J. Sikora, K. Toborek, L. Szczepaniak
Lublin University of Technology, Department of Automatics and Metrology,
Lublin, Poland

EMISSION CURRENT STABILIZER TO ELECTRON-IMPACT GAS ION SOURCES

We describe an electron emission current stabilizer with an error amplifier dc voltage gain depending on the electron emission current. A negative feedback loop of the error amplifier contains a solid-state digital potentiometer, which is controlled by a microprocessor according to the empirically determined (based on the Ziegler – Nichols method) exponential dc voltage gain function. The obtained mean relative standard deviation of the electron emission current, for a tungsten filament operated at the pressure of *p*=0.1Pa, is 36 ppm.

1. Introduction

The electron beams are applied for gas ionisation in various vacuum instruments such as vacuum gauges, gas residuals or mass spectrometers. The thermal generation of electron beam can be distinguished for its application of low voltage and power. A simplified model of electron source with a hot filament can be written by the following form [1]:

$$G(s) = \frac{G_0}{s\tau + 1}, \tag{1}$$

where G_0 is the transconductance for a constant signal component and τ is time constant.

A careful inspection of the relation between the dc voltage gain of the stabilizer error amplifier, and the obtained emission current standard deviations, lead us to the conclusion, that to obtain lower standard deviations the dc voltage gain should correspond to natural, non-linear characteristics of the electron source with a hot filament for each operating point.

2. Fundamental concept of the design

In order to verify the above consideration, the empirically obtained dc voltage gain of the stabilizer error amplifier versus the electron emission current has been determined using the Ziegler – Nichols method [3]. The measurements have been done for a tungsten filament (ϕ=0,1mm, l=40mm, operated at the pressure of p=0.1Pa). The obtained voltage gain factors have been fitted to an exponential function of the reference voltage , V_{ref1}, in the following form:

$$K_1\left(V_{ref1}\right) = K_{10}\exp(-aV_{ref1}), \tag{2}$$

where K_{10}=5607 V/V and a=0.34 $1/V$.

A diagram of the electron emission current stabilizer with a programmable dc voltage gain is shown in figure 1.

The solid-state potentiometer DS 1267 (Dallas Semiconductor) is composed of 512 resistive sections and its resistance value equals 20kΩ. The dc voltage gain of A_1 with a negative feedback loop containing the digital potentiometer and the resistor R_7 = 200kΩ (WX 68124 - 200k, Tesla), may be approximately written as follows

$$K_1\left(V_{ref1}\right) = \frac{n\left(V_{ref1}\right) + 5100}{510 - n\left(V_{ref1}\right)}, \tag{3}$$

where n is a number of resistive sections connected between the input and output of A_1.

Combining equations (2) and (3) the following expression can be obtained:

$$n\left(V_{ref1}\right) = \frac{510K_0\exp\left(-aV_{ref1}\right) - 5100}{1 + K_0\exp\left(-aV_{ref1}\right)}. \tag{4}$$

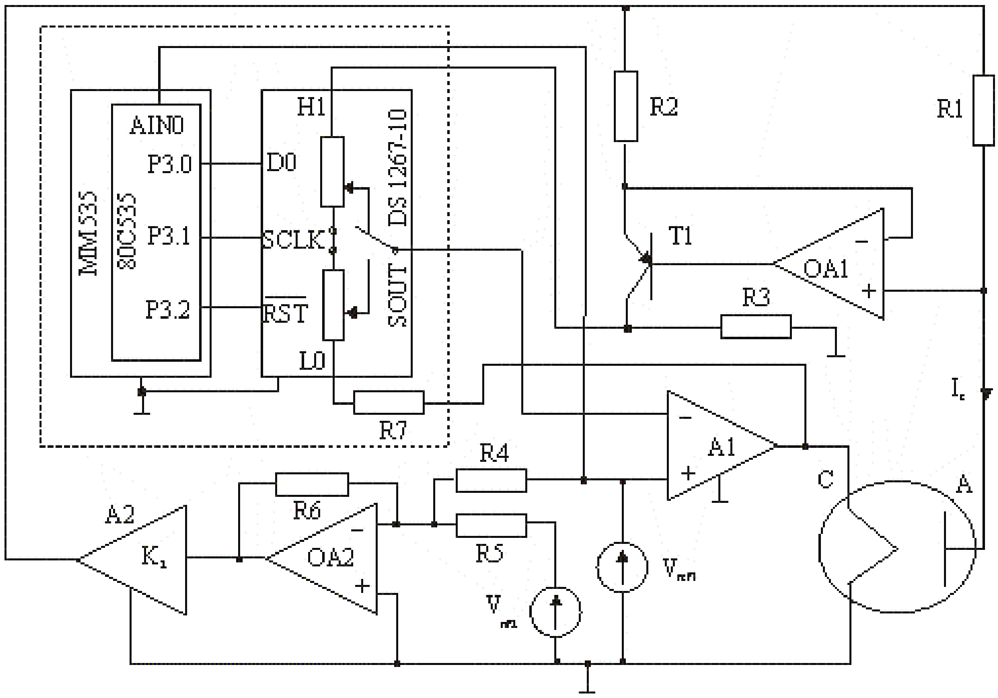

Fig. 1. Simplified diagram of a an electron emission current stabilizer with an expotencjal voltage gain [3, 4]. For more details the reader is referred to Sikora [1]. The part implemented the programmable gain of A_1 is indicated by the broken line (see text)

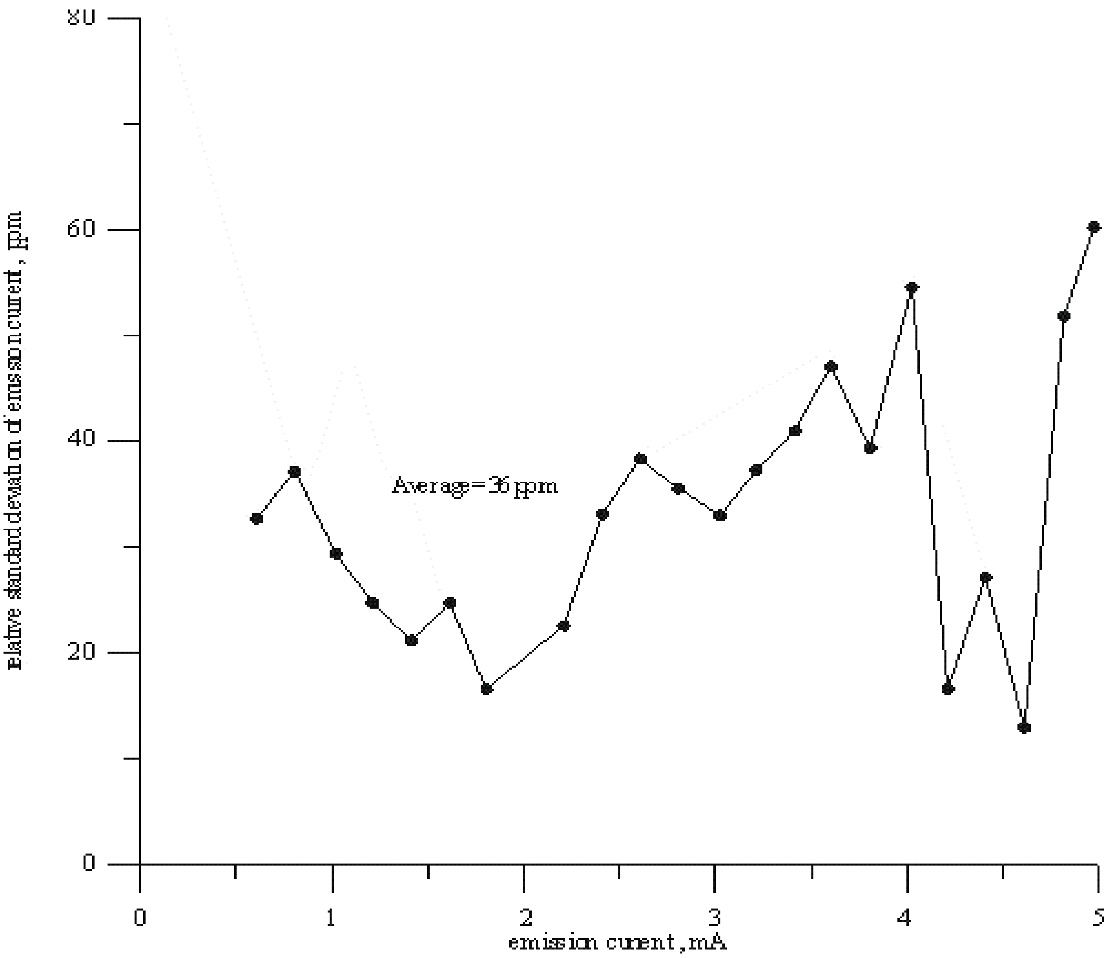

Fig. 2 The relative standard deviation of the electron emission current versus the electron emission current, I_e, *for a long tungsten filament (0.1 mm x 40 mm)*

This function has been implemented as a look up table (LUT) in the program memory of a controller MM535 (WG Electronics) based on a Simens model PB 80C535 micro-controller. The micro-controller ADC converts the input voltage, V_{ref1}, to its eight bit number representation, which is a LUT address. Finally, the controller sets an appropriate wiper position of the digital potentiometer and consequently the dc voltage gain of A_1. The reference sources V_{ref1}, V_{ref2} are based on the Maxim models REF02 , REF01, respectively.

3. Results and conclusions

The precision of the emission current stabilizer has been presented in terms of the relative standard deviation of the stabilized emission current versus its intensity. The emission current has been measured by means of a Keithley model DMM 2000. The duration of the measurement for each value of the emission current was 300s. The results for the investigated tungsten filament are shown in figure 2.

The obtained mean relative standard deviation of the electron emission current, for a tungsten filament operated at the pressure of p=0.1Pa, is 36 ppm.

In conclusion, one may state that the application of the expotencjal dc voltage gain in the emission current stabilizer enhances the emission current quality as compared to the previous design [3]. For this reason the presented stabilizer is perfectly applicable to electron-impact gas ion sources, for example in isotope ratio mass spectrometers.

Another important conclusion is that the presented configuration of the electron emission current stabilizer allows to easely investigate the other dc voltage gain functions (selected by other methods).

1. *Krolopp W., Sikora J. and Halas S. Simplified dynamic model of electron source with a hot filament, Journal of Technical Physics, 1997,* ***38****, no 1, pp. 87–95.*
2. *De Larminat P. T. Y. 1977 Automatique Des Systemes Lineaires 3 Commade (Paris: Flammaricon Sciences).*
3. *Sikora J 2004 Dual application of a biasing system to an electron source with a hot cathode Meas. Sci. Technol.,* ***15*** *N10–N14.*
4. *Sikora J. Toborek K. Szczepaniak L. High precision emision current stabilizer witch a programable voltage gain, Meas. Sci. Technical (in revier).*

M. Skoczylas[1], W. Szydełko[2]
[1]Rzeszów University of Technology,
Department of Electronic and Communication Systems, Rzeszów, Poland,
[2]Rzeszów University of Technology,
Department of Computer and Control Engineering, Rzeszów, Poland

CONCEPT OF STREET LIGHT CONTROL SYSTEM USING THE PLC TECHNOLOGY

The lights in the streets, roads and squares is a big budget load, so the solutions for decreasing of the costs are strongly required. The paper includes two proposition of dealing with the problem. The first is finding more efficient sources of light and the second is optimizing the usage of existing ones. The second way has been described in this work.

1. Introduction

The lights in the streets, roads and squares is a serious problem to the budget, therefore we are looking for solutions where the main criteria is lowering the electricity consumption. We can find two ways of dealing with the problem. The first is finding more efficient sources of light and the second is optimizing the usage of existing ones. The second way is to be dealt in this work.