TECHSAVIATION
Training Center

Este material em hipótese alguma substituirá os manuais do fabricante para qualquer ação de manutenção. Consulte os manuais correspondentes. **EDUCATIONAL PURPOSE ONLY**

Flight Controls

Flight Control Systems

Primary Flight Control Function

The Primary Flight Control Function (PFCF) is a modern, three-axis, flyby- wire system. The fly-by-wire design permits a more efficient structural design. Some benefits of this design are increased fuel economy, smaller vertical fin, and smaller horizontal stabilizer.

This technology lets the airplane meet strict safety requirements with decreased weight and supplies improved control and protection.

The PFCF supplies manual and automatic airplane control and envelope protection in all three axis.

The PFCF calculates commands to move the control surfaces with sensor inputs from these components:

- Control wheels
- Control column
- Rudder pedals
- Speedbrake lever
- Pitch trim switches
- Rudder trim selector.

These are the control surfaces for roll control:

- Two ailerons
- Two flaperons
- Fourteen spoilers.

For pitch control, there are two elevators and a movable horizontal stabilizer.

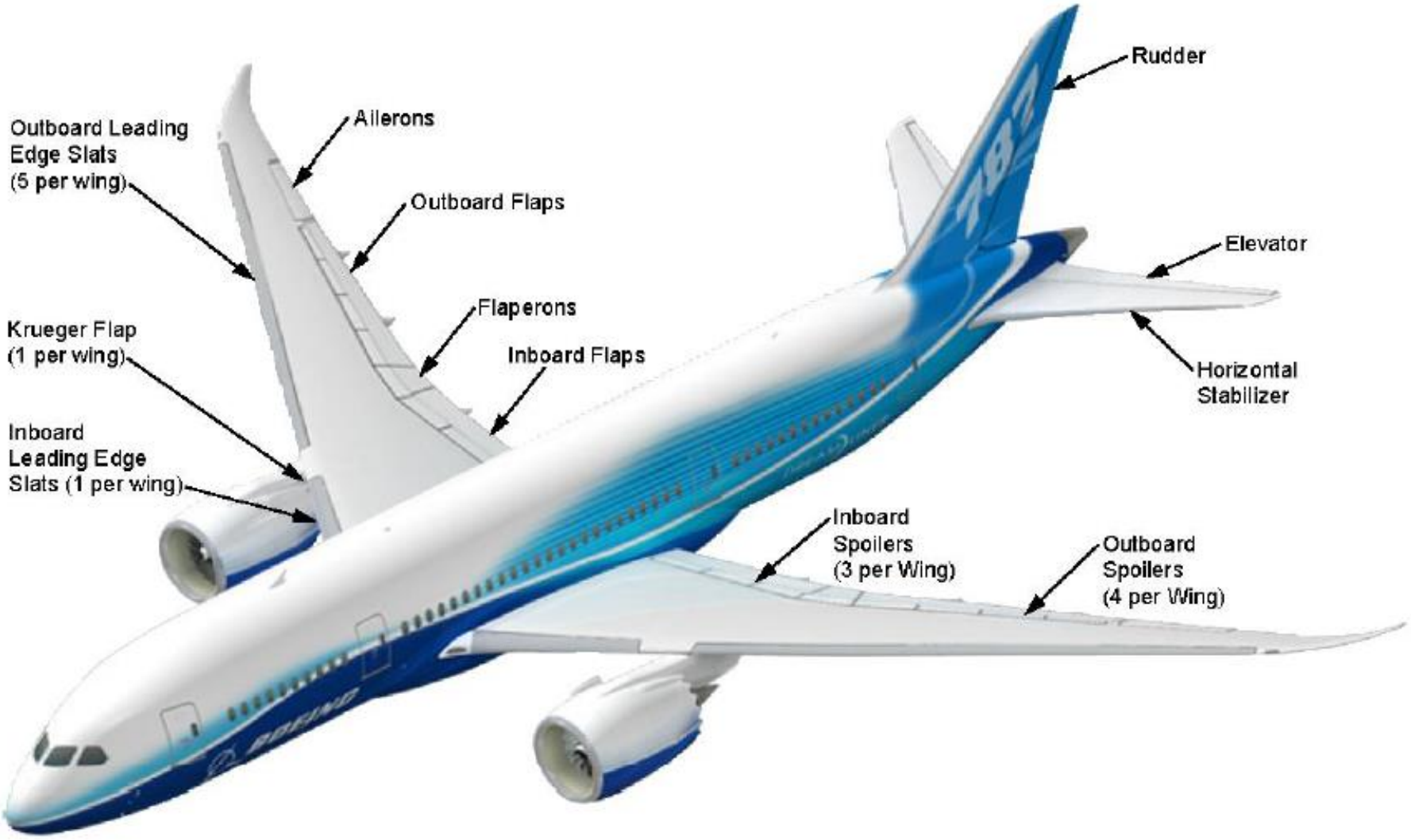
There is a single-piece rudder for yaw control.

High Lift Function

The High Lift Function (HLF) supplies increased lift at lower speeds for takeoff and landing.

High lift surfaces include one inboard and one outboard trailing edge flap on each wing.

There are six leading edge slats and one Krueger flap on each wing.



Flight Control Functions

Manual Operation

Position transducers change the flight crew commands of the control wheels, the control columns, the rudder pedals, rudder trim switch, pitch trim switches, and the speedbrake lever to electrical signals.

These signals go to the Primary Flight Control Function (PFCF) in the Flight Control Electronics (FCE) cabinets.

The PFCFs communicate with the airplane systems through the Common Data Network (CDN). In addition to command signals from the position transducers, the PFCFs receive these sensor inputs:

- Air data
- Inertial reference data
- Navigation receiver data.

The PFCFs calculate the flight control commands based on control laws, stability augmentation, ride quality, envelope protection, and load alleviation. The digital command signals from the PFCFs go to these components:

- Remote Electronics Units (REU)
- Spoiler REUs
- Electric Motor Control Units (EMCU)
- Empennage Door Actuation System (EDAS) controller
- (787-9/787-10)
- Power Drive Units (PDU) for flaps and slats.

The REUs are integrated with hydraulic Power Control Units (PCU) to operate the rudder, elevators, ailerons, and flaperons.

The spoiler REUs control 10 hydraulically operated spoilers.

Four spoilers are controlled by EMCUs.

The horizontal stabilizer is also controlled by two separate EMCUs.

On the 787-9 and the 787-10, the EDAS controller operates electric actuators for the laminar flow function on the vertical and horizontal stabilizers.

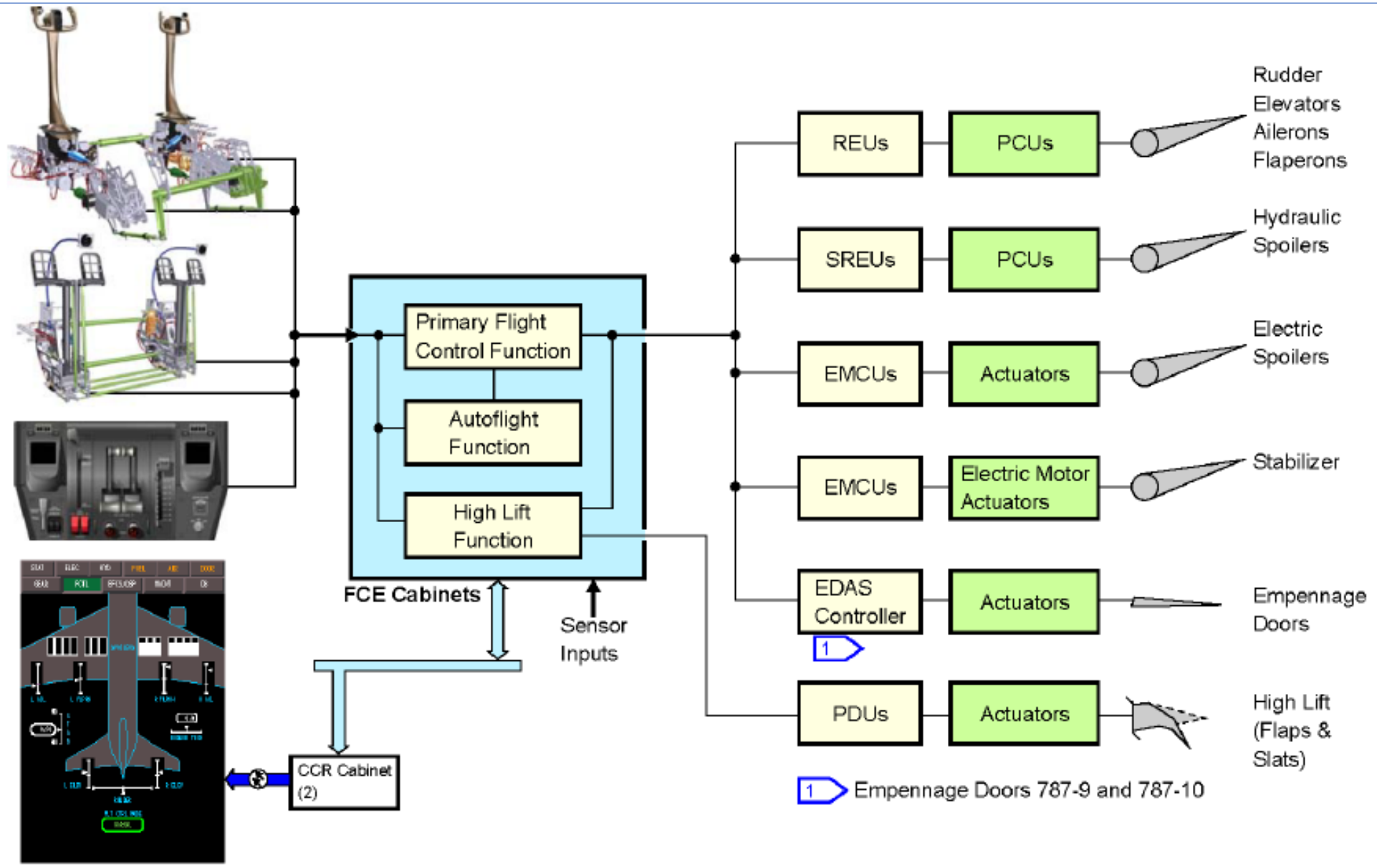
The High Lift Function (HLF) operates the PDUs to control the leading edge flaps/slats and the trailing edge flaps.

Autopilot Operation

The PFCFs receive autopilot commands from the Autoflight Function (AFF) in the FCE cabinets.

The PFCFs calculate the flight control commands in the same manner as for manual operation.

In addition, the PFCFs supply the backdrive signals to the backdrive actuators. The movement of the flight deck controls supplies visual feedback of autopilot control to the flight crews.



Flight Control Functions

Flight Controls and Indications

These are the flight controls:

- Two control columns
- Two control wheels
- Two sets of rudder pedals
- Control wheel pitch trim switches
- Alternate pitch trim switches
- Rudder trim selector
- Flap lever
- Alternate flap switches
- Speedbrake lever
- Horizontal stabilizer cutout switches.
- Flight control lock switches
- Primary Flight Control (PFC) disconnect switch.

The control columns, control wheels, and rudder pedals provide mechanical inputs to electrical position transducers.

The control wheel pitch trim switches send signals to the Flight Control Electronics (FCE) cabinets to change the airplane trim reference speed.

The alternate pitch trim switches provide a different control path for the horizontal stabilizer.

The rudder trim selector is used to change the rudder neutral position.

The flap lever is used to position the leading edge and trailing edge devices. It has gates at the 1 and 20 positions.

The alternate flap switches provide a different method of operating the leading edge and trailing edge devices.

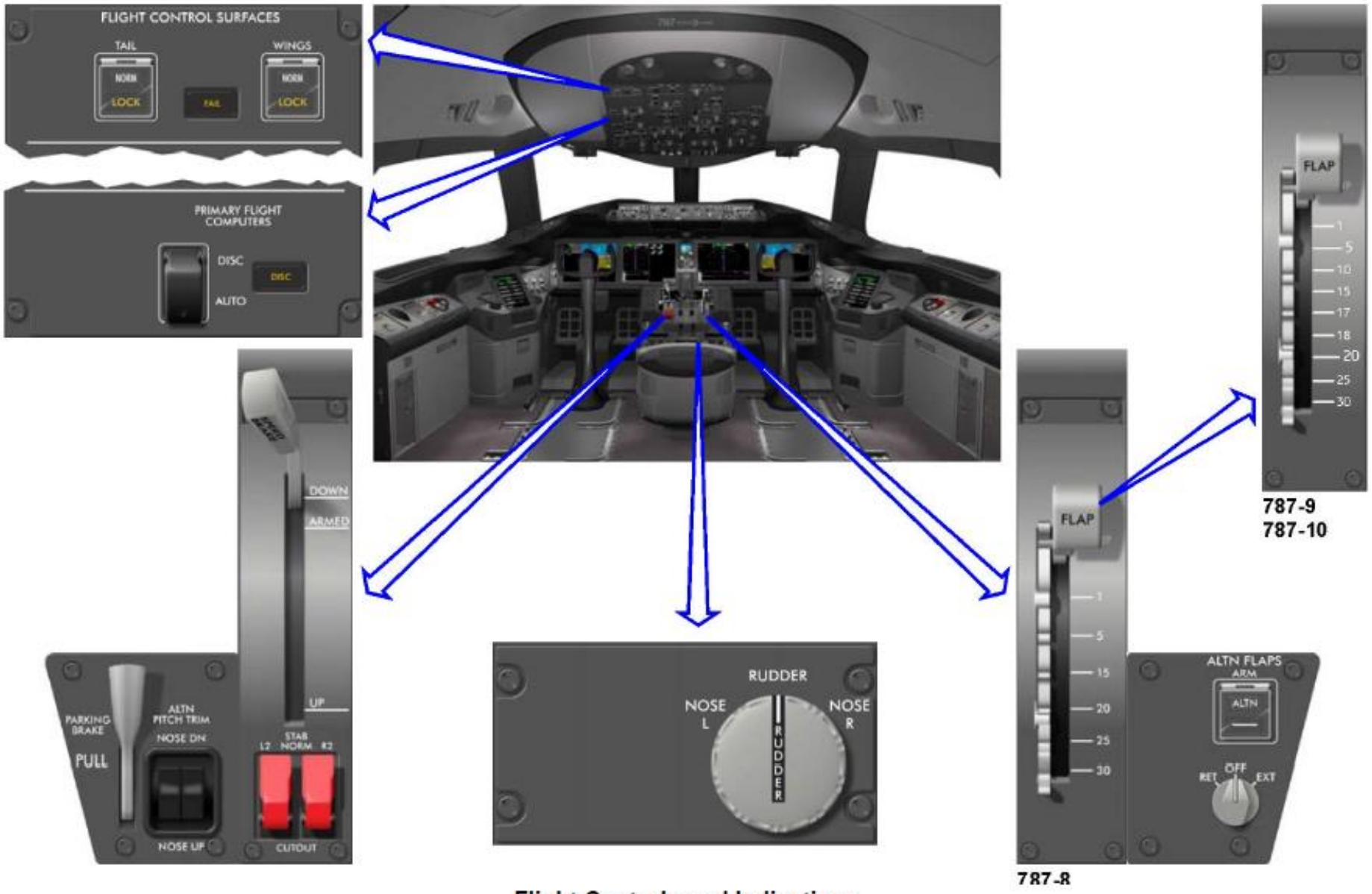
The speedbrake lever arms and/or operates the spoilers in the air or on the ground.

The horizontal stabilizer cutout switches remove power from the stabilizer electric motors.

The flight control lock switches are used to lock out the controls on the wing and tail of the airplane on the ground.

The PFC disconnect switch is used to select the flight control direct mode. It is also used to restore normal or secondary mode operation in flight.

There is an annunciator to indicate when the flight control system is in the direct mode.



Flight Controls and Indications

Flight Controls EICAS Indications

These are the flight control indications on the EICAS display:

- Horizontal stabilizer
- Flaps
- Rudder trim.

The horizontal stabilizer indication shows a digital readout and analog pointer for stabilizer trim.

The digital readout and pointer are green if the trim is within the green band range. They will be white if not in the green band range.

The Flight Management Function (FMF) calculated stabilizer setting is shown in magenta above the digital readout.

The flap indication is a white vertical tape with flap position data on the right side of the tape.

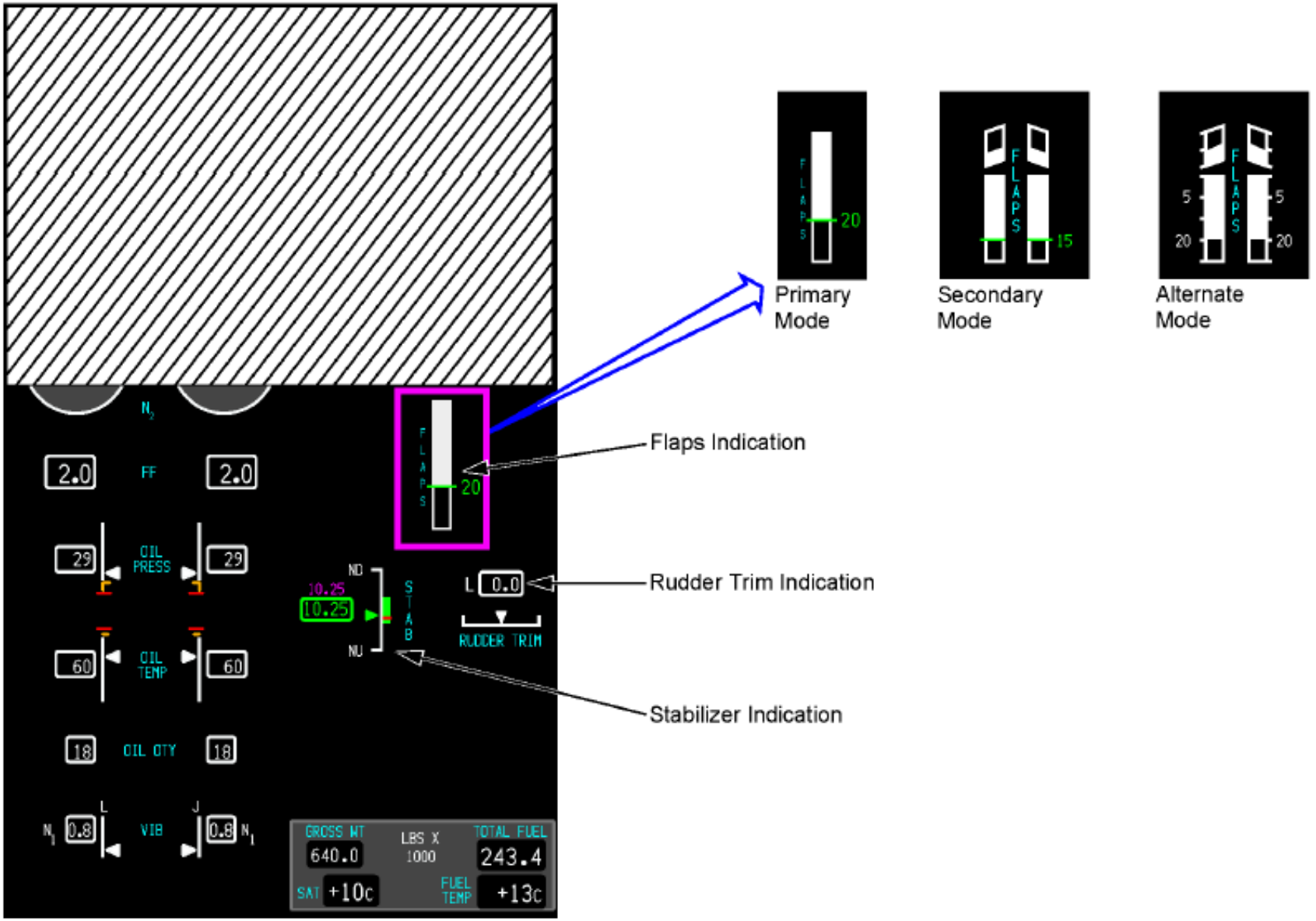
When the flaps are in the commanded position, the bar and number are green. If the flaps are in transit, the bar and number are magenta.

When the flaps are fully retracted and 10 seconds have elapsed, the flap indication is blank.

The rudder trim indication shows a digital readout and pointer. An L or R indicates left or right rudder trim.

If rudder trim is inoperative, an amber X is shown inside the box.

The rudder trim and the stabilizer trim indications are blank when the landing gear is retracted and 10 seconds have elapsed or when the airplane has been in the air for 60 seconds.



Flight Control EICAS Indications

Flight Control Synoptic Display

The flight control synoptic display shows the status of the flight control surfaces on an airplane outline.

The synoptic shows this information:

- Spoiler position
- Flaperon position
- Aileron position
- Elevator position
- Horizontal stabilizer position
- Rudder trim position
- Rudder position
- Flight control mode
- Hydraulic system status
- Electrical buses L2 and R2 status
- Actuator Control Electronics (ACE) status.

Normal indications are in white or green. If that data is not available, the indications are blank and if the data is invalid, an amber X is displayed.

The spoiler positions appear as a white vertical tape.

The flaperon, aileron, and elevator positions appear as a pointer on a vertical scale.

The horizontal stabilizer position appears as a digital readout and a pointer on a vertical scale.

The rudder trim position appears as a pointer on a horizontal scale.

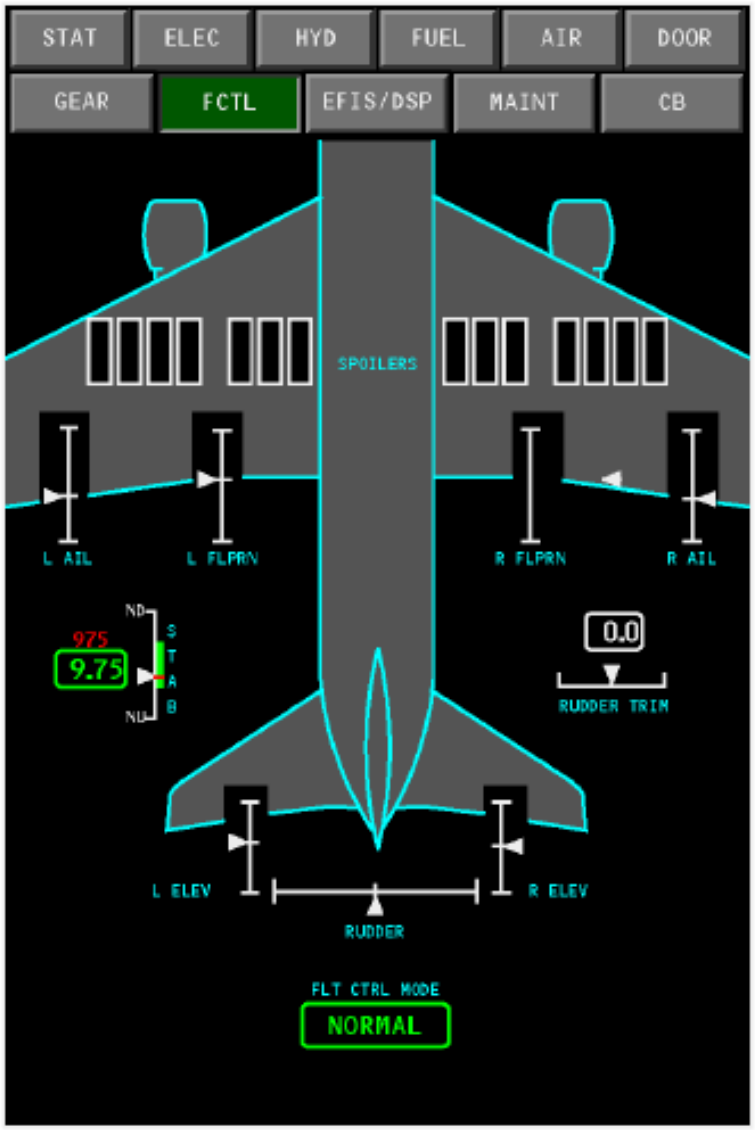
The flight control mode shows these indications:

- Normal (green)
- Secondary (amber)
- Direct (amber).

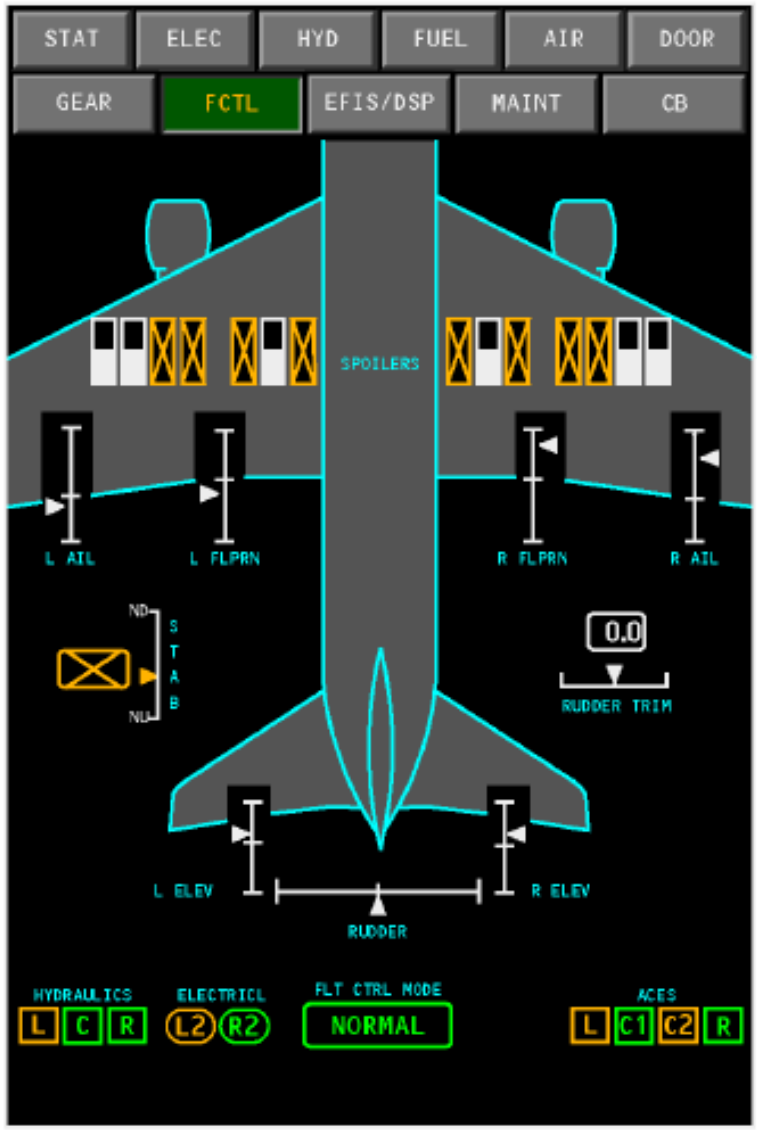
The hydraulic system status blocks appear when there is low pressure in any of the three systems. The system with low pressure appears in amber and the normal systems appear in green. When all three systems are normal, the hydraulic status blocks are removed from the display.

The electrical status blocks appear when either the L2 or R2 235V AC buses are unpowered. The unpowered bus appears in amber and the powered bus appears in green. When both buses are powered, the electrical status blocks are removed.

The ACE status blocks appear when there is a failure. The failed ACE appears in amber and the normal ACEs appear in green. When all the ACEs are normal, the ACE status blocks are removed.



Normal Indications



Non Normal Indications

Flight Controls Synoptic Page

Empennage Door Actuation System

The Empennage Door Actuation System (EDAS) is on the 787-9 and 787-10. The graphic shows the 787-10.

The purpose is to improve the flight control systems by drag reduction.

The EDAS has these components:

- Software logic in the Flight Control Electronics (FCE) R
- Motor controller
- Two motors that operate doors in the stabilizers
- Perforated Leading Edge (LE) of both vertical and horizontal stabilizers
- Ducting to the LE of both vertical and horizontal stabilizers
- Purge and Suction System (PASS) doors.

The doors have these positions:

- One position for closed on the ground
- A second position at low airspeed to pressurize the LE cavity
- Multiple positions for cruise (high airspeed and altitude).

The EDAS is part of the hybrid laminar flow control system, which generates laminar flow.

The boundary layer suction through the perforated titanium empennage LE creates laminar flow. The suction is from venting the LE cavity to downstream areas of low pressure.

The system is passive because there is no active flow control, such as a vacuum or pumping system.