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MCFT White Paper

CMTL's MCFT Card : State-of-the-Art memory testing

CMTL's **MCFT** Card (**M**emory **C**ompatibility & **F**unctionality **T**ester), is a memory testing PCI card designed for the rigorous testing needs of personal computer manufacturers, memory manufacturers, PC design engineers, and computer service professionals. MCFT is one of the fastest, most robust, and most accurate memory diagnostic and verification tools available on the market today. MCFT supports all SIMMs, DIMMs, RIMMs, (SDRAM, DDR, DDR2, RDRAM, SRAM, ECC, Parity and Non Parity) and others.

The Technology behind the MCFT Card

In developing the MCFT card, CMTL worked closely with Ultra-X (the creators of R.S.T. Ram Stress Test) and other high end, industry leading microprocessor and memory manufacturers to design new algorithms and testing patterns that are specifically oriented towards testing the latest chip technology and towards supporting future technologies. As a result MCFT's capabilities were greatly exceeded. MCFT can currently test up to 64 gigabytes and is designed to handle 4096 gigabytes for future processors.

MCFT's Advantage

Memory is one of the most notoriously difficult system functions to troubleshoot, exercise, and test. PC's are not only being equipped with increasingly large amounts of RAM but they're often complex system hardware and software configurations can make it even more difficult to determine if a problem is truly a RAM failure, or if it is caused by hardware or software conflicts, or by a combination of both. MCFT's capabilities far exceed those of stand-alone testers in meeting both of these challenges. Unlike stand-alone testers, MCFT has the capacity to test today's larger amounts of RAM. MCFT can also test RAM more comprehensively than stand-alone testers, which can only test memory one module at a time from outside the system. MCFT works inside the system to test for all of the factors that are potential causes of memory failure, such as problems caused by the



system chipset or noise, or problematic interactions between modules.

MCFT is also unique in its ability to exercise the complete range of a computer's RAM, verifying that the memory module will work with the latest chipsets, the latest speeds, and with all access methods. While stand-alone systems run at a slower speed, MCFT can run at the maximum speed of the latest PCs. MCFT also has the capability to test memory with the broadest range of algorithms, including newer, more sophisticated algorithms that can find problems in the latest modules. In addition, since some problems can be caused when the operating system is accessing memory, MCFT tests for this kind of problem by replicating different operating systems' access methods. All of these factors make MCFT one of the best, easiest, and fastest ways to test system RAM and it's also the reason why MCFT successfully resolves RAM problems in many environments where standalone testers fail.

Test Patterns

Most of the advanced testing algorithms developed by CMTL, were developed using field failure parts rather than theoretical numerical patterns. This in-depth study of field failures has given MCFT unique access mechanism that can catch true failures rather than erroneous or no defect faults.

Small but Robust Program Size

In addition, MCFT is a small but potent memory testing package that loads itself into the least amount of RAM possible. MCFT occupies far less RAM than many other memory testing products which boast similar functionality.

Testing Flexibility

MCFT allows you to select the number of testing loops desired, the memory address range to be tested, and other testing criteria.

Who Should Use MCFT?

MCFT was designed for manufacturers of computer systems and memory modules, system designers, and computer service professionals.



Manufacturers of Computer systems

- Manufacturers of high end computer systems and servers who need to test the complete range of a system's memory before it is shipped will benefit from using MCFT. MCFT is the only product that is equipped to test the larger amounts of RAM in these newer high end systems.
- MCFT is also important as a testing tool in an assembly line environment because it enables technicians to test memory as it functions in a specific system.

Manufacturers of Memory Modules

- Manufacturers of Memory Modules can depend on MCFT to do everything possible to exercise the memory module before it is shipped, and to verify that their memory modules will work with the latest chipsets, the latest speeds, and with all access methods.

System Designers

- MCFT was also developed to aid system designers who need to exercise the complete range of the system's RAM, and who need a dependable and comprehensive tool to check compatibility issues and problems that arise in the process of designing a new computer.

Service Professionals

- MCFT is an invaluable tool to computer service professionals. Its ability to test RAM comprehensively from inside a system and to exercise the complete range of even the newer, high end modules, will enable a diagnostic professional to determine definitively whether a problem is rooted in hardware or software.

This highly integrated product provides the following capabilities:

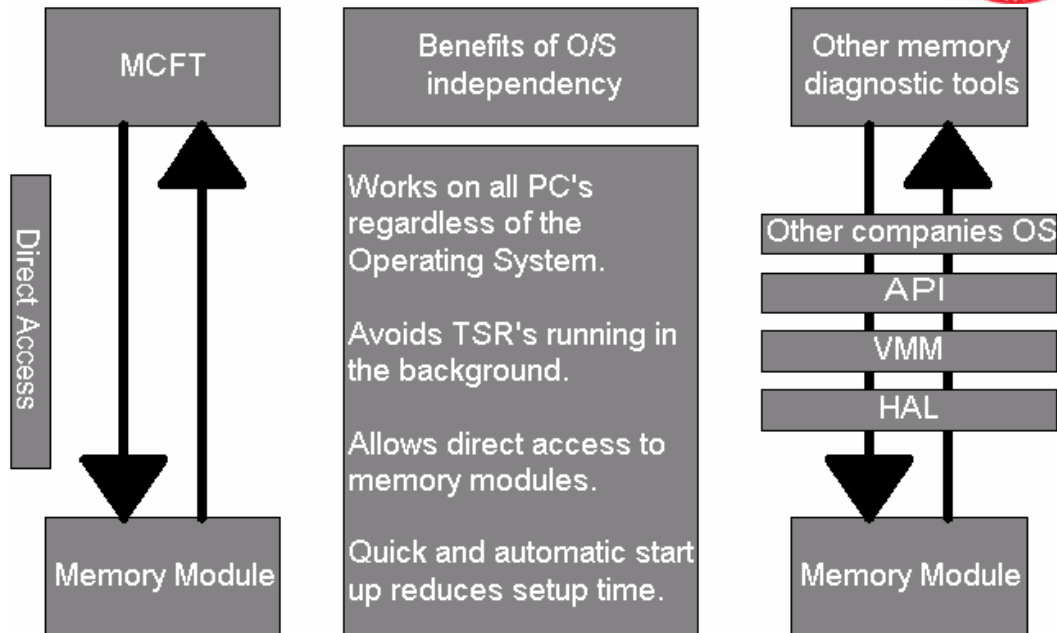
- Tests base, extended, and all memory in any system using x86 compatible architecture.



- PCI card with on-board self-loading program eliminates operating system and hard drive dependencies.
- Provides full manufacturing-level diagnostics using the latest memory testing techniques, yet occupies a minimum amount of RAM.
- Runs completely in protected mode for exceptional testing speed and exclusive memory access.
- Includes over 30 industry standards and proprietary memory tests that can be run on all accessible RAM.
- Capable of testing entire CPU memory range. Up to 4096 Gigabytes on future processors. 64G limit for Pentium 4.
- Permits customized testing sessions to be defined; any test can be included or excluded from testing as desired.
- Memory address range to be tested can be specific in 1 Gigabyte, 10 Mb, 1 Mb, and 1 Kb increments.
- Allows the user to specify the number of times all selected tests are to be executed (from 1 to 9,999 testing loops per session).
- Provides an unattended Burn-In mode for lengthy troubleshooting sessions and new RAM installation verification testing.

O/S Independent vs. Windows/Linux

The self-boot technology that CMTL has developed, loads the diagnostics directly from on-board firmware. Because competitive products require preloading of an Operating System, such as Windows, Linux, UNIX, or DOS, proper and true memory diagnosis cannot be achieved. Reasons for poor diagnosis when an OS is loaded are due to problems created during the boot stage in addition to adhering to the O/S's rules. With all these different criteria, it only dilutes the problem resulting in a poor diagnosis. With the MCFT utilizing the self-boot technology, TSR's are eliminated and true memory access is available in addition to the quick and automatic start up.



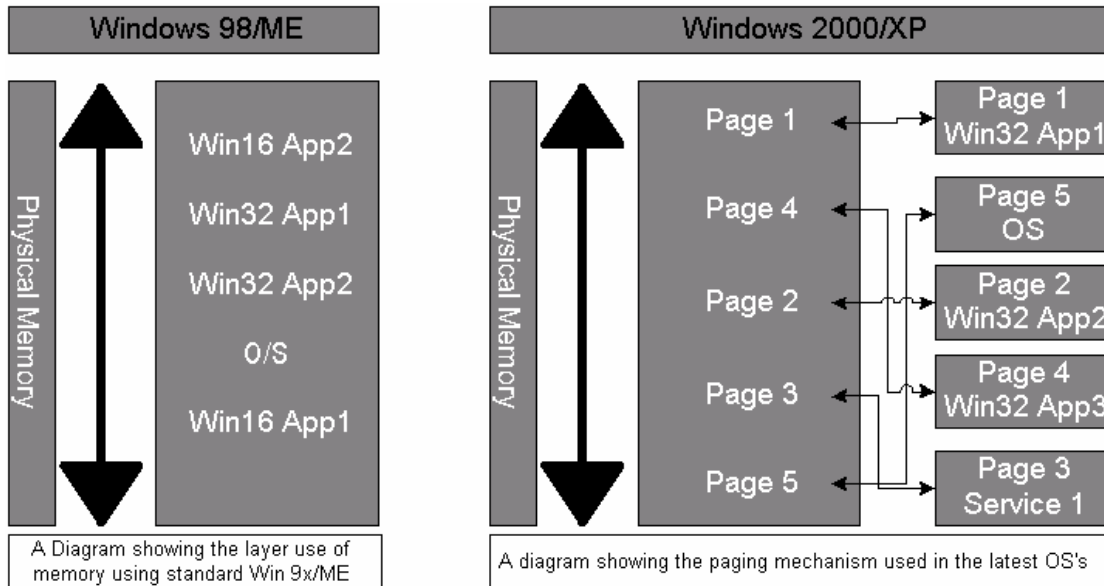
MCFT uses algorithmic code that runs independent of an OS. The card is designed as such to rid itself from OS obstacles. The following are a list of obstacles that are overcome when running without the presence of an OS:

- ✓ No OS interrupt table
- ✓ No interference from software to CPU
- ✓ No OS Driver layer
- ✓ Smaller code.
- ✓ Maximum coverage of memory range
- ✓ No OS API layer
- ✓ No OS threading layer
- ✓ No OS overhead layer
- ✓ No OS memory driver layer
- ✓ Restricts access to memory.
- ✓ Dilutes memory testing
- ✓ Cleanest environment
- ✓ Access full CPU memory range using native CPU flat mode
- ✓ Emulation of different O/S's using a single easy to use MCFT card.
- ✓ Patterns designed to maximize fault coverage

The Test levels and Algorithms

MCFT emulates real world access's by a performing a series of in-house designed memory patterns to catch problem that are caused by stresses created by various methods of RAM access.

MCFT's multiple algorithms simulate a variety of memory usage methods. As seen from the two diagrams below, newer operating systems are more rigorous than standard Windows products. MCFT is designed to test for multitude access mechanisms being used in current operating systems.



MCFT Testing Capabilities and Memory Algorithms

Support Memory capacity

Base Memory to 64G – (4096 G for future Processors)

Test Patterns

Most of the advanced testing algorithms developed by CMTL were developed using field failure parts rather than theoretical numerical patterns. This in-depth study of field failures has given MCFT unique access mechanism that can catch true failures rather than erroneous or no defect faults.

- Base Memory to 64G – (4096 G for future Processors)
- Sequence 1 (Test 1 & 2)
- Sequence 2 (Test 3 & 4)
- Sequence 3 (Test 5)
- Sequence 4 (Test 6, 7 & 8)
- Sequence 5 (Test 9 & 10)
- Sequence 6 (Test 11)
- Sequence 7 (Test 12)
- Sequence 8 (Test 13 & 14)



- Sequence 9 (Test 15, 16, 17 & 18)
- Sequence 10 (Test 19)
- Sequence 11 (Test 20)
- Sequence 12 (Test 21)
- Sequence 13 (Test 22)
- Sequence 14 (Test 23)
- Sequence 15 (Test 24)
- Sequence 16 (Test 25 & 26)
- Sequence 17 (Test 27)
- Sequence 18 (Test 28)
- Sequence 19 (Test 29)
- Sequence 20 (Test 30)
- Sequence 21 (Test 31)
- Sequence 22 (Test 32)
- Sequence 23 (Test 33)
- Sequence 24 (Test 34)
- Sequence 25 (Test 35)

Sequence & Test Descriptions

Due to the proprietary nature of some tests, details may not be provided. A Star * next to the test name indicates a proprietary pattern developed by CMTL and its partners.

Sequence 1

- Test 1: Filling all memory with zeros, then checks for any bits that still equal one. Any bit which equals 1 is flagged as "ON".
- Test 2: Filling all memory with ones, then checks for any bits that still equal zero. Any bit which equals 0 is flagged as "OFF".

Sequence 2

- Test 3: Testing using a "weave" pattern to check memory for address lines stuck High (On), and to verify that data can be written and read reliably.
- Test 4: Testing using a "weave" pattern to check memory for address lines stuck Low (Off), and to verify that data can be written and read reliably.

Sequence 3

- Test 5: Filling memory with zeros and then alternating by jumping from the beginning and end of RAM to the middle block of memory.



Sequence 4 *

- Test 6: Performing a checkerboard combination sequence test that incorporates walking and auto base sequencing routines.
- Test 7: Performing an inverted checkerboard combination sequence test that incorporates walking and auto base sequencing routines.
- Test 8: Performing a combination of the checkerboard and inverted checkerboard sequence test that incorporates three bits walking and auto base sequencing routines.

Sequence 5

- Test 9: Checking each byte's parity bit using a checker board pattern.
- Test 10: Checking each byte's parity bit using an inverted checker board pattern.

Sequence 6

- Test 11: Copying the system BIOS code into RAM until the memory is filled and then reading all RAM to verify that the BIOS data was written correctly.

Sequence 7

- Test 12: Performing test to verify and isolate failures in the data lines between the system bus and RAM.

Sequence 8

- Test 13: Filling each word of RAM with a unique data pattern and then checking each word's value to ensure that it is the same as the value written.
- Test 14: Filling each word of RAM with a unique address pattern and then checking each word's value to ensure that it is the same as the value written.

Sequence 9

- Test 15: Performing walking bit patterns; a bit is written and the next is skipped and then one is written again, etc.
- Test 16: Performing inverted walking bit patterns; a bit is written and the next is skipped and then one is written again, etc.
- Test 17: Performing walking bit patterns left; a bit is written and the next is skipped and then one is written again, etc.
- Test 18: Performing inverted walking bit patterns left; a bit is written and the next is skipped and then one is written again, etc.



Sequence 10

- Test 19: Attempting to detect single coupling failures and multiple failures of any combination of bits stuck at zero or one.

Sequence 11 *

- Test 20: Reading each bit for a preloaded expected value, then writing the opposite value and reading the value a second time.

Sequence 12

- Test 21: Filling and writing all memory with zeros and then, in ascending order, verifying that zero is present in every bit. Then filling and writing all memory with ones. Another pass inverts all of the patterns and performs a complete data integrity check.

Sequence 13 *

- Test 22: Testing for cross contamination of cell data.

Sequence 14 *

- Test 23: Testing for cross contamination of cell data.

Sequence 15

- Test 24: Testing memory transfer which determines if data can be moved from one location in RAM to another without causing changes to the data.

Sequence 16 *

- Test 25: Testing a combination of unique access methodology and standard pattern testing.
- Test 26: Testing a combination of custom walking and standard pattern testing.

Sequence 17 *

- Test 27: Additional Address line testing using proprietary methods for stressing address line.

Sequence 18 *

- Test 28: Combination of unique access methodology testing of Address and Data lines to isolate failures.



Sequence 19 *

- Test 29: Test pattern designed to uncover memory cell failures such as address decoder faults, stuck at faults and cell interaction problems.

Sequence 20 *

- Test 30: Testing for data line adjacent cell intrusion or disturbance.

Sequence 21 *

- Test 31: DDR module specific test algorithm stresses unique DDR behavior mechanism.

Sequence 22 *

- Test 32: Alternate DDR module specific test algorithm stresses unique DDR behavior mechanism.

Sequence 23 *

- Test 33: Data line stress level pattern for DDR memory controller.

Sequence 24 *

- Test 34: DDR2 module specific test algorithm stresses unique DDR behavior mechanism.

Sequence 25 *

- Test 35: Data line stress level pattern for DDR2 memory controller.

MCFT Hardware Test Card vs. Software Memory Test Products

MCFT hardware provides additional circuitry to optimize pattern generation and system access. This enhances the testing and provides a faster mechanism for failure isolation.

Memory Testing Levels to Emulate Real World Memory Usage

Level One

This level emulates application programs that are running DOS and a limited Windows OS, Single user. Older systems & systems that may still be used in imbedded process control applications.



Level Two

This level emulates standard use of a Windows OS and application programs. Single user. Home and light business applications. Spreadsheet, e-mail, documents, etc.

Level Three

This Level emulates rigorous use of Windows based programs. Single user. Demanding programs: publishing, 3-D imaging, gaming, video editing, etc.

Level Four

Emulates multi-user OS's such as Windows NT Enterprise Server, Linux, UNIX. Muti-user. Server and workstations. Extremely demanding programs and high end gaming. Maximum memory stress.

Level Five

Emulates multi-user OS's such as Windows XP & 2003 Enterprise Server, Linux, UNIX. Extremely demanding enterprise class applications and web servers. Over clocked PC's and servers used in high-end gaming environments. Extreme memory stress.

Conclusion

CMTL has designed a product to surpass over memory test products. The new MCFT card uses different memory testing technologies to better detect memory failures. The card is also designed with features designed specifically to meet the demanding and changing needs of memory testing Laboratories.