

Thermal Scout Data Output Mode

In its normal mode of operation the *Thermal Scout* indicates thermal lift by controlling a servo (usually the rudder servo) to produce a distinctive “tail wag”. No special radio or additional equipment is needed. This normal operation mode is detailed in the *Thermal Scout* instruction sheet.

In some cases, a modeler may desire an output signal that can be used with telemetry, logging, or other electronic systems. Beginning with Version 2.1*, the *Thermal Scout* offers an output mode with selectable formats to provide real-time rate-of-climb information to such systems.

**Note: The version number is marked on the black label on the top of the circuit board. Earlier versions (v1.1 or v1.2) can be updated; contact Winged Shadow Systems for details.*

Output Formats

PWM Voltage Output

This format produces a voltage signal ranging from approximately 0.2 to 3.2V. The mid point, 1.6V, represents zero lift. If the plane is in a thermal and climbing the voltage will increase. If it is descending in sink the voltage will decrease. The faster the climb the higher the voltage. Similarly, the faster the descent the lower the voltage.

Since the output of the *Thermal Scout* is in digital form, it cannot directly output an analog voltage. It actually produces a 10.4KHz digital signal that varies in duty cycle. This is known as pulse-width modulation (PWM). This PWM signal is converted to a voltage using a simple Resistor/Capacitor (RC) filter. An external 1K ohm resistor and a 10uF capacitor must be added. You can construct this yourself using the schematic in Figure 1 or purchase an adapter cable with the filter circuit built in. We sell ready-to-use filter cables with connectors for popular telemetry radios. (See Figure 4.)

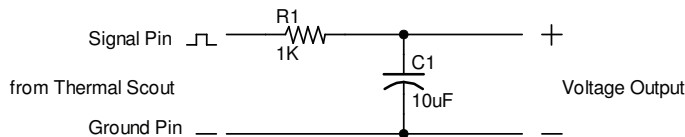


Figure 1. PWM-to-Voltage Filter

Tone Output

This format produces a varying audio frequency signal. The signal can drive the modulation input of a radio transmitter or even a small speaker. The frequency is 262Hz (middle C) at zero lift and rises during climb or falls during descent. To further aid in discerning lift, the tone is pulsed when rising; producing a beeping sound that increases with the climb rate. For descending flight you can choose a falling tone or turn the tone off completely.

Output Range

Figure 2 graphically illustrates the output values by depicting a variometer dial. A variometer is a sensitive rate-of-climb instrument used in full-scale gliders. In this case it is calibrated in feet per minute (and meters per second). The numbers outside the dial provide approximate values for the *Thermal Scout* voltage output (top) and tone frequency (bottom).

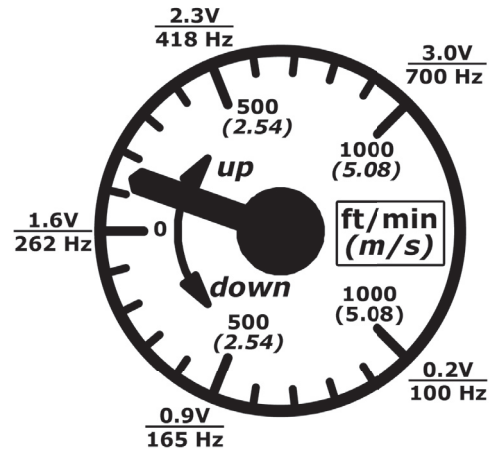


Figure 2. Variometer Dial

Connections

In output mode the gold 3-pin connector on the *Thermal Scout* circuit board is used to connect to your equipment instead of a servo.

NOTE: NEVER PLUG A SERVO INTO THE THERMAL SCOUT WHEN USING OUTPUT MODE.

The output signal is provided on the signal (⌚) pin. The negative (–) pin provides the ground reference. The positive (+) pin is tied to the red wire from your receiver. It is not used in most output mode applications.

To activate the output mode, leave the RED connector disconnected. The *Thermal Scout* will detect that nothing is attached to the RED plug and will switch to output mode. The output mode uses only the BLACK connector. The RED connector is left disconnected.

Plug the BLACK connector into a receiver channel that you can control from your transmitter. Preferably, use a channel that is controlled by a transmitter switch (like the gear, flap, or aux channel). If this is not possible you can use any other controllable channel. These instructions will refer to this as the “Control Channel” and the associated transmitter control as the “Control Switch”.

During flight, the output signal will be active whenever the Control Switch is ON. When this switch is OFF, the output is disabled (the voltage output will be held at a level just below zero lift; the tone output turns off). This control allows you to effectively shut off the system during powered climbs or anytime the output signal is unwanted or annoying. If the control channel signal is not present, the unit defaults to ON (so the system can be used without an R/C receiver). The Control Switch is also used to select the output format.

WARNING

When the RED connector is unplugged the output mode is activated. In this case, **NEVER** connect a servo to the output pins. Sending the output mode signal to a servo could damage the servo. Whenever a servo IS plugged into the *Thermal Scout* you **MUST** connect the RED connector to your receiver.

Setting Output Preferences

Table 1 lists the available formats for the output data. Follow these steps to enter the setup mode and select your desired format:

1. Make sure the BLACK connector is plugged into the receiver. Leave the RED connector disconnected. The 3-pin connector on the circuit board can be disconnected or attached to your telemetry system (just be sure it is NOT connected to a servo).
2. Turn on your transmitter and receiver. When the output mode is active the yellow LED on the circuit board will blink continuously -- once per second when the Control Switch is ON, once every 2 seconds when the Control Switch is OFF.
3. Put the transmitter Control Switch (the switch associated with the BLACK connector channel) in the OFF position. Enter setup mode by switching the Control Switch

ON-OFF-ON-OFF-ON.

This is a sequence of five clicks of the switch starting in the OFF position and ending in the ON position. The entire five click sequence must be completed within 4 seconds but not faster than 1 second.

4. When you have entered setup mode the LED will flash in the following sequence:
flash flash-flash flash-flash-flash flash-flash-flash-flash
5. The sequence will keep repeating (1,2,3,4 - 1,2,3,4) as long as the Control Switch is ON. **To select an output format, simply turn OFF the Control Switch during, or right after, the specific number of flashes.** Figure 3 shows the flash sequence and the turn-off timing. The output formats are shown in the following table:

Flashes	Format
1	Voltage (PWM) Output (Stronger Lift = Higher Voltage)
2	Voltage (PWM) Output -- Reversed (Stronger Lift = Lower Voltage)
3	Tone Output (Tone Active in Lift & Sink)
4	Tone Output (Tone Active in Lift, Silent in Sink)

Table 1. Data Output Formats

When you turn off the Control Switch the selected format is saved and the *Thermal Scout* returns to output mode. You will not need to repeat the setup process again (unless you want to change the format).

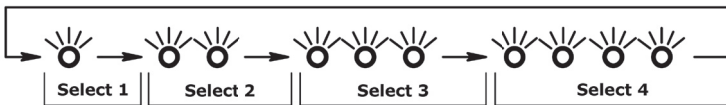


Figure 3. Setup Mode LED Flash Sequence

Applications

Popular R/C Telemetry Radios

For most R/C radios with telemetry you will use the Voltage Output (#1) format. Using the PWM filter circuit (or cable), connect the output to a voltage measurement input on your telemetry unit.

Table 2 lists voltage connections for popular telemetry systems.

Brand	Telemetry Product	Connector
Spektrum	TM1000 or TM1100 Telemetry Module	"Temp/Volt" (or Y-adapter)
Hitec	HTS-SS "Blue" Sensor Station	"V" (2-pin)
FrSky	D8R Receiver	"AD2"

Table 2. Voltage Input Connections for Popular Telemetry Systems

If your system has adjustable alarms, you can setup a "max voltage" alarm to beep when you find lift. To find a starting point for the alarm threshold, first find your system's zero-lift level. Power up the system and place your plane on the ground. Note the zero-lift voltage. This is nominally 1.6V, but depending on the accuracy and loading of your telemetry system, it may differ. Once you know the zero-lift voltage for your system, add 0.1V to 0.3V and set the alarm to that level. You can effectively adjust the sensitivity of the alarm point by increasing (less sensitive) or decreasing (more sensitive) the threshold voltage.

Some systems, like the Hitec Aurora 9, only provide "low voltage" alarms. In this case, you can choose the Voltage Output Reversed (#2) format. With this format the zero-lift voltage is about the same, but the voltage decreases with lift.

Other Telemetry and FPV Systems

If your system has a modulation, audio, or microphone input, the Tone Output formats (#3 or #4) allow the *Thermal Scout* to act as audio variometer. Do not use the filter circuit or a filter cable (that is only for voltage output -- not tone). The signal is a 3.2V square wave with an on-board 150 ohm series resistor. If your system requires a lower signal voltage, a resistor divider can be created by adding an external resistor to ground.

For systems with microphones a small piezo speaker or earphone can be connected directly between the signal and negative pins for an audible output.

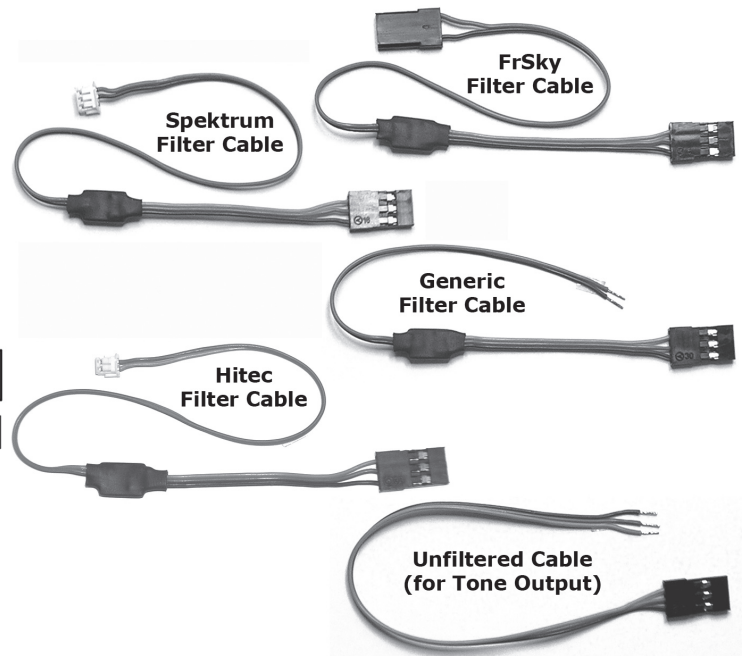


Figure 4. Cables available at www.WingedShadow.com

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