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TESTING DYNAMIC CHARACTERISTICS OF MEASURING DEVICES

P. Mróz
Department of Informatics and Electronics, Technical University
ul. Podgórna 50, PL-65-246 Zielona Góra, Poland

Abstract: The duration of the measurement is most important in metrology apart from measurement accuracy. Testing systems are used to speed up the object's verification. It is needed to know the dynamic characteristics of the object to propose optimal operation algorithm of testing systems.

In the paper, the response measurement results of the thermoregulator to the step input function, using the method of the direct measure and the trapezoids method. are described and compared

Keywords: system for testing devices accuracy, the trapezoids' method, dynamic characteristics

1 INTRODUCTION

The duration of the measurement is most important in a measuring technique apart from their accuracy.

The duration of the measurement depends on both the dynamic performance of the measuring system as well the dynamic characteristic of the tested object. When the response time of the microprocessor objects has a high value or when algorithms of their structure are very complex, the duration of the measurement depends mainly on the dynamic characteristics of the tested object. If these characteristics are known, it is possible to rationalise the algorithms of the measuring system to cause it more quickly. For the study of the dynamic characteristics of the object the mathematical models are evolved. Then these models should be verified experimentally.

It is necessary to know the step response time of all parts of the testing system for elaboration algorithms in order to accelerate the tests of the object's accuracy.

This paper illustrates the way of determining dynamic characteristics of the device's input circuit using the two above mentioned methods.

2 THE STEP FUNCTION RESPONSE METHOD

The direct recording of the object's answer to one step input signal is one of the based methods to verify the object mathematical description. In this case, a measuring circuit shown on Figure 1 was build to record these characteristics. It consist of the one step input signal source, tested object and two channel oscilloscope. Oscillograms of input signal shown on Figure 2a) and output signal shown on Figure 2b) were recording.

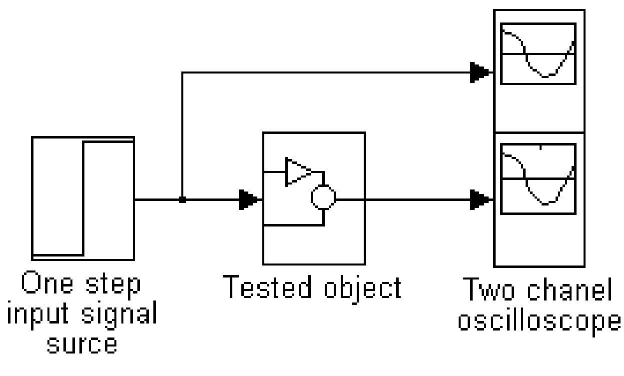

Figure 1. A measuring circuit.

An assumption was made, based of oscillograms (Figure 2), that the tested object is an inertial object [1] with transmittance

$$G(s) = \frac{240}{0.01 * s + 1} \tag{1}$$

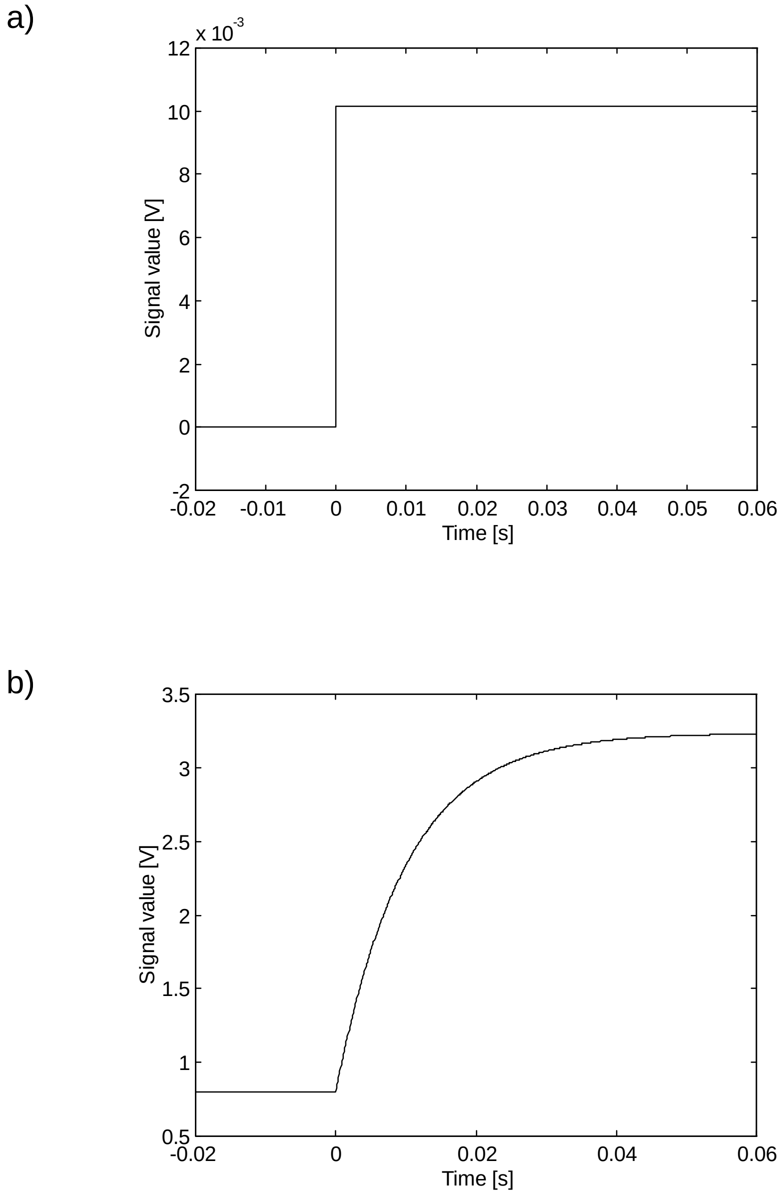

Figure 2. Oscillogram of input signal (Figure a)) and output signal (Figure b)).

This method gives good results in objects in which time-constants are significantly bigger then time-constants of the recording device. The error of this method increase when the dynamic characteristic of the object closes proximity to the dynamic characteristic of the recording instrument. On Figure 3 oscillograms recorded with oscilloscope with time-constants T are shown closes proximity to time-constants of the first object T_1 ($T1 \rightarrow T$) (curve 1 and 2) and the object with bigger time-constants T_2 ($T_2 >> T$) (curve 3 and 4).

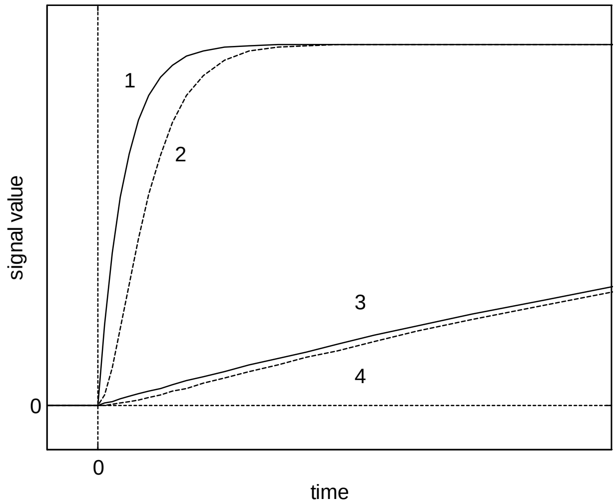

Figure 3. Oscillogram.

3 THE TRAPEZOIDS' METHOD

It is possible to determine the response time function to the one step input signal using the trapezoids' method. This method bases on transformations of amplitude-phase characteristics. It is possible to determine the amplitude-phase characteristics with bigger accuracy than step response time function, especially for quick objects. The determination of the step response time function by means of this method is based on transformation of the amplitude-phase characteristics using Solodovnikov functions [2].

To determine the response time function using trapezoids' method a measuring circuit was build like shown on Figure 1, but in which the one step function source was replaced by the sinusoidal wave source. The real part of amplitude-phase characteristic (Figure 4) was determined, using the oscillograms recorded for different frequencies (with constant amplitude). This characteristic was divided for trapezoids (Figure 5). The Solodovnikov functions are related to each of these trapezoids. The family of the functions obtained trough multiplication of the amplitude of each trapezoid by related to them function (curve 1 and 2 Figure 6). The one step function is the sum of these functions (curve 3).

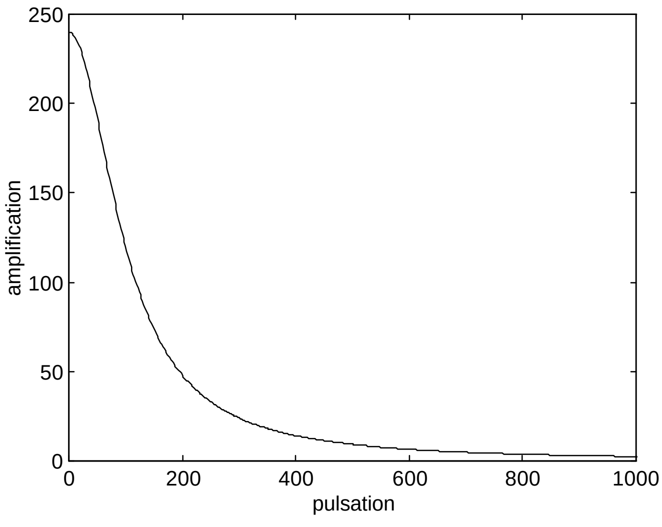

Figure 4. The real part of object amplitude-phase characteristic.

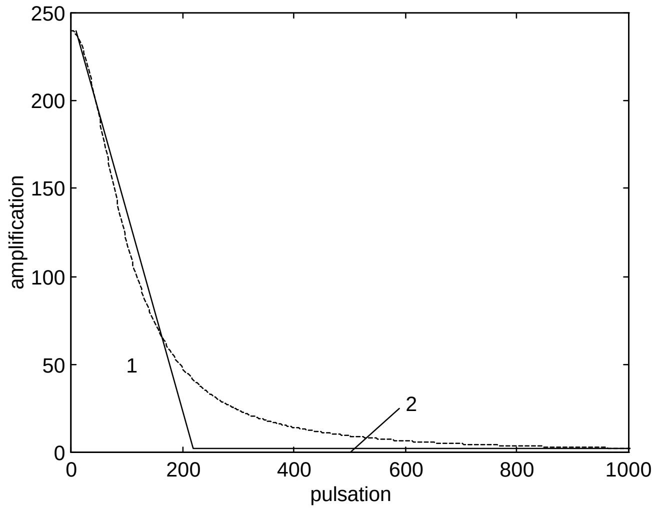

Figure 5. The characteristic after division for trapezoids.

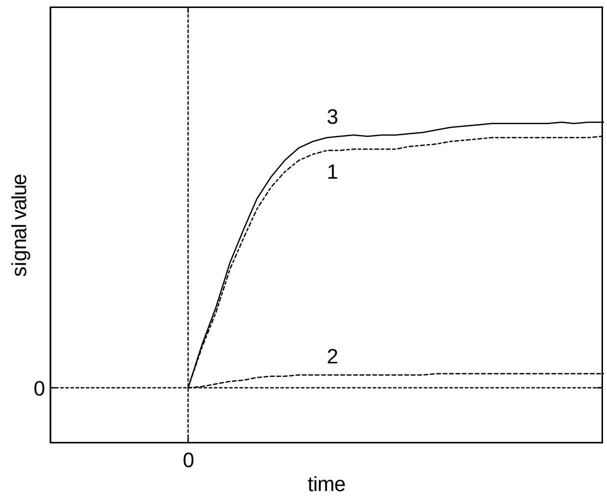

Figure 6. The family of the Solodovnikov functions.

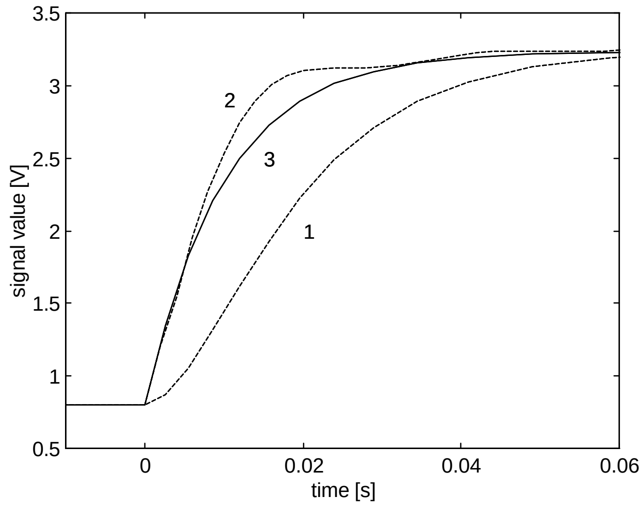

Figure 7. The results of the measurement described in chapters 2 (curve 1) and in chapter 3 (curve 2) and the true object function (curve 3).

4 COMPARISON THE RESULTS

On Figure 7, the results of the measurement described in chapters 2 (curve 1) and in chapter 3 (curve 2) are shown. These functions were compared with the true object function (curve 3). The curve 2 lies more close to the curve 3 than to the curve 1, hence for objects with time-constants of the object closes proximity to the time-constants of the recording instrument, the trapezoids' method gives better results than the method of the direct measurement of the one step function response.

5 RECAPITULATION

For object with time-constants of the object closes proximity to the time-constants of the recording instrument, the trapezoids' method gives better results than the method of the direct measurement of the response to the one step function input signal, but it needs more labour consumption.

REFERENCES

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[2] Ä. Â. Âàñèëüåâ, Ã. Ñ. Ôèëèïïîâ, „Îñíîâû òåîðèè è ðàñ÷åòà ñëåäÿùèõ ñèñòåì".

AUTHOR: MSc. Piotr MROZ, Politechnika Zielonogórska, Instytut Informatyki i Elektroniki, ul. Podgórna 50, PL-65-246 Zielona Góra, Poland, Phone: +48 683282627, Fax: +48 683244733,
E-mail: P.Mroz@iie.pz.zgora.pl