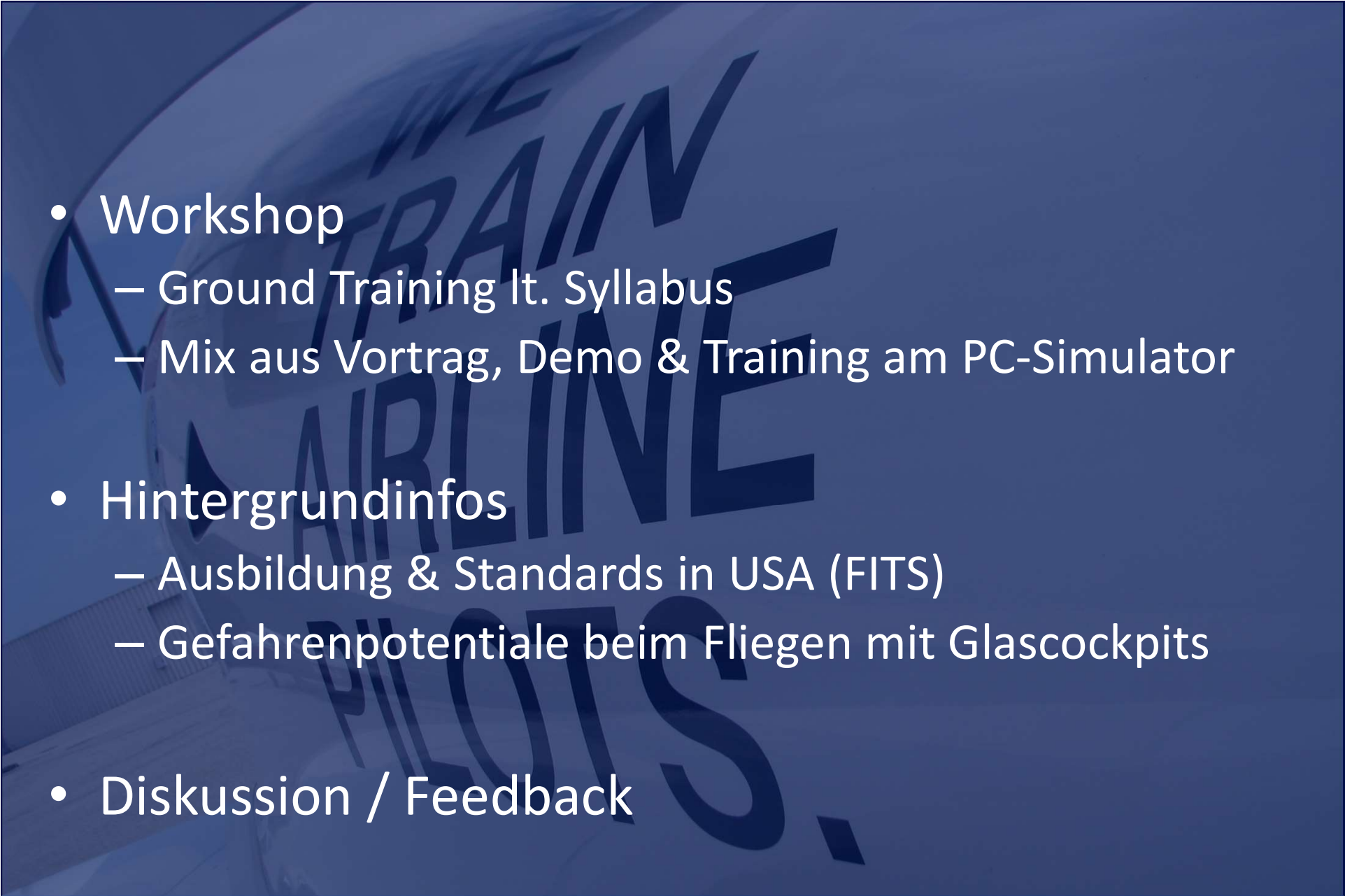




Garmin G1000 Glasscockpit

- 
- Workshop
 - Ground Training lt. Syllabus
 - Mix aus Vortrag, Demo & Training am PC-Simulator
 - Hintergrundinfos
 - Ausbildung & Standards in USA (FITS)
 - Gefahrenpotentiale beim Fliegen mit Glascockpits
 - Diskussion / Feedback

Course aim

- 
- Allgemeine Einführung
 - Grundsätzlicher Systemaufbau & Komponenten
 - PFD - Primary Flight Display
 - MFD - Multi Function Display
 - Audio-Panel
 - Automatic Flight Control System
 - Übungs-Szenarien VFR / IFR

Agenda

- Auszug aus den verwendeten Präsentationen
(Grafiken, Schaubilder)
- Dokumentation
 - PDF-Dokumente
 - (1.1) System Overview.pdf (935 KB)
 - (1.2) Quick Reference Card.pdf (394 KB)
 - (1.3) Cockpit Reference Guide.pdf (6,87 MB)
 - Training-Software
 - Garmin G-1000 GlassCockpit Simulator

- TAA – Technically Advanced Aircraft
- PFD – Primary Flight Display
- MFD – Multi-Function Display
- AHRS - Attitude Heading and Reference System
- LPV – Localizer Performance with Vertical Guidance
- TIS – (Traffic Information Service)
- TAWS – Terrain Awareness (& Warning System)
- AFCS – Automatic Flight Control System (AP)
- FITS – FAA Industry Training Standards
(e.g. TAA with PFD/MFD)

Terminology

Glasc cockpit-Einsteiger...

- Ist ein Glasc cockpit sicherer als ein konventionelles Panel?
- Was passiert, wenn der Strom ausfällt (Panel ist dunkel)?
- Wie viel Training ist notwendig, um “competent & safe” zu sein (z.B. IFR in IMC)?
- Muss ich mein Instrument-Scanning (T) umlernen?
- Was bringt mir mein GNS430-KnowHow?

Garmin G1000 Glasc cockpit



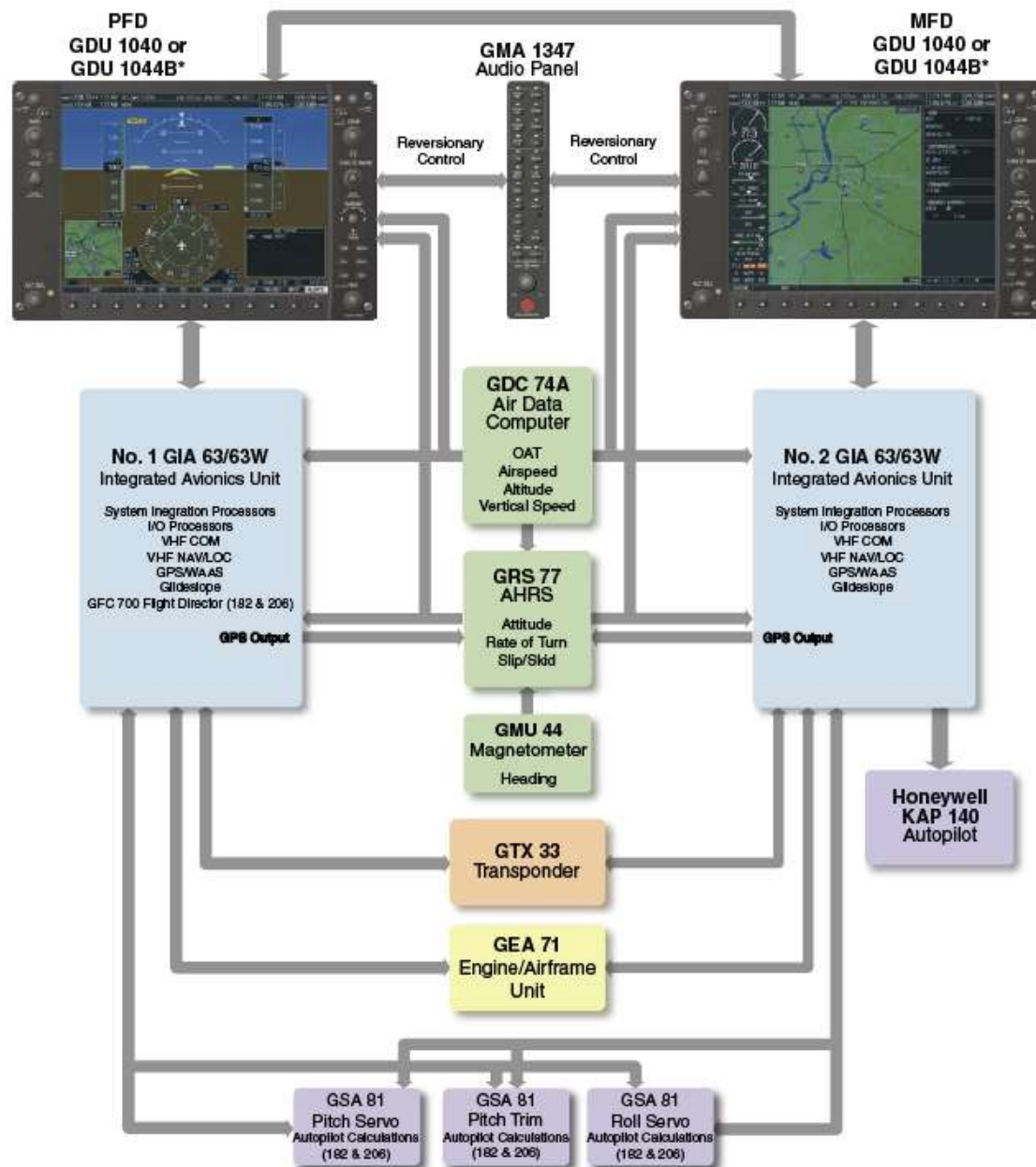
Lab 0 – Installation G1000 Trainer

Garmin G1000 Glasscockpit

- 
- Allgemeine Einführung
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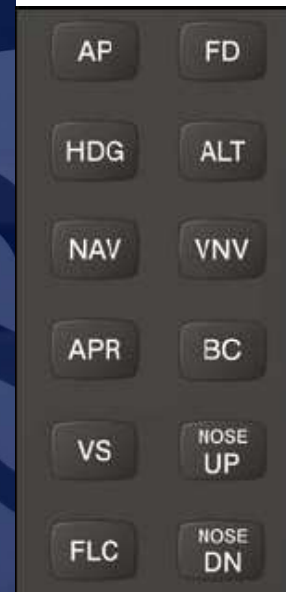
G1000 Cessna 182 Turbo Skylane



- Ethernet-Bus
- Proprietäres Garmin Protokoll
- Line Replaceable Units (LRU)

Components

- 10" TFT LCD Displays for the PFD and MFD (1024 x 768 pixels)
- High-Speed Data Bus (HSDB) Ethernet connection
- GDU 1044B additional controls for the Automatic Flight Control System (AFCS)



GDU 1040 / 1044B

Attitude

Nav/Com Tuning

Bezel Mounted Controls

Airspeed

Altitude
and
Vertical
Speed

Map Inset

FMS Controls

HSI



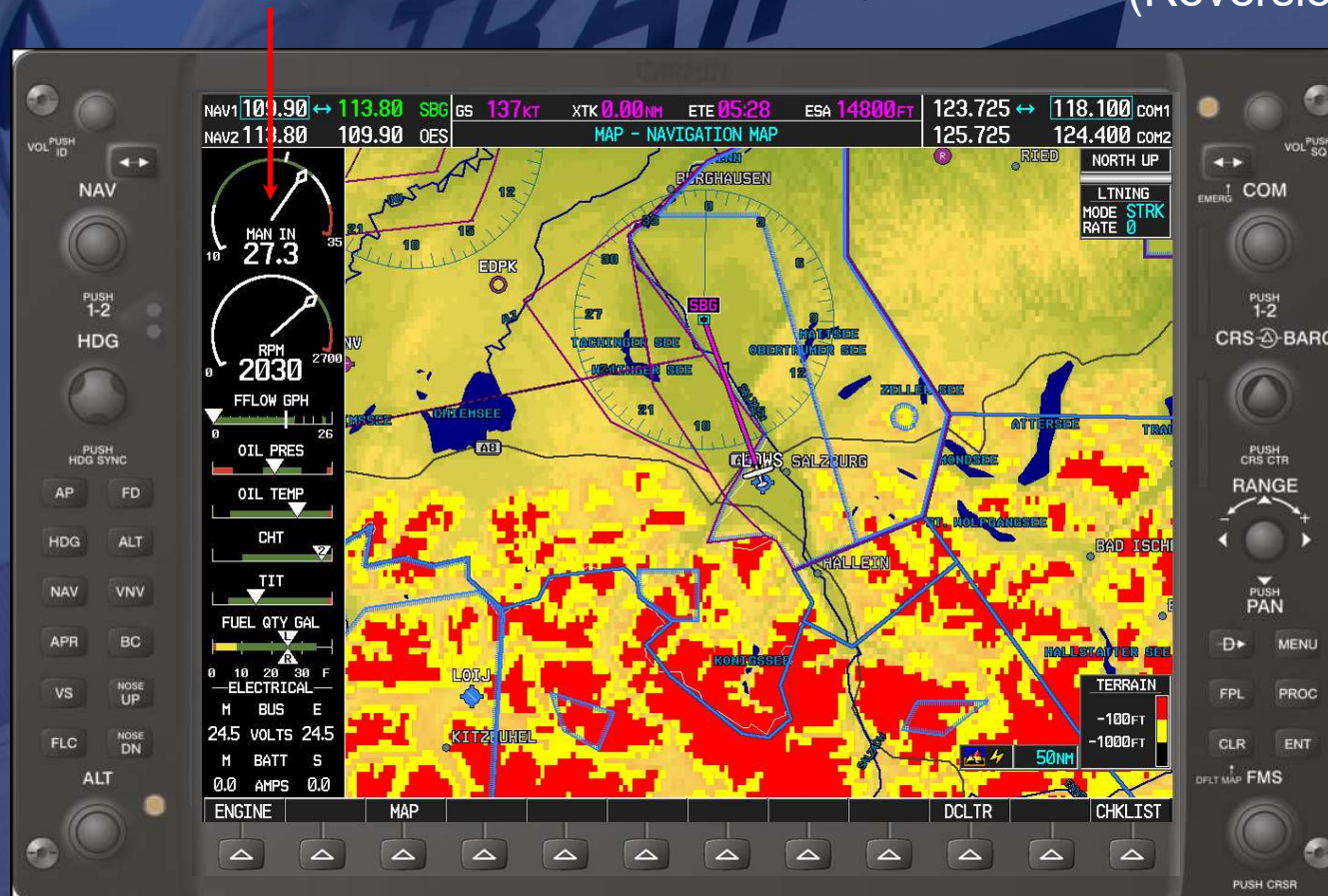
PFD



PFD

Engine and Systems
Instruments with detailed
information

Same controls as on PFD, and
automatically reverts to PFD
image if PFD should fail
(Reversionary Mode)

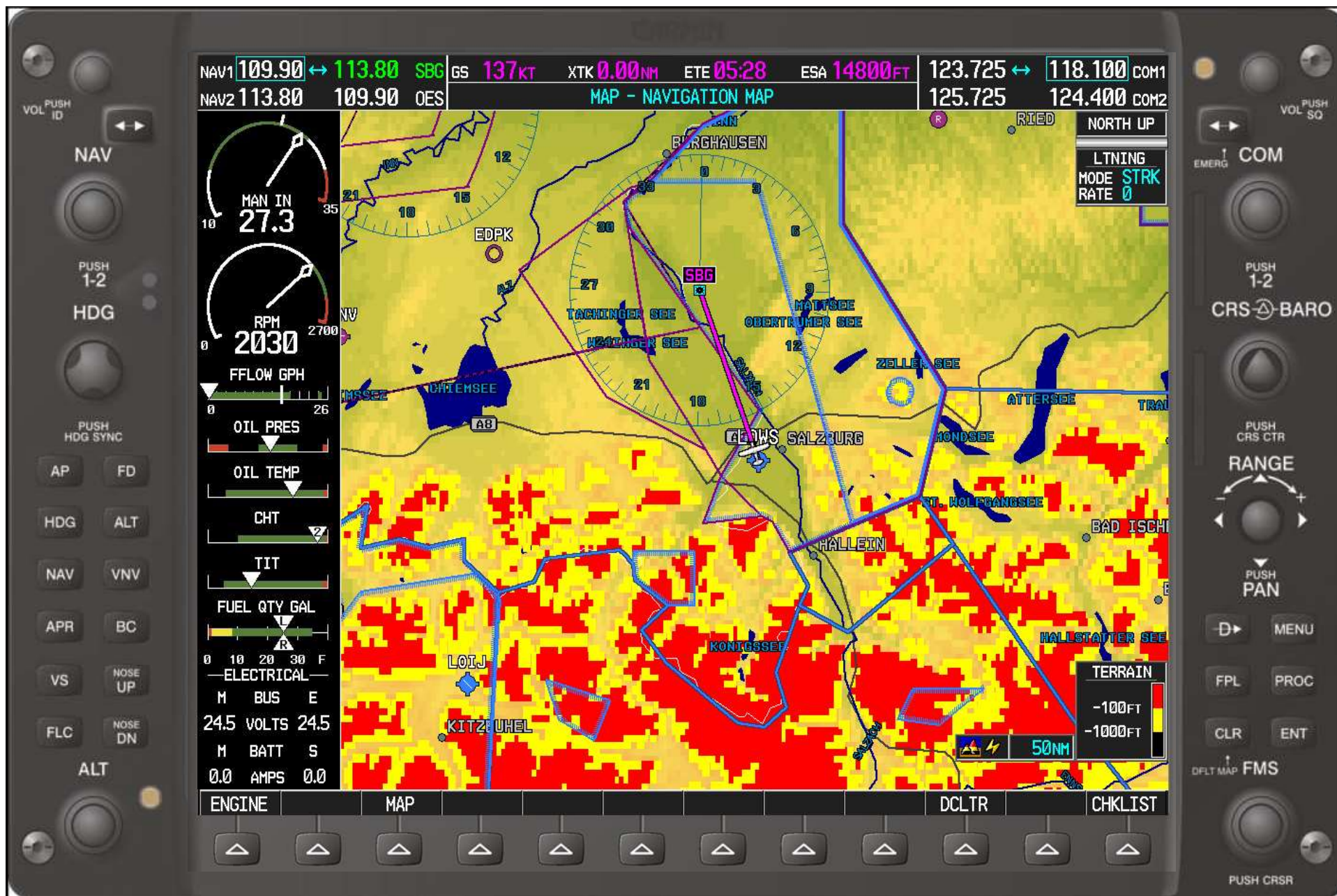


Can Display:

- Topographic Data
- Lightning (Stormscope)
- Terrain
- (Traffic)

FMS Controls

MFD



MFD



- Digital audio is used for the Garmin NAVs and COMs
- Emergency analog operation that bypasses the GMA 1347
- Reversionary Mode button

GMA 1347 Digital Audio Panel



Reversionary Mode



Reversionary Mode



Reversionary Mode

- Communications hub for the system
 - COM / NAV / GS
 - GPS
 - FD
 - Primary communications path for AHRS and Air Data information
 - Interfaces with GDL69, StormscopeTM, etc.



GIA 63 Integrated Avionics Unit

- Attitude-Bestimmung durch mathematische Berechnung mittels
 - 3D GPS
 - 3D Magnetometer
 - Airdata
- Rapid alignment during taxi
 - Typically aligns in less than 1 min! (CIRRUS zB. ca. 3 Minuten)
- In-Air Dynamic Restarts
 - Bank angles up to 20 degrees!
- Robust
 - Operates well in absence of GPS, Air Data, or Magnetometer (nur 2 Systeme notwendig)
 - Lebenszeit ca. 10.000 Stunden vs. 1.000 Vacuum



GRD 77 AHRS and GMU 44

- Inputs include pitot, static and OAT
- Range
 - Altitude -1,400 ft to 55,000 ft
 - IAS up to 430 kts
 - Operate -55°C to +70°C



GDC 74 Air Data Computer

- Extensive input capabilities
 - EGT/CHT on all cylinders
 - Manifold pressure, Engine RPM
 - Oil temp/pressure
 - Electrical system data
- Communicates with both GIA 63s



GEA 71 Engine/Airframe Interface

- Communicates with both GIA 63 units
- Standard Garmin Transponder features
 - Auto ALT mode as speed exceeds 30kts
 - Solid State electronics require no warm-up time
- GTX 33 Mode S Transponder
 - (Traffic Information Service (TIS) Traffic displays on PFD Inset and MFD as map overlay and on dedicated traffic page)

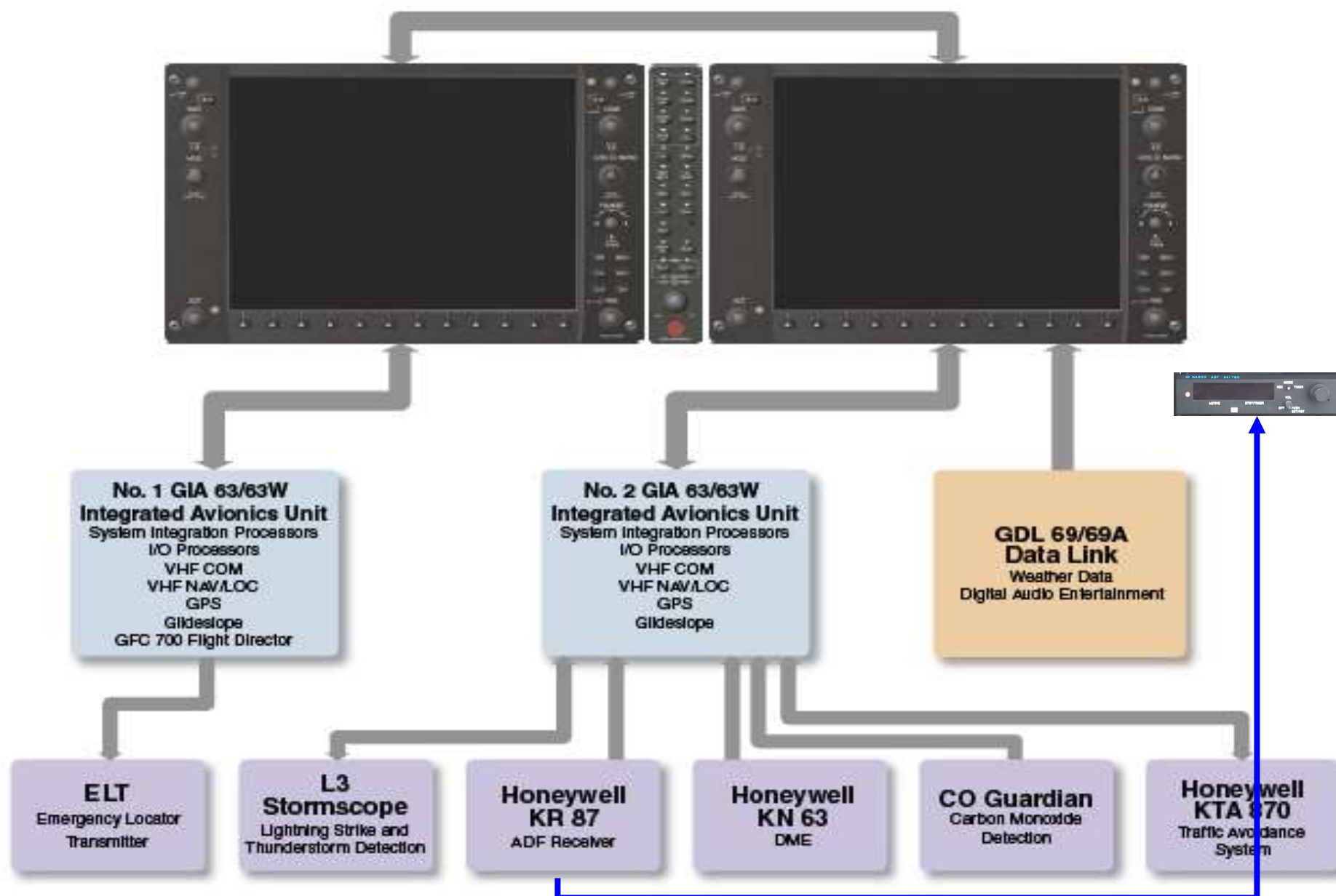


GTX 33 Mode S Transponders

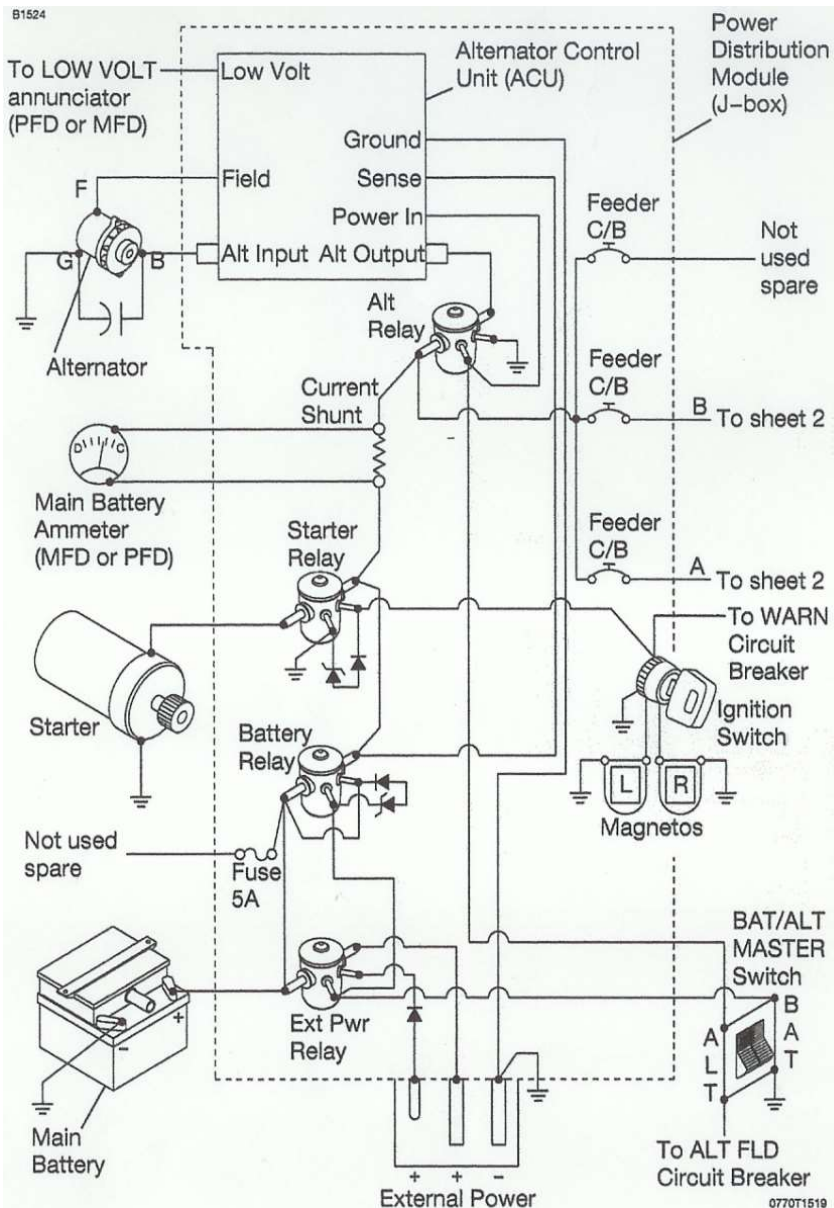
- GSA 81 servos are used for the automatic control of
 - Roll
 - Pitch
 - Pitch trim



GSA 81 / GSM 85



Optional Equipment

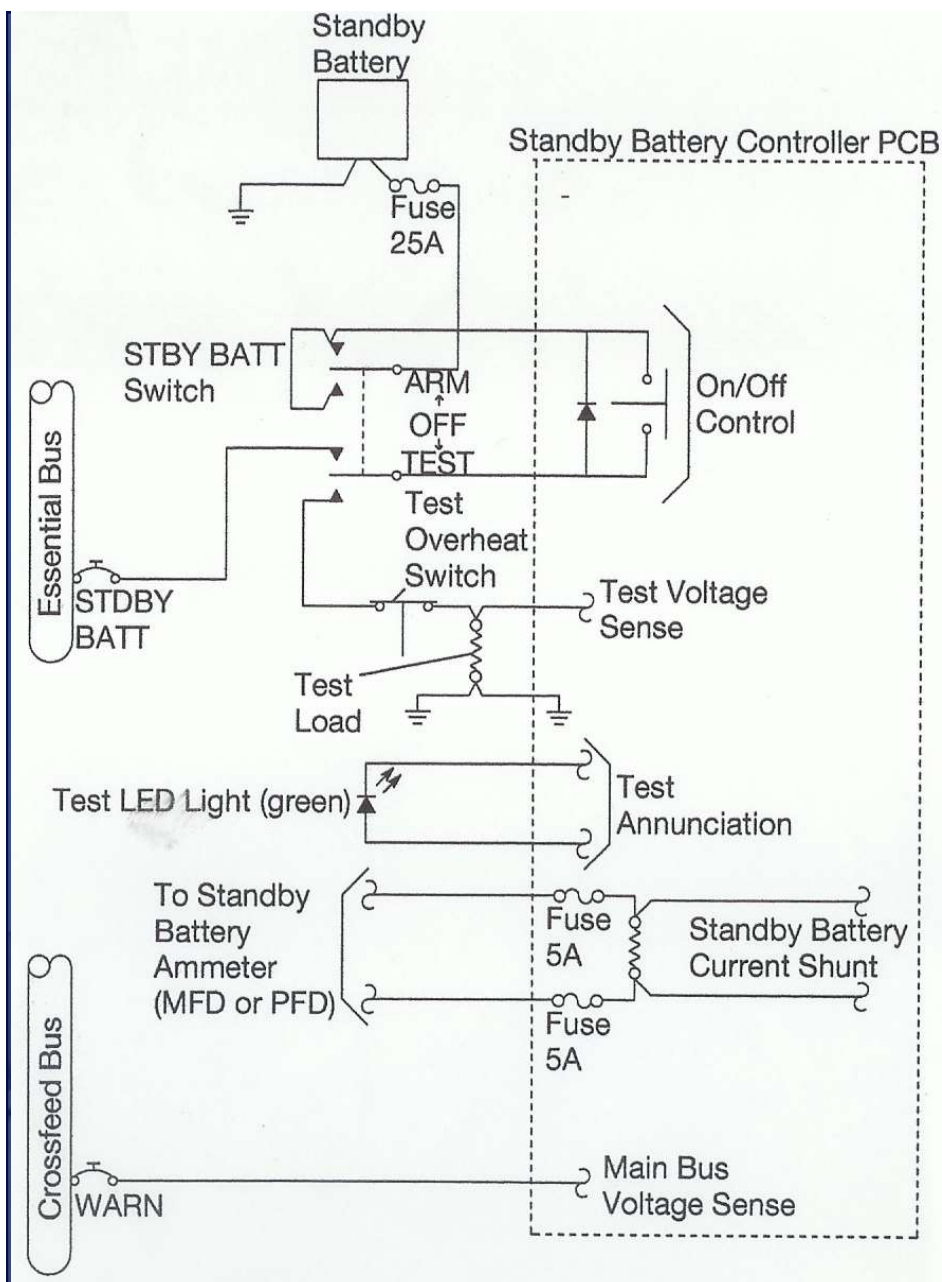


- 2 Batterien
 - Main
 - Standby
- 1 Alternator
- Low Volts Alert: < 24,5 Volt
- unter ca. 20 Volt: PFD dunkel!

WARNING Alerts

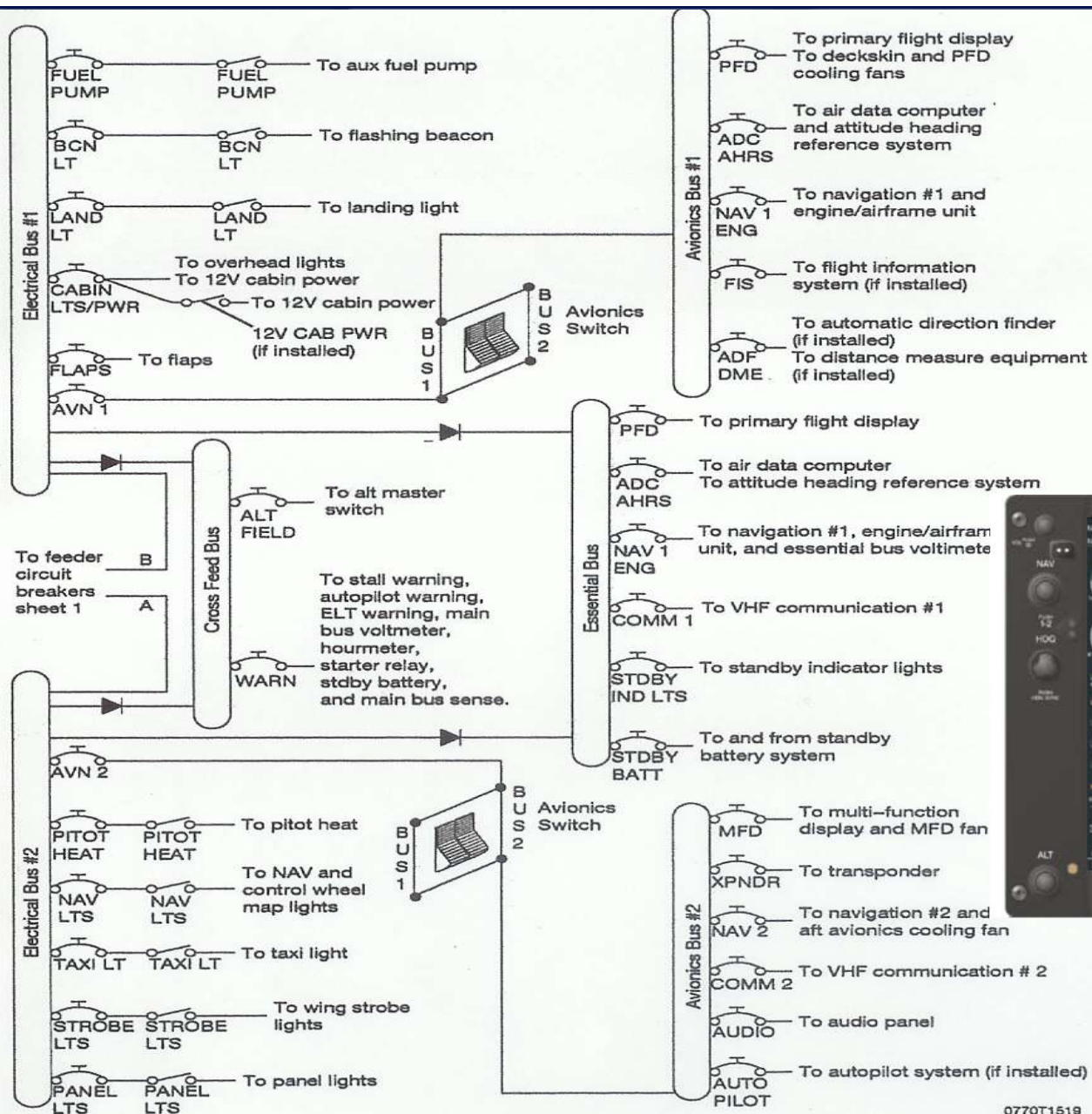
Annunciation Window Text	Audio Alert
OIL PRESSURE	Continuous Aural Tone
LOW VOLTS	Continuous Aural Tone*
HIGH VOLTS	Continuous Aural Tone
CO LVL HIGH	Continuous Aural Tone
PITCH TRIM**	No Tone

Electrical System



Standby Batterie Switch:
ARM
(sonst keine Ladung!)

Standby Battery



Electrical Bus Systems

- 
- Allgemeine Einführung
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- Bedienung entspricht größtenteils dem GNS 530/430
- “Buttons and knobs” übernehmen die gleichen Funktionen wie beim GNS 530/430
- Soft keys vereinfachen “frequently used options” am PFD und MFD, um die Anzahl an “Clicks” zu reduzieren



- Speed data entry: Vereinfachte Auswahl von Frequenzen

System Logic



Preflight Inspection (Avionics)



Starting Engine



Airspeed

Altitude

Attitude

Vertical Speed

DG/HSI

Analogue vs. Glasscockpit

Lab 1 - PFD

- Airspeed Indicator
 - Trend vector
 - Reference flags
- Attitude Indicator
 - slip/skid indication
- Altimeter
 - Trend vector
 - Barometric setting
 - Selected Altitude
 - Glidepath
- Vertical Speed Indicator
- System time
- Waypoint status window



Horizontal Situation Indicator

- Heading and course indications
- Turn Rate Indicator
- Navigation source
- Course Deviation Indicator
- Bearing pointers
- DME Information
- Auto-Center (HDG)
- Wind data
- Outside Air Temperature
- TMR/REF - reference speeds and timer
- INSET - Moving map

- COM
 - Active (grün, innen) – Standby (außen)
 - Auto-Tuning (NRST)
 - EMRG-Funktion
 - Squelch
- NAV
 - Auto-Tuning (NRST)
 - CDI-Funktionen (NAV1, NAV2, GPS) – AutoCenter (CRS)
 - PFD-Funktionen (BRG, RMI, DME)
 - Identification
 - Auto ILS/LOC/VOR bei Nav-Source GPS (ILS/CDI-Capture)
- Transponder
 - Code-Einstellungen
 - Modi
 - Auto ALT ab 30 kts

121.900	118.600	COM1
135.100 TX	118.400	COM2

- AHRS failure
 - Refer to backup Attitude Indicator, attempt in-flight reset by pulling AHRS circuit breaker
 - Inkl. Magnetometer
- Air Data failure
 - Refer to standby Airspeed and Altitude indicators
- Nav/Com failure
 - Use other nav/com radio
- Audio Panel
 - Has backup analog mode that connects directly to Com 1 radio, no intercom



Failures and Actions

Alarms

- Alert Level

WARNING

Annunciation Window Text

OIL PRESSURE
LOW VOLTS
HIGH VOLTS
CO LVL HIGH
PITCH TRIM**

CAUTION

Annunciation Window Text

LOW VACUUM
LOW FUEL L
LOW FUEL R
STBY BATT

ADVISORY

- Dead Reckoning



Alarms

Lab 1 - PFD

- Setup Position LOWS – Demo Mode
 - TRK Mode: TRK FPL
 - Waypoint: LOWS
- Squawk: 3444
- COM1: Salzburg Tower – Salzburg Radar
- COM2: Salzburg ATIS – Wien Information (Vienna ARTCC)
- NAV1: SBG VOR
- NAV2: FRE VOR
- GPS-Flugplan: LOWS – FRE – LOWL
- Altitude 5500 ft
- CDI: GPS, BRG: FRE

Lab 3 PFD

- 
- Allgemeine Einführung
 - Grundsätzlicher Systemaufbau & Komponenten
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 - Übungs-Szenarien VFR / IFR

Agenda

The Page Group Icon shows which page group and page you are viewing.

Page group indicator

Selected page indicator

Selected page group is highlighted

MAP WPT AUX NRST ■ □ □ □

Map page group

MAP WPT AUX NRST ■ □ □ □ □

Waypoint page group

MAP WPT AUX NRST □ ■ □ □ □

Auxiliary page group

MAP WPT AUX NRST ■ □ □ □ □ □ □

Nearest page group



1. Navigation Map



2. Traffic Map

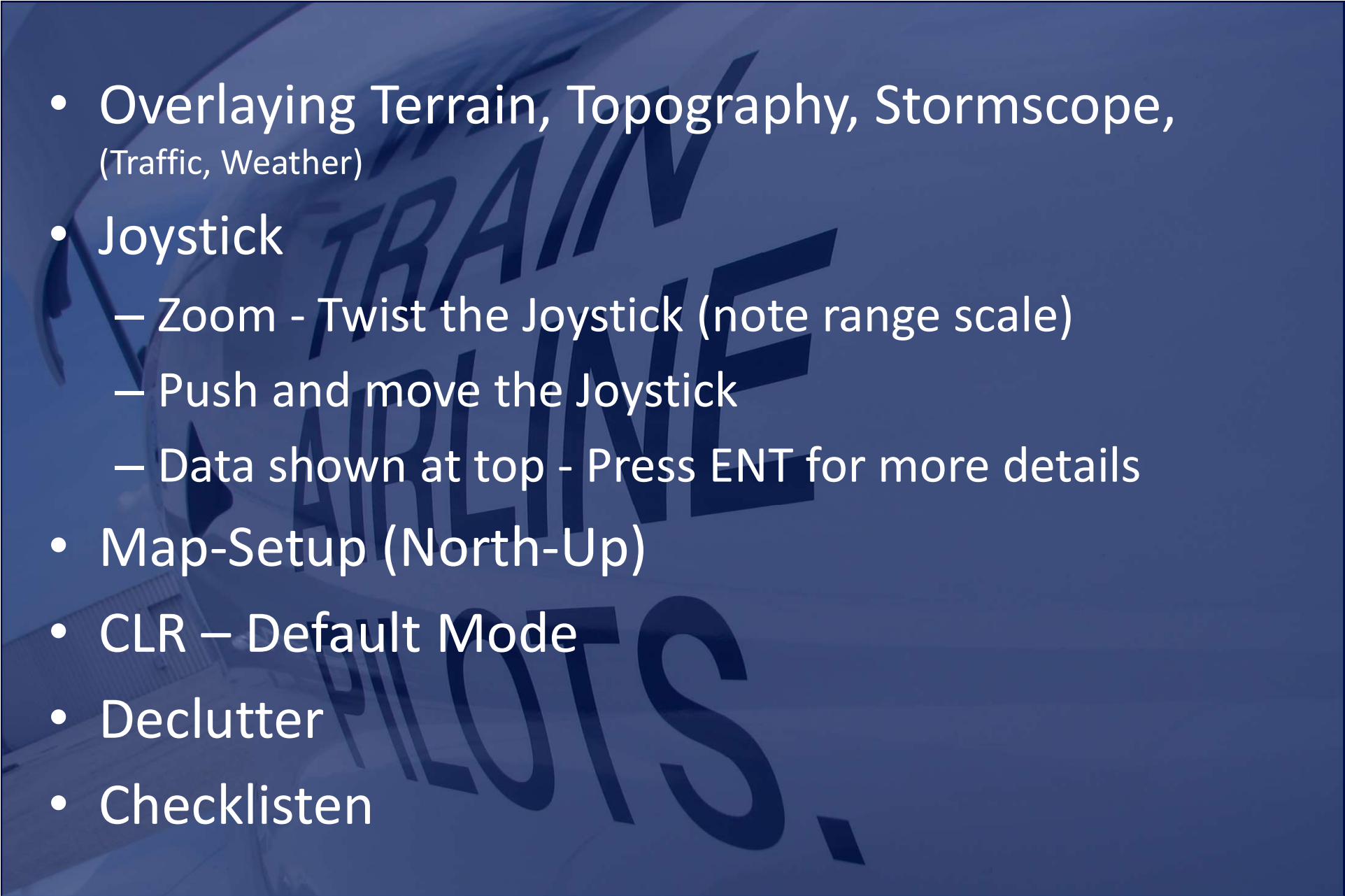


3. Weather Map



4. Terrain Awareness

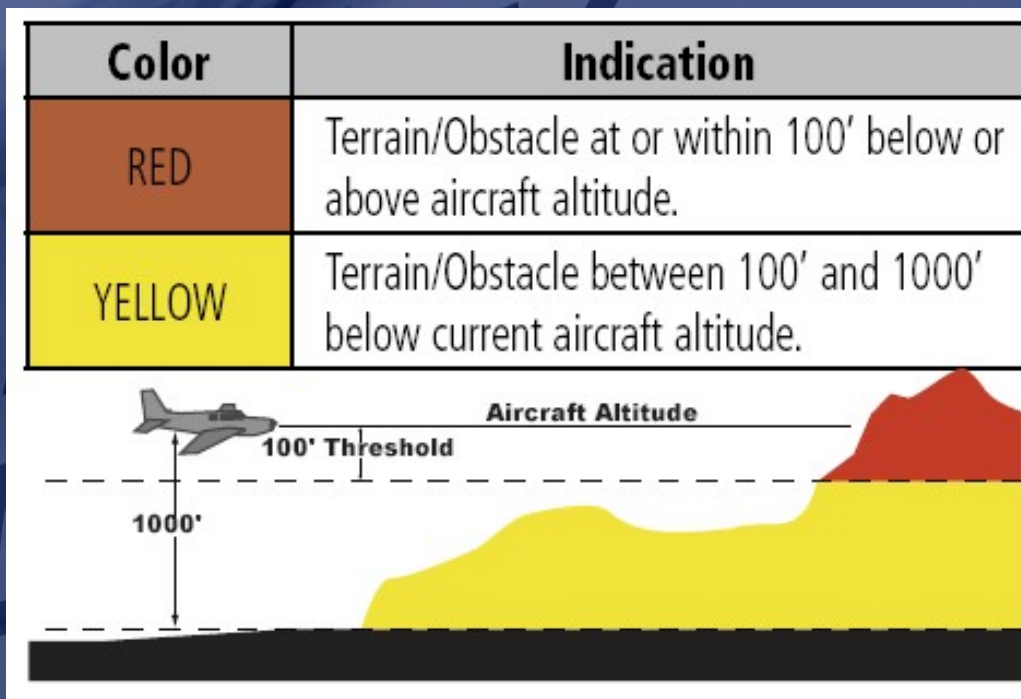
Map Pages

- 
- Overlaying Terrain, Topography, Stormscope,
(Traffic, Weather)
 - Joystick
 - Zoom - Twist the Joystick (note range scale)
 - Push and move the Joystick
 - Data shown at top - Press ENT for more details
 - Map-Setup (North-Up)
 - CLR – Default Mode
 - Declutter
 - Checklisten

- Always operating
- Overlay on Map, or dedicated page with either 360 or 120 arc view modes
- Strike or Cell mode selected by soft key
- Range by use of Zoom/Pan joystick
- Data clear by soft key
- Strike aging
 - New strike is bold for 6 seconds
 - Normal lightning bolt for 1 minute
 - “+” 1 additional minute after strike
 - Smaller “+” for 2-3 minutes

Lightning Age	Symbol
Strike is less than 6 seconds old	
Strike is between 6 and 60 seconds old	
Strike is between 1 and 2 minutes old	
Strike is between 2 and 3 minutes old	

L-3TM WX-500 Stormscope Interface



Unlighted Obstacle (Height is less than 1000' AGL)	Lighted Obstacle (Height is less than 1000' AGL)	Unlighted Obstacle (Height is greater than 1000' AGL)	Lighted Obstacle (Height is greater than 1000' AGL)
			

Terrain Awareness



Terrain



1. Airport Information



2. Intersection Information



3. NDB Information

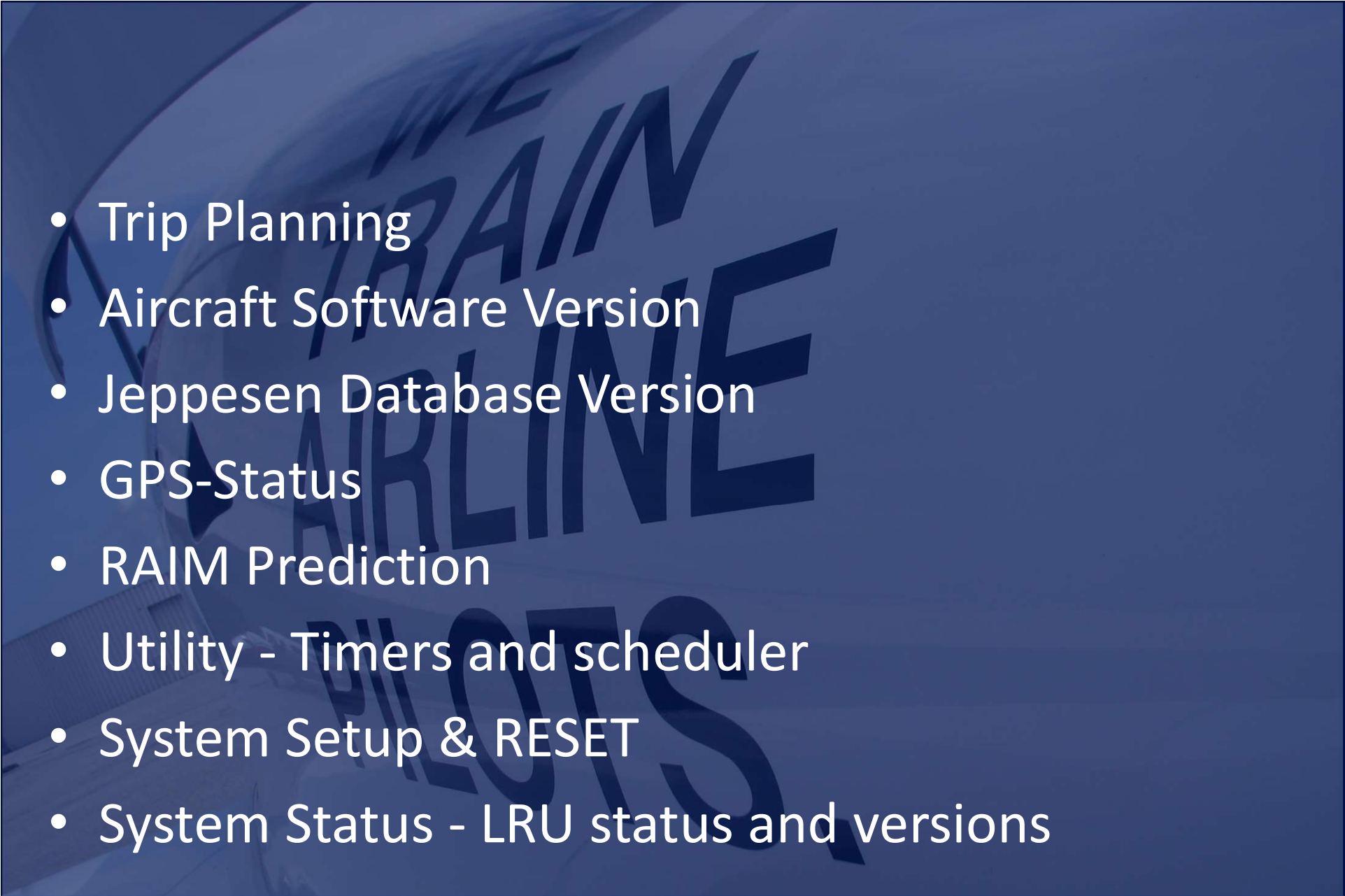


4. VOR Information



5. User WPT Information

Waypoint Pages

- 
- Trip Planning
 - Aircraft Software Version
 - Jeppesen Database Version
 - GPS-Status
 - RAIM Prediction
 - Utility - Timers and scheduler
 - System Setup & RESET
 - System Status - LRU status and versions



1. Trip Planning



2. Utility



3. GPS Status



4. System Setup



5. System Status

Aux Pages

Nearest...

- Airports
- Intersections
- NDBs
- VORs
- User Waypoints
- ARTCC/FSS/WX
- Airspaces



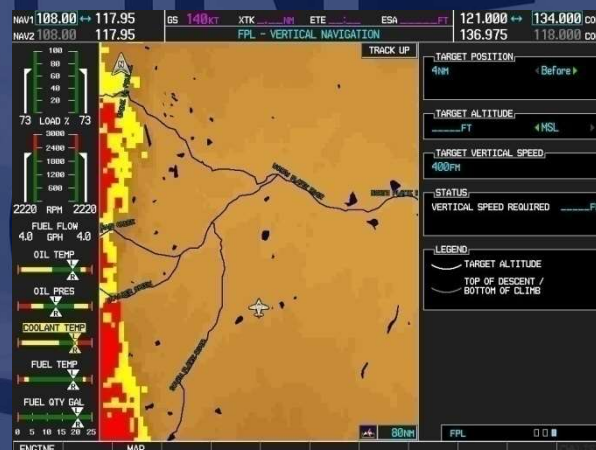
Nearest Pages



1. Active Flight Plan



2. Flight Plan Catalog



3. Vertical Navigation

Flight Plan Pages

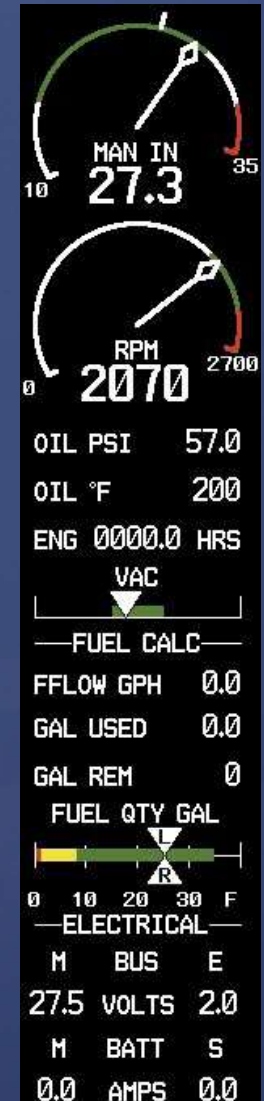
Demo 5 – GPS/VNAV

- GPS
 - Flightplan
 - Building the Flight Plan
 - Storing a Flight Plan
 - Canceling a Flight Plan
 - Auto-Squencing
 - OBS
 - GPS-Approaches (5 – 1 – 0.3 NM, 40 Meter für LPV)
 - Procedures
- VNAV
 - TOP / BOD
 - Automatic Flight Control System-Integration (VNV – VPTH)

Lab 6 GPS / VNAV

Engine Indication System

- Default page - graphic engine gauges
- Lean page
 - Graphic EGT and CHT
 - Softkey cycles through cylinders for digital readout
 - Softkey for Lean Assist mode
- System page
 - Digital engine gauges
 - Fuel used
 - Engine Hours (Tachometer hours)



- 
- Allgemeine Einführung
 - Grundsätzlicher Systemaufbau & Komponenten
 - PFD - Primary Flight Display
 - MFD - Multi Function Display
 - Audio-Panel
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 - Übungs-Szenarien VFR / IFR

Agenda

- COM MIC
- SplitCOM ?
- Manuelle Squelch
- Intercom System Isolation (ICS)
- VOL
- **Display Backup**



Audio Panel

Mode	PILOT KEY ANNUNCIATOR	COPLT KEY ANNUNCIATOR	Pilot Hears	Copilot Hears	Passenger Hears
ALL	OFF	OFF	Selected radios; pilot; copilot; passengers; MUSIC 1	Selected radios; pilot; copilot; passengers; MUSIC 1	Selected radios; pilot; copilot; passengers; MUSIC 2
PILOT	ON	OFF	Selected radios; pilot	Copilot; passengers; MUSIC 1	Copilot; passengers; MUSIC 2
COPILOT	OFF	ON	Selected radios; pilot; passengers; MUSIC 1	Copilot	Selected radios; pilot; passengers; MUSIC 2
CREW	ON	ON	Selected radios; pilot; copilot	Selected radios; pilot; copilot	Passengers; MUSIC 2



Intercom System Isolation (ICS)

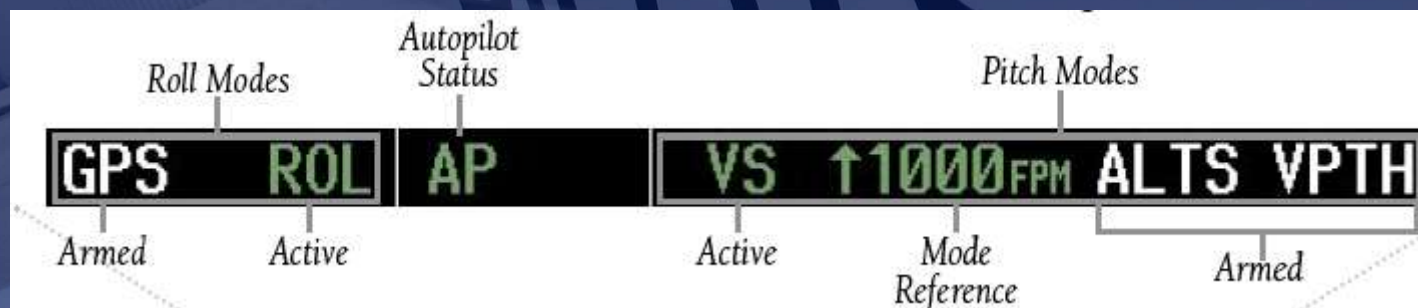
Agenda

- Allgemeine Einführung
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Automatic Flight Control System

Maximum commanded

- pitch (+20°/-15°)
- bank (22°)
- AFCS Status Box
 - Roll Modus



Armed = weiß
Active = grün

Bedienung des Automatic Flight

Control Systems

- AP Engages/disengages the AFCS and flight director
 - HDG Selects/deselects Heading Select Mode
 - NAV Selects/deselects Navigation Mode
 - APR Selects/deselects Approach Mode
 - VS Selects/deselects Vertical Speed Mode
 - FLC Selects/deselects Flight Level Change Mode
 - FD Activates/deactivates the flight director only
 - ALT Selects/deselects Altitude Hold Mode
 - VNV Selects/deselects Vertical Navigation Mode
 - BC Selects/deselects Back Course Mode
 - UP/ DN Controls the active pitch reference
-
- AP DISC Switch (Autopilot Disconnect)
 - MET Switch (Manual Electric Trim)
 - CWS Button (Control Wheel Steering)





Automatic Flight Control System

Flight Director



Autopilot Status:

- GPS ROL AP VS ↑1000 FPM ALTS VPTH
- ROL AP PIT ALTS
- ROL AP PIT ALTS

AFCS – Roll Modi

Roll Mode	Control	Annunciation
Roll Hold	(default)	ROL
Heading Select	HDG Key	HDG
Navigation, GPS Arm/Capture/Track	NAV Key	GPS
Navigation, VOR Enroute Arm/Capture/Track		VOR
Navigation, LOC Arm/Capture/Track (No Glideslope)		LOC
Backcourse Arm/Capture/Track	BC Key	BC
Approach, GPS Arm/Capture/Track	APR Key	GPSa
Approach, VOR Arm/Capture/Track		VAPP
Approach, ILS Arm/Capture/Track (Glideslope Mode automatically armed)		LOC
Go Around (in air)	GA Switch	GA

Roll Modi - Auswahl

NAV1 111.90 ↔ 114.10 SJC
NAV2 113.80 110.90 ISJC
DIS NM BRG °
HKG + PIT
ALTS
118.200 ↔ 136.975 COM1
136.975 118.000 COM2



AFCFS – Pitch Modi

Pitch Mode	Control	Annunciation	Reference Range	Reference Change Increment
Pitch Hold	(default)	PIT	-20° to +15°	0.5°
Selected Altitude Capture	*	ALTS		
Altitude Hold	ALT Key	ALT nnnnn FT		
Vertical Speed	VS Key	VS nnnn FPM	-3000 to +1500 fpm	100 fpm
Flight Level Change, IAS Hold	FLC Key	FLC nnn kt	70 to 165 kt	1 kt
Vertical Path Tracking	VNV Key	VPTH		
VNAV Target Altitude Capture	**	ALTV		
Glidepath	APR Key	GP		
Glideslope		GS		
Go Around (in air)	GA Switch	GA		

* *ALTS is armed automatically when PIT, VS, FLC, or GA is active, and under VPTH when the Selected Altitude is to be captured instead of the VNAV Target Altitude.*

** *ALTV is armed automatically under VPTH when the VNAV Target Altitude is to be captured instead of the Selected Altitude.*

Pitch Modi (Auswahl)

Vertical Speed mit Selected Altitude Capture Mode (ALTS)

ROL	AP	VS ↑1000FPM ALTS
GPS	AP	ALTS 3000FT ALT
GPS	AP	ALT 3000FT

Glideslope (GS)



Instrument Flying

VOR Intercept

VOR	HDG	AP	ALT	7000FT
-----	-----	----	-----	--------

VOR	AP	ALT	7000FT
-----	----	-----	--------

ILS-Approach

LOC	HDG	AP	ALT	3000FT	GS
-----	-----	----	-----	--------	----

Go-Around

GA	AP	GA	ALT
----	----	----	-----

Loss of Signal

VOR	AP	ALT	7000FT
-----	----	-----	--------

AFCS Alarme

NAV1 **113.00** ↔ **110.90** IIXD
NAV2 **115.90** **110.90** IIXD

ROL

AFCS

Alert Condition	Annunciation	Description
Aileron Mistrim Right	AIL→	Roll servo providing sustained force in the indicated direction
Aileron Mistrim Left	←AIL	
Elevator Mistrim Down	↓ELE	Pitch servo providing sustained force in the indicated direction
Elevator Mistrim Up	↑ELE	
Pitch Trim Failure (or stuck MET Switch)	PTRM	If AP engaged, take control of the aircraft and disengage AP If AP disengaged, move MET switches separately to unstick
Roll Failure	ROLL	Roll axis control failure; AP inoperative
Pitch Failure	PTCH	Pitch axis control failure; AP inoperative
System Failure	AFCS	AP and MET are unavailable; FD may still be available
Preflight Test	PFT	Performing preflight system test; aural alert sounds at completion Do not press the AP DISC Switch during servo power-up and preflight system tests as this may cause the preflight system test to fail or never to start (if servos fail their power-up tests). Power must be cycled to the servos to remedy the situation.
	PFT	Preflight system test failed; aural alert sounds at failure



- 
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Agenda

Lab 2 - VFR

- Erstellung eines UserDefined Waypoints
EUGENDORF (EUGD)
 - Ergänzung im VFR-Flugplan:
LOWS – EUGD – FRE – LOWL
- Direct-TO EUGD
- Direct-TO LOWL

Lab 3 - IFR

- Nav-Setting für folgende Clearance
OE-KHF is cleared to LOWL via FRE1S Depature then direct, climb and maintain 5000, squawk 5503
- Setup für ILS Approach 09 LOWL
- Missed Approach, Holding LNZ

Wiederholungsfragen

- Was sollte man tun, wenn der MFD System-Selfcheck „failed“?
- Wo kann man die Aktualität der Jeppesen-DB prüfen?
- Wo & wie können DME-Infos am PFD angezeigt werden?
- NAV-Tuning auf VOR: Von welcher Quelle wird die Entfernung angezeigt?
- Unterschied „Vectors to Final“ vs. Initial Approach Fix?
- Wie bzw. wie kann ich das PFD / MFD dimmen?
- Wie kann ich den Automatic Flight Control System ausschalten (3 Varianten)?
- GIA2 fällt aus – funktioniert das AFCS noch?

Wiederholungsfragen

- In welcher MFD-Page kann man den GPS-Status prüfen?
- Wie kann man die Orientierung der Karte (z.B. auf North-Up) ändern?
- Wie kann ich das PFD zurücksetzen?
- AHRS fällt aus (IMC)
 - Was sollte man sofort tun?
 - Welchen Instrumenten kann man (noch) trauen?
- Alternator fällt aus – Wie lange funktioniert das G1000?
- An welchen Displays können Stormscope-Informationen angezeigt werden?

Agenda

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Agenda

Praktische Simulation von Ausfällen

Failure to Be Simulated	Examiner Action	Applicant Action
Loss of primary flight instruments on the PFD (AHRS, ADC failure)	Dim PFD.	Control the aircraft by reference to the backup attitude, altitude and airspeed indicators.
Complete loss of PFD	Dim PFD.	Manually initiate reversionary mode and control aircraft via reversionary mode presentation on the MFD.
Loss of MFD	Dim MFD.	Manually initiate reversionary mode and control aircraft via reversionary mode presentation on the PFD.

Praktische Simulation von Ausfällen

Failure to Be Simulated	Examiner Action	Applicant Action
Loss of AHRS and ADC* (simulates loss of all primary flight instruments)	Pull AHRS and ADC circuit breakers.	Control the aircraft by reference to the backup attitude, altitude and airspeed indicators; engage the autopilot if it is rate-based and has its own gyro source in roll mode.
Loss of AHRS (attitude and heading)	Pull AHRS circuit breaker.	Control the aircraft by reference to the backup attitude indicator; engage the autopilot if it is rate-based and has its own gyro source in roll mode.
Loss of ADC (airspeed, altitude and vertical speed)*	Pull ADC circuit breaker.	Control the aircraft by reference to the PFD attitude presentation and the backup airspeed and altitude indicators; engage the autopilot in roll, HDG, or NAV mode.
Loss of PFD	Pull PFD circuit breakers. This action prevents the tuning of the COM 1/NAV 1 frequencies; COM 2 must be tuned to the proper frequency and must be in use.	Control the aircraft by reference to the MFD in reversionary mode (this mode also removes all moving map presentations).



NOTE: * When the ADC has failed, pressure altitude data is no longer available to the transponder. As a result, the transponder loses its Mode C (i.e., altitude reporting) capability. Therefore, without the required coordination with the appropriate air traffic control facility, failing the ADC should be avoided in Class B and C airspaces, or within the Mode C veil of Class B airspace.

Komplexität TAA

- Es ist nicht so einfach, wie es aussieht...

— AOPA

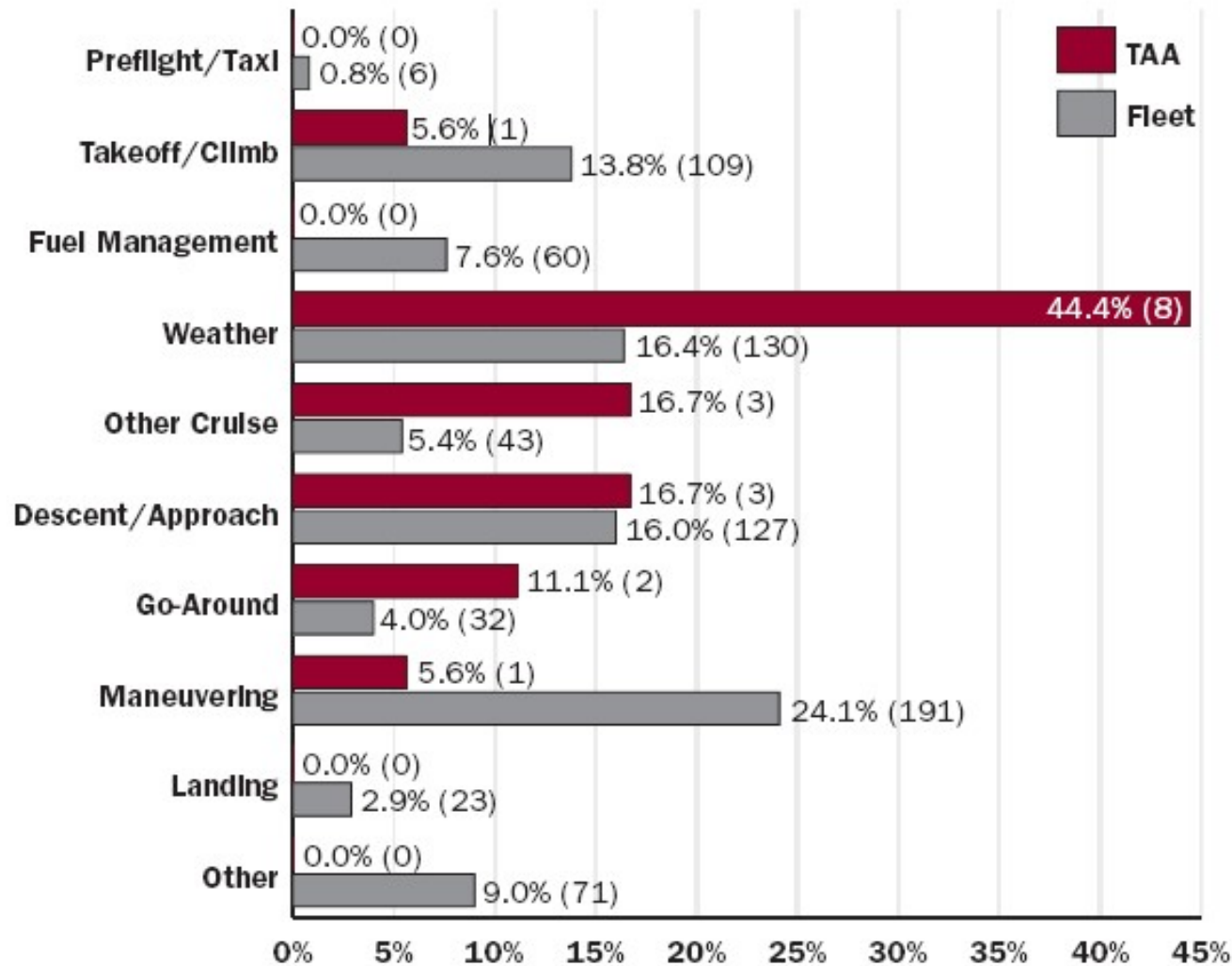
<http://download.aopa.org/asf/TAA2007.pdf>

- Fliegerische Skills
- “Computer Skills”



Typische Fehlerquellen

Pilot-Related Accident Categories, TAA vs. Fleet—Fatal



Losing skills

- “Use it or lose it”
 - Hand-flying skills atrophy when automation is overused
 - Automation skills atrophy when automation is underused

- Look out the window !!!

Automation can decrease
and increase workload!

- Experience level of the pilot
 - Total Time
 - High Performance Time
- Garmin GNS-430 Experience
- PFD/MFD Experience
- Pilot Preparation Prior to Training

If Pilot flight experience includes:	Plan for:
500+ hours Total Time (with at least 100 hours in previous 12 mos.) 50+ hours high performance Experience with Avidyne Integra (PFD/MFD) and Garmin 430GPS Instrument rated, instrument current and proficient	8-10 hours
200 - 500 hours Total Time 25 - 50 hours high performance Instrument rated, current and proficient OR experienced with advanced avionics and GPS	10 hours
Less than 200 hours Total Time Less than 25 hours High Performance No instrument rating or experience with advanced avionics or GPS	10 + hours

Weitere Tipps

- Sorgsamer Umgang
 - Reinigung der Displays (Schutzfolie)
 - Headsets nicht auf das Panel legen
- Handling der Cessna
 - Lüfter der Avionik!
- G1000
 - Weniger ist mehr (Inset, Overlay, BRG-Pointer etc.)
 - Single Pilot IFR: Autopilot!!! (auch in Emergencies)
(SRM – Single Pilot Ressource Management)
 - GPS immer mit Flugplan
- <http://wn.com/G1000>



CAUTION: The GDU 1040 and GDU 1044B PFD/MFD displays use a lens coated with a special anti-reflective coating that is very sensitive to skin oils, waxes, and abrasive cleaners. CLEANERS CONTAINING AMMONIA WILL HARM THE ANTI-REFLECTIVE COATING. It is very important to clean the lens using a clean, lint-free cloth and an eyeglass lens cleaner that is specified as safe for anti-reflective coatings.



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Garmin G1000 Glasscockpit