Miltech Simulations U-2

Navigation System (INS Steering)

The U-2S carries its own INS steering computer. It takes the route from the ACTIVE destination point file and the position from the INS, and from those it works out where to fly next: the leg to hold, where to start each turn, and how steeply to bank.

Everything else in the cockpit shows or follows that one result - the flight director on the PFD, the MILES / TTG read-outs, the track on the map, the NAV pages, the UFCD and BCDU, and the autopilot in NAV mode.

INS Steering Computer

Reads	Computes	Drives
ACTIVE destination point file (up to 99 DPs, each with a turn radius) INS position - the INS must be in NAV Your steering selection: mode, TO DP, course, distance, overfly, orbits	Desired track, cross-track error, turn points Bank command for the turns Bearing, MILES, DTG, TTG, TT and 21-seconds-to-turn	PFD flight director, HSI course and NAV block MAP track, turn circles and DS / OFLY lines NAV DATA, UFCD NAV / HOM, BCDU NAV PRIM and RT page AFCS NAV mode (bank steering)

One computer, one answer. The MSFS flight plan is not part of it.

Note
You change the steering from any of these places, and the others follow: MFD NAV → DATA (EDIT, the STEERING DATA block), NAV → DPS (DS), NAV → RPLAN (EXEC), the UFCD NAV page, the UFCD HOM page steering line, the UFCD EMER page (DIR STR), or the map (DS / OFLY). With the AVP off, the BCDU can set a direct steer and the steering mode.

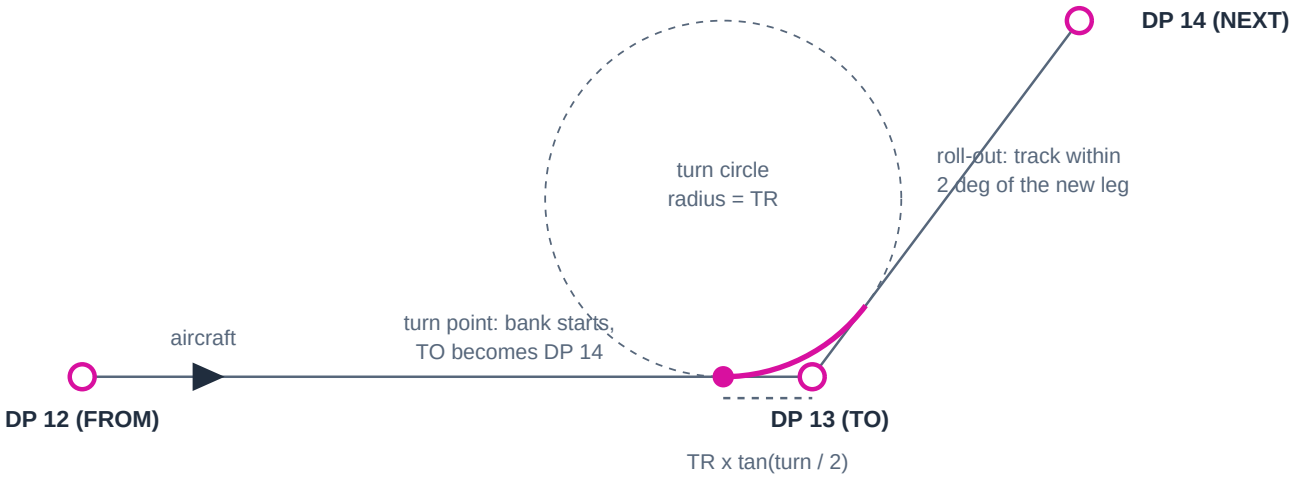
Destination Points and the Turn Radius

A destination point (DP) is a position with a name and a **turn radius** (TR, in NM, default 6.7). The turn radius is not decoration: it is the radius of the circle the aircraft flies when it turns at that DP.

At U-2 speeds a 6.7 NM radius is a turn of about 22° of bank at cruise ground speed; pick a larger TR for a gentler turn, a smaller one (5.5 NM minimum) for a tighter one. Set it on the NAV/DPS page (TURN), on the UFCD DP page or on the BCDU.

F/T - From / To (Sequential Steering)

The normal mode. The aircraft flies the file in order: from the last DP to the TO DP, turns, and continues to the next one.



F/T: the turn starts before the DP so the aircraft rolls out on the next leg. The TO DP switches at the turn point, not over the DP.

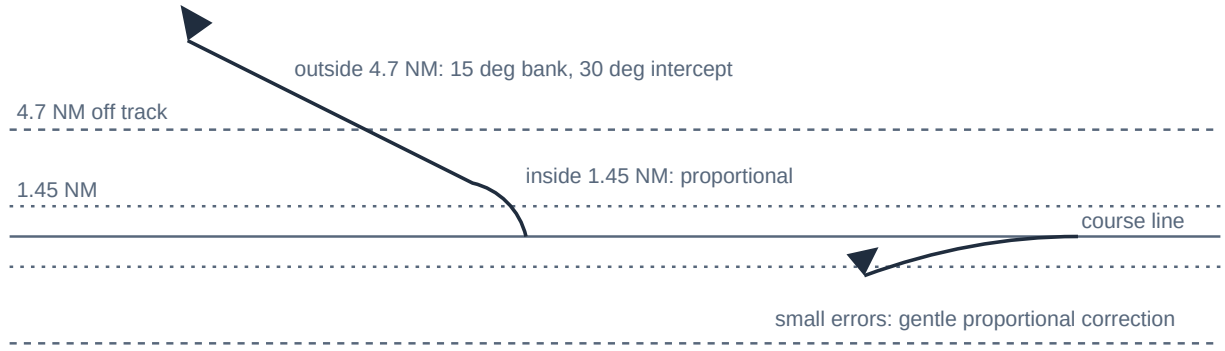
- **Turn point:** TR × tan(turn angle / 2) before the DP. A 90° turn with TR 6.7 starts 6.7 NM before the DP; a 45° turn 2.8 NM before it.
- **In the turn** the bank comes from the TR and your ground speed (so wind is corrected) plus a correction for being off the circle, limited to 15° - the autopilot's normal bank limit in NAV. A turn that is too tight for that at your ground speed is flown wider, on the radius a 13° bank gives.
- **A turn that does not fit between its DPs** gets a smaller radius, for that turn only, so it stays a curve and not a corner. A leg too short for the turns at both its ends is shared between them. Your TR stays in the file; the TURN column on NAV/DPS shows the radius in use in yellow.

This is the one case where NAV banks past 15°: as far as the turn needs, up to 25°. That room closes back to 15° between about 75 % and 87 % of the stall angle. Past the limit the aircraft swings wider than the small radius, and the map draws the turn at the radius it can fly.

- **TT** on the NAV block is the *time to turn*, and 21 seconds before the turn point the DS line on the map and the TT flash (21 seconds to turn).
- **Turns over 140°** cannot be flown on the circle: the turn point stays at the 140° position and the steering shows NAV STEERING (overshoot turn). The aircraft rolls out beside the next leg and steers along the line the map draws from there to the next turn point, unless that line is more than 25° off the leg; then it goes back to the leg.
- **Last DP in the file** (or a blank DP next): once past it the aircraft flies a continuous 15° right turn until you select something else. If it passes the DP more than 1.45 NM away, it first steers back to the DP.

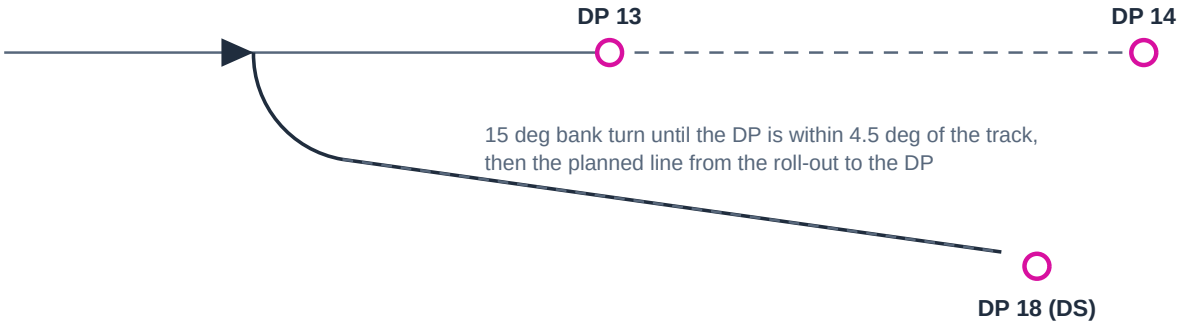
Maintaining Track

Between turns the computer holds you on the great-circle line between the two DPs. The map draws that same line, turns included, so the aircraft stays on the line you see.



- Within 4.7 NM of the line the correction is proportional to the error - a gentle, continuous steer.
- Further out the computer flies a 30° intercept at 15° of bank (the PFD steering source shows the intercept), and hands back to proportional steering 1.45 NM from the line.
- XTK on the NAV DATA page and the box under the aircraft symbol on the HSI show the error; R = right of course.
- The steering reads your heading and a smoothed drift angle, not the raw GPS track, so a gust does not swing the steering bar from side to side.

Direct Steer (DS)



A direct steer takes you straight to any DP from where you are. When it starts, the computer plans the path: a 15° bank turn from your present position and track, then the straight line from the end of that turn to the DP.

It flies the turn until the DP is within 4.5° of the track and then holds that line. The HSI deviation and XTK show how far you are off this path, in the turn as well as on the line, so they stay centered while you follow the steering.

(If the turn cannot line up with the DP - the DP is inside the turn circle, or it would take more than 270° of turn - the aircraft holds its track until it can, so it does not circle the DP.

There is no planned path until then, and the deviation shows only from there.) When you arrive, sequential steering continues from that DP. Select it with DS on the map or on NAV → DPS (both also offer DP 00, the position the INS was aligned at), by entering a new TO DP on NAV/DATA or the UFCD HOM / NAV page, or with >DR STR DP on the BCDU (AVP off).

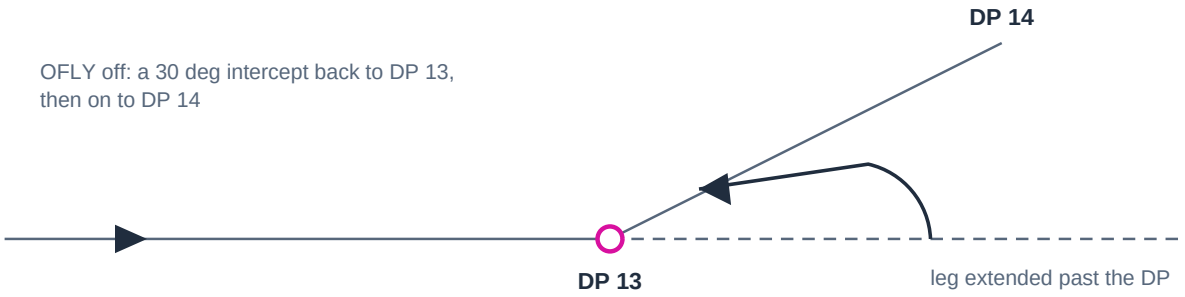
A dashed cyan line on the map shows the proposed track before you confirm it, and a solid cyan line the direct steer once it is sent, from whichever panel - see MAP.

To a TP. NAV → DPS also steers direct to a targeting point. The path is the same, but a TP is a point, not a DP of the file, so there is no next DP: on arrival the aircraft goes into a continuous right turn at 15° of bank and

stays there until you make another steering selection.

The TO DP reads 00 meanwhile, and a magenta line on the map shows the leg to the TP. It is not available while EMER is the active file.

Overfly (OFLY)

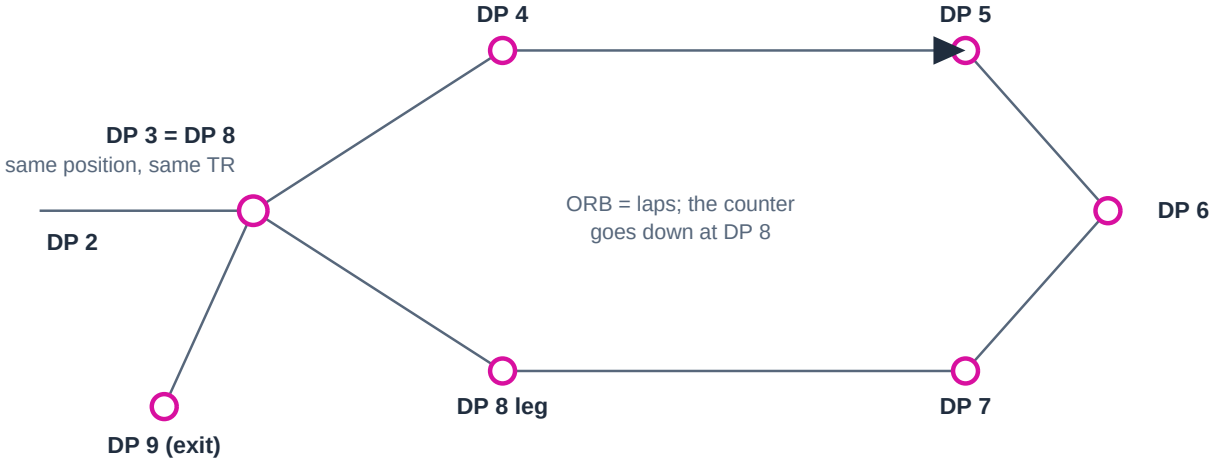


With overfly ON the computer ignores the turn point and flies straight over the TO DP, extending the leg beyond it. When you switch OFLY off (or press it again) it turns back with a 30° intercept to the overflown DP and then continues to the next one.

The PFD steering source reads OFLY in yellow while it is on. Overfly is only available in F/T and is refused while a turn is in progress. It is also the trigger for an orbit adjust, below.

Orbits

An orbit is a loop inside the route that the aircraft flies a number of times - for example while a sensor collects over an area. You do not draw the loop; you build it into the file:



Enter the same position twice (here DP 3 and DP 8). With ORB set, the aircraft flies 3-4-5-6-7-8, goes back to DP 4 instead of DP 9, and leaves for DP 9 on the last lap.

1. In the ACTIVE file, enter the loop's start point twice: once where the loop begins and again where it ends, with the same latitude / longitude and the same turn radius (the "double DP").
2. Put the exit DP right after the second copy, and leave the DP after that blank.
3. Steering mode F/T, and set ORB (2 to 15) on the NAV DATA page, the UFCD HOM / NAV page or the BCDU NAV PRIM page. ORB then shows in green on the map top bar while the orbit is active, and counts down each lap. Entering 0 ends the orbit at the next end DP.

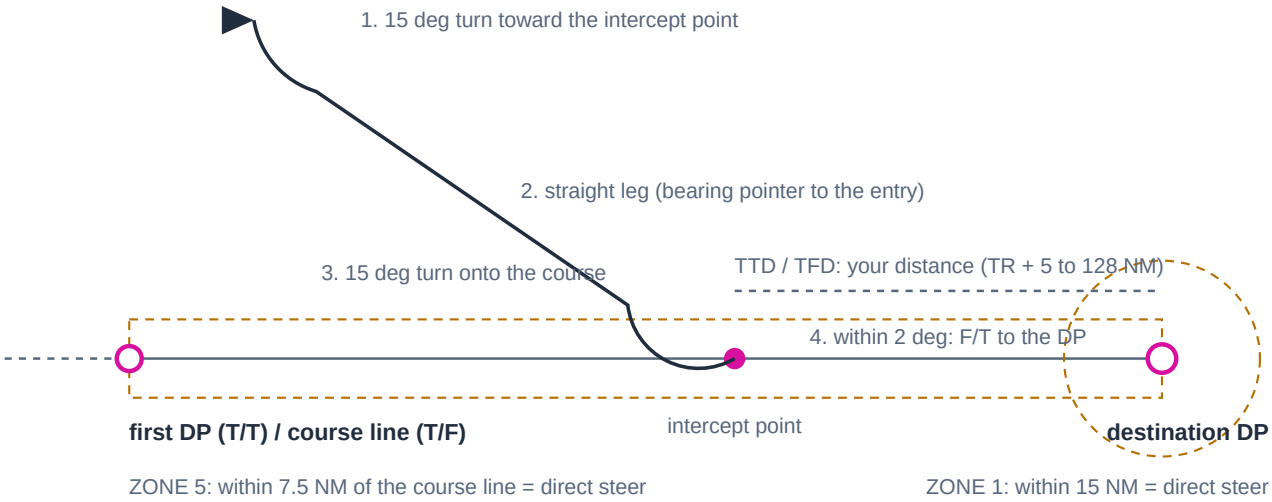
- ORBIT REJECT means the file has no usable double DP: no matching pair, the two copies with different turn radii, no exit DP after the second copy, no blank DP after the exit, or the loop crosses a hemisphere. Orbits only exist in F/T - in the other modes the ORB field is greyed out.
- Three of the shipped routes contain an orbit (DP 3 = DP 8): CROSS US (ACTIVE), DEBORAHA (STORE 2) and JOANR001 (STORE 4). Selecting a store file on the DPS page only shows it - use LOAD to make it ACTIVE.
- **Orbit adjust:** on a leg that has a parallel leg two turn radii away (± 2 NM), pressing OFLY arms an adjust and pressing it again turns the aircraft once onto that parallel leg - the way a real U-2 shifts its orbit sideways. The TO / FROM DPs change at the start of the turn.

T/T, T/F, TTD, TFD - Intercept Steering

These four modes bring you onto a chosen course into a DP - established on a track, not just pointed at a point - rather than flying the file in order. They differ in how the course is defined and in whether you choose where you join it.

Mode	You enter	Use it to...
T/T to / to	DP a / DP b	Join a leg of the route partway along, lined up on the a → b track, instead of going direct to b. Typical cases: after departure vectors, after a weather or ATC detour, or when a collection line has to be flown exactly on its planned track. A direct steer would get you to b on whatever inbound course the geometry gives you; T/T gets you established on the actual leg.
TTD	DP a / DP b / distance	Like T/T, but you choose how far before b you are established on the course. Use it when you need a set length of stable straight track before the point - so a sensor run starts settled, or to stay clear of airspace. The distance is limited to between TR + 5 NM and 128 NM.
T/F to / from	DP / inbound course	Arrive at a DP on a course that isn't a leg in the file. Examples: a gate or entry point that needs a set inbound heading, a target or bullseye run with a fixed look direction, or lining up with a runway course at an arrival fix. It needs no first DP.
TFD	DP / inbound course / distance	T/F plus your choice of how far out you're established on that course. The same distance limits as TTD apply.

Note
A limit that applies to all four: selecting any of them more than 400 NM from the destination DP just gives a direct steer.



How it is flown: a 15° turn toward the intercept point, a straight leg, a second 15° turn onto the inbound course, and as soon as the track is within 2° of the bearing to the destination the computer snaps a course to it and the mode becomes F/T to that DP.

It does the same if the track has already passed that bearing or the DP ends up inside the turn circle, so a missed intercept does not become a circle. Through both turns the bearing pointer, MILES, DTG and XTK are frozen at their entry values; on the straight leg the bearing pointer points at the entry to the intercept turn. TT shows the total time to the destination.

For T/T and T/F the intercept point depends on where you are ("zones"):

- Closer than **15 NM** to the destination (zone 1), or within **7.5 NM** of the inbound line (zone 5): the computer flies a **direct steer** to the DP instead and the NAV block shows it.
- Behind the destination, within 30° of the outbound course (zone 2): the intercept is placed TR + 5 NM before the DP.
- T/T only, beyond the first DP on the far side (zone 4): direct to the first DP, then along the line to the destination.
- Anywhere else (zone 3): a 30° intercept geometry, never further than 128 NM from the destination.
- More than **400 NM** away, or an entered distance over 128 NM: the computer defaults to a direct steer and NAV STEERING shows 400 MAX / 128 MAX.

EMER - Emergency Field

Selected with DIR STR on the UFCD EMER page, with DS on the EMER file of MFD NAV/DPS, or with the BCDU EMR key. The steering computer copies the EMER file over the ACTIVE file (the active file is then named EMER and your route is no longer in it), flies a direct steer to the chosen field and, once over it, holds a right-hand turn so you can set up an approach. You can still direct steer to another field of the file.

- **Leaving EMER:** the mode stays EMER until another file is loaded into ACTIVE - LOAD a store file on NAV/DPS (or on the BCDU TRACK ID page). Then select the steering mode and DPs you want. Keep your route in a store file if you want it back.
- **Not under autopilot NAV:** an emergency direct steer is refused while the autopilot is engaged in NAV mode on the INS steering. The UFCD DIR STR flashes and the NAV/DPS key reads ANAV. Leave autopilot NAV first (for example select HDG).

Entering a Steering Selection

Where	How
MFD NAV/DATA	L2 EDIT: the mode field first, then the DP / course / distance fields that belong to it, then ORB and OFLY. Defaults are filled in for you - second DP = TO + 1, course = present track, distance 50 NM. Values by INC/DEC or the UFCD pad.
UFCD NAV page	LS1 steps the mode candidate, ENT confirms it; LS2 holds the DPs / course / distance for that mode; LS4 overfly.
UFCD HOM page	The F/T line: TO DP and ORB.
MAP page	DS and OFLY.
MFD NAV/DPS	Direct steer: with the ACTIVE file shown, L3 DS, pick the DP with the right rocker (DP 00 = the alignment position), R1 YES. With the EMER file shown, L3 DS, pick the field with L1 / L2, R1 YES - an emergency direct steer. With the TP file shown, L3 DS, pick the TP with L1 / L2, R1 YES - see Targeting Points. While the autopilot flies NAV the key reads ANAV and does nothing.
MFD NAV/RPLAN	L4 LN and L3 / L4 pick a line, R6 EXEC, R6 YES: a direct steer to that line's DP, then the legs as planned - including reverse, out-of-sequence and direct-steer steps built with PLAN - to the END point, then a direct steer to the next DP of the file (or the right-hand turn if there is none). When the plan ends, or another steering entry or a new ACTIVE file ends it, RPLAN DISABLE shows. Not available while EMER is the active file.
UFCD EMER page	LS4 DIR STR, ENT: emergency direct steer (see EMER above).
BCDU (AVP off)	NAV-2 → BRG/RNG >DR STR DP (direct steer to an active-file DP); NAV PRIM steering-mode key L5 (↑ ↓ pick the mode, type the DPs, ENT), OVFLY< and ORBITS<; the EMR key for an emergency direct steer.

> Caution
> The steering computer needs the INS in NAV. Without it the PFD NAV block is hidden, MILES shows ---- and the autopilot refuses NAV mode. If the autopilot is in NAV and the INS drops out, the autopilot falls back to heading hold.

What the Displays Show

- **PFD NAV block:** mode and DPs, e.g. F/T 12/13, T/T 02/03, T/F 02/270, TFD 02/270/050; the bearing and range to the TO DP; TTG; and TT.
- **PFD steering source:** NAV, or OFLY while overflying.
- **Map:** magenta legs on the great circle and curved turns, the next DP in green, a cyan direct-steer line, a yellow overfly line, and ORB in the top bar while orbiting.
- **NAV DATA:** the STEERING DATA block with the steering status message in magenta (128 MAX, 400 MAX, ZONE 1, ZONE 5, OVERSHOOT TURN), DTG / TTG to the turn point, XTK.
- **Alerts:** NAV STEERING (128 MAX, 400 MAX, zone 1, zone 5, overshoot turn) and ORBIT REJECT.

Related pages: Inertial Navigation System (INS) · Navigation Pages (NAV) · Up-Front Control Display (UFCD) · AFCS System (Autopilot) · Targeting Points

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