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# **Output power consideration for Class-B”SO” AIS**

# **Background**

The AIS TWG, met in Melbourne on 7-11 February 2011, discussed the liaison note from IEC TC80 WG15 regarding technical clarifications for Class-B”SO” AIS (Melbourne-input 24). The liaison note requests several technical clarifications; however this document focuses on the high power level setting issue.

In the liaison note, IEC WG15 is of the opinion that high power level setting for Class-B”SO” should be lower than 12,5W because of the following reasons:

* Class-B is intended to be a low-cost system for use mainly on pleasure and small vessels.
* A high power setting of 2 W provides sufficient range and will provide compatibility with existing Class B”CS” designs.
* Power settings above 2 W will result in a more expensive product.
* 12,5 W increases the blocking problem when vessels are in close proximity which is more likely with small vessels.
* 12,5 W increases the possibility of negative impact to the VDL when Class B population increases in the future.

AIS TWG decided, at the Melbourne meeting, to evaluate the blocking levels theoretically using several parameters such as output power level, antenna height, and distance between Class-B”SO” ships, and to discuss this issue again at the e-Nav 9 meeting.

This document provides the evaluation results.

# **Prerequisite**

Section 2.1.1.2, Annex 1 in M.1371-4 specifies that Annex 2 is applied to the Class-B”SO” and Annex 7 is applied to the Class-B”CS”; however due to the low-cost system of the Class-B”SO”, the receiver characteristics should conform to Annex 7 (relaxed requirements) while transmitter should conforms to Annex 2 to maintain a high level of VDL protection. This is also supported by IEC WG15 in the liaison note.

Therefore, the blocking level consideration below use the specified value in Table 33, Annex 7 in M.1371-4

# **Blocking considerations**

To consider the high power level setting for Class-B”SO”, a model case described in Figure 1 applies. In Figure 1, the ship-A and ship-B are the Class-B”SO” equipped ships and will come close to the distance D (NM). The ship-C is any kind of AIS equipped ship, and is located in distance L (NM). The Ship-A receives the weak signals from the Ship-C and this signal reception may be interfered by a strong signal from the Ship-B.

D (NM)

L (NM)

Ship-A

(Class-B”SO”)

Ship-B

(Class-B”SO”)

Ship-C

(any kind of AIS.)

**Figure 1: Ship locations under consideration**

To consider the receiving interference by the Ship-B, co-channel rejection and blocking should be taken into account; however co-channel rejection could be excluded because the Ship-A and Ship-B are in the nearby area, which means both Ship-A and Ship-B recognize the same slots as free; therefore the transmission by Ship-B will not interfere the reception of Ship-A. On the other hand, when the Ship-A receives a weak signal from the Ship-C on AIS 1, the Ship-B may transmit on the same slot number on AIS 2, because the slot conditions may not be the same on both AIS 1 and AIS 2. In this case, the Ship-A reception on AIS 1 may be blocked by the strong signal on AIS 2 from the Ship-B.

As specified in Table 33, Annex 7 in M.1371-4, the blocking will occur with the unwanted signal level of −23 dBm when receiving wanted signal level of −101 dBm.

The distance which obtains the desired level, e.g. −23 dBm and −101 dBm, can be calculated using propagation theories. Figure 2 shows an example of VHF propagations using the following parameters:

* transmit power : 5 W
* antenna height (TX = RX): 5 m
* antenna gain: 2.15 dBi

In Figure 2, the red dotted line shows the free-space propagation, blue dotted line shows the approximation including sea surface reflection, and the purple solid line shows the calculation using Recommendation ITU-R P.526-10, which well conforms to the real measurement.



**Figure 2: Propagation characteristics**

By using the equations specified in the Recommendation ITU-R P.526-10, the distances D (NM) and L (NM) calculations results are shown in Table 1 with the following parameters:

* output power: 1W, 2 W, 5 W and 12,5 W
* antenna height (TX = RX): 3 m, 4 m, 5 m and 10 m
* antenna gain: 2.15 dBi

The calculation results in Table 1 indicate that:

* in case of transmit power of 12,5W and the antenna height is 4 m, the blocking will occur when the ship-B comes close to the distance D = 0.08 NM (150 m).
* in case of transmit power of 2 W and the antenna height is 4 m, the blocking will occur when the ship-B comes close to the distance D = 0.06 NM (110 m).
* in case of transmit power of 2 W and the antenna height is 4 m, the transmit signal will reach to L = 8.4 NM (16 km) for sensitivity level (−107 dBm) and to L = 5.5 NM (10 km) for blocking measurement level (−101 dBm).

NOTE: If Class-B”SO” uses the receiver characteristics specified in Annex2 in M.1371-4 (same as Class-A AIS), the blocking will occur at the antenna input level of −15dBm. This is also indicated in Table 1 with green highlighted cells:

* in case of transmit power of 12,5W and the antenna height is 4 m, the blocking will occur when the ship-B comes close to the distance D = 0.06 NM (110 m).
* in case of transmit power of 2 W and the antenna height is 4 m, the blocking will occur when the ship-B comes close to the distance D = 0.043 NM (80 m).

For other situation, it is easily read out from Table 1



Table 2 shows, for reference, the line of sight distance (radio horizon) relating to the antenna height.



# **Conclusion**

As shown in Table 1, there is no major difference on the distance to occur the blocking. For example, when using 4 m antenna height, the blocking occurrence distance is 0.06 NM (110 m) at 2 W and 0.08 NM (150 m) at 12,5 W – only 40 m difference.

However, when looking at the coverage distance (reaches to the sensitivity level), 5 W transmission is about 78% of 12,5 W transmission (21 km/27 km at 4m antenna height). Also, 2W transmission is about 59% (16 km/27 km at 4 m antenna height) of 12,5 W transmission. When considering that the product range of Class-B”SO” is between Class-B”CS” and Class-A, the high power level setting for Class-B”SO” is recommended to 5 W, which is 4 dB higher than 2 W (Class-B”CS”) and 4 dB lower than 12,5 W (Class-A).