

# WAG-AERO FLY-BY-NIGHT RECEIVER, REV A: INSTALLATION, OPERATION, AND MAINTENANCE

## GENERAL INFORMATION.

### Functional Description.

The Wag-Aero Fly-by-Night Receiver is a tough, commercial-grade, receiver with very good sensitivity and selectivity. It is designed for operation at small airports to facilitate pilot control of lighting.

The Receiver is tunable over a range of 118-137 MHz in 25kHz increments. It uses triple-tuned circuits in the front end and ceramic filters in the i-f with steep skirts for good adjacent channel selectivity.

The Receiver has one microcontroller which is responsible for watching the squelch to determine what is happening on the air. It can be programmed to perform several different tasks in response. The primary task for this application is Pilot-control of runway lights.

- Runway lights may be activated by keying the aircraft radio microphone several times, typically three times in five seconds.
- If the airport is equipped with variable intensity lighting, the pilot can select intensities by keying the microphone 3, 5, or 7 times in a 5-second period.
- Lights remain on for a programmable period of time, usually 15 minutes.
- Various programming options allow for turn off, change in intensity after initial turn-on, and flashing lights to warn of turnoff during last minute.
- Front panel red LED indicates when lights have been activated at any intensity.
- A green LED indicates when the squelch is closed.

**Table 1. Quick Reference**

**Frequency range:** 118-137 MHz  
**Channel spacing:** 25 kHz. Frequency set with dip switch; (repeaking coils required for freq change more than 2 MHz - use A28 tool)  
**Squelch sensitivity:** adjustable 2-35  $\mu$ V  
**12dB sinad:** 2.5 $\mu$ V  
**Adjacent channel selectivity:** 60 dB  
**Image rejection:** 40dB (at +900kHz)  
**Other spurious rejection:** 50 dB  
**Temp stability:**  $\pm$ 10ppm +20 to +30° C;  $\pm$ 20ppm -30 to +50deg C.  
**Control outputs:** three separately controlled open-collector switching transistors able to sink up to 50 mA to ground on circuits up to 15Vdc. External relays can be controlled for high current loads.  
**Antenna connector:** UHF jack on cabinet.  
**Power and control connections:** 9 pin D-sub jack on cabinet  
**Size:** 7 in wide, 8 in deep, 2 in high.  
**Operating Power:** +13.6Vdc  $\pm$ 10% at approx. 45mA.

## INSTALLATION.

### General.

Following are general instructions for installation of the receiver. For proper operation and to prevent damage to the unit, it is recommended that a qualified two-way radio technician do the installation.

### Mounting.

The receiver enclosure can be mounted against any vertical surface with screws through the mounting flanges. If you want to use the whip antenna for localized operation, mounting the unit with the connectors up will allow you to simply attach a whip antenna to the connector.

Selecting a location for the receiver depends on several factors. It should be near the electrical circuit for the runway lights so the relay to switch the lights is close to the receiver. It should also be near an ac outlet to provide power for the receiver.

If you want to use the whip antenna, you want to select a location which allows the antenna to pick up transmissions well and not be near sources of interference such as motors or fluorescent lights. Normally, the higher the antenna, the better, and it should not be in an area enclosed by metal siding, which could restrict the range. If you cannot find a location which provides interference free reception with an indoor antenna, you may want to use a roof mounted antenna of some sort. A simple scanner radio antenna from Radio Shack should do the job nicely.

### Cover Removal.

If you need to remove the cover for any reason, remove the four screws on the *side* of the cover, and slide it off. Do not remove screws from bottom.

### Relay Mounting.

The relay should be mounted in an electrical cabinet for safety, and it should be mounted on a metal surface for proper heatsinking. As shown in the derating curve in figure 3, the relay may be operated with a load up to 4Amp at room temperature with no heatsink.

**For operation at elevated temperatures or for load currents over 4 Amp, the relay needs to be heat sunk to a large metal surface, and a good size metal cabinet should provide ample surface for that.**

To provide heatsinking for the relay, it must be mounted on a bare metal surface. If necessary, an aluminum plate can be installed in the cabinet to provide bare metal for heatsinking. Before screwing the relay to the heatsink surface, spread a very thin layer of heatsink compound on the metal relay base to transfer the heat to the heatsink. The heatsink compound and a toothpick for applying it are

provided in a small plastic bag in the box for the relay for shipping.

⚠ **CAUTION:** *Installer is responsible to ensure that proper heatsinking is provided. Warranty does not cover damage to relay which might result from improper installation.*

## ELECTRICAL CONNECTIONS.

The antenna connection is made with a coaxial connector. The power and relay connections are made with a DB9 connector. Table 2 identifies the terminals used for these connections. Figure 1 shows the terminals on the DB9 connector.

### Antenna Connections.

For normal operation, the whip antenna supplied with the unit should be sufficient to provide useful range. It should be plugged into the coaxial connector and the wire antenna unfolded to full length.

In the event that you need to use an outside antenna, it should be connected with good, low-loss 50 ohm coaxial cable plugged into the antenna connector with a suitable UHF (PL-259) plug.

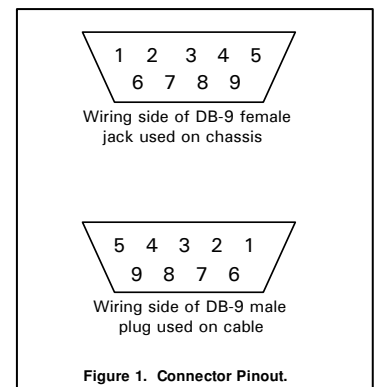
### Power Connections.

The receiver operates on +13.6 Vdc at about 200 mA peak with full audio. An ac power adapter is provided; so all you need to do is plug it into a source of 115Vac once the installation is completed.

If you want to operate the receiver on some other source of power, be sure to use a regulated and filtered 12Vdc power supply and observe polarity when connecting the power supply in place of the ac adapter supplied with the unit. Operating with reverse polarity will damage the unit.

### Control Outputs.

The FBN Receiver has three output transistors used to control relays for operating the runway lights with three, five, or seven clicks of the microphone push-to-talk button. Each transistor can sink as much as 50mA at voltages up to +15Vdc. In other words, the transistors switch ground on and off and can be used to ground one end of a circuit. The common use is to ground one side of a relay



**Table 2. Power, Audio, and Control Connections**

Function	Module Pin	DB9 Pin
Ground	screws	6
+12Vdc	E3	1&2
Output A	E4	3
Output B	E5	4
Output C	E6	5

input to energize a relay.

For this application, one solid state relay is provided to simply turn runway lights on with three microphone clicks. The input side of the relay should be connected as shown in figure 2A, with the red wire connected to the positive input, terminal 3, and the black wire connected to the negative input, terminal 4. Be careful not to reverse polarity.

Should it be necessary to use a conventional relay, connect as per figure 2B. Be sure to use a diode across the relay coil to prevent damage to the receiver from transients generated when the coil is de-energized. Be sure that the relay coil does not require more than 50mA. (Using the solid state relay, as explained above, avoids these problems.)

### Runway Light Connections.

The solid state relay provided will control runway lights of either 115 Vac or 230 Vac with a load current up to 10 Amp if proper heatsinking is provided. Connect the output or load side of the relay in series with the hot ac line to the runway lights as shown in figure 2A. The load terminals of the relay are not polarity sensitive; so terminals 1 and 2 are interchangeable.

## OPERATION.

### General.

The receiver has one microcontroller which is responsible for watching the squelch to determine what is happening on the air. It can be programmed to perform several different tasks in response.

### Squelch Setting.

The squelch control, which is the small trim pot on the pc board, sets the threshold at which signals will be detected. The green LED, on the left, indicates when a signal is detected. It normally is lit when waiting for a signal (squelch closed) and it is extinguished when a signal is detected. The proper way to set the squelch threshold is to turn the pot ccw until the LED goes out and then turn it cw just past the point where the LED comes on again. Of course, do this when no one is transmitting. *Note: the squelch control is preset at the factory and should not be adjusted unless there is a problem.*

**There may be installations where the default setting is too sensitive. If you get false triggering of the relay, try setting the squelch control a little more clockwise.** Since aircraft normally have line of sight communications with the airport, often times a receiver does not need maximum sensitivity.

### Mode Switch.

The red LED, on the right, is used to indicate various conditions detected as explained for each mode below.

Seven position dip switch S2 is used to program the microcontroller which provides special features. In the discussion below, "1" indicates that a particular switch is ON or closed and "0" indicates that a switch is OFF or open.

**Positions 1 and 2** set the mode of operation. The four possible modes are as follows:

- 0 0 = not used
- 0 1 = test mode
- 1 0 = not used

**1 1 = PCL mode (normal setting)**

**Position 3** is set to allow changes to be made by the pilot after initially turning on lights.

**Position 4** is an optional setting for the PCL mode. It controls how the output responds during the last minute runway lights are on. If switch position 4 is turned on, the runway lights will flash during the last minute they are on to warn pilots that the lights are about to go out. If the switch is off, no flashing will occur; lights will simply turn off at the end of the timer period.

**Positions 5 through 7** set the time delay for ELT and PCL modes in 5 minute increments. The switches set a four digit binary number which, multiplied by 5, is the time delay in minutes. Following are example settings:

- 000 = 1 min                      100 = 20 min
- 001 = 5 min                      101 = 25 min
- 010 = 10 min                     110 = 30 min
- 011 = 15 min                     111 = 35 min

Note that 000 sets it for one minute, an exception, handy for testing.

### Test Mode.

Turning on switch section 2 with section 1 turned off sets the microcontroller for a special test mode in which the red LED blinks on and off one cycle every two seconds. This allows a technician to check the controller clock accuracy, as there should be about 30 flashes per minute. Note that the controller clock is not as precise as a regular clock; so there may be a small variation in timing. This is normal. The purpose of the test is simply to see if the controller is running properly and that the

clock is roughly accurate. The blinking will stop if the squelch is opened.

### Pilot Control of Lighting.

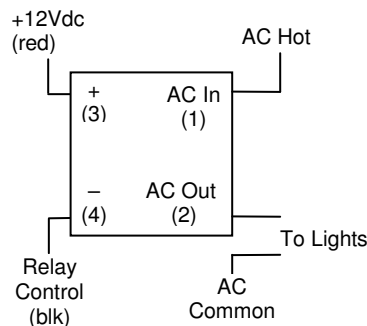
In the PCL mode, if a pilot clicks his push-to-talk button three, five, or seven times within five seconds, runway lights can be activated with Outputs A, B, and C, respectively. Depending on wiring, this can turn on runway lights at up to 3 intensity levels.

As explained earlier, programming the dip switch for PCL mode requires that switch sections 1 and 2 both be turned on. Switch position 3 allows for the option of letting the pilot make a change in settings once the lights are initially activated. Once the lights are activated, they will stay on for the length of time programmed with switch sections 5 through 7. Note that the timing system isn't precise; so if the time is too short, simply increase the setting until you get the about the length of time you want. Position 4 controls whether or not the lights flash during the final minute as a warning that they are about to go out.

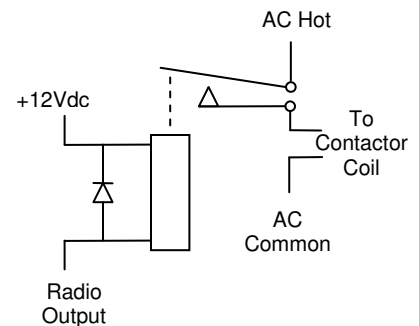
When you install the system, carefully plan how you want the lights to respond to any possible condition. With the proper combination of programming and wiring the outputs to relays, you can make the lighting system operate smoothly and safely. Following are factors to be considered.

Your system may have only one or two intensities. Any outputs which are not wired to one of the relays controlling the lights allows the pilot to turn off the lights. This may be undesirable from a safety standpoint, especially considering that someone may send the required command unintentionally, perhaps even someone trying to access lights at another nearby airport. Sending one of the three commands overrides the other two commands. You can prevent turnoff simply by wiring any unused outputs in parallel with another output so that accidental commands will turn on the lights. Or you can turn off dip switch 3, which will prevent any changes once the initial command is sent.

The receiver has the option of allowing changes to the command after an initial command is executed. If the switch is on, subsequent commands will be carried out, otherwise, they will be ignored until the time delay is completed for turning off the lights.



**Figure 2A. Solid State Relay Wiring.**



**Figure 2B. Small Relay Switching Power Contactor.**

Allowing changes may be good, depending on the way the relays are wired. If you are sure there is no way to turn the lights off altogether, it allows a pilot to correct an erroneous command or to increase or decrease the intensity. If you do not allow changes and someone, even unintentionally, sends a command, they cannot carry out another command for 15 minutes or whatever the time delay is set for.

The red LED on the front of the receiver will illuminate anytime a command is in effect, that is, whenever one of the outputs is activated.

## FREQUENCY ADJUSTMENTS.

### Opening Case.

To access the dip switches on the pc board, remove the four screws on the *side* of the cabinet, and lift off the cover.

### General Procedure.

The channel frequency is determined by frequency synthesizer circuits, which use dip switch S1 in conjunction with programming in microcontroller U1 to set the channel. The microcontroller reads the dip switch information and does mathematics, applying serial data to the synthesizer ic whenever power is applied. Following is a discussion of how to set the dip switch to the desired channel frequency.

**NOTE:** *If the frequency is changed more than about 1 MHz, a complete alignment of the receiver should be performed, as described in later text. Optimum operation only occurs if the synthesizer is adjusted to match the frequency switch setting and all the tuned amplifier circuits are peaked for the desired frequency.*

To determine what channel frequency to use, the microcontroller adds the frequency information from the dip switch to the 118 MHz "base" frequency.

Dip switch settings are binary, which means each switch section has a different weighting, twice as great as the next lower section. Sections have weights such as 25

kHz, 50 kHz, etc., all the way up to 12.800 MHz. (See Table 3 or the schematic diagram for switch values. Also see the shortcuts and tricks which follow this discussion.)

The system sounds cumbersome, but it really is fairly simple, and you don't need to do this frequently. (Also, see shortcut after this discussion.) A piece of paper or a small calculator is handy to aid in determining which sections of the switch to turn on. When done, you might want to record the switch settings in table 4 for future reference.

Begin by subtracting the base frequency, 118.000, from the desired frequency to determine the total value of all the switch sections required to be turned on.

If the difference is greater than 12.800 MHz, turn on switch #1, and subtract 12.800 from the difference frequency to determine the remainder. Otherwise, turn off switch #1.

Do the same for each of the other sections, from highest to lowest weighting, in sequence. Each time you consider the remainder, turn on the switch section with the highest weighting which will fit within the remainder without exceeding it. Each time it is found necessary to turn on a switch section, subtract the value of that section from the remainder to get the new remainder.

**As an example,** let us consider how to set the receiver for 127.325 MHz. The following discussion is broken down into steps so you can visualize the process easier.

a.  $127.325 - 118.000$  base freq. = 9.325 MHz remainder. Turn on switch #2, which represents the largest increment to fit remainder. Turn off switch #1 because its value is larger than 9.325.

b.  $9.325 - 6.400$  value of switch #2 = 2.925 MHz. Turn off switch #3, which is too large a value. Turn on #4, which is 1.600 MHz, the largest increment to fit the remainder.

c.  $2.925 - 1.600 = 1.325$  MHz remainder. Turn on switch #5, which has a value of 0.800 MHz (800 kHz).

d.  $1.325 - 0.800 = 0.525$  MHz (525 kHz) remainder. Turn on switch #6, which has a value of 400 kHz.

e.  $525 - 400 = 125$  kHz remainder. Now it is easy. Looking at the weightings of the switches, you can see that turning on switches 8 and 10 gives 125 kHz. Turn off switches 7 and 9, which are not needed.

f. When we finished, we had turned on switch sections 2, 4, 5, 6, 8, and 10. We turned off all the others. This can also be expressed as the binary number 010110101.

**Note:** Dip switch information is read by the synthesizer only when power is first applied. If switch settings are changed, turn the power off and on again.

### Shortcut.

If you have access to the internet, our website has a long table of numbers which gives the equivalent binary number settings for every possible frequency. We couldn't print it here because it takes many printed pages of space. Surf to our website at [www.hamtronics.com](http://www.hamtronics.com) and look for Dip Switch Programming for R121/R122 Aviation Receiver under Reference Info. The complete url is [hamtronics.com/dipswitch\\_r122.htm](http://hamtronics.com/dipswitch_r122.htm).

Look up the frequency, and it will give you all the binary switch settings. The address is case sensitive, and you must enter the address carefully, exactly as shown.

Also, here are settings for two common frequencies:

122.800 MHz = 0011000000

122.900 MHz = 0011000100

Note that it is easy to do frequencies just above 122.800 just by adding the least significant digits on the right. See that for 122.900, we just add the setting to increase the frequency 100 kHz above 122.800.

### MAINTENANCE.

Complete electrical specs, diagrams, and alignment and troubleshooting information is available on our website. Go to [www.hamtronics.com](http://www.hamtronics.com) and download the manual for the R122 Receiver. The complete url is [hamtronics.com/pdf/Manuals/R122.pdf](http://hamtronics.com/pdf/Manuals/R122.pdf).

Table 3. Frequency Settings

Device	Frequency Weight
Switch #1	12.800 MHz
Switch #2	6.400 MHz
Switch #3	3.200 MHz
Switch #4	1.600 MHz
Switch #5	800 kHz
Switch #6	400 kHz
Switch #7	200 kHz
Switch #8	100 kHz
Switch #9	50 kHz
Switch #10	25 kHz