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High Density Harp For SSCL Linac

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Abstract

AlliedSignal Inc., Kansas City Division, and the Superconducting Super Collider Laboratory (SSCL) are collaboratively developing a high density harp for the SSCL linac. This harp is designed using hybrid microcircuit (HMC) technology to obtain a higher wire density than previously available. The developed harp contains one hundred twenty-eight 33-micron-diameter carbon wires on 0.38-mm centers. The harp features an onboard broken wire detection circuit. Carbon wire preparation and attachment processes were developed. High density surface mount connectors were located. The status of high density harp development will be presented along with planned future activities.

INTRODUCTION

AlliedSignal Inc., Kansas City Division, and the Superconducting Super Collider Laboratory (SSCL) are developing a high density harp for use in the SSCL linac. The SSCL required a 128-wire harp with overall dimensions no greater than 80 mm X 80 mm X 50 mm (L X W X D). The carbon wires needed to be approximately 25 microns in diameter and spaced 380 microns on center[1]. The harp must mount to the end of a SSCL actuator[2] using a 2.125-inch conflat flange.

To accomplish the SSCL's design goals, the Kansas City Division's experience in designing and manufacturing hybrid microcircuits (HMCs) was utilized.

Utilizing the technologies used to fabricate hybrid microcircuits, a harp can be produced with greater wire density than previously obtainable. The high density harp utilizes thick film conductor lines printed on a ceramic substrate. Since thick film networks (TKNs) can be fabricated with 0.127-mm lines and spaces, carbon wires spaced 0.254 mm on center are possible.

A carbon wire attachment process was developed to bond carbon wires to gold TKN bond pads. The attachment was required to be a maximum of 0.254-mm wide to match the minimum TKN line spacing

HARP DESIGN

Figure 1 illustrates the design for a high density harp. The overall dimensions of this harp are 80 mm X 75 mm X 45 mm (L X W X D). This harp has been designed to mount to the SSCL actuator with a 2.125-inch conflat flange. Connection to the data monitoring circuitry[3] is made within the 25.4 mm I.D. actuator arm by mating to the harp's four 37-contact high density surface mount connectors manufactured by Nanonics Corporation. These dual-row nanominiature connectors feature 0.635 mm contact spacing and measure only 11.43 mm X 5.72 mm X 3.18 mm (L X W X D).

The harp TKN is a 1-mm-thick alumina substrate printed with thick film conductor inks. Conductor inks used include gold for the wire bond pads and conductor lines and a platinum/gold composition for the connector pads. The platinum/gold composition allows the connectors to be surface mount soldered without leaching the pads off the substrate. The harp's TKN has six conductor layers printed on both sides. Printed dielectric layers separate the conductor layers. A 0.15 mm X 0.23 mm oval-shaped through-hole via geometry was developed to make the required 128 TKN front-to-backside connections in the available amount of space.

A benefit of utilizing a TKN for the harp network is that a 1 M-ohm resistor array can be printed directly on the harp substrate. This allows the incorporation of a broken wire

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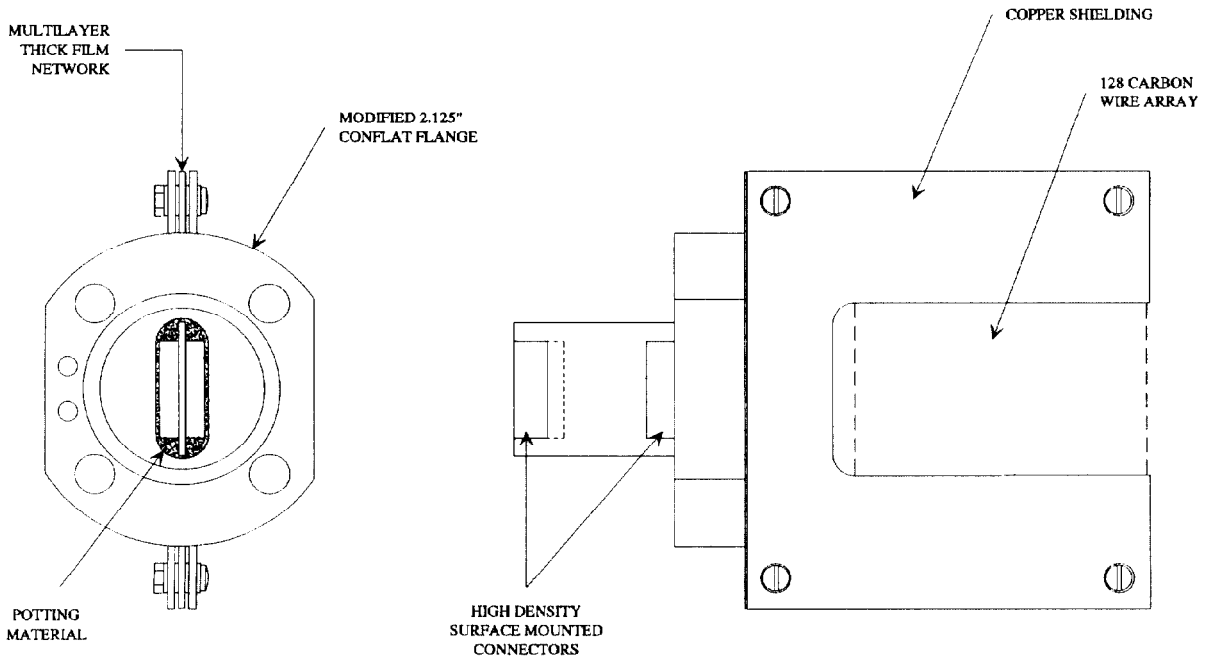

Figure 1. High density harp

detection circuit without increasing the harp's thickness or adding components.

To obtain a vacuum feedthrough with 128+ conductors, the harp thick film network was designed with a necked-down region that may be potted into the conflat flange, forming a hermetic seal.

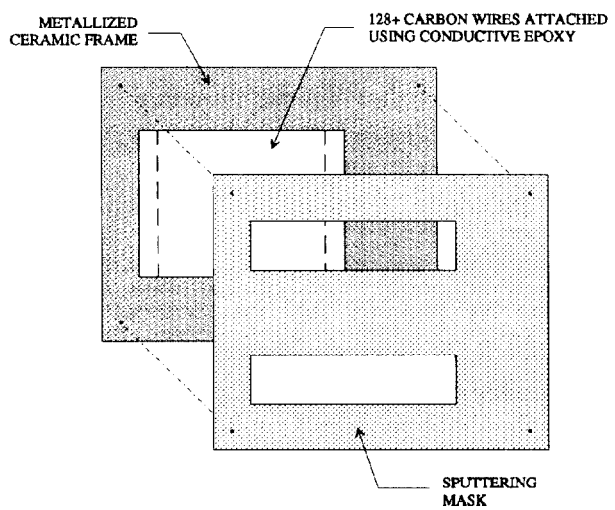

Figure 2. Wire preparation for Ti/Pd sputtering

CARBON WIRE ATTACHMENT

The high density carbon wire array required the development of a bonding technique to attach the carbon wires to the harp TKN bond pads. The technique makes it possible to attach 33-micron-diameter carbon wires to 0.127-mm-wide metallized pads, providing mechanical and electrical connection.

Before carbon wires are bonded to the harp network, the ends of the wires are metallized with titanium, palladium, and gold. In preparation for the metallization process, the wires are epoxy-attached under tension to a metallized ceramic frame so that all of the wires are parallel to each other and properly spaced (Figure 2). The ceramic frame is made from standard herman-size (3.75 X 4.5-inches) ceramic to be easily accommodated by the Kansas City Division's processing equipment, a vacuum deposition chamber and a gold electroplating tank, without new fixturing.

The frame containing the carbon wires, masked to expose only the ends of the wires, is sputtered with

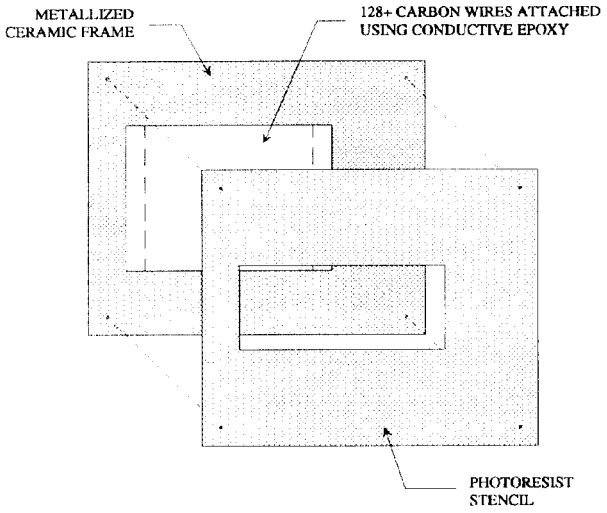

Figure 3. Wire preparation for gold electroplating

approximately 1,500 Å of titanium, followed by approximately 2,500 Å of palladium.

The frame is then overlaid with a stencil to apply photoresist to the center region of the wires (Figure 3), thereby preventing gold from adhering during the plating process. The photoresist-covered wires are then electroplated with approximately 500 microinches of gold.

The prepared carbon wires are positioned over the harp network bond pads in preparation for bonding. The end metallized carbon wires are bonded to the harp TKN bond pads using a parallel gap welding process. Figure 4 shows an example of an end metallized carbon wire bonded to a thick film gold bond pad. The process provides a strong mechanical bond, maintaining wire tension, without damaging the carbon wire.

Figure 4. Bonded carbon wire

STATUS

- A wire scanner has been designed and built utilizing a thick film network with welded carbon wires demonstrating the design features to be used on the high density harp.
- A potted vacuum feedthrough was demonstrated during the fabrication of a collector[2].
- A TKN test pattern has been designed and fabricated successfully demonstrating the 0.15 mm X 0.23 mm oval-shaped through-hole via geometry .
- Layout of the high density harp TKN is nearly complete. Fabrication of the high density harp is scheduled to be completed later this year.

REFERENCES

[1]J. Hurd and others, "Physics Requirements of Commissioning Diagnostics for SSCL Linac," *Proceedings of the 1993 IEEE Particle Accelerator Conference*

[2]C. Crist and others, "SSCL Linac Commissioning Diagnostic Cart," *Proceedings of the 1993 IEEE Particle Accelerator Conference*

[3]A. VanDeusen and others, "High Density Data Monitoring for SSCL Linac," *Proceedings of the 1993 IEEE Particle Accelerator Conference*