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CompactPCI Solutions Fully Exploite the Potential for Rear I/O

Increasing demands are being made on industrial computer systems, especially by telecommunications. And this is where CompactPCI, with its special hot-swap and computer telephony solutions, is steadily gaining market share. Often when consideration is given to system requirements the attention focuses on the front panel, while valuable potential in the rear I/Os remains unexploited. Thanks to its well designed products, Schroff is able to provide comprehensive support to customers in making full use of these options.

INTRODUCTION

There has already been much debate about the future of the CompactPCI bus. The growth that has been predicted for some time is now clearly beginning. Schroff is expecting significantly higher increases in sales over the next few years for the CompactPCI than for the VMEbus market segment. It is estimated that by the year 2005 the CompactPCI will have reached the sales volume of the VMEbus, although they in turn will have increased steadily. In particular, the CompactPCI is gaining on the VMEbus in the telecommunications sector where, unlike in machine control, real time and determinism play no significant part.

This positive development for the CompactPCI can be attributed to the strongly growing demand for high-availability computer systems suitable for industrial use and with large I/O capacity. Here the CompactPCI has some advantages over its competitors, such as the industrial PC, thanks to its multi-pin hard metric connectors. Nevertheless, the conditions for the increasingly wide use of the CompactPCI have been achieved only by the ongoing enhancement of the CompactPCI specification, with its supplementary requirements in terms of hot-swap and computer telephony.

The fact that ”high availability” has top priority in telecommunication and data networks made it critical to ensure the hot-swap capability of the systems. In practice this means that, to achieve a system availability of 99.999%, the system may only go offline for about five minutes each year, for example for maintenance work. It therefore follows that it must be possible to exchange defective components without switching off the system (hot-swap) and swap out boards without downtime. Managing this process without crashing is a challenging task for the software, but without precisely-functioning hardware it would never be possible.

HOT-SWAP FOR THE REAR I/O AS WELL?

On the hardware side, the hot-swap specification prescribes three different pin lengths for the backplane connector, enabling timing differences in establishing the contacts, ensuring that the requirements for safe working of the board hardware and software are met. Long pins (11.25 mm) ensure that when the connector is plugged into the 'early power', the output stages of the backplane bus driver are supplied first. These switch their outputs into a high-impedance state and raise them to a defined voltage (1.0V). For the VMEbus, which in terms of its specification has long provided for high-reliability applications, this value is specified as 1.5V. The voltage rise is necessary to ensure that when contact is made with the bus line on the backplane no unwanted transients are triggered on the signal line, which could cause incorrect switching of other modules (glitches).

The mid-length pins (9.75 mm), which make contact with the backplane a few milliseconds later, when the process described above has been completed, link up the bus-signals of the CompactPCI. Finally, the short pins (8.25 mm) subsequently establish the contacts between the daughter card and the backplane. This connects the I/O pins and a system pin that is used to activate the software's configuration procedure.

This process guarantees that the I/O areas of the plug-in modules already have a stable connection to the power supply and are behaving in a defined way before the signals are electrically connected to the CompactPCI backplane.

With this connector configuration, the hot-swap function is theoretically limited in the first instance to those plug-in cards which the user inserts into the system from the front - i.e. front-inserted modules. At first sight it appears that sequential contacts, and correspondingly hot-swap, are not intended for cards plugged-in from behind - the rear I/O transition boards. However, with the continuously rising volumes of data to be processed and the desire for ever-smaller system solutions, there are many applications where it is advisable to make full use of the possibilities on the rear of the backplane, when the number of I/O lines is such that they cannot or should not be routed through the front panel.

If the rear I/O card, also referred to as the transition module, is also fitted with active components, such as simple line drivers or even with more complex circuits, then here again the question arises of how to

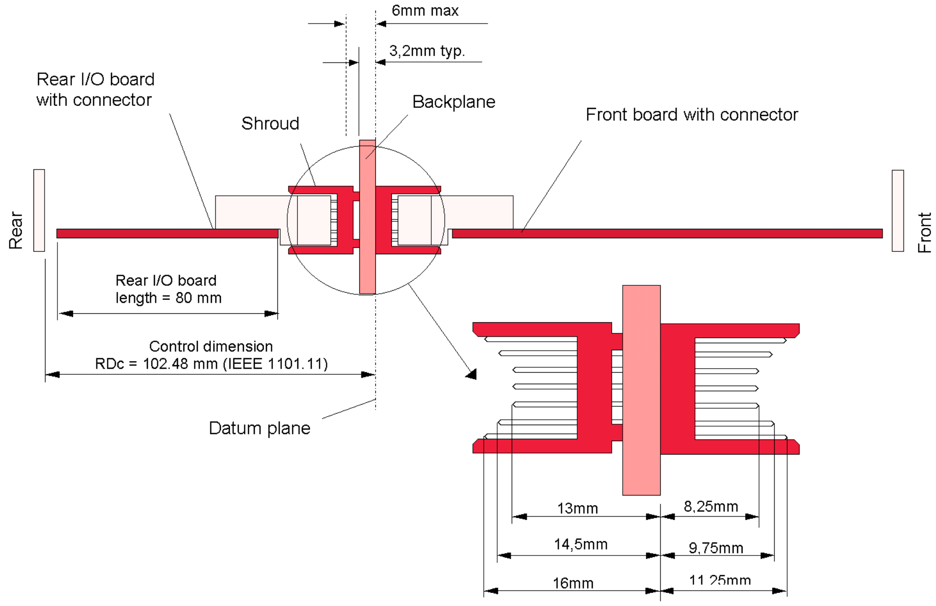

Figure 1. IEEE 1101.11 defines the control dimension RDc for the rear I/O area.

exchange faulty modules during ongoing operation. So that hot-swap functionality can be utilised on the rear side as well, closer attention must be given to the mechanical frame specification.

IS THE POTENTIAL OF CONNECTORS BEING FULLY UTILISED?

In many respects, the CompactPCI specification is based on existing international standards, including IEC 61076-4-101. This latter defines the requirements to be met by metric connectors with a 2 mm grid, and also includes a specification of the different pin lengths - 8.25 mm, 9.75 mm and 11.25 mm - and 13 mm, 14.5 mm and 16 mm on the rear.

For matters relating to the insertion of rear plug-in modules into the subrack, the CompactPCI specification is based on IEEE 1101.11. This specifies a dimension of 102.48 mm (Figure 1) for the rear depth of the subrack from the front side of the backplane to the bearing surface of the panel of the rear board. This distance, called the control dimension (RDc) in the standard, corresponds to the preferred depth of the rear board for CompactPCI applications, of 80 mm.

If an 80 mm board which conforms to the standard is now used in a subrack which also conforms to its standard, it will be found that the rear contacts of the metric connector can only be pushed into the connecting strip of the rear board to a limited depth (Figure 2). With the value specified in IEEE 1101.11 for the dimension RDc, only the 16 mm long rear contacts of the backplane will make positive contacts, while the pins with contact lengths of 14.5 mm or 13 mm either make intermittent contact, or none at all.

Figure 2. When an 80mm board is pushed into a subrack which conforms to the standard, the connector does not go fully home onto the connecting strip.

WHAT IS THE SITUATION WITH THE SCREEN CONTACTS?

Consequently it is not possible, within the framework of the current standards, to use sequential contacts, and hence the hot-swap functionality, for rear I/O transition boards in CompactPCI systems. And yet another major problem arises. The two outer rows of contacts, f and z on the metric connector with their 16 mm long pins, no longer make contact with the screening plane on the board, because the contact points are set back relative to the inner contact springs.

The screen contacts are required primarily for "fast" signals, when the discontinuity that the connector introduces into the signal path can no longer be tolerated. The capacitive coupling, particularly between the outer rows and the screening plane, can be used to compensate partially for their inductive component. A dramatic situation can arise if there is no contact to the screening plane, and if no GND pins are provided in the connector, as is generally normal for "slow" signals on ”single-ended lines”. The signal return current ”finds” some return path via the chassis or other route, leading to interference in the transmission which is difficult to trace.

WHAT CAN BE DONE?

Approaches already exist for solving these problems. For CompactPCI system integrators who want to effect both sequential establishment of contacts and connection of the screening contacts, VITA 30-2000 offers a design aid. Following discussions among technical specialists, either the rear board can be lengthened by 2.5 mm or the subrack can be shortened by the same 2.5 mm. Because of the large number of existing rear boards on the market, it is certainly logical to implement only the latter option. Hence VITA 30-2000 also suggests adjusting the mounting dimension of the subrack for installation from the rear (102.48 mm - 2.5 mm = 99.98 mm).

This measure will result in the rear contacts of a metric connector pressing 2.5 mm deeper into the contact strip on the rear board. This will provide reliable contacts for the rear contacts with lengths of 13 mm and 14.5 mm, which can then also be utilised for a hot-swap operation. Also, the 16 mm-long contacts in the f and z rows now make contact with the screening planes, and fulfil their function of conducting the signal return current and attenuating impedance step-changes due to inductive pins.

Currently, an IEC standardisation committee in which Schroff is participating is working on a unified solution. This is expected to aim at the shortening of the mounting dimension when metric connectors that conform to IEC 61076-4-101 are being used.

In order to maintain compatibility of the rear I/O transition boards from different manufacturers, it is advisable to leave the task of ensuring correct contacting to the system supplier. Schroff carefully matches all the system components, such as the backplane, pin lengths on the connectors and the mechanical parts of the system, and thereby guarantees that all rear I/O boards offer hot-swap functionality, and also that contact rows f and z really are utilised for conducting the return current and improving signal integrity. This relieves the system integrator of the time-consuming and costly task of analysing in detail the system interrelationships, and the need to put together suitable components.

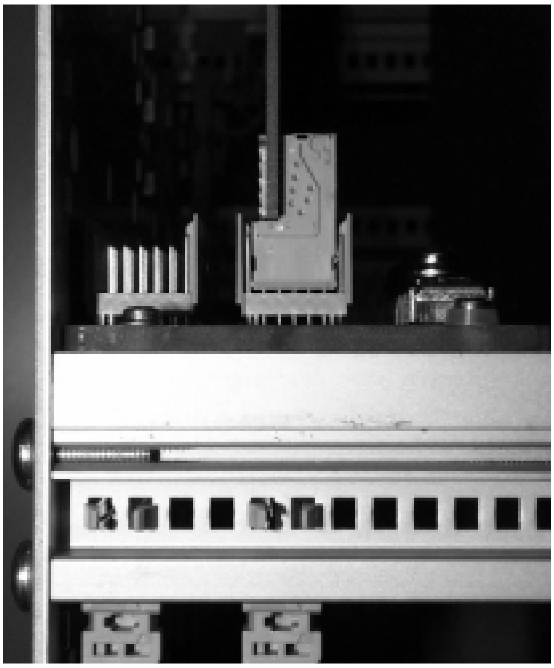

Figure 3. If the depth dimension of the subrack is reduced by 2.5mm, even 13.5mm pins can be used for the hot-swap process.

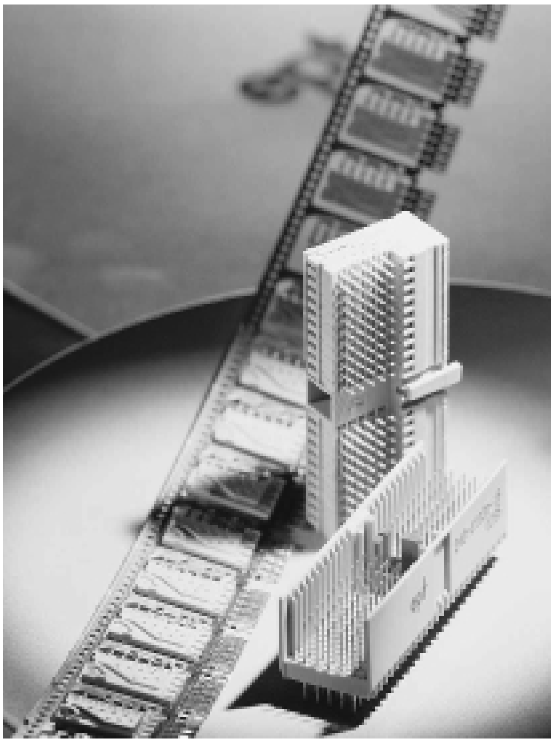

Figure 4. Hard metric connector module A; the guide pins and the coding recess can be clearly seen.

The Schroff solution is based on the proposal that the depth dimension of the subrack should be reduced by the 2.5 mm mentioned (Figure 3). This can be effected with no great difficulties, thanks to the modular design of the Schroff europac PRO subrack. The circuit board thickness, typically 3.2mm, with the mechanical stiffening of the backplane, is also exactly matched to the connector and the rear shrouds. If the circuit boards used have a different thickness, the height of the rear shroud can also be appropriately adjusted.

SECURELY PLUGGED INTO THE REAR SHROUD?

In selecting the rear shroud, there are again a number of points to note. It can assist in avoiding incorrect insertion of the plug connector, for example misoriented by 180 or mislocated by one or more rows. Particularly from the point of view of hot-swap, it is essential to guarantee this.

On the front side, it is normal to use A and B modules with the 2 mm plug connection system (Figure 4). For the loss of three contact rows (rows 12, 13, 14), the A module offers a so-called multi-function block, which ensures that the mating connector is guided and cen-

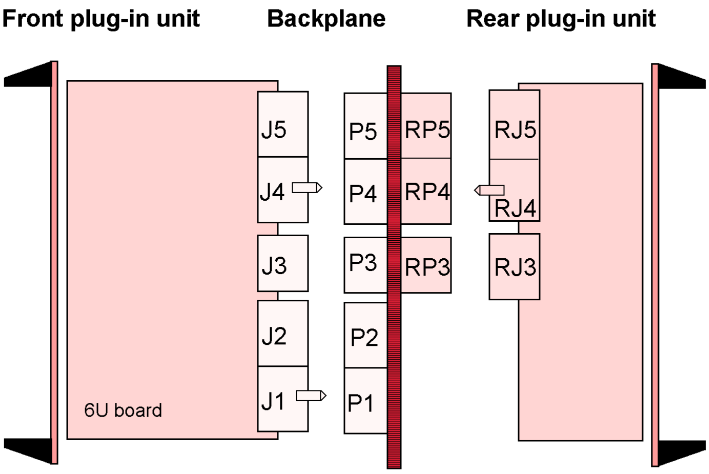

Figure 5. Arrangement and designation of the connectors in the system, showing clearly the guide pins in positions J1, J4 and RJ4.

tred, as well as permitting encoding. On the other hand, the B module can be inserted in an arbitrary position, even rotated through 180º. Consequently, for each plug-in position at least one A module is used; with the CompactPCI bus, positions P1 and P4 are fitted with one (Figure 5).

The connector in P1, which has such a guide component, has no rear transfer; it makes contact with the first 32 bits of the PCI bus and the status signals. There are no problems if plug-in position P4 is also used for rear I/O, because it has a rear shroud and guide.

However, for some time there have also been rear I/O cards for the CompactPCI which pass the rearward signals only to P3 and/or P5, as is the case with the H110 computer telephony backplane. Here, there is absolutely no guide for the rear board while it is being plugged in. It is true that the guide rails do not allow it to be plugged in with a misorientation of 180 , but they cannot offer "pin-point" guidance. It is entirely possible for a vertical displacement by one or two rows to arise when the board is fed in at an angle, this being something that can be tolerated mechanically by the connector but not electrically by the system.

This problem can be solved with the so-called AB shrouds (Figure 6). On this, guides are set into the sidewall, in each case at the cost of three ground pins, as will be familiar from the A module. For the connector on the front, a so-called AB-friendly module is used, which is fitted with short ground pins in the region of each guide. These are fitted in the front connector area and are also connected to ground, so that there is no

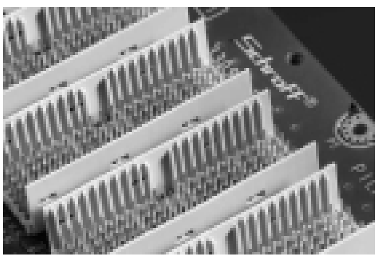

Figure 6. AB shrouds offer reliable guidance of the connectors and will not allow incorrect plugging into the rear I/Os.

change - either mechanical or electrical - from a pure B module.

This makes the pairing of the AB shroud and AB-friendly connector fully backward compatible, i.e. B modules can be used in AB shrouds. The reverse does not work, so that a new rear I/O card with AB plug connectors in position P3 or P5 cannot be used in a backplane which is still equipped with B shrouds in these positions, in accordance with the old principle. For this reason, all future Schroff backplanes will be fitted with the new AB shrouds in positions P3 and P5. This, in turn, relieves the system integrator of the need to order the shroud in the correct position for his rear I/O board.

Their detailed know-how, not only of 19" engineering but also of backplane technology, puts Schroff in the position of being able to offer optimised CompactPCI solutions which also fully exploit the potential for rear I/O. As part of their flexible microcomputer packaging offering, complete systems are available comprising, for example, 19" subracks and backplanes plus integral mains power supplies, appropriate EMC provisions and application-specific thermal management. The user need to do no more than push in the CompactPCI boards and switch on the system ■

Andreas Lenkisch has worked for Schroff GmbH, a Pentair Company, as Product Manager for Backplanes since 2000. Andreas studied Electronics and Physics at Technical University in Germany from 1974 -78. He began working in the backplane business more than 10 years ago as a design engineer. Later, as an internal sales manager, he became familiar with commercial aspects of the business, before heading a Research Department, focusing on design capabilities and investigating emerging bus standards and related technologies.
He has published several papers in technical magazines and held presentations at major international conferences. As a member of several VITA and PICMG task groups, Andreas is actively involved in developing new bus standards and specifications.