

# VOA MEMS TESTER

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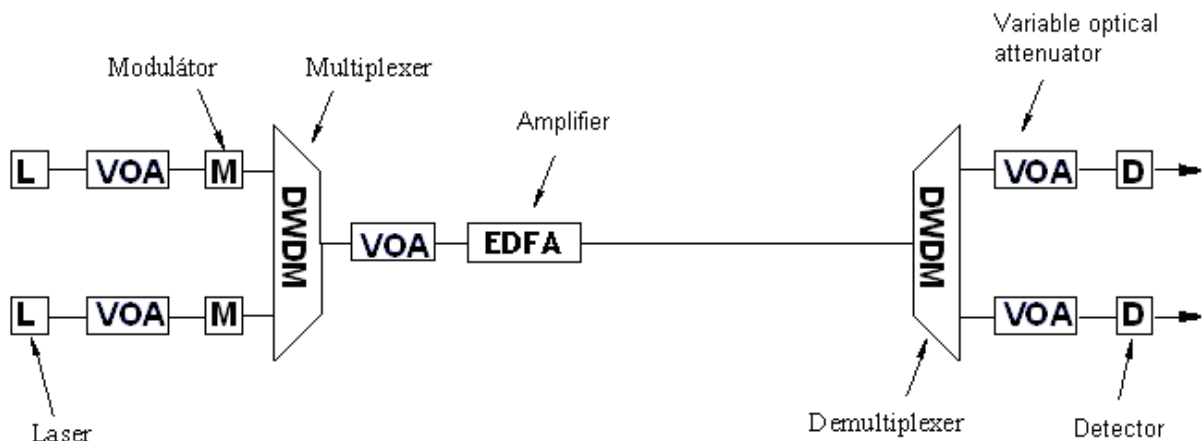
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## ABSTRACT

This article is about device for testing variable optical attenuator (VOA) produced by MEMS technology. Until now, MEMS VOAs are tested with interferometer, which is very expensive device and the test is very time consuming. With this device called VOA MEMS Tester can be VOA tested much faster with smaller expenses.

## 1. INTRODUCTION

Variable optical attenuator produced by MEMS technology (MEMS VOA) is very small mechanical device used in many optical systems, especially in DWDM (Dense Wavelength Division Multiplex) systems, which are used in optical networks for transmissions of more laser beams at different wavelength in one optic fiber.



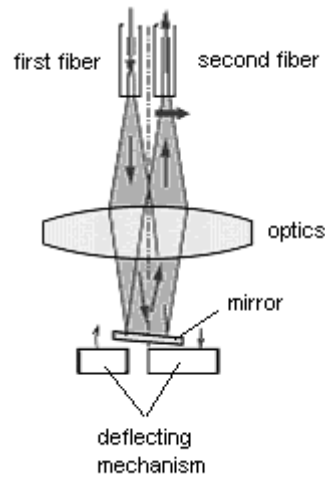
**Fig 1: Simplified scheme of DWDM system**

Because MEMS VOA is mechanic device and production by MEMS technology is not very reliable, we need to test each sample to check if sample meets all required criteria.

## 2. DESCRIPTION

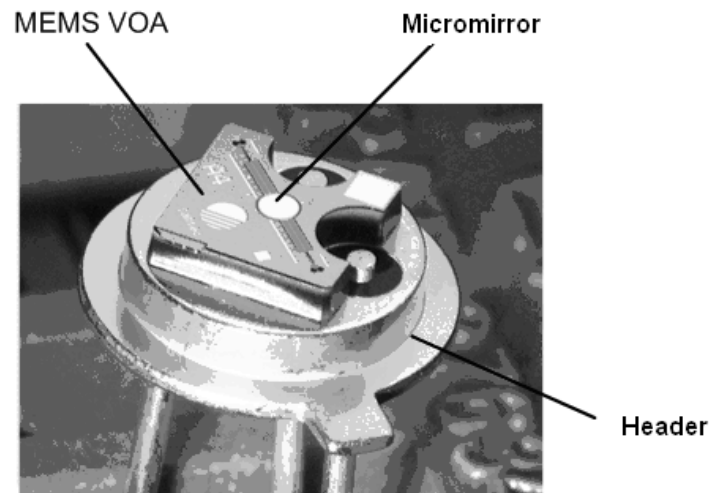
### 2.1. MEMS VOA

MEMS VOA is variable optical attenuator produced by MEMS technology. It contains mirror, which is deflected by micro mechanic elements according the voltage on VOA input. By moving with mirror, we can control quantity of reflected input laser beam and change attenuation of signal.



**Fig 2: Principle of function MEMS VOA**

On picture below is photography of MEMS VOA, which is mounted on header. Mirror is deflected according voltage on header pins.



**Fig 3: MEMS VOA**

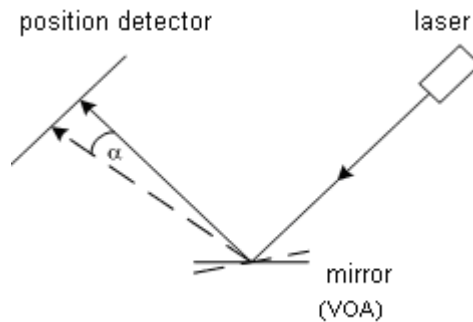
### 2.2. VOA MEMS TESTER

VOA MEMS Tester contains mechanical and hardware part. Purpose of mechanical part is connect laser diode, socket for VOA and position detector into optical system, which can evaluate move of reflected beam on voltage level, purpose of hardware system is recalculate voltage data from mechanical part into deflected angle of mirror,

communication with master PC, setting voltage through D/A converter, reading voltage through A/D converter and performing additional functions. Main function of VOA MEMS Tester is to find out maximal mirror's angle of deflection. This angle is most important parameter of MEMS VOA for everyone, who wants to use it.

### 2.3. MECHANICAL SECTION

Mechanical system contains holder, which is linked to laser diode, socket for MEMS VOA and position detector (PSD). Main idea is, that mirror from VOA reflect laser beam into position detector, which evaluate the move of laser beam (on picture below).

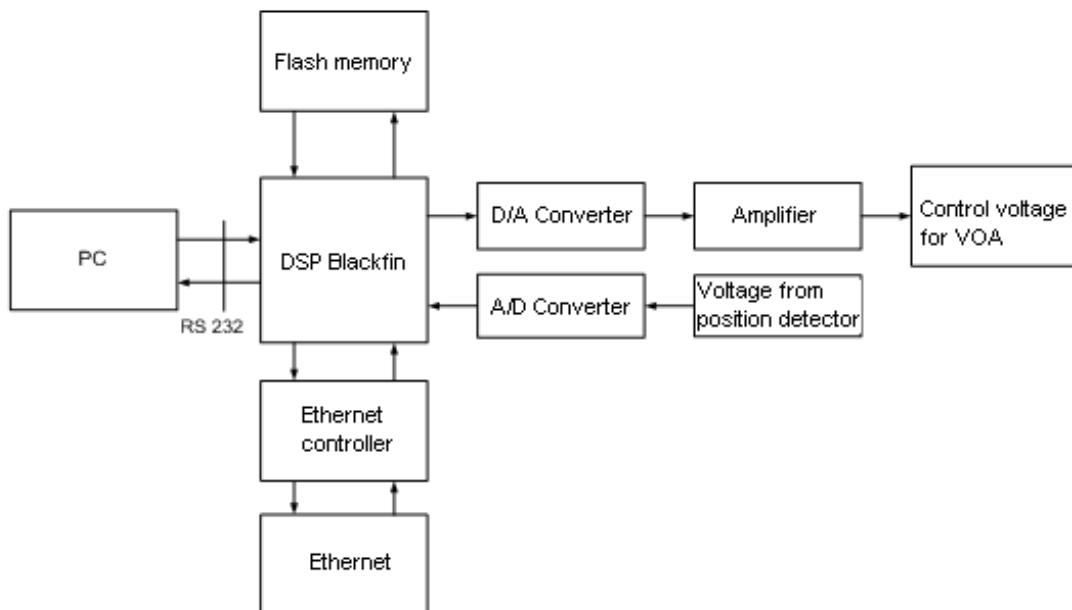


**Fig 4: Principle of VOA MEMS Tester (Mechanical part)**

As a position detector was used 2D sensor S5990-01 from Hamamatsu with active detection area 4 x 4 mm. PSD has 4 voltage outputs, from which is calculated absolute position of beam on PSD detecting area.

### 2.4. HARDWARE SECTION

Heart of the hardware part is DSP Blackfin 532 from Analog Devices. As fast A/D converter was used AD7490 and as D/A converter was used DAC8532.



**Fig 5: Block scheme**

## 2.5. MAIN TESTING OF MEMS VOA

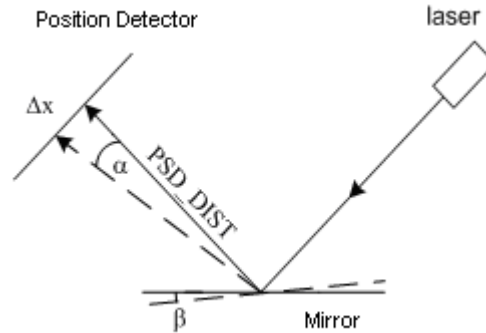
User place attenuator into socket (mechanical part) and run test through GUI in PC. After that, PC sends command to VOA Tester and starts internal test procedure. Firstly, output voltage is set on DAC and mirror is deflected into initial position. Next, voltage values from PSD are read and VOA Tester calculate position coordinates according these equations:

$$x = \frac{L}{2} * \frac{(U_2 + U_3) - (U_1 + U_4)}{U_1 + U_2 + U_3 + U_4}$$

$$y = \frac{L}{2} * \frac{(U_2 + U_4) - (U_1 + U_3)}{U_1 + U_2 + U_3 + U_4}$$

**L** is PSD constant

After that, higher output voltage is set and mirror is deflected into next position. New voltage values from PSD are read and coordinates of next point are calculated. Now we have coordinates of two points and we can calculate the distance between  $\Delta X$ .



**Fig 6: How to calculate angles**

We have  $\Delta X$  and  $PSD\_DIST$ , now we can calculate angle

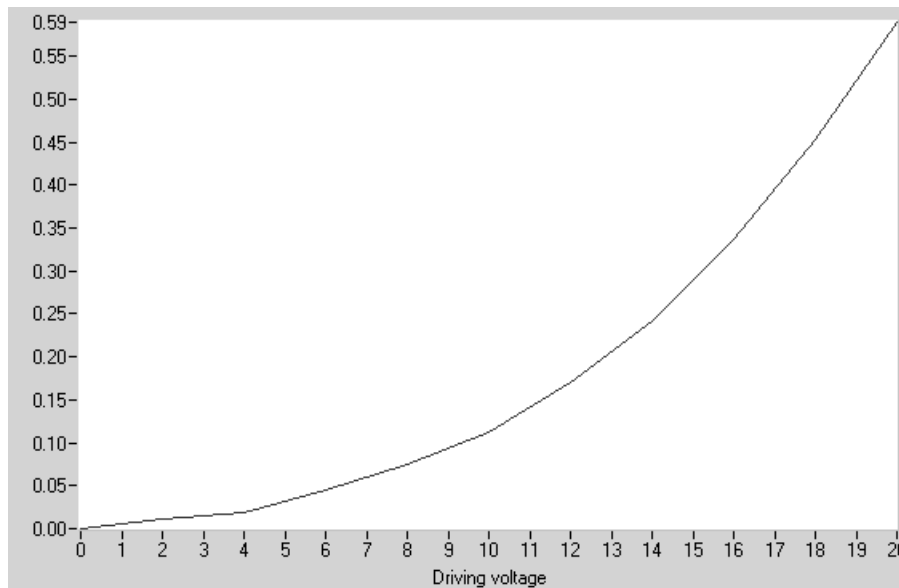
$$\alpha = \arctan\left(\frac{\sqrt{(\Delta X)^2 + (\Delta Y)^2}}{PSD\_DIST}\right)$$

and

$$\beta = \frac{\alpha}{2}$$

Where  $\beta$  is deflect angle of mirror in dependence of VOA input voltage.

The main test is commonly from 0V to 20V with step 1V, on picture below, we can see graph generated from one of these tests. Unit on left axe are degrees of deflection.



**Fig 7: Dependence of overall deflect angle on VOA input voltage**

### 3. CONCLUSION

VOA's mirror deflecting angle is the most important parameter of MEMS VOA and main function of VOA MEMS Tester is to measure this angle. VOA MEMS Tester works as expected, is very helpful and time saving. This device is used in Active Optical MEMS Inc. and test is 30 times faster, than test with interferometer. Measurement error compared to interferometer is about 3%, which is better, than expected.

### 4. ACKNOWLEDGEMENT

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- [3] Internal documentation from Active Optical MEMS