Orqa **IRONghost** Product Family

Operator Manual

20-Feb-2024 : Version 1.2

Products Included in this document:

- IRONghost Dual SubGHz JR module
- IRONghost Dual SubGHz Hybrid Rx/Video Tx

Valid for firmware version 1.1.0.4 or later

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Dual SubGHz JR Module Control Link

Introduction

The Dual SubGHz JR Module is a highly EW-resilient control link transmitter, in an industry standard 'JR Module' form factor.

Two independent 3 watt radios operate on 100MHz wide frequency bands, with the standard product factory configured for 400-500MHz, and 860-960MHz;

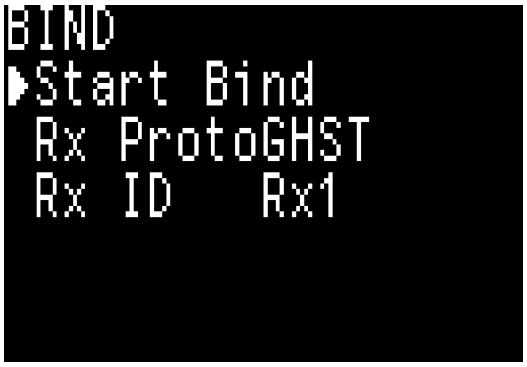
Specifications

- **Full NDAA Compliance**, designed and manufactured 100% in the EU
- **AES256** Encryption for Control and Telemetry *
- Sub-GHz ghost JR transmitter with dual independent Tx chains
- Factory configurable on **each** of the two bands from **400MHz** - **960MHz**
- **3W** Output power on Band 1 (Typically 915MHz)
- **3W** Output power on Band 2 (Typically 433MHz)
- Standard JR module format, powered directly from the R/C Controller
- Bidirectional **MAVLINK** telemetry*
- Twin **RP-SMA** antenna ports
- **OLED**/Joystick menu system
- **USB** upgradable firmware

* *With software release planned for Mar 2024*

Binding

Binding is initiated from the OLED menu, as follows:



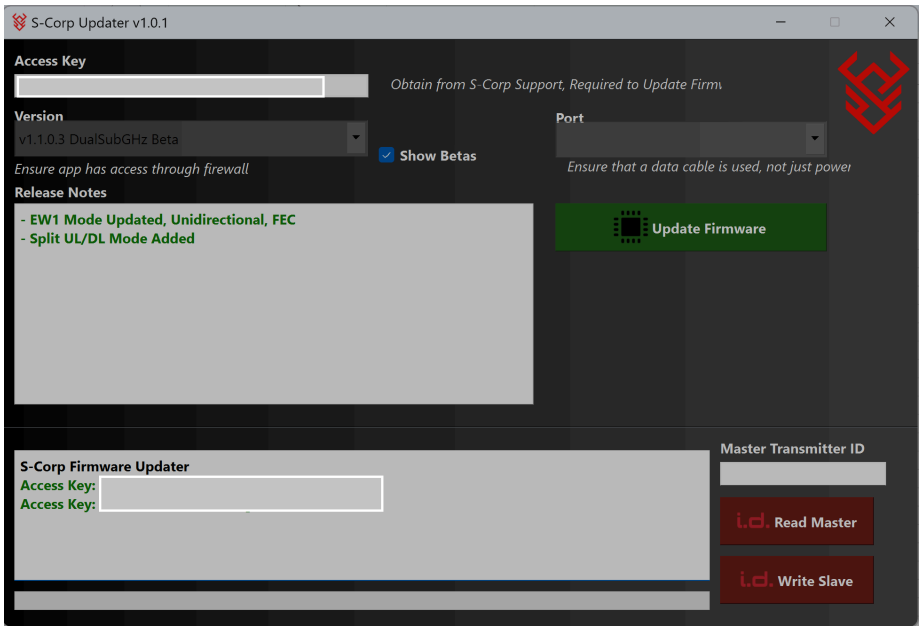
For new IRONghost receivers (including hybrids), as delivered from the factory, simply power up the receiver, and start the bind operation from the transmitter.

For receivers that have been bound previously, press the bind button on the receiver/hybrid after applying power. A flashing blue LED indicates that the receiver is in bind mode.

Firmware Update

Firmware for the JR module is performed over a USB port, from a Windows™ computer.

Please contact Orqa support for access to the updater software, and a unique access key for your client account.
(this access key enables the distribution of 'private' EW-resilient builds on a per-client basis).



During the transmitter update process, firmware for all compatible receivers is also transferred to the transmitter's onboard storage.

Receivers will receive this update over-the-air during the next bind process.

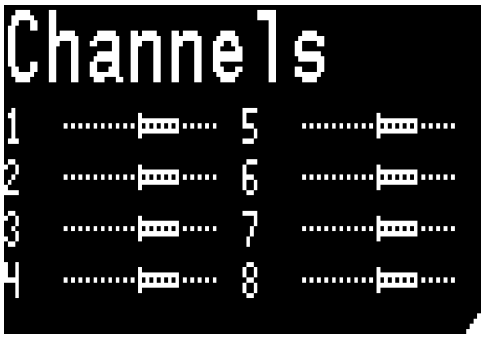
R/C Transmitter Compatibility

Serial Protocol

The IRONghost product line uses the **GHST** protocol for communication between the R/C controller, and the transmitter module. This protocol is supported by any recent **OpenTx**/**EdgeTx** build.

To verify that the connection between the R/C controller, and the IRONghost transmitter is working correctly, click twice to the right on the joystick to show the channel monitor page.

Moving sticks on the radio should be reflected by movement in these bars.



Battery/Power Supply

The Dual SubGHz JR module places much higher demands on R/C Transmitters than traditional low-power modules.

For the power supply side, it is highly recommended to run either high-capacity 18650 cells, or 21700s if the radio is capable.

Radio Interference

High power sub-GHz transmissions from modules mounted in R/C controllers can create issues for these controllers which are not designed for high power levels on these frequencies.

To minimize interfering with the normal operation of the R/C controller, it is highly recommended to use high-quality antennas, tuned for the band being used.
This reduces potentially harmful RF reflections, which can create problems for the R/C controller's (generally unscreened) electronics.

These same reflections can reduce the life span, or in the worst case, damage, the power amplifiers in the transmitter.

As shipped, IRONghost transmitter firmware is restricted to 1W output power on each radio. This is recommended while evaluating radio compatibility.

To unlock the 2W, and 3W modes, use the entry in the Options menu.

Note that to avoid radio compatibility issues, Orqa's TAC.Ctrl radio, with remote transmitter module is highly recommended as an alternative to standard 'Consumer' R/C Controllers.

Antenna Compatibility

For omnidirectional use, the Orqa **Mega-qT** antennas are highly recommended. These classic half-wave dipoles are robust, and electrically matched with an integral balun for the designed frequency band.

Note that as with most tuned antennas, these have a relatively narrow bandwidth, of a few tens of MHz, and for maximum performance should be used only on the design frequency. Antennas for most commonly used frequency bands are available (433MHz, 490MHz, 750MHz, 915MHz, etc.)

For directional use, with a few dB of gain in the direction of the UAV, the Orqa **Moxon** antennas are also highly recommended. These can allow control and telemetry at approx. 2x the range of the Mega-qTs, and are robust enough for enterprise/defense applications.

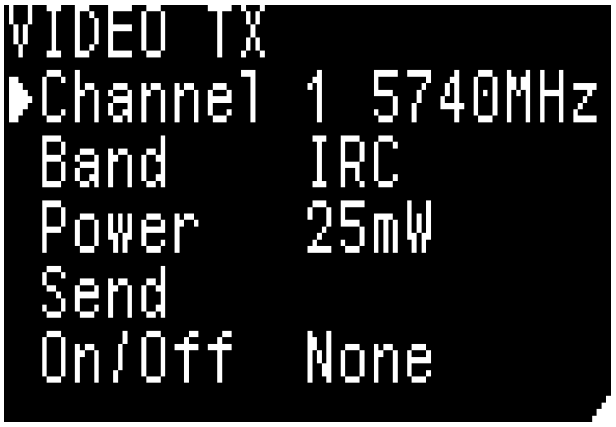
Never operate the IRONghost transmitter with no antenna connected. When using high power settings, this will almost definitely result in damage to the power amplifier.

Note that for FCC compliance, all IRONghost transmitters use RP-SMA antenna connectors, and not the more traditional SMA.

Video Transmitter Control

In the IRONghost ecosystem, the video transmitter on the remote UAV is controlled by the transmitter, allowing a completely flight-controller agnostic control mechanism.

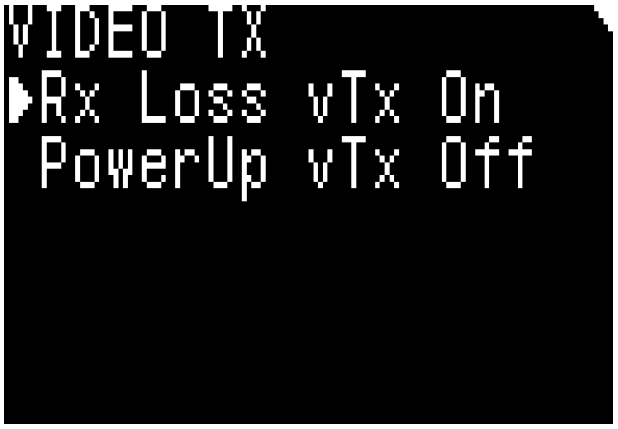
The menu to set up and control the Video Transmitter is located in the **Video Tx** menu.



The band and channel, plus video transmitter power, are all set here.

Once configured, selecting the **Send** menu item will send these new settings to the UAV.

Note that the vTx may be enabled using a switch on the R/C Controller, with channel specified in the **On/Off** menu item. Keeping the vTx disabled, and enabling only immediately before flight is recommended.



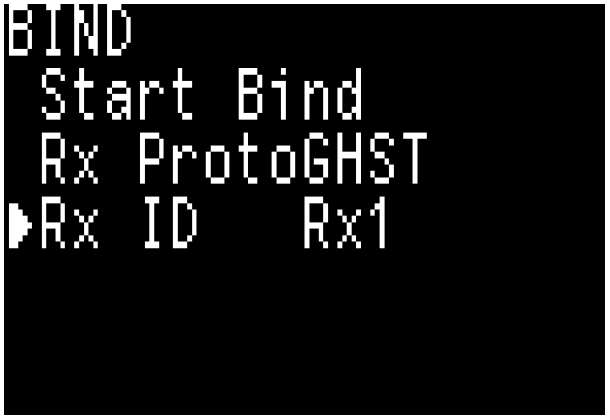
Other settings in the **Video Tx** menu allow the behavior of the transmitter on failsafe (Rx Loss), and on powerup (before Tx/Rx have connected).

It is recommended for enterprise/defense applications to leave the vTx enabled after Rx Loss.

Multi-Drone Operations

A single IRONghost transmitter may be used to control up to 12 UAVs, with switches on the R/C controller defining the drone that is currently active.

All of these drones may be powered-on, and bound to the transmitter, but will only accept control, and send telemetry, when the R/C controller-mounted switches are in the appropriate positions.



To start multi-drone operations, bind each of the drones with a different **Rx ID** (making sure to note these IDs on the craft).

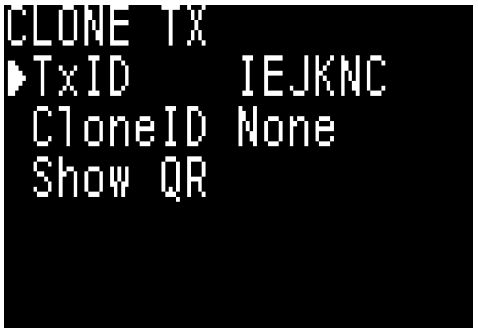
To enable the pilot to decide which drone he is controlling, use the **Multi-Drone** menu, to assign one or more R/C controller switches to the drone selection task.

In this example, two R/C controller switches are used to determine which drone is active. CH8 defines the group of drones to control, and CH7 defines which drone within the group is active.

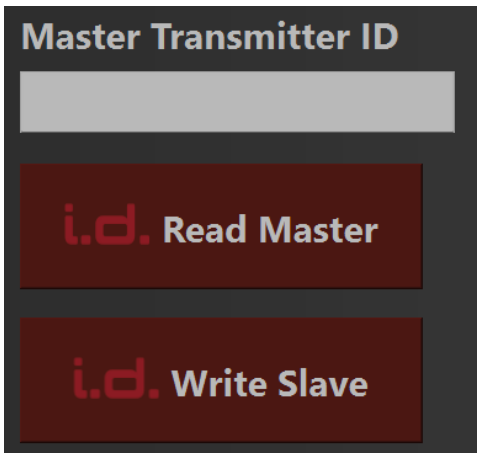
Transmitter Cloning

The process of transmitter cloning in IRONghost products, allows a ‘slave’ transmitter to be configured with the same transmitter ID as a ‘master’ transmitter.

For the configuration of large numbers of drones, this feature enables drones to be ‘pre-bound’ during configuration to the transmitter of the ‘end-user’ pilot.



Use the transmitter cloning feature of the IRONghost firmware updater to perform the cloning operation, noting that the ‘slave’ transmitter may use either its original TxID, or that of the master, under switch control.



Spectrum Analyzer

IRONghost transmitters with a built-in user-interface (OLED) include rudimentary spectrum-analyzer functionality, found in the **Spectrum** menu.

Select the band to be scanned, along with the start and end frequencies.

Dual SubGHz Hybrid Control Link/Video Downlink

Introduction

The Orqa ghost Dual-SubGHz Hybrid is an all-in-one control link receiver, and video transmitter, integrated onto a single-sided 30 x 30 PCB.

Two independent receivers are integrated, each capable of operating on any supported 100MHz SubGHz band chosen at ordering time.
The standard stocked product supports 860-960MHz on Band 1, and 400-500MHz on Band 2.

Specifications

- **Full NDAA Compliance**, designed and manufactured 100% in the EU
- Control Uplink and Video Downlink on a single module
- **AES256** Encryption for Control and Telemetry *
- Factory configurable on **each** band from **400MHz** - **960MHz**
- **1.5W 5.8GHz** Video Transmitter
- Bidirectional **MAVLINK** telemetry *
- Robust **MMCX** Connectors for Tx and Rx
- **2s-6s** Direct battery power

Firmware Update

Firmware for the Hybrid is updated over-the-air from a compatible Ghost SubGHz transmitter.

To update the firmware on the hybrid, update the transmitter using the Ghost Updater (Windows application, with USB connection to the transmitter).

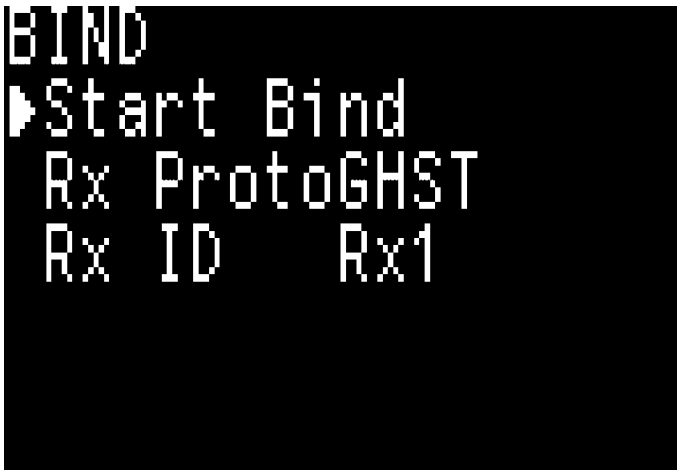
During the USB update process, firmware images for all compatible receivers are loaded into the transmitter, and will be sent to the receiver during the bind process, if required.

Binding

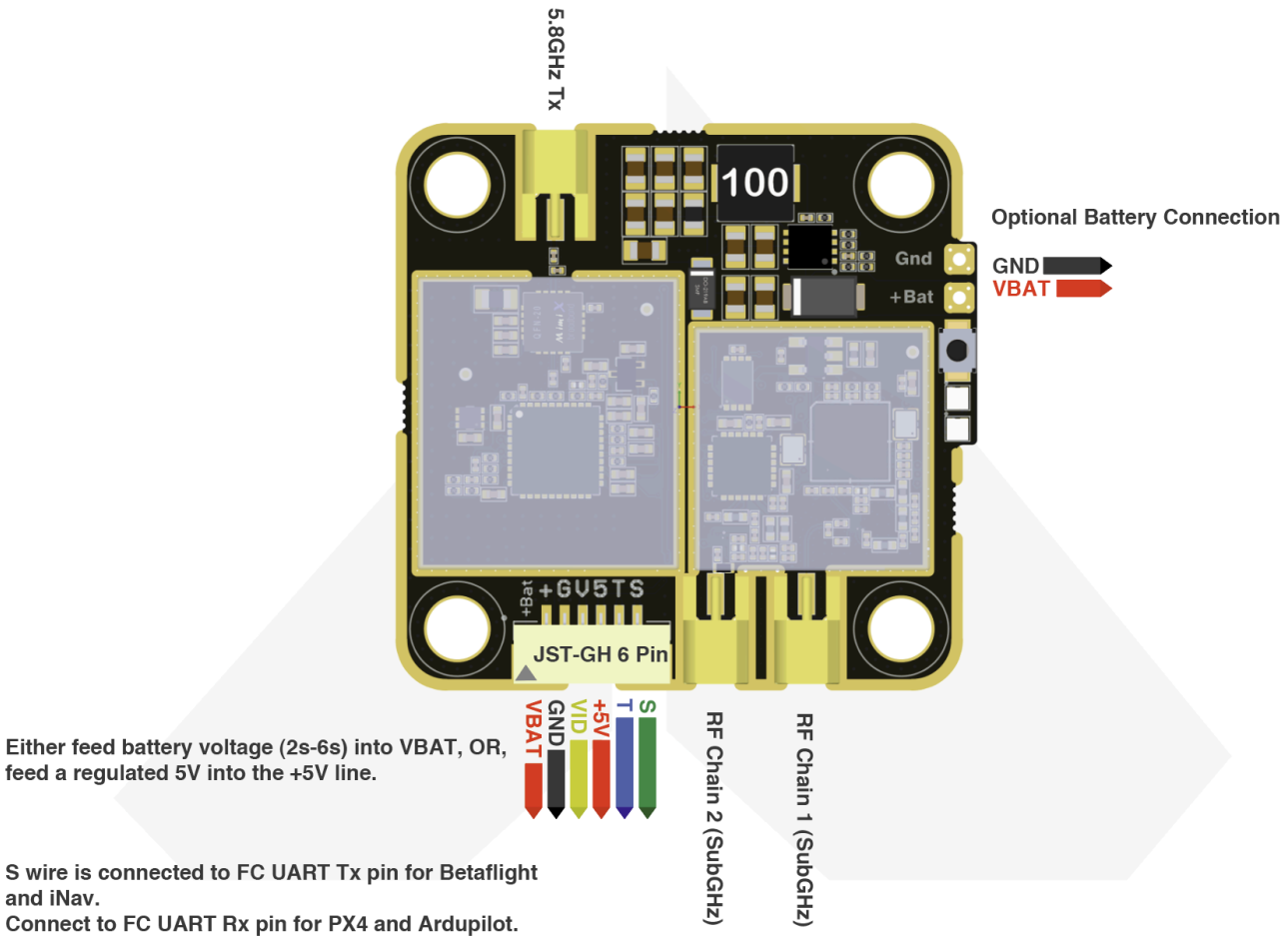
As for all IRONghost products, the hybrid is shipped in 'virgin' mode, where it will bind to the first transmitter that attempts the bind operation.
This method of binding requires no button press, or other operation, on the hybrid, allowing the product to be embedded in an airframe.

For binding with different transmitters, press the bind button after the hybrid is powered up. This will result in a flashing blue light, until the transmitter-request bind operation is complete.

Note that the serial output protocol (GHST or other) is selected during the bind process:
This protocol will be emitted by the IRONghost receiver, and interpreted by the flight controller. Be sure to select GHST protocol on the flight controller also.



Connectors, and Pinouts



Pinouts

TX (and Serial Rx) Connection

1.25mm pitch, 6-pin JST-GH connector, compatible mating part numbers:
GHR-06V-S Housing
SSHL-002T-P0.2 Connector pin for 30-26AWG

NOTE: The +10V output on the Orqa FC must be pre-configured using the solder-jumper on the bottom of the PCB. Either VBat, or +10V BEC output may be selected.

Pin	Name	Function	Notes
1	**VBAT**	Battery Voltage Input	
2	**Gnd**	VTX Ground	
3	**VID**	Video Output	
4	**+5V**	+5V BEC Output	Alternate Power supply for Video Tx
5	**T**	Telemetry	Not Currently Used
6	**S**	Serial Data	Bidirectional, Control and Telemetry

Serial Rx Connections

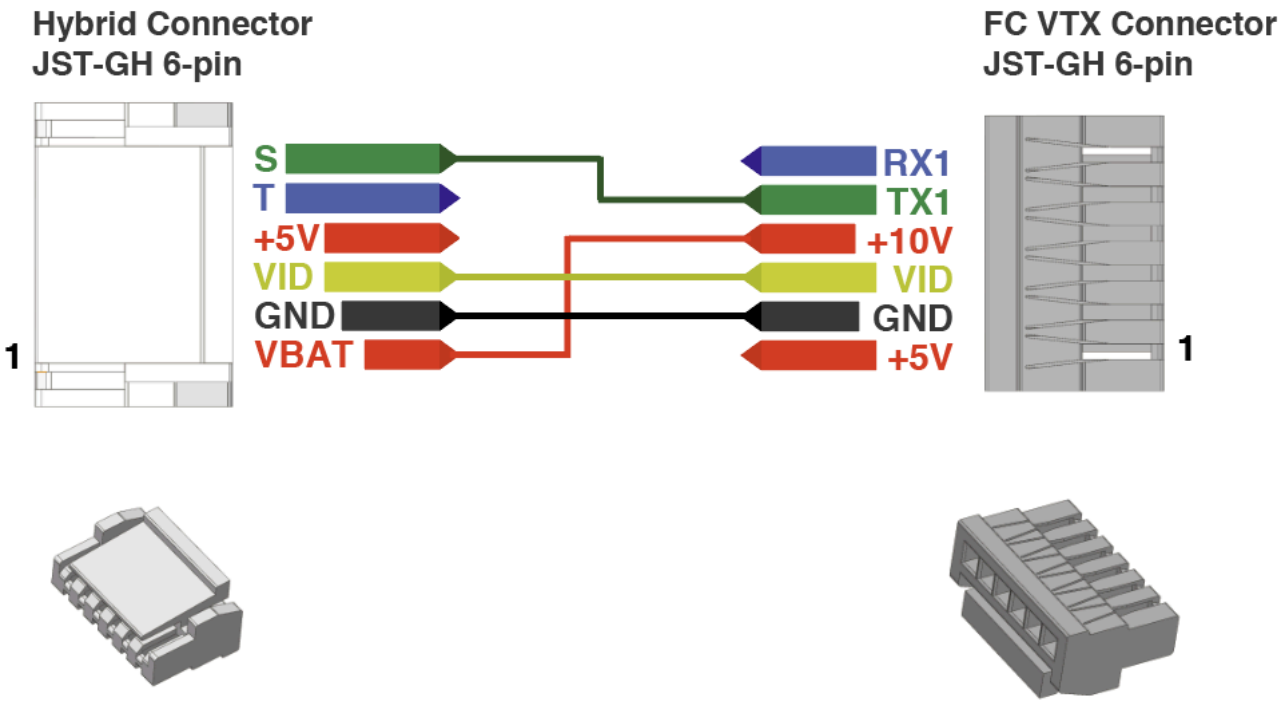
Note that depending upon the flight controller firmware in use, the wiring of the control link serial wires may differ.

For Betaflight, and iNav, serial data from the ghost receivers (the 'S' pin on the receivers) must be hooked to a UART TX pin on the FC (**TX1** in this case).. Cables shipped with the FC will use this standard.

For PX4 (and possibly Ardupilot), the convention is to use the UART RX pin on the FC (**RX1**), but this is configurable when building the firmware, so it may not always be the case.

Connecting to the Orqa 3030 FC

To connect the Dual-SubGHz Hybrid to the Orqa 3030 FC the following cable may be used. Note that since the same connector is used on each side, the orientation of this cable is critical, and is marked on cables supplied by Orqa.



RGB LED Colors and Sequences

Color	Meaning
Blue	Bind Mode - Will bind with a previously seen transmitter
Flashing Blue	Bind Mode - Will bind with any transmitter
Purple	Scanning mode - Trying different RF modes to connect
Red/Green Flash	Normal operation, shows packet reception
Red	Lost data link

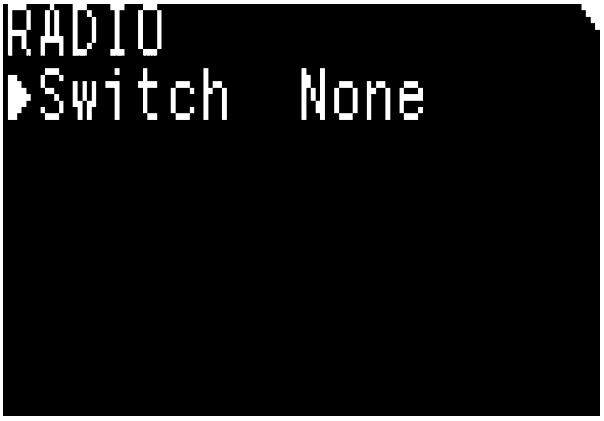
General Concepts

EW-Evading Band Switching

To ensure seamless functionality in EW-rich environments, switching between frequency bands is initiated by the pilot in the default operating mode.

To enable an FPV pilot to switch bands during flight, a switch on the R/C Controller may be assigned to the band switching function.

Flying into a zone with EW activity on one band, and switching seamlessly to another band to terminate the flight is recommended.
Note that no transmissions occur on this second 'shadow' band prior to switching, ensuring that it remains under cover until required.



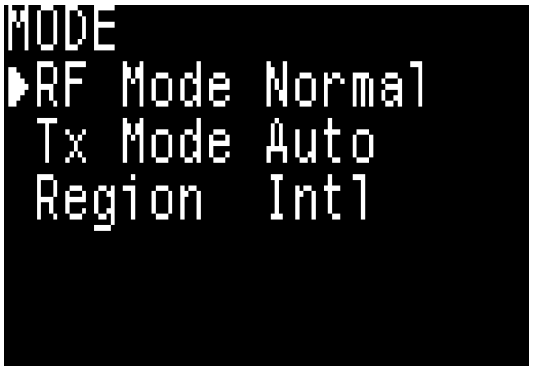
Each radio has an independent power level setting, so it is possible, for example, to fly into an EW-active zone on relatively low power, to avoid detection, and switch to high power on the shadow band.

RF Modes

Various RF modes are available in the standard firmware build, with **Normal** being the default.

These modes will be fairly dynamic as the IRONghost firmware evolves. Please contact Orqa for details on the latest modes, and functionality.

Normal is a good tradeoff between RF link frame rate, and EW resilience. It is a bidirectional mode, so the airborne drone will be transmitting short telemetry packets back to the pilot's radio after each control packet.
Frame rate is 33Hz in this mode.



Race mode increases frame rate to 60Hz, and is also a bidirectional protocol, but with lower sensitivity (and therefore range) than Normal mode.
It is also less resilient to EW.

PureRace increases frame rate further to close to 150Hz, and is a unidirectional protocol, with no telemetry downlink.
It is less sensitive than Race mode, and significantly less sensitive than Normal mode.

For modes **EW1..4**, please contact Orqa for more information.

Mode	Frame Rate	Telemetry	Usage	Sensitivity
Long Range	20Hz	Yes	Extreme Range (40% > Normal)	-120dBm
Normal	34Hz	Yes	Reasonable Compromise	-117dBm
Race60	58Hz	Yes	Lower Range, Lower Latency	-112dBm
Race150	142Hz	No	Lowest Latency	-111dBm
EW1	50Hz	No		-117dBm

Settings for FCC-Legal use (USA)

The IRONghost EW-Resilient radio links may be used on various parts of the radio frequency spectrum, and in various operating modes, some of which allow legal operation within the United States during peacetime operations.

915MHz ISM Band Operation, for Control

All IRONghost radios shipped to date are capable of operation on the standard 915MHz ISM band, legal for use within the USA. This should be the preferred band during test and evaluation.

This band is regulated by the FCC, and covered by part 15.247 of their standards:

Frequency Range and Duty Cycle

The 915MHz ISM band has a frequency range of 902-928MHz.

The 915MHz IRONghost FHSS hopping range is 902.5MHz to 926.5MHz, with a PRBS sequence of 12, out of 48 possible frequency bins, on a 500kHz raster.

Under part 15.247(f) rules, IRONghost is considered a hybrid system, which employs both DSSS (LoRa), and FHSS. This enables the use of 12 hopping frequencies (out of 48).

Dwell time limits (per channel) for this mode of operation are 400ms within a time period of 0.4x the number of channels.
0.4 x 12 = 4.8s
With a hopping rate of 29.4ms, and a transmission time, per packet, of 13.8ms, the system transmits for 2.05s in the 4.8s time period, which corresponds to 172ms/channel, below the 400ms limit.

Power Limits

IRONghost currently has a 3W (+34.7dBm) conducted power capability.
It also has settings for both 100mW (+20dBm), and 1000mW (+30dBm) settings.

Staying Legal

To configure IRONghost systems equipped with an OLED display (or remote equivalent), the following settings should be used:

In the radio menu for the 9xx band, ensure that 915MHz ISM is selected (vs. 868MHz for EU use).
Also ensure that no more than 1000mW is selected as the power setting.

In the Radio menu, ensure that the 915MHz radio is selected (Radio 1 in the above case).

To confirm that the correct settings have been applied, return to the 'root' menu of the OLED, where the link summary page is displayed.

5.8GHz ISM Band Operation, for Video

For video operation, on the 5.8GHz band, it is assumed that the operator is a qualified Ham radio operator (or equivalent) in order to transmit more than the ~1mW authorized under license-free FCC rules.

To stay legal, the 8 channel 'RaceBand' has a range of 5658MHz to 5917MHz, within the Ham band of 5650MHz to 5925MHz (with appropriate guard-bands either side of the used spectrum).

The video transmitter is controlled by the IRONghost transmitter menu, under the VIDEO TX option.

Select one of the RaceBand channels, and 1W or less.

Support

For technical support, please use our Help Desk at the following link:
https://orqafpv.freshdesk.com/