TERA 2012

The 2-nd International Conference "Terahertz and Microwave radiation: Generation, Detection and Applications", 20-22 June 2012, Moscow, Russia.

Abstract book

Organized by

Lomonosov Moscow State University

Institute of Applied Physics of the Russian Academy of Sciences

Budker Institute of Nuclear Physics

Supported by

RUSSIAN FOUNDATION FOR BASIC RESEARCH RFBR

SPIE

OSA The Optical Society

BRUKER

TerRaLab NTS

Integrated terahertz measurement module based on the electro-optical detector

A. Kaveev[a], G. Kropotov[a], I. Tzibizov[a]
[a] TYDEX J. S. Co., St. Petersburg, Russia

Integrated terahertz measurement module based on the electro-optical detector (EOD) that implements the division of the photodiode difference signal by the total (reference) was developed. Also built-in lock-in amplifier was developed and integrated with EOD in single unit with optics.

I. Introduction And Background

The classic balanced photodetector is a device that measures the difference between photocurrents, generated by light falling into two photodiodes, which is then enhanced with built-in amplifier. In our integrated terahertz measuring module the difference signal from balanced photodetector is supplied to the external lock-in amplifier and displayed on the visualizer (oscilloscope or a computer).

EOD is widely used in schemes of terahertz Time Domain Spectroscopy (TDS) as detector of THz field, where the optical mixture of THz emission and the reference laser beam on a nonlinear crystal is possible. Further progress in development of this device is associated with the integration of electronics and optics into one system, allowing one to obtain analyzed output signal suitable for a personal computer.

On the other hand, the realization of calculation not the difference but the division between the signals of photodiodes in electronics would lead to greater stability of the instrument with respect to fluctuations of the reference laser beam.

As a result of searching and comparing the characteristics of EOD manufacturing companies it became clear that only one manufacturer [2] offered to conclude in one module electronic and optical elements, but without the electro-optical crystal (EOC). Also it became clear that none of manufacturers uses the built-in lock-in amplifier and that no one realizes the division of the difference photodiode's signal to the reference in electronics.

II. Results

As a result of developments in Tydex some significant improvements in the design of the balanced detector were made, thus turning it into a more compact, versatile instrument module, fully replacing the detection scheme, used in TDS. (Fig. 1).

Main of these improvements is a hardware implementation of the division of the difference signal, detected by photodiodes, the total (reference). This enhancement improves the detector's signal to noise ratio by normalizing the difference signal to all the noise of IR laser. Second improvement is embedding of lock-in amplifier directly into EOD, which makes external lock-in device unnecessary. Third improvement is the integration of all optics and electronics including electro-optical crystal in single unit.

Schematics of a typical balanced detector contains an electrical circuit autobalance that in the developed module was replaced by the electro-using stepper motor which rotates a quarter-wave plate, which is the part of the optical system of EOD. Rotation around the optical axis is ± 30° with an accuracy of 1°. Also a mechanical realization of electro-optic crystal auto-tuning azimuth rotatable around the optical axis of the system in ± 30° range is made with vernier adjustable handly with an accuracy of 5°.

To date designed instrument module has no direct analogues in the world market today because of its multifunctionality and flexibility, in addition to used the know-how in terms of layout, multifunctionality and flexibility of use. On of the results of the device testing is shown in fig. 2.

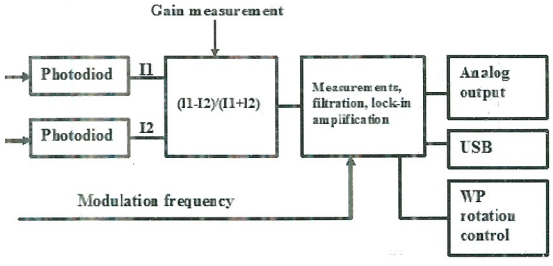

Fig 1. Block diagram of the developed instrumentation module.

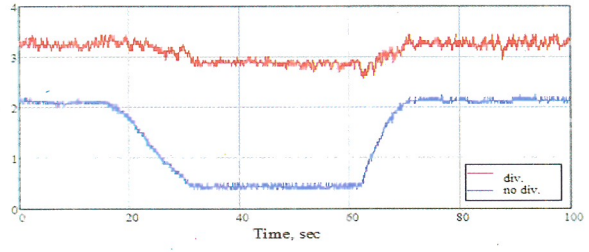

Fig. 2. Signal measured with (red) and without (blue) new signal division scheme. Optical knife was entered in IR laser beam to simulate obstacle (instability of the laser). Significant improvement of the signal is clearly seen.

In summary, new device which should significantly improve the convenience and quality of work with TDS systems is developed.

References

[1] Y Lee, 2009 Principles of terahertz science and technology. Springer P. 92
[2] http://dl.z-thz.com/brochures/ABL100.pdf