CONTROL STATION: Rover UAS

Specifications: The Rover UAS described here is controlled by a handheld radio control system and is flown entirely by conventional radio control. The radio control system is a 2.4 GHz seven-channel transmitter and receiver that uses dual sequence spread spectrum transmission. This is a high reliability system that has good rejection of interference and noise.

Manufacturer: Spektrum RC
Transmitter Model: DX-7
Receiver Model: AR-7000
Specifications:
Frequency: 2.4 GHz
Modulation: Digital Spread Spectrum
Channels: 7 control channels (throttle, aileron, elevator, rudder, flaps, 2 aux

Excerpts from the manufacturer's manual follow

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Filename: COA Appl 2248_CONTROL STATION.doc
D.A. Price
C.O.A. Draft #2248
22 Feb 2011

SPEKTRUM®

DX7

Instruction Manual

HORIZON HOBBY

4105 Fieldstone Road
Champaign, Illinois 61822
(877) 504-0233
www.horizonhobby.com
www.spektrumrc.com

Revised 11/08

11329.2

SPEKTRUM®

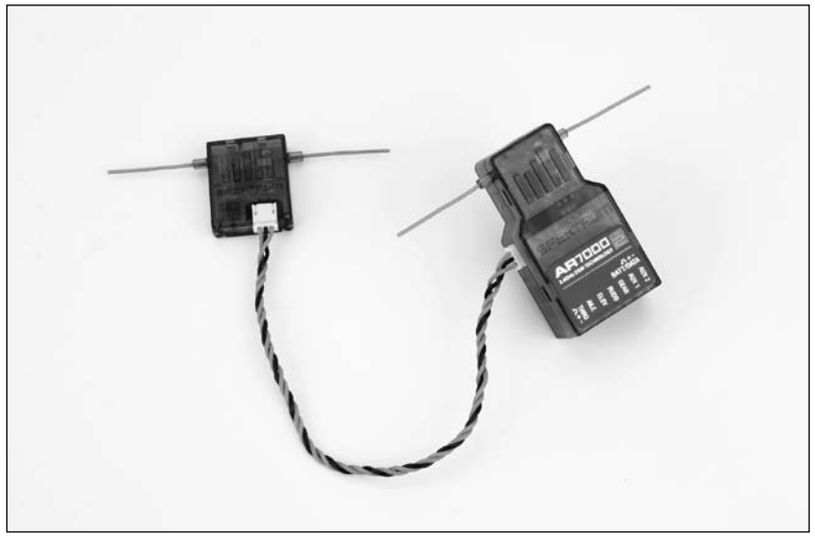
Welcome to the World of Spektrum™ DSM2™ Full Range Technology

Spektrum's DX7 is the first-ever full range 2.4GHz Spread Spectrum Radio system for RC aircraft. With Spektrum's DSM2 technology, now even large gas- and glow-powered aircraft can take advantage of Spektrum technology. No longer will you have to wait for a frequency pin or be concerned that someone may inadvertently turn on to your same frequency. With Spektrum DSM2 technology, when you're ready to fly any aircraft—from parkflyer to giant-scale—simply turn on the system, and go flying!

DSM2 DuaLink® Technology

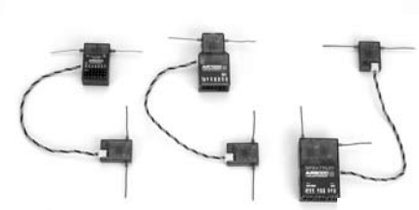
Your DX7 transmits on the 2.4GHz band and utilizes DSM2 second-generation Digital Spread Spectrum Modulation giving visual range in all types and sizes of aircraft. Unlike conventional narrow band systems, Spektrum's 2.4GHz digital DuaLink technology is virtually immune to internal and external radio interference.

Included with your DX7 is an AR7000 7-channel receiver. The AR7000 combines an internal and external receiver, offering superior path diversity. The system simultaneously transmits on two frequencies, creating dual RF paths. This dual path redundancy, plus the fact that each of the two receivers is located in a slightly different location exposes each to a different RF environment and creates a bulletproof RF link in all conditions.

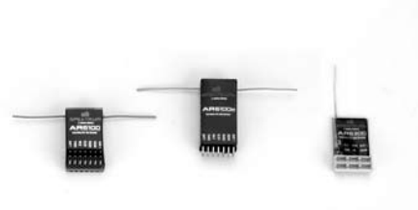


Receiver Compatibility

You'll be glad to know that the DX7 is compatible with all Spektrum and JR DSM receivers including the AR500, AR6000, AR6100(e), AR6200, AR6300, AR7100(r), AR9000, AR9100, JR921 and JR1221. **Note: when using the DX7 with a park flyer receiver like the AR6000 or AR6100, it's imperative that the receiver be limited to use in Parkfly type aircraft only. This includes small electric and non-powered airplanes and mini and micro electric helicopters.**



AR6200, AR7000, AR9000



AR6100, AR6100e, AR6300

AR7100, AR7100R, AR9100

ModelMatch™

With patent pending ModelMatch technology, you'll never mistakenly try to fly your model using the wrong memory again. The DX7 features ModelMatch technology that prevents the operation of a model if the wrong model memory is selected. During binding, the receiver actually learns and remembers the specific model memory (1 of 20) that the transmitter is currently programmed to. Later, if the incorrect model is selected in the transmitter and the receiver is turned on, the model simply won't operate preventing a possible crash. Change programming to the matching model memory and you are set to fly.

Using This Manual

For your convenience, this manual is arranged with separate sections for airplane and helicopter software functions. Airplane Programming is located on pages 31 through 66; Helicopter Programming is located on pages 67 through 102. Programming functions are discussed in the same order that they appear on the radio. An explanation of the use and purpose of each feature is provided, followed by an illustration of its LCD display. A blank data sheet has been included at the end of each section. Once all data has been input for a particular model, it is highly recommended that you also record it on a copy of the data sheet provided.

Table of Contents

Battery Charging

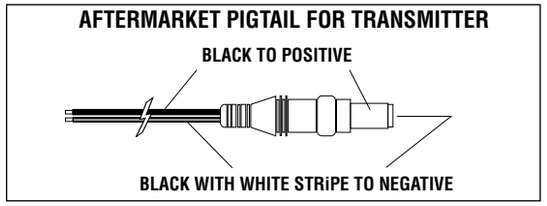
Transmitter/Receiver

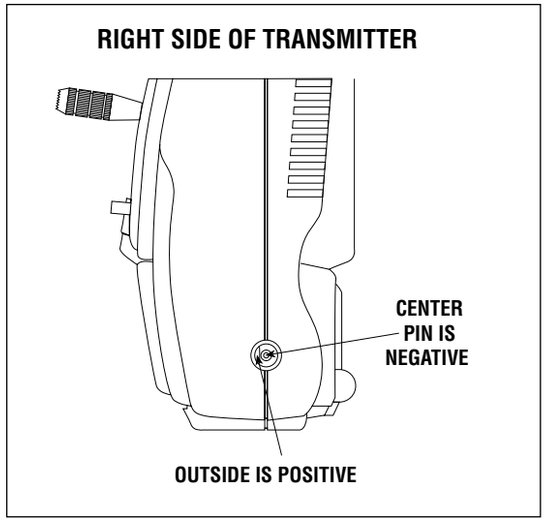
It is imperative that you fully charge both the transmitter and the receiver battery packs prior to each flying session. To do so, using the included wall charger, leave the charger and batteries connected overnight (16 hours).

The charger supplied with this system is designed to recharge your batteries at a rate of 110mA for the transmitter and 110mA for the receiver battery pack.

Transmitter Polarity

The center pin on all Spektrum transmitters is negative. Therefore, the center pin on all Spektrum chargers is negative, not positive. This is different from many other manufacturers' chargers and radio systems. Beware of improper connections based on "color coded" wire leads, as they may not apply in this instance. You must make sure that the center pin of your Spektrum transmitter is always connected to the negative voltage of your charger for correct polarity hookup.





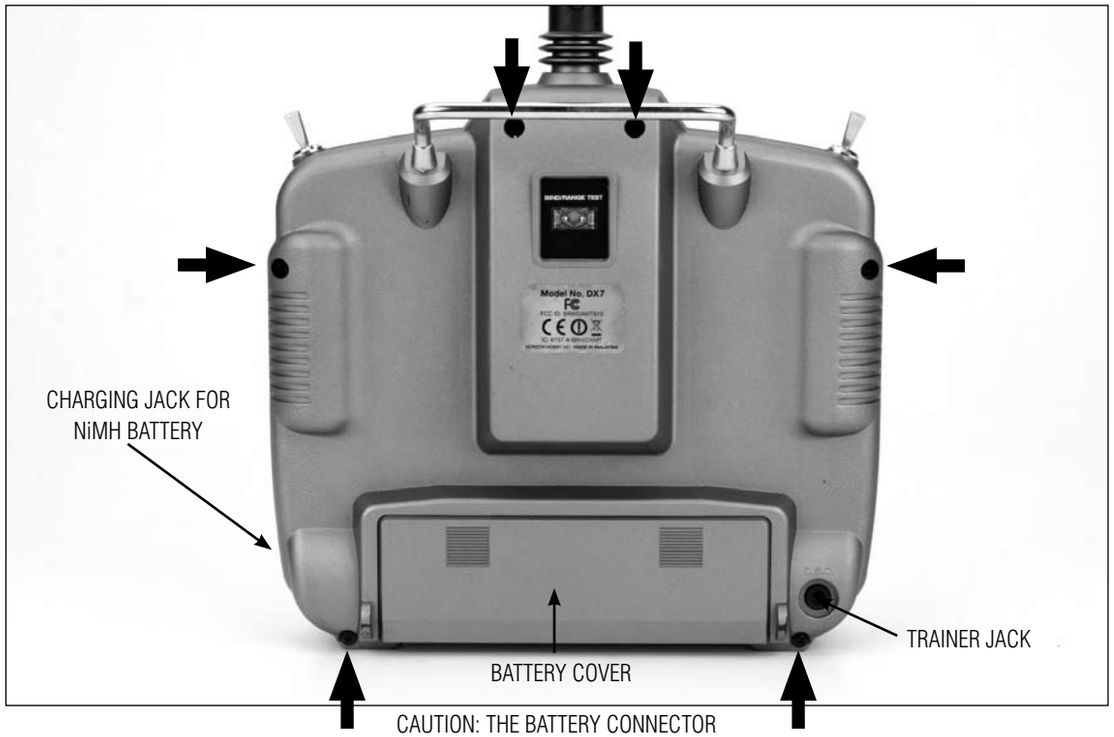
Charger

The pilot lamps should always be ON during the charging operation. If they're not, check to make sure that both the transmitter and receiver are switched OFF. Do not use this charger for equipment other than Spektrum. The charging plug polarity may not be the same and equipment damage can result. During the charging operation, the charger's temperature is slightly elevated. This is normal.

Control Stick Tension Adjustment

Removing the Back of the Transmitter

Remove the battery cover by pressing down on the ridged areas of the cover and sliding the cover towards the bottom of the transmitter. Unplug the battery and set it aside. Carefully remove the screws from the back of the transmitter using a small Phillips screwdriver.

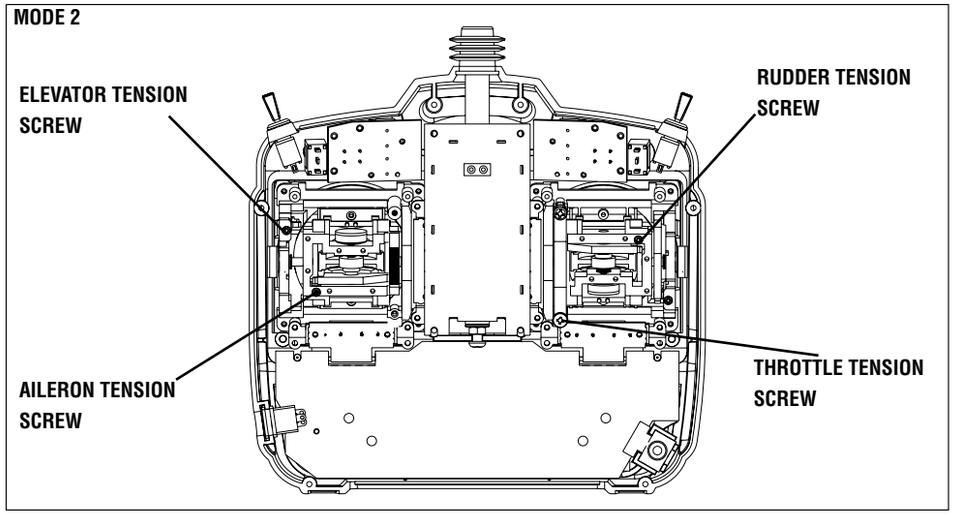


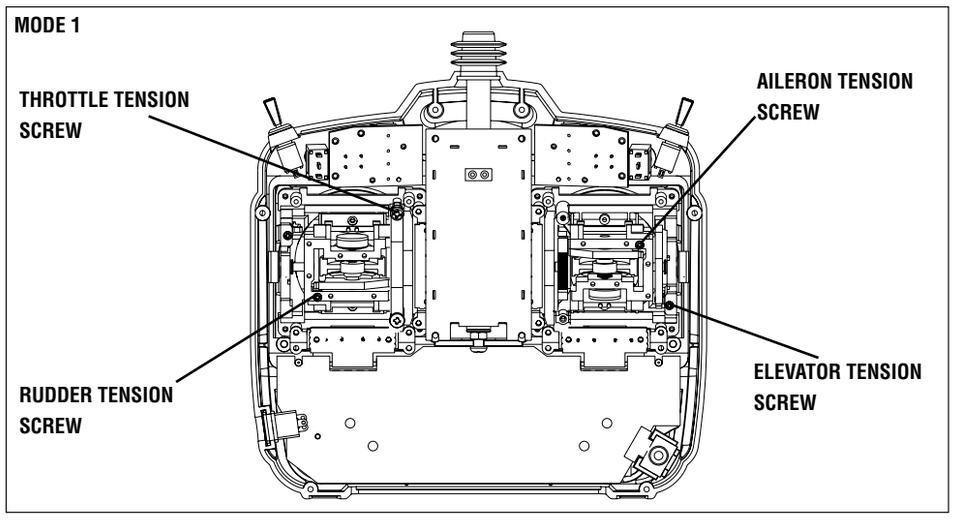
Note: Use care when installing the screws securing the back of the transmitter. They are threading into plastic and can be stripped if over-tightened.

Adjusting the Control Stick Tension

Note: Remove the six (6) transmitter back cover screws. Remove the transmitter back, being careful not to cause damage to any components.

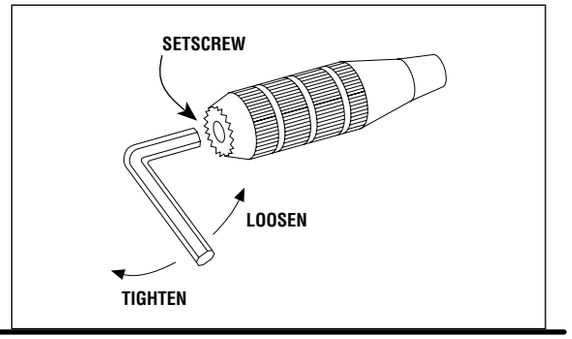
Adjust each stick tension screw for the desired tension (counterclockwise to loosen stick tension, clockwise to tighten stick tension).





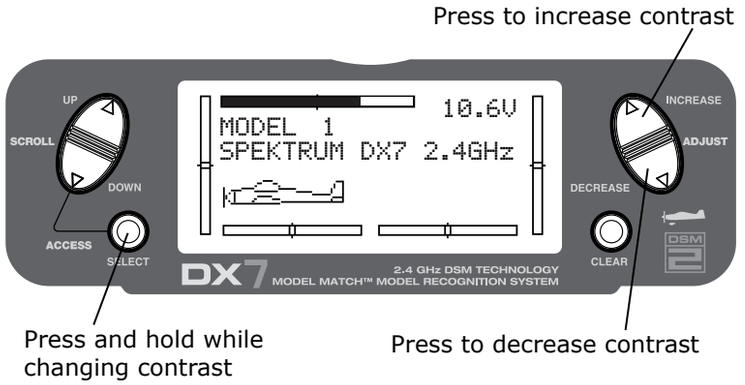
Control Stick Length Adjustment

The DX7 allows you to adjust the control stick's length. Use the 2mm Allen wrench (supplied with your DX7 transmitter) to unlock the setscrew. Turn the wrench counterclockwise to loosen the screw. Then, turn the stick clockwise to shorten or counterclockwise to lengthen. After the control stick length has been adjusted to suit your flying style, tighten the 2mm setscrew.



Screen Contrast

The screen contrast is adjustable, allowing the user to vary the contrast for improved clarity in all conditions. To adjust contrast: with the transmitter on and in the main menu, press and hold the select key. Then press the ***INCREASE*** or ***DECREASE*** key to lighten or darken the contrast.

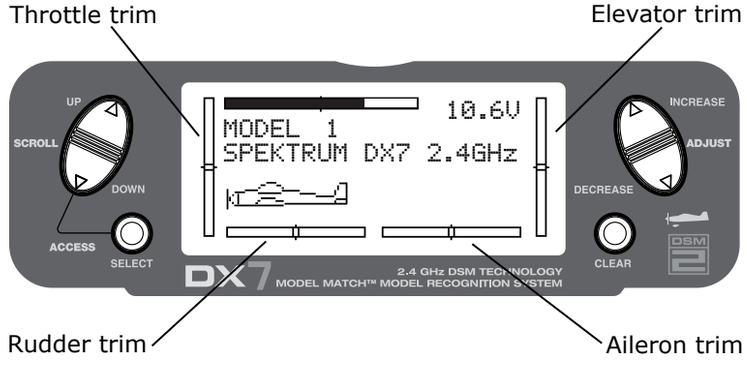


Advanced Digital Trims

The DX7 employs digital trim levers on aileron, elevator, throttle and rudder (hover pitch and hover throttle for helicopters). The ADT (Advanced Digital Trim) feature is designed to automatically store the selected trim values for each model. When a different model is selected, the previously stored trim positions for that model are automatically recalled.

When using the helicopter program, each flight mode has its own trim that is automatically recalled each time that flight mode is entered.

Visual trim positions are displayed on the main screen. The trims feature dual speed scrolling. Holding the trim lever for an extended time will cause the trim rate of change to increase.



Tips on Using 2.4GHz Systems

While your DSM equipped 2.4GHz system is intuitive to operate, functioning nearly identically to 72MHz systems, following are a few common questions from customers.

1. Q: Which do I turn on first, the transmitter or the receiver?

A: If the receiver is turned on first (except for the AR500, AR6100 and the AR7100 receivers), all servos except for the throttle will be driven to their preset failsafe positions set during binding. At this time, the throttle channel doesn't put out a pulse position preventing the arming of electronic speed controllers or, in the case of an engine-powered aircraft, the throttle servo remains in its current position. When the transmitter is then turned on, the transmitter scans the 2.4GHz band and acquires two open channels. Then the receiver that was previously bound to the transmitter scans the band and finds the GUID (GIobally Unique Identifier code) stored during binding. The system then connects and operates normally.

> **Note:** When using the AR500, AR6100 or the AR7100, if the receiver is turned on first, no output pulses are sent to any channels.

If the transmitter is turned on first, the transmitter scans the 2.4GHz band and acquires two open channels. When the receiver (except forAR500, AR6100 and AR7100 receivers) is then turned on for a short period (the time it takes to connect), all servos except for the throttle are driven to their preset failsafe positions while the throttle has no output pulse. The receiver scans the 2.4GHz band looking for the previously stored GUID, and when it locates the specific GUID code and confirms uncorrupted repeatable packet information, the system connects and normal operation takes place. Typically this takes 2 to 6 seconds.

2. Q: Sometimes the system takes longer to connect and sometimes it doesn't connect at all?

A: In order for the system to connect (after the receiver is bound) the receiver must receive a large number of continuous (one after the other) uninterrupted perfect packets from the transmitter in order to connect. This process is purposely critical of the environment, ensuring that it's safe to fly when the system does connect. If the transmitter is too close to the receiver (less that 4 feet) or if the transmitter is located near metal objects (metal transmitter case, the bed of a truck, the top of a metal work bench, etc.) connection will take longer, and in some cases, connection will not occur as the system is receiving reflected 2.4GHz energy from itself and is interpreting this as unfriendly noise. Moving the system away from metal objects or moving the transmitter away from the receiver and powering the system up again will cause a connection to occur. This only happens during the initial connection. Once connected, the system is locked-in and, should a loss of signal occur (failsafe), the system connects immediately (4ms) when signal is regained.

3. Q: I've heard that the DSM system is less tolerant of low voltage. Is that correct?

A: All DSM receivers have an operational voltage range of 3.5 to 9 volts. With most systems, this is not a problem as most servos cease to operate at around 3.8 volts. When using multiple high current draw servos with a single or inadequate battery/power source, heavy momentary loads can cause the voltage to dip below this 3.5-volt threshold, causing the entire system (servos and receiver) to brown out. When the voltage drops below the low voltage threshold (3.5 volts), the DSM receiver must reboot (go through the start-up process of scanning the band and finding the transmitter) and this can take several seconds. Please read the receiver power requirement on page 24 as this explains how to test for and prevent this occurrence.

Tips on Using 2.4GHz Systems (continued)

4. Q: Sometimes my receiver loses its bind and won't connect, requiring rebinding. What happens if the bind is lost in flight?

A: The receiver will never lose its bind unless it's instructed to. It's important to understand that during the binding process the receiver not only learns the GUID (code) of the transmitter but the transmitter learns and stores the type of receiver that it's bound to. If the bind button on the transmitter is pressed at any time and the transmitter is turned on, the transmitter looks for the binding protocol signal from a receiver. If no signal is present, the transmitter no longer has the correct information to connect to a specific receiver and in essence the transmitter has been "unbound" from the receiver. We've had several customers that use transmitter stands or trays that unknowingly depress the bind button and the system is then turned on, losing the necessary information to allow the connection to take place. We've also had customers that didn't fully understand the range test process and pushed the bind button before turning on the transmitter, also causing the system to "lose its bind." If, when turning on, the system fails to connect, one of the following has occurred:

- The wrong model has been selected in the model memory (ModelMatch).
- The transmitter is near conductive material (transmitter case, truck bed, etc.) and the reflected 2.4GHz energy is preventing the system from connecting (see #2 above).
- The bind button was unknowingly (or knowingly) depressed and the transmitter was turned on previously, causing the transmitter to no longer recognize the receiver.

5. Q: Can I use a 3-cell Li-Po pack in my transmitter?

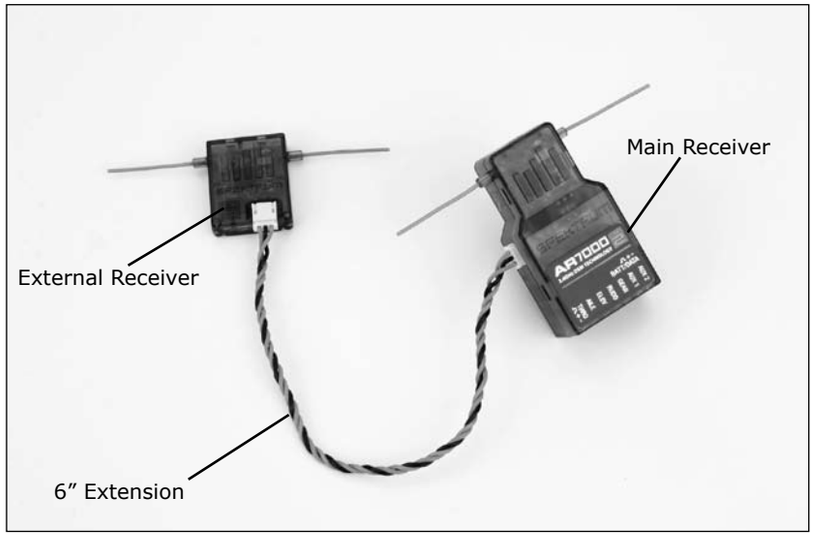
A: No. All current JR and Spektrum transmitters are designed to operate using a 9.6-volt transmitter pack. A fully charged 3-cell Li-Po pack puts out 12.6 volts. This higher voltage can overload the power-regulating transistor causing damage and or failure, possibly in flight. Many of our customers have experienced failures using 3-cell Li-Po packs and their use in JR and Spektrum transmitters is highly advised against. The X9303 2.4 system will operate for over 15 hours using a 2700mAh Ni-MH battery.

6. Q: How important is it that I test my system using the Spektrum Flight Log?

A: For most sport airplanes and helicopters, the use of the Flight Log is unnecessary. For sophisticated aircraft, especially those that have significant conductive materials within the airframe (e.g., jets, scale airplanes, etc.), the Flight Log offers an extra measure of confidence that all radio components are working optimally. The Flight Log is an important tool that allows the confirmation that the installation (position of the internal and remote receivers relative to the conductive materials in the aircraft) is optimized and that the RF (radio) link is operating at the highest levels of performance.

Receiver and Servo Installation

The AR7000 incorporates dual receivers, offering the security of dual path RF redundancy. An internal receiver is located on the main PC board, while a second external receiver is attached to the main board with a 6-inch extension. By locating these receivers in slightly different locations in the aircraft, each receiver is exposed to its own RF environment, greatly improving path diversity (the ability for the receiver to see the signal in all conditions).



QuickConnect™ and Brownout Alert

The remote receivers now included with the AR7000 feature QuickConnect with Brownout Detection. Should a power interruption occur (brownout), the system will reconnect immediately when power is restored and the LEDs on each connected receiver will flash indicating a brownout (power interruption) has occurred. Brownouts can be caused by an inadequate power supply (weak battery or regulator), a loose connector, a bad switch, an inadequate BEC when using an electronic speed controller, etc. Brownouts occur when the receiver voltage drops below 3.2 volts thus interrupting control as the servos and receiver require a minimum of 3.2 volts to operate.

How Brownout Detection Work

When the receiver voltage drops below 3.2 volts the system drops out (ceases to operate). When power is restored, the receivers will immediately attempt to reconnect to the last two frequencies they were connected to. If the two frequencies are present (the transmitter was left on) the system reconnects typically in about 4ms. The receivers will then blink indicating a brownout has occurred. If at any time the receiver is turned off then back on and the transmitter is not turned off, the receivers will blink as a power interruption was induced by turning off the power to the receiver. In fact this simple test (turning off then on the receiver) will allow you to determine if your system's brownout detection is functioning.

Note: If a brownout occurs in-flight it is vital that the cause of the brownout be determined and corrected. QuickConnect and Brownout Detection are designed to allow you to safely fly through most short duration power interruptions. However, the root cause of these interruptions must be corrected before the next flight to prevent catastrophic safety issues.

Receiver Installation

Install the main receiver using the same method you would use to install a conventional receiver in your aircraft. Typically, wrap the main receiver in protective foam and fasten it in place using rubber bands or hook and loop straps. Alternately, in electric models or helicopters, it's acceptable to use thick double-sided foam tape to fasten the main receiver in place.

Antenna Polarization

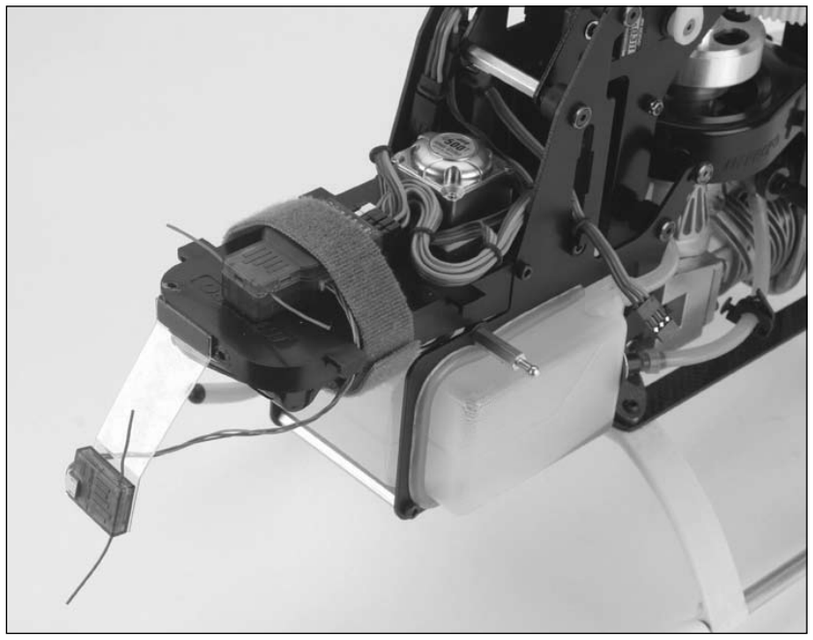
For optimum RF link performance it's important that the remote antennas be mounted in an orientation that allows for the best possible signal reception when the aircraft is at all possible attitudes and positions. This is known as antenna polarization. If two receivers are used, the antennas should be oriented perpendicular to each other, typically one vertical and one horizontal. This allows the greatest exposed visual cross section of the antennas from all aircraft orientations. If three antennas are used it is recommended that one antenna be mounted vertically, one horizontally in-line with the fuselage and one horizontally perpendicular to the fuselage. This covers the X,Y and Z axis offering superb cross section visibility in all aircraft orientations. An optional fourth antenna can be added at an intermediate angle offering even greater RF link security and system redundancy.

Mounting the remote receiver in a slightly different location, even just inches away from the primary receiver, gives tremendous improvements in path diversity. Essentially, each receiver sees a different RF environment and this is key to maintaining a solid RF link, even in aircraft that have substantial conductive materials (e.g., larger gas engines, carbon fiber, pipes, etc.), which can weaken the signal.

Using servo tape, mount the remote receiver keeping the remote antennas at least 2 inches away from the primary antenna. Ideally, the antennas will be oriented perpendicularly to each other, however, we've found this to not be critical. In airplanes, we've found it best to mount the primary receiver in the center of the fuselage on the servo tray and to mount the remote receiver to the side of the fuselage or in the turtle deck.

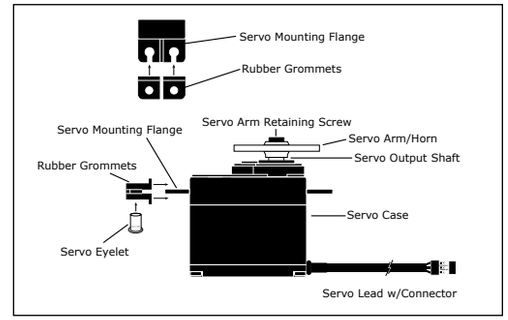
Receiver Installation (continued)

In helicopters, there is generally enough room on the servo tray to achieve the necessary separation. If needed a mount can be fashioned using clear plastic to mount the external receiver.



Servo Installation

In gas- and glow-powered aircraft where vibration is present, the servos should be mounted using the supplied rubber grommets and bushings. Do not over-tighten the mounting screws. The diagram will assist you in properly mounting the grommets and bushings. In electric and non-powered aircraft, there are many acceptable methods for mounting the servo, including servo tape and even glue. See the information included with your aircraft for the recommendation for installing servo(s) in your aircraft.

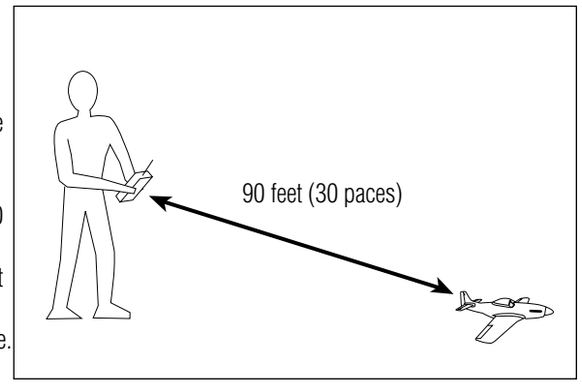


How to Range Test the DX7

Before each flying session, and especially with a new model, it is important to perform a range check. The DX7 incorporates a range testing system which, when the bind button on the back of the transmitter is pressed and held, reduces the output power, allowing a range check.

Range Testing the DX7

1. With the model resting on the ground, stand 30 paces (approx. 90 feet) away from the model.
2. Face the model with the transmitter in your normal flying position and depress and hold the bind button on the back of the transmitter. This causes reduced power output from the transmitter.
3. You should have total control of the model with the button depressed at 30 paces (90 feet).
4. If control issues exist, call the Product Support Team at 1-877-504-0233 for further assistance.



Advanced Range Testing Using a Flight Log

While the above Standard Range Testing procedure is recommended for most sport aircraft, for sophisticated aircraft that contain significant amounts of conductive/reflective materials (e.g., turbine-powered jets, some types of scale aircraft, aircraft with carbon fuselages, etc.) the following advanced range check will confirm that all internal and remote receivers are operating optimally and that the installation (position of the receivers) is optimized for the specific aircraft. This Advanced Range Check allows the RF performance of each individual internal and remote receiver to be evaluated and the location of each individual remote receiver to be optimized.

Advanced Range Testing the DX7

1. Plug the Flight Log (optional) into the data port in the AR7000 receiver and turn on the system (transmitter and receiver).

2. Advance the Flight Log until F- frame losses are displayed, by pressing the button on the Flight Log.

3. Have a helper hold your aircraft while observing the Flight Log data.

4. Standing 30 paces away from the model, face the model with the transmitter in your normal flying position and depress and hold the bind button on the back of the transmitter. This causes reduced power output from the transmitter.

5. Have your helper position the model in various orientations (nose up, nose down, nose toward the transmitter, nose away from the transmitter, etc.) while your helper is watching the Flight Log, noting any correlation between the aircraft's orientation and Frame Losses. Do this for 1 minute. The timer on the DX7 can be used here. For giant-scale aircraft, it's recommended that the airplane be tipped up on its nose and rotated 360 degrees for one minute, then record the data. Next place the airplane on its wheels and do a second test, rotating the aircraft in all directions for one minute.

6. After one minute, release the bind button. A successful range check will have recorded zero frame losses. Scrolling the Flight Log through the Antenna fades (A, B, L, R) will allow you to evaluate the performance of each receiver. Antenna fades should be relatively uniform. If a specific antenna is experiencing a high degree of fades, then that antenna should be moved to a different location.

7. A successful Advanced test will yield the following:
   H- 0 holds
   F- 0 frame losses
   A, B, R, L- Antenna fades will typically be less than 100. It's important to compare the relative antenna fades and if a particular receiver has significantly higher antenna fades (2 to 3X), then the test should be redone, and if the same results occur, move the offending receiver to a different location.

Binding

The AR7000 receiver must be bound to the transmitter before it will operate. Binding is the process of teaching the receiver the specific code of the transmitter so it will connect to that specific transmitter. Once bound, the receiver will only connect to the transmitter when the previously bound model memory is selected. If another model memory is selected, the receiver will not connect. This feature is called ModelMatch and prevents flying a model using the wrong model memory.

SmartSafe™ Failsafe

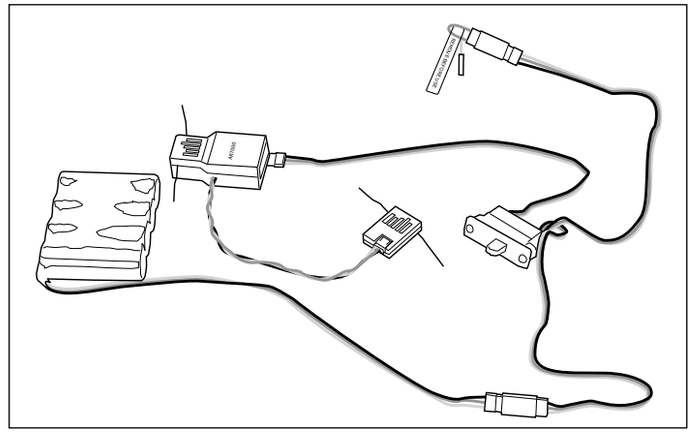
The AR7000 features the SmartSafe failsafe system.

SmartSafe:

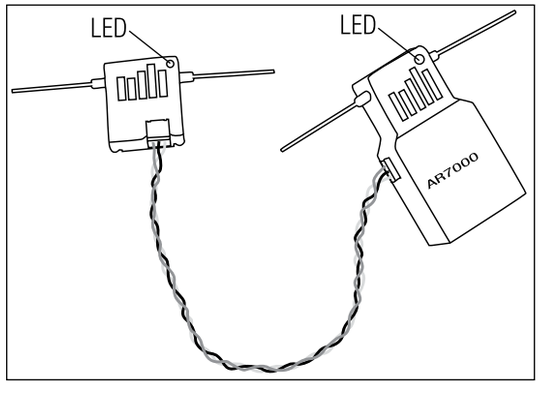
- Prevents unintentional electric motor response on start-up.
- Eliminates the possibility of overdriving servos on start-up.
- Establishes low-throttle failsafe if the RF signal is lost.
- Maintains last-commanded control surface position in the event of RF link interruption.

Note: Failsafe positions are stored via the stick and switch positions on the transmitter during binding.

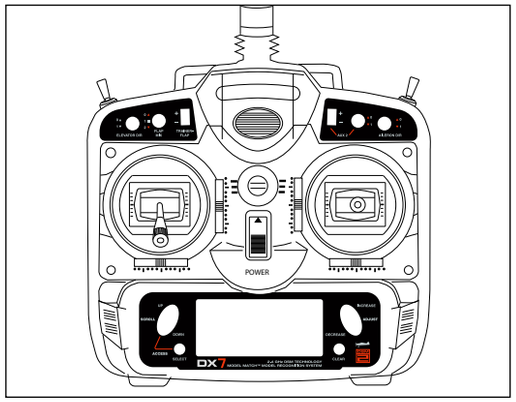
1. With the system hooked up as shown, insert the bind plug in the charge plug receptacle.



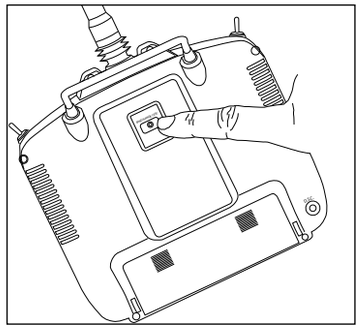
2. Turn on the receiver switch. Note that the LED's on both receivers should be flashing, indicating that the receiver is ready to bind.



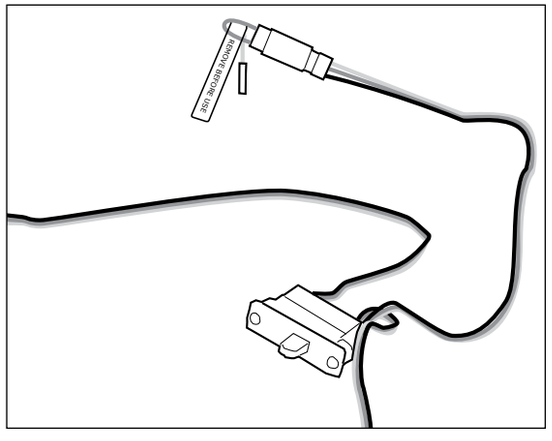
3. Establish the desired failsafe stick positions: normally low throttle and flight controls neutral.



4. Press and hold the bind button on the back of the transmitter while turning on the power switch. The bind button should flash and within a few seconds the system should connect. The LED's on the receivers should go solid indicating the system has connected.



5. Remove the bind plug from the receiver and store it in a convenient place.



6. After you've programmed your model, it's important to rebind the system so the true low throttle and neutral control surface positions are programmed.

Note: The AR7000 features DSM2 technology and is only compatible with DSM2 transmitters. The AR7000 will not operate with the DX6 or Spektrum surface systems.

Flight Log—Optional for AR7000 Receiver

The Flight Log is compatible with AR7000 receivers. The Flight Log displays overall RF link performance as well as the individual internal and external receiver link data. Additionally it displays receiver voltage.

Using the Flight Log

After a flight and before turning off the receiver or transmitter, plug the Flight Log into the Data port on the AR7000 receiver. The screen will automatically display voltage e.g., 6v2= 6.2 volts.

Note: When the voltage reaches 4.8 volts or less, the screen will flash indicating low voltage.

Press the button to display the following information:

A - Antenna fades on internal antenna A

B - Antenna fades on internal antenna B

L - Antenna fades on the left external antenna

R - Antenna fades on the right external antenna

F - Frame loss

H - Holds

Antenna fades—represents the loss of a bit of information on that specific antenna.

Typically it's normal to have as many as 50 to 100 antenna fades during a flight.

If any single antenna experiences over 500 fades in a single flight, the antenna should be repositioned in the aircraft to optimize the RF link.

Frame loss—represents simultaneous antenna fades on all attached receivers. If the RF link is performing optimally, frame losses per flight should be less than 20.

A hold occurs when 45 consecutive frame losses occur.

This takes about one second. If a hold occurs during a flight, it's important to reevaluate the system, moving the antennas to different locations and/or checking to be sure the transmitter and receivers are all working correctly.

Note: A servo extension can be used to allow the Flight Log to more conveniently be plugged in without having to remove the aircraft's hatch or canopy. On some models, the Flight Log can be plugged in, attached and left on the model using double-sided tape. This is common with helicopters, mounting the Flight Log conveniently to the side frame.