

Avidyne Corporation
55 Old Bedford Road
Lincoln, MA 01773


FAA Approved
Airplane Flight Manual Supplement
For
Cirrus Design Corporation Model SR20/SR22
and SR22 when modified per STC SA10588SC
(Tornado Alley turbo-normalizer)
with
Avidyne DFC90 Digital Flight Control System p/n 700-00170-000

Registration No. _____

Serial No. _____

This supplement must be attached to the applicable FAA Approved Airplane Flight Manual when Avidyne 700-00170-000 DFC90 Digital Flight Control autopilot system is installed in accordance with STC SA00296BO. The information contained herein supplements or supersedes the basic manual only in those areas listed. For limitations and procedures not contained in this supplement consult the basic Airplane Flight Manual.

FAA Approved _____

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FOR


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LOG OF REVISIONS

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Section 1 – General

This airplane is equipped with an Avidyne 700-00170-000 DFC90 Digital Flight Control Autopilot System as a replacement of an S-TEC System 30/55X/55/55SR autopilot along with a hardware-software compatible EXP5000 or Aspen EFD1000 Pilot Pro (s/w version 2.6 or later) Primary Flight Display (PFD). The Avidyne flight control computer will herein be referred to as the “DFC90”.

The DFC90 Autopilot Control Panel (ACP) also contains the autopilot computer and is a form-fit replacement of the removed S-TEC including using the existing S-TEC tray.

The EXP5000 PFD is required to be loaded with Release 8 or later software and EXP5000 PFD version 8.0.4 is required for DCF90 Release 2 or later. The Aspen EFD1000 must be software version 2.6 or later in order to be compatible with the DFC90 autopilot.

Figure 1 depicts the Avidyne 700-00170-000 DFC90 Autopilot Control Panel.



Figure 1 – DFC90 Autopilot Control Panel

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Section 2 – Limitations

1. The DFC90 must not be used during icing conditions.
2. The DFC90 minimum use height is 200ft AGL. This means the autopilot must be disengaged for takeoff and landing and disengaged for missed approach or go around until climb and configuration are established above 200ft AGL.
3. Use of the DFC90 is prohibited in aircraft equipped with pitch trim-only when flaps are deployed more than 50%.
4. Maximum flap retraction speed (50% to full retracted) with autopilot engaged is 110 KIAS in aircraft equipped with pitch trim-only.
5. DFC90 operation is prohibited above 185 KIAS
6. The Avidyne DFC90 Series of Digital Autopilots Pilot's Guide, P/N 600-00252-000, Revision 04, or later appropriate revision, must be available to the pilot during all flight operations.

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Section 3 – Emergency Procedures

Autopilot Disconnect

The DFC autopilot may be disconnected using the stick mounted disconnect switch, which may be accomplished by either a dedicated (red) disconnect button or by center press of the roll/pitch trim switch. Activating pitch trim (up/dn) will also disconnect the DFC90. Additionally pressing the AP button on the DFC90 will disengage the autopilot. In the event the autopilot cannot be disconnected using the normal means, the circuit breaker may be used, however, only the visual disconnect annunciation will be presented on the PFD; no accompanying aural tone will be presented.

Servo Malfunctions

A servo malfunction will result in altitude loss as indicated below. Altitude losses are extracted from the S-TEC System 55 series supplement and are applicable to this modification using S-TEC servos.

Flight Phase	Bank Angle (deg)	Altitude Loss (ft)
Climb	40	200
Cruise	45	300
Descent	40	350
Maneuvering	10	60
Approach	10	80

Disconnect the autopilot in the event of any malfunction that results in significant deviation from that commanded.

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General Failure Mode Information

The only failure modes that result in the loss of a DFC90 autopilot are when the system AHRS is unavailable (Red-Xs over the attitude display) or when the PFD has no power whatsoever.

In all cases, basic airmanship should be exercised and fundamentals such as maintain aircraft control, analyze the situation, and take proper action utilized.

Each DFC90 autopilot contains an internal data recorder for use during service operations. If an anomalous behavior is observed with the autopilot, pressing the “GS” button on the autopilot control panel will act as an event marker to identify an event or a series of events in the data log that will aid the Avidyne Service Center in finding and analyzing the data logs during troubleshooting operations.

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Loss of PFD Display (AHRS still Operational)

Failure Indication:

A loss of display condition is identified by a PFD display being unreadable but PFD bezel button lights are still lit.

Functionality Lost:

Under these conditions, if there are no readable PFD displays left, there is a degradation in the ability to enter some autopilot commands/bug settings.

Recommended Pilot Action:

All autopilot modes remain functional. The pilot will be unable to select target altitudes for altitude captures. For vertical modes use the autopilot VS, and IAS sync capability, and count clicks on the reference (bug) knobs to modify the intended mode reference. For example, to accomplish an altitude capture, one technique is to press the “ALT” button on the autopilot control panel to achieve altitude hold mode. Then push either the “VS” or “IAS” knobs to synch to the current condition and twist the knob in the desired direction, counting each click of the knob (e.g. 5 counter clock-wise clicks of IAS results in 5 knots less than current IAS; each click of the VS knob results in 50 fpm). At this point, engage either “IAS” or “VS” to climb/descend and then press “ALT” again when the standby altimeter shows the desired altitude.

Loss of PFD Bezel buttons

Failure Indication:

A failure of the PFD bezel buttons is indicated by the display still being present and functional but the bezel buttons are inoperative.

Functionality Lost:

The ability to enter altitude and heading autopilot commands/target bugs will be lost.

The ability to change which GPS/VHF navigation source is driving the PFD nav solution will also be lost.

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Recommended Pilot Action:

Use the autopilot in the remaining usable modes (e.g. Alt Hold, NAV, GPSS, VS, IAS, Envelope Protection). Cycle both PFD circuit breakers for less than 20 seconds to conduct a warm-start (warm-starts are PFD power cycles of less than 20 seconds so that the ADAHRS data is intact upon the re-start).

Loss of PFD Display and Bezel Buttons

Failure Indication:

A failure of the PFD display and bezel buttons is indicated by the display being blank or a solid color such as green, and the bezel buttons are inoperative.

Functionality Lost:

The ability to enter some autopilot commands/bugs will be degraded or lost. The rest of the PFD remains functional in this case (e.g. internal ADAHRS, automatic communication with MFD and 3rd party avionics, etc).

Recommended Pilot Action:

Use the autopilot in the remaining usable modes (e.g. Alt Hold, NAV, GPSS, VS, IAS, Envelope Protection). Cycle both PFD circuit breakers for less than 20 seconds to conduct a warmstart. If in a dual PFD airplane the cross-side (#2) ADAHRS may be selected via the panel switch and the autopilot will function normally using the right PFD.

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Loss of Turn Coordinator or Miscompare

Failure Indication:

A failure of the internal turn coordinator is indicated by an alert message (“TC FAIL” or “GYRO MISCOMPARE”) displayed in the autopilot mode annunciator area (top strip) of the PFD display. The autopilot will also disconnect under these conditions if experienced in-flight and the AP disconnect aural tones will be heard. **Note that DFC90 Release 2 or later will not disconnect with these messages.**

Functionality Lost:

One of the two attitude comparators that are running in the background will be inoperative in this case.

If the turn coordinator is failed upon initial power-up, the autopilot will be prevented from engaging in any mode. This special case is indicated by a yellow “AUTOPILOT INOP TURN COORDINATOR FAIL” message in the center of the PFD autopilot mode annunciator area.

Recommended Pilot Action:

Apply extra attention to the normal instrument cross check and if the PFD display(s) are assessed to be accurate, manually re-engage the autopilot in the desired mode.

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Loss of AHRS

Failure Indication:

A failure of an AHRS is identified by Red-Xs over the attitude and HSI compass card. Additionally, a yellow “AUTOPILOT INOP AHRS FAIL” message is displayed in the center of the autopilot mode annunciator area on the PFD. AP disconnect aural tones will be heard.

Functionality Lost:

A loss of the AHRS will result in a complete loss of autopilot functionality in a single ADAHRS installation.

Recommended Pilot Action:

Immediately transition to hand-flying via the standby instruments and seek VMC as soon as feasible. Perform a single PFD warmstart by cycling both PFD circuit breakers for less than 20 seconds.

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Loss of Air Data

Failure Indication:

A failure of the on-board air data system is indicated by the airspeed, altimeter and vertical speed tapes being replaced by Red-Xs.

Functionality Lost:

The following autopilot modes will be lost::

- Altitude Hold
- Altitude Capture
- IAS Hold
- VS Hold
- Envelope Protection

Recommended Pilot Action:

Press the “STRAIGHT & LEVEL” button on the autopilot control panel, OR, manually disconnect the autopilot, maneuver the airplane to the desired attitude, and then re-engage the autopilot via the “AP” button, which puts the system into Roll and Pitch Hold. All lateral modes are still fully functional including Heading mode as are Roll and Pitch, Straight and Level, and NAV modes including glide slope.

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Loss of PFD

Failure Indication:

A total failure of the PFD is indicated by both the display and bezel buttons all blank/unlit.

Functionality Lost:

A loss of the PFD will result in a complete loss of autopilot functionality in a single ADAHRS installation.

Recommended Pilot Action:

Immediately transition to hand-flying via the standby instruments and seek VMC as soon as feasible.

Perform a PFD warmstart by cycling both PFD circuit breakers for less than 20 seconds. A successful warmstart will restore all PFD and autopilot functionality.

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Loss of Engine

Loss of engine does not affect the DFC90 operation but use of the DFC90 autopilot can be useful during loss of engine situations. One technique is to set the IAS bug to best glide speed and engage IAS mode in the event of engine-out conditions. The autopilot will adjust aircraft pitch as required to slow down, or speed up to achieve V_g , freeing up time to perform other cockpit duties during this emergency situation.

One minor variation of this technique is to set the IAS bug to V_g after climb-out so that it is already preset to V_g .

Other Error Modes

Autopilot failures that prevent any operation are annunciated across the center of the PFD mode annunciator strip in amber (yellow) as shown in the example immediately below.

PFD Autopilot Annunciator



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General or Unknown Failures

Failure Indication:

If the DFC-PFD system recognizes that the autopilot is invalid but cannot decipher the reason, a yellow “AUTOPILOT INOP” message is displayed along middle of the PFD annunciator strip.

Functionality Lost:

All autopilot functionality will be lost for the duration of this message display, meaning the autopilot would disconnect or prevent engagement. It is possible that the autopilot will conduct an auto-reset which would kick off any engaged autopilot mode but following a successful reset, all functionality would be restored and a manual re-command of autopilot modes will be available.

Recommended Pilot Action:

Immediately transition to hand-flying via the PFD display. If the autopilot does not conduct a successful automatic restart, perform an autopilot restart by cycling the autopilot circuit breaker.

TC Mismatch during Ground Operations

Failure Indication:

If the DFC-PFD system recognizes that the AHRS and the Turn Coordinator are experiencing a mismatch during ground operations, a yellow “AUTOPILOT INOP AHRS MISMATCH” message is displayed along middle of the PFD annunciator strip.

Functionality Lost:

This message can only occur on the ground and if it does, the autopilot will not engage in any modes while this alert is active.

Recommended Pilot Action:

Cycle power to the PFD and autopilot via the circuit breakers or using the Avionics Master. If that is not successful, plan the flight without the autopilot.

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Built-in Test (BIT) Failure

Failure Indication:

If the DFC-PFD system recognizes that the autopilot is invalid due to failing an internal self-test, a yellow “AUTOPILOT INOP SELF TEST FAIL” message is displayed along middle of the PFD annunciator strip.

Functionality Lost:

All autopilot functionality will be lost for the duration of this message display. It is most likely experienced during initial power on of the autopilot during ground operations and therefore, would not allow autopilot engagement.

Recommended Pilot Action:

If on the ground and the fault does not clear itself within 15 seconds, cycle power to the autopilot either via the circuit breaker or the overall avionics master.

If unsuccessful, recognize that all autopilot functionality will be lost so plan your flight accordingly.

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AHRS Aligning

Failure Indication:

If the PFD AHRS has not finishing aligning, a yellow “AUTOPILOT INOP AHRS ALIGNING” message is displayed along the middle of the PFD annunciator strip. This message should be expected to be seen during all normal ground operations in the course of all standard alignments.

Functionality Lost:

Since the DFC autopilot requires a fully aligned AHRS for its attitude source, the autopilot will remain non-functional until the AHRS is aligned and the message is removed.

Recommended Pilot Action:

If on the ground, wait until the AHRS has finished aligning before taking off.

If in the air, follow the PFD Pilot Guide instructions for completing an in-air restart before attempting to use the autopilot. If the in-air restart is not successful, plan the rest of the flight without use of the autopilot.

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No Communication With Autopilot

Failure Indication:

If the PFD stops receiving data from the autopilot, a yellow “NO COMMUNICATION WITH AUTOPILOT” message is displayed in the center of the PFD annunciator strip.

Functionality Lost:

All autopilot functionality will be lost for the duration of this message display. It is possible that the autopilot will conduct an auto-reset which would kick off any engaged autopilot mode but following a successful reset, all functionality would be restored and a manual re-command of autopilot modes will be available.

Recommended Pilot Action:

Immediately transition to hand-flying via the PFD display.
If the autopilot does not conduct a successful automatic restart, attempt an autopilot restart by cycling the autopilot circuit breaker.

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Alerts

In addition to recognized system failures as noted above, there are several alerts that may affect DFC autopilot and subsequent pilot operations.

Trimming Up/Down

Failure Indication:

If the DFC-PFD system recognizes that trim has been running for an excessive duration (4 seconds), a yellow “TRIMMING UP” or “TRIMMING DN” message is displayed along the right edge of the PFD annunciator strip.

Functionality Lost:

No functionality has been lost. In all cases, the trim system can be manually overridden with pilot-controlled control stick/yoke inputs.

Recommended Pilot Action:

Monitor the alert and if it is removed within a few seconds, no further action need be taken – the autopilot is operating normally.

If the alert is present for more than a few seconds, disconnect the autopilot, manually trim the aircraft accordingly and if autopilot operations are still desired, re-engage the autopilot in the desired mode.

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GPSS Invalid

Failure Indication:

If the DFC-PFD system recognizes that the autopilot mode is GPSS but the roll steering information from the GNS-430 is invalid, a yellow “GPSS INVALID” message is displayed along the right edge of the PFD annunciator strip.

Functionality Lost:

Either a flight plan has not been entered in the governing GNS-430 and GPSS mode was selected on the autopilot control head in which case, there is no loss of functionality, or the system is unable to fly the flight plan in GPSS roll steering due to a GNS-430 error or the ground speed is less than 40 knots.

Recommended Pilot Action:

Enter a flight plan into the GPS/VHF navigation source or select an autopilot mode that is not GPSS.

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Nav Invalid

Failure Indication:

If the DFC-PFD system recognizes that the VHF lateral nav signal from the GPS/VHF navigation source is invalid, a yellow “NAV INVALID” message is displayed along the right edge of the PFD annunciator strip. In addition, the Horizontal Deviation Indicator (HDI) along the bottom edge of the ADI will be Red-X’d.

The autopilot will command a wind corrected course hold and, if sufficient power is available, the flight path angle at the time the system displayed “NAV INVALID”.

Functionality Lost:

The ability to track a VHF lateral course (VOR or Localizer) from the selected GPS/VHF navigation source has been lost.

Recommended Pilot Action:

Switch to the GPS/VHF navigation source that is driving the PFD CDI and autopilot. If unable to select a usable alternative navigation source, take the proper action when a navigation source has been lost. If on a published approach that requires VHF-based lateral guidance, the approach must be terminated.

Alternately, switch to GPSS or Heading modes of the autopilot for lateral mode operations.

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Glide slope Invalid

Failure Indication:

If the DFC-PFD system recognizes that the VHF vertical nav signal (glide slope) from the GNS-430 is invalid, a yellow “GS INVALID” message is displayed along the right edge of the PFD annunciator strip. In addition, the Vertical Deviation Indicator (VDI) along the right edge of the ADI will be Red-X’d.

Functionality Lost:

The ability to track a VHF vertical course (Glide Slope) from the selected GPS/VHF navigation source has been lost.

Recommended Pilot Action:

Switch the GPS/VHF navigation source that is driving the PFD VDI and autopilot. If unable to select a usable alternative navigation source, take the proper action when the glide slope signal has been lost. If on a published ILS approach, transition to non-precision approach procedures and minimums or go missed approach. **Note that the autopilot will transition to ALT mode on loss of valid GS signal.**

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TC Fail

Failure Indication:

If the DFC-PFD system recognizes that the blind-mounted turn coordinator has failed, a yellow “TC FAIL” message is displayed along the right edge of the PFD annunciator strip. In addition, the autopilot, if it were engaged at the time, will automatically disconnect and the AP disconnect aural tones will be heard.

Functionality Lost:

If on the ground, the autopilot will not allow engagement in any mode with this condition.

If the turn coordinator fails at any time after initially working during any given ground operation or flight, then the only autopilot functionality that has been lost is the automatic, behind-the-scenes comparator that is running between the Avidyne AHRS and the blind-mounted turn coordinator. The autopilot will automatically disengage but will allow manual re-engagement and will still function in all modes during this condition.

Recommended Pilot Action:

If on the ground during this condition, cycle power to the turn coordinator by cycling the avionics master. This also has the affect of cycling power to the autopilot itself which would clear any false reports of TC failure.

If the alert is presented at some time after initial autopilot engagement, re-engage the autopilot and continue standard autopilot operations but be vigilant knowing that the AHRS-TC comparator is not running.

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AHRS Miscompare

Failure Indication:

If the DFC-PFD system recognizes that a miscompare condition is active between the Avidyne AHRS and the blind-mounted turn coordinator, a yellow “AHRS MISCOMP” message is displayed along the right edge of the PFD annunciator strip. This display alert is accompanied by an aural alert “GYRO MISCOMPARE” that is audible in the headsets. In addition, the autopilot, if it were engaged at the time, will automatically disengage and the AP disconnect aural tones will be heard.

Functionality Lost:

If on the ground, the autopilot will not allow engagement in any mode with this condition. If a miscompare condition is experienced at any time after initially engaging the autopilot in any mode, then the only autopilot functionality that has been lost is the automatic, behind-the-scenes comparator that is running between the Avidyne AHRS and/or the blind-mounted turn coordinator. The autopilot will still function in all modes during this condition. Note that the DFC90 will disconnect on AHRS or GYRO miscompare conditions.

Note that DFC90 Release 2 or later will not disconnect on AHRS or GYRO miscompare conditions.

Recommended Pilot Action:

If on the ground during this condition, cycle power to the turn coordinator by cycling the avionics master. This also has the affect of cycling power to the autopilot itself which would clear any false reports of AHRS-TC miscompares.

If the alert is presented at some time after initial autopilot engagement, evaluate the “goodness” of the PFD AHRS solution by comparing the PFD display to the backup gauges, and if in VMC conditions, the out-the-window view. If it can be concluded that the PFD is accurate, re-engage the autopilot and continue standard autopilot operations but be vigilant knowing that the AHRS-TC comparator has noted sensor miscompare.

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No PFD Comm

Failure Indication:

If the autopilot stops receiving data from the PFD, a yellow “NO PFD COMM” message is displayed along the right edge of the PFD annunciator strip.

Functionality Lost:

All autopilot functionality will be lost.

Recommended Pilot Action:

Immediately transition to hand-flying via the PFD display. Perform a PFD warmstart by cycling both PFD circuit breakers for less than 20 seconds.

MSR Fail

Failure Indication:

If the autopilot computer determines that it can no longer read from, or write to the internal maintenance and safety recorder, a yellow “MSR FAIL” message is displayed along the right edge of the PFD annunciator strip. In addition, all aural associated with the autopilot (e.g. disconnect beeps, envelope protection alerts, autopilot command mismatch alerts), will be absent. In DFC90 release 2, the disconnect tone will remain functional.

Functionality Lost:

The autopilot will still be fully functional in all pilot-usable modes but the on-board data logging has likely stopped and all autopilot aural alerts will be unavailable. Note the disconnect tone will remain functional in DFC90 Release 2 or later.

Recommended Pilot Action:

Apply extra vigilance to the autopilot annunciator status messages along the top of the PFD due to the absence of the associated aural alerts.

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After the flight, notify an Avidyne Service Center or Avidyne Customer Support to coordinate for a repair action.

The following is applicable to DFC90 Release 2 or later:

Servo Limit reached (Applicable to Roll Trim Only installations)

Failure Indication:

In the event the DFC system believes the roll-axis servo limit has been reached, a yellow “**SERVO LIMIT**” text message is displayed along the top edge of the PFD pages.

Functionality Lost:

Reaching Servo Limits Can Cause Uncommanded Rolls

If the roll servo limit is reached, the autopilot may stop following lateral commands. This could appear to the pilot as an uncommanded roll or a failure to follow the commanded lateral target.

Recommended Pilot Action:

As a result, it is highly recommended that a pilot avoid making flight control inputs while in coupled autopilot mode operations aside from minor rudder input to maintain coordinated flight. Moderate rudder or any roll input may result in an inability of the DFC100 autopilot to track the commanded targets.

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Section 4 – Normal Procedures

To Activate the DFC90:

1. Autopilot circuit breaker-----IN
2. Battery 1 or 2 Master Switch -----ON
3. After AHRS fully aligned-----Engage Desired Mode

To Deactivate the DFC90

1. Activate the AP Disconnect Switch

Note: If the disconnect switch is used as the disconnect means, a second press of the disconnect switch will silence the aural disconnect tones.

Or

1. Autopilot circuit breaker-----OUT

Pre-Flight Test

1. Ensure “AP READY” is displayed on PFD annunciator strip
2. Press AP button on autopilot control head
 - a. Ensure AP button is lit in green
 - b. Ensure “AP”, “ROLL”, “PITCH”, annunciations are depicted in green on the PFD annunciator strip
3. Set the Heading Bug to be approximately 90 deg off current aircraft heading
4. Press HDG button on autopilot control head
 - a. Ensure HDG button is lit in green
 - b. Ensure the ailerons are being driven in the proper direction by the servos
 - c. Ensure “HDG” annunciation has replaced ROLL annunciation and that it is depicted in green on the PFD annunciator strip (“UNDERSPEED” may also be displayed along the right edge and the green engaged autopilot modes will flash – this is normal.)
5. Press VS button
 - a. Ensure VS button is lit green
 - b. Adjust VS bug and ensure the elevator is driven in the proper direction by the servo
 - c. Pull or push yoke against engaged pitch servo (pitch servo airplanes only)
 - d. Note trim movement opposing force applied (i.e. fwd pressure results in up trim), (pitch servo airplanes only)

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6. Press the AP Disconnect switch on the control yoke
 - a. Ensure the aural autopilot disconnect tone is heard in the headset
 - b. Ensure “AUTOPILOT DISCONNECTED” annunciation is depicted in yellow on the PFD annunciator strip
 - c. Ensure “AP READY” annunciation is then depicted in green on the PFD annunciator strip
7. Trim the aircraft to the appropriate pre-takeoff position in accordance with normal aircraft checklist procedures.

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Section 5 – Performance

No change from basic Handbook.

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Section 6 – Weight and Balance

No change from basic Handbook. See POH for current weight and balance for this aircraft.

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Section 7 – Systems Description

Note

This supplement provides a general description of the Avidyne DFC90 Digital Flight Control autopilot system p/n 700-00170-000, system operation, and SR22/SR20 interface. For a detailed description of the DFC90, refer to the Avidyne Pilot's Guide P/N 600-00252-000, Revision 04, or later.

The Avidyne DFC90 autopilot supports the following functions:

- Flight Director
- Heading Capture/Hold
- NAV Tracking
- GPSS Mode
- Approach Mode (includes LOC, ILS, VOR, BC)
- Altitude Hold
- Altitude Capture
- Vertical Speed Hold
- Indicated Airspeed Mode
- Straight and Level
- Speed-based Envelope Protection
- Envelope Alerting in Flight Director mode
- Full time Envelope Alerting (DFC90 release 2)
- Pilot Selectable Intercept Angles
- Control Wheel Steering (CWS)

The Digital Flight Control DFC90 autopilot has been designed to be a form-fit replacement for the S-TEC System 55X or replace S-TEC System 30 autopilots. It requires an Avidyne PFD with Release 8 or later (with mod 55). DFC90 release 2 requires Avidyne PFD with Release 8.0.4 or later (with mod 55). Alternately, if an Aspen EFD1000 PFD is installed it requires software release 2.6 or later.

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In a DFC-equipped airplane, the autopilot is able to use the output of the Avidyne or Aspen ADAHRS embedded in the PFD and is therefore an attitude-based autopilot.

The DFC-series of autopilots has a more readily distinguishable indication of armed vs. engaged modes in order to provide the user higher awareness of the current autopilot state and upcoming state transitions.

An armed mode is defined as a state that will be captured when and if the airplane crosses that target. Armed modes are indicated by a cyan (blue) color on both the autopilot control panel and on the PFD mode annunciator strip.

An engaged mode is defined as a state that the autopilot is holding. Engaged modes are indicated by a green color on both the autopilot control panel and on the PFD mode annunciator strip.

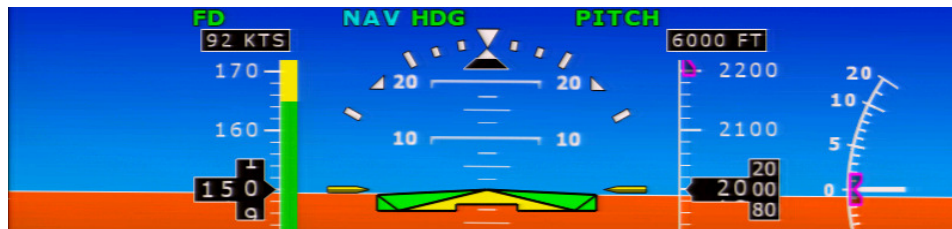
Automatic transition from armed (cyan) to engaged (green) states is indicated by the cyan armed button on the autopilot control panel and mode annunciation on the PFD changing to green and flashing for up to 10 seconds.

The engaged (green) autopilot mode annunciators will also flash when in underspeed or overspeed conditions. This flashing is intended to gain the pilot's attention and to indicate that while the modes are still engaged (green), the underspeed or overspeed condition may be affecting the system's ability to hold the target value. As soon as the underspeed or overspeed condition is no longer true, the annunciators stop flashing and the system re-acquires the target values as required.

The images below demonstrate the armed and engaged coloring on both the display and the autopilot control head. In this example, Heading (HDG) and Pitch modes are engaged and Nav mode is armed.

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Any attempt to engage manual electric trim (MET) via the cockpit controls will result in the autopilot disconnecting and then the trim running as commanded by the MET control.



The DFC90 autopilot has been designed to always have both a lateral and vertical mode engaged. If a specific lateral mode has not been selected by the pilot, then the system defaults to Roll Hold mode. If a specific vertical mode has not been selected by the pilot, then the system defaults to Pitch Hold mode.

A single button press is typically required to engage a desired mode while a dual button press is typically required to capture a new target. For example, to engage altitude hold, press ALT; to engage heading hold, press HDG, to hold indicated airspeed, press IAS. Likewise, to capture a new altitude, press both IAS and ALT or VS and ALT, to capture a course, press both HDG and NAV, etc.

The primary location for setting both the IAS and VS targets are via the dedicated knobs on the autopilot control head.

NOTE

IAS Mode with ALT armed will not allow the aircraft to descend if the altitude target is above and insufficient power is set/available to accelerate to the selected target airspeed and climb. The DFC90 will hold the current altitude until power is applied to accelerate to the target airspeed (bug) and will not climb until sufficient power is available to climb at the target airspeed. Conversely the airplane will not climb to achieve the target airspeed with an armed altitude below the airplane until power is reduced to descend at that airspeed.

The primary location for setting the HDG and ALT targets are via line select keys and right-hand knob on the PFD.

VS target can optionally be set via a line select key on the PFD. The VS target stays synched between the two locations for setting targets. Engagement limits of the autopilot may be wider than the hold limits.

The autopilot will not engage if an engagement was attempted outside of the published engagement limits. If the autopilot was engaged between the maximum engagement limits and the maximum hold limits, the autopilot will reduce the value to be within the published maximum hold limits. DFC90 Release 2 has no engagement limits. The engagement and hold limits are:

Note: Maximum demonstrated engagement is within the non-aerobatic attitude limits of this airplane and within the airspeed and altitude envelope of this type.

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Autopilot Mode	Maximum Engagement Limits	Maximum Engagement Limits (DFC90 Release 2)	Maximum Hold Limits (all)
Roll Hold	±60° bank	None	±22° bank
Heading	±60° bank	None	±22° bank (but typically holds 1 standard rate of turn)
Pitch Hold	±30° pitch	None	±10° pitch
IAS Hold	20 KIAS to V_{ne}	None	1.2 V_s (1.1 V_s in APPR) to V_{ne}
VS Hold	±1600 fpm	None	±1600 fpm
Straight and Level	The demonstrated limits are the same as the autopilot engagement limits	None	Will stabilize in +2° pitch and zero bank angle
Localizer, VOR, GPS approach Capture	Not Applicable	None	±22° bank

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Aural alerting through the aircraft audio system is provided for some important states of the autopilot. In the context of the bullets below, “coupled” describes the condition when the autopilot servos are flying the airplane and “non-coupled” describes the condition when the servos are not flying the airplane and instead, the pilot is expected to follow the flight director command bars. Specifically, aural alerts as defined in the parenthesis are provided under the following conditions:

- Autopilot Disengaged (5 Disconnect beeps)
- Underspeed during coupled operations (“Speed Protection Active”)
- Overspeed during coupled operations (“Speed Protection Active”)
- Underspeed during non-coupled Flight Director-only operations (“Caution, Underspeed”)
- Overspeed during non-coupled Flight Director-only operations (“Caution, Overspeed”)
- AHRS-Turn Coordinator Miscompare (“Gyro Miscompare”)

DFC90 Rel 2 or later:

- Bank beyond 60 degrees during non-coupled or Flight Director-only operations (“Caution Excessive Bank”).
- (Optional) Airspeed above limit for first notch of flaps with any flaps extended (“Caution Flap overspeed”)

NOTE

Flap Overspeed Envelope Alerting and Envelope Protection is more conservative, based on no flaps, without (optional) flap position input.

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Straight and Level mode is entered by pressing the “STRAIGHT & LEVEL” button on the autopilot control panel. The system will light up the control panel button in green (blinking) and immediately change the bank and pitch as required to seek wings level, +2° pitch angle conditions. Once straight and level is achieved, the Straight & Level button on the autopilot control panel will be steady green until another mode is selected. Upset recovery will be a smooth, but depending on the entry attitude, aggressive maneuver designed to achieve those steady state conditions in an expedited manner. At sufficiently high power settings and aircraft configurations (e.g. no drag devices), a +2° pitch angle will result in a shallow climb. At low power settings and/or aircraft configurations, a +2° pitch angle may result in a descent.

Straight and Level mode can be entered from any autopilot state, including from the off position.

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NOTE

Straight and Level Usable Envelope

Even though the Straight and Level button and functionality were demonstrated to be functional in a wide range of aircraft attitudes and energy states during flight test, it should be emphasized that the aircraft limitations as stated in the POH still govern the operational use of the aircraft and normal use of the Straight and Level button. This mode is not to be relied upon to stabilize an aircraft under all conditions.

NOTE

Straight and Level Mode (Aspen PFD) Steady state conditions in this mode result in a +2° pitch angle and wings level. The resultant airspeed and vertical speed is dependent on power and aircraft loading. Any adjustments made to the ATTITUDE REF SYMBOL ADJ value on the Aspen PFD will directly affect the steady state pitch attitude in this mode.

NOTE

Limitation of Overspeed Protection in Straight and Level

Overspeed protection is not ensured during initiation of Straight and Level mode. Depending on the dynamics of the airplane and the available torque in the servos, the recovery to straight and level conditions may exceed V_{ne} . For example, if the aircraft were in an extreme nose-low and/or high-speed condition at time of Straight and Level activation, it is possible for V_{ne} to be exceeded during the recovery to straight and level conditions.

The DFC90 system provides a speed-based form of Envelope Protection.

Envelope Protection, which provides underspeed and overspeed warnings and protection during these autopilot operations, is always operational whenever the autopilot is engaged in any mode.

NOTE

Aircraft Stall Possible with Envelope Protection
Conditions can exist where an aircraft can be placed in an attitude and/or configuration that would exceed the capability of the Envelope Protection system to prevent a stall.

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When the servos are engaged (AP mode), the likelihood that a command that can be made resulting in an autopilot induced stall is significantly reduced over conventional autopilots. If for example, a positive rate of climb was commanded and a low power setting is being held, the autopilot will attempt to achieve the commanded state but as the energy of the airplane decays to approximately $1.2 V_s$ (clean stall speed), the autopilot will adjust bank angle and then pitch angle as required to maintain no lower than $1.2 V_s$. Bank angle may be reduced before pitch is adjusted in an effort to avoid even entering envelope protection. As soon as bank angle is adjusted by the autopilot, the pilot is alerted through visual means on the PFD (“**UNDERSPEED**” text alert and any engaged (green) autopilot mode annunciator will flash) and as soon as pitch is adjusted, the pilot is alerted through the same visual means on the PFD, and aural alerting in the headsets.

If the autopilot is not in AP mode but instead is in FD-only mode, envelope protection is disabled and envelope alerting becomes active. In DFC90 Release 2 (or later) envelope alerting is active as long as the autopilot is powered (indicates RDY). Using that same example of positive climb rate and low power settings, envelope alerting will provide underspeed cautions. If selected, the flight director command bars will indicate bank and pitch to follow the commanded mode but not to reduce bank or increase airspeed. As always in flight director only mode, it is up to the pilot to maneuver the aircraft to achieve the flight director guidance.

Similarly, on the high-speed end of the spectrum, envelope protection will provide protection and alerting near V_{ne} . In this case, as V_{ne} is approached in AP mode, the autopilot will adjust pitch as required to maintain an airspeed near V_{ne} . Aircraft bank angle is not adjusted by the autopilot during overspeed protection. Depending on conditions (e.g. rapidly changing airspeed, turbulence, etc.), it is possible for V_{ne} to be exceeded. An overspeed condition is annunciated to the pilot via an “**OVERSPEED**” text alert on the PFD, an aural alert in the headsets, and by a flashing of any engaged (green) autopilot mode annunciators.

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If the autopilot is not in AP mode but instead is in FD-only mode (or AP On/RDY in Release 2), overspeed protection is no longer functioning but envelope alerting becomes active. In this case envelope alerting will annunciate an overspeed caution several knot below V_{ne} to aid the pilot in avoiding an overspeed condition. If selected, the flight director command bars will indicate pitch to follow the commanded mode but not to reduce airspeed.

NOTE

Envelope Protection During Icing Conditions

The DFC90 autopilot is not to be used during icing conditions. The autopilot does not collect any kind of AOA or icing input and therefore does not register changing aircraft dynamics during icing conditions. Therefore, this means that Envelope Protection is not effective under icing conditions.

NOTE

Suppression of Full-time Envelope Alerting

Full-time Envelope Alerting is suppressed during very low power (near idle) conditions when flaps are set to the full-flap position in order to minimize nuisance calls in the landing phase.

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There is no autopilot-related pilot action that is required after changing the system barometric altimeter setting. In other words, if the autopilot was in Altitude Hold for example, changing the baro setting will result in the autopilot automatically correcting the appropriate amount to re-capture the previous MSL altitude hold target.

The input forces required for roll-axis control surface actuation are demonstrably light and it is not difficult to force the servo (roll trim spring cartridge) to drive to its limit. By design, reaching the physical limit causes a micro-switch to be tripped which effectively decouples the autopilot commands from the flight control surfaces.

Pilot-induced inputs on the system including yoke input, rudder input, p-factor, fuel imbalance, airspeed and general aircraft trim alignment can all contribute to this condition.

WARNING

Reaching Servo Limits Can Cause Uncommanded Rolls. If the roll servo limit is reached, the autopilot may stop following lateral commands. This could appear to the pilot as an uncommanded roll or a failure to follow the commanded lateral target. This message is only applicable to Cirrus installations with Roll Trim Servo only (no dedicated roll servo).

It is highly recommended that a pilot avoid making flight control inputs while in coupled autopilot mode operations aside from minor rudder input to maintain coordinated flight. Moderate rudder or any roll input may result in an inability of the DFC90 autopilot to track the commanded targets.