FlightGear Flight Simulator – Flight School

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FlightGear Flight School Version 0.0.2
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Contents

Preface

Welcome to the fascinating world of Flight Simulation - and welcome back to school! Flight simulation can be a very nice hobby. You can just do a short flight during lunch time break in the office, but You can also do a 'professional' pilot's job, including flight planing, checking the weather, calculating the fuel consumption, programming the FMC, et cetera. In both cases You need at least some basic knowledge of what you are doing.

I tried to set up this tutorial as easy as possible, but also as comprehensive as possible. Hopefully You should be able do to simple 'go arounds' after reading only the second chapter. In the following sections we will go deeper into flight planing, navigation, instrumentation and other aspects of flying. But You will also get to know all different airplanes available in *FlightGear*, even uncommon ones like a balloon or an ufo.

This tutorial is part of the whole *FlightGear* documentation.

- *FlightGear* Installation and Getting Started
- *FlightGear* School
- *FlightGear* Scenery and Aircraft Design[1]
- *FlightGear* Programmer's Manual [1]

Disclaimer Even though we tried to make this tutorial as real as possible, it is not for real world flying. Using it for any other purpose than entertainment is at Your own risk.

Carsten Höfer, November 2002
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[1] not written yet

Chapter 1

NOTAMs

This section is more or less for internal use. I will list here all changes since the last version, will give comments to special topics or simple ask for help or information for some sections.
I will keep the notam entries as long as I still need information. So please also read the sections of previous releases.

Version 0.0.3

Version 0.0.2

- **History:** I've tried to add a brief history of aviation. Unfortunately my knowledge of history is very limited. Especially if it deals with anything besides the 'big milestones' or outside germany. I do not have any information concerning the development of helicopters also.

- **Property Manager:** I've added a Chapter for the property manager. Until there is a easy and self explaining menue structure, it is neccessary to explain new users how to use this manager. I am not experienced with this tool. To save me a lot of trial and error work on the manager, I need at least a brief explanation, who it works.

Version 0.0.1

This is only the basic structure of this flight training. To give You an idea of what's planed, I've added at least an abstract for each section.

You will notice that I've also included program option not yet available in *FlightGear* like ATC, multi-player mode, combat simulation. But even if they are not implemented, I think, there are some interesting points to know and learn. Also I am absolutely convinced to have all these options in the future.

I have to confess to be only a computer pilot. I have no idea how it is to fly a real plane and if any sim is comparable. Therefore I guess I will put a lot of wrong things to this tutorial. Also english is not my native language (I think, You've noticed already).Please send me corrections and 'bug lists' as much as possible!!

I did mention above to use this NOTAMs also to ask for help. So here is my list, where I need Your help and assistance:

- **Airplanes:** For the section about the airplanes I need to have as much technical information as possible. So if you know something about speed, climb rates, fuel consumption, engines, FMC, equipment, history, et cetera, send it to me. If know know someone at Boing or Cessna give him (or her) my e-mail address and ask him (or her) to contact me.
- **Checklists:** To make the simulation as real as possible it's necessary to have real checklists for at least the essential parts of the flight. If You have or can get any checklists or procedures, please send them to me.
- **Combat strategies:** I do not know anything about flight combat and its strategies. If someone out there is an expert, please feel free to write the section about combat.
- **VFR:** For the chapter explaining VFR I would like to have a real good scenery, that enables VFR flying and navigation with checkpoints. Do we have any?
- **Links and Bibliography:** If you know any good links, books, magazines or whatever, please tell me to add to the list.
- **Translations:** The main document will be the english one. I will also try to work at the same time on the german translation. If You would like to have this tutorial also in Your favorite language, please feel free to work on it.
- **Help:** Setting up the structure of this document, I was surprised how much I would like to put in it. For me it looks like a decade's work. So everyone is invited to send me articles or sections for this tutorial.

Part I

Basic Flying

Chapter 2

Basics

2.1 *FlightGear* Fundamentals

2.1.1 Installation and Start

The installation of *FlightGear* either as pre-build binaries or as source code, that has to be compiled, is well documented in the Getting-Started-Manual[4].
As long as there is no menu structure to choose Aircraft within *FlightGear* the best is to start the program out of a shell[1]. This enables the user to pass different options to *FlightGear*. Theses options will be explained in later chapters when needed.
Simply start the simulation according to [4].

Fig.: Starting Screen of *FlightGear*

[1]MS-Windows: Start-Programs-?????

2.1.2 Overview

When the program starts, You will sit the first time in Your aircraft, which should be a Cessna 172 by default. Right in front of You, You will see the cockpit with all different instruments, switches and knobs. Looking outside You will see the airport of San Francisco Intl.(KSFO).
Pressing shift key and numeric keys according to the following table, You can have a look around[2]:

Shift+8	Forward
Shift+7	Left/forward
Shift+4	Left
Shift+1	Left/back
Shift+2	Back
Shift+3	Right/back
Shift+6	Right
Shift+9	Right/forward

Maybe You feel a little bit disturbed by the engine sound. Either press [p] for pausing the simulation or press [??] for muting the program. Hitting [v] will toggle between views from the cockpit, from a chasing aircraft or from the tower. Especially for the tower view sometimes it help's a lot to find the aircraft by zooming in [x] and out [X].
Back to the cockpit view, You can switch it off completely by [P] or reduce it to the important instruments only by [s].
Most of these keys work like on/off switches. For example, pressing [P] once will hide the cockpit panel, pressing [P] a second time, will display it again.

2.1.3 Menus

Located at the top of the screen You will find the menu with the following drop-down menu:

File

Save Flight: Saves the actual flight to the installation directory. You can either specify a name or accept the default fgfs.sav[3].

Load Flight: Loads a previous saved flight. The saved file contains all actual information about the aircraft but not the pitch. You will always resume a straight and horizontal flight.

[2] requires deactivated numlock
[3] Files will be overwritten without warning

Reset: Resets the simulation to the selected starting point. This is either the beginning of the actual simulation or the state of the last save.

Hires Snap Shot: Saves a high resolution screen shot under fgfs-screen-XXX.ppm. 'ppm' is a basic image format, taht can be manipulated by image processors like Gimp or ImageMagick. Further details can be found in the Programers Guide[5].

Snap Shot: Saves a normal resolution screen shot under fgfs-screen-XXX.ppm.

Print: Prints a screen shot (Linux only).

Exit: Exits the program.

View

Properties: Provides access to numerous properties managed via *FlightGear*'s property manager. This is acu tually a quite powerful tool allowing to set all the values in the property tree. Obviously, this is a good place to crash the program by entering a "bad" value. A detailed description is given in the appendix section.

HUD Alpha: Toggles anzialiasing of HUD lines on/off.

Pilot Offset: Allows setting a different view point (useful for R/C flying).

Toggle Panel: Toggles instrument panel on/off.

Environment

Goto Airport: Enter the airport ID and You will be brought to this airport.

Autopilot

Set Heading: Sets heading manually.

Set Altitude: Sets altitude manually.

Add Waypoint: Adds waypoint to waypoint list.

Skip Current Waypoint: Deletes the acutal waypoint from waypoint list.

Clear Route: Clears current route.

Adjust AP Settings: Allows input of serveral autopilot parameters.

Toggle HUD format: Toggles figures of latitude/longitude in HUD.

Network

(Supposes compile option –with-network-olk)

Unregister for FGD: Unregister from *FlightGear* daemon.

Register for FGD: Register for *FlightGear* daemon.

Scan for Daemons: Scan for daemons on the net.

Enter Callsign: Enter a call sign.

Toggle Display: Toggle call sign etc. on/off.

Help

Help: Opens Your browser and displays an overview on serveral help options.

2.2 Physics of Aero- and Flight Dynamics

Isn't it astonishing, that heavy airplanes like a Boing 747 with a take off weight greater than 400tons is able to fly? Sure, but only at a first glance. If You look more closely to aerodynamics and physics, than it's obvious, what keeps the plane up in the sky.

2.2.1 Four Forces

Basically there are four forces loading a flying airplane: Lift, Weight, Thrust and Air Drag. Always two of them are loading the plane in opposite directions: Lift and Weight, Thrust and Air drag. In a 'normal' horizontal straight flight these four forces remain an equilibrium. This means, the plane will not descent nor climb or deccelerate nor accelerate.

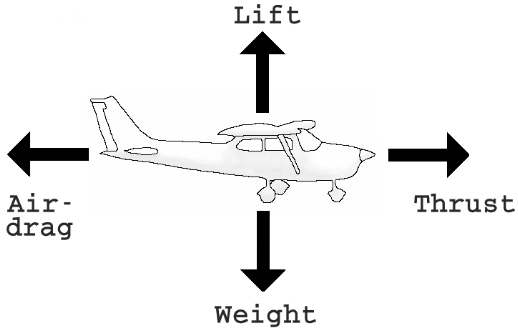


Fig.: Plane with four resulting forces

Lift

Lift is the force pulling the aircraft up (most of the time). When a body moves through air or any other medium and this stream is not exact normal to the body, it will be moved either up or down. For example, when You move Your hand out of the window of a driving car and turns it a little bit that the front side points upwards, Your arm will raise. This effect may be enhanced by profiling the body.
The wings of a airplane are not flat but curved. If now the wings (means the aircraft) move through the air, the air is devided by the front of the wing. Due to the profile of the wing, the air at the lower side has to move a shorter distance than the air streaming around the upper side of the wing. To maintain the equilibrium the upper stream has to be accelerated. The faster upper stream causes less pressure to the wing than the slower lower stream (sentence of Bernoulli: The product of pressure and velocity remains constant; p*v=const).

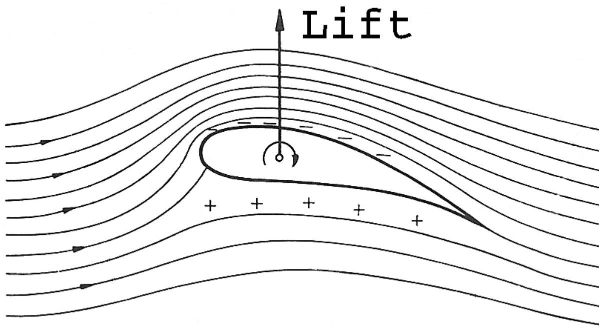


Fig.: Wing with streamlines and resulting Lift[7]

This difference in pressure on the wing results in a lifting force. The Lift is always pointing normal upwards to the wing.
The force is depending on several parameters like the wing profile, the velocity of the plane relative to the air, wing forms, the area of the wing, et cetera.

Weight

Weight is the opposite force to Lift and is always pointing towards the earth.

Thrust

Thrust is the force moving the airplane in the longitudinal direction. In most cases (except hanggliders) the thrust is produced by one or more engines with propellors, turboprop- or turbojet engines. We will start here with simple propellor engines. Other types of engines will be discussed in the appropriate later chapters.
The power for the propellor is produced by an engine, that is very similar to car engines. The rotating propellor pushes the air backwards to the rear of the plane. Due to Newtons laws (actio = reactio), this will generate a forward movement of

the plane.
There is a concurring or additional explanantion, why a plane is moved by rotating propellors. They are build out of two to four single wings. The expression 'wing' is not wrong in this context. Like the two wings of the plane also the propellor has a profile and produces 'lift'. The difference to the above described wing is, that the propellor rotates around the logitudinal axis of the plane. When the propellor rotates the air moves around its profile, is diverted to the front (upper) and the back (lower) side of the wing. Thus resulting in a force driving the plane.

Air Drag

Opposing to thrust is air drag. It acts everytime a body is moved through an other medium, like water, air or ice cream. It is depending on size, form and surface of the moving body, its velocity and the density of the medium.
Drag is divided into four different forms:

- Form Drag
- Friction Drag
- Induced Drag
- Interference Drag

Every body moving through air can be regarded as a hindrance to the air. The air is slowed down, has to move around the body and come together behind the body, causing whirls. The amount of this form drag depends on the form and the face of the body and the relative velocity. An expression for the form of the body is the c_w-value. It describes the relative drag to a flat plate (c_w of 1). A sphere reduces the value to 0.5. Very good is a drop like form resulting in a value of 0.05 with the same facing area.

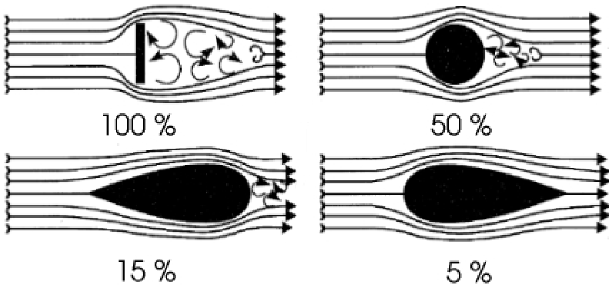


Fig.: Different forms with according air drag and c_w-value [1]

While drag is proportional to the size of the facing area, the velocity has an quadratic effect. If the velocity is doubled the drag increases by four. Form drag is the biggest of the four drag types.
This advises the air plane designer to give the plane a low form drag, for example

by usage of retractable gear.

When the air moves around the body there is friction between the air and the body. The amount of friction depends on the quality of the surface. Painted or varnished surfaces give a very low friction drag.

The differences in pressure between the upper and the lower wing surface is compensated at the lateral end of the wings. This compensation causes whirls or wake turbulences behind the airplane. These turbulences depend on the weight and velocity of the plane and the form of the wings. The larges amount of this whirls is generated by slow flying large planes (with full extended flaps). Besides the induced drag, these turbulences give also a big risk for following air planes. To reduce this risk the distance between to planes in the final approach can be up to several miles.
Today the designers try do minimize the induced drag by modifying the lateral ends of the wings (wing tips or winglets).

All parts of the plane generate drag. These drags interfere with each other. Sometimes neutralizing each other, sometimes intensifying each other. The difference between the theoretical drag of all single parts and the the effective drag is called interference drag. By creating smooth transitions between the single parts or appropriate facing todays designer try to reduce the interference drag.

The better the form and surface, the lower the interference and induced drag, the lower is the total drag of a plane. A very low total drag let a plane fly faster with less fuel consumption.

2.3 Airplanes

Unregarding of the size of a plane the general layout is the same for a small Cessna or a Concorde.

2.3.1 General Set up

Normally a plane consists of a tube like structure called the body. The body gives space for the cockpit, passenger and luggage compartments, electronics and more.

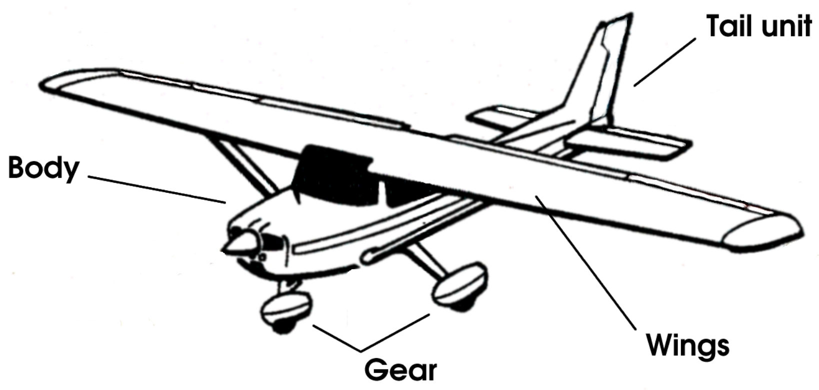


Fig.: General Set up of an aircraft

Mounted to the body one will find the wings, gear and the tail unit.

Mostly smaller airplanes are separated by the mounting points of the wings:

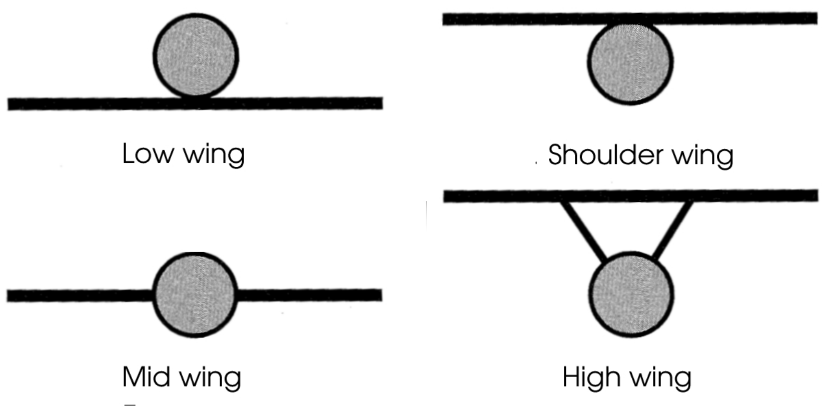


Fig.: Different types of wing forms[1]

The wings contain the fuel tanks, Flaps, spoilers and ailerons.

The tail unit is mounted at the back of the body. The tail unit contains the elevators and rudder. Normally the elevators are mounted lateral to the body and the rudder above. Besides this, there are T-tail units, where the elevators are mounted on top of the rudder and V-tail, combining elevators and rudder in two diagonal wings.

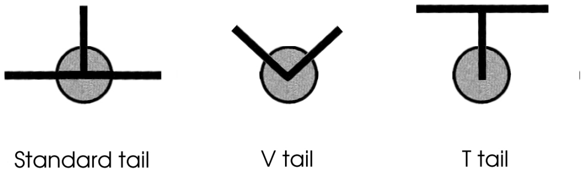


Fig.: Different types of tail units

Below the body or the wings one will find the gear. Advanced aircrafts have retractable gears to reduce air drag. Most of the planes have a single front gear and several major gears at the center of the plane. At lower speeds at the ground the plane is steered by the single front gear. Some smaller planes have the single gear mounted at the back below the tail unit.

The engine(s) are mounted either at the front of the body or at the wings.

2.3.2 Controls

Due to our improved kowlegde of aerodynamics we now know, what makes a plane fly. But how to control it? In this section the basic controls of a plane are duscussed. In later chapters we will see how they work up in the air.
A plane can move in all three dimensions, therefore there are six basic directions: up,down, left, right, front and back.
To make the plane go up or down one moves the yoke backward or forward. This will move the elevators mounted at the tail unit.If the ends of the elevators are moved upwards, the tail of the plane will be pushed downwards. The acting force is also the lift. The lowered tail will rotate the plane and therefore increase the angle between the plane and the streaming air (angle of attack). The plane will start to climb. But only for a very limited time. Than the plane will loose speed. The lift of the wings is depending on the speed and therefore the speed will decrease. It's like driving up a hill. When You do not increase the power, the car will slow down due to the ascent.
So for a permanent climb one has to adjust the power setting of the plane also.
To reduce height in most cases it is sufficient to reduce the power setting. The speed will reduce and also the lift.

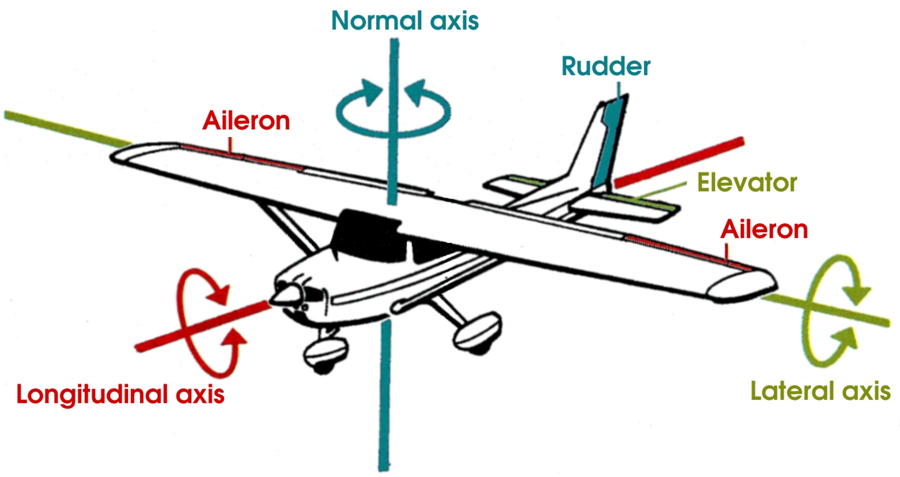


Fig.: General Set up of an aircraft ([3])

At the lateral ends of the wings one finds the ailerons.
Ailerons are controlled by the lateral movement of the yoke. Moving the yoke to the right, makes the left aileron point downwards and the right one point upwards. This causes the plane to rotate about the longitudinal axis. This bank will make the plane to fly a curve.

To rotate the plane around the normal axis one uses the rudder mounted at the rear end of the tail unit. The rudder will be controlled by the pedals. Pushing the right pedal will turn the plane to the right side, pushing the left pedal will turn the plane to the left side. Both pedals are coupled. Moving one to the front will move the other one to the back.
In smaller planes the pedals are also used to turn the plane on the ground. Bigger planes have a separat wheel to control the front gear.
The top ends of the pedals are used to activate the tyre brakes of the plane. Bigger planes also have 'air brakes', called spoilers. Spoilers are mounted on the top of the wings and destroy the current around the wings and increase the air drag. In addition to this heavier planes have thrust reversers to brake a plane on the ground. As the name implies, thrust reversers act as if the engine is switched to rear gear.

2.4 General Cockpit Layout

Like the general outer layout is similar for most planes it is quite the same for the cockpit. At least the bigger planes are equipped for two 'pilots': the pilot and the 1st officer.
In smaller planes like the Cessna 172 most of the instruments are placed in front of the left seat, while for the right seat there is only the flight stick. But due to the narrow cockpit, also the person on the right hand side is able to have a view to all instruments.

Besides the main instrument panel there are several more in greater planes. The main engine controls a mainly placed in the centre console, electrical instruments are also to be found in overhead panels or side panels next to the pilots and copilots seat.

2.4.1 Instruments

In front of the pilot one will find the most important instruments in the plane.
Before looking at these instruments en detail, we will have a short look at the way they work. There are two different types of instruments: pressure driven instruments and gyroscopic instrumentsgyroscopic instruments.
Altimeter, vertical speed indicator and airspeed indicator are pressure driven instruments, artificial horizont, directional gyro and attitude gyro are gyroscopic instruments.

Pressure Instruments

Pressure driven instruments are basically very simple. One has a membrane, which is filled with air with a certain pressure. Outside of this membrane there is also air with a certain pressure. If these pressures are in equilibrium the attached pointer remains in a neutral position. If the outside pressure is greater than the inside pressure, the membrane will expand and the pointer will move, and vice versa.

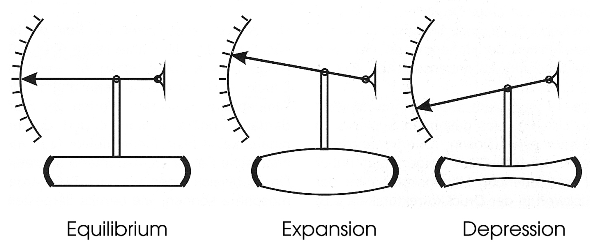


Fig.: Sceme of pressure powered instruments[1]

The advantage of this system is, that it is independent of any power supply or anything else than the air pressure.
The big(!) disadvantage is, that these instruments are depending of the air pressure, which is never constant.

Gyroscopic Instruments

Do You remember spinning Your top some years ago? Did You ever try to move a spinning top? There were hugh forces acting normal to Your force. This is the principal of any gyroscopic instrument. They have a fast rotating kernel acting according to every change in position and orientation. For a gyro rotating with a constant speed the re-acting force is well known and can be used for measurement. Unfortunately the rotating earth and the movement of the gyro also create these forces.

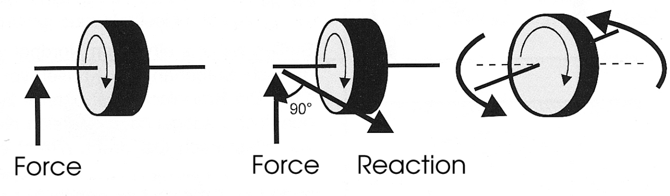


Fig.: Sceme of gyroscopic instruments[1]

Gyroscopic instruments are powered either electrical or by vacuum pumps, meaning that they allways need electricity or a runing engine.

The Altimeter

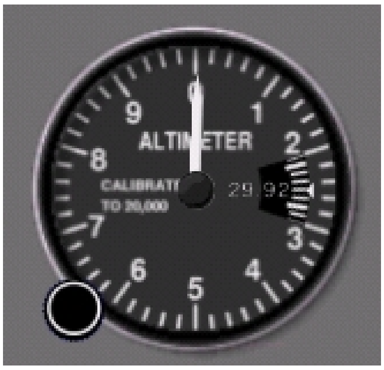


Fig.: The Altimeter

The Altimeter is used to give the actual height above MSL of the airplane. It is measured in feet[4]. The display is divided in 20 feet steps with numbers for every 100 feet. The short hand gives the altitude in 100 feet steps and the longer hand in 1.000 feet steps. 10.000 feet steps are displayed in a small window in the upper part of the altimeter.
To adjust the current instrument settings to local air pressure there is a small knob (Kollman knobat the lower left of the instrument. The actual setting is displayed in a small window in the middle of the left side of the instrument. Standard is 29,92 Inch of mercury (or 1013,25hPa).

The Attitude Gyro

The attitude gyro shows the actual climb situation of the plane. The scale is given in feet per minute (fpm).

[4]For unit convertion see H.

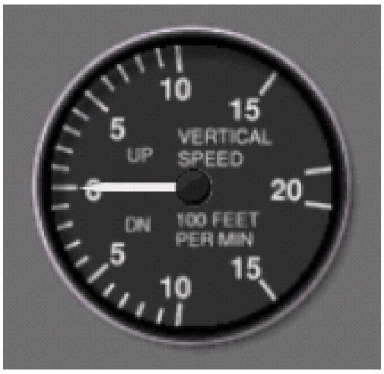


Fig.: The Attitude Gyro

The Airspeed Indicator

During a flight it is allways important to know the speed of the plane. The instrument to show is the airspeed indictaor. But even a 'simple' instrument like a speed indicator is complicated in avionics.
In a car it is quite simple to measure the actual speed. One knows the speed of the rotating axes and can multiply this speed with the Umfang of the tyre and some other simple mathematical operations and got the aproximate velocity.
But how may this be done in an aircraft? First of all one has to distinguish the different velocities of a plane. Different velocities? How is this possible? Sure a plane can only fly at one speed at a time. But in aviation there are several possibilities to measure this velocity.

- Ground Speed (GS)
- Callibrated Airspeed (CAS)
- True Airspeed (TAS)
- Indicated Airspeed (IAS)
- Rectified Airspeed (RAS)

The ground speed is quite similar to the velocity of a car. The distance between two points is divided by the time the plane needs for it and this gives the ground speed.[5]

[5]For unit systems used in aviation see H.

Fig.: The Airspeed Indicator

2.4.2 Overhead Panels

lights, fuses

2.4.3 Center Console

lever for mixture, prop speed,

2.4.4 Radio Stack

Nav and com unit

Chapter 3

First Steps

After the first theoretical sections Your are now up to take Your first practical lesson. The plane we will use is the ’standard’ training aircraft all over the world. It’s the Cessna 172P Skyhawk.

3.1 Pre-Flight

Please start *FlightGear* and load the file chapxx[1].
You will find Yourself at the parking area of EDWO. It’s a small local airport in northern germany.

3.1.1 Airport

Before a normal flight it is always essential to make a very detailed and careful flight planning. We will skip this for the first flight and come back to this task in section ’Flight Planing’ **??**. To find the runway, we need at least a little overview of the airport we are going to start from.
For every airport there are a lot of different charts about the airport layout, departure, arrival, etc. We will use only the airport layout chart.

Fig.: Airport layout of EDWO

At the moment the plane is standing at the parking area at the bottom of the chart.
You see the only runway (01/19) above the parking area.

3.1.2 Outside Checks

Before we enter the Cockpit and start the engine, there are some outside checks[2].

[1] You may download the file from http:
home.xxxxx

[2] For detailed checklists see B.1

Fig.: Outside Checks[?]magazin101

1. **Fuel** In the Cockpit switch on the master switch, which You will find in the left lower edge of the panel.
   In opposite to our well know car, there are keys and a master switch. In a plane the engine ignition does not dependent on the battery or a generator. This is very important, because both may fail. Therefore the ignition get's the power directly from to magnetos at the engine. All other electric parts of the plane get the power from the battery.
   To check the fuel, the master switch has to be switched on, so the instruments gets power from the battery.
   At the left side of the panel You will find the fuel gauge. It should now show the actual fuel stand. For this time, the fuel tank is full. For a regular fly the pilot has to calculate the fuel before the flight. Taking too less fuel may result in a dangerous situation. Taking too much, will increase the weight of the plane, leading to Higher fuel consumption and worse flight conditions. In later chapters You will learn to calculate the fuel to take before a flight.
   Switch off the master switch again. This is very important. At the moment all systems of the plane take the energy directly out of the battery. Due to the engine not running yet, it is not loaded and will drain very soon.

2. **Tail unit** Are all connections of the moveable parts secured safely? Is the rudder easily moveable?

3. **Aileron** Ailerons shouldn't have no Spiel in lateral direction, but should be moveable around the lateral axis.

4. **Main gear** Is the pressure of the tyres correct? The supplies for the brakes?
   Fuel tank Is water inside the fuel tank? There are valves below the wings where one can take some fuel out of the tank into a small glass. Water weights more than fuel, therefore one can see, if there is water inside.
   The fuel gauges inside the cockpit are not very accurate. Therefore there are some fuel maesurement bars to check the amount of fuel manually.

5. **Oil** Check the amount of oil inside the engine
   Propellor Check the propellor. Check for the keys. Rotating the propellor may start the engine! Please be careful!!
   Lights Check the landing lights. The glass should be clear and clean.
   Front gear Check for tyre pressure and working spring.

6. **Static port** The opening of the static port should be free and clean for working instruments.

Pitot tue For working airspeed indicator the opening of the pitot tue should be free and clean.
Stall warning opening For working stall warning the opening should be free and clean.

3.1.3 Cockpit

Back inside the cockpit, let's take a look around. You will find a lot of instruments, we've already seen in previous sections.
Directly in front of You, You will see the 'holy six'.

3.2 Starting the Engine

Check if the fuel selector is set to both tanks and that the trim is set to starting position.
Turn the master switch on. Some of the lights will start to flash while self checking and instruments (fuel and battery gauges) will start to move. Please check again the fuel.
6 How to start the engine, setting lights, setting avionics, checklist

3.3 Pre-Flight Checks

CIGARS

3.4 Take off

Often, when people have trouble controlling a plane in a PC simulator, it's because they're fixating on the panel and chasing the gauges. That's the wrong way to fly; here's the right way:

LOOK OUT THE WINDOW.

These pictures show how you can fly smoothly by concentrating on where the horizon hits the nose of the plane; in other words, by paying attention to the plane's attitude. You actual visual references for the horizon may change if you use a different pilot viewpoint or a different 3D model, but your first step should always be to learn the attitudes that work for the plane you're flying and then stick with them, cross-checking the airspeed indicator and altimeter no more often than you would check your rearview mirror in a car. The run-up and pre-takeoff checks are finished and tower has cleared us onto the runway. The plane's not moving yet, so all three wheels are solidly on the ground. Look closely at the vertical distance between the top of the white cowling and the horizon. Right now, the horizon is between a third and a half way up the windshield, just like it will be during level

cruise on the downwind leg and during final approach with the flaps down.
When I advance the throttle to full, the plane starts moving down the runway. The speed causes the nose to lift slightly on its own, but the horizon is still between a half and a third of the way up the windshield.
As the speed increases, I pull back just a little to take some weight off the nosewheel. At 55kt, the nose wheel has started to lift a little off the runway: you can tell, because the horizon is now touching the bottom of the windshield. I am almost in the climb attitude.

Fig.: Raising the nose to the horizon

At 65kt, the other two wheels leave the runway and the plane is flying. Note that I do not yank it off by pulling the yoke way back: raising the nose only a tiny sliver above the horizon and holding it there is sufficient to get the plane into the air. Note where the horizon strikes the sides of the cowling, just above the top of the panel.

Fig.: Lift off

3.5 Climbing

After I lift off, the plane keeps speeding up: in ground effect, there is no more friction from the tires but drag is very low. Since I want to climb at 70 kt, I have to raise the nose a sliver higher to keep the airspeed down. Now, at 100 ft AGL, my plane is in the climb attitude: all of the white cowling is now above the horizon, and the horizon hits the sides at very top of the panel itself. As long as I hold the horizon at this point, the plane will keep climbing smoothly at 70 kt.

Fig.: Climbing

3.6 Straight

Keeping the aircraft at a constant height

3.7 Some Curves

First turns with and without rudder

3.8 Back Home

Finding the airport

3.9 Landing

speed, height, downwind, crosswind, final, landing

3.10 Black Boxes

instant replay and flight analysis (do we have one?)

Chapter 4

Basic Maneuvers

4.1 Autopilot I

Introduction to ap, setting heading

4.2 Straight

4.2.1 Trim

How does it work? Why is it needed?

4.3 Curves

180deg turns, turns while climbing or descending, with flaps and gear

4.4 Stall

4.4.1 Angle of Attack

Normal stall, stall at low speed, stall in turns, flying with minimum speed

4.4.2 Flaps

4.5 Spin

How to spin and to to escape spin

4.6 Slipping

How to slip and why

Chapter 5

VFR Flying

5.1 Basics of VFR

What is VFR, what is IFR

5.1.1 Air Space

Differences in airspace

5.1.2 VFR Conditions

Am I allowed to fly?

5.2 Flight Planing

How to set up an flight plan, why, alternative airport

5.3 Navigation

Using maps, checkpoints, minimum en route height

5.3.1 Compass

Magnetic heading, true heading

5.3.2 Speed

True speed, IAS

5.3.3 Heading

Side winds, drift

5.4 Flying

From start to landing

5.4.1 Emergency Routines

What do I do if I lost my way?

Part II

Navig2ation and more

Chapter 6

Navigation I

6.1 Non Directional Beacon - NDB

6.1.1 What's a NDB?

How does it work, frequencies

6.1.2 Instrumentation

Which instrument do I need to find NDBs? How does it work

6.1.3 Position

Position relative to a NDB

6.1.4 Tracking

How do I keep track on a NDB

6.1.5 Intersecting

Change to an other course

6.2 Transponder

What's it? Instruments and how to use

6.2.1 Transponder Codes

7700 ;-)

6.2.2 Transponder Modes

STBY, ON, ALT, IDENT

Chapter 7

More Power - Twin Engine

7.1 Basics of Twin Engines

Physics with two engines, counter rotating probs, turboprob?

7.2 Cessna 310

Introduction of the airplane, retractable gear

7.3 Starting Two Engines

procedure for (cross) starting

7.4 Taxiing

Use the engines to make turns on the ground, CIGAR-TIP

7.5 Flying

Power setting, getting used to the aircraft

7.6 Autopilot II

Explanation of additional functions like height and climb control

7.7 Emergency - Engine Failure

7.7.1 ... while flying

Procedures to reach the next airport (Fly the aircraft!!!)

7.7.2 ... while starting

How to take off safely

Chapter 8

Navigation II

8.1 VHF Omni directional Range - VOR

8.2 What's a VOR?

8.2.1 Types of VORs

8.2.2 DME

8.3 Instrumentation

8.3.1 Position

8.3.2 Tracking

8.3.3 Intersecting

Chapter 9

Jet Engines

9.1 How do Jets work?

9.2 LearJet 24

Inrtoduction to the airplane

9.3 Starting the Engine

Procedure for starting the engine

9.4 Take Off

Power setting, take off speeds (V1 VR V2)

9.5 Flying

Mach-speed, descend

9.6 Landing

setting for landing, speed (VREF)

Chapter 10

Basics of IFR

Which instruments to use, how to read them

Chapter 11

B747 - The real big One!

Introduction to the airplane

11.1 Cockpit

Where to find everything

11.2 Starting the Engine

Procedure for starting the engines, pre-flight checks

11.3 FMC

Capabilities of FMC (do we have one?), how to use

11.4 Take Off

Speeds, rotation, flaps

11.5 Landing

Speed, flaps, air brakes, reverse thrust

Chapter 12

Is there anybody out there? - ATC

12.1 Who is there?

12.1.1 FSS

What's FSS?

12.1.2 ATIS

What's ATIS

12.1.3 Ground

What's...

12.1.4 Tower

What's...

12.1.5 Departure and Approach

What's...

12.1.6 Center

What's...

12.2 Procedures

12.2.1 VFR

Who do I talk to? When and why

Multicom

How does it work without any responsible person?

Circuit

Traffic patterns

12.2.2 IFR

Who do I talk to? When and why

12.3 Multi Player Mode

How to use multi player mode in *FlightGear*

12.3.1 Log In

log on to servers

12.3.2 Communication

speaking to other pilots

Chapter 13

Navigation III

13.1 Instrument Landing System - ILS

How does it work?

13.2 Maps and Charts

SIDs, STARs IAP-Charts

13.3 Instrumentation

How to set nav and read HSI

13.4 Landing

Establish ILS

13.4.1 Autopilot III

Approach mode and automatic landing

13.4.2 Manually

How to keep track on ILS in foggy conditions

Chapter 14

Weather

Why do we have weather

14.1 Climate

low and high pressure areas

14.2 Wind

strength of winds, layers

14.3 Clouds

Types of clouds, storms, lightning

14.4 Ice

Icing conditions, anti-icing systems

14.5 Flight Planing

How to get information concerning the weather, how does this influence my flight

14.6 weather radar

How to read it?

Chapter 15

Navigation IV

15.1 Global Positioning System - GPS

15.2 What's GPS?

How does GPS work? Satellites, resolution

15.3 Instrumentation

How to use it? Navigation using GPS, GPS approaches

Chapter 16

War Games

16.1 Tactics

How do I fly in a combat situation, wing man's work

16.2 Harrier

Introduction to the airplane

16.2.1 Cockpit

Where to find everything

16.2.2 Weapons

Systems, targeting, shooting

Chapter 17

Flying???

17.1 Baloon

How to fly a baloon

17.2 The Steps of Wilburgh and Arthur

History ao the wright brothers. How to fly their bird

17.3 UFO - The Future?

Going to mars

Part III

Appendix

Appendix A

Aviation History

b.c.	According to greek mythology Daidalos and Ikarus were the first men in history to fly. They made wings from feathers to escape their prison on the greek island Crete. Unfortunately they flew too high and the sun melted the wax they us
aprox. 1500	Leonardo da Vinci (1452-1519) made first sketches of planes and helicopters.
aprox. 1782-83	The french brothers Jacques Etienne and Joseph Michel de Montgolfier build the first balloons and reached in 1783 a height of 1800m with an unmanned balloon.
aprox. 1890	Otto Lilienthal made first hanggliding flights of some 100m after studies of birds, bird flight and aerodynamics. He died in a plane crash in 1896.
1903	Based on the work of Lilienthal, Orville and Wilbur Wright made the first motor flight in history.
1911	After 11 years of development the first commercial passenger transportation started using Zeppelin aircrafts.
1924	First trans atlanic flight of a zeppelin.
1927	First single trans atlanic of Charles Lindbergh from New York to Paris in $33\frac{1}{2}$ hours. His plane was called ’Spirit of St.Louis’.
1937	The crash of the zeppelin ’Hindenburg’ in Lakehurst ended a 13 year trans atlantic passenger service between europe and nord or south america.
1939	The Henkel He178 was the first plane equipped with a jet engine.
1942	The first rockets were developped in Germany.
1947	The Bell X-1 was the first plane to fly at supersonic speed. The pilot was Chuck Yeager.
1956	Using the Tupolev TU-104 the first jet passenger service started between Moskow and Prague.
1957	The first satellite called ’Sputnik’ was started in the Soviet Union.
1961	Juri Alexejewitsch Gagarin was the first man to round the world in space.
1968	The Tupolev TU-144 was the first supersonic passenger plane.
1969	N. Armstrong and E. Aldwin were the first man on the moon. M. Collins was the third man of the Apollo 11 mision, he had to stay in the space craft ’Columbia’ surrounding the moon.

1976	Air France and British Airways start a regulary supersonic passenger service from Paris and London to New York using the ’Concorde’.
1994	Development of *FlightGear* started.

Appendix B

The Aircrafts

Technical description of the airplanes available in *FlightGear*. All information listed below is only for use within *FlightGear*. Do not use in real flight situations.

B.1 Cessna 172R - Skyhawk

B.1.1 General

The Skyhawk aircraft is an all-metal, single piston, high-wing monoplane with a four-person seating capacity including a crew of one or two. Suitable allowance for luggage is provided.
The model 172R is certified to the requirements of U.S. FAA Federal Aviation Regulation Part 23 including day, night, VFR and IFR.[1]

B.1.2 Technical Information

Approximate Dimensions[1]

	English	Metric
Baggage Door		
Height (front)	22”	0.56 m
Height (rear)	21”	0.53 m
Width	15.3”	0.39 m
Cabin		
Height (max)	48”	1.22 m
Lenght (firewall to aft baggage area)	142”	3.61 m
Width	39.5”	1.00 m
Cabin Door		
Height (front)	40.5”	1.03 m

[1]Information of this chapter is taken from Skyhawk web page (18.11.2002), see App. I

Height (rear)	39”	0.99 m
Width (top)	32.5”	0.83 m
Width (bottom)	37”	0.94 m
Overall Height (max)	8’11”	2.72 m
Overall Lenght	27’2”	8.28 m
Wing		
Span (overall)	36’1”	11.0 m
Area	174 sq ft	16.2 sq m

Design Weights and Capacities[1]

	English	Metric
Baggage Allowance	120 lbs	54 kg
Fuel Capacity		
Total capacity	56.0 gal	212 liters
Total usable	53.0 gal	200.6 liters
Total capacity each tank	28.0 gal	106 liters
Landing Weight		
	English	Metric
kg		
Utility category	2,100 lbs	953 kg
Maximum Useful Load		
Normal category	837 lbs	380 kg
Utility category	487 lbs	221 kg
Oil Capacity	8 qts	7.6 liters
Ramp Weight		
Normal Category	2,457 lbs	1,114 kg
Utility Category	2,107 lbs	956 kg
Standard Empty Weighgt	1,620 lbs	743 kg
Take-off Weight		
Normal Category	2,450 lbs	1,111 kg

[1] Information of this chapter is taken from Skyhawk web page (18.11.2002), see App. I

Utility Category	2,100 lbs	953 kg

Further Information[2]

Velocities		
max. Velocity at MSL		123 knots
Cruise, 75% power at 8.000ft		120 knots

Cruise: lean mixture, additional fuel for starting the engine, taxiing, take-off, climb and 45 min. reserve.

75% power at 8.000 ft	range	440 NM (814,88 km)
40 gal (151,4 liters) fuel	time	3,8 hrs
max. range at 10.000 ft	range	520 NM (963,04 km)
40 gal (151,4 liters) fuel	time	5,6 hrs

Rate of climb	700 fpm
Max. height	13.000ft
Take-off	
Take-off distance	890 ft
Total distance (50 ft obstacle)	1.625 ft
Landing	
Landing distance	540 ft
Total landing distance (50 ft obstacle)	1.280 ft

Velocities[3]

	KCAS	KIAS
V_{NE}	152	158
V_{NO}	123	127
V_A		
2.400 lbs (1.088,64 kg)	97	99
2.000 lbs (907,2 kg)	91	92
1.600 lbs (725,76 kg)	81	82
V_{NE}		
10°flaps	108	110
10°- 30°flaps	84	85

[2] for Cessna Skyhawk 172P[6]
[3] for Cessna Skyhawk 172P[6]

Instrument markings[4]

	KIAS
airspeed indicator	
white area	33 - 85
green area	44 - 127
yellow area	127 - 158
red line	158

Instrument	red line (min.)	green area	red line (max.)
rpm indicator			
MSL	-	2.100 - 2.450 rpm	-
5.000 ft	-	2.100 - 2.575 rpm	2.700 rpm
10.000 ft	-	2.100 - 2.700 rpm	-
oil temperature	-	100°- 245°F	245°F
oil pressure	25 psi	60 - 90 psi	115 psi

B.1.3 Checklists

PREFLIGHT INSPECTION

(1) Cabin

1. Pilot's Operating Handbook – AVAILABLE IN THE AIRPLANE.
2. Control Wheel Lock – REMOVE.
3. Ignition Switch – OFF.
4. Avionics Power Switch – OFF.
5. Master Switch – ON.
6. Fuel Quantity Indicators – CHECK QUANTITY.
7. Avionics Cooling Fan – CHECK AUDIBLY FOR OPERATION.
8. Master Switch – OFF.
9. Static Pressure Alternate Source Value (if installed) – OFF.
10. Baggage Door – CHECK, lock with key if child's seat is to be occupied.

(2) Empennage

1. Rudder Gust Lock – REMOVE.
2. Tail Tie-Down – DISCONNECT.
3. Control Surfaces – CHECK freedom of movement and security.

[4] for Cessna Skyhawk 172P[6]

(3) Right Wing Trailing Edge

1. Aileron – CHECK freedom of movement and security.

(4) Right Wing

1. Wing Tie-Down – DISCONNECT.
2. Main Wheel tire – CHECK for proper inflation.
3. Before the first flight of the day and after each refueling, use sampler cup and drain small quantity of fuel from fuel tank sump quick-drain valve to check for water, sediment, and proper fuel grade.
4. Fuel Quantity – CHECK VISUALLY for desired level.
5. Fuel Filler Cap – SECURE.

(5) Nose

1. Engine Oil Level – CHECK, do not operate with less than five quarts. Fill to seven quarts for extended flight.
2. Before first flight of the day, and after each refueling, pull out strainer drain knob for about four seconds to clear fuel strainer of possible water and sediment. Check strainer drain closed. If water is observed, the fuel system may contain additional water, and further draining of the system at the strainer, fuel tank sumps, and fuel selector value drain plug will be necessary.
3. Propeller and Spinner – CHECK for nicks and security.
4. Landing Light(s) – CHECK for condition and cleanliness.
5. Carburetor Air Filter – CHECK for restrictions by dust or other foreign matter.
6. Nose Wheel Strut and Tire – CHECK for proper inflation.
7. Nose Tie-Down – DISCONNECT.
8. Static Source Opening (left side of fuselage) – CHECK for stoppage.

(6) Left Wing

1. Main Wheel Tire – CHECK for proper inflation.
2. Before first flight of the day and after each refueling, use sampler cup and drain small quantity of fuel from fuel tank sump quick-drain value to check for water, sediment, and proper fuel grade.
3. Fuel Quantity – CHECK VISUALLY for desired level.
4. Fuel Filler Cap – SECURE.

(7) Left Wing Leading Edge

1. Pitot Tue Cover – REMOVE and check opening for stoppage.
2. Fuel Tank Vent Opening – CHECK for stoppage.
3. Stall Warning Openbfseriesing – CHECK for stoppage. To check the system, place a clean handkerchief over the vent opening and apply suction: a sound from the warning horn will confirm system operation.
4. Wing Tie-Down – DISCONNECT.

(8) Left Wing Trailing Edge

1. Aileron – CHECK for freedom of movement and security.

BEFORE STARTING ENGINE

1. Preflight Inspection – COMPLETE.
2. Seats, Seat Belts, Shoulder Harnesses – ADJUST and LOCK.
3. Fuel Selector Value – BOTH.
4. Avionics Power Switch, Autopilot (if installed), Electrical Equipment – OFF.
5. Brakes – TEST and SET.
6. Circuit Breakers – CHECK IN.

STARTING ENGINE

1. Mixture – RICH.
2. Carburetor Heat – COLD.
3. Master Switch – ON.
4. Prime – AS REQUIRED (2 to 6 strokes; none if engine is warm).
5. Throttle – OPEN 1/8 INCH.
6. Propeller Area – CLEAR.
7. Ignition Switch – START (release when engine starts).
8. Oil Pressure – CHECK.
9. Flashing Beacon and Navigation Lights – ON as required.
10. Avionics Power Switch – ON.
11. Radios – ON.

BEFORE TAKEOFF

1. Parking Brake – SET.
2. Cabin Doors and Window(s) – CLOSED and LOCKED.
3. Flight Controls – FREE and CORRECT.
4. Flight Instruments – SET.
5. Fuel Selector Value – BOTH.
6. Mixture – RICH (below 3000 feet).
7. Elevator Trim and Rudder Trim (if installed) – TAKEOFF.
8. Throttle – 1700 RPM.
   (a) Magnetos – CHECK (RPM drop should not exceed 125 RPM on either magneto or 50 RPM differential between magnetos).
   (b) Carburetor Heat – CHECK (for RPM drop).
   (c) Engine Instruments and Ammeter – CHECK.
   (d) Suction Gage – CHECK.

9. Throttle – 1000 RPM or LESS.
10. Radios – SET.
11. Autopilot (if installed) – OFF.
12. Air Conditioner (if installed) – OFF.
13. Strobe Lights – AS DESIRED.
14. Throttle Friction Lock – ADJUST.
15. Brakes – RELEASE.

TAKEOFF

Normal Takeoff

1. Wing Flaps – 0 deg - 10 deg.
2. Carburetor Heat – COLD.
3. Throttle – FULL OPEN.
4. Elevator Control – LIFT NOSE WHEEL (at 55 KIAS).
5. Climb Speed – 70-80 KIAS.

Short Field Takeoff

1. Wing Flaps – 10 dbfserieseg.
2. Carburetor Heat – COLD.
3. Brakes – APPLY.
4. Throttle – FULL OPEN.
5. Mixture – RICH (above 3000 feet, LEAN to obtain maximum RPM).
6. Brakes – RELEASE.
7. Elevator Control – SLIGHTLY TAIL LOW.
8. Climb Speed – 56 KIAS (until all obstacles are cleared).

ENROUTE CLIMB

1. Airspeed – 70-85 KIAS.
2. Throttle – FULL OPEN.
3. Mixture – RICH (above 3000 feet, LEAN to obtain maximum RPM).

CRUISE

1. Power – 2100-2700 RPM (no more than 75
2. Elevator and Rudder Trim (if installed) – ADJUST.
3. Mixture – LEAN.

DESCENT

1. Fuel Selector Value – BOTH.
2. Mixture – ADJUST for smooth operation (full rich for idle power).
3. Power – AS DESIRED.
4. Carburetor Heat – FULL HEAT AS REQUIRED (to prevent carburetor icing).

BEFORE LANDING

1. Seats, Seat Belts, and Shoulder Harnesses – SECURE.
2. Fuel Selector Value – BOTH.
3. Mixture – RICH.
4. Carburetor Heat – ON (apply full heat before reducing power).
5. Autopilot (if installed) – OFF.
6. Air Conditioner (if installed) – OFF.

LANDING

Normal Landing

1. Airspeed – 65-75 KIAS (flaps UP).
2. Wing Flaps – AS DESIRED (0 deg - 10 deg below 110 KIAS, 10 deg - 30 deg below 85 KIAS).
3. Airspeed – 60-70 KIAS (flaps DOWN).
4. Touchdown – MAIN WHEELS FIRST.
5. Landing Roll – LOWER NOSE WHEEL GENTLY.
6. Braking – MINIMUM REQUIRED.

Short Field Landing

1. Airspeed – 65-75 KIAS (flaps UP).
2. Wing Flaps – FULL DOWN (30 deg).
3. Airspeed – 61 KIAS (until flare).
4. Power – REDUCE to idle after clearing obstacle.
5. Touchdown – MAIN bfseriesWHEELS FIRST.
6. Brakes – APPLY HEAVILY.
7. Wing Flaps – RETRACT.

BALKED LANDING

1. Throttle – FULL OPEN.
2. Carburetor Heat – COLD.
3. Wing Flaps – 20 deg (immediately).
4. Climb Speed – 55 KIAS.
5. Wing Flaps – 10 deg (until obstacles are cleared).
   RETRACT (after reaching a safe altitude and 60 KIAS)

AFTER LANDING

1. Wing Flaps – UP.
2. Carburetor Heat – COLD.

SECURING AIRPLANE

1. Parking Brake – SET.
2. Avionics Power Switch, Electrical Equipment, Autopilot if installed) – OFF.
3. Mixture – IDLE CUT-OFF (pulled full out).
4. Ignition Switch – OFF.
5. Master Switch – OFF.
6. Control Lock – INSTALL.

B.2 Cessna 182

B.3 Cessna 310

B.4 Beech 99

B.5 Harrier

B.6 DC 3

B.7 Boing 747

Appendix C

Property Manager

C.1 xxx

C.2 yyyy

Appendix D

Abbreviations

A

AD	Airworthiness Directive
ADF	Automatic Defense Finder
ADIZ	Air Defense Identification Zone
A/FD	Airport/Facility Directory
AFSS	Automated Flight Service Station
AGL	Above Ground Level
AI	Attitude Indicator
AIM	Airmen's Information Manual
AIRMET	Airmen's Meteorological Information
ALS	Approach Light System
ALT	Altitude; Altimeter
ARTCC	Air Route Traffic Control Center
ARTS	Automated Radar Terminal System
ASI	Airspeed Indicator
ASOS	Automated Surface Observing System
ATA	Airport Traffic Area
ATC	Air Traffic Control
ATCRBS	Air Traffic Control Radar Beacon System
ATCT	Air Traffic Control Tower
ATD	Actual Time of Departure
ATIS	Automatic Terminal Information System
ATP	Airline Transport Pilot
AVGAS	Aviation Gasoline
AWOS	Automated Weather Observing System

B

BRITE	Bright Radar Indicator Tower Equipment

C

C	Centigrade
CAS	Calibrated Airspeed
CAT	Clear Air Turbulence
CD	Clearance Delivery
CDI	Course Deviation Indicator
CFI	Certified Flight Instructor
CG	Center of Gravity
CH	Compass Heading
CRS	Course
CT	Control Tower
CTAF	Common Traffic Advisory Frequency

D

DA	Density Altitude
DF	Direction Finder
DG	Directional Gyro
DH	Decision Height
DME	Distance Measuring Equipment
DR	Dead Reckoning
DUAT	Direct User Access Terminal

E

EFAS	En Route Flight Advisory Service
EGT	Exhaust Gas Temperature
ELEV	Elevation
ELT	Emergency Locator Transmitter
ETA	Estimated Time of Arrival
ETD	Estimated Time of Departure
ETE	Estimated Time En Route

F

F	Fahrenheit
FA	Area Forecast
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation
FBO	Fixed Base Operator
FL	Flight Level
FPM	Feet Per Minute
FSS	Flight Service Station
ft	feet

G

g	Gravity
GD	Ground Control
GMT	Greenwich Mean Time
GND	Ground
GOES	Geostationary Operational Enviromental Satellite
GPS	Global Positioning System
GS	Ground Speed; Glide Slope

H

HAA	Height Above Airport
HDG	Heading
HF	High Frequency
Hg	Mercury (barometric measure)
HGT	Height
HI	Heading Indicator
HIRL	High Intensity Runway Lights
HSI	Horizontal Situation Indicator
Hz	Hertz (cycles per second)

I

IAF	Initial Approach Fix
IAS	Indicated Airspeed
ICAO	International Civil Aviation Organization

IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
ISA	International/ICAO Standard Atmosphere

K

KCAS	Knots Calibrated Airspeed
kHz	Kilohertz
km	Kilometer
kt	Knot
KTAS	Knots True Airspeed

L

LDA	Localizer Directional Aid
LIFR	Low Instrument Flight Rules
LIRL	Low Intensity Runway Lights
LL	Low Lead
LORAN	Low Range Navigation
LW	Landing Weight

M

MALSR	Medium Intensity Approach Light System with Runway Alignment
MAYDAY	International Distress Radio Signal
MC	Magnetic Compass; Magnetic Course
MDA	Minimum Descent Altitude
MEF	Maximum Elevation Figures
METAR	Meteorological Reports-Aviation Routine
MH	Magnetic Heading
MHz	Megahertz
MIRL	Medium Intensity Runway Lights
MLS	Microwave Landing System
MOA	Military Operations Area
MSA	Minimum Sector Altitude
MSL	Mean Sea Level
MTOW	Maximum Take-off Weight
MTR	Military Training Route

Multicom	self-announcing radio frequency
MVFR	Marginal Visual Flight Rules

N

Navaid	Navigational Aid
NDB	Non-Directional Beacon
NM	Nautical Miles
NOS	National Ocean Service
NOTAM	Notice To Airmen
NTSB	National Transportation Safety Board
NWS	National Weather Service

O

OAT	Outside Air Temperature
OBS	Omni Bearing Selector
OVC	Overcast

P

PA	Pressure Altitude
PAPI	Precision Approach Path Indicator
PIREP	Pilot Weather Report
PVASI	Pulsating Visual Approach Slope Indicator

Q

QFE	Air Pressure at Airport Height
QNH	Air Pressure at Airport Height, callibrated to MSL
QNE	Standard Air Pressure (1.013 hPA)

R

RAIL	Runway Alignment Indicator
RAS	Rectified Airspeed

RBI Relative Bearing Selector
RCLS Runway Centerline Lightning System
RCO Remote Communications Outlet
REIL Runway End Identifier Lights
RNAV Area Navigation
RPM Revolutions Per Minute
RVR Runway Visual Range
RWY Runway

S

SA Surface Observations
SCTD Scattered
SDF Simplified Directional Facility
SIGMET Significant Meteorological Advisory Alert
SM Statute Mile
SPECI Special Forecast
Squawk activate transponder code
SUA Special Use Airspace
SVFR Special Visual Flight Rules

T

TAC Terminal Area Chart
TACAN Tactical Air Navigation
TAF Terminal Area Forecast
TAS True Airspeed
TC True Course
TCA Terminal Control Area
TDZL Touchdown Zone Lights
TH True Heading
TRACON Terminal Radar Service Approach Control
TRSA Terminal Radar Service Area
T-VASI T-form Visual Approach Slope Indicator
TWEB Transcribed Weather Broadcast

U

UHF Ultra High Frequency

Unicom	aeronautical advisory radio communications unit
UTC	Universal Time Coordinated or Greenwich Mean Time

V

VAR	Variation
VASI	Visual Approach Slope Indicator
VFR	Visual Flight Rules
VHF	Very High Frequency
VOR	VHF Omnidirectional Range
VOR/DME	VOR + Distance Measuring Equipment
VORTAC	VOR + TACAN
VSI	Vertical Speed Indicator
V_A	Maneuvering Speed
V_{FE}	Maximum Flap Extended Speed
V_{LE}	Maximum Landing Gear Extended Speed
V_{LO}	Maximum Landing Gear Operating Speed
V_{min}	Minimum Speed
V_{NE}	Never Exceed Speed
V_{NO}	Maximum Structural Cruising Speed, Maximal Normal Operating Speed
V_S	Stalling Speed
V_{S0}	Stalling Speed with extended Flaps
V_{S1}	Stalling Speed with retracted Flaps
V_X	Best Angle of Climb Speed
V_Y	Best Rate of Climb Speed

W

WAC	World Aeronautical Charts
WCA	Wind Correction Angle
WSFO	Weather Service Forecast Office
WSO	Weather Service Office

Z

Zulu	Universal Time Coordinated (UTC); Greenwich Mean Time

Appendix E

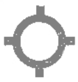
Airport Lightning Systems

Explanation of different lightning systems at airports

Appendix F

Chart Symbols

Aerodomes

	Hamburg	International Airport
	Lemwerder	Airport resp. Airfield IFR
	Buchel	Military aerodrome
	Hohenfels	Airfield (civil/military)
	Breitscheid	Airfield, alignment on the longest hardened runway
	Hettstadt	Airfield, alignment on the longest grass runway
		Airfield, closed
	Saffig	Heliport Civil resp. Military
		Heliport for ambulances

	Baldenau	Glider site aero tow resp. winch launching
	Berg	Ultra light flying
	Waldkirch	Hang glider site
	Calw	Parachute jumping site, low resp. high activities
	Attrach	Free balloon site
		Aerodrome beacon light

123.000 650m

- 650m — The shorter of the available landing dist of the longest RWY
- 123.000 — Available frequency (underlined VDF available)

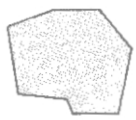
118.450 A/A

- Air/Air Communications (France)

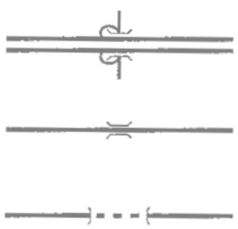
Radio Navigation Facilities

	VOR	VHF omindirectional radio range
	VOR/DME	VHF omnidirectional radio range with distance measuring equipment
	VORTAC	Co-located VOR and TACAN facilities
	NDB	Co-located VOR and TACAN facilities

Build-up Areas

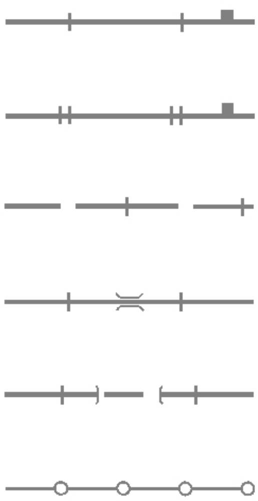
	Bonn	City (100 000 inhabitants and more)
	Hof	Town (more than 20 000 inhabitants and villages with less than 20 000 inhabitants)
	**Neuhaus**	Village (5 000 to 20 000 inhabitants and villages with less than 5 000 inhabitants in sparsely populated areas)

Roads



- Dual Highway
- Dual Highway under construction
- Primary road
- Secondary road
- Race track
- Dual highway entry
- Road bridge
- Road tunnel

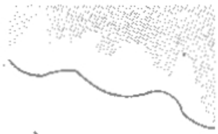
Railways

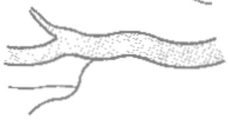


- Railway (single track) with station
- Railway (multiple track) with station
- Railway (abandoned or under construction)
- Railway bridge
- Railway tunnel
- Aerial railway

Hydrography


Shore line

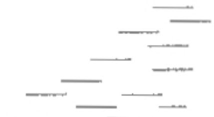

Tidal flats


River

Canal

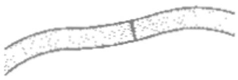
Abandoned canal or canal under construction


Lake


Swamp


Ferry


Dam


Barrage


Lock, ship hoist


Groyne, mole


Pier, submerged rock

Boundaries

Landmarks

Miscellaneous

Airspace Structure

Airspace Restrictions

Transponder Setting

Appendix G

Communications

Phonetic Alphabet

Alpha	**G**olf	**M**ike	**S**ierra	**Y**ankee
Bravo	**H**otel	**N**ovember	**T**ango	**Z**ulu
Charlie	**I**ndia	**O**scar	**U**niform	
Delta	**J**uliett	**P**apa	**V**ictor	
Echo	**K**ilo	**Q**uebec	**W**hiskey	
Foxtrott	**L**ima	**R**omeo	**X-**ray	

Morse Alphabet

A	.-	**K**	-.-	**U**	..-	**5**	.....
B	-...	**L**	.-..	**V**	...-	**6**	-....
C	-.-.	**M**	–	**W**	.–	**7**	–...
D	-..	**N**	-.	**X**	-..-	**8**	—..
E	.	**O**	—	**Y**	-.—	**9**	—-.
F	..-.	**P**	.–.	**Z**	–..	**0**	——
G	–.	**Q**	–.-	**1**	.—-	**.** (dot)	.-.-.-
H	....	**R**	.-.	**2**	..—	**,** (colon)	–..–
I	..	**S**	...	**3**	...–	**/**	-..-.
J	.—	**T**	-	**4**	....-	**?**	..–..

Appendix H

Unit Systems

H.1 SI Units

H.2 British System

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[6] Sierra ProPilot Users Manual (1998)

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Appendix I

Related Links

I.1 General Aviation

I.1.1 Aircrafts

www.skyhawk.cessna.com

I.2 Flight Simulation

I.2.1 *FlightGear*

www.flightgear.org

Appendix J

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