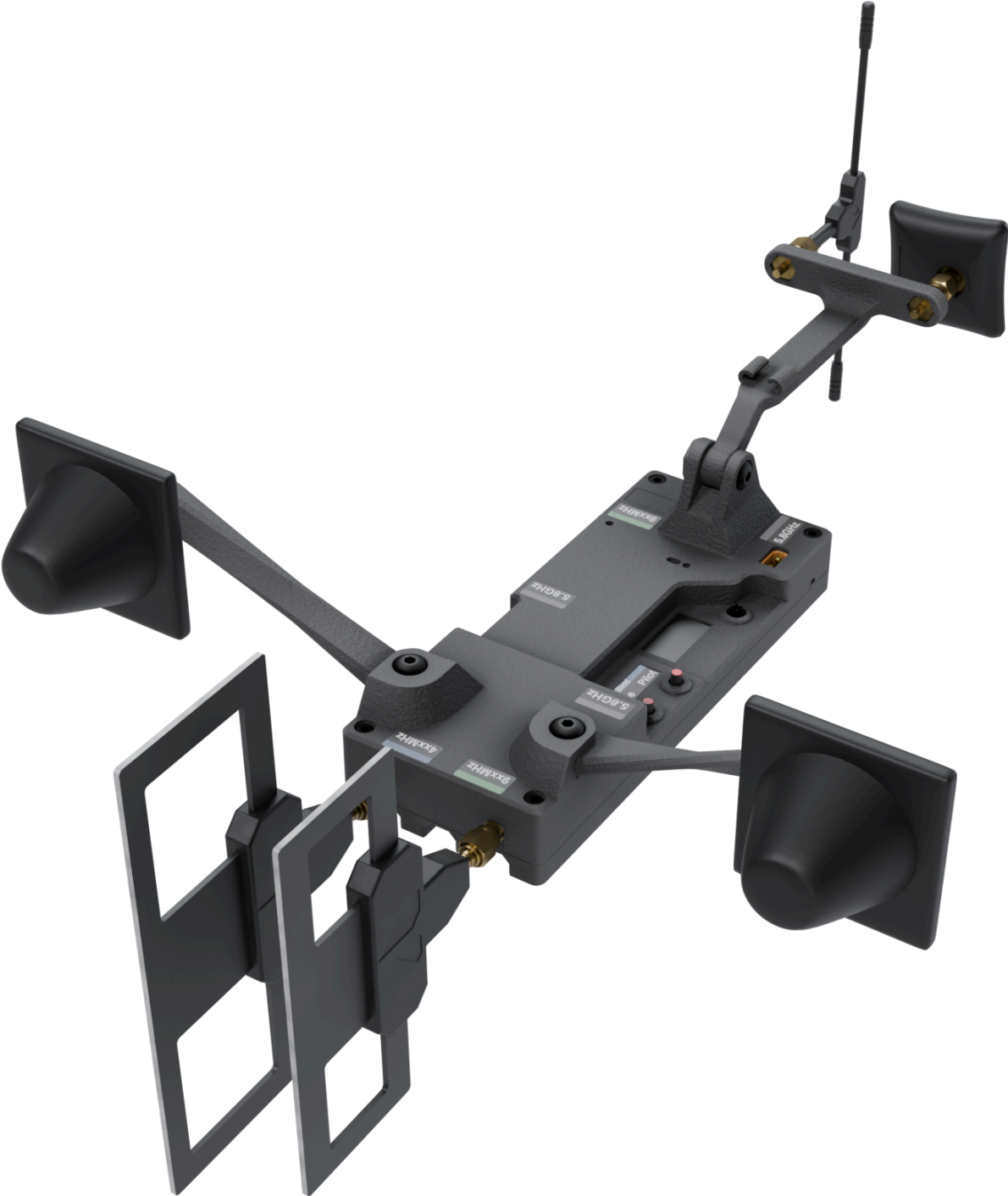


# IRONghost Airborne Repeater - Preliminary Manual

v1.0

Ready for Review & Publication



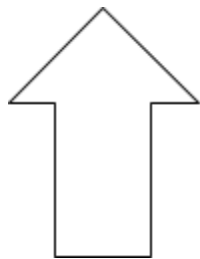
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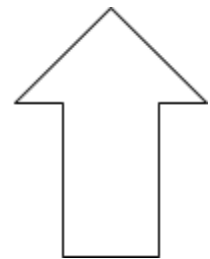
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## Key Takeaways From This Manual

1. **Center of Gravity**/Thrust of a Mavic-style drone carrying the repeater is critical to get right, relative motor temperature can be a good indication of whether it is correct (or not).
2. DJI products that transmit digital video on 5.8GHz will knock out the sensitivity of the receiver on the repeater. Ensure that the carrier drone is set to **2.4GHz Control/Video before flight**.
3. Ensure that **appropriate antennas** are installed on all RF connectors before powering up the repeater.



If Reading Manuals is not your thing... please be sure to understand the above points.



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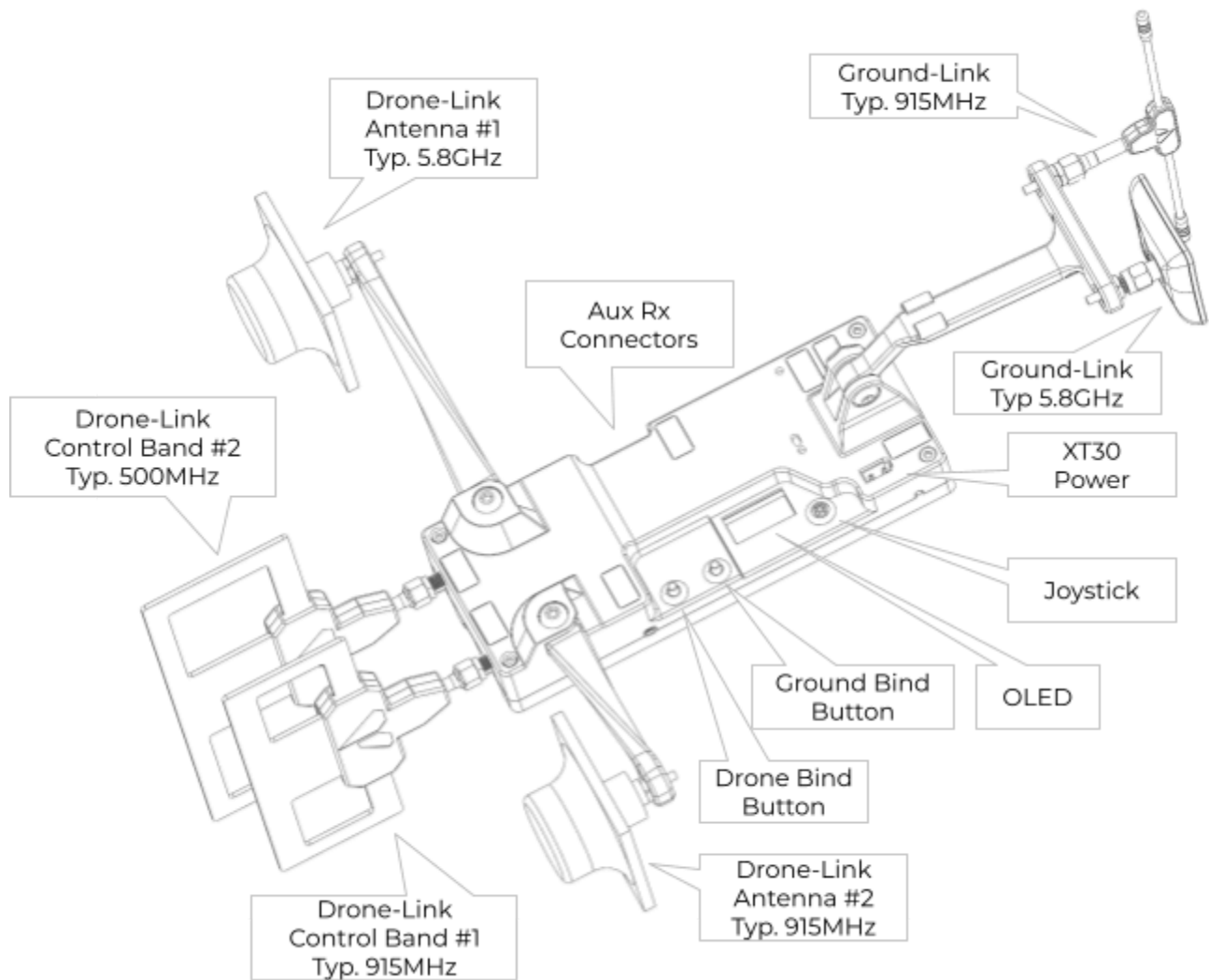
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## Anatomy of an IRONghost Airborne Repeater



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## Specifications

### General

- Power Requirements: **2s - 6s (7V - 28V)** via **XT30** connector
  - **~170mA** rms @ 20V w/1W transmit power on 9xxMHz (**3.4W**)
  - **~260mA** rms @ 20V w/3W transmit power on 9xxMHz (**5.2W**)
- Battery Recommendation
  - **3s 450mAh** Li-Po : ~5Wh, approx. **45 minutes** operation @ 3W
  - **2s 18500 Li-ion, 2000mAh**: ~15Wh, approx **3 hours** operation @ 3W
- Total weight: **350 g** with 9xx and 4xxMHz Drone-Link antennas (without battery)
- Flight time on stock **Mavic 3 Classic**, w/2s 18500 Li-ion 2000mAh pack, approx. **22 minutes**.

### Drone-Link

- Two control/telemetry radios, each with **~100MHz** bandwidth, typically **850-950MHz**, and **400-500MHz**
  - *Contact sales for other options*
- **3W** RF output power for control link
- Highly EW resilient **IRONghost** protocol
- Extremely **low harmonic content** (~???? dBm)
- Twin integrated rapidFIRE analog video receivers
  - *Installed on the repeater PCB by default, but upon special request may be located remotely to improve performance.*
- **4.99 - 6.02GHz** Frequency Range
- Receiver frequency set automatically when drone frequency is changed
- **rapidFIRE** receiver settings all available;
  - OSD Mode
  - Receiver Mode : Mode 1, Mode 2, Legacy
  - Antenna Mode: Left, Right, Both

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## Ground-Link

- Integrated **Dual-SubGHz hybrid**, with control/telemetry, and video transmitter onboard.
- **25mW - 1.5W video downlink** (minimum power suggested for repeater->pilot use)

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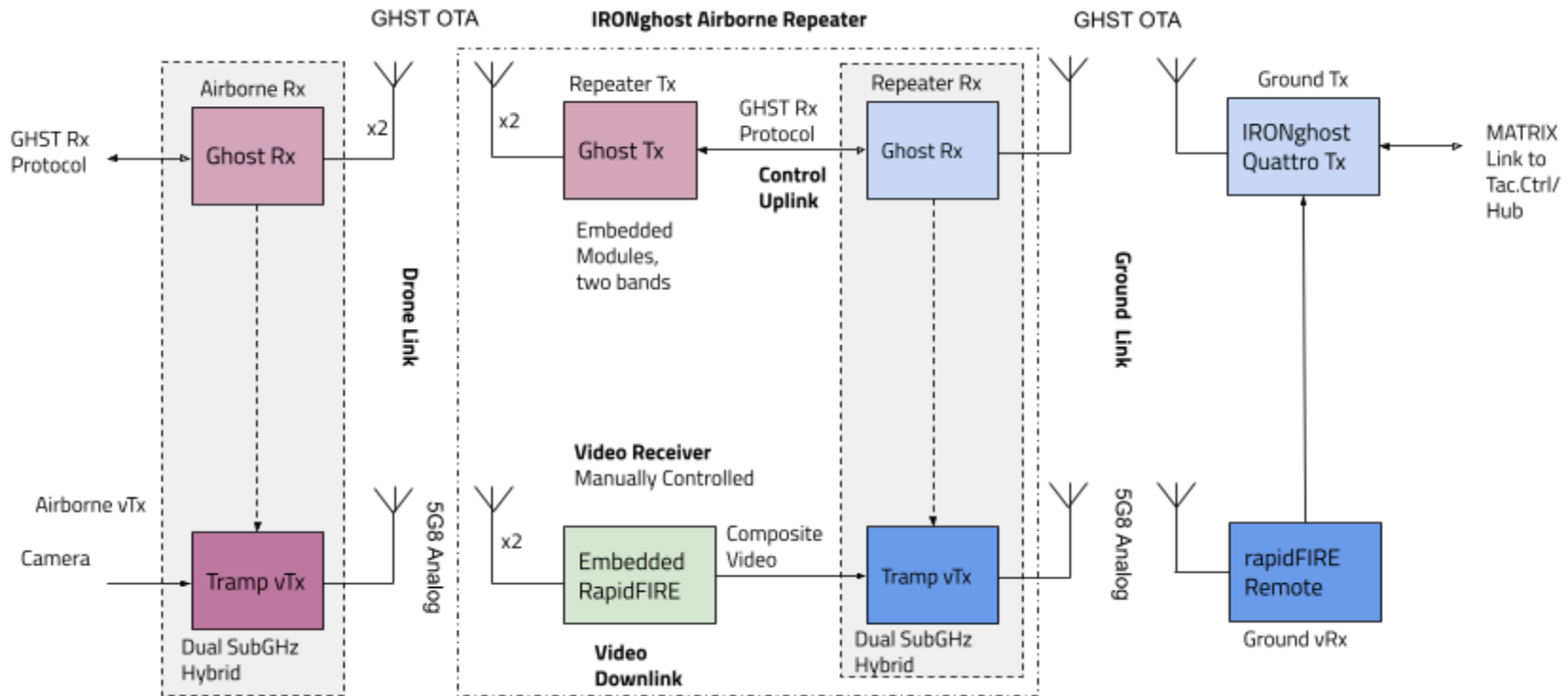
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## System Block Diagram



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## Design Philosophy

The IRONghost repeater was designed to be modified and extended by the end-user. Electronics and firmware are the core of the repeater system, and are fairly independent of the case/antennas/antenna mounts used.

The 3D printed case, and antenna mounting arms, are a sample of what is possible, and support readily available mid-long range antennas.

The source files of this case are available upon request, for end-user customization.

## Connectors

All Orqa IRONghost control link antenna connections are **RP-SMA**, and not SMA.

All video link antenna connections are **SMA**.

## Cables

Coaxial cables shipped with the repeaters are intentionally exposed to enable end-user modifications of antenna selection, and position.

These cables use the **MMCX** standard to reduce weight on this airborne device, but this does make the cables fairly fragile

Use the Orqa/IRC RF Power meter to test antenna ports if cable damage is suspected, or simply swap out cables for some of the spares included.

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## Terminology

The four communications links that need to be active for a wireless repeater to work can create some confusion.

To simplify this, we will use the following terminology in this document:

### Ground Link

The control uplink, and video downlink, between the **repeater** and the **ground station/pilot**.

### Drone Link

The control uplink, and video downlink, between the **drone** and the **repeater**.

	Ground Link	Drone Link
<b>Ghost Control</b>	Bind using the <b>Bind</b> menu of the Ground Station module.  Press the <b>Ground Bind</b> button on the repeater to start the bind operation.	Bind using the <b>Bind</b> menu of the repeater's OLED, or the dedicated <b>Drone Bind</b> bind button.
<b>Video Downlink</b>	Set using the <b>Video Tx</b> menu on the ground-based JR module.  <i>Using low power for this video downlink is highly recommended to avoid de-sensitizing the onboard video receiver.</i>	Set using the <b>Video Tx</b> menu on the repeater's OLED..  Send settings to the quad during setup.  This also sets the frequency of the repeater's video receivers.

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## Installation

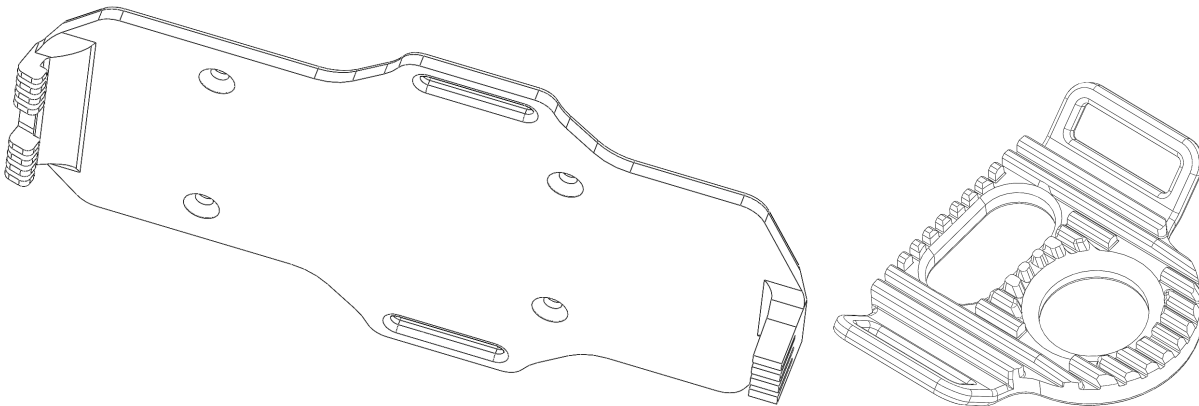
### Installation on a Mavic 3 Classic

To install the repeater on a Mavic 3 Classic, the included adapter plate may be used, with belly-clip.

The adapter plate clips onto the top of the drone, and is secured around the belly clip using straps.

Once the adapter plate is installed, use Velcro to mount the repeater in an appropriate place ensuring that the center of thrust is correct (see section 'Center of Gravity' below).

*NOTE: Installing velcro directly on the top of the Mavic can eliminate the weight of this adapter mount, straps, and belly-clip.*



### Obstacle Avoidance

Note that installing the repeater on a Mavic 3 Classic requires that obstacle avoidance be disabled. This is due to the fact that several distance sensors are blocked by the repeater.

This setting may be found in the Safety menu of the DJI drone's controller.

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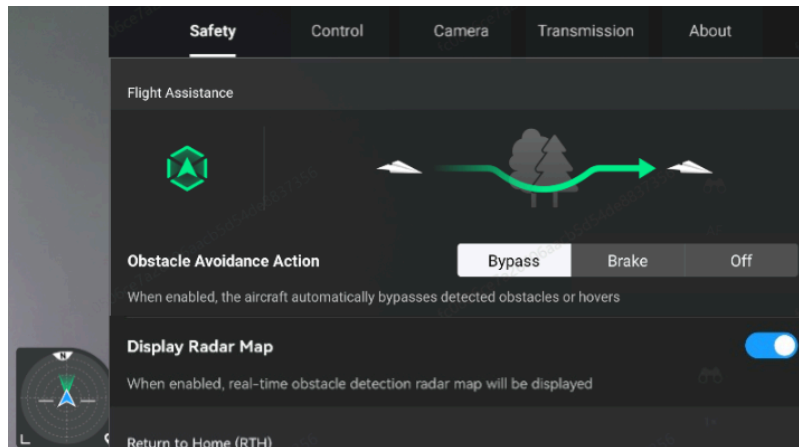
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## Transmission Band

Another setting which has to be changed is the transmission band used by the Mavic. The 5.8GHz band has to be disabled to avoid interference on the repeater's Drone Link vRx.



NOTE: This setting has to be changed before every flight with stock Mavic firmware!



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## Installation on a DJI Matrice

Each of the DJI Matrice multirotors has a different mounting pattern. Contact Orqa for if a custom mount is required for the repeater.

## Center of Gravity

When mounting any payload on a drone, such as the DJI Mavic™, ensuring that the center of mass of the payload (repeater) is close to the center of thrust of the drone is critical.

Failure to do this results in poor flight performance, and overheated motors, which eventually cease to function, resulting in an expensive rapid descent to terra-firma.

The easiest way to do this is to hover the drone for a couple of minutes, land it, and compare motor temperatures. If the front motors are hotter than the rear, use the velcro pad to move the repeater towards the rear of the drone.

On the Mavic, with the 915 and 490MHz antennas hanging from the front of the repeater, moving the repeater far enough back to balance it can be a challenge, so mounting the repeater battery on the rear arm is highly recommended.

If balance cannot be achieved, use a larger battery.

## Harmonics - Usable 4.9-6.0GHz Channels

FPV repeaters concentrate several high power receivers, and sensitive receivers, in the same physical space. This generates all kinds of challenges to prevent desensitization of receivers, with corresponding reduction of range.

The IRONghost transmitter modules contain a steep RF filter, which dramatically reduces the power emitted on multiples of the SubGHz transmission frequency. This opens up the entire 4.9-6.0GHz band for control use.

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## Antenna Choices

### Control/Telemetry Link to Drone

The standard repeater product ships with Orqa Mox antennas, with an approx. 5dBi gain. These are relatively lightweight, and can easily create a 100km+ link in ideal conditions.

For EW resilience two antennas may be used, with band switching tied to a control on the ground-based R/C controller.

### Control/Telemetry Link to Ground (Pilot)

A shortened 915MHz megaQT dipole is included for this ground link. Note that in the standard configuration only one port of the Dual SubGHz Hybrid is used on the repeater, since EW resilience is rarely a problem for the ground -> repeater link.

If required, the second port may be used, with a suitable antenna connected. This does have the advantage of being able to use different frequency bands for the ground -> repeater, and repeater -> drone links.

### Video Link to Drone

The standard repeater product ships with TrueRC Sniper II 13dBi antennas. These may be slightly angled apart to create a wide horizontal beam, with rapidFIRE diversity.

These antennas, in ideal conditions, can achieve 20+ km, but for longer distances, higher gain antennas may be used.

### Video Link to Ground (Pilot)

A standard ImmersionRC 8dBi RHCP patch is used for this link. It has a wide beam when pointed roughly in the direction of the ground-based pilot, and is relatively

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immune to antenna direction changes due to yawing the repeater drone to aim antennas.

## Powering the Repeater

If power from the drone 'mothership' is not available, then a small 3s/4s LiPo battery will make a suitable power source.

A 2s 18500 Li-ion, 2000mAh pack will provide approx 3 hours of operation @ 3W transmitter power (see specifications).

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## Initial Setup - Ground Link

### Control Link binding to the Repeater

Enter the Bind menu on the ground-based IRONghost control transmitter. Select the **GHST** protocol, Set the **Rx ID** to **Repeater**, apply power to the repeater, and start the bind operation.

```
BIND
Start Bind
Rx ProtoGHST
▶Rx ID    Repeater
Rx LQ    CH12
Rx RSSI  None
```



*Note that this binding operation is required only once, to bind a ground-based Ghost Tx to the repeater. Binding models is a separate (simpler) operation.*



Note that the receiver in the repeater is delivered in a special operating mode where it will **ONLY** bind with a transmitter with **Rx ID** set to Repeater.

When this condition is met, it will bind without the need to hold down the button on the hybrid receiver (which is buried in the metal casing).

This mode prevents the hybrid receiver from binding to the JR module embedded in the repeater .

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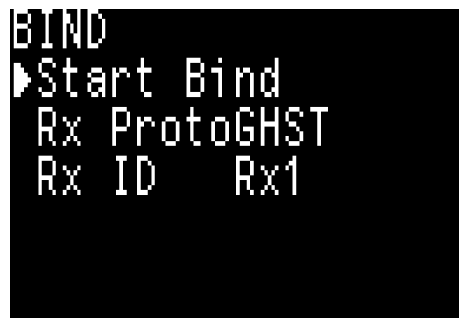
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## Initial Setup - Drone Link

Binding to a newly built drone (with receiver in 'virgin mode', as delivered from the factory), involves simply powering up the drone, and pressing the **Drone Bind** button on the repeater, or alternatively, starting bind using the **Bind** menu on the repeater's OLED.



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## Firmware Updates

Both the Control/Telemetry part of the repeater, and the Video Receiver, are updated using Windows-based tools.

Each of these blocks uses a separate USB-C port, which may be used after power is applied to the repeater.

*NOTE: Ensure that appropriate antennas are installed on the repeater before applying power to update, to avoid transmitter damage.*

Firmware update tools are available from our enterprise support site:

<https://orqaenterprise.freshdesk.com/>

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