

## Rotorcross Australia

### Digital Video System Rules



#### Rule Summary

**Note: These rules currently cover HDZero (previously Sharkbyte or Bytefrost) systems, DJI FPV systems (01 and 02 version systems- to be referred to as DJI systems) and Walksnail Avatar VRX systems (to be referred to as Walksnail systems). Walksnail Avatar systems are currently in testing, so far we have tested with the VRX only and not the goggles. We currently have minimal test data with DJI 03 systems and as yet cannot reliably time or DVR capture from them and therefore cannot currently include them in a race event. Should future digital systems be released, we will endeavour to integrate them with our current system in line with the purpose of these rules.**

It is considered the pilot's responsibility to conform to the rules below, without causing harmful interference to other pilots, or the race director's running of the event:

- 1) Video transmission power must be set to 25mW (in accordance with existing analogue video rules).
- 2) DJI FPV pilots must ensure their video system is in the 25Mbit mode (this can be determined by the number of channels they have available in settings. 50Mbit has half the channels)
- 3) Pilots using the DJI FPV headset (in digital mode) or Walksnail VRX are to pilot their craft from a designated area separated from the non DJI/ Walksnail pilots. Suggested DJI/ Walksnail pilot area is in front of the canteen as this provides the physical separation while remaining behind the safety net. Recommended for Walksnail goggle and VRX units to be powered off when not in use as they may continue broadcasting without a VTX paired.
- 4) Digital pilots must provide a realtime video stream in a format which TracksideFPV can receive and stream alongside the other channels in the race\*. HDZero and analog video feeds are received via the event RX's; **DJI** must provide video stream through a smart controller, Raspberry Pi or similar device to a HDMI input to the PC; and **Walksnail** VRX via a HDMI splitter to a HDMI input to the PC.
- 5) Two or more pilots may agree to share a resource/'ground station' though in the event that multiple of those pilots are in the same heat, only one will be allowed to fly. It is at the race director's discretion to arrange heats so that pilots sharing a ground station do not fly together, and the race director may prioritise smooth event running over separating the pilots to different heats.
- 6) Pilots are expected to be able to reliably trigger the detection of lap times via VTX timing as would an analogue pilot\*.

- 7) Tuning of timing device settings should not negatively impact the reliability for existing, non-digital systems.
- 8) Channels to be adhered to according to the table:

	Analog IMD and HDZero	DJI FPV	Walksnail Avatar VRX
Channel 1	R1 (5658MHz)	DJI1 (5660MHz)	CH1 (5650-5670MHz)
Channel 2	R2 (5695MHz)	DJI2 (5695MHz)	CH2 (5685-5705MHz)
Channel 3	F2 (5760MHz)	DJI4 (5770MHz)**	CH4 (5760-5780MHz)
Channel 4	F4 (5800MHz)	DJI5 (5805MHz)	CH5 (5795-5715MHz)
Channel 5	R7 (5880MHz)	DJI6 (5878MHz)	CH6 (5868-5888MHz)
Channel 6	R8 (5917MHz)	DJI7 (5914MHz)	CH7 (5904-5924MHz)

Failure to comply with the above rules, may result, at the race director's discretion, in disqualification from a heat or round, extreme repeated intentional abuse of the rules may result in disqualification from future events by decision from the committee.

Additional:

\*It is recognised that even on existing analogue systems DVR/video input and VTX timing are prone to error and technical difficulty. Reasonable allowance will be made for similar issues with digital systems as would be for analogue, at the race director's discretion. It is also recognised that the integration of digital FPV systems may be slightly more prone to sub optimal performance but this is considered an acceptable risk. The race director may decide to limit participation of a digital pilot in a round/heat if it is reasonably deemed the digital pilot is negatively affecting the other pilots, just as the race director would do in an all analogue race.

\*\*The "DJI4" channel does not line up as directly with the IMD channel "F2" but testing so far has proven there is sufficient frequency spacing to allow for adjacent pilots on "R2" and "F4" to fly unhindered. Real world behaviour of this combination will continue to be monitored, particularly for intermodulation behaviour with a fully populated heat.

## **Objectives of these Rules**

For the purpose of integrating Digital video transmission systems into the existing race format these rules have been developed. The end goal is to run digital systems such as DJI FPV, HDZero (previously Fatshark Sharkbyte or Bytefrost), Walksnail VRX and future systems alongside the existing analogue transmission and provide greater inclusivity for pilots regardless of the video system they choose to run. Integration should not cause detriment to legacy video systems.

### **The key criteria to be addressed:**

1. Pilots should not cause interference to other pilots
2. The race director PC/trackside should be able to receive and feed in a live video stream of the pilot on their assigned channel
3. VTX timing should reliably detect lap events
4. Pilots should be able to set video transmission to any and all of the frequency bands used on race day (currently these are structured around the IMD spread frequencies of: R1, R2, F2, F4, R7, R8)

### **Interference:**

Digital video systems bring a new set of challenges to sharing the "5.8ghz spectrum". The majority of the test cases have been with the "Bidirectional" nature of the DJI FPV system, with Walksnail still in testing. One of the main identified causes of interference with Digital Video has been the telemetry link from the DJI FPV goggle headset. Another variable some Bidirectional systems bring to the table is the option to not only set a power output on the VTX (Air Unit) but also a bitrate of 25Mbit/s or 50Mbit/s. The 50Mbit/s setting effectively uses two adjacent channels to double its data rate.

Rules to mitigate the **Interference** concerns are:

- Video transmission power must be set to 25mW (in accordance with existing analogue video rules) Bidirectional pilots must ensure their video system is in the 25Mbit mode (this can be determined by the number of channels they have available in setting 50Mbit generally has half the channels)
- Pilots using the DJI FPV headset (in digital mode) or Walksnail goggle/VRX (Bidirectional Pilots) are to pilot their craft from a designated area separated from the non Bidirectional pilots. Suggested Bidirectional pilot area is in front of the canteen as this provides the physical separation while remaining behind the safety net.
- Testing has shown that a metallic shield blocking line-of-sight between Bidirectional VRX's and other pilots can significantly reduce interference as well. Combination of distance and shielding can virtually eliminate complaints of digital interference. A similar technique also has been found to work with timing (see "VTX-Timing").

**Video Out/In:**

As well as being useful for broadcasting races over the internet, DVR provides a video review for the Race Director to check close calls and course compliance. Race management software such as TracksideFPV even provides DVR replay, giving the Race Director even better ability to rule on disputes and confirm race timing in the event of timing system failure or a missed lap time.

Options for video in to the Race PC are:

- HD Zero “Events RX” which accommodates HDZero and analogue video feeds with automatic switching and option of HDMI or CVBS output
- HDMI to USB capture device on the PC, allowing a HDMI feed provided by systems not catered to by the Events RX

Since available digital video systems require specific receiving and decoding hardware, this has been a major hurdle for integrating these systems with existing infrastructure. At the time of writing, the most cost effective video out option for DJI FPV is via a Raspberry Pi (or similar) running “Cosmo-Streamer FPV”. The DJI Smart Controller is a more expensive option from DJI themselves.

Both methods require the pilot's goggles to connect via USB-C where a real time video stream is passed out by HDMI to the USB capture device. These 'ground station' devices are currently the responsibility of the pilot however the club is working on making this part of our regular infrastructure.

Walksnail/Avatar systems provide HDMI out with their goggle and VRX, use of a HDMI Splitter will allow these pilots to provide a real time FPV feed to the race PC.

Rules for the **Video Out/In** concern are:

- Digital pilots must provide a realtime video stream in a format which TracksideFPV can receive and stream alongside the other channels in the race, unless provided for by existing club infrastructure\*.
- Two or more pilots may agree to share a resource/'ground station' though in the event that multiple of those pilots are in the same heat, only one will be allowed to fly. It is at the race director's discretion to arrange heats so that pilots sharing a ground station do not fly together, and the race director may prioritise smooth event running over separating the pilots to different heats.

**VTX Timing:**

Just as Video/DVR feed is considered crucial for reliable, fair and accurate race calling, precise lap timing is an integral part of the racing format. The 'best-practice' method employed widely is the use of an 8-way ImmersionRC Lap-RF VTX timing device. This device measures the signal strength of video transmitters in racing drones and monitors each assigned channel for a 'peak

signal of specific amplitude above a floor level and the rate of rise and fall'. It has been shown that these devices can and will record lap times for the DJI digital FPV system and Walksnail VRX, though additional tuning of the detection settings may be required. Shielding the Goggles/VRX of Bidirectional video systems from the lap timing device has proven effective, along with positioning and aiming the 'field of view' of the timer.

#### Suggested rules regarding **VTX Timing**:

- Pilots are expected to be able to reliably trigger the detection of lap times via VTX timing as would an analogue pilot\*. Tuning of timing device settings should not negatively impact the reliability for existing, non-digital systems.
- When Bidirectional video systems are present, a timer shield can be used to block line of sight between the goggle and the VTX timer.

#### **Channel compliance:**

FPV flight relies on clean transmission of video signals via wireless technology. To achieve the best experience for each individual while allowing as many pilots as possible operating concurrently, the frequencies employed must be carefully selected. Existing club infrastructure and event management procedure has been progressively built and developed around providing an all-round enjoyable experience for as many pilots as possible. The FPV sport has progressed over time to use different sets of channels and bands for video transmission on the '5.8GHz' spectrum. The predominant bands used at time of writing are the "Fatshark band" and "Raceband" with Raceband occupying a wider section of the spectrum. To avoid detrimental interference by overlapping channels, or from intermodulation (production of new output signals which are created from the nonlinear combination of two or more input signals, or 'weird harmonics creating random-ass interference') the club uses a mix of the two bands referred colloquially as IMD frequencies, though IMD does not describe just one set of frequencies. At the time of writing the club uses the channels: R1 R2 F2 F4 R7 and R8 for 6 concurrent pilots, with well tested success. Digital integration will require digital FPV pilots to be able to transmit on compatible frequencies to these. This is to ensure optimal experience of the other pilots sharing the 5.8GHz spectrum, and for the timing system to accurately detect lap events.

Suggested **Frequency Rules** are as laid out in the table;

	Analogue IMD and HDZero	DJI FPV	Walksnail Avatar VRX	Sharkbyte (now superceded and integrated with the analogue IMD channels)
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Channel 1	R1 (5658MHz)	DJI1 (5660MHz)	CH1 (5650-5670 MHz)	SB1 (5660MHz)
Channel 2	R2 (5695MHz)	DJI2 (5695MHz)	CH2 (5685-5705 MHz)	SB2 (5696MHz)
Channel 3	F2 (5760MHz)	DJI4 (5770MHz)**	CH4 (5760-5780MHz)	SB4 (5769MHz)**
Channel 4	F4 (5800MHz)	DJI5 (5805MHz)	CH5 (5795-5815MHz)	SB5 (5805MHz)
Channel 5	R7 (5880MHz)	DJI6 (5878MHz)	CH6 (5868-5888MHz)	SB6 (5878MHz)
Channel 6	R8 (5917MHz)	DJI7 (5914MHz)	CH7 (5904-5924MHz)	SB7 (5914 MHz)

Each frequency in a row can be considered equivalent for channel assignment and will exclude the other frequencies in that row. Example: Pilot A is assigned to R1, so DJI1 and SB1 cannot be in the same race. In the same race Pilot B is assigned DJI4 and so F2 and SB4 cannot be in the same race.

#### Additional:

\*It is recognised that even on existing analogue systems DVR/video input and VTX timing are prone to error and technical difficulty. Reasonable allowance will be made for similar issues with digital systems as would be for analogue, at the race director's discretion. It is also recognised that during this trial phase, the integration of digital FPV systems may be slightly more prone to sub optimal performance but this is considered an acceptable risk. The race director may decide to limit participation of a digital pilot in a round/heat if it is reasonably deemed the digital pilot is negatively affecting the other pilots, just as the race director would do in an all analogue race.

\*\*The "DJI4" channel does not line up as directly with the IMD channel "F2" but testing so far has proven there is sufficient frequency spacing to allow for adjacent pilots on "R2" and "F4" to fly unhindered. Real world behaviour of this combination will continued to be monitored, particularly for intermodulation behaviours with a fully populated heat.

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