ANNEX 2-12: Amateur/Amateur satellite systems (Amateur)

Summary

Stations of the amateur service (and amateur satellite service) between 1 and 10 GHz use very sensitive receivers.

Amateur stations exist predominantly in built-up areas where UWB deployment will be intense.

In a typical situation a single UWB transmitter will rise the noise floor of the amateur receiving system at a distance of 10 meter with at least 5 dB in the 5,7 GHz band (A.). In order to limit the interference to a rise of the noise floor of <= 1 dB, the max eirp of the UWB device shall be –51dBm/MHz in the 5,7 GHz band.

For the 10 GHz (X.) band the figures are respectively 4 dB and –46 dBm/MHz.

For the 3,4 GHz (B.) band the figures are respectively 9 dB and –55 dBm/MHz.

For the 2,4 GHz (C.) band and the 1,3 GHz (D.) band the UWB eirp mask limits are –61 and –85 dBmMHz and for those bands no interference will be measurable at 10 meter from a single interferer.

Introduction

The amateur and amateur-satellite services have allocations in the frequency ranges in which ultra-wideband (UWB) devices may operate. The characteristics of the amateur and amateur-satellite earth stations are not generally known due to the fact that the amateur service is an experimental service. For interference studies, however amateur activities using relatively large transmitter power (in the order of 10 -20 dBW near 1 GHz going down to 0-15 dBW on 10 GHz), state of the art receiver sensitivities (receiver noise figures near 1 dB and receiver bandwidths of 400-3000 Hz) and antenna's with effective apertures of 1 m² near 1 GHz and 0,5 m² near 10 GHz are in use.

The characteristics and deployment of UWB devices are not yet understood and studies should be performed before the potential interaction between UWB and amateur systems can be determined more in detail.

As stations in the amateur satellite service are in general identical to those in the amateur service and the antenna's are following orbiting satellites till the satellite disappears below 0 degrees elevation, for the purpose of this note receiving stations in the amateur service and the amateur satellite service will be considered identical.

Deployment scenario

Many amateur stations operating in the UHF and SHF bands are situated in residences including urban, suburban and rural environments. In addition, there are some repeater stations located on high-rise buildings or towers using these frequencies for linking between repeater stations.

Minimum Separation Distances

A 'worst case' deployment scenario for the UWB/amateur installation can be considered to be the situation where a UWB wireless loudspeaker system or video recorder to TV link is within a short distance (<1 metre) of a relatively large window, and the amateur antenna is 10 metres distant (slant distance). Such a deployment is not unlikely in urban areas. Under these circumstances, it is arguable that free space propagation can be considered as applicable, and a loss of 67dB assumed. Further, the amateur antenna will not have the UWB transmitter in its main beam, but a gain of 0 dBi is not unusual for typical amateur antennas when a separation from the main beam of 45 degree is achieved.

Domestic use of UWB in such equipments such as remote wireless loudspeakers, video recorders and other domestic entertainment equipment have been suggested as viable applications, requiring effectively continuous operation for extended periods.

0 Activity factor

1 Amateur transmission

Amateur stations use listen-before-transmit (LBT) access techniques. An amateur station listens for a time sufficient to determine that a frequency is not in use by another station or that the received noise level is suitable for communications.

Amateurs receive more than they transmit, perhaps on the order of a 95/5 ratio. Communications are normally conducted in sessions called "contacts" or "schedules" if pre-arranged. Such contacts may last a few minutes or perhaps as long as an hour. Within a contact, stations in communication alternate their transmissions.

2 UWB Activity Factor

Especially in domestic deployment scenarios employing effectively continuous operation (as outlined in 2 above), the UWB Activity Factor is 1 i.e. 0dB. Even where applications are such that the application of an Activity Factor is appropriate, the effects of the relatively strong amateur signal on the UWB requires some consideration, especially where the UWB operates with a pre-emptive access system or with ARQ. This is because interference from the amateur signal may well lead to a large number of retries. This suggests that when considering the effects of UWB on the amateur and amateur satellite services, except in identifiable special circumstances, the Activity Factor of UWB should also be taken as 0dB.

3 Frequency bands of interest

The frequency bands in which UWB devices may operate and frequencies allocated to the amateur services are shown in Table 1.

4 Amateur service frequencies

The frequency bands allocated in Europe to the amateur and amateur satellite service in which UWB devices may operate are shown in Table 1.

TABLE 1: Amateur Allocations between 1 and 10 GHz

Amateur Service	Amateur Satellite Service
D. 1240-1300 MHz	1260-1270 MHz Uplink only
C. 2 300-2 450 MHz	2400-2450 MHz
B. 3 400-3 500 MHz (CEPT ECA)	
A. 5 650-5 850 MHz	5650-5670 (uplink) 5830-5850 (downlink)
X. 10 000 – 10500 MHz	10450 – 10500 MHz

TABLE 2: Typical UHF/SHF amateur station using Morse Telegraphy and SSB Characteristics

Frequency bands (MHz)	1240-1300, 2300-2450, 3400-3500, 5650-5850, 10000 - 10500
Emission types	100HA1A (Morse Telegraphy) 2K70J3E
Transmitter power (dBW)	10 (for this report taken as typical) (Maximum power subject to administration Regulations –varies with frequency, generally being higher at lower frequencies)
Antenna line loss (dB)	3
Antenna gain (dBi)	Varies (Highly directional antennas are used - 0dBi typical for >450 degree off the main lobe)
e.i.r.p (dBW)	31
Polarization	Horizontal
Receiver noise figure (dB)	1 (Antenna mounted preamplifiers are generally used)
Receiver bandwidth (Hz)	400 (typical telegraphy) 2700 (typical SSB telephony)
Receiver SNR (dB)	>=2

5 Effects of the UWB Deployment in 2.1

Using the parameters from Sections 2.1 and the amateur station parameters in Table 3, an MCL calculation for (A.)the 5650-5850 MHz band shows that the UWB signal level (assuming -41.3 dBm/MHz as the UWB e.i.r.p.) from a single UWB transmitter at the amateur receiver will be -168.2 dBm/Hz, or some 5dB above the receiver noise floor. This assumes the UWB spectrum is flat (i.e. noise like) ; this assumption may not be true in many cases and this will aggravate the situation with the very narrow band amateur receivers.

One also can calculate the distance required between the UWB device and the amateur station antenna in order not to lift the receiver noise level by more than 1 dB.

The receiver noise level being –173 dBm/Hz ; the interferer therefore shall not be stronger than –179 dBm/Hz, which requires a propagation loss of around 78 dB > 33 meters in the 5,7 GHz band (A.).

Using a reference distance of 10 meters and a limit to the noise level increase of 1 dB, the UWB eirp shall not be more than –51 dBm/MHz in the case of a single interferer in the 5,7 GHz band (A.).

For the other 4 frequency bands the figures are as follows:

B. 3,4 GHz band >= 55 meter or –55 dBm/Hz

X. 10 GHz band >= 19 meter or –46 dBm/MHz

For the other two bands the UWB spectrum mask limits the UWB eirp to –61 dBm/MHz in the 2.4 GHz band and –85 dBm/MHz in the 1,3 GHz band and this results in no interference to the amateur receiver in the model situation.

6 Single and multiple interferers

In the paragraphs above the single interferer scenario has been applied. It can be expected that this will be applicable in a majority of situations as there always will be one UWB device which has the strongest coupling with the amateur station antenna.