TLAR

Aircraft Performance

PILOT GUIDE 6.22

OWYHEE AVIATION, LLC.

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WELCOME

Welcome to the TLAR pilot community and thank-you for joining the team! The TLAR app is designed to improve general aviation pilot situational awareness regarding aircraft performance. It is currently capable of computing takeoff, climb, cruise, and landing performance of several models of single-engine piston-powered aircraft.

TLAR's performance engine runs a physics and aerodynamic model that predicts aircraft performance in real time. It does this once per second by calculating the three-dimensional position, attitude, and speed of your aircraft as a function of the physical forces (e.g. lift vs weight, thrust vs drag) that affect all aircraft as they move through the air. Why should you care? This enables TLAR to make reasonably accurate predictions of performance between and beyond the conditions explicitly covered by the POH.

We have spent a long time testing various user interfaces and hope that you like where we have landed thus far. Making an interface that is both simple and intuitive, yet powerful and accurate for such a complex subject as aircraft performance is a difficult balance indeed. We welcome any suggestions you may have to improve the design or it's accuracy. Rest assured that we will continue to innovate and upgrade the TLAR application for the foreseeable future. This is a journey; we are glad you are on it with us!

TLAR LICENSE

HARDWARE/SOFTWARE REQUIREMENTS

Your iPad or iPhone must be running iOS 14.3 or higher and meet the following minimum hardware requirements to run TLAR:

- GPS
- Accelerometer
- Magnetometer
- Gyroscope
- Location Services
- ARM64 architecture
- Minimum performance of A12 chip

Translated to exact device models, TLAR performs on the following:

iPhones: SE (2nd gen and higher), and all models of iPhone 10 thru 15

iPads: cellular models required (GPS): iPad Pro 12.9" (3rd gen and higher), iPad Pro 11" (all gens), iPad Mini (5th gen and higher), iPad Air (3rd gen and higher), iPad (8th gen and higher)

If your device is not listed, TLAR should not install on your device. For more on hardware requirements, see:

https://developer.apple.com/support/required-device-capabilities/

Mounting

TLAR serves you best mounted to your aircraft's dash or somewhere that it can be cross-checked readily in flight. Additionally, TLAR-pro and TLAR-expert offer audible reports that you can hear on headset if you have a blue-tooth enabled audio panel/headsets, or an auxiliary sound input jack connected your iDevice.

CONTACT

You can download a full-size TLAR manual at:

www.tlarpilot.com

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Suggestions for improvement:

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Technical support:

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Privacy Policy:

https://www.tlarpilot.com/privacy-policy.html

End User License Agreement:

https://www.apple.com/legal/internet-services/itunes/dev/stdeula/

TLAR BACKGROUND

We created TLAR to fill what we saw was a need in the General Aviation community. Having "grown up" steeped in military aviation, complete with solid performance manuals and information, we were disappointed by the lacking and/or partially complete performance information contained in some General Aviation aircraft pilot operating handbooks (especially experimental category aircraft). Flying back country in the mountains of Idaho, Nevada, Oregon, Utah, Colorado, and others, it became an especially acute need for us to create something that could reasonably estimate aircraft performance. "TLAR" was born of this need. Like many terms used within TLAR, the "TLAR" name itself comes from a military aviation term/acronym. TLAR stands for "That Looks About Right," which in military circles is usually used in a conversation with one's thumb held high acting as a gunsight. It means that what follows is to be considered an estimate, something more-or-less accurate enough to be useful, but not something to be taken as precisely correct, hence, "That Looks About Right" or TLAR.

TLAR VERSION HISTORY

1.03 – Initial public release

1.04 – Added Solar data to TLAR-pro

1.05 – Not Publicly Released

1.06

- Added selectable units (meters, mph etc.) to both TLAR-basic and TLAR pro to facilitate international release
- Added manual control of headwinds and tailwinds to TLAR-pro
- Added performance capture and debrief view to TLAR-pro

1.07

- Added RV-7 aircraft type to TLAR-basic and -pro
- Added flight category info (VFR, MVFR, IFR, and LIFR)
- Updated Global airfield database

1.08

- Updated interface to work better with iOS 16

1.09

- Added military-style aviation clock with time zone support as well as solar and lunar data to TLAR-basic and TLAR-pro
- Improved height over obstacle accuracy
- Fixed Sunrise/sunset bug for Extreme Northern/Southern latitudes for TLAR-pro
- Added ability to capture takeoff roll accurately on displaced runways for TLAR-pro
- Improved debrief data capture for TLAR-pro

2.0

- Time zones improved in TLAR-basic and TLAR-pro. Added support for 30 and 45-minute offset time zones in Canada, Australia, and New Zealand. Also added Z+13-hour time zone.
- Added flight status indicator to TLAR-basic and TLAR-pro
- Added smart Visual Approach Path Indicators to TLAR-pro which compute glideslope, track distance, and track feet per minute required for downwind, base, turn-to-final, and straight-in approaches.
- Added ability for pilot to set the stabilization distance
- Added cross-track and required bank angle gauges to TLAR-pro
- Added auto-hiding of magenta bearing pointer when on runway or short final in TLAR-pro imagery or map mode.

- Fixed radian/degrees conversion bug that caused erroneous USGS-obtained slope data for user-created landing zones

2.1
- Added Vz climb profiles to TLAR-basic and TLAR-pro
- Added ability to survey your own landing zones to TLAR-pro
- Added ability to search airport database using any string (i.e. city name, state, country, common name etc.)
- Fixed TLAR-pro bug that caused crashes on downwind approaching the perch
- Fixed TLAR-pro bug where an airport's elevation status might report "SET to ZERO" when actually should have reported "Field Elev"

2.2 (all TLAR-pro improvements, TLAR-basic unaffected)
- Improved database search engine
- Added ability to set the Mark Point bearing pointer to a database airstrip that only has a coordinate (previously, TLAR would ignore such airstrips)
- Re-fixed "SET to ZERO" error we thought we fixed in 2.1
- sVAPIs, pattern information, and stabilized approach monitoring guidance will no longer appear if the active LZ approach end is set to the airport center-point or if the TDZE is set to the field elevation
- Improved loading of previous LZ information on start-up

2.3
- Added stopwatch function to the TLAR-basic and TLAR-pro clock
- Added ability to load any runway into the mark-point bearing pointer in TLAR-pro
- Improved search accuracy in the global airport database for TLAR-pro

2.4
- Added Cessna 170B to both TLAR-basic and pro
- Increased use of GPS-track versus compass heading in both TLAR-basic and pro
- Added color differentiation to track pointer to show when TLAR is using GPS-track (magenta) versus iOS heading (cyan) for both TLAR-basic and pro
- Improved accuracy of iBaro in flight in TLAR-pro
- Stopped auto-update of temperature when in manual temperature mode for TLAR-pro
- Disabled rotate and zoom in imagery and graphical map views until user upgrades to iOS 16.4 or higher (see https://developer.apple.com/forums/thread/719084?page=2 for more information on the issue)

2.5

- Added ability to adjust drag coefficient on any plane in TLAR-basic and TLAR-pro
- Added Cessna A185F to both TLAR-basic and TLAR-pro
- Improved model accuracy for Cessna C180K in both TLAR-basic and TLAR-pro
- Added time (in seconds) to perch-point and time to threshold to the pattern-status window at the bottom of the HSI on TLAR-pro
- Changed the mark-point function such that the "mark" button is "hot" on app start-up. Previously, TLAR-pro would save the previous mark-point during app shutdown and then on a subsequent app startup the "old" mark point was loaded as the active mark-point. This could be confusing, especially if it had been a while since the last use of TLAR.

2.6

- Added Cessna 172S to both TLAR-basic and -pro
- Added course deviation indicator (CDI) and glide slope indicator (GSI) gauges to TLAR-pro
- Added TLAR-pro ability to share Landing Zone parameters via airdrop, e-mail, text message etc.
- Added TLAR-pro ability to send a Situation Report (departure, position, destination, ETE/ETA, and other status information) via airdrop, e-mail, text message etc.
- Updated TLAR's point-elevation internet query to be compatible with the USGS's new required format for the same.
- Fixed TLAR voice call-outs which stopped working with the release of iOS 16.

2.7

- All updates apply to TLAR-pro only, TLAR basic unaffected.
- Fixed problem whereby a user-created LZ could default to pavement values for rolling friction and braking friction coefficients for non-pavement surface types. This fix will auto-correct existing user-created LZs.
- Fixed a bug that could cause the app to crash after deleting a user-created LZ
- Added a cautionary "Coordinates Not Precise" note when the loaded active landing zone's approach-end coordinate is not on the runway. If so, TLAR will not display the CDI, GSI, or sVAPIs.
- Improved display of default data when user deletes the active LZ.

3.0 [significant upgrade]

- Added "Big Sky" mode to TLAR-pro which displays a full-screen edge-to-edge moving map view with performance data displayed graphically.

  - sVAPI changes
  - ETE changes, pattern text changes
  - Max map cycle rate 1Hz
- Improved clock behavior when moving across time zones in both TLAR-pro and -basic.
- Improved "recovery" of performance metrics after exceeding service ceiling and then descending back to fly-able altitudes (using manual elevation adjustments) for both TLAR-pro and -basic.
- Improved aerodynamics engine increased performance accuracies for nearly all modelled aircraft
- Changed the takeoff length arrow (visible in map views) from ground run to takeoff distance over the fence and added a lift-off dot to the same in TLAR-pro.
- Improved closest weather station search and auto-updating in TLAR-pro
- Improved database search functionality in TLAR-pro
- Updated some airfields in the airport database in TLAR-pro
- Added 10NM ring centered on the approach-end to the maps in TLAR-pro

3.1

- Added Piper PA-22 aircraft to -basic and -pro
- For TLAR-pro:
  - Added most fuel-efficient climb profile ("ECO")
  - Added "Cruise MSL" parameter to VNAV/CRZ Settings
  - Moved the Stabilization Distance parameter from VNAV/CRZ settings to PILOT settings
  - Removed the Fence Margin parameter, Pilots can still set the Fence Height parameter to control for close-in obstacles
  - Improved stabilization audio call
  - Added sVAPIs to Big Sky View
  - Track distance to go used in Big Sky view only (inside 10NM to go). Performance view uses DME (straight-line distance to approach end) only.
  - Replaced "Vpatt" with "Vstol" or "Vnorm" as applicable in Big Sky Mode

3.2

- Corrected flap settings on Mooney M20F
- Global airfield database corrections

3.3

- Added Vans RV-4 to both -basic and -pro
- Improved RV-7, RV-8, and HROC2 windmilling glide drag model in both -basic and -pro.

- Fixed typo whereby TLAR would display track distance to go on the performance view (yet label it “DME”) in -pro
- Fixed bug affecting left patterns in “Big Sky” mode in -pro
- Fixed bug that displayed cruise speed and fuel flow in place of max endurance and max range speeds and fuel flows when selected in -pro

3.4, 3.5, 3.6, 3.8
- Not commercially available. Testbeds for an offshoot project.

3.7
- For both -basic and -pro, improved the way TLAR handles performance computations from liftoff until reaching climb speed. Now, TLAR will compute takeoff over an obstacle (fence height) and height by end of runway that results from the pilot’s selected climb profile. All previous versions used a Vx profile regardless of selected climb.
- Added Vans RV-10 in -basic and -pro
- Changed flap setting names for RV-4 from “UP”, “F1”, “F2” to “UP”, “20”, “40” in -basic and -pro
- Fixed a bug in -pro in the set FPM climb profile where TLAR would sometimes select the backside of the power curve speed instead of the front-side speed yielding the same climb rate.
- Changed Bottom Of Descent marker to mark where set FPA meets TDZE (used to mark when hit pattern altitude of 1000 feet above TDZE) in -pro
- Added ability to cycle the climb profile on the “big sky” view for -pro
- Fixed runway name error where TLAR would drop the “R”,”L”, or “C” from a runway name after hitting the runway flip button in -pro

3.9, 4.0, 4.2
- Not commercially available. Beta Testbeds for an offshoot project.

4.1
- Added power push time to aircraft settings in -basic and -pro
- Added Vans RV-14A to -basic and -pro
- Improved flap drag model on RV-10 to -basic and -pro
- Improved drag model on RV-4, added Catto prop to RV-4 to -basic and -pro
- Improved density altitude computations in -basic and -pro
- Added ability to load departure and destination fields and flip flop from one to the other to -pro

4.3

- Short-lived version pushed to fix -pro crashes caused when NOAA changed its METAR server location and format on 16 Oct 2023. This version removed ability to download METARs.

4.4

- Restored METAR functionality to -pro, the fix also downloads all global METARs and saves them for offline use.
- Added ability to manually set wind direction on big-sky page in -pro
- Added ability to change climb profile on big sky page in -pro
- Improved handling of dewpoints and auto/manual temperature switching in -pro

4.5

- Added Cessna 150M (basic and pro)
- Added performance calculations using wind gusts (pro)
- Added ability to use most METARs with variable winds (pro)
- Global airfield database updates (pro)
- Added Weather Station marker, vector line, and METAR Text to maps (pro)

4.6 Beta testbed for offshoot project.

4.7

- Added L39C jet to -basic and -pro
- Added ability to select fuel units in pounds or kilograms in -basic and -pro
- Added ability to select MACH for airspeed units in -basic and -pro
- Fixed reporting of Vg from true to calibrated speed -basic and -pro
- Added constant MACH climb profile to -pro
- Fixed endurance cruise fuel flow in -pro
- Global airfield database updates -pro

4.8 Beta testbed for offshoot project.

4.9

- Added Diamond DA-40 Aircraft -basic and -pro
- Improved A36, C182P, SR20, SR22, and SR22T aero models -basic and -pro
- Added caution if height by end is within 10 feet of fence height – basic and -pro

- Added Accelerate-Stop Distance -pro

4.91 Beta testbed for offshoot project.

- Corrected glide slope indicator -pro
- Refined use of turn-rate for turn-back calculations -beta
- Accounted for distance into takeoff run to land straight-ahead calculations -beta version only

4.92 Beta testbed for offshoot project.

- Recoded turnback audio logic to reduce nuisance “turnback possible” calls -beta version only
- Corrected KGFZ runway end coordinates and data -pro

4.93

- Global airfield database updates -pro
- Fixed glideslope carrot bug -pro

5.0

- Critical fix of bug that crashed app for brand new users
- Improved performance modelling of A36, C152, C172N, C172S, C180K, C182, CA185F, DA40, GLST, M20F, PA28140, and PA28181 aircraft -basic and -pro
- Improved display of Nav and Motion sensor status -pro
- Corrected screen-size error which displayed the CDI and GSI in the wrong place on certain iPhones -pro

5.1

- Starting with iOS 17.4, Apple now requires the user to grant permission for an app to use the barometer and motion sensors. This change broke TLAR’s iBaro and performance capture functions. This version fixes that. Users should get a prompt to allow TLAR to access these sensors.
- Numerous small tweaks to display labels and buttons.

6.0 TLAR-expert initial commercial release

- TLAR-expert has all of TLAR-pro’s features and adds emergency turnback functionality
- TLAR-expert also adds aircraft telemetry recording for debrief/analysis purposes
- Added flight path marker if descending to maps -pro and -expert
- Added requirement for user to acknowledge the EULA on app start up on all versions
- Minor adjustments to GUI on all versions

6.11

- Fixed bug which scrambled pilot-selected units (e.g. knots vs mph etc) on shutdown

6.20

- Changed start-up settings for -expert. TLAR defaults to fully automatic modes for weather and runways.
- Automatically load and activate the closest runway -expert
- Continuously scan for and automatically load the best wind-corrected emergency runway (one that yields the most excess altitude available upon arrival and after turns to align with said runway) and compute an emergency glide to it during flight -expert
- Added auto-motor start/stop -expert
- Vastly improved global airfield database search speed -pro -expert
- Fixed a bug that displayed gsi and hsi carrots for imprecise LZ's if one was loaded with gsi and hsi data showing for a previously active LZ -pro -expert
- Tightened up the criteria to auto-switch to dynamic KGS mode for landing performance calculations -pro -expert
- Fixed sitrep telemetry file bug causing nothing but zeros to be output for the turnback possible column -expert
- Rationalized when TLAR displays DME versus Track Distance To Go when in Emergency modes. -expert
- Moved weather source (blue) line from approach end to center point of runway on map displays -pro -expert
- Added low fuel caution and warning colors to fuel remaining -basic, -pro, -expert

6.21

- Improved LZ-AUTO search -expert
- Improved auto METARs when off net -expert -pro
- Global airfield database updates -pro -expert
- Added audio "Joker"/"Bingo" fuel calls -basic -pro -expert

6.22

- Improved LZ-AUTO search speed 50-fold. -expert
- Added automatic elevation source selection. -expert
- Improved map view movements in AUTO-LZ mode. -expert
- Fixed bug that caused app to freeze on startup for some customers. -basic -pro -expert

- Known Issues

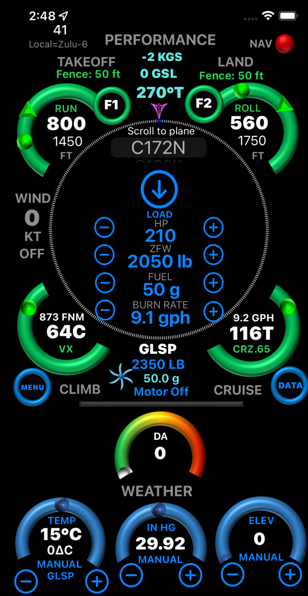
- EULA pop up frequently presents twice on start-up.
- Text labels will be slightly off if user places their phone or iPad in “Zoomed” mode [Settings/Display and Brightness/Display Zoom].

- On iPads, rotating the screen using this iOS rotation button:

Will completely scramble the screen necessitating a restart of the TLAR app!

JUMP-START





Jump-start checklist

1) Hit the “Menu” button 

2) Hit the “Aircraft” button 

3) Scroll to your aircraft type and hit “Activate” button 

4) Toggle your zero-fuel weight, fuel load, burn rate, and HP using the (-) and (+) buttons. See Aircraft Settings section later in this manual for more.

5) Hit the “Menu” button to return to the compass view

6) Use the (+) and (-) buttons to set your weather conditions (Temperature and Pressure) and elevation

7) After actual engine start, toggle the motor on/off button to start the TLAR motor (TLAR will decrement the on-board fuel over time using the entered burn rate (when flying) or 20% of the entered burn rate (on ground).

8) Go FLY!

TLAR stores many key parameters on your phone so they do not need to be re-entered each time you use the app. This includes aircraft parameters but does not include weather or elevation information.

Aircraft Models

TLAR currently models the following General Aviation Aircraft:

- Aero L39C (L39)
- Bonanza A36 (A36)
- Cessna 150M (C150M)
- Cessna 152 (C152)
- Cessna 170B (C170B)
- Cessna 172M (C172M)
- Cessna 172N (C172N)
- Cessna 172S (C172S)
- Cessna 180K (C180K)
- Cessna 182P (C182P)
- Cessna A185F (CA185F)
- Cirrus SR20 (SR20)
- Cirrus SR22 (SR22)
- Cirrus SR22T (SR22T)
- Cub Crafters FX-2 (FX2)
- Cub Crafters FX-3 (FX3)
- Diamond DA40 (DA40)
- Glasair Sportsman (GLSP)
- Glasair Glastar (GLST)
- Harmon Rocket II (HROC2)
- Kitfox 7 Series SS (K7SS)
- Kitfox 7 Series STI (K7STI)
- Mooney M20F (M20F)
- Piper J3 (J3)
- Piper PA18 (PA18)
- Piper PA22 (PA22)
- Piper PA28-140 (PA28140)
- Piper PA28-181 (PA28181)
- Vans RV-4 (RV4)
- Vans RV-7 (RV7)
- Vans RV-8 (RV8)
- Vans RV-10 (RV10)
- Vans RV-14A (RV14A)

We apologize if your exact aircraft is not yet represented. We will continue to add more planes in the future. For now, you can select a model that approximates your aircraft and adjust it's horsepower and drag to better match the plane you have. It's not perfect, but it might be "good enough."

Units

TLAR defaults to the following units:

- Nautical Miles Per Hour (Knots) for aircraft and wind speed
- Feet per minute for vertical speed
- Nautical miles for distance
- Feet for distances, altitudes, and heights
- Degrees for angles and bearings
    - Note – all bearings within TLAR are with reference to True North unless otherwise annotated with an "M"
- Gallons for liquid volume
- Gallons per hour for fuel flow rate
- Hours, Minutes, and Seconds for time
- Celsius for temperature
- Inches of Mercury for pressure
- Pounds for weight
- Revolutions per minute for engine/propeller speeds
- Horsepower for engine power
- Feet per Nautical Mile for gradients

Many of these can be changed in UNITS settings accessed by hitting the MENU button, then AIRCRAFT, then UNITS.

Colors

TLAR makes extensive use of color to either alert the pilot or display information regarding data sourcing. The color RED is used to alert the pilot to potentially hazardous conditions and/or invalid or unmade inputs. The color YELLOW is used to indicate some measure of CAUTION is required. GREEN is used to indicate a value that is generally "good" or normal. BLUE text indicates values entered by the pilot ("blue is from you"). WHITE is used to display performance information that is TLAR-computed. Indigo is used to indicate values that came from the internet or a database. CYAN text indicates parameters which are mostly derived from your iDevice’s internal sensors. Magenta indicates values associated with the currently active landing zone.

Airspeeds

At present TLAR does not correct for pitot-static position error, which means all “indicated” speeds within TLAR are in calibrated speed. Most, but not all, general aviation aircraft do not display *calibrated* airspeed on their airspeed indicators. Fortunately, at speeds above approach speed, in most general aviation aircraft, there is a very small difference between indicated and calibrated airspeed. However, as the aircraft slows down this error increases for many general aviation aircraft and will *indicate* a speed approximately 5 knots different than *calibrated* airspeed at landing and/or stall speed for many aircraft (there are exceptions). Usually, this error is more pronounced with flaps down than flaps up. In some aircraft types, the airspeed indicator may even show zero at stall speed. These are generalizations and may or may not be true for your aircraft. See your aircraft’s Pilot Operating Handbook for details and specifics regarding these errors in your exact make and model of aircraft.

Altitude

You determine the altitude to compute performance data in TLAR-basic using increment/decrement buttons next to the elevation gauge.

TLAR-pro offers the pilot three ways to “set” what altitude to use for performance calculations. It can use the touchdown-zone elevation as loaded from a global airfield database, or a user-created airstrip. Alternatively, TLAR-pro can use your iDevice’s sensed elevation (as derived from Satellite sources, Cellular Tower, and Wi-Fi triangulation) minus 4 feet to account for the approximate standing height/location height in your plane. Finally, you can manually override this and toggle the aircraft altitude up and down as done in TLAR-basic.

Sensor Accuracies

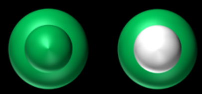
Position and Speed Errors

TLAR combines your iDevice's estimated accuracies for position and speed into a single green-yellow-red rating displayed in the top right corner as a colored ball next to "NAV." TLAR will report "green" if horizontal, vertical, and speed accuracies are each "green" in accordance with the table below. If one or more of them is "yellow," TLAR will display a yellow ball. If one or more of them are red, TLAR will display a red ball.

	Accuracy color codes		
	Horizontal	Vertical	Speed
Green	<= 50 ft	<= 20 ft	<= 2 kgs
Yellow	> 50 ft	> 20 ft	> 2 kgs
Red	Invalid	Invalid	Invalid

Motion Sensor Status (TLAR-pro only)

TLAR-pro/expert uses your iDevice's motion sensor to detect the liftoff point on takeoff. When this sensor is on, the center ball inside the NAV-status ball will be GREEN. When it is off, the center ball will be WHITE.



iBaro Errors (TLAR-pro/expert only)

TLAR calculates an altimeter setting called iBaro using your iDevice's built-in barometer and it's GPS-derived elevation. We added iBaro to TLAR for purposes of obtaining a pressure reading for performance calculations when "off the net" in the backcountry. Although it is reasonably accurate on the ground, *we do not recommend setting your aircraft altimeter using iBaro.* Be aware of iBaro's limitations:

Pressurized planes in flight. *Do not use the iBaro setting inside a pressurized aircraft.* TLAR will assume the measured cabin pressure is the outside air pressure, resulting in a *wildly high* iBaro altimeter setting. TLAR limits the maximum iBaro to 32.00 inches Hg.

Unpressurized planes in flight. As air flows around the fuselage of your aircraft, the static pressure drops, which lowers the pressure of the air inside the cabin of an unpressurized aircraft. TLAR has a factor to account for this drop, but, the resulting

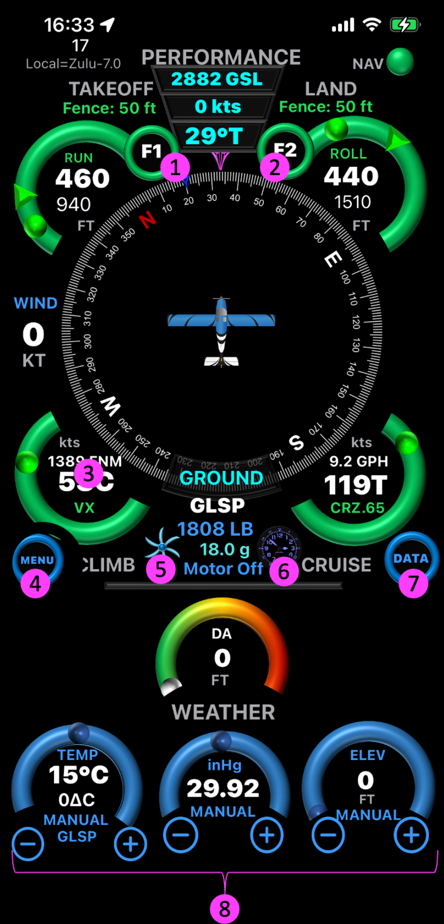
"That Looks About Right" setting is good enough for performance calculations, but not good enough for air navigation purposes.

TLAR-BASIC

This is a screen-shot of TLAR's primary screen.

Buttons

The numbered magenta circles are buttons.



(1) Takeoff flaps button – Toggles takeoff flap setting you want TLAR to use when calculating takeoff data. If this is set to a non-standard setting, the button will turn yellow.

(2) Land flaps button – Toggles landing flap setting you want TLAR to use when calculating landing data. If this is set to a non-standard setting, the button will turn yellow.

(3) Climb profile button – There are three climb profiles available in TLAR-basic: Vx, Vy and Vz. This button will toggle which climb profile’s performance is displayed.

(4) Menu button – The menu button will display the main settings menu from which sub-menus can be reached. It is also used to back out of those menus to the previous menu or to the compass display.

(5) Motor button – The motor on/off button will toggle the TLAR motor. When “on”, the propeller will spin and TLAR will decrement the on-board fuel over time using the entered aircraft burn rate (when flying) or 20% of the entered burn rate (on ground).

(6) Clock button – The clock button cycles the display of the aviation clock and stopwatch in the center of the HIS. See Clock Gauge below for more information.

(7) Data button – In TLAR-basic, the data button toggles the display of Vspeeds and flight path angle inside the compass rose. Displayed speeds are calibrated not indicated.

Vto = takeoff speed, **Vref** = approach speed, **Vg** = best windmilling propeller glide speed, and **Vs** is stall speed for the selected landing flaps setting. If a settings menu is visible, the data button will remove it and return to the compass view.

(8) (-)decrement (+)increment buttons – These buttons change the temperature, pressure, and elevation up and down in steps.

Gauges

Horizontal Situation Indicator (HIS) – TLAR's HIS is oriented "Track-Up" with a rotating compass rose bezel slewed to True North. The pointer shows true heading/track. If iOS can establish a GPS-track, the track pointer will be colored magenta. If not, TLAR uses your iDevice's internal compass and the pointer will be colored cyan indicating your true heading. The smaller indigo-pointer shows magnetic heading/track. Each aircraft type has it's own aircraft graphic that displays in the center of the HSI.

Flight Status display.

The flying status window displays GROUND, TAXI, or FLYING.

TAKEOFF.

TLAR-basic computes takeoff performance assuming no wind, a paved, level, dry runway accounting for atmospheric pressure and temperature as well as aircraft gross weight and flap setting. TLAR assumes maximum power, a one second delay to rotate (for non-STOL-type aircraft), and a maximum performance Vx climb. TLAR basic assumes a 3000-foot runway.

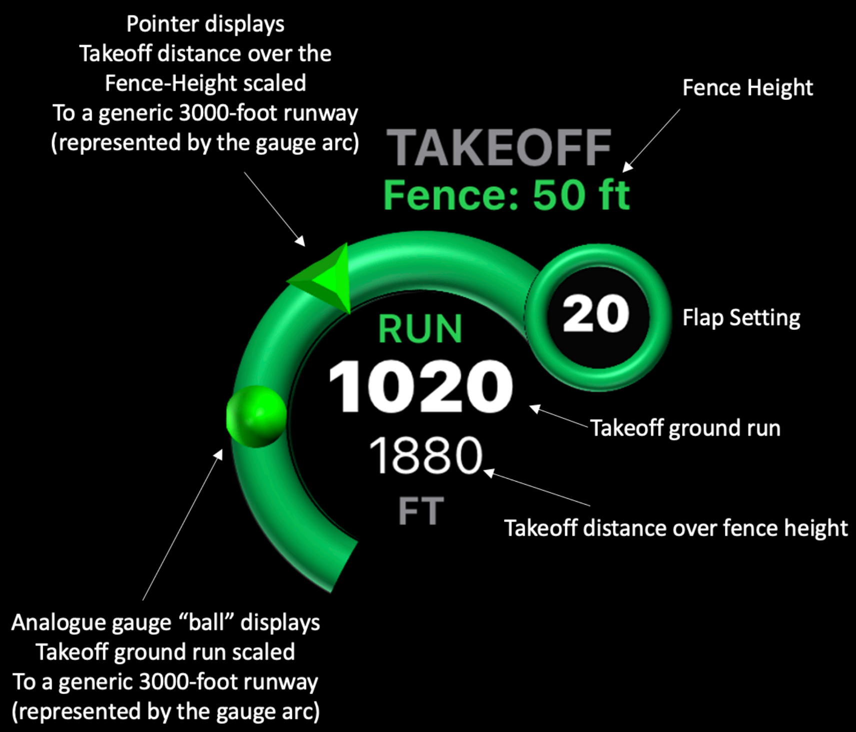


Figure 1 – Takeoff Gauge

Fence height – obstacle height assumed to be at the departure end of the runway. In TLAR-basic this height is fixed at 50 feet.

Takeoff ground run – distance in feet from brake release to liftoff including a 1 sec delay for rotation.

Takeoff distance over fence height – distance from brake release to reaching the fence height.

LANDING.

TLAR-basic computes landing performance assuming no wind, a paved, level, dry 3000-foot runway accounting for atmospheric pressure and temperature as well as aircraft gross weight and flap setting. TLAR-basic uses an approach speed that matches the approach speed stall margin specified in the POH (typically ~ 1.3 x stall speed) and assumes a touchdown ground speed equal to 90% of approach ground speed.

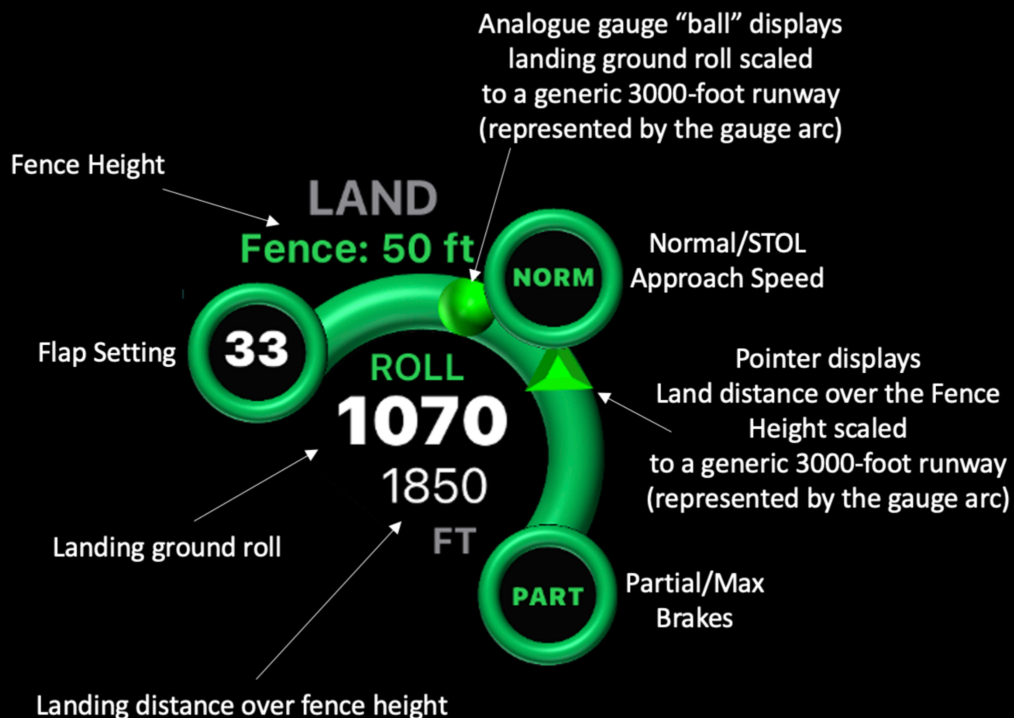


Figure 2 – Landing Gauge (TLAR-basic doesn't have Partial/Max)

Fence height – obstacle height assumed to be at the approach end of the runway. In TLAR-basic this height is fixed at 50 feet.

Landing distance over fence height – distance from threshold to the point where the aircraft is stopped. TLAR-basic assumes the aircraft crosses the threshold at the fence height using maximum glidepath angle of -3.5^{o}, a 500-foot touchdown zone (to account for distance used in the flare and getting the plane level), and that maximum braking begins at the end of the touchdown zone.

Landing ground roll – distance from the end of the touchdown zone (where TLAR assumes maximum braking begins) to the stopping point. TLAR-basic assumes maximum braking.

CLIMB.

TLAR-basic computes Vx, Vy, and Vz climb profiles using maximum-power, no-winds, and corrects for aircraft gross weight and atmospheric conditions. TLAR uses flaps up for Vy and Vz climbs, and the pilot-selected takeoff flap setting for Vx climbs.

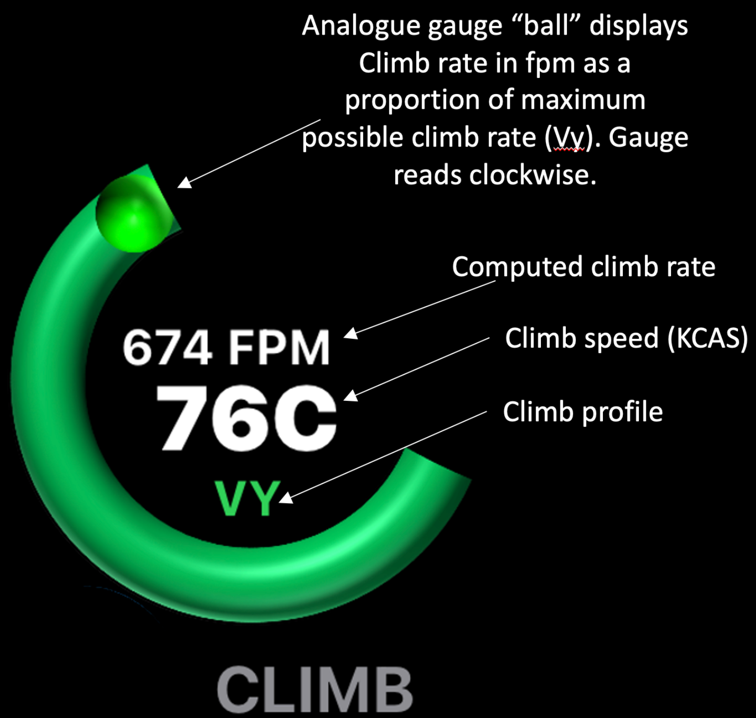


Figure 3 – Climb Gauge

The Vy climb speed yields the maximum climb rate possible for the given conditions. The Vx climb speed gives the highest climb angle/gradient. These two climb speeds are well established in the flying community. The "Vz" climb seeks a practical balance between climbing at a reasonable rate with making forward progress in cruise. Pioneered by a aero-engineer named Norman Howell in his master's thesis, "Introducing Vz: Best Efficiency Of Climb Speed For Small Airplanes" Vz is 1.32 times Vy and it is a "better" way to climb if the intent is to then cruise to a destination. This because the aircraft travels much further down track in the climb while burning nearly the same amount of fuel as compared to a Vy or Vx climb followed by cruising. Additional benefits are improved visibility over the nose, engine cooling, and passenger comfort.

CRUISE.

TLAR-basic computes flaps-up 65% power cruise performance corrected for atmospheric conditions and gross weight (99.8% RPM for the L39C jet). Information is displayed on the CRUISE gauge:

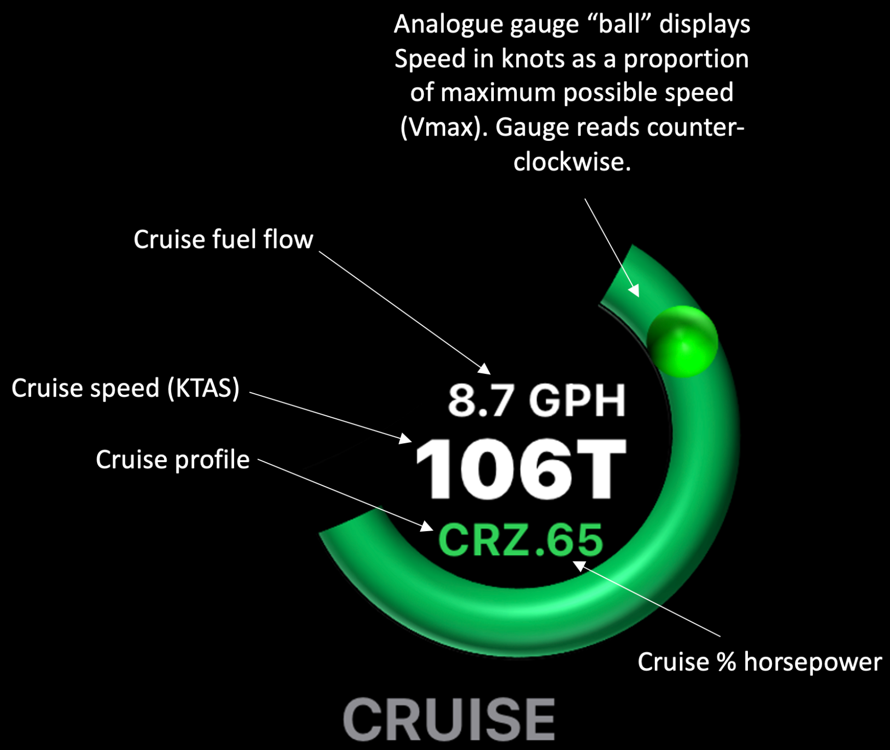


Figure 4 – Cruise Gauge

AIRCRAFT SPEED, ALTITUDE, TRACK.

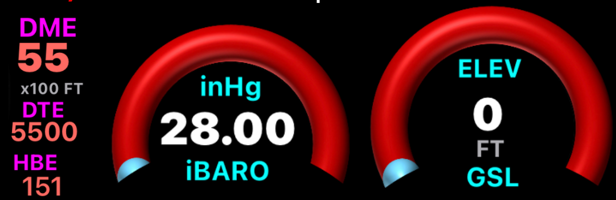
TLAR uses your iDevice’s sensors to determine speed, altitude, magnetic heading/track, and true heading/track. Unless you select different units, Speed is in knots, altitude in feet, and heading/track in degrees from magnetic/true north. TLAR displays GPS–track if your iDevice can determine one, otherwise TLAR uses your iDevice’s heading using it’s internal compass sensor. The text will be colored CYAN if the applicable sensor is providing a valid input, and RED otherwise.

Figure 5 – Aircraft Performance Gauge

Like most navigation–related apps, disabling location services degrades TLAR’s usefulness, particularly the TLAR–pro version of the app. Nevertheless, without location services TLAR is still able compute aircraft performance using manual settings for pressure, temperature, winds, and elevation.

If you turn off location services or disable location for TLAR or turn off precise location: the aircraft speed, altitude, and track labels will turn RED, and the groundspeed label will read “Location Off” or “Precise Loc Off.”

TLAR–pro/expert only: the active landing zone vectors, iBaro, GSL gauges also turn RED, and the compass wind arrow disappears.



AIRCRAFT SPECIFICS.

TLAR computes aircraft gross weight by adding weight to the pilot-specified zero-fuel weight. TLAR uses 6.0 (100LL) and 6.75 (Jet-A) pounds per gallon to estimate this weight. If the motor is on, TLAR will display the current fuel flow in the motor status field and the propeller will spin. As fuel burns off, TLAR will continuously re-compute the gross weight and adjust aircraft performance accordingly. If your total fuel falls below your hourly fuel burn rate, TLAR will caution you by turning the fuel load label YELLOW. If the fuel load falls below 2/3rds of the hourly burn rate, the label will turn RED.

AVIATION CLOCK.

The aviation clock displays time in hours, minutes, and seconds using a modernized version of the analogue clock installed in many military aircraft. The TLAR version of this clock also has five solar displays, lunar phase/illumination data, time zone controls, and allows you to choose one of seven color schemes.

Figure 6 – Aviation Clock

There are four buttons that control the clock.

The lunar button  is dynamic.   It's appearance shifts to correspond to the current phase of the moon.

Tapping on the button will toggle display of the current percent moon illumination. Zero corresponds to no moon illumination, 100 corresponds to full moon illumination.

The color scheme button  cycles the clockface scheme thru seven colors: white, indigo, blue, cyan, red, green, and yellow.

The clock mode button  cycles the clock from displaying time, to displaying one of five important solar times: lightrise, sunrise, solar noon, sunset, and darkset. TLAR-basic computes these times using your iDevice's current location. TLAR-pro/expert computes these solar times either for your current location and time or for the active landing zone and your ETA to it depending on your selection of elevation-source (aircraft or landing zone).

> Note - If location services are off, or you are located at a latitude where one or more of the solar parameters is invalid (such as extreme North in the Summer when the sun does not set for months), TLAR will hide the clock mode button from view and only display time.

Lightrise. This is the time prior to sunrise that it is light enough to see objects and some detail. TLAR uses -6.8 degrees of sun elevation to determine this time.

Sunrise. Sunrise is defined in TLAR when the center of the sun disk elevation is -0.833 degrees as it rises.

Solar Noon. Solar noon is when the sun reaches it's highest point in the sky as determined by your location on Earth. It almost always does NOT correspond to noon local time due to where you are located within a given time zone. Solar noon is special in that all shadows point directly true North (in the Northern Hemisphere) or true South (in the Southern Hemisphere) at solar noon.

Sunset. Sunset is defined in TLAR when the center of the sun disk reaches -0.833 degrees as it sets.

Darkset. This is the time after sunset where it is too dark to see most objects or any detail. TLAR uses -6.8 degrees of sun elevation to determine this time.

Time Zone Button. 

The time zone button changes the time-zone of the clock and controls whether time zones adjust automatically to that of your iDevice, or if they are manually set. Tapping the button will move the set time zone ahead by one time zone. Worldwide there are 40 time zones because several have 30 or 45-minute offsets. TLAR's clock currently will increment to all one-hour zones up to Z+13, plus all 30/45 minute time zones in Canada (Z-3.5), Australia (Z+8.75, Z+9.5, Z+10.5), and New Zealand (Z+13.75). TLAR displays the current time zone relative to Zulu (e.g. Z+13.8 is Zulu plus 13.75 hours) in BLUE text.

If the selected time zone is the same as the current time zone of the iOS clock, TLAR will "lock onto" the iOS clock and display the localized abbreviation for the active iOS time zone (e.g. "MST") in CYAN letters. In this mode, TLAR's clock will change with your iOS's clock meaning if you change the time zone on your iDevice (either manually or automatically as set in your iOS settings), TLAR's clock will change to match. Once in this "follow iOS" mode, a single tap of the time zone button will stop TLAR from following iOS time zone changes, but will keep the current iOS time zone in manual mode, displaying it's Zulu offset (e.g. "Z-7.0") in place of the time zone label (MST). This is useful if you want to lock TLAR's clock to your home field time zone.

STOPWATCH.

Pressing the cycle clock button  with the clock displayed will shift the clock from “CHRONO” to “STOPWATCH” mode.

Figure 7 – Stopwatch

In stopwatch mode, TLAR replaces the time zone button with a multi-function start/stop/reset button.

Pressing the start button will start the stopwatch, and the stop button will appear. While the stopwatch is running, you can leave the clock if you want (by pressing the cycle clock button) and the stopwatch will continue to run.

Pressing the stop button will stop the stopwatch and the reset button will appear.

Pressing the reset button will reset the stopwatch to zero.

WEATHER.

TLAR displays four digital/analogue gauges at the bottom of the screen. These are a density altitude gauge, a temperature gauge, a pressure gauge, and an elevation gauge.

The temperature, pressure, and elevation gauges display their source below the digital value. In the example below, all three say “MANUAL” as this is the only option in TLAR-basic. Additionally, the temperature gauge shows it’s reference elevation source (C172 in this case, as opposed to the airport or METAR reporting station which TLAR-basic does not have the capability to display).

Density altitude is pressure altitude corrected for temperature and humidity. TLAR-basic ignores the effect of humidity.

The temperature gauge displays the absolute temperature and delta temperature from standard in degrees Celsius.

The pressure gauge shows altimeter setting in inches of mercury.

The elevation gauge sets the reference elevation in feet to compute performance.

TLAR-basic does not model wind effects, TLAR-pro and TLAR-expert do.

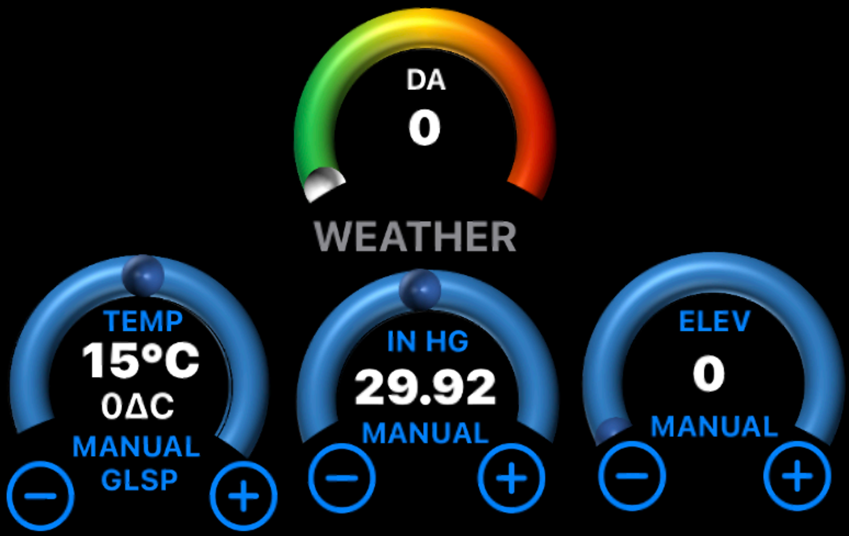


Figure 8 – Weather Gauges

Settings

Pressing the MENU button will bring up the menu settings window. In TLAR-basic, this window will allow you to access sub-windows for aircraft settings, a built-in guide, or manage/upgrade your subscription to TLAR-pro/expert. If the MENU button is hit again, this menu window will go away and you will return to the compass rose.

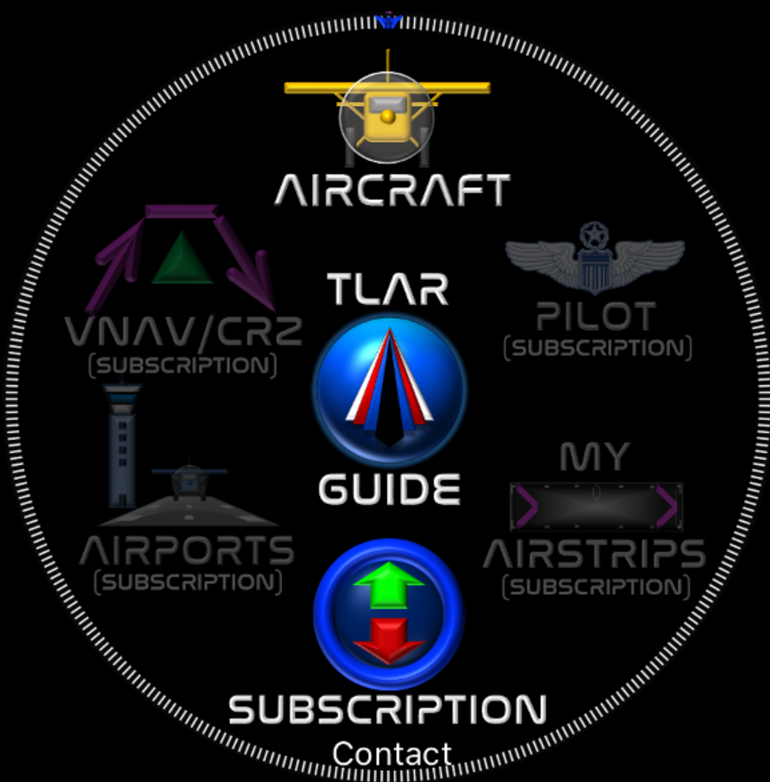


Figure 9 – TLAR-basic Settings

AIRCRAFT. The aircraft button will take you to the AIRCRAFT settings window.

TLAR-GUIDE. This button will fill the entire screen with a pilot guide. Pinch and zoom in to read the fine print as required.

SUBRIPTION. This button will take you to the SUBSCRIPTION page.

Contact. This button displays Owyhee Aviation, LLC. Contact, privacy policy, and licensing information.

AIRCRAFT.

Use this window to select your plane type and adjust the power-push time, aircraft drag, rated horsepower, zero fuel weight, fuel load, and fuel burn rate. Of note, TLAR pre-loads the scroll wheel to display the currently active aircraft type. The "ACTIVATE" button will not appear until the scroll wheel moves to a different aircraft type. When it does appear, the drag entry line will disappear to make room. Hit the "activate" button to selecta new aircraft type.

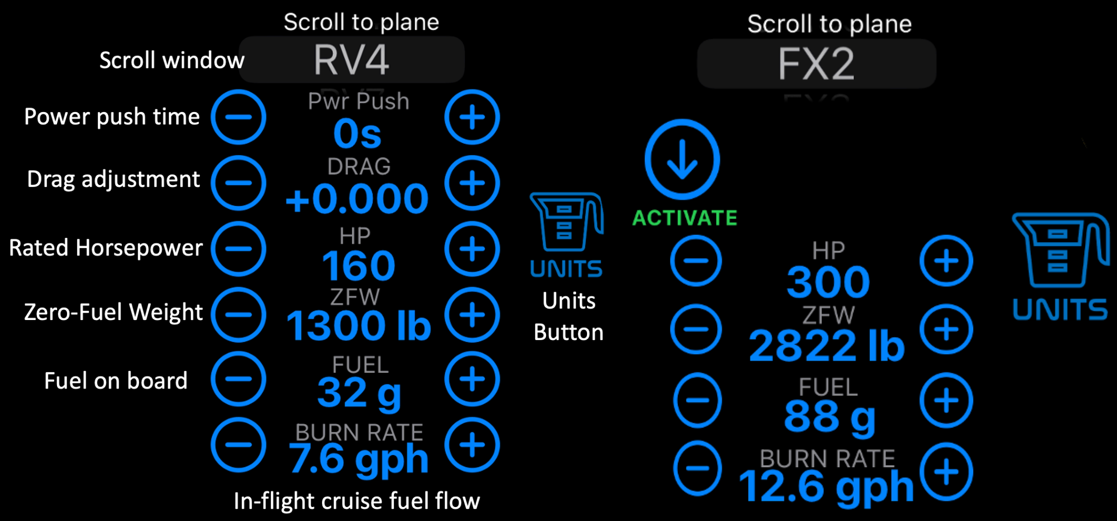


Figure 10 – Aircraft Settings

You can set the power-push time to replicate the time it takes to push the throttle from idle to max power on takeoff. Use zero seconds for a static max-power takeoff.

TLAR is tuned to match manufacturer stated and/or POH performance for each aircraft represented. However, there are a multitude of modifications available to the GA community that change an aircraft's drag such as larger tires, cargo pods, floats, skis, fairings, wheels pants etc. Use the drag adjustment parameter to add or subtract drag in 0.001 increments to match your aircraft's situation. TLAR adds this adjustment to the baseline coefficient of drag to obtain a new coefficient of drag. The easiest way to do "get it right" is to adjust the drag until TLAR's predicted cruise speed matches your plane's actual cruise speed. Be careful to set the same environmental conditions (elevation, temperature, pressure, power setting etc.) when matching speeds.

The maximum you can add to the baseline is +0.05 (which is a lot!). For reference, most aircraft in TLAR have a drag coefficient of around 0.02 to 0.03. The most you can subtract varies by aircraft type to ensure that no aircraft can end up with a negative overall drag coefficient (baseline drag minus the adjustment cannot be less than zero). If you select a new aircraft type, the drag increment will be zeroized, and the other parameters will be TLAR defaults for the new aircraft until re-adjusted by you.

TLAR will save these settings so they will be the same the next time you start the app.

TLAR applies a 95% installed-horsepower factor to most aircraft types to account for installation power losses (as opposed to the full rating of the motor which is generated on a test stand under ideal conditions). If you have reason to think that the motor as installed in your aircraft can generate its fully-rated engine horsepower, you can enter a new higher horsepower for your engine. We would recommend comparing TLAR’s predicted performance with your aircraft’s actual performance before making such an adjustment.

> Note – TLAR ignores the cruise burn rate parameter for the L39C aircraft. Its cruise fuel burn rate is computed based on the percent RPM set in VNAV/CRZ settings.

On the aircraft settings view, you can access the “UNITS” settings page by pressing the UNITs button.

UNITS.

Use the UNITS settings to adjust which units of measure you want to use. Each measure is a button than will toggle/cycle the units as follows:

Fuel:	gallons, liters, pounds, kilograms
Airspeed:	knots, miles/hr, kilometers/hr, or Mach
Runway length:	feet or meters
Aircraft weight:	pounds or kilograms
Wind speed:	knots or meters per second
Pressure:	inches mercury or millibars

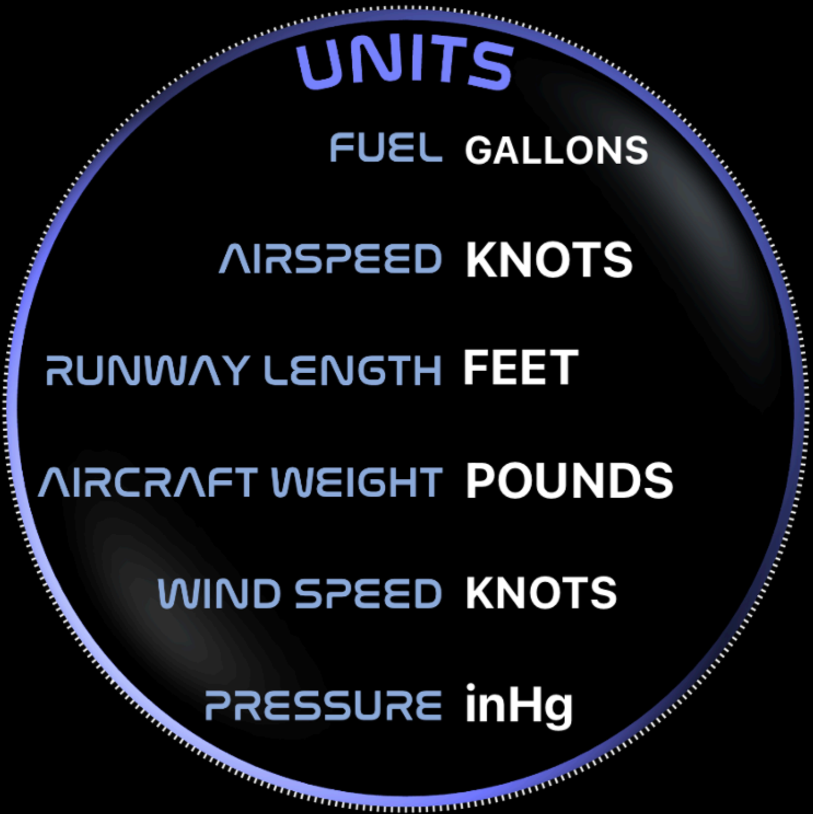


Figure 11 – Units View

Once you are finished, use the MENU button 

to back out of this menu.

SUBSCRIPTIONS.

TLAR has two upgraded tiers of capability. TLAR-pro is the mid-tier and TLAR-expert is the top-of-the-line premium version. From the screen below, you can learn a little about what TLAR-pro and TLAR-expert offer by hitting the “WHY BUY?” button. If you decide to buy, you can upgrade to TLAR-pro or TLAR-expert buy hitting the corresponding button. When pressed, you will get iOS prompts to log into your iCloud account and authorize the purchase. TLAR-pro and TLAR-expert are auto-renewing monthly subscriptions which can be cancelled at any time. If your TLAR subscription is active, yet TLAR is only in TLAR-basic mode, you can restore your already paid-for subscription using the “RESTORE PURCHASES” button. This situation could happen if you uninstalled TLAR and then re-installed it, perhaps after upgrading to a new iDevice. The cancel subscription button is greyed out in TLAR-basic because you do not have a subscription to cancel yet. However, as of this writing, Apple does not allow developers to provide a way for a user to cancel a subscription from within their app. Instead, cancellations are accomplished from inside iOS by accessing SETTINGS/[your name]/SUBSCRIPTIONS.

Figure 12 – Subscription Settings

WHY BUY? TLAR-pro is far more capable than TLAR-basic. It will improve your situational awareness and make you a more informed and safer pilot. You can gain a fuller understanding of what TLAR-pro and TLAR-expert can do by reading the rest of this manual instruction. Or you can just spend a couple bucks and find out for yourself, it's only a couple bucks, which must be about the cheapest thing you can spend money on in aviation! If you don't like it, or don't use it, cancel your subscription.

Figure 13 – TLAR-pro and TLAR-expert Summary

TLAR-expert is more powerful still. It has all the features of TLAR-pro and adds patent-pending emergency glide functionality and telemetry recording. On the ground, it will show you where and how high you will be when your aircraft will be capable of conducting an engine windmilling turnback to the runway on takeoff. In flight, it will show you your current wind-corrected glide footprint and announce on headset your latest abort point, when a turnback is possible and show you the route of flight back to the runway along with your predicted altitude when reaching the runway. This feature is designed for takeoff/early climb, but works just as well in cruise. For more, read the TLAR-expert section of this manual.

TLAR-pro

TLAR-Pro adds real-time three-dimensional analysis of your plane's aerodynamic performance and reacts automatically to changes in downloaded NOAA weather as well as to your aircraft's position, speed, altitude, and attitude all in reference to your selected or pilot-defined airstrip. TLAR-pro has two screen views: Performance and Big Sky. You control which view you see with the "Big Sky" toggle switch at the bottom center of the screen.

Figure 14 – Performance view (left) and Big Sky view (right)[1]

The performance view allows access to all TLAR's controls and settings (except traffic-pattern type), displays all weather information, and shows flap configuration, performance data on takeoff, climb, cruise, and landing. The Big Sky view controls the traffic-pattern types, declutters the screen, maximizes the

[1] These screenshots show a basic/pro switch and a flying switch. These switches are not available in the commercial version of TLAR. We use them for debugging.

map, and displays performance information for takeoff and landing in a graphical way.

The Performance screen interface of TLAR-pro builds upon that of TLAR-basic and will be explained first. Following that, this manual will cover the “Big Sky” view and it’s interface.

Buttons

In addition to those available in TLAR-basic, TLAR-pro adds 15 new buttons (9 thru 24).

(9) Map 

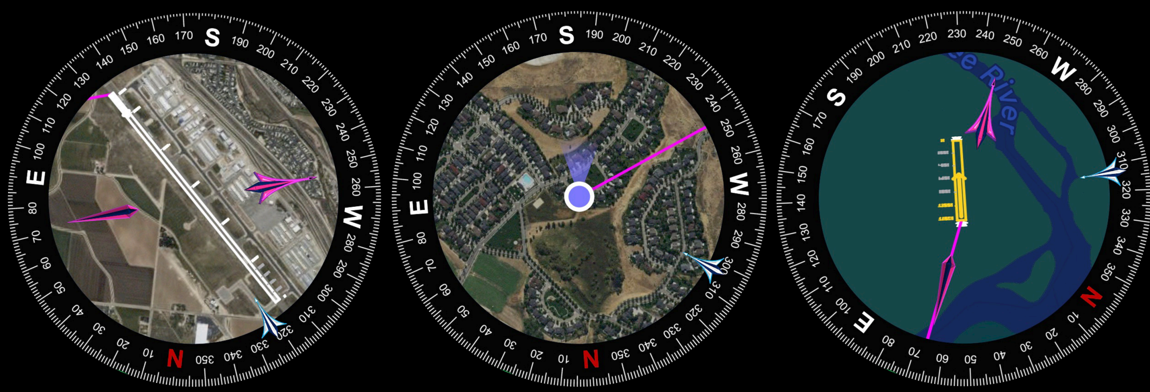
button – this button cycles the map displayed inside the compass rose[2]:

– compass with graphics

---

[2] Note – Cycling of the map is programmatically limited to once per second. We found that rapid cycling crashed the app.

- satellite imagery centered on your position
- satellite imagery centered on the active landing zone
- satellite imagery centered on the mark point (if active)
- map centered on your position
- map centered on active landing zone
- map centered on the mark point (if active)



(10) Normal 

STOL 

approach button – Toggles approach mode from normal to STOL and back.

(11) Partial 

Max 

brakes button – Toggles back and forth between using partial brakes and maximum braking during landing.

(12) MARK 

button – stores the present position as a mark point. A green bearing pointer appears pointing to the mark point along with the mark point's distance, elevation, latitude, and longitude. TLAR-pro uses the USGS elevation point server to determine the mark point's elevation. This only works for points in the USA and requires a network connection. If either of these conditions is not met, TLAR will default the point's elevation to -888 feet. If a mark point has already been stored, the MARK button simply toggles the display of mark point information on and off. Use the RESET button (13) to erase the current mark point, rearming the MARK button to set a new mark point.

(13) RESET 

button. The RESET button erases the current mark point and re-arms the MARK button to be able to store a new mark point.

Note – TLAR also resets the mark-point on app shutdown.

(14) CRUISE profile button – This button cycles the cruise profiles. The profiles are maximum speed (MAX), selected power cruise (CRZ), maximum range (RNG), and maximum endurance (EDR) each computed for conditions with flaps up. You can set the desired cruise % power on the VNAV/CRZ page described later.

(15) WIND AUTO/MAN button – The WIND button toggles the wind between automatic and manual modes. In the AUTO position, TLAR colors wind-related information INDIGO and uses the wind as reported by the nearest METAR weather reporting station to either your current position if the elevation source is the aircraft, or to the active landing zone if the elevation source is set to TDZE.

In the MAN position, TLAR colors wind-related information BLUE and headwind/tailwind increment/decrement buttons (–)(+) appear to allow you to manually adjust the headwind component for takeoff and landing performance calculations. The plus sign + indicates a headwind, a minus – sign indicates a tailwind.

CAUTION – in both automatic and manual modes, TLAR limits the maximum headwind component to the lessor of 35 knots or stall KCAS minus 5 knots. TLAR will color wind-related information YELLOW and *display* the winds as reported, but *use* the speed-limited components for performance calculations. This is to prevent performance calculations in conditions that might allow a near, vertical, or even backward takeoff/landing.

CAUTION – TLAR will color wind information YELLOW if the tailwind component exceeds 10 knots , but is <= 20 knots

DANGER – TLAR will color wind information RED if the windspeed exceeds 50 knots or if the tailwind component exceeds 20 knots and will invalidate takeoff and landing performance calculations displaying "WIND" on the takeoff and landing gauges.

Note – TLAR uses the wind gust speed as the wind speed for tailwinds, and ignores the gust speed for headwinds. For instance, if the winds are reported 15 gust 25 and you choose the runway where the wind is a tailwind, TLAR will use 25 knots as the wind speed. Conversely, on a runway where these winds are a headwind, TLAR would use 15.

(16) Download/update the weather button – Forces TLAR to update the weather using the NOAA aviation weather server. It displays flight category, distance in nautical miles from the selected elevation source (aircraft or landing zone) to the weather reporting station, the time in minutes since the weather was last downloaded, and the Zulu time of the actual observation.

Note – If a network is available TLAR downloads all global METARs on app start-up and then every 10 minutes thereafter. TLAR selects the nearest METAR to the loaded LZ or aircraft (if using GSL or manual elevation). If the aircraft is the elevation source, TLAR selects nearest METAR station every 60 seconds.

(17) WET/DRY 

runway button – Toggles back and forth between using dry or wet runway conditions to compute rolling and braking frictions.

(18) LZ 

button – cycles the active landing zone between none, LZ-A, and LZ-B. You can load your departure airport in the "A" slot and the arrival airport in the "B" slot. If none, TLAR sets the reference elevation to the aircraft, updates the weather, and removes all functionality regarding the runway.

Note – With LZ information off, TLAR uses the aircraft's heading/track as the runway heading for purposes of calculating headwind/tailwind components.

(19) Flip Rwy 

button. The flip runway button will change the active runway to it's 180-degree opposite runway and recompute the displayed performance data.

(20) Temperature source button – This button toggles between setting the temperature manually, or automatically via the net.

In automatic mode, TLAR will use the METAR surface temperature from the nearest weather station to either the aircraft or LZ (depending on which is selected as the elevation source), adjusted for differences in altitude between the weather station and either the aircraft or the LZ.

In manual, the pilot can adjust the delta-from-standard-temperature up and down one degree at a time using the associated decrement and increment buttons which become visible when in manual mode. TLAR will apply this delta-temperature to either the aircraft or the LZ depending on which is the elevation source.

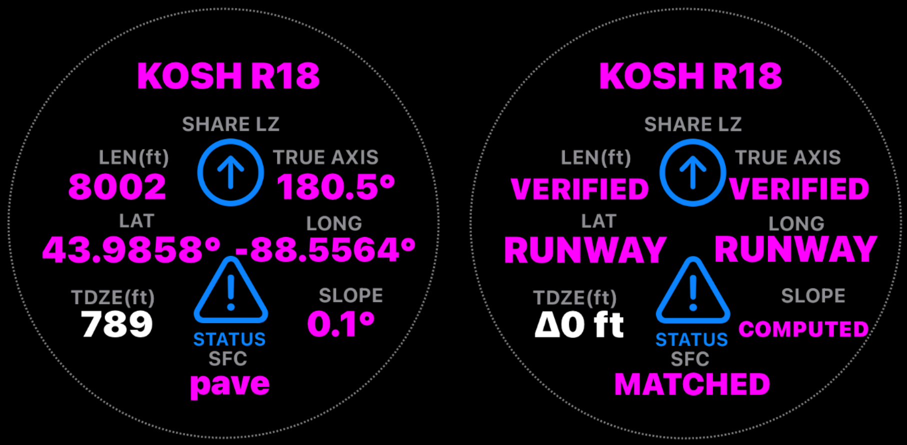
(21) Pressure source button – This button will cycle the altimeter setting source from using your iDevice’s internal barometer (“iBaro” displayed), to using the METAR altimeter setting from the nearest weather station (ICAO of station displayed), or to manually-entered. (“MANUAL” displayed)

(22) Elevation source button – This button switches the reference altitude for performance calculations from the landing zone approach end elevation, to the aircraft’s current GSL (GPS-derived altitude), or to manual settings. In manual, increment/decrement buttons appear to allow the pilot to adjust the elevation in 500-foot increments. TLAR attempts to find the closest weather reporting station to the selected elevation source (landing zone or aircraft) for automatic weather updates to temperature, dewpoint, altimeter setting, and winds.

(23) Big Sky switch – Use this switch to enable/disable the “Big Sky” interface (see “Big Sky” section of this manual) which is a full-screen moving map that displays takeoff and landing information graphically.

(7) Data button DATA – TLAR-pro adds two more data screens accessed using the data button. The DEBREIF view and the LZ Data view. Each is only available if you have selected the USE LZ Data (magenta bearing pointer visible).

The LZ data view displays information about the active LZ. The status button will reveal the status of each parameter.



The DEBRIEF view and it’s use is more complex and is described in the features section at the end of this guide.

(24) Accelerate-Stop button – Use this button to enable/disable accelerate-stop runway calculations for takeoff

Settings

Pressing the MENU button from the HIS view will bring up the Main Settings Menu.

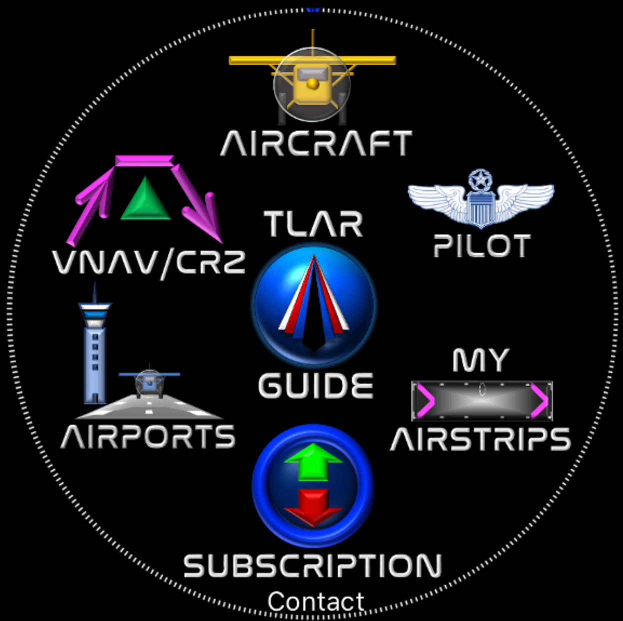


Figure 15 – TLAR-pro Main Settings Menu

AIRCRAFT.

The aircraft settings menu works the same in TLAR-pro as it does in TLAR-basic, but adds a new button at left called "SITREP," a US military term meaning "Situation Report."

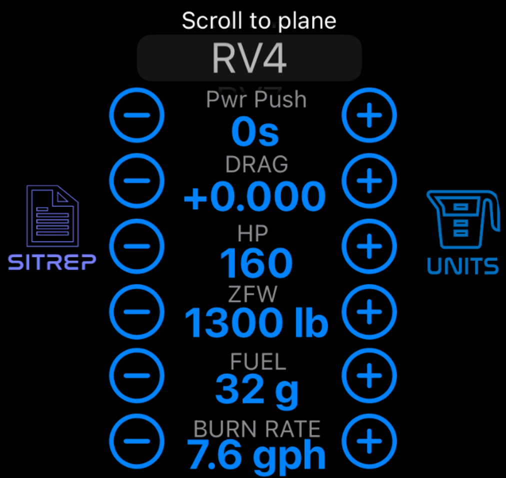


Figure 16 – TLAR-Pro Aircraft Settings

The SITREP button will bring up iOS’s standard sharing pop-up window which allows you to select a method (airdrop, text message, email etc.) to share a TLAR-preloaded Situation Report with someone.

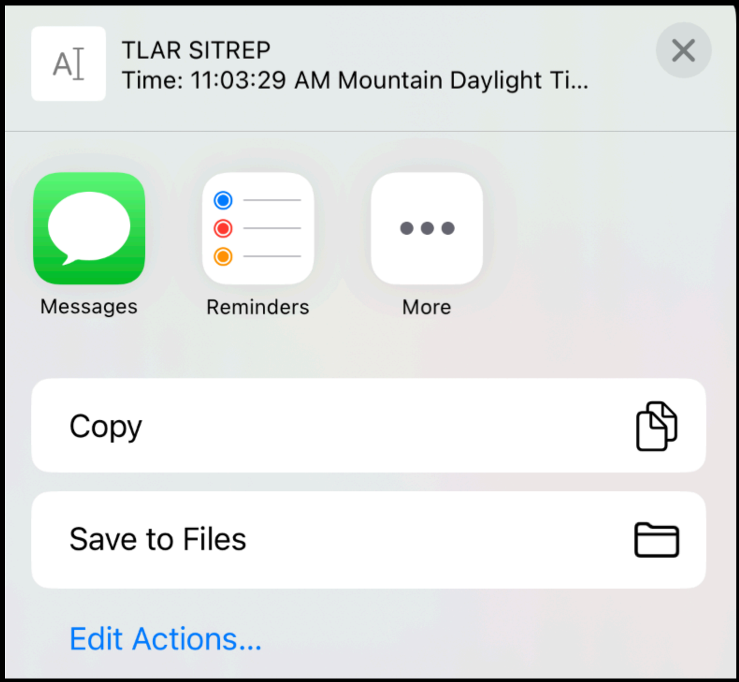
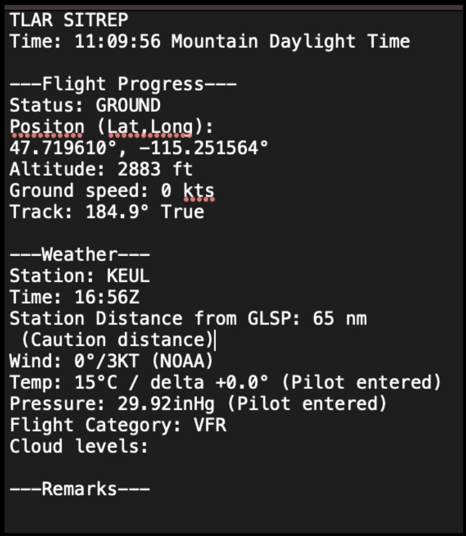


Figure 17 – iOS Sharing Pop-up

There are two formats for TLAR’s auto generated SITREPs based on whether you have an active LZ loaded and in use. This is an example of a TLAR SITREP sent without an active LZ:



TLAR SITREP
Time: 11:09:56 Mountain Daylight Time

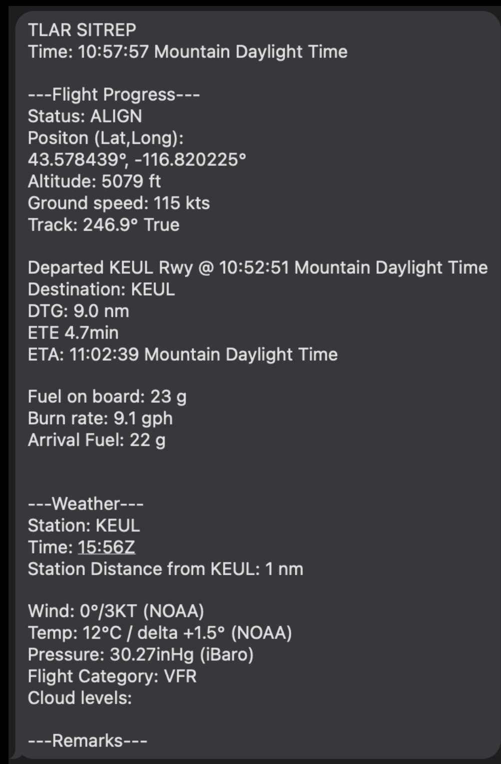
---Flight Progress---
Status: GROUND
Positon (Lat,Long):
47.719610°, -115.251564°
Altitude: 2883 ft
Ground speed: 0 kts
Track: 184.9° True

---Weather---
Station: KEUL
Time: 16:56Z
Station Distance from GLSP: 65 nm
(Caution distance)
Wind: 0°/3KT (NOAA)
Temp: 15°C / delta +0.0° (Pilot entered)
Pressure: 29.92inHg (Pilot entered)
Flight Category: VFR
Cloud levels:

---Remarks---

Figure 18 – TLAR SITREP without an active LZ

This is an example of a TLAR SITREP sent with an active LZ:


TLAR SITREP
Time: 10:57:57 Mountain Daylight Time

---Flight Progress---
Status: ALIGN
Positon (Lat,Long):
43.578439°, -116.820225°
Altitude: 5079 ft
Ground speed: 115 kts
Track: 246.9° True

Departed KEUL Rwy @ 10:52:51 Mountain Daylight Time
Destination: KEUL
DTG: 9.0 nm
ETE 4.7min
ETA: 11:02:39 Mountain Daylight Time

Fuel on board: 23 g
Burn rate: 9.1 gph
Arrival Fuel: 22 g

---Weather---
Station: KEUL
Time: 15:56Z
Station Distance from KEUL: 1 nm

Wind: 0°/3KT (NOAA)
Temp: 12°C / delta +1.5° (NOAA)
Pressure: 30.27inHg (iBaro)
Flight Category: VFR
Cloud levels:

---Remarks---

Figure 19 – TLAR SITREP sent with an active LZ

Notice departure/arrival as well as ETE, ETA, and fuel status added to the SITREP.

PILOT.

The Pilot settings menu allows you to configure several landing-related safety parameters by toggling their values up (+) or down (-). See LANDING geometry section below to better understand how each affects computed performance data.

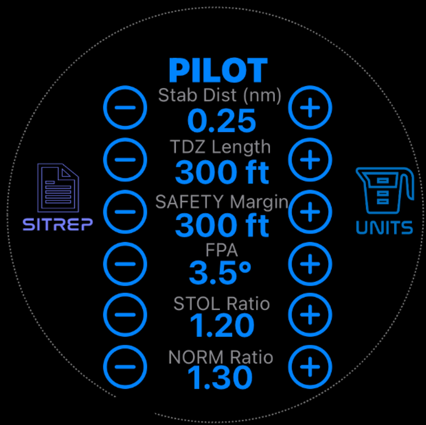


Figure 20 – Pilot Settings

Stab Dist. This sets the stabilization distance in 0.05 Nautical Mile increments. The valid range is zero to 2.00 NM. Behind the scenes, the Stab Dist also changes the rollout distance which is always equal to twice the stabilization distance. See Stabilized Approach Monitoring System and Figure 39 – Downwind Criteria

TDZ Length. This parameter is the distance TLAR uses for landing performance computations to account for round-out, flare, touchdown, and to begin braking. The shorter you set the TDZ length, the more accurate your spot landing will need to be to validate TLAR's computed landing performance. Student pilots may want to use 1000 feet for this parameter, whereas experienced STOL pilots may want to dial this down to 50 or even 0 feet. The toggles change the value from 0 to 2000 in 50-foot increments.

SAFETY Margin. This is the runway length safety margin. TLAR will caution the pilot whenever the predicted stopping point on landing is within the SAFETY margin distance of the end of the runway (exception if accel-stop selected, see below). Similarly on takeoff, TLAR will caution the pilot anytime the predicted lift-off point is within the SAFETY margin distance of where the plane MUST be airborne to clear the specified fence height by the end of the runway. Seemingly small changes in wind-speed, gross weight, and temperature (to name a few) can have significant impacts on actual take-off/landing performance. Use this parameter to mitigate these unknows by setting it wisely. The toggles change the value from zero to 1000 feet in 50-foot increments.

Acceleration-Stop distance. If selected, TLAR will caution the pilot if the available runway length for takeoff is less than the accel-stop distance.

FPA. This is the target flight-path angle on approach and landing. TLAR uses this angle to display VAPI information, determine the fence shadow length on landing, and to assess approach stability at the stabilization point on approach. The toggles change this value from 2.0º to 20.0º in 0.1º increments.

> CAUTION – Most GA aircraft cannot achieve a glidepath steeper than about 6 to 8 degrees without slipping. While slipping the aircraft is a somewhat common maneuver in some GA aircraft, it should be acknowledged that slipping an approach to get down is a last-ditch method to fix a bad approach and can place the aircraft in an unsafe situation.
>
> Note – Setting this parameter to a low value (2-3 degrees) will result in long computed landing over a fence height and nuisance unstable calls. We recommend using moderate values of 3.5-7 degrees for this parameter. As always, you are the PIC and can use wherever you desire.

STOL Ratio. This is the multiplier of power-off stall speed (for the selected flap setting and gross weight) to determine approach speed (Vref) for a Short Take-Off Landing approach. Lower ratios result in slower approach speeds on final and slower touchdown speeds which reduces landing distance. Unfortunately, lower ratios also reduce your stall-margin and can be dangerous. The toggles change this value from 1.0 to 2.0 in 0.01 increments. TLAR will not allow you to set the STOL Ratio *higher* than the NORM ratio setting.

NORM Ratio. This is the multiplier of power-off stall speed (for the selected flap setting and gross weight) to determine approach speed (Vref) for a Normal Landing approach. Higher ratios increase approach speeds. If they are too high, the aircraft will be too fast and will likely float down the runway. The toggles change this value from 1.0 to 2.0 in 0.01 increments. TLAR will not allow you to set the NORM Ratio *lower* than the STOL ratio setting.

WARNING – flight at, near, or below computed power-off stall speed is inherently dangerous.

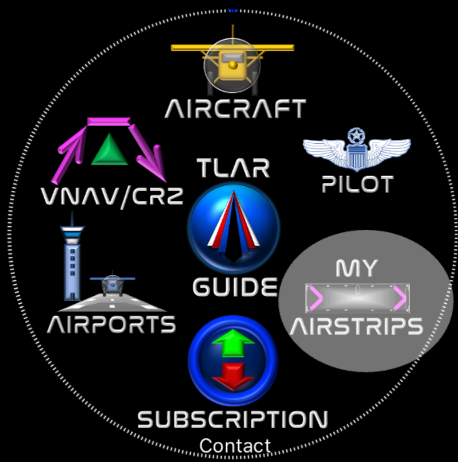
CAUTION – approaches flown at high ratios of stall speed should be avoided as they result in long landings that could cause the aircraft stop beyond the end of the runway.

NOTE – In general, the FAA recommends pilots fly 1.3 times power-off stall speed for normal approaches as a good balance between slowing down to land yet retaining a margin above stall. Many certified and experimental aircraft have approach speeds listed in their pilot operations handbooks that vary from this generalized guidance. See the appendix for specific values TLAR uses for your aircraft.

NOTE – TLAR ships with a default STOL approach ratio of 1.2 for all aircraft types. TLAR ships with a normal approach ratio that matches the approach speed as listed in the applicable Pilot Operating Handbook (POH). This ratio will result in a ground roll that closely matches those listed in the POH (see appendix). If you change this ratio, landing distances will also change and TLAR's landing distances will not match the applicable POH.

NOTE – On start-up, TLAR resets the normal approach ratio to the POH-value for certificated aircraft. For experimental aircraft, TLAR starts with the stored value from the last time you used the app.

MY AIRSTRIPS.



TLAR-pro allows you to create your own landing zones and save them for immediate or future use.

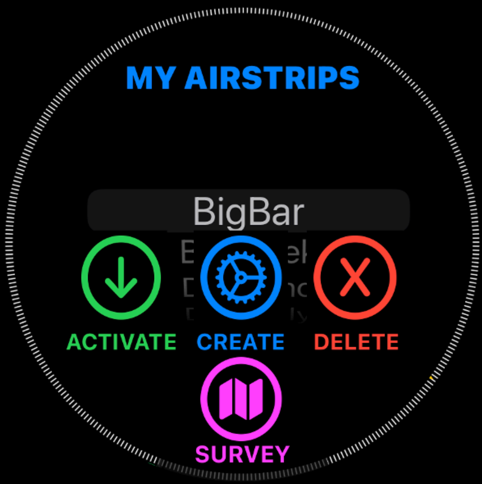
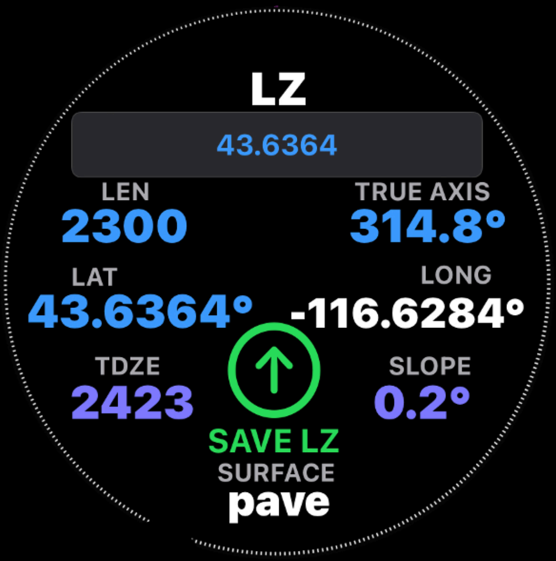


Figure 21 – My Airstrips Settings

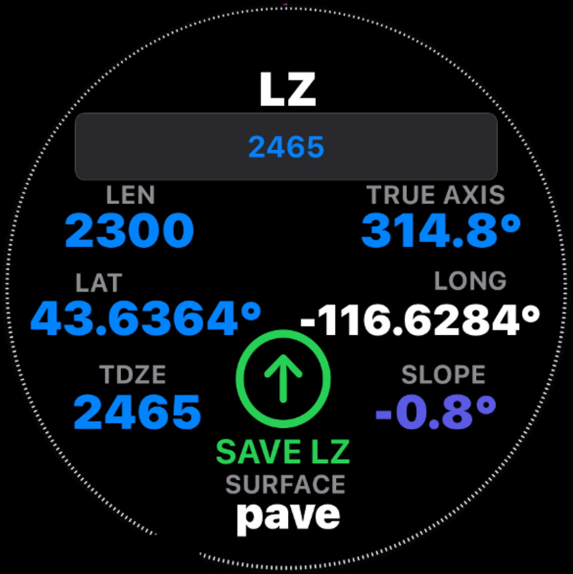
One way to create your own airstrip is to hit the “CREATE LZ” button. You should see a new window that looks like this:

Tap on one of the parameters and it’s title will appear in the data entry window as well as a keyboard. The example below shows what you would see after tapping the “TRUE AXIS” parameter:

You can then use the keyboard to enter a value for the TRUE AXIS of the new LZ. As parameters are entered, TLAR color’s their values in BLUE (recall, blue is from you):

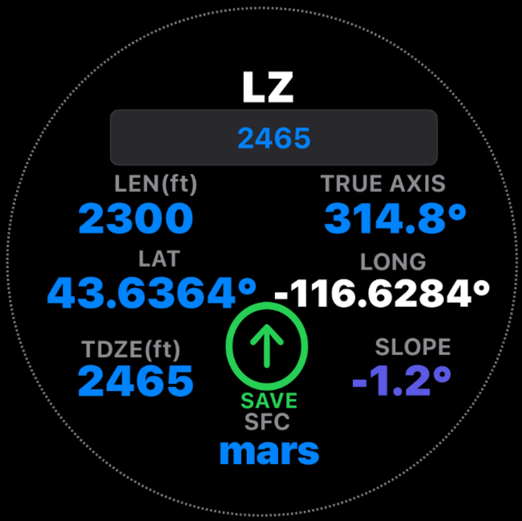


As you enter data, TLAR will query the USGS point-elevation server (if a network is available) to obtain the approach and departure end point elevations and then update the Touchdown Zone Elevation (TDZE) and SLOPE parameters. If successful, TLAR will color those parameters INDIGO indicating that they are from or derived from an Internet source. You can override these values if you want by tapping them to re-enter a new value. If you do, it's value will turn BLUE. In the example below, we have overridden the TDZE value with a new value of 2465. TLAR then computed a new slope (-0.8°) using the new TDZE and the (unseen) departure-end elevation which it had previously obtained from the USGS server:

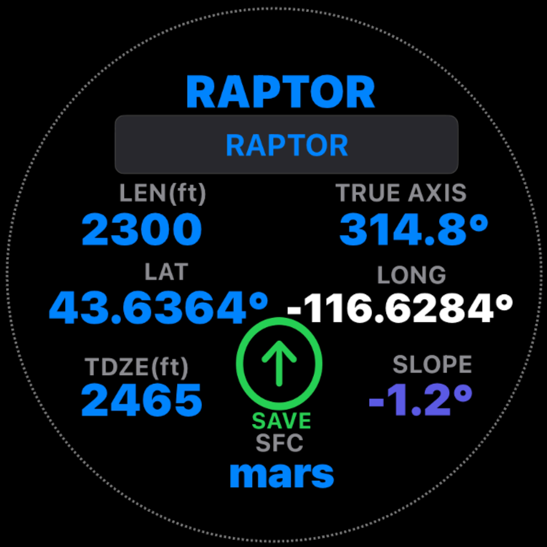


If the slope is manually entered, TLAR will compute a new departure-end elevation (not displayed) using the TDZE, runway length, slope, and of course some trigonometry. After the new LZ is activated and in use, you can find out the departure-end elevation by flipping the runway. The resulting TDZE will show the elevation of what used to be the departure-end of the runway (before you flipped runways).

Tapping the SURFACE parameter will cycle the surface type from PAVE to GRASS to GRAVEL to SAND to LAKEBED to SNOW to MARS and then back to PAVE. The "MARS" name is a bit of humor of course, its friction values are designed to most closely represent the runway surfaces of many of the back country airstrips in Southern Utah such as Happy Canyon or Hidden Splendor.

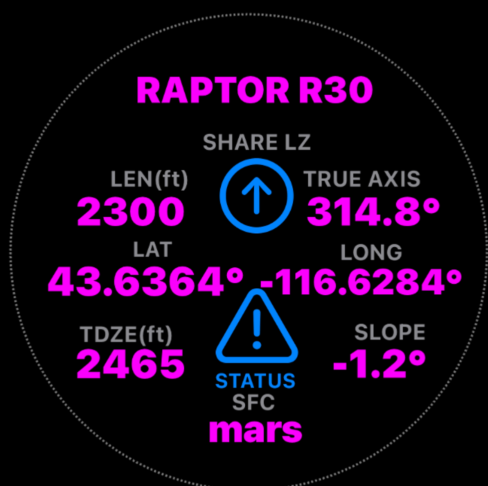


Once you are happy with the entered parameters, give your new LZ a name by tapping the "LZ" button. A keyboard will appear, and you can type name in:



Finally, don’t forget to SAVE your new LZ by tapping the SAVE LZ button. TLAR will save the LZ on your iDevice, and the screen will return to the “MY AIRSTRIPS” view. You can then roll the scroll wheel down to your new LZ …

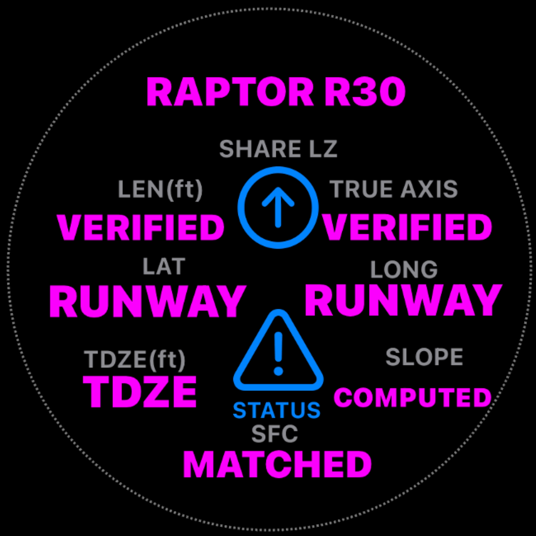
… and activate it by hitting the “ACTIVATE” button resulting in the following view:



TLAR loads this in LZ slot A if “A” or no LZ (--) is selected on the LZ button 

. If “B” is selected, TLAR loads the “B” slot. All parameters are now MAGENTA because this is now the active LZ. Notice also that TLAR has given the runway a name (R30 in this example). TLAR names your runway using its axis in *degrees* ***magnetic north*** using NOAA’s 2020 World Magnetic Model.

You can toggle the “STATUS” button to see the status of each parameter as desired:



Also note, you can share your LZ by hitting the “SHARE LZ” button. IOS’s share pop-up window will appear allowing you to send your LZ via text message, email, airdrop etc.

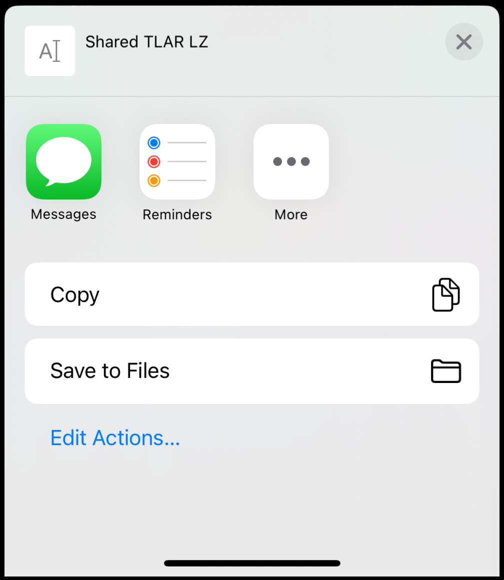
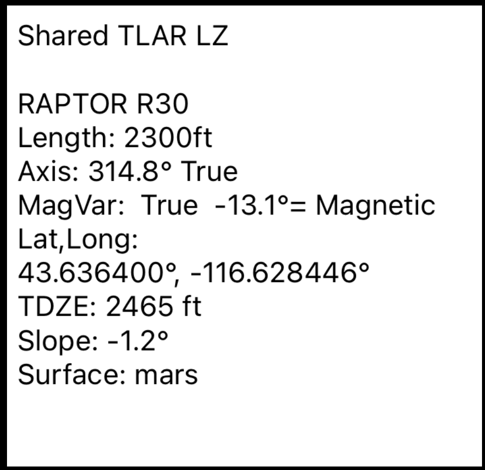


Figure 22 – Share LZ Pop-up


Shared TLAR LZ

RAPTOR R30
Length: 2300ft
Axis: 314.8° True
MagVar: True -13.1°= Magnetic
Lat,Long:
43.636400°, -116.628446°
TDZE: 2465 ft
Slope: -1.2°
Surface: mars

Figure 23 – TLAR Shared LZ Data

Hit the “MENU” button to return to the main settings view. From there you can select other settings menus, or hit the “MENU” button again to return to the HIS view. For now, we will navigate back to the MY AIRSTRIPs settings to illustrate how to DELETE a saved LZ.

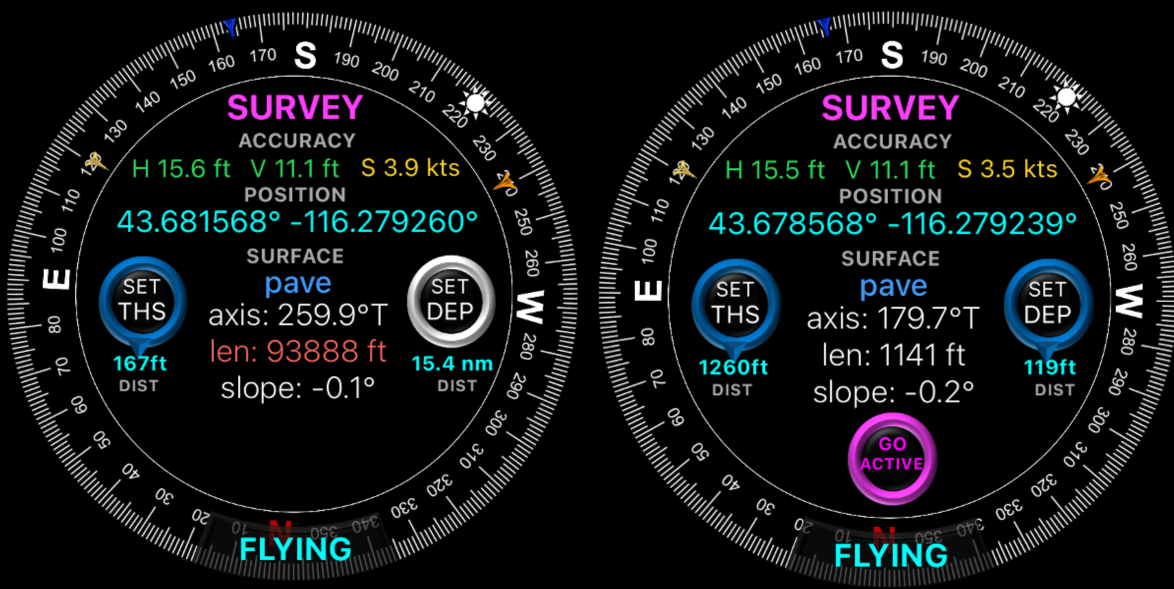
After navigating back to the “MY AIRSTRIPS” settings view, scroll the wheel to the LZ you wish to delete and then press the DELETE LZ button. The LZ will disappear from the scroll wheel and is erased from your iDevice:

You can also survey your own landing zone using your iDevice’s satellite-based navigation by pressing the “SURVEY” button (location services must be available to TLAR to survey an LZ).

The top of the survey view displays iOS’s assessment of it’s location and speed accuracies. The horizontal accuracy value is the “radius of uncertainty” as to your actual position. Similarly, the vertical and speed accuracies display iOS’s uncertainly around your current altitude and speed. Negative values indicate an invalid position or speed, typically because you are not receiving satellite, cellular, or Wi-Fi position information. TLAR color codes these accuracies according to the table below.

	Accuracy color codes		
	Horizontal	Vertical	Speed
Green	<= 50 ft	<= 20 ft	<= 2 kgs
Yellow	> 50 ft	> 20 ft	> 2 kgs
Red	Invalid	Invalid	Invalid

If the horizontal and vertical accuracies are valid, WHITE-colored set threshold (“SET THS”) and set departure end (“SET DEP”) buttons will be visible. When pressed, these buttons turn BLUE and TLAR will set the survey landing zone’s threshold/departure end to your current position and elevation. In-flight, the stored elevation is your current elevation minus 50 feet.



TLAR then calculates the survey landing zone’s axis, length, and slope from the position/elevation of each end of the runway. The distance to the set point is shown below each SET button, and a pointer appears on the SET button’s ring that points to the corresponding THS or DEP. If you are unhappy with the set location, pressing the button again will reset the point to your current location. You can set threshold and departure points in any order and as many times as you want.

Tapping the surface button will toggle the surface types (pave, grass, gravel, sand, lakebed, snow, mars).

If the computed LZ is valid (length > 0 and length < 2 NM and the absolute value of the slope < 10º), a third button will appear:

If you are stationary, a green “CREATE” button appears. Pressing this button takes you to the CREATE LZ view with the surveyed LZ’s data pre-loaded into all the data entry fields. Use this view to then give the LZ a name, correct any information as desired, and then save the LZ as described above in the CREATE LZ section.

If you are moving, a magenta “GO ACTIVE” button appears. Pressing this button does several things:

- The surveyed LZ becomes the active LZ named “SURVEY”
- TLAR loads this in LZ slot A if “A” or no LZ (--) is selected on the LZ button 

. If “B” is selected, TLAR loads the “B” slot.
- The elevation source is set to TDZE
- The surveyed LZ is saved to your MY AIRSTRIPS under the name “SURVEY”
- The surveyed LZ is pre-loaded in the CREATE LZ view.
- The map reverts to graphical mode

NOTE – TLAR uses the same filename for all surveyed LZs which means if you subsequently survey a new LZ, the new surveyed LZ will replace the old one. To permanently save a surveyed LZ, go to the CREATE LZ view, give the LZ a name, and then save it.

NOTE – iOS’s typical vertical accuracy of 10-30 feet can cause erroneous slope calculations for surveyed LZs, particularly on short airstrips. If this happens, you can override the surveyed slope value using the CREATE LZ view after surveying an LZ.

AIRPORTS.

TLAR-pro comes with an embedded global airfield database. TLAR's airport database is a modified version of an open-source public website (https://ourairports.com/data/). It's terms of service state, "All data is released to the Public Domain, and comes with no guarantee of accuracy or fitness for use." It is useful, but has errors, so use it at your own risk. While Owyhee Aviation will continue to correct errors we find in it, we make no claims about its suitability or accuracy. We recommend that you verify any airport loaded from this database using standard aeronautical sources or, as a minimum, zooming in on satellite imagery of the airport in question using the MAP button to cross check where TLAR plotted the airport against the imagery. Alternatively, you can use an imagery product like Apple Maps, Bing Maps, Google Maps, Google Earth, etc.

Pressing the "AIRPORTS" button from the main settings menu will take you to this view:

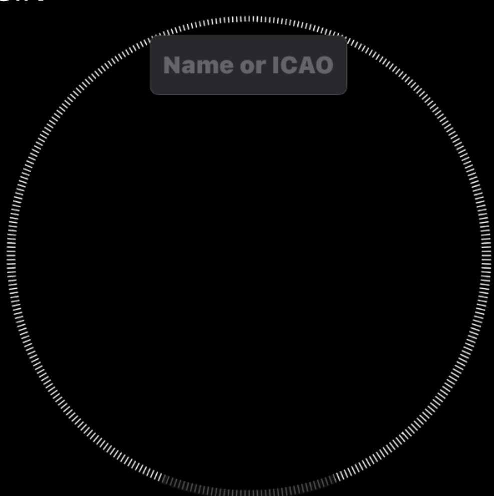
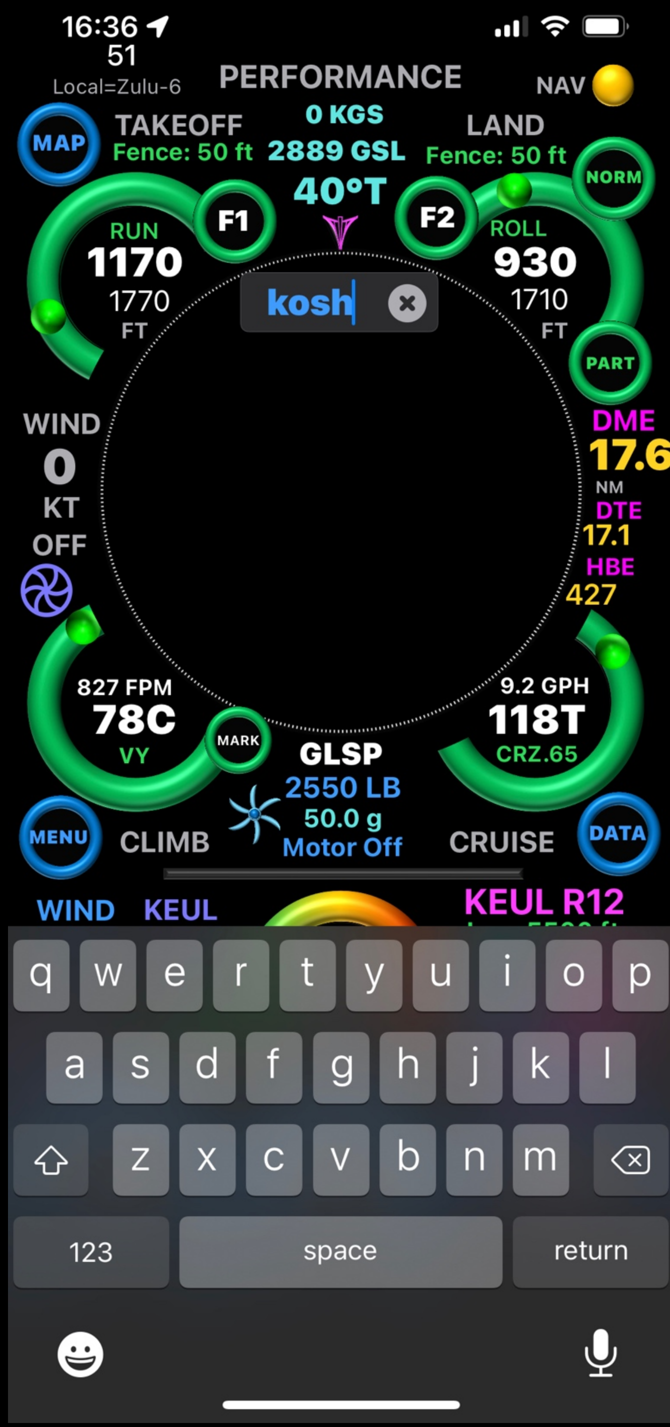


Figure 24 – Airport Search Window

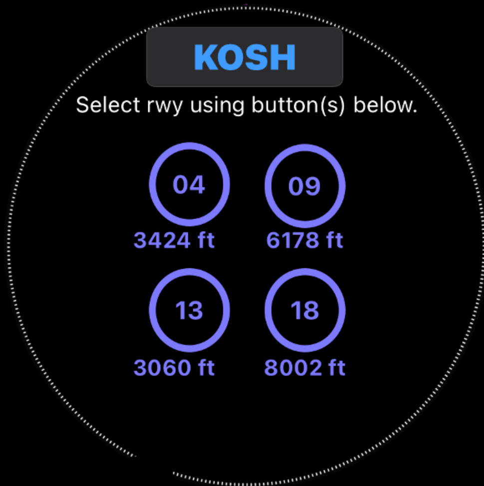
As of this writing, there are 73,000+ airports and 43,000+ runways contained in the database. We'll start with how to search, load, and activate a runway. Then, we'll cover some of the errors or what-ifs that can happen.

Begin a search by tapping on the text-entry window. A cursor should appear in the text-window and a keyboard should pop up. You can use the keyboard to enter an ICAO (i.e. KOSH) or a search name (i.e. Chicago). We'll cover ICAO entries first, then searching using a name.



Search by ICAO

In this example, we entered KOSH and then hit return. TLAR then displays runways associated with your ICAO search from the database (if there are no runways for your search ICAO in the database, “No runway found” will appear):

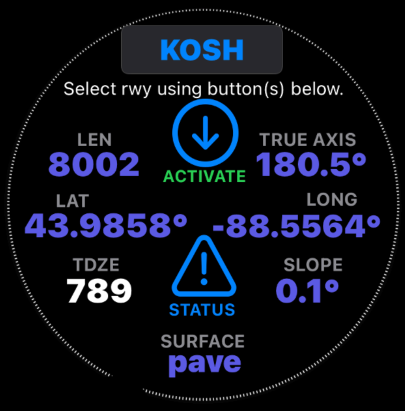


Each of those runways will appear as INDIGO circle buttons with the runway name inside, and length of runway displayed below each. In our example, we have searched for Wittman Regional Airport (KOSH). The database has four runways for KOSH.

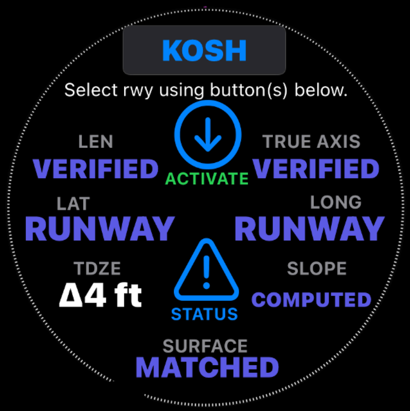
> Note – If you desire to use the opposite runway from what is displayed (e.g. R36 at KOSH), first load and activate R18 and then flip runways using the Flip Rwy button. 

So, let’s try that. Select R18 but tapping the 

button. This should result in a view like this:



You can check the status of the values by tapping the STATUS button, which will then show:



TLAR does several checks behind the scenes to fix errors.

- VERIFIED means that distance from approach to departure end based on their lat-longs is within 100 feet of the runway length as stored in the database

- Compares database TDZE with the USGS elevation for the same point and reports the difference (Δ) in feet between the two (4 feet in this example)

- If the database did not contain a TDZE, but TLAR was able to get one from the USGS server, the TDZE status will read USGS.

- MATCHED means the database-listed surface matches one of the seven surface types within TLAR, if a match cannot be made TLAR will default to GRASS.

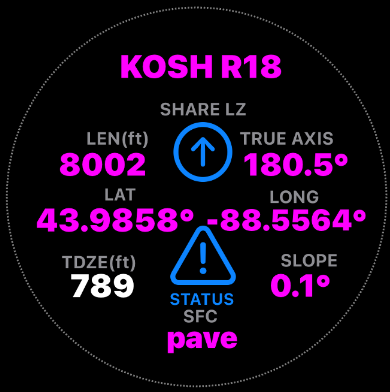
- Reports whether the approach-end lat-long is an actual RUNWAY coordinate according to the database, or if it is an aerodrome center-point instead

  Note – When this happens, TLAR will report "Coordinates Not Precise" and disable the Course Deviation Indicator, Glideslope Deviation Indicator, and smart Visual Approach Indicator

- Reports whether the axis is VERIFIED meaning it was listed in the database and passed a check comparing the bearing from the approach end to the departure end point via their lat-longs to the database-listed value, or "ESTIMATED" using the runway name (e.g. R30 = 300.0 +/- magnetic variation)

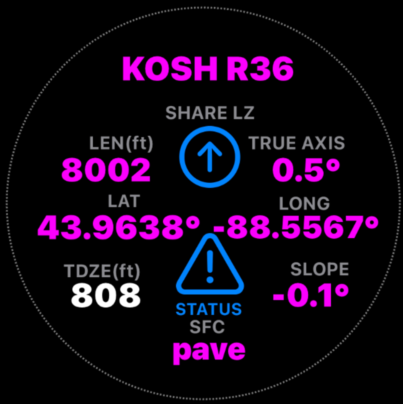
- COMPUTED means TLAR calculated the slope using approach/departure end elevations and runway length. If not, TLAR defaults to zero slope

If you are happy with what you see, tap the "ACTIVATE" button and TLAR will activate the selected runway and display this:



TLAR loads this in LZ slot A if "A" or no LZ (--) is selected on the LZ button 

. If "B" is selected, TLAR loads the "B" slot. All parameters are now MAGENTA because KOSH R18 is now the active LZ. As previously mentioned, if you really wanted to activate the North Runway, hit the "Flip Rwy" button and the runway flips revealing:



Tapping the "MENU" button will return to the main settings menu. From there you can select another setting menu or tap the "MENU" button again will return you to the HIS view. From there, it's good practice to tap the "MAP" button to view the newly loaded runway using satellite imagery to visually verify it:

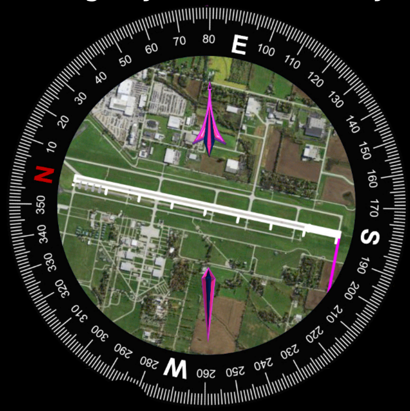
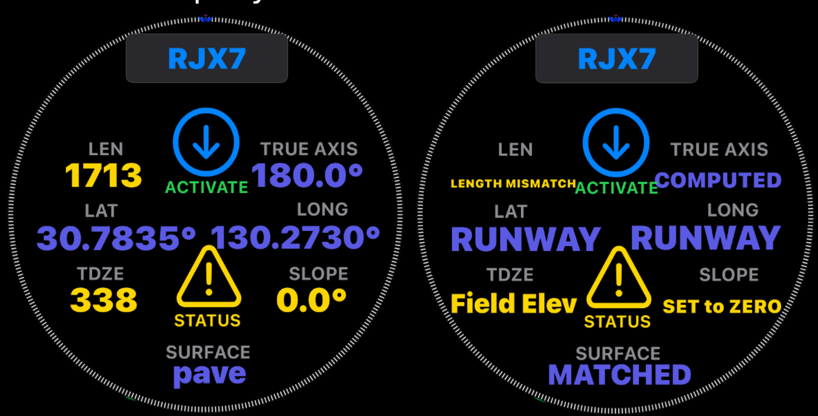


Figure 25 – Imagery verification of KOSH Rwy 36

Note magenta line to approach end and rwy orientation wrt compass

Database Flags and Errors.

Let's investigate some of the flags you may see loading runways from the database starting with Satsuma Iōjima Airport (RJX7) in Japan as an example. After searching for "RJX7" and selecting its runway, TLAR will display:



TLAR lists the LEN status as "LENGTH MISMATCH" because the runway's listed length is different from the distance measured between the approach and departure end lat-long pair by more than 100 feet. Usually this is because of a displaced threshold (which is true the case of RJX7).

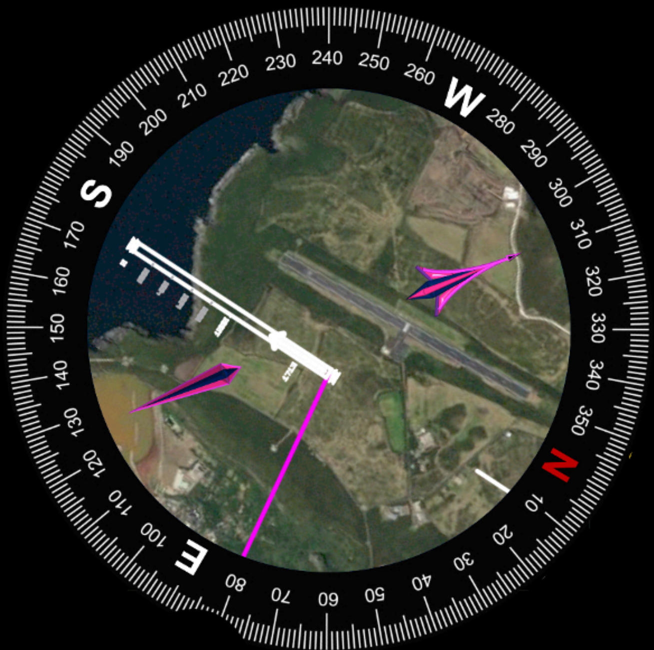
The TDZE's status is "Field Elev" because TLAR substituted the field elevation for the missing TDZE. The database does not have an elevation for the RJX7 runway, but it does have a field elevation for the airport. Normally, TLAR would then attempt to fill in the missing TDZE using the USGS elevation point server.

However, RJX7 is outside the USA, and the USGS server will not return an elevation, so, TLAR defaulted to using the database's field elevation as a proxy for the TDZE.

Because the TDZE is a proxy, TLAR sets the slope to zero, and flags it in YELLOW.

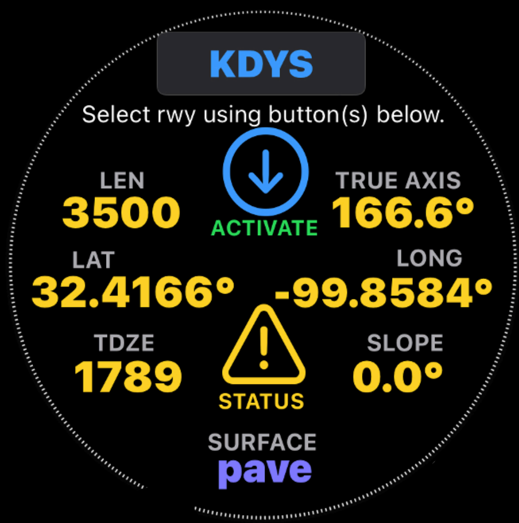
The true axis status is "COMPUTED" because the database does not have an axis listed for the runway, however, it does have lat-longs for both the approach-end and departure-end points, which allows TLAR to compute a bearing from one to the other.

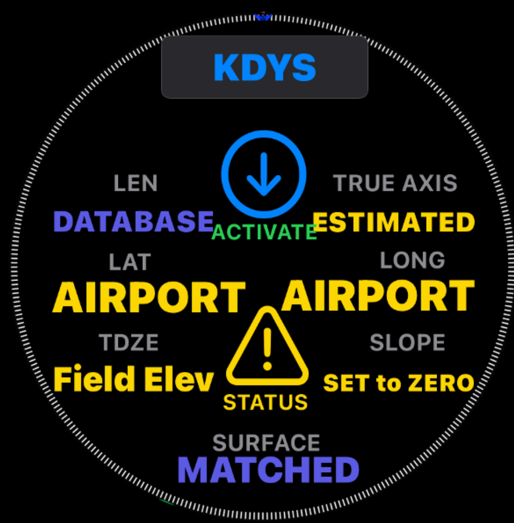
As is good practice, let's take a look at RJX7's location as compared to satellite imagery:



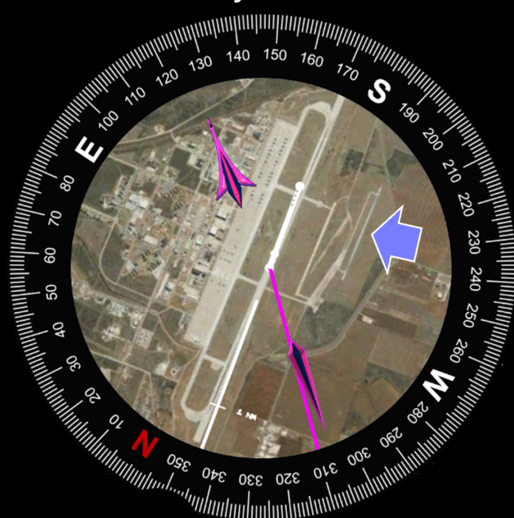
As you can see, the database runway is displaced from the actual runway. A problem for navigation, but a minor issue for performance calculations. The axis is correct (so no issues computing wind components). Cross checking Google Earth, the field elevation of RJX7 is 317 feet, whereas the database lists the same as 338 feet, negligible from an aircraft performance standpoint.

As another example, let's take a look at one of the C-130 assault strips at Dyess AFB, LZ 162:



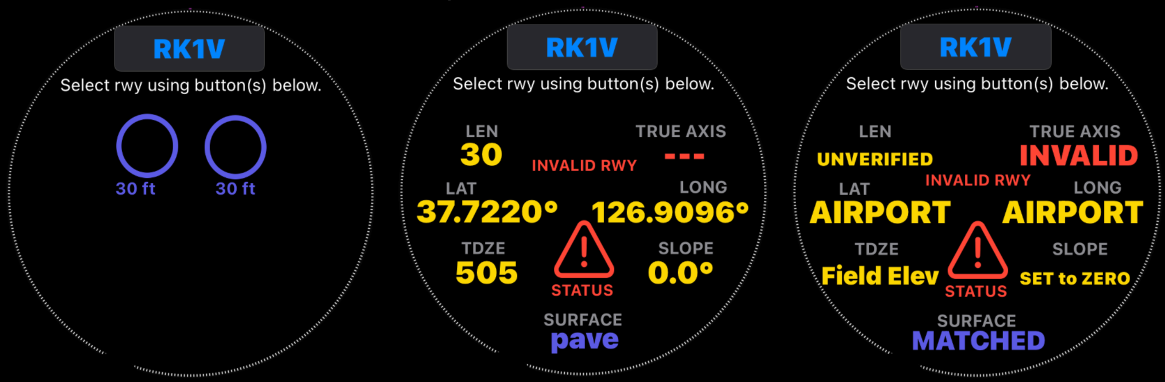


In the database, this runway does not have lat-longs, a TDZE, or an axis. As such, TLAR cannot verify it's listed length, and is forced to insert field elevation (1789') in for the TDZE (1797' is the LZ TDZE per Google Earth), which results in a forced zero slope. Without an axis in the database, TLAR estimated the LZ's axis using the runway's name (R162) and corrected it to a true bearing using the magnetic variation for airport (-4.6º). A quick check of the imagery reveals the LZ constructed from the airfield's midpoint (the INDIGO arrow points to the actual runway) is displaced from the actual runway:



While this displacement would be important for navigation, it is relatively minor from an aircraft performance standpoint because the two axes are nearly the same (affecting headwind calculations) and the elevations are nearly the same (affecting density altitude calculations).

For our final example, let’s try to load an invalid airport. RK1V is a heliport in Korea. There are two helipads listed in the database. Neither has an axis (note the lack of runway number inside the INDIGO buttons):



Because the database has no axis for these helipads (which it true for most helipads) and they do not have a runway name (e.g. R18), and without end-point coordinates TLAR has no way to figure out an axis. Without an axis, the runway is invalid and TLAR will not display a “LOAD” button to allow you to load it. Use the “MENU” button to back out of this view.

Search by name

You can also enter a search name (TLAR's search is NOT case sensitive, i.e. dfw = DFW = DfW) in the search window and TLAR will search the database for any airport with a name that contains the search text you enter. For instance, you can enter "MIAMI" in the search window and TLAR will return the (up to) eight closest airports whose name contains the string, "MIAMI."

Figure 26 – Search by Name "MIAMI"

A two-letter country name appears inside each bubble, and the ICAO or GPS code below each bubble. You can select the airport by pressing it. At this point, TLAR's data-entry flow will be as described in the section above regarding searching by ICAO.

If the search has no matches, no bubbles will appear and TLAR will report "No runway found.". If your search name only matches one airport in the database, the runway's screen will appear as previously described in the search by ICAO section.

TLAR can display up to eight results. If your search has more than eight matches, TLAR will display the eight closest matches to your position. For instance, if you search for "AIR FORCE," the eight closest airports with "AIR FORCE" in their name appear.

Figure 27 – Search by Name “AIR FORCE”

You can also enter “CLOSEST” in the search window and TLAR will find the eight closest airports to your location in it’s database.

Figure 28 – Search by Name “CLOSEST”

If you select an airfield that lacks sufficient information to construct a runway, but there is at least a coordinate, TLAR will give you the option to load the coordinate (and elevation if available) into the mark point bearing pointer.

SUBSCRIPTION.

The SUBSCRIPTION view displays your current version (TLAR-pro), the auto-renewal date of your subscription, and your assigned unique to you PilotID

Owyhee Aviation, LLC uses your Pilot ID in conjunction RevenueCat, our back-end services provider, to help us find your subscription history to assist us in helping you if you have a subscription-related problem. If you need help, include this number with your request to help us help you! We realize the font is quite small on the screen, you can snap a screen-shot of it and then zoom in to read the numbers, or just send us the screen-shot with your trouble request to support@tlarpilot.com

Figure 29 – TLAR-pro Subscription Settings

You can cancel your subscription at any time. As of this writing, Apple does not allow developers to provide a way for a user to cancel a subscription *from within* their app. Instead, cancellations are accomplished from inside iOS by accessing SETTINGS/[your iCloud name]/SUBSCRIPTIONS on your iDevice. If you do cancel, TLAR-pro will downgrade itself to TLAR-basic at the expiration of your current subscription.

VNAV/CRZ.

Use the Vertical Navigation / Cruise window to set climb and cruise parameters:

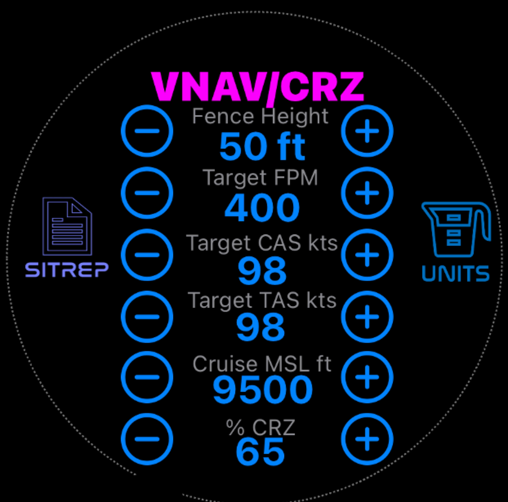


Figure 30 – VNAV/CRZ Settings

Fence Height. This parameter sets the approach and departure-end fence heights. Set it to the height of any obstacles located at the start/end of the runway. Use the (+) (–) toggles to change the fence height from 0 to 100 feet in foot increments.

Target FPM. This sets the desired climb rate for the constant FPM climb profile. The minimum setting is 200 feet per minute. The maximum value is the computed maximum climb rate for the conditions (weather and weight). The toggles move the rate in 100-foot increments.

Target CAS. This sets the desired calibrated airspeed for the constant CAS climb profile. Flaps-up stall speed (for conditions) is the slowest speed that can be set. Maximum calibrated airspeed is the highest setting. Use the toggles to change the target CAS.

Target TAS. This sets the desired true airspeed for the constant TAS climb profile. Flaps-up stall speed (for conditions) is the slowest speed that can be set. Maximum calibrated airspeed is the highest setting. Use the toggles to change the target TAS.

Exception: Target Mach. If you select “Mach” for airspeed units, the Target CAS window disappears and the Target TAS window is replaced with Target MACH.

Cruise MSL. This sets the cruise altitude TLAR uses to compute the economy climb profile (“ECO”). If you are at or above this altitude, TLAR will change this parameter to match your current altitude.

% CRZ. Use this parameter to set the percent of rated horsepower to use for the cruise CRZ profile. The lowest setting corresponds to the power required for maximum endurance. The highest allowable setting corresponds to the maximum power available for conditions. The toggles change the % CRZ value in one-percent increments.

Exception: % RPM. If you select a jet-powered aircraft, % CRZ is replaced with % RPM.

Displays and Gauges

Horizontal Situation Indicator (HSI) – TLAR's HIS is oriented "Track-Up" with a rotating compass rose bezel slewed to True North. The interior of the HIS has five potential views. The base HIS is graphics-oriented. Alternatively, you can select imagery centered on the plane or LZ; and map centered on the plane or LZ.

Base HSI.

TLAR's base HSI uses graphics instead of a map. This intuitive display can be used at any time and does not require a network connection to properly update.

Runway graphic is aligned to runway direction, magenta chevrons on the graphic indicate direction of active runway, and the type of graphic changes with surface type (pave, grass, gravel etc.).

Magenta Bearing Pointer. This pointer points to the approach-end of the active landing zone.

Green Bearing Pointer. This pointer points to the mark-point (if activated).

Magenta Heading/Track. This pointer shows your current heading/track referenced to True North. TLAR uses your device's reported track if your iDevice can resolve a track (based on GPS movement). Otherwise, TLAR will use your device's magnetometer and magnetic variation to determine true heading. See section on smart Visual Approach Indicators for much more.

Course Deviation Indicator. Shows horizontal position relative to extended runway axis. See section below on course deviation and glide slope indicators for more information.

Glide Slope Indicator. Shows vertical position relative to the selected flight path angle. See section below on course deviation and glide slope indicators for more information.

sVAPI (smart Visual Approach Indicator). Similar to a PAPI, TLAR's sVAPIs display current glidepath to the threshold, but unlike a normal PAPI, they can accurately compute this path for turning approaches and on downwind. See section on smart Visual Approach Indicators for much more.

Indigo Magnetic Heading/Track. This pointer shows your currenting magnetic heading/track using the World Geomagnetic 2020 model and your current location to determine magnetic variation.

Magenta Cross-track and angle of bank displays your current cross-track relative to runway extended centerline and required angle of bank to roll-out on runway centerline.

Blue/White Wind arrow. This arrow depicts the true direction winds are “from.” Aviation winds are reported in degrees magnetic north. TLAR converts these to degrees true to accurately place the wind arrow on the HIS. If the wind speed is less than 0.5 knots or the pilot turns winds off, the wind arrow will be absent.

Pale Yellow Sunrise Azimuth depicts the current sunrise azimuth based on time and your location on Earth. See Solar Data below for more information.

Dark Yellow Sunset Azimuth depicts the current sunset azimuth based on time and your location on Earth. See Solar Data below for more information.

Sun Azimuth indicator displays the sun’s azimuth.

The flight status indicator displays current flight status. TLAR-pro adds pattern and runway awareness to this display. Possible indications are: GROUND, TAXI, LINEUP, RUNWAY, FLYING, ALIGN, DW, EXT-DW, BASE, ST-IN, FINAL. TLAR displays magenta text when status is relative to the active LZ, and cyan otherwise.

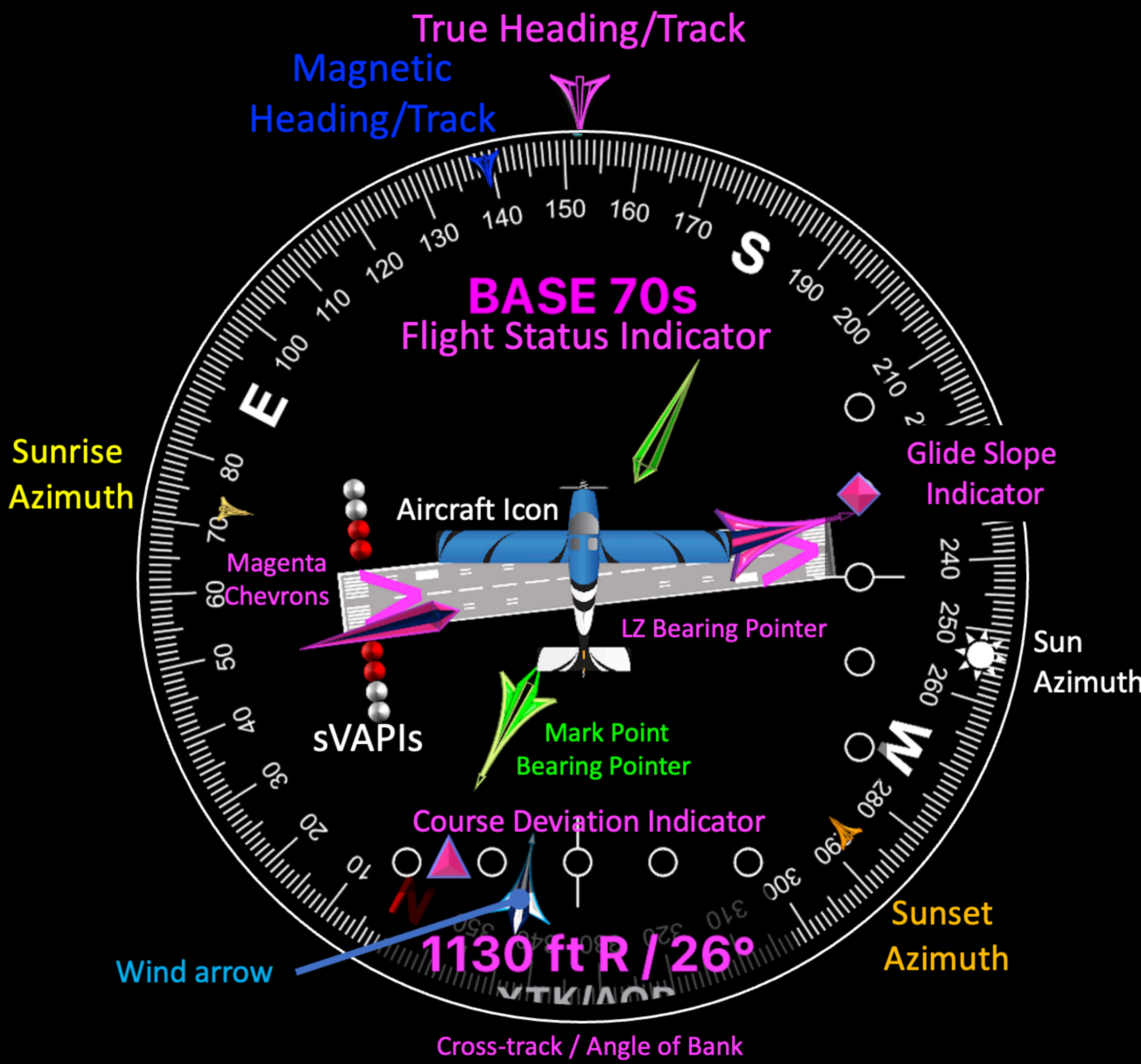


Figure 31 – TLAR-pro base HSI

Solar Data.

TLAR-pro displays sunrise, azimuth, and sunset pointers on the outer-edge of the compass rose. If you have selected to see active LZ information (magenta bearing pointer visible), TLAR displays solar information for the LZ's latitude and longitude. If you are not displaying LZ information (magenta bearing pointer not visible), TLAR calculates solar information for your present position using the current time of day. The time of day that TLAR uses for LZ-centered solar data depends.

Figure 32 – Sunrise, Azimuth, Sunset Pointers

In flight with an LZ active, TLAR computes an estimated time of arrival (ETA) direct to the LZ from your present position using your groundspeed. TLAR then adjusts the sun azimuth/elevation based on your ETA. In other words, the sun position shown is where the sun will be when you arrive at the LZ. If you are on the ground, the sun azimuth will be for the current time.

TLAR color-codes the sun azimuth pointer based on the computed sun elevation as follows. If the elevation is >= +10º the sun pointer will be WHITE. Between +10º and 0º, the sun is low enough to cause issues trying to see a runway, thus the pointer will be YELLOW. Between 0º and -6.8º the sun pointer will be INDIGO, indicating twilight. Below -6º the sun pointer will be BLACK indicating darkness.

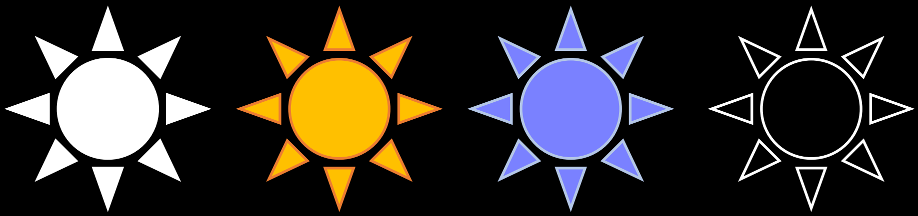
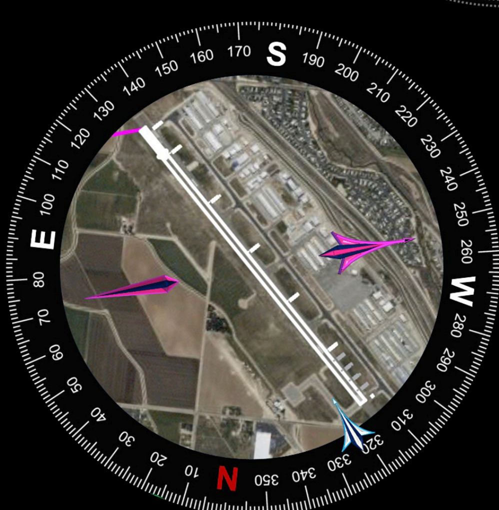


Figure 33 - Solar azimuth pointers (color-coded by elevation)

HSI Imagery/Map Centered On LZ.

Using the MAP button, the pilot can choose to center the HIS on the active landing zone, either using imagery or a map view. The magenta LZ bearing pointer and wind arrow will still function. In either of these “centered on LZ” maps, you can pinch, zoom, and rotate the map. This can be useful to zoom in the LZ touchdown zone. Note – The map version can also be tilted to give a 3D perspective by placing two fingers on the screen and sliding in up or down.

> CAUTION – If you rotate the map, the map azimuth will no longer be aligned properly to the compass, bearing pointer, or wind arrow. Pressing the MAP button once will reset the map azimuth and recenter the map on the LZ.



TLAR-pro annotates these maps with important information

- Active landing zone and extended centerline w/ distance ticks
- 10 NM ring around the center of the LZ
- Runway distance remaining markers
- Smart VAPI glidepath indicators
- Magenta route line from present position to approach end
- On the ground, the takeoff distance is drawn onto the LZ with a large arrow drawn down the center of the LZ
- In flight, TLAR will plot the braking distance on the LZ using a rectangle.
- You can zoom into either end of the runway to read information about the landing zone such as name, elevation, axis, and lat-long.

TLAR will auto-shift between takeoff mode and land mode and change the displayed data to show the appropriate performance (i.e. show takeoff information when on the ground, and landing information when in the air).

To declutter the display, the magenta bearing pointer will temporarily auto-hide from view when: in the HIS is in map or imagery centered on the LZ view AND one of either of the following:

- The aircraft is lined up for takeoff or on takeoff roll
- Or, the aircraft is in-flight, within 2NM of the approach-end, and in dynamic-KGS mode.

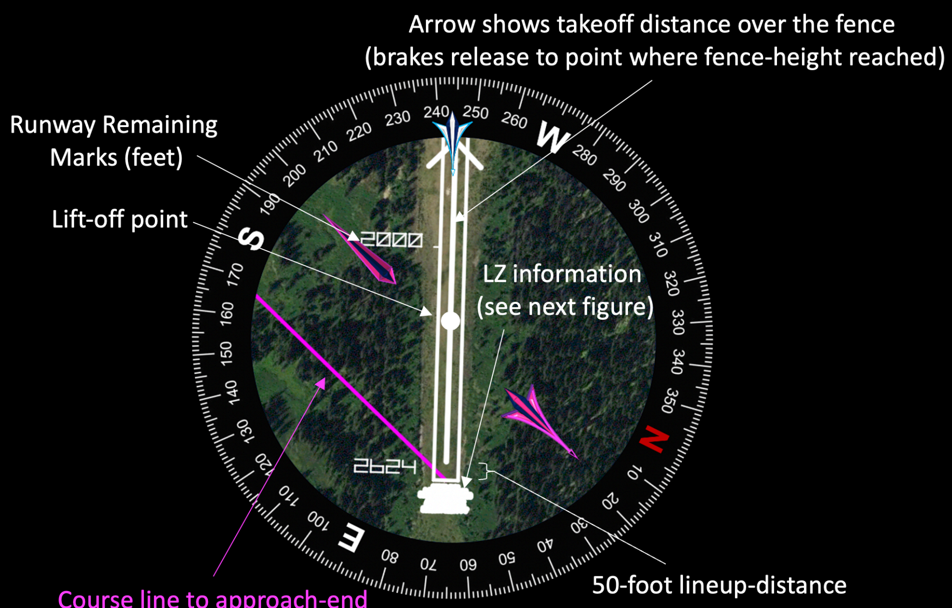


Figure 34 – Takeoff Map annotations

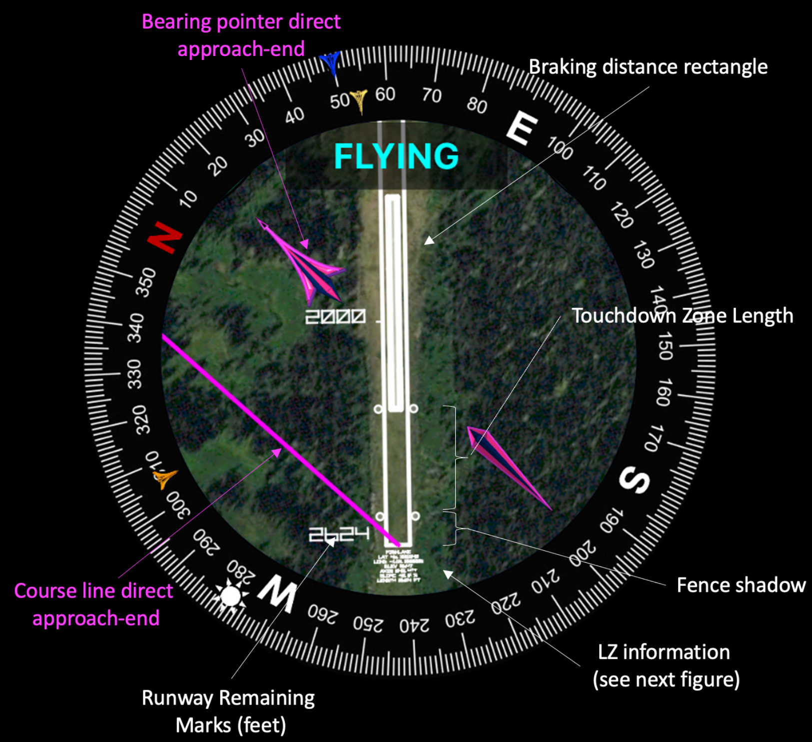
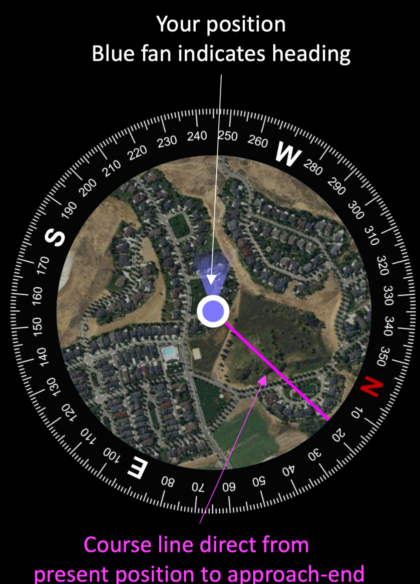


Figure 35 – Landing annotations

Figure 36 – Fishlake Idaho (S92) LZ Info

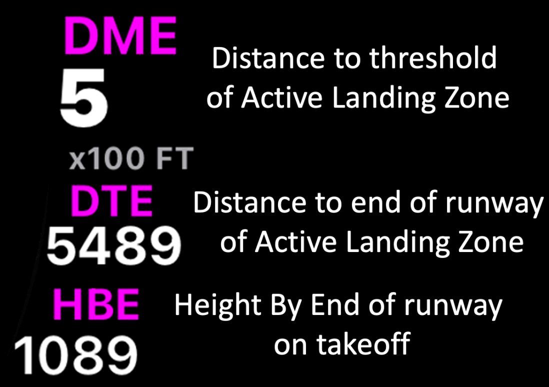
TLAR-pro color codes the LZ drawing in a similar fashion to the takeoff/landing analogue gauges. The LZ is WHITE if takeoff and landing performance is “in the green.” The LZ is CYAN if TLAR has shifted to DYNAMIC-KGS mode (see Figure 49 – Landing Gauge in Dynamic-KGS mode) and both takeoff and landing performance are “in the green." The LZ will be YELLOW if a safety margin must be violated to make the takeoff or landing work, and RED if TLAR assesses the takeoff or landing as not possible. When flying, TLAR puts the display in Land mode. If the landing performance is “in the green,” but *takeoff* performance is assessed as not “in the green,” TLAR will color the LZ VIOLET. Likewise, if on the ground, TLAR goes into Takeoff mode. If takeoff performance is “in the green,” but *landing* performance is not, the LZ will be colored VIOLET. In other words, VIOLET means, “what you are doing right now is OK, but, if you plan to takeoff/land next, you will need to adjust something because it may not be safe.”

HSI Centered on Present Position

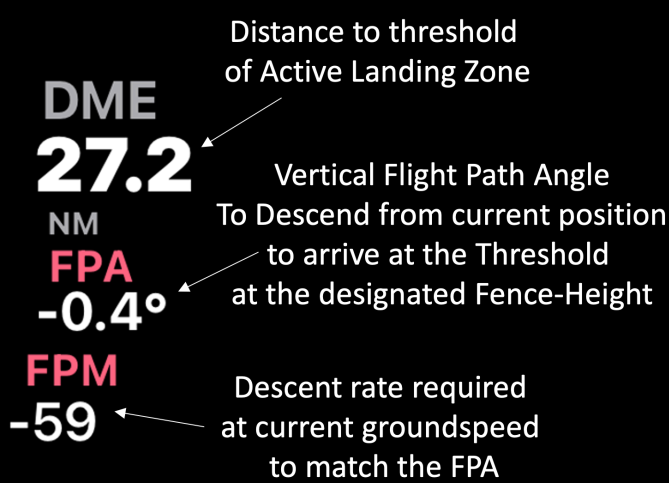


Note – Map interaction (pan/scroll/rotate/pinch and zoom etc.) is disabled using either of the centered-on current position maps. Full user-interaction is available on either of the center-on-LZ maps.

Landing Zone Vectors. On the ground, TLAR-pro displays distance to the threshold/runway end points and predicted aircraft height by end of runway (HBE) on takeoff (in feet). HBE accounts for runway slope to display the predicted height above the departure-end of the runway. HBE assumes a maximum-power takeoff at the selected takeoff flap setting, atmospheric conditions as displayed in the “WEATHER” section, a three second rotation delay followed by a Vx climb to the end of the runway.



In flight, TLAR-pro changes these outputs to display VNAV information to arrive at the approach-end of the active runway at the specified fence-height:



TLAR color-codes the values of the landing zone vectors as follows: WHITE if the NAV status is GREEN or if NAV status is YELLOW and the distance to both ends of the LZ is > 1NM. The vectors will be YELLOW if the NAV status is YELLOW and the distance to either end of the LZ is less than 1 NM, and RED if the NAV status is RED.

Course Deviation and Glide Slope Indicators

Important distinction: on the "Performance View," TLAR's GSI computes a glidepath using the straight-line DME distance from your current position to the approach-end of the active LZ. On the "Big Sky" view, and within 10NM of the LZ, TLAR uses your track-distance to touchdown (distance including turns) to compute your glidepath. Outside 10NM to go, TLAR will again use straight-line DME to compute your glidepath. TLAR will label the distance to go with "DME" if using straight-line distance, and "Tdtg" when using track distance to go.

TLAR-pro will auto-display a Course Deviation Indicator (CDI) and Glide Slope Indicator (GSI) once each of these conditions is met:

- Pilot selected "Use LZ" which brings up LZ information and the magenta LZ bearing pointer
- Active LZ has a valid approach end coordinate, a valid axis, and a valid elevation
- Within 10NM of the approach end

Course Deviation Indicator. TLAR's CDI indicates your horizontal position relative to the extended runway axis. Each dot equals 5 degrees of deviation. Figure 37 – Course Deviation Indicator below shows a case where the aircraft is about 2.5º right of centerline. At the current distance to the threshold this offset is 445 feet right. The CDI gets more sensitive the closer you are to the approach end of the LZ because the cross-track distance required (in feet or meters) to traverse, say, one degree of azimuth gets smaller and smaller.

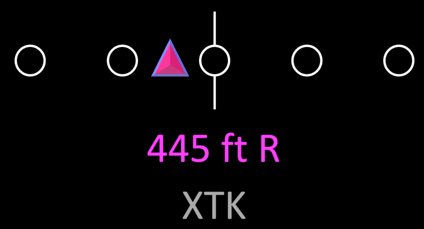
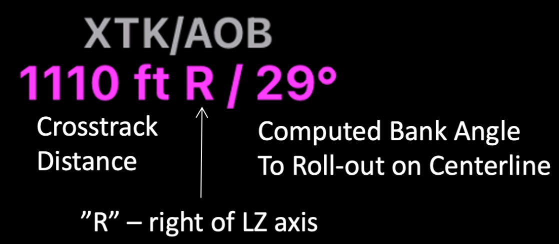


Figure 37 – Course Deviation Indicator

Within 10NM of the LZ TLAR will display cross-track/computed bank angle information. The cross track is your distance from extended runway centerline (LZ axis). TLAR computes the bank angle required to roll out on centerline using your current groundspeed. The computed bank angle will disappear once established on final.



Glide Slope Indicator. TLAR's GSI indicates your vertical position relative to your selected flight path angle (as entered in VNAV/CRZ settings). Each dot equals 0.5° of deviation. Figure 38 – Glide Slope Indicator shows a case where the aircraft is 0.5° below the selected flight path angle (-3.6° in this example). The vertical data shows a current FPA of -3.1° based on a track distance to the approach end of 3.4 NM requiring a descent rate of 439 FPM to reach the approach end at the entered fence height. Similar to the CDI, the GSI gets more sensitive the closer you are to the approach end of the LZ. This GSI is like what you might see on an ILS or LPV approach, with two key differences.

First, YOU select the approach glidepath angle by setting a desired FPA in the VNAV/CRZ settings. Second, an ILS Glideslope is 1.4° wide top to bottom whereas the TLAR Glideslope is 2° wide top to bottom. See Figure 45 and Figure 46 for more.

Like the CDI, the GSI gets more sensitive the closer you are to the approach end of the LZ.

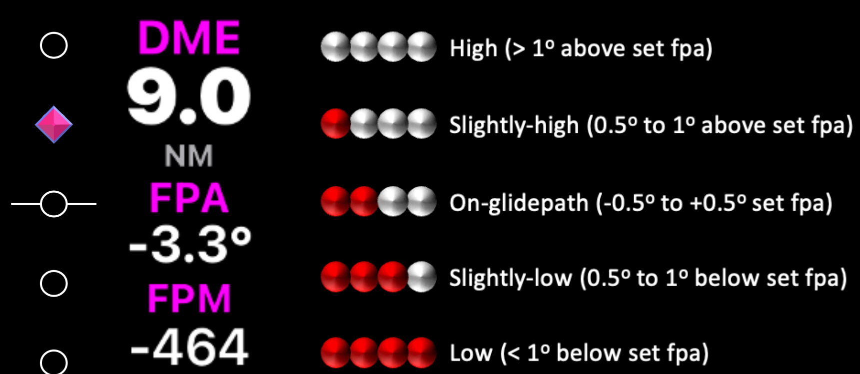


Figure 38 – Glide Slope Indicator, Vertical Path Data, VAPI

WARNING – TLAR's CDI and GSI are for VFR situational awareness. While you can set them up to mimic an instrument approach such as an ILS or LPV, they are NOT approved to be used in place of an instrument approach. You should NEVER use TLAR's CDI or GSI as the primary guidance instrument on an instrument approach.

Pattern Operations

TLAR determines your position in the pattern and displays this on the HIS.

Figure 39 – Downwind Criteria shows the criteria TLAR uses to declare your aircraft on downwind.

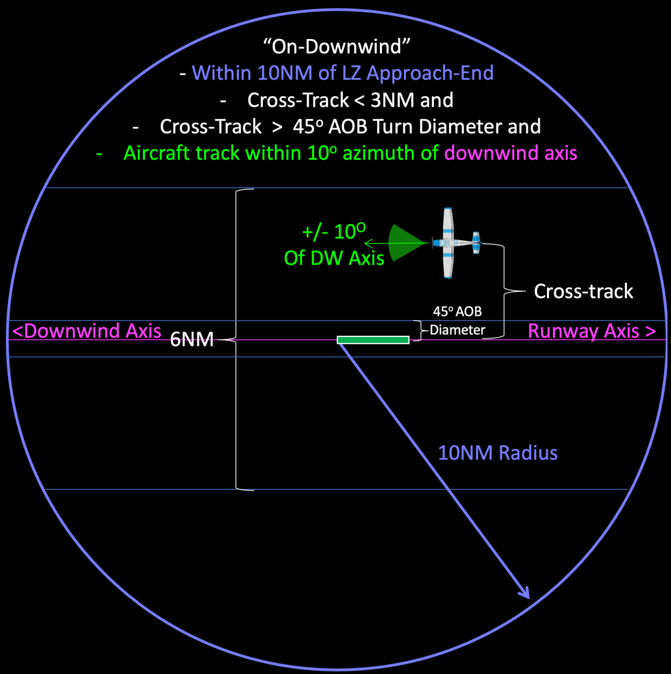


Figure 39 – Downwind Criteria

On downwind, TLAR computes total track distance to go based on your position relative to the perch point. The perch-point is on downwind abeam the rollout point, a point located on LZ-axis twice the stabilization distance from LZ approach-end. Referencing Figure 40 – Computing Track Distance to go on Downwind:

"On-Downwind" Prior Perch (position 1) – The flight status display will read "DW" (Downwind). TLAR assumes a base turn made abeam the rollout point. TLAR adds distance to perch, to distance on turns, rollout distance, and, if cross-track is greater than the turn diameter, TLAR adds base-leg distance. The sum of these distances is the total track distance to touchdown used in conjunction with your current altitude to determine the glidepath angle.

At the perch-point, TLAR will announce “Perch” over headset if your iDevice is connected to your audio panel.

“On-Downwind” After Perch (position 2) – The flight status display will read “EXT-DW” (Extended-Downwind). TLAR assumes an immediate base turn. TLAR adds the distance in turns to your current in-track distance, and, if cross-track is greater than the turn diameter, TLAR adds base-leg distance. The sum of these distances is the total track distance to touchdown used in conjunction with your current altitude to determine the glidepath angle.

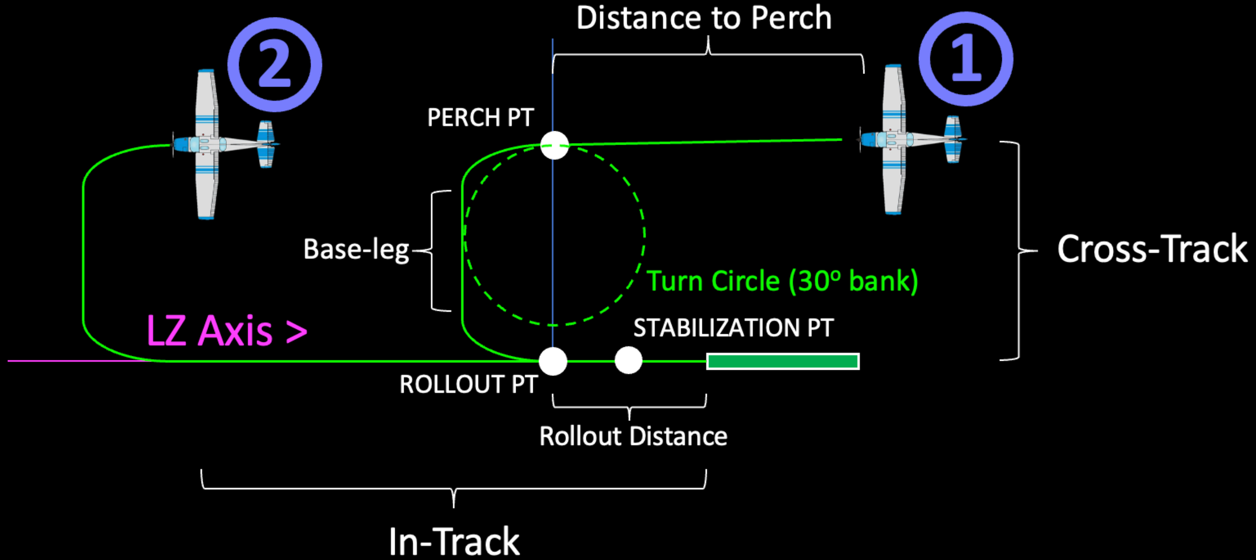


Figure 40 – Computing Track Distance to go on Downwind

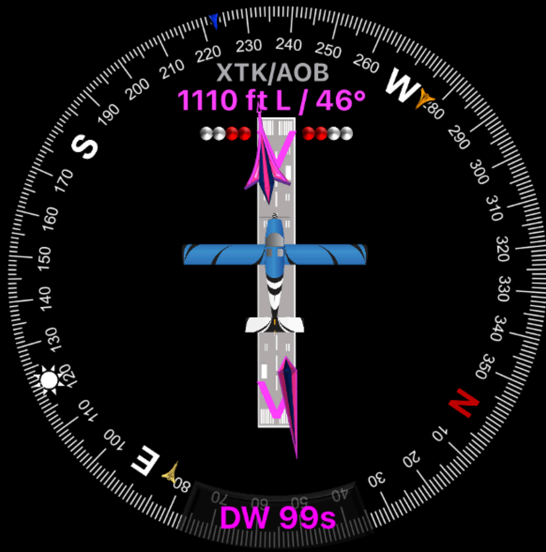


Figure 41 – HSI On-Downwind Prior to Perch

Figure 41 – HSI On-Downwind Prior to Perch depicts a Sportsman on downwind prior to the perch point with a left cross-track of 1110 feet. TLAR calculates the plane will reach the perch in 99 seconds and that a 46º bank angle at the current groundspeed will result in a continuous turn to final to roll-out on centerline.

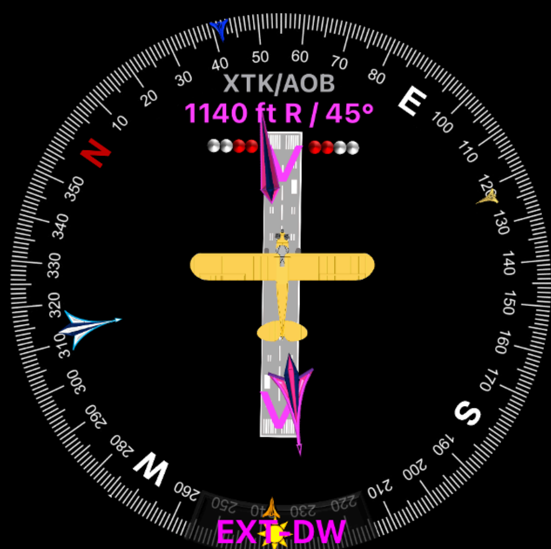


Figure 42 – HSI Extended Downwind Post Perch

Figure 42 – HSI Extended Downwind Post Perch depicts a cub on extended downwind after the perch point with a right cross-track of 1140 feet. TLAR calculates that an 45º bank angle at the current groundspeed will result in a continuous turn to final to roll-out on centerline.

TLAR shifts to “on-base” calculations using criteria depicted in Figure 43 – Base Turn.

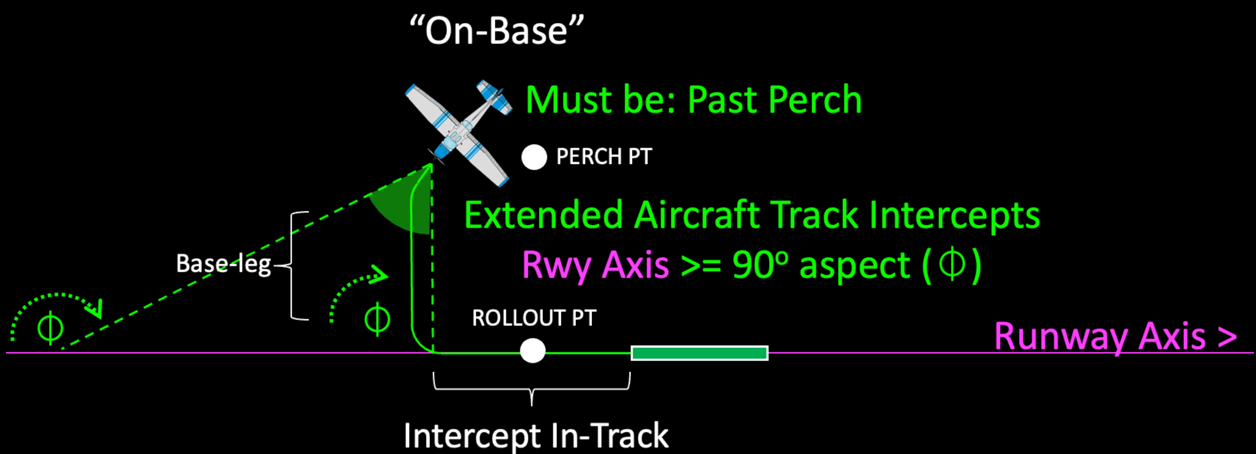


Figure 43 – Base Turn

On base, TLAR displays “BASE” in the flight status display and calculates track distance to go assuming an immediate/continued turn and adds base-leg distance if needed. TLAR then adds distance on turns to intercept in-track distance.

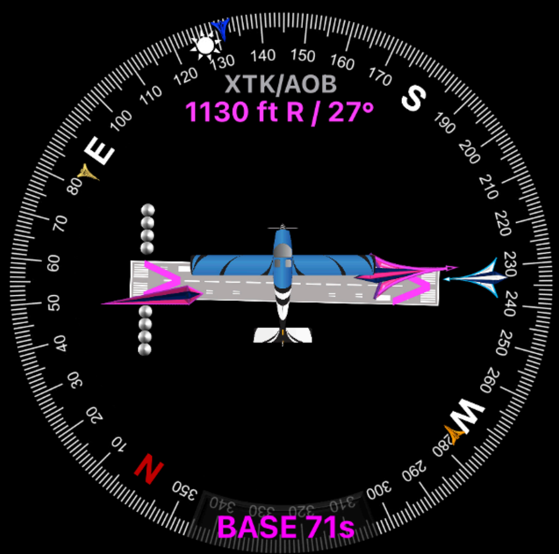


Figure 44 – HSI On-base

Figure 44 – HSI On-base is an example showing a Sportsman on base, high on glidepath, 1130 feet right cross-track, approaching a turn to final requiring a 27° bank angle to roll-out on centerline. Estimated time to the threshold is 71 seconds. As the turn continues (or on a direct-to-final approach), TLAR shifts to “base turn to final” calculations using criteria shown in Figure 45 – Base Turn to Final.

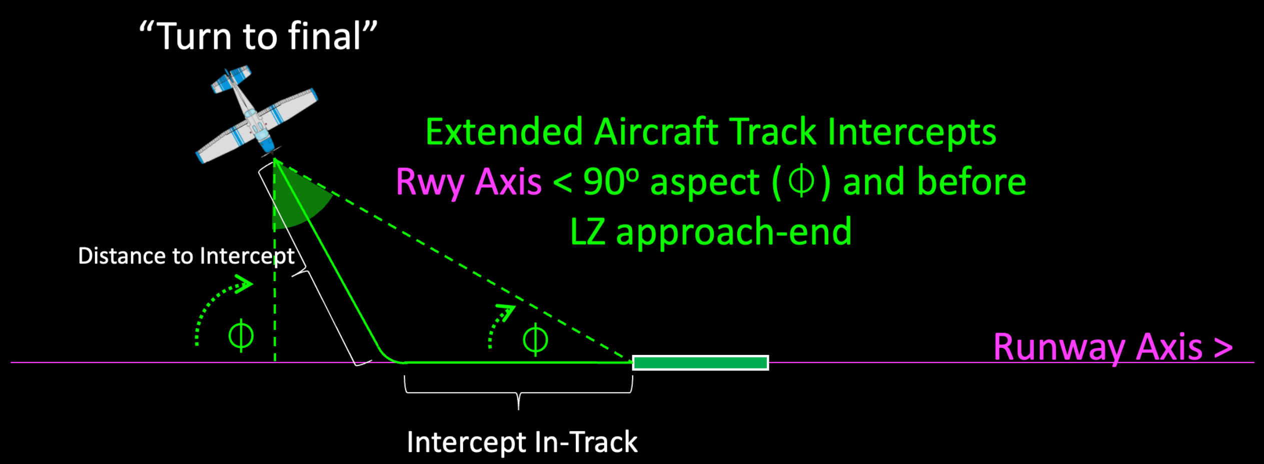


Figure 45 – Base Turn to Final

Once established in a "Base Turn to final" geometry, TLAR will display "BASE" in the flight status window, but now uses the current aircraft track to compute the distance to the intercept and then adds the arc distance on the turn to final to the intercept in-track distance. As the approach continues, the aircraft will eventually capture straight-in criteria and using the criteria shown in Figure 46 – On-Final.

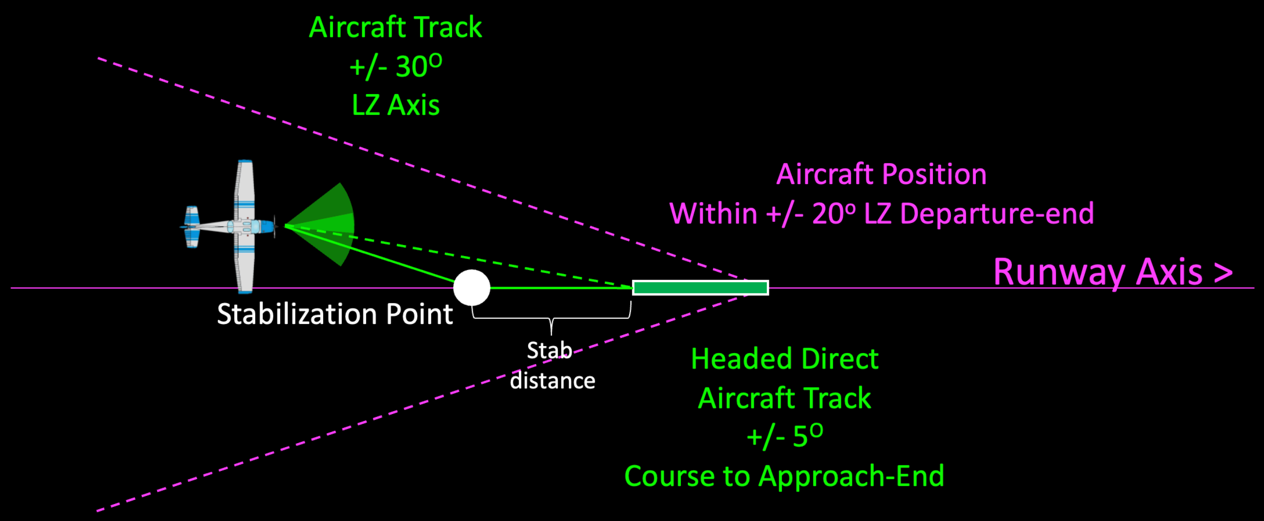


Figure 46 – On-Final

"Straight in," if the aircraft position is within +/- 15º azimuth of *departure*-end, tracking within +/- 30º of the LZ Axis, and outside the stabilization point, TLAR displays "ST-IN" for status and adds distance to stabilization point to stabilization distance (solid line) to get track-distance to approach-end. TLAR assesses "On final" if the aircraft position and track meet "straight-in" criteria above and additionally the track is within 5º azimuth of a direct course to the approach-end (regardless of inside/outside stabilization point) or you are inside the stabilization distance to go, TLAR displays “FINAL” for status and uses direct distance (dotted-line) to the approach end as the track distance to threshold. Computed bank angle also disappears from the cross-track display on final.

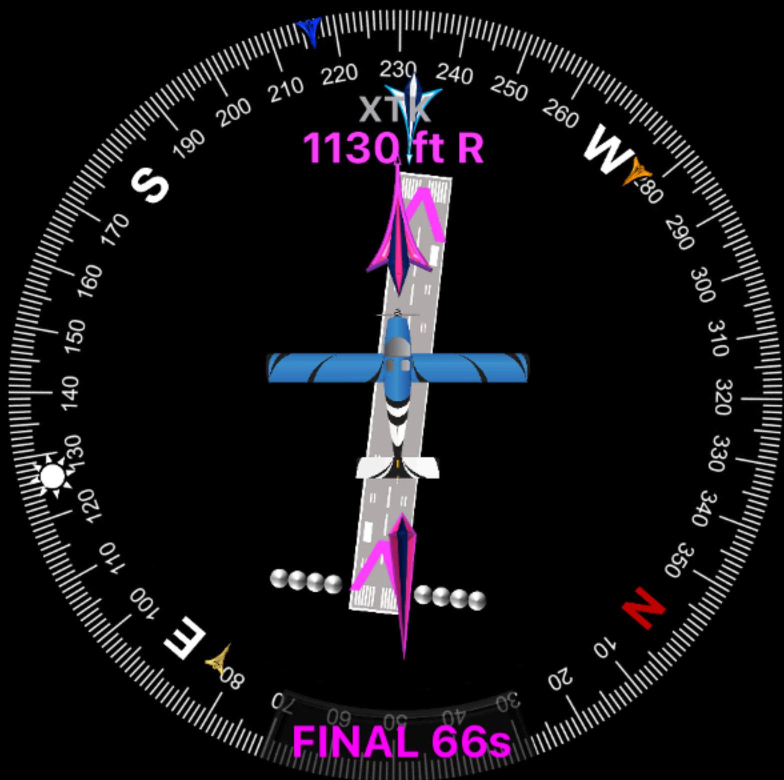


Figure 47 – HIS On Final

Figure 47 – HIS On Final shows an “on final” example depicting a final approach where the aircraft is 1130 feet right of centerline, high on glidepath. Estimated time to threshold is 66 seconds.

Weather Gauges.

TLAR-pro adds several modes to the weather gauges, tap each gauge to cycle it's mode.

The **elevation gauge** has three modes: MANUAL, GSL, and TDZE. *This is the most important setting to get "right" when using TLAR because this is the altitude that TLAR uses to compute your aircraft's performance.*

In MANUAL mode, you can toggle the reference elevation up and down in 500-foot increments from -1000 to 25000 feet. In GSL mode the elevation comes from your iDevice's satellite-derived altitude. In TDZE mode (Touchdown Zone Elevation), TLAR uses the active runway's approach end elevation.

The **Pressure gauge** also has three modes: MANUAL, iBARO, and closest reporting Weather Station.

In MANUAL mode, you can toggle the pressure up and down in increments of either inches of mercury or millibars. In iBARO mode, TLAR uses your iDevice's internal barometer and GPS sensors to compute an altimeter setting (Note – you must enable fitness tracking in iOS settings for iBaro to work as per Apple's privacy policy). In Weather Station mode (and with a network available), TLAR will poll the NOAA weather server to find the altimeter setting of the closest reporting weather station to your selected elevation-source (your location or the active runway).

The **Temperature gauge** has two modes and adds a label to let you know if the temperature is relative to your aircraft or to the active LZ. In MANUAL mode, you can toggle the delta-Celsius up and down in 1ºC increments. In Weather Station mode (and with a network available), TLAR will poll the NOAA weather server to find the surface delta-C temperature of closest reporting weather station to your selected elevation-source (your location or the active runway). TLAR “thinks” in delta-C but displays delta-C and the estimated absolute temperature for the selected elevation.

Wind. TLAR displays windspeed information on the left side of the HIS in a vertical stack. If the data source for the wind is from the internet (NOAA METAR), the WIND title will be INDIGO and depicts velocity and reporting station. If the wind is set to MANUAL, the headwind/tailwind component of the wind speed is shown along with HW/TW in BLUE. Wind direction is shown on the HIS compass ring using the wind arrow.

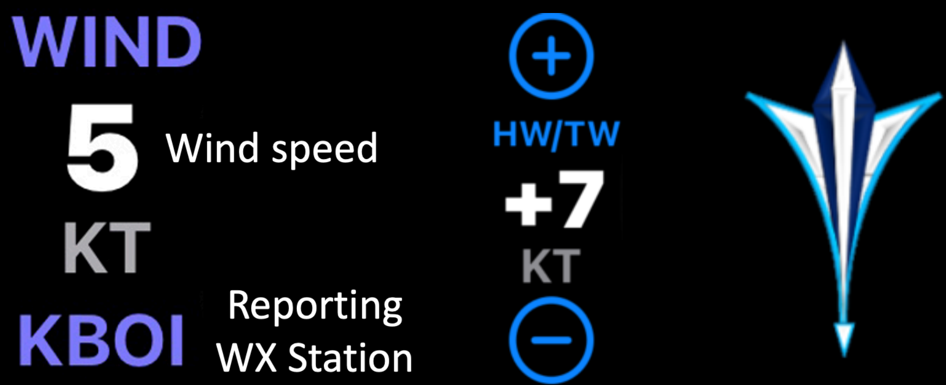


Figure 48 – METAR Wind, Manual Wind, and Wind Arrow

TAKEOFF. TLAR-pro displays your takeoff run and distance to clear the fence height both digital (numbers inside the gauge donut) and analogue (ball "needle" shows ground run, pyramid "needle" shows distance over the fence height). The analogue gauge arc is scaled to the runway length. TLAR-pro colors the takeoff gauge arc yellow if either safety margin (safety margin and/or fence margin) will be violated to takeoff and clear the fence height. You can enter the fence-margin in pilot settings. If TLAR assesses you cannot takeoff on the available runway or cannot clear the fence height, the gauge arc will be red.

TLAR assumes the aircraft will line up with 50-feet of runway behind the plane. However, after taxiing onto the runway and lining up, TLAR will announce "lined up" and shift to using the measured distance from present position to the departure end as the available runway length. When this happens TLAR will change the runway length label from it's database length value e.g. "Len: 5500" to match the DTE label, e.g. "Len: 5489." This feature is particularly helpful during intersection takeoffs.

Examples from an LZ 1203 ft long. In the green case, fence height is 0 feet. Liftoff occurs 550 feet after brake release, the plane clears the 10-foot fence safety margin 830 feet from brake release, and crosses departure end at a height of 76 feet.

In the yellow caution case, the fence height is 20 feet. Liftoff happens, 550 feet from brake release. The plane clears the 20-foot fence 920 feet after brake release, reaching a height by the end of the runway of 76 feet. This case is yellow because the 920-foot minimum takeoff runway is within the pilot-defined safety margin (300 feet) of the total runway length (1203).

In the red danger case, the fence height is 50-feet and we are attempting a flaps-up takeoff on a 1203 foot runway. Liftoff occurs 740 feet after brake release, and the plane crosses the end of the runway at only 35 feet height by fence, which is less than the 50-foot fence. Under these conditions the aircraft requires 1300 feet from brake release to reach the 50-foot fence height.

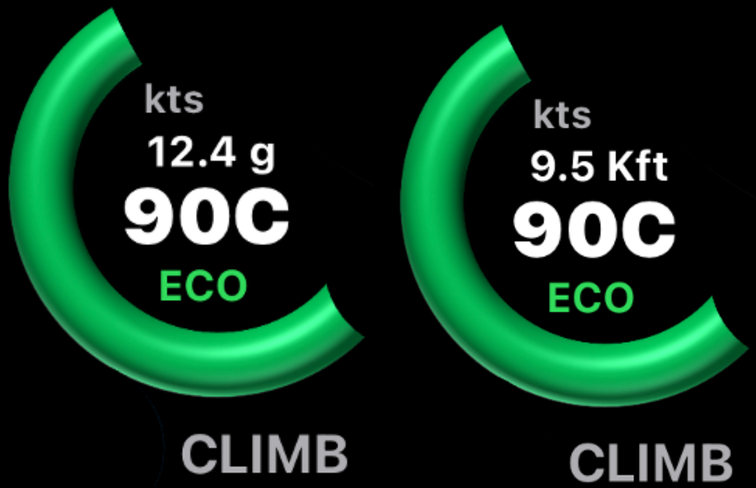
Accelerate-Stop (ASTOP) Distance. If selected, the takeoff gauge changes to display accelerate-stop distance instead of takeoff run distance. The accelerate-stop runway distance is the distance required to accelerate to takeoff speed, lose all thrust, and then stop the aircraft straight ahead using landing brakes as selected (partial or max). TLAR assumes a 3 second reaction time prior to braking. If the available runway length exceeds the accelerate-stop runway distance, TLAR will color the takeoff gauge GREEN. If the available runway length is less than the accelerate-stop runway distance, TLAR will color the takeoff gauge YELLOW. If available runway length is less than computed ground-run, TLAR will de-select ASTOP and display ground run and a RED gauge.

CLIMB. TLAR-pro adds four new climb profiles beyond the Vx, Vy, and Vz profiles offered in TLAR-basic. These are the constant calibrated airspeed climb (CAS), constant true airspeed climb (TAS), constant climb rate climb (FPM), and economy (ECO). You can set the target speeds/rate on in the VNAV/CRZ settings. The climb profile gauge lists the type in GREEN letters, the targeted speed/rate in the center of the gauge, and the resulting predicted climb rate or KCAS to fly for conditions (weather, elevation, and weight). The analogue gauge reads clockwise from zero fpm up to the maximum climb rate (Vy) possible for conditions.

The climb gauge will turn YELLOW if the predicted Vy climb rate is below 400 feet per minute and RED if the predicted Vy climb rate falls below 200 feet per minute.

Economy Profile.

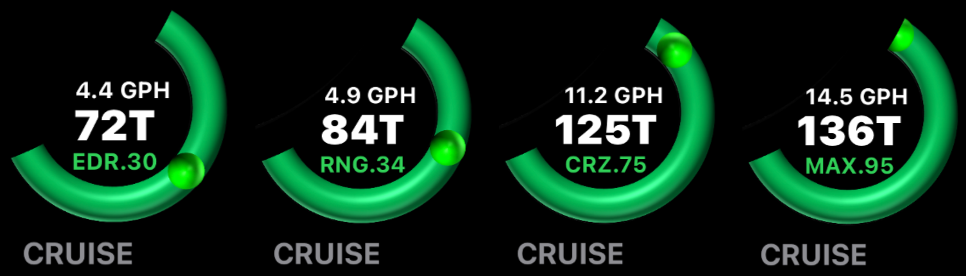
ECO mode is available if you have an active LZ and have elected to display the LZ bearing pointer. TLAR uses direct routing to the active LZ as the destination. TLAR selects a calibrated climb speed that balances climb rate with distance travelled in the climb seeking to minimize the total fuel used in the climb, cruise, and descent portions of your flight. In ECO mode, TLAR will alternate between displaying the total fuel used to touchdown with the cruise MSL. The ECO profile climbs from present altitude to cruise MSL, cruises at a speed/fuel flow resulting from the selected cruise percent power, and descends at the same cruise TAS using the entered flight path angle. TLAR computes a reduced power setting and fuel flow during the descent based on the FPA (steeper FPA's require less power). TLAR applies the current headwind to all altitudes in its calculations. For maximum accuracy, set winds to MANUAL and dial the HW/TW component for the altitude winds which the majority of the flight will experience (usually the cruise altitude). The ECO profile saves about 0.5 – 1.0 gallons of fuel as compared to a Vy climb for most GA aircraft. Fly the displayed CAS (which will change as the climb progresses) to maximize your fuel efficiency to destination. If you are too close to the LZ to climb to and/or descend from the selected cruise MSL, TLAR will not compute a profile and display a "---" for the climb CAS. In this situation, lower the selected cruise MSL to one that is feasible. Once you reach the cruise msl (or if you climb higher), TLAR will display the predicted calibrated cruise airspeed and the ECO label will read "CRZ.65" where "65" is the cruise power setting.



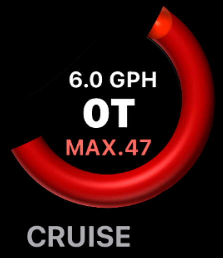
CRUISE.

TLAR-pro adds three new cruise profiles and allows you to vary cruise power in one percent increments (use the VNAV/CRZ menu to set). The new profiles are maximum speed (MAX), maximum range (RNG), and maximum endurance (EDR) each computed for conditions with flaps up. Maximum endurance speed is a flying speed at with minimum fuel flow. Maximum range is the speed producing maximum air nautical miles per gallon of fuel.

The cruise profile gauge lists the cruise type and percent power in GREEN letters, the resulting true airspeed in the center of the gauge, the resulting fuel flow in gallons per hour (GPH) is above the speed. The analogue gauge reads counterclockwise from zero up to the maximum speed possible for conditions.

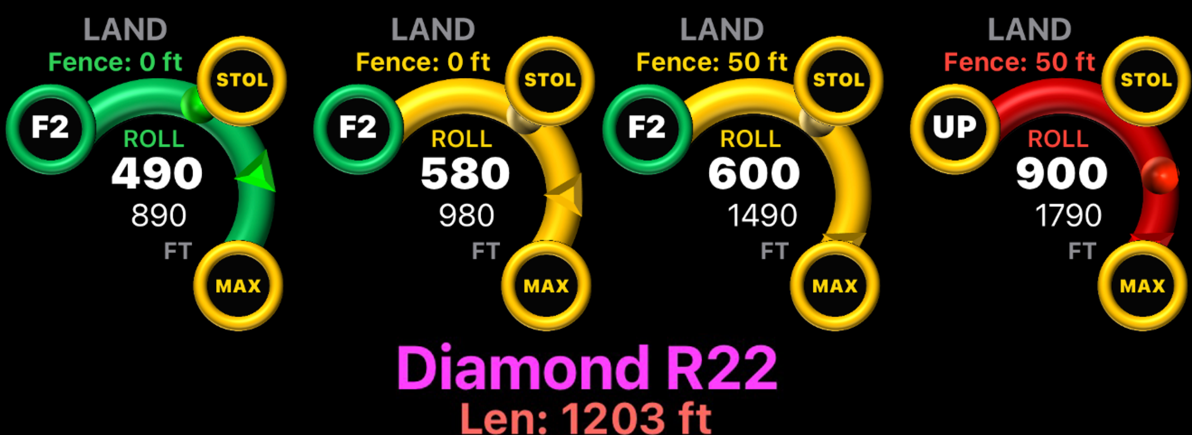


If cruise flight is not possible (e.g. you manually set an elevation above absolute ceiling), the cruise gauge will turn red.



LANDING. TLAR-pro adds several features to the Landing gauge. The normal/STOL button selects type of approach, which changes the approach speed (Vref) and touchdown speed of the aircraft. The default setting for a normal approach matches the selected aircraft's POH. For a STOL approach, the default is 1.2 times Vstall. These ratios can be changed in TLAR-pro on the PILOT settings sub-window. Additionally, the pilot can select partially braked (PART) or maximum braked (MAX) landings. TLAR colors the normal/STOL button yellow if the pilot selects STOL to caution the pilot about a reduced stall margin. Similarly, the PART/MAX button is yellow when MAX is selected as maximum braking from touchdown to complete stop is hard on the plane.

TLAR-pro also colors the gauge arc yellow if one or both pilot-set safety margins (touchdown zone length or safety margin) must be violated to stop the plane on the runway. If TLAR assesses that the aircraft cannot be stopped on the available runway, even if safety margins are ignored, the gauge arc will be red.



The four example landing gauges above depict increasingly "bad" situations landing on Diamond LZ, length 1203 feet. Recall that the landing distance over a fence height includes the entered touchdown zone length (300 feet in this example). In the "green" case, the aircraft can land and stop on the LZ without violating either the 300-foot touchdown zone length or the 300-foot safety margin. Note the fence height is zero (and we dialed the weight down). In the first yellow caution case, the plane can land over the fence height and stop, but the stop occurs with only 223 feet of runway remaining, which violates the 300-foot entered safety margin. In the second yellow caution case, the braking distance is 600, but landing over a 50-foot fence is 1490 feet, which exceeds available runway length by 287 feet. This means the pilot must touchdown in the first 13 feet of the 300-foot touchdown zone to stop the plane on the available runway. In the red danger case, we retract the flaps which increases braking distance to 900 feet and landing distance over fence height to 1790 feet. Even if the pilot landed on "brick-one" of the touchdown zone, the aircraft would still require 1490 feet of runway, which exceeds the 1203 feet available. Thus, TLAR assesses that the aircraft cannot be stopped before the end of Diamond LZ across a 50-foot fence with flaps up.

To be clear, TLAR-basic also colors it's land gauge using the same criteria that TLAR-pro uses, however, in TLAR-basic the LZ is hard wired to a generic 3000-foot long paved, level airstrip with a 50-foot fence height and an approach flight path of -3.5º. Further, the pilot touchdown zone length and safety margins too are hard-wired at 500-feet each.

See the Figure 63 for more on Landing Zone Geometry.

Dynamic Groundspeed. On the ground or at high speed in flight, TLAR-pro computes touchdown ground speed assuming that the pilot lands on speed, and winds are exactly as predicted. However, in practice, most of us are not precisely on speed all the time, nor are the winds exactly as called. TLAR-pro overcomes these error sources by shifting into DYNAMIC mode when appropriate. In DYNAMIC mode, TLAR assumes touchdown groundspeed will be 90% of the current ground speed. TLAR-pro indicates that it is in "DYNAMIC" mode by coloring the text inside the land gauge **CYAN** as show below. TLAR-pro operates in DYNAMIC mode when groundspeed is between 20 KGS and 1.5 times the predicted landing groundspeed if the elevation source is GSL or Manual OR, if the elevation source is an LZ, when groundspeed is between 20 KGS and 1.5 times the predicted landing groundspeed AND you are within 5NM of the threshold OR always (regardless of speed or distance) when inside the stabilization point on approach.

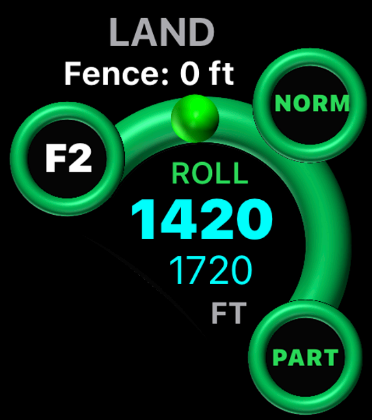


Figure 49 – Landing Gauge in Dynamic-KGS mode

Big Sky View

TLAR-pro’s Big Sky view gives you a decluttered edge-to-edge map view. There are four map settings: imagery with plane, imagery centered on the landing zone, map with plane, and map centered on the landing zone. TLAR auto-zooms and moves camera angles in the “with plane” modes to try and get both the plane and LZ visible. User interaction is disabled in “with plane” modes, but full user-interaction (pan/zoom/rotate) remain in the LZ modes.

Note – all screenshots in this section of the manual show two switches at the bottom that do not exist in the commercial product: a Basic/Pro switch, and a Flying switch. These for demo/debugging purposes, and not available in the commercial TLAR product.

Big Sky Map Modes:

Figure 50 – Imagery with Plane, Imagery on LZ, Map with Plane, Map on LZ

You can cycle through the map types using the cycle-map button at top left.

Digital Data

Wind speed, landing zone DME, FPA, FPM data, and the flip runway button “transfer in” from the Performance view screen onto the same position on the Big Sky screen.

Below the landing zone vectors, the Big Sky view adds Estimated Time Enroute (ETE), Groundspeed (kts/kmh/mph), and Angle Of Bank (AOB).

ETE – TLAR computes an estimated time enroute using your current groundspeed and distance to go to the active landing zone. Outside 10NM, your TLAR uses the direct-line distance from current position to the landing zone’s approach-end coordinate. Inside 10NM, TLAR uses your track distance to touchdown, shown by the magenta line.

Groundspeed – TLAR displays your current groundspeed in the units you have selected in the UNITS settings.

AOB – Angle of Bank shows the bank angle TLAR is using to compute turn radii in the traffic pattern. The AOB text will be **WHITE** if TLAR is currently using 30º of bank for turns. It changes to **CYAN** above 30º and less than or equal to 35º, **YELLOW** above 35º and less than 45º, and **RED** if 45º.

Symbology and indicators

The Big Sky view uses the same map annotations as the various map modes previously discussed but adds a few that are unique.

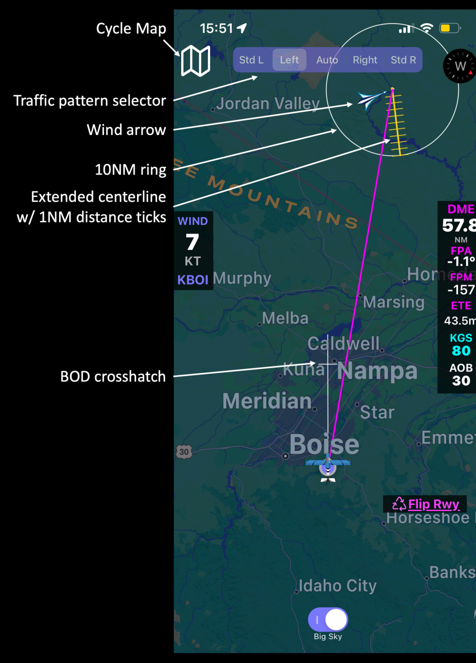


Figure 51 – Enroute

Figure 52 – Takeoff (left) and Landing (right)

Pattern Speed. This "behind the scenes" speed is not visible on any screen. Pattern speed is 1.2 times approach speed for the currently set landing flap and STOL/NORMAL approach settings. This speed is converted to true airspeed and used to compute turn radii. Simultaneously, TLAR monitors your actual ground speed and computes what bank angle/turn radius would be required to make a continuous turn to final. If this bank angle exceeds 30º, TLAR changes pattern speed to your current groundspeed and uses the new required bank angle (up to the 45º limit) to compute turn radii.

Turn Radius "Whisker" Indicators. TLAR places a left and right turn radius "whisker" arc originating from present position on the maps. They will not be present on a straight in or on final. The default radius is colored **WHITE** and is the no-wind radius corresponding to a 30º bank level turn at a true airspeed of 1.2 times Vref at the current gross weight and flap setting.

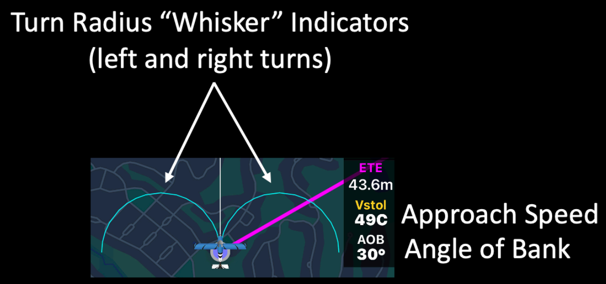


Figure 53 – Turn Radius "Whisker" Indicators

The turn whiskers will be colored **WHITE** if TLAR is currently using 30º of bank to calculate turns. They change to **CYAN** above 30º and less than or equal to 35º, **YELLOW** above 35º and less than 45º, and **RED** if 45º.

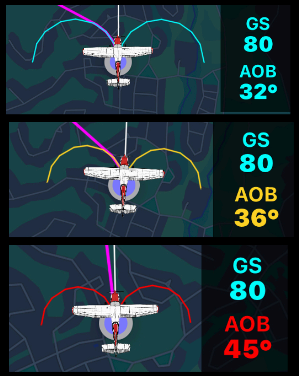


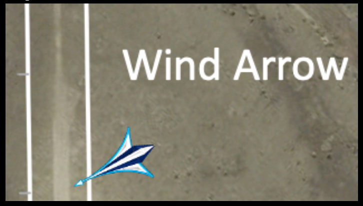
Figure 54 – Cyan, Yellow, and Red Turn Radius Whiskers

Bottom of Descent (BOD) Crosshatch. TLAR computes the location where a descent using the selected FPA intersects the selected LZ's TDZE, placing a crosshatch across the current track vector.

This is the BOD using the currently entered FPA assuming an immediate descent.

Flightpath marker. In a descent, TLAR computes a flight path marker which shows where the aircraft's current 3-dimensional vector would intersect the selected LZ's TDZE. In other words, the BOD crosshatch shows you what you have set, and the flightpath marker shows you what the plane is doing.

Wind arrow. Instead of along the compass edge, the wind arrow is placed near the center of the landing zone pointing the direction where the wind is coming from. If the windspeed is less than 1 or if using manual winds, the wind arrow will not be visible.



Wind controls. In manual wind mode, you can adjust the wind speed and wind direction on the Big Sky screen using toggle buttons. These settings carry-over to the performance screen (but are translated into headwind/tailwinds).

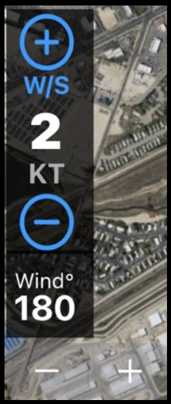


Figure 55 – Big Sky Manual Wind Controls

Traffic-Pattern Control

TLAR's traffic pattern engine constantly seeks to trace out an expeditious and flyable ground track from your present position to touchdown. It's not perfect, but it does a good job anticipating what kind of pattern makes sense to fly and displays that pattern using a magenta line. You can control TLAR's options using the traffic pattern selector at the top of the screen.

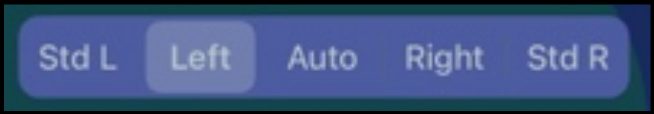


Figure 56 – Traffic Pattern Selector

The selector has five modes:

AUTO. This is the default setting. In auto mode, TLAR seeks to fly an efficient ground track to the active runway touchdown using either left or right traffic, straight-ins, direct to base, overflight of the airstrip etc.

Figure 57 – AUTO mode example

LEFT or RIGHT. TLAR will only use left or right traffic, but will still fly a straight-in or direct to base if it makes sense.

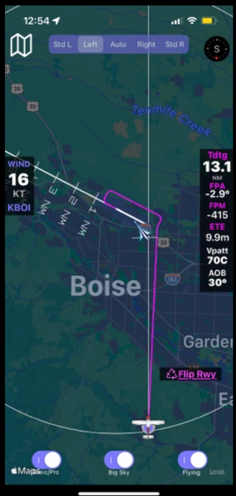


Figure 58 – Left mode example

STD L or **STD R.** In these modes, TLAR is forced to select a standard pattern entering at the right/left (as selected) 45º downwind entry point, or midfield downwind if you are already inside the downwind entry point. TLAR will honor the left/right selection but disregard entry via the downwind entry/midfield downwind points if already established in the traffic pattern.

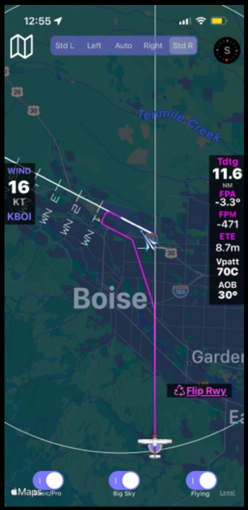


Figure 59 — Std R mode example

TLAR uses the resulting magenta-line ground track distance for ETE, FPA, FPM, sVAPI, and Glidepath Deviation indications.

Smart Visual Approach Path Indicator (sVAPI)

A traditional PAPI provides glidepath information based on an aircraft's straight-line distance and height to the PAPI and can only be seen within +/- 10º azimuth from runway centerline. Thus, they provide pilots no information on downwind, and erroneous information on base until the aircraft is lined up on final.

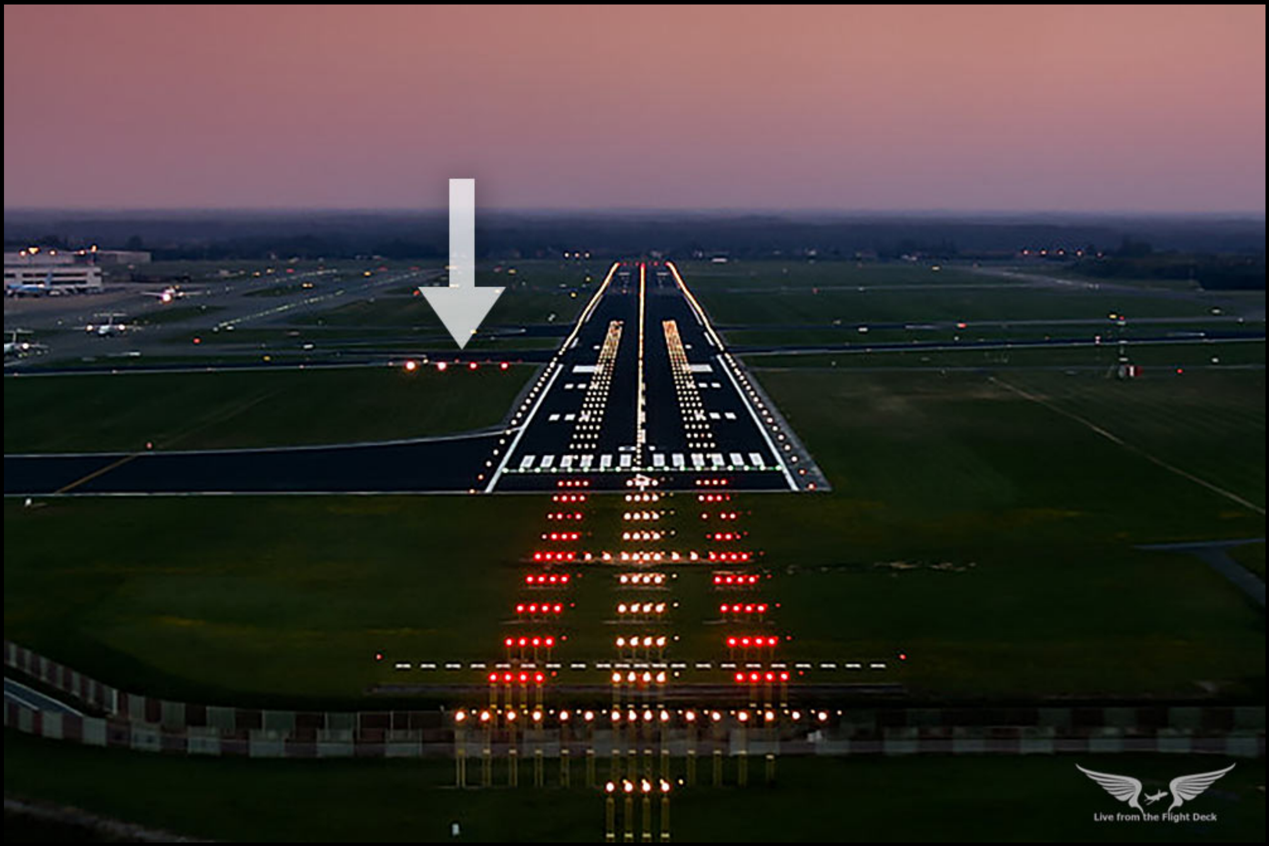
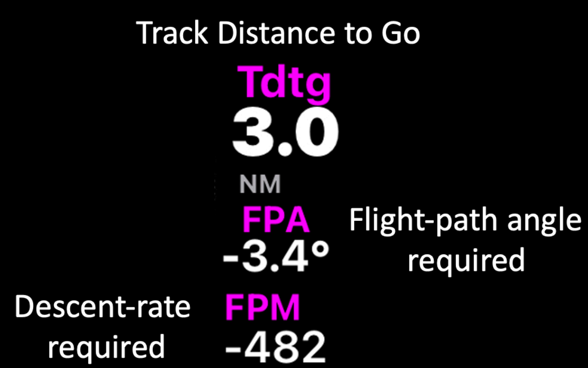


Figure 60 – Traditional PAPIs

TLAR's sVAPIs are smarter than that. TLAR computes an expected track-distance to touchdown and uses this distance in conjunction with the aircraft's height above the intended fence-crossing height to display glidepath information. TLAR updates it's estimated track-distance once each second. It's not perfect, but in flight testing we found it more useful than a standard PAPI.

Note – TLAR uses a 30° bank angle at 1.2 times computed approach true airspeed to calculate all pattern turn radii and distances. Exception- if the bank angle required to roll-out on final (based on position, groundspeed, and geometry) exceeds 30° TLAR will use up to 45° if needed.

TLAR will activate “sVAPIs” on each side of the LZ within 10NM of the approach-end and if the active LZ has a valid approach end coordinate, a valid axis, and a valid elevation, and if your position/track meet criteria. When the sVAPI’s are active, Track Distance to Go (Tdtg) replaces straight-line DME distance. The FPA/FPM shown is what is required along the track to reach the approach-end of the LZ at the desired threshold crossing height (fence height set in VNAV/CRZ settings plus the fence safety margin set in PILOT settings)(see Figure 63 – Landing Geometry).

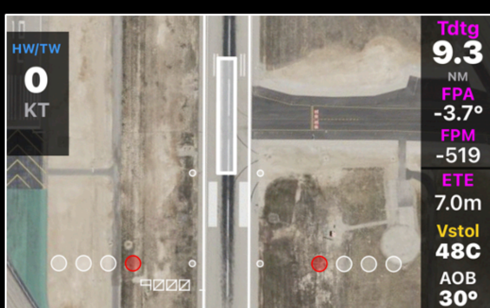


The sVAPI looks the same as a traditional Precision Approach Path Indicator (PAPI) but differs from a PAPI in its sensitivity, RPI, and “smart” glidepath guidance on downwind, base, and final.

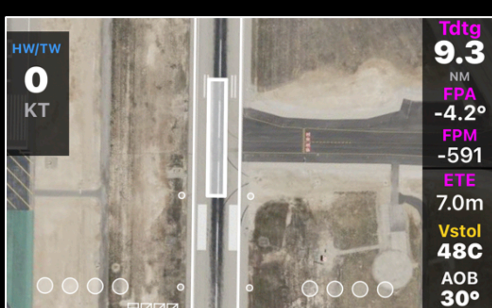
Low (< 1° below set fpa)

Slightly-low (0.5° to 1° below set fpa)

On-glidepath (-0.5° to +0.5° set fpa)



Slightly-high (0.5° to 1° above set fpa)



High (> 1° above set fpa)

Figure 61 – TLAR sVAPIs and Sensitivity

TLAR's sVAPI provides glideslope guidance to reach the approach-end waypoint at the entered threshold-crossing height (fence height plus fence safety margin) and changes colors in 0.5° glidepath increments. This means that on a runway with zero fence-height and zero-fence margin entered, the VAPI provides glidepath guidance to intercept the runway *at the threshold*. TLAR uses the flight path angle entered in PILOT SETTINGS as the reference glidepath for the sVAPIs. A traditional PAPI provides glideslope guidance normally coincident with the glide slope for one of the precision-instrument approaches with an RPI of about 1000 feet down the runway. A typical PAPI also has a tighter fpa tolerance to shift colors (<2.5° = low, 2.5° – 2.8° = slightly low, 2.8° – 3.2° = on glidepath, 3.2° – 3.5° = slightly high, and > 3.5° = high). We opted for a wider tolerance for the sVAPIs because most GA aircraft operate under VFR using a steeper glidepath day-to-day than the precision glidepaths of most instrument approaches.

> WARNING – TLAR has no terrain awareness and will not warn the pilot if the selected FPA will impact terrain.

> Note – Set your FPA wisely. If you select a steep reference FPA, say 6°, TLAR's VAPIs will show you "LOW" on glidepath if you are on a, say 4.9° glidepath, which is normally considered high on glidepath for nearly all approaches.

The normal transition sequence for a VFR approach is downwind, base, turn to final, and final. When inside 10NM from the LZ approach end and flying, TLAR determines what it thinks is the best pattern track to touchdown constrained by the pattern restrictions set using the pattern selector on the "Big Sky" view (Figure 56 – Traffic Pattern Selector). This track is shown as a magenta line on all map views.

You do not have to fly an approach in the traditional sequence (downwind to base to turn to final to final) for TLAR to detect what it thinks you are doing. For example, if you line up on a 20NM straight-in approach, TLAR will activate the sVAPIs using "On final" computations as soon as your aircraft is within 10NM of the approach-end of the LZ. Similarly, if your aircraft is lined up for a direct-to-base approach, TLAR will activate the sVAPIs using the "on base" calculations as soon as your aircraft meets "on-base" criteria.

TLAR will not display the sVAPIs if the approach end waypoint is not valid, or if it cannot determine a reasonable path to touchdown, or the approach geometry is ambiguous, or your turn radius will prevent arriving at the approach–end in a position to land. When this condition occurs, TLAR will display "ALIGN" in the flight status display. That said, eventually your approach geometry will almost certainly meet one the recognizable approach conditions and TLAR will active the sVAPIs.

Note – When the sVAPIs are deactivated, DME, FPA, and FPM displays revert to using direct-line distance to the LZ approach end for computations.

Landing Zone Geometries

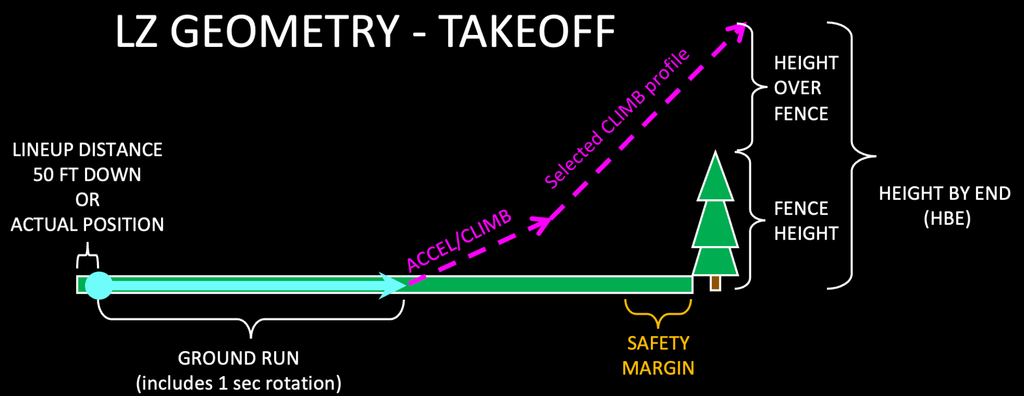
TAKEOFF

TLAR computes aircraft takeoff speed, takeoff ground run, takeoff distance over an obstacle, height by end, and climb gradient. TLAR uses maximum power available for takeoff, a 1 second delay for rotation, and accounts for aircraft weight, flap setting, atmospheric pressure, temperature, dew point, altitude, winds, surface type and condition, and runway slope. TLAR uses part of the excess power after liftoff to accelerate to the selected climb speed, and the rest of the excess to climb. After reaching the selected climb speed, TLAR uses all excess power to climb.

Toggle the accelerate-stop button to select the accelerate-stop geometry. The accelerate-stop runway distance is the distance required to accelerate to takeoff speed, lose all thrust, and then stop the aircraft straight ahead using landing brakes as (partial or max). TLAR assumes a 3 second reaction time prior to braking.

> WARNING – It is unwise and can be dangerous to plan a takeoff with little to zero margin for error. This is true in all aircraft, but especially so in most general aviation aircraft as their performance margins are less than other types of aircraft. Seemingly small differences in wind-speed, weight, temperature, surface conditions etc. can have large impacts on general-aviation aircraft performance.

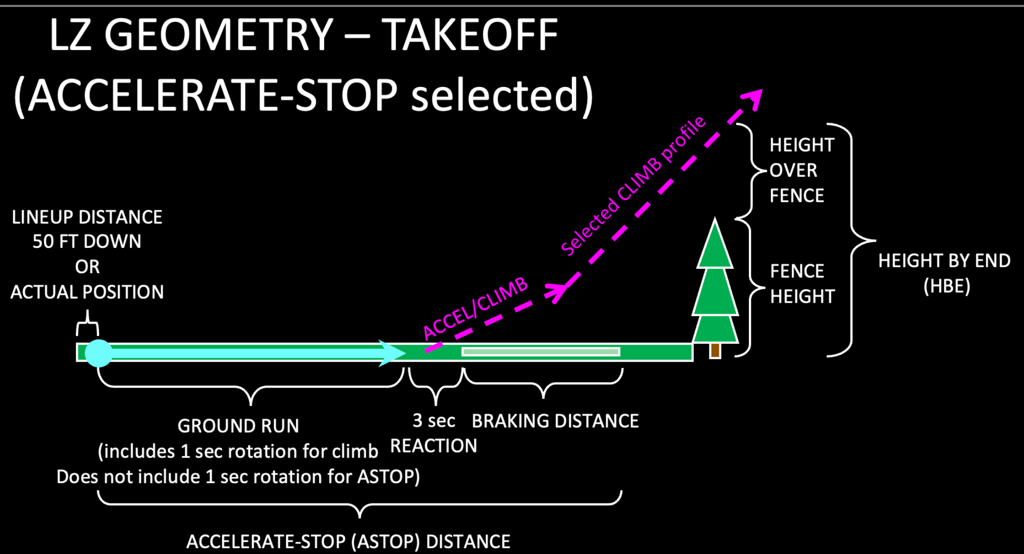
> CAUTION – Rolling takeoffs will likely result in TLAR not using actual aircraft position to determine available runway length. Instead, TLAR will use full-length minus a 50-foot line-up distance for runway available. Computed ground run distance will still be accurate, but the liftoff point may not be. This error is especially acute if the pilot elects to conduct a rolling intersection or rolling mid-field departure. We recommend lining up and bringing the aircraft to a stop on the runway as this will cause TLAR to update the available runway length based on actual position improving TLAR predictions for both takeoff ground run and lift-off points, especially on shorter runways or in cases with reduced runway available. As always, the pilot in command makes the decision and accepts the risk.



TLAR ASSESES "GREEN" IF BOTH (AND):
- LINEUP DISTANCE + GROUNDRUN + ROTATION + SAFETY MARGIN < RUNWAY LENGTH
- HEIGHT BY END > FENCE HEIGHT + 10

TLAR ASSESES "YELLOW" IF CONDITION IS NOT RED AND/OR:
- LINEUP DISTANCE + GROUNDRUN + ROTATION + SAFETY MARGIN > RUNWAY LENGTH
- OR PREDICTED HEIGHT OVER FENCE IS LESS THAN 10 FT

TLAR ASSESES "RED" IF EITHER/OR:
- LINEUP DISTANCE + GROUNDRUN + ROTATION > RUNWAY LENGTH
- HEIGHT BY END < FENCE HEIGHT



TLAR ASSESES "GREEN" IF BOTH (AND):
- LINEUP DISTANCE + ASTOP DISTANCE < RUNWAY LENGTH
- HEIGHT BY END > FENCE HEIGHT + 10

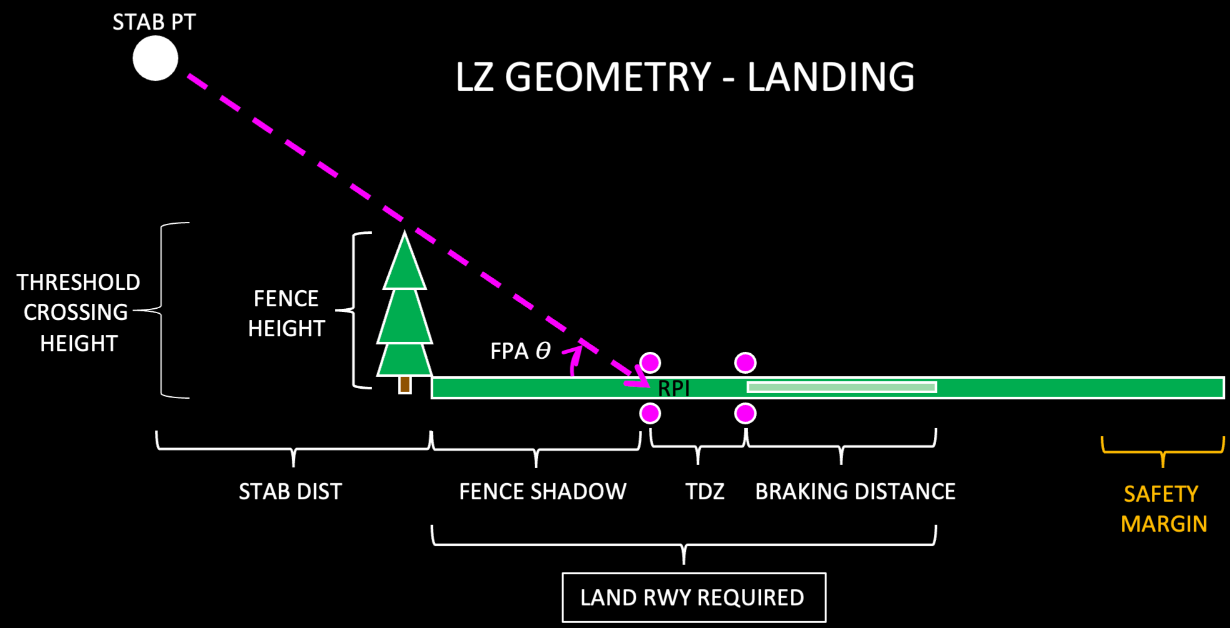
TLAR ASSESES "YELLOW" IF CONDITION IS NOT RED AND/OR:
- LINEUP DISTANCE + ASTOP DISTANCE > RUNWAY LENGTH
- OR PREDICTED HEIGHT OVER FENCE IS LESS THAN 10 FT

TLAR ASSESES "RED" IF EITHER/OR:
- LINEUP DISTANCE + GROUNDRUN + 1 SEC ROTATION > RUNWAY LENGTH
- HEIGHT BY END < FENCE HEIGHT

Figure 62 – Takeoff Geometries

LANDING

The Flight Path Angle (FPA) sets the flightpath angle TLAR uses to compute the fence shadow distance on landing. The fence shadow is the first portion of a landing zone that is essentially unreachable because the angle from the obstacle to the runway exceeds the set flight path angle.



TLAR ASSESES "GREEN" IF:
- FENCE SHADOW + TDZ + BRAKING DISTANCE + SAFETY MARGIN < RUNWAY LENGTH

TLAR ASSESES "YELLOW" IF CONDITION IS NOT RED AND:
- FENCE SHADOW + TDZ + BRAKING DISTANCE + SAFETY MARGIN > RUNWAY LENGTH

TLAR ASSESES "RED" IF:
- FENCE SHADOW + BRAKING DISTANCE > RUNWAY LENGTH

Figure 63 – Landing Geometry

In extreme cases, runway down slope can exceed the entered FPA. If so, you probably shouldn't be landing there! TLAR will invalidate landing performance calculations if this situation exists.

The runway point of intercept (RPI) is where the glidepath intercepts the runway. This where TLAR starts the touchdown zone.

The touchdown zone length is meant to account for the distance required for the pilot to round-out, flare, touchdown, and begin braking. The touchdown zone's length is set in the Pilot settings menu. Set this parameter wisely.

During an actual approach, TLAR will adjust the RPI if needed. If you are too steep (FPA required higher than the set FPA), TLAR will displace the RPI down the runway until the RPI can be reached using the entered FPA, and then re-compute the landing distances and re-assess green-yellow-red status.

TLAR assumes that braking begins at the end of the touchdown zone, and computes the distance required to dissipate ground speed to zero as a function of selected brakes (PARTIAL/MAX), surface type (Grass etc.), condition (DRY/WET), and runway slope.

Features

Stabilized Approach Monitoring System

When the aircraft enters the stabilization zone (distance to the threshold is less than the set stabilization distance, aircraft track is within 30º of LZ axis, the aircraft is within 15º of bearing to the departure end), TLAR will **(see Figure 64)**:

- Switch to DYNAMIC mode if not already, which uses GPS ground speed for landing performance calculations

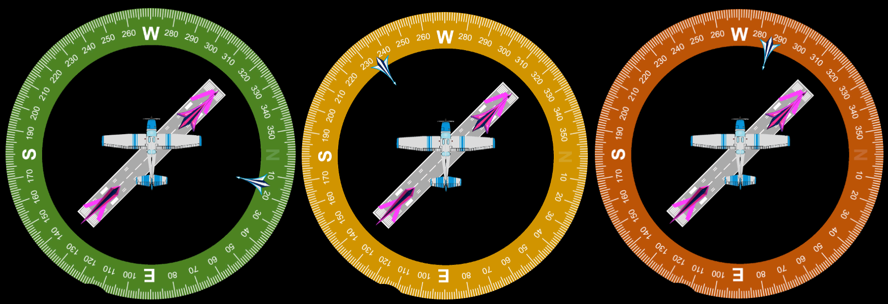
- Assess approach stability

  - as “nominal” if:
    - required glidepath to the intended threshold crossing height is within 1º of the FPA parameter as entered in Pilot settings. -AND-
    - actual ground speed is within 10 knots of predicted approach ground speed

  - as “unstable” if either criterion above is not met

  - color the compass with TLAR’s stop point assessment:
    - GREEN = you can stop without violating your set safety margin
    - FLASHING YELLOW = you will stop inside your set safety margin from runway end
    - FLASHING RED = you cannot stop by runway end

  - make an audio call-out (see Audio Call Outs)



- As the approach continues, once per second TLAR will adjust the predicted touchdown point (if necessary) based on GPS altitude above glidepath using the pilot-entered maximum flight-path angle and color the compass corresponding to its new assessment.

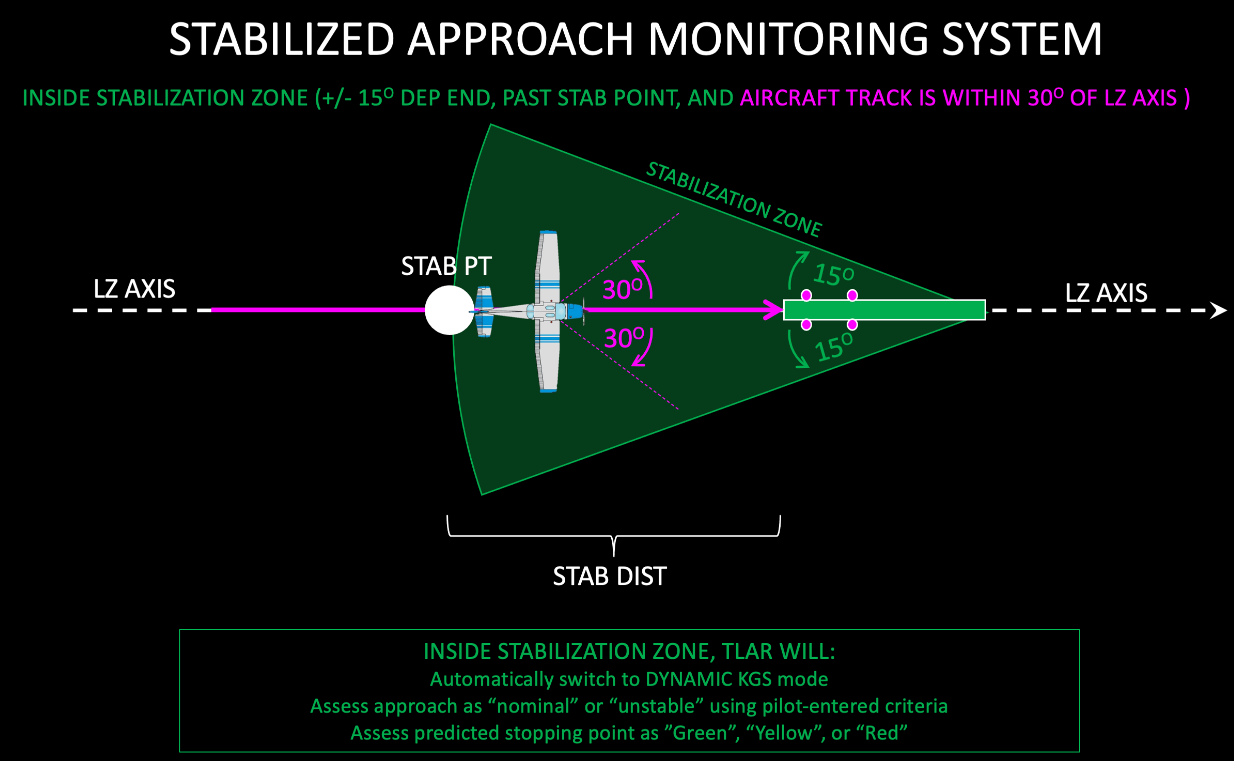


Figure 64 – Stabilized Approach Monitoring System

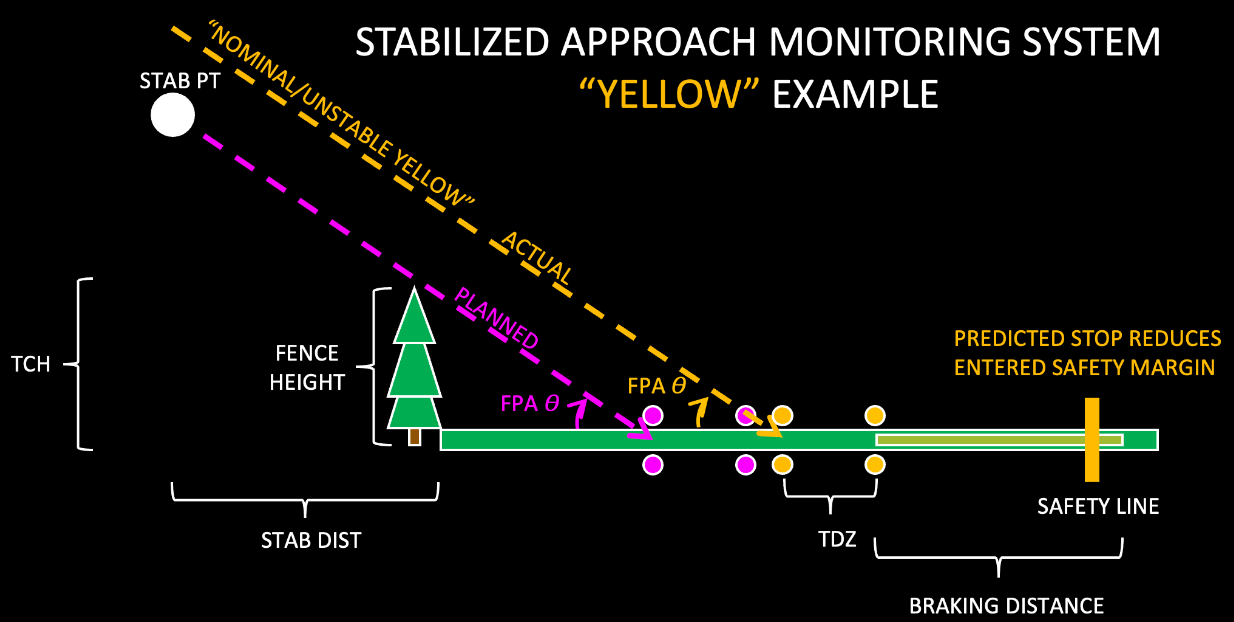


Figure 65 – Stabilized Approach Yellow Example

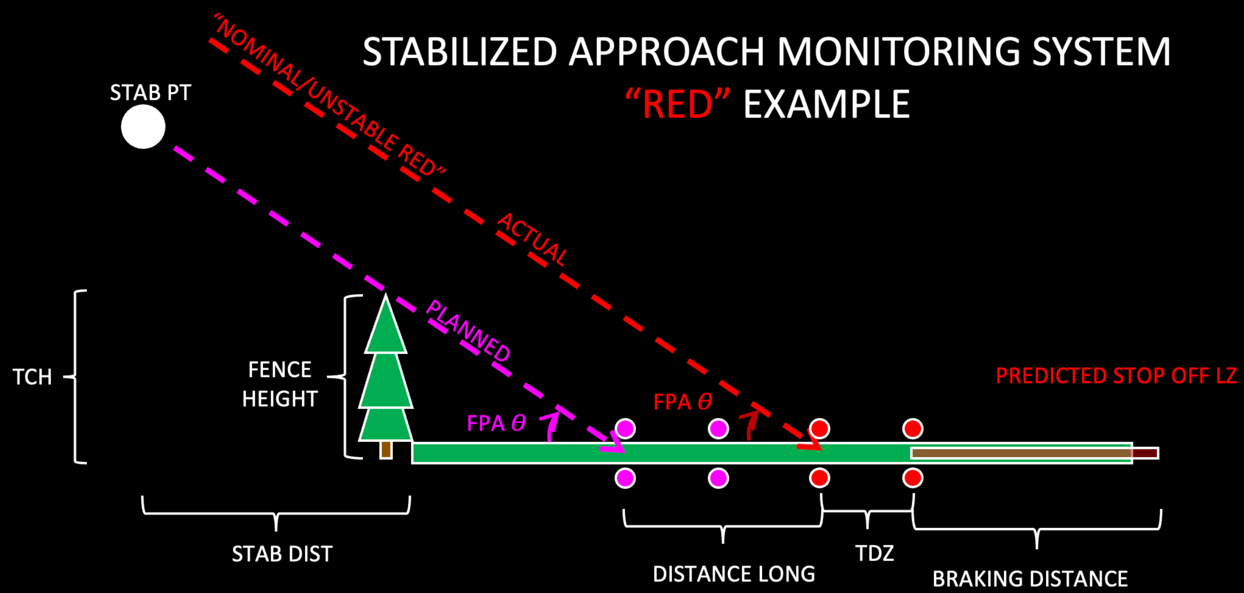


Figure 66 – Stabilized Approach Red Example

Audio Call Outs

Line-up

When the aircraft is on the active LZ, lined up with the runway axis, and stopped, TLAR will announce “Lined up.” This call is important to wait for if you intend to capture accurate takeoff data for use on the DEBRIEF view. TLAR also turns on your iDevice’s motion sensors once lined up. You can confirm this by looking for a GREEN colored center status ball inside the NAV status ball. 

Perch-Point

Crossing the perch-point on downwind (point abeam the roll-out point which is twice the set stabilization distance from the threshold on LZ extended centerline), TLAR will announce “Perch.”

Stabilization

When the aircraft first enters the stabilization zone (see Figure 64), TLAR will evaluate stability using the aircraft’s position on glidepath and it’s current groundspeed vs predicted Vref groundspeed. TLAR will assess the approach and report it’s assessment via voice. TLAR constructs it’s call-out as follows:

If stable, call out will begin with the word, “NOMINAL.” If unstable, the call-out will begin with “UNSTABLE” and will add the words “HIGH/LOW” and/or “FAST/SLOW” as applicable.

All calls end with TLAR’s assessment of the plane’s ability to stop using “GREEN” if can stop before the safety margin, “YELLOW” if the plane will stop past the safety line, and “RED” if TLAR assesses the plane unable to stop by the end of the runway.

A few examples:

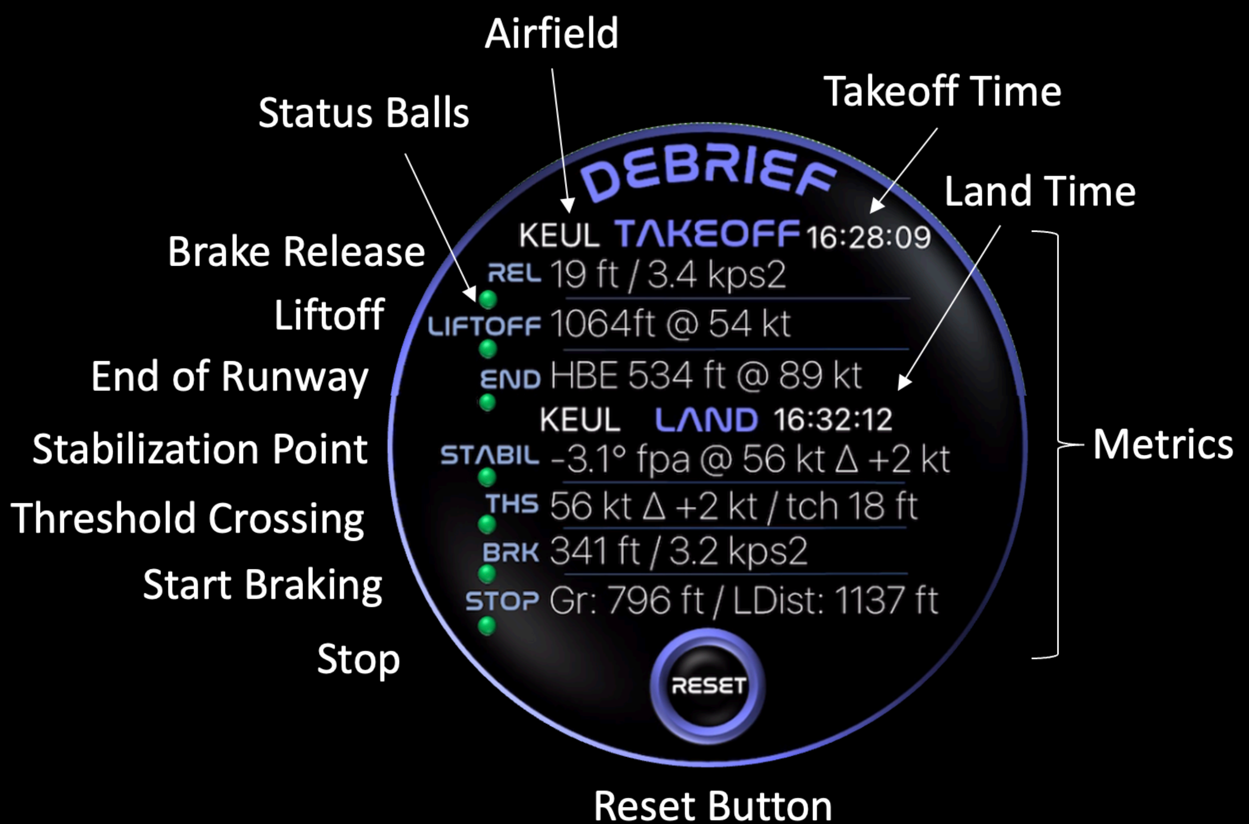
- “Nominal Green”
- “Nominal Yellow”
- “Unstable High Green”
- “Unstable Fast High Red”

Note – on longer runways, it is possible to be “unstable,” yet still “green” just as on short runways it is possible to be “nominal yellow.”

As always, the Pilot-In-Command is the one to decide whether to continue an approach or go-around.

Debrief

TLAR's debrief screen is useful for analyzing actual performance during takeoffs and landings. You can access this screen by toggling the DATA button IF there is an active LZ is use (magenta pointer visible). TLAR resets the brake release, liftoff, and end of runway metrics when the plane is on the runway, lined up for takeoff, and stopped.[3] TLAR then turns your iDevice's motion sensor on (motion-sensor ball inside the NAV-status ball will turn from WHITE to GREEN). The stabilization metric is reset after liftoff, or just prior to entering the stabilization zone if a liftoff is not recorded (such as after a go-around). The threshold crossing, start braking, and stop metrics get reset at the approach stabilization point. See the takeoff and landing geometries section for more information about these points.



<u>Brake Release</u> – at brake release TLAR captures your position and measures the average acceleration of the aircraft during the

[3] Note –If you line up on a runway more than 1500 feet behind the approach end waypoint, TLAR will NOT activate the motion sensors. There are some runways in the world with displaced thresholds greater than 1500 feet.

takeoff run. TLAR displays position in feet or meters measured from the approach end of the runway to the release point.

Liftoff – TLAR uses two techniques to capture the liftoff point. The first uses pitch-changes. This method works if your phone and aircraft have the same pitch axis from brakes release until liftoff. This should be true if your iDevice is mounted to the aircraft panel or dash with the screen facing the pilot in a portrait orientation such that the iDevice will rotate about it's pitch axis when the aircraft pitches up/down:

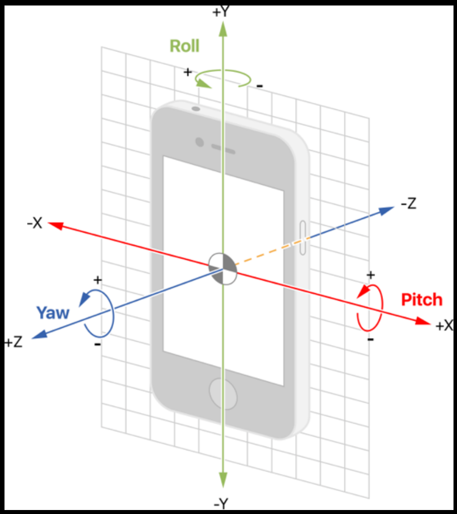


Figure 67 – iPhone Axes

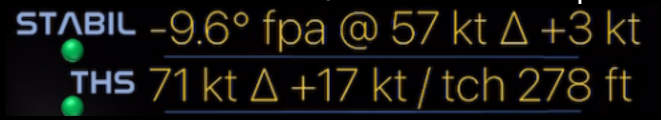
TLAR uses groundspeed as a backup to the pitch method, recording a liftoff when you reach predicted takeoff groundspeed. When either occurs, TLAR display's your groundspeed at liftoff and the measured ground run in feet or meters from either brake release (if captured) or the approach end of the runway (if brake release is not captured). TLAR will place an asterisk* after the liftoff speed if groundspeed was used to determine the distance.

End of Runway – If you fly over the departure end of the runway, TLAR will capture your actual height by end in feet or meters and your groundspeed.

Stabilization – At the stabilization point, TLAR will capture your required flight path angle to reach the threshold at the set fence-height plus the fence safety margin. TLAR also captures the groundspeed at this point and displays the delta speed as compared to the expected approach groundspeed based on approach type (STOL or NORM) and winds.

Threshold Crossing – TLAR captures the aircraft's groundspeed, delta from predicted, crossing height in feet, and time of arrival when you cross the threshold.

If you are close to unstable (required FPA not within 0.5° of entered FPA or groundspeed not within 5 knots of expected) crossing the stabilization and / or threshold crossing point, TLAR will color the metric text YELLOW. If you are unstable the text will be RED (required FPA more than 1° higher/lower than entered FPA, or KGS more than 10 knots faster/slower than predicted).



Start Braking – At the onset of braking, TLAR captures the position (measured in feet or meters from the approach end) and average deceleration during braking until stopped.

Stop – once stopped, TLAR records the ground roll (distance from start braking to stop) and landing distance (approach end to stop point) measured in feet or meters. If the start braking point was not captured, the ground roll and landing distances will be the same and measured from the approach end of the runway and TLAR will place an asterisk* after the ground roll distance.

Status Balls – TLAR displays a small colored ball under each metric to indicate it's status as follows:

White Ball – Metric reset and ready to be captured

Green Ball – Metric recorded

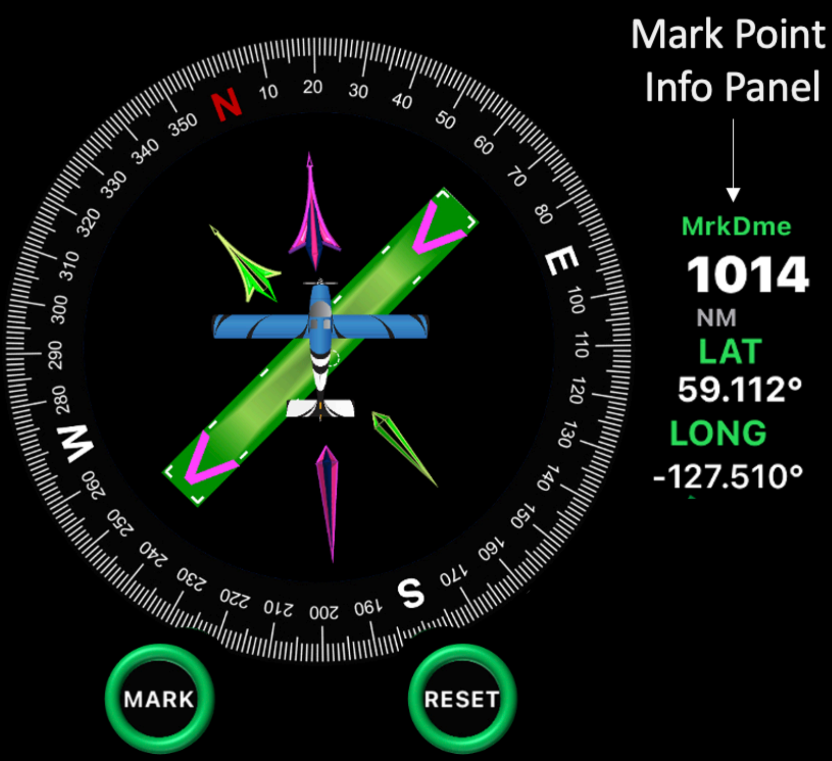
Yellow Ball – Metric recorded, but one or more metrics from the same event have been reset (usually seen for landing metrics when stabilization reset after takeoff)

Red Ball – Metric recorded but might be erroneous or from a previous event.

Reset button – manually resets all metrics to zero and ready for capture.

Mark Point

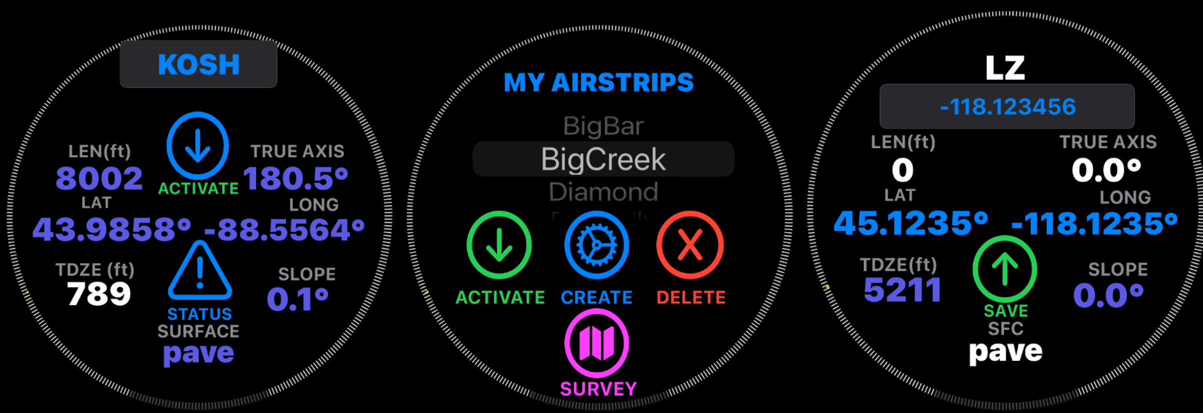
You can mark your current position using the "MARK" button. When pressed, TLAR will store your current position, display a green bearing pointer on the HIS which points to the stored point, and change the landing zone information panel into a mark point information panel. The longitude data field will alternate once a second to display mark point elevation as obtained from the USGS elevation point server (if network available). TLAR defaults this value to -888 feet if the server is unavailable, or if a point outside the United States is stored.



Once you store a mark point, the "MARK" button change's function. It now serves to toggle on/off display of the green bearing pointer and mark point information panel at right. To store a new mark point, you must use the "RESET" button.

The "RESET" button appears after you store a mark point. Tapping the "RESET" button will erase the current mark point, remove the green bearing pointer, and revert the mark store information panel to the landing zone information panel. The "MARK" button is now armed and ready to store a new mark point when pressed.

TLAR can also load the mark point with the coordinates of an airport from either the global database or one of your personal LZ’s from “My Airstrips”. If the “mark” button is pressed on each of the three screens below, TLAR will load the approach end coordinates into the mark-point.



On the “My Airstrips” window, TLAR loads the approach-end coordinates of the currently selected LZ on the scroll-wheel. On the activate loaded runway and save created runway views, TLAR loads the coordinates displayed. You do not have to save the created LZ to load the mark point.

TLAR-EXPERT

TLAR-expert adds patent-pending technology that assists the pilot with engine-failure in flight decision-making. It also adds an automatic mode that continuously scans for and auto-loads the nearest/best glide-to runway, defaults to auto-METARs on start, and automatically turns your motor on/off. This combination of changes allows TLAR to operate accurately with very little pilot interaction. Set your zero-fuel weight and fuel on board, then go fly, TLAR will do it's best to handle the rest. Finally, we've added telemetry recording to TLAR-expert.

Engine Failure On Takeoff

TLAR-expert's emergency modes are our best engineering answer to the "the impossible turn." For those who may not be familiar, the "impossible turn" is the label placed on the maneuver to return to the runway of departure following an engine failure shortly after takeoff in a single engine aircraft.

In 2023, Owyhee Aviation, LLC informally partnered with the EAA and FlyOnSpeed.org to develop an emergency landing capability inside TLAR. At present, this BETA capability has been test flown in Glasair Sportsman (many flights), Vans RV-4 (many flights), and a Piper Cherokee (once) aircraft. We welcome your participation as operational test flight pilots to give us feedback for the purpose of making this capability more accurate and hence more useful for the community at large. We consider this technology to be promising, but not "validated," and it may never be "validated." Very few (none?) POH's have hard data on emergency turn-backs, most limit themselves to providing an engine-out glide ratio chart with an airspeed (Vg), usually at max gross weight. The aerodynamics and physics of the turnback maneuver is complex, yet a decision to turn back or land ahead must be made quickly and under stress. The TLAR turnback engine re-evaluates this maneuver once per second and displays what it thinks the aircraft is capable of doing assuming that the pilot flies the aircraft in accordance with the set parameters and weather conditions. While we have shown through flight testing that it is useful, it ***WILL NOT EVER*** be "spot on" given all the variables involved.

WARNING – The emergency turnback maneuver is inherently dangerous, even conducted in training with an operating engine. It involves maneuvering the aircraft with precision, near stall-speed, and close to the ground. In most cases the safest course of action is to glide-land the aircraft on the most suitable off-airport surface that is in front of the aircraft. Stalling the aircraft is the primary threat.

The following paragraph is credit to FlyOnspeed.org and is quoted here to underscore the WARNING above:

> *Turnback Feasibility. NTSB data since 1 January 2013 include* ***133 turnback attempts*** *after partial or full power loss during initial climb. Of those attempts,* ***9 were successful*** *(7 of those were partial power loss and 2 were to long runways). The exact number of turnbacks that resulted in successful landing and not reported is not known; but based on available mishap data, it is reasonable to estimate the actual number of successful turnbacks is low. Mishaps where the pilot maneuvered ahead of the wing line were 35% fatal. The fatal rate when the pilot attempted to maneuver aft of the wing line nearly doubled to 59%. For turnback attempts below 600' AGL,* ***54% stalled with a 95% rate of severe or fatal injury****. Aircraft that maneuvered ahead of the wing line, 8% stalled with a 71% rate of severe or fatal injury. The probability of severe or fatal injury because of stall and loss of control following power loss is high when post engine failure maneuvering is attempted. This contrasts with the 25% fatality rate for EAB airplanes that hit structures on the ground (worst-case scenario) under control. Mishap rates are relatively consistent regardless of pilot experience, license, or ratings, including instructors. Fully 1/3 (28-38%) of all pilots attempted turnback, regardless of altitude, and 28% of all attempts were below 200' AGL. These statistics clearly demonstrate the need for improving pilot decision making and handling skills in the event a power loss occurs during takeoff or initial climb. They also demonstrate that the safest course of action in the event of power loss during initial climb is to maneuver ahead of the wing line without stalling the airplane.*

Understanding the Turnback

The two keys to a successful turnback following a real or simulated engine failure shortly after takeoff are 1) starting at an altitude above the minimum turnback altitude and 2) maintaining aircraft control (i.e. not stalling in the turn). The minimum turnback altitude varies by aircraft type, drag configuration (flaps, aircraft modifications, and motor/prop status (windmilling? Stopped? Coarse or fine pitch, throttle open or closed? etc)), gross weight, temperature, pressure, elevation, wind, bank angle, g-loading, and distance from the airfield. Almost all these factors vary day to day and minute by minute, which means, contrary to common anecdote, *there is no single altitude you can rely on as a guide as to whether you can make a turnback. In fact, some of these factors make very significant changes in the minimum turnback altitude.* TLAR does a good job of analyzing these factors in real time and displays its estimate of your capability to execute a turnback. That said, it is just a model, and the "garbage in, garbage out" maxim applies. If inputs such as Vref speed, glide ratio/speed, weather conditions, bank angle, climb profile etc. do not match actual conditions, TLAR's estimate will be wrong.

Minimum turnback distance

The minimum turnback distance (downtrack) is (usually[4]) equal to the two times the turn radius of the aircraft (plus roll-in/roll-out). Turn radius is a function of bank angle (g-load) and true airspeed. True airspeed is a function of flown calibrated airspeed, air pressure, air temperature, and humidity. The higher the true airspeed, the larger the turn radius and lower the turn rate for any given bank angle (g-load). Likewise, the higher the bank-angle (g-load) the smaller the turn radius and higher the turn rate for any given true airspeed.

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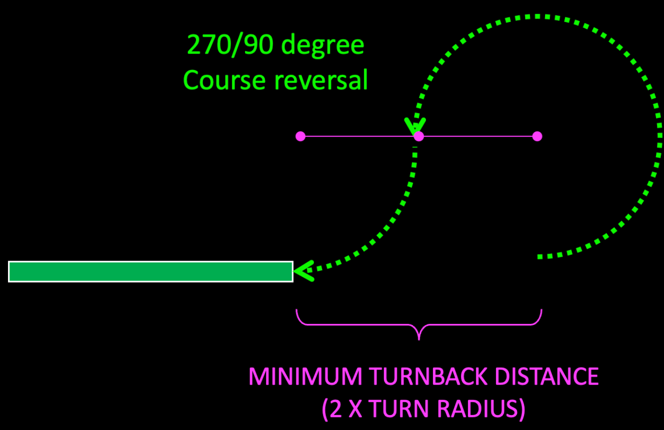
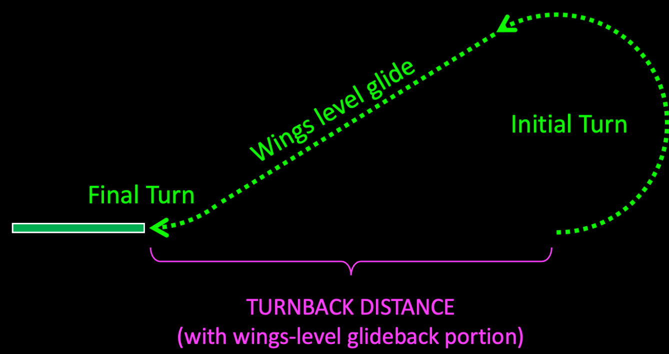
[4] Some combinations of long runways and/or very high climb gradients can result in geometries where an aircraft could execute a 360-degree gliding turn (or even a gliding turn to downwind, base, and final) to land straight ahead instead of an opposite direction turnback. In other cases, a gliding forward teardrop turning to land opposite direction may be possible. TLAR will identify these cases and display them graphically in its dynamic emergency mode (when flying).



As the aircraft climbs out, the geometry of a turnback maneuver changes with less degrees of total turn, but with a wings-level glide back portion.



Minimum turnback altitude

The minimum turnback altitude is equal to the altitude lost in an engine-out glide while performing the turnback maneuver. Initially, this altitude is the altitude lost in a 270/90 degree gliding course reversal. As the aircraft climbs out and gets further from the runway, this altitude becomes the altitude lost in the initial and final turns plus altitude lost gliding back with wings level.

Turnback bank, speed, and angle of attack

Forty-five degrees of bank (1.41 g's) is optimum to minimize altitude loss during gliding turns. Using a higher or a lower bank will result in a greater altitude loss during the maneuver.

For aircraft lacking angle of attack systems, we have found that the most reasonable speed to fly during a turnback is 1.3 times the wings level, flaps up stall speed. We call this speed Vref.

This speed is a balance between stall margin and altitude lost turning. For many GA aircraft 1.3 x Vs level yields about a 5-6 knot stall margin in a 45-degree banked (1.41g) turn. For most aircraft this speed is slower than best glide speed.

Contrary to intuition, flying best glide speed during a turnback is NOT necessarily the best. While best glide speed yields the furthest distance to glide in a straight line, things change in turns. This is because anything that increases the true airspeed in the turn, like flying best glide speed, results in a larger turn radius and a slower turn rate, which increases track distance and time in the turn, and subsequently more altitude loss in the turnback. However, this is balanced by the fact that best glide speed is the best speed to fly when wings level.

Early on, the total track distance flown in a turnback is dominated by distance flown on turns. As the climb out continues, this changes and eventually the wings-level glide portion of the maneuver dominates the total track distance flown. This might suggest using one speed in the turn and another for the wing level glide. This suffers two drawbacks. First, you must sacrifice altitude to gain airspeed to accelerate to best glide speed. Second, it complicates what the pilot must do in an already stressful situation. A constant speed turnback is a variable angle of attack maneuver (higher AoA in the turn, lower AoA when level or rolling out).

The proper use of a calibrated angle of attack system alleviates the speed-conundrum. During a turnback, aircraft so equipped should be flown at a constant angle of attack equating to 60% of available lift in both turns and in level flight. This results in a near optimum maneuver which is flown at a constant angle of attack and a variable airspeed.

Regardless of selected glide speed or angle of attack, the pilot must not stall in the turn! Proper speed control, and use of angle of attack / stall warning systems is paramount.

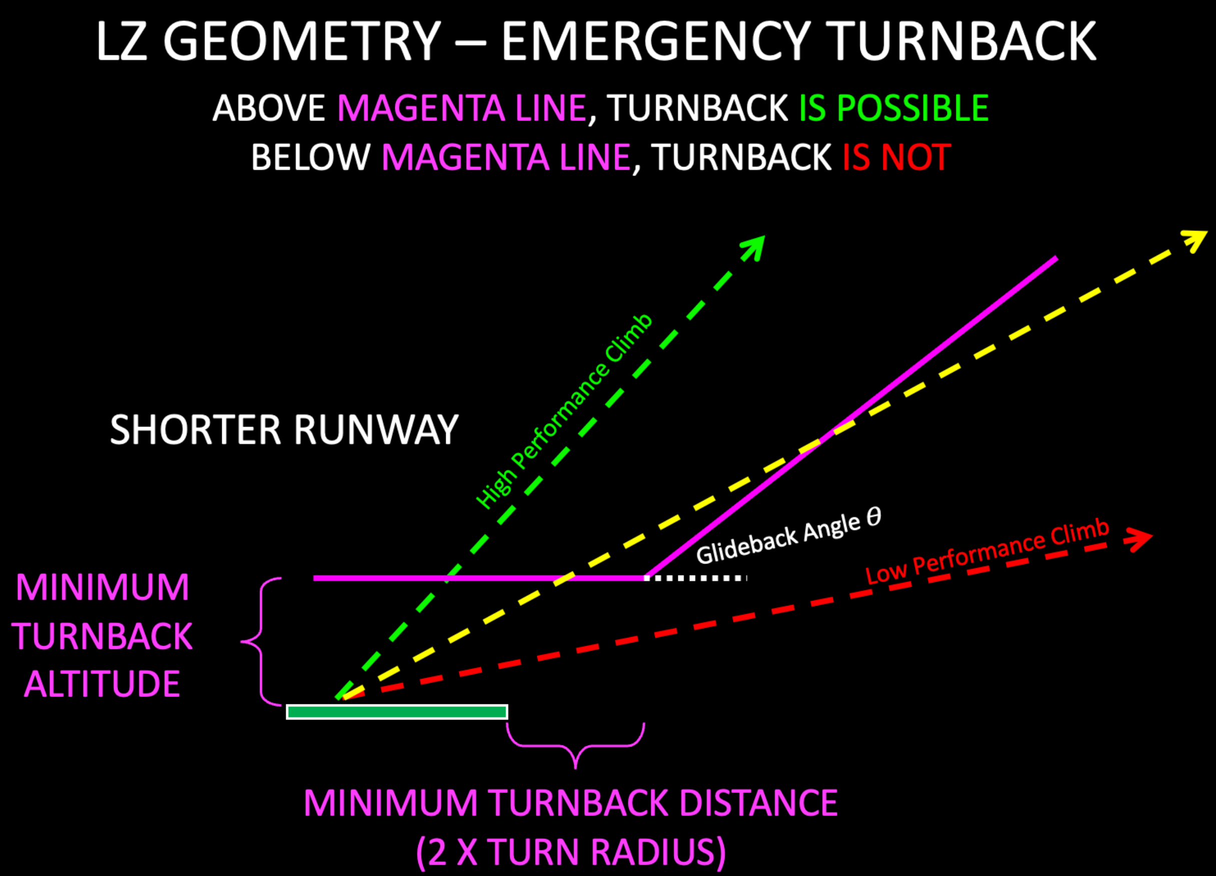
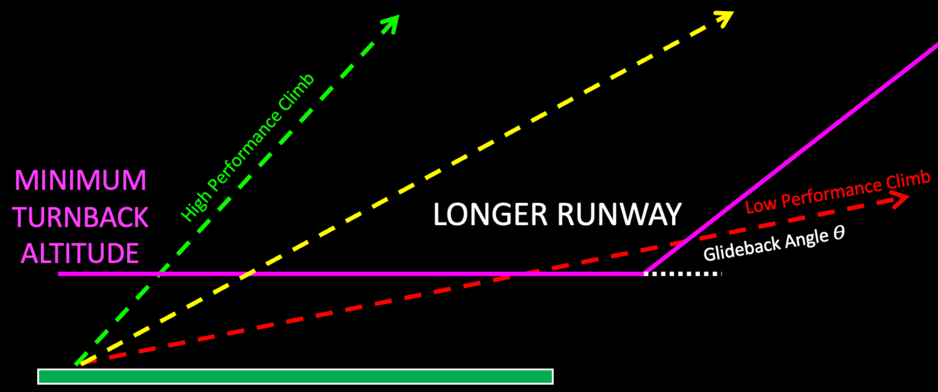


Figure 68 – Turnback Geometry Shorter Runway

The figure above shows the vertical geometry of the emergency turnback on a shorter runway. As expected, high performing aircraft reach a turnback-possible condition sooner than lower performing aircraft. Also note that if the climb angle is less than the glide back angle, the result can be reaching a turn-back possible condition for a period and then exiting that condition back to a negative turnback condition (yellow profile in the figure). This can occur even for shallow (low performance) climbs on long runways (see red profile in the figure below). These examples pre-suppose a straight ahead climb and departure. One way to improve the likelihood of reaching a turnback possible condition would be to execute a turn shortly after takeoff remaining close to the runway (such as a turn to a downwind departure) or even spiral up over the runway.



CLIMB PERFORMANCE, RUNWAY LENGTH, ALTITUDE LOST IN TURNBACK, AND GLIDEBACK DESCENT ANGLE DETERMINE TURNBACK POTENTIAL

Figure 69 – Turnback Geometry Longer Runway

It should be noted that even high performing aircraft will eventually (on an extended straight-ahead climb out) cross back into a negative turnback condition. As air density decreases in the climb, their climb angle decays below their glide back angle which eventually cancels out the buffer above the glidepath they generated earlier in the climb.

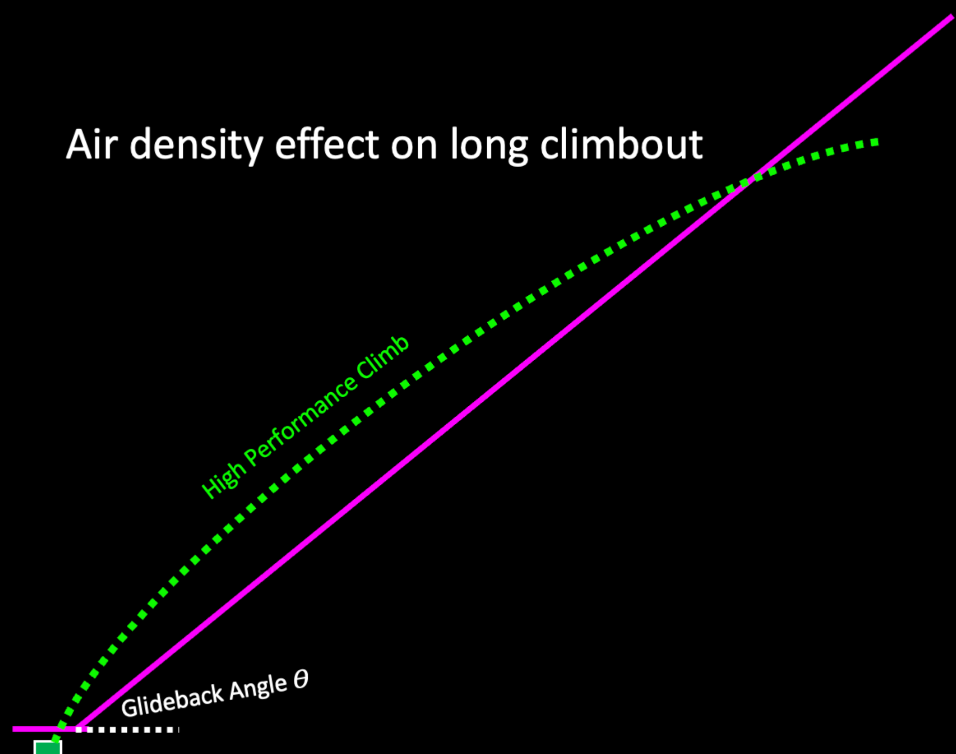


Figure 70 – Air Density Effect on Climb

TLAR-expert's Emergency Modes

TLAR implements two emergency landing modes. A predictive mode used on the ground, and a dynamic mode which takes over once flying. TLAR auto-switches between these modes based on groundspeed. Each mode displays its information on the "Big Sky" screen if the pilot activates the "EMERGENCY" switch at bottom right on the "Big Sky" screen.

Predictive Mode (on ground).

TLAR uses a predictive model when the aircraft is on the ground. TLAR assumes a straight-ahead departure on runway axis using the selected climb profile until engine failure. TLAR computes the profile from brake release to 5NM down track and displays several key parameters. The first is a yellow X which is the latest location you can still stop/land straight ahead on the runway. An X prior to the liftoff point is the latest abort point prior to liftoff. An X after the liftoff point is the latest point where you can glide back to the runway and stop before the end. The second is a green dot which is the earliest location where an emergency engine-out turnback is possible. TLAR also displays the MSL altitude coinciding with this earliest turnback location. In some cases, a continued straight-ahead climb will transition from a turnback-capable region and to a negative turnback capable one. If this situation exists, TLAR displays a red dot at its predicted location, and displays a red MSL altitude corresponding to this point. If conditions permit a turnback all the way through 5 NM down track, TLAR will display "thru >5NM." All these predictions are a function of aircraft performance, weather conditions, selected climb profile, selected turn-back bank angle, set glide ratio/speed, and selected Vref stall ratio. If a turnback is not predicted to be possible, TLAR will not display a turnback location and the turnback altitude will show "N/A."

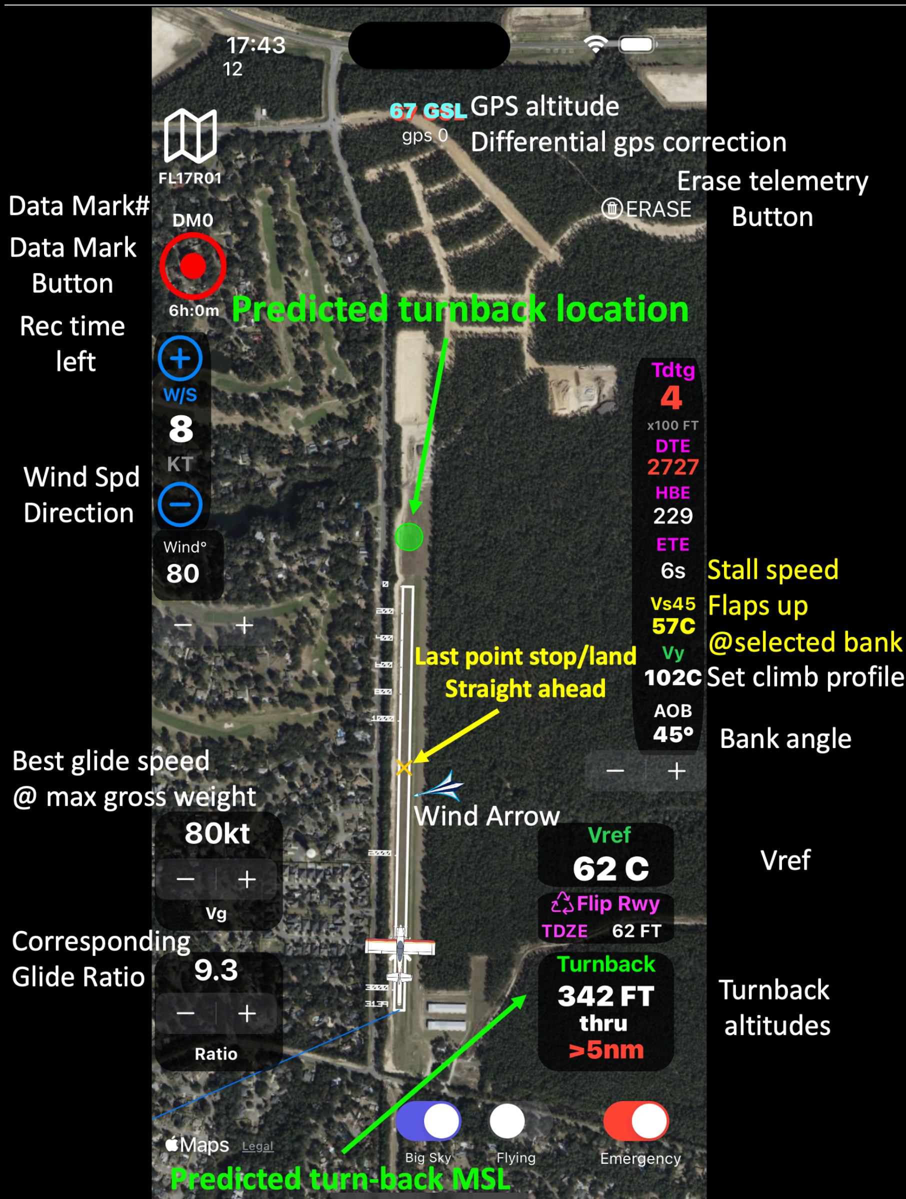


Figure 71 – Predictive Mode

CAUTION – All general-aviation aircraft on a straight-ahead departure, regardless of performance capability, at some point will reach a point where a turnback to the runway of departure is not possible. This point occurs at a relatively low altitude for lower performance planes (those unable to outclimb their gliding descent angle, but taking off from a long runway) and higher altitudes for high performance planes that can outclimb their gliding descent angle. For these high performing planes, as air density decreases in the climb, their climb angle decays and eventually will reach a point where a turnback is not possible. TLAR displays this "negative turnback" point if it occurs before reaching 5 NM down track on climb-out.

Note – Many GA aircraft do not have the climb performance necessary to *ever* reach a turnback-possible condition on a straight-out departure *from a short runway*. Even so-called high-performance planes can be rendered not turn-back possible with even just a modest tailwind on takeoff.

Dynamic Model (in flight).

Once flying, TLAR evaluates each second whether you can glide to a land-able location on the active LZ. In dynamic mode, TLAR no longer uses the selected climb profile. Instead, it uses the aircraft's actual position, speed, track, and altitude to determine if a glide to a land-able spot is possible based on weather conditions. This includes turns required to align the aircraft with the land-able location on the active LZ.

TLAR displays your aircraft's glide footprint until you reach a position where an engine-out glide to the runway is possible. At that point, the glide footprint goes away and TLAR draws a CYAN route of flight, including turns, to the runway. TLAR also displays the predicted threshold crossing height reaching the runway.

Threshold crossing height (TCH) is the predicted altitude above ground that you would arrive at the runway aimpoint after an engine-out turnback/glide to that point. It assumes a Vref speed glide using the selected bank angle and factors in current aircraft and environmental conditions. There is also an adjustment for the current energy state.

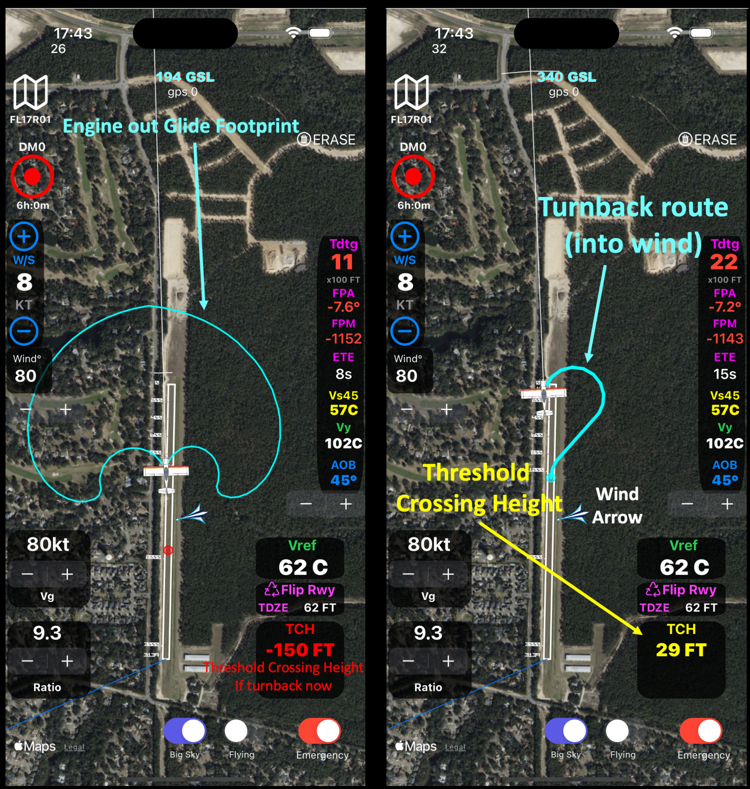


Figure 72 – Dynamic Mode

Set-up guidance.

Two of the most important factors to "get right" are the windmilling glide ratio and windmilling best *calibrated* glide speed of your aircraft *at maximum gross weight*. TLAR uses this information to compute drag and wing efficiency coefficients and will automatically adjust gliding/turning performance for different gross weights. If your aircraft's POH has this data, but your configuration is different (larger tires, STOL modifications, propeller, engine, etc), your aircraft will not glide the same as the test aircraft the manufacturer used to produce the data in the POH. If such is the case, or your POH does not have glide data, you *must* glide test your aircraft and measure your glide performance at maximum gross weight for your specific configuration and enter it into TLAR for it to be accurate. *Failure to do so will result in faulty guidance.* For aircraft with controllable propellers, there is a significant difference in gliding performance between using coarse versus fine pitch. Use coarse pitch to maximize your glide. During an actual emergency, you may or may not be able to change your propeller's pitch depending on the nature of the emergency. *This results in a decision YOU must make: whether to enter glide data based on coarse or fine pitch on your propeller.*

Load all "normal" settings for Aircraft, Pilot, Airport/My Airstrips and VNAV as described in the main TLAR manual. Some of these settings are particularly important to emergency gliding calculations:

Using either AIRPORTS or MY AIRSTRIPS, activate an airport or airstrip. This is required. The LZ must have precise coordinates (some airports in the database don't have precise coords, TLAR will notify you if such is the case). TLAR will hide the "Emergency" switch until a precise LZ is activated. If your selected airport is not precise, you can create an LZ in MY AIRSTRIPS either via manual entry ("CREATE") or survey ("SURVEY"). TLAR assumes all pilot-created LZ's are precise.

After activating a precise LZ, get/set the weather conditions (Temperature, Pressure, Elevation Source, and Winds) using either manual entry some some/all or METAR data downloaded from the internet for some/all. Set elevation source to TDZE.

CAUTION – While it is important that the temperature, pressure, and elevation source are accurate. It is CRITICAL that the winds are accurate.

Vref

Vref is the speed which TLAR uses to compute engine-out gliding performance. As discussed previously in the "Turnback bank, speed, and angle of attack" section above, best glide speed is not necessarily the best speed to fly on turns during an emergency turnback, a slower speed might be based on track distance flown on turns versus distance flow level. Selecting this speed is a trade-off between stall margin and altitude lost in the turn.

In PILOT settings, the "NORM Ratio" parameter sets the ratio of stall speed TLAR uses for Normal approaches. In normal modes the resulting normal approach speed is this ratio times the stall speed *for the selected flap setting*. In emergency mode, TLAR uses this same "NORM ratio" to determine Vref (the gliding speed used by TLAR for emergency calculations). This speed is the set "NORM ratio" times the *flaps-up* stall speed at the set bank angle. In other words, even if you have flaps down set for landing, Vref for emergency calculations will still be the set ratio times the *flaps-up* stall speed.

CAUTION – There is no such thing as a free lunch. Using a high stall margin such as 1.5 or 2.0 will decrease the chance of a stall in a turnback, but will also increase the altitude required before a turnback is possible, which increases the chance of a forced off-field landing when a turnback could have been made. Likewise, selecting a low stall margin such as 1.2 will dramatically increase the chance of a stall in the turnback, even if it mathematically lowers the altitude required to make the turnback.

In VNAV/CRZ settings, the "Fence Height" parameter sets when TLAR will color the Threshold Crossing Height (TCH) label RED. If the predicted TCH is less than the set fence height, the TCH information will be RED.

After setting all the "normal" settings, select "Big Sky" mode and slide the "Emergency" switch to ON (red color showing on background of slider switch).

If you have not set your aircraft's glide speed and ratio, TLAR will prompt you to do so. After entering these, TLAR will save them for subsequent uses of the app and will not prompt you to enter them again.

Verify that the climb mode, bank angle, and winds (both speed and direction) are correct.

TLAR Emergency Mode Checklist

1. Aircraft Settings (Menu/Aircraft) – SET
    a. AIRCRAFT Type - Loaded
    b. DRAG – Normally set to Zero
    c. HP – Matches rated engine power
    d. ZFW – Set to Zero Fuel Weight
    e. FUEL – Set to current amount of fuel

2. Pilot Settings (Menu/Pilot) – SET
    a. FPA – As Required, for emergencies consider using glide angle
    b. NORM Ratio – Up to you, but typically 1.3 to 1.4. Controls Vref speed TLAR uses for gliding calculations

3. Vnav/Crz (Menu/Vnav/Crz) – SET
    a. Fence Height – Set to obstacle height on sides/end of runway

4. Landing Zone – ACTIVATED
    a. Either: Menu/Airports to load a runway (must be precise)
    b. Or: Menu/My Airstrips: Activate or Create an LZ
    c. Flip/Rwy as required

5. Motor – ON, after actual engine start

6. Climb Profile – SELECT, Vy recommended. Vx not recommended.

7. Weather – CHECKED/ENTERED
    a. WIND – AUTO (METAR accurate), or MAN (then set wind speed and direction on Big Sky View)
    b. TEMP – AUTO (METAR accurate), or MAN (set OAT to match aircraft temperature if aircraft close to the runway)
    c. ELEV – TDZE or GSL. Do not use MAN for emergency modes.

8. Big Sky View Switch – ON

9. Emergency Switch – ON

10. MAP – AS REQUIRED. Centered on Runway recommended.

11. Winds – VERIFIED (this is CRUCIAL to get right)
    a. Check windspeed (W/S), direction (numeric & wind arrow)

12. Vg – SET to POH/Known best glide speed at max gross weight

13. Ratio – SET to Windmilling propeller glide ratio

14. Climb Profile – VERIFIED

15. AOB – SET.
    a. SET planned bank angle for turnback, verify stall margin
    b. RESET as required: consider using 5 degrees less than intended to account for roll-in and roll-out.

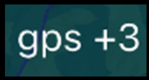
16. Vref – VERIFIED.
    a. Stall Margin Sufficient. Check at planned bank angle.

Execution.

Perform TLAR Emergency Mode checklist and all normal checklists and preparations for takeoff.

GPS-elevation correction.

TLAR computes a GPS-elevation correction used for emergency gliding calculations.



Once on the runway and with Emergency mode ON, TLAR will compute a running average GPS-elevation correction and display the correction at the top under the GSL altitude. This elevation correction is computed as a running average difference between the GPS-derived elevation and the “known” LZ elevation as a function of the approach and departure end elevations of the LZ and the slope of the runway. TLAR does this automatically and will continue to perform a running average correction as long as you are on the runway within 100 feet of centerline and your groundspeed is less than 2 knots. In cases of runways with displaced thresholds, you must be no further than 500 feet prior to the threshold, or 500 feet past the departure end coordinate.

You can reset the GPS-elevation correction by cycling the emergency switch from ON to OFF and back to ON.

Predicted Points.

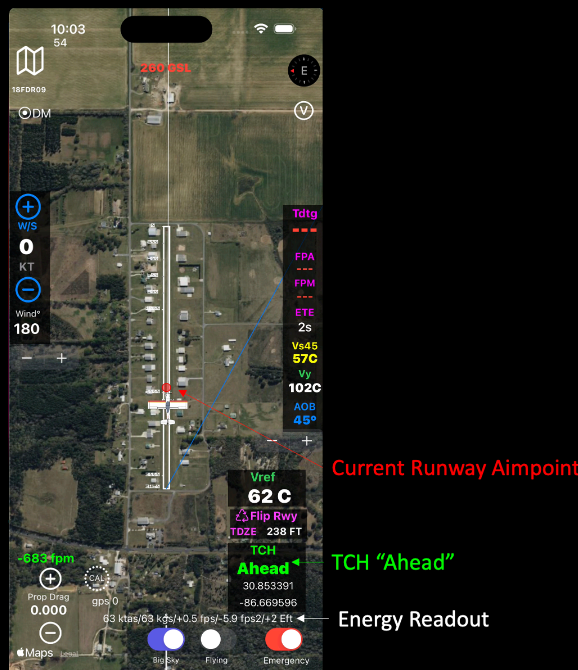
TLAR will adjust its predicted latest land straight ahead and predicted turnback points for your actual location on the runway if you are lined up and your groundspeed is less than 2 knots. If you are not lined up for takeoff or your groundspeed exceeds 2 knots, TLAR computes predicted points based on an assumed line-up point 50-feet down from the threshold on centerline.

Switch to Dynamic mode.

TLAR switches from predictive emergency mode to dynamic emergency mode when your groundspeed exceeds expected landing groundspeed with landing flaps set. In other words, when you are flying.

Dynamic Mode.

Initially (on takeoff) your best engine-failure course of action is to stop/land straight-ahead on the remaining runway. While this condition exists, TLAR displays “Ahead” in the TCH label.



As the takeoff progresses, a straight ahead *on-runway* abort/landing will eventually no longer be possible. When this happens, TLAR will announce “Off field.” TLAR will also start displaying computed threshold crossing values along with the wind-corrected glide-range footprint. As you climb out, your glide-range footprint will expand and computed TCH will change.

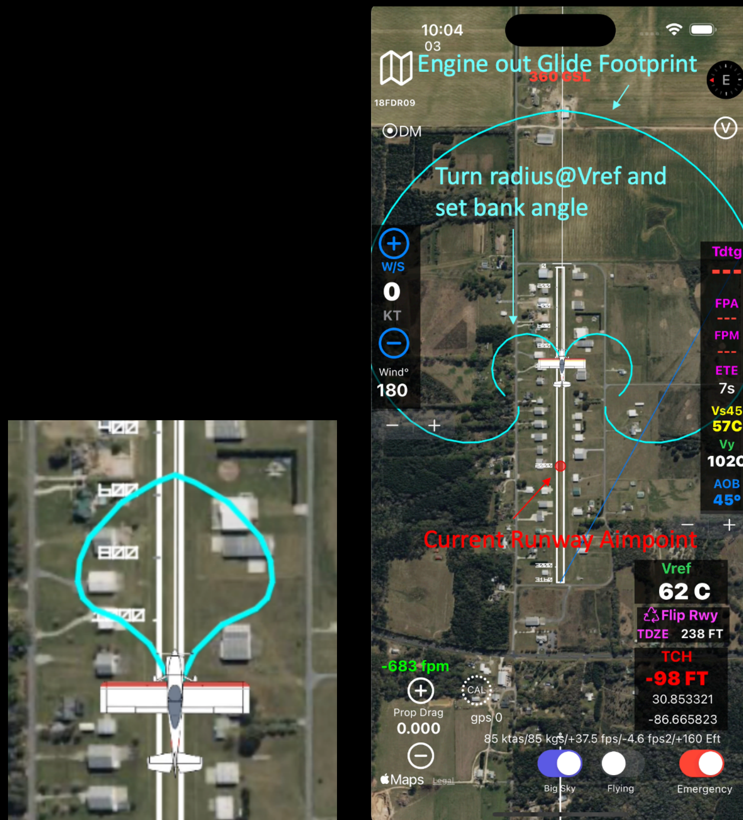
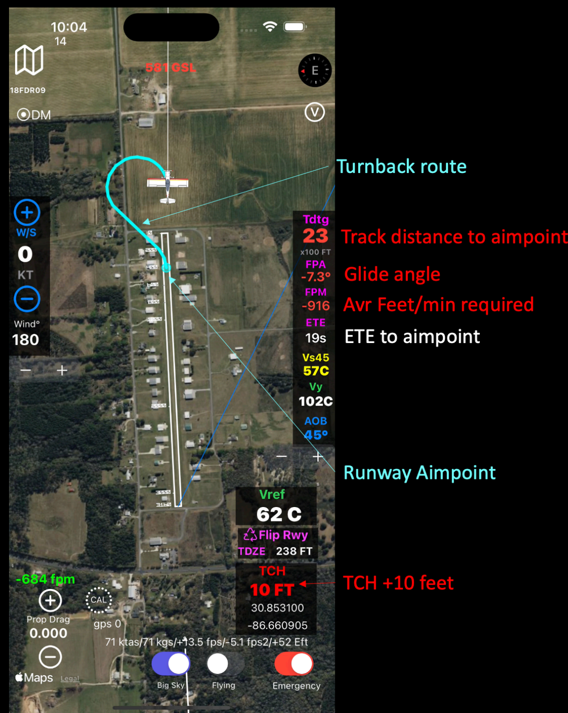


Figure 73 – CYAN Glide Footprints

If this footprint captures a land-able point on the runway and TCH is greater than zero, TLAR will announce “Turnback possible” and change the display from a glide range footprint to a CYAN colored route of flight to the land-able point on the runway.



In the figure above the TCH is colored RED, this is because the set fence height is 50 feet, so TLAR is saying while you may be able to glide to the aimpoint, you will arrive at that point below the set fence height. The TCH label will be YELLOW above fence height up to 300 feet and GREEN above 300.

> CAUTION – depending on track distance to touchdown, it's possible to be too high to make the runway even with a slip, yet not high enough to conduct a 360-degree turn to waste altitude.

> CAUTION - TLAR will declare turnback possible as soon as the predicted TCH is greater than zero, even if there is a fence height. The reason for this is that in many cases, a turnback glide will not cross the runway at the departure-end, but somewhere mid-field. Also, the app defaults to using a 50ft fence height, but most airports do not have a significant obstacle on the departure end.

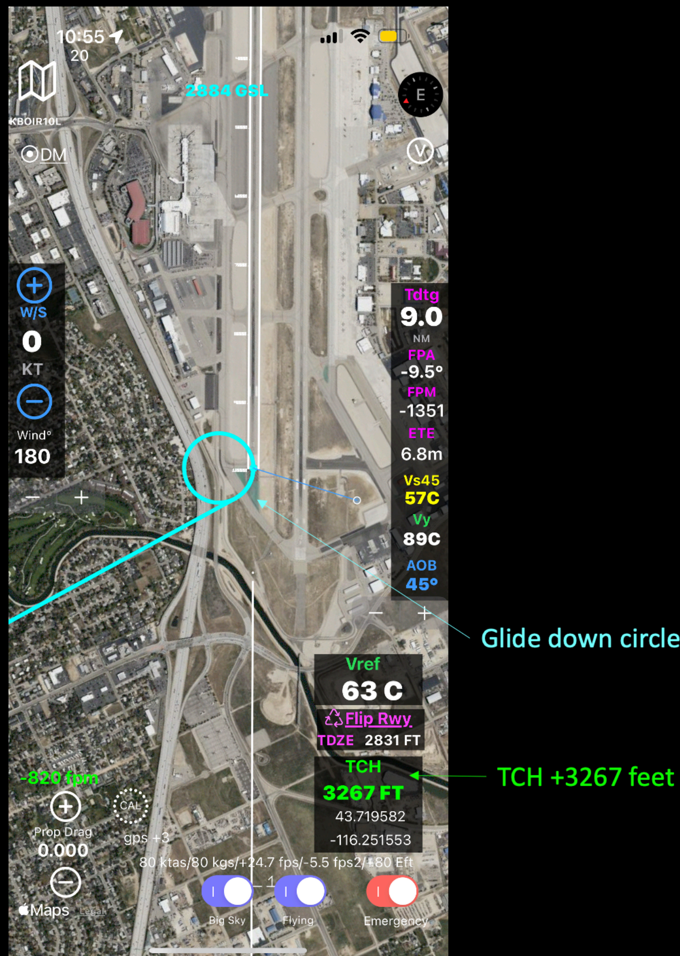
TLAR selects the best land-able point on the runway. A point is "land-able" if the computed TCH is greater than zero and it is possible to stop the aircraft on the runway from that point, and the required glide angle is less than 8 degrees OR if greater than 8 degrees, the TCH is high enough to allow at least one 360-degree turn to "waste" altitude. For all points that meet these criteria, TLAR then computes a figure of merit to pick the best. For those with a computed TCH less than 100 feet, the figure of merit is the TCH. For points that yield a TCH of greater than or equal to 100 feet, TLAR adds runway remaining after stop to that figure to prioritize runway available for stopping over additional TCH. TLAR then selects the point which has the highest figure of merit as the aimpoint. TLAR computes runway remaining after stop using ground roll and braking action as selected (MAX or PARTIAL). *This means there is no allowance for round-out/flare distance or set safety margin. There is a small margin if partial brakes are selected as maximum braking is the likely result during an actual turnback with limited runway remaining at touchdown. In an actual emergency landing it may be preferrable to intentionally ground-loop the aircraft rather than depart the end of the runway at high speed. This is obviously situational.*

WARNING – TLAR's glide calculations are NOT terrain or airspace-aware. It is possible for TLAR to declare a glide route to a runway that collides with terrain or violates airspace restrictions.

Track lag. During a turnback, TLAR will continuously recompute TCH. iOS has an approximate 3-second lag in track during turns. We have coded a correction into TLAR to "take out" most of this error, but it's not perfect. In flight testing, we've seen that TCH tends to decay in the early part of a turn and recover in the latter part. If during the turnback TCH decays to less than negative 30 feet and there is more than 60 degrees of turn still required, TLAR will announce "negative turnback." As always, it is up to the pilot to determine the best course of action.

In Emergency mode and flying, TLAR is constantly evaluating whether the plane can glide to a land-able point on the active LZ (including turns or a turnback). What this means is that if you turn on emergency mode during cruise and/or at altitude, TLAR will display the same glide footprint / route to a land-able point to the active LZ along with computed TCH.

If TCH is high enough to require at least one 360-degree turn to "burn excess altitude," TLAR will draw a circle corresponding to the turn radius at Vref and selected bank angle that intersects the best land-able point on the LZ. See figure below.


10:55
2884 GSL
KBOIR10L
DM
W/S
0
KT
Wind°
180
Tdtg
9.0
NM
FPA
-9.5°
FPM
-1351
ETE
6.8m
Vs45
57C
Vy
89C
AOB
45°
Vref
63 C
Flip Rwy
TDZE 2831 FT
TCH
3267 FT
43.719582
-116.251553
-820 fpm
Prop Drag
0.000
CAL
gps +3
80 ktas/80 kgs/+24.7 fps/-5.5 fps2/+80 Eft
Big Sky
Flying
Emergency
Maps
Glide down circle
TCH +3267 feet

TLAR-expert adds four more audio call-outs.

Latest abort point.

As the takeoff progresses, a straight ahead on-runway abort/landing will eventually no longer be possible. When this happens, TLAR will announce “Off field.”

Earliest Turnback Possible Point.

When and if the aircraft first reaches a turnback possible condition, TLAR will announce “Turnback possible.”

Turnback no longer possible

If the aircraft transitions from a turnback possible condition to one where it is no longer possible to turnback, TLAR will announce “Negative Turnback.”

LZ-AUTO flip runway

If you turn around on the runway in LZ-AUTO mode, TLAR will announce “Flip Runway” and flip the runway to the opposite runway.

Fully Automatic Mode

In TLAR-expert, the cycle landing zone button has a new setting called "LZ-AUTO." In "LZ-AUTO" mode, TLAR scans (every 5 seconds) runways in its global database and all LZ's you have saved in "My Airstrips" to find the nearest/best glide to runway. This runway is then loaded and activated. TLAR -expert defaults to "LZ-AUTO" mode on start-up. It also starts up with all weather inputs (Wind, Temp, Pressure) set to auto METARs if your iOS device has an internet connection. AUTO-LZ mode will also set your elevation source to "TDZE-AUTO" if you are within the terminal area defined by a 10NM ring around the approach end of the loaded LZ and at an altitude at or below 3000 feet above TDZE. If you are not in the terminal area, TLAR will set your elevation source to "GSL-AUTO," which uses your iDevice's satellite navigation altitude (i.e. you are in cruise). Doing so ensures your climb and cruise data reflect what your aircraft can do at its current altitude when in cruise, and that your takeoff and landing data is most accurate when in the terminal area. Finally, in "LZ-AUTO" mode, TLAR handles when to turn on/off the motor based on your position and ground speed.

> Note – In "LZ-AUTO" mode, you cannot load a new runway using "airports" or "my airstrips." You also cannot control turning the motor on/off or select the elevation source to compute performance data. These controls are disabled and have labels over top of each indicating that you are in "LZ-AUTO" mode. Toggle the LZ selector button to another mode to re-enable these controls.

On the ground TLAR searches for the closest runway approach end and loads that runway. On airfields with several runways, you may notice it "grabbing" runways during taxi that are not your intended runway of departure. As you taxi, eventually your intended runway of departure will become the closest and TLAR will load it. TLAR will auto-flip the runway as required to match which runway you appear to be using (e.g. back-taxi or a mid-field takeoff). In flight, TLAR searches for a new runway using predicted threshold crossing height (TCH) reaching the approach end of the runway from present position after an engine-out glide. This prediction accounts for wind and turns to align the aircraft with the runway axis. At present, TLAR uses surface wind for altitude wind. We are investigating ways to add altitude winds. You can change the wind manually during a long glide if needed.

Telemetry

Telemetry recording and DM button. TLAR-expert will automatically record up to 6 hours of telemetry when the aircraft is on the active runway and/or when flying. When it is recording, the DM button will be colored RED and the remaining record time available will decrement down and display "FULL" at zero time remaining. Use the erase button to clear the stored telemetry as needed. After landing and when groundspeed is 10 knots of less, TLAR will automatically pop-up the share sitrep dialogue to allow you to share/store it. Dismiss the pop-up if you do not want to save/share the data. You must land on the same runway that is currently active in TLAR for this automatic feature to work. You can also share the telemetry manually via the sitrep buttons in pilot, aircraft, and vnav/crz settings. TLAR does not store this information after the app is closed within iOS. The "DM" button increments the data mark index and stores said index in each row of the recorded telemetry. If TLAR is not recording (on ground not on runway), the DM button has no effect.

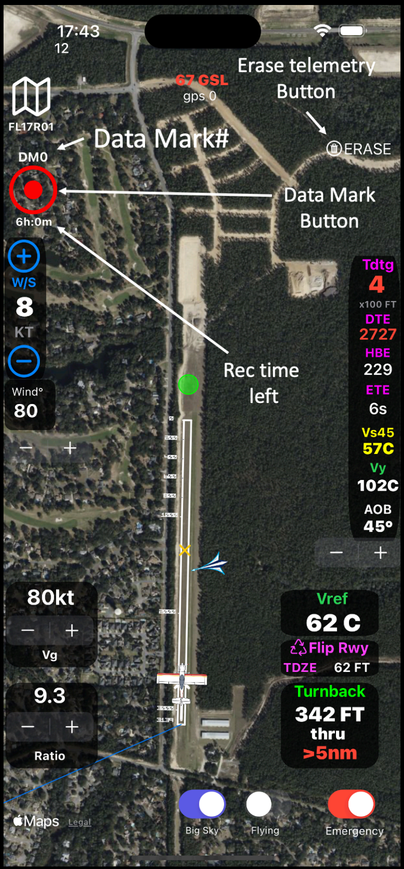


Figure 74 – Telemetry Buttons / Indicators

Telemetry metrics

TLAR-expert stores telemetry once per second in a large text file which is appended to a TLAR SITREP (see section on SITREPs). This file can be imported into a spreadsheet program such as Microsoft Excel for analysis. Each row has the following metrics:

Dm – data mark number

elapsedTime – time used to compute all aerodynamics and physics

HH – time of day hours
MM – time of day minutes
SS – time of day seconds

Lat - latitude
Long – longitude

geoAlt – satellite-based geometric altitude from iOS device

planeDa – computed density altitude at the plane

Kgs – knots ground speed

Trk – track

gpsTrk – iOS track derived from satellite navigation

trueHdg – true device heading

magHdg – magnetic device heading

turnRt – derived turn rate

bank – derived bank angle

aKgs – acceleration in Knots per second squared

iOSPressure – iOS measured pressure

iBaro – altimeter setting derived from iOS pressure and geo-altitude

gpsAltCor – differential altitude correction

hError – iOS reported horizontal position error
vError – iOS reported vertical position error

sError – iOS reported speed error
tError – iOS reported track error

gw – aircraft gross weight

cdo – coefficient of drag
cdoBias – coefficient of drag bias

cdp – coefficient of windmilling propeller drag
cdpBias – coefficient of windmilling propeller drag bias

setAob – selected angle of bank for gliding turns

hw – headwind on takeoff

ktas – computed knots true airspeed
kcas – computed knots calibrated airspeed

isFly – Boolean indicating if flying or not

lzLat – active LZ threshold latitude
lzLong – active LZ threshold longitude

trkDtg – track distance to threshold including turns

trkFpa – flight path angle to threshold along track

fence – fence height

lzTemp – Celcius temperature at LZ

deltaT – delta temperature from standard day (Celcius)

aircraftTemp – temperature at plane

selAlt – altitude selected for performance calculations

wdir – wind direction

ws – wind speed

lzda – density altitude at the LZ

useLzDa? – Boolean indicating if TLAR using LZ or Plane for density altitude vRefSelected – set Vref

avrVviFps – average VVI in feet per second

AvrVFps – average ground velocity in feet per second

eFt – glide altitude factor based on current energy state

tch – predicted threshold crossing height

offield? – Boolean indicating if straight ahead landing on runway is possible or not

turnbackPoss? – Boolean indicating if turnback is possible or not

GLOSSARY

AC – Aircraft

aFence – approach-end Fence height (feet). This is the height of any obstacles located at the approach-end of the runway (like a tree on a back-country airstrip).

ASTOP – Accelerate-Stop distance. The distance required on takeoff to accelerate to liftoff speed, lose thrust, and then stop straight ahead. Assumes a 3 second reaction time and braking as selected (partial/max).

Axis – the bearing (degrees) of the runway centerline.

DA – Density Altitude (feet). Pressure altitude corrected for the effect of temperature and dew point.

dFence – departure-end Fence height (feet). This is the height of any obstacles located at the departure-end of the runway (like a tree on a back-country airstrip).

Alt – Altimeter setting (inches Hg)

Burn – assumed fuel burn rate in gallons per hour when the engine is set to “RUNNING.” TLAR uses the full value when the aircraft is airborne, and 20% of this value when on the ground. TLAR decreases aircraft gross weight as fuel is burned off. TLAR stops decrementing fuel and thus weight if the fuel reaches zero.

Crz Rpm – cruise revolutions per minute. The set propellor RPM for constant speed propellers used in cruise to compute available horsepower.

Clb Rpm – climb revolutions per minute. The set propellor RPM for constant speed propellers used in climb to compute available horsepower.

Dynamic – indicates that TLAR is using current actual groundspeed from the GPS to compute landing performance (see Static below).

DewPt – Dewpoint (degrees Celsius). Used to compute the relative humidity, which affects density altitude, and the Lifted Condensation Altitude (LCA).

Elev – Elevation (feet). The height of a geographic point above mean sea level.

F0 or UP – Flaps Zero. Flaps-up configuration.

F1 – Flaps One. Partial-flaps configuration. In planes with continuously variable flaps (e.g. electric flaps) or planes with >3 flap settings, TLAR uses the takeoff flap setting as specified in the aircraft's POH for this setting.

F2 – Flaps Two. Full-flap configuration.

Other flap indications – For aircraft that only have two settings, TLAR uses "UP" and "DN." For those with specific percentages (like Cirrus) or degrees (like some Pipers), a number representing the setting will be displayed (e.g. "25" for 25 degrees)

FENCE Margin – Pilot entered parameter specifying the minimum vertical distance above the fence obstacle is "acceptable" on approach or on takeoff.

Fuel – Fuel on board (in gallons).

Fpm – climb/descent rate in feet per minute.

FPM – Climb profile using a set climb rate in feet per minute.

FpNM – Feet per Nautical Mile. Climb gradient.

G – G-loading in units of Earth's average gravitational acceleration (32.xyz fps2)

gph – fuel burn rate in gallons per hour.

CAS – Climb profile using a constant Calibrated Airspeed

GW – aircraft gross weight (pounds).

Land – landing

iBaro – barometric altimeter setting computed using the iDevice's internal pressure sensor and current GSL.

wxBaro – barometric altimeter setting as entered/downloaded on the Planning Weather sub-page.

ΔT – delta Temperature (degrees Celsius) from the ICAO standard temperature for the current surface or cruise altitude.

HVST – Horizontal Vertical Speed Track (Green, Yellow, Red). Indicators of the current accuracy of each as reported by iOS.

	Accuracy color codes		
	Horizontal	**Vertical**	**Speed**
Green	<= 50 ft	<= 20 ft	<= 2 kgs
Yellow	> 50 ft	> 20 ft	> 2 kgs
Red	Invalid	Invalid	Invalid

GSL – GPS-derived altitude (feet)

Lat – Latitude (degrees and decimal degrees). Positive numbers are North. Negative South.

Long – Longitude (degrees and decimal degrees). Positive is East, negative is West.

Len – Length (feet). The length of the LZ measured from the approach-end to the departure-end points.

LZ – Landing Zone. The active airport/airfield/airstrip.

KCAS – Knots Calibrated Airspeed (knots). Indicated airspeed corrected for instrument and position errors.

KGS – Knots Ground Speed (knots). The speed across the ground.

KTAS – Knots True Airspeed (knots). The actual speed of the aircraft moving through the air.

M – abbreviation for minutes

M – abbreviation for MSL

FPA – Flight Path Angle. This is the pitch angle of the aircraft on approach and landing. TLAR uses FPA to display VAPI information, calculate the fence-shadow length on landing, and to assess approach stability crossing the stabilization point.

MSL – Mean Sea Level (feet). Altitude above mean sea level.

Mu – Effective Braking Friction Factor (g’s). The average g-force the aircraft’s brakes can produce during landing as a function of runway surface type (eg pavement, grass, gravel etc).

nm – Nautical Miles

Norm:Vs – Ratio of Normal approach speed to stall speed (number:1). TLAR computes normal approach speed by multiplying this number by the aircraft’s stall-speed as a function of landing flap setting and current gross weight.

Norm – Normal approach speed.

Pwr – abbreviation for power (% of rated engine horsepower).

Rf – Rolling Friction Factor (g’s). Used to compute the rolling drag on the aircraft during takeoff roll

SAFETY Margin – Pilot entered parameter specifying the minimum horizontal distance from the end of the runway is “acceptable” to stop during landing or clear the fence-height on takeoff

Slope – slope of the runway in *degrees* (NOT Percent). Positive values are uphill and negative values are downhill.

SfcT/D – surface temperature (in Celsius) and dewpoint (in Celsius).

Sfc T – surface temperature (in Celsius)

Sfc Wdir – surface Wind Direction (degrees magnetic north)

Sfc Wspd – surface Wind Speed

Static – indicates that TLAR is using predicted touchdown groundspeed based on approach speed (STOL or NORMAL) and winds (see Dynamic above).

Stol – Short TakeOff and Landing.

STOL Ratio – Pilot-entered parameter. Ratio of STOL approach speed to stall speed (number:1). TLAR computes STOL approach speed by multiplying this number by the aircraft’s stall-speed as a function of landing flap setting and current gross weight.

sVAPI – Smart Visual Approach Path Indicator. TLAR’s version of a traditional PAPI.

T – abbreviation for TRUE

TAS – climb mode using a constant true airspeed.

TDZ – abbreviation of TDZ Req (see next entry).

TDZ Length – Touch Down Zone (feet). A distance the pilot enters on the plan pilot subpage which TLAR uses to account for runway used in the flare, transition to braking attitude, and actual application of brakes.

TDZE – Touchdown Zone Elevation (feet MSL)

TO – Takeoff

TO Margin – Takeoff Safety Margin (feet). A pilot-entered parameter that TLAR uses as a safety distance for takeoff and landing. TLAR will color parameters which violate these safety distances in Yellow.

TO Pitch Delta – Takeoff Pitch Delta (degrees). Sets how many degrees of pitch change are required for the takeoff distance measuring system to “declare” liftoff and then compute an estimated takeoff distance.

Va – Maneuvering speed (KCAS). The slowest speed at which the aircraft’s wings can generate enough lift at maximum angle of attack to exceed the aircraft’s maximum g-limit. This speed is faster for heavier aircraft and slower for lighter ones.

VAPI – Visual Approach Path Indicator. TLAR’s version of a Precision Approach Path Indicator displaying glidepath information (High, Slightly High, On Glidepth, Slightly Low, and Low) referenced to the set FPA.

Vc – Sustained corner speed (KCAS). The speed at which the aircraft can generate and sustain a minimum turn radius using max power, high AoA, and flaps set at selected by the takeoff flaps segmented controller. As AoA and level-flight turning G-loads increase, turn radius decreases and drag increases. There is a point in which this increased drag equals the maximum-thrust the engine-prop can generate for the conditions. This speed where this occurs is the sustained corner speed of the aircraft.

Vg – Best Glide Speed (KCAS). The speed which produces the best glide angle (longest distance glide) for the current gross weight and flap setting. This speed is also the lowest drag airspeed. TLAR uses a windmilling propeller for calculating this speed.

Vref – Approach Reference Speed (calibrated airspeed) for flaps as set. In emergency mode in TLAR-expert, Vref is the speed used to calculate altitude lost while gliding. It is equal to the norm approach ratio setting multiplied by the flaps up stall speed.

Vs – Stall speed (calibrated airspeed) for flaps as set.

Vto – Takeoff speed (calibrated airspeed). The liftoff airspeed of the aircraft.

Vy – Best climb rate speed. The speed which produces the highest climb rate (fpm) at maximum engine power and with flaps set as selected.

VyFPM – Best climb rate in feet per minute. Results from flying a Vy climb.

VyFPNM – Climb gradient in feet per nautical mile that results from flying a best *rate* (fpm) profile

Vx – Best angle climb speed. The speed which produces the highest climb angle or gradient (feet per nautical mile) at maximum engine power and with flaps as selected.

VxFPM – Climb rate (fpm) that results from flying best climb *angle* speed.

VxFPNM – Best climb gradient in feet per nautical mile. TLAR adjusts this gradient for winds. It results from flying a Vx climb.

Vz – Efficient climb speed. The “Vz” climb seeks a practical balance between climbing at a reasonable rate with making forward progress in cruise.

Wid – Width (feet). Width of the runway.

ZFW – Zero Fuel Weight (pounds). The weight of the aircraft as loaded with people and cargo, but with zero fuel.

APPENDIX A – ACCURACY

Certificated aircraft are required to published performance information in their Pilot Operating Handbooks (POH). Included in this appendix is information comparing these published numbers with those which come out of TLAR. Experimental aircraft manufactures are not required to publish detailed performance information. But, for the information that they do provide, those numbers are also compared here to what TLAR predicts. We here at Owyhee Aviation are dedicated to a relentless pursuit of accuracy. To improve TLAR's performance engine, we encourage you to send us verified/real-world performance data on any aircraft (flightlead@tlarpilot.com).

What follows is not an exhaustive comparison of *every* performance number published, but instead, a sampling of low, mid, and high-pressure altitudes at cold, medium, and hot temperatures. Light-weight and heavy-weight are added for aircraft types whose manufacturer publishes performance for differing gross weights.

Distances are measured in feet, climb rates in feet-per-minute, speeds in knots calibrated (CAS) or true (TAS), weight in pounds, and fuel flow in gallons per hour.

TLAR uses mid-CG (average) stall speed in cases where a POH contains both forward and aft CG stall speeds. Many manufacturers publish *indicated* stall speeds, but provide calibration charts to correct indicated speed to calibrated speed for given flap configurations. We corrected these indicated stall speeds to calibrated ones where possible.

An astute reader may notice that landing distances over a 50-foot obstacle are missing from these validation charts. The reason we chose not to validate TLAR performance against this metric is that assumptions regarding pilot technique (such as glidepath angle, flare distance, and delay before braking) *greatly* affect this distance. Use TLAR's Fence Height, Fence Margin, TDZ length, and FPA parameters to "shape" the landing distance to suit your preference or to closely match your POH.

Takeoff over a 50-foot obstacle too is affected by assumptions (such as rotation rate, flap setting, and climb speed), but to a lesser extent. As such, we've included takeoff over a 50-foot obstacle in some figures below, but you'll notice this metric tends to be less accurate versus the POH than most other metrics.

Beechcraft A36

Benchmark: POH for Bonanza 36 and A36 Serials E-1 thru E-926. Originally published February 1978, updated thru July 1994.

Power: Continental 285-HP IO-520-B engine driving a 2-blade McCauley 2A36C3 84-inch constant-speed propeller.

Aircraft	Engine	Is Turbocharged?	HP	Rpm	Prop Diameter
A36	IO-550B	false	285	2700	84

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
A36	3100	Stall clean KCAS	62.5	62.3	-0.2	0.997
A36	3100	Stall partial flaps KCAS	60.0	58.8	-1.2	0.980
A36	3100	Stall full flaps KCAS	58.0	58.0	0.0	1.000
A36	3100	Takeoff GroundRun (0 msl / 15 C)	800.0	840.0	40.0	0.950
A36	3100	Takeoff GroundRun (4000 msl / 7 C)	1150.0	1150.0	0.0	1.000
A36	3100	Takeoff GroundRun (8000 msl / -1 C)	1600.0	1640.0	40.0	0.975
A36	3100	Takeoff 50 (0 msl / 15 C)	1350.0	1420.0	70.0	0.948
A36	3100	Takeoff 50 (4000 msl / 7 C)	2050.0	1910.0	-140.0	0.932
A36	3100	Takeoff 50 (8000 msl / -1 C)	2900.0	2680.0	-220.0	0.924
A36	3100	Takeoff KCAS	68.5	66.5	-2.0	0.970
A36	3100	Vy FPM (0 msl / 15 C)	1330.0	1288.5	-41.5	0.969
A36	3100	Vy FPM (6000 msl / 3 C)	960.0	916.4	-43.6	0.955
A36	3100	Vy FPM (12000 msl / -10 C)	565.0	558.0	-7.0	0.988
A36	3100	Normal appproach CAS (1.300 to 1)	75.5	75.4	-0.1	0.999
A36	3100	Landroll (0 msl / 15 C)	910.0	910.0	0.0	1.000
A36	3100	Landroll (4000 msl / 7 C)	1015.0	1020.0	5.0	0.995
A36	3100	Landroll (8000 msl / -3 C)	1150.0	1140.0	-10.0	0.991

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
A36	3600	Vg KCAS	110.0	106.9	-3.1	0.972
A36	3600	Vg Ratio	10.2	10.6	0.4	0.962
A36	3600	Stall clean KCAS	65.0	65.0	0.0	1.000
A36	3600	Stall full flaps KCAS	55.5	55.5	0.0	1.000
A36	3600	Takeoff GroundRun (0 msl / 15 C)	1100.0	1240.0	140.0	0.873
A36	3600	Takeoff GroundRun (4000 msl / 7 C)	1550.0	1730.0	180.0	0.884
A36	3600	Takeoff GroundRun (8000 msl / -1 C)	2180.0	2580.0	400.0	0.817
A36	3600	Takeoff 50 (0 msl / 15 C)	2020.0	2030.0	10.0	0.995
A36	3600	Takeoff 50 (4000 msl / 7 C)	2850.0	2810.0	-40.0	0.986
A36	3600	Takeoff 50 (8000 msl / -1 C)	4100.0	4240.0	140.0	0.966
A36	3600	Takeoff KCAS	71.5	71.6	0.1	0.998
A36	3600	Vy KCAS (0 msl / 15 C)	96.0	96.0	0.0	1.000
A36	3600	Vy KCAS (6000 msl / 3 C)	96.0	96.0	0.0	1.000
A36	3600	Vy KCAS (12000 msl / -10 C)	96.0	96.0	0.0	1.000
A36	3600	Vy FPM (0 msl / 15 C)	1030.0	979.4	-50.6	0.951
A36	3600	Vy FPM (6000 msl / 3 C)	685.0	647.8	-37.2	0.946
A36	3600	Vy FPM (12000 msl / -10 C)	350.0	138.6	-211.4	0.396
A36	3600	55% cruise KTAS (0 msl / Std Day)	138.0	130.0	-8.0	0.942
A36	3600	55% cruise KTAS (6000 msl / Std Day)	142.8	137.0	-5.8	0.959
A36	3600	55% cruise KTAS (10000 msl / Std Day)	134.0	142.0	8.0	0.940
A36	3600	65% cruise KTAS (0 msl / Std Day)	149.8	141.0	-8.8	0.941
A36	3600	65% cruise KTAS (6000 msl / Std Day)	156.0	149.0	-7.0	0.955
A36	3600	65% cruise KTAS (10000 msl / Std Day)	149.5	155.0	5.5	0.963
A36	3600	75% cruise KTAS (0 msl / Std Day)	159.2	150.0	-9.2	0.942
A36	3600	75% cruise KTAS (6000 msl / Std Day)	167.5	159.0	-8.5	0.949
A36	3600	55% cruise FF (0 msl / Std Day)	11.5	11.4	-0.1	0.991
A36	3600	55% cruise FF (6000 msl / Std Day)	11.5	11.4	-0.1	0.991
A36	3600	55% cruise FF (10000 msl / Std Day)	10.3	11.4	1.1	0.894
A36	3600	65% cruise FF (0 msl / Std Day)	13.3	13.4	0.1	0.991
A36	3600	65% cruise FF (6000 msl / Std Day)	13.3	13.4	0.1	0.991
A36	3600	65% cruise FF (10000 msl / Std Day)	11.5	13.4	1.9	0.833
A36	3600	75% cruise FF (0 msl / Std Day)	15.2	15.0	-0.2	0.988
A36	3600	75% cruise FF (6000 msl / Std Day)	15.2	15.0	-0.2	0.988
A36	3600	Normal appproach CAS (1.300 to 1)	72.0	72.2	0.2	0.998
A36	3600	Landroll (0 msl / 15 C)	825.0	840.0	15.0	0.982
A36	3600	Landroll (4000 msl / 7 C)	940.0	940.0	0.0	1.000
A36	3600	Landroll (8000 msl / -3 C)	1060.0	1050.0	-10.0	0.991

Cessna C-150M

Benchmark: POH for 1977 C-150M.

Power: Lycoming 100-HP O-200-A engine driving a 2-blade McCauley 1A102/TCM6948 69-inch fixed-pitch propeller.

Aircraft	Engine	Is Turbocharged?	HP	Rpm	Prop Diameter
C150M	O-200	false	100	2750	69

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
C150M	1600	Vg KCAS	60.0	59.0	-1.0	0.983
C150M	1600	Stall clean KCAS	48.5	48.5	0.0	1.000
C150M	1600	Stall partial flaps KCAS	45.5	45.5	0.0	1.000
C150M	1600	Stall full flaps KCAS	42.0	42.0	0.0	1.000
C150M	1600	Takeoff GroundRun (0 msl / 0 C)	655.0	680.0	25.0	0.962
C150M	1600	Takeoff GroundRun (0 msl / 20 C)	765.0	770.0	5.0	0.993
C150M	1600	Takeoff GroundRun (0 msl / 30 C)	820.0	820.0	0.0	1.000
C150M	1600	Takeoff GroundRun (3000 msl / 0 C)	870.0	880.0	10.0	0.989
C150M	1600	Takeoff GroundRun (3000 msl / 20 C)	1010.0	1010.0	0.0	1.000
C150M	1600	Takeoff GroundRun (3000 msl / 30 C)	1090.0	1090.0	0.0	1.000
C150M	1600	Takeoff GroundRun (6000 msl / 0 C)	1160.0	1190.0	30.0	0.974
C150M	1600	Takeoff GroundRun (6000 msl / 20 C)	1360.0	1370.0	10.0	0.993
C150M	1600	Takeoff GroundRun (6000 msl / 30 C)	1465.0	1480.0	15.0	0.990
C150M	1600	Takeoff 50 (0 msl / 0 C)	1245.0	1270.0	25.0	0.980
C150M	1600	Takeoff 50 (0 msl / 20 C)	1435.0	1470.0	35.0	0.976
C150M	1600	Takeoff 50 (0 msl / 30 C)	1540.0	1610.0	70.0	0.955
C150M	1600	Takeoff 50 (3000 msl / 0 C)	1650.0	1810.0	160.0	0.903
C150M	1600	Takeoff 50 (3000 msl / 20 C)	1915.0	1990.0	75.0	0.961
C150M	1600	Takeoff 50 (3000 msl / 30 C)	2065.0	2060.0	-5.0	0.998
C150M	1600	Takeoff 50 (6000 msl / 0 C)	2245.0	2290.0	45.0	0.980
C150M	1600	Takeoff 50 (6000 msl / 20 C)	2640.0	2540.0	-100.0	0.962
C150M	1600	Takeoff 50 (6000 msl / 30 C)	2870.0	2630.0	-240.0	0.916
C150M	1600	Takeoff KCAS	53.0	52.6	-0.4	0.992
C150M	1600	Vx KCAS (0 msl / 20 C)	56.0	57.5	1.5	0.973
C150M	1600	Vy KCAS (0 msl / 40 C)	68.0	65.4	-2.6	0.962
C150M	1600	Vy KCAS (4000 msl / 20 C)	65.0	63.5	-1.5	0.978
C150M	1600	Vy KCAS (8000 msl / -20 C)	63.0	63.1	0.1	0.998
C150M	1600	Vy FPM (0 msl / -20 C)	770.0	752.6	-17.4	0.977
C150M	1600	Vy FPM (0 msl / 20 C)	655.0	655.4	0.4	0.999
C150M	1600	Vy FPM (0 msl / 40 C)	595.0	611.8	16.8	0.972
C150M	1600	Vy FPM (4000 msl / -20 C)	580.0	573.8	-6.2	0.989
C150M	1600	Vy FPM (4000 msl / 20 C)	465.0	482.2	17.2	0.963
C150M	1600	Vy FPM (4000 msl / 40 C)	405.0	440.3	35.3	0.913
C150M	1600	Vy FPM (8000 msl / -20 C)	390.0	402.0	12.0	0.969
C150M	1600	Vy FPM (8000 msl / 20 C)	280.0	313.9	33.9	0.879
C150M	1600	Vy FPM (8000 msl / 40 C)	215.0	272.9	57.9	0.731
C150M	1600	55% cruise KTAS (2000 msl / Std Day)	90.0	88.0	-2.0	0.978
C150M	1600	55% cruise KTAS (6000 msl / Std Day)	93.0	91.0	-2.0	0.978
C150M	1600	55% cruise KTAS (10000 msl / Std Day)	96.0	93.0	-3.0	0.969
C150M	1600	65% cruise KTAS (2000 msl / Std Day)	96.0	96.0	0.0	1.000
C150M	1600	65% cruise KTAS (6000 msl / Std Day)	99.0	99.0	0.0	1.000
C150M	1600	65% cruise KTAS (10000 msl / Std Day)	102.0	101.0	-1.0	0.990
C150M	1600	75% cruise KTAS (2000 msl / Std Day)	102.0	103.0	1.0	0.990
C150M	1600	75% cruise KTAS (6000 msl / Std Day)	105.5	104.0	-1.5	0.986
C150M	1600	55% cruise FF (2000 msl / Std Day)	4.2	4.3	0.1	0.982
C150M	1600	55% cruise FF (6000 msl / Std Day)	4.2	4.3	0.1	0.982
C150M	1600	55% cruise FF (10000 msl / Std Day)	4.2	4.3	0.1	0.982
C150M	1600	65% cruise FF (2000 msl / Std Day)	4.9	4.9	0.0	0.990
C150M	1600	65% cruise FF (6000 msl / Std Day)	4.9	4.9	0.0	0.990
C150M	1600	65% cruise FF (10000 msl / Std Day)	4.8	4.8	-0.1	0.985
C150M	1600	75% cruise FF (2000 msl / Std Day)	5.6	5.7	0.1	0.991
C150M	1600	75% cruise FF (6000 msl / Std Day)	5.6	5.4	-0.2	0.972
C150M	1600	Normal appproach CAS (1.310 to 1)	52.0	55.0	3.0	0.942
C150M	1600	Landroll (0 msl / 0 C)	425.0	430.0	5.0	0.988
C150M	1600	Landroll (0 msl / 20 C)	455.0	460.0	5.0	0.989
C150M	1600	Landroll (0 msl / 40 C)	484.0	490.0	6.0	0.988
C150M	1600	Landroll (4000 msl / 0 C)	490.0	490.0	0.0	1.000
C150M	1600	Landroll (4000 msl / 20 C)	525.0	520.0	-5.0	0.990
C150M	1600	Landroll (4000 msl / 40 C)	560.0	560.0	0.0	1.000
C150M	1600	Landroll (8000 msl / 0 C)	570.0	560.0	-10.0	0.982
C150M	1600	Landroll (8000 msl / 20 C)	610.0	600.0	-10.0	0.984
C150M	1600	Landroll (8000 msl / 40 C)	655.0	640.0	-15.0	0.977

Cessna C-152

Benchmark: POH for 1978 C-152.

Power: Lycoming 110-HP O-235-L2C engine driving a 2-blade McCauley 1A103/TCM6958 69-inch fixed-pitch propeller.

Aircraft	Engine	Is Turbocharged?	HP	Rpm	Diameter
C152	O-235	false	110	2550	69

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
C152	1670	Vg KCAS	60.0	62.6	2.6	0.957
C152	1670	Vg Ratio	9.6	9.4	-0.2	0.982
C152	1670	Stall clean KCAS	47.0	47.0	0.0	1.000
C152	1670	Stall partial flaps KCAS	44.5	44.5	0.0	1.000
C152	1670	Stall full flaps KCAS	42.0	42.0	0.0	1.000
C152	1670	Takeoff GroundRun (0 msl / 0 C)	640.0	670.0	30.0	0.953
C152	1670	Takeoff GroundRun (0 msl / 20 C)	755.0	750.0	-5.0	0.993
C152	1670	Takeoff GroundRun (0 msl / 30 C)	810.0	800.0	-10.0	0.988
C152	1670	Takeoff GroundRun (3000 msl / 0 C)	855.0	870.0	15.0	0.982
C152	1670	Takeoff GroundRun (3000 msl / 20 C)	1000.0	980.0	-20.0	0.980
C152	1670	Takeoff GroundRun (3000 msl / 30 C)	1080.0	1050.0	-30.0	0.972
C152	1670	Takeoff GroundRun (6000 msl / 0 C)	1145.0	1160.0	15.0	0.987
C152	1670	Takeoff GroundRun (6000 msl / 20 C)	1345.0	1330.0	-15.0	0.989
C152	1670	Takeoff GroundRun (6000 msl / 30 C)	1455.0	1430.0	-25.0	0.983
C152	1670	Takeoff 50 (0 msl / 0 C)	1190.0	1120.0	-70.0	0.941
C152	1670	Takeoff 50 (0 msl / 20 C)	1390.0	1240.0	-150.0	0.892
C152	1670	Takeoff 50 (0 msl / 30 C)	1495.0	1320.0	-175.0	0.883
C152	1670	Takeoff 50 (3000 msl / 0 C)	1600.0	1440.0	-160.0	0.900
C152	1670	Takeoff 50 (3000 msl / 20 C)	1870.0	1560.0	-310.0	0.834
C152	1670	Takeoff 50 (3000 msl / 30 C)	2020.0	1670.0	-350.0	0.827
C152	1670	Takeoff 50 (6000 msl / 0 C)	2200.0	1930.0	-270.0	0.877
C152	1670	Takeoff 50 (6000 msl / 20 C)	2610.0	2200.0	-410.0	0.843
C152	1670	Takeoff 50 (6000 msl / 30 C)	2855.0	2360.0	-495.0	0.827
C152	1670	Takeoff KCAS	52.0	54.3	2.3	0.955
C152	1670	Vx KCAS (0 msl / 20 C)	55.5	55.5	0.0	1.000
C152	1670	Vy KCAS (0 msl / 40 C)	67.0	65.4	-1.6	0.977
C152	1670	Vy KCAS (4000 msl / 20 C)	65.0	63.5	-1.5	0.978
C152	1670	Vy KCAS (8000 msl / -20 C)	62.0	63.1	1.1	0.982
C152	1670	Vy FPM (0 msl / -20 C)	835.0	813.6	-21.4	0.974
C152	1670	Vy FPM (0 msl / 20 C)	700.0	706.8	6.8	0.990
C152	1670	Vy FPM (0 msl / 40 C)	630.0	658.6	28.6	0.955
C152	1670	Vy FPM (4000 msl / -20 C)	635.0	613.9	-21.1	0.967
C152	1670	Vy FPM (4000 msl / 20 C)	505.0	527.0	22.0	0.957
C152	1670	Vy FPM (4000 msl / 40 C)	445.0	481.1	36.1	0.919
C152	1670	Vy FPM (8000 msl / -20 C)	440.0	450.1	10.1	0.977
C152	1670	Vy FPM (8000 msl / 20 C)	320.0	360.8	40.8	0.873
C152	1670	Vy FPM (8000 msl / 40 C)	265.0	309.1	44.1	0.834
C152	1670	55% cruise KTAS (2000 msl / Std Day)	88.0	86.0	-2.0	0.977
C152	1670	55% cruise KTAS (6000 msl / Std Day)	90.0	89.0	-1.0	0.989
C152	1670	55% cruise KTAS (10000 msl / Std Day)	92.0	91.0	-1.0	0.989
C152	1670	65% cruise KTAS (2000 msl / Std Day)	95.0	94.0	-1.0	0.989
C152	1670	65% cruise KTAS (6000 msl / Std Day)	98.0	97.0	-1.0	0.990
C152	1670	65% cruise KTAS (10000 msl / Std Day)	101.0	101.0	-0.0	1.000
C152	1670	75% cruise KTAS (2000 msl / Std Day)	101.0	100.0	-1.0	0.990
C152	1670	75% cruise KTAS (6000 msl / Std Day)	105.0	103.0	-2.0	0.981
C152	1670	55% cruise FF (2000 msl / Std Day)	4.5	4.5	-0.0	0.994
C152	1670	55% cruise FF (6000 msl / Std Day)	4.5	4.5	-0.0	0.994
C152	1670	55% cruise FF (10000 msl / Std Day)	4.4	4.5	0.1	0.983
C152	1670	65% cruise FF (2000 msl / Std Day)	5.3	5.2	-0.1	0.987
C152	1670	65% cruise FF (6000 msl / Std Day)	5.3	5.2	-0.1	0.987
C152	1670	65% cruise FF (10000 msl / Std Day)	5.3	5.2	-0.1	0.987
C152	1670	75% cruise FF (2000 msl / Std Day)	6.1	6.0	-0.1	0.985
C152	1670	75% cruise FF (6000 msl / Std Day)	6.1	6.0	-0.1	0.985
C152	1670	Normal appproach CAS (1.310 to 1)	55.0	55.0	0.0	1.000
C152	1670	Landroll (0 msl / 0 C)	450.0	450.0	0.0	1.000
C152	1670	Landroll (0 msl / 20 C)	485.0	480.0	-5.0	0.990
C152	1670	Landroll (0 msl / 40 C)	515.0	510.0	-5.0	0.990
C152	1670	Landroll (4000 msl / 0 C)	520.0	510.0	-10.0	0.981
C152	1670	Landroll (4000 msl / 20 C)	560.0	540.0	-20.0	0.964
C152	1670	Landroll (4000 msl / 40 C)	580.0	580.0	0.0	1.000
C152	1670	Landroll (8000 msl / 0 C)	605.0	590.0	-15.0	0.975
C152	1670	Landroll (8000 msl / 20 C)	650.0	630.0	-20.0	0.969
C152	1670	Landroll (8000 msl / 40 C)	675.0	670.0	-5.0	0.993

Cessna C-170B

Benchmark: POH for 1952-1955 C-170. TLAR model based on 1955 C-170B.

Power: Continental O-300-A engine driving a 2-blade McCauley fixed-pitch propeller.

The Cessna 170B POH uses indicated speeds for its performance charts and does not have an airspeed calibration chart to convert to calibrated airspeeds. This induces uncertainty when comparing TLAR speeds and performances with the POH as TLAR uses calibrated airspeeds to compute aerodynamic performance. For consideration, the C-172M indicates 2-9 knots slow at lower airspeeds (9 knots slow at 40 KIAS reducing to 2 knots slow at 60 KIAS). The C-170B POH implies that Vx is 62 mph (53.8 knots) indicated with 20º flaps as it lists this speed as the target climb speed to maintain "until clear of the obstacle" after takeoff. By convention, this speed *should* be a sea-level, standard day, max gross weight airspeed, but it may not be and the POH does not specify. *IF* the C-170B has the same pitot-static position error as the C-172M, then the C-170B Vx speed at sea-level, standard day, max gross weight should be ~58 KCAS. TLAR computes 57 KCAS under the same conditions.

Takeoff speed comparison is also difficult as the C-170-*B* POH does not list a liftoff speed at all. We found a textual reference in a C-170-*A* POH that reads, "The airplane "breaks ground" at approximately 50 m.p.h." If true, that's 43.4 knots plus position error yielding ~50 knots. TLAR computes a lift-off speed of 48.7 knots calibrated airspeed for the C-170B.

Climb speeds at Vy are not significantly affected by this issue as position errors wash out and approach zero at speeds above 60 KIAS (at least for the C-172M).

TLAR takeoff data is based on Flaps 20º *except* when density altitude exceeds 6100 feet. Above this, TLAR uses flaps up for C-170B takeoffs. At temperature/pressure altitude combinations that exceed ~6100 feet density altitude, the POH specifies flaps up takeoffs will produce better performance over a 50-foot obstacle than flaps 20º. If the computed density altitude exceeds 6100 feet, TLAR will auto-switch the takeoff flap setting to flaps up.

CAUTION, TLAR's predicted distance over a 50-foot obstacle for the C-170B is significantly shorter than the POH. This difference increases with higher density altitudes. However, TLAR's predictions of ground roll and climb rates are very accurate in comparison to the POH. We hypothesize that the difference in takeoff over a 50ft obstacle distance is in technique used after lift-off. The POH does state that the speed Cessna used over the 50ft obstacle was 67 indicated mph, which is 5 mph faster than Vx, which means they used a flatter (hence longer) climb profile than TLAR's Vx climb until clear of the obstacle.

Aircraft	Engine	Is Turbocharged?	HP	Rpm	Prop Diameter
C170B	O-300A	false	145	2700	75

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
C170B	2200	Vg KCAS	60.0	60.2	0.2	0.997
C170B	2200	Stall clean KCAS	50.4	50.4	-0.0	1.000
C170B	2200	Stall partial flaps KCAS	46.9	46.9	0.0	1.000
C170B	2200	Stall full flaps KCAS	45.2	45.2	0.0	1.000
C170B	2200	Takeoff GroundRun (0 msl / -7 C)	513.0	550.0	37.0	0.928
C170B	2200	Takeoff GroundRun (0 msl / 16 C)	618.0	630.0	12.0	0.981
C170B	2200	Takeoff GroundRun (0 msl / 38 C)	758.0	740.0	-18.0	0.976
C170B	2200	Takeoff GroundRun (4000 msl / -7 C)	802.0	810.0	8.0	0.990
C170B	2200	Takeoff GroundRun (4000 msl / 16 C)	980.0	950.0	-30.0	0.969
C170B	2200	Takeoff GroundRun (4000 msl / 38 C)	1193.0	1250.0	57.0	0.952
C170B	2200	Takeoff GroundRun (7000 msl / -7 C)	1178.0	1240.0	62.0	0.947
C170B	2200	Takeoff GroundRun (7000 msl / 16 C)	1419.0	1500.0	81.0	0.943
C170B	2200	Takeoff GroundRun (7000 msl / 38 C)	1693.0	1820.0	127.0	0.925
C170B	2200	Takeoff 50 (0 msl / -7 C)	1350.0	1260.0	-90.0	0.933
C170B	2200	Takeoff 50 (0 msl / 16 C)	1625.0	1500.0	-125.0	0.923
C170B	2200	Takeoff 50 (0 msl / 38 C)	1995.0	1810.0	-185.0	0.907
C170B	2200	Takeoff 50 (4000 msl / -7 C)	2110.0	2070.0	-40.0	0.981
C170B	2200	Takeoff 50 (4000 msl / 16 C)	2580.0	2580.0	0.0	1.000
C170B	2200	Takeoff 50 (4000 msl / 38 C)	3140.0	2980.0	-160.0	0.949
C170B	2200	Takeoff 50 (7000 msl / -7 C)	3100.0	2980.0	-120.0	0.961
C170B	2200	Takeoff 50 (7000 msl / 16 C)	3735.0	3720.0	-15.0	0.996
C170B	2200	Takeoff 50 (7000 msl / 38 C)	4455.0	4450.0	-5.0	0.999
C170B	2200	Takeoff KCAS	50.0	48.7	-1.3	0.974
C170B	2200	Vx KCAS (0 msl / 16 C)	58.0	57.0	-1.0	0.982
C170B	2200	Vy KCAS (0 msl / 38 C)	77.3	72.9	-4.4	0.943
C170B	2200	Vy KCAS (4000 msl / 16 C)	73.0	71.5	-1.5	0.979
C170B	2200	Vy KCAS (7000 msl / -7 C)	68.6	70.1	1.5	0.978
C170B	2200	Vy FPM (0 msl / -7 C)	740.0	713.3	-26.7	0.964
C170B	2200	Vy FPM (0 msl / 16 C)	690.0	663.6	-26.4	0.962
C170B	2200	Vy FPM (0 msl / 38 C)	645.0	617.9	-27.1	0.958
C170B	2200	Vy FPM (4000 msl / -7 C)	555.0	541.4	-13.6	0.976
C170B	2200	Vy FPM (4000 msl / 16 C)	510.0	494.2	-15.8	0.969
C170B	2200	Vy FPM (4000 msl / 38 C)	465.0	450.1	-14.9	0.968
C170B	2200	Vy FPM (7000 msl / -7 C)	420.0	415.6	-4.4	0.990
C170B	2200	Vy FPM (7000 msl / 16 C)	370.0	369.7	-0.3	0.999
C170B	2200	Vy FPM (7000 msl / 38 C)	325.0	326.5	1.5	0.995
C170B	2200	55% cruise KTAS (2500 msl / Std Day)	97.3	96.0	-1.3	0.986
C170B	2200	55% cruise KTAS (5000 msl / Std Day)	98.2	98.0	-0.2	0.998
C170B	2200	55% cruise KTAS (7500 msl / Std Day)	99.9	101.0	1.1	0.989
C170B	2200	65% cruise KTAS (2500 msl / Std Day)	104.3	106.0	1.7	0.983
C170B	2200	65% cruise KTAS (5000 msl / Std Day)	106.9	107.0	0.1	0.999
C170B	2200	65% cruise KTAS (7500 msl / Std Day)	108.6	109.0	0.4	0.997
C170B	2200	75% cruise KTAS (2500 msl / Std Day)	109.5	111.0	1.5	0.986
C170B	2200	75% cruise KTAS (5000 msl / Std Day)	113.8	112.0	-1.8	0.984
C170B	2200	55% cruise FF (2500 msl / Std Day)	7.0	7.0	-0.0	0.999
C170B	2200	55% cruise FF (5000 msl / Std Day)	7.0	7.0	-0.0	0.999
C170B	2200	55% cruise FF (7500 msl / Std Day)	7.0	7.0	-0.0	0.999
C170B	2200	65% cruise FF (2500 msl / Std Day)	8.3	8.3	-0.0	0.999
C170B	2200	65% cruise FF (5000 msl / Std Day)	8.2	8.3	0.1	0.988
C170B	2200	65% cruise FF (7500 msl / Std Day)	8.2	8.3	0.1	0.988
C170B	2200	75% cruise FF (2500 msl / Std Day)	9.6	9.6	0.0	1.000
C170B	2200	75% cruise FF (5000 msl / Std Day)	9.6	9.3	-0.3	0.972
C170B	2200	Normal appproach CAS (1.288 to 1)	58.2	58.2	-0.0	1.000
C170B	2200	Landroll (0 msl / -7 C)	428.0	430.0	2.0	0.995
C170B	2200	Landroll (0 msl / 16 C)	458.0	460.0	2.0	0.996
C170B	2200	Landroll (0 msl / 38 C)	486.0	490.0	4.0	0.992
C170B	2200	Landroll (4000 msl / -7 C)	482.0	490.0	8.0	0.983
C170B	2200	Landroll (4000 msl / 16 C)	512.0	520.0	8.0	0.984
C170B	2200	Landroll (4000 msl / 38 C)	540.0	560.0	20.0	0.963
C170B	2200	Landroll (7000 msl / -7 C)	522.0	540.0	18.0	0.966
C170B	2200	Landroll (7000 msl / 16 C)	552.0	580.0	28.0	0.949
C170B	2200	Landroll (7000 msl / 38 C)	580.0	630.0	50.0	0.914

Cessna C-172M

Benchmark: POH for 1977 C-172M.

Power: Lycoming 150-HP O-320-E2D engine driving a 2-blade McCauley 1C160/DTM7553 75-inch fixed-pitch propeller.

Aircraft	Engine	Is Turbocharged?	HP	Rpm	Prop Diameter
C172M	O-320	false	150	2700	75

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
C172M	1900	Takeoff GroundRun (0 msl / 0 C)	505.0	500.0	-5.0	0.990
C172M	1900	Takeoff GroundRun (0 msl / 20 C)	580.0	550.0	-30.0	0.948
C172M	1900	Takeoff GroundRun (0 msl / 30 C)	620.0	590.0	-30.0	0.952
C172M	1900	Takeoff GroundRun (3000 msl / 0 C)	660.0	630.0	-30.0	0.955
C172M	1900	Takeoff GroundRun (3000 msl / 20 C)	760.0	720.0	-40.0	0.947
C172M	1900	Takeoff GroundRun (3000 msl / 30 C)	815.0	770.0	-45.0	0.945
C172M	1900	Takeoff GroundRun (6000 msl / 0 C)	870.0	830.0	-40.0	0.954
C172M	1900	Takeoff GroundRun (6000 msl / 20 C)	1010.0	950.0	-60.0	0.941
C172M	1900	Takeoff GroundRun (6000 msl / 30 C)	1080.0	1020.0	-60.0	0.944
C172M	1900	Takeoff 50 (0 msl / 0 C)	915.0	820.0	-95.0	0.896
C172M	1900	Takeoff 50 (0 msl / 20 C)	1035.0	910.0	-125.0	0.879
C172M	1900	Takeoff 50 (0 msl / 30 C)	1105.0	970.0	-135.0	0.878
C172M	1900	Takeoff 50 (3000 msl / 0 C)	1180.0	1040.0	-140.0	0.881
C172M	1900	Takeoff 50 (3000 msl / 20 C)	1345.0	1180.0	-165.0	0.877
C172M	1900	Takeoff 50 (3000 msl / 30 C)	1435.0	1250.0	-185.0	0.871
C172M	1900	Takeoff 50 (6000 msl / 0 C)	1555.0	1410.0	-145.0	0.907
C172M	1900	Takeoff 50 (6000 msl / 20 C)	1785.0	1660.0	-125.0	0.930
C172M	1900	Takeoff 50 (6000 msl / 30 C)	1910.0	1770.0	-140.0	0.927
C172M	1900	Takeoff KCAS	53.0	51.8	-1.2	0.978

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
C172M	2100	Takeoff GroundRun (0 msl / 0 C)	630.0	620.0	-10.0	0.984
C172M	2100	Takeoff GroundRun (0 msl / 20 C)	725.0	700.0	-25.0	0.966
C172M	2100	Takeoff GroundRun (0 msl / 30 C)	780.0	750.0	-30.0	0.962
C172M	2100	Takeoff GroundRun (3000 msl / 0 C)	830.0	800.0	-30.0	0.964
C172M	2100	Takeoff GroundRun (3000 msl / 20 C)	955.0	920.0	-35.0	0.963
C172M	2100	Takeoff GroundRun (3000 msl / 30 C)	1025.0	990.0	-35.0	0.966
C172M	2100	Takeoff GroundRun (6000 msl / 0 C)	1100.0	1080.0	-20.0	0.982
C172M	2100	Takeoff GroundRun (6000 msl / 20 C)	1275.0	1250.0	-25.0	0.980
C172M	2100	Takeoff GroundRun (6000 msl / 30 C)	1370.0	1360.0	-10.0	0.993
C172M	2100	Takeoff 50 (0 msl / 0 C)	1130.0	1030.0	-100.0	0.912
C172M	2100	Takeoff 50 (0 msl / 20 C)	1290.0	1120.0	-170.0	0.868
C172M	2100	Takeoff 50 (0 msl / 30 C)	1375.0	1190.0	-185.0	0.865
C172M	2100	Takeoff 50 (3000 msl / 0 C)	1475.0	1380.0	-95.0	0.936
C172M	2100	Takeoff 50 (3000 msl / 20 C)	1690.0	1570.0	-120.0	0.929
C172M	2100	Takeoff 50 (3000 msl / 30 C)	1805.0	1680.0	-125.0	0.931
C172M	2100	Takeoff 50 (6000 msl / 0 C)	1965.0	1920.0	-45.0	0.977
C172M	2100	Takeoff 50 (6000 msl / 20 C)	2270.0	2190.0	-80.0	0.965
C172M	2100	Takeoff 50 (6000 msl / 30 C)	2435.0	2350.0	-85.0	0.965
C172M	2100	Takeoff KCAS	55.0	54.5	-0.5	0.991

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
C172M	2300	Vg KCAS	66.0	65.7	-0.3	0.995
C172M	2300	Stall clean KCAS	51.5	51.5	-0.0	1.000
C172M	2300	Stall partial flaps KCAS	49.0	49.0	0.0	1.000
C172M	2300	Stall full flaps KCAS	45.5	45.5	-0.0	1.000
C172M	2300	Takeoff GroundRun (0 msl / 0 C)	775.0	770.0	-5.0	0.994
C172M	2300	Takeoff GroundRun (0 msl / 20 C)	895.0	880.0	-15.0	0.983
C172M	2300	Takeoff GroundRun (0 msl / 30 C)	960.0	940.0	-20.0	0.979
C172M	2300	Takeoff GroundRun (3000 msl / 0 C)	1020.0	1020.0	0.0	1.000
C172M	2300	Takeoff GroundRun (3000 msl / 20 C)	1180.0	1180.0	0.0	1.000
C172M	2300	Takeoff GroundRun (3000 msl / 30 C)	1270.0	1270.0	0.0	1.000
C172M	2300	Takeoff GroundRun (6000 msl / 0 C)	1365.0	1400.0	35.0	0.974
C172M	2300	Takeoff GroundRun (6000 msl / 20 C)	1580.0	1630.0	50.0	0.968
C172M	2300	Takeoff GroundRun (6000 msl / 30 C)	1700.0	1780.0	80.0	0.953
C172M	2300	Takeoff 50 (0 msl / 0 C)	1380.0	1400.0	20.0	0.986
C172M	2300	Takeoff 50 (0 msl / 20 C)	1575.0	1700.0	125.0	0.921
C172M	2300	Takeoff 50 (0 msl / 30 C)	1685.0	1810.0	125.0	0.926
C172M	2300	Takeoff 50 (3000 msl / 0 C)	1815.0	2070.0	255.0	0.860
C172M	2300	Takeoff 50 (3000 msl / 20 C)	2085.0	2420.0	335.0	0.839
C172M	2300	Takeoff 50 (3000 msl / 30 C)	2235.0	2590.0	355.0	0.841
C172M	2300	Takeoff 50 (6000 msl / 0 C)	2450.0	2920.0	470.0	0.808
C172M	2300	Takeoff 50 (6000 msl / 20 C)	2850.0	3360.0	510.0	0.821
C172M	2300	Takeoff 50 (6000 msl / 30 C)	3070.0	3650.0	580.0	0.811
C172M	2300	Takeoff KCAS	57.0	57.0	0.0	0.999
C172M	2300	Vx KCAS (0 msl / 20 C)	61.0	61.5	0.5	0.992
C172M	2300	Vy KCAS (0 msl / 40 C)	78.0	78.3	0.3	0.996
C172M	2300	Vy KCAS (4000 msl / 20 C)	74.0	76.4	2.4	0.967
C172M	2300	Vy KCAS (8000 msl / -20 C)	70.0	73.3	3.3	0.952
C172M	2300	Vy FPM (0 msl / -20 C)	755.0	704.3	-50.7	0.933
C172M	2300	Vy FPM (0 msl / 20 C)	630.0	627.6	-2.4	0.996
C172M	2300	Vy FPM (0 msl / 40 C)	565.0	585.7	20.7	0.963
C172M	2300	Vy FPM (4000 msl / -20 C)	555.0	538.0	-17.0	0.969
C172M	2300	Vy FPM (4000 msl / 20 C)	440.0	461.7	21.7	0.951
C172M	2300	Vy FPM (4000 msl / 40 C)	380.0	421.1	41.1	0.892
C172M	2300	Vy FPM (8000 msl / -20 C)	365.0	374.0	9.0	0.975
C172M	2300	Vy FPM (8000 msl / 20 C)	255.0	301.5	46.5	0.818
C172M	2300	Vy FPM (8000 msl / 40 C)	200.0	261.8	61.8	0.691
C172M	2300	55% cruise KTAS (2000 msl / Std Day)	98.0	99.0	1.0	0.990
C172M	2300	55% cruise KTAS (6000 msl / Std Day)	100.0	102.0	2.0	0.980
C172M	2300	55% cruise KTAS (10000 msl / Std Day)	103.5	106.0	2.5	0.976
C172M	2300	65% cruise KTAS (2000 msl / Std Day)	108.0	108.0	0.0	1.000
C172M	2300	65% cruise KTAS (6000 msl / Std Day)	110.0	111.0	1.0	0.991
C172M	2300	65% cruise KTAS (10000 msl / Std Day)	114.0	113.0	-1.0	0.991
C172M	2300	75% cruise KTAS (2000 msl / Std Day)	113.0	114.0	1.0	0.991
C172M	2300	75% cruise KTAS (6000 msl / Std Day)	118.0	116.0	-2.0	0.983
C172M	2300	55% cruise FF (2000 msl / Std Day)	6.5	6.3	-0.2	0.977
C172M	2300	55% cruise FF (6000 msl / Std Day)	6.4	6.3	-0.1	0.984
C172M	2300	55% cruise FF (10000 msl / Std Day)	6.5	6.3	-0.2	0.969
C172M	2300	65% cruise FF (2000 msl / Std Day)	7.3	7.3	0.0	0.999
C172M	2300	65% cruise FF (6000 msl / Std Day)	7.2	7.3	0.1	0.985
C172M	2300	65% cruise FF (10000 msl / Std Day)	7.3	7.1	-0.2	0.966
C172M	2300	75% cruise FF (2000 msl / Std Day)	8.2	8.4	0.2	0.976
C172M	2300	75% cruise FF (6000 msl / Std Day)	8.2	8.1	-0.1	0.984
C172M	2300	Normal appproach CAS (1.363 to 1)	62.0	62.0	-0.0	1.000
C172M	2300	Landroll (0 msl / 0 C)	495.0	500.0	5.0	0.990
C172M	2300	Landroll (0 msl / 20 C)	530.0	530.0	0.0	1.000
C172M	2300	Landroll (0 msl / 40 C)	565.0	570.0	5.0	0.991
C172M	2300	Landroll (4000 msl / 0 C)	570.0	570.0	0.0	1.000
C172M	2300	Landroll (4000 msl / 20 C)	615.0	610.0	-5.0	0.992
C172M	2300	Landroll (4000 msl / 40 C)	655.0	650.0	-5.0	0.992
C172M	2300	Landroll (8000 msl / 0 C)	665.0	660.0	-5.0	0.992
C172M	2300	Landroll (8000 msl / 20 C)	710.0	700.0	-10.0	0.986
C172M	2300	Landroll (8000 msl / 40 C)	760.0	750.0	-10.0	0.987

Cessna C-172N

Benchmark: POH for 1978 C-172N.

Power: Lycoming 160-HP O-320-H2AD engine driving a 2-blade McCauley 1C160/DTM7557 75-inch fixed-pitch propeller.

Aircraft	Engine	Is Turbocharged?	HP	Rpm	Prop Diameter
C172N	O-320h2ad	false	160	2700	75

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
C172N	1900	Vg Ratio	9.0	8.5	-0.5	0.950
C172N	1900	Takeoff GroundRun (0 msl / 0 C)	470.0	460.0	-10.0	0.979
C172N	1900	Takeoff GroundRun (0 msl / 20 C)	540.0	520.0	-20.0	0.963
C172N	1900	Takeoff GroundRun (0 msl / 30 C)	580.0	550.0	-30.0	0.948
C172N	1900	Takeoff GroundRun (3000 msl / 0 C)	615.0	590.0	-25.0	0.959
C172N	1900	Takeoff GroundRun (3000 msl / 20 C)	710.0	670.0	-40.0	0.944
C172N	1900	Takeoff GroundRun (3000 msl / 30 C)	760.0	710.0	-50.0	0.934
C172N	1900	Takeoff GroundRun (6000 msl / 0 C)	810.0	760.0	-50.0	0.938
C172N	1900	Takeoff GroundRun (6000 msl / 20 C)	940.0	880.0	-60.0	0.936
C172N	1900	Takeoff GroundRun (6000 msl / 30 C)	1010.0	940.0	-70.0	0.931
C172N	1900	Takeoff 50 (0 msl / 0 C)	865.0	750.0	-115.0	0.867
C172N	1900	Takeoff 50 (0 msl / 20 C)	985.0	840.0	-145.0	0.853
C172N	1900	Takeoff 50 (0 msl / 30 C)	1045.0	890.0	-155.0	0.852
C172N	1900	Takeoff 50 (3000 msl / 0 C)	1115.0	960.0	-155.0	0.861
C172N	1900	Takeoff 50 (3000 msl / 20 C)	1275.0	1080.0	-195.0	0.847
C172N	1900	Takeoff 50 (3000 msl / 30 C)	1365.0	1140.0	-225.0	0.835
C172N	1900	Takeoff 50 (6000 msl / 0 C)	1470.0	1230.0	-240.0	0.837
C172N	1900	Takeoff 50 (6000 msl / 20 C)	1690.0	1440.0	-250.0	0.852
C172N	1900	Takeoff 50 (6000 msl / 30 C)	1810.0	1580.0	-230.0	0.873
C172N	1900	Takeoff KCAS	53.0	51.8	-1.2	0.978

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
C172N	2100	Vg Ratio	9.0	8.5	-0.5	0.950
C172N	2100	Takeoff GroundRun (0 msl / 0 C)	585.0	570.0	-15.0	0.974
C172N	2100	Takeoff GroundRun (0 msl / 20 C)	680.0	650.0	-30.0	0.956
C172N	2100	Takeoff GroundRun (0 msl / 30 C)	725.0	690.0	-35.0	0.952
C172N	2100	Takeoff GroundRun (3000 msl / 0 C)	770.0	750.0	-20.0	0.974
C172N	2100	Takeoff GroundRun (3000 msl / 20 C)	890.0	850.0	-40.0	0.955
C172N	2100	Takeoff GroundRun (3000 msl / 30 C)	955.0	910.0	-45.0	0.953
C172N	2100	Takeoff GroundRun (6000 msl / 0 C)	1025.0	980.0	-45.0	0.956
C172N	2100	Takeoff GroundRun (6000 msl / 20 C)	1185.0	1140.0	-45.0	0.962
C172N	2100	Takeoff GroundRun (6000 msl / 30 C)	1275.0	1230.0	-45.0	0.965
C172N	2100	Takeoff 50 (0 msl / 0 C)	1070.0	940.0	-130.0	0.879
C172N	2100	Takeoff 50 (0 msl / 20 C)	1220.0	1020.0	-200.0	0.836
C172N	2100	Takeoff 50 (0 msl / 30 C)	1300.0	1080.0	-220.0	0.831
C172N	2100	Takeoff 50 (3000 msl / 0 C)	1390.0	1220.0	-170.0	0.878
C172N	2100	Takeoff 50 (3000 msl / 20 C)	1595.0	1420.0	-175.0	0.890
C172N	2100	Takeoff 50 (3000 msl / 30 C)	1710.0	1500.0	-210.0	0.877
C172N	2100	Takeoff 50 (6000 msl / 0 C)	1850.0	1700.0	-150.0	0.919
C172N	2100	Takeoff 50 (6000 msl / 20 C)	2140.0	1940.0	-200.0	0.907
C172N	2100	Takeoff 50 (6000 msl / 30 C)	2300.0	2070.0	-230.0	0.900
C172N	2100	Takeoff KCAS	55.0	54.5	-0.5	0.991

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
C172N	2300	Vg KCAS	66.0	65.7	-0.3	0.995
C172N	2300	Vg Ratio	9.0	8.5	-0.5	0.950
C172N	2300	Stall clean KCAS	51.5	51.5	-0.0	1.000
C172N	2300	Stall partial flaps KCAS	49.0	49.0	0.0	1.000
C172N	2300	Stall full flaps KCAS	45.5	45.5	-0.0	1.000
C172N	2300	Takeoff GroundRun (0 msl / 0 C)	720.0	720.0	0.0	1.000
C172N	2300	Takeoff GroundRun (0 msl / 20 C)	835.0	820.0	-15.0	0.982
C172N	2300	Takeoff GroundRun (0 msl / 30 C)	895.0	870.0	-25.0	0.972
C172N	2300	Takeoff GroundRun (3000 msl / 0 C)	950.0	940.0	-10.0	0.989
C172N	2300	Takeoff GroundRun (3000 msl / 20 C)	1100.0	1080.0	-20.0	0.982
C172N	2300	Takeoff GroundRun (3000 msl / 30 C)	1185.0	1150.0	-35.0	0.970
C172N	2300	Takeoff GroundRun (6000 msl / 0 C)	1265.0	1260.0	-5.0	0.996
C172N	2300	Takeoff GroundRun (6000 msl / 20 C)	1475.0	1470.0	-5.0	0.997
C172N	2300	Takeoff GroundRun (6000 msl / 30 C)	1585.0	1600.0	15.0	0.991
C172N	2300	Takeoff 50 (0 msl / 0 C)	1300.0	1270.0	-30.0	0.977
C172N	2300	Takeoff 50 (0 msl / 20 C)	1490.0	1430.0	-60.0	0.960
C172N	2300	Takeoff 50 (0 msl / 30 C)	1590.0	1620.0	30.0	0.981
C172N	2300	Takeoff 50 (3000 msl / 0 C)	1710.0	1770.0	60.0	0.965
C172N	2300	Takeoff 50 (3000 msl / 20 C)	1970.0	2070.0	100.0	0.949
C172N	2300	Takeoff 50 (3000 msl / 30 C)	2115.0	2270.0	155.0	0.927
C172N	2300	Takeoff 50 (6000 msl / 0 C)	2305.0	2690.0	385.0	0.833
C172N	2300	Takeoff 50 (6000 msl / 20 C)	2680.0	3080.0	400.0	0.851
C172N	2300	Takeoff 50 (6000 msl / 30 C)	2895.0	3320.0	425.0	0.853
C172N	2300	Takeoff KCAS	57.0	57.0	0.0	0.999
C172N	2300	Vx KCAS (0 msl / 20 C)	61.0	59.5	-1.5	0.975
C172N	2300	Vy KCAS (0 msl / 40 C)	73.0	79.3	6.3	0.913
C172N	2300	Vy KCAS (4000 msl / 20 C)	71.0	77.4	6.4	0.910
C172N	2300	Vy KCAS (8000 msl / -20 C)	69.0	74.2	5.2	0.925
C172N	2300	Vy FPM (0 msl / -20 C)	875.0	776.6	-98.4	0.888
C172N	2300	Vy FPM (0 msl / 20 C)	755.0	713.0	-42.0	0.944
C172N	2300	Vy FPM (0 msl / 40 C)	695.0	665.0	-30.0	0.957
C172N	2300	Vy FPM (4000 msl / -20 C)	655.0	615.6	-39.4	0.940
C172N	2300	Vy FPM (4000 msl / 20 C)	545.0	533.4	-11.6	0.979
C172N	2300	Vy FPM (4000 msl / 40 C)	485.0	491.2	6.2	0.987
C172N	2300	Vy FPM (8000 msl / -20 C)	440.0	439.2	-0.8	0.998
C172N	2300	Vy FPM (8000 msl / 20 C)	335.0	364.3	29.3	0.912
C172N	2300	Vy FPM (8000 msl / 40 C)	280.0	323.4	43.4	0.845
C172N	2300	55% cruise KTAS (2000 msl / Std Day)	101.0	102.0	1.0	0.990
C172N	2300	55% cruise KTAS (6000 msl / Std Day)	105.0	107.0	2.0	0.981
C172N	2300	55% cruise KTAS (10000 msl / Std Day)	108.0	110.0	2.0	0.981
C172N	2300	65% cruise KTAS (2000 msl / Std Day)	109.0	111.0	2.0	0.982
C172N	2300	65% cruise KTAS (6000 msl / Std Day)	113.0	114.0	1.0	0.991
C172N	2300	65% cruise KTAS (10000 msl / Std Day)	116.0	115.0	-1.0	0.991
C172N	2300	75% cruise KTAS (2000 msl / Std Day)	116.0	117.0	1.0	0.991
C172N	2300	75% cruise KTAS (6000 msl / Std Day)	120.0	118.0	-2.0	0.983
C172N	2300	55% cruise FF (2000 msl / Std Day)	6.2	6.5	0.3	0.957
C172N	2300	55% cruise FF (6000 msl / Std Day)	6.4	6.5	0.1	0.989
C172N	2300	55% cruise FF (10000 msl / Std Day)	6.2	6.5	0.3	0.957
C172N	2300	65% cruise FF (2000 msl / Std Day)	7.3	7.1	-0.2	0.975
C172N	2300	65% cruise FF (6000 msl / Std Day)	7.3	7.1	-0.2	0.975
C172N	2300	65% cruise FF (10000 msl / Std Day)	7.2	7.0	-0.2	0.966
C172N	2300	75% cruise FF (2000 msl / Std Day)	8.4	8.9	0.5	0.940
C172N	2300	75% cruise FF (6000 msl / Std Day)	8.4	8.4	-0.0	0.994
C172N	2300	Normal appproach CAS (1.363 to 1)	62.0	62.0	-0.0	1.000
C172N	2300	Landroll (0 msl / 0 C)	495.0	500.0	5.0	0.990
C172N	2300	Landroll (0 msl / 20 C)	530.0	530.0	0.0	1.000
C172N	2300	Landroll (0 msl / 40 C)	565.0	570.0	5.0	0.991
C172N	2300	Landroll (4000 msl / 0 C)	570.0	570.0	0.0	1.000
C172N	2300	Landroll (4000 msl / 20 C)	615.0	610.0	-5.0	0.992
C172N	2300	Landroll (4000 msl / 40 C)	655.0	650.0	-5.0	0.992
C172N	2300	Landroll (8000 msl / 0 C)	665.0	660.0	-5.0	0.992
C172N	2300	Landroll (8000 msl / 20 C)	710.0	700.0	-10.0	0.986
C172N	2300	Landroll (8000 msl / 40 C)	760.0	750.0	-10.0	0.987

Cessna C-172S

Benchmark: POH for C-172S, first published 20 Dec 2007, revision-2 18 Nov 2010.

Power: Lycoming 180-HP IO-360-L2A engine driving a 2-blade McCauley 76-inch fixed-pitch propeller.

Note – TLAR predicts a maximum power of 68% at 8000 MSL and 59% at 12000 MSL for the C-172S with a fixed-pitch prop. This is less than the POH (77% and 64%). The theoretical maximum power available for a normally aspirated engine at 8000 MSL (std day) is 76.2% and 65.8% at 12,000 MSL which does not account for installation losses. The cruise speeds predicted by TLAR at those altitudes and power settings are lower than the POH. We welcome your feedback to help us make TLAR more accurate!

Aircraft	Engine	Is Turbocharged?	HP	Rpm	Prop Diameter
C172S	IO-360L2A	false	180	2700	76

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
C172S	2200	Vg Ratio	9.0	8.8	-0.2	0.978
C172S	2200	Takeoff GroundRun (0 msl / 0 C)	610.0	620.0	10.0	0.984
C172S	2200	Takeoff GroundRun (0 msl / 20 C)	705.0	700.0	-5.0	0.993
C172S	2200	Takeoff GroundRun (0 msl / 30 C)	760.0	750.0	-10.0	0.987
C172S	2200	Takeoff GroundRun (4000 msl / 0 C)	870.0	880.0	10.0	0.989
C172S	2200	Takeoff GroundRun (4000 msl / 20 C)	1010.0	1000.0	-10.0	0.990
C172S	2200	Takeoff GroundRun (4000 msl / 30 C)	1090.0	1070.0	-20.0	0.982
C172S	2200	Takeoff GroundRun (8000 msl / 0 C)	1270.0	1300.0	30.0	0.976
C172S	2200	Takeoff GroundRun (8000 msl / 20 C)	1475.0	1520.0	45.0	0.969
C172S	2200	Takeoff GroundRun (8000 msl / 30 C)	1580.0	1640.0	60.0	0.962
C172S	2200	Takeoff 50 (0 msl / 0 C)	1055.0	950.0	-105.0	0.900
C172S	2200	Takeoff 50 (0 msl / 20 C)	1205.0	1060.0	-145.0	0.880
C172S	2200	Takeoff 50 (0 msl / 30 C)	1290.0	1130.0	-160.0	0.876
C172S	2200	Takeoff 50 (4000 msl / 0 C)	1490.0	1370.0	-120.0	0.919
C172S	2200	Takeoff 50 (4000 msl / 20 C)	1725.0	1540.0	-185.0	0.893
C172S	2200	Takeoff 50 (4000 msl / 30 C)	1855.0	1690.0	-165.0	0.911
C172S	2200	Takeoff 50 (8000 msl / 0 C)	2195.0	2130.0	-65.0	0.970
C172S	2200	Takeoff 50 (8000 msl / 20 C)	2555.0	2350.0	-205.0	0.920
C172S	2200	Takeoff 50 (8000 msl / 30 C)	2745.0	2510.0	-235.0	0.914
C172S	2200	Takeoff KCAS	53.0	57.4	4.4	0.917

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
C172S	2400	Vg Ratio	9.0	8.8	-0.2	0.978
C172S	2400	Takeoff GroundRun (0 msl / 0 C)	745.0	760.0	15.0	0.980
C172S	2400	Takeoff GroundRun (0 msl / 20 C)	860.0	860.0	0.0	1.000
C172S	2400	Takeoff GroundRun (0 msl / 30 C)	925.0	930.0	5.0	0.995
C172S	2400	Takeoff GroundRun (4000 msl / 0 C)	1065.0	1090.0	25.0	0.977
C172S	2400	Takeoff GroundRun (4000 msl / 20 C)	1240.0	1260.0	20.0	0.984
C172S	2400	Takeoff GroundRun (4000 msl / 30 C)	1335.0	1350.0	15.0	0.989
C172S	2400	Takeoff GroundRun (8000 msl / 0 C)	1560.0	1680.0	120.0	0.923
C172S	2400	Takeoff GroundRun (8000 msl / 20 C)	1815.0	1980.0	165.0	0.909
C172S	2400	Takeoff GroundRun (8000 msl / 30 C)	1950.0	2160.0	210.0	0.892
C172S	2400	Takeoff 50 (0 msl / 0 C)	1275.0	1180.0	-95.0	0.925
C172S	2400	Takeoff 50 (0 msl / 20 C)	1470.0	1320.0	-150.0	0.898
C172S	2400	Takeoff 50 (0 msl / 30 C)	1570.0	1410.0	-160.0	0.898
C172S	2400	Takeoff 50 (4000 msl / 0 C)	1830.0	1780.0	-50.0	0.973
C172S	2400	Takeoff 50 (4000 msl / 20 C)	2130.0	2020.0	-110.0	0.948
C172S	2400	Takeoff 50 (4000 msl / 30 C)	2295.0	2070.0	-225.0	0.902
C172S	2400	Takeoff 50 (8000 msl / 0 C)	2755.0	2600.0	-155.0	0.944
C172S	2400	Takeoff 50 (8000 msl / 20 C)	3240.0	3510.0	270.0	0.917
C172S	2400	Takeoff 50 (8000 msl / 30 C)	3500.0	3800.0	300.0	0.914
C172S	2400	Takeoff KCAS	56.0	60.0	4.0	0.929

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
C172S	2550	Vg KCAS	68.4	72.9	4.5	0.935
C172S	2550	Vg Ratio	9.0	8.8	-0.2	0.978
C172S	2550	Stall clean KCAS	53.0	53.0	0.0	1.000
C172S	2550	Stall partial flaps KCAS	50.0	50.0	0.0	1.000
C172S	2550	Stall full flaps KCAS	48.0	48.0	0.0	1.000
C172S	2550	Takeoff GroundRun (0 msl / 0 C)	860.0	890.0	30.0	0.965
C172S	2550	Takeoff GroundRun (0 msl / 20 C)	995.0	1010.0	15.0	0.985
C172S	2550	Takeoff GroundRun (0 msl / 30 C)	1070.0	1080.0	10.0	0.991
C172S	2550	Takeoff GroundRun (4000 msl / 0 C)	1235.0	1290.0	55.0	0.955
C172S	2550	Takeoff GroundRun (4000 msl / 20 C)	1440.0	1500.0	60.0	0.958
C172S	2550	Takeoff GroundRun (4000 msl / 30 C)	1550.0	1610.0	60.0	0.961
C172S	2550	Takeoff GroundRun (8000 msl / 0 C)	1820.0	2020.0	200.0	0.890
C172S	2550	Takeoff GroundRun (8000 msl / 20 C)	2120.0	2430.0	310.0	0.854
C172S	2550	Takeoff GroundRun (8000 msl / 30 C)	2280.0	2670.0	390.0	0.829
C172S	2550	Takeoff 50 (0 msl / 0 C)	1465.0	1380.0	-85.0	0.942
C172S	2550	Takeoff 50 (0 msl / 20 C)	1690.0	1550.0	-140.0	0.917
C172S	2550	Takeoff 50 (0 msl / 30 C)	1810.0	1700.0	-110.0	0.939
C172S	2550	Takeoff 50 (4000 msl / 0 C)	2120.0	2120.0	0.0	1.000
C172S	2550	Takeoff 50 (4000 msl / 20 C)	2480.0	2340.0	-140.0	0.944
C172S	2550	Takeoff 50 (4000 msl / 30 C)	2685.0	2490.0	-195.0	0.927
C172S	2550	Takeoff 50 (8000 msl / 0 C)	3265.0	3580.0	315.0	0.904
C172S	2550	Takeoff 50 (8000 msl / 20 C)	3880.0	4420.0	540.0	0.861
C172S	2550	Takeoff 50 (8000 msl / 30 C)	4225.0	5030.0	805.0	0.809
C172S	2550	Takeoff KCAS	58.0	61.8	3.8	0.934
C172S	2550	Vx KCAS (0 msl / 20 C)	61.0	62.5	1.5	0.976
C172S	2550	Vy KCAS (0 msl / 40 C)	74.0	77.3	3.3	0.955
C172S	2550	Vy KCAS (4000 msl / 20 C)	73.0	75.5	2.5	0.965
C172S	2550	Vy KCAS (8000 msl / 0 C)	72.0	73.3	1.3	0.982
C172S	2550	Vy FPM (0 msl / 0 C)	785.0	784.3	-0.7	0.999
C172S	2550	Vy FPM (0 msl / 20 C)	710.0	730.5	20.5	0.971
C172S	2550	Vy FPM (0 msl / 40 C)	645.0	680.2	35.2	0.945
C172S	2550	Vy FPM (4000 msl / 0 C)	620.0	584.6	-35.4	0.943
C172S	2550	Vy FPM (4000 msl / 20 C)	555.0	533.6	-21.4	0.961
C172S	2550	Vy FPM (4000 msl / 40 C)	495.0	485.3	-9.7	0.981
C172S	2550	Vy FPM (8000 msl / 0 C)	405.0	392.3	-12.7	0.969
C172S	2550	Vy FPM (8000 msl / 20 C)	345.0	343.3	-1.7	0.995
C172S	2550	Vy FPM (8000 msl / 40 C)	285.0	296.5	11.5	0.960
C172S	2550	55% cruise KTAS (4000 msl / Std Day)	103.0	104.0	1.0	0.990
C172S	2550	55% cruise KTAS (8000 msl / Std Day)	105.0	107.0	2.0	0.981
C172S	2550	55% cruise KTAS (12000 msl / Std Day)	109.0	110.0	1.0	0.991
C172S	2550	65% cruise KTAS (4000 msl / Std Day)	112.0	114.0	2.0	0.982
C172S	2550	65% cruise KTAS (8000 msl / Std Day)	115.0	118.0	3.0	0.974
C172S	2550	65% cruise KTAS (12000 msl / Std Day)	119.0	119.0	0.0	1.000
C172S	2550	75% cruise KTAS (4000 msl / Std Day)	118.5	121.0	2.5	0.979
C172S	2550	75% cruise KTAS (8000 msl / Std Day)	123.0	123.0	0.0	1.000
C172S	2550	55% cruise FF (4000 msl / Std Day)	7.8	7.9	0.1	0.985
C172S	2550	55% cruise FF (8000 msl / Std Day)	7.7	7.9	0.2	0.972
C172S	2550	55% cruise FF (12000 msl / Std Day)	7.8	7.9	0.1	0.985
C172S	2550	65% cruise FF (4000 msl / Std Day)	9.0	9.1	0.1	0.989
C172S	2550	65% cruise FF (8000 msl / Std Day)	9.1	9.1	0.0	1.000
C172S	2550	65% cruise FF (12000 msl / Std Day)	8.9	8.8	-0.1	0.992
C172S	2550	75% cruise FF (4000 msl / Std Day)	10.2	10.2	0.1	0.994
C172S	2550	75% cruise FF (8000 msl / Std Day)	10.2	9.9	-0.3	0.974
C172S	2550	Normal appproach CAS (1.333 to 1)	64.0	64.0	-0.0	1.000
C172S	2550	Landroll (0 msl / 0 C)	545.0	550.0	5.0	0.991
C172S	2550	Landroll (0 msl / 20 C)	585.0	580.0	-5.0	0.991
C172S	2550	Landroll (0 msl / 40 C)	605.0	620.0	15.0	0.975
C172S	2550	Landroll (4000 msl / 0 C)	630.0	630.0	0.0	1.000
C172S	2550	Landroll (4000 msl / 20 C)	675.0	670.0	-5.0	0.993
C172S	2550	Landroll (4000 msl / 40 C)	700.0	720.0	20.0	0.971
C172S	2550	Landroll (8000 msl / 0 C)	735.0	720.0	-15.0	0.980
C172S	2550	Landroll (8000 msl / 20 C)	790.0	770.0	-20.0	0.975
C172S	2550	Landroll (8000 msl / 40 C)	815.0	830.0	15.0	0.982

Cessna C-180K

Benchmark: POH for 1978 C-180K.

Power: Continental 230-HP O-470-U engine driving a 2-blade McCauley C2A34C204/90DCB-8 82-inch constant-speed propeller.

Note – The 1978 POH says best flaps-20 obstacle clearance climb speed is 57 knots indicated airspeed at max gross weight. Using the airspeed calibration table from the POH yields a calibrated Vx of 58 knots. The 1964 C-180 POH under the same conditions computes to a Vx of 61 KCAS. TLAR predicts 63.5 KCAS under the same conditions.

Aircraft	Engine	Is Turbocharged?	HP	Rpm	Diameter
C180K	O-470U	false	230	2400	82

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
C180K	2400	Vg KCAS	69.0	69.8	0.8	0.989
C180K	2400	Vg Ratio	10.5	10.0	-0.5	0.953
C180K	2400	Takeoff GroundRun (0 msl / 0 C)	395.0	400.0	5.0	0.987
C180K	2400	Takeoff GroundRun (0 msl / 20 C)	450.0	450.0	0.0	1.000
C180K	2400	Takeoff GroundRun (0 msl / 30 C)	485.0	470.0	-15.0	0.969
C180K	2400	Takeoff GroundRun (3000 msl / 0 C)	510.0	500.0	-10.0	0.980
C180K	2400	Takeoff GroundRun (3000 msl / 20 C)	590.0	570.0	-20.0	0.966
C180K	2400	Takeoff GroundRun (3000 msl / 30 C)	630.0	600.0	-30.0	0.952
C180K	2400	Takeoff GroundRun (6000 msl / 0 C)	670.0	650.0	-20.0	0.970
C180K	2400	Takeoff GroundRun (6000 msl / 20 C)	775.0	750.0	-25.0	0.968
C180K	2400	Takeoff GroundRun (6000 msl / 30 C)	830.0	800.0	-30.0	0.964
C180K	2400	Takeoff 50 (0 msl / 0 C)	770.0	810.0	40.0	0.948
C180K	2400	Takeoff 50 (0 msl / 20 C)	875.0	900.0	25.0	0.971
C180K	2400	Takeoff 50 (0 msl / 30 C)	930.0	950.0	20.0	0.978
C180K	2400	Takeoff 50 (3000 msl / 0 C)	995.0	1020.0	25.0	0.975
C180K	2400	Takeoff 50 (3000 msl / 20 C)	1135.0	1130.0	-5.0	0.996
C180K	2400	Takeoff 50 (3000 msl / 30 C)	1210.0	1190.0	-20.0	0.983
C180K	2400	Takeoff 50 (6000 msl / 0 C)	1310.0	1300.0	-10.0	0.992
C180K	2400	Takeoff 50 (6000 msl / 20 C)	1505.0	1460.0	-45.0	0.970
C180K	2400	Takeoff 50 (6000 msl / 30 C)	1610.0	1550.0	-60.0	0.963
C180K	2400	Takeoff KCAS	49.0	49.0	0.0	1.000

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
C180K	2600	Vg Ratio	10.5	10.0	-0.5	0.953
C180K	2600	Takeoff GroundRun (0 msl / 0 C)	475.0	470.0	-5.0	0.989
C180K	2600	Takeoff GroundRun (0 msl / 20 C)	545.0	530.0	-15.0	0.972
C180K	2600	Takeoff GroundRun (0 msl / 30 C)	585.0	570.0	-15.0	0.974
C180K	2600	Takeoff GroundRun (3000 msl / 0 C)	620.0	600.0	-20.0	0.968
C180K	2600	Takeoff GroundRun (3000 msl / 20 C)	710.0	690.0	-20.0	0.972
C180K	2600	Takeoff GroundRun (3000 msl / 30 C)	765.0	740.0	-25.0	0.967
C180K	2600	Takeoff GroundRun (6000 msl / 0 C)	815.0	800.0	-15.0	0.982
C180K	2600	Takeoff GroundRun (6000 msl / 20 C)	945.0	930.0	-15.0	0.984
C180K	2600	Takeoff GroundRun (6000 msl / 30 C)	1015.0	990.0	-25.0	0.975
C180K	2600	Takeoff 50 (0 msl / 0 C)	925.0	960.0	35.0	0.962
C180K	2600	Takeoff 50 (0 msl / 20 C)	1050.0	1060.0	10.0	0.990
C180K	2600	Takeoff 50 (0 msl / 30 C)	1120.0	1120.0	0.0	1.000
C180K	2600	Takeoff 50 (3000 msl / 0 C)	1200.0	1210.0	10.0	0.992
C180K	2600	Takeoff 50 (3000 msl / 20 C)	1375.0	1350.0	-25.0	0.982
C180K	2600	Takeoff 50 (3000 msl / 30 C)	1470.0	1440.0	-30.0	0.980
C180K	2600	Takeoff 50 (6000 msl / 0 C)	1600.0	1580.0	-20.0	0.988
C180K	2600	Takeoff 50 (6000 msl / 20 C)	1850.0	1800.0	-50.0	0.973
C180K	2600	Takeoff 50 (6000 msl / 30 C)	1990.0	1910.0	-80.0	0.960
C180K	2600	Takeoff KCAS	51.0	51.0	0.0	0.999

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
C180K	2800	Vg KCAS	74.0	76.0	2.0	0.974
C180K	2800	Vg Ratio	10.5	10.0	-0.5	0.953
C180K	2800	Stall clean KCAS	54.0	54.0	0.0	1.000
C180K	2800	Stall partial flaps KCAS	50.0	50.0	0.0	1.000
C180K	2800	Stall full flaps KCAS	49.0	49.0	0.0	1.000
C180K	2800	Takeoff GroundRun (0 msl / 0 C)	560.0	560.0	0.0	1.000
C180K	2800	Takeoff GroundRun (0 msl / 20 C)	645.0	630.0	-15.0	0.977
C180K	2800	Takeoff GroundRun (0 msl / 30 C)	695.0	670.0	-25.0	0.964
C180K	2800	Takeoff GroundRun (3000 msl / 0 C)	735.0	730.0	-5.0	0.993
C180K	2800	Takeoff GroundRun (3000 msl / 20 C)	850.0	840.0	-10.0	0.988
C180K	2800	Takeoff GroundRun (3000 msl / 30 C)	910.0	900.0	-10.0	0.989
C180K	2800	Takeoff GroundRun (6000 msl / 0 C)	975.0	990.0	15.0	0.985
C180K	2800	Takeoff GroundRun (6000 msl / 20 C)	1130.0	1140.0	10.0	0.991
C180K	2800	Takeoff GroundRun (6000 msl / 30 C)	1215.0	1230.0	15.0	0.988
C180K	2800	Takeoff 50 (0 msl / 0 C)	1090.0	1130.0	40.0	0.963
C180K	2800	Takeoff 50 (0 msl / 20 C)	1245.0	1250.0	5.0	0.996
C180K	2800	Takeoff 50 (0 msl / 30 C)	1330.0	1320.0	-10.0	0.992
C180K	2800	Takeoff 50 (3000 msl / 0 C)	1430.0	1440.0	10.0	0.993
C180K	2800	Takeoff 50 (3000 msl / 20 C)	1645.0	1630.0	-15.0	0.991
C180K	2800	Takeoff 50 (3000 msl / 30 C)	1765.0	1730.0	-35.0	0.980
C180K	2800	Takeoff 50 (6000 msl / 0 C)	1935.0	1930.0	-5.0	0.997
C180K	2800	Takeoff 50 (6000 msl / 20 C)	2255.0	2210.0	-45.0	0.980
C180K	2800	Takeoff 50 (6000 msl / 30 C)	2435.0	2370.0	-65.0	0.973
C180K	2800	Takeoff KCAS	53.0	53.0	-0.0	0.999
C180K	2800	Vx KCAS (0 msl / 20 C)	58.0	63.5	5.5	0.906
C180K	2800	Vy KCAS (0 msl / 40 C)	80.0	80.3	0.3	0.996
C180K	2800	Vy KCAS (4000 msl / 20 C)	77.0	75.5	-1.5	0.981
C180K	2800	Vy KCAS (8000 msl / -20 C)	74.0	74.2	0.2	0.998
C180K	2800	Vy FPM (0 msl / -20 C)	1250.0	1138.3	-111.7	0.911
C180K	2800	Vy FPM (0 msl / 20 C)	1080.0	1030.8	-49.2	0.954
C180K	2800	Vy FPM (0 msl / 40 C)	995.0	972.4	-22.6	0.977
C180K	2800	Vy FPM (4000 msl / -20 C)	980.0	920.8	-59.2	0.940
C180K	2800	Vy FPM (4000 msl / 20 C)	825.0	798.6	-26.4	0.968
C180K	2800	Vy FPM (4000 msl / 40 C)	750.0	740.7	-9.3	0.988
C180K	2800	Vy FPM (8000 msl / -20 C)	715.0	692.1	-22.9	0.968
C180K	2800	Vy FPM (8000 msl / 20 C)	575.0	572.4	-2.6	0.995
C180K	2800	Vy FPM (8000 msl / 40 C)	505.0	517.2	12.2	0.976
C180K	2800	55% cruise KTAS (2000 msl / Std Day)	117.0	116.0	-1.0	0.991
C180K	2800	55% cruise KTAS (6000 msl / Std Day)	120.5	121.0	0.5	0.996
C180K	2800	55% cruise KTAS (10000 msl / Std Day)	124.0	125.0	1.0	0.992
C180K	2800	65% cruise KTAS (2000 msl / Std Day)	126.0	126.0	0.0	1.000
C180K	2800	65% cruise KTAS (6000 msl / Std Day)	131.0	131.0	0.0	1.000
C180K	2800	65% cruise KTAS (10000 msl / Std Day)	135.0	136.0	1.0	0.993
C180K	2800	75% cruise KTAS (2000 msl / Std Day)	134.0	134.0	0.0	1.000
C180K	2800	75% cruise KTAS (6000 msl / Std Day)	139.0	139.0	0.0	1.000
C180K	2800	55% cruise FF (2000 msl / Std Day)	9.4	9.5	0.1	0.990
C180K	2800	55% cruise FF (6000 msl / Std Day)	9.5	9.5	-0.0	0.999
C180K	2800	55% cruise FF (10000 msl / Std Day)	9.4	9.5	0.1	0.990
C180K	2800	65% cruise FF (2000 msl / Std Day)	11.1	11.1	0.0	0.999
C180K	2800	65% cruise FF (6000 msl / Std Day)	11.1	11.1	0.0	0.999
C180K	2800	65% cruise FF (10000 msl / Std Day)	11.1	11.1	-0.0	0.996
C180K	2800	75% cruise FF (2000 msl / Std Day)	12.8	12.7	-0.1	0.994
C180K	2800	75% cruise FF (6000 msl / Std Day)	12.8	12.6	-0.2	0.983
C180K	2800	Normal appproach CAS (1.327 to 1)	65.0	65.0	-0.0	1.000
C180K	2800	Landroll (0 msl / 0 C)	455.0	470.0	15.0	0.967
C180K	2800	Landroll (0 msl / 20 C)	490.0	500.0	10.0	0.980
C180K	2800	Landroll (0 msl / 40 C)	520.0	530.0	10.0	0.981
C180K	2800	Landroll (4000 msl / 0 C)	525.0	530.0	5.0	0.990
C180K	2800	Landroll (4000 msl / 20 C)	565.0	570.0	5.0	0.991
C180K	2800	Landroll (4000 msl / 40 C)	605.0	610.0	5.0	0.992
C180K	2800	Landroll (8000 msl / 0 C)	615.0	610.0	-5.0	0.992
C180K	2800	Landroll (8000 msl / 20 C)	655.0	650.0	-5.0	0.992
C180K	2800	Landroll (8000 msl / 40 C)	700.0	700.0	0.0	1.000

Cessna C-182P

Benchmark: POH for 1976 C-182P.

Power: Continental 230-HP O-470-S engine driving a 2-blade McCauley C2A34C203/90DCB-8 82-inch constant-speed propeller.

Note – TLAR's predicted cruise speeds are lower than the POH by about 4 to 7 knots. This seems to make sense comparing the C182P with the C180K. The two planes each have 230HP O470 engines, very nearly the same 82" prop, share the same wing and have similar fuselages. Yet, comparing the POHs, a 2950lb C182P is 4-7 knots faster than a 2800lb C180K at the same altitudes and power settings. As always, we'd love to hear from you, flightlead@tlarpilot.com.

Aircraft	Engine	Is Turbocharged?	HP	Rpm	Prop Diameter
C182P	O-470S	false	230	2600	82

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
C182P	2400	Vg Ratio	9.5	9.2	-0.3	0.972
C182P	2400	Takeoff GroundRun (0 msl / 0 C)	395.0	400.0	5.0	0.987
C182P	2400	Takeoff GroundRun (0 msl / 20 C)	455.0	440.0	-15.0	0.967
C182P	2400	Takeoff GroundRun (0 msl / 30 C)	485.0	470.0	-15.0	0.969
C182P	2400	Takeoff GroundRun (3000 msl / 0 C)	515.0	500.0	-15.0	0.971
C182P	2400	Takeoff GroundRun (3000 msl / 20 C)	590.0	570.0	-20.0	0.966
C182P	2400	Takeoff GroundRun (3000 msl / 30 C)	630.0	600.0	-30.0	0.952
C182P	2400	Takeoff GroundRun (6000 msl / 0 C)	670.0	650.0	-20.0	0.970
C182P	2400	Takeoff GroundRun (6000 msl / 20 C)	770.0	750.0	-20.0	0.974
C182P	2400	Takeoff GroundRun (6000 msl / 30 C)	825.0	800.0	-25.0	0.970
C182P	2400	Takeoff 50 (0 msl / 0 C)	775.0	780.0	5.0	0.994
C182P	2400	Takeoff 50 (0 msl / 20 C)	875.0	880.0	5.0	0.994
C182P	2400	Takeoff 50 (0 msl / 30 C)	930.0	940.0	10.0	0.989
C182P	2400	Takeoff 50 (3000 msl / 0 C)	995.0	1010.0	15.0	0.985
C182P	2400	Takeoff 50 (3000 msl / 20 C)	1130.0	1130.0	0.0	1.000
C182P	2400	Takeoff 50 (3000 msl / 30 C)	1205.0	1180.0	-25.0	0.979
C182P	2400	Takeoff 50 (6000 msl / 0 C)	1300.0	1290.0	-10.0	0.992
C182P	2400	Takeoff 50 (6000 msl / 20 C)	1490.0	1460.0	-30.0	0.980
C182P	2400	Takeoff 50 (6000 msl / 30 C)	1595.0	1550.0	-45.0	0.972
C182P	2400	Takeoff KCAS	53.0	49.5	-3.5	0.934

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
C182P	2700	Vg Ratio	9.5	9.2	-0.3	0.972
C182P	2700	Takeoff GroundRun (0 msl / 0 C)	520.0	520.0	0.0	1.000
C182P	2700	Takeoff GroundRun (0 msl / 20 C)	595.0	580.0	-15.0	0.975
C182P	2700	Takeoff GroundRun (0 msl / 30 C)	635.0	610.0	-25.0	0.961
C182P	2700	Takeoff GroundRun (3000 msl / 0 C)	675.0	670.0	-5.0	0.993
C182P	2700	Takeoff GroundRun (3000 msl / 20 C)	775.0	760.0	-15.0	0.981
C182P	2700	Takeoff GroundRun (3000 msl / 30 C)	830.0	810.0	-20.0	0.976
C182P	2700	Takeoff GroundRun (6000 msl / 0 C)	885.0	880.0	-5.0	0.994
C182P	2700	Takeoff GroundRun (6000 msl / 20 C)	1020.0	1020.0	0.0	1.000
C182P	2700	Takeoff GroundRun (6000 msl / 30 C)	1095.0	1100.0	5.0	0.995
C182P	2700	Takeoff 50 (0 msl / 0 C)	1000.0	1040.0	40.0	0.960
C182P	2700	Takeoff 50 (0 msl / 20 C)	1135.0	1150.0	15.0	0.987
C182P	2700	Takeoff 50 (0 msl / 30 C)	1210.0	1210.0	0.0	1.000
C182P	2700	Takeoff 50 (3000 msl / 0 C)	1295.0	1320.0	25.0	0.981
C182P	2700	Takeoff 50 (3000 msl / 20 C)	1485.0	1480.0	-5.0	0.997
C182P	2700	Takeoff 50 (3000 msl / 30 C)	1585.0	1570.0	-15.0	0.991
C182P	2700	Takeoff 50 (6000 msl / 0 C)	1730.0	1730.0	0.0	1.000
C182P	2700	Takeoff 50 (6000 msl / 20 C)	1995.0	1990.0	-5.0	0.997
C182P	2700	Takeoff 50 (6000 msl / 30 C)	2150.0	2140.0	-10.0	0.995
C182P	2700	Takeoff KCAS	56.0	52.5	-3.5	0.937

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
C182P	2950	Vg KCAS	72.0	76.0	4.0	0.945
C182P	2950	Vg Ratio	9.5	9.2	-0.3	0.972
C182P	2950	Stall clean KCAS	57.5	57.5	0.0	1.000
C182P	2950	Stall partial flaps KCAS	53.0	53.0	0.0	1.000
C182P	2950	Stall full flaps KCAS	52.0	52.0	0.0	1.000
C182P	2950	Takeoff GroundRun (0 msl / 0 C)	635.0	630.0	-5.0	0.992
C182P	2950	Takeoff GroundRun (0 msl / 20 C)	730.0	720.0	-10.0	0.986
C182P	2950	Takeoff GroundRun (0 msl / 30 C)	780.0	770.0	-10.0	0.987
C182P	2950	Takeoff GroundRun (3000 msl / 0 C)	825.0	830.0	5.0	0.994
C182P	2950	Takeoff GroundRun (3000 msl / 20 C)	950.0	960.0	10.0	0.989
C182P	2950	Takeoff GroundRun (3000 msl / 30 C)	1020.0	1030.0	10.0	0.990
C182P	2950	Takeoff GroundRun (6000 msl / 0 C)	1090.0	1140.0	50.0	0.954
C182P	2950	Takeoff GroundRun (6000 msl / 20 C)	1260.0	1330.0	70.0	0.944
C182P	2950	Takeoff GroundRun (6000 msl / 30 C)	1350.0	1440.0	90.0	0.933
C182P	2950	Takeoff 50 (0 msl / 0 C)	1220.0	1260.0	40.0	0.967
C182P	2950	Takeoff 50 (0 msl / 20 C)	1395.0	1410.0	15.0	0.989
C182P	2950	Takeoff 50 (0 msl / 30 C)	1490.0	1490.0	0.0	1.000
C182P	2950	Takeoff 50 (3000 msl / 0 C)	1605.0	1630.0	25.0	0.984
C182P	2950	Takeoff 50 (3000 msl / 20 C)	1850.0	1870.0	20.0	0.989
C182P	2950	Takeoff 50 (3000 msl / 30 C)	1985.0	2000.0	15.0	0.992
C182P	2950	Takeoff 50 (6000 msl / 0 C)	2185.0	2250.0	65.0	0.970
C182P	2950	Takeoff 50 (6000 msl / 20 C)	2555.0	2610.0	55.0	0.978
C182P	2950	Takeoff 50 (6000 msl / 30 C)	2765.0	2820.0	55.0	0.980
C182P	2950	Takeoff KCAS	57.0	54.9	-2.1	0.963
C182P	2950	Vx KCAS (0 msl / 20 C)	62.0	64.4	2.4	0.960
C182P	2950	Vy KCAS (0 msl / 40 C)	80.0	83.3	3.3	0.959
C182P	2950	Vy KCAS (4000 msl / 20 C)	77.0	82.0	5.0	0.935
C182P	2950	Vy KCAS (8000 msl / -20 C)	75.0	79.3	4.3	0.943
C182P	2950	Vy FPM (0 msl / -20 C)	1040.0	1009.7	-30.3	0.971
C182P	2950	Vy FPM (0 msl / 20 C)	870.0	903.9	33.9	0.961
C182P	2950	Vy FPM (0 msl / 40 C)	785.0	852.1	67.1	0.915
C182P	2950	Vy FPM (4000 msl / -20 C)	820.0	801.2	-18.8	0.977
C182P	2950	Vy FPM (4000 msl / 20 C)	660.0	691.8	31.8	0.952
C182P	2950	Vy FPM (4000 msl / 40 C)	585.0	642.4	57.4	0.902
C182P	2950	Vy FPM (8000 msl / -20 C)	600.0	590.8	-9.2	0.985
C182P	2950	Vy FPM (8000 msl / 20 C)	460.0	487.2	27.2	0.941
C182P	2950	Vy FPM (8000 msl / 40 C)	390.0	439.6	49.6	0.873
C182P	2950	55% cruise KTAS (2000 msl / Std Day)	122.0	116.0	-6.0	0.951
C182P	2950	55% cruise KTAS (6000 msl / Std Day)	124.5	120.0	-4.5	0.964
C182P	2950	55% cruise KTAS (10000 msl / Std Day)	129.0	124.0	-5.0	0.961
C182P	2950	65% cruise KTAS (2000 msl / Std Day)	131.0	126.0	-5.0	0.962
C182P	2950	65% cruise KTAS (6000 msl / Std Day)	135.0	131.0	-4.0	0.970
C182P	2950	65% cruise KTAS (10000 msl / Std Day)	140.0	133.0	-7.0	0.950
C182P	2950	75% cruise KTAS (2000 msl / Std Day)	138.5	134.0	-4.5	0.968
C182P	2950	75% cruise KTAS (6000 msl / Std Day)	143.5	137.0	-6.5	0.955
C182P	2950	55% cruise FF (2000 msl / Std Day)	10.3	10.6	0.3	0.967
C182P	2950	55% cruise FF (6000 msl / Std Day)	10.3	10.6	0.3	0.967
C182P	2950	55% cruise FF (10000 msl / Std Day)	10.4	10.6	0.2	0.977
C182P	2950	65% cruise FF (2000 msl / Std Day)	12.1	12.5	0.4	0.967
C182P	2950	65% cruise FF (6000 msl / Std Day)	12.0	12.5	0.5	0.962
C182P	2950	65% cruise FF (10000 msl / Std Day)	11.9	12.0	0.0	0.999
C182P	2950	75% cruise FF (2000 msl / Std Day)	13.9	14.3	0.4	0.974
C182P	2950	75% cruise FF (6000 msl / Std Day)	13.9	13.7	-0.3	0.980
C182P	2950	Normal appproach CAS (1.231 to 1)	64.0	64.0	-0.0	1.000
C182P	2950	Landroll (0 msl / 0 C)	560.0	570.0	10.0	0.982
C182P	2950	Landroll (0 msl / 20 C)	600.0	610.0	10.0	0.983
C182P	2950	Landroll (0 msl / 40 C)	640.0	650.0	10.0	0.984
C182P	2950	Landroll (4000 msl / 0 C)	650.0	650.0	0.0	1.000
C182P	2950	Landroll (4000 msl / 20 C)	670.0	700.0	30.0	0.955
C182P	2950	Landroll (4000 msl / 40 C)	740.0	740.0	0.0	1.000
C182P	2950	Landroll (8000 msl / 0 C)	755.0	750.0	-5.0	0.993
C182P	2950	Landroll (8000 msl / 20 C)	810.0	800.0	-10.0	0.988
C182P	2950	Landroll (8000 msl / 40 C)	865.0	860.0	-5.0	0.994

Cessna C-A185F

Benchmark: POH for 1975 C-185F

Power: Continental 300-HP IO-520-D engine driving an 82-inch constant speed propeller. (Type not specified by POH)

Note – The POH indicates a 75% power cruise at 7500 MSL under standard conditions is possible using 2550 RPM and a manifold pressure of 23 inHg. The maximum *cruise* power TLAR computes for the IO-520D @ 7500 MSL std day is 70% power, hence the slower predicted cruise speed and lower fuel flow for that entry.

Aircraft	Engine	IsTurbocharged?	HP	Rpm	PropDiameter
CA185F	IO-520D	FALSE	300	2850	82

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
CA185F	2300	Takeoff GroundRun (0 msl / 15 C)	330.0	340.0	10.0	0.970
CA185F	2300	Takeoff GroundRun (2500 msl / 10 C)	395.0	390.0	-5.0	0.987
CA185F	2300	Takeoff GroundRun (7500 msl / 0 C)	565.0	550.0	-15.0	0.973
CA185F	2300	Takeoff 50 (0 msl / 15 C)	785.0	660.0	-125.0	0.841
CA185F	2300	Takeoff 50 (2500 msl / 10 C)	865.0	740.0	-125.0	0.855
CA185F	2300	Takeoff 50 (7500 msl / 0 C)	1090.0	950.0	-140.0	0.872
CA185F	2300	Vy FPM (0 msl / 15 C)	1815.0	1806.6	-8.4	0.995
CA185F	2300	Vy FPM (5000 msl / 5 C)	1460.0	1454.0	-6.0	0.996
CA185F	2300	Vy FPM (10000 msl / -5 C)	1115.0	1122.9	7.9	0.993

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
CA185F	2800	Takeoff GroundRun (0 msl / 15 C)	515.0	500.0	-15.0	0.971
CA185F	2800	Takeoff GroundRun (2500 msl / 10 C)	610.0	600.0	-10.0	0.984
CA185F	2800	Takeoff GroundRun (7500 msl / 0 C)	885.0	860.0	-25.0	0.972
CA185F	2800	Takeoff 50 (0 msl / 15 C)	1025.0	880.0	-145.0	0.859
CA185F	2800	Takeoff 50 (2500 msl / 10 C)	1150.0	1050.0	-100.0	0.913
CA185F	2800	Takeoff 50 (7500 msl / 0 C)	1530.0	1580.0	50.0	0.967

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
CA185F	3350	Vg KCAS	71.3	73.9	2.6	0.963
CA185F	3350	Vg Ratio	7.9	7.8	-0.1	0.982
CA185F	3350	Stall clean KCAS	56.5	56.5	0.0	1.000
CA185F	3350	Stall partial flaps KCAS	50.4	50.4	0.0	1.000
CA185F	3350	Stall full flaps KCAS	48.7	48.7	0.0	1.000
CA185F	3350	Takeoff GroundRun (0 msl / 15 C)	770.0	760.0	-10.0	0.987
CA185F	3350	Takeoff GroundRun (2500 msl / 10 C)	930.0	910.0	-20.0	0.978
CA185F	3350	Takeoff GroundRun (7500 msl / 0 C)	1350.0	1380.0	30.0	0.978
CA185F	3350	Takeoff 50 (0 msl / 15 C)	1365.0	1390.0	25.0	0.982
CA185F	3350	Takeoff 50 (2500 msl / 10 C)	1590.0	1650.0	60.0	0.962
CA185F	3350	Takeoff 50 (7500 msl / 0 C)	2325.0	2480.0	155.0	0.933
CA185F	3350	Vx KCAS (0 msl / 5 C)	60.0	64.1	4.1	0.931
CA185F	3350	Vy KCAS (0 msl / 15 C)	88.0	87.5	-0.5	0.994
CA185F	3350	Vy KCAS (5000 msl / 5 C)	82.0	82.7	0.7	0.992
CA185F	3350	Vy KCAS (10000 msl / -5 C)	77.0	81.0	4.0	0.948
CA185F	3350	Vy FPM (0 msl / 15 C)	1045.0	1054.7	9.7	0.991
CA185F	3350	Vy FPM (5000 msl / 5 C)	785.0	788.5	3.5	0.996
CA185F	3350	Vy FPM (10000 msl / -5 C)	515.0	533.7	18.7	0.964
CA185F	3350	55% cruise KTAS (2500 msl / Std Day)	121.7	121.0	-0.7	0.995
CA185F	3350	55% cruise KTAS (7500 msl / Std Day)	126.4	126.0	-0.4	0.997
CA185F	3350	55% cruise KTAS (10000 msl / Std Day)	128.6	129.0	0.4	0.997
CA185F	3350	65% cruise KTAS (2500 msl / Std Day)	131.2	131.0	-0.2	0.998
CA185F	3350	65% cruise KTAS (7500 msl / Std Day)	136.4	138.0	1.6	0.988
CA185F	3350	65% cruise KTAS (10000 msl / Std Day)	139.9	140.0	0.1	0.999
CA185F	3350	75% cruise KTAS (2500 msl / Std Day)	138.2	140.0	1.8	0.987
CA185F	3350	75% cruise KTAS (7500 msl / Std Day)	146.0	142.0	-4.0	0.973
CA185F	3350	55% cruise FF (2500 msl / Std Day)	11.7	11.6	-0.1	0.995
CA185F	3350	55% cruise FF (7500 msl / Std Day)	11.7	11.6	-0.1	0.995
CA185F	3350	55% cruise FF (10000 msl / Std Day)	11.7	11.6	-0.1	0.995
CA185F	3350	65% cruise FF (2500 msl / Std Day)	13.7	13.6	-0.1	0.993
CA185F	3350	65% cruise FF (7500 msl / Std Day)	13.7	13.6	-0.1	0.993
CA185F	3350	65% cruise FF (10000 msl / Std Day)	13.7	13.4	-0.3	0.977
CA185F	3350	75% cruise FF (2500 msl / Std Day)	15.8	15.6	-0.2	0.987
CA185F	3350	75% cruise FF (7500 msl / Std Day)	15.8	14.6	-1.2	0.922
CA185F	3350	Normal appproach CAS (1.446 to 1)	70.4	70.4	-0.0	1.000
CA185F	3350	Landroll (0 msl / 15 C)	480.0	470.0	-10.0	0.979
CA185F	3350	Landroll (5000 msl / 5 C)	540.0	540.0	0.0	1.000
CA185F	3350	Landroll (7500 msl / 0 C)	575.0	580.0	5.0	0.991

Cirrus SR-20

Benchmark: POH for 2020 SR-20 (P/N 11934-005)

Power: Lycoming 215-HP IO-390C engine driving a 3-bladed 74” Aluminum Hartzell HC-E3YR-1RF/F7392S-1 constant speed propeller.

Aircraft	Engine	Is Turbocharged?	HP	Rpm	Prop Diameter
SR20	IO-390C	false	215	2700	74

Aircraft	GrossWeight	Metric(Pa/Temp)	POH	TLAR	Delta	Accuracy
SR20	2600	VgKCAS	91	90.5	-0.5	0.994
SR20	2600	VgRatio	9	9	0	1
SR20	2600	TakeoffGroundRun(0msl/15C)	1023	1050	27	0.974
SR20	2600	TakeoffGroundRun(4000msl/7C)	1414	1420	6	0.996
SR20	2600	TakeoffGroundRun(8000msl/-1C)	2004	2000	-4	0.998
SR20	2600	Takeoff50(0msl/15C)	1566	1480	-86	0.945
SR20	2600	Takeoff50(4000msl/7C)	2141	2090	-51	0.976
SR20	2600	Takeoff50(8000msl/-1C)	3001	2930	-71	0.976
SR20	2600	TakeoffKCAS	67	67.2	0.2	0.997
SR20	2600	VyFPM(0msl/15C)	1160	1023.8	-136.2	0.883
SR20	2600	VyFPM(6000msl/3C)	760	730	-30	0.961
SR20	2600	VyFPM(10000msl/-5C)	494	540	46	0.907
SR20	2600	55%cruiseKTAS(2000msl/StdDay)	127	126	-1	0.992
SR20	2600	55%cruiseKTAS(6000msl/StdDay)	132	132	0	1
SR20	2600	55%cruiseKTAS(10000msl/StdDay)	138	137	-1	0.993
SR20	2600	65%cruiseKTAS(2000msl/StdDay)	137	137	0	1
SR20	2600	65%cruiseKTAS(6000msl/StdDay)	143	143	0	1
SR20	2600	65%cruiseKTAS(10000msl/StdDay)	148	148	0	1
SR20	2600	75%cruiseKTAS(2000msl/StdDay)	146	146	0	1
SR20	2600	75%cruiseKTAS(6000msl/StdDay)	151	152	1	0.993
SR20	2600	55%cruiseFF(2000msl/StdDay)	9.6	9.4	-0.2	0.979
SR20	2600	55%cruiseFF(6000msl/StdDay)	9.3	9.4	0.1	0.995
SR20	2600	55%cruiseFF(10000msl/StdDay)	9.2	9.4	0.2	0.978
SR20	2600	65%cruiseFF(2000msl/StdDay)	11	10.8	-0.2	0.984
SR20	2600	65%cruiseFF(6000msl/StdDay)	10.8	10.8	0	0.998
SR20	2600	65%cruiseFF(10000msl/StdDay)	10.7	10.8	0.1	0.988
SR20	2600	75%cruiseFF(2000msl/StdDay)	13	13.1	0.1	0.992
SR20	2600	75%cruiseFF(6000msl/StdDay)	13.3	13.1	-0.2	0.985

Aircraft	GrossWeight	Metric(Pa/Temp)	POH	TLAR	Delta	Accuracy
SR20	3150	VgKCAS	100	99.7	-0.3	0.997
SR20	3150	VgRatio	9	9	0	1
SR20	3150	StallcleanKCAS	69	69	0	1
SR20	3150	StallpartialflapsKCAS	62.5	62.5	0	1
SR20	3150	StallfullflapsKCAS	58.5	58.5	0	1
SR20	3150	TakeoffGroundRun(0msl/15C)	1685	1690	5	0.997
SR20	3150	TakeoffGroundRun(4000msl/7C)	2329	2370	41	0.982
SR20	3150	TakeoffGroundRun(8000msl/-1C)	3300	3560	260	0.921
SR20	3150	Takeoff50(0msl/15C)	2530	2470	-60	0.976
SR20	3150	Takeoff50(4000msl/7C)	3460	3460	0	1
SR20	3150	Takeoff50(8000msl/-1C)	4851	5240	389	0.92
SR20	3150	TakeoffKCAS	74	74	0	1
SR20	3150	VxKCAS(0msl/3C)	81	79.6	-1.4	0.983
SR20	3150	VyKCAS(0msl/15C)	97	99	2	0.979
SR20	3150	VyKCAS(6000msl/3C)	94	95.1	1.1	0.988
SR20	3150	VyKCAS(10000msl/-5C)	92	94.8	2.8	0.969
SR20	3150	VyFPM(0msl/15C)	864	737.2	-126.8	0.853
SR20	3150	VyFPM(6000msl/3C)	522	474.2	-47.8	0.908
SR20	3150	VyFPM(10000msl/-5C)	294	304.4	10.4	0.965
SR20	3150	NormalappproachCAS(1.333to1)	78	78	0	1
SR20	3150	Landroll(0msl/15C)	853	860	7	0.992
SR20	3150	Landroll(4000msl/7C)	960	960	0	1
SR20	3150	Landroll(8000msl/-3C)	1085	1070	-15	0.986

Cirrus SR-22

Benchmark: POH for 2020 SR-22 (P/N 13772-006)

Power: Continental 310-HP IO-550N engine driving a 3-bladed composite 78” McCauley D3A34C443/78CYA-0 constant speed propeller.

Aircraft	Engine	Is Turbocharged?	HP	Rpm	Prop Diameter
SR22	IO-550N	false	310	2700	78

Aircraft	GrossWeight	Metric(Pa/Temp)	POH	TLAR	Delta	Accuracy
SR22	2900	VgKCAS	88	84.3	-3.7	0.958
SR22	2900	VgRatio	8.8	8.9	0.1	0.984
SR22	2900	TakeoffGroundRun(0msl/15C)	684	690	6	0.991
SR22	2900	TakeoffGroundRun(4000msl/7C)	959	900	-59	0.938
SR22	2900	TakeoffGroundRun(8000msl/-1C)	1367	1240	-127	0.907
SR22	2900	Takeoff50(0msl/15C)	1080	950	-130	0.88
SR22	2900	Takeoff50(4000msl/7C)	1498	1230	-268	0.821
SR22	2900	Takeoff50(8000msl/-1C)	2113	2110	-3	0.999
SR22	2900	TakeoffKCAS	66	66.4	0.4	0.994
SR22	2900	VyKCAS(0msl/15C)	101	100.1	-0.9	0.991
SR22	2900	VyKCAS(6000msl/3C)	98	96	-2	0.98
SR22	2900	VyKCAS(10000msl/-5C)	96	95.7	-0.3	0.996
SR22	2900	VyFPM(0msl/15C)	1732	1732.5	0.5	1
SR22	2900	VyFPM(6000msl/3C)	1326	1318.1	-7.9	0.994
SR22	2900	VyFPM(10000msl/-5C)	1056	1055.2	-0.8	0.999
SR22	3400	55%cruiseKTAS(4000msl/StdDay)	154	152	-2	0.987
SR22	3400	55%cruiseKTAS(8000msl/StdDay)	160	158	-2	0.988
SR22	3400	55%cruiseKTAS(12000msl/StdDay)	166	164	-2	0.988
SR22	3400	65%cruiseKTAS(4000msl/StdDay)	165	164	-1	0.994
SR22	3400	65%cruiseKTAS(8000msl/StdDay)	171	170	-1	0.994
SR22	3400	65%cruiseKTAS(12000msl/StdDay)	178	177	-1	0.994
SR22	3400	75%cruiseKTAS(4000msl/StdDay)	173	174	1	0.994
SR22	3400	75%cruiseKTAS(8000msl/StdDay)	180	181	1	0.994
SR22	3400	55%cruiseFF(4000msl/StdDay)	11.3	11.3	0	1
SR22	3400	55%cruiseFF(8000msl/StdDay)	11.3	11.3	0	1
SR22	3400	55%cruiseFF(12000msl/StdDay)	11.3	11.3	0	1
SR22	3400	65%cruiseFF(4000msl/StdDay)	15.4	15.4	0	1
SR22	3400	65%cruiseFF(8000msl/StdDay)	15.4	15.4	0	1
SR22	3400	65%cruiseFF(12000msl/StdDay)	15.4	15.4	0	1
SR22	3400	75%cruiseFF(4000msl/StdDay)	17.8	17.8	0	1
SR22	3400	75%cruiseFF(8000msl/StdDay)	17.8	17.8	0	1

Aircraft	GrossWeight	Metric(Pa/Temp)	POH	TLAR	Delta	Accuracy
SR22	3600	VgKCAS	91	94.6	3.6	0.961
SR22	3600	VgRatio	8.8	8.9	0.1	0.985
SR22	3600	StallcleanKCAS	71.5	71.5	0	1
SR22	3600	StallpartialflapsKCAS	66.5	66.5	0	1
SR22	3600	StallfullflapsKCAS	60.5	60.5	0	1
SR22	3600	TakeoffGroundRun(0msl/15C)	1082	1130	48	0.956
SR22	3600	TakeoffGroundRun(4000msl/7C)	1512	1550	38	0.975
SR22	3600	TakeoffGroundRun(8000msl/-1C)	2146	2190	44	0.979
SR22	3600	Takeoff50(0msl/15C)	1868	1930	62	0.967
SR22	3600	Takeoff50(4000msl/7C)	2578	2520	-58	0.978
SR22	3600	Takeoff50(8000msl/-1C)	3616	3190	-426	0.882
SR22	3600	TakeoffKCAS	74	74	0	1
SR22	3600	VxKCAS(0msl/3C)	84	83.7	-0.3	0.997
SR22	3600	VyKCAS(0msl/15C)	109	106.2	-2.8	0.974
SR22	3600	VyKCAS(6000msl/3C)	102	106.1	4.1	0.96
SR22	3600	VyKCAS(10000msl/-5C)	99	104.1	5.1	0.948
SR22	3600	VyFPM(0msl/15C)	1251	1281.6	30.6	0.976
SR22	3600	VyFPM(6000msl/3C)	906	923.7	17.7	0.98
SR22	3600	VyFPM(10000msl/-5C)	676	692.6	16.6	0.975
SR22	3600	NormalappproachCAS(1.306to1)	79	79	0	1
SR22	3600	Landroll(0msl/15C)	1178	1190	12	0.99
SR22	3600	Landroll(4000msl/7C)	1326	1330	4	0.997
SR22	3600	Landroll(8000msl/-3C)	1499	1480	-19	0.987

Cirrus SR-22T

Benchmark: POH for 2020 SR-22T (P/N 13772-007)

Power: Continental Turbo-charged 315-HP TSIO-550K engine driving a 3-bladed composite 78" Hartzell PHC-J3Y1F-1N/N7605(B) constant speed propeller.

CAUTION – The Cirrus SR22 and SR22T have takeoff performance charts that seem to contradict each other: The normally-aspirated 310 HP SR22 has better takeoff performance from Sea-Level to 9000 feet PA at 3600 lbs than the turbo-charged 315 HP SR22T. Yet, the reverse is true at a 2900 lb gross weight. Similarly, the charted lift-off speeds seem contradictory. 3600 lbs: SR22 = 76 KIAS, SR22T = 80 KIAS, 2900 lbs: SR22 = 70 KIAS, SR22T = 67 KIAS. The two aircraft share the same wing and fuselage. TLAR's aero/physics model reasonably matches SR20 POH performance light and heavy weight, SR22 light and heavy weight, and SR22T at light weight. *But, TLAR's predicted performance for the SR22T at heavy gross weight is significantly different from the POH for takeoff distances, takeoff speed, and Vx speed. We crave feedback from the Cirrus SR22T community to correct this difference (flightlead@tlarpilot.com).*

Note

The SR22T POH specifies climb performance using a constant 120 KIAS climb profile regardless of weight and altitude. Performance validation runs for the SR22T used a 121 KCAS climb to match (pitot static calibration charts for the SR22T show that calibrated airspeed is 1 knot higher than indicated at 120 knots).

Aircraft	Engine	Is Turbocharged?	HP	Rpm	Prop Diameter
SR22T	TSIO-550K	true	315	2500	78

Aircraft	GrossWeight	Metric(Pa/Temp)	POH	TLAR	Delta	Accuracy
SR22T	2900	VgKCAS	88	85.3	-2.7	0.97
SR22T	2900	VgRatio	8.6	8.6	0	0.998
SR22T	2900	TakeoffGroundRun(0msl/15C)	544	610	66	0.879
SR22T	2900	TakeoffGroundRun(4000msl/7C)	665	710	45	0.932
SR22T	2900	TakeoffGroundRun(8000msl/-1C)	819	830	11	0.987
SR22T	2900	Takeoff50(0msl/15C)	852	930	78	0.908
SR22T	2900	Takeoff50(4000msl/7C)	1021	1050	29	0.972
SR22T	2900	Takeoff50(8000msl/-1C)	1231	1210	-21	0.983
SR22T	2900	TakeoffKCAS	61.2	64.3	3.1	0.949
SR22T	2900	VyKCAS(0msl/15C)	121	121	0	1
SR22T	2900	VyKCAS(6000msl/3C)	121	121	0	1
SR22T	2900	VyKCAS(10000msl/-5C)	121	121	0	1
SR22T	2900	VyFPM(0msl/15C)	1498	1610	112	0.925
SR22T	2900	VyFPM(6000msl/3C)	1515	1595.6	80.6	0.947
SR22T	2900	VyFPM(10000msl/-5C)	1512	1576.5	64.5	0.957
SR22T	3400	55%cruiseKTAS(6000msl/StdDay)	147	148	1	0.993
SR22T	3400	55%cruiseKTAS(14000msl/StdDay)	157	160	3	0.981
SR22T	3400	55%cruiseKTAS(25000msl/StdDay)	171	174	3	0.982
SR22T	3400	65%cruiseKTAS(6000msl/StdDay)	159	160	1	0.994
SR22T	3400	65%cruiseKTAS(14000msl/StdDay)	170	172	2	0.988
SR22T	3400	65%cruiseKTAS(25000msl/StdDay)	188	189	1	0.995
SR22T	3400	75%cruiseKTAS(6000msl/StdDay)	168	170	2	0.988
SR22T	3400	75%cruiseKTAS(14000msl/StdDay)	181	182	1	0.994
SR22T	3400	75%cruiseKTAS(25000msl/StdDay)	201	201	0	1
SR22T	3400	55%cruiseFF(6000msl/StdDay)	12.7	12.7	0	1
SR22T	3400	55%cruiseFF(14000msl/StdDay)	12.7	12.7	0	1
SR22T	3400	55%cruiseFF(25000msl/StdDay)	12.7	12.7	0	1
SR22T	3400	65%cruiseFF(6000msl/StdDay)	14.6	14.6	0	1
SR22T	3400	65%cruiseFF(14000msl/StdDay)	14.6	14.6	0	1
SR22T	3400	65%cruiseFF(25000msl/StdDay)	14.6	14.6	0	1
SR22T	3400	75%cruiseFF(6000msl/StdDay)	16.4	16.4	0	1
SR22T	3400	75%cruiseFF(14000msl/StdDay)	16.4	16.4	0	1
SR22T	3400	75%cruiseFF(25000msl/StdDay)	16.4	16.4	0	1

Aircraft	GrossWeight	Metric(Pa/Temp)	POH	TLAR	Delta	Accuracy
SR22T	3600	VgKCAS	91	95.6	4.6	0.949
SR22T	3600	VgRatio	8.6	8.6	0	0.998
SR22T	3600	StallcleanKCAS	71.5	71.5	0	1
SR22T	3600	StallpartialflapsKCAS	66.5	66.5	0	1
SR22T	3600	StallfullflapsKCAS	60.5	60.5	0	1
SR22T	3600	TakeoffGroundRun(0msl/15C)	1517	1030	-487	0.679
SR22T	3600	TakeoffGroundRun(4000msl/7C)	1856	1200	-656	0.647
SR22T	3600	TakeoffGroundRun(8000msl/-1C)	2284	1400	-884	0.613
SR22T	3600	Takeoff50(0msl/15C)	2080	1550	-530	0.745
SR22T	3600	Takeoff50(4000msl/7C)	2505	1740	-765	0.695
SR22T	3600	Takeoff50(8000msl/-1C)	3036	2000	-1036	0.659
SR22T	3600	TakeoffKCAS	80	71.7	-8.3	0.896
SR22T	3600	VxKCAS(0msl/3C)	86	74.5	-11.5	0.867
SR22T	3600	VyKCAS(0msl/15C)	121	121	0	1
SR22T	3600	VyKCAS(6000msl/3C)	121	121	0	1
SR22T	3600	VyKCAS(10000msl/-5C)	121	121	0	1
SR22T	3600	VyFPM(0msl/15C)	1174	1194.4	20.4	0.983
SR22T	3600	VyFPM(6000msl/3C)	1110	1173.6	63.6	0.943
SR22T	3600	VyFPM(10000msl/-5C)	1067	900.8	-166.2	0.844
SR22T	3600	NormalappproachCAS(1.306to1)	79	79	0	1
SR22T	3600	Landroll(0msl/15C)	1178	1190	12	0.99
SR22T	3600	Landroll(4000msl/7C)	1326	1330	4	0.997
SR22T	3600	Landroll(8000msl/-3C)	1499	1480	-19	0.987

Cub Crafters FX3

Benchmark: Cub Crafters website performance specifications as of Oct 2022 (https://cubcrafters.com/carboncub/fx).

Power: Continental 186-HP CC363i engine driving a 2-blade composite Hartzell 78-inch “Trailblazer” constant-speed propeller.

Aircraft	Engine	Is Turbocharged?	HP	Rpm	Prop Diameter
FX3	CC363I	false	186	2700	78

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
FX3	1345	Stall full flaps KCAS	32.2	32.2	0.0	1.000
FX3	1345	Takeoff GroundRun (0 msl / 15 C)	90.0	90.0	0.0	1.000
FX3	1345	Vx KCAS (0 msl / 15 C)	49.5	50.0	0.5	0.990
FX3	1345	Vy KCAS (0 msl / 15 C)	61.7	64.0	2.3	0.962
FX3	1345	Vy FPM (0 msl / 15 C)	2400.0	2419.5	19.5	0.992
FX3	1345	75% cruise KTAS (0 msl / Std Day)	117.3	117.0	-0.3	0.997
FX3	1345	Normal appproach CAS (1.300 to 1)	41.8	41.8	0.0	1.000
FX3	1345	Landroll (0 msl / 15 C)	155.0	160.0	5.0	0.968

Cub Crafters FX2

Benchmark: Cub Crafters website performance specifications as of Oct 2022 (https://cubcrafters.com/carboncub/fx).

Power: Continental 180-HP CC340 engine driving a 2-blade composite CATO 80-inch ground-adjustable propeller.

Aircraft	Engine	Is Turbocharged?	HP	Rpm	Prop Diameter
FX2	CC340	false	180	2700	80

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
FX2	1304	Stall full flaps KCAS	31.3	31.7	0.4	0.988
FX2	1304	Takeoff GroundRun (0 msl / 15 C)	110.0	110.0	0.0	1.000
FX2	1304	Vx KCAS (0 msl / 15 C)	43.4	50.0	6.6	0.849
FX2	1304	Vy KCAS (0 msl / 15 C)	61.7	54.0	-7.7	0.875
FX2	1304	Vy FPM (0 msl / 15 C)	2000.0	2007.7	7.7	0.996
FX2	1304	75% cruise KTAS (0 msl / Std Day)	95.6	98.0	2.4	0.975
FX2	1304	Normal appproach CAS (1.300 to 1)	40.7	41.2	0.5	0.988
FX2	1304	Landroll (0 msl / 15 C)	140.0	140.0	0.0	1.000

Diamond DA-40-180 (DA40)

Benchmark: Diamond POH Doc #6.01.01-E, dated 18 Sep 2023

Power: Lycoming 180-HP IO-360-M1A driving a 3-bladed 71” Aluminum MTV-12 Constant-Speed propeller.

Note – TLAR predicts a significantly shorter takeoff run @2640 lbs and 8000 feet MSL than the POH. As always, we encourage feedback from you to make the model better. Also, the predicted climb performances in the table below are not apples to apples. The POH posts climb data using a reduced power 2400 rpm climb due to maximum power time restrictions. TLAR uses maximum power (2700 rpm) when computing Vy climbs.

(flightlead@tlarpilot.com)

Aircraft	Engine	Is Turbocharged?	HP	Rpm	Prop Diameter
DA40	IO-360-M1A	false	180	2700	71

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
DA40	2640	Vg KCAS	77.0	70.8	-6.2	0.920
DA40	2640	Vg Ratio	8.8	9.5	0.7	0.920
DA40	2640	Stall clean KCAS	60.0	59.9	-0.1	0.999
DA40	2640	Stall partial flaps KCAS	58.0	57.9	-0.1	0.999
DA40	2640	Stall full flaps KCAS	56.0	55.9	-0.1	0.999
DA40	2640	Takeoff GroundRun (0 msl / 0 C)	862.9	1020.0	157.1	0.818
DA40	2640	Takeoff GroundRun (4000 msl / 15 C)	1574.8	1540.0	-34.8	0.978
DA40	2640	Takeoff GroundRun (8000 msl / 25 C)	3116.8	2490.0	-626.8	0.799
DA40	2640	Takeoff 50 (0 msl / 0 C)	1312.3	1690.0	377.7	0.712
DA40	2640	Takeoff 50 (4000 msl / 15 C)	2313.0	2410.0	97.0	0.958
DA40	2640	Takeoff 50 (8000 msl / 25 C)	4429.1	4440.0	10.9	0.998
DA40	2640	Takeoff KCAS	62.0	62.5	0.5	0.991
DA40	2640	Vx KCAS (0 msl / 15 C)	68.0	66.0	-2.0	0.971
DA40	2640	Vy KCAS (0 msl / 30 C)	80.0	88.0	8.0	0.900
DA40	2640	Vy FPM (0 msl / -5 C)	920.0	891.3	-28.7	0.969
DA40	2640	Vy FPM (4000 msl / 15 C)	540.0	686.9	146.9	0.728
DA40	2640	Vy FPM (8000 msl / 30 C)	200.0	463.2	263.2	-0.316
DA40	2640	55% cruise KTAS (2000 msl / Std Day)	113.0	113.0	0.0	1.000
DA40	2640	55% cruise KTAS (6000 msl / Std Day)	118.0	118.0	0.0	1.000
DA40	2640	55% cruise KTAS (10000 msl / Std Day)	122.0	123.0	1.0	0.992
DA40	2640	65% cruise KTAS (2000 msl / Std Day)	123.0	121.0	-2.0	0.984
DA40	2640	65% cruise KTAS (6000 msl / Std Day)	129.0	126.0	-3.0	0.977
DA40	2640	65% cruise KTAS (10000 msl / Std Day)	131.0	130.0	-1.0	0.992
DA40	2640	75% cruise KTAS (2000 msl / Std Day)	132.0	128.0	-4.0	0.970
DA40	2640	75% cruise KTAS (6000 msl / Std Day)	136.0	132.0	-4.0	0.971
DA40	2640	55% cruise FF (2000 msl / Std Day)	7.5	7.5	0.0	1.000
DA40	2640	55% cruise FF (6000 msl / Std Day)	7.5	7.5	0.0	1.000
DA40	2640	55% cruise FF (10000 msl / Std Day)	7.5	7.5	0.0	1.000
DA40	2640	65% cruise FF (2000 msl / Std Day)	8.5	8.5	0.0	1.000
DA40	2640	65% cruise FF (6000 msl / Std Day)	8.5	8.5	0.0	1.000
DA40	2640	65% cruise FF (10000 msl / Std Day)	8.5	8.3	-0.2	0.978
DA40	2640	75% cruise FF (2000 msl / Std Day)	9.5	9.5	0.0	1.000
DA40	2640	75% cruise FF (6000 msl / Std Day)	9.5	9.3	-0.2	0.976
DA40	2640	Normal appproach CAS (1.300 to 1)	73.0	72.7	-0.3	0.996
DA40	2640	Landroll (0 msl / 0 C)	853.0	890.0	37.0	0.957
DA40	2640	Landroll (4000 msl / 15 C)	1148.3	1070.0	-78.3	0.932
DA40	2640	Landroll (8000 msl / 30 C)	1378.0	1310.0	-68.0	0.951

Glasair Glastar (GLST)

Benchmark: Composite of the 1998 Glastar POH, 2005 Symphony POH, and a 2015 Performance Article located on the Glasair Owners Association website. Of note – we would love to hear from Glastar owners about observed takeoff performance over a 50ft obstacle.

Power: Lycoming 160-HP O-320 engine driving a 2-blade 74” Aluminum Hartzell Constant-Speed “Blended Airfoil” propeller (F7497).

Aircraft	Engine	Is Turbocharged?	HP	Rpm	Prop Diameter
GLST	O-320	false	160	2700	74

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
GLST	1960	Vg KCAS	61.0	61.6	0.6	0.990
GLST	1960	Vg Ratio	9.1	9.1	0.0	0.999
GLST	1960	Stall clean KCAS	52.0	52.0	0.0	1.000
GLST	1960	Stall partial flaps KCAS	45.0	45.0	0.0	1.000
GLST	1960	Stall full flaps KCAS	43.0	43.0	-0.0	1.000
GLST	1960	Takeoff GroundRun (0 msl / 0 C)	617.0	660.0	43.0	0.930
GLST	1960	Takeoff GroundRun (0 msl / 20 C)	712.0	740.0	28.0	0.961
GLST	1960	Takeoff GroundRun (0 msl / 40 C)	794.0	830.0	36.0	0.955
GLST	1960	Takeoff GroundRun (4000 msl / 0 C)	892.0	920.0	28.0	0.969
GLST	1960	Takeoff GroundRun (4000 msl / 20 C)	1056.0	1030.0	-26.0	0.975
GLST	1960	Takeoff GroundRun (4000 msl / 40 C)	1211.0	1170.0	-41.0	0.966
GLST	1960	Takeoff GroundRun (8000 msl / 0 C)	1293.0	1320.0	27.0	0.979
GLST	1960	Takeoff GroundRun (8000 msl / 20 C)	1565.0	1510.0	-55.0	0.965
GLST	1960	Takeoff GroundRun (8000 msl / 40 C)	1824.0	1730.0	-94.0	0.948
GLST	1960	Takeoff 50 (0 msl / 0 C)	1198.0	1030.0	-168.0	0.860
GLST	1960	Takeoff 50 (0 msl / 20 C)	1342.0	1140.0	-202.0	0.849
GLST	1960	Takeoff 50 (0 msl / 40 C)	1467.0	1350.0	-117.0	0.920
GLST	1960	Takeoff 50 (4000 msl / 0 C)	1778.0	1550.0	-228.0	0.872
GLST	1960	Takeoff 50 (4000 msl / 20 C)	2103.0	1770.0	-333.0	0.842
GLST	1960	Takeoff 50 (4000 msl / 40 C)	2418.0	1970.0	-448.0	0.815
GLST	1960	Takeoff 50 (8000 msl / 0 C)	2631.0	2250.0	-381.0	0.855
GLST	1960	Takeoff 50 (8000 msl / 20 C)	3219.0	2370.0	-849.0	0.736
GLST	1960	Takeoff 50 (8000 msl / 40 C)	3812.0	2740.0	-1072.0	0.719
GLST	1960	Vx KCAS (0 msl / 20 C)	65.0	55.5	-9.5	0.854
GLST	1960	Vy KCAS (0 msl / 15 C)	78.0	81.3	3.3	0.958
GLST	1960	Vy FPM (0 msl / 15 C)	1120.0	1015.4	-104.6	0.907
GLST	1960	65% cruise KTAS (6000 msl / Std Day)	122.0	124.0	2.0	0.984
GLST	1960	75% cruise KTAS (6000 msl / Std Day)	129.0	129.0	0.0	1.000
GLST	1960	65% cruise FF (6000 msl / Std Day)	7.6	8.0	0.4	0.947
GLST	1960	75% cruise FF (6000 msl / Std Day)	8.7	9.4	0.7	0.921
GLST	1960	Normal appproach CAS (1.354 to 1)	55.9	58.2	2.3	0.958
GLST	1960	Landroll (0 msl / 15 C)	430.0	460.0	30.0	0.930

Glasair Sportsman (GLSP)

Benchmark: Numerous flight tests. Selected metrics are those in the POH.

Configuration: Taildragger without wheel pants. 8.50 x 6 tires. Lycoming 210-HP IO-390B with electronic ignition and 74” Aluminum Hartzell Constant-Speed Blended Airfoil propeller (F7497).

Aircraft	Engine	Is Turbocharged?	HP	Rpm	Prop Diameter
GLSP	IO-390B	false	210	2700	74

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
GLSP	1750	Takeoff KCAS	51.6	51.6	0.0	0.999
GLSP	1750	Vy FPM (0 msl / 15 C)	1624.0	1624.1	0.1	1.000
GLSP	1750	65% cruise KTAS (8000 msl / Std Day)	128.0	128.0	0.0	1.000
GLSP	1750	75% cruise KTAS (8000 msl / Std Day)	134.0	134.0	0.0	1.000
GLSP	1750	65% cruise FF (8000 msl / Std Day)	9.2	9.2	0.0	0.996
GLSP	1750	75% cruise FF (8000 msl / Std Day)	10.5	10.5	0.0	1.000
GLSP	1750	Landroll (0 msl / 15 C)	430.0	430.0	0.0	1.000

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
GLSP	2350	Vg KCAS	80.0	68.8	-11.2	0.860
GLSP	2350	Stall clean KCAS	57.8	57.8	-0.0	1.000
GLSP	2350	Stall partial flaps KCAS	50.8	50.7	-0.1	0.999
GLSP	2350	Stall full flaps KCAS	46.7	46.7	-0.0	0.999
GLSP	2350	Takeoff GroundRun (0 msl / 15 C)	800.0	800.0	0.0	1.000
GLSP	2350	Takeoff 50 (0 msl / 15 C)	1450.0	1320.0	-130.0	0.910
GLSP	2350	Takeoff KCAS	59.8	59.8	0.0	1.000
GLSP	2350	Vx KCAS (0 msl / 20 C)	64.4	64.4	0.0	0.999
GLSP	2350	Vy KCAS (0 msl / 15 C)	81.3	81.3	0.0	1.000
GLSP	2350	Vy FPM (0 msl / 15 C)	1086.0	1086.2	0.2	1.000
GLSP	2350	65% cruise KTAS (8000 msl / Std Day)	125.0	125.0	0.0	1.000
GLSP	2350	75% cruise KTAS (8000 msl / Std Day)	131.0	131.0	0.0	1.000
GLSP	2350	65% cruise FF (8000 msl / Std Day)	9.2	9.2	0.0	0.996
GLSP	2350	75% cruise FF (8000 msl / Std Day)	10.5	10.5	0.0	1.000
GLSP	2350	Normal appproach CAS (1.400 to 1)	65.4	65.3	-0.1	0.999
GLSP	2350	Landroll (0 msl / 15 C)	560.0	560.0	0.0	1.000

Harmon Rocket II

Benchmark: Scant “official” information is publicly available on this experimental aircraft. The “POH” numbers used to validate this plane is a composite of website data and flight tests conducted in concert with Owyhee Aviation, LLC.

Power: Lycoming 330-HP IO-540-HO engine driving a 2-blade Hartzell 82-inch constant-speed propeller.

Aircraft	Engine	Is Turbocharged?	HP	Rpm	Prop Diameter
HROC2	IO-540HO	false	330	2700	82

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
HROC2	1200	Landroll (0 msl / 15 C)	350.0	370.0	20.0	0.943

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
HROC2	2000	Stall full flaps KCAS	47.8	56.2	8.4	0.825
HROC2	2000	Takeoff GroundRun (0 msl / 15 C)	500.0	480.0	-20.0	0.960
HROC2	2000	Vy FPM (0 msl / 15 C)	3100.0	3188.0	88.0	0.972
HROC2	2000	55% cruise KTAS (8000 msl / Std Day)	186.8	183.0	-3.8	0.980
HROC2	2000	75% cruise KTAS (8000 msl / Std Day)	199.9	200.0	0.1	0.999
HROC2	2000	Normal appproach CAS (1.300 to 1)	65.5	73.0	7.5	0.885
HROC2	2000	Landroll (0 msl / 15 C)	500.0	590.0	90.0	0.820

Kitfox K7-SS

Benchmark: Kitfox company website.

Power: Rotax Turbocharged 115-HP R914 engine driving a 2-blade 75” Whirlwind ground-adjustable propeller.

Aircraft	Engine	Is Turbocharged?	HP	Rpm	Prop Diameter
K7SS	R914	true	115	2550	75

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
K7SS	1550	Stall clean KCAS	42.1	42.1	0.0	1.000
K7SS	1550	Stall partial flaps KCAS	33.0	38.0	5.0	0.848
K7SS	1550	Stall full flaps KCAS	36.5	36.5	0.0	1.000
K7SS	1550	Takeoff GroundRun (0 msl / 15 C)	290.0	340.0	50.0	0.828
K7SS	1550	Vy FPM (0 msl / 15 C)	1000.0	1083.1	83.1	0.917
K7SS	1550	75% cruise KTAS (0 msl / Std Day)	106.9	99.0	-7.9	0.926
K7SS	1550	Normal appproach CAS (1.300 to 1)	47.5	47.5	-0.0	0.999
K7SS	1550	Landroll (0 msl / 15 C)	290.0	290.0	0.0	1.000

Kitfox K7-STI

Benchmark: Kitfox company website and a Kitplanes magazine article (https://www.kitplanes.com/kitfox-s7-sti/).

Power: Continental 180-HP CC340 engine driving a 2-blade 80” Whirlwind STOL-80 ground-adjustable propeller.

Aircraft	Engine	Is Turbocharged?	HP	Rpm	Prop Diameter
K7STI	CC340	false	180	2700	80

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
K7STI	1550	Stall clean KCAS	34.0	38.5	4.5	0.868
K7STI	1550	Stall partial flaps KCAS	33.0	35.0	2.0	0.939
K7STI	1550	Stall full flaps KCAS	27.8	33.0	5.2	0.812
K7STI	1550	Takeoff GroundRun (0 msl / 15 C)	150.0	150.0	0.0	1.000
K7STI	1550	Takeoff 50 (0 msl / 15 C)	350.0	500.0	150.0	0.571
K7STI	1550	Vy FPM (0 msl / 15 C)	1800.0	1776.9	-23.1	0.987
K7STI	1550	75% cruise KTAS (0 msl / Std Day)	106.9	103.0	-3.9	0.964
K7STI	1550	Normal appproach CAS (1.300 to 1)	36.1	42.9	6.8	0.812
K7STI	1550	Landroll (0 msl / 15 C)	175.0	250.0	75.0	0.571

Aero L39C

Benchmark: TO 1T-L39C-1. No date.

Power: AI-25TL Jet Engine.

Note – The “POH” value for climb rates is questionable. The Tech order does not have max climb-rate data. We used some tech data found on the internet that seemed legitimate, but, may not be. That data was for a 4300 Kg aircraft. The validation runs below are at 3800, 4000, and 4600 Kg (8378, 8818, and 10141 lbs). To get a more accurate comparison, the TLAR Vy climb rates shown below at 4000 and 4600 Kg must be averaged.

Aircraft	Engine	TurboJet	SL Thrust
L39	AI25L	TRUE	3792

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
L39	8378	Takeoff GroundRun (0 msl / 0 C)	1082.7	1090.0	7.3	0.993
L39	8378	Takeoff GroundRun (0 msl / 35 C)	1312.3	1420.0	107.7	0.918
L39	8378	Takeoff GroundRun (6562 msl / 0 C)	1607.6	1840.0	232.4	0.855
L39	8378	Takeoff GroundRun (6562 msl / 35 C)	2624.7	2510.0	-114.7	0.956
L39	8378	Takeoff 50 (0 msl / 0 C)	2198.2	2430.0	231.8	0.895
L39	8378	Takeoff 50 (0 msl / 35 C)	2624.7	3020.0	395.3	0.849
L39	8378	Takeoff 50 (6562 msl / 0 C)	3280.8	3750.0	469.2	0.857
L39	8378	Takeoff 50 (6562 msl / 35 C)	5249.3	4870.0	-379.3	0.928
L39	8378	Takeoff KCAS	92.9	94.9	2.0	0.979
L39	8378	Normal appproach CAS (1.300 to 1)	107.5	107.2	-0.3	0.998
L39	8378	Landroll (0 msl / 0 C)	1624.0	1740.0	116.0	0.929
L39	8378	Landroll (0 msl / 15 C)	1656.8	1830.0	173.2	0.895
L39	8378	Landroll (0 msl / 35 C)	1804.5	1950.0	145.5	0.919
L39	8378	Landroll (6562 msl / 0 C)	2198.2	2190.0	-8.2	0.996
L39	8378	Landroll (6562 msl / 15 C)	2296.6	2310.0	13.4	0.994
L39	8378	Landroll (6562 msl / 35 C)	2624.7	2480.0	-144.7	0.945

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
L39	8818	Vg KCAS	142.0	149.8	7.8	0.945
L39	8818	Vg Ratio	11.0	8.8	-2.2	0.797
L39	8818	Takeoff KCAS	96.7	97.3	0.7	0.993
L39	8818	Vy FPM (0 msl / 15 C)	4330.7	5793.6	1462.9	0.662
L39	8818	Vy FPM (19685 msl / -24 C)	2126.0	2476.2	350.2	0.835

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
L39	10141	Stall clean KCAS	106.4	106.4	0.0	1.000
L39	10141	Stall partial flaps KCAS	97.2	97.2	0.0	1.000
L39	10141	Stall full flaps KCAS	90.7	90.7	0.0	1.000
L39	10141	Takeoff GroundRun (0 msl / 0 C)	1706.0	1650.0	-56.0	0.967
L39	10141	Takeoff GroundRun (0 msl / 35 C)	2198.2	2180.0	-18.2	0.992
L39	10141	Takeoff GroundRun (6562 msl / 0 C)	2624.7	2890.0	265.3	0.899
L39	10141	Takeoff GroundRun (6562 msl / 35 C)	4199.5	4060.0	-139.5	0.967
L39	10141	Takeoff 50 (0 msl / 0 C)	3444.9	3420.0	-24.9	0.993
L39	10141	Takeoff 50 (0 msl / 35 C)	4429.1	4320.0	-109.1	0.975
L39	10141	Takeoff 50 (6562 msl / 0 C)	5249.3	5500.0	250.7	0.952
L39	10141	Takeoff 50 (6562 msl / 35 C)	8366.1	7380.0	-986.1	0.882
L39	10141	Takeoff KCAS	102.6	104.4	1.8	0.983
L39	10141	Vy FPM (0 msl / 15 C)	4330.7	4896.6	565.9	0.869
L39	10141	Vy FPM (19685 msl / -24 C)	2126.0	1912.7	-213.3	0.900
L39	10141	75% cruise KTAS (19685 msl / Std Day)	297.0	327.0	30.0	0.899
L39	10141	75% cruise FF (19685 msl / Std Day)	145.0	172.4	27.4	0.811
L39	10141	Normal appproach CAS (1.300 to 1)	118.3	117.9	-0.3	0.997
L39	10141	Landroll (0 msl / 0 C)	1968.5	2090.0	121.5	0.938
L39	10141	Landroll (0 msl / 15 C)	1984.9	2190.0	205.1	0.897
L39	10141	Landroll (0 msl / 35 C)	2132.5	2350.0	217.5	0.898
L39	10141	Landroll (6562 msl / 0 C)	2624.7	2630.0	5.3	0.998
L39	10141	Landroll (6562 msl / 15 C)	2919.9	2770.0	-149.9	0.949
L39	10141	Landroll (6562 msl / 35 C)	3248.0	2980.0	-268.0	0.917

Mooney M20F

Benchmark: POH for 1967 M20F.

Power: Lycoming 200-HP IO-360AIA engine driving a 2-blade 74” Aluminum constant-speed propeller.

Aircraft	Engine	Is Turbocharged?	HP	Rpm	Prop Diameter
M20F	IO-360AIA	false	200	2700	74

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
M20F	2300	Takeoff GroundRun (0 msl / 15 C)	595.0	590.0	-5.0	0.992
M20F	2300	Takeoff GroundRun (2500 msl / 10 C)	730.0	710.0	-20.0	0.973
M20F	2300	Takeoff GroundRun (5000 msl / 5 C)	900.0	870.0	-30.0	0.967
M20F	2300	Takeoff 50 (0 msl / 15 C)	1020.0	910.0	-110.0	0.892
M20F	2300	Takeoff 50 (2500 msl / 10 C)	1235.0	1080.0	-155.0	0.874
M20F	2300	Takeoff 50 (5000 msl / 5 C)	1515.0	1290.0	-225.0	0.851
M20F	2300	Takeoff KCAS	56.5	60.1	3.6	0.936
M20F	2300	Vy FPM (0 msl / 15 C)	1340.0	1302.7	-37.3	0.972
M20F	2300	Vy FPM (6000 msl / 3 C)	1000.0	980.5	-19.5	0.980
M20F	2300	Vy FPM (14000 msl / -13 C)	580.0	578.1	-1.9	0.997
M20F	2300	55% cruise KTAS (2500 msl / Std Day)	132.0	137.0	5.0	0.962
M20F	2300	55% cruise KTAS (5000 msl / Std Day)	143.0	140.0	-3.0	0.979
M20F	2300	55% cruise KTAS (10000 msl / Std Day)	146.0	147.0	1.0	0.993
M20F	2300	65% cruise KTAS (2500 msl / Std Day)	140.0	146.0	6.0	0.957
M20F	2300	65% cruise KTAS (5000 msl / Std Day)	153.0	150.0	-3.0	0.980
M20F	2300	65% cruise KTAS (10000 msl / Std Day)	157.0	156.0	-1.0	0.994
M20F	2300	75% cruise KTAS (2500 msl / Std Day)	151.0	155.0	4.0	0.974
M20F	2300	75% cruise KTAS (5000 msl / Std Day)	156.0	158.0	2.0	0.987
M20F	2300	55% cruise FF (2500 msl / Std Day)	8.3	8.3	0.0	0.996
M20F	2300	55% cruise FF (5000 msl / Std Day)	8.3	8.3	0.0	0.996
M20F	2300	55% cruise FF (10000 msl / Std Day)	8.3	8.3	0.0	0.996
M20F	2300	65% cruise FF (2500 msl / Std Day)	9.4	10.0	0.6	0.936
M20F	2300	65% cruise FF (5000 msl / Std Day)	9.4	10.0	0.6	0.936
M20F	2300	65% cruise FF (10000 msl / Std Day)	9.7	9.8	0.1	0.990
M20F	2300	75% cruise FF (2500 msl / Std Day)	10.8	12.0	1.2	0.889
M20F	2300	75% cruise FF (5000 msl / Std Day)	11.2	12.0	0.8	0.929
M20F	2300	Landroll (0 msl / 15 C)	640.0	670.0	30.0	0.953
M20F	2300	Landroll (5000 msl / 5 C)	740.0	770.0	30.0	0.959
M20F	2300	Landroll (7500 msl / 0 C)	800.0	830.0	30.0	0.963

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
M20F	2740	Vg KCAS	91.2	90.6	-0.7	0.993
M20F	2740	Vg Ratio	10.3	10.4	0.1	0.994
M20F	2740	Stall clean KCAS	59.1	59.1	-0.0	1.000
M20F	2740	Stall partial flaps KCAS	55.6	55.6	0.0	1.000
M20F	2740	Stall full flaps KCAS	53.9	53.9	-0.0	1.000
M20F	2740	Takeoff GroundRun (0 msl / 15 C)	880.0	910.0	30.0	0.966
M20F	2740	Takeoff GroundRun (2500 msl / 10 C)	1085.0	1120.0	35.0	0.968
M20F	2740	Takeoff GroundRun (5000 msl / 5 C)	1320.0	1400.0	80.0	0.939
M20F	2740	Takeoff 50 (0 msl / 15 C)	1385.0	1350.0	-35.0	0.975
M20F	2740	Takeoff 50 (2500 msl / 10 C)	1650.0	1930.0	280.0	0.830
M20F	2740	Takeoff 50 (5000 msl / 5 C)	2050.0	2370.0	320.0	0.844
M20F	2740	Takeoff KCAS	65.2	65.6	0.4	0.994
M20F	2740	Vx KCAS (0 msl / 3 C)	81.7	66.4	-15.3	0.812
M20F	2740	Vy KCAS (0 msl / 15 C)	97.3	98.0	0.7	0.993
M20F	2740	Vy KCAS (6000 msl / 3 C)	92.1	91.5	-0.6	0.993
M20F	2740	Vy KCAS (14000 msl / -13 C)	84.3	91.4	7.1	0.916
M20F	2740	Vy FPM (0 msl / 15 C)	1070.0	1014.8	-55.2	0.948
M20F	2740	Vy FPM (6000 msl / 3 C)	745.0	730.1	-14.9	0.980
M20F	2740	Vy FPM (14000 msl / -13 C)	300.0	361.6	61.6	0.795
M20F	2740	55% cruise KTAS (2500 msl / Std Day)	127.0	133.0	6.0	0.953
M20F	2740	55% cruise KTAS (5000 msl / Std Day)	138.0	136.0	-2.0	0.986
M20F	2740	55% cruise KTAS (10000 msl / Std Day)	141.0	142.0	1.0	0.993
M20F	2740	65% cruise KTAS (2500 msl / Std Day)	135.0	144.0	9.0	0.933
M20F	2740	65% cruise KTAS (5000 msl / Std Day)	148.0	147.0	-1.0	0.993
M20F	2740	65% cruise KTAS (10000 msl / Std Day)	152.0	152.0	0.0	1.000
M20F	2740	75% cruise KTAS (2500 msl / Std Day)	146.0	153.0	7.0	0.952
M20F	2740	75% cruise KTAS (5000 msl / Std Day)	151.0	156.0	5.0	0.967
M20F	2740	75% cruise KTAS (10000 msl / Std Day)	161.0	161.0	0.0	1.000
M20F	2740	55% cruise FF (2500 msl / Std Day)	8.3	8.3	0.0	0.996
M20F	2740	55% cruise FF (5000 msl / Std Day)	8.3	8.3	0.0	0.996
M20F	2740	55% cruise FF (10000 msl / Std Day)	8.3	8.3	0.0	0.996
M20F	2740	65% cruise FF (2500 msl / Std Day)	9.4	10.0	0.6	0.936
M20F	2740	65% cruise FF (5000 msl / Std Day)	9.4	10.0	0.6	0.936
M20F	2740	65% cruise FF (10000 msl / Std Day)	9.7	9.8	0.1	0.990
M20F	2740	75% cruise FF (2500 msl / Std Day)	10.8	12.0	1.2	0.889
M20F	2740	75% cruise FF (5000 msl / Std Day)	11.2	12.0	0.8	0.929
M20F	2740	75% cruise FF (10000 msl / Std Day)	11.1	11.1	0.0	1.000
M20F	2740	Normal appproach CAS (1.300 to 1)	70.0	70.0	0.0	1.000
M20F	2740	Landroll (0 msl / 15 C)	785.0	790.0	5.0	0.994
M20F	2740	Landroll (5000 msl / 5 C)	910.0	910.0	0.0	1.000
M20F	2740	Landroll (7500 msl / 0 C)	990.0	970.0	-20.0	0.980

Piper J-3-65 Cub

Benchmark: Reproduction 1946 J-3-65 POH and two public websites with J-3 checklist/performance data.

Power: Continental 65-HP A-65-8 engine driving a 2-blade 72" fixed pitch propeller.

There is a significant difference between indicated and calibrated airspeeds on the J-3, especially at low speeds. Unfortunately, we have not been able to find a conversion chart for the J-3. The POH values below for the J-3 are indicated, whereas the TLAR speeds are calibrated.

Aircraft	Engine	Is Turbocharged?	HP	Rpm	Prop Diameter
J3	A-65	false	65	2300	72

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
J3	1220	Vg KCAS	52.1	52.0	-0.1	0.998
J3	1220	Stall clean KCAS	33.0	38.4	5.4	0.837
J3	1220	Takeoff GroundRun (0 msl / 15 C)	370.0	370.0	0.0	1.000
J3	1220	Takeoff 50 (0 msl / 15 C)	1000.0	1000.0	0.0	1.000
J3	1220	Takeoff KCAS	33.9	40.3	6.5	0.809
J3	1220	Vx KCAS (0 msl / 15 C)	37.4	43.0	5.6	0.849
J3	1220	Vy KCAS (0 msl / 15 C)	43.4	49.0	5.6	0.872
J3	1220	Vy FPM (0 msl / 15 C)	450.0	445.3	-4.7	0.990
J3	1220	75% cruise KTAS (0 msl / Std Day)	73.0	73.0	0.0	1.000
J3	1220	75% cruise FF (0 msl / Std Day)	4.5	4.3	-0.2	0.967
J3	1220	Normal appproach CAS (1.200 to 1)	42.9	46.1	3.1	0.927
J3	1220	Landroll (0 msl / 15 C)	290.0	290.0	0.0	1.000

Piper PA-18 Super Cub

Benchmark: POH for 150 HP 1974 and later.

Power: Lycoming 150-HP O-320 engine driving a 2-blade 76” Aluminum Sensenich 74-DM-56 fixed-pitch propeller.

Aircraft	Engine	Is Turbocharged?	HP	Rpm	Prop Diameter
PA18	O-320	false	150	2700	74

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
PA18	1750	Vg KCAS	60.8	64.0	3.2	0.948
PA18	1750	Vg Ratio	7.0	7.0	0.0	0.996
PA18	1750	Stall full flaps KCAS	37.4	37.4	0.0	0.999
PA18	1750	Takeoff GroundRun (0 msl / 15 C)	200.0	210.0	10.0	0.950
PA18	1750	Takeoff 50 (0 msl / 15 C)	500.0	540.0	40.0	0.920
PA18	1750	Vx KCAS (0 msl / 15 C)	39.1	44.0	4.9	0.875
PA18	1750	Vy KCAS (0 msl / 15 C)	65.2	60.0	-5.2	0.921
PA18	1750	Vy FPM (0 msl / 15 C)	960.0	956.6	-3.4	0.996
PA18	1750	55% cruise KTAS (0 msl / Std Day)	86.9	86.0	-0.9	0.990
PA18	1750	75% cruise KTAS (0 msl / Std Day)	99.9	101.0	1.1	0.989
PA18	1750	55% cruise FF (0 msl / Std Day)	6.5	6.7	0.2	0.973
PA18	1750	75% cruise FF (0 msl / Std Day)	9.0	8.9	-0.1	0.989
PA18	1750	Normal appproach CAS (1.300 to 1)	48.6	48.6	0.0	0.999
PA18	1750	Landroll (0 msl / 15 C)	350.0	350.0	0.0	1.000

Piper PA-22-150 Tri-Pacer

Benchmark: 1960 POH (revised in 1977) for 150 HP and 160 HP PA-22-160 and PA-22-150

Power: Lycoming 150-HP O-320 engine driving a 2-blade 74" Aluminum Sensenich M74-DM-61 fixed-pitch propeller.

Aircraft	Engine	Is Turbocharged?	HP	Rpm	Prop Diameter
PA22	O-320	false	150	2700	74

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
PA22	2000	Vg KCAS	73.0	71.0	-2.0	0.973
PA22	2000	Stall clean KCAS	54.2	54.2	0.0	1.000
PA22	2000	Stall full flaps KCAS	48.7	48.7	0.0	1.000
PA22	2000	Takeoff GroundRun (0 msl / 15 C)	1220.0	980.0	-240.0	0.803
PA22	2000	Takeoff 50 (0 msl / 15 C)	1600.0	1470.0	-130.0	0.919
PA22	2000	Takeoff KCAS	57.4	60.4	3.1	0.947
PA22	2000	Vx KCAS (0 msl / 15 C)	60.8	61.0	0.2	0.997
PA22	2000	Vy KCAS (0 msl / 15 C)	73.0	76.0	3.0	0.959
PA22	2000	Vy FPM (0 msl / 15 C)	725.0	663.6	-61.4	0.915
PA22	2000	75% cruise KTAS (0 msl / Std Day)	106.9	106.0	-0.9	0.992
PA22	2000	75% cruise KTAS (7000 msl / Std Day)	114.7	110.0	-4.7	0.959
PA22	2000	75% cruise FF (0 msl / Std Day)	9.0	9.0	0.0	1.000
PA22	2000	75% cruise FF (7000 msl / Std Day)	9.0	8.8	-0.2	0.983
PA22	2000	Normal appproach CAS (1.300 to 1)	58.2	63.3	5.0	0.913
PA22	2000	Landroll (0 msl / 15 C)	500.0	500.0	0.0	1.000

Notes

1) TLAR's base PA-22 is the 150HP version. IF you have the 160 HP version, you can adjust the HP up on the aircraft settings page. Likewise, if you have one of the older models with less horsepower, you can adjust the HP down.
2) The POH specifies a takeoff run of 1220 feet on a level, paved runway at sea level, standard conditions. We are skeptical that the 150 HP Tri-Pacer takeoff performance is this poor. The older PA-20/22 POH for aircraft with 135HP has the same 1220' takeoff number. Seems unlikely that the 135HP version has the same takeoff performance as the 150HP version. We'd love feedback from you to ascertain truth!
3) The POH specifies cruise at 7000 MSL, standard conditions with 75% engine power. TLAR predicts 74% for the PA-22-150 at the same, thus produces ~1.3% less thrust.
4) The POH cruise speed chart shows the same cruise speed at sea level for the PA-22-150 and PA-22-160 using 75% power. This seems unlikely since the -160 has 10 more HP than the -150.

Piper PA28-140

Benchmark: POH for 1964 PA-28-140 revised 1991.

Power: Lycoming 150-HP O-320-E2A engine driving a 2-blade 74" Aluminum Sensenich M74DM60 fixed-pitch propeller.

Aircraft	Engine	Is Turbocharged?	HP	Rpm	Prop Diameter
PA28140	O-320	false	150	2700	74

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
PA28140	2150	Vg KCAS	72.1	74.5	2.4	0.967
PA28140	2150	Vg Ratio	10.3	9.1	-1.2	0.885
PA28140	2150	Stall clean KCAS	54.7	54.7	0.0	1.000
PA28140	2150	Stall full flaps KCAS	46.9	46.9	0.0	1.000
PA28140	2150	Takeoff GroundRun (0 msl / 15 C)	800.0	830.0	30.0	0.963
PA28140	2150	Takeoff GroundRun (3000 msl / 9 C)	1200.0	1090.0	-110.0	0.908
PA28140	2150	Takeoff GroundRun (6000 msl / 3 C)	1550.0	1540.0	-10.0	0.994
PA28140	2150	Takeoff 50 (0 msl / 15 C)	1700.0	1760.0	60.0	0.965
PA28140	2150	Takeoff 50 (3000 msl / 9 C)	2400.0	2380.0	-20.0	0.992
PA28140	2150	Takeoff 50 (6000 msl / 3 C)	3375.0	3380.0	5.0	0.999
PA28140	2150	Vx KCAS (0 msl / 5 C)	64.3	62.1	-2.2	0.965
PA28140	2150	Vy KCAS (0 msl / 15 C)	73.9	74.3	0.4	0.994
PA28140	2150	Vy KCAS (5000 msl / 5 C)	66.9	74.3	7.4	0.890
PA28140	2150	Vy KCAS (10000 msl / -5 C)	65.2	69.2	4.0	0.939
PA28140	2150	Vy FPM (0 msl / 15 C)	825.0	807.3	-17.7	0.979
PA28140	2150	Vy FPM (5000 msl / 5 C)	585.0	566.1	-18.9	0.968
PA28140	2150	Vy FPM (10000 msl / -5 C)	340.0	311.2	-28.8	0.915
PA28140	2150	55% cruise KTAS (2000 msl / Std Day)	92.1	91.0	-1.1	0.988
PA28140	2150	55% cruise KTAS (6000 msl / Std Day)	95.6	94.0	-1.6	0.983
PA28140	2150	55% cruise KTAS (10000 msl / Std Day)	99.1	95.0	-4.1	0.959
PA28140	2150	65% cruise KTAS (2000 msl / Std Day)	99.9	103.0	3.1	0.969
PA28140	2150	65% cruise KTAS (6000 msl / Std Day)	104.3	106.0	1.7	0.983
PA28140	2150	65% cruise KTAS (10000 msl / Std Day)	107.8	108.0	0.2	0.998
PA28140	2150	75% cruise KTAS (2000 msl / Std Day)	107.8	110.0	2.2	0.979
PA28140	2150	75% cruise KTAS (6000 msl / Std Day)	112.1	113.0	0.9	0.992
PA28140	2150	55% cruise FF (2000 msl / Std Day)	6.2	6.3	0.1	0.984
PA28140	2150	55% cruise FF (6000 msl / Std Day)	6.2	6.3	0.1	0.984
PA28140	2150	55% cruise FF (10000 msl / Std Day)	6.2	6.3	0.1	0.984
PA28140	2150	65% cruise FF (2000 msl / Std Day)	7.3	7.3	0.0	0.999
PA28140	2150	65% cruise FF (6000 msl / Std Day)	7.3	7.3	0.0	0.999
PA28140	2150	65% cruise FF (10000 msl / Std Day)	7.3	7.3	0.0	0.999
PA28140	2150	75% cruise FF (2000 msl / Std Day)	8.4	8.4	0.0	1.000
PA28140	2150	75% cruise FF (6000 msl / Std Day)	8.4	8.4	0.0	1.000
PA28140	2150	Normal appproach CAS (1.300 to 1)	66.0	61.0	-5.0	0.924
PA28140	2150	Landroll (0 msl / 15 C)	535.0	530.0	-5.0	0.991
PA28140	2150	Landroll (3000 msl / 9 C)	585.0	580.0	-5.0	0.991
PA28140	2150	Landroll (6000 msl / 3 C)	620.0	630.0	10.0	0.984

Note – The POH specifies using Flaps-25 for takeoff, but quotes flaps-up distances over a 50-foot obstacle. TLAR uses takeoff flap setting for takeoff distances over a 50-foot obstacle.

Piper PA 28-181

Benchmark: POH for 1976 PA-28-181.

Power: Lycoming 180-HP O-360-A4M engine driving a 2-blade 76” Aluminum Sensenich M76EM8S5-62 fixed-pitch propeller.

Aircraft	Engine	Is Turbocharged?	HP	Rpm	Prop Diameter
PA28181	O-360A4M	false	180	2700	76

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
PA28181	2100	Vg Ratio	10.0	9.5	-0.5	0.950
PA28181	2100	Stall clean KCAS	55.0	53.5	-1.5	0.973
PA28181	2100	Stall partial flaps KCAS	50.0	49.0	-1.0	0.980
PA28181	2100	Stall full flaps KCAS	46.0	47.6	1.6	0.964
PA28181	2100	Takeoff GroundRun (0 msl / 15 C)	610.0	630.0	20.0	0.967
PA28181	2100	Takeoff GroundRun (4000 msl / 7 C)	1000.0	840.0	-160.0	0.840
PA28181	2100	Takeoff GroundRun (6000 msl / 3 C)	1150.0	980.0	-170.0	0.852
PA28181	2100	Takeoff 50 (0 msl / 15 C)	1090.0	1010.0	-80.0	0.927
PA28181	2100	Takeoff 50 (4000 msl / 7 C)	1750.0	1550.0	-200.0	0.886
PA28181	2100	Takeoff 50 (6000 msl / 3 C)	2130.0	1870.0	-260.0	0.878
PA28181	2100	Takeoff KCAS	47.0	52.1	5.1	0.892
PA28181	2100	Normal appproach CAS (1.300 to 1)	60.0	61.9	1.9	0.968
PA28181	2100	Landroll (0 msl / 15 C)	750.0	780.0	30.0	0.960
PA28181	2100	Landroll (4000 msl / 7 C)	850.0	870.0	20.0	0.976
PA28181	2100	Landroll (7000 msl / -1 C)	925.0	940.0	15.0	0.984

Note – The POH specifies using Flaps-25 for takeoff, but quotes flaps-up distances over a 50-foot obstacle. TLAR uses takeoff flap setting for takeoff distances over a 50-foot obstacle.

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
PA28181	2550	Vg KCAS	76.0	77.6	1.6	0.979
PA28181	2550	Vg Ratio	10.0	9.5	-0.5	0.950
PA28181	2550	Stall clean KCAS	59.0	59.0	0.0	1.000
PA28181	2550	Stall partial flaps KCAS	54.0	54.0	0.0	1.000
PA28181	2550	Stall full flaps KCAS	52.5	52.5	0.0	1.000
PA28181	2550	Takeoff GroundRun (0 msl / 15 C)	870.0	1000.0	130.0	0.851
PA28181	2550	Takeoff GroundRun (4000 msl / 7 C)	1390.0	1390.0	0.0	1.000
PA28181	2550	Takeoff GroundRun (6000 msl / 3 C)	1675.0	1680.0	5.0	0.997
PA28181	2550	Takeoff 50 (0 msl / 15 C)	1650.0	1890.0	240.0	0.855
PA28181	2550	Takeoff 50 (4000 msl / 7 C)	2650.0	2590.0	-60.0	0.977
PA28181	2550	Takeoff 50 (6000 msl / 3 C)	3250.0	2970.0	-280.0	0.914
PA28181	2550	Takeoff KCAS	54.0	57.4	3.4	0.938
PA28181	2550	Vx KCAS (0 msl / 5 C)	59.0	66.1	7.1	0.879
PA28181	2550	Vy KCAS (0 msl / 15 C)	78.0	78.4	0.4	0.995
PA28181	2550	Vy FPM (0 msl / 15 C)	740.0	761.2	21.2	0.971
PA28181	2550	Vy FPM (5000 msl / 5 C)	500.0	540.0	40.0	0.920
PA28181	2550	Vy FPM (10000 msl / -5 C)	275.0	321.0	46.0	0.833
PA28181	2550	55% cruise KTAS (2000 msl / Std Day)	97.5	95.0	-2.5	0.974
PA28181	2550	55% cruise KTAS (6000 msl / Std Day)	100.5	99.0	-1.5	0.985
PA28181	2550	55% cruise KTAS (10000 msl / Std Day)	104.5	109.0	4.5	0.957
PA28181	2550	65% cruise KTAS (2000 msl / Std Day)	111.0	112.0	1.0	0.991
PA28181	2550	65% cruise KTAS (6000 msl / Std Day)	114.5	116.0	1.5	0.987
PA28181	2550	65% cruise KTAS (10000 msl / Std Day)	119.5	120.0	0.5	0.996
PA28181	2550	75% cruise KTAS (2000 msl / Std Day)	119.0	119.0	0.0	1.000
PA28181	2550	75% cruise KTAS (6000 msl / Std Day)	123.0	123.0	0.0	1.000
PA28181	2550	55% cruise FF (2000 msl / Std Day)	6.3	6.4	0.1	0.978
PA28181	2550	55% cruise FF (6000 msl / Std Day)	6.3	6.4	0.1	0.978
PA28181	2550	55% cruise FF (10000 msl / Std Day)	6.3	6.4	0.1	0.978
PA28181	2550	65% cruise FF (2000 msl / Std Day)	7.6	7.5	-0.1	0.993
PA28181	2550	65% cruise FF (6000 msl / Std Day)	7.6	7.5	-0.1	0.993
PA28181	2550	65% cruise FF (10000 msl / Std Day)	7.6	7.5	-0.1	0.993
PA28181	2550	75% cruise FF (2000 msl / Std Day)	8.8	8.8	0.0	0.996
PA28181	2550	75% cruise FF (6000 msl / Std Day)	8.8	8.8	0.0	0.996
PA28181	2550	Normal appproach CAS (1.300 to 1)	68.0	68.2	0.2	0.996
PA28181	2550	Landroll (0 msl / 15 C)	920.0	930.0	10.0	0.989
PA28181	2550	Landroll (4000 msl / 7 C)	1040.0	1040.0	0.0	1.000
PA28181	2550	Landroll (7000 msl / -1 C)	1145.0	1130.0	-15.0	0.987

Vans RV-4

Benchmark: Vans company website performance data and data taken from an test-instrumented RV-4.

Power: Lycoming 160-HP O-320-H2AD engine driving a 2-bladed 69” Catto 6972 fixed-pitch propeller.

Aircraft	Engine	Is Turbocharged?	HP	Rpm	Prop Diameter
RV4	O-320h2ad	false	160	2700	69

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
RV4	1160	Stall full flaps KCAS	41.7	41.6	-0.1	0.997
RV4	1160	Takeoff GroundRun (0 msl / 15 C)	300.0	290.0	-10.0	0.967
RV4	1160	Vy KCAS (0 msl / 15 C)	102.0	100.1	-1.9	0.982
RV4	1160	Vy FPM (0 msl / 15 C)	2050.0	2128.5	78.5	0.962
RV4	1160	55% cruise KTAS (8000 msl / Std Day)	151.2	153.0	1.8	0.988
RV4	1160	75% cruise KTAS (8000 msl / Std Day)	167.7	168.0	0.3	0.998
RV4	1160	Landroll (0 msl / 15 C)	300.0	340.0	40.0	0.867

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
RV4	1500	Vg KCAS	80.0	81.1	1.1	0.986
RV4	1500	Stall clean KCAS	50.4	50.8	0.4	0.992
RV4	1500	Stall partial flaps KCAS	48.7	48.7	0.0	1.000
RV4	1500	Stall full flaps KCAS	46.9	47.3	0.4	0.992
RV4	1500	Takeoff GroundRun (0 msl / 15 C)	450.0	510.0	60.0	0.867
RV4	1500	Vy KCAS (0 msl / 15 C)	103.0	103.1	0.1	0.999
RV4	1500	Vy FPM (0 msl / 15 C)	1650.0	1525.0	-125.0	0.924
RV4	1500	55% cruise KTAS (8000 msl / Std Day)	150.3	149.0	-1.3	0.991
RV4	1500	75% cruise KTAS (8000 msl / Std Day)	166.8	165.0	-1.8	0.989
RV4	1500	Normal appproach CAS (1.300 to 1)	61.0	61.5	0.5	0.992
RV4	1500	Landroll (0 msl / 15 C)	425.0	430.0	5.0	0.988

Vans RV-7

Benchmark: Vans company website performance data.

Power: Lycoming 180-HP O-360-A4M engine driving a 2-bladed 74”
Aluminum Hartzell Constant-Speed Blended Airfoil propeller.

Aircraft	Engine	Is Turbocharged?	HP	Rpm	Prop Diameter
RV7	O-360A4M	false	180	2700	74

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
RV7	1400	Takeoff GroundRun (0 msl / 15 C)	275.0	340.0	65.0	0.764
RV7	1400	Vy FPM (0 msl / 15 C)	2200.0	2273.8	73.8	0.966
RV7	1400	55% cruise KTAS (8000 msl / Std Day)	158.2	159.0	0.8	0.995
RV7	1400	75% cruise KTAS (8000 msl / Std Day)	177.3	180.0	2.7	0.985
RV7	1400	Landroll (0 msl / 15 C)	350.0	390.0	40.0	0.886

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
RV7	1800	Stall full flaps KCAS	50.4	50.5	0.1	0.999
RV7	1800	Takeoff GroundRun (0 msl / 15 C)	575.0	580.0	5.0	0.991
RV7	1800	Vy FPM (0 msl / 15 C)	1650.0	1623.9	-26.1	0.984
RV7	1800	55% cruise KTAS (8000 msl / Std Day)	156.4	152.0	-4.4	0.972
RV7	1800	75% cruise KTAS (8000 msl / Std Day)	176.4	176.0	-0.4	0.998
RV7	1800	Normal appproach CAS (1.300 to 1)	65.5	65.6	0.1	0.999
RV7	1800	Landroll (0 msl / 15 C)	500.0	490.0	-10.0	0.980

Vans RV-8

Benchmark: Vans company website performance data.

Power: Lycoming 180-HP O-360-A4M engine driving a 2-bladed 74”
Aluminum Hartzell Constant-Speed Blended Airfoil propeller.

Aircraft	Engine	Is Turbocharged?	HP	Rpm	Prop Diameter
RV8	O-360A4M	false	180	2700	74

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
RV8	1400	Takeoff GroundRun (0 msl / 15 C)	275.0	340.0	65.0	0.764
RV8	1400	Vy FPM (0 msl / 15 C)	2300.0	2273.8	-26.2	0.989
RV8	1400	55% cruise KTAS (8000 msl / Std Day)	158.2	159.0	0.8	0.995
RV8	1400	75% cruise KTAS (8000 msl / Std Day)	177.3	180.0	2.7	0.985
RV8	1400	Landroll (0 msl / 15 C)	350.0	390.0	40.0	0.886

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
RV8	1800	Stall full flaps KCAS	50.4	50.5	0.1	0.999
RV8	1800	Takeoff GroundRun (0 msl / 15 C)	575.0	580.0	5.0	0.991
RV8	1800	Vy FPM (0 msl / 15 C)	1650.0	1623.9	-26.1	0.984
RV8	1800	55% cruise KTAS (8000 msl / Std Day)	156.4	152.0	-4.4	0.972
RV8	1800	75% cruise KTAS (8000 msl / Std Day)	176.4	176.0	-0.4	0.998
RV8	1800	Normal appproach CAS (1.300 to 1)	65.5	65.6	0.1	0.999
RV8	1800	Landroll (0 msl / 15 C)	500.0	490.0	-10.0	0.980

Vans RV-10

Benchmark: Most metrics from Vans company website performance data. Stall clean from XFLR5 airfoil model. Partial-flaps stall estimated. Stall full flaps from Vans. Vy KCAS and Vg KCAS from web available POH posted here: https://docs.google.com/document/d/1lUbt-H7ucK9eFcgMIUvAItQ_fRlBXZ5Tv1v9qPAeKKU/edit

Power: Lycoming 260-HP IO-540D engine driving a 2-bladed 80” Aluminum Hartzell Constant-Speed Blended Airfoil propeller.

Aircraft	Engine	Is Turbocharged?	HP	Rpm	Prop Diameter
RV10	IO-540D	false	260	2700	80

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
RV10	2200	Stall full flaps KCAS	49.5	49.4	-0.1	0.998
RV10	2200	Takeoff GroundRun (0 msl / 15 C)	360.0	370.0	10.0	0.972
RV10	2200	Vy FPM (0 msl / 15 C)	1950.0	1986.4	36.4	0.981
RV10	2200	55% cruise KTAS (8000 msl / Std Day)	156.4	154.0	-2.4	0.985
RV10	2200	75% cruise KTAS (8000 msl / Std Day)	174.7	174.0	-0.7	0.996
RV10	2200	Landroll (0 msl / 15 C)	525.0	540.0	15.0	0.971

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
RV10	2700	Vg KCAS	85.0	88.3	3.3	0.962
RV10	2700	Stall clean KCAS	58.0	58.0	0.0	1.000
RV10	2700	Stall partial flaps KCAS	56.1	56.1	0.0	1.000
RV10	2700	Stall full flaps KCAS	54.7	54.7	0.0	1.000
RV10	2700	Takeoff GroundRun (0 msl / 15 C)	500.0	570.0	70.0	0.860
RV10	2700	Vy KCAS (0 msl / 15 C)	90.0	95.2	5.2	0.942
RV10	2700	Vy FPM (0 msl / 15 C)	1450.0	1491.7	41.7	0.971
RV10	2700	55% cruise KTAS (8000 msl / Std Day)	152.9	149.0	-3.9	0.974
RV10	2700	75% cruise KTAS (8000 msl / Std Day)	171.2	171.0	-0.2	0.999
RV10	2700	Normal appproach CAS (1.300 to 1)	71.1	71.2	0.1	0.999
RV10	2700	Landroll (0 msl / 15 C)	650.0	650.0	0.0	1.000

Vans RV-14A

Benchmark: Most metrics from Vans company website performance data. Stall clean from XFLR5 airfoil model. Partial-flaps stall estimated. Stall full flaps from Vans.

Note – We'd love to hear from any of you with an RV-14A as to whether or not the aircraft can achieve the published takeoff/landing performance at the weights below on a paved, level runway, no wind, sea level, 15C, 29.92 conditions.

Power: Lycoming 215-HP IO-390-EXP119 engine driving a 2-bladed 74" Aluminum Hartzell Constant-Speed Blended Airfoil propeller.

Aircraft	Engine	Is Turbocharged?	HP	Rpm	Prop Diameter
RV14A	IO-390C	false	215	2700	74

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
RV14A	1715	Stall full flaps KCAS	46.9	47.3	0.3	0.993
RV14A	1715	Takeoff GroundRun (0 msl / 15 C)	225.0	350.0	125.0	0.444
RV14A	1715	Vy FPM (0 msl / 15 C)	2050.0	2055.1	5.1	0.998
RV14A	1715	55% cruise KTAS (8000 msl / Std Day)	158.2	158.0	-0.2	0.999
RV14A	1715	75% cruise KTAS (8000 msl / Std Day)	178.1	179.0	0.9	0.995
RV14A	1715	Landroll (0 msl / 15 C)	330.0	430.0	100.0	0.697

Aircraft	Gross Weight	Metric (Pa/Temp)	POH	TLAR	Delta	Accuracy
RV14A	2050	Stall clean KCAS	54.8	54.9	0.0	1.000
RV14A	2050	Stall partial flaps KCAS	53.0	53.0	-0.0	0.999
RV14A	2050	Stall full flaps KCAS	51.3	51.7	0.4	0.992
RV14A	2050	Takeoff GroundRun (0 msl / 15 C)	375.0	500.0	125.0	0.667
RV14A	2050	Vy FPM (0 msl / 15 C)	1680.0	1612.5	-67.5	0.960
RV14A	2050	55% cruise KTAS (8000 msl / Std Day)	155.5	154.0	-1.5	0.990
RV14A	2050	75% cruise KTAS (8000 msl / Std Day)	176.4	177.0	0.6	0.997
RV14A	2050	Normal appproach CAS (1.300 to 1)	66.7	67.2	0.5	0.992
RV14A	2050	Landroll (0 msl / 15 C)	340.0	510.0	170.0	0.500

APPENDIX B: TACTICS, TECHNIQUES, AND PROCEDURES

Managing the elevation-source

The most important parameters to get “right” when using TLAR are the winds and elevation. Elevation is controlled using the elevation gauge at the bottom right of the screen. TLAR-basic is simple in this respect because it only has the manual option. Use the decrement/increments buttons (-)(+) to adjust the reference elevation up/down to match field elevation to get accurate takeoff and landing performance numbers. Match your aircraft’s actual/planned altitude to get accurate climb and cruise numbers.

TLAR-pro adds two other options to set the reference elevation. The first is using your iDevice’s GPS elevation which TLAR calls “GSL.” In this mode, TLAR continuously updates performance calculations based on changes in your elevation and TLAR will search for the closest METAR station to your location for weather.

In GSL-mode, TLAR’s climb and cruise performance predictions will be as accurate as possible and also very accurate for takeoff predictions when you are on the ground. In flight, takeoff/landing predictions will be off because TLAR is not using airport elevation to predict takeoff/landing performance. However, as you descend, TLAR’s performance accuracy will improve directly in proportion to how close in elevation you are to TDZE, eventually becoming very accurate by the time the aircraft is on short-final. The advantage of GSL-mode is that it is a “hands-off” mode especially suited for use in flight.

In TDZE-mode, TLAR uses the elevation of the active LZ to calculate performance. In this mode, takeoff and landing performance predictions are as accurate as possible but climb and cruise performance is erroneous in direct proportion to the difference between actual aircraft altitude and TDZE. This mode is well suited for pre-flight planning and in-flight to get an accurate prediction of takeoff/landing performance while in cruise.

Operating TLAR without a Network

Often (particularly out West and in Alaska), you may find yourself flying in areas “off the net.” In this situation, TLAR is unable to query the NOAA weather server to get weather updates, nor can it poll the USGS server to get point elevations when creating a new landing zone or storing a mark-point, and finally, the moving map and imagery maps are hampered. There are several ways to get around these limitations:

Weather Mitigation:

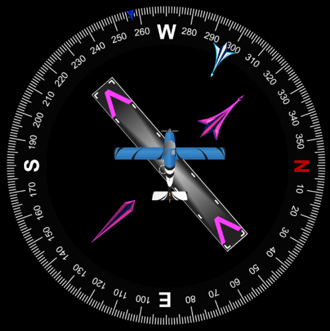
- Place the TLAR temperature gauge in manual mode and toggle the delta-Temp up/down until the OAT matches the OAT as displayed by your aircraft. This should allow TLAR to make relatively accurate performance predictions for any elevation using the set delta-C. If it drifts over time, reset it so that the OAT as displayed in TLAR matches what your aircraft’s temperature gauge reads.
- Turn WIND to MANUAL with zero wind. Always land/takeoff into the wind using a windsock or other method to determine wind direction. This avoids two issues: first, your aircraft should outperform TLAR’s predictions. Second, you will not accidentally use an “old” wind that is no longer valid that could lead you to land/takeoff with a tailwind when you “thought” it was a headwind because of where TLAR placed the wind arrow.
- Put the pressure gauge in “iBARO” mode. In this mode, TLAR uses your iDevice’s built-in barometer in conjunction with your GSL to determine the altimeter setting. On the ground iBaro tends to be very accurate. In flight, iBaro will usually read a couple tenths high (unpressurized plane), which will not significantly affect predicted performance.

Elevation Mitigation:

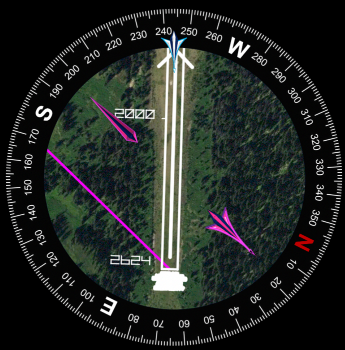
- Maximize use of TLAR’s built-in airport database
- Create any new LZs you might want before departing an area with network coverage
- If you are creating a new LZ and are off the net, determine/estimate the approach end elevation and slope using methods outside of TLAR such as a chart, published information, aircraft database, aviation app (e.g. Foreflight or Garmin Pilot), etc.
- Mark points will still work for lat-longs, but the elevation will be invalid.

Map Mitigation:

- Place HIS in graphical mode as it does not use the internet:



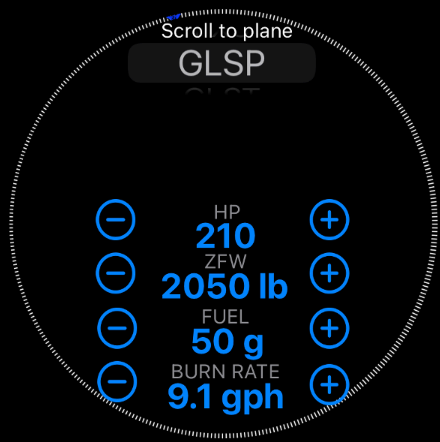
- Before losing a network connection, load your LZ and place TLAR in a map mode centered on the LZ, your iDevice will cache the map/imagery and it will be available for viewing later in the flight even without a network connection:

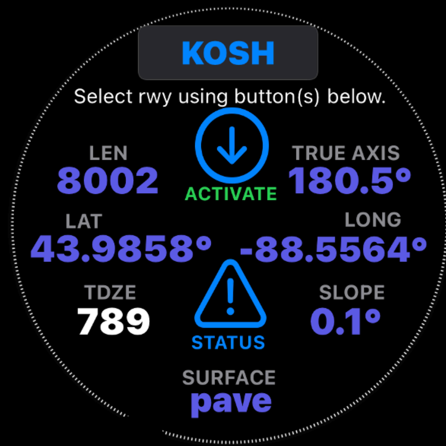


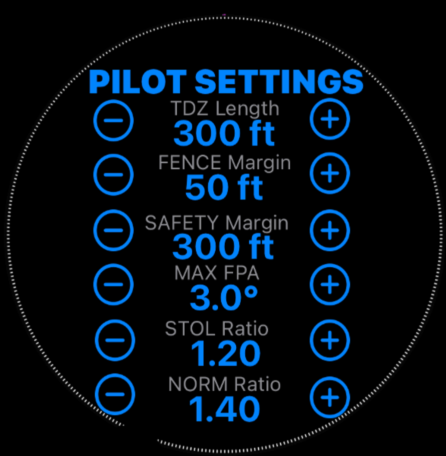
- The maps still operate without a connection, but the underlying background may be an iOS generated blank grid:

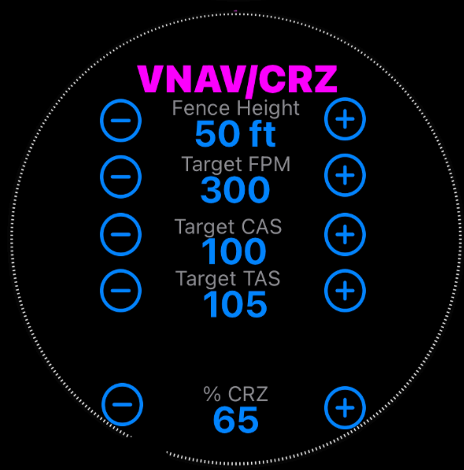
Before Start

Load/Check AIRCRAFT and AIRFIELD data. Check PILOT and VNAV/CRZ settings. Most will be the same as they were the last time the app was used. Exception, Fence height always resets to 50 feet.







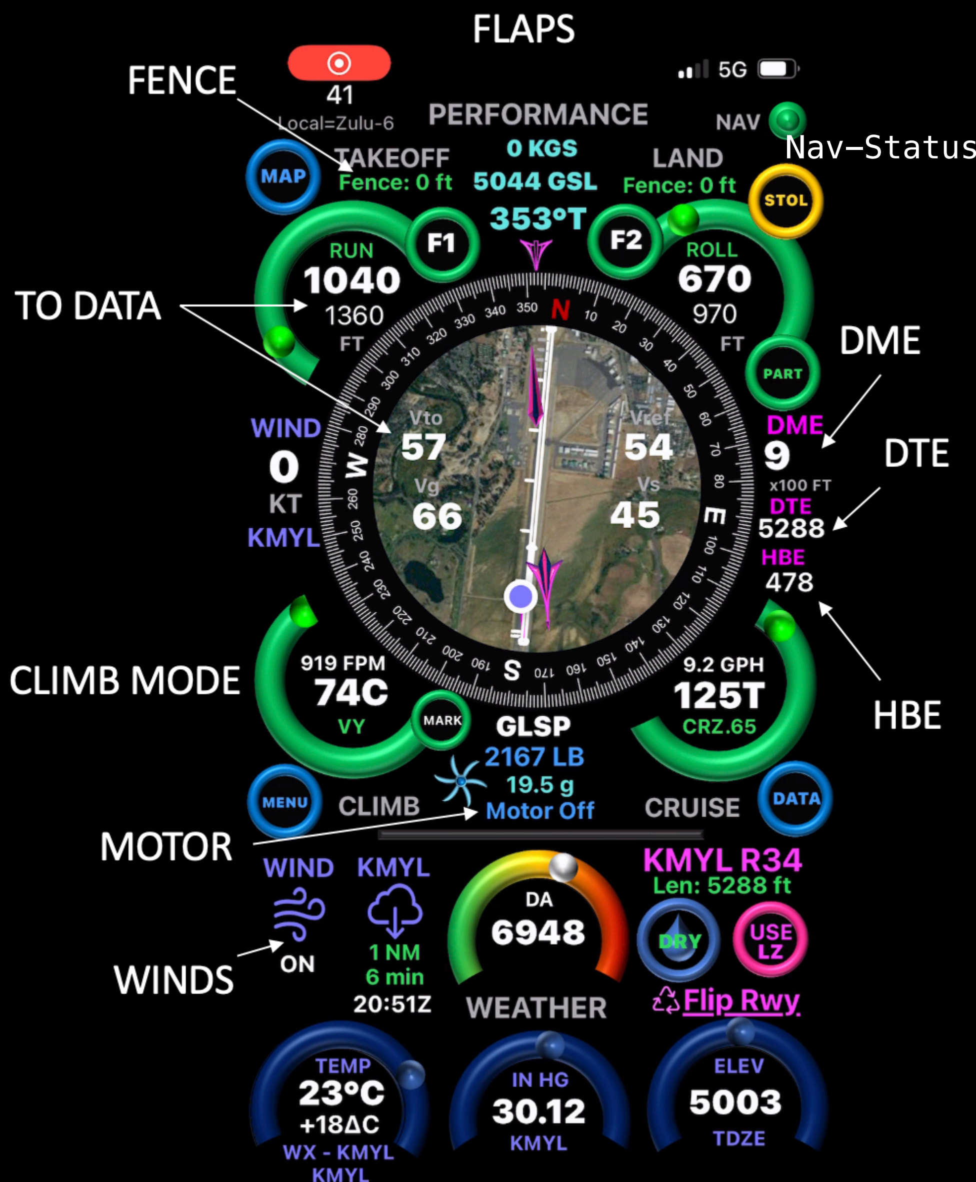


Prior to Taxi

Start TLAR's motor by tapping on the prop. Double check the weather information (Temp, Pressure, and Elevation) with the ATIS/AWOS/ADS-B and/or aircraft gauges. Also ensure the mode (automatic, iBARO, and or MANUAL) for each gauge makes sense. In other words, don't use automatic modes if you do not have a network connection, or if you are too far away from the closest METAR station to trust it as a source. Don't use iBARO in a pressurized aircraft, and if you use any MANUAL modes, set the parameters to match current conditions.

Takeoff

The screenshot below is from a takeoff at McCall airport in Idaho.



When lined-up on the runway, check for the center NAV-status ball to be GREEN, indicating the motion sensors are on waiting to capture your takeoff performance, and the outer ball is GREEN indicating high GPS accuracy.

Fence height – set to accurate value

Flaps – set to match actual configuration

Climb mode – set to intended profile after lift-off. If obstacles are a factor use Vx mode.

Winds – Check

Motor – double check that the motor is on (we missed this step in this example!). If you forget, you can always go into the aircraft settings page and dial the fuel down to match your actual load, and then turn the motor on.

TOLD – check takeoff speed (Vto) RUN and distance to reach fence-height against available runway as displayed by the DTE vector (mirrored by the LEN label). Check that your predicted Height By End (HBE) exceeds the fence height by an acceptable margin

DME – DME displays your distance to the *approach-end* of the runway. On takeoff this is the runway distance *behind* you. If that distance is less than 1NM, DME will read in hundreds of feet.

Climb

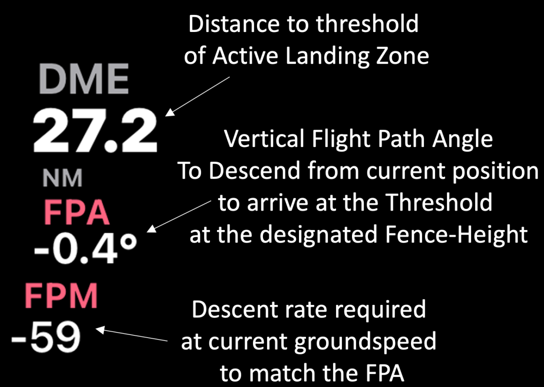
Set climb mode as desired. Ensure the elevation reference corresponds to the climb data you seek. You can find your approximate service ceiling by setting the elevation reference to MANUAL and then dialing it up until the Vy climb rate reduces to ~200 fpm. You can also check your climb gradient in Feet per Nautical Mile using the Vx profile. This gradient is wind-corrected using surface winds, or you can turn the WIND off for a no-wind prediction.

Cruise

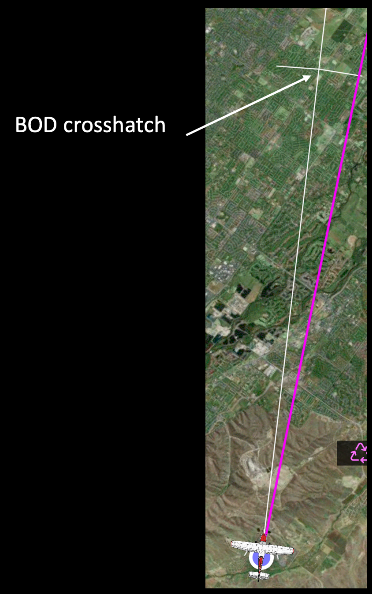
Set cruise mode as desired. Make sure the elevation reference is set to the altitude you are seeking cruise information about. Recall that you can set cruise power percentages in VNAV/CRZ settings.

Top of Descent

You can use the FPA and FPM vectors to identify the top of descent point.   When either reaches your desired angle or rate, start your descent.



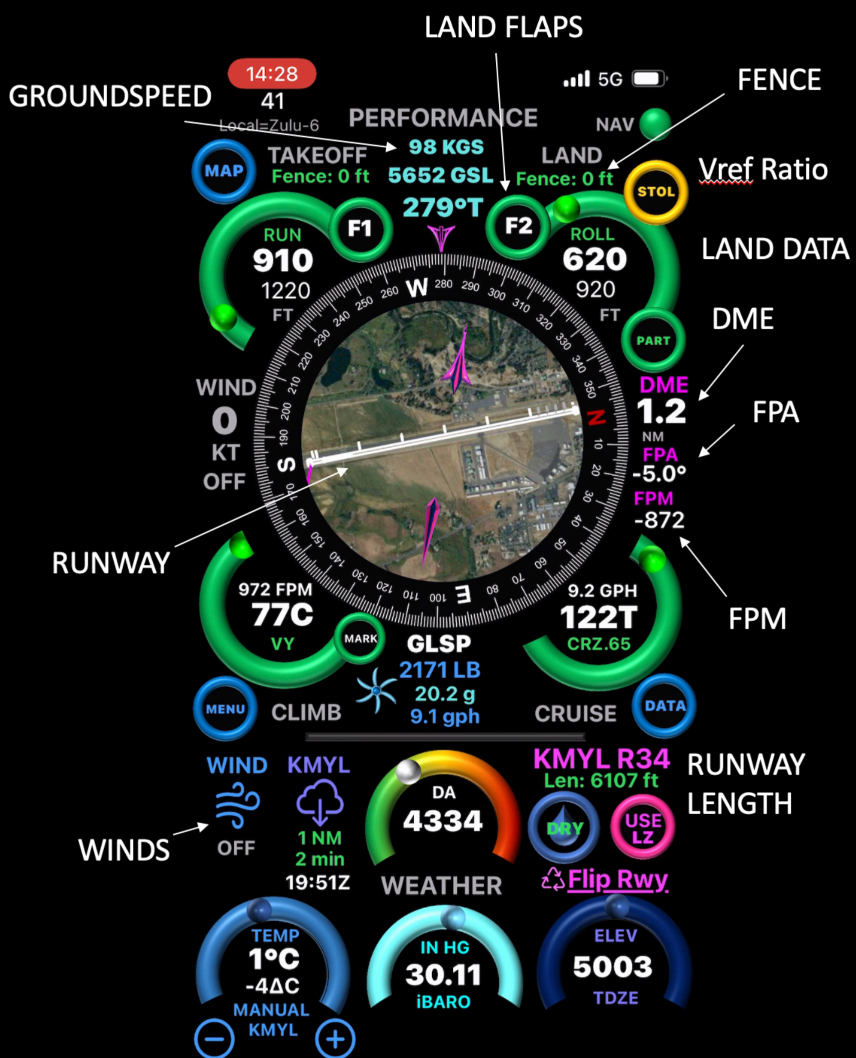
You can also use the bottom of descent crosshatch mark by descending when the crosshatch reaches the point where you want to be at field elevation.



Landing

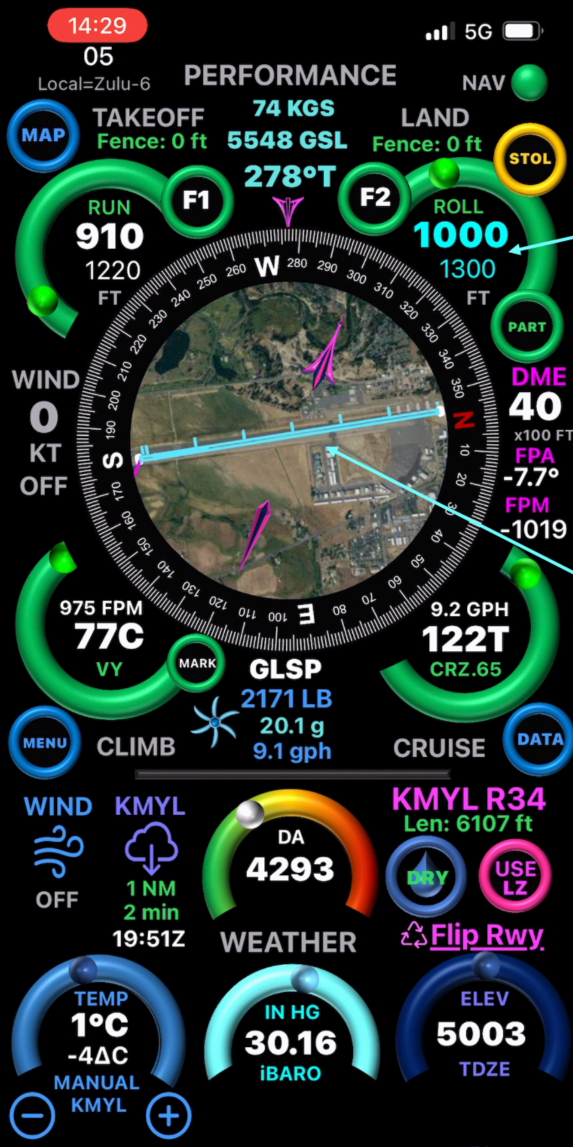
The screenshot below is from a landing at McCall, Idaho (KMYL). The test pilot deliberately landed long, which TLAR assessed as unstable at the stabilization point because TLAR assumes you intend to land in the touchdown zone.

Before 5NM to touchdown, ensure:



Runway – Correct Airport and correct Runway for Landing Direction
Flaps – set to planned landing configuration
STOL/NORM – set to planned approach type
Vspeeds – display as desired using the DATA button
WIND – set ON/OFF as desired
LANDING DATA – checked, no unexpected YELLOW or RED gauges

Prior to Stabilization Point:



CYAN colored Landing data and Runway outline indicate DYNAMIC mode. If the runway is CYAN or WHITE, TLAR assesses you can stop safely.

The Runway will be YELLOW if TLAR assesses you must violate a set safety margin, and RED if it thinks you cannot stop by the end of the runway.

The Runway will be VIOLET if you can land safely, but TLAR assesses a takeoff from the same runway is not safe

Aircraft on speed and glidepath (in this example, the −7.7º FPA at 4000 feet distance to threshold would NOT be desirable if a landing at the threshold was the plan)

TLAR should shift to DYNAMIC mode as indicated by coloring the landing distances and the runway outline on the map CYAN. In this mode, TLAR uses actual groundspeed to predict braking distance. This corrects TLAR's landing distance for differences in wind and aircraft speed.

At the stabilization point:

TLAR will assess aircraft stability, color the compass rose, and make an audible call (if your iDevice is tied into your aircraft's headset system). In the example below, TLAR's call was "UNSTABLE, GLIDEPATH, GREEN" because the FPA exceeded the set FPA of 6.0, but "GREEN" because the aircraft can still land and stop on the available runway (6107 feet long) without violating any safety margins.

Well, if you made it all the way through, congratulations and thanks. Writing this manual took a fair amount of work. We are glad at least you made it to the end!

Send suggestions, gripes, complaints, and ideas to flightlead@tlarpilot.com. We are dedicated to serving the aviation community and improving our collective situational awareness.

TLAR

Pilot Guide 6.22

OWYHEE AVIATION, LLC.