CIRCUIT CELLAR ONLINE

LESSONS FROM THE TRENCHES

George Martin

Connecting the Dots

Working with Board-to-Board Connectors

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Don't be afraid to get creative with your daughterboard connector selections. This month, George takes us down a number of paths for adding a daughterboard to your design. The classic solution: chassis with backplane. With several manufacturers, good pricing, and availability, the moral of the story is to move with no fear in making that connection.

Every once in a while you'll need to add a daughterboard to a design. The daughterboard may have optional features that are not installed in every unit, or may have components that are intended for removal as a memory card application. I came across such a requirement in a recent design, and I'd like to share what I found.

The first classic solution for board-to-board interconnection is the chassis with a backplane (I would put even the IBM PC into this category). The backplane can have either no active components or, as in the case of the PC, a ton of active components. So, the first solution to look at is the one that uses one-piece connectors mounted on the main logic board and accept cards with edge connectors built into their artwork. The connectors are relatively inexpensive, but the daughter card must have gold fingers to provide good connectivity. Also, the inexpensive versions of these connectors are spaced on 0.100″ centers, so there isn't a dense connection.

The next classic solution uses the usual headers on 0.100″ centers, typically seen at the ends of ribbon cables. With a lot of manufacturers, good pricing, and availability, what more could you ask for? This product line is broad and you can find all sorts of oddball variations.

The basic setup would have a socket on the main board and right angle pins on the daughterboard. And, the daughterboard would connect at right angles to the main board. However, you can also find a socket that accepts the pins and provides clearance for the pins to go through the board. This can be used for card stacking, as in PC/104 systems, or for height adjustment. Another feature of this stacking approach is that the main board and daughterboard are mounted parallel to each other, making a smaller overall unit.

These connectors are also available with locking hardware for a more rugged application. And, some manufactures make these style connectors on 0.050″ centers, twice the density of the 0.100″ devices. One of the units I designed had three boards, each with 50-pin headers at the edge. I used ribbon cable with mating connectors for the backplane, which eliminated one printed circuit board and all the accompanying mechanical design of a classic backplane.

OFF THE BEATEN PATH

Before I continue exploring other connector options, let me switch subjects and talk about costs. I use a standard cost of $0.10 a pin as a target price, and that's for a complete solution. Digi-Key has 3M 2 mm x 2 mm, 60-pin connectors for $7.74 (socket) and $4.99 (straight pin) in single quanities. These include a gold-plated contact area. In quantities of 500, prices drop to $5.32 and $3.44, respectively. That's a total of $8.76 for 60 pins, slightly over my standard cost

but acceptable. As you look at all the connector options available, make note of their prices. Some will surprise you because they're at both ends of the spectrum.

Another avenue to explore is the standard daughter card solutions, such as the ones used for DRAM modules, Futurebus+, VESA Media Bus, DIN, PCMCIA cards, or even Pentium II connectors. These are medium- and high-density connectors that are being built in high quantities, and that means low prices. These connectors are even appearing in distributors' catalogs, so you know they're available. Some of them mount the daughter card at right angles to the main board, and others (like the DRAM connectors) mount the daughter card at an angle to the main board. This angle might give you additional packaging density.

Whenever I'm using a standard connector for a nonstandard application, I ask a couple of questions. What if my daughter card gets plugged into a standard application? What if a card from the standard application gets plugged into my unit? There is no easy answer to either question. The best I've come up with is to use the same signals on your card as the standard, or at least the same power. And, match inputs and outputs with the standard. Or, you can just not worry about it if your application is far removed from the standard. However, whatever you decide, write it up well in the manual.

THE CHOSEN PATH

Let's look at how I applied the connectors I chose. Samtec makes a line of board-to-board connectors (SFML and TFML) that are dual-row, surface-mount connectors with pins on 0.050″ centers. They offer gold plating, alignment pins, and latches. The gold was a requirement for my design because I have address and data type signals running to the daughterboard. The alignment pins are helpful because, otherwise, the surface mount tails on the connectors can float in the solder and move the connector out of position. And, the latches were required for my application because it's going to be kicked around and probably dropped once or twice.

These connectors mount to the board surfaces, making the daughterboard parallel to the main board. When these connectors are mated, the board-to-board spacing is 0.250″. So, you can place SMT ICs between the boards, but only on one of the boards. You can't fit a DIP thru hole or any sockets.

I chose to place the ICs on top of the main board. On the daughterboard, I placed the ICs on the top and the connectors on the bottom. You may ask, how'd you do that? I placed the SMT parts on top of daughterboard, using the normal assembly process. Then, I screened the connector patterns on the back of the daughterboards and placed the connectors by hand. The alignment pins come in handy at this point. I passed the assemblies upside down through the reflow oven again. You can use low-temperature solder for the connector patterns or just shield the parts already soldered. It's not the standard use for a reflow oven, but it works well.

MARKING THE PATH

The other thing to watch out for is when you do the artwork. Holding the connector vertically, typically pin 1 is the top left as viewed from the top of the board. Pin 2 is then the top right, and pin 3 is below pin 1. The connector that is on the back of the daughter card still has pin 1 on the top left when viewed from the top of the board. This means you'll need a different pin sequencing when the part is mounted on the backside of the daughter card.

In my application, I selected 40- and 50-pin connectors and split the signals logically between them. I placed the only ground in the system at both ends of both connectors on the first and last three pins. I placed 5 V opposite the ground pins in three places, and in the fourth, I placed 3.3 V (see Figure 1), making it easy to decouple the power supplies as they enter the daughter card.

By selecting different size connectors, I made it impossible to plug a board in backwards. This is a good feature, but I lost quantity and now may have to pay a price penalty. So, I had the distributor price twice my requirements and convinced them that my PO for half the quoted units in two different items is a good deal. I'll let you know if I run into any problems in the end.

This parallel to the main board mounting approach keeps a low profile and probably will be less of an antenna for FCC part 15 than a right angle approach. It's something to consider.

You will find available three- and four-row connectors that are dense but present a routing problem for the artwork. Let me explain. With more than two rows, you are probably looking at a through-hole device. The holes take up routing area, and there is just enough area to get the signal traces to the pins. So, the connector has blocked the routing of traces that would like to pass through (but not connect to) the connector. This works if the signals on the connector are unique to the connector and you have board space to pass around the connector. But, going to three or four rows will probably take you to six or eight layers for the circuit board.

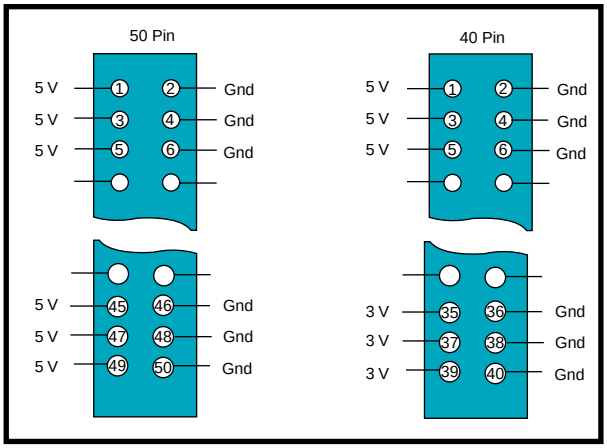

Figure 1—*Here you can see the placement of the pins on each connector.*

THE FINAL STRETCH

Conventional wisdom places the pins on a removable board. Pins are more fragile and less protected than the socket. If a pin is bent on the removable unit, then repairs can be made easily. But, sometimes the socket is the least expensive of the pair. And if only one unit in 50 will ever have the daughterboard installed, it makes sense to reverse the normal orientation and lower parts costs.

The last thing to consider is cleaning the connectors after soldering. Using either SMT or through-hole technologies and water cleaning, look for connectors that have enough clearance for the wash water to flow in and around everywhere. It also would be great if you could visibly inspect each solder joint after the cleaning. However, this is impossible with some connectors. It's important that the part be cleaned and dried properly.

The moral of the story—don't be afraid to get creative with your daughterboard connector selections.

George Martin began his career in the aerospace industry in 1969. After five years at a real job, he set out on his own and cofounded a design and manufacturing firm. Typical systems that George designs include servo-motion control, graphical input and output, data acquisition, and remote control. George is a charter member of the Ciarcia Design Works Team and most recently, he's been working on the people-tracking system for Bill Gates' new house. You can reach him at george.martin@worldnet.att.net

SOURCES

Board-to-board connectors
3M
(888) 364-3577
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Samtec
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