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| **Radiocommunication Study Groups** |  |
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| Source: Document 5A/TEMP/127 | **Annex 10 toDocument 5A/359-E** |
| **12 May 2021** |
| **English only** |
| Annex 10 to Working Party 5A Chairman’s Report |
| Preliminary Draft New Report ITU-R M.[AMATEUR.CHARACTERISTICS] |
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# 1 Introduction

[The frequency band 1 240-1 300 MHz is allocated worldwide to the amateur service on a secondary basis and has been used for a range of applications. The amateur-satellite service (Earth‑to-space) may operate in the frequency band 1 260-1 270 MHz under No. **5.282** of the Radio Regulations.

The frequency band 1 240-1 300 MHz is also allocated worldwide to the radionavigation-satellite service (RNSS) in the space-to-Earth direction on a primary basis. Many RNSS systems are operational and various types of RNSS receivers are being in use. Report ITU-R M.2458 summarizes the RNSS applications in this frequency band.

Some cases of harmful interference caused by emissions from the stations in the amateur service into RNSS (space-to-Earth) receivers have been observed. Furthermore, number of similar interference cases may be increased, unless proper guidelines to protect RNSS (space-to-Earth) from the amateur and amateur-satellite services are implemented. Thus, this potential interference issues need to be studied.

In this regard, Resolution **774 (WRC-19)** invites ITU-R to study possible technical and operational measures to ensure the protection of RNSS (space-to-Earth) receivers from the amateur and amateur-satellite services in the frequency band 1 240-1 300 MHz, without considering the removal of these amateur and amateur-satellite service allocations.]

# 2 Amateur and amateur-satellite service band plans in the 1 240‑1 300 MHz frequency band

Before going into the details of the individual amateur and amateur-satellite services applications in the 1 240-1 300 MHz frequency band it is necessary to understand the general way in which amateur and amateur-satellite services activities are organised to maximise usage of the various frequency bands and minimise interference between incompatible amateur service applications. This is achieved through the use of band plans which recommend where particular applications are used within each amateur and amateur-satellite service allocations. The International Amateur Radio Union (IARU) develops such band plans on behalf of all amateur services.

[The IARU coordinates and represents the interests of radio amateurs through its national member-associations. Three IARU regional organizations correspond to the ITU Radio Regions and are recognized as representing the amateur and amateur-satellite services by the regional telecommunications organizations.] [*20210429 Ed: Keep for now*]

Amateur and amateur-satellite services band planning is achieved on a regional basis in order to take into account the regional differences with the frequency allocations. The current IARU recommended band plans for the frequency range 1 240-1 300 MHz across the three regions are summarized in Table 1.

The usage of the frequency range by the amateur and amateur-satellite services is driven by the varied operational and experimental interests of the users themselves. To support this, each regional band plan is developed to maintain order, avoid conflict and interference between amateur service applications, provide understanding of the most suitable frequencies for specific activities and form a basis for intra and inter-service coordination when required.

The band plans are not mandatory in regional regulations but are strongly recommended for adoption and in general are followed by the individual national societies. In some cases, the regional IARU band plan may be adopted to some extent in national regulations, and it may need to be adjusted on a national basis to facilitate national coordination and sharing with other services in the band.

Respecting the band plan is common practice in the amateur service and is necessary to facilitate successful radio contacts especially between countries and for inter-regional communications.

The band plan is reviewed periodically and may be adjusted to reflect new technologies and evolving applications in the amateur services. External influences driven by the requirements to share with other services can also be taken into account. The regional band plans are maintained, published and approved by the IARU regional bodies. The band plans are continually reviewed nationally and regionally and evolve as new amateur experimentation and operational modes or applications emerge.

The published band plans for each of the three regions may differ and may not be fully harmonised at the detailed level for every amateur service application. However, it is necessary to harmonise parts of the band for specific applications where these could involve inter-regional communications. This applies particularly to parts of the band recommended for narrowband weak signal applications.

Furthermore, the blocks identified for ATV use can accommodate a number of systems depending on the bandwidth occupied by the technology in use. The actual assignments are planned on a national basis.

Table 1

Global Summary of amateur service and amateur-satellite-service IARU band plans

| Frequency range (MHz) | Applications | Comments |
| --- | --- | --- |
| 1 240-1 260 | Low bandwidth telegraphy, voice and data modes up to around 20 kHz.Amateur TV (ATV using Analogue or Digital technologies).  | Organised into channelized groups for voice and data applications in some regions.One 16.75 MHz block is identified for ATV in this range in Region 1.Two 6 MHz blocks are identified for ATV in Region 2. |
| 1 260-1 270 | Satellite uplink band. | In Region 2 simplex ATV is also identified for experimental use in this range. |
| 1 270-1 296 | Low bandwidth telegraphy, voice and data modes up to around 20 kHz.Amateur TV (ATV using Analogue or Digital technologies).  | Organised into channelized groups for voice and data applications in some regions.One 18.994 MHz block is identified for ATV in this range in Region 1.Two 6 MHz blocks are identified for ATV in Region 2. |
| 1 296-1 297 | Low bandwidth telegraphy, voice and data modes up to 3 kHz. | Focused on narrowband weak signal applications in all three regions including beacons. No channelization. |
| 1 297-1 300 | Low bandwidth voice and data modes up to around 20 kHz. Medium bandwidth data up to 150 kHz bandwidth. | Organized into channelized groups for voice and data applications in some regions. |

# 3 Applications and typical operational characteristics of the amateur and amateur-satellite services operating in the frequency band 1 240‑1 300 MHz

## 3.1 Amateur and amateur-satellite applications and station categories

The detailed list of amateur and the amateur-satellite services applications in the band 1 240‑1 300 MHz can be divided into three categories:

1) Home station

This refers to equipment located at the station licence holder’s home address.

2) Temporary “portable” station

A temporarily sited station is usually located in an advantageous position (usually high ground) away from a home station location and operational for a short period radiosport contest, an experimental long-distance communication test or a time-limited special activity event.

3) Permanent installation (sometimes referred to as “automatic” or “unmanned” stations)

Permanent installations refer to stations installed away from a home station. They operate as propagation beacons, voice, amateur television (ATV) or data repeaters. As permanently installed stations, these are licensed by the national authority in their own right for their designated location, operating frequency and output power. The licence and responsibility of the station operation are usually associated with an already licensed radio amateur operator known as the “keeper” of the installation.

Propagation beacons are usually intended to operate continuously and are required to transmit a short repeating message using on/off keying or a narrow-band FSK signal with call sign ID and location information.

Voice repeaters usually re-transmit narrow-band analogue and digital voice traffic when activated with a signal on the input frequency and are mostly associated with extending geographic coverage area. Data and ATV repeater stations transmit wider bandwidth amateur signals and ATV repeater stations may transmit test signals when not being accessed by a user station on the input channel. All repeater stations are required by national regulations to transmit identification information.

Satellite communications (1 260-1 270 MHz, Earth-to-space only; see RR No. **5.282**) and mobile stations are possible, but these are rare in this frequency band. Tables 2 and 3 provide a matrix of the amateur and amateur-satellite applications versus station categories:

Table 2

Narrow-band amateur and amateur satellite applications against the station category

| Application | Station type | Max. bandwidth | Comments |
| --- | --- | --- | --- |
| Home | Temporary | Installation |
| Repeater | Beacon |
| Voice (Analogue SSB)  | Yes | Yes |  |  | 2 700 Hz | Long distance tropospheric weak signal communications. Radiosport operation (incl. EME). |
| Voice (Analogue NBFM) | Yes | Yes | Yes |  | 12 500 and 25 000 Hz (channel width dependent) | Local neighbourhood communications.Satellite communications. |
| Voice (Digital) | Yes |  | Yes |  | 12 500 Hz | Local neighbourhood communications |
| Telegraphy (Morse code On/Off keying) | Yes | Yes |  | Yes | 500 Hz | Long distance tropospheric weak signal communications. Radiosport[[1]](#footnote-1) operation (incl. EME). |
| Machine Generated Modes e.g. RTTY, SSTV[[2]](#footnote-2), PSK31[[3]](#footnote-3), WSJT[[4]](#footnote-4)  | Yes | Yes |  | Yes | 6 to 2 700 HzMode dependent | Local and long distance tropospheric weak signal communications. (incl. EME). Imaging |
| Data e.g. AFSK 1k2, FSK 9k6, D‑STAR[[5]](#footnote-5), Digital Data 128 kbit/s | Yes | Yes (Mobile) | Yes |  | 12.5 to 150 kHzMode dependent | Local neighbourhood communication links. |

Table 3

Wide band amateur applications against the station category

|  |  |  |  |
| --- | --- | --- | --- |
| Application | Station type | Max. bandwidth | Comments |
| Home | Temporary | Installation |
| Repeater | Beacon |
| Analogue ATV(FM-TV) | Yes | Yes | Yes |  | 20 MHz | Legacy technology, deployments decreasing. |
| Digital ATV(DVB Standards) | Yes | Yes | Yes |  | 1-8 MHz Symbol rate dependent | State of the art technology, deployments increasing |

Modern ATV installations employ spectrally efficient digital TV transmitters based on DVB-S/MPEG-2 signals. Symbol rates of 2 MBd or 4 MBd operate in lower bandwidth channels and further experimentation continues to increase the spectrum efficiency of amateur TV signals. It has been shown possible to transmit HD MPEG-4 signals with symbol rates less than 333 kBd in a bandwidth as low as 500 kHz.

## 3.2 Typical amateur station antenna characteristics in the 1 240‑1 300 MHz band

There is no standard amateur station and in most cases the antenna installation at any individual amateur station is constrained or influenced by the physical location and town planning restrictions. The following antenna types are typical and based on deployments detailed in published information relating to activity periods and reports from radiosport contests. In general home and temporary stations use highly directional, narrow beam width antennas in this frequency range.

1) Home station and temporary “portable” station antennas

Home stations generally use a single directional antenna, however in a few cases multiple antennas are combined to increase the array gain. This is more usual for EME[[6]](#footnote-6) operators for whom high antenna gain is essential for overcoming the high path and reflection loss. A higher performance EME station might use instead a medium size dish antenna. Table 4 contains the antenna details:

Table 4

Typical home station and temporary “portable” station antennas

|  |  |  |
| --- | --- | --- |
| Antenna type | Gain | 3 dB beam width |
| Single Yagi beam (23 to 55 element) | 18 to 21 dBi | 18° to 10° |
| Multiple Yagi beams (for EME)Dish antenna (for EME) | 21 dBi32 dBi (4 m diameter) | 10°4° |

2) Permanent installation antennas

Permanent installations operate for different applications using a variety of antenna types characterized by different gain and directivity figures. However, most permanent installations antennas are less directional and (in the case of repeaters) are generally intended to provide coverage over a local area. It should be noted, that the antenna type used depends not only on the application but also on the local topography[[7]](#footnote-7). Table 5 summarizes antenna characteristics with indications of minimum, median and maximum parameter values of a typical installation.

Table 5

Antenna characteristic of a typical permanent installation

|  |  |  |
| --- | --- | --- |
| Antenna types | Gain[[8]](#footnote-8) | Beamwidth in the azimuth plane. |
| Various (e.g. linear slot, co-linear array, horn, flat panel etc.) | Minimum = 2.15 dBiMedian = 13 dBiMaximum: refer to footnote 7 for information | Median = 60° (−3 dB)Maximum = Omnidirectional  |

Antennas with linear polarization are mainly used, but occasionally circular polarization can also be found.

## 3.3 Typical amateur station power level distribution in the 1 240‑1 300 MHz band

Typical power level distribution can be derived from published information about the stations that submit information resulting from national activity periods and reports from radiosport contests.

NOTE: In the following tables the power is specified differently because of the different sources of information.

1) Home station and temporary “portable” station

Table 6

Transmitter power ranges in use

|  |  |  |
| --- | --- | --- |
| Transmitter power (watts) | % home stations | % temporary stations |
| Up to 10 | 47% | 61.5% |
| 11 – 25 | 9% | 7.5% |
| 26 – 100 | 26% | 7.5% |
| 101 – 300 | 12% | 15% |
| Over 300 | 6% | 7.5% |

2) Permanent installation

Propagation beacon and repeater station directories can be consulted to gather information on the permanent stations deployed within a territory. They are usually licensed to operate at a specific ERP. Table 7 summarises information on stations in current use extracted from published information from a number of countries:

Table 7

Transmitter radiated power ranges in use

| ERP (watts) | % propagation beacons | % repeaters |
| --- | --- | --- |
| Up to 10 | 69% | 16% |
| 11 – 25 | 8% | 76% |
| 26 – 100 | 20% | 8% |
| 101 – 300 | 1% | 0% |
| Over 300 | 1% | 0% |

According to the information in Table 7, no repeater is currently in use with an ERP of more than 100 W. However, based on the extract from the license database of one administration on unmanned amateur radio stations parameters, it is indicated that some repeater / relay - stations are licensed to operate with a radiated power up to 380 W[[9]](#footnote-9) ERP, but the operational status of these stations is unknown. Note that there is a limit on the radiated power of unmanned stations given by national regulation and licensing conditions.

## 3.4 Representative antenna heights

The following antenna heights are representative of typical amateur station installations.

– Typical antenna height for a home station; 12 m above ground level.

– Typical antenna height for a temporary station; 3 m to 15 m above ground level.

– Typical height for a permanent installation station; 25 m above ground level.

Permanent installation stations are often installed at an advantageous location so as to take advantage of elevated local terrain or tall structures in order to increase the effective antenna height.

## 3.5 Amateur station 1 240-1 300 MHz band usage patterns

For all home and temporary “portable” station applications, narrow-band or wideband, the highest number of actively transmitting amateur stations can be found during the scheduled operating and radiosport contest periods. Table 8 summarises the total scheduled operating and contest periods scheduled in one region for a typical year. As these activities are usually formalised in the amateur operator calendars, the published national results[[10]](#footnote-10) can be consulted to determine the number of transmitting stations that were active during any one activity or contest period.

Table 8

Scheduled operating periods and active operating station numbers

| Usage type | Annual scheduled operating periods | Total active stations per scheduled operating period | Active temporary stations per scheduled operating period |
| --- | --- | --- | --- |
| Narrow-band activity period and radiosport | Total, on average 108 hours over a year | From 9 to 140 maximum depending on the country reviewed.  | 15 to 20 maximum depending on the country reviewed. |
| EME activity | 5 × 24-hour contest periods | Up to 10 maximum depending on the country reviewed.(Maximum < 70 across the European area) | None |
| Wideband (typically ATV) activity period and radiosport  | Total, on average 120 hours over a year | From 1 to 24 maximum depending on the country reviewed.(Maximum < 100 across the European area) | 10 maximum depending on the country reviewed. |

Permanent installation stations present a different scenario when considering the operational time. Unmanned amateur radio stations are more or less in continuous operation, while manned stations only transmit intermittently. Propagation beacon and repeater station directories from a representative region can be consulted to develop the summary presented in Table 9.

Table 9

Permanent Installation station operating periods in a typical year

| Usage type | Annual operation | Active installations |
| --- | --- | --- |
| Narrow-band propagation beacons | Transmitting continuously usually. | From 4 to 20 depending on the country reviewed. Region 1 = 88 in total. |
| Narrow-band repeaters | Low and only when activated on the input frequency by a user station.May transmit more regularly if a beacon mode is present. | From 9 to 19 depending on the country reviewed. |
| ATV repeaters (the users are usually home stations) | Low and only when activated on the input frequency by a user station in a random and sporadic manner.May transmit more regularly if a beacon mode is present. | From 10 to 18 depending on the country reviewed. 5 to 10 users within the local coverage area transmitting one at a time. |

## 3.6 Activity factors of amateur transmitting stations in the 1 240‑1 300 MHz band

Activity factor considers the amount of time that any particular station is transmitting during any operational period of activity. All applications involve two-way communication requiring periods of reception as well as transmission. It is usual practice for any home station or temporary portable station to spend more time receiving than transmitting.

Maximum Activity Factor for home station and temporary “portable” stations = 50% and typically less.

Any permanent installation station operating in a beacon mode will exhibit a 100% activity factor.

## 3.7 User density of amateur transmitting stations in the 1 240-1 300 MHz band

1) Home station and temporary “portable” station

– For narrow-band activity periods the maximum density of transmitting stations = 0.000 2 stations/km2.

– For wideband activity periods the maximum density of transmitting stations = 0.000 1 stations/km2.

– For EME operations the maximum density of transmitting stations =
0.000 013 stations/km2.

Recognising that not all active stations may submit a record of their activities, a 33% uplift has been added to the total active stations per scheduled operating period from Table 8.

2) Permanent installation

– For narrow-band data and voice repeaters the average density of transmitting stations = 0.000 3 stations/km2.

– For wideband ATV repeaters, the average density of transmitting stations = 0.000 1 stations/km2.

– For propagation radio beacon stations, the average density of transmitting stations = 0.000 1 stations/km2.

# 4 To be determined [Observations/measurements/coexistence aspects etc.]

[20210429 Ed: Consider making this section about possible mitigation measure depending on WP 4C study results and other contributions.]

## 4.1 Relationship between RNSS system frequencies in 1 240-1 300 MHz and amateur service application band plans

The figure below highlights the relationship between the various RNSS systems usage across the range 1 240-1 300 MHz and the IARU band plans:



Note 1: GLONASS navigation receivers manufactured before 2006 can receive navigation signals in frequency band from 1237.8275 MHz to 1260.735 MHz.

Note 2: In Region 2 ATV is also identified for experimental use in this range.

[20210429 Ed: This text is not agreed for here, but is left subject to further discussion. Text is based on 5A/293 input.]

## 4.2 [One set of measurements][Actual measurements of interference thresholds]

Actual measurement results have been made available of interference thresholds on a single geodetic Galileo E6‑B/C RNSS receiver, as a function of different amateur radio transmission modes. It appears that, apart from analogue amateur television (ATV) (in a bandwidth of 10 MHz), there is a significant margin (greater than 30 dB) between the power at the antenna input required to degrade the carrier-to-noise density, *C/N*0, at the output of the tracking loop for every single satellite’s signal by 1 dB, as compared to the threshold value [*20210430 Ed: Need more details about frequency separation*]. This set of measurements suggests that while wideband analogue TV transmissions may be a problematic source of interference for the Galileo RNSS receivers considered, narrowband transmissions may be less likely to cause interference and may enable coexistence with RNSS systems. Whether these results are more generally applicable to other RNSS systems, needs be to confirmed with further studies.

]

# X Conclusion

1. See the [ITU Amateur and amateur-satellite](https://www.itu.int/pub/R-HDB-52-2014) handbook for further details of radiosport activities. [↑](#footnote-ref-1)
2. Slow Scan Television (SSTV) is an imaging protocol which us issued to transmit images at a relatively low speed by using a frequency modulated subcarrier or digital encoding. Such transmissions are designed to fit within the bandwidth of a voice channel. [↑](#footnote-ref-2)
3. See Recommendation [ITU-R M.2034-0](http://www.itu.int/rec/R-REC-M.2034/en) which establishes a telegraphic alphabet and transmission protocols for phase shift keying at 31 baud (PSK31) in the amateur and amateur-satellite services. [↑](#footnote-ref-3)
4. These WSJT applications consist of a number of highly structured data modes which send a limited amount of data with strong Forward Error Correction which allows the data to be recovered at very low signal-to-noise ratios. WSJT modes –Weak Signal Joe Taylor– are named after their inventor Dr Joe Taylor. [↑](#footnote-ref-4)
5. D-STAR (Digital Smart Technologies for Amateur Radio) is a digital voice and data protocol specification for amateur radio. The system was developed in the late 1990s by the Japan Amateur Radio League and uses minimum-shift keying in its packet-based standard. [↑](#footnote-ref-5)
6. Earth-Moon-Earth (EME) communications use the Moon as a passive reflector which allows long distance communications between stations that have a simultaneous view of the moon. The reflected signals are very weak, though modern digital signal processing techniques and structured data modes reduce the need for high power transmitters. [↑](#footnote-ref-6)
7. According to the extract from the database of one administration on unmanned amateur radio stations parameters, the antenna gain for 25th percentile, median and 75th percentile are 8.1 dBi, 11.2 dBi and 12.7 dBi. Minimum and maximum gain are found to be 2.15 dBi and 21.5 dBi. However, a gain of 21.5 dBi is exceptionally high in this application. It should be noted, that those installations mostly operate in hilly and mountainous areas. [↑](#footnote-ref-7)
8. Feeder loss not included which may be up to 3 dB. [↑](#footnote-ref-8)
9. According to the extract from the license database of one administration on unmanned amateur radio stations parameters, 30% of repeaters are licensed to operate with an ERP of more than 100 W. [↑](#footnote-ref-9)
10. The analysed results were published by the national radio amateur societies in several European countries. [↑](#footnote-ref-10)