Flying with L-NAV Version 5.7 and S-NAV Version 7.6 & 8.6

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A. Introduction

The latest S/L-NAV firmware has a configurable “Smart” Averager and improved audio tone patterns. The wisdom guiding these advances comes from racing and recreational pilots who fly with our instruments as well as from our own staff. Our User’s Guides are concise, technical documents. They list capabilities and options without explaining why they exist.

This document compliments the S/L-NAV User’s Guide. It explains how to choose configuration settings best suited to your flying style.

B. Cruise/Climb Switching

1. Basics

Glide computers behave differently during cruise and thermal climb flight modes. Speed commands that are useful in cruising flight have no meaning while circling in a thermal. A sink tone may be useful while circling in weak lift, but will surely be annoying during inter-thermal flight.

First generation glide computers used a manually operated switch to select glide computer cruise or climb mode. The switch was often coupled to the flaps in gliders equipped with them.

Circling in a glider increases wing loading (1.15 g at 30 degrees bank angle). The S-NAV and L-NAV have an optional, precision g-meter and sophisticated, airspeed-based algorithm to switch automatically between cruise and climb modes. Switching takes less than 5 seconds in strong conditions and up to 15 seconds during low bank angle circling in weak lift.

GPS receivers compute the glider's track over the ground. Track is updated every 2 seconds and is accurate to within 1 degree. Cambridge products use this information to switch automatically between cruise and climb. The algorithm is simple and reliable. If the track change exceeds 3 degrees/second for 12 seconds, and if the total track change exceeds 110 degrees, the mode changes from cruise to climb. If track change falls below 3 degrees/second for 12 seconds, the mode changes from climb to cruise.

2. Mode switch priorities, robustness, and speed

The S/L-NAV uses all three methods for cruise/climb switching. This discussion assumes that the instrument is connected to a GPS receiver.

If no g-meter or manual "Hold" switch is present, the instrument takes ~12 seconds to switch from cruise to climb, and from climb to cruise.

If the g-meter is present, the instrument takes 4 -12 seconds to switch modes.

The external "Hold" switch overrides other cruise/climb transitions and is therefore instantaneous if the pilot pays attention. Further, if the switch has been in climb mode (contacts closed), and the contact is opened, the transition to cruise mode occurs within 1 second.

Competition pilots often like fast cruise/climb switching. They are willing to pay for the optional Cambridge g-meter, and sometimes even prefer the manual "Hold" switch. Recreational pilots are often satisfied with cruise/climb switching based on GPS Track.

C. The "Smart" Averager

Competition pilots need to quickly estimate the potential climb rate in a thermal. The decision to stay or leave a weak thermal should be made within 10 seconds. The traditional 30-second averager is too slow to provide useful information. Until now the pilot had to rely on the variometer and qualitative "feel" in making this decision. The new S/L-NAV "Smart" averager solves this problem.

1. Averager Basics

Historically, the Averager function was done in analog electronic circuitry.
The "20 second" averager actually reached 2/3 of its final value in 20 seconds.
The limited analog design favors the most recent variometer readings. Thus, it does not give a "true" average of the lift over the last 30 seconds.

2. Moving Window Averagers

Cambridge S-NAV & L-NAV use a 30 second moving window digital averager. The last thirty variometer readings (one per second) are kept in a file. The Averager is just the sum of the readings divided by 30. Each second, a new vario reading is added and the oldest reading is thrown out. Then the Averager display is updated.

This averager also reaches 2/3 of its final value in 20 seconds. Unlike the older, analog averager, each of the last thirty variometer readings is given equal weight in the average.

3. The Variable Window "Smart" Averager

Competition pilots need to evaluate thermal strength as quickly as possible. Each turn in a marginal thermal costs at least 20 seconds. Until now, pilots had to rely on mental averaging of the variometer audio, plus qualitative "feel" to estimate thermal strength.

The Cambridge "Smart" averager gives the best possible estimate of thermal strength for making the important stay-or-leave decision. At the cruise/climb transition, the Averager displays the current variometer reading. The next second, two variometer readings are summed and the result is divided by 2. At 3 seconds, 3 readings are summed and divided by 3, etc. This process continues for thirty seconds. After 30 seconds, the number of samples is fixed at 30. For each new sample added, the oldest sample is discarded.

Pilots can use the manual "Hold" switch to force an averager reset at exactly the right time. For the first 30 seconds after a cruise/climb transition, all samples have equal weight. Netto average shown at the upper left of the LCD screen is also "Smart".

4. Averager Configuration [Average 30] [Average 20] [Average S]

When the cruise/climb transition is under instrument rather than pilot control, the averager will jump suddenly to a new value at the transition. This may be confusing to some pilots. Therefore, The S-NAV and L-NAV averager may be configured three different ways.

a. The traditional 30 second moving window averager [Average 30]

b. A 20 second moving window averager [Average 20]
This setting may appeal to pilots who want a faster averager but do not want to think about manually switching from cruise to climb.

c. The "Smart" Averager described above [Average S].

The factory default setting is the standard Cambridge [Average 30]. If you use the averager for decision making during the first circle in a thermal, you may wish to experiment with the two new modes.

D. Audio tone patterns

When it appeared in ~1965, the electronic audio variometer was revolutionary for two reasons. First, it provided instantaneous feedback on the airmass vertical motion. It became easier to optimize thermal climb. Second, it meant pilots could spend more time looking out of the cockpit, thus improving safety in crowded thermals.

With the addition of an airspeed sensor, the old variometer “speed ring” was replaced by visual and audio “speed-to-fly” signals. This was refined so the audio sounds are present only when the speed error exceeds a pilot settable threshold. Pilots can enjoy silent flight when gliding at the optimum speed.

Cambridge speed-to-fly and glide computers (CMP, C-NAV, M-NAV, S-NAV, and L-NAV) have used an interrupted tone as a speed-up command and a continuous tone as a slow-down command. Also, in “climb” mode, Cambridge products have traditionally been silent in sink.

European glide computers have often used a continuous tone as a speed-up command, and an interrupted tone as a slow-down command. In “climb” mode, these instruments give a continuous tone in sink.

As instruments and designers became smarter, warning and alarm functions have been added to the audio channel. In [Audio 2] mode, the climb tone pattern changes subtly as lift falls below the current MacCready setting. With the optional g-meter, the L/S-NAV provides a pilot-configurable “slow-alarm” tone that relates to both the glider polar and the instantaneous wing loading.

Landing gear alarm buzzers are often fitted to gliders. If the spoilers are extended with the landing gear retracted, an alarm is sounded.

Failure to latch spoilers in the closed position for takeoff is another common problem. The spoilers can deploy as the glider hits a bump on takeoff, causing problems with the tow. Traditional landing gear warning systems cannot give an alarm for this situation.

The L-NAV now provides both landing gear and spoiler alarms. Switches on the spoiler and landing gear actuators are combined with airspeed to make intelligent alarms for both the landing gear and for spoilers.

There are a large number of different audio functions. This can be confusing to the pilot. The L/S-NAV defaults to simple audio tones. Configuration switches are used to add only those audio functions that the pilot finds useful. The following discussion assumes that all audio functions have been activated.

1. Tone pattern priorities.
High priority tones override low priority tones. A unique “police siren” tone is used for Spoiler or Landing gear alarms. The pitch of all other tones depends on the variometer reading.

Spoiler or Landing Gear Alarms	-- Highest Priority
Slow Alarm	
Climb Tone Pattern	
Speed-to-fly tones	-- Lowest Priority

2. The Climb Tone
The default climb tone starts when the vario reading goes from negative to positive. The pitch rises and the interrupt rate increases as lift improves. The [Audio 1] default tone pattern is 75% on, 25% off. The optional [Audio 2] pattern is 50% on, 50% off for lift less than the MacCready setting and 75% on, 25% off for lift above the MacCready setting.

3. [No Sink T] [Sink Tone] and Speed-to-fly tone patterns
This configuration switch does two things. In climb mode it activates the continuous sink tone, and in cruise mode it selects the speed-to-fly tone pattern.

In the default [No Sink T] configuration, the variometer tone disappears when the vario goes negative in climb mode. In cruise mode, the double-beep tone means you should speed up. The continuous tone means you should slow down.

In [Sink Tone] configuration, the variometer goes from interrupted to continuous tone as the variometer reading goes from positive to negative in climb mode. In cruise mode, the audio is silent if you are cruising at the correct speed. A continuous tone means you should speed up. A short tone (25% on, 75% off) means you should slow down.

E. The “Slow Alarm” tone pattern

The goal of this alarm tone pattern is to help the pilot maintain appropriate airspeed while circling in lift. The glider polar is modified by wing loading. Higher wing loading from ballast or increased g-forces during circling increase stall speed. The S/L-NAV uses the built-in g-meter to measure increased wing loading. The g-meter is needed for this feature to work.

The threshold airspeed for the slow alarm is set on the configuration screen labeled [Slow Alarm]. Units are knots or kilometers/hour depending on units selected. This speed assumes 1.0 g and an un-ballasted glider. Assume straight and level flight in smooth air (1.0 g). When your speed falls below the threshold, you will hear a dit-dit-dah tone pattern. If you are carrying water ballast or circling, you will hear the sound at a slightly higher airspeed.

F. Spoiler and Landing Gear Alarm Tones (L-NAV only)

1. Wiring
These alarms depend on switches connected to spoiler and landing gear actuators. The black and yellow wires in the "Hold" switch cable go to the switch activated by the spoilers. Switch contacts are closed if the spoilers are not in the closed and locked position. The red and yellow wires go to the landing gear switch. The switch is closed if the landing gear is up. The manual, external cruise/climb switch is connected to the green and yellow wires of the "Hold" switch cable.

2. Alarm logic.

The L-NAV measures airspeed. Airspeed above 25 knots (46 kph) means "flying".

If the glider is not flying and the spoilers are not locked, the alarm tone is heard, and the screen shows [Spoilers?]

Pressing the GO key cancels the alarm for pilots who want to deploy spoilers for the takeoff roll.

If the glider goes from non-flying to flying state with the spoilers unlocked, the [Spoilers?] alarm sounds again. Closing the spoilers cancels the alarm.

If the glider is flying with the landing gear up and the spoilers are unlocked, the alarm sound is heard and the screen says [L Gear Up?]. Lowering the landing gear or pressing the GO key cancels the alarm.

Please note that testing the landing gear switch wiring requires airspeed above 25 knots. An offset may be entered in the [ASI zero] Calibrate screen to artificially raise the airspeed for testing purposes. Don't forget to reset the airspeed zero!

G. The "Upper Left" configurable display

Pilots have a wide choice of parameters to show in this space. The switch for these parameters is shown close to the top of the configuration section. It is relatively easy to select different parameters for different phases of a single flight.

1. Show Track Error [Show Tk Er]

This setting is useful when flying with a hand-held GPS receiver. Track Error is the difference between GPS Track and Bearing to the goal. A zero indication means you are flying towards the goal. The negative sign means "Turn left".

2. Show Average over the whole Thermal [Sh Thermal]
This choice is good for the cross-country pilot who stays too long at the top of a dying thermal. It is often wise to leave when the average lift (upper right) is less than the lift averaged over the whole thermal. This number is always shown in the first Statistics screen at the right side of the main flying screen map.

3. Show MacCready Setting [Show McC.]
This is for racing pilots who want to watch the Vector wind final glide screen but can't remember their MacCready setting.

4. Show Maximum MacCready [Sh Max Mc]
This shows the maximum MacCready setting possible for the Final Glide. The number shown is the maximum MacCready value at which the glide can be achieved. The number is valid for either the Vector or HW/TW Final Glide screen It changes from --- to 0.0 when the glide becomes possible at best L/D. A final glide is optimized when it is started with Max Mc = current Averager reading.

5. Show the achieved glide slope [Show Slope].

$$\text{Achieved Glide slope} = \frac{\text{Air Distance Flown}}{\text{Altitude lost}}$$

The largest number the instrument can display is a glide slope of 99/1. Achieved Glide Slope has no meaning in climb, so the instrument shows - -.

If the glider polar is accurate, and if the airmass is not moving up or down, this is the sailplane's glide ratio. The number goes down as you fly faster. The achieved glide slope goes down if the wings are wet or covered with bugs. I smile when my LS-4 achieves 70/1 on a marginal glide!

This number is most useful during a final glide. The altitude required for a final glide assumes no vertical airmass motion. Suppose you are flying a 40/1 glider at best glide speed, and the glide altitude required exactly matches the altimeter reading.
If the Achieved Glide Slope > 40, you will make the glide. If the Achieved Glide Slope stays below 40, you will need to find lift or prepare to land.

6. Show Net Airmass Motion [Show Netto]

This number is the Vario reading PLUS the computed sink rate at the glider's airspeed. If the glider polar is accurate, and the air mass is not moving up or down, Netto = 0. Recalling that final glide altitudes assume no vertical airmass motion, a negative Netto means you are falling below glide path.

Netto yields almost the same information as slope. However, it is independent of cruise airspeed. It is also easy to interpret positive as well as negative Netto values.

H. Short (S) and Long (L) averaging intervals for Slope and Netto

Fifteen-meter gliders have quicker control response than open class gliders.
Soaring conditions vary widely around the world.
Pilots have different gliding backgrounds and tastes.
Therefore the S/L-NAV gives pilots a choice of response speeds for the glide slope and netto average displays. There are separate configuration switches for each parameter.

1. [Slope: L] [Slope: S]

The averaging interval for [Slope: L] is 120 seconds.
The averaging interval for [Slope: S] is 30 seconds.

2. [Netto: L] [Netto: S]

The averaging interval for [Netto: L] is the same as for the averager.
The averaging interval for [Netto: S] is 4 seconds.
If [Average S] is chosen, Netto resets on cruise/climb transitions.
In this case, [Netto S] starts out at 1 second and builds up to 4 seconds.

I. Configuring the "HOME" Screen

The S/L-NAV has both a component wind and a vector wind glide calculator.
Each is useful under different conditions. The basic design separates these two glide screens with a screen that displays instantaneous wind component and altitude (HW/TW screen). This is the default HOME screen.

In response to pilot input over the last year, pilots may now configure the HOME screen.

1. [HOME 1]
The HW/TW wind and Altimeter screen is the HOME screen.

2. [HOME 2]
The Vector Wind glide screen becomes the HOME Screen.
This screen also shows GPS status information when no fix has been obtained.

3. [HOME 3]
The Vector Wind glide screen is the HOME screen. The HW/TW screen is deleted.
From this HOME screen, MacCready can be changed with 1 click of the right arrow key.

Appendix: Features added with this release:

1. Configurable HOME Screen
2. Configurable, "Smart" Averager
3. Choice of averaging interval for Slope and Netto calculation.
4. Revised speed-to-fly tone patterns when [Sink Tone] is used
5. Improved logic for Spoilers and Landing gear alarms
6. Altimeter screens in both Ft. and Meters when metric units are selected
7. Glide altitude graphic display now shows when you are very high or low.
8. Measurement of Outside Air Temperature using optional PC board
9. Support for Cambridge Palm-NAV Graphic display system
10. The ASI zero calibrate screen shows airspeed in selected units (Knots or kph)