PMSE IN AIRCRAFT FREQUENCIES?

INTRODUCTION

In the Radio Band 960 to 1215 MHz (sometimes named as Aircraft Frequencies or DME Band) is mainly operated the Distance Measuring Equipment (DME), a transponder-based radio navigation technology.

This Radio Band is currently in study, if Audio PMSE can be operated there. Therefore, in the text below we present some details and like to invite our homepage reader for discussion and/or to present further information.

SYSTEMS OPERATED IN 960 TO 1215 MHZ

(Section updated in February 2018)

Among others the following services are currently operating in this band:

- Airborne Collision Avoidance System (ACAS)
  - ➔ see also Traffic Collision Avoidance System (TCAS)
- Automatic Dependent Surveillance – Broadcast (ADS-B)
- Distance Measuring Equipment (DME)
- Secondary Surveillance Radars (SSR)
- TACtical Air Navigation (TACAN) System
- Global Navigation Satellite System (GNSS)
- Joint Tactical Information Distribution System (JTIDS)
- Multifunctional Information Distribution System (MIDS)
- Multilateration (MLAT)

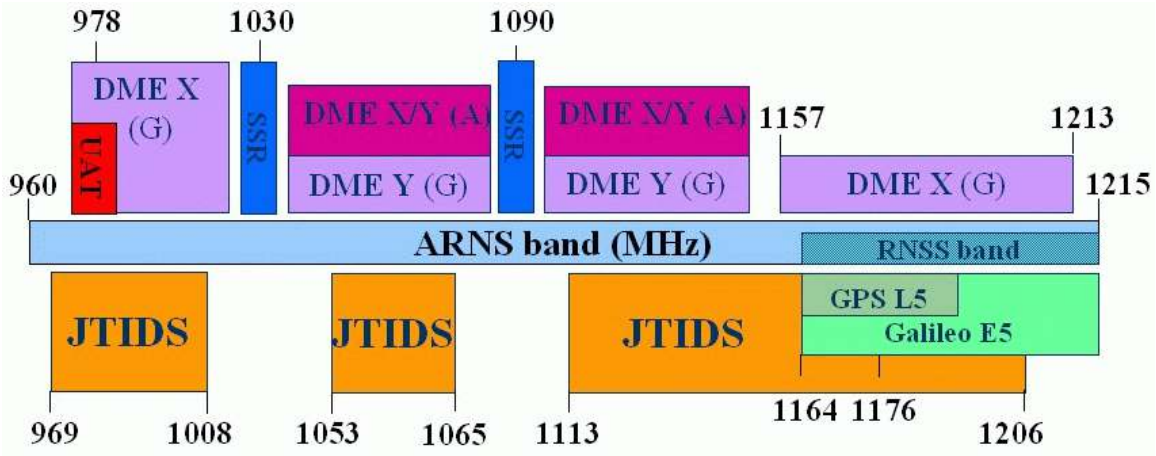
- Identification Friend or Foe, Mode 1 to 5 (IFF)
- Reverse-Identification Friend-Foe (Reverse IFF)
- Radiotechniczny System Bliskiej Nawigacji (RSBN)
- Wide Aera Multilateration (WAM)

Further systems will be operated in this band. For example, still in research might be L-DACS.

Update: already end of 2014 ICAO was noting the Status of LDACS Development.

In addition, WRC-15 agreed the implementation of a new Flight Tracking System.

This might be operated in the lower band segment, e.g. GFT in 1087.7-1092.3 MHz.



Picture 1: Various frequency allocations in the 960-1215 MHz, Source: Navigation System Panel at WRC-07

STUDY OF UNIVERSITY ERLANGEN-NÜRNBERG PRESENTED

(Section added in May 2019)

FAU University Erlangen-Nürnberg studied methods for improving compatibility of PMSE operation with "Airband" (960-1164 MHz) applications. For that purpose an advanced receiver concept is developed that conducts interference cancelation for DME (Distance Measurement Equipment) signals.

Two main ideas were studied.

First a blanking scheme is studied that blanks the PMSE received symbols during occurrence of DME pulses.

During blanking softbit information will carry 50:50 chance for "1" versus "0". Bundling errors are broken up by deinterleaving. As a result this will lead to improved softbit quality entering channel decoder, which runs sequence estimation.

With the second interference cancelation scheme FAU tries to reconstruct the DME signals and subtracting it from the received PMSE symbols.

It is expected that the second scheme will deliver higher robustness, however it requires careful estimation of phase and frequency offset of DME signal.

In May 2019, M.Sc. Florian Irnstorfer, Student of FAU, presented the output of his Master Thesis:

Advanced Receiver Design for Cancellation of DME Interference into PMSE [3.073 KB]

Detailed information can be found in this document:

Master Thesis of M. Sc. Florian Irnstorfer [6.239 KB]

For further info please contact Prof. Dr.-Ing. Georg Fischer at:
mailto:georg.fischer@fau.de

Note: FAU acknowledges support by a fund from APWPT.

STUDIES IN CEPT

(Section added in April 2020)

Publication of the finlly agreed ECC Report 306 by CEPT ECO

CEPT investigations on possible usage of low power audio PMSE in the band 960-1164 MHz

(Section added in March 2020)

The 52nd ECC Plenary agreed ECC Report 306. From now on, the relevant administrations can take decisions on national spectrum use into account, based on the available information.

(Section added in January 2020)

In December 2019, the meeting of CEPT FM PT51 focused on reviewing the consolidated document, reviewed and resolved the changes proposed in the public consultation. The resolved version of the reviewed Report will now be considered at CEPT WGFM (from February 10, 2020). Assuming the comment resolutions are agreed by WGFM the report will be approved by WGFM and then move forward to the next ECC meeting (from March 3, 2020) where publication should be finally agreed.

(Section added in May 2019)

CEPT has mandated two working groups to conduct studies, FM51 and SE7.

This work item is in two parts:

1) Identify and scope out the requirements for possible compatibility and sharing studies by WG SE tobe presented to the 87th meeting of WG FM for consideration (completed).

2) Carry out preliminary investigations on regulatory and legal issues and on the feasibility in the band by May 2018 - in a draft internal report to WG FM (completed).

3) Further developing the report on "Preliminary investigations on regulatory and legal issues on the feasibility of introducing low power audio PMSE in the band 960-1164 MHz" (see No. 2) for completion by June 2019 (completed).

4) Preparation of an ECC Report on CEPT investigations on possible usage of low power audio PMSE in the band 960-1164 MHz for approval by ECC in July 2019 (public consultation) / March 2020 (final approval completed).

(Source of this information CEPT)

Links: CEPT FM PT51 - PMSE / CEPT SE 7 - Compatibility and sharing issues of mobile systems

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QUESTION BEFORE PMSE STARTS IN 960 TO 1215 MHZ

(Section updated in October 6, 2016)

With regards to current discussion in UK, we summarize:

1) Legal Aspects with reference to Aviation Safety

In the case of an air traffic accident, caused by interference to systems and equipment belonging to the safety of life service Aeronautical Radio Navigation

System (ARNS) in the band 960 -1215 MHz, what is the liability of PMSE operators when PMSE signals are identified to be at least in part the cause for the accident?

Will operation of PMSE equipment operating on frequencies and within the parameter assigned by OFCOM relieve PMSE operator of any responsibility at a later date, when research concludes that that signals originating from PMSE equipment alone or in combination with other signals from non ARNS systems in the band, like JTIDS/MIDS, are responsible?

Evaluation: This position is legally controversial. A dispute before the court takes a long time and is expensive.

2) Aircraft World might change

Will PMSE operators receive financial reimbursement and new frequency band compensating for their investment into PMSE equipment operating in the band 960 to 1215 MHz, if more stringent protection is found to be necessary for existing ARNS systems. In addition, if new aeronautical systems and equipment are standardized and put into operation, such as Modes S phase overlay or L-Band Digital Communication System (LDACS) where does that leave the PMSE user?

Note: see below the section "Expected Effect of new LDACS1 System"

3) PMSE Quality Assurance

Aviation Products are subject to strict quality control. If PMSE share Air bands, there is the question whether PMSE must meet similar requirements in the future. Who will take responsibility for problems?

4) Who will pay finally?

Will PMSE operator be reimbursed for payment withheld or refused if the program making product delivered is found substandard due to interference by signals generated in the band 960 - 1215 MHz?

EXPECTED EFFECT OF NEW LDACS1 SYSTEM

In current discussions it is suggested that PMSE is to be operated in the gaps between DME channels. But these frequencies have been discussed for a number of years with regards to the implementation of a new L-DACS 1 system. This might have a significant impact on the remaining empty DME gaps that can be used for PMSE.

Get further information in this presentation: LDACS1 - Overview and Current Status [803 KB]

MOBILE SPECTRUM RECORDING IN UK

(Section added in August 2016)

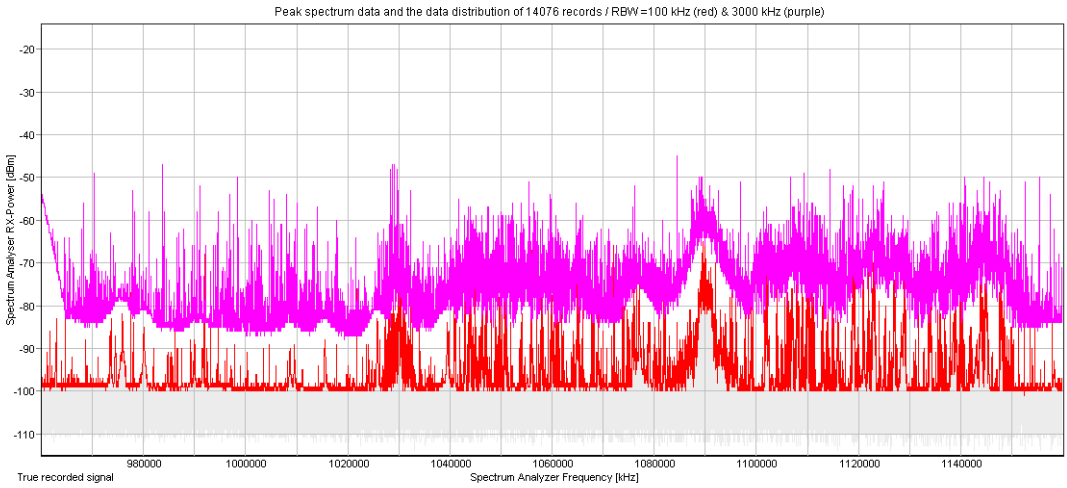
In late 2015 Ofcom UK consulted on the possible future use of two new frequency bands for audio PMSE. They were; 960-1164 MHz and 1525-1559 MHz. In the end, Ofcom UK decided, that of the two bands, 960-1164 MHz (the air band) was the most suitable. Therefore, the APWPT made a scanning roundtrip over about 1500 km across the United Kingdom. For the first time, a spectrum recording of the band 960 to 1170

MHz was carried out, seen through the eyes of the current PMSE technology (e.g. in the antenna size and the audio PMSE receiver class B/C).

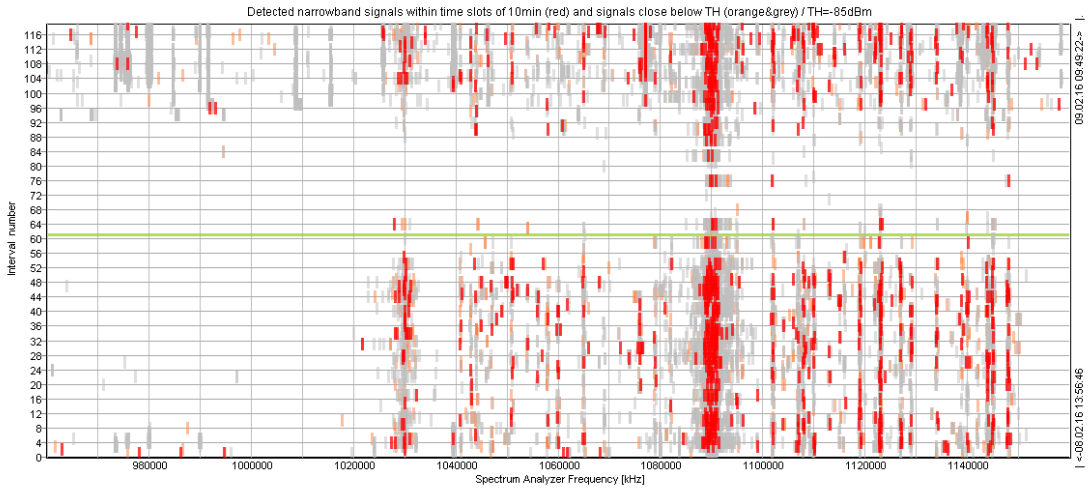
APWPTs Report: Spectrum Recording in UK [5.439 KB]

SPECTRUM SCANS

Spectrum scans can show the distribution and density of operated wireless devices. The pictures below show a typical indoor scenario.



Picture 2: In a time frame of about 8 hours were aggregated the scans of a professional Spectrum Analyser. One can see, the DME band is completely in use, Source: APWPT



Picture 3: Timing of narrowband signals close or above a threshold of -85 dBm, Source: APWPT

What's the problem in this spectrum recording?

- For several hours the lower spectrum is completely empty
- But later we see an intensive spectrum use in the lower band

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HOW TO SET-UP YOUR SPECTRUM ANALYSER?

If you are interested in further spectrum scans, how to set-up your Spectrum Analyser?

The typical default configuration of your Spectrum Analyser will show incorrectly the signals in band 960 to 1215 MHz. Therefore, it is suggested to set-up your scanner to this parameter:

- Detector; set to (Positive) Peak
- Resolution bandwidth; set to..
- ..1) 100 kHz (for scans using PMSE bandwidth) and/or
- ..2) 1 or 3 MHz (for scans using DME bandwidth)
- Sweep Counter; set to 1
- Sweep Time; set 5 times higher that default Sweep Time value
- Trace Mode; set to Max Hold

Please note: Below 960 MHz are operated a number of high-power application. This might provide interference to your scans. Therefore it is suggested to add a High-Pass Filter, i.e. NHP-1000+, close to input of Spectrum Analyser.

Feel free for any comments to office@apwpt.org

HOW TO SUMMARIZE RF SCANS THAT CAN BE COMPARED?

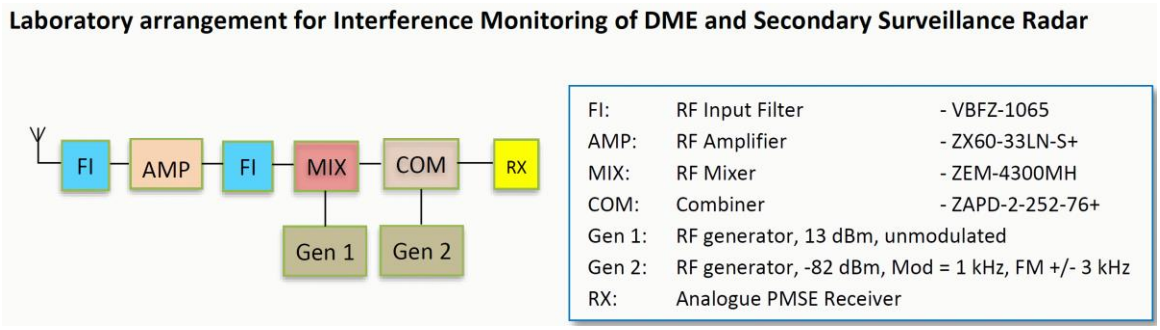
Above, the Picture 2 and 3 were made by a special scanning software, "PMSE Occupation Recorder". This a tool of the PMSE working group in German DIN/VDE.

If you are interested on further information send a mail to mailto:office@apwpt.org.

HOW TO GET INFORMATION ON PMSE INTERFERENCE?

So far we know, there is now PMSE on market that can be operated in 960 to 1215 MHz.

If the DME band signal will be mixed down to an existing PMSE tuning range, the effect of interference can be studied.



Picture 4: Test Set-Up, Source: APWPT

LINKS TO DATA SHEETS OF USED RF COMPONENT

Combiner ZAPD-2-252-N+ or ZAPD-2-252-S+: ZAPD-2-252.pdf

RF Amplifier ZX60-33LN-S+: ZX60-33LN+.pdf

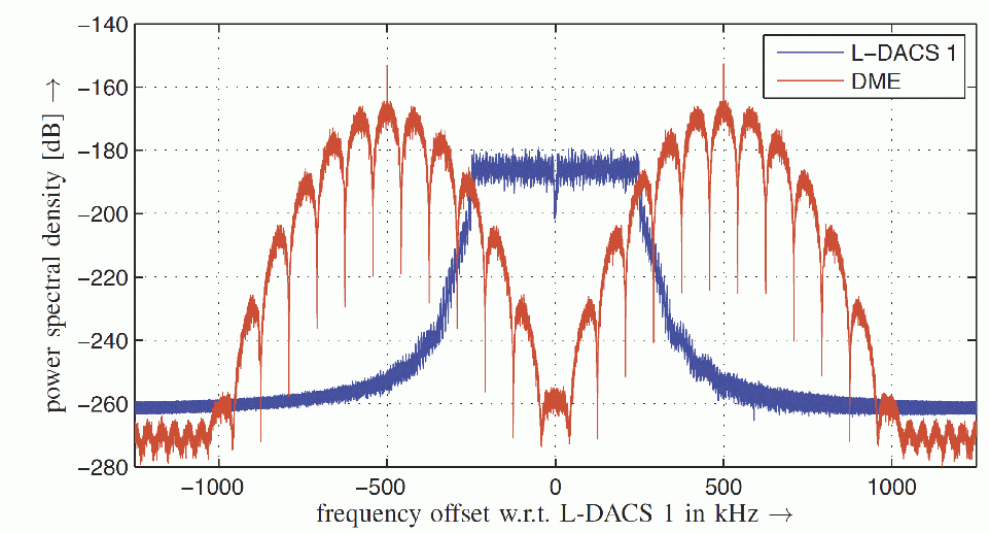
RF Mixer ZEM-4300MH: ZEM-4300MH.pdf

RF Filter VBFZ-1065: VBFZ-1065+.pdf

PMSE OPERATION BETWEEN TWO DME SIGNALS

DME is operated in a 1 MHz channel grid. There is the question if PMSE can be operated in between.

The DME signal behaviour was examined by scientific facilities. Find below a typical picture:



Picture 5: L-DACS 1 and DME signals with frequency offsets -500 kHz and +500 kHz, Source: {hirschbeck,huber}@LNT.de at SCC 2015

There is the question how the PMSE operation is affected in those scenarios?

PLEASE LISTEN A FEW TYPICAL SOUND FILES

Find below two indoor-recorded Sound Files. Please note:

The Sound will change if different PMSE are operated or the sound test will take part on a different Location.

- INDOOR DME SOUND IN AN ADJACENT CHANNEL SCENARIO
- INDOOR DME SOUND IN A CO-CHANNEL SCENARIO