SimCheck Airbus A300B4-200

Carousel IV INS

For use with Microsoft Flight Simulator X

SIMCHECK A300B4-200: CAROUSEL IV – PILOTS GUIDE

INTRODUCTION

The Carousel IV Inertial Navigation System (Carousel IV INS) was developed by AC Electronics. It incorporates an (in 1969) advanced concept in navigation design as an integral part of a commercial airplane's avionics system.
The "carouseling" technique is a process of rotating the inertial platform at a uniform rate. This technique suppresses certain errors and provides highly accurate, long range navigation.
Combining this feature with the rapid problem solving capabilities of a digital computer provides the pilot with a reliable all-weather navigation system independent of conventional navigational aids.
This guide has been prepared to acquaint the pilot with SimCheck A300B4 implementation of the Carousel IV INS. It highlights the capabilities and operational characteristics of the Carousel IV INS and then presents an illustrated discussion of in-flight operations.

LIMITATIONS

The SimCheck simulation of the Carousel IV does not match the real unit 100%. We have not simulated some of the pre-flight preparations and VOR updating, on the other hand we have added the capability to load and fly a complete FSX flight plan.

DESCRIPTION

The Carousel IV INS is composed of four units:

- The Mode Selector Unit (MSU)
- Control/Display Unit (CDU)
- Navigation Unit
- Battery Unit

A typical inertial navigation complex will include two (SimCheck A300B4-200) or three Carousel IV systems.
The MSU's are installed on the overhead panel.
The CDU's are located in the center console for easy access. The Navigation Units are located in the airplane's electronics bay.
The advanced navigation concept of the Carousel IV INS provides the pilot with maximum automatic navigation capabilities and instantaneous response with minimum effort on his part. The SimCheck A300B4-200 Carousel IV INS even allows to load and fly a complete FSX flight plan !
This system not only will assist in great circle navigation, but it will also provide steering commands to the autopilot to steer the airplane through predetermined waypoints, to the destination. On the other hand, if so chosen, the pilot has the option of changing the course manually. In addition to providing steering commands for automatic control, the Carousel IV INS also provides the attitude signals for the autopilot, flight instruments, and weather radar (not simulated).

As the flight progresses from waypoint to waypoint, the Carousel IV INS will inform the crew of the flight leg presently being flown and alert an impending course change as each waypoint is approached. The pilot can insert the latitude and longitude of any waypoint during flight as conditions require (when NOT in flightplan mode). This loading capability permits the

pilot to utilize any number of waypoints when it becomes necessary to alter the original flight plan.

In addition, one may bypass up to 8 waypoints which have been preloaded into the Carousel IV INS.

Throughout the entire flight, whether the Carousel IV INS is steering the airplane or whether the airplane is under direct control, the Carousel IV INS provides navigation data, such as present position, ground speed, heading, distance and time to waypoint or destination, wind speed and direction, as well as other pertinent data illustrated later in this guide.

This data is instantly available in numerical form on the CDU, and it is constantly being updated to provide the crew with current information in easily readable form.

The Carousel IV INS has been designed to minimize the cockpit work load. For example, to load data into multiple navigation system installations requires only the loading of data into one Control/Display Unit. Latitude and longitude of the point of origin (not required in the SimCheck simulation) and one or more waypoints, including the destination, are all the information the navigation system needs.

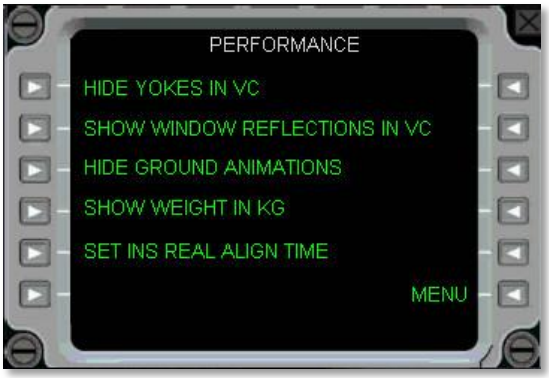
The Carousel IV INS automatically loads the current position at start-up. It will also load the position at time of loading into the waypoint "0" slot.

The Carousel IV INS continuously performs self-tests to monitor its own performance and to maintain a knowledge of its operating condition. Should the system detect an out-of-tolerance condition, the crew informed by a warning light of possible degradation in performance. Furthermore, a backup Carousel IV INS is available as a source of primary navigation and attitude information and control.

INS ALIGNMENT (SP2)

Before the INS system can be used an alignment procedure has to be performed. This alignment normally takes approximately 10 minutes. During these 10 minutes the aircraft should NOT move at all or the alignment will fail. Each INS has to be aligned separately.

In the Setting pages we have added an option to speed up the alignment process to a few seconds.



COLD AND DARK

When you enter the cold-and-dark aircraft the INS's will be off and the MSU rotary switches are in the OFF position.

ENTER CURRENT POSITION

Note: Before entering the current position, set the parking brake to avoid that the aircraft will move during the alignment process

- Set the MSU rotary switch to STBY
- Set the main rotary of the CDU to "POS"
- Enter the present latitude and press "INSERT"
- Enter the present longitude and press "INSERT"

Any discrepancy between the actual FSX position and the position entered into the INS will be carried throughout the flight until a new alignment is performed!

ALIGN THE INS

Now set the MSU rotary to "ALIGN" and wait until the READY light turns green. If "SET INS REAL ALIGN TIME" was selected this can take up to 10 minutes.

If the aircraft moves during alignment the red light will go on and the alignment will have to be restarted. Set the main rotary switch to "STDBY" and then back to ALIGN to restart realignment.

NAVIGATION

When the "READY" light is GREEN, set the INS rotary to "NAV". The INS can now be used for navigation.

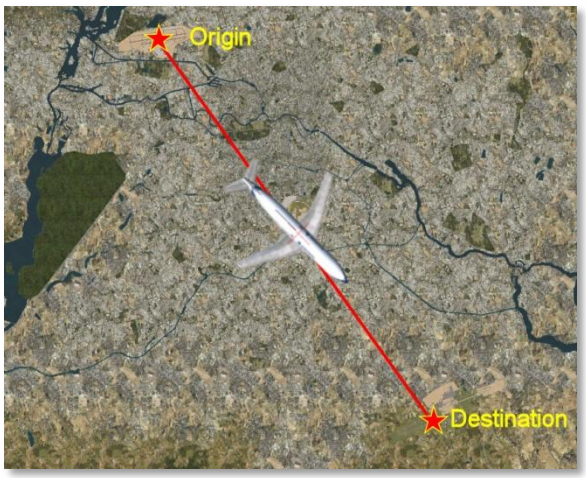
DISPLAY MODES

The Carousel IV INS has 8 different display modes: TK/GS mode (Ground Track Angle/Ground speed)

At any point in flight it is possible to observe ground track angle and ground speed in the data displays after placing the data selector to TK/GS (ground track/ground speed). Ground track angle is displayed in the left-hand display to the nearest tenth of a degree with respect to True North; ground speed is displayed in the right-hand data display in knots to the nearest knot.

Heading/Drift Angle

The airplane's true heading and drift angle are displayed at any time during flight by selecting the HDG/DA (heading/drift angle) position. The left-hand data display indicates airplane heading with respect to True North to the nearest tenth of a degree. The drift angle is displayed in the right-hand data display in degrees right or left of the airplane heading to the nearest degree.



Cross Track Distance/Track Angle Error

Cross track distance and track angle error are displayed at any point in flight when the XTK/TKE (cross track distance/track angle error) position is selected. Cross track distance appears in the left-hand data display in nautical miles either right or left

Position

Displays the current latitude and longitude, display can be frozen by pressing the "HOLD" key. Pressing the "HOLD" again will un-freeze the position display.

Waypoint

Displays the coordinates of the waypoint selected with the waypoint selector keys ("+" and "-").

Unassigned waypoints have position

00°00.0N 000°00.0W

Distance/Time

Shows the distance in NM and time in minutes to the next waypoint at current ground speed.

This mode can also be used to show the distance between any two waypoints:

- Press the "WY PT CHG" key
- Press the "FROM" waypoint number and next the "TO" waypoint number to show the distance and time between these two waypoints. The time between these two waypoints is based on the current groundspeed

Wind

Wind direction and speed are displayed at any time during flight by setting the data selector to WIND. Wind direction is indicated in the left-hand data display to the nearest degree, and wind speed is indicated in knots in the right-hand data display to the nearest knot.

Desired Track

The left display shows the current desired track to the nearest degree with respect to True North.
The right display shows the name of the waypoint when a flight plan was loaded (see below) or "-" when the waypoint was entered manually through the CDU.

ENTERING WAYPOINTS INTO THE INS VIA THE CDU

Manual waypoint entry

The Carousel IV INS can hold up to 9 LATITUDE/LONGITUDE waypoints at one time. Waypoints can either be entered one by one manually or by loading an FSX flight plan.
First we'll discuss how to enter waypoints manually.

CDU set-up

Set the main selector switch to "WAY PT" by left/right clicking the switch. Left mouse clicks will turn the switch counter clockwise, right mouse clicks will turn it clockwise.
To enter a waypoint into position "1", set the left indicator to the "1" position by using left and right mouse clicks (small red circle).

Latitude

Next enter the LATITUDE of the waypoint.
Start by clicking on "2"-"N" for waypoints in the northern hemisphere or "8" – "S" to enter a waypoint in the southern hemisphere.
Notice how the "INSERT" light goes on once you start entering data.
Then enter the Latitude from left to right by clicking the appropriate number on the CDU keyboard.
Confirm the latitude by clicking the "INSERT" button. To cancel the entry, click the "CLEAR" button.
In this case we entered: "263527INSERT"

Longitude

Entering the LONGITUDE is done in exactly the same way as entering the Latitude.
Start by pressing "4"-"W" or "6"-"E" and then the coordinates, followed by "INSERT" to confirm or "CLEAR" to cancel the entry.

LOADING AN FS FLIGHTPLAN

General

Contrary to the real Carousel INS, this simulation is able to load any FSX XML based flight plan.
The flight plan has to be stored in the "Microsoft Flight Simulator X files" folder (or the localized version of this folder e.g. "Microsoft Flight Simulator X – datteien" in German). The name of the flight plan has to be a number between "0" and "99999".
In a standard FSX flight plan the first waypoint is the departure airport, as it doesn't make any sense to include this in the INS flight plan, we skip this waypoint and immediately go to the second waypoint in the flight plan.
To load the flight plan follow the steps described below.

Step 1

- Loading a flight plan is always done from the number 1 (left) CDU
- If you want to load the flight plan simultaneous in both INS modules, press the "REMOTE" key on both CDU's, the buttons will light up when pressed
- Set the main selector switch to "DSRTK/STS"

Step 2

- Set the waypoint selector to the position where you want the first waypoint of the flight plan to be stored (mostly "1")
- Right click the number 1 key on the INS keyboard ➔ The light on the left top corner will turn orange.

*NOTE: A **grey** light means no flight plan is being loaded – an **orange** light means a flight plan is being loaded – a **green** light means a flight plan is loaded*

Step 3

- Using the CDU keyboard, enter the number of the flight plan e.g. "111"
- Press the "INSERT" key to load the flight plan, press "CLEAR" to cancel loading a flight plan

NOTE: as you enter a number the "WY PT CHG" and the "INSERT" light go on.

STEP 4

There is no step 4, it's that easy !
The flight plan is loaded which is indicated by the green light. The names of the waypoints are now displayed and can be checked by scrolling through the different waypoints in the flight plan.

NOTE: When the last waypoint in the flight plan has been loaded the red "WARN" light will go on

CHECKING THE FLIGHT PLAN

Whether you entered the waypoints manually into the CDU or loaded a pre-built flight plan, you always have to check:

- The correctness of the coordinates entered into the CDU
- The distance between the consecutive waypoints

CHECKING COORDINATES

- Set the main selector switch to "WAY PT"
- Scroll through the waypoints of the flight plan (maximum 9 at a time) and check the LATITUDE and LONGITUDE against the data in the flight plan

CHECKING DISTANCES

- Set the main selector switch to "DIS/TIME"
- Press the "WY PT CHG" button on the CDU
- Enter the FROM and then the TO waypoint number
- The distance between these two waypoints will be displayed on the left display
- Press "CLEAR" to remove the waypoint change

NOTE: Don't press the "INSERT" button because this will instruct the INS to fly from the FROM to the TO waypoint

NORMAL OPERATIONS

CHECK POSITION

Before anything else, start by checking the position displayed on either CDU against the current location of the aircraft.

LOAD FLIGHT PLAN

Using either of the two techniques described earlier on, enter the first 9 waypoints of the flight plan.

CHECK FLIGHT PLAN

Using the techniques described earlier on, check the coordinates of each of the waypoints and the distances between each pair of consecutive waypoints against your printed flight plan.

SET INS TO AUTO MODE

The INS works in either AUTO or MAN. In AUTO mode the INS will automatically switch to the next waypoint when it reaches the current waypoint, in MAN mode it will not.

NOTE: The Carousel INS will not overfly waypoints, depending on the track change from one leg to the next it will start to turn before reaching a waypoint

SELECT INS UNIT

Set the INS selector button on the main CPT panel to INS1 or INS2 depending on which INS will provide navigation data, in most cases INS1 is used.

HSI DATAFEED SET-UP

In order for the HSI to show data from the INS the V/L – GPS switch has to be switched to GPS. The HSI on the CPT or the F/O side have separate switches for data feed and operate independent.

INS DATA ON THE HSI

When in "GPS" mode, the HSI will show a lot of information fed from the INS:

1. The desired true track to the next waypoint
2. Distance to the next waypoint
3. The red ALERT flag will come when the time to the next waypoint is 2 minutes or less
4. Time to the next waypoint at current ground speed
5. Ground speed
6. Data source, in this case RNAV 1 ➔ INS 1

NOTE: the HSI compass rose is oriented with Magnetic reference, we have adjusted INS input to magnetic north for convenience of use

Waypoint number "0" a special waypoint

Before we go on with the actual flight, we need to talk about waypoint 0. Contrary to waypoints 1-9, waypoint 0 can not be set manually.
At start-up of FS waypoint 0 contains the current position of the aircraft. The only way to change the coordinates of waypoint 0 is by performing a "DIRECT TO" action. A DIRECT TO means that the FROM waypoint in set to "0" and the TO waypoint to the waypoint you want to fly to in a straight line. The moment a DIRECT TO action is performed waypoint 0 will updated to the current position when the "INSERT" button was pressed.

On the runway ready for departure

We have loaded and checked the flight plan, set HSI feed to GPS and made sure the INS is set to AUTO mode. It is time to get moving! Turn on a flight director and activate NAV mode by pressing the NAV button on the glareshield. The master INS will now feed track data to the FD

After take-off

Once airborne we can proceed direct to the first waypoint and it is time to do a DIRECT TO.

- Press the "WY PT CHG" button
- As we are proceeding from the current position direct to waypoint 1, press "0" then "1" on the CDU keyboard
- To activate the change press "INSERT" on the CDU keyboard

En-route directs

Once the aircraft is established on track it will fly all the waypoints entered into the INS from 1-9. The FROM-TO indicator will automatically switch from "01" to "12" to "23" etc…
If ATC clears you direct to a waypoint further in the flight plan this can be achieved by performing a DIRECT TO from the current position ("0") to the target waypoint e.g. "04" in case the waypoint you are cleared direct to is currently entered in position 4

Flight plans containing more than 9 waypoints

Most flight plans will contain more than 9 waypoints. As you pass one waypoint to the next the waypoints that lie behind you serve no further purpose and can be replaced with new waypoints.

Manual waypoint entry

It is important to understand what is happening in the INS when entering new waypoints. If the FROM-TO indicator for instance shows "34", the INS is following the track between waypoint 3 and waypoint 4. Entering a different location into waypoint 3 will mean that the INS will try to get on the track between the newly entered waypoint 3 and waypoint 4 ! So never enter new data in any of the waypoint locations that are currently displayed in the FROM-TO

window! If you desperately want to enter new data in waypoint 3, then perform a direct to "04" first so waypoint 3 is no longer used for the current leg navigation.

Flying a pre-loaded FSX flight plan

When you are proceeding along an FSX flightplan you don't have to worry about entering new waypoints yourself, but you have to keep checking the flight plan coordinates and distances as you go along.

Also you have to be aware how we solved the issue that the INS can at any time only hold 9 programmed waypoints! This limitation is not removed because you are flying a pre-loaded FSX flight plan, the INS will at any time still only hold 9 waypoints.

Here's an example of how the INS deals with flight plans that contain more than 9 waypoints. The left column describes the action taken by the pilot and what happens behind the scenes in the INS memory, the right column shows a table that describes what happens with the INS memory locations (top row - INS) and which waypoint is stored in which memory location (bottom row - FP).

- Flight plan with 20 waypoint is loaded, the first waypoint is stored in position "1" ➔ The first 9 waypoints are stored in the INS

INS	1	2	3	4	5	6	7	8	9
FP	1	2	3	4	5	6	7	8	9

- Pilot pressed "01" to proceed direct to waypoint 1 after take-off ➔ The INS still stores the same 9 waypoints

INS	1	2	3	4	5	6	7	8	9
FP	1	2	3	4	5	6	7	8	9

- The flight proceeds along the pre-programmed route and we are now flying from waypoint 2 to waypoint 3 ➔ INS waypoint 1 is no longer required and is replaced with waypoint 10 in the FSX flight plan

INS	1	2	3	4	5	6	7	8	9
FP	10	2	3	4	5	6	7	8	9

- ATC clears direct to waypoint 5 in the flight plan and you perform a DIRECT TO "05" ➔ INS waypoints 2, 3 and 4 are no longer required and are replaced with waypoints 11, 12 and 13 in the FSX flight plan

INS	1	2	3	4	5	6	7	8	9
FP	10	11	12	13	5	6	7	8	9

- We are still en route to waypoint 5 and ATC clears us direct waypoint 18. As you can see FSX waypoint 18 is not loaded into the INS at this time so we can not proceed direct to this waypoint, the furthest waypoint along the route that is currently loaded in the INS is FSX waypoint 13 which is stored in INS waypoint 4. We start by doing DIRECT TO "04" ➔ INS waypoints 5 to 9 and also 1 to 3 are no longer necessary as all these waypoints lie before FSX flight plan waypoint 13

INS	1	2	3	4	5	6	7	8	9
FP	19	20	12	13	14	15	16	17	18

INS	1	2	3	4	5	6	7	8	9
FP	19	20	12	13	14	15	16	17	18

- As you can see the INS now contains all the waypoints from 12 up to 20. Although FX flight plan waypoint 12 lies before the current direct to waypoint (13), it is not replaced because the flight plan only contains 20 waypoints. To go direct to waypoint 18 we now do a DIRECT TO "09" as that INS memory position now contains the location of FSX flight plan waypoint 18

As you can see using a 9 waypoint INS to fly flight plans with more than 9 waypoints can be a bit confusing at first and you have to keep track of where you are in the flight plan to avoid doing stupid things.
This is why we have added the waypoint name to the data displayed on the CDU so are at all times aware exactly which waypoint you are flying to !
Once you get used to the logic behind the system however, things become very clear and simple !