1 Closed Loop Speed Control (Fixed Wing)

This manual is an addendum to the Vector and MicroVector manuals.

1.1 Overview

⊥ "Closed Loop" speed control refers to using the model's present speed to control the ESC/propeller RPM, rather than just directly controlling the RPM with the throttle stick position.

When closed loop is enabled and functioning, the "Cruise," "Climb" and "Off" throttle settings that are learned during the Receiver Analysis Wizard are no longer used to control the speed of the model, in GPS modes.

Closed loop is available during the following flight operations:

- Return to Home (RTH)
- Loiter
- Waypoints
- "2D + Speed" and "2D Hold + Speed" "Cruise Control" flight modes, as described below.

Note that the model's actual speed will vary from the specified speed, due to a variety of factors.   For example, if a model is in a dive, it cannot be slowed down much by reducing RPM, and in a climb, the model will not go faster than the speed obtainable at maximum RPM.

1.2 Pitot Tube Support

1.2.1 Pitot Tube vs GPS Speed

Both GPS speed and pitot airspeed closed loop support is provided.   Using a pitot tube for speed control results in control of airspeed, rather than ground speed.   Using a pitot tube has advantages and disadvantages:

Advantages:

- The model will travel at a fixed speed relative to the wind.   So, in a strong tailwind, for example, the model is less likely to stall due to slow airspeed.
- Battery life can be more accurately predicted, since the model is traveling at a relatively constant speed through the air, meaning that the propeller RPM and air resistance remain relatively constant.
- With the pitot tube, if the GPS signal should be lost or if no GPS is used, closed loop speed control is still available.

Disadvantages:

- A pitot tube adds another failure point. If the pitot tube should become clogged or otherwise fail during flight, speed control would become erratic, possibly resulting in a crash!
- Since airspeed is being measured, in a high headwind the model may make no forward progress or actually move backwards relative to the ground. The "Minimum Groundspeed" setting can help mitigate this issue, however.

1.2.2 Pitot Tube Safety Checks

If pitot tube speed control is enabled, the following checks are done to help ensure that the pitot tube is working correctly.

- If the pitot sensor is not detected by the controller during startup, the system will fall back to GPS speed.

- Until the measured pitot speed reaches about 10MPH (16KPH), GPS speed will be used. This check helps to ensure that the pitot tube is connected and not clogged. Note that if the pitot tube hoses become disconnected or if the tube becomes clogged during flight, this condition will NOT be detected, and closed loop speed control will become erratic, possibly resulting in a crash!
- If the pitot sensor becomes electrically disconnected from the Vector during flight, the system will fall back to GPS speed.

Note that if GPS signal is inadequate AND a pitot failure is detected, closed loop speed control will be disabled.

1.3 Closed Loop Speed Control Related Settings

The following settings are used to configure closed loop, in both the OSD "stick menus" and the GUI.

1.3.1 OSD Stick Menu Setup

The settings are available by navigating to the "Safety/RTH/Nav Configuration" menu page, in the stick menus.

On the "Safety/RTH/Nav Configuration" OSD Stick Menu:

- **Auto Navigation Speed:** this setting lets you set the desired closed loop speed for RTH, loiter and waypoint modes. This speed must be well above your model's stall speed, or a stall will likely occur!
- **Min Speed for 2D+Speed Modes:** this setting controls the speed corresponding to the 15% throttle stick throw position when using a 2D+Speed flight mode.   This speed must be well above your model's stall speed, or a stall will likely occur!
- **Max Speed for 2D+Speed Modes:** this setting controls the speed corresponding to the "Climb" throttle stick position learned during the wizard, when using a 2D+Speed flight mode. This speed must be greater than the Min Speed described above.

On the "Advanced" menu, under the "Safety/RTH/Nav Configuration" OSD Stick Menu:

- **Minimum Ground Spd(0 disable):** this option is useful if you are flying in windy areas. If your model is flying using closed loop, and the measured ground speed is less than this specified speed, the model should speed up to this speed.
- **Use Pitot Tube for Navigation:** enabling this option will cause closed loop speed control to use the pitot tube (airspeed).   If this option is disabled, GPS speed (ground speed) will be used. Make sure your pitot tube is mounted correctly, tested and (if necessary) calibrated, as described in "**Mounting the Optional Pitot Tube**" in the Vector/MicroVector manual, before enabling this option!
- **Speed Ctrl Throt Gain Proport**: this setting allows adjustment of the proportional term of the speed control "PI" controller.
- **Speed Ctrl Throt Gain Integrl:** this setting allows adjustment of the integral term of the speed control "PI" controller.
- **Loiter Speed (0=Use Auto Spd):** this setting lets you specify the closed loop speed during loiter flight mode.   Note that if this setting is 0, the "Auto Navigation Speed" setting is used for loiter mode. Note that the "Auto Navigation Speed" setting MUST be nonzero for closed loop speed control to function in loiter. This speed must be well above your model's stall speed, or a stall will likely occur!

1.3.2 GUI Setup

Each of the above settings is also available on the "Flight Controller Setup" and "Safety/Nav Setup" tabs in the GUI, as shown below:
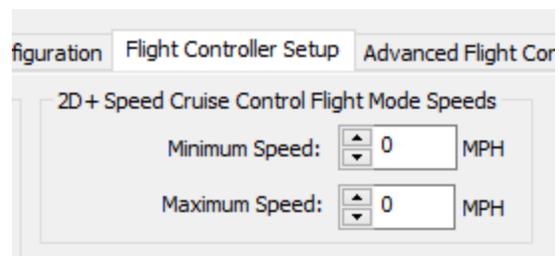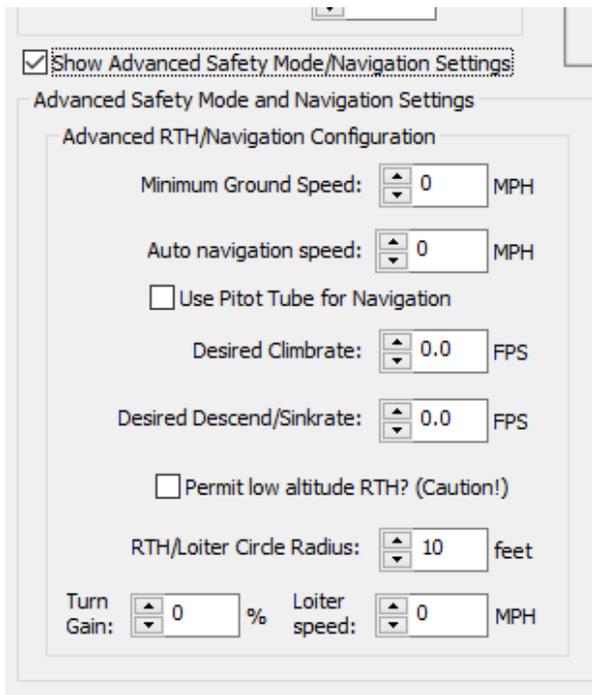
1.4 Configuring Closed Loop with Waypoint, RTH and Loiter Modes

If Closed Loop speed control is desired during Waypoint, RTH and Loiter modes, set the "Auto Navigation Speed" to the desired cruise speed.   If desired, enable the pitot tube with the "Use Pitot Tube for Navigation" setting.

For Loiter mode, the "Loiter Speed" setting can additionally be changed to a nonzero value, if a different loiter speed is desired.

For Waypoint mode, the "Change Speed" waypoint command can be added to the waypoint command list to set a new target speed (and optionally a new minimum ground speed) for subsequent waypoints.   Multiple "Change Speed" waypoint commands can be added to the command list.   Note that the "Auto Navigation Speed" (or throttle based speed control if this setting is 0) is used for waypoints until the first "Change Speed" waypoint command is encountered.

1.5 Closed Loop "Cruise Control" Flight Modes

1.5.1 Overview

EXPERIMENTAL!

In closed loop speed flight modes, the system adjusts the ESC/propeller RPM to attempt maintain speed within a specified range, based on the radio's throttle stick position.

⚠ Selecting a closed loop flight mode will result in the propeller spinning at its maximum speed, even on the ground, if the model is moving more slowly than the commanded speed, when closed loop is armed and the throttle is in any position other than off!

Closed loop flight modes are not recommended for takeoff or landing!

1.5.2 Available Modes

Two closed loop flight modes are available:

2D Hold + Speed – Identical to "2D + Hold" flight mode, except closed loop speed is enabled. When this mode is selected, armed, and functioning correctly, "2HS" will be displayed on the OSD Flight Mode Indicator.

 2D + Speed – Identical to "2D" flight mode, except speed is controlled by throttle position.   When this mode is selected, armed and functioning correctly, "2DS" will be displayed on the OSD Flight Mode Indicator.

1.5.3 Configuration

To configure closed loop flight modes, first program the desired closed loop flight mode(s) to the desired mode and/or submode switch position(s).
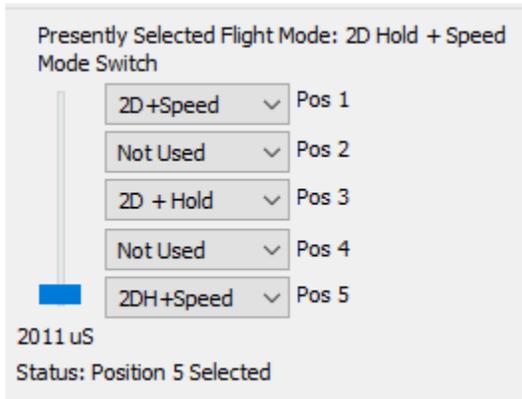
Then, configure the "Min Speed for 2D+Speed Modes" and "Max Speed for 2D+Speed Modes" settings as described above.   If desired, enable the pitot tube with the "Use Pitot Tube for Navigation" setting.

1.5.4 Closed Loop Flight Mode Behavior

1.5.4.1 Relationship Between Throttle Stick Position and Speed

The throttle stick position results in the following behavior, in normal operation:

- Throttle stick moved to a low setting (below about 15% throw position or less): normal throttle control (direct passthrough of throttle stick position to ESC) is enabled.
- Throttle stick moved between about 15% and the "Climb" throttle position learned during the Receiver Analysis Wizard: commanded speed is proportionally scaled between the "Min Speed for 2D+Speed Modes" and "Max Speed for 2D+Speed Modes" settings.
- Throttle stick moved above the "Climb" throttle position: commanded speed is limited to "Max Speed for 2D+Speed Modes" setting.

 Note that as you move the throttle, the commanded target speed will briefly display in the OSD notification window.

1.5.4.2 Initial Speed Requirement to Arm Closed Loop Mode

When a closed loop flight mode is selected via the mode or submode switch, normal throttle control (direct passthrough of throttle stick position to ESC) is utilized until and unless the model has reached a trigger speed of about 10MPH (16KPH), which arms closed loop mode.

Note that the minimum speed requirement is disabled once the trigger speed is reached. In other words, if the model reaches the trigger speed, then decelerates below that speed, closed loop speed control will remain active under normal operation, as long as the throttle stick position remains above about 15% throw.

Closed loop mode is disarmed, requiring the trigger speed to be exceeded again for closed loop control, whenever the throttle is brought below about 15% throw.

1.5.4.3 Closed Loop Flight Mode Fallback

Closed loop flight mode will be disabled (and direct throttle stick passthrough to ESC will be enabled) when one of these events occur:

- If the GPS fix quality is inadequate, and closed loop is not using the pitot tube.
- If pitot tube navigation is enabled, and a problem is detected with the pitot tube, and GPS fix quality is inadequate.
- When the throttle stick position is brought below about 15%. This also disarms closed loop mode.
- Until the initial speed reaches about 10MPH (16KPH), which arms closed loop mode if not presently armed.

When closed loop flight mode is disabled, either standard "2D + Hold" or "2D" flight mode will be engaged, and the OSD Flight Mode Indicator will show either "2DH' or "2D" flight mode, depending on which closed loop flight mode is presently selected.