World’s Best Minimal Package?

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Finally! The ultimate micro-package! And it’s about time, isn’t it? Picture a chip-size package that is economical, very robust, easy to assemble and reworkable. Better yet, the super-package doesn’t require underfill. This is certainly a breakthrough. The inventors call this simple but innovative minimal package the SLT. The product appears to be the long-sought “ultimate micropackage”. Nothing can be smaller, the process is simple, materials are cheap and electricals look fantastic. So what’s the gimmick?

The innovation comes from material selection and structure design. This tiny package does not use the common solder bumps or spheres like most flip chips and micro-BGAs. Instead, copper balls are used for the interconnect. Is it a flip chip or a chip scale package? Well, there are elements of both, but since there is no on-chip routing, it’s more flip chip. The non-fusible Cu spheres may require better planarity and size control than solder bumps, but solid copper provides some noteworthy benefits.

The copper BGA system can enable easy testing and rework. Unlike soft solder interconnects, the harder copper spheres can be easily probed, clamped or plugged into burn-in sockets. Solder spheres deform under clamping pressure, especially under burn-in heating conditions. What’s more, since the Cu balls are attached to the chip with high-melting alloy, the SLT can be removed and replaced without the common “reballing” process. The package is really just another Surface Mount device (SMD) that falls into the microBGA class.

The chip is well protected by inorganic passivation layers and does not use encapsulation. The assembled package is robust and underfill is not required. But if desired, underfill can still be used without any adverse effects. The copper interconnect structure boosts strength and improves electrical performance. Solders generally have much higher volume resistivity than copper. Lower resistance paths have become increasingly desirable as frequency is pushed ever higher. Perhaps this package style can offer cost-effective solutions in the high radio frequency (RF) product including Bluetooth.

OK, this sounds like a good candidate to nominate for the smallest, fastest and cheapest minimal package, but can it be built? Well, there is a problem with availability. You won’t be able to get the SLT in quantity. You may be wondering if there are some unresolved technical problems. No, essentially all the problems have been solved and the manufacturing process is proven. So what’s the hold up? It’s all about timing.

This new package has already come and gone. The SLT concept was first proposed to management 40 years ago on August 1, 1961 at IBM. Lab work obviously began earlier, but the 1961 date is documented according to “Dr. Flip Chip”, Paul Totta (semi-retired but still very active at IBM). Billions of SLTs went into 360 mainframes and other great computers that set an incredible reliability record, perhaps the best ever. The 40-year old SLT was the first BGA and surface mount device. The copper balling process, using Alpha Metals Cu spheres, was eventually replaced by Controlled Collapse Chip Connection (C4) better known as flip chip. As evidence that “old is new” and “new is old”, Alpha’s BGA sphere group gets an increasing number of requests for copper micro-spheres. So maybe this old idea is the best new idea for 2001 packaging. What do you think?

[Figure shows the SLT – courtesy of IBM]

Notes: The substrate was low expansion ceramic and underfill was not required but was later used to seal the connections. The device was so early that it was applied to the transistor, hence the 3 microsphere configuration. SLT stands for Solid Logic Technology. The package was not reworked and probably never needed rework, but the choice of materials would have allowed easy removal and replacement.