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Flex-PCB Pitch-Adapters for Silicon Micro-Strip Detectors*

R. Schnell[†1], *K.-Th. Brinkmann*[1], *and S. Krah*[2]

[1]II. Physikalisches Institut, Justus-Liebig-Universität Gießen, Heinrich-Buff-Ring 16, 35392 Gießen, Germany;
[2]Helmholtz-Institut für Strahlen- und Kernphysik, Universität Bonn, Nussallee 14-16, 53115 Bonn, Germany

Introduction

Silicon micro-strip sensors for tracking detectors with high spacial resolution feature a vast number of channels. A single detector can have up to one thousand channels per side to be read out. With a strip pitch in the order of tens of micrometers, a high interconnection density between the detector and the front-end chip is required. In most cases the read-out pitch of the sensor and the input pitch of the front-end chip do not match. Thus, an interconnection device between sensor and front-end is required to adapt for this. These pitch-adapters are often made by thin film technology on a glass or ceramic substrate. This report demonstrates the effort to use advanced flex-PCB technology as pitch-adapter. This development was carried out for the Micro-Vertex-Detector (MVD) of $\overline{\text{P}}$ANDA [1].

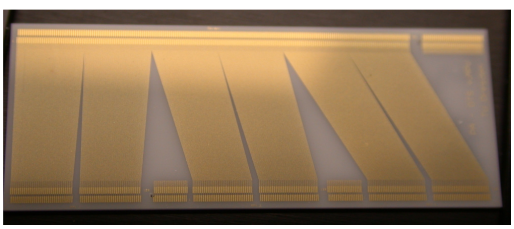

Figure 1: Photograph of the pitch-adapter design based on thin film technology [2].

Pitch-Adapter Design

Prototyping for silicon strip sensors was done with a pitch-adapter made by thin film technology with a wire structure of 2.0 µm thickness made from TiW with gold plating for wire bonding. The pitch is 44.0 µm on the front-end input side and 50.0 µm on the sensor side using two staggered rows of bond pads. A change of the sensor or the front-end would need a redesign with a new set of production masks. Therefore, the possibility to reach the same interconnection density employing standard PCB-technology was explored. In order to reach this aim, a two-layer design of flex-PCB was chosen. This was necessary since the trace width of 35 µm is larger than using thin film technology. The traces on the bottom layer are connected to the top bonding pads using laser-drilled microvias of 50 µm diameter [3].
The production with standard industrial methods will allow the pitch-adapter to be seamlessly integrated into the front-end hybrid circuit. In addition, the flexible material permits the realization of detector geometries not possible using rigid hybrid carriers.

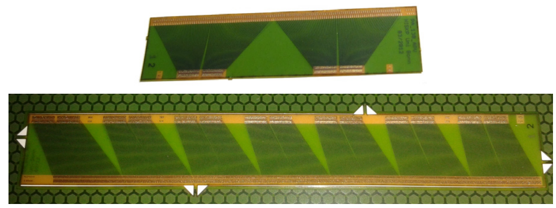

Figure 2: Photographs of two out of ten designs of flex-PCB pitch-adapters. Top: Design for two front-ends and 130 µm sensor strip pitch. Bottom: Design for seven front-ends and 65 µm sensor strip pitch.

Results

A double-sided prototype module based on $\overline{\text{P}}$ANDA geometry sensors and flex-PCB pitch-adapters was produced and employed in a CERN test-beam. No changes in performance compared to thin film technology pitch-adapters were observed.
An electrical characterization measurement using an LCR-meter was performed to investigate the influence of the additional capacitance and resistivity introduced by the pitch-adapter. The results indicate an additional crosstalk up to 2% and an increase in noise of less than 0.5% [4]. Advantages in terms of material budget arise from the small thickness and the material composition of flex-PCB. The radiation length of polyimide is 28.6 cm compared to 7.4 cm for aluminum oxide [5]. Therefore, a pitch-adapter based on thin film technology made from aluminum oxide with a thickness of 0.38 mm yields 0.51 % of one radiation length. Whereas a pitch-adapter based on polyimide films with a total thickness of 50 µm (25 µm for core layer and coverlay respectively) exhibits 0.017 % of one radiation length.

References

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[5] PDG, Atomic and Nuclear Properties of Materials

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† Robert.Schnell@exp2.physik.uni-giessen.de