

# MAKING A RELIABLE CONNECTOR FOR SAFETY DEVICES

BY JEFF KLEIN

*Using both mechanical strength and solder joints to maintain reliability in a new smoke detector design*

## SPEC SHEET

**End Applications:** Smoke detectors, HVAC duct applications

**Related Products:** PCBs, through-hole connectors, surface mount connectors, receptacles, sensors, pick-and-place machines

**Main Point:** The trend toward production of ever-smaller components and products increases the pressure on manufacturers to ensure reliability — particularly in applications directly involving human safety. One such manufacturer wanted to redesign its smoke detector products to incorporate the latest technology. The company had a number of redesign goals it wanted to accomplish, including:

- using only surface mount components to achieve a single-sided PCB on the sensor side,
- placing parts using the company's existing pick-and-place equipment and
- ensuring maximum reliability in this critical application.

The cost savings and size reduction inherent in miniaturization are two of the driving forces behind the trend in printed circuit board (PCB) assembly away from through-hole and toward surface mount technology. Production of ever-smaller components and products, however, increases the pressure on manufacturers to ensure reliability — particularly in applications directly involving human safety.

One such application is smoke detection. System Sensor, a fire detection and prevention equipment provider, took up the challenge and decided to incorporate the latest surface mount technology into its products. The company's product development team wanted to redesign an existing company device that had been on the market for 10 years. The new design would require replacing a through-hole-mounted electronic connector with a surface mount connector specially designed by Zierick Mfg. Corp. of Mt. Kisco, N.Y.

The connector is used in smoke detectors for commercial heating/ventilating/air conditioning (HVAC) duct

applications. The detector is comprised of a 14 x 5" plastic housing with two compartments, each containing a PCB. One compartment houses air input, air output, the smoke sensor and the sensor PCB. The board in this compartment was redesigned for surface mount assembly only. The second compartment houses the power control board, which is hard wired either to an alarm system, an accessory, or directly to HVAC equipment such as a rooftop unit, a fan or a damper. The power control board retained its through-hole components during the redesign.

The company had a number of redesign goals to accomplish. First, it envisioned using only surface mount components to achieve a single-sided PCB on the sensor side. Second, parts had to be placed using the new pick-and-place equipment, made by Zevatech Inc. (Morrisville, N.C.), although certain modifications to the nozzle were required. The third goal, of course, was to ensure maximum reliability in this critical application.

A further motivation, probably the most compelling one on the manufacturing floor, was that the old receptacle, supplied in loose-piece format, was continually getting jammed during feeding. Odd form

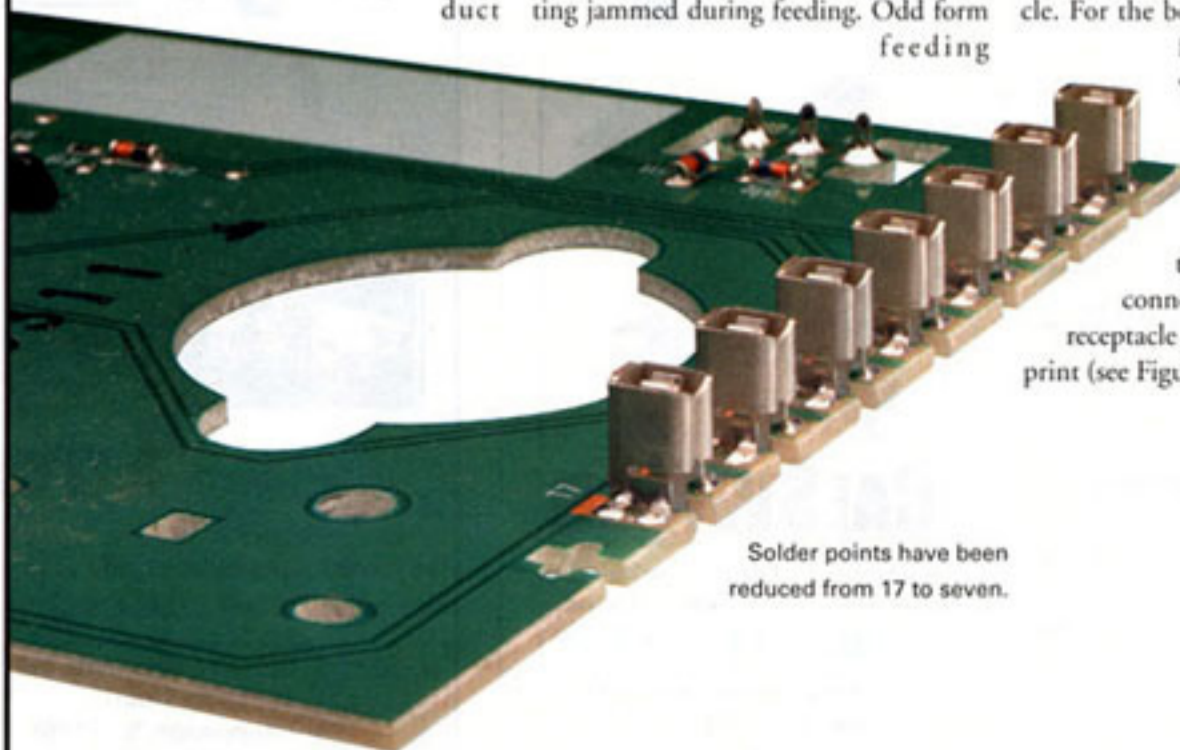
and placement has advanced so far in the past 10 years that there was never any question that the new connector would have to be supplied in continuous-reel format, an area in which Zierick has unique expertise.

### The Key Component

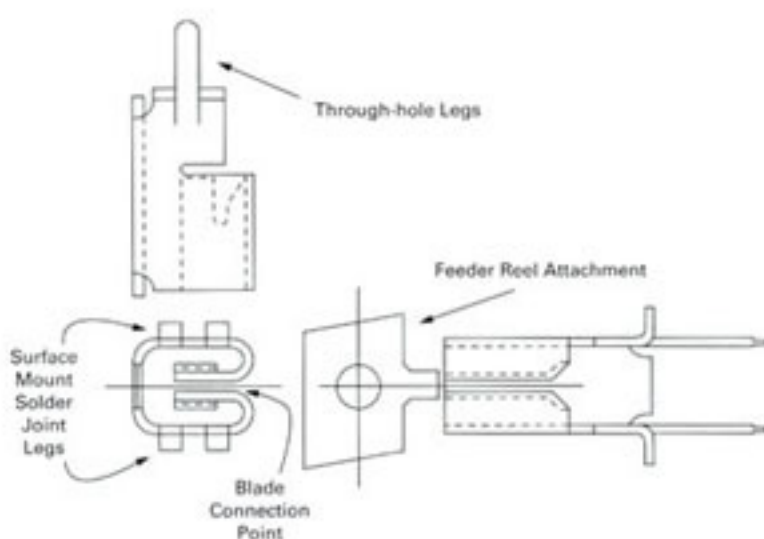
The signal generated at the device's sensor travels from the sensor board to the power control board through U-shape receptacles, seven on each PCB. Fitting into these adjacent receptacles are stainless steel, blade-type interconnects that are embedded in the divider of the plastic housing during the molding operation. With the blade connector embedded in the housing, greater stress was placed on the receptacles. Not only did they have to carry the signal through the solder joint, but they also had to offer mechanical strength provided by through-hole legs — in other words, they had to provide both belt and suspenders for this application.

The product development team realized they had to start from scratch with a completely new design. After some initial discussion with Zierick, with whom they had worked in the past, the manufacturer contracted Zierick to develop the receptacle. For the better part of a year, teams from each company were in weekly contact, accumulating a file of design considerations.

Derived from a standard design for a tin-over-copper, quick-disconnect tab connector, the new receptacle did require a unique footprint (see Figure 1).



Solder points have been reduced from 17 to seven.



**Figure 1.** The design of the receptacle required some unique features including surface mount solder legs to attach to the PCB solder pads and through-hole legs for a mechanical connection.

### Mounting

The surface mount PCB, which measures 3.75 x 5.50", is loaded with parts while on the Zevatech fully automatic, high-speed placement machine. The receptacles are supplied in a continuous chain and use a feeder system, supplied by Zierick, that feeds, separates and presents each surface mount receptacle for nozzle pickup. The receptacle is reeled without prepackaging, providing substantial savings because the cost of surface mount taping is often more than that of the terminals themselves. All that was necessary in attaching the reel feeder system to the placement machine was a slight alteration to the feeder base for precise mounting.

Slight modification was required to the pickup head on the pick-and-place system. Because the receptacle geometry prohibited pickup by vacuum alone, a gripping feature was added. Furthermore, the receptacle has through-hole legs for mechanical strength, so modification was needed on the through-hole side as well to achieve a frictionless fit. Therefore, the holes in the board were enlarged to achieve zero resistance between part and board during low-pressure insertion.

### Testing

Zierick tested the receptacle for insertion and withdrawal forces. System Sensor took over system testing once the receptacle was

mounted. In applications like smoke detection, retaining the connection over time is of prime importance and requires accelerated life testing to simulate performance over five years. Normally, only two or three mating cycles are required per part in production. In order to receive an agency listing, however, 50 mating cycles are required and System Sensor actually performed more than 100. Both insertion force and retention force, properties specified in the part design, were tested for as well.

### Conclusion

Production is successfully under way now, and the company uses the new surface mount PCB in a number of products including both photoelectric and ionization duct smoke detectors. The total number of solder points required for the PCBs has been reduced from 17 to seven on the sensor side. And, although not the reason the company redesigned the product, average yield has been increased to between 5 and 10 percent. ✓

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