RESEARCH OF VIBRATION SPECTRUM OF THE BULLETS EQUIPPED WITH PROXIMITY FUSE

S. Grzywiński[1, a)] S. Żygadło[1, b)]

[1]*Faculty of Mechatronics and Aerospace, Military University of Technology, Urbanowicza 2, 00-908 Warsaw 46, Poland*
[a)]stanislaw.grzywinski@wat.edu.pl [b)]stanislaw.zygadlo@wat.edu.pl

Abstract. The paper describes the research stand and presents analysis of selected vibrations results of artillery and rocket missiles equipped with a radio proximity sensor.

1. INTRODUCTION

Proximity fuse should reliably work after traveling a certain distance from the gun barrel or launcher, at a specified height ensuring maximum effectiveness of the target's attack and should not act during storage, transport and charging. The fulfilment of these requirements depends on many structural and technical factors of the igniter itself, as well as the operating conditions, shooting and flight conditions and the fall of the projectile near the target.

In the case of electronic proximity fuse, the basic parameters are: the frequency range of the transceiver unit, center frequency and bandwidth of the amplifiers and construction of analog matching of the signal processing unit. Their values are dictated by the equations for the proximity fuse [1].

Doppler pulsation of the coherent ω_{Dk} and dispersed ω_{Dr} component depend on the final velocity v_p, the angle of the projectile's fall Θ_p and the wavelength λ_s, on which the transceiver of the proximity detector works. In the case of artillery projectiles, for which the range of changes in the final speed is contained between v_p=(220÷400)m/s, range of changes in the angle of fall θ_p=(10÷75)^O and the wavelength of the probe signal is λ_s=15cm, the range of Doppler frequency changes is set between f_{Dk}=(0.5÷5)kHz. For the wavelength of the signal λ_s=3cm interval is located at f_{Dr}=(15÷27)kHz. In the case of rocket missiles for which the range of changes in the final linear velocity is v_p=(240÷650)m/s, range of changes in the angle of fall θ_p=(10÷60)^O and the wavelength of the probe signal λ_s=15cm, the range of Doppler frequency changes is set between f_{Dk}=(0.6÷7.5)kHz, while for λ_s=3cm interval is set at f_{Dr}=(16÷43)kHz.

The presented results impose the necessity to use amplifiers of the ignition signal processing unit with a specific central frequency and bandwidth. Their choice depends on the coefficients occurring in equations (1) and (2), which largely depend on mechanical vibrations occurring during the flight of the projectile. From the analysis of the design of artillery projectiles and rocket missile, it follows that the frequency of signals caused by vibrations will lie within the ranges of Doppler frequencies specified above. In the worst case they may enter the input of the band amplifiers of the signal processing unit and may cause the actuation system to operate on the missile track. Such a fuse cannot enter the military utilities so it is necessary to conduct experimental research.

2. Measuring stand and test results

Investigations of signal frequency intervals change caused by vibrations for 122mm and 152mm artillery projectiles and rocket missile caliber 122mm were carried out on a laboratory stand, the view of which is shown in the figure 1. The selected test result is shown in figure 2.

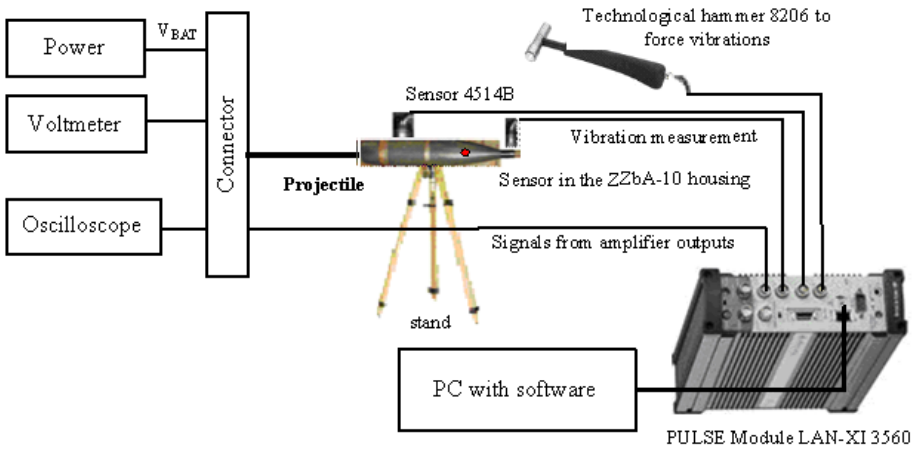

FIGURE 1. Measuring stand for testing spectrum vibration with the Brüel & Kjær measuring equipment

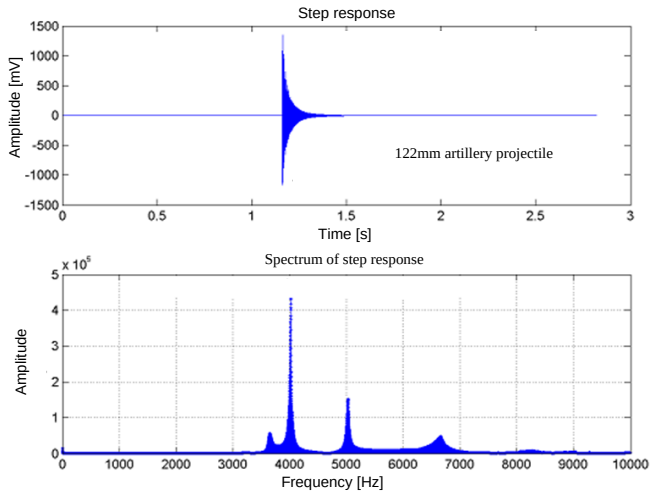

FIGURE 2. The step response and the spectrum of vibration signal of the 122mm artillery projectile

Based on the results obtained during the research, the following conclusions can be made:

- in the case of 122mm artillery projectile with a model of a proximity fuse, the vibration spectrum is occupied by the band (3.5÷6.5) kHz, while in the case of an projectile 152mm with the fuse model the spectrum is occupied by the band (2.0÷9.0)kHz. These bands should be considered as prohibited for the Doppler proximity fuse for 122 and 152mm artillery projectiles;
- in the case of a 122mm rocket missile with the MRW fuse, the spectrum of signal vibrations occupies a bandwidth of up to 5.0kHz. This band should be considered prohibited for the Doppler proximity fuse for a 122mm missile.

Taking into account the ranges of changes in the final velocity and fall angles, as well as obtained results of vibrations, it can be concluded that for the Doppler proximity fuse used in 122 to 155mm artillery projectiles the forbidden operation frequency of the transceiver system is 1 ÷ 6GHz, while for a rocket missile caliber 122mm forbidden frequencies are below 1.5GHz.