Anyleaf ExpressLRS receiver datasheet

General Description

The AnyLeaf single and dual radio ExpressLRS (ELRS) receivers are 2.4GHz radio receivers intended for use on small hobby-grade remotely-piloted vehicles. Suitable uses include on quadcopters, fixed-wing aircraft, boats, and wheeled or tracked vehicles. When paired with an ELRS transmitter, they provide a control link between the pilot and aircraft: Transmitters send control channel data (eg commanded pitch, roll, yaw and throttle settings) to receivers. Receivers process this data, and pass it to flight controllers (FC) over UART lines using the CRSF protocol. They transmit telemetry data back to the transmitter. In addition to control channel data, ELRS receivers pass link statistics to their flight controllers, which includes data about signal strength.

Both AnyLeaf receiver types run firmware provided by the ExpressLRS team. They both include power amplifiers (PA), and low-noise amplifiers (LNA), and use Semtech SX1280 or SX1281 LoRa radios. Both receivers connect to 2 antennas. (Diversity).

The receivers differ as follows: The dual-radio receiver includes 2 independent radio and PA/LNA circuits, while the single-radio receiver includes a single circuit, with an antenna multiplexer at the final stage. Additionally, the dual-radio receiver uses a color status LED capable of displaying status through color changes, while the single-radio receiver uses a monochrome red LED that displays status through blink pattern.

The dual radio receiver may provide a more robust radio link in some cases, and is compatible with ELRS Gemini transmitters.

This datasheet includes a mix of information generic to ExpressLRS, and specific to these receivers. The official ExpressLRS documentation is available at this website: **https://www.expresslrs.org/3.0/quick-start/getting-started/**

Single radio Rx Specifications

- **Dimensions:** 37 × 37 × 6 (height) mm (31 × 31 mm with breakaways sections removed)
- **Weight (without antenna):** 4 grams
- **Mounting holes:** 30.5mm × 30.5mm pattern: M3 (4mm diameter, with 3mm grommets). 20mm × 20mm pattern: M2 (3.2mm diameter, with 2mm grommets)
- **Power input:** 3.3V – 7V
- **Operating frequency:** 2.4GHz
- **MCU:** ESP8285
- **Radio Receiver:** Semtech SX1280 or SX1281, with DC-DC power

- **Low-noise Amplifier / Power Amplifier:** Skyworks SE2431L
- **Power Amplifier amplification:** +24 dBm
- **Radio timing source:** 52MHz crystal oscillator
- **Update capabilities:** WiFi, Betaflight Passthrough, UART
- **Pin header to flight controller:** JST GH, 1.5mm pitch, 4 pins
- **Antenna connector:** 2 × IPEX MHF-1
- **Status LED:** Red monochrome

Dual radio Rx Specifications

- **Dimensions:** 37 × 37 × 6 (height) mm (31 × 31 mm with breakaways sections removed)
- **Weight (without antenna):** 4 grams
- **Mounting holes:** 30.5mm × 30.5mm pattern: M3 (4mm diameter, with 3mm grommets). 20mm × 20mm pattern: M2 (3.2mm diameter, with 2mm grommets)
- **Power input:** 3.3V – 7V
- **Operating frequency:** 2.4GHz
- **MCU:** ESP32-PICO-V3
- **Radio Receiver:** 2 × Semtech SX1280, with DC-DC power
- **Low-noise Amplifier / Power Amplifier:** AT2401C
- **Power Amplifier amplification:** +22 dBm
- **Radio timing source:** 52Mhz temperature-compensated crystal oscillator (TCXO)
- **Update capabilities:** WiFi, Betaflight Passthrough, UART
- **Pin header to flight controller:** JST GH, 1.5mm pitch, 4 pins
- **Antenna connector:** 2 × IPEX MHF-1
- **Status LED:** RGB (full color)

Mounting and connecting to a flight controller

The receiver is intended to be mounted on an aircraft's 20x20mm, or 30.5x30.5mm square mounting patterns. This may be the same stack as the flight controller or ESC, or a separate one; details depend on the aircraft's frame.

The receiver connects to a FC using 4 wires: 2 of these supply power to the receiver from the FC, and 2 pass data (control, signal, and telemetry) to and from it. They are intended to be connected using the provided JST GH (1.25mm pitch) cable and connector, but may optionally be soldered to the square pads on the back of the receiver.
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We recommend using the GH connector, because it's disconnectable, requires less work, and eliminates the possibility of the wires becoming brittle from solder wicking.

Both the connector, and pads are labeled on their respective sides. Connections are as follows:

- VCC (5V) (**red**) This connection provides power to the flight controller; it should be connected to a 5-volt power supply on the flight controller.

- Ground. (**black**) This provides a voltage ground reference, and should be connected to the flight controller's ground.

- UART Transmission (Tx) (**blue**) This line passes control and signal data from the receiver to the flight controller. Connect this to a free UART Rx line on the flight controller. Use the same UART line as the Rx connection.

- UART Reception (Rx) (**green**) This line passes telemetry from the flight controller to the receiver. Connect this to a free UART Tx line on the flight controller. Use the same UART line as the Tx connection.

Breaking off the 30.5mm tabs

If you wish to mount the receiver using the 20mm holes, or in some other manner, you may remove the tabs that contain the 30.5mm mounting holes. To do so, hold the body of the receiver firmly, with a thumb or hard object near one of the 20mm holes. Press the end of the adjacent tab against a table or other firm surface at an angle, and carefully apply force to bend the tab away at the line of small holes. The tab will snap off.

Note that the included rubber grommets won't fit inside the smaller 20mm holes directly, but may be placed under or above the board at these hole positions.

LED status indications

The single-radio receiver uses a red LED that blinks in different patterns to indicated status. The dual-radio Rx uses a full-color LED that provides more robust status indications. The meanings of both can be found at the official ELRs documentation here:
https://www.expresslrs.org/3.0/quick-start/led-status/

Status for the single-radio receiver:

LED Indication	Status
Slow blink 500ms on/off	Waiting for connection from transmitter
Fast blinking 25ms on/off	WiFi mode enabled
Medium speed blink 100ms on/off	Radio chip not detected

LED Indication	Status
Double blink then pause	Binding mode enabled
Triple blink then pause	Connected to transmitter but mismatched model-match configuration
Solid on	Connected to a transmitter, or bootloader mode enabled

Status for the dual-radio receiver:

LED Indication	Status
Rainbow fade effect	Starting Up
Green heartbeat	Web update mode enabled
Slow blink 500ms on/off	Waiting for connection from transmitter
Red flashing 100ms on/off	Radio chip not detected
Orange Double blink then pause	Binding mode enabled
Orange Triple blink then pause	Connected to transmitter but mismatched model-match configuration
Solid single color	Connected to a transmitter, color indicates packet rate

When connected, color indicates the current packet rate and RF protocol (selected on the transmitter), as follows:

Red: 1kHz FLRC
Orange: 500Hz FLRC
Yellow: 500Hz Deja Vu
Light green: 250Hz Deja Vu
Dark green: 500Hz LoRa
Teal: 333Hz LoRa
Light blue: 250Hz LoRa
Dark blue: 150Hz LoRa
Purple: 100Hz LoRa
Pink: 50Hz LoRa

These rates and protocols are selected on the transmitter, in its ELRS settings. (Eg *SYS* button, *Tools* tab, *ExpressLRS* LUA, on Radiomaster controllers. *Note* that FLRC provides lower latency, while LoRa provides longer range. Déjà Vu sends the same packet multiple times at 1kHz using FLRC, which provides resistance to interference.

To use F1000, you may need to increase your radio controller's baud rate from its default. For example, on Radiomaster controllers, this is adjustable by pressing the *SYS* button, then navigating to the *Hardware* tab. Setting the rate above 400kHz may be required.

Binding to a transmitter

Reference the ExpressLRS documentation here for details on binding a transmitter: **https://www.expresslrs.org/3.0/quick-start/binding/**

By default, the receiver is set up in manual bind mode. After power is applied, the status LED will blink orange, indicating it is ready to bind. To bind from this mode, activate the *Bind* feature using your transmitter's ELRS LUA script.

For automatic binding, set up a binding phrase shared by the transmitter and receiver. This can be set, for either, by allowing the transmitter and receiver each to go into WiFi mode. Using a computer or phone with WiFi capability, connect to the *ExpressLRS RX* or *ExpressLRS TX* WiFi networks. The password is *expresslrs*.

 Your web browser should load a configuration page automatically upon opening, similar to WiFi login pages at cafes. Once the page loads (10.0.0.1 is the address), set a binding phrase using the web interface on that page. This should be the first field on the page that loads, labeled *Binding Phrase*. Click the *SAVE & REBOOT* button towards the bottom of that page.

Binding Phrase

i<3elrs

UID **Flashed** (Auto updated by changing the bind-phrase above)

211,1,163,201,243,224

WiFi "auto on" interval (s)

60

UART baud

420000

☐ Invert TX pin
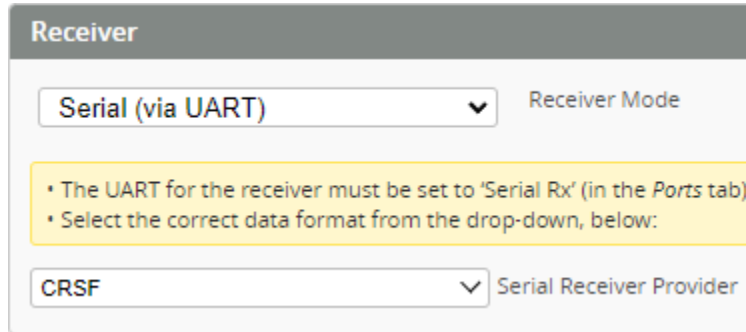☑ Lock on first connection

SAVE & REBOOT

Note that on the single-radio Rx, you can tell it's in WiFi mode by the LED strobing rapidly. On the dual-radio Rx, the LED will pulse yellow and green to indicate it's in WiFi mode. In either case, this occurs after being powered on for 1 minute without binding to a transmitter.

 Make sure the bind phrases set on the receiver and transmitter match. The bind phrase should be kept private.

Setting up with Betaflight

The receiver is compatible with any flight controller that has an available UART connection pair, and any firmware that supports the CRSF protocol. To set up in Betaflight, you need to #1: Set the reception type to CRSF. #2: Enable the UART port. To set up, connect the flight controller to a PC via USB, and load *Betaflight Configurator*.

#1: Open the R*eceiver* section. On the *Receiver* subsection, set *Receiver Mode* to **Serial (via UART)**, and *Serial Receiver Provider* to **CRSF**.

#2: Open the Ports section. Find the column associated with the UART port you connected the receiver to. Click the associated selector in the **Serial Rx** column. Leave the *Configuration/MSP* selector unselected. Example, when connected to UART1:

Control channel data

The receiver passes data to and from the flight controller using the UART transmission protocol (Tx and Rx lines). The data protocol used is CRSF; two types of messages are passed to the flight controller by the receiver: control channel data, and link statistics. Control channel data consists of the following data:

Ch 1-4: 10-bit flight control data: ie for pitch, roll, yaw, and throttle.
Ch 5; Aux1: A 2-position arm switch
Channels 6-1; Aux2-8: 6-bit or 7-bit switch data, depending on telemetry ratio. These are useful for settings, eg on switches with up to 6-positions or 7 positions. For example, changing flight mode, or enabling various autopilot settings.

Make sure your transmitter interface is configured accordingly. Make sure the arm switch is set to Aux1 (channel 5), with values of 1000 for disarmed, and 2000 for armed.

For details, see see the official documentation page here:
https://www.expresslrs.org/3.0/software/switch-config/

Link statistics

In addition to control channel data, the Rx intermittently transmits link statistics, which are an indication of signal health.

The following stats are passed:
Timestamp these stats were recorded

Uplink RSSI 1: received signal strength antenna 1 (RSSI). RSSI dBm as reported by the RX. Values vary depending on mode, antenna quality, output power and distance. Ranges from -128 to 0.

Uplink RSSI 2: received signal strength antenna 2 (RSSI). Second antenna RSSI.

Uplink link quailty: link quality (valid packets). The number of successful packets out of the last 100 from TX → RX

Uplink signal-to-noise ratio: SNR reported by the RX. Value varies mostly by radio chip and gets lower with distance. Only works in LoRa modes.

Active antenna: Which antenna is active on the single-radio Rx

Uplink transmitting power

Downlink RSSI: RSSI dBm of telemetry packets received by TX.

Downlink link quality (valid packets): An LQ indicator of telemetry packets received RX → TX (0 - 100)

Downlink signal-to-noise ratio: SNR reported by the TX for telemetry packets

The most important stats to monitor in flight are uplink link quality, and uplink RSSI. One (ideally both) of these should be monitored in flight, eg on an OSD.

For details, check out the official ELRS documentation on this here:
https://www.expresslrs.org/3.0/info/signal-health/

Note that when using a DJI OSD, Betaflight currently only supports passing a single link stats value. In the *Receiver* tab of *Betaflight Configurator*, configure RSSi channel as *AUX11/ch15* to display link quality (percent of packets received), or *AUX12/ch16* to display RSSI dBm.

Transmitter power setting

You may wish to enable *Dynamic power* on the transmitter – this allows transmitter power output to scale as required to maintain a strong link between transmitter and receiver, without using more power than required. This is enabled using your transmitter UI, in conjunction with the ELRS LUA script installed on it. When *Dynamic power* is enabled, the *transmitter power* setting is the maximum power the transmitter will transmit at; it will use the lowest setting possible to maintain a high link quality and RSSI.

Updating firmware

Reference the ExpressLRS documentation here for details on binding a transmitter: **https://www.expresslrs.org/3.0/quick-start/firmware-options/**

AnyLeaf receivers come with ELRS 3.1.1 installed. To update the firmware, you can use Betaflight passthrough, WiFi, or if you have UART-USB bridge, UART. We think WiFi will be the easiest option in most cases. For all updating options, you'll need a PC program called *ExpressLRS Configurator*, which you can download here: **https://github.com/ExpressLRS/ExpressLRS-Configurator/releases**.

Using *Configurator*, build firmware of the version you wish to update to; note that you may also configure a bind phrase here, as well as adjust other options, such as regulatory domain. After clicking *Build* at the bottom, you may upload the built file using the WiFi interface. You may also be able to upload over WiFi directly, or use Betaflight, if the receiver is connected to a flight-controller that has Betaflight installed.

To update using WiFi, apply power to the receiver, eg by connecting it to a flight controller. Do not allow it to connect to a transmitter. After 1 minute, the LED will begin strobing (single radio), or pulsing green (dual radio). This indicates WiFi is set up: The Rx is acting as a wifi hotspot. Place it near a WiFi-capable device (eg PC or phone). Connect to the *ExpressLRS RX* WiFi network. Open the network login page as prompted by your device. (Address: 10.0.0.1). Click the *UPDATE* tab towards the right of the screen.

Click the *Browse* button. Select the file that was output by *Configurator*'s build step. Click the *UPDATE* button. The update takes about 30s, after which you should see an *Update Succeeded* message.

If flashing using UART, bridge the 2 pads labeled *Boot* on the back of the receiver while power is being applied (eg the connector is being plugged in). You might do this using a paperclip, the 2

ends of a male 2.54mm-pin wire, or 2 pins on a 2.54mm header with a jumper bridging them. This will put the receiver in bootloader mode, which allows flashing via UART.

Power delivery

The Rx has a regulator that accepts up to 8V, and delivers 3.3V to the onboard circuitry. It can be connected to a flight-controller's 5V, or 3.3V lines. The flight controller (or whatever power source you use) needs to be able to support 500mA, which is the peak expected current used by the Rx. (Although its steady-state current use is less).

Support

If you have any questions, or support requests, contact us by email: anyleaf@anyleaf.org.

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