESS PANEL. LET AIR FLOW THROUGH THE WORK AREA. AIR FROM THIS SYSTEM HAS A LOW OXYGEN CONTENT AND CAN CAUSE INJURY OR DEATH.

Figure 1 Safety Precaution

MAINTENANCE SAFETY ITEMS

Nitrogen Enriched Air (NEA)

Normally the Fuel Tank Inerting system is only activated in flight but can be activated on ground for maintenance reason.

During system activation the fuel center tank is flooded with Nitrogen Enriched Air (NEA) which is then ventilated into the l/h wing vent/surge tank.

Via the NACA inlet this NEA is realeased overboard.

WARNING: EVEN WITH A DEACTIVATED SYSTEM THE CENTER TANK AND L/H VENT TANK CONTAINS STILL A DANGEROUS LOW LEVEL OF OXYGEN. IF MAINTENANCE ACCESS IS NECESSARY THE RELATED AREA MUST BE VENTILATED FOR SUFFICIENT TIME.

Oxygen Enriched Air (OEA)

When the system is activated Oxygen Enriched Air (OEA) is released via an outlet connected to the pneumatic HP 3“ GRD connector access panel.

WARNING: OEA CONTAINS A HIGH LEVEL OF OXYGEN. AVOID ANY IGNITION SOURCE CLOSE TO THE HP GRD CONNECTION IF THE SYSTEM IS ACTIVATED.

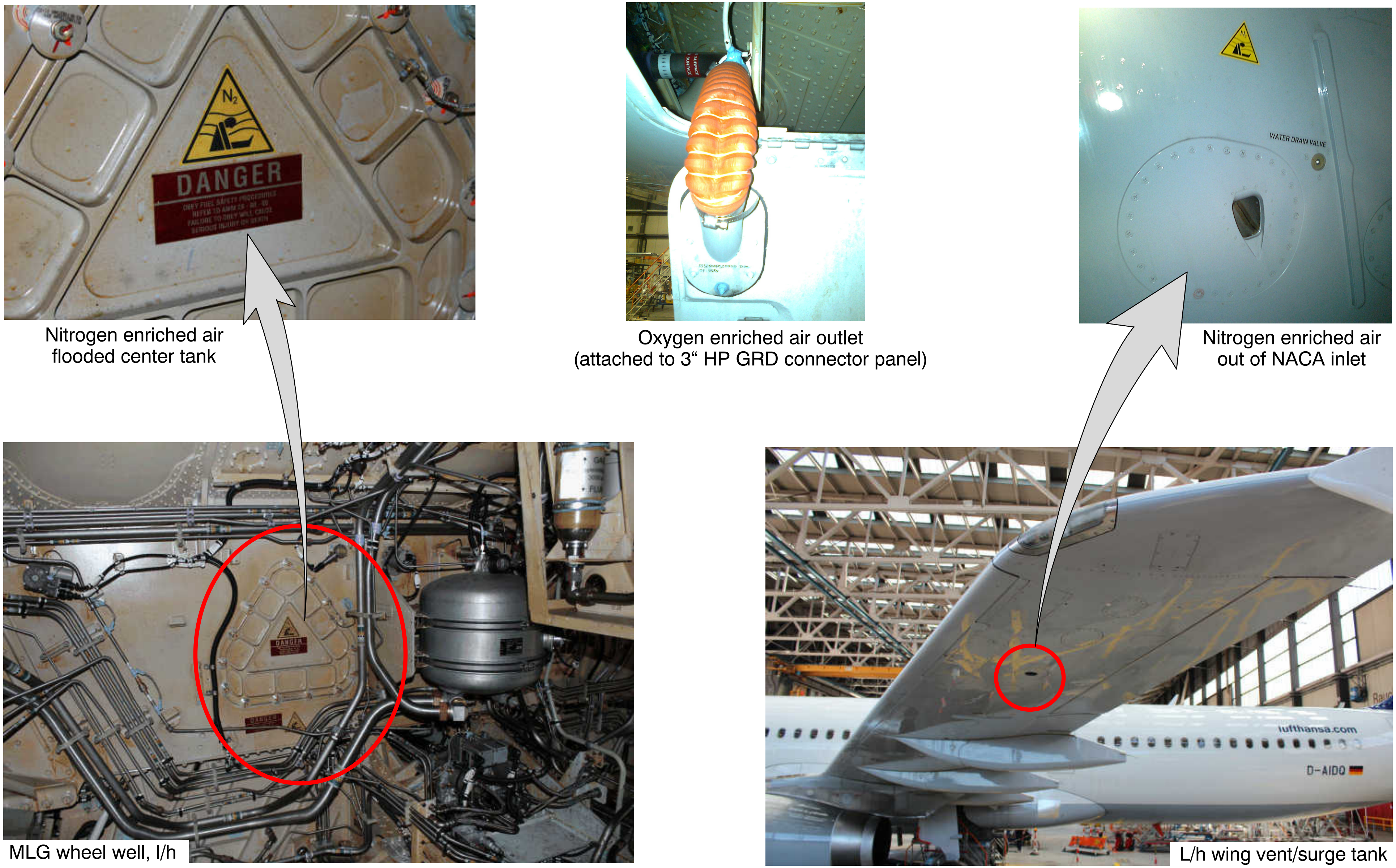


Figure 2 Maintenance Safety Items

GENERAL DESCRIPTION

The Fuel Tank Inerting System (FTIS) is composed of two sub-systems:

- the **C**onditioned **S**ervice **A**ir **S**ystem (CSAS) ATA 21
- the **I**nert **G**as **G**eneration **S**ystem (IGGS) ATA 47

CSAS

The CSAS takes hot air from the bleed air system and cools down the air to a level compatible with the IGGS sub-system.

IGGS

The IGGS uses an **A**ir **S**eparation **M**odule (ASM) to filter the conditioned air stream, creating **N**itrogen **E**nriched **A**ir (NEA) and **O**xygen **E**nriched **A**ir (OEA).

The OEA is sent overboard, the NEA is sent to the Fuel Center Tank.

When the NEA goes into the fuel tank, it pushes the air with oxygen through the vent line out of the fuel tank and causes the inert conditions in the fuel tank.

The fuel tank is inert when the average oxygen concentration is below 12% at sea level up to 3048 m.

General Operation

The aircraft crew does not operate the FTIS, because it has automatic control.

Normally the system is only active in flight, with bleed pressure available, Pack No.1 operational and no failure detected.

On ground the system can be activated for maintenance as a BITE Test or Interactive Test with bleed air from APU or ground supply.

Control and Monitoring

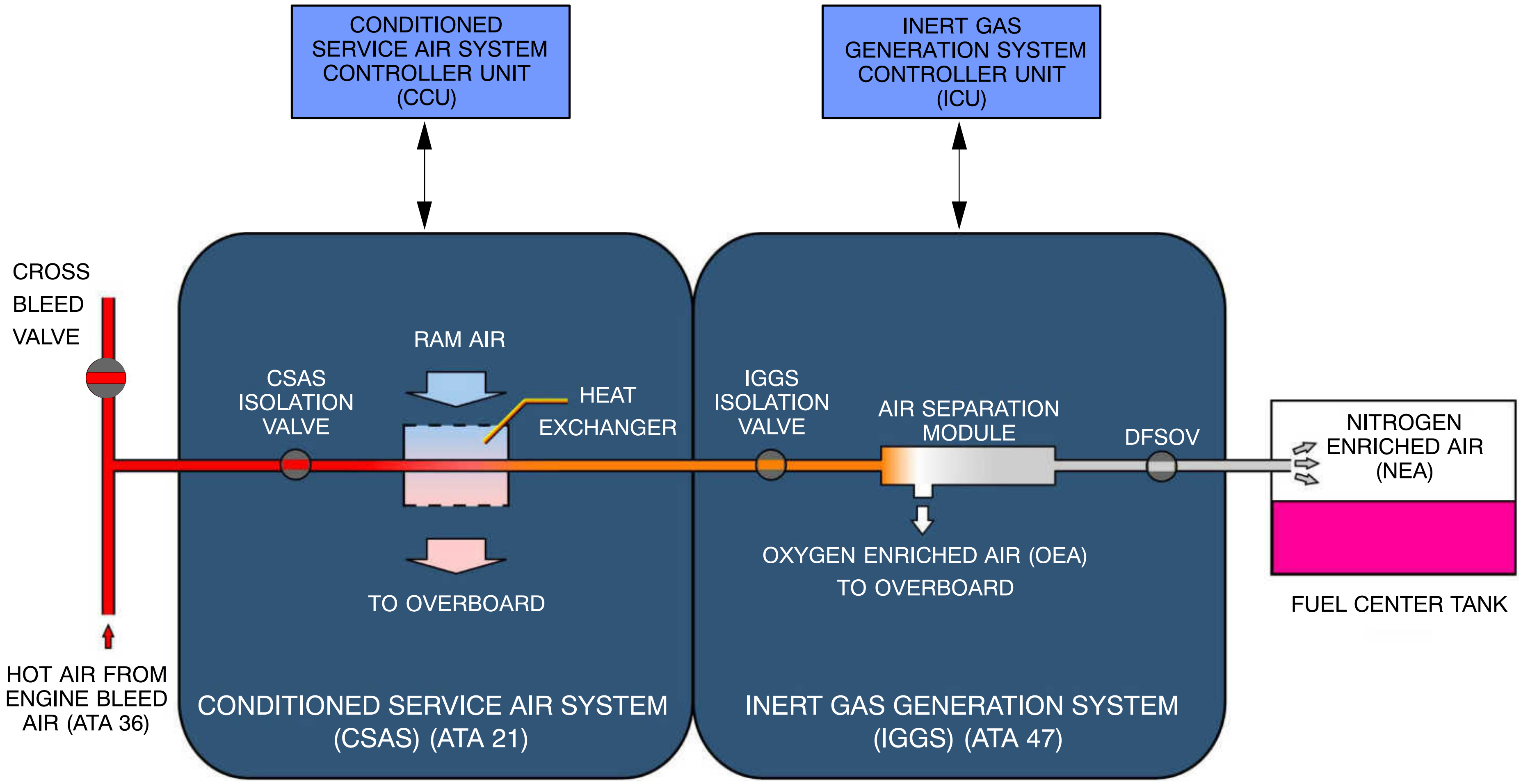
Each subsystem is controlled and monitored by an independent controller:

- the CSAS by the **C**onditioned Service Air system **C**ontroller **U**nit (CCU)
- the IGGS by the **I**nert Gas Generation System **C**ontroller **U**nit (ICU)

The CCU and ICU monitor their system conditions independently.

They interface with each other and various aircraft systems.

If one finds an incorrect condition or a limit exceedance, both will stop their systems.



CSAS: CONDITIONED SERVICE AIR SYSTEM
DFSOV: DUAL FLOW SHUT OFF VALVE
IGGS: INERT GAS GENERATION SYSTEM

Figure 3 Basic Description

21–58 CONDITIONED SERVICE AIR SYSTEM (CSAS)

SYSTEM DESCRIPTION

The CSAS is composed of:

- the **C**onditioned service air system **C**ontroller **U**nit (CCU), which performs system control and health monitoring (BITE) and interfaces with the **I**nerting Gas Generation System **C**ontroller **U**nit (ICU), FWS and CFDS
- a CSAS isolation valve, which protects the system in case of low pressure, overpressure or overtemperature
- an Ozone Converter
- a heat exchanger to cool down the air
- a Bypass Valve for temperature regulation
- a temperature and pressure sensor for monitoring

CSAS Operation

Engine 1 is the primary bleed source and Eng. 2, through the X-Bleed valve, is the secondary bleed source.

APU or Ground Cart supply can be used for interactive test on Ground.

In normal operation, the CSAS isolation valve is open to let the air go through the ozone converter.

The ozone converter decreases the quantity of ozone in the bleed air to give protection to the IGGS components

After the Ozone converter, the air temperature is decreased by the CSAS heat exchanger to get a temperature of 60˚C+/–6˚C.

The Bypass Valve adds hot air to the always cold air downstream of the heat exchanger if necessary.

The output of the heat exchanger is connected to the IGGS.

Temperature and pressure control

On the output duct, a temperature sensor and a pressure sensor monitor the condition before the air is routed into the IGGS.

If there is overpressure or overtemperature, the CSAS isolation valve closes to stop the system.

Overpressure is considered above 60 PSI.

Overtemperature is monitored digitally at a time/pressure relation basis (but latest at 85˚C) and an analog shut off signal from the sensor (90˚C).

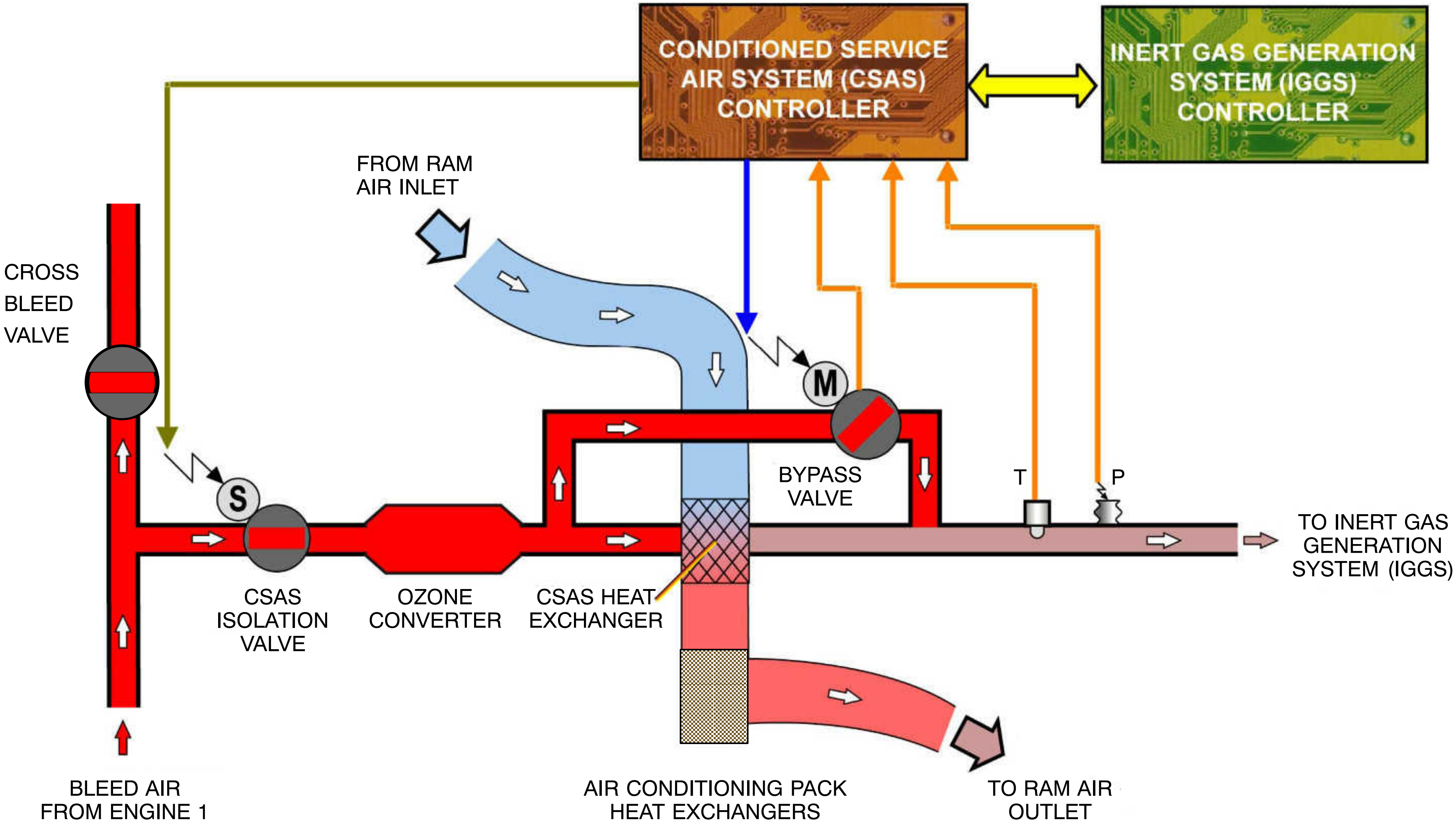


Figure 4 CSAS Schematic

LOCATION

General

The system is installed on the left hand side of the aircraft belly fairing.

The bleed air is pulled from the **H**igh **P**ressure **G**round **C**onnector (HPGC) tube.

The output of the heat exchanger is connected to the IGGS.

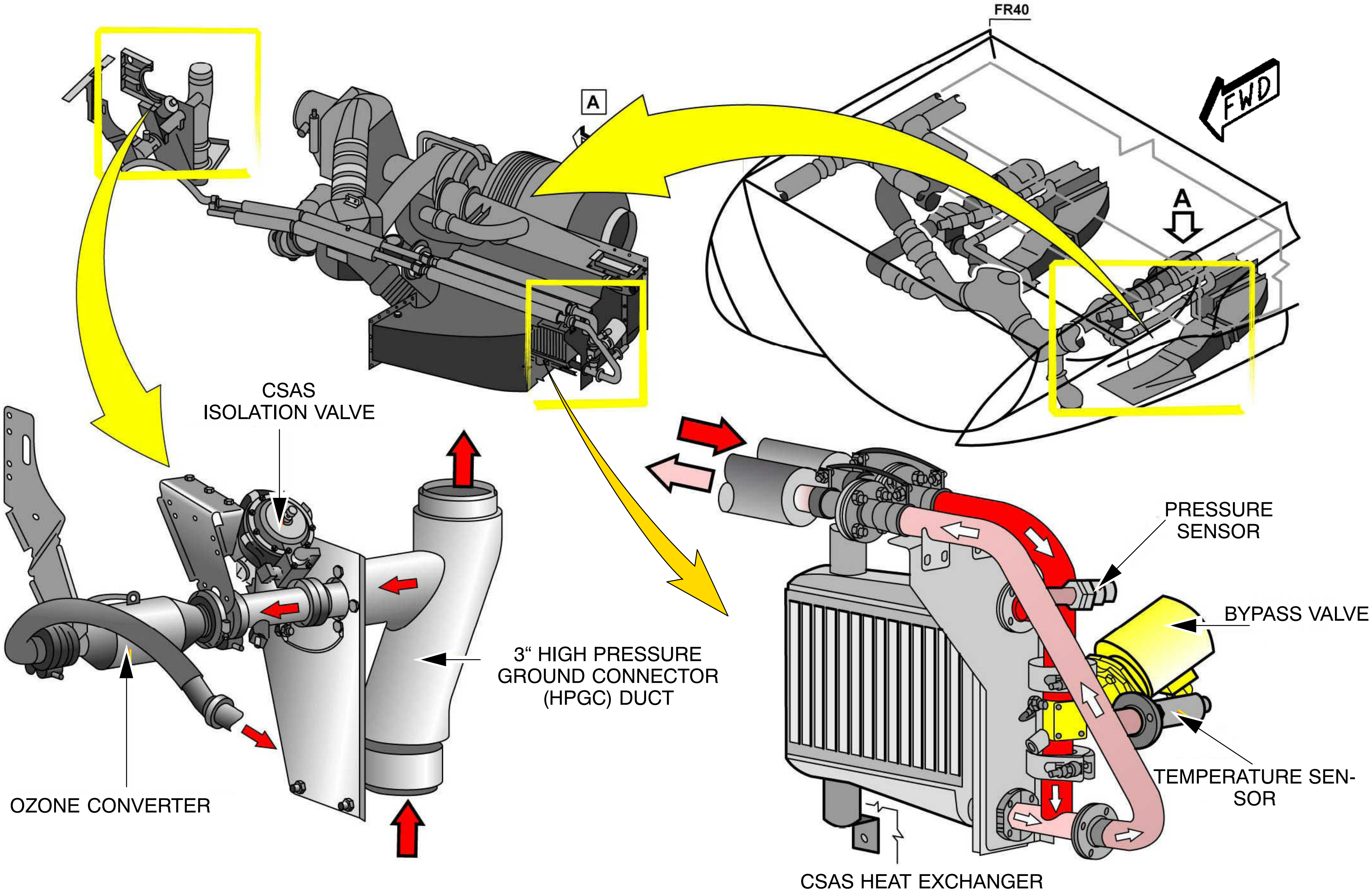


Figure 5 CSAS Component Location

COMPONENT DESCRIPTION

CSAS Controller Unit (CCU)

The CCU communicates with the IGGS CU and monitors the CSAS parameters such as the temperature and pressure of the FTIS inlet.

The CSAS controller can shut off the system by closing the CSAS Isolation Valve (CIV).

The CCU shuts the system off in case of malfunction, overpressure (>60 PSI) and overtemperature (digital latest 85˚C, analog latest 90˚C).

CSAS Isolation Valve (CIV)

The CSAS Isolation Valve (CIV) is a solenoid controlled, pneumatically actuated butterfly valve.

The CSAS isolation valve lets hot bleed air flow to the Temperature Control components.

Without bleed air pressure (spring loaded) or without electrical power, the valve closes automatically and stops the operation of the system.

The CIV can additionally be closed manually (manual override).

Ozone Converter

By using a catalytic process, the Ozone Converter decreases the ozone concentration of the air supply to the Temperature Control Module in order to protect the **A**ir **S**eparation **M**odule (ASM) fiber.

CSAS Heat Exchanger

The Heat Exchanger decreases the temperature of the hot bleed air from the pneumatic system.

Bypass Valve

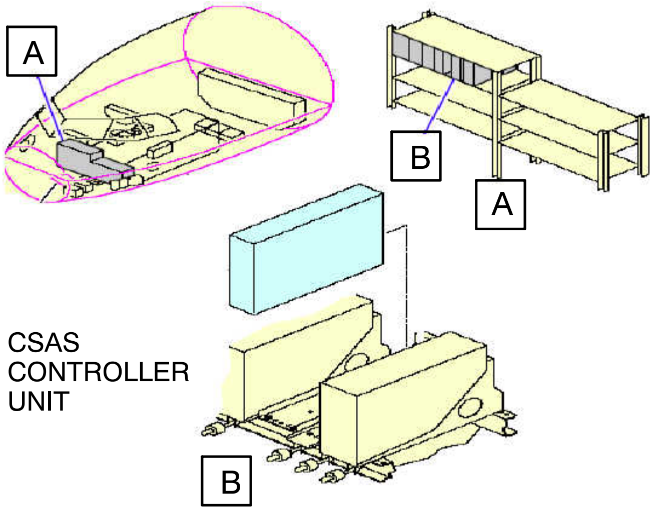
The Bypass Valve adds hot bleed air to the cold air from the heat exchanger to increase the temperature.

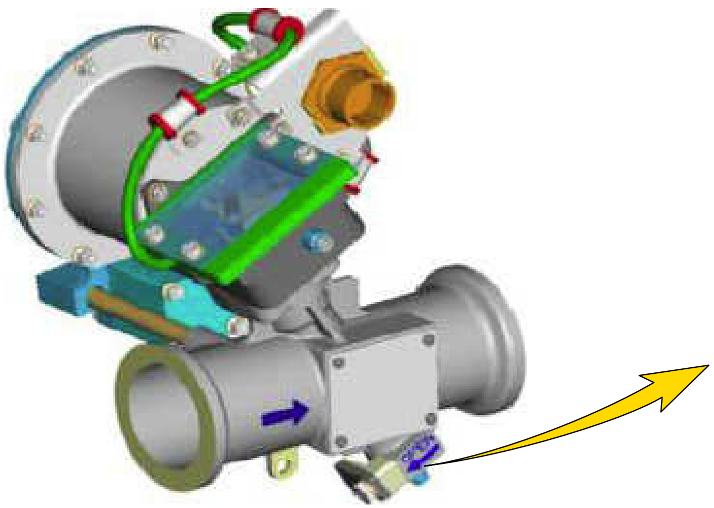
It consists of an actuator with a stepper motor which moves a butterfly flap to open and close.

Temperature Sensor and Pressure Sensor

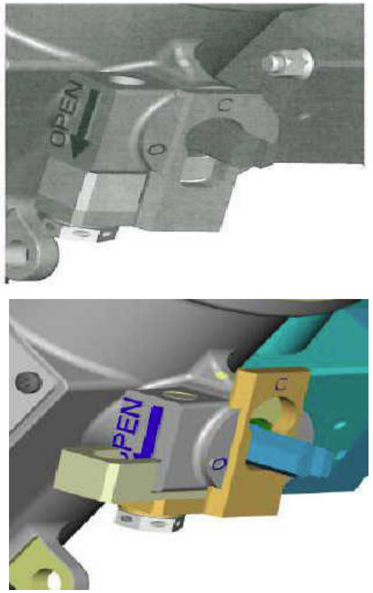
These sensors are used to monitor the system conditions and send signals to the CCU.

The Temperature Sensor is a dual element type.



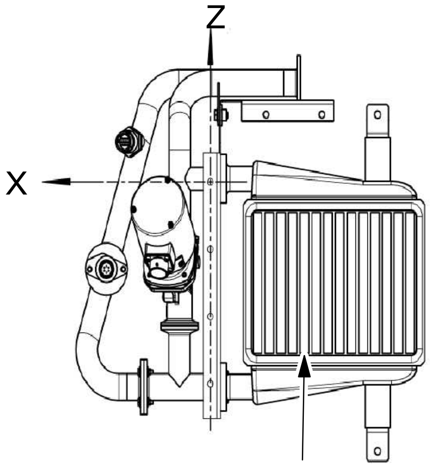


CSAS ISOLATION VALVE



MANUAL OVERRIDE

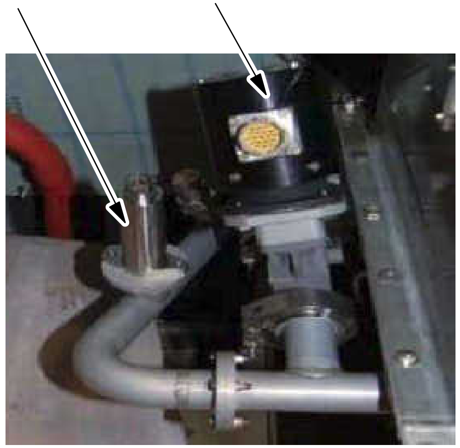
OZONE CONVERTER



HEAT EXCHANGER

PRESSURE
SENSOR

BYPASS VALVE



TEMPERATURE
SENSOR

Figure 6 Component Description

47–00 INERTING GAS GENERATION SYSTEM (IGGS)

SYSTEM DESCRIPTION

The IGGS is composed of:

- a IGGS Controller Unit (ICU) to control and monitor the system
- a IGGS Isolation Gate Valve to protect the system from overpressure and overtemperature
- a D–ULPA (Double Ultra Low Particle) filter
- a temperature sensor and a pressure transmitter on the inlet of the ASM
- an Air Separation Module (ASM) to separate oxygen and nitrogen
- one combined oxygen/pressure sensor at the outlet of the ASM for monitoring
- a Dual Flow Shut Off Valve (DFSOV) to switch between low/middle/high NEA flows
- one dual flapper check valve as a double barrier to protect from fuel back-flow

Normal Operation

The bleed air comes from the CSAS and is filtered by the D–ULPA filter to keep the ASM inlet clean from hydrocarbons and dust.

Downstream of the D–ULPA filter one temperature sensor and one pressure sensor send air parameters to the ICU.

The ASM, which is the core of the IGGS, removes oxygen and sends NEA to the fuel center tank.

The OEA is sent overboard through an outlet on the HPGC door.

Downstream of the ASM, an oxygen sensor measures the oxygen rate to prevent a high oxygen concentration in the center tank.

The oxygen sensor has a pressure sensing capability when it is energized and thus it prevents overpressure in the center tank.

The DFSOV controls the NEA flow to the fuel tank and lets the system change between low/mid/high NEA flow in relation to the flight phases or in abnormal conditions. The DFSOV also isolates the IGGS from the fuel tank if a limit is exceeded. A Dual Flapper Check Valve makes a double barrier to prevent possible back–flow of fuel.

Operational Flow Modes

The ICU controls the system to three operational flow modes:

- low, during climb and cruise phases
- mid, during approach phase
- high, during usual descent phase

Abnormal Operation

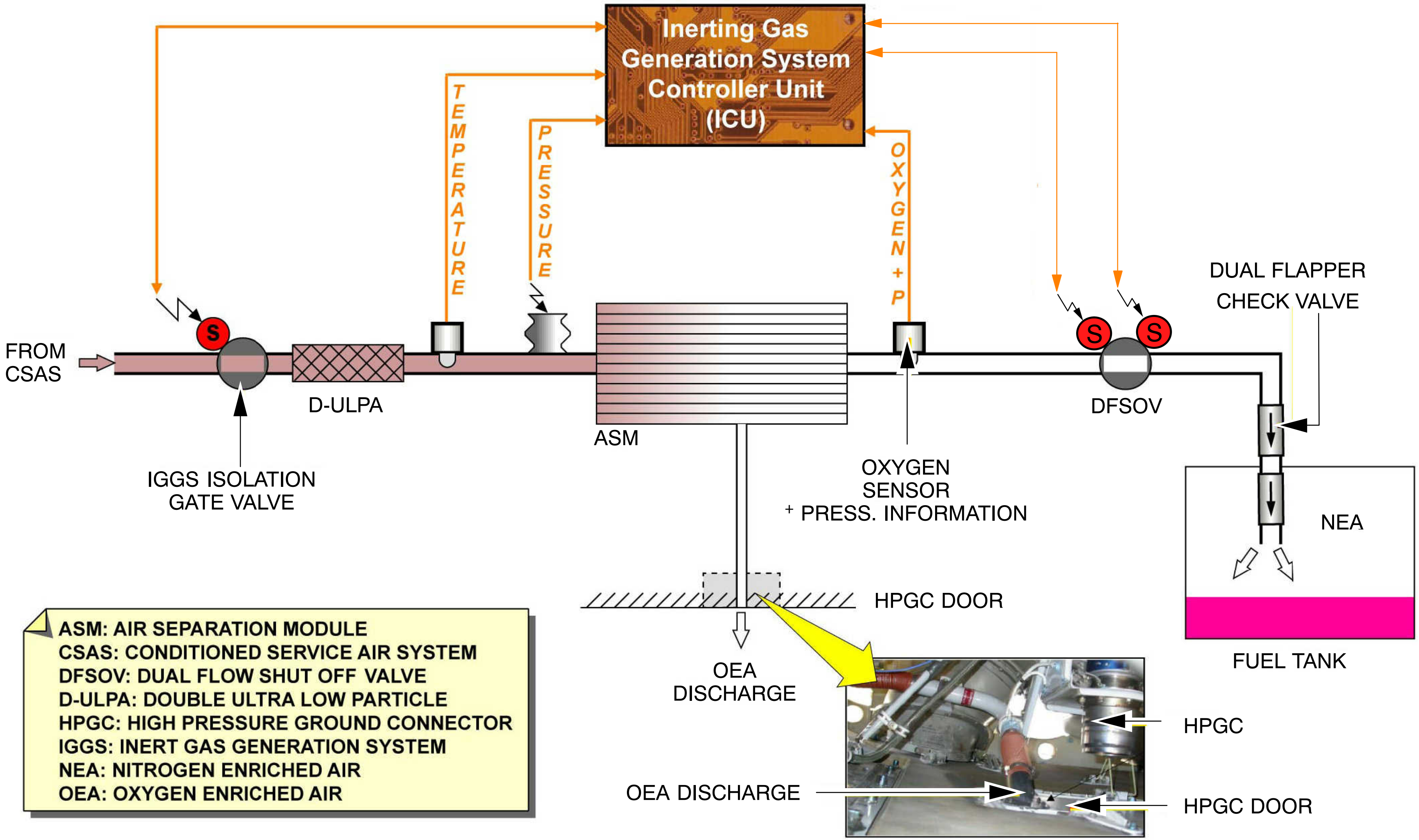
In following conditions the ICU de–energizes the IGGS Isolation Gate Valve and Dual Flow Shut Off Valve solenoids to close the valves:

- aircraft not in flight and no ground test active
- no bleed pressure available or Fault in relevant pack
- bleed temperature low (< 47˚C)
- bleed temperature high(> 85˚C digital and 90˚C analog)
- bleed pressure high (> 60 PSI)
- bleed pressure low (< 15 PSI)
- oxygen Sensor senses an oxygen rate higher than approx. 12% depending on altitude

NOTE: the overtemperature monitoring has digital and analog lanes.
Digital control follows a time/temperature relation.
E.g. if the temperature is above 66˚C, the flow is reduced for a few minutes and only stopped if the temperature still raises.
At latest 85˚C it is stopped immediately.
An independent analog lane activates a direct stop at 90˚C.

If the system is stopped a digital/analog latch is active and must be reset on ground. The digital reset occurs after a successful BITE Test and the analog reset after power cycle.

NORMAL OPERATION



ASM: AIR SEPARATION MODULE
CSAS: CONDITIONED SERVICE AIR SYSTEM
DFSOV: DUAL FLOW SHUT OFF VALVE
D-ULPA: DOUBLE ULTRA LOW PARTICLE
HPGC: HIGH PRESSURE GROUND CONNECTOR
IGGS: INERT GAS GENERATION SYSTEM
NEA: NITROGEN ENRICHED AIR
OEA: OXYGEN ENRICHED AIR

Figure 7 IGGS Schematic

LOCATION

The IGGS pallet assembly is installed on the left hand side of the aircraft belly fairing.

Bleed air comes from the **C**onditioned **S**ervice **A**ir **S**ystem (CSAS).

Then the air is separated into an **N**itrogen **E**nriched **A**ir (NEA) flow and an **O**xygen **E**nriched **A**ir (OEA) flow.

The NEA flow is routed into the center tank.

The OEA flow is discharged overboard via an outlet on the 3" **H**igh **P**ressure **G**round **C**onnector (HPDC) door.

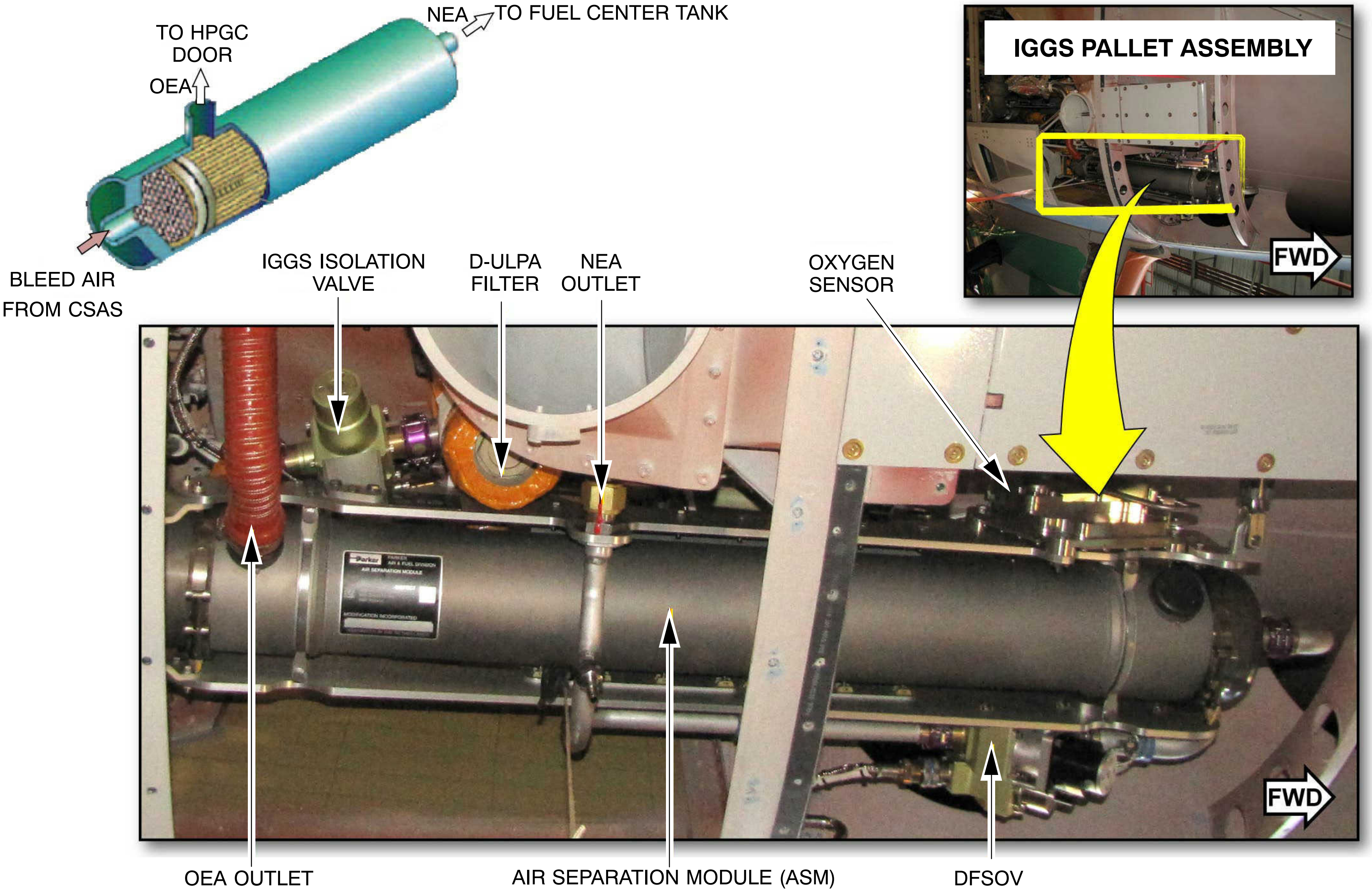


Figure 8 IGGS Component Location

COMPONENT DESCRIPTION

IGGS Controller Unit (ICU)

The ICU performs system control and health monitoring and interfaces with the CCU and ADIRU 1.

The ICU controls the IGGS Isolation Gate Valve and **D**ual **F**low **S**hut **O**ff **V**alve (DFSOV) based on system conditions, limit exceedance and flight phases.

IGGS Isolation Valve

The Isolation Valve is a solenoid controlled, pneumatically actuated valve.

Without bleed air pressure (spring loaded) or without electrical power, the valve closes automatically and stops the operation of the system.

It has a mechanical visual position indicator for trouble shooting and a closed position indicator switch for position monitoring.

Double Ultra Low Particle (D-ULPA) Filter

The D-ULPA Filter removes pollution from the air to avoid ASM fiber damage.

It consists of a multi layer composite filter pack which traps particles within the internal filter fibers.

Temperature Sensor and Pressure Sensor

These sensors give signals to the ICU for condition monitoring.

Air Separation Module

The ASM is the core of the Inert Gas Generation System and removes oxygen from the compressed air stream.

With an internal, semi-permeable, hollow fiber membrane bundle it separates air into **N**itrogen **E**nriched **A**ir (NEA) and **O**xygen **E**nriched **A**ir (OEA).

NEA is sent to the center tank and OEA is sent overboard.

Oxygen Sensor

The Oxygen Sensor measures the oxygen concentration and sends it to the ICU.

It is used to monitor ASM health and FTIS performance.

It also contains a pressure capsule which is used for system monitoring.

Dual Flow Shut Off Valve (DFSOV)

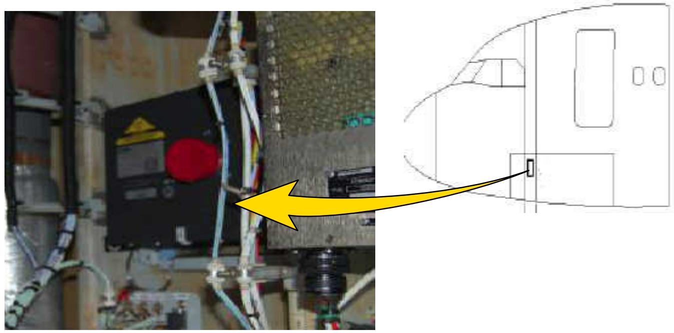
The DFSOV controls the NEA flow to the center tank and enables the system to switch between low/middle/high NEA flows and isolates the IGGS from the fuel tank.

It is fail–safe (de-energized) close and controls the different flows by the activation of two solenoids.

The valve is equipped with indication switches for monitoring and visual position indicators to aid in trouble shooting.

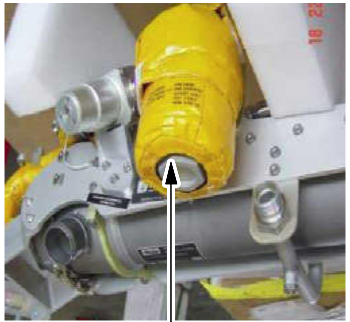
Dual Flapper Check Valve

The Dual Flapper Check Valve has a housing with two internal, spring loaded check valves, which prevent fuel back-flow from the tank to the IGGS.



IGGS CONTROLLER UNIT

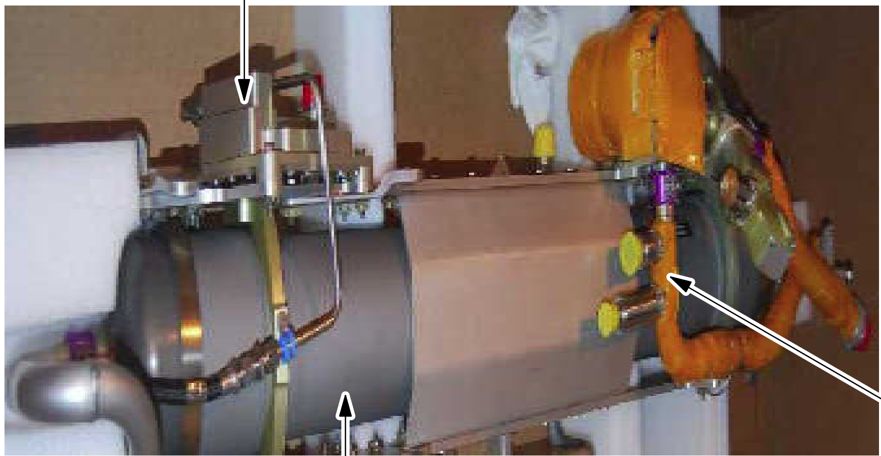
IGGS ISOLATION VALVE



DOUBLE ULTRA LOW PARTICLE (D-ULPA) FILTER

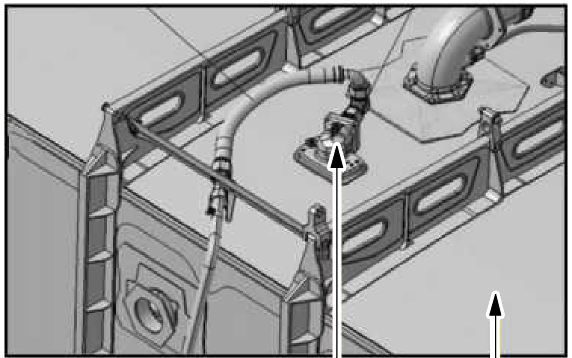
DUAL FLOW SHUT OFF VALVE

OXYGEN SENSOR



AIR SEPARATION MODULE

PRESSURE AND TEMPERATURE SENSOR



CENTER TANK

DUAL FLAPPER CHECK VALVE

Figure 9 Component Description

BITE/CFDS INTERFACE ATA 21/47 – INTRODUCTION

Conditioned Service Air System Controller (CCU) Interfaces

The CCU has interfaces with the **F**light **W**arning **S**ystem (FWS) and the maintenance computer.

The CCU receives temperature information from the ICU and, if necessary, adjusts the Temperature.

If a failure of the CSAS system occurs, the status message ”FUEL INERT“ will come into view only in flight phase 1 and 10 for maintenance.

Inerting Gas Generation System Controller (ICU) Interfaces

The ADIRU 1 supplies Standard Altitude, True Airspeed, Total Air Temperature and Altitude Rate signals to the ICU.

The CCU makes communication possible between the IGGS controller, the CFDIU and the FWS.

Both controllers monitor the operational conditions independently but the communication between the two controllers is used to transfer the condition of each system.

For example, if the CSAS stops because of an overtemperature scenario, the CCU will tell the ICU that the system is closed and they will compare the readings of the sensors that come from the two systems.

If a failure in the IGGS system occurs, the ICU sends a failure message to the CCU and the CCU gives an ECAM warning, at the end of the flight, for maintenance functions.

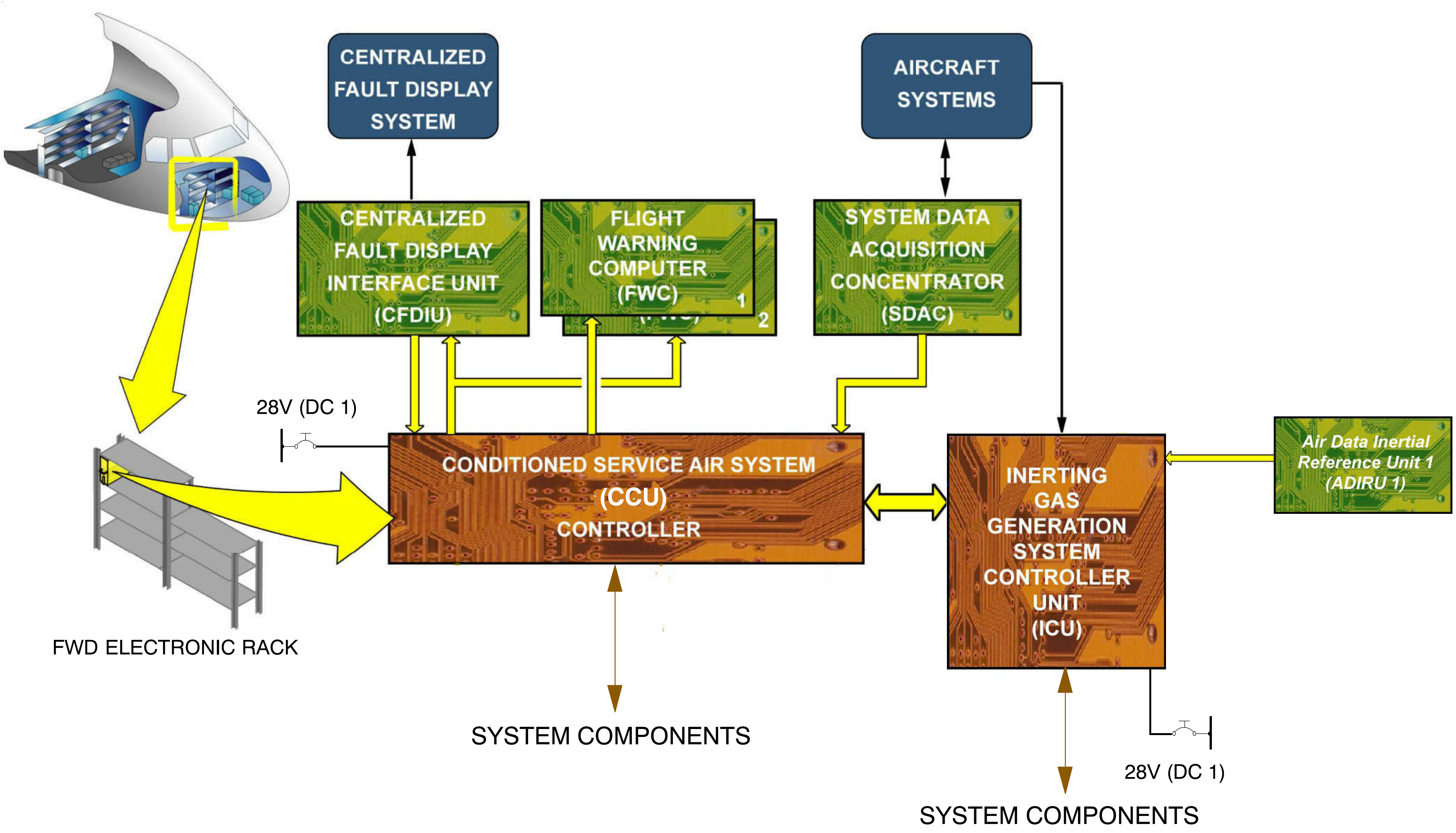


Figure 10 CCU/ICU Interfaces

BITE/CFDS

The **C**entralized **F**ault **D**isplay **I**nterface **U**nit (CFDIU) gives test functions of the CCU, available through the MCDU in the cockpit.

The CCU also has BITE functions of the ICU.

System entry is via the new MCDU menu point:

- CFDS - SYSTEM REPORT/TEST - **INERTING**

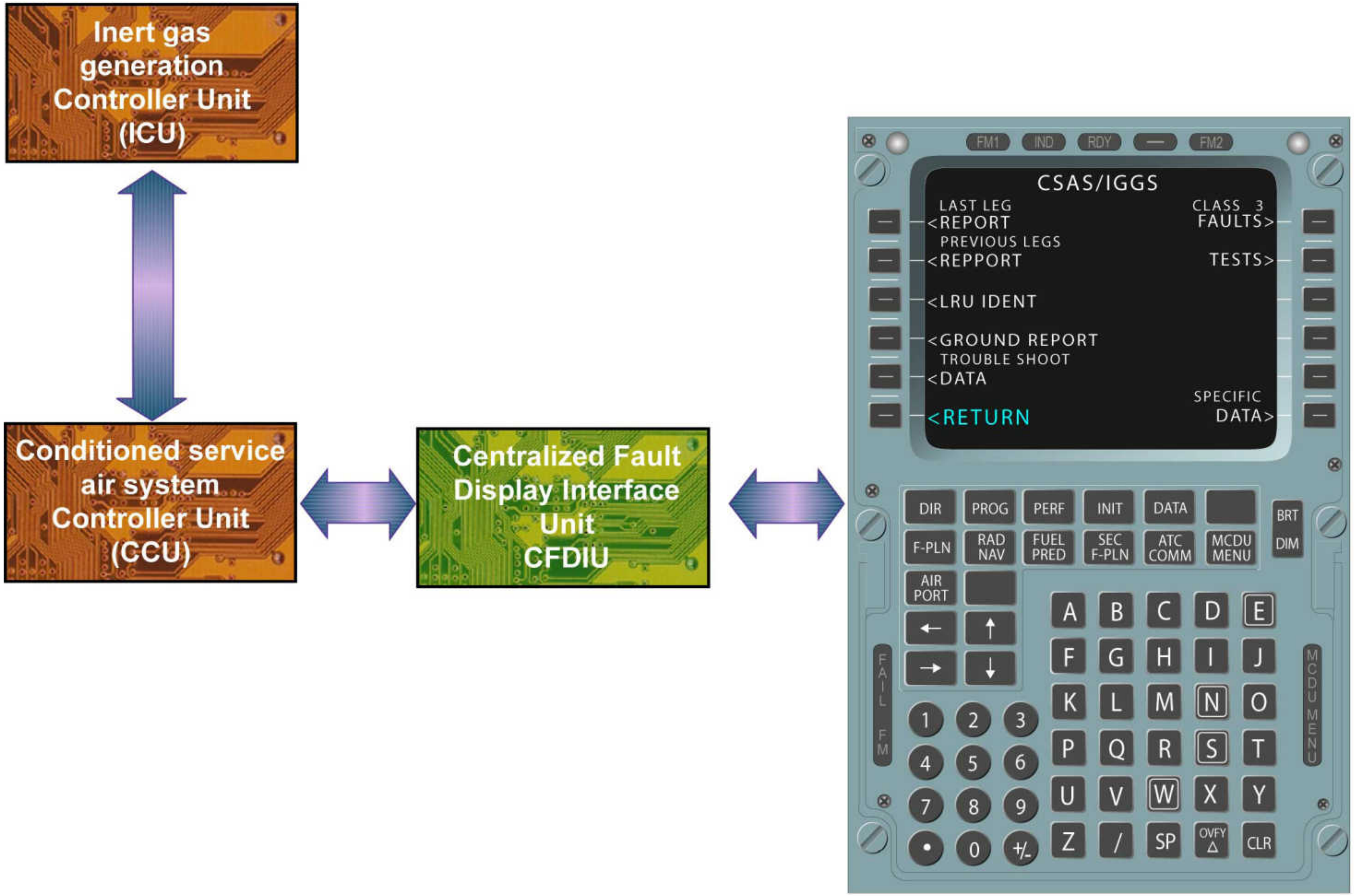


Figure 11 MCDU Menu

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