Approaches to decrease the level of parasitic noise over vibroacoustic channel in terms of configuring information security tools

A V Ivanov1, I L Reva1 and A A Babin1
1 Novosibirsk State Technical University, 20, K Marksa av., Novosibirsk, 630073, Russia
E-mail: andrej.ivanov@corp.nstu.ru

Abstract. The article deals with influence of various ways to place vibration transmitters on efficiency of rooms safety for negotiations. Standing for remote vibration listening of window glass, electro-optical channel, the most typical technical channel of information leakage, was investigated. The modern system "Sonata-AB" of 4B model is used as an active protection tool. Factors influencing on security tools configuration efficiency have been determined. The results allow utilizor to reduce masking interference level as well as parasitic noise with keeping properties of room safety.

1. Introduction
With a room being prepared for private negotiations, certain levels of speech intelligibility outside the room must be provided. With insufficient of sound/vibration isolation of enclosing structures, masking interference (i.e. applying active protection means – noise generators) is the most commonly used method. Applying active protection means is granted to be the simplest way to solve the problem, consisting of purchase and configuring costs only. However the disadvantage is that active protection means create «parasitic noise» during their operation.

Electro-optical channel is considered to be the most often protected channel of information leakage (remote vibration listening of window glass). Being created on the glass surface by vibration transmitters, vibration noise reemits inside the room in the form of acoustic noise which is regarded to be parasitic. Low-quality configuring of active protection means can result in essential level of parasitic noise, preventing from comfortable negotiations and being incompatible with Russian Sanitary Norms [1].

2. Research Objective
Firstly we will define factors influencing on active protection tool operation efficiency in terms of vibration transmitters SV-4B, the part of «Sonata-AV», model 4B. Interference spectrum and parasitic noise level are affected by:
- interference spectrum configuration (active protection tool is equipped with equaliser);
- ways to fit transmitters on the surface;
- the number of transmitters being used.

3. Theoretical Treatment
Noise level at the workplace is subject to Russian Sanitary Norms SN 2.2.4/2.1.8.562-96 «Industrial vibration, vibration of residential and public buildings» [1].

The Sanitary Norms establish the classification of noises, allowed noise levels and rate parameters. The Norms are valid for residential and public buildings, as well as for the area of residential blocks. The Norms are mandatory to follow.

The noise workplace characteristics is the equivalent (in terms of energy) sound level in dBA. [1] provides with allowed sound levels as well as with allowed sound pressure levels in octave bands, equivalent and maximal sound levels of noise penetrating in rooms of residential and public buildings and noise at the area of residential blocks (table 1).
Table 1. Allowed levels of sound pressure, sound levels, and equivalent sound levels for most typical types of labour activity and workplaces.

| Sounds pressure level, [dB], in octave bands with the centre frequencies, [Hz] | Sound levels and equivalent sound levels, [dBA] |
|---|---|
| 31.5 | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
| 86 | 71 | 61 | 54 | 49 | 45 | 42 | 40 | 38 |
| 50 |

The levels are given for the following types of labour activity and workplaces:
- creative work, management work with increased demands, research activity, design and engineering, software development, instruction and training, medical practice;
- workplaces located in management offices, planning and design office, designers offices, programming stuff offices, computer engines room, in laboratories for theoretical work and data processing, reception of the patients in medical clinics.

Measurements of noise levels in areas of residential blocks, in residential and public buildings are conducted according to Russian methodological guidelines MUK 4.3.2194—07 «Noise monitoring within the residential development area, in residential and public buildings and premises» [2].

4. Experiments and Results

The noise level meter ZET 110, microphone BC501, and accelerometer BC111 are used for parasitic noise measuring. The complex is absolutely appropriate for noise measurements at residential and public buildings according to the Sanitary Norms [1] requirements.

4.1. Influence of interference spectrum

White and pink noise are used as the interference in the experiment. The vibration transmitter and the test point are placed as shown in Fig.1.

Figure 1. Placement of the vibration transmitter and the test point.

Values of interference levels in octave bands, word intelligibility and parasitic noise levels have been measured. The results are presented in tables 2 and 3.

The word intelligibility of 20% level has been achieved. As it is known, conversation subject is difficult to identify if the word intelligibility level is lower than 20-30% [3].

Background noise level (with turned off active protection means) in the experiment room was 38.2 dBA.

Table 2. Measured results for white noise levels in the test point.

| f, [Hz] | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
|---|---|---|---|---|---|---|---|
| L_{noise}, [dB] | 68.4 | 75.5 | 80.1 | 84.4 | 87.7 | 89.3 | 72.6 |

Word Intelligibility W=0.22. Parasitic noise level Leq=53.4 dBA.
Table 3. Measured results for pink noise levels in the test point.

| f, [Hz] | 125  | 250  | 500  | 1000 | 2000 | 4000 | 8000 |
|---------|------|------|------|------|------|------|------|
| Lnoise, [dB] | 68.6 | 86.2 | 86.9 | 86.6 | 86.6 | 85.4 | 68.7 |

Word Intelligibility $W = 0.21$. Parasitic noise level $L_{eq} = 51.3$ dBA.

Parasitic noise level is found to be 2.1 dB lower with using pink noise in comparison with using white noise. Based on the experiment results, we can make a conclusion that applying of different interference types makes decrease of parasitic noise level by several dB possible. More essential results can be obtained by using formant-like interference, its effectiveness is confirmed by [4].

4.2 Influence of ways to fit the vibration transmitters on the surface

Two most common ways to fit the vibration transmitters on the glass surface are considered:
- with use of glue;
- with use of special-purpose fixing device «window frame» (Fig.2).

Obviously, the way to fit the transmitters influences on emitted parasitic noise level as well as on final interference spectrum in test point along with its level. We have corrected the interference level to obtain the same word intelligibility level as achieved for the first way of fitting, since the aim is to make word intelligibility value meet the Norms.

![Figure 2. Fixing device «window frame»](image)

Measured results are presented in tables 4 and 5.

Table 4. Measured results for noise levels in the test point using glue fixation.

| f, [Hz] | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
|---------|-----|-----|------|------|------|------|
| Lnoise, [dB] | 37.9 | 36.0 | 41.9 | 44.3 | 53.1 | 61.0 |

Word intelligibility $W = 0.20$, parasitic noise level $L_{eq} = 51.5$ dBA.

Table 5. Measured results of noise levels in the test point using the fixing device fixation.

| f, [Hz] | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
|---------|-----|-----|------|------|------|------|
| Lnoise, [dB] | 41.5 | 40.0 | 47.8 | 47.7 | 57.7 | 57.1 |

Word intelligibility $W = 0.21$, parasitic noise level $L_{eq} = 56.2$ dBA.

As a result, change of ways to fit the vibration transmitter has allowed us to decrease parasitic noise level almost by 5 dB, and the same word intelligibility level has been achieved.

4.3. Influence of the number of the transmitters being used

Two experiments with one and two transmitters being used are conducted. Placement of vibration transmitters and the test point is shown in Fig.3. Measured results are presented in tables 6 and 7. Obviously, in case with two transmitters their interference levels should be decreased, but the word intelligibility value should be the same.
Figure 3. Placement of vibration transmitters and the test point

Table 6. Measured results of noise levels in the test point with use of one transmitter.

| f, [Hz] | 250  | 500  | 1000 | 2000 | 4000 | 8000 |
|--------|------|------|------|------|------|------|
| L_{\text{noise}}, [dB] | 37.9 | 36.0 | 41.9 | 44.3 | 53.1 | 61.0 |

Word intelligibility \( W = 0.22 \), parasitic noise level \( L_{\text{eq}} = 51.5 \text{ dBA} \).

Table 7. Measured results of noise levels in the test point with use of two transmitters.

| f, [Hz] | 250  | 500  | 1000 | 2000 | 4000 | 8000 |
|--------|------|------|------|------|------|------|
| L_{\text{noise}}, [dB] | 37.4 | 35.9 | 40.4 | 43.1 | 50.5 | 65.0 |

Word intelligibility \( W = 0.21 \), parasitic noise level \( L_{\text{eq}} = 45.2 \text{ dBA} \).

Parasitic noise level is proved to be decreased by more than 6 dB by using of higher amount of the vibration transmitters.

4.4. Results Analysis
Summarizing all the obtained results, we can make a conclusion that all considered factors have influence on parasitic noise level, therefore, can be used for its decrease. The results are presented in the bar chart (Fig. 4).

Figure 4. Comparison of the empirical results.

5. Conclusion
During the tests, influence of different factors on the parasitic noise levels was quantitatively estimated:
interference spectrum – 2 dB (The results would be more essential with use of formant-like interference);
way to fix – 5 dB; the number of the transmitters being used – 6 dB;
Taking the obtained results into account allows essential decrease of parasitic noise level in setting active protection means with making it meet the Norms.
References
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