

Best in Class FAQ

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1. What does “Best in Class” mean to our Customers?

Our Best in Class products are designed with the end user in mind. There are a growing number of requirements in the military and industrial communities that require solutions capable of operating in some of the most challenging environments. Extreme temperatures, dust, dirt, shock, and vibration are just a few of the significant factors that can impact the successful operation of mission critical weapon systems, command and control platforms, and key infrastructure nodes. Our Best in Class servers are designed to provide the best solutions in the market to meet these challenges.



The Best in Class is about value to the end user. The design represents the best service, warranty, ruggedness, performance, and configuration management in the industry. This design focuses on using materials and processes that extend the performance of COTS based products while using leading edge technology and open architecture systems. We have been able to take this COTS technology and operate it in Military and extreme industrial environments. We have adapted some of the techniques used to create military Avionics to building rugged servers by acquiring some of that talent. The trick is making COTS work at a reasonable price, which is the true value to the customer. Our engineering staff creates made to order configurations to meet every customers needs from our basic building blocks of standard product offerings. We also do semi custom work which means we use COTS components on Crystal designed CPU cards. This allows us to provide a stable configuration for tens of years rather than months like so much of the industry. Best in Class serves a market segment where customers value reliability, performance, and ruggedness in environmental extremes. The product fills a gap where no other computer manufacturers have chosen to go, this proves to be very valuable to some customers.

Many military weapon systems and industrial applications spend a considerable amount of resources on the software application. Our reliable hardware solutions specifically designed to meet the users' operational environment are critical in ensuring that the application will continue to operate correctly when it's needed most. Our configuration management processes also ensure effective control of the hardware baseline, further guaranteeing that a certified application doesn't have to undergo costly recertification based on hardware changes that are controllable.

Crystal Group's Best in Class solutions are COTS offerings that are based on open architectures and standard interfaces. But "COTS" doesn't mean a customer needs to settle for a solution that's close to their actual need. Crystal Group can produce custom systems built to specification using a configuration management process that guarantees effective life cycle management for up to seven years.



2. Why are the supporting walls so thick in this design?



Figure 1, RS377 Rugged 3U Server

Most of our competitors use thin, 16-18 ga cold-rolled steel to create chassis structures. That's fine if you're operating in a conditioned, stationary, protected environment. This product is constructed remarkably different. The side walls are constructed from 0.360" thick 6000 series aircraft aluminum while support structures inside as well as the front and rear plates are made from milled plate stock. We selected thicker all aluminum construction to limit weight, improve thermal conductivity and vibration performance, and enhance electrical conductivity (for EMI/EMP purposes). The base plate is structurally bonded to the side walls in addition to being mechanically fastened. The construction is designed around MIL-STD-810, MIL-STD-461, MIL-S-901D, and MIL-STD-167-1 test results. We have been able to vibration/shock isolate key components while stiffening the structure to prevent flexure, enabling considerable vibration robustness. Crystal Group has developed a combined 5 Grms vibration profile for testing, which encompasses wheeled vehicles, military transports, and ship board applications in a single test. The bottom line is the improvement in the structural stiffness allows for industry standard large ball count BGA packages on CPU cards without damaging the packages. Modifications to the COTS power supplies were necessary to get them to pass 5 GRMS vibration levels.

3. What did you do to extend the thermal performance?

Most every server in the industry relies solely on convective cooling (fans). This design combines convective cooling from high speed (17,000 RPM for 1U) fans with conductive cooling similar to the approach the Avionics industry utilizes. Crystal engineers converted the chassis to an all aluminum design for numerous reasons but heat transfer was one of those reasons. Basically the 6000 series aluminum material has almost twice the thermal conductivity as 1018 CR steel. By combining both the convective cooling in conventional server packaging with Avionics style conductive cooling for thermal spreading, the CPU ambient temperature range has been increased by 10 to 20°C depending on the CPU power. We offer a quad core Xeon design in a 1U RS chassis can easily perform to 71°C ambient with 8 instances of Prime95 running and does not exhibit throttling. We also use a great deal of custom cabling to reduce the obstructions to airflow within the unit.

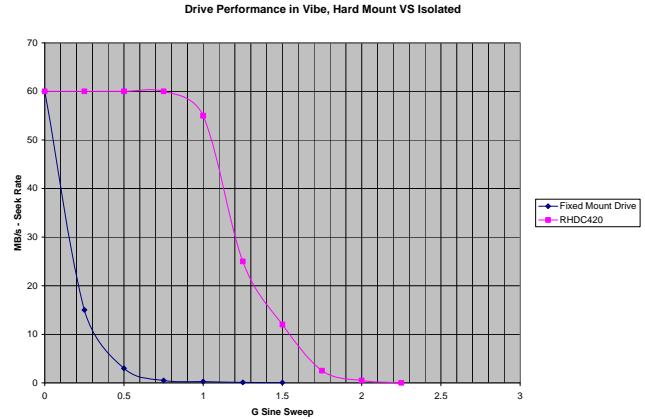


Figure 2, Custom Cables Improves Airflow by Reducing Pressure Drop through the Unit

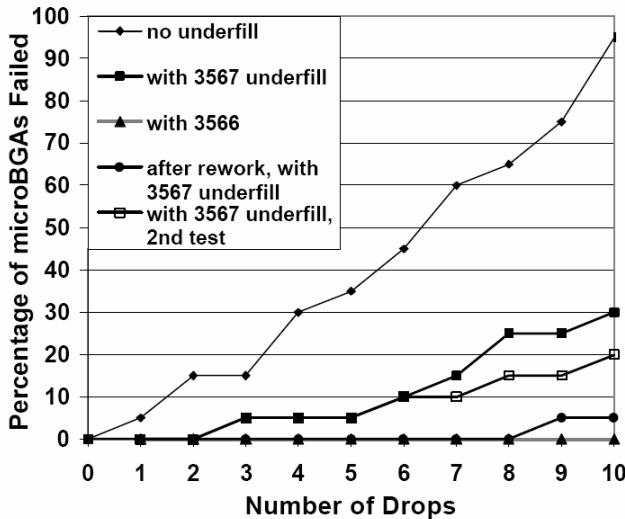
4. How did you solve the vibration problem for the hard drives and CD ROM?



Hard drives which employ rotational media tend to be extremely sensitive to vibration. Most are rated at .75G to 1.2G vibration in the lower frequencies. Crystal group has significantly extended this performance by calculating the optimal resonance given the boundary conditions and provided sufficient sway space to include vibration isolators. The net effect is to alter the system input energy into the



device to a frequency and amplitude that does not harm the equipment. This allows the rotational media hard drives to withstand approximately 2.5G. The seek rate is measured on the vertical axis of the graph with G force on the horizontal axis. Note the improvement in seek time with the Crystal isolation technique. The sine sweeps occurred from 2Hz to 30Hz. The head resonance is approximately 15Hz. This approach is limited depending on the input frequencies, amplitudes, and available sway space. Crystal also uses 2.5" SAS drives in high vibration environments and has successfully implemented these drives in a 4Grms test environments. Failure to adequately cushion the drive requires the use of solid state memory, which is obviously more expensive, but always a viable option. All connectors are retained either by design or by modification. Cables are dressed and secured to prevent chaffing under extreme conditions. All hardware within the servers is retained using a locking mechanism. All components on the



Motherboard having a height to base ratio greater than 2 are staked with flexible potting compound to prevent motion and eventual lead failure in vibe. DIMM memory modules have been locked in place by adding a foam pad to prevent relative motion. The processor heat sinks have been attached directly to the chassis base plate to eliminate the possibility of flexure to the BGA. Additionally in extreme vibration environments, BGA under fill adhesive has been added to the board to firmly attach the BGA. Testing has shown this under fill to provide remarkable improvements in long-term vibration resilience.



Figure 3, Crystal RS112 in 901D Hammer Blow Testing

5. How does the design perform in shock testes like MIL-S-901D?

The main shock threat to a high performance computer system lies in the storage functions. Rotational media tends to be the weakest link in the system. Isolating the hard drives using floating visco-elastic medium in conjunction with an extremely stiff (ie. High first resonant frequency) chassis aids in reducing deflections which damage the HDD platters. Crystal Group was able to pass MIL-S-901D grades A and B testing with such an isolation system. While this is possible with rotational media, we do recommend solid state hard drives for shock pulses over 40G, 11msec duration. A crude estimate on the 901D test levels are 800-1000G for 25msec. The next area of concern is the power supply which typically contains heavy toroids, transformers, and heatsinks. These items are modified in the Crystal server to survive high G shock and vibration loads with a 901D kit if the customer so chooses to implement. Ask for a copy of the RS112 MIL-S-901D test report.

6. What about acoustic and structure borne noise for sub applications?

Structure borne noise in Crystal chassis' is limited by way of the construction technique. This is an unintentional benefit of designing for high vibration, high thermal ambient conditions. Essentially structural noise is limited by increasing the resonant frequency of the chassis to a level that is insensitive to exterior excitation. By this we merely mean the chassis, cover, base, sides, brackets, etc are significantly stiff requiring large amplitude, high frequency excitation to be detectable by man or machine. This is accomplished by using very thick sections for the side rails (0.360"), front and rear end plates (0.375"), and center brackets/braces (0.187") with screws attaching these structural components every 2". The base, sides, center braces, and front and rear plates are also adhesively bonded using a hi-temperature structural epoxy designed for this application. The net result is a robust server that not only survives high vibration and shock, but also doesn't rattle when subjected to external excitation. Acoustical noise is merely balancing the fans to limit the amplitude of emissions. The structural borne noise is related to limiting vibrations that are transferred through the chassis from the fans and the power supply. These characteristics are critical in sub-surface Navy operations. Crystal can customize an application to use very low noise fans without significantly sacrificing thermal performance to reduce the noise. Recent testing on our 3U rugged product indicated a worse case output of less than 40dB at 1 meter for a US Marine application. Additionally, Crystal can detune the fans to operate at slightly different frequencies to limit noise output further reducing the acoustical signature of the server using a acoustic noise kit by adding an in-house thermal fan controller module which reduces fan RPM/noise as a function of temperature.

7. How did the design do in MIL-STD-461E testing?

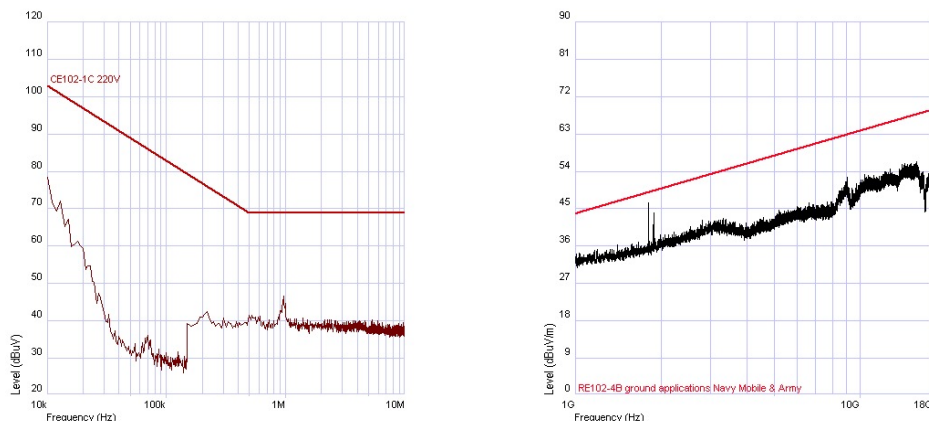


Figure 4, CE102, RE102, RS235

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All of the RS chassis have been designed to pass MIL-STD-461E and F with the proper filtering kits installed. The RS112, RS232SF, RS235, RBC-75 have test documents available for review. Crystal uses spread spectrum clocking technologies to provide additional margin for compliance as well as specific shielding and filtering techniques to meet these requirements.

Crystal Group designed the chassis to form 6061T-651 aluminum and coated it with a trivalent chromate, which maintains the electrical conductivity of the chassis, thereby creating low impedance interfaces. Additional corrosion protection can be obtained using eNi plating if necessary. An underlying objective in EMI suppression is to maximize very low impedance grounding around the perimeter of covers. Spacing between fasteners are considered slit antenna radiators if there is not a metal to metal low impedance path. This also requires that overlapping seams be included in the design. The only approach to solving the problem is few gaps with low impedance short to ground in the EMI circuit. This design limits gaps and reduces contact resistance by utilizing adequate screw spacing to prevent radiated emissions. Additionally the compartmentalization of the interior components (hard drive, CD ROM, Power supply, CPU) using thick aluminum interior bracing helps to constrain emissions. Custom filtering on the input side of the design manages the conducted emissions.

8. What is the weight?



The Best in Class 1U server with 2 Hard Drives, CD ROM, Dual Xeon processors and 4G RAM weighs less than 20 lbs.
The Best in Class 2U server with 4 Hard Drives, CD ROM, Dual Xeon processors and 4G RAM weighs less than 35 lbs.
The Best in Class 3U server with 7 Hard Drives, CD ROM, Dual Xeon processors and 4G RAM weighs less than 50 lbs.
The Best in Class 4U server with 15 Hard Drives, CD ROM, Dual Xeon processors and 4G RAM weighs less than 80 lbs.

9. What processor and memory options are available?

Currently Crystal is producing 1U, 2U, 3U, and 4U Best in Class servers with various configurations. The design accommodates ATX motherboard formats with dual Xeon and Core 2 Duo motherboard options with up to 24G FB-DIMM RAM.

10. What kind of warranty can I get?

Bronze – 3 Year Warranty parts and labor
24/7 Technician availability by phone
Depot repair within 48 hours
1 way ground shipping paid by Crystal

Silver – 3 Year Warranty parts and labor
24/7 Technician availability
Next Day on site service
Need final location of unit



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Crystal pays for parts shipped and on-site tech support

- Gold –**
- 3 Year Warranty parts and labor
 - 24/7 Technician availability
 - Gold Reserve kit charge
 - Need final location of unit
 - Same day, on-site service within 4 hours

All warranties have three-year extension option.

11. Is it Expensive?

The cost of these enhancements ranges from 30 to 35% higher than a standard industrial server depending on the degree of ruggedization and the content; the price follows this cost. The product provides considerable expansion of the capability in otherwise unobtainable applications.



Other suppliers provide embedded solutions for these applications at approximately 10X the price, which is why Crystal Best in Class provides the best value in the industry. Our offering can be tailored to meet your needs. COTS does not mean you have to settle. However, Crystal Group continues to carry a full line of less rugged products for those

customers with applications that do not require “bullet proof” solutions.

12. Crystal Group Also Produces Liquid Crystal Displays

The engineering team at Crystal Group has a combined experience level of 31 years of providing rugged displays to the industry including military helo's, fighters, and Boeing commercial wide-body applications. Most of the displays we focus on are Vetrionics (heavy ground mobile vehicle) applications. Our strengths in this area are optics expertise, packaging experience, and helping customers capture the requirements. We are able to tailor a design for the specific application to minimize cost. We specialize in high brightness, high resolution displays packaged in a resilient enclosure.



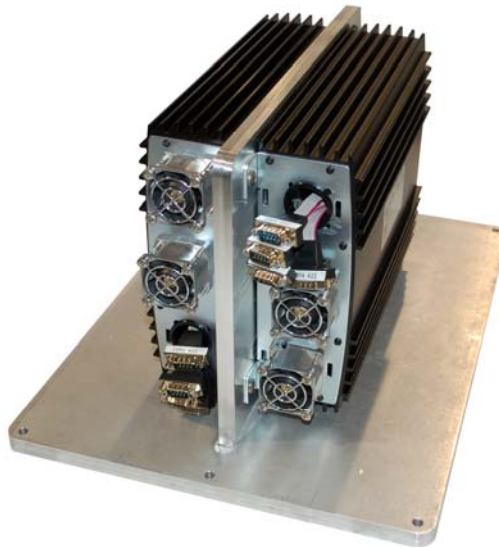
13. Crystal Group is Producing Embedded Computers, PC104, eBX, network switches and Mini-ITX Platforms

We are very adept at quickly providing custom hardware for the military to suit nearly any application. The photos below are just a small sample of the unique items we have produced and qualified for military primes.



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14. Crystal also integrates Transit case products for customers.



15. So what is the 60 second company summary?

Crystal Group is a small Veteran owned company located in Iowa. The company is heavily capitalized enabling a variety of services including in-house CNC machining, design engineering, production, and a fully capable SMD line. The value we provide to the industry is we ruggedize COTS electronics through a detailed modification process that enables military levels of performance. This approach provides leading-edge technology, in open architecture systems, in rugged military packages, quickly for the war fighter. Ultimately our value statement is we provide greater capabilities, at a lower cost, faster than our competitors. The company grew sales in 2008 by over 20%.