Real-time Laser Beam Position Detector

„XY4QD”

User Manual

1. Introduction

The *XY4QD* is a 4-quadrant-diode with readout electronics and outputs for x and y position. The position of the laser beam on the diode can be displayed without relevant time delay on a scope. Thus, even fastest fluctuations can be resolved. This is the main difference between this detector and beam profilers that can not measure a position in real-time and integrate over several pulses or fast photodiodes that can not measure any position. In addition to the x- and y-position there is also an output for the measured intensity level on the detector.

The XY4QD displays the information about the intensity level and the position directly on the housing. For this purpose an LED line and an LED cross are used, respectively.

The following figure shows the backside with the displays:

Figure 1: XY4QD with displays for intensity level and position

2. System components

A typical delivery includes the following components:

- Detector with integrated 4-quadrant-diode (4-QD), readout electronics, and optical filter
- 3 measurement cables MCX↔BNC
- Wall power supply 12V
- User manual

3. Specification

3.1 Technical data

Opto-electronic properties	
Bandwidth	up to 10 kHz (without intensity scaling > 100 kHz) (The bandwidth is optimized to a customized value in our lab. For the resolution of single pulses one should choose: bandwidth ≤ laser repetition rate)
Sensor area	10.0 x 10.0 mm^2
Typical spatial resolution	< 1 µm (depending on the beam diameter and profile)
Spectral sensitivity	320 – 1100 nm
Mechanical dimensions	
Housing	49 x 40 x 23.9 m^3
Thread	M4
Optical filter	(can be adapted on laser power and wavelength)
Dimensions	11.9 x 11.9 mm^2
Fastening screws	M2
Connectors	
x, y, I / Connectors	analog x, y: ± 5 V / I: 0 – 7V / MCX Coax connectors, standard oscilloscope input (high impedance, ≥ 4,7kOhm)
Power supply / Connector	12V, < 200mA / DC pin-and-socket connector 1.1mm
Measurement cables	MCX↔BNC, standard length1,8m (other lenghts on request)

3.2 Housing

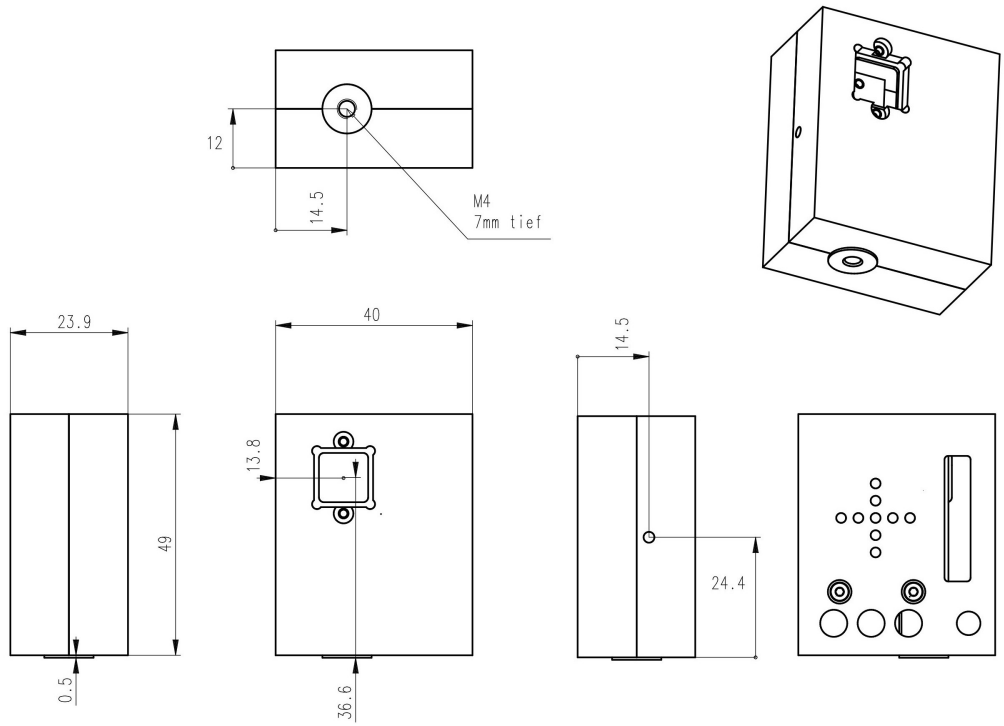

Figure 2: Housing

3.3 Position accuracy

The position accuracy depends on several parameters:

- Beam diameter: Having the same absolute change of laser beam position, a smaller diameter leads to stronger power differences on the quadrants and therefore a steeper control signal. That is why laser beams with smaller diameter can be measured with higher accuracy.
- Intensity: The resolution of the detectors further depends on the intensity hitting the sensitive area. This can be varied by an appropriate choice of optical filters and optimised electronically (see also section 3.5).

In figure 3 typical resolutions of the detector are displayed. The example shows that a resolution of better than 100 nm on the detector can be achieved with an appropriate choice of parameters.

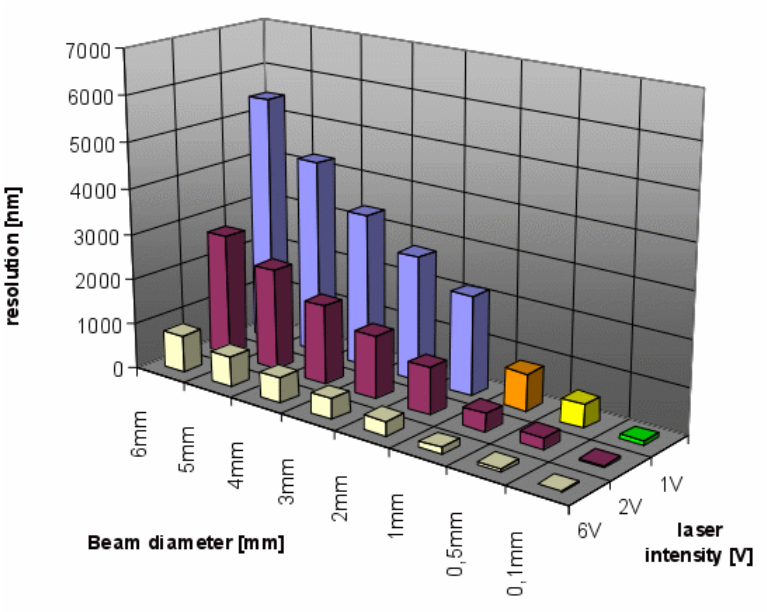

Figure 3: Resolution of a 4-quadrant-diode irradiated by a red He-Ne laser with different beam diameters and laser intensities

3.4 Displays

The XY4QD is delivered with a LED line for the intensity level and a LED cross for position display.

3.5 Intensity adjustment

To make sure that the detector operates in the linear range, the power level can be adjusted by tuning the potentiometer for intensity variation (see figure 4). For that purpose adjust the laser beam onto the detector in that way that at least 3 but not more than 9 elements of the power level display are shining. The amplification increases by counter-clockwise rotation.

If you do not find an appropriate adjustment you have to exchange the optical filters in front of the 4-QD. If the required filters are not available please contact the manufacturer or distributor.

Figure 4: 4-quadrant-diode. The arrow points to the potentiometer for intensity variation (Please use a screwdriver)

Notes:

- In a standard delivery we integrate two optical filters in front of the sensor area. These are filters with a high and a low density for coarse and fine adjustment, respectively. Usually the filter which is the first to be reached is the low density one.
- Please be aware that the sensor area is quite sensitive. If you want to clean it you should do this carefully with a wet lint-free cotton swab.

If you want to exchange the filters you can detach the plastic screws which fix the filters in the housing. With a tilt of the detector housing it should be possible to release the filters. Once you put in new filters please be careful so that you do not damage the detector. Finally you can fix them with the plastic screws.

3.6 Intensity scaling

The standard XY4QD is equipped with an intensity scaling. Here, a divider is integrated into the readout electronics that sets the intensity of each quadrant in relation to the total intensity on all four quadrants. In that way the measurement is independent of the actual laser power.

The intensity scaling can be omitted on request in order to reach even higher bandwidths and get access to the raw data.

4. Installation and operation

The intensity on the 4-QD should be chosen with values that lead to illumination of at least 2 and not more than 9 LEDs. This corresponds to voltages of 0.5 to 6 V. You can achieve the correct values by means of appropriate filters in front of the 4-QD. The XY4QD should be aligned to the laser beam in that position where it hits the center of the 4-QD. In this case you can detect the widest range of position changes.

You can get a comparable information regarding the position by using a scope. In order to get this you can connect the x and y signals to two channels of the scope and choose the scope's x-y-display mode.

4.1 LED cross for position display

If the laser beam hits the center of the 4-QD only the green LED of the position display will shine. In other cases also yellow and red LEDs will shine according to the examples in figure 5.

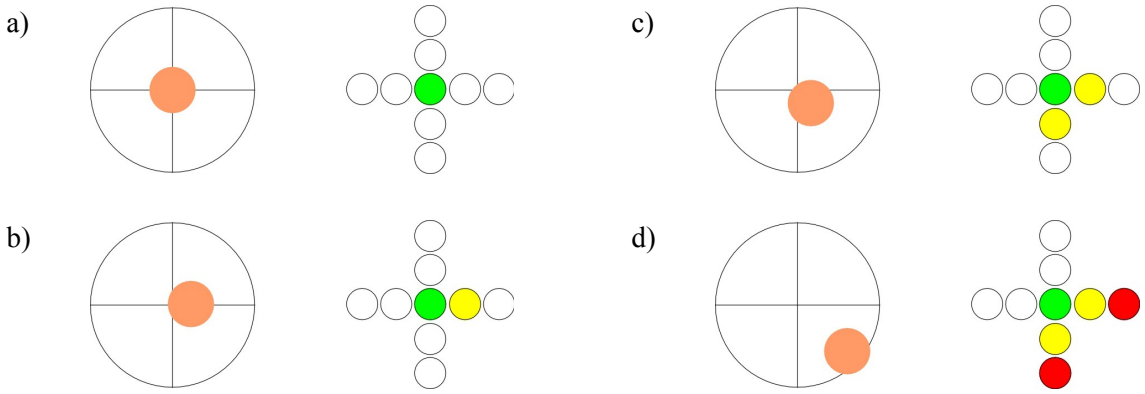

Figure 5: Examples for laser beams hitting the 4-QD (orange spots) and the corresponding position display. The left pictures are shown from the direction of the position display, i.e. from the rear side of the housing.

If only green and yellow LEDs shine the sensor electronics is in the linear range where a direct correlation between measured signal and position exists (see section “Calibration”). If a red LED shines too, the correlation is no more possible due to the principle of 4-QDs.

4.2 Calibration

The absolute position in x and y depends on the laser beam's diameter and (without the intensity-scaling feature) intensity. We recommend to perform a calibration of the detector for the actual laser beam parameters by moving the XY4QD relative to the laser beam by means of a micro-positioner and measuring the voltages for different positions.

4.3 Sham fluctuations at low intensities

Depending on the laser beam diameter and the chosen bandwidth sham fluctuations of the beam position can occur at low intensities although the beam position might be stable. These fluctuations are due to small intensity deviations of the laser and the noise of the diodes. Please take care for an appropriate intensity on the 4-QD.

If the intensity on the 4-QD is too small, the central green LED will not shine.

5. Safety

The detector has left our factory in a faultless state. Please only store and operate it in dry environments in order to maintain this state.

CE The device was designed and manufactured according to DIN EN 61000-3-2 and satisfies the requirements of the European EMC Directive 89/336/EWG.

Label

6. Contact

MRC Systems GmbH
Hans-Bunte-Strasse 10
D-69123 Heidelberg
Germany
Phone: +49-6221/13803-00
Fax: +49-6221/13803-01
Web: www.mrc-systems.de
E-mail: info@mrc-systems.de