Saab JA 37D Viggen

FlightGear Flight Manual

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Version 5.4.0

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Introduction

The Saab 37 Viggen

The Saab 37 Viggen is a Swedish, supersonic, single-seat military aircraft, notable for its short takeoff and landing capability offered by a thrust reverser. It was developed in the 1960's, entered service in 1971, and was retired in 2005. While the Viggen was intended as a multi-role aircraft, it never truly achieved that goal—unlike its successor the JAS 39 Gripen. Instead, the Viggen was developed into a multitude of versions for different roles: surface attack (AJ 37), reconnaissance (SF 37, SH 37), and fighter interceptor (JA 37).

Specification (JA 37)

Wing span	10.60m
Length	16.40m
Height	5.93m
Main wing area	46.00m^2
Max takeoff weight	ca. 20000kg
Max static thrust	66.6kN dry, 110.3kN with afterburner

FlightGear Model

This flight manual is intended for the Saab 37 Viggen model for the FlightGear flight simulator. The model is available through FlightGear's official hangar FGAddon. Alternatively, development versions can be found in the Github repository[1]. Two variants of the Viggen have been developed in this model:

JA 37D A modernised fighter interceptor version from the 1990's. It notably features some of the glass instrument panels used in the JAS 39 Gripen.

AJS 37 Primarily a surface attack version, which resulted out of a modification programme providing some existing Viggens with limited multi-role (attack, fighter, and reconnaissance) capabilities.

This version of the manual is for the JA 37D.

Compatibility Note This manual was designed for version 5.4.0 of the Viggen model. Minimum supported FlightGear version is 2020.3.1. Using the latest stable FlightGear version is generally recommended.

[1] `https://github.com/NikolaiVChr/flightgear-saab-ja-37-viggen`

Part I

Aircraft Description

1. Cockpit Overview

1. Thrust reverser status light
2. Thrust reverser handle
3. Backup attitude indicator
4. Altimeter
5. Backup altimeter
6. Autopilot pushbuttons/lights
7. G-meter
8. Master warning lights and button
9. Angle of attack indicator
10. Autothrottle lights
11. Airspeed/Mach indicator
12. Afterburner zone lights
13. Attitude/director indicator (ADI)
14. RPM indicator (N2)
15. Engine pressure ratio indicator
16. HUD brightness knobs
17. Target display (MI)
18. Parking brake handle
19. Heading indicator
20. Backup heading pushbutton/light
21. Fast-reset pushbutton/light
22. Transonic / low speed reverse light
23. Horizontal situation display (TI)
24. Fuel gauge
25. Left warning lights panel (cf. fig. 2.1).
26. Right warning lights panel (cf. fig. 2.1).

Figure 1.1: Cockpit—front panel

1. Autothrottle lever
2. Landing gear lever
3. Cycle selected pylon button
4. Warning sounds volume
5. Air conditioning controls
6. Instruments light knob
7. Panel light knob
8. Backup trim controls
9. Yaw trim centered light
10. Trim reset button
11. FR 29 comm. radio panel
12. Canopy jettison button
13. Radar control panel (not implemented)
14. Engine start switch
15. Generator switch
16. Master power switch
17. Fuel cutoff switch
18. Comm. radio channel selector KV1
19. Datalink channel selector KV3
20. Warning lights test button
21. Roll trim centered light
22. Pitch trim indicator
23. Brake pressure indicator
24. Cabin pressure indicator
25. Taxi/landing lights switch

Figure 1.2: Cockpit—left panel

1. Clock / chronometer
2. Automatic fuel regulator switch
3. Afterburner cutoff switch
4. Emergency ram air turbine switch
5. Pitch gearing switch
6. Fuses panel
7. Weapons panel
8. Countermeasures panel
9. Formation lights intensity knob
10. Ignition plug switch
11. Oxygen pressure indicator
12. Oxygen cutoff switch
13. Navigation panel
14. Radar altimeter switch
15. GPWS switch
16. Windshield defogging knob
17. Test panel
18. Nozzle position indicator
19. Exhaust temperature indicator
20. Data panel
21. RWR control panel
22. Comm. radio FR 31 panel
23. Transponder
24. Formation lights switch
25. Navigation lights switch
26. Anti-collision lights switch
27. Identification transponder panel

Figure 1.3: Cockpit—right panel

2. Instrumentation and Indicators

2.1 Flight Instruments

Altitude Indicator (fig. 1.1:4) The long pointer is graduated in 100m, the short one in 1000m. The indicator can only display altitudes in the range 0–10km, after which it will cycle back to 0.

The knob is used to set reference pressure, which is displayed in hPa on a digital counter. Pulling the knob (click the center of the knob) sets the altimeter to the standard reference pressure 1013hPa. The pressure counter is covered with the text 'STD' in this case.

The altimeter requires AC power. A red-white flag indicates power failure.

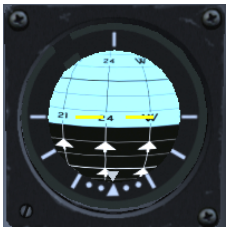
Airspeed/Mach Indicator (fig. 1.1:11) The airspeed indicator is graduated in km/h on a pseudo-logarithmic scale, up to 1500km/h. The airspeed indicator is fully mechanical.

The digital Mach indicator has a range of M 0–2.5. It is partially covered at M <0.4. The Mach indicator requires AC power. A red-white flag indicates power failure of the Mach indicator (but not of the airspeed indicator).

Heading Indicator (fig. 1.1:19) The heading scale itself rotates to indicate aircraft heading, read against a fixed index. The thin pointer indicates commanded heading, or bearing to the destination. The wide pointer indicates track angle to the target, or runway direction (at landing). The heading indicator requires AC power. A red-white flag indicates power failure.

The heading indicator can also display the output of the backup gyrocompass, cf. section 2.2.

Attitude/Director Indicator (fig. 1.1:13) The ADI consists of a sphere which rotates in 3 axes, indicating pitch, roll, and course. The two flight director needles (horizontal and vertical) show ILS deviation for landing. The ADI requires AC power. A red flag indicates power failure.



Angle-of-Attack Indicator (fig. 1.1:9) The AoA indicator is graduated in degrees, from -4° to 30°. When on the ground, the indicator displays pitch angle instead of AoA. The AoA indicator requires DC power. In case of power failure, the pointer returns to the -4° position.

Accelerometer (fig. 1.1:7) The accelerometer shows G-load (acceleration along the vertical axis), between -2g and +9g. A second pointer shows the maximum (positive) acceleration reached. The button resets the maximum acceleration pointer. The accelerometer is fully mechanical.

Chronometer (fig. 1.3:1) The chronometer has two scales. The inner scale and the white pointers indicate time. The outer scale and the yellow pointers are used for the stopwatch. The lower-left knob is used to adjust time. The top-right button controls the stopwatch. The first push starts the stopwatch, the second push stops it, and the third push resets it.

2.2 Backup Instruments

Backup Altimeter (fig. 1.1:5) The long pointer is graduated in 100m, the short one in 1000m. The indicator can only display altitudes in the range 0–10km, after which it will cycle back to 0. The knob is used to set reference pressure, which is displayed in hPa on a digital counter. The backup altimeter is fully mechanical.

Backup Heading Indicator (fig. 1.1:20) The JA 37 does not have a separate backup heading indicator. Instead the main heading indicator can display the output of the backup gyrocompass. The button BACKUP HEADING (RESERVKURS) toggles this functionality. When the button light is lit, backup heading is displayed. The backup gyrocompass requires AC power.

Backup Attitude Indicator (fig. 1.1:3) The backup horizon indicates pitch and roll angles. The display is mechanical, but the gyro uses AC power. A red-white flag indicates power failure. The instrument will continue to function with reasonable accuracy for a few minutes after loss of AC power.

2.3 Engine Instruments

RPM Indicator (fig. 1.1:14) The RPM indicator shows the high pressure compressor speed (N2), on a scale graduated up to 110%. It requires AC power.

Engine Pressure Ratio Indicator (fig. 1.1:15) The EPR indicator shows the pressure ratio between the intake and the outlet of the turbine (before the afterburner stage). It requires AC power.

Exhaust Gas Temperature Indicator (fig. 1.3:19) The EGT gauge indicates gas temperature after the turbine (before the afterburner stage) in °C. It requires DC power.

Nozzle Position Indicator (fig. 1.3:18) The nozzle indicator shows the position of the engine exhaust nozzle and the current afterburner zone. It requires DC power.

Afterburner Zone Indicator (fig. 1.1:12) The afterburner zone lights activate to indicate the afterburner zones (1 to 3) commanded by the throttle lever position. The lights are commanded purely by the throttle position, and not the afterburner zones which are actually lit: for instance moving the throttle in the afterburner zone during thrust reverse causes the lights to activate, despite afterburner being inhibited during reverse.

Fuel Gauge (fig. 1.1:24) The fuel gauge indicates fuel quantity as a percentage. Under standard conditions, the gauge indicates 112% with full internal tanks, and 136% with the external tank in addition. A second black-white pointer indicates required fuel quantity (not implemented). The fuel gauge requires AC power.

Figure 2.1: Left and right warning panels (fig. 1.1:25,26)

2.4 Warning Lights Panels

Left Side

Swedish	English	Description
BRAND	FIRE	Engine fire
BRÄ UPPF	FUEL DIST	Fuel distributor failure
X-TANK BRÄ	X-TANK FUEL	External tank pump low pressure
TANK PUMP	TANK PUMP	Fuel feed pump low pressure
LANDSTÄLL	GEAR	Steady: landing gear in movement. Blinking: gear failure, or gear retracted at low speed and altitude.
FÖRV FÖRBJ	NO REVR ARM	Risk of reverser engaging without WoW
NOS-/V-/H-STÄLL	NOSE-/L-/R-GEAR	Gear down and locked
ELFÖRS	ELEC FAIL	Failure of electrical system
ELREVERS	ELEC RES	Emergency ram air turbine failure
HYDR-TR 1/2	HYD PRESS 1/2	Low pressure in main hydraulic systems
AFK	A/T	Steady: auto-throttle disengaged. Blinking: A/T failure or abnormal disengagement.
EJ REV	NO REVR	Reverser or tertiary air intake failure
HYDRRESERV	HYD RES	Backup hydraulic pump low pressure
OLJETRYCK	OIL PRESS	Low pressure in engine oil system
OLJETEMP	OIL TEMP	High engine oil temperature

Right Side

Swedish	English	Description
SPAK	STICK	Stability assist failure (press any autopilot button to reset after acknowledgment)
ATT	ATT	Attitude hold failure (idem)
HÖJD	ALT	Altitude hold failure (idem)
BRAND GTS	FIRE GTS	Engine starter turbine fire
TIPP VÄXEL	PITCH GEAR	Failure of elevation reduction gearing
KABINHÖJD	CABIN ALT	Low cabin pressure
HUV o STOL	CANOPY/SEAT	Canopy open or ejection seat disarmed
TÄNDSYS	IGN SYS	Engine ignition system active
STARTSYST	START SYS	Starting sequence in progress
MAN BR REG	MAN FUEL	Manuel fuel injection regulation
CD	COMPUTER	Primary computer failure
PRIMÄRDATA	PRI DATA	Flight data computer failure
TN	INS	Inertial navigation central failure
RADAR	RADAR	Radar failure
IKS	IFF	Military identification transponder failure
ALFA	ALPHA	Angle-of-attack sensor failure
SYRGAS	OXYGEN	Oxygen mask low pressure
UTL TEMP	EXH TEMP	High exhaust gas temperature
BRÄ MÄNGD	FUEL QTY	Low fuel quantity
ANP 37	ANP 37	Weapon computer failure

2.5 Other Indicator Lights

Master Warning (fig. 1.1:8) The master warning consists of two flashing red lights, sometimes accompanied by a sound warning, depending on the cause. It generally lights up together with a blinking light on the warning panels. Pressing the button between the lights acknowledges the warning, which causes the corresponding light on the warning panels to become steady.

Reverser (fig. 1.1:1) Green light, indicates that the reverser handle (fig. 1.1:2) is pulled, and the reverser is armed (but not necessarily active).

Autopilot (fig. 1.1:6) Three green pushbuttons/lights. Used to select one of the autopilot modes: stability assist (STICK/SPAK), attitude hold (ATT), altitude hold (ALT/HÖJD). When an autopilot mode is active, the light for it and any lower mode are lit. The lights can blink to indicate special flight conditions under which the autopilot is not fully functional.

Autothrottle (fig. 1.1:10) The orange A/T (AFK) light indicates that autothrottle is active. The pushbutton/light 15,5° is used to select the high-alpha landing mode (requires landing gear down).

Transonic / Low Speed Reverse(fig. 1.1:22) Yellow light, indicates that the aircraft is in the transonic regime.

On the ground, it instead indicates that the reverser is active at low airspeed, causing a risk of hot air ingestion and engine fire. A low throttle setting (EPR<1.4) should be maintained in this case.

3. Control Panels

3.1 Radios

The JA 37D is equipped with two communication radios.

The FR 29 primary radio operates in the VHF band 103.000–159.975 MHz and in the UHF band 225.000–399.975 MHz, both with 25KHz spacing. It consists of two FR 28 transceivers, called A and B. At all time, one transceiver is used for voice communication, while the other is used for data link. Transceiver B (unlike A) can be powered by the aircraft battery, and should thus be used when AC power is unavailable, on the ground before startup or in case of electrical failure. The FR 29 can use 934 programmable channels, as well as direct frequency input.

The FR 31 secondary radio operates in the VHF band 104.000–161.975 MHz and in the UHF band 223.000–407.975 MHz, both with 25KHz spacing. It can use 971 programmable channels, as well as direct frequency input.

3.1.1 FR 29 Radio Panel

The FR 29 radio panel (fig. 1.2:11) is used to set the operating mode and volume of the FR 29.

1. Mode / channel knob
2. Select FR 28 transceiver A/B
3. Volume knob. Inner knob sets FR 29 volume. Outer knob sets warnings volume.

Figure 3.1: FR 29 Radio Panel

The radio operation modes, selected with the FR 29 panel knob (fig. 3.1:1) are the following.

N+L (NORM+LARM) Frequency is set with the KV1 channel selector. An additional receiver integrated in the FR 28 monitors the guard channel 121.5MHz.

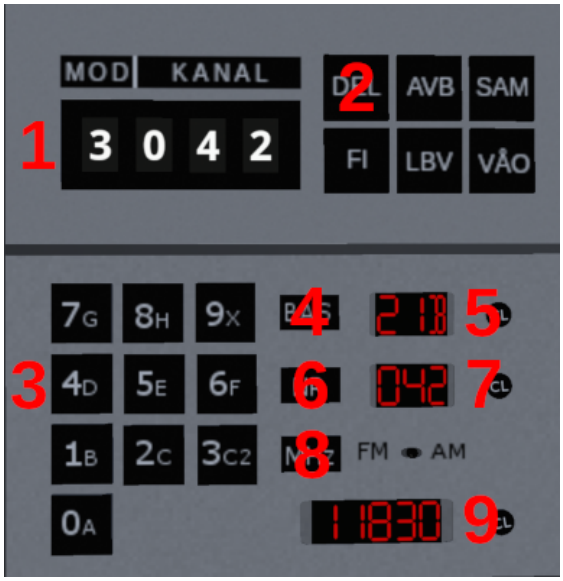
N (NORM) Same as N+L, without the guard channel receiver.

E,F,G,H Sets the corresponding global channel.

M,L Sets the corresponding custom channel.

3.1.2 KV1 and KV3 Channel Selectors

The KV1 (fig. 1.2:18) is used to set the channel of frequency for the FR 29 comm radio. The KV3 (fig. 1.2:19) is used to set the datalink channel.



1. KV3 datalink identifier and channel display.
2. KV3 'clear display' button.
3. Input keypad.
4. Airbase channel mode button.
5. Airbase channel input screen and clear button.
6. Generic channel mode button.
7. Generic channel input screen and clear button.
8. Frequency mode button.
9. Frequency input screen and clear button.

Figure 3.2: KV1 and KV3 channel selector panels

To enter a frequency or channel on one of the four screens (fig. 3.2:1,5,7,9), press the corresponding 'clear' button and input the new value using the KV1 keypad (fig. 3.2:3).

- Airbase channels are input in the format XXC, where XX is the airbase number, and C is the channel letter. For instance channel 21B is selected in fig. 3.2. If the letter is E,F, or G, the airbase number is ignored and the corresponding global channel is selected, e.g. 21E will select channel E.
- Generic channels are input with three digits. Channels 000–429 can be used.

- Frequencies are input with five digits, rounded down to 10KHz, For instance frequency 118.300MHz is selected in fig. 3.2. Since frequencies have 25KHz spacing, the last digit must be one of 0,2,5,7.

The three mode buttons (fig. 3.2:4,6,8), are used to select whether the airbase channel, generic channel, or frequency is used. When a screen is cleared for input, its previous value remains in use until the new input is complete and correct. The old value is restored on the screen when pressing the corresponding mode button, or if a different screen is cleared for input. An erroneous input is indicated by '≡', and the screen must be cleared to correct it. A screen waiting for input will start blinking with symbol '-' after 9 seconds.

If the airbase or generic channel mode is selected and no screen is waiting for input, pressing a keypad button will change the last character of the current airbase, respectively generic channel. E.g. if airbase channel 21A is in use, pressing button 1/B will switch to channel 21B.

3.1.3 FR 31 Radio Panel (fig. 1.3:22)

1. Input keypad.
2. Airbase channel mode button.
3. Generic channel mode button.
4. Frequency mode button.
5. Backup PTT button (not implemented).
6. Input screen and clear button.
7. Volume knob.

Figure 3.3: FR 31 radio panel

To enter a frequency or channel, select the airbase channel, generic channel, or frequency mode with the respective buttons if it is different from the current mode, (fig. 3.3:2–4), then press the 'clear' button and enter the new value with the keypad (fig. 3.3:1). The previous channel or frequency remains in use until the new input is complete. Invalid key presses are ignored.

- Guard channel H is selected by entering a single H, in any mode.
- Airbase channels are input in the format XXXC, where XXX is the airbase number, and C is the channel letter. Airbase numbers 000–169 can be used.
- Generic channels are input with three digits. Channels 000–119 can be used.
- Frequencies are input with five digits, rounded down to 10KHz. Since frequencies have 25KHz spacing, the last digit must be one of 0,2,5,7.

3.1.4 Radio Channels

The different Viggen radios can use a number of configurable radio channels. Available channel names are the following.

Generic channels These channels are normally used to communicate between aircrafts, and with fighter control. Their name consists of 3 digits. The FR 29 can use channels 000 to 429, and the FR 31 can use channels 000 to 119.

Airbase channels These channels are normally used to communicate with ATC. Their name consists of an airbase number (2 digits), followed by one of the letters A,B,C,C2,D. The FR 29 can use airbase numbers 00 to 99, and the FR 31 can use airbase numbers 000 to 169 (airbase numbers have an additional leading digit on the FR 31).

Guard channel The international guard channel 121.5MHz, called channel H.

Global channels Three fixed, global channels, called E,F,G (unavailable on the FR 31).

Others The FR 29 has two programmable channels called M,L.

These channels (except for guard channel H) are defined in text configuration files, which can be loaded through JA 37D > Load radio channels. Configuration file syntax is described in `Aircraft ▸ JA37 ▸ Doc ▸ channels-example.txt`. By default the file `Aircraft ▸ JA37 ▸ Nasal ▸ radios ▸ channels-default.txt` is loaded.

3.1.5 Data Link

Data link is used to communicate data such as position of friendly aircrafts and of targets with ground control (STRIL) and between fighters (fighter link). A very limited part of fighter link is implemented, allowing aircrafts to share their position, and the position of aircrafts they are tracking. This information is displayed on the TI.

Datalink is activated with the DL button in the SYST page on the TI. The KV3 screen (fig. 3.2:1) is used to set the datalink channel on the last 3 digits, and a datalink identifier on the first digit. Aircrafts must be on the same datalink channel to communicate. The identifier helps to distinguish between aircrafts on a same datalink channel. Each aircraft should set it to a different number, (e.g. its position in the formation). The identifier is ignored if it is 0.

On the TI, an aircraft connected through datalink shows as a green ⌂ with its identifier below it, if any. Furthermore, an aircraft A connected through datalink may transmit information about an aircraft B which it is tracking. Then, aircraft B is displayed as ⌂ with the identifier of A below it, if any.

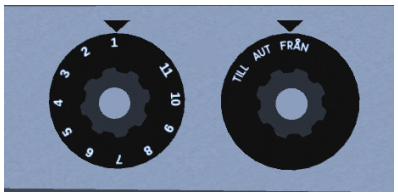
3.2 Identification Friend or Foe (IFF)

IFF is a radar system designed to identify friendly aircrafts.[1] Each aircraft can set a *query code* for its IFF system, and aircrafts with the same query code set will be identified as friendly. Thus, allied aircrafts can identify each other by using a shared code, chosen before the mission. In FlightGear, other aircrafts with a compatible IFF system include the F-16 and Justin Nicholson's MiG-21[2].

[1] Despite the name, IFF can by no mean identify foes. An enemy aircraft is undistinguishable from e.g. a civilian aircraft, or an aircraft with a non-functioning IFF system.

[2] `https://github.com/l0k1/MiG-21bis`

Control Panel The IFF control panel fig. 1.3: 27 is located on the rear right side of the cockpit. The right knob is the power knob, with 3 positions: OFF/FRÅN, AUTO (on when airborne), ON/TILL. The left knob is used to set the query code, between 1 and 11.



Identification of Contacts IFF interrogation is done with N, and lasts 10 seconds, during which the IK light on the MI frame is lit. The IFF radar is a secondary radar physically tied to the primary radar, which will interrogate any contact in the primary radar search area. Friendly responses are displayed with a cross on the MI.

For any tracked radar contact, the IFF response or lack thereof is stored, as long as tracking is maintained. It is displayed on the HUD and the TI with a cross over friendly contacts. Additionally, the TI uses a color code: green for friendly contacts, red for contacts which failed to answer an IFF interrogation, and yellow for contacts which were not interrogated. The IFF information displayed on the TI and HUD can also use information transmitted by other aircrafts on datalink.

Friendly Callsigns The menu JA-37Di » Friends (IFF) allows to set a list of friendly callsigns. Aircrafts with these callsigns will always be identified as friendly by IFF, even if they do not have the same IFF query code. This allows to operate with other aircrafts which do not have a compatible IFF system.

4. Displays

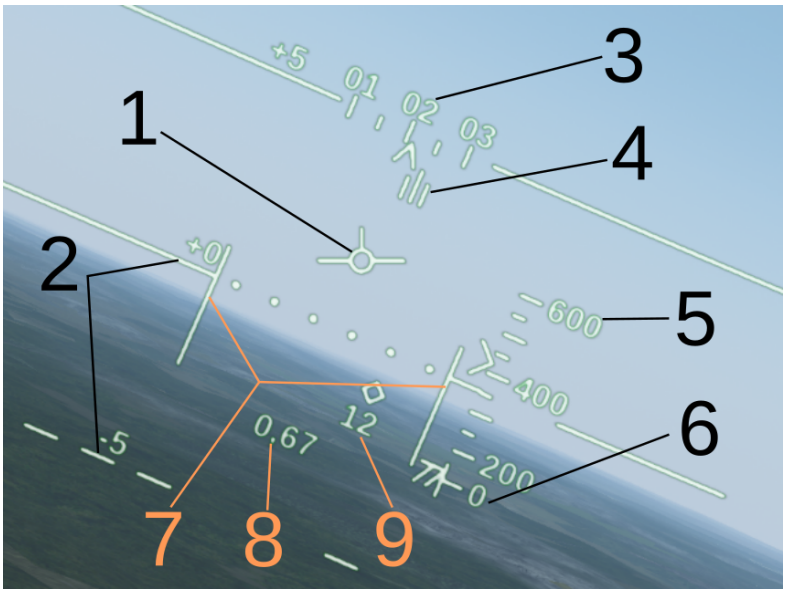
4.1 Generalities

All primary displays use electrical power from the secondary AC bus. The displays are turned on by the yellow top-left button on the TI (fig. 1.1:23). In addition, displays are turned on at takeoff when RPM exceeds 90%.

The HUD requires 40 seconds of preheating after AC power is available, before turning on.

4.2 Head Up Display (HUD)

4.2.1 Overview



1. Flight path vector
2. Artificial horizon and pitch lines
3. Heading scale
4. Destination bearing
5. Altitude scale
6. Radar altimeter index and reference
7. Altitude bars
8. Airspeed / Mach indicator
9. Distance indicator

Figure 4.1: HUD overview

Artificial Horizon (fig. 4.1:2) The artificial horizon and pitch scale provide an attitude reference. The pitch scale consists of a line every 5 degrees. Lines above the horizon are solid,

lines below the horizon are dashed. The artificial horizon itself is distinguished by six center dots. Only the three pitch lines closest to the flight path vector are displayed.

Flight Path Vector (fig. 4.1:1) The FPV marker indicates the aircraft path direction relative to the ground. Most of the HUD is centered around the FPV marker.

Heading Scale (fig. 4.1:3) The heading scale is located above the FPV. The fixed wedge index indicates aircraft track angle. The second index consisting of 3 vertical lines (fig. 4.1:4) indicates bearing to the next waypoint.

Altitude Scale (fig. 4.1:5) The altitude scale is located right of the FPV. The fixed wedge index indicates aircraft altitude. At low altitude the scale zooms in, allowing to read the altitude more precisely for low level flight.

When the radar altimeter is active and in range, the altitude 0 mark is displayed just below the altitude scale (fig. 4.1:6). The radar altitude index, consisting of two wedges, can be read against this mark. This can be used to set the altimeter QFE in flight.

Altitude Bars (fig. 4.1:7) The two altitude bars indicate the reference altitude (also called commanded altitude) relative to the current altitude.

The top of the altitude bars represents commanded altitude, while the artificial horizon represents current altitude. If the top of the bars is on the horizon, the aircraft is at the commanded altitude. If the top of the bars is above (resp. below) the horizon, the aircraft is below (resp. above) the commanded altitude.

When the FPV is within 1° of the horizon, the altitude scale index is fixed on the horizon. Under these conditions, the top of the altitude bars can be read on the altitude scale to obtain the commanded altitude.

Altitude bars are only displayed below 1000m. When autopilot altitude hold is active, boxes are displayed together with (below 1000m) or instead of (above 1000m) the altitude bars.

Reference Altitude The reference altitude displayed by the altitude bars is set as follows.

- During takeoff, the altitude bars are fixed over the horizon. After leaving takeoff mode, reference altitude is set to 500m.
- During flight, the reference button (keybinding ⇧+R) sets the reference altitude to the current altitude.
- If autopilot altitude hold mode is active, the reference altitude is the autopilot altitude.
- When entering landing mode, reference altitude is set to 500m. It can still be modified with the reference button or by engaging autopilot altitude hold.

Airspeed / Mach Indicator (fig. 4.1:8) Digital airspeed is displayed below the FPV, with a minimum of 75km/h and a precision of 5km/h (40kts and 1kts respectively in imperial units mode). Above M 0.5, airspeed is replaced by a Mach indicator.

Distance Indicator (fig. 4.1:9) Displays digital distance to the next waypoint.

Radar Altitude When radar altitude is less than 100m, it is displayed digitally in the lower left part of the HUD, with the format e.g. 'R 45'. It is hidden for 30s after exiting takeoff mode, and in landing mode.

Ground Collision Warning Ground collision warning is displayed on the HUD as a flashing arrow over the FPV, pointing in the pull-up direction.

Text Indications To the lower left of the FPV, plain text indications can be shown in the following priority order:

1. Altimeter setting warning 'QFE' (flashing). At takeoff, indicates that the altimeter is incorrectly set. In flight, indicates that the altimeter should be switched to/from STD mode (assumes transition altitude 1500m).
2. In landing mode, 'TILS' indication when receiving ILS signal. (flashing if glideslope is not available or not in range).
3. Selected weapon type (at the earliest 30s after leaving takeoff mode).

4.2.2 Takeoff Mode

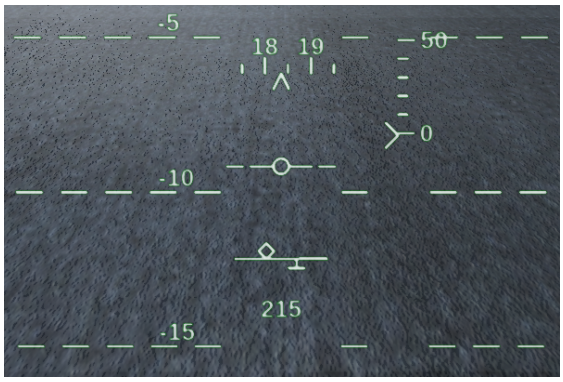


Figure 4.2: HUD during takeoff

Takeoff mode is enabled when the nose gear is compressed.

During takeoff, the FPV is fixed vertically 10° below the aircraft forward axis, and its symbol changes. Horizontally, the FPV functions as in navigation mode, and will e.g. move due to sidewind after rotation.

The distance line is displayed below the FPV, and represents airspeed. The diamond upper index indicates aircraft speed, and the inverted-T bottom marker indicates recommended rotation speed. When the rotation angle reaches 5°, the distance line is hidden.

Takeoff mode stops once the airspeed exceeds M 0.35, when the climb angle is at least 3°, or at landing gear retraction.

4.2.3 Landing Mode

In landing mode, the HUD changes when starting the final. The -5° pitch line is removed, and a glideslope line is added 2.86° below the horizon (corresponding to a slope of 5%). Altitude scale, digital airspeed, and distance indicator are positioned around the glideslope line. Heading scale is positioned over the horizon, and changes to a 1:1 scale. Altitude bars are hidden.

If the climb or dive angle exceeds ±7.5°, the default presentation of the pitch scale, digital airspeed, and distance indicator is restored, while the heading and altitude scales are hidden.

Figure 4.3: HUD during final

Speed / AoA Indicator In landing mode, the vertical fin ('tail') of the flight path vector symbol moves vertically to indicate deviation from the target speed or angle of attack.

The speed is correct when the bottom of the tail is on the FPV circle (default position in navigation mode). If the tail is higher than the circle, the aircraft speed is too high. If the tail is lower (inside the circle), the aircraft speed is too low.

While the landing gear is up, the target speed is 550km/h. Once the landing gear is down and locked, the target angle of attack is computed based on aircraft weight, with a maximum of 12° (15.5° if the button fig. 1.1:10 is pressed and lit).

When the landing gear is down, the fin will blink if the angle of attack is critically high.

ILS Guidance If ILS guidance is used, the reference point on the glideslope line indicates the heading to follow to align with the localizer. Four vertical bars on the glideslope line indicate ILS glideslope deviation: if the top of the bars is above, resp. below the glideslope line, the aircraft is below, resp. above the ILS glideslope.

If ILS is not used (optical landing mode), the reference point is aligned with the FPV, and the vertical bars are hidden.

Touchdown Below 35m, the HUD switches to optical landing display (ILS indications disappear). Below 15m radar altitude, the HUD switches to flare mode. The glideslope line moves up to indicate the descent angle which gives a vertical speed of 2.8m/s, the maximum for touchdown. If radar altitude is unavailable, transition to flare mode occurs at 35m.

Once the nose gear is compressed, the HUD switches to takeoff mode.

4.2.4 Tactical Information

Some tactical information is displayed on the HUD when a weapon is selected, when a radar contact is tracked, and while in aiming mode.

4.3 Target Display (MI)

The MI (fig. 1.1:17) is the JA 37 main radar display.

4.3.1 Overview

The following indication lights and buttons are located around the MI.

1. Brightness setting knob
2. Ground proximity warning light
3. Missile warning lights
4. Left side buttons
5. Right side indication lights
6. Bottom buttons

Figure 4.4: MI indication lights and buttons

Left side buttons (fig. 4.4:4)
A/B TI map zoom out/in
PEK/JL Fighter control / fighter link controls (not implemented)
REG Recorder (not implemented)

Right side lights (fig. 4.4:5)
ID/J Radar modes (not implemented)
TNF Inertia navigation alignment indicator
TLS TILS signal indicator
IK IFF interrogation

Bottom buttons (fig. 4.4:6) Pressing button P3 displays a help text on the MI.

button	help text	function
P1	D	Radar interference mode (not implemented)
2	SVY/SDV	Toggle TI sideview display
M2	VMI/RWR	Toggle TI radar warning display
M4	TNF/INN	Reset interial navigation
X1	BIT	Start RB 99 built in test
X2	LNK	Toggle RB 99 datalink
X3	HÄN/EVN	Register manual event

Other buttons have no functionality in the real aircraft.

4.3.2 Flight Indications

1. Destination bearing
2. Heading scale
3. Digital altitude
4. Artificial horizon
5. Flight path marker
6. Ground proximity warning
7. Altitude reference bars
8. Radar altitude index
9. Altitude scale
10. Ground proximity indicator
11. Altitude index

Figure 4.5: MI flight symbology

Artificial Horizon (fig. 4.5:4) and Flight Path Marker (fig. 4.5:5) The flight path marker is fixed, and serves as a reference for the artificial horizon. The artificial horizon line rotates to indicate roll, and deviates from the flight path marker to indicate flight path angle. Deviation is proportional to the sine of the flight path angle.

Altitude Indications Digital altitude (fig. 4.5:3) is displayed above the artificial horizon. A marker (fig. 4.5:11) indicates altitude on the altitude scale (fig. 4.5:9), on the right side.

Altitude bars (fig. 4.5:7) are read against the artificial horizon, and indicate reference altitude relative to the current altitude. The top of the altitude bars represents reference altitude, while the artificial horizon represents current altitude. If the top of the bars is on the horizon, the aircraft is at the commanded altitude. If the top of the bars is above (resp. below) the horizon, the aircraft is below (resp. above) the commanded altitude. Altitude bars are displayed below 1000m, or when autopilot altitude hold is active.

Ground height measured by the radar altimeter is displayed by a chevron index on each altitude bar (fig. 4.5:8), when the radar altitude is less than 600m.

Heading Indications The heading scale (fig. 4.5:2) shows current heading with a fixed central marker, and heading to next waypoint with a second marker (fig. 4.5:1).

Ground Proximity Warning The distance between the ground symbol (fig. 4.5:10) and the flight path marker (fig. 4.5:5) indicates margin from a ground proximity warning. When the ground symbol touches the flight path marker, a ground proximity warning occurs. On the MI, it is indicated by a flashing arrow on the flight path marker pointing in the pull-up direction (fig. 4.5:6), as well as the flashing ground proximity warning light (fig. 4.4:2).

4.3.3 Text Messages

1. SIKT / AIM
2. TYST / SILENT
3. Left upper text, here weapon type
4. Left lower text, here flare and chaff
5. Right upper text, here manual event
6. Right lower text, here Rb 99 datalink

Figure 4.6: MI text messages

SIKT / AIM (fig. 4.6:1) Indicates that the HUD is in aiming mode.

TYST / SILENT (fig. 4.6:2) Indicates that the radar is off.

Bottom left upper text(fig. 4.6:3) The following can be displayed, by order of priority:
1. Altimeter setting warning 'QFE' (flashing). Same conditions as on the HUD.
2. Selected weapon type, if any.
3. Mach number, at M>0.4.

Bottom right upper text (fig. 4.6:5) The following can be displayed, by order of priority:
1. MREG, indicating a manually registered event (button X3 below the MI fig. 4.4:6)
2. FÖ / FAIL, indicating an aircraft failure. Goes off when consulting the TI failure page.

Bottom (fig. 4.6:4,6) The following can be displayed, by order of priority:
1. Memo for the MI lower buttons (fig. 4.4:6), when pressing button 'P3' (cf. section 4.3.1).
2. On the left, number of remaining chaff and flares. On the right, RB99 datalink estimated time to target and chance of hit, enabled with button X2.

4.3.4 Radar Display

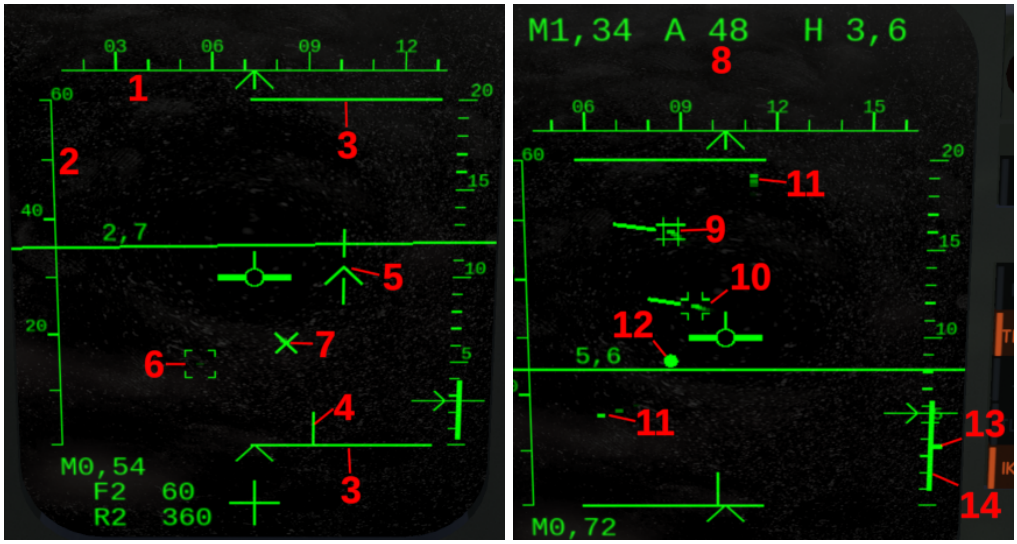
The radar display, at the center of the MI screen, is a B-scope, i.e. the x-axis represents bearing, read against the heading scale (fig. 4.7:1), and the y-axis represents distance, read against the distance scale (fig. 4.7:2). The heading scale has a range of ±60° around the aircraft heading. The distance scale range is the same as the radar range.

Radar Scan Horizontal lines at the bottom and top of the radar display indicate radar scan arc width (fig. 4.7:3). On the bottom line, a sweeping cursor indicates current radar azimuth (fig. 4.7:4).

Vertically, a thick bar on the altitude scale indicates the range of altitudes scanned by the radar scale (fig. 4.7:14). This altitude range is computed at a reference distance which is either that of the MI cursor, or that of the primary target.

Radar Echoes and Tracks Radar echoes are displayed as trails of small bars (fig. 4.7:11). A tracked contact is covered by an additional symbol, and a vector indicating speed and heading. Before acquiring lock, the primary target is displayed as a square. After lock, the sides of the square collapse, forming a '#' (fig. 4.7:9). For a secondary target, the symbols are similar, except the middle of each line is missing (fig. 4.7:6,10). A radar echo with a friendly IFF response is covered with a cross (fig. 4.7:7). See also section 3.2 regarding the IFF system.

Primary Target Information When a primary target is selected, the MI displays the following additional information. At the top, numerical speed, distance, and altitude of the primary target are shown (fig. 4.7:8). On the altitude scale, a thick horizontal dash indicates target altitude (fig. 4.7:13). A large dot indicates target azimuth and elevation, read relative to the artificial horizon and flight path marker (fig. 4.7:12).



1. Heading scale
2. Distance scale
3. Radar scan arc
4. Radar sweep marker
5. Cursor (here: STT designate)
6. Lost or not yet acquired contact
7. Echo with friendly IFF response
8. Primary target information
9. Primary target
10. Secondary target
11. Other radar echo
12. Primary target azimuth and elevation
13. Primary target altitude
14. Radar scan altitude limits

Figure 4.7: MI radar symbology

4.3.5 Radar Operation

Radar is turned on or off with R. It can not be turned on when the nose gear is compressed. Radar range is controlled with [/], between 15km and 120km,

The radar has four operation modes.

Scan A wide search mode, with 120° lateral search arc and 12° vertical search arc. It is not possible to track contacts in this mode. Scan mode can be selected with ⇧+F.

STT (Single Target Track) The radar focuses on a single target, and is blind to anything else. This mode is required to guide Rb 71 semi-active radar missiles.

TWS (Track While Scan) A narrow search mode, with 60° lateral search arc and 8° vertical search arc. This mode allows tracking up to 4 contacts at once, while continuing to scan. TWS mode can be selected with Ctrl+F.

Disk search The radar scans a disk of radius 10° straight ahead, and locks (STT) on any contact found. It is intended for close range engagements. It is selected with ⇧+N.

Target Designation In scan or TWS modes, the MI cursor (fig. 4.7:5) is used to designate contacts to track, by moving the cursor over the contact and 'clicking'. Refer to section 5.1.1 regarding general cursor controls.

The cursor has two modes: STT and TWS designation—corresponding to the radar mode obtained after designating a contact to track. In STT designation mode, the cursor consists of a chevron with vertical bars above and below it. In TWS designation mode, the cursor is a cross. When the cursor is active, pressing F switches between the two cursor modes.

Regardless of cursor mode, designating a contact makes it the primary tracked target, and causes the MI cursor to disappear. While a primary target is designated, pressing F switches between radar STT and TWS modes, while continuing to track this target. Clicking a second time un-designates the primary target, and restores the MI cursor. In STT mode, doing so also cancels tracking of the primary target, and returns to the previous radar mode. In TWS mode, this instead continues to track the primary target as a secondary track, allowing to designate another contact to track.

Repeating the previous process in TWS mode allows to track up to four contacts at once: one primary target and three secondary tracks, or four secondary tracks. Once this limit is reached, designating a new contact will cancel tracking of the oldest target. The primary target can be changed with M, cycling through all the secondary tracks. Alternatively, one can make a secondary track the primary target by designating it with the cursor.

Scan Direction Controls In scan and TWS mode, the radar scan direction can be controlled vertically. In TWS mode, it can additionally be controlled in azimuth. When a primary target is selected, these controls are inhibited: the radar scan pattern is always centered on the primary target. Otherwise, the radar elevation is controlled manually with < / >, up to 20° above or below the horizon, while the horizontal scan direction follows the MI cursor.

When the radar is on, vertical and horizontal scan limits are read on the corresponding MI indications (fig. 4.7:3,14). Horizontal scan arc is also displayed on the TI map, while vertical scan angle is displayed on the TI sideview.

Dogfight Radar disk search mode is intended for engagement within visual range. It is not the same as the HUD aiming mode, but the two are often used together, and interact.

Aiming mode is switched on or off with H, provided the landing gear is up and locked. In aiming mode, SIKT / AIM is displayed at the top of the MI (fig. 4.6:1). The button R has a different behaviour: in aiming mode it always turns the radar off, instead of switching on or off.

Pressing ⇧+N will engage aiming mode, turn the radar on, and engage disk search mode. In this mode, the radar follows a quick scan pattern in a disk of radius 10°, centered a bit above the middle of the HUD. The range is fixed to 15km, and cursor and elevation controls are disabled. As soon as the radar detects a contact, it will lock it, switching to STT. One can return to disk search mode by pressing ⇧+N again, or with a cursor click.

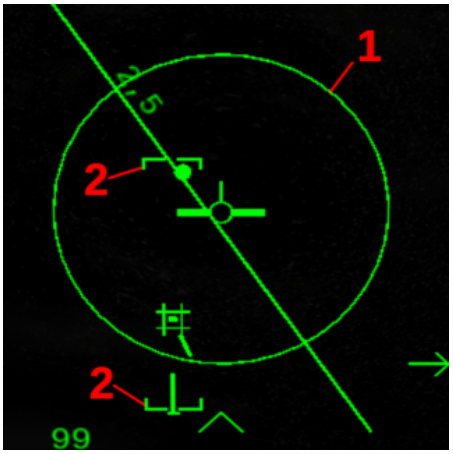
Aiming mode is disabled with H, while disk search mode is disabled by switching to scan or TWS mode.

4.3.6 Missile Launch Indications

When a weapon is selected, four brackets in the radar display show the weapon minimum firing range and optimistic firing range (fig. 4.8:2). Horizontally, these brackets follow the radar scan arc indicator.

When furthermore a missile is selected, armed, and locked on the primary target, several cues are displayed at the center of the MI, indicating target range relative to missile performance (fig. 4.8:1). The cues appear in the following order, as the target distance diminishes:

1. At the maximum firing range, a circle arc with the top-left quadrant missing appears.



1. Dynamic launch zone circle
2. Weapon range limit brackets

Figure 4.8: MI missile launch symbology

2. As the target range decreases, this circle grows until reaching optimistic launch range.
3. When the target is in the no-escape-zone, the top-left arc appears, completing the circle.
4. When the target is inside the minimum firing range, the circle is replaced by a large cross.

Part II

Operation

5. Generic FlightGear Operations

5.1 Key Bindings

A summary of the key bindings can also be found in Help ⟩ Aircraft Help.

General

⟵ Toggle thrust reverser.

⇧+PageUp / ⇧+PageDown Raise/lower seat position.

Ctrl+O Open/close canopy.

Ctrl+E ×3 Eject

J Jettison drop tank (in flight only).

⇧+S Acrobatic smoke.

Ctrl+Y Display landing airport informations (requires runway selected in route manager).

Displays

⇧+R Set reference altitude (cf. section 4.2.1) / toggle IR missile boresight mode.

H Toggle HUD aiming mode / engage visual landing mode.

⇧+I Toggle between english/imperial and swedish/metrics display modes.

⇧+Y Engage landing mode.

⇧+H Cycle HUD brightness.

Y Use flight controls to controls cursor.

L Cursor click. See also section 5.1.1.

⇧+M Switch cursor between MI and TI.

View

⇧+Q Reset view.

Ctrl+Q Zoom on radar display.

Ctrl+⇧+Q Zoom on HUD.

Autopilot

Ctrl + T Autopilot stability assist mode.

Ctrl + W Autopilot attitude hold mode.

Ctrl + A Autopilot altitude hold mode.

Ctrl + D Disengage all autopilot modes.

Ctrl + S Toggle autothrottle lever.

U Autothrottle quick disengage .

Ctrl + ← / Ctrl + → Trim yaw, or adjust autopilot heading/bank angle.

Radar Controls

R Toggle radar. In aiming mode: turn radar off.

[/] Decrease/increase radar range (positions: 15km, 30km, 60km, 120km).

< / > Adjust radar elevation down / up.

⇧ + F Wide scan mode.

Ctrl + F TWS (Track While Scan) mode.

F Toggle STT (Single Target Track) or TWS mode. When a primary target is selected, this directly toggles between the two modes. If the MI cursor is active, it instead changes the radar mode which will be obtained after designating a contact.

⇧ + N Engage aiming mode, radar disk search mode with auto-lock ('dogfight mode').

M Cycle TWS primary target.

N IFF interrogation.

Combat

C Missile quick select.

⇧ + C Cannon quick select.

⇧ + E Toggle trigger safety.

E Fire weapon.

⇧ + U Uncage IR missile seeker (requires lock). Hold for 1s: cage/reset IR missile seeker.

(/) Decrease/increase cannon sight wingspan.

{ / } Decrease/increase cannon sight distance.

Q Release flare/chaff.

5.1.1 Radar Stick Controls

The radar stick is used to control the cursor on the MI and TI.

There are three ways to move the cursor:

- Enable the option JA-37Di » Options » Arrow keys control radar cursor, and use the arrow keys to move the cursor, ↵ to click/select.
- Add joystick bindings to control the cursor. This can be done under File » Joystick Configuration, the controls are named Cursor Horizontal, Cursor Vertical, and Cursor Click. Alternatively, manually edit joystick configuration files to bind the properties

  ```
  /controls/displays/cursor-slew-x
  /controls/displays/cursor-slew-y
  /controls/displays/cursor-click
  ```

- Press Y to use the main flight controls (joystick, mouse, arrow keys, whatever you use to control the aircraft) to instead control the cursor. In this mode, elevator and aileron controls are used to move the cursor. Normal flight controls are restored by pressing Y again. A ground collision warning will also immediately restore normal flight controls.

  Consider using autopilot when controlling the cursor in this way.

In all cases, L can also be used to click.

5.2 JA 37D Menu

The menu JA-37Di contains Viggen-specific dialogs and menus. The following entries are present.

Manual (open in browser) Open this manual in a browser or PDF reader.

Select Livery There is a variety of liveries available, both historical and fictional.

Auto start/stop Lets you start and stop the plane without needing to switch switches etc. yourself. The progress is shown in the top centre of the screen in blue text. The final notification of the start-up sequence is 'Engine ready'. The shut-down sequence is done, when the aircraft is dark.

Repair Repairs system failures. In case of a full crash, this option is of limited use; one should restart instead with File » Reset.

Performance monitor Display aircraft performance (mostly for development).

Systems monitor Display internal status of some systems (mostly for development).

Combat log Multiplayer damage log (damage dealt and received).

Load radio channels Load configuration files for programmable radio channels.

Friends (IFF) Allows to set a list of friendly callsigns for IFF (cf. section 3.2).

Toggle chocks Parking chocks. Only available when fully stopped.

Toggle external power External electrical power, normally used for startup. An electrical power truck is shown to the right of the aircraft when enabled. Only available when fully stopped.

Options Viggen specific configuration options, see section 5.3.

5.3 JA 37D Options

The dialog JA-37Di » Options contains the following configuration options.

Head shaking Head shaking during ground roll and at high alpha. May conflict with other view control scripts, e.g. headtracking.

Cockpit labels in Swedish Enable historical Swedish cockpit, instead of the English translation. (Cockpit translation is incomplete.)

This option is for *physical labels* only, and should not be confused with the next one which affects displays.

HUD/TI in metric units and Swedish Change the unit system and language used in displays. Shortcut: ⇧ + I.

This option is for *displays* only, and should not be confused with the previous one which affects physical labels.

TI: show non-functional menu items On the TI (HSD), show non-implemented menus.

TI Display: use Internet to fetch map Enable download of the world map displayed on the TI (HSD).

Arrow keys control radar cursor When enabled, the arrow keys will control the radar stick to move the cursor on the different displays, and ↵ is used to 'click' (select the target under the cursor, or other depending on context).

When disabled, the arrow keys are used for elevator and aileron, and ↵ is used for rudder (FlightGear default behaviour). Cf. section 5.1.1 for more details regarding cursor controls.

Enable multiplayer damage Allows to deal and receive damage from other compatible aircrafts (other Viggens, F-14, F-15, F-16, M-2000, MiG-21, etc.) in multiplayer. This requires *both* involved aircraft to enable damage.

For fairness, this option can only be toggled when stopped on the ground. It also enforces some realism options: blackout, normal simulation speed, no external views, and disabling fuel, payload, repair, and combat log menus while in flight.

6. Standard Procedures

To come! Please check FlightGear built-in checklists Help » Aircraft Checklists in the meantime.

7. Weapons Operation

7.1 General Procedures

The generic weapon employment procedure is the following.

1. Select weapon type with C (A/A missiles), ⇧+C (cannon), or through the TI.
2. If desired, engage aiming mode with H.
3. For missiles, lock on to the target.
4. Open trigger safety with ⇧+E to arm the selected weapon.
5. Fire the weapon with E. Press and hold for ca. 1 second to fire missiles.
6. Secure the trigger with ⇧+E.

Remarks:

- Upon switching to aiming mode, the HUD changes to a weapon-specific aiming presentation.
- It is possible to fire without using the aiming mode. In this case, a simplified aiming presentation is engaged when opening the trigger safety.

7.1.1 Trigger Safety Usage

The trigger safety role is not just to prevent unintentional fire. It is an important part of the fire control system as it arms the weapon. Improper use of trigger safety will prevent weapon usage.

General guidelines are:

- Only open the trigger safety once the target is in sight / on radar, and the decision to engage it has been made.
- Only open the trigger safety after the desired weapon is selected. If a new weapon is selected while the trigger is unsafe, the new weapon will not be armed (until the trigger is secured and unsecured again).
- Secure the trigger shortly after firing.
- When firing several missiles in succession, the trigger must be secured between each weapon.

A. Viggen Swedish Dictionary

	Swedish	English
	TILL	ON
	FRÅN	OFF
Instruments:		
	Höjd	Altitude
	Fart	Speed
	Kurs	Course/Heading
	Varv	Revolution (RPM)
	Bränsle	Fuel
Autopilot:		
	SPAK	Stability assist mode (lit. Stick)
	ATT	Attitude hold
	HÖJD	Altitude hold
	AFK (Automatisk FartKontroll)	Auto-throttle
Displays:		
	SI (SiktlinjesIndicator)	HUD
	CI (CentralIndicator)	AJS radar screen
	MI (MålIndicator)	JA radar screen (lit. Target Display)
	TI (TaktiskIndicator)	JA Horizontal Situation Display