GFC 500 Autopilot as installed in C172S N97PD (and other aircraft)

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2014 National CFI of the Year
Designated Pilot Examiner
BEFA member since 1997

GFC 500 Autopilot – N97PD / RV12iS / N2365C

GMC 307 Control Unit

Digital input from ADAHRS for Roll / Pitch

G5 AI

G3X Touch

GI 275 AI

GFC 500 Autopilot System Components

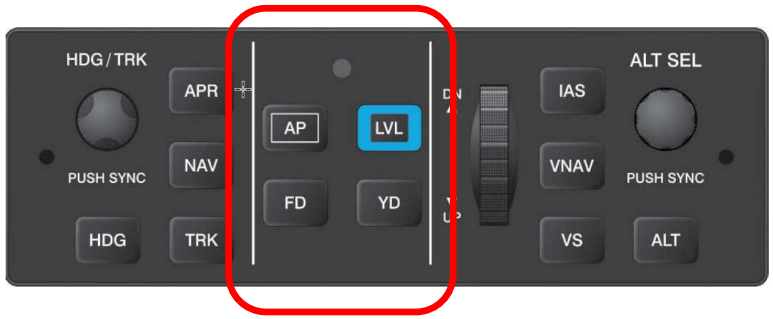
GFC 500 Autopilot Disconnect, Trim, PPT on Yoke

BLACK PPT

RED AP Disconnect & Trim Interrupt

Manual electric trim

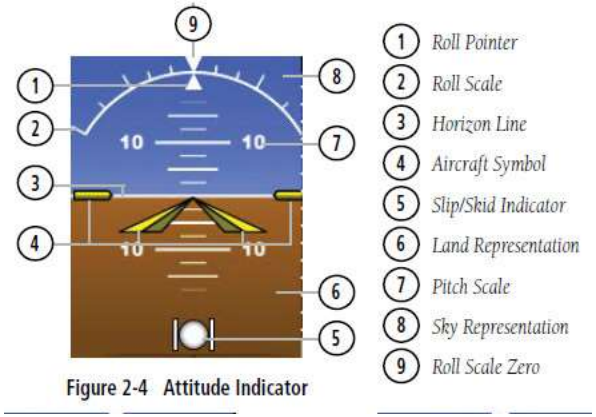
GFC 500 Autopilot



Autopilot supports 3 basic modes of operation via central control buttons:

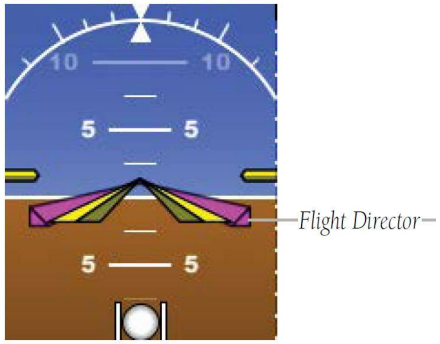
- **FD** Flight Director
- **AP** Full Autopilot Control
- **LVL** Level Roll and Pitch
- **YD** Optional Yaw Damper is not implemented

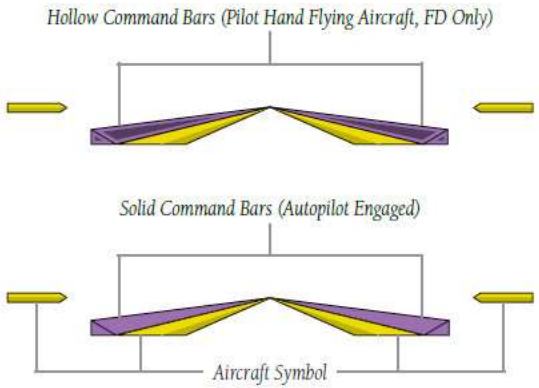
Flight Director on G5



1. Roll Pointer
2. Roll Scale
3. Horizon Line
4. Aircraft Symbol
5. Slip/Skid Indicator
6. Land Representation
7. Pitch Scale
8. Sky Representation
9. Roll Scale Zero

Figure 2-4 Attitude Indicator





GFC 500 Autopilot

Lateral Modes (left buttons) include:

- Heading
- Track
- Navigation
- Approach (Navigation plus GS/GP)
- Roll Hold (default no other mode)

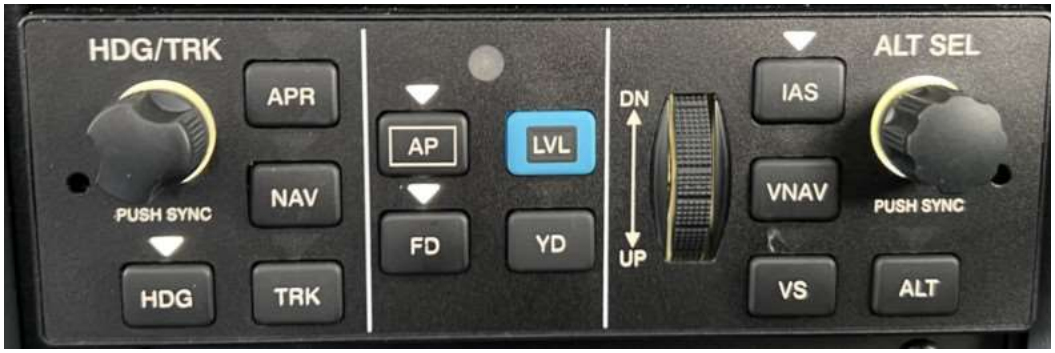
Vertical Modes (right buttons) include:

- Altitude Hold
- Vertical Speed climb/descend (set by pitch wheel)
- Vertical Navigation
- Indicated Airspeed climb/descend (set by pitch wheel)
- Pitch Hold (default with no other mode)

Pilot specified values of Heading/Track and Altitude are selected via rotary knobs on the Autopilot Mode Controller

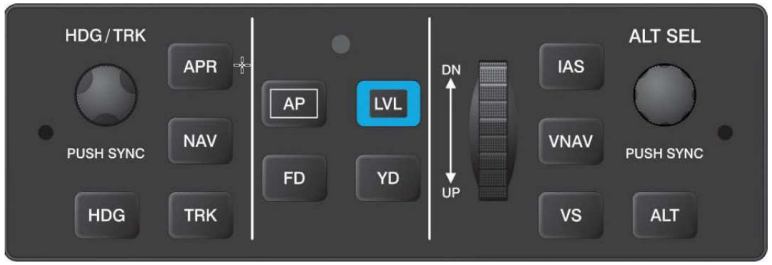
Pressing an Active Lateral or Vertical mode causes the mode to revert to the default ROL/PIT

GFC 500 Autopilot



Lights over selected buttons

GFC 500 Autopilot



Current autopilot modes and Armed (future) autopilot modes are displayed on the G5 AI "Score Board" [Green Active; White Armed]

A TOGA (Takeoff / Go-Around) button on the panel just above the throttle is used on the ground to select Takeoff annunciation (level wings and 7 degrees pitch up) and in the air to initiate a Go-Around, which enables a couple Missed Approach from an instrument approach

A Pilot's Got To Know his GFC 500 Limitations

1. **Pilot's Guide (G5/G3X/GI 275) must be immediately available to the flight crew**
2. **A Pilot must be seated in the left pilot's seat, with seatbelt fastened, during all autopilot operations.**
3. **AP use prohibited during takeoff and landing**
4. **GFC500 AFCS preflight test must complete successfully prior to use of the autopilot, flight director or manual electric trim**
5. **Maximum fuel imbalance with the autopilot engaged is 10 gallons**
6. **Maximum engagement speed is 150 KIAS**
7. **AP engagement is limited to flap positions no greater than 10°**
8. **AP must be disengaged below 200' AGL during approach operations**
9. **AP must be disengaged below 800' AGL for all other operations**
10. **AP is approved for Category 1 precision approaches and non-precision approaches only**

GFC 500 Autopilot Test

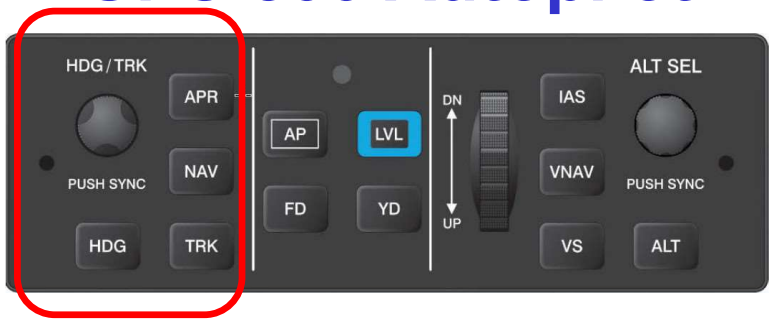
An Autopilot Test is included in the runup section of the revised BEFA checklist

- **Engage the autopilot (default Roll/Pitch mode) by the "AP" button on the control unit**
- **Ensure the AP can be overpowered (both Roll & Pitch) with the control column. The control forces will increase with AP engaged [be gentle]**
- **Note the forces required to overpower the autopilot servo clutches**
- **Verify that Autopilot disengages with the Red AP Disconnect Button**

GFC 500 Autopilot - Methods of Disconnect

- **Press Red AP Disconnect Button on the Yoke (the normal method)**
- **Move the Manual Electric Trim when AP is engaged**
- **Press the AP button on the control unit when AP is engaged**
- **Pull the AP circuit breaker**

GFC 500 Autopilot



Typical Uses of Lateral Modes

- Heading: fly HDG selected by pilot
- Track: fly TRK selected by pilot
- Navigation: track a course (GPS, VOR, LOC)
- Approach: Navigation plus GS/GP

Typical Uses of Vertical Modes

- Climb: Indicated Airspeed (set by pitch wheel)
- Enroute: Altitude Hold (following climb/descent)
- Descent: Vertical Speed (set by pitch wheel) or
- Descent: via Vertical Navigation

GFC 500 Autopilot

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- Approach: Navigation plus GS/GP

Typical Uses of Vertical Modes

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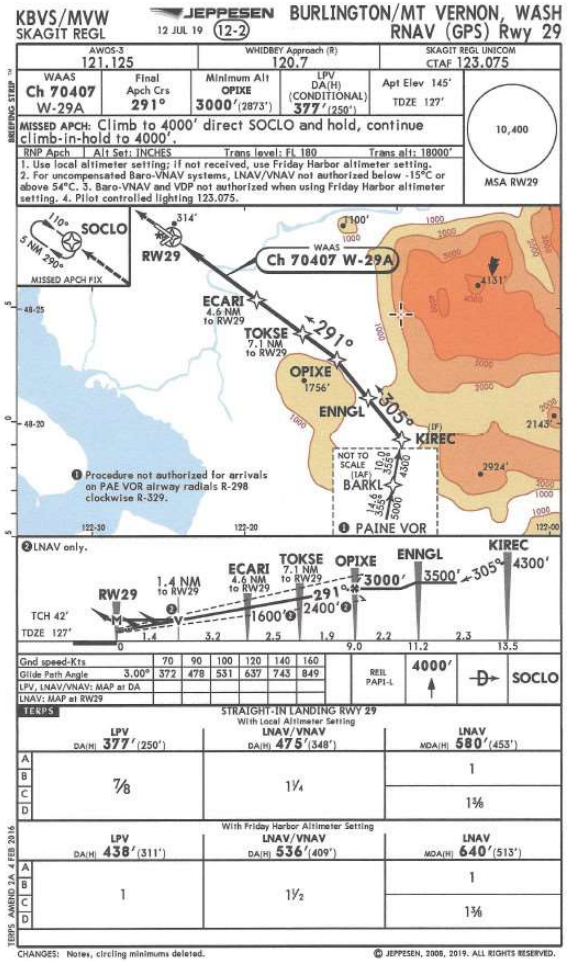
- Enroute: Altitude Hold (following climb/descent)
- Descent: Vertical Speed (set by pitch wheel) or
- Descent: via Vertical Navigation

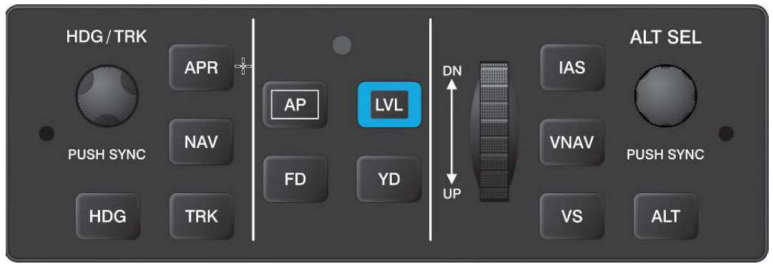
Pitch Wheel moves nose of airplane not value

Note: Pilot should not move elevator with yoke while autopilot is engaged: doing so will cause the autopilot to trim in the opposite direction, potentially to full up or full down trim!


Flying the Garmin GFC 500 Autopilot (webinar recording)
GARMIN
AVIATION TRAINING
Flight Scenario
KSSF-KTFP
GFC 500 AFCS
Play (k)
36:22 / 1:03:37 • Abnormal Operations ›
Scroll for details

GFC 500 Autopilot and VNAV





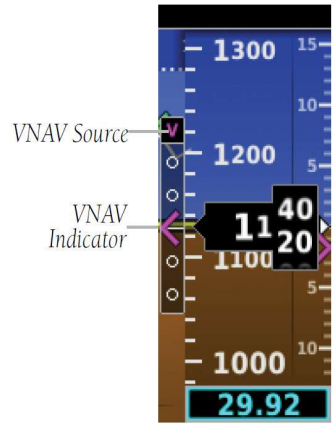
Vertical Modes include:

- **Altitude Hold**
- **Vertical Speed climb/descend (set by pitch wheel)**
- **Vertical Navigation**
- **Indicated Airspeed climb/descend (set by pitch wheel)**
- **Pitch Hold (default with no other mode)**


Settings
IAS
0 KT
HDG
214°
ALT
2500 FT
Resources
GARMIN
HOME
Push
COM
124.70
KRNT TWR
STBY
121.60
KRNT GND
Com Vol
Psh Sq
Audio Panel
Intercom
MIC
1
MON
1
XPDR
IDENT
1200
STBY
NAV SEA
116.80
SEA VOR
STBY
110.60
PAE VOR
PROC – Approach
Sequence
PAE
BARKL 355° 14.6 NM
KIREC 355° 10.0 NM
ENNGL 306° 2.3 NM
OPIXE 306° 2.2 NM
TOKSE 291° 1.9 NM
ECARI 291° 2.5 NM
RW29 291° 4.6 NM
SOCLO
KBVS
4000 FT
KNUW
KIREC
KNRA
430
BARKL
5000 FT
PAE
10 NM
Airport
KBVS
Approach
RNAV 29 GPS LPV
Transition
PAE
Channel / ID
70407 W29A
Load Approach
Load Approach & Activate
Cancel
Chart
In
Out
ENR DEMO GPS
Com Freq / Psh Nav
+
IAS
-
+
ALT
-
Push
Track Mode: Manual
-
HDG
+

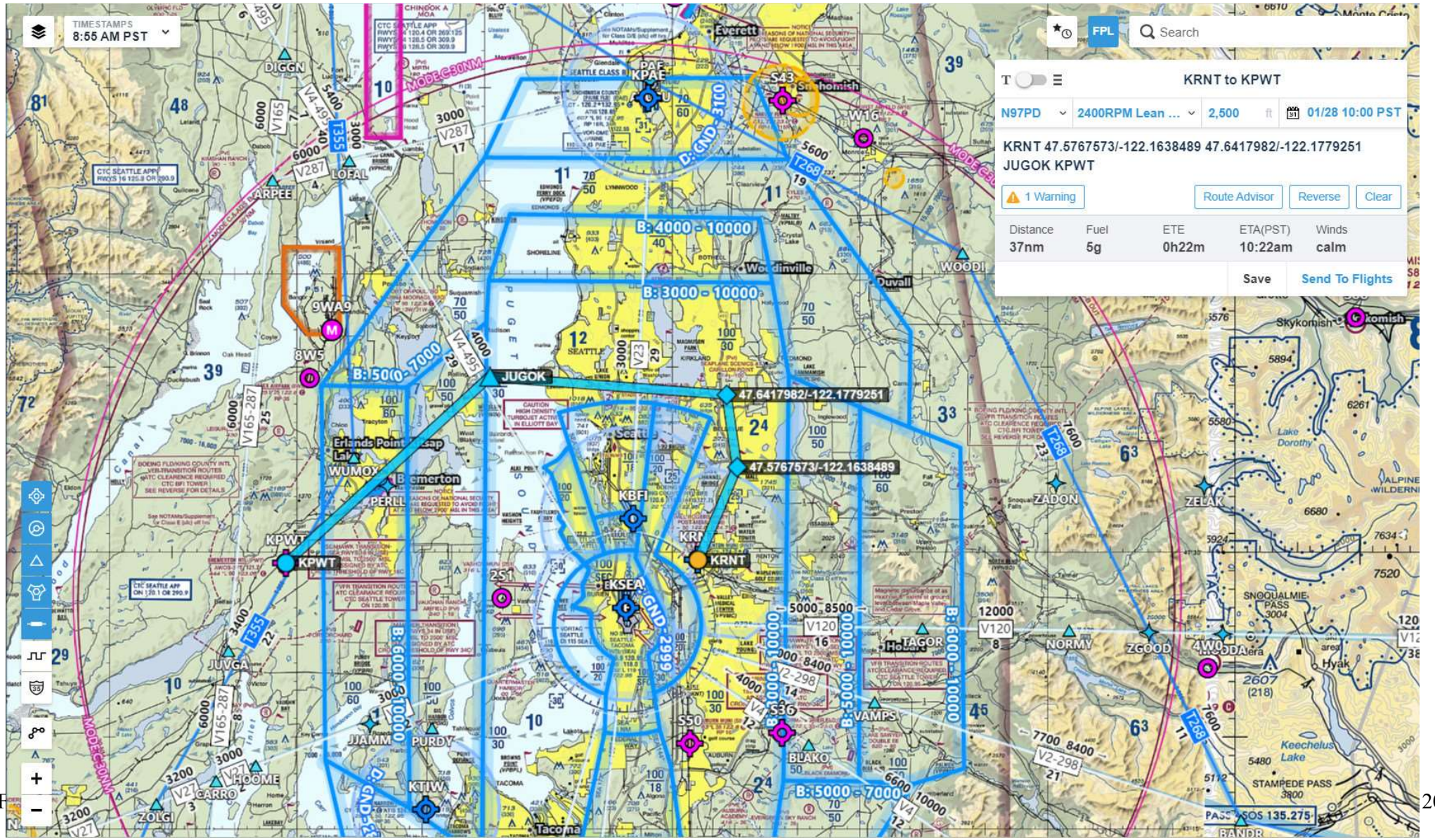

Settings
IAS
0 KT
HDG
214°
ALT
2500 FT
Resources
GARMIN
HOME
Push
COM
124.70
KRNT TWR
STBY
121.60
KRNT GND
Com Vol
Psh Sq
Audio Panel
Intercom
MIC
1
MON
1
XPDR
IDENT
1200
STBY
NAV SEA
116.80
SEA VOR
STBY
110.60
PAE VOR
Active Flight Plan
KBVS / KBVS
ALT
DTK
DIS
BARKL iaf 5000 FT 355° 39.9 NM
KIREC 4300 FT 355° 10.0 NM
ENNGL 3500 FT 306° 2.3 NM
OPIXE faf 3000 FT 306° 2.2 NM
TOKSE 2400 FT 291° 1.9 NM
Back
Menu
Up
Down
TERM
DEMO
GPS
Com Freq / Psh Nav
+
IAS
-
+
ALT
-
Push
Track Mode: Manual
-
HDG
+

VNAV Basics

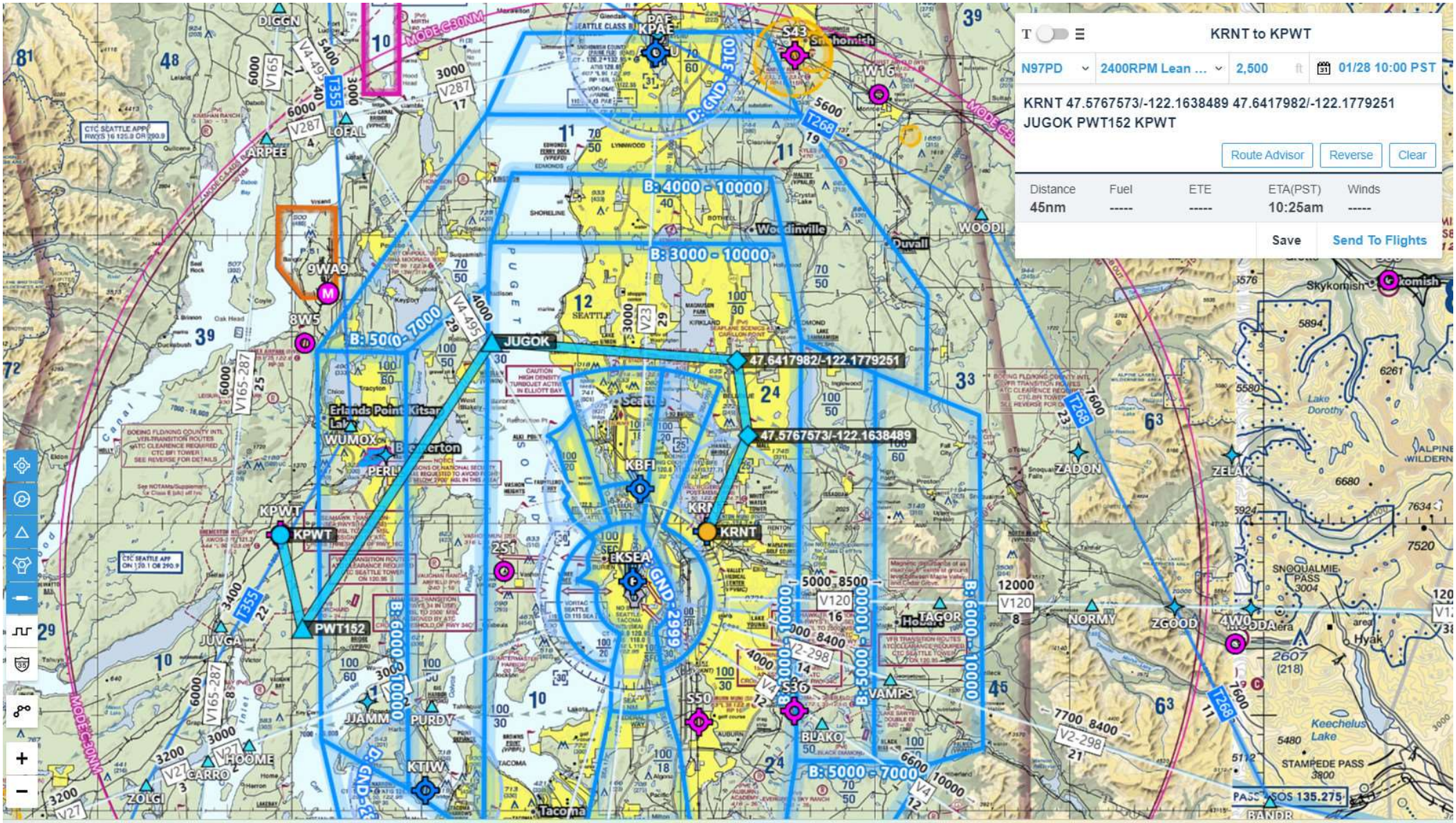


- Have flight plan in the GTN that has valid altitude constraints
- Have active leg in the GTN for navigation
  - GTN calculates and displays TOD and BOD
  - GTN calculates required descent rate for descent path (default 3^{o})
- Have GTN navigating to valid waypoint and GFC500 in NAV
- Set Altitude Select to authorized descent altitude on G5
- Press VNAV on GFC500 – VPATH should display on G5 as armed (white)
- When 1 minutes from TOD, audio alert "VERTICAL PATH"
- G5 will show a Vertical Deviation Indicator (initially high)
- At TOD, G5 VDI will be at the center, green VPATH, descent commences

Garmin Training Video on VNAV (20 minutes)
https://www.youtube.com/watch?v=GxM2k0gOqVU


TIMESTAMPS
8:55 AM PST
FPL
Search
KRNT to KPWT
N97PD
2400RPM Lean ...
2,500
ft
01/28 10:00 PST
KRNT 47.5767573/-122.1638489 47.6417982/-122.1779251
JUGOK KPWT
1 Warning
Route Advisor
Reverse
Clear
Distance
37nm
Fuel
5g
ETE
0h22m
ETA(PST)
10:22am
Winds
calm
Save
Send To Flights
JUGOK
47.6417982/-122.1779251
47.5767573/-122.1638489
KPWT
KRNT
KBFI
KSEA
KPAE
S43
W16
9WA9
8W5
S50
S36
KTIW
DIGGN
LOFAL
HARPEE
JUVGA
JAMMM
PURDY
HOOME
CARRO
ZOLCI
WUMOX
PERLL
ZADON
ZELAK
NORMY
ZGOOD
TAGOR
VAMPS
BLAKO
WOODI
Everett
Snohomish
Woodinville
Duvall
Seattle
Tacoma
Bremerton
Skykomish
Hyak
Lake Dorothy
Keechelus Lake
SNOQUALMIE PASS
STAMPEDE PASS
B: 4000 - 10000
B: 3000 - 10000
B: 1500 - 7000
B: 5000 - 7000
B: 6000 - 10000
5000 8500
7700 8400
12000
GND - 3100
GND - 2900
MODE C 30NM
T355
T268
V165
V165-287
V287
V4-495
V120
V2-298
V23


Settings
IAS
0 KT
HDG
159°
ALT
0 FT
Resources
GARMIN
HOME
Push
Com Vol – Psh Sq
COM
124.70
KRNT TWR
STBY
121.60
KRNT GND
Audio Panel
Intercom
MIC
1
MON
1
XPDR
IDENT
1200
STBY
NAV SEA
116.80
SEA VOR
STBY
110.60
PAE VOR
Active Flight Plan
KRNT / KPWT
ALT
DTK
DIS
KRNT
Renton Mun
FACTM
SEA028 / 10
_____ FT
031°
4.8 NM
LUTSY
_____ FT
314°
8.9 NM
JUGOK
_____ FT
248°
10.2 NM
KPWT
Bremerton Natl
_____ FT
212°
14.9 NM
Back
MSG
Menu
Up
Down
TERM
DEMO
GPS
Com Freq / Psh Nav
+
IAS
-
+
ALT
-
Push
Track Mode: Manual
-
HDG
+


KRNT to KPWT
N97PD
2400RPM Lean ...
2,500 ft
01/28 10:00 PST
KRNT 47.5767573/-122.1638489 47.6417982/-122.1779251
JUGOK PWT152 KPWT
Route Advisor
Reverse
Clear
Distance
45nm
Fuel

ETE

ETA(PST)
10:25am
Winds

Save
Send To Flights
JUGOK
47.6417982/-122.1779251
47.5767573/-122.1638489
KPWT
PWT152
KRNT
KBFI
KPAE
S43
W16
9WA9
8W5
LOFAL
ARPEE
DIGGN
WUMOX
PERLL
JUVGA
JJAMM
PURDY
HOOME
CARRO
ZOLGI
KTIW
2S1
S50
S36
BLAKO
VAMPS
TAGOR
NORMY
ZGOOD
ZELAK
ZADON
WOODI
Woodinville
Duvall
Skykomish
Tacoma
SNOQUALMIE PASS 3004
STAMPEDE PASS 3800
Keechelus Lake
Lake Dorothy
SOS 135.275
BANDR
B: 4000 - 10000
B: 3000 - 10000
B: 150(0 - 7000
B: 5000 - 7000
B: 6000 - 10000
B: 5000 - 10000
D: GND - 3100
GND - 2999
MODE C 30NM
T355
T268
V165
V165-287
V287
V4-495
V23
V120
V2-298
V27


Settings
IAS
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HDG
159°
ALT
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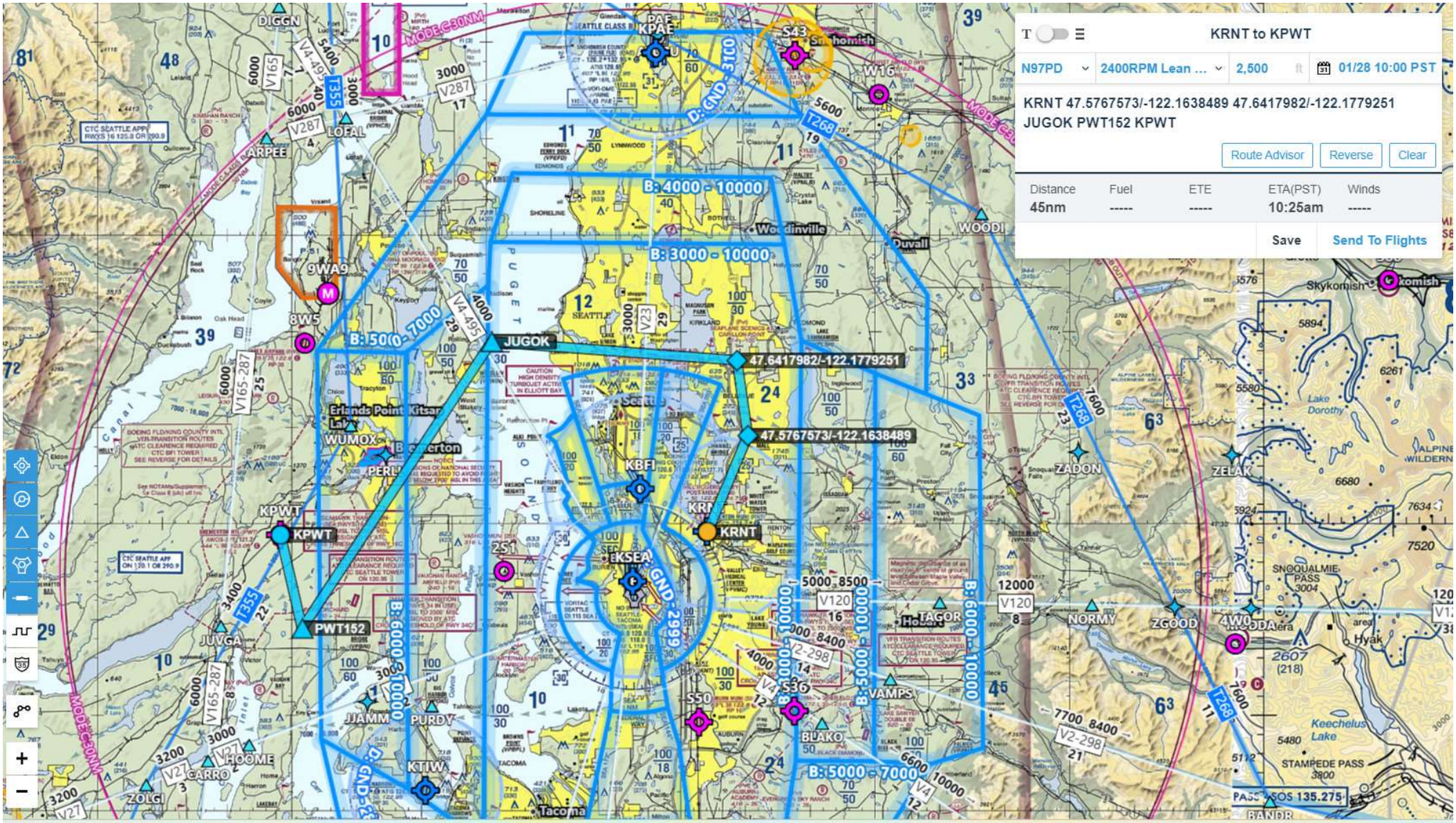
Resources
GARMIN
HOME
Push
COM
124.70
KRNT TWR
STBY
121.60
KRNT GND
Com Vol
Psh Sq
Audio Panel
Intercom
MIC
1
MON
1
XPDR
IDENT
1200
STBY
NAV SEA
116.80
SEA VOR
STBY
110.60
PAE VOR
Create User Waypoint
User Identifier
PWT152
Airport
Comment
KPWT152 / 3
Position Type
Radial / Distance
N
2500 FT
REF WPT
KPWT
Radial
152.0°
Distance
3.0 NM
Temporary
Elevation
FT
Create
Cancel
MSG
In
Out
TERM
DEMO
GPS
Com Freq / Psh Nav
+
IAS
-
+
ALT
-
Push
Track Mode: Manual
-
HDG
+

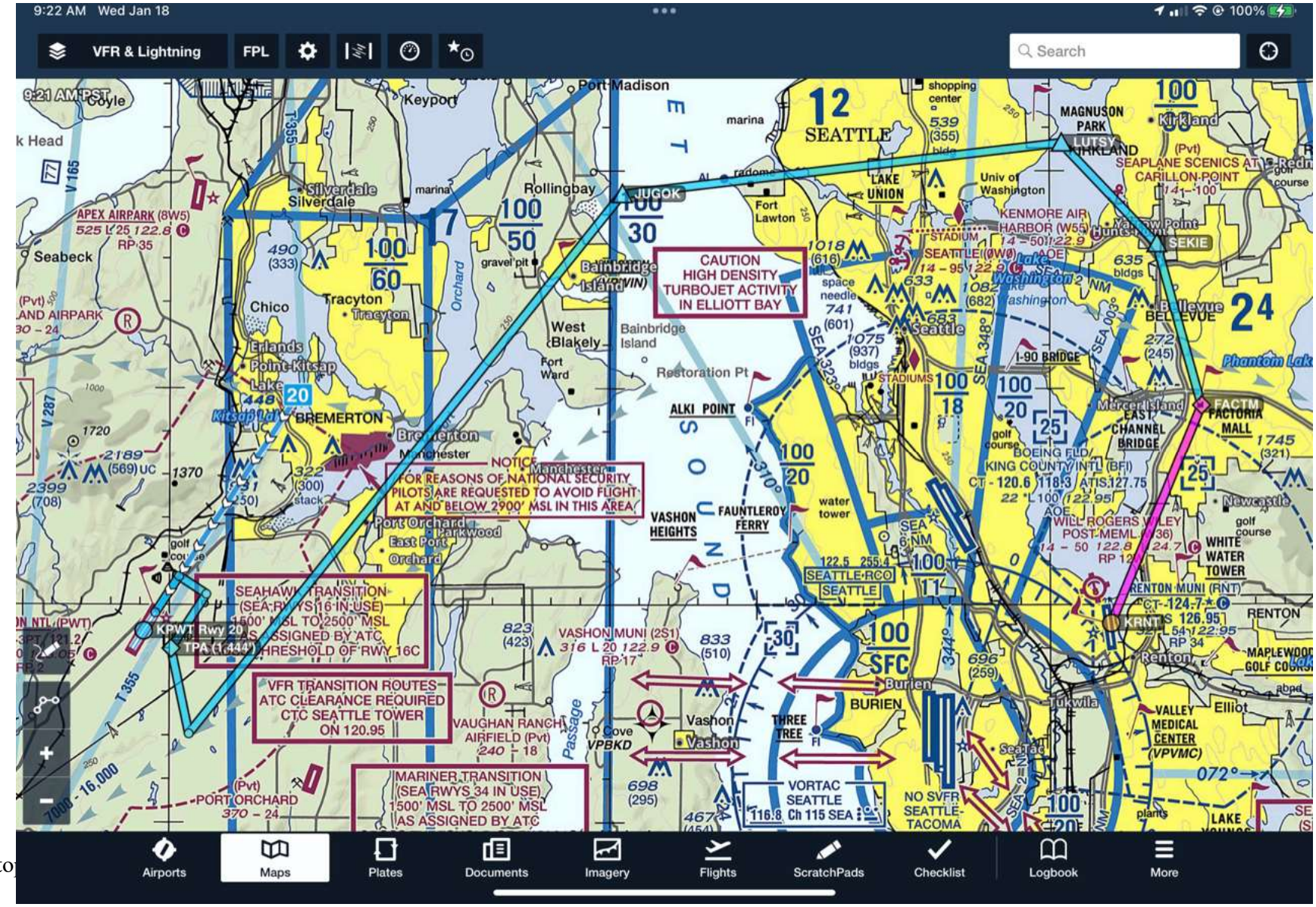

Settings
IAS
0 KT
HDG
159°
ALT
0 FT
Resources
GARMIN
HOME
Push
Com Vol
Psh Sq
COM
124.70
KRNT TWR
STBY
121.60
KRNT GND
Audio Panel
Intercom
MIC
1
MON
1
XPDR
IDENT
1200
STBY
NAV SEA
116.80
SEA VOR
STBY
110.60
PAE VOR
Active Flight Plan
KRNT / KPWT
ALT
DTK
DIS
FACTM
SEA028 / 10
2500 FT
031°
4.8 NM
LUTSY
2500 FT
314°
8.9 NM
JUGOK
2500 FT
248°
10.2 NM
PWT152
KPWT152 / 3
1440 FT
203°
16.3 NM
KPWT
Bremerton Natl
_____ FT
332°
2.7 NM
Back
MSG
Menu
Up
Down
TERM
DEMO
GPS
Com Freq / Psh Nav
+
IAS
-
+
ALT
-
Push
Track Mode: Manual
-
HDG
+


KRNT to KPWT
N97PD
2400RPM Lean ...
2,500 ft
01/28 10:00 PST
KRNT 47.5767573/-122.1638489 47.6417982/-122.1779251
JUGOK PWT152 KPWT
Route Advisor
Reverse
Clear
Distance
45nm
Fuel

ETE

ETA(PST)
10:25am
Winds

Save
Send To Flights
JUGOK
47.6417982/-122.1779251
47.5767573/-122.1638489
KPWT
PWT152
KRNT
KBFI
KPAE
S43
W16
9WA9
8W5
LOFAL
ARPEE
DIGGN
WUMOX
PERLL
JUVGA
JJAMM
PURDY
HOOME
CARRO
ZOLGI
KTIW
2S1
S50
S36
BLAKO
VAMPS
TAGOR
NORMY
ZGOOD
ZELAK
ZADON
WOODI
Woodinville
Duvall
Skykomish
Tacoma
SNOQUALMIE PASS 3004
STAMPEDE PASS 3800
Keechelus Lake
Lake Dorothy
SOS 135.275
BANDR
B: 4000 - 10000
B: 3000 - 10000
B: 150(0 - 7000
B: 5000 - 7000
B: 6000 - 10000
B: 5000 - 10000
D: GND - 3100
GND - 2999
MODE C 30NM
T355
T268
V165
V165-287
V287
V4-495
V23
V120
V2-298
V27


9:22 AM Wed Jan 18
100%
VFR & Lightning
FPL
Search
9:21 AM PST
CAUTION
HIGH DENSITY
TURBOJET ACTIVITY
IN ELLIOTT BAY
NOTICE
FOR REASONS OF NATIONAL SECURITY
PILOTS ARE REQUESTED TO AVOID FLIGHT
AT AND BELOW 2900' MSL IN THIS AREA
SEAHAWK TRANSITION
(SEA RWYS 16 IN USE)
1500' MSL TO 2500' MSL
AS ASSIGNED BY ATC
THRESHOLD OF RWY 16C
VFR TRANSITION ROUTES
ATC CLEARANCE REQUIRED
CTC SEATTLE TOWER
ON 120.95
MARINER TRANSITION
(SEA RWYS 34 IN USE)
1500' MSL TO 2500' MSL
AS ASSIGNED BY ATC
VORTAC
SEATTLE
116.8 Ch 115 SEA
NO SVFR
SEATTLE-
TACOMA
SEATTLE
BREMERTON
BURIEN
Airports
Maps
Plates
Documents
Imagery
Flights
ScratchPads
Checklist
Logbook
More

GFC 500 Autopilot Coupled Missed Approach/Go-Around

Prior to Decision Altitude / Missed Approach Point, set MA Altitude

1. **At MAP, Press GA [Wings level roll, and 7° pitch up on AI]**
2. **Apply Climb Power**
3. **Verify CDI switched to GPS or Manually Adjust**
4. **Select HDG / TRK / NAV as Appropriate for the MAP**
5. **Select IAS for climb**
6. **Verify Proper Execution of MAP to the typical hold**

GFC 500 Autopilot

Two integrated safety systems:

- **When Autopilot is engaged:**
  - **Underspeed Protection (USP)**
  - **Overspeed Protection (OSP)**

- **When Autopilot is NOT engaged:**
  - **Electronic Stability Protection (ESP)**

GFC 500 Autopilot

Underspeed Protection (USP) — (autopilot is engaged)

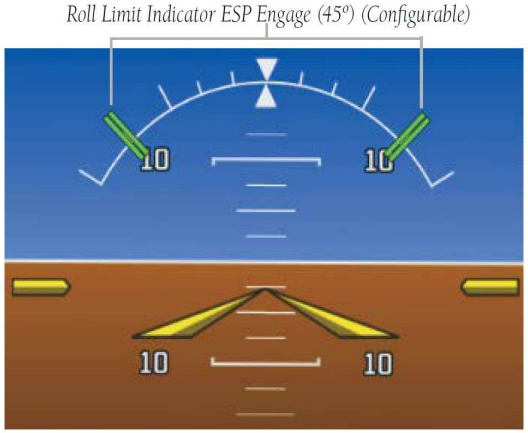
- **When the minimum airspeed of 60 KIAS is reached, a visual MINSPD message will appear above the airspeed tape and the autopilot will lower the nose to maintain 60 KIAS.**
- **An aural "AIRSPEED, AIRSPEED" voice alert will sound for installations connected to an audio panel.**
- **Underspeed Protection is exited automatically when airspeed exceeds 65 KIAS.**

GFC 500 Autopilot

Overspeed Protection (OSP) — (autopilot is engaged)

- **When the maximum airspeed of 150 KIAS is reached, visual MAXSPD message will appear above the airspeed tape and the autopilot will raise the nose of the aircraft to avoid exceeding the maximum configured airspeed.**
- **An aural "AIRSPEED, AIRSPEED" voice alert will sound for installations connected to an audio panel.**

GFC 500 Electronic Stability Protection



A separate Electronic Stability Protection (ESP) system monitors aircraft status (Pitch, Bank, Airspeed) when AP is not engaged (inactive at 200' AGL)

- **ESP will use servo pressure to discourage pilot operations outside of normal operating envelope (pitch +20°, -15°, bank > 45°, airspeed >161kts, <50kts)**
- **ESP will activate the autopilot (with an aural warning) in Level mode if operations are maintained outside the normal operating envelope (Pitch, Bank, Airspeed) for sufficient time – 10 seconds**
- **ESP can be disabled for training via options on the G5, or via holding AP Disconnect**

GFC 500 Electronic Stability Protection

Enabling/Disabling ESP using the G5 Menu:

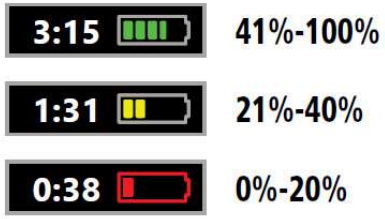
1) From the PFD Page, press the Selection Knob to display the Menu.
2) Turn the Selection Knob to highlight **ESP**.
3) Press the Selection Knob to enable or disable ESP.

Figure 3-25 AFCS (ESP Enabled)

Other considerations: G5 Battery Status

2.1.7 BATTERY STATUS INDICATOR

When the G5 is powered by the aircraft electrical bus, the battery status indicator can be displayed by pressing the G5 Power Button. When the G5 is powered by the battery, the battery status indicator is displayed automatically. This indicator shows the estimated percent charge of the battery. After about one minute on battery power, the indicator shows the estimated time (in hours and minutes) until the battery is empty. The current charge level of the battery is indicated by the filled-in portion of the battery icon. The battery icon turns yellow or red to indicate a low-battery condition



The battery is required for the G5 unit installed as an attitude display indicator (ADI) and is optional for the G5 unit installed as a horizontal situation indicator (HSI)

When the G5 is connected to external power and the battery is being charged, a lightning bolt symbol appears over the battery icon.

Other considerations: Autopilot on FAA Practical Test

FAA-S-ACS-6B C1 6-6-2019 Private Pilot Airmen Certification Standards page A-19

"To assist in management of the aircraft during the practical test, the applicant is expected to demonstrate automation management skills by utilizing installed, available, or airborne equipment such as autopilot, avionics and systems displays, and/or a flight management system (FMS). The evaluator is expected to test the applicant's knowledge of the systems that are available or installed and operative during both the ground and flight portions of the practical test."

GFC 500 Autopilot Documentation

In addition to the G5 Pilot's Guide, the Autopilot Airplane Flight Manual Supplement (AFMS) for the C172 provides Limitations, Emergency Procedures, Non-Normal Procedures and Normal Procedures for the Autopilot

AFMS – GFC 500 Autopilot in Textron 172 Series
https://static.garmin.com/pumac/190-02291-02_08.pdf

G5 Electronic Flight Instrument Pilot's Guide for Certified Aircraft
https://static.garmin.com/pumac/190-01112-12_j.pdf

Extensive (1:03) Sportys / Garmin Webinar Video on GFC 500
https://www.youtube.com/watch?v=g4YGFbYhoMk

QUESTIONS ???

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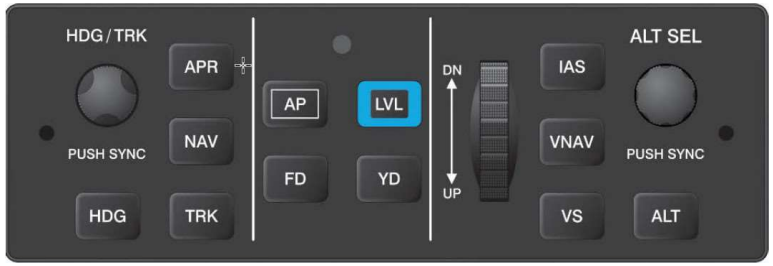
GFC 500 Autopilot



When automatic electric trim is not available:

Figure 3-21 TRIM UP Alert

Figure 3-22 TRIM DOWN Alert