Xtreme Power Systems

X24

Integrated Flight Control System

Installation And Usage Manual

Supports: XtremeLink® RFU and Nano receivers
Futaba SBUS and SBUS2 receivers
Spektrum DSM2/DSMX satellite receivers
Spektrum SRXL
JR DMSS X-BUS receivers in Mode A or Mode B
JETI receivers in UDI or Ex-Bus modes
Graupner HoTT receivers in SUMD mode

Firmware v2.3

Manual v2.2

Revision Data: October 9, 2020

Warranty Information

The X24 IFCS carries a limited lifetime warranty. Units subject to improper installation, misuse, abuse (including reversed power), or unauthorized modifications will not be covered under this warranty.

Xtreme Power Systems, LLC. (XPS) may at its discretion either repair or replace the unit covered under warranty. The customer will pay all freight charges to and from XPS. You must purchase a REPAIR order from our online store and follow the instructions for returning the product. The REPAIR order cost will be only for shipping, the repair is free. However, if there is damage to the unit that is not covered under warranty we will contact you to discuss the repair cost. Any product returned without authorization will be refused/returned without repair.

Liability

You understand that by using this product, you agree to hold XPS free from any type of liability, either directly or indirectly.

Legal Information

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Introduction and Overview

Thank you for purchasing the X24 Integrated Flight Control System (know as just *X24* throughout this manual). This device uses up to four serial based receivers, and drives up to 24 servo outputs. The X24 monitors the input voltage and displays the past and current power conditions. Programming the input mode, channel mapping, failsafe mapping, failsafe time, failsafe override, BEC output, endpoints, centering, and many more features are all possible using the push button programming and OLED screen. It is possible to program all of the features and upgrade the X24 firmware using the XPS Serial Link USB device (sold separately).

Power to the X24 is provided through dual high current inputs. 16awg or larger gauge wires will handle up to 100A per side. Longer power wires can be used and the X24 circuit board has holes large enough to accommodate up to 12awg wire. The X24 operates from 2.1v to 16v, making it ideal for use with any power system. **WARNING!! THE INPUT VOLTAGE IS PASSED THROUGH TO ALL OF THE SERVO PORTS AND TO THE MAIN SERIAL RECEIVER PORTS! MAKE SURE YOUR SERVOS AND RECEIVERS ARE RATED TO HANDLE THE INPUT VOLTAGE THAT YOU POWER THE X24 WITH! THE TRUM SATELLITE RECEIVER PORTS ARE ALWAYS POWERED WITH 3.3 VOLTS NO MATTER WHAT THE INPUT VOLTAGE IS, SO THEY CAN BE POWERED DIRECTLY.**

Yes, this is a rather advanced product. Don't panic at first glance! The X24 is capable of very complex programming, but it's user interface is laid out so it is easy to understand and follow. Our support forum on RCGroups is a good resource to ask questions and see if you need help.

Installation Requirements

The installation of the X24 is simple! Solder connectors to the main power inputs to match the batteries you will use. Attach one or more serial based receivers using a proper cabling (JR female to female cable for standard receivers, or PH to PH for Spektrum satellite receivers). Now, connect power to one or both of the high current power inputs and you are ready to go!

It is recommended that you mount the X24 on top of something that will help dampen vibration if you are installing it in a gas powered model. Electric or turbine powered models don't cause enough vibration to ever be a concern. The X24 ships with a foam mounting pad, which are also available separately from XPS.

SECTION 1 – X24 INFORMATION

Basic Details

This product requires the use of receivers that output a serial data stream. If your receiver does not have a serial data stream output, it will not work with this product! Currently, the following serial protocols are supported:

XPS Xtreme
Spektrum DSM2 and DSMX (*satellite receivers only*)
Futaba SBUS and SBUS2
JR DMSS Mode A and Mode B
JETI UDI and Ex-Bus (*UDI12 and UDI16 are recognized automatically*)
Graupner HoTT SUMD
Multiplex SRXL
Spektrum SRXL

The X24 consists of a high speed microcontroller with voltage monitoring capabilities, three push button switches, one external LED output, one multi-colored internal LED (known as just *LED* throughout this manual), an OLED screen, four serial receiver inputs, four Spektrum satellite receiver compatible inputs, two main power inputs, two switch inputs, one match power input, and 24 servo outputs (two of which are powered by the BEC power). The LED is a "RGB" type, allowing for virtually any color to be displayed. Different colors and flashes are used to indicate various status conditions.

Receiver Inputs

There are four main receiver inputs and four Spektrum compatible receiver inputs. The main receiver inputs pass the input voltage directly to the receiver(s). You will need to make sure that any receiver you are using can handle the input voltage! Some older receivers can be destroyed. The Spektrum compatible inputs pass 3.3v to each receiver, which is required for all Spektrum and compatible satellite receivers.

BEC

The BEC voltage is programmable as either 5v or 6v, and appears on both the D2 and E2 outputs at the same time. This voltage can be used to drive anything requiring current up to 3A. Some example uses are ignition boxes for gas engines, LED lighting, or servos that can not handle more than 5v.

External LED

The external LED output will drive a LED with a forward voltage of 3.3v at up to 10mA (and higher current at a lower forward voltage). LEDs that have a resistor already inside of them (for 12v applications) will not work. XPS offers a variety of LED colors that are specifically made for the X24. The LED output is connected to the state of the BEC output. When the BEC is enabled, the LED is on. When the BEC is off, the LED is off. The only exception is when there is a system error of some kind in which case the LED will flash to indicate there is a problem that needs to be checked.

Internal LED

The internal LED shows the current status of the system while operating. The LED colors have various meanings:

Pulsating red: no signal detected from receiver(s)
Green: connected with good voltage
Yellow: connected with voltage below the Minimum Voltage warning
Purple: connected with severe voltage problem (below 3.5v)
Blue: in the menu system
Solid red: in failsafe due to loss of RF link

The brightness of the internal LED can be set using the LED Options menu, found in the System Menu.

Push Buttons

The X24 has three push buttons used for programming and changing modes. The left most button is the ENTER button in all menus, and also acts as a RESET for some display functions. The middle button is the DECREMENT (DEC) button used to go backwards or reduce a value in a menu option.
The right most button is the INCREMENT (INC) button used to go forwards or increase the value in a menu option.

OLED

The X24 has an Organic LED (OLED) screen, which is a high contrast and bright display. Using this screen along with the three push buttons gives you the ability to program all of the X24 options.
The OLED screen can be removed from the X24 and remotely located if desired. A re-location kit (available from XPS) is necessary to do this.

External Switches

There are two inputs for switches, one on each side of the X24. This was done for wiring installation convenience. You only need one of the two inputs in order to control the power off/on for the X24. A switch should be a single contact type, such as a simple momentary push button, slide, or pin & flag type switch. A switch only needs to handle low current (1mA). The X24 is never actually turned off, instead it is put into a super low power sleep mode where a 2300mAh supply would last for well over ½ a year before being fully drained. When you are not using the X24 for extended periods of time, you should disconnect the main power inputs from the batteries.

Match Power

If you purchased the version of the X24 that has current matching, then the Match Power input will be used to provide power during the current match programming. Normally, this input is never used for anything other than the current matching, however, it can be used as a fully isolated backup power supply to the main power inputs. Power at this input makes the X24 permanently on, meaning that the switch that controls the power off/on will have no affect when trying to turn off the X24. A separate switch on this input would be necessary in order to retain the off/on functionality using switches. The maximum current input on this port is 5A, which would be shared across all 24 servo outputs. There is a deliberate .25v drop when powering from this port. **During normal use do NOT solely power your model from this port, or any servo port! Primary power MUST come from one or both of the main power inputs!**

Power Inputs

Each of the main power inputs are capable of handling up to 100A of current. The power inputs are not electrically isolated from each other, however, they are isolated individually from the servo bus through large power MOSFETS. When using dual batteries, there will be an equal drain from both batteries. Keep in mind that the batteries are connected in parallel once connected to the X24, so you must be using batteries that have the same capacity and voltage.

Note: shorting one set of main power inputs while the other set is connected to a battery can damage the X24. Both sets of power inputs should be used. If not, then fully insulate the unused set to prevent possible shorting.

Servo Outputs

22 of the 24 output ports will provide the main input voltage to the servos. The remaining two output ports (D2 and E2) provide the BEC voltage. **MAKE SURE YOUR SERVOS CAN HANDLE YOUR INPUT VOLTAGE!**

The servo outputs occur virtually simultaneously to eliminate latency that commonly occurs in systems that output servos in groups of two or four at a time. The center and end points for every output port can be adjusted (matched) individually.

Note the X24's labels showing the plug polarity for JR connectors. The shape of the plug outline indicates the direction. The negative lead is **always** towards the bottom of the X24. Futaba connectors are keyed and can only plug in one direction. See Figure 1 for details on X24's inputs and outputs.

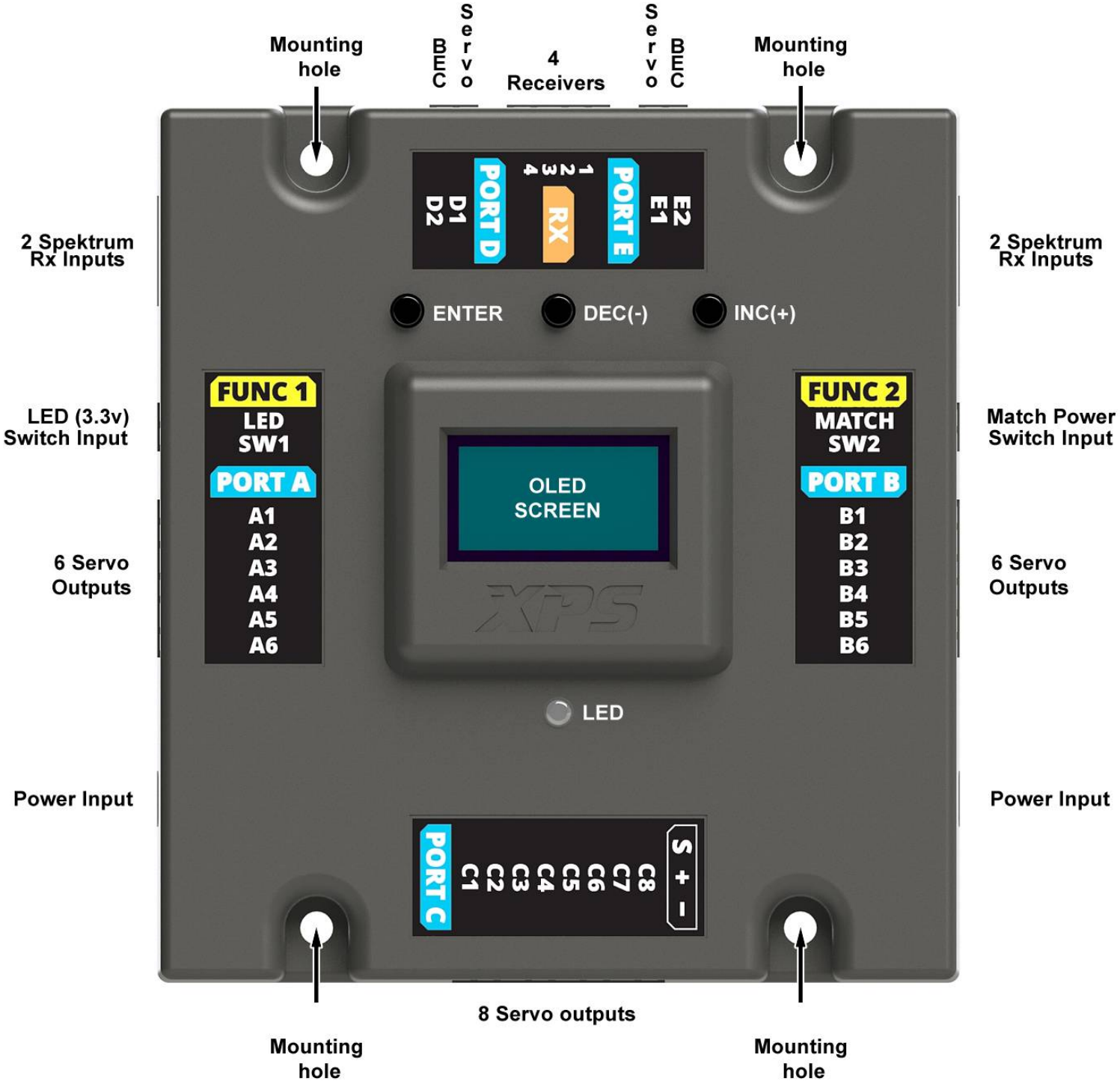


Figure 1 – X24 details

SECTION 2 – INSTALLATION

Powering the X24

Power being applied to the X24 is passed to the servos and to the receiver(s). MAKE SURE that your servos and receiver(s) can handle the input voltage! If you intend to power the X24 with a 2S Lipo setup, make sure that the receiver is a 'HV' type. Most older receivers have a maximum input voltage of 6 volts. Please consult the information included with your receiver to check its maximum input voltage. All XPS receivers have a maximum input voltage of 16v-25v, depending on the model. Likewise, there are many types of servos that can not handle more than a 5 volt input voltage, so please check to make sure your servos will work with the input voltage you intend to use! **DON'T EXPERIMENT!** What appears to work initially could fail if you are exceeding the manufacturer's specifications!

Connect one or two batteries to the X24's main power inputs. If you connect only a single battery to one input, then you must make sure that the other power input wires are fully insulated from shorting.

When using dual battery configurations make sure that the batteries are the same type, voltage, and capacity. Dual batteries are electrically connected in parallel, so they will even out in voltage after being connected together over a period of time.

As soon as power is connected to the X24, it is 'on'. The only way to turn it 'off' (sleep mode) is by using a switch that is plugged into one of the switch inputs, or through the menu system. You will need to program the X24 for the type of switch you are using. The default is a slide switch on FUNC 1.

The X24 can be ordered with either 16awg or 14awg wires. 16awg wire works fine for 100A when wiring (X24 wires and battery wires) is kept under 12” of total length. If the total length is greater than 12”, then you should consider using larger power wires for the battery pack and/or X24. If you need to extend the power wires from the X24 it is recommended that you replace the wires at the X24 itself instead of soldering on extra lengths of wire. You can replace the wires in the X24 by removing the 8 screws from the case, de-soldering the original wires, and soldering the new power wires.

NOTE! WHEN SOLDERING WIRES FOR POWER, PAY CLOSE ATTENTION TO THE POLARITY! REVERSING POLARITY CAN NOT ONLY DAMAGE THE X24, IT CAN DESTROY RECEIVERS AND SERVOS!

Mounting the X24

There are four holes provided in the X24 board for screws or bolts. The mounting holes will accommodate #6 size (and smaller) threads. It is recommended that you use shouldered bolts or screws when possible, and dampening washers (rubber backed type) to help reduce vibration. It is also recommended that you mount the X24 on a rubber or foam pad. If using self tapping screws, put a drop of CA in each pre-drilled screw hole to stiffen the wood.

Wiring the X24

The X24 requires a serial data stream for it's information. This can be supplied from any compatible receiver. With exception of the Spektrum satellite receivers, the connection between receivers and the X24 requires a JR (or Futaba) female to female type cable. This is different from a standard servo extension that has a male and female connector at opposite ends. Spektrum satellite receivers require a special JST-PH to JST-PH cable.

Plug one end of the female to female cable into one of the X24's Rx Ports. Note the polarity of the connection. Reversing the connection may damage the X24 and/or receiver. Plug the other end of the female to female cable into the receiver's serial data port (see the receiver manufacturer's documentation for details on where this port is located). Note that by default, Rx port 1 is the only port enabled. You will need to enable all ports that you have receivers connected to and you must disable all ports where no receivers are connected.

For Spektrum satellite receivers, connect the proper cable between the X24 and the receivers. Refer to Figure 1 - top/right is Rx port 1, bottom/right is Rx port 2, top/left is Rx port 4, and bottom/left is Rx port 3.

Plug your servos into the X24. Note the polarity of the servos. Like all connections to the X24, the negative (-) lead will be nearest to the bottom of the X24. Note: any type of servo can be used with the X24. SBUS servos are not required, even though you might be using a SBUS receiver.

Since you have the ability to assign any output port to be any channel, simplify your wiring by using connections that are as close as possible to the nearest servo output port. The X24 was designed so that the top (with receiver ports) should face towards the front of your aircraft. This gives you Ports A and B for the wing surfaces, Port C for the tail surfaces, and Ports D and E for the throttle control and ignition.

Channel Mapping is the assignment of a channel to an output port. This means that output port 'x' will output channel 'y' data.

By default, the channel mapping is set for JR type systems:

(Left/right ailerons)

PORT A1 – channel 2	PORT B1 – channel 6
PORT A2 – channel 2	PORT B2 – channel 6
PORT A3 – channel 2	PORT B3 – channel 6
PORT A4 – channel 2	PORT B4 – channel 6
PORT A5 – channel 2	PORT B5 – channel 6
PORT A6 – channel 2	PORT B6 – channel 6

(elevator/rudder)

PORT C1 – channel 3
PORT C2 – channel 3
PORT C3 – channel 4
PORT C4 – channel 4
PORT C5 – channel 4
PORT C6 – channel 4
PORT C7 – channel 3
PORT C8 – channel 3

(Throttle/ignition kill)

PORT D1 – channel 1
PORT D2 – channel 5
PORT E1 – channel 1
PORT E2 – channel 5

You can of course change the channel mapping for all output ports.

If you have a Futaba system it is recommended that you go to the SYSTEM MENU, select RESET DEFAULTS and choose the default for the Futaba system. This will change the channel mapping so that channels 1-4 will be mapped to the proper output ports for the Futaba system (matching the JR outputs in functionality).

If you have a JETI system it is recommended that you go to the SYSTEM MENU, select RESET DEFAULTS and choose the default for the JETI system. This will change the channel mapping for JETI's 1:1 mapping.

SECTION 3 – USAGE

General Information

Plug power into the X24. The OLED will turn on and display information about your setup. It doesn't matter what position your switch(es) are in, the X24 will power on when power is connected! A slide switch or pin & flag switch may have to be toggled to be in the proper state if left in the "off" position while power is applied.

The top line will show the current input mode selected for the serial based receivers. Below that will be the average input voltage, updated in real time. The number of receiver ports enabled is shown on the lower left, and below that will be the number of lost frames. The connection indicator is shown on the lower right, and below that is the BEC status. See Figure 2 below for details.

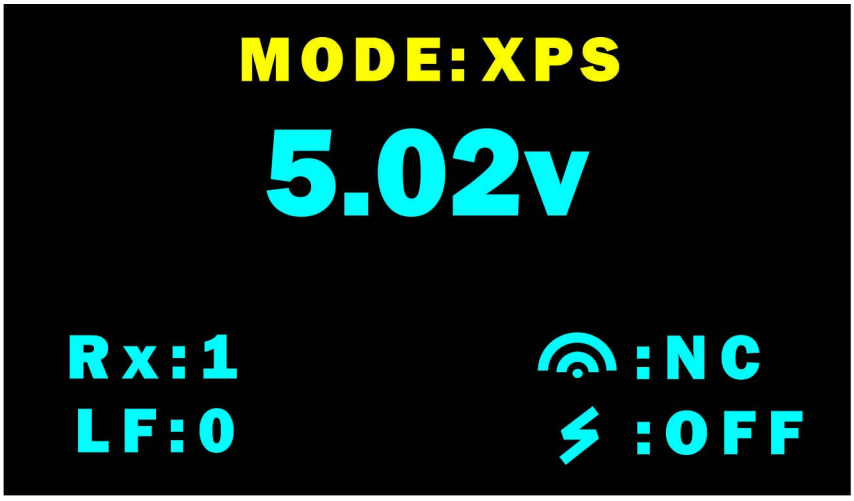


Figure 2 – Main display screen

At this point pressing the INC (middle) or DEC (right) buttons will cycle through the various information displays that are available. When your transmitter is not on, and no receiver is connected, only the live active voltage display and main display screens are available.

The LED (located below the display screen) will be pulsing red when no receivers are connected.

When you turn on your transmitter and your receiver(s) connect, the main screen will be updated and new display screens will be available. The LED will also turn green, providing the input voltage is higher than the Minimum Voltage warning setting.

While on the main display screen, briefly pressing the ENTER (left) button will reset the LF (lost frames) counter to 0. The LF value increments every time a frame is lost. A failsafe occurs when NONE of the receivers acquired a valid packet of serial data during the programmed failsafe timeout period.

Voltage Information

While are at the main display screen, press the INC button to change to the Voltage Info screen. See Figure 3 for details.

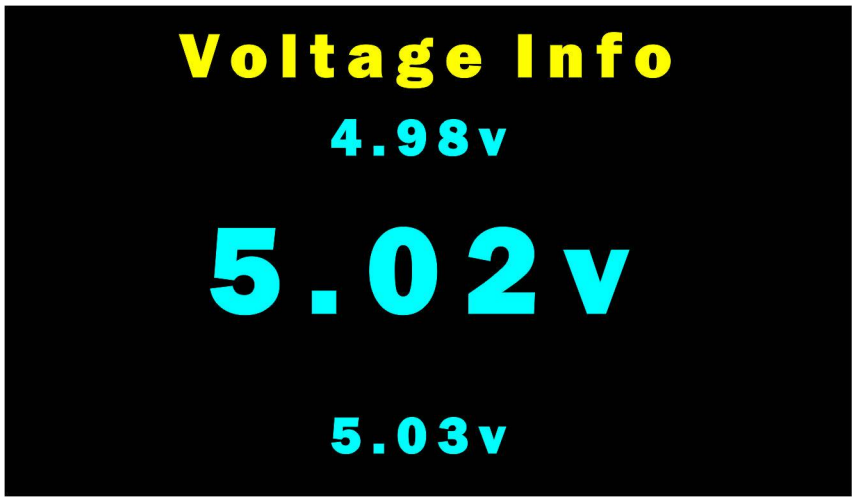


Figure 3 – Voltage Info display screen

The top voltage displayed is the minimum voltage that the X24 has seen since powered up (or reset). The middle voltage displayed is the actual voltage in real time. The bottom voltage displayed is the maximum voltage seen since powered up (or reset). Briefly pressing the ENTER button will reset the minimum and maximum values.

Unlike the main display screen that is averaged 10 times per second, the middle voltage value is not averaged. Instead, that voltage is updated 1000 times per second giving you a true real time voltage display, exposing every dip. When you move servos, this voltage will change dramatically!

After your flight, you can look at the minimum and maximum values to see what changes occurred while you were flying.

Note: The Minimum Voltage warning detection looks at the averaged voltage value, not the absolute minimum real time voltage.

SECTION 4 – PROGRAMMING OPTIONS

NOTE: IF YOUR X24 APPEARS TO BE "MISSING" FEATURES DESCRIBED IN THIS MANUAL, PLEASE UPDATE YOUR X24's FIRMWARE!

To enter the programming mode, press and hold the ENTER button (for approximately 3 seconds) until the Main Menu screen appears.

The Menu System

The menu system is very simple. You use the DEC and INC buttons to move up and down the menu list, and the ENTER button to select the menu option.

When a menu item can have a value changed, briefly pressing the ENTER button will cause the highlighting to toggle between the menu item name and the menu item value. When the menu item name is highlighted, pressing the DEC and INC buttons will scroll down and up the list of menu items. When a menu item value is highlighted, pressing the DEC and INC buttons will decrease/increase the value or change the selection of that menu item.

Pressing and holding the INC or DEC buttons while a menu item value is highlighted will enable automatic repeat of the INC or DEC function if that option allows it (not all options have automatic repeat). Pressing and holding the INC and DEC buttons at the same time for 3 seconds will reset the value to it's default value.

At the top/left of the display screen is the "exit" (go back) symbol. Pressing the ENTER button when this symbol is highlighted will go backwards one level in the menu system. See Figures 4 and 5 for details.

At the top/right of the display screen is the menu list status. If there are more entries than what can be displayed on the screen at the same time, then an arrow will appear. A down arrow indicates that there are more entries in the list that can be displayed by moving downwards (INC) in the list. When there is both an up arrow and down arrow shown, it means that there are more entries available to be displayed in each direction (DEC or INC).

An up arrow indicates that there are more entries in the list that can be displayed by moving upwards (DEC) in the list. See Figures 6, 7, and 8 for details. The arrows referred to are highlighted with a red circle.

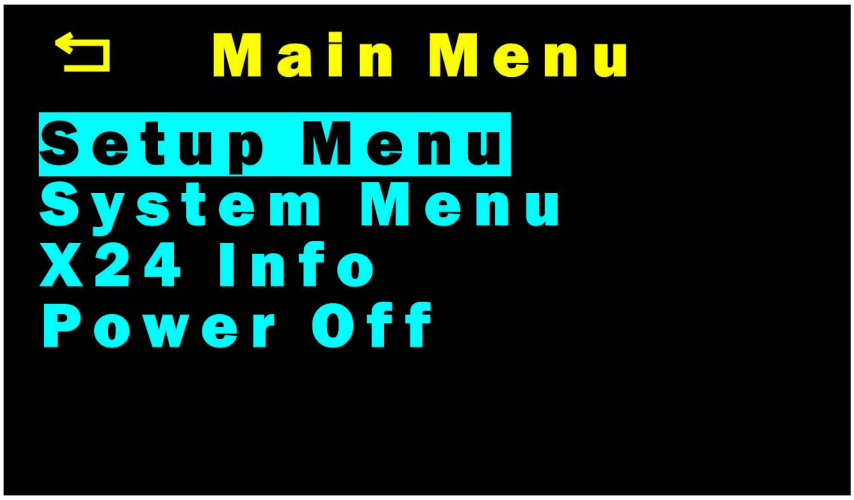


Figure 4 – Main Menu

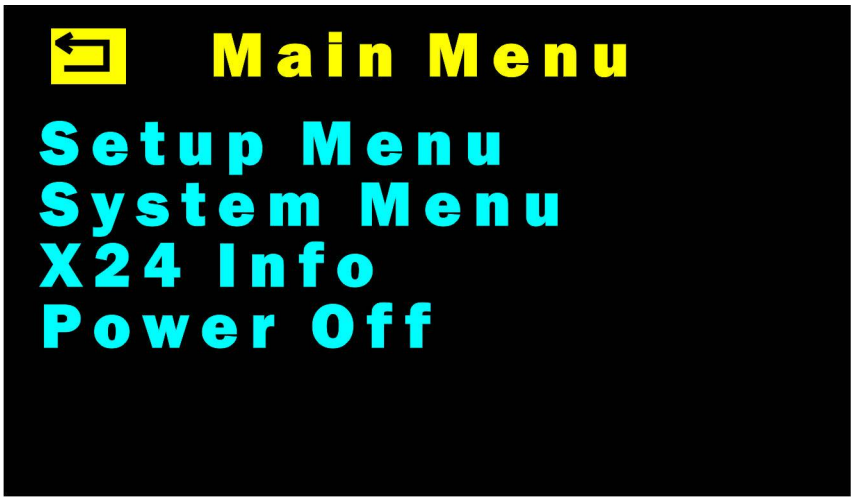


Figure 5 – Main Menu w/exit highlighted

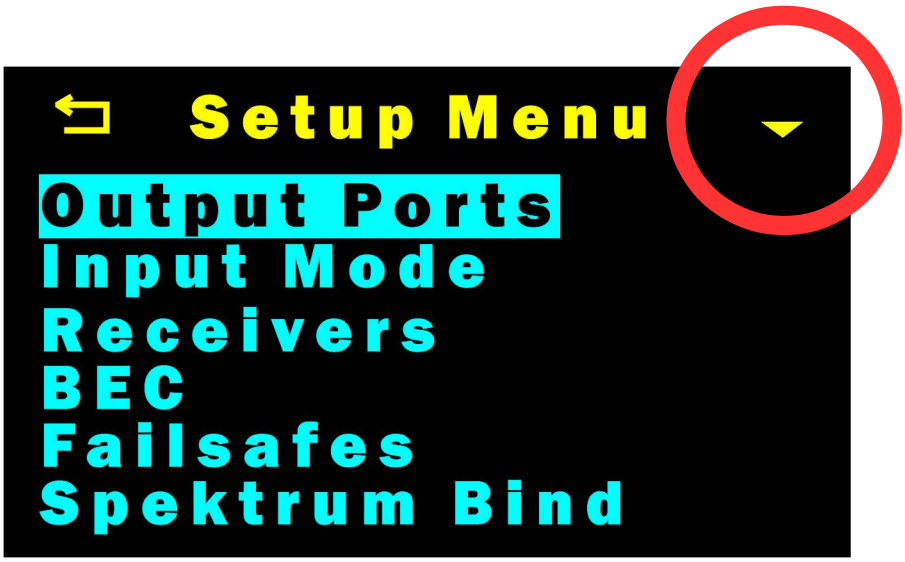


Figure 6 – Down arrow - more entries available downwards

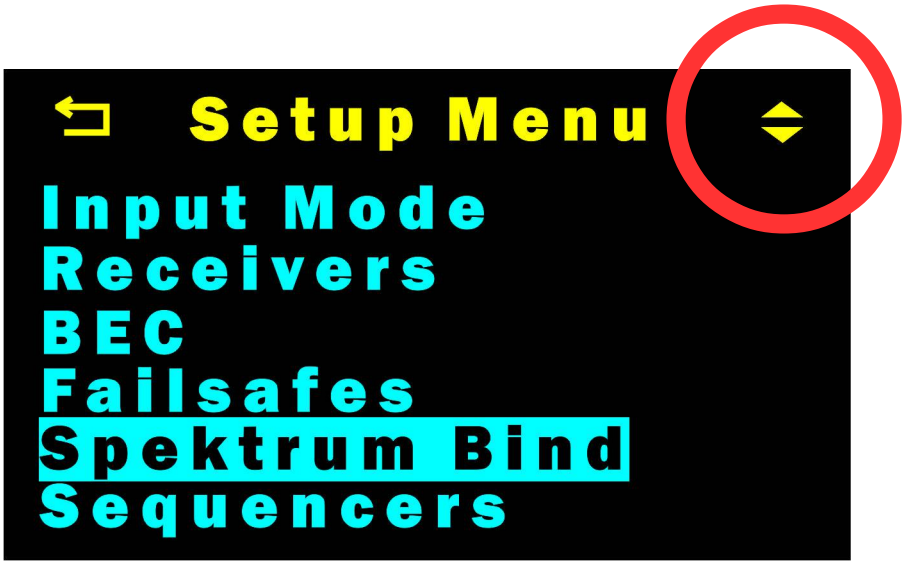


Figure 7 – Up/Down arrow - more entries are available both directions

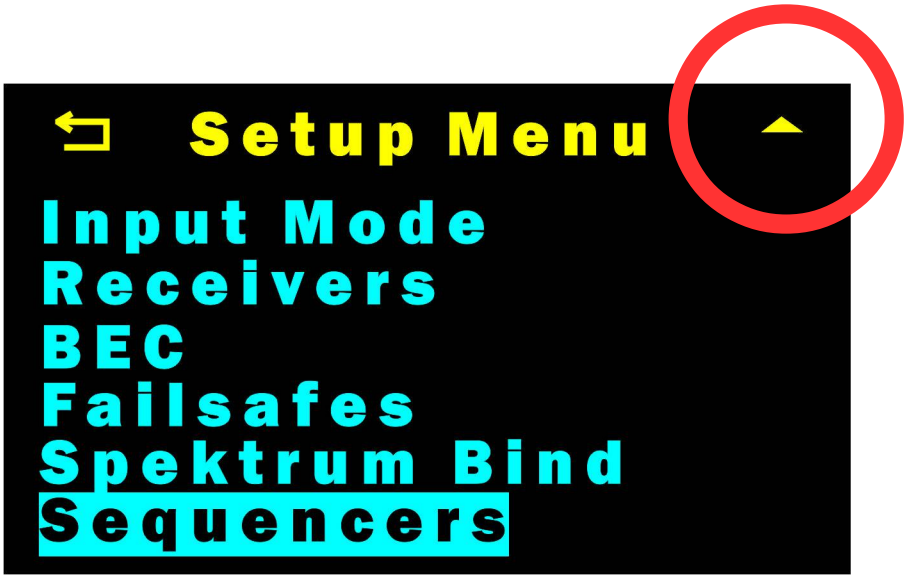


Figure 8 – Up arrow - more entries available upwards

MENU - Main Menu has four options:

Setup Menu will take you to the menus associated with setting up the various functions.

System Menu will take you to the menus associated with setting up system specific options that affect a specific X24 feature.

X24 Info will give you information about the X24 hardware options and installed firmware.

Power Off will power down the X24. Press the ENTER button or change the position of an external switch (SW1 or SW2) to turn the X24 back on.

MENU - Setup Menu

The Setup Menu is for setting up the various options pertaining to the output ports, receivers, and BEC. The following is a description of each of the Setup Menu options:

Output Ports – this menu selects which channel appears on each output port, along with the servo matching functions (direction, center and end points) and type of servo.

Input Mode – this menu selects the serial bus receiver protocol and failsafe functionality.

Receivers – this menu selects which receiver ports are enabled or disabled.

BEC – this menu selects the channel, trigger point, voltage, and failsafe operation for the BEC output.

Failsafes – this menu selects the failsafe type for each output port, as well as the failsafe delay time, and enabling the live active failsafe.

Spektrum Bind – this menu selects the type of Spektrum binding protocol to use (satellite receivers only), and initiates the binding.

Sequencers – this menu selects the sequencer trigger channel, positions, speed, and delays.

AutoMatch™ – this menu sets up the automatic current matching.

<u>Setup Menu</u> - Output Ports

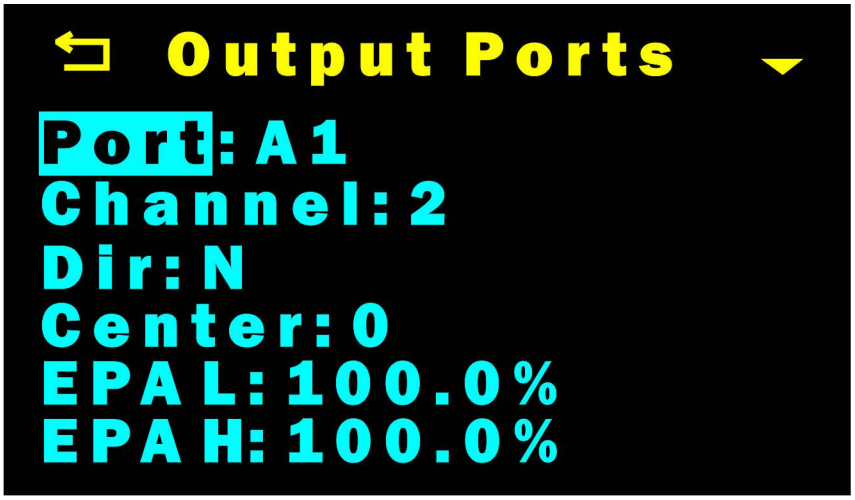


Figure 9 – Output Ports menu

The Output Ports menu has several options that let you setup output ports.

Port – the output port number that is being changed
Channel – channel number for output port
Dir – direction of servo (Normal or Reverse) for output port
Center – offset (+/-) of servo's center position for output port
EPA L – end point low for output port
EPA H – end point high for output port
Servo – type of servo being used (Digital or Analog) for output port

When you change the Port value, ALL of the menu items below the Port menu item will change to reflect the value of the currently selected Port number. Port numbers A1-A6, B1-B6, C1-C8, D1-D2, and E1-E2 can be selected, and all settings for these ports can be changed.

The values being changed are done in real time. If you have your transmitter on and the receiver(s) are connected, changes to these items will be seen as you change them. For example, if you change the center position you can watch the center position of the servo change in real time. Because of this capability you can make changes to the direction, center, and end points to match servos together on the same surface (like other dedicated matching devices can).

Care should be taken when switching the Channel number for a port. It is possible that some channel positions can greatly over-extend the expected amount of throw and damage the servo, linkage, or surface!

The EPA L and EPA H settings allow you to change the end points for the high and low positions (each end of the servo's travel). When you have either EPA L or EPA H selected, and the transmitter is on and the receiver(s) are connected, then changes to the stick position will automatically select the proper EPA L or EPA H setting for you. Changing the end point values is how you can manually match surfaces together.

The Servo setting allows you to set the Servo type to be either Digital or Analog. The difference is the frame rate passed to the servo. If you are using a fast frame rate radio (under 20ms), most analog servos will have a problem processing the fast update (frame) rate, and this can lead to servo failure, sometimes immediately! To eliminate this problem, set the Servo type to be Analog. This will double the time between servo updates, and eliminates the problem completely. If you are using a digital servo on the selected output port you will want to set the Servo type to be digital so that the latency is reduced.

<u>Setup Menu</u> – Input Mode

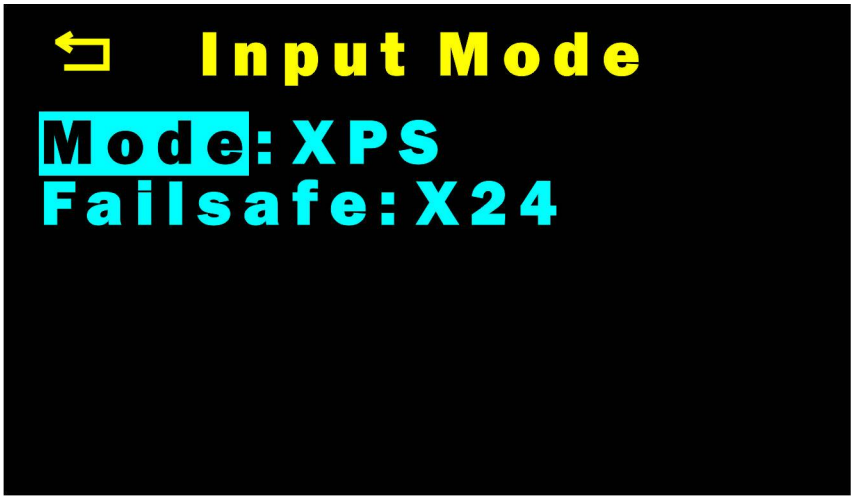


Figure 10 – Input Mode menu

The Input Mode menu has two options that let you setup the serial receiver protocol:

Mode – the protocol to use for the receiver inputs
Failsafe – what handles the failsafe condition

Using the Mode menu item you can select the protocol that your receivers use for their serial communications. Please consult the manufacturer's information on how to setup your receiver to output a serial protocol.

The Failesafe menu item allows you to change how the failsafes are handled when one occurs. By default, the X24 handles all failsafes itself. It is possible that some receivers can provide failsafe data and that could be used instead. If you need to have the receiver(s) control the failsafe output, set the Failsafe to "Rx". Unless you have a seriously good reason to let your receiver control your failsafe, don't! The X24 has a much better idea of what is going on between multiple receivers than any single receiver has!

NOTE: All radio systems except JETI use a fixed frame rate. The X24 requires that you set the frame rate of your JETI system in UDI mode to 14ms. No other frame rate will work.

<u>Setup Menu</u> – Rx Ports

Figure 11 – Rx Ports menu

The Rx Ports menu lets you enable (turn On) or disable (turn Off) each of the four serial ports. Turn on any Port you want to connect a receiver to and turn off any Port that is not being used.

<u>Setup Menu</u> – **BEC Output**

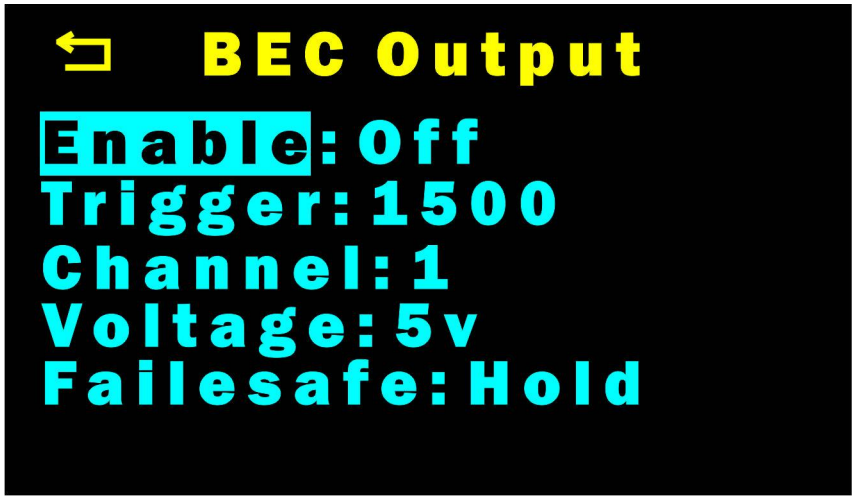


Figure 12 – BEC Output menu

The BEC Output menu has several options that let you setup the BEC output.

Enable – setting what turns on and off the BEC output
Trigger – the channel threshold value to turn on and off the BEC
Channel – the channel to use for the threshold value
Voltage – the output voltage
Failsafe – what the BEC output is set to when a failsafe occurs

There are four possible options for enabling the BEC. You can select **Off, On**, **-->**, or **<--**. Selecting --> means to turn on the BEC when the trigger threshold is greater than the value set in Trigger. So, if the Trigger value was 1500, then a servo channel value of 1501 or higher would turn on the BEC, and 1499 or lower would turn off the BEC. Selecting <-- means to turn on the BEC when the trigger threshold is lower than the value set in Trigger.

The Trigger value is the servo pulse value used to determine when to turn On or Off the BEC when --> or <-- is used.

The BEC's output voltage can be set to either 5v or 6v. Note that the input voltage must be at least .25v higher than the programmed BEC voltage to achieve the programmed value. The maximum current output for the BEC is 3A total. The BEC voltage is available (shared) on output ports D2 and E2.

The failsafe option determines what happens to the BEC output when there is a failsafe condition. Options are Hold, Off, and On.

Hold keeps the BEC output at the state before the failsafe occurred. Off turns off the BEC, and On turns on the BEC.

The LED output will turn on when the BEC is enabled and turn off when the BEC is disabled. The LED can be a visual indicator for when the BEC is on which is handy when using the BEC to drive a gas engine ignition. Note that during a system error condition (low voltage or failsafe occurred), the LED will flash to indicate a problem has occurred. The state of the BEC does not affect the LED when a system error condition is detected.

<u>Setup Menu</u> – **Failsafes**

Figure 13 – Failsafes menu

You can program what happens to every output port when a failsafe condition occurs.

Port – the port number to program
Type – how the failsafe is handled
Position – the servo pulse position to move to during a failsafe
Delay – amount of time losing the RF connection before a failsafe occurs
Live Set: Start – used to invoke the Live Active Failsafe programming

Changing the Port number will show the current failsafe settings for that port, and allow you to then change those settings.

There are three failsafe types that are possible. **Hold** means that during a failsafe condition the current output value will not change. **User** means that the when a failsafe occurs, the output port value will be set to the value show in Position. **Off** means that the servo output for that port is turned completely off. This is required for some auto-pilots in order to think there was a loss of signal.

Delay is the amount of time (in 1/10ths of a second resolution) that must go by without a RF signal before invoking the failsafe system.

Live Set: Start, this is a special option that starts the Live Active Failsafe feature.

If you press the DEC or INC button when **Start** is highlighted you will have 10 seconds to move your transmitter sticks and switches to the position you want them to be during a failsafe condition.
Only ports set to a failsafe type of User will be affected. Once the display shows "Locked", the settings are permanently saved.

<u>Setup Menu</u> – Spektrum Bind

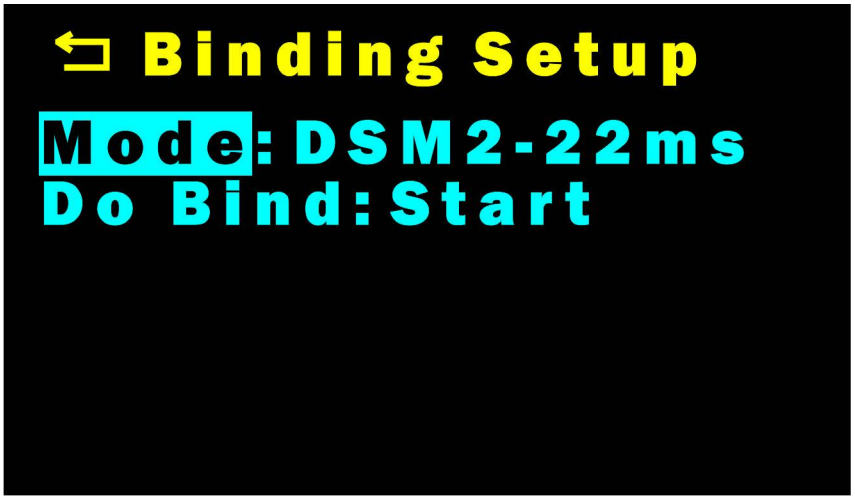


Figure 14 – Binding Setup menu

Spektrum (and compatible) satellite receivers need to be bound to the transmitter. Normally, this is done when connecting satellite receivers to the main receiver. Since the satellite receivers are connected to the X24 directly (and not a Spektrum receiver), a way to bind them is necessary. Before you do any binding, make sure that the Input Mode is set to Spektrum!

Mode – the protocol used when binding
Do Bind: Start – used to invoke binding

There are four different possible protocols supported for the binding:

DMS2 – 22ms
DSM2 – 11ms
DSMX – 22ms
DSMX – 11ms

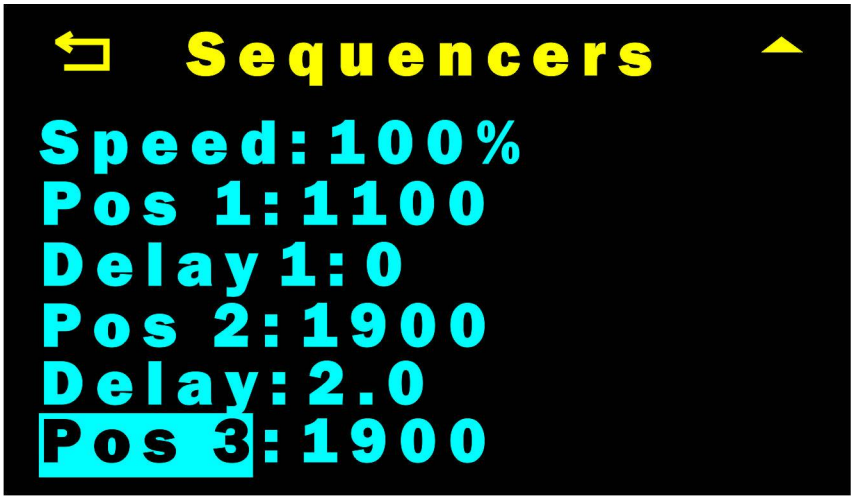
Consult your Spektrum manual to determine what protocols your transmitter and receiver can support.

Do Bind: Start is a special option that starts the binding. Pressing the DEC or INC buttons while **Start** is highlighted will enable the binding for all receivers connected to the Spektrum receiver ports.

Follow the instructions in your Spektrum transmitter manual for putting the transmitter into binding mode. Once the binding has completed, the system will be immediately ready for use.

NOTE: ALWAYS TRY USING DSMX-11ms for binding first. This setting may be required to get ALL of the channel from your transmitter!

<u>Setup Menu</u> – Sequencers



Figures 15 & 16 – Sequencer menu

There are 16 individual event sequencers that can be enabled. The sequencer setup is the most complex operation that you can perform with the X24. However, this is a very powerful feature that allows you to perform a series of servo movements controlled by using just a single channel input.

Each sequencer has 5 stages and 3 positions. The sequencer can be used for things such as gear door sequencing, scale motion (pilot turning head, waving arms, etc.), multiple release mechanisms, folding wings w/locks, canopy slider, etc. A common example use is a split gear door setup where a door will open, delay for a period of time, and then close.

There are 11 different settings available for programming.

Seq # - the sequencer number
Enabled – whether the sequencer is enabled or not
Channel – the channel used for triggering the sequencer
Trigger > - the trigger threshold of the channel to change the trigger state
Port – the output port to use for the sequencer
Speed – how fast to move the servo
Pos 1 – starting position of the servo
Delay 1 – delay before moving to next position
Pos 2 – second position of the servo
Delay 2 – delay before moving to next position
Pos 3 – ending position of the servo

Changing the Seq # (sequencer number) will change all of the items below it, showing you the current settings for that sequencer number.

Enabled can either be N (no) or Y (yes).

The Channel number is the channel used to activate the sequencer.

Trigger is the threshold value (channel position value) to use for determining the direction of the sequence. When the channel value is lower than the Trigger value, the sequence is moving from stage 5 to stage 1 (position 3 to position 1). When the channel value is higher than the Trigger value, the sequence is moving from stage 1 to stage 5 (position 1 to position 3).

Port is the output port used for the sequence. If the sequencer is enabled, then this port is controlled by the sequencer, and any other programming associated with that port is ignored.

Speed is the how fast the transition from one position to another occurs. With the speed set to 100% there is no delay in transitions.
With the speed set to 1%, moving from one position to another where the difference between positions was 1000us, would takes 10 seconds (a difference of 500us would take 5 seconds). Reducing the speed can give a more scale like appearance to things like gear doors.

A sequence occurs stage by stage in each direction until the sequence is finished. A sequence can be reversed in the middle at any time but could be delayed as necessary to keep the sequence in sync.

Because there are multiple positions and delays, the sequence moving forwards and backwards are slightly different.

Forwards: Position 1 -> Delay 1 -> Position 2 -> Delay 2 -> Position 3
Backwards: Position 3 -> Delay 1 -> Position 2 -> Delay 1 -> Position 1

Notice that the backwards direction has the delays swapped. This is done so that the sequencing stays proper for the 3 positions.

The value shown in the positions is the physical servo position in microseconds (us). This value can be anything within the limits of the servo (the Limits Menu can change the available range). 1500us is typically center.

The Delay times are in 1/10ths of a second resolution, and will pause the sequence for that time before continuing to the next stage.

Using the above example settings (see Figures 15 and 16), the sequence of event would go like this:

When channel 9's value on power up is less than (<) 1500us, then the sequence is at Stage 1, and output port A4's value is 1100us.

When channel 9's value changes to a value that is greater than (>) the Trigger position (1500us), then the sequence starts moving from Stage 1 to stage 5.

The first thing that happens is Stage 2 (Delay 1), which in this case is 0 (no delay), the next stage occurs.

Now, Stage 3 occurs and the servo position on output port A4 will change from Pos 1 (1100us) to Pos 2 (1900us).

Now, Stage 4 (Delay 2) occurs, which in this case is 2.0 seconds. So, there is a 2 second delay before the next (and final) stage occurs.

The last step in the sequence is Stage 5, which moves the servo position from Pos 2 (1900us) to Pos 3 (1900us). Since the servo is already at 1900us, no additional servo movement occurs.

Since there are always 5 stages, and 3 positions, if you only need 2 positions, make the 2nd and 3rd positions identical.

Note: the output port assigned to a sequencer does NOT change the position of a servo during a failsafe condition! When a failsafe occurs, the sequencers are frozen <u>after</u> completing the sequence, if a sequence was occurring prior to the failsafe condition.

<u>Setup Menu</u> – AutoMatch™

The X24 uses a high precision current sensor that is only enabled when powering the X24 from the Match Power input (see Figure 1 for details). When using the AutoMatch™ feature, all batteries MUST be unplugged from the X24! Only power plugged into the Match Power port can be used! During the AutoMatch™ process, your transmitter and receiver must be on and the X24 operational (you can move servos with your sticks). Any signal loss will immediately terminate the AutoMatch™ process!

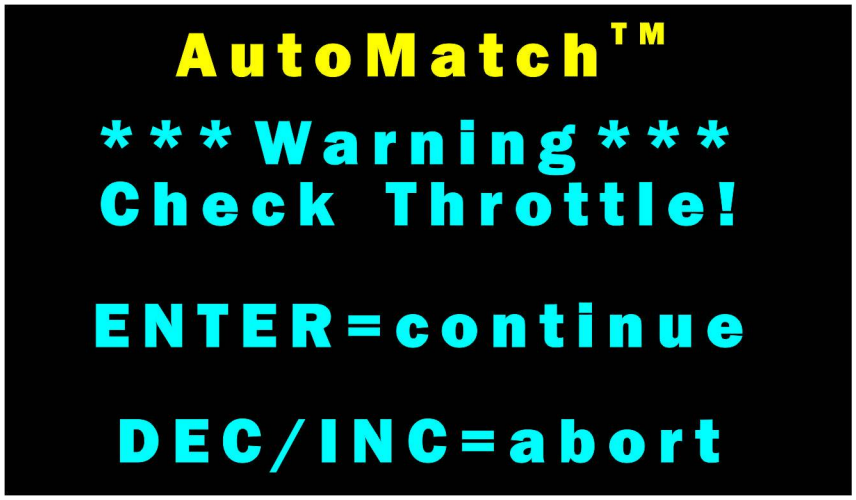


Figure 17 – AutoMatch™ Warning

The AutoMatch™ system gives you the ability to automatically current match up to 12 pairs of master and slave servos. During the AutoMatch™ procedure servos will be turned on and off as needed. If a servo you are using has a failsafe feature built-in, it MUST be disabled in order to use the AutoMatch™ feature. You should always disable servo failsafes anyways because failsafe control is one of the features that the X24 provides.

When you select the AutoMatch™ menu you will be presented with a warning screen to check your throttle. The AutoMatch™ system will shut off ALL servos once you have pressed the ENTER button.

*****WARNING*** Systems that are using an Electronic Speed Controller (ESC) with an electric motor, could turn ON when there is a loss of signal.**

This is not normally the case, however, you must be fully aware that this is a possibility. It is recommended that you either disconnect the throttle channel, or carefully determine what happens when there is no signal present to the ESC before proceeding! Typically, an ESC failsafe will lock out a motor from turning on, but it's better to be safe than to risk an accident!

Figure 18 – Select Group menu

NOTE: SET THE CHANNEL NUMBER ON ALL OUTPUT PORTS THAT YOU INTEND TO USE AS SLAVES TO "OFF". ONLY THE MASTER SERVO SHOULD BE CONTROLLING A SURFACE BEFORE DOING THE AUTOMATCH™ PROCESS. ALL SLAVE SERVOS MUST BE OFF.

The AutoMatch™ function allows matching up to three slave servos per master in a single operation. The AutoMatch™ setup defines which servo is to be the "Master" and which servo is to be used as a "Slave". Servo Groups are used to define the pairs of master and slave servos. You can have more than one slave servo matched to the same master servo by setting up an additional group and just selecting the same master. So, you could have all 12 groups set to use the same master servo controlling up to 12 slave servos. Each group is setup and matched individually.

IMPORTANT NOTICE! If your servos have a failsafe programmed into them, the failsafe must be turned OFF for the AutoMatch™ to work. "Failsafe OFF" means that the when the receiver signal is lost to the servo (but power is still present), the servo can freely move – there is no holding force at all. Most Hitec digital servos do NOT have a failsafe that operates this way - instead, during a signal loss the servo moves to 1500us and retains the normal holding force. This will interfere with the setup of the automated setup. These servos can still be used, but will require some extra effort plugging in and unplugging servos as needed.

If your servos can not be turned OFF with a loss of signal you will have to unplug ALL servos before doing the AutoMatch™, and only plug in the servos as outlined below:

When you enter the AutoMatch™ mode all servos must be unplugged.

After selecting the Setup Master option, plug in just the master servo, make all of your adjustments, unplug the master servo, and then exit the Setup Master option.

After selecting the Setup Slave, plug in just the slave servo, make all of your adjustments, unplug the slave servo, and then exit the Setup Slave option.

After selecting Start AutoMatch, plug in just the master servo, and setup the end points. Setup the master's center position by not moving the sticks. At this point, plug in the slave servo, and press the ENTER button to actually start the AutoMatch™ process.

When the AutoMatch™ is done, unplug the slave servo and exit the menu system (LED will be green). You can then plug in the slave servo.

If your servos do shut off (can freely move) when there is no PWM pulse, then you can simply follow the on-screen instructions to setup and start the AutoMatch™ without having to unplug any of the servos.

Select a Group number to use. There is no requirement for using any particular Group number, but it's recommended that you start with Group 1 and work your way down as needed.

Figure 19 – Group Setup menu

The Group Setup has the following options:

Setup Master – defining the master servo and its settings
Setup Slave – setting up the slave servo
Start AutoMatch – starts the AutoMatch™ process

Selecting the Setup Master option will let you define all of the same parameters found in normal Output Port setup (described above). The menus and functions are the exact same, so any changes here will also affect the Output Port setup as well. While setting up the master, only the servo defined by the Port can be moved using your transmitter. All other servos are disabled while setting up the master servo.

Selecting the Setup Slave option will let you define the port that the slave will use, the direction of the servo travel, and the center offset, and if the slave servo is enabled or not.

Always setup your master servo first!

When you select Start AutoMatch, the matching process begins.

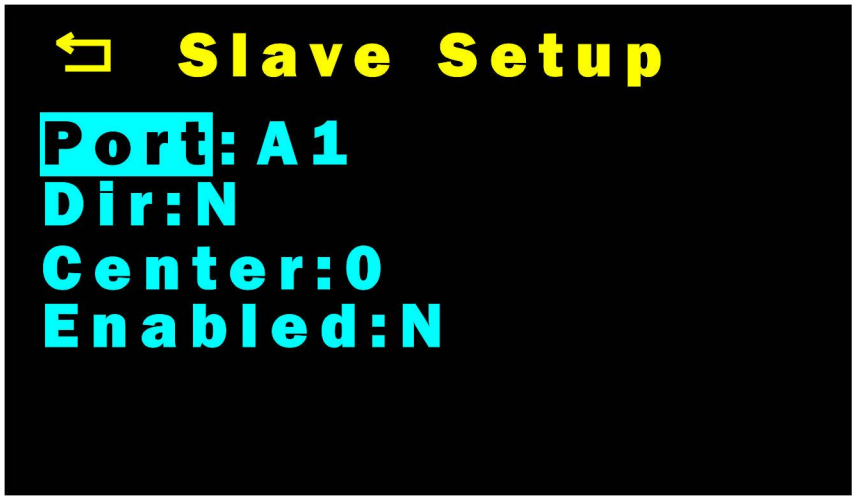


Figure 20 - Slave Setup menu

The Port item lets you choose which output port the slave servo is assigned to. You can not select the same port that is selected for the master controlling it. If you do, the slave servo will not move! While setting up a slave, only the servo defined by Port can be moved using your transmitter.

If the direction of travel for the slave NEEDS to be backwards from the master, you can change that by selecting the Dir item and toggling between N (normal) and R (reverse) modes. When setting up the slave, it MUST travel the same direction that the master does when moving your stick.

You use the Center item to set the center offset of the slave servo to be as close as possible to the where the master servo's neutral position is. It does not have to be perfect. This is used just as a reference for the start of the current matching. Make sure that your transmitter's stick position is centered while adjusting the center offset!

To enable a slave servo, you must set the Enabled option to Y. Otherwise the slave is disabled. Once an AutoMatch™ has been completed, this can be used to enable/disable the servo for diagnosing servo problems.

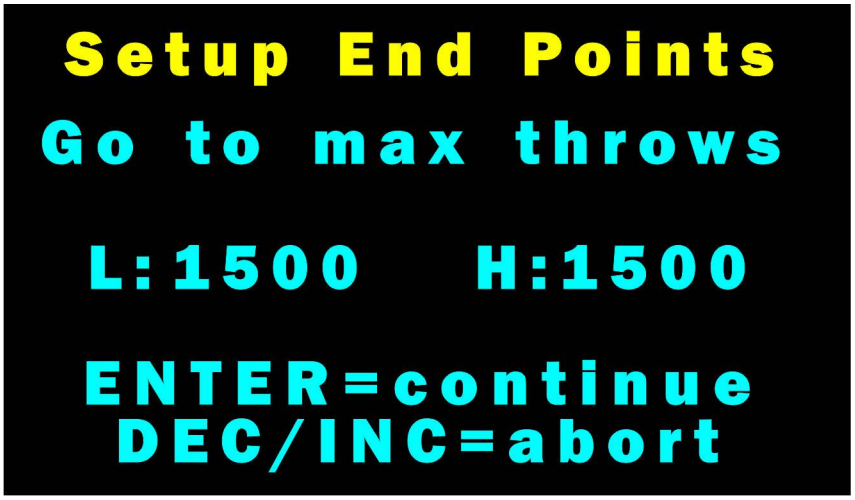


Figure 21 – AutoMatch™ – Setup End Points

When you select Start AutoMatch™ you will see the screen shown in Figure 21. You need to define the maximum throws for the master servo. Only the master servo will move while this screen is shown. Make sure you move your stick to the absolute maximum in each direction. The channel values for Low and High will be shown. This information is not needed, and is only provided as a reference. Once you are satisfied with the input range, press the ENTER button.

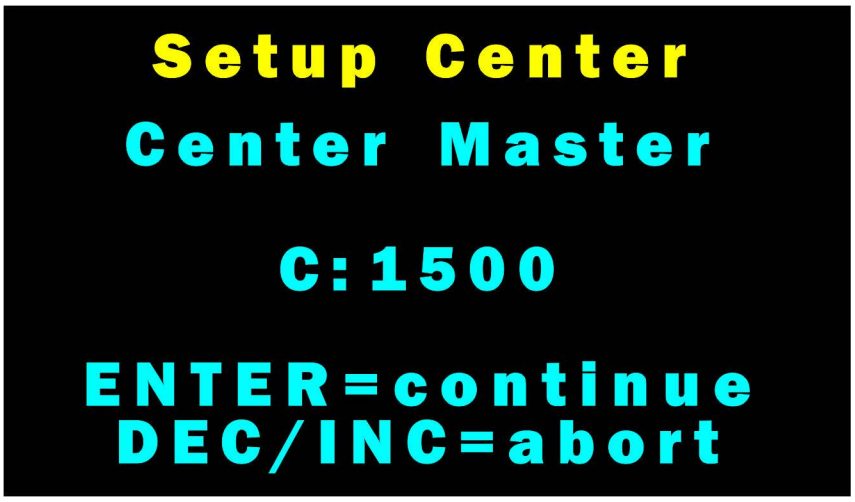


Figure 22 – AutoMatch™ – Set Center

After setting the end points, the next step is to center the master servo. To do this, just make sure you are not moving the sticks. The center value is shown as a reference. Press the ENTER button to start the auto matching of the servos!

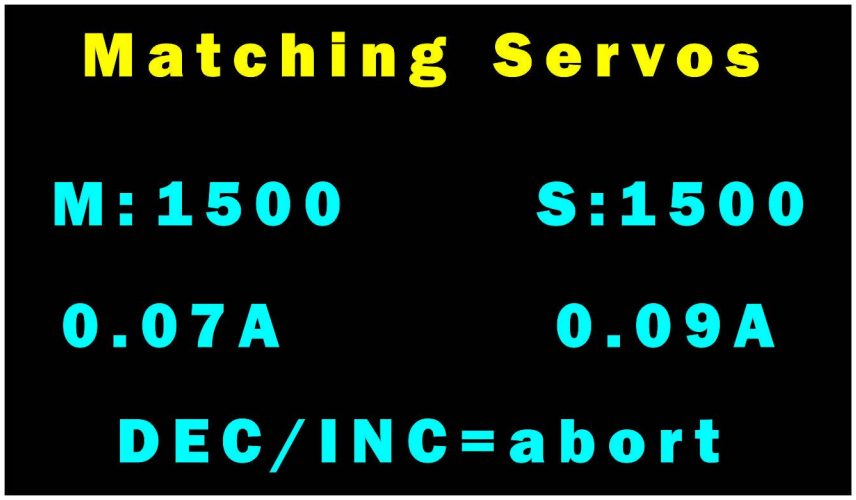
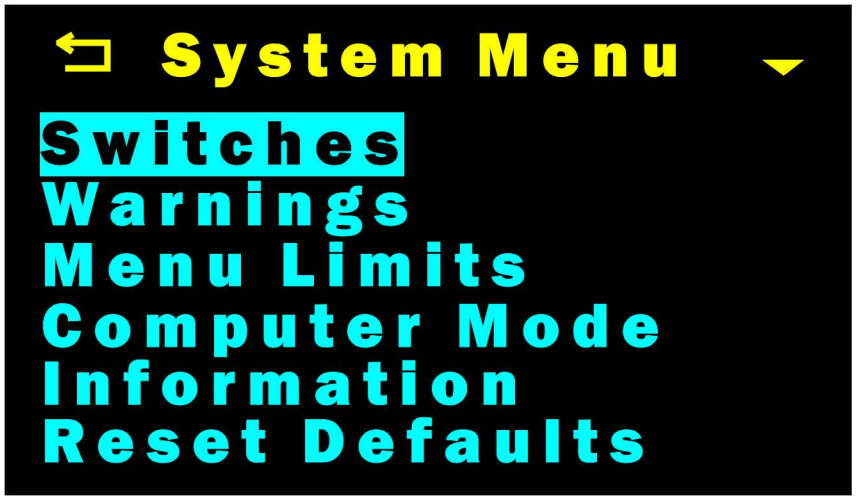


Figure 23 – AutoMatch™ Active

While the AutoMatch™ is occurring the master and slave servo positions as well as current will be shown as a reference. The matching process will take quite some time as the system builds up to a 1536 point match curve. During the AutoMatch™, do not apply any pressure to the surfaces being matched! Doing so will interfere with the matching process, and give you inaccurate results. For the best results it is recommended that you place all surfaces vertically when performing the AutoMatch™.

If you abort the matching, it must be started over from the beginning for that Group. Once the AutoMatch™ is complete, you can proceed to the next Group and continue matching until you are finished.

MENU - System Menu



The System Menu is for setting up the various options pertaining to system functions. The following is a description of each of the System Menu options:

Switches – this menu selects which switch(es) are used to control the power of the of the X24. The type of switch and how the switch works is also programmable.

Warnings – this menu selects warnings and how they are handled.

Menu Limits – this menu selects the minimum and maximum limits that are used for all of the various Setup menus.

Computer Mode – this menu enters the computer programming mode using the Serial Link (sold separately).

Information – this menu shows information about the hardware options and firmware.

Reset Defaults – this menu allows you to reset all of the X24 settings to the factory defaults.

Diagnostics – this menu shows the X24 diagnostics page.

<u>System Menu</u> - Switches

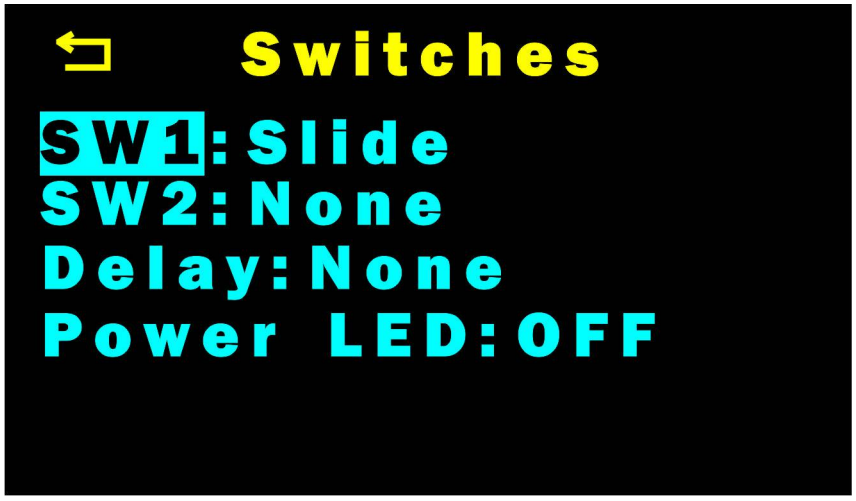


Figure 24 – Switches menu

The Switches menu has several options that let you define how a switch or two switches are used. Either switch input can be used, but only one switch at a time is acted upon. Having two different inputs is more for a convenience of wiring, not for having back ups of switches. The X24 switch inputs are for turning OFF the X24, and so they are wired so that an open circuit means that the X24 is actually on. The X24 does not use the center positive (+) wire of the port connection for switches. Only the signal and ground connections are used. See Figure 25 for details. Although there is no polarity requirement for switches, it's good practice to make the negative (-) lead black.

SW1 – switch 1 input port, located on FUNC1 port
SW2 – switch 2 input port, located on FUNC2 port
Delay – the length of time any switch must be in its off state to turn off the X24
Power LED – option to leave the LED on, or turn it off when the X24 is powered off.

There are 3 different types of switches support: Slide, Button, and Pin & Flag.

The slide switch (normally open) can be used with the X24. However, there are two distinct differences from normal R/C slide switch assembly and any slide switch used with the X24. First, with a R/C slide switch assembly the wiring typically passes through the switch assembly so each end has connectors - an input (from a battery) to an output (to your receiver). The

X24 needs a SPST type slide switch. You will likely need to re-wire your switch for use with the X24. Secondly, the switch function is backwards from traditional operation. In the closed (typically "on") position, the X24 turns off. In the open position (typically "off"), the X24 turns on.

You will need to reverse the ON/OFF name plate to have accurate labeling of a slide switch's functionality.

A momentary SPST (normally open) push button switch can be used with the X24. Pressing and holding the button will turn the X24 off and on.

A Pin & Flag SPST (normally open) switch assembly can be used with the X24. Inserting the pin will turn the X24 off, and removing the pin will turn the X24 on.

The delay value is number of seconds that a switch must be "off" before the X24 actually powers off.

Once the X24 is OFF, pressing the ENTER button or changing the position of an external switch (SW1 or SW2) will turn the X24 back on. Remember, the X24 is not actually "off" - it is in a deep sleep mode and **battery power should be disconnected from the X24 when your aircraft is being stored**.

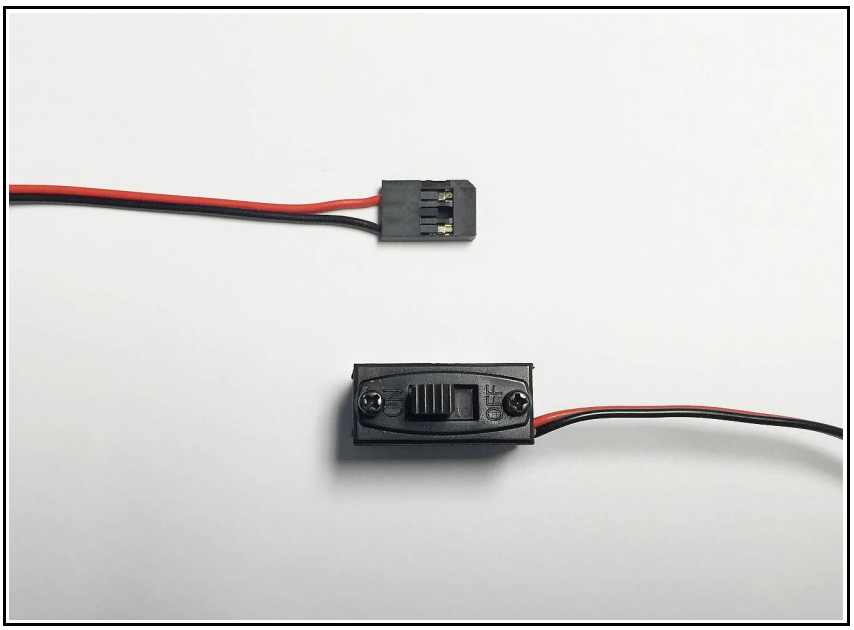


Figure 25 – Switch wiring

<u>System Menu</u> - Warnings

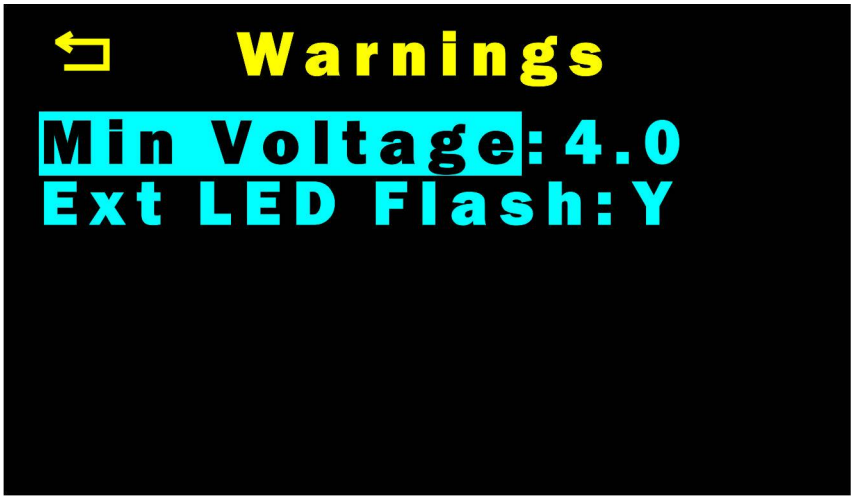


Figure 26 – Warnings menu

The Warnings menu has the option to change the voltage level trigger and set the LED and OLED screen Brightness.

Min Voltage – the minimum voltage that causes the LED to change colors.

Ext LED Flash – whether a warning causes the external LED to flash.

The LED is normally green when the voltage is above the Min Voltage threshold. When the input voltage drops below this voltage, the LED will change to yellow. If the input voltage drops below 3.5v the LED will change to purple. The LED will remain this color (when not in a menu system) until the voltage is reset in the Voltage Info screen (see Page 3, Voltage Information).

By default, the external LED output will flash when there is a situation that results in a warning. The warning flashing takes priority over the BEC status. A warning is generated for any of the following reasons:

Min Voltage threshold reached
Voltage dropped below 3.5v
Failsafe condition occurred

If after flying your aircraft you see the external LED flashing, you should look at the information screen to see if a low voltage condition or failsafe occurred. If the voltage was good, then the flashing is due to a failsafe that occurred during flight. You can check the number of lost frames.

<u>System Menu</u> – Brightness

Figure 27 – Brightness Options menu

The Brightness menu currently has two options, one for changing the brightness of the internal LED, and another to change the brightness of the OLED screen.

Display – brightness level of the OLED screen. Range is from 1 to 10, with 10 being the brightest. Default is 8.

Int. LED – brightness level of the internal LED. Range is from 1 to 10, with 10 being the brightest. Default is 3.

The internal LED can be very bright, especially indoors so the level can be changed to suit your liking.

<u>System Menu</u> – **Menu Limits**

Figure 28 – Menu Limits

The Limits menu has lets you control the minimum and maximum ranges used throughout the Setup Menu.

EPA Min – minimum for EPA
EPA Max – maximum for EPA
Ctr Min – minimum value for center offset
Ctr Max – maximum value for center offset
Out Min – minimum value for output port
Out Max – maximum value for output port

Only make changes to these values if you know what you are doing!

<u>System Menu</u> – **Computer Mode**

Selecting this mode goes to the computer programming mode. The Serial Link (sold separately) is a USB interface that connects the X24 through the MATCH port (FUNC 2). The Serial Link powers the X24 in this mode.

You MUST power off the X24 to get out of the computer programming mode!

WARNING! ALL POWER (BATTERIES) MUST BE DISCONNECTED FROM THE X24 WHEN USING THE SERIAL LINK, OR THE SERIAL LINK AND/OR YOUR PC CAN BE DESTROYED!

<u>System Menu</u> – Reset Defaults

Figure 29 – Reset Type menu

The Reset Defaults menu has lets you reset all of the X24's setting to the factory defaults. You can select the type of radio system you are using to specify the channel mapping.

JR radio systems have the following channel mapping:

Channel 1 = throttle
Channel 2 = aileron
Channel 3 = elevator
Channel 4 = rudder
Channels 5+ = various

Futaba radio systems have the following channel mapping:

Channel 1 = aileron
Channel 2 = elevator
Channel 3 = throttle
Channel 4 = rudder
Channels 5+ = various

JETI radio systems have a 1:1 map based on the transmitter.

Choose the mapping that matches your type of radio system by pressing the ENTER button when either selection is highlighted. **Note that the Input Mode and Receiver Ports options are not changed during a reset!**

<u>System Menu</u> – Diagnostics

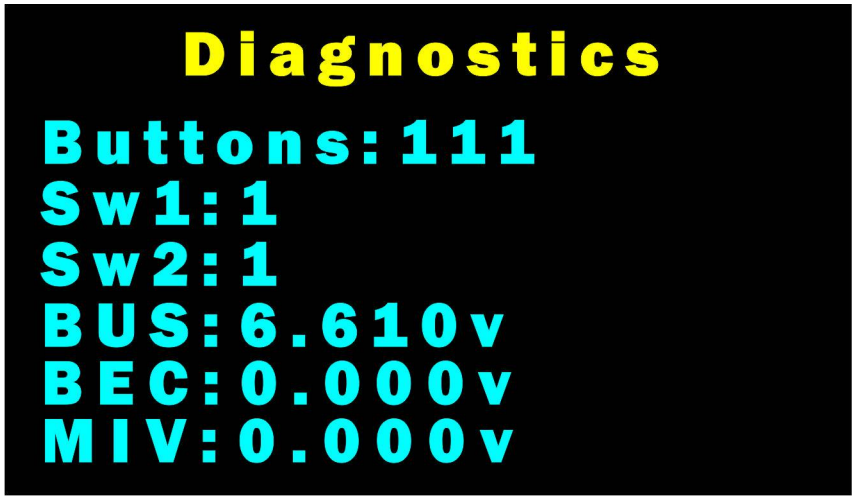


Figure 30 – Diagnostics Display

The Diagnostics screen shows the real time information about the X24's various input and output voltages, the state of the push buttons, and the state of the external switch inputs.

By default, all buttons and external switch states should show as "1" (high level), which is "open". Pressing any button should change its state to a "0" (low level), which is "closed".

The voltage levels shown are:

BUS – the voltage of the servo bus. This comes from the battery input(s).
BEC – the BEC output voltage (when the BEC is enabled).
MIV – the Match input voltage. This is power on the Match input, typically used when doing the AutoMatch.

To exit the Diagnostics menu, press and HOLD the ENTER key until the System Menu is displayed.

<u>Main Menu</u> – Info

Selecting this menu item will give you information about the X24 hardware options and installed firmware.

<u>Main Menu</u> – Power Off

Selecting this option will power off the X24. This really puts the X24 into a deep sleep mode. Pressing the ENTER button or moving the position of any external switch will turn the X24 back on.

You can not power off the X24 if there is any input power from the match power input!

SECTION 5 – HINTS AND TIPS

Basic Setup

It is recommended that you install the X24 on the C/G of your aircraft if possible. This typically allows for connections to ailerons, flaps, landing gear, etc. straight out each side of the X24. PORTC should face towards the tail of your aircraft, allowing the elevator and rudder connections going straight back. PORTD and PORTE can handle your ignition, throttle, smoke, etc. Using this type of setup allows for the cleanest installation, and uses the shortest wire routing for the servos.

Mounting

The X24 can be mounted with either #4 or #6 size screws or bolts. You can use #4 size screws commonly used for mounting servos along with #4 size bounded rubber washers. These will help with vibration. If vibration is not a real concern, then #6 size servo mounting screws can be used. Optionally, brass grommets used with servos can be used to take up extra space of the screw body. Use a foam mounting pad in high vibration applications, like gas engines. XPS offers foam mounting pads.

Refer to Figure 31 for exact hole mounting locations. If you print this page in 100% scale, you can use this template for drilling the mounting holes. You can also use this template for making a foam or rubber pad by cutting the template out, placing it over a foam or rubber pad, tracing the edges, and then cutting out the shape of the pad.

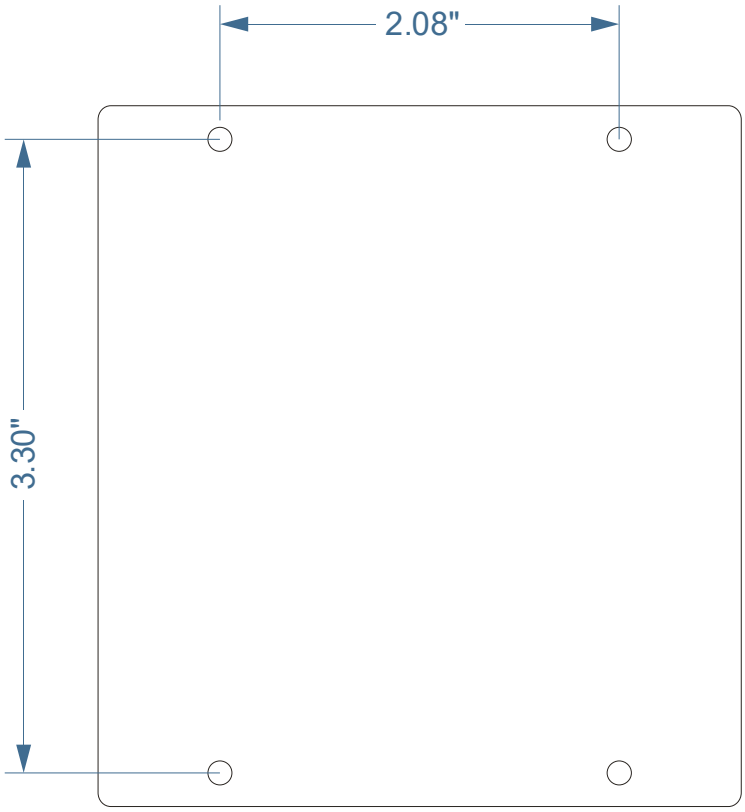


Figure 31 – X24 Mounting/pad template

SECTION 6 – GENERAL SERVO INFORMATION

Servos - PWM

Servos operate using a Pulse Width Modulated (PWM) signal. This signal is measured in microseconds, typically labeled as "µs".

Sometime between 1950 and 1970 (nobody seems to know the exact date) a couple of the radio control system manufacturers got together and came up with the PWM protocol and what it means. The original specification allowed for a servo pulse between 750µs and 2250µs to represent a rotational position of a servo. In reality, the range was limited to between 1000µs and 2000µs. It was decided at some point that officially 100% throws would be 1100µs to 1900µs, with 1500µs being dead center.

So, when you change your end point adjustments (EPA) or travel throw limits (TTL) – all depending on the radio system you use – the percentage you are adding is based on 100% being a 400µs difference from center. So, at 125% throws the servo could move 125% of 400, which is 500. So, 125% throws are 1000µs to 2000µs. 150% of 400 is 600. So 150% throws are 900µs to 2100µs. Center is always 1500µs except for Futaba, which typically uses 1520µs. Multiplex systems have a mode where center is 1400µs.

The X24 can increase your throws well beyond what a servo will handle, especially if you have your transmitter's end points at 150% already. So be careful when changing end points with the X24 unless your transmitter's end points are all set to 100%.

Servos – Frame rate

Servos require that the PWM pulse be "refreshed" at some interval. In the history of R/C this refresh has been around every 22ms (about 44.45 times per second). So, for example every 22ms the PWM pulse of 1500µs is output to make a servo go to center.

There is a limitation of how fast the refresh rate can be. Analog servos are typically limited to a max of about 15ms refreshes. Any faster and the amplifier circuit never reduces its current draw and the servo can burn up.

The faster the frame rate, the less latency the system will have.

Servos – Analog vs. Digital

Analog servos require a PWM pulse that occurs within a window of allowable refresh range. Every time an analog servo receives the PWM pulse, the servo driver increases the drive power to the servo motor for a few milliseconds, and then a ramps down the power. Without the PWM refresh the driver never outputs current to the motor and the servo's holding force goes away completely.

A digital servo updates the motor driver independently from the frame rate. Some servos, such as those used for tail rotors in helicopters update the motor driver every 3ms (333 times per second), even though the frame rate may only be 22ms. Most digital servos can handle frames rates as fast as 5ms.