

RPAS Symposium 2022

Critical Systems for RPAS Operations: Updates on
C2 Link and Detect and Avoid (Annex 10)

RPAS WG-2 and Spectrum Issues

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RPAS Panel WG-2 -- C2 Links

- RPAS Panel developing C2 Link SARPs:
 - SARPs contained in their own Volume (VI) in Annex 10
- First package of Annex 10, Volume VI, SARPs Adopted by the ICAO Council during its 222nd Session, with Effectivity July 2021
 - Covers the “procedures” associated with the use of C2 Links
- Second package of Annex 10, Volume VI, SARPs amendment proposals endorsed by RPASP 20 in October 2022 and is now awaiting ANC Preliminary Review prior to being sent to States
 - Anticipated Effectivity November 2025
 - Covers the “systems” aspect of C2 Links
 - High level performance requirements to enable safe RPAS operation
 - Communication Service Providers
- Manual on C2 Links for RPAS, first publication due Q4 2023
 - Supporting SARPs and providing guidance on the derivation of required link performance (RLP) and C2 Link Communications Service Provider (C2CSP) operation
 - Technology solutions are covered at a high level
 - Updates to the Manual on C2 Links for RPAS will focus on specific RLPs and specific technology solutions for C2 Link Systems

Terrestrial C2 Link Frequencies

- Annex 10, Volume V, C2 Link frequency bands for terrestrial based C2 Links:
- **4.1.1 General allotment of frequency band 117.975 – 137.000 MHz**
 - *Note 2.—As of 26 November 2026, subject to the conditions stated in 5.2.1, the frequency 136.925 MHz may be used for the provision of remotely piloted aircraft systems (RPAS) C2 Link communication services described in Annex 10, Volume V, Chapter 5.*
- **4.2 Utilization in the frequency band 108 – 117.975 MHz**
 - *Note 3.— As of 26 November 2026, subject to the conditions stated in 5.2.1, the frequency 113.250 MHz may be used for the provision of RPAS C2 Link communication services described in Annex 10, Volume V, Chapter 5.*
- **4.3 Utilization in the frequency band 960 – 1 215 MHz for DME**
 - *Note 2.— As of 26 November 2026, subject to the conditions stated in 5.2.1, the frequency band 960 – 1 164 MHz may be shared with RPAS C2 Link communication services described in Annex 10, Volume V, Chapter 5.*
- **4.4 Utilization in the frequency band 5 030 – 5 091 MHz**
 - *Note 3.— As of 26 November 2026, subject to the conditions stated in 5.2.1, this frequency band is shared with RPAS C2 Link terrestrial communication services in the portion 5 030 – 5 091 MHz, as described in Annex 10, Volume V, Chapter 5.*
- *5.2.1 Terrestrial RPAS C2 Link systems shall operate in bands allocated to the Aeronautical Mobile (Route) Service (AM(R)S). Frequency bands with such allocations include 113.250 MHz and 136.925 MHz (common signaling frequencies for VDL Mode 4), 960-1164 MHz and 5030-5091 MHz. The operation of the C2 Link within any of these bands shall be implemented so as to be compatible with the systems currently using these allocations. Compatibility shall be ensured through the development and application of necessary SARPs and determined on the basis of regional air navigation agreements.*

Satellite Based C2 Link Frequencies

- Annex 10, Volume V, C2 Link frequency bands for satellite based C2 Links:
- **5.1.1 a)** *frequency bands with an appropriate allocation to aeronautical safety services under the aeronautical mobile satellite (route) service (AMS(R)S). Frequency bands that meet these criteria and can be used for RPAS C2 Links, subject to the conditions associated with the allocations, are: 1 610 – 1 626.5 MHz and 5 000 – 5 150 MHz;*
- **5.1.1 b)** *frequency bands with an allocation to aeronautical safety services under the mobile-satellite service (MSS) where AMS(R)S operations have priority access. Frequency bands that meet these criteria and can be used for RPAS C2 Links are: 1 545 – 1 555 MHz and 1 646.5 – 1 656.5MHz;*
- **5.1.1 c)** *frequency bands with an allocation to the fixed satellite service (FSS) where the conditions in ITU Resolution 155 (WRC-15) are met. Frequency bands in which this resolution applies are:*
 - 10.95 – 11.2 GHz (space-to-Earth);
 - 11.45 – 11.7 GHz (space-to-Earth);
 - 11.7 – 12.2 GHz (space-to-Earth) in Region 2;
 - 12.2 – 12.5 GHz (space-to-Earth) in Region 3;
 - 12.5 – 12.75 GHz (space-to-Earth) in Regions 1 and 3;
 - 19.7 – 20.2 GHz (space-to-Earth);
 - 14.0 – 14.47 GHz (Earth-to-space); and
 - 29.5 – 30.0 GHz (Earth-to-space)

with an ITU satellite earth station class of “UG”.

Conditions on the use of FSS

- Annex 10, Volume V, C2 Link frequency bands for satellite based C2 Links - use of the FSS Bands is subject to:
 - **5.1.2** Remotely piloted aircraft (RPA) and remote pilot station (RPS) earth stations shall operate within the notified and recorded technical parameters of the associated satellite network, including specific or typical earth stations as published by the ITU.
 - **5.1.3** RPA and RPS earth stations operating in accordance with 5.1.1 c) shall use FSS assignments that have been successfully coordinated under Article 9 of the ITU Radio Regulations and recorded in the Master International Frequency Register (MIFR) with a favourable finding under Article 11 of the ITU Radio Regulations including Nos. 11.31, 11.32 or 11.32A where applicable, and except those assignments that have not successfully completed coordination procedures under No. 11.32 by applying Appendix 5 paragraph 6.d.i of the ITU Radio Regulations
 - *Note 1.— UG is an earth station on board an unmanned aircraft communicating with a space station of a geostationary-satellite network in the fixed-satellite service for the control and non-payload communications of unmanned aircraft systems in non-segregated airspaces in the frequency bands listed under resolves 1 of ITU Resolution 155 (WRC-15).*
 - *Note 2.— Particular note needs to be taken of the timing and order of functions as delineated in ITU Resolution 155 (WRC-15), and in particular the references to necessary actions.*

Conditions on the use of FSS

- ITU-R Resolution 155 - Use of the identified FSS Bands by UAS:
- Provides the basis for the use of some Fixed Satellite Service allocations by mobile aeronautical Earth stations (aka RPA) requiring safety-of-life related communications
- In some allocations and regions of the world the resolution must provide protection of the co-primary terrestrial services from these mobile aeronautical Earth stations
- FSS bands are not AMS(R)S, so ICAO SARPs must provide the equivalent safety protection through procedures and technical requirements that would be given by an AMS(R)S allocation
- Complex set of State (interference = ITU-R and safety = ICAO) responsibilities for preventing and responding to safety related inference
 - State responsible for licensing the use of the satellite, not the same as
 - State responsible for accepting the levels of interference, not the same as
 - State responsible for setting the flight safety requirements, not the same as
 - State responsible for certifying the RPAS design, etc.

DAA Spectrum

- Cooperative Systems
 - ACAS
 - ADS-B
- Radars operate in two types of spectrum
 - Radionavigation
 - Radiolocation
- Definitions (ITU-R Radio Regulations)
 - *radionavigation*: Radiodetermination used for the purposes of navigation, including obstruction warning.
 - *radiolocation*: Radiodetermination used for purposes other than those of radionavigation.
 - *aeronautical radionavigation service*: A radionavigation service intended for the benefit and for the safe operation of aircraft.

DAA frequency bands identified in ITU-R Report M.2204

- 1300-1350 MHz Ground based only
- 2700-2900 MHz Ground based only
- 5350-5470 MHz Airborne only
- 8750-8850 MHz Airborne only
- 9000-9200 MHz Ground Based only
- 9300-9500 MHz Airborne only
- 13.25-13.40 GHz Airborne Only
- 15.40-15.70 GHz Airborne and Ground
- 24.45-24.65 GHz Airborne and Ground (western hemisphere)

- ITU-R Report M.2204
<https://www.itu.int/pub/publications.aspx?lang=en&parent=R-REP-M.2204-2010>

Thank You