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**Background information regarding compatibility studies between low power audio PMSE[[1]](#footnote-1) and aeronautical systems in the band 960 to 1164 MHz**

## Introduction

In many CEPT administrations low power audio PMSE[[2]](#footnote-2) has access to the band 470 to 790 MHz on a shared basis with Digital Terrestrial Television broadcasting, and this provides the main spectrum resource for audio PMSE. However, at the World Radio Conference 2015 the band 694 to 790 MHz (the 700 MHz band) was allocated on a co-primary basis to the mobile service (alongside the broadcasting service), and as administrations start to make the band available for new mobile broadband services some, or all, of the band will cease to be available for use by PMSE.

The amount of spectrum access lost to PMSE depends on national decisions, for example some administrations may continue to allow access in the guard band (694 to 703 MHz) and/or the duplex gap (733 to 758 MHz) but other countries may remove access to the whole band (see ECC decision (15)01 on the harmonisation of the 694-790 MHz frequency band for MFCN which provides in particular national flexibility for PMSE). European Union Member States are subject to the Commission Implementing Decision (EU) 2016/687. The European Parliament and Council has confirmed the date by which the 694 to 790 MHz band must be made available in Member States is 30 June 2020.

In its analysis, the UK concluded that in order to mitigate the loss of the 700 MHz band for PMSE an alternative spectrum sharing opportunity for audio PMSE was required. After carrying out theoretical and practical coexistence studies the UK consulted on making the band 960 to 1164 MHz available for PMSE, on a shared basis with aeronautical civil and military radio navigation and communication services. After reviewing responses to the consultation the UK made the band available to low power (<17 dBm) audio PMSE in March 2016[[3]](#footnote-3).

To date only the UK has made this band available to PMSE, but in its 86th meeting WG FM considered a request to ask WG SE to carry out coexistence studies between low power audio PMSE and aeronautical systems in the band.

In response to the WGFM request, PT FM 51 has carried out a review of the current/future aeronautical usages in the 960-1164 MHz band (see hereafter), and some possible interference scenarios to be considered regarding the compatibility studies between low power audio PMSE and incumbent systems. At its 87th meeting WG FM sent a letter to ICAO advising them of the work and inviting them to participate in the studies and to provide information on aeronautical systems and parameters.

## Use of the band 960 to 1164 MHz

The following tables provide preliminary information on systems designed for use in the band 960-1164 MHz. It should be noted that some of the uses quoted may extend beyond the band and the lists of systems may not be complete.

## Civil radionavigation and communication systems

Table 1: Civil aeronautical systems currently in use in the band 960 to 1164 MHz

| System | Frequency (MHz) | Notes |
| --- | --- | --- |
| Distance Measuring Equipment (DME/TACAN) | 962-1164 Note 1 | Aircraft (interrogator) determines slant range to a ground beacon (transponder) at a known location based on round trip timing of pulses. Aircraft transmits and ground beacon replies on an assigned pair of frequencies separated by 63 MHz both using omnidirectional antennas – for some operational requirements the ground antenna may be directional. Multi-channel interrogators use simultaneous ranging to multiple transponders for the aircraft to determine its location via a multilateration process. DME/TACAN channelisation is across the 960 – 1215 MHz band. |
| Secondary Surveillance Radar | 1030 (Gnd Tx, limited Air Tx, Air Rx)  1090 (Air Tx, Gnd Rx, limited air Rx) | Ground (interrogator) at a known location determines azimuth and slant range of aircraft transponder based on round trip timing of pulses. Ground transmissions on 1030 MHz, using a rotating, high gain antenna; all aircraft reply omnidirectionally on 1090 MHz. Different SSR Modes (A, A/C, S) have different additional capabilities with different signal structures including a data channel. Mode A codes aircraft identity, A/C codes identity and aircraft derived altitude, Mode S as for A/C with ability to selectively call  specific aircraft / request other aircraft data. There is also limited use of airborne interrogators transmitting on 1030 MHz and receiving on 1090 MHz. |
| Far Field Monitors (FFM) | 1090 (Gnd Tx)  1030 (Gnd Rx) | SSR interrogators have up to two ground based monitors at fixed locations several nautical miles from the interrogator to provide constant confirmation of correct operation and monitoring of health and performance of interrogators |
| Automatic Dependent Surveillance-Broadcast (ADS-B) | 1090 (Air Tx, Air, Gnd and space Rx) Note 2 | Air to air, air to ground, air to space datalink. Provides aircraft identity, aircraft derived (hence “dependent”) position plus other data. An extension of the SSR Mode S data set (also permitted to be received in space following an allocation by WRC-15). Aircraft fit could be part of SSR transponder or a separate transmitter / receiver. |
| Airborne Collision Avoidance System / Traffic Collision Avoidance System (ACAS/TCAS): | 1030 and 1090 (Air Tx and Rx) | Aircraft system on both 1030 and 1090 MHz operating independently of ground-based equipment and air traffic control in warning pilots of the presence of other aircraft that may present a threat of collision. If the risk of collision is imminent, the system initiates a manoeuvre that will reduce the risk of collision. |
| Multilateration systems (MLAT) | 1030 (Gnd Tx, Air Rx)  1090 (Gnd and Air Tx, Gnd Rx) | Largely passive network of ground receivers (of order of 40 to 50 for a large airport) to enable independent determination of aircraft (and suitably equipped ground vehicle) position on or near an airport using difference in time of arrival techniques based upon SSR Mode S transmissions. MLAT systems also have several ground based 1030 MHz emitters to elicit additional replies from aircraft transponders where necessary .and 1090 MHz emitters to provide constant confirmation of correct system operation |
| Wide area multilateration (WAM) | 1030 (Gnd Tx, Air Rx)  1090 (Gnd and Air Tx, Gnd Rx) | Similar to MLAT but over a wider geographic area and typically having a greater reliance on active interrogation at 1030 MHz to augment SSR- and Mode S based Radar detection of aircraft. |
| RSBN (Radiosystem of short range navigation) | 960-1164 | A civil/military Aeronautical Navigation system operates under an ITU footnote RR 5.312 which is a non-ICAO aeronautical system. RSBN provides information for approach / landing and En Route navigation similar to ILS, VOR, DME and TACAN. |

Note 1: Airborne transmissions limited to 1025-1150 MHz

Note 2: 978 MHz is also used for ADS-B (known in this case as Universal Access Transceiver) and it is increasingly being used for RPAS/drones but is not currently implemented in Europe

Table 2: Future Civil aeronautical systems in the band 960 to 1164 MHz

| **System** | **Frequency (MHz)** | **Notes** |
| --- | --- | --- |
| L Band Digital Aeronautical Communication System (LDACS) | 960-1164 | LDACS received an allocation between 960 to 1164 MHz at the WRC 2012 and is presently under standardization by ICAO. LDACS is envisaged to use a cellular point-to-multipoint concept, which means that the airspace is segmented into cells. In each cell, all aircraft are connected to a centralised ground station which controls the entire air/ground communication within the cell. It is designed as a frequency-division duplex system, preferably deployed using an inlay approach, interleaving with DME. Expected to be introduced in the mid-2020s. |
| Mode S Phase overlay | 1090 | Additional Phase Overlay modulation to the 1090 MHz Mode S telegram to enhance the data throughput to ~ 4 MB/s. Currently under standardization within ICAO  1090 MHz transmission and reception |
| Remotely Piloted Aircraft System / Unmanned Aircraft System | 960-1164 | (RPAS/UAS) command and control: systems under development – could be introduced if seen as a viable solution. RTCA completed Phase 1 of Mops for use in the USA. |

## Military radionavigation and communication

Table 3: Military aeronautical systems currently in use in the band 960 to 1164 MHz

|  |  |  |
| --- | --- | --- |
| System | Frequency (MHz) | Notes |
| Tactical Air Navigation (TACAN) | 962-1164 Note 1 | Similar to DME in that it allows determination of slant range from aircraft to a known location but with the addition of further modulation(s) that allow aircraft to determine their bearing from the ground beacon. TACAN is also used in an air-to-air mode and used by Civil Aviation as DME. |
| Interrogation Friend or Foe (IFF) | 1030 and 1090 | Mode 4 and it’s successor IFF Mode 5 operating on the SSR frequencies 1030 and 1090 MHz, since about 1980. Employs different modes (signal structures) with different capabilities. |
| Joint Tactical Information Distribution System/Multifunctional Information Distribution System (JTIDS/MIDS) – also known as Link16 | 51 channels across the range 969 to 1207Note 2 | Link16 is a multi-platform (air, ground, sea) military datalink and communications system providing secure, flexible and highly survivable communications links which are resistant to jamming. The system employs TDMA and frequency hopping, spread spectrum over 51 distinct channels. Equipment is required to use standardised additional capabilities to mitigate risks of interference to aviation systems. |
| RSBN (Radiosystem of short range navigation) | 960-1164 | A civil/military Aeronautical Navigation system operates under an ITU footnote RR 5.312 which is a non-ICAO aeronautical system. RSBN provides information for approach / landing and En Route navigation similar to ILS, VOR, DME and TACAN. |

Note 1: Airborne transmissions limited to 1025-1150 MHz

Note 2: A frequency remapping of the 51 channels for JTIDS/MIDS is currently being considered in order to increase the protection of GNSS reception. This would lead to a reduction in the number of frequencies used by JTIDS/MIDS, and a corresponding increase in the usage of the remaining frequencies

## Use of the adjacent bands below 960 MHz and above 1164 MHz

## Mobile below 960 MHz

Within the ITU Radio Regulations the band 942 to 960 MHz is allocated to the mobile service and the band is used for MFCN (GSM, UMTS, LTE) throughout Europe.

## Radio navigation satellite service (RNSS) above 1164 MHz

Within the ITU Radio Regulations the band 1164 to 1215 MHz is also allocated to the RNSS. Specific satellite signals are Galileo E5a and E5b (1176.45 and 1207.14 MHz), GPS L5 (1176.45 MHz) and GLONASS G3 (1207.14 MHz).

## Possible scenarios for compatibility studies

For compatibility studies there are principally four interference scenarios to consider between low power audio PMSE and aeronautical systems in the band 960 to 1164 MHz (note that airborne use of PMSE is not a requirement):

1. Interference from indoor/outdoor PMSE transmission into airborne receivers of the aeronautical systems;
2. Interference from airborne transmissions of the aeronautical systems into indoor/outdoor PMSE receivers;
3. Interference from indoor/outdoor PMSE transmission into ground receivers of the aeronautical systems; and
4. Interference from ground transmission of the aeronautical systems into indoor/outdoor PMSE receivers.

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1. Programme Making and Special Events [↑](#footnote-ref-1)
2. Wireless microphones and in ear monitors [↑](#footnote-ref-2)
3. http://stakeholders.ofcom.org.uk/binaries/consultations/new-spectrum-audio-PMSE/summary/new-spectrum-audio-pmse.pdf [↑](#footnote-ref-3)