HDI

high-performance flex

Turning Low-Density Flexible Circuits into High-Performance Assemblies

Using a simple, innovative technique, low-density electrical circuits can deliver localized high-density electrical function, creating both cost savings and greater flexibility in the placement of electronic devices.

By Bruce Lindahl

Standards for automotive safety, performance and comfort have increased dramatically in recent years, especially with the advent of more sophisticated electronic components. Electrical control units (ECUs), environmental controls, navigational read-outs and "infotainment" centers are now found in a multitude of places in the average new truck or automobile, sometimes far from the main instrument cluster.

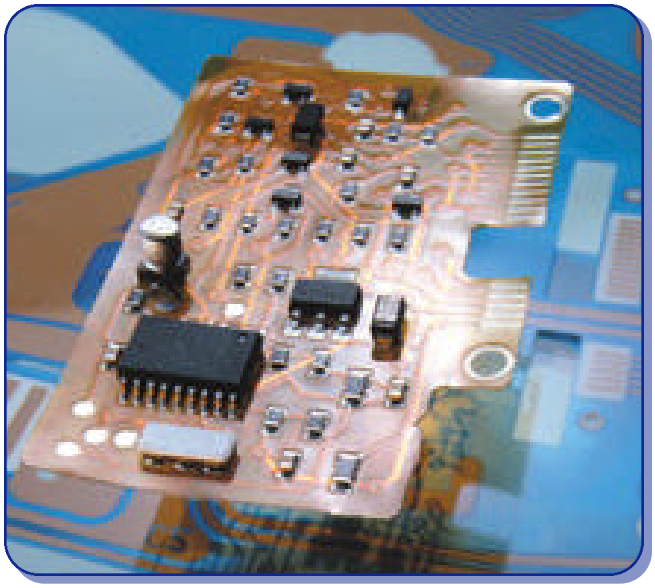
Such advancements bring with them new design challenges. Among the most daunting is the need for high-density electrical functions in isolated or far-flung places, usually joined by expanses of flexible interconnect with lower processing requirements. The issue for engineers is how to accommodate these discrete areas of high density without specifying needless processing power elsewhere.

New manufacturing technologies have produced a practical, reliable and cost-effective answer. By lap-soldering a high-performance electrical Density Patch™ to a lower density substrate, a localized area of high-density function can be achieved at a lower cost. The process results in a strong, stable, multipurpose solution that can handle a variety of configurations and deployments.

While this kind of patch holds promise for many industries and products — including the appliance industry where "smart" appliances such as cooktops, microwaves, and clothes washers and dryers are requiring new microprocessor functions — it is most suited for the automotive industry where new and dispersed capabilities are being added seemingly with each model iteration. Density patches are a simple, innovative and affordable answer to a thorny design problem.

Reliability and Versatility

In the early 1990s, the task of placing a patch circuit on a larger flexible substrate was achieved by bonding high-density integrated circuitry to the substrate using a Z-axis anisotropic adhesive. Mechanical and electrical performance limitations, however,



High temperature and humidity	75°C at 95% RH for 24 hr
Extended humidity	38°C at 98% RH for 100 hr
Temperature cycling	25 temperature cycles • 1 hour at -30°C • 1 hour at 22°C • 1 hour at 80°C

TABLE 1: Effective temperature and humidity ranges for a density patch.

prevented such a solution from achieving widespread use.

Today's density patch alternative affords a far greater degree of design freedom and reliability. By employing durable lap solder techniques, as many as 40 components or more can populate a large-area circuit without the need of a high-density substrate.

Using a density patch, electrical function can be placed precisely at the point where the capability is needed, thus avoiding the cost associated with large, fine-line printed wiring boards (PWBs), wire bundles or other high-density solutions. Not only does a density patch make distribution of electrical function easier, but it also gives designers greater compositional freedom, as even the highest-level instrumentation can be installed without the need for clustering in a limited number of locations.

Overall, users can typically save 10 to 25 percent in cost compared to large-area high-density circuitry, depending on specific application requirements. New applications using density patches have already met Ford Motor Company's industry-standard automotive testing requirements, and automated optical inspection (AOI) ensures that quality is maintained throughout the manufacturing and assembly process.

Also, because the technology typically uses off-the-shelf components, a wide variety of custom configurations can be assembled to user specifications with no incremental increase in design or assembly costs.

Lap Solder Assembly

To create a density patch, high-density circuits are first manufactured using an extremely efficient, roll-to-roll production process to keep unit costs low. Patches are populated with surface mount components in multiple-up panels then pre-tested and separated for use.

The patch is aligned to the base circuit using a pinning template, afterwhichthejointislapsoldered. A hotbarprocessisusedto reflow thesolderinthejoint.Becausethehotbarmakescontactwiththehigh-density polyimide circuit only, it eliminates the need for more expensivefilmusedinthemanufacture ofthebase.

The resulting connection is a permanent, durable and highly reliable interconnect. Effective temperature and humidity ranges for a density patch allow it to be specifiedin a large variety of applications (Table 1); because the patch occurs on a flexible host, it also is not as vulnerable to extreme vibration or shock. The design maximizes the overall strength of the joint and minimizes the chance of mechanical failure over the life of the installation (Figure 1).

Design Considerations

Patches can be placed on a variety of polyimide and polyester substrates in a myriad of conductor widths and spaces. Depending on power and space requirements, specifiers can choose from a standard single-layer screen print density flexible interconnect offering up to two-layer printed circuits with 50-µm conductor capability.

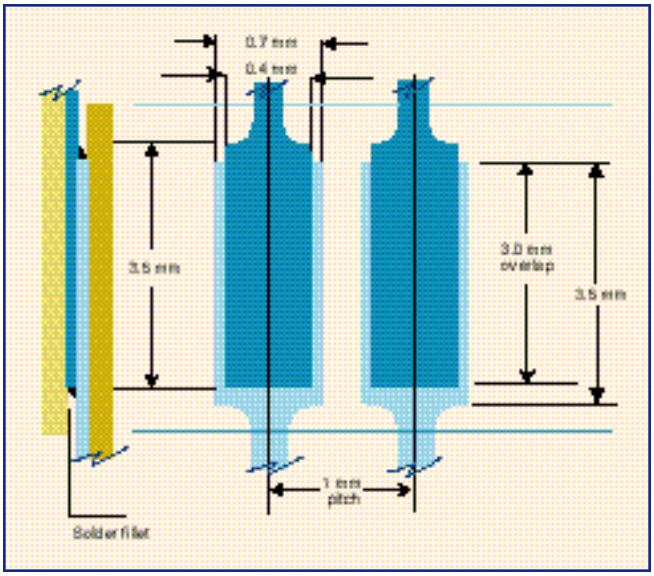


FIGURE1: Design requirements fortheflex-to-flex interface.

Beyond the standard considerations of shielding and cross-talk prevention, density patches enjoy relatively few design limitations. They can be placed on either or both sides of the flexible interconnect, in as many locations as needed, and patches of differing densities can be easily populated on a single base circuit. In all cases, however, care should be taken to avoid flexing the substrate at the patch site.

Because stock interconnect components are used, prototypes can generally be built to user specification in conveniently small quantities. Turnaround is in the range of two to four weeks depending on complexity and quantity, and shorter lead times can often be accommodated.

Change Demands Innovation

As automobiles become more populated with high technology devices to improve owner convenience, fuel economy, safety and reliability, demands on the vehicle's electronic infrastructure will inevitably increase. Engineers will be called upon to find more innovative solutions to keep manufacturing costs in line while delivering practical and high-quality electronic connectivity.

In this stringent design environment, the density patch becomes a valuable alternative for turning low-density circuits into high-performance assemblies. It gives users a new option for producing cost-effective electronics in a dependable, custom-manufactured format. ■

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