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Why Buy Compaq Memory?

Compaq is best able to certify the compatibility and quality of Compaq memory for upgrades. This white paper outlines the reasons to upgrade memory through Compaq rather than third party suppliers. This paper is intended for customers, vendors, VARs, and Compaq Field Systems Engineers.

EXECUTIVE SUMMARY

In addition to providing the convenience of a single supplier, buying Compaq memory for Compaq systems nets the customer superior quality and assured compatibility for the new and complex Synchronous Dynamic Random Access Memory, SDRAM. SDRAM is the fastest memory solution, starting at 66MHz. It achieves access five times faster than the previous forms of DRAM.

With the advent of SDRAM, it is even more important than in the past for customers to buy memory from Compaq. Memory is one of the most important components in a computer. The memory module must perform properly to maximize uptime and minimize data loss. SDRAM is much more complex than previous forms of memory. This complexity raises new design, testing, and verification issues versus third party memory suppliers. Simply put, only Compaq has the facilities and procedures to test, verify, and certify Compaq SDRAM memory.

Today's SDRAMs exhibit variations in multiple parameters including but not limited to the following: setup times, hold times, the data valid window, data valid from clock, output drive characteristics, and susceptibility to system noise, power supply noise, ground bounce, and undershoot. This complex set of variations must be tested and compatibility guaranteed with special test screens and verification of operation in the specified motherboard, on a system-by-system basis.

Customers upgrading memory in their existing Compaq servers, desktops, and portables must choose whether to purchase memory from Compaq or from one of over 90 third party memory suppliers. Third party suppliers do not have the facilities to conduct adequate SDRAM testing on a system-by-system basis over the matrix of variations detailed above. Compaq recommends that customers choose only Compaq brand memory. Only Compaq has the testing facilities to assure quality compatible memory for Compaq products. Compaq's quality testing and certification allow Compaq to offer a Three-Year Pre-Failure Warranty on Compaq memory, drives, and processors.[1]

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[1] Certain restrictions and exclusions apply. Warranty applies to servers using Compaq Insight Manager. Compaq memory means only memory manufactured by Compaq.

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THE IMPORTANCE OF MEMORY QUALITY

Every memory system, however well designed, has the possibility of experiencing a hard or soft memory device failure. Soft errors, which often result from a temporary loss of charge in a DRAM cell, cause data to be stored incorrectly in a memory location. Subsequent accesses can correctly store data in that same cell. A hard error, on the other hand, is a physical failure within a DRAM cell that prevents data from being stored reliably in one or more locations. Failure of a single DRAM can abruptly halt a system.

Memory operates under continuously changing conditions. An operating system puts great stress on memory – stress that changes in cause and intensity. Key operating parameters such as temperature, signal strength, and electric current all fluctuate. A minor manufacturing defect can become a problem, especially where 7 x 24 use exerts protracted heat and electrical exposure on server components. A memory problem can cause platform failure and permanent data loss.

With SDRAM, quality differences become critical. This is because the SDRAM memory module is much more complex than previous forms of memory; therefore, minor variations can compound more rapidly into a platform failure.

Because of the unpredictable nature of memory, the best way to prevent errors from occurring is to screen memory components for defects that are likely to cause problems. Customers using Compaq memory are assured that they have memory manufactured to the highest quality standards and subjected to the most rigorous testing procedures.

INDUSTRY PRACTICES AFFECTING MEMORY QUALITY

The memory industry is divided into two main components, DRAM manufacturing and memory module manufacturing. Both segments contain OEMs and resellers (including brokers). Because of the enormous capital investment required, there are only a few DRAM manufacturers in the world. In contrast, there are many module assemblers. In addition, most DRAM manufacturers also assemble memory modules. Because the most important component of a memory module is its memory chips, customers should understand how the various companies that supply the DRAM and finished memory modules are related. These relationships are important because they are the foundation for most companies' overall strategies and the primary factor in determining the quality of their products.

DRAM Suppliers

There are two main sources of DRAM integrated circuits, or chips: manufacturers, and resellers often referred to as brokers.

The DRAM supply companies operate like those in most commodity markets. Competition is primarily focused on price and availability. Economies of scale are very important, so companies must invest billions of dollars in state-of-the-art fabrication facilities. Due to the high costs involved, there are only a handful of companies in this industry.

DRAMs are typically built to industry standards. As technology improves and specifications change, DRAM manufacturers retool their factories in order to produce the latest version of a DRAM chip. Recent DRAM chips have shown incompatibilities between different chip suppliers.

DRAM brokers typically buy chips from OEMs who have excess production or from PC and memory module companies with excess inventory. They then sell to other companies needing additional supply. Usually these brokers do not test the chips for quality and will mix various DRAM versions and deliver them as a single lot.

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Memory Module Suppliers

Unlike the case with DRAMs, there are many companies supplying memory modules. DRAM manufacturers assemble memory modules to diversify their business and to ensure their components are used. Third-party memory vendors assemble memory modules for other companies or for their own brands. Brokers sell memory produced by other companies.

Assembling memory modules is much less capital intensive; therefore, more companies can afford to participate. The industry is made up of many companies of all sizes. This diversity causes production techniques and quality standards to vary widely.

Most third party modules are designed for the broad computer marker, which includes several different computer brands with varying system designs and configurations.

Brokers buy excess inventory from manufacturers and resell it to others. Many brokers are reputable businesses and operate with full knowledge of a manufacturer's products. Most manufacturers provide authorization to a particular broker to resell its memory.

Some brokers, who are not authorized resellers, or who perform deceptive practices such as selling remanufactured modules as new, comprise what is known as the gray market. In this case there is no certainty about the origin of the parts. The modules may have been ones that did not meet a manufacturer's specifications. If there is typically no additional testing before resale, there is no guarantee that parts will be compatible with the purchaser's system.

Reputable brokers often rely on the testing and quality measures of their suppliers, and generally do not perform quality or compatibility testing of their own.

DESIGN, TESTING, AND VERIFICATION OF MEMORY: COMPAQ VS. THIRD PARTY MEMORY SUPPLIERS

SDRAM Module Design Issues

Memory problems occur because the module assembler has not designed the SIMMs/DIMMs to handle the actual conditions to which they will be subjected in an operating environment.

SDRAM, or Synchronous DRAM, is the latest DRAM technology. It provides a host of performance benefits to a memory subsystem in a computer. In the past, layer minimization and ease of manufacturing drove memory module designs. Layout technicians followed physical rules mostly independent of electrical, timing, loading, and noise constraints, all of which could be ignored at 40MHz and below.

The SDRAM frequency of operation is 100MHz now and is projected to achieve 200 – 400MHz by the year 2000. A new approach is vital. The design of the module requires the same approach as the design of the motherboard. The memory controller model, the connector model, and the traces and components on the module must be considered in order to simulate the signal-integrity of the design. The complexity of interconnections on the module means that more than 100 signals must be routed on the module, a new challenge to the designer. Other new issues faced by the designer are clock skew, reflections, loading, cross-talk, and characteristic impedance.

With SDRAM, not only is there a higher frequency, allowing the SDRAM to respond to system requests rapidly, but memory operations are synchronized to a common system clock. Synchronization introduces challenges during the design, evaluation, and testing phases of SDRAM modules as well.

One issue is that of trace lengths. With a common clock, the response time for a signal to travel to the module connector becomes critical. Traveling time along trace lengths on the memory module's Printed Circuit Board can vary due to even small variations in trace lengths. There are

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only 10 nanoseconds available in a cycle at 100MHz and the SDRAM uses up 6 nanoseconds or more, making all timing aspects critical. Multiple variations in travel time over a period of time can compound into a fatal failure.

Many third party manufacturers AutoRoute, which is a carry-over from asynchronous DRAM days when just the logical connections in a memory module mattered. Auto-routing connects logical signals together by the system software, which was appropriate when trace lengths did not matter. Most auto-routing programs do not keep the common signals at a consistent length. Instead, they find the shortest connect distance. This leads to inconsistent trace lengths, causing reliability problems.

Compaq's SDRAM-based motherboards have specific timing requirements for all of the associated signals. Compaq's engineering team best understands these timing requirements. Even if third party companies derive methods to maintain consistent trace lengths on the different nets in a module, a difficult achievement in itself, they still do not know what exact module net values are required for Compaq's motherboards. These values are not public domain. Only Compaq's memory engineering team has the expertise and experience to specify these values.

The new tighter specifications raise serious questions about third party memory suppliers. According to Paul Popadak, design-engineering manager at Kingston Technology, one memory module does not fit all, and there is a growing interoperability risk for end users and channel partners. Popadak said, "…it probably will prove impossible to design PC-100 DIMMs that will plug into any motherboard and work all the time."

The chart below lists some of the many problems that can occur in memory and demonstrates the importance of rigorous quality assurance.

MEMORY MODULE RELIABILITY PROBLEMS

Problem	Potential Consequences
Insufficient testing of memory modules by third party.	Possible data corruption, high single bit correctable errors, or, worst case, possible performance degradation or system failure.
Use of incompatible SDRAMs.	
Improper module PCB layout and routing (i.e., incorrect trace lengths, incorrect clock loading, improper trace impedance.	
Serial Presence Detect (SPD) improperly configured or not configured at all.	System memory controller not configured for optimum performance, or system will not boot.
Presence detect improperly configured or not configured at all.	Processor misinformed of module speed and density, causing system instability.
Gold finger contamination.	Single, double, or multiple bit correctable errors causing NOS failure.
Poor-quality solder joint.	Long-term failure after continuous operation in high-temperature environment.
Use of incompatible PLLs and registers on SDRAM registered DIMMs.	Extreme amounts of skew and jitter resulting in data corruption, system instability, or possible system failure
Improper routing of module, resulting in incorrect pinnout.	Electrical short causing burn and possible damage to server.
DRAMs sensitive to unstable signal from chipset during don't-care status.	Single, double, or multi-bit errors, causing machine not to boot.
Broken or missing decoupling capacitors.	Module vulnerable to damage from power supply spikes and surges.
DRAMs not adequately grounded; copper traces poorly placed and routed.	Poor performance due to noise, reflections, and cross-talk, resulting in increased possibility of bit errors
Routing of high-speed signals through ground and/or power planes.	Noise issues and cross-talk, resulting in single, double, or multi-bit errors, cross-talk causing system instability or possible system failure.

Compaq purchases DRAM components only from the most reputable suppliers, and further subjects purchased components to rigorous multi-parametric testing to minimize problems with reliability.

Testing Issues

Component-only testing is inadequate to identify randomly occurring memory problems. Some assemblers do not test their SIMMs/DIMMs while installed in a computer. SIMMs/DIMMs that appear to function well in one brand or model may fail in another. An additional consideration is that characteristics and quality of SIMMs/DIMMs from one manufacturer can vary significantly from lot to lot. Compounding that problem are variations between SIMMs/DIMMs revision levels from the same supplier. The fact that SIMMs/DIMMs of a previous revision level performed well in a given system under real-world tests is no guarantee that the next revision level of the same SIMMs/DIMMs will perform identically. For all these reasons, reliance on testing and quality checks by the memory module manufacturer leaves the door open for memory problems and computer downtime.

With the advent of SDRAM, parametric testing of each DRAM chip as well as of the SDRAM module itself becomes very important. The response times for SDRAM chips manufactured by the various chip manufacturers show differences. Parameters such as Tcac (access time from CAS) and CAS latency have a direct bearing on the reliable functioning of a module. These parameters vary among the different chip manufacturers.

The only way to reliably qualify the timings is to test the response times for all of the AC and DC parameters at varying module loads. Parametric testing can detect shifts in SDRAM power and I/O levels as well as I/O leakage. I/O leakage testing can indicate a defect in an input protection circuit that may not affect functional testing or operation in the system. This defect can degrade over time and result in an SDRAM and system failure.

This type of testing calls for expensive parametric test equipment, which can cost upward of $1M. Compaq understands that a robust design can be obtained only with modules characterized on the tester with each SDRAM type and verified on the target motherboard over temperature and voltage variations. Compaq has the equipment to conduct the necessary testing. During system module qualification, specific chips manufactured by certain SDRAM manufacturers are selected to ensure the highest reliability in Compaq systems. Only qualifying memory is used in the manufacture of Compaq memory products.

Verification Issues

This new class of module that must be synchronized to the system clock and operate at 2 times the memory bus speed of a year ago requires the additional step of verification during the development process. Combinations of memory controllers, motherboard designs, module designs, and different SDRAMs must be verified one combination at a time. This is the only way to guarantee a robust working design.

As SDRAM evolves to speeds of 125MHz and beyond, the margin of error becomes tighter. Again, as with testing issues under the new tighter specifications, most third party manufacturers do not have the test equipment or the capability to acquire sufficient combinations of Compaq systems to adequately verify and certify SDRAM memory for Compaq products. Compaq's internal qualification data suggests that only a limited group of SDRAM chip types manufactured by certain DRAM integrated circuit manufacturers work reliably in Compaq systems. Only Compaq memory can be verified for Compaq systems.

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REASONS TO BUY COMPAQ MEMORY

Compaq Quality Standards

Compaq provides a more thorough evaluation of its memory modules than third party memory manufacturers. In the award-winning ISO 9002-certified Compaq manufacturing facility modules are subjected to rigorous testing beginning upon receipt of DRAM components and continuing through the production process resulting in finished memory modules.

Compaq takes a proactive role in verifying the quality and reliability of components used in its products, from purchase to placement in inventory. Compaq systems are designed to use industry-standard components, and Compaq purchases memory components only from certified suppliers who meet Compaq specifications.

To begin with, before a manufacturer is added to the authorized vendor list, Compaq engineers thoroughly investigate the designs, manufacturing processes, testing, and quality assurance of the DRAM chips produced by that vendor. Only manufacturers that meet Compaq standards are placed on the authorized vendor list from which Compaq purchasing agents can procure memory.

Compaq purchases memory components from the authorized vendors. When a shipment of purchased DRAM components arrive from the manufacturer, they do not go directly into component inventory. They are held until the lot passes Compaq in-house qualification tests.

The process is identical for both memory upgrade kits and memory shipped standard in a Compaq system. If the DRAM chips pass the initial battery of tests, they are received into Compaq inventory. If they fail, they are rejected. When in-house testing identifies a memory problem, Compaq notifies the DRAM manufacturer and assists in resolving the problem.

With initial in-house testing, Compaq engineers do full characterization of each memory module revision for use in specific memory configurations. For this characterization, Compaq engineers run early production memory samples through a large battery of tests that have proven effective in uncovering memory design problems. These tests check timing and I/O voltages, confirm that the module is within the specified parameter range, and ensure that it performs acceptably.

Compaq uses a system level test that runs under the Microsoft Windows NT operating system and bombards memory randomly to apply real-world stress. This test has revealed basic problems in DRAM chip and module designs that cause memory failures, and has identified occasions when a manufacturer has shipped to Compaq a new, unapproved revision of DRAM components instead of the approved chips.

During production, if new or additional problems arise with memory modules, Compaq tests a much larger sample from each lot of memory on Compaq's multimillion-dollar, state-of-the-art memory testing machine. At this point, each sample tested must achieve a 0.1 percent average quality level. If a single failure occurs in the sample, then the entire lot is tested. In this single-point testing, individual SIMMs/DIMMs that do not meet this standard are rejected.

Only thoroughly qualified memory is used in Compaq systems and upgrade kits. For this reason, Compaq offers with servers using Compaq Insight Manager a standard three-year pre-failure warranty covering memory as well as drives and processors. No other company offers such a comprehensive coverage.

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Compaq Compatibility

Compaq's warranty does not cover service or parts damage resulting from the use of non-Compaq brand memory. While several third-party vendors may claim that their memory is compatible with a Compaq system, only Compaq-brand memory has been tested and authorized for use in Compaq portables, desktops, and servers.

Compaq ensures that a memory component authorized for use in a specific Compaq computer will work on that unit. As part of the process for designing a computer, Compaq engineers thoroughly test memory modules as they interact with the other components and subsystems. Compatibility tests are performed on the memory while the unit operates under different hardware and software configurations. Results from these tests are incorporated into the design and quality specifications so that Compaq memory modules will be less likely to fail.

Given the complexity of SDRAM quality control, most third party suppliers cannot purchase the quantity of Compaq systems required to certify complete compatibility and do not have the test facilities to assess compatibility.

Single Supplier Convenience

Customers choosing Compaq brand memory upgrades have the convenience of dealing with a single company for all service and further expansion. Compaq's well-trained technical support personnel can diagnose memory-related errors. Authorized service dealers will be able to replace parts without additional charges during the on-site warranty period. And the Pre-Failure Warranty makes it possible for customers to schedule service before a critical failure, for Compaq servers using Compaq Insight Manager, on Compaq memory, drives, or processors.

CONCLUSION

Today's computer and server environments demand exacting memory standards and extreme care in selecting memory for use in upgrades. The rigorous, real-world testing and continual vigilance provided by Compaq's test engineering can best prevent potential problems and ensure the high reliability of the components and subsystems of a Compaq platform. Customers using Compaq memory can be assured the highest confidence and convenience.

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