Making Complex Electrically Conductive Patterns on Cloth

Circuit patterns are implemented in tightly woven cloth instead of stitched conductive thread.

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A method for automated fabrication of flexible, electrically conductive patterns on cloth substrates has been demonstrated. Products developed using this method, or related prior methods, are instances of a technology known as "e-textiles," in which electrically conductive patterns are formed in, and on, textiles. For many applications, including high-speed digital circuits, antennas, and radio frequency (RF) circuits, an e-textile method should be capable of providing high surface conductivity, tight tolerances for control of characteristic impedances, and geometrically complex conductive patterns. Unlike prior methods, the present method satisfies all three of these criteria. Typical patterns can include such circuit structures as RF transmission lines, antennas, filters, and other conductive patterns equivalent to those of conventional printed circuits.

E-textiles of various forms have previously been demonstrated, but have typically been hindered by one or more shortfalls. For example, geometrically complex antennas have revealed performance levels that are indistinguishable from identical designs on conventional materials. However, construction of the complex geometrical patterns has often been laborious, involving hand-stitching. Another automated method for e-textiles circuit construction uses conductive threads in an embroidery process. However, the embroidered conductive threads do not provide sufficient surface conductivity for many high-speed digital and RF applications. Furthermore, some studies have indicated that the conductive embroidery threads are more subject to breaking than conventional non-conductive embroidery thread.

The present method overcomes the limitations of the prior methods for forming the equivalent of printed circuits on cloth. A typical fabrication process according to the present method involves selecting the appropriate conductive and non-conductive fabric layers to build the e-textile circuit. The present method uses commercially available woven conductive cloth with established surface conductivity specifications. Dielectric constant, loss tangent, and thickness are some of the parameters to be considered for the non-conductive fabric layers. The circuit design of the conductive woven fabric is secured onto a non-conductive fabric layer using sewing, embroidery, and/or adhesive means. The portion of the conductive fabric that is not part of the circuit is next cut from the desired circuit using an automated machine such as a printed-circuit-board milling machine or a laser cutting machine. Fiducials can be used to align the circuit and the cutting machine. Multilayer circuits can be built starting with the inner layer and using conductive thread to make electrical connections between layers.

This work was done by Andrew Chu, Patrick W. Fink, Justin A. Dobbins, Greg Y. Lin, Robert C. Scully, and Robert Trevino of Johnson Space Center. Further information is contained in a TSP (see page 1).