VME backplanes and accessories – making life easy for designers

By Justin Moll

It's no wonder VME has reigned supreme in the embedded systems world for more than 20 years. Besides being such a reliable bus, with all of its inherent strengths, using the technology offers designers so much convenience. Whether you are prototyping, looking for new parts or replacements, or testing your system design, the VME community offers an expansive range of products and easy-to-implement designs. VME has such well-defined specifications, that a designer can have confidence that any software and drivers he develops will work. There are many new and existing design challenges and VME backplanes and accessories that make life easy for today's designers.

Overcoming backplane design challenges

Using advanced design techniques has helped improve the performance and reliability of VME backplanes. For example, impedance control is a major issue in backplane design. It will continue to grow in importance as higher speed signals are used. The higher speeds have the potential to generate more noise. To help alleviate this problem, controlled-impedance stripline design is a common technique. The stripline design reduces crosstalk by shielding the signal lines with the power layers above and below. The outer ground planes fully shield the backplane and minimize EMI/RFI emissions susceptibility, minimize crosstalk, and maximize power distribution. In addition, by placing the ground planes on the outside, it keeps the inside layers more protected from nicks and scrapes. Most of today's VME and VME64x backplane designs utilize stripline design. Some designs use guard traces around the high-speed signals for shielding. They should be grounded at frequent intervals along the length of the trace. Simulations can be performed to optimize the effectiveness of the shield.

Signal assignment is another important consideration, especially in custom VME backplanes. Proper organization of the signals on the backplane connectors makes it much easier to achieve high performance. When dealing with custom bus routing, the physical orientation of signal assignments is important. Direct connector-pin-to-connector-pin wiring and avoiding the use of vias, is a design concept that helps improve signal quality. A via, or feed-through, from one layer to another can cause several problems. For example, if the trace width is 0.006 of an inch, when the trace comes to the via, the diameter of a via hole could make the trace width 0.075 of an inch or so. In turn, the impedance that was balanced at 65 ohms suddenly shoots down to a much lower level, causing reflections and ringing of the signal. If the via can't be avoided, the direct routes for clocks and high-speed data signals should be reserved, while using the vias for steady-state or low-speed signals.

As VITA 41 and VITA 34 come into light, it will be increasingly important to consider LVDS, a common transmission method for switched fabrics, and other high-speed signaling. The benefits they carry are higher speeds, low power, low noise, and low costs. The high-speed signal differential impedances should be kept the same. In general, the traces are kept close together and the same length to minimize the skew. If one signal arrives before the other, the effect is a phase difference between the voltages that causes noise. Keeping a distance between the sets of differential pairs is important in limiting noise. Also, sharp turns in the routing also cause discontinuity of the impedances. Routing design techniques will need to be carefully considered in the upcoming high-speed VME specifications.

Overcoming performance limitations

VME has continued to overcome performance limitations. The technology has progressed from 16-bit, 40 Mbytes/sec to 32-bit (3U) and 64-bit (6U) with twice the bandwidth (80 Mbytes/sec) to IEEE 1014-1987 and ANSI/VITA 1-1994 (VME64). Next, ANSI/VITA 1.1-1997, the VMEbus Extensions or VME64X increased the speeds to 160 Mbytes/sec bandwidth. For even higher performance, Arizona Digital, in cooperation with Bustronic, announced the VME320, boasting true 320 Mbytes/sec bandwidth. In the VME320, a signal driven from slot 1 goes to slot 11 and then radiates out to all other slots. All the capacitance concentrates at slot 11 instead of having a transmission line effect like conventional shared-bus backplanes. The result is that the equivalent circuit of the backplane is a simple lumped 200 pF capacitance. In a standard VME backplane, the signals have propagation delay and must wait for their turn to go across the bus. Since the slots have their own paths in the VME320, the signals get to their destination several times faster. In fact, the VME320 can achieve 528 Mbytes/sec at 66 MHz with up to 21 slots (or more than 1 Gbyte/sec at 133 MHz with 10 slots). This is 12 to 25 times the bandwidth of the original VME specification.

When new standards such as VITA 41, aka the VXS backplane (switched serial fabrics over P0 on VME64x) or VITA 34 (embedded modular architecture) come into being, the performance of VME will continue to expand. However, several new products will need to be developed.

VITA 41 will require new payload cards, switch cards, and backplanes. The switch cards are the drivers of the fabric with a single slot or dual redundant slots. The payload cards take the fabric and disperse them any of three ways: 1) parallel bus only, 2) parallel bus and switch fabric, 3) switch fabric only. The VXS spec allows for four differential serial pairs per direction link, and supports up to two such ports on each VMEbus card. It is quite possible that in the near future we will see a subcommittee develop for a StarFabric implementation over VITA 41, in addition to VITA 41.1 for Ethernet and other fabric interfaces.

VITA 34 will be a whole new form factor, but still comply with Eurocard standards. VITA 34's initial developments look to have a module pitch on the backplane of 1.2 inches and use the ZD connector (see Figure 1). The ZD connector is capable of handling speeds of up to 5 Gbytes/sec over standard FR-4. The modules are 4U or 8U high and 220mm deep and may

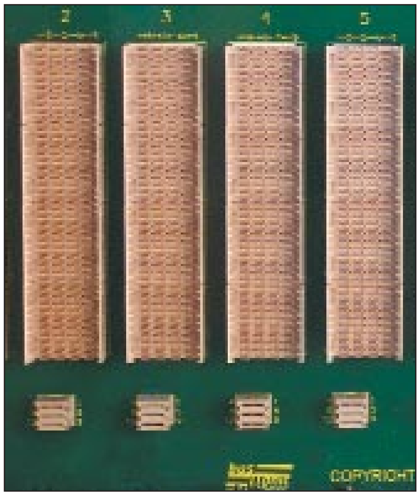

Figure 1

have sheet metal enclosing them for several reasons. The enclosure will keep EMI from the electronics inside the module to a minimum and will keep external EMI from disrupting the circuitry within the module. An enclosed module allows a spray cooling application if desired. The connector areas on the module will likely have as many I/O pins as possible, with areas set aside for power, fiber optic connectors, keying, and guide/ESD pins.

More choices for power

There are several VME system accessories that provide more choices for a system designer. Power interface boards (PIBs) are separate boards for the power section of the backplane (see Figure 2). A designer can choose to hardwire to a backplane or use pluggable modules and special connectors on the PIB. The PIBs often feature pluggable power supply connectors, such as the Positronic 47-pin connector, compliant to the PICMG 2.11 specification. Other common features are headers for various functions such as voltage sense, current sharing, disk drive power, and an Intelligent Platform Management Bus (IPMB) interface. PIBs are also excellent for prototyping. One can implement the power and header interfaces on the PIB and when ready for production move to a custom backplane with the same interfaces on one monolithic board.

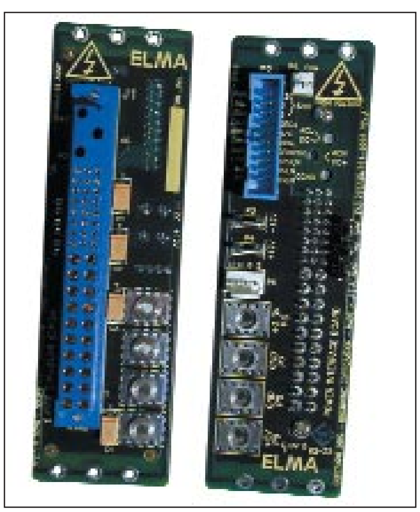

Figure 2

As VITA 1.4 (live insertion for VME64x) progresses and VME moves more toward hot-swap, the use of redundant pluggable power supplies and system management may increase the demand for PIBs or other interfaces. With VITA 41 and VITA 34, we may see an increase in hot-swappable VME applications. VITA 34 seems more geared for communications applications, so system management will be an important issue.

Testing, prototyping, and monitoring

Another advantage of VME is the wealth of devices for testing, prototyping, and monitoring systems. VME voltage monitors check the status of 5V, 12V, –12V voltages in the system and can signal an out-of-tolerance “FAIL” output. VME system monitors can sense power supply output voltages, indicate the presence of installed cards, and monitor the temperature and airflow within an enclosure. These are key factors in maintaining optimum performance.

Test extender boards are designed to bring a circuit card completely out of a card cage or enclosure, so that it can be tested or debugged (see Figure 3). This provides access to both sides of the test board with test points for all of the lines on each 96-pin or 160-pin signal connector. Many versions have DIP-switches where each signal, power, and ground line can be individually isolated. Models can be found in VME, VME64x, VXI, and CompactPCI form factors. Using a similar design concept, form factor extenders allow a designer to adapt boards of different depths for use in the same VMEbus system. For example, a 160mm VME board fitted with a 180mm form factor extender will plug into a system designed for 340mm deep boards. The extender boards maintain the correct depth dimensions and allow the front panel to be aligned.

Figure 3

Another testing and prototyping tool that can make a designer’s life easier is a load board. VME/VME64x load boards provide significant time and cost savings by assuring a system’s operating specifications. A load board can test a system’s cooling capabilities by first applying the load to the power supply for verification and finally creating the necessary heat to confirm chassis cooling. By locating hot spots in the chassis, a system designer can verify where to optimally redirect the airflow to prevent overheating.

Conclusion

Every year, the projections come out showing that VME will start a downward trend into what will become a steady decline. We’ve seen these forecasts for many years now, but they never hold true. The VMEbus continues to show its temerity and appears to be on a growth path this year. Although the bus may be near its peak, it keeps surprising us. With exciting new innovations for higher levels of performance, or improvements to standard VME products, the VMEbus remains king in the open embedded systems market.

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