CRC GENERATOR BOARD
for OS-9 GMX III

User's Manual

GIMIX Inc.
1337 W. 37th Place
Chicago, IL 60609
312-927-5510 * TWX 910-221-4055

GIMIX CRC GENERATOR BOARD

The GIMIX CRC GENERATOR board is a hardware implementation of the CRC (Cyclic Redundancy Check) algorithm used by Microware's OS-9™ operating system. The board occupies one 30-pin I/O slot in SS-50 bus systems, and is currently available only for GIMIX systems using the GMX 6809 CPU III and the Support ROM version of OS-9 GMX III.

CONTENTS

The GIMIX CRC GENERATOR board uses a proprietary circuit, designed for GIMIX by TERRY F. RITTER.

INTRODUCTION

OS-9 uses the concept of "Memory Modules" to manage objects that are loaded into the system memory. A Memory Module may be an executable 6809 object code program or subroutine, a data module, or a program in an intermediate code that is used by a high-level language. In addition to the actual data in the module, each module includes a header to describe its contents and a three byte Cyclic Redundancy Check (CRC) value. The CRC is computed and appended to the module when it is created. Each time OS-9 loads a module into memory, the CRC is recomputed and checked against the value appended to the module to verify the integrity of the module's contents. If a module's CRC does not check, it can not be loaded into memory or executed.

OS-9 normally computes the CRC by using a software algorithm. Each byte of the module is sequentially passed through the algorithm, resulting in a 24-bit value based on the new byte and the previous CRC value. The CRC is accumulated in this way until each byte in the module has been passed through the algorithm. The final 24-bit CRC is then appended to the module. When the module is loaded into memory, the process is repeated to check the integrity of the data. Note: The module is actually loaded completely into memory before being checked, so the loading process actually checks both the data and, to a certain extent, the memory into which it was loaded. The CRC computation is a relatively slow process that requires considerable CPU time. It accounts for a major portion of the time required to load a module from disk into memory and make it available to the system. By using high-speed hardware to replace the actual CRC computation software, a considerable improvement in load times can be realized. Since most, if not all of the software that creates Memory Modules (assemblers, compilers, etc.) computes the CRC value by calling OS-9's internal CRC algorithm, an improvement in assemble/compile times can also be realized by replacement of the CRC software in OS-9 with a hardware equivalent.

The GIMIX CRC GENERATOR BOARD duplicates, in hardware, the CRC generation algorithm used by OS-9. When interfaced to the operating system kernel, it completely replaces the software algorithm, and its operation is totally transparent to the user. The board is used for all CRC computations performed by OS-9 or programs that use OS-9's CRC related system calls (F$CRC and F$VModul).

The software algorithm requires a minimum of 111 machine cycles (55.5 microseconds in a 2 MHz. system) to process 1 byte, or approximately 455 milliseconds for an 8K module. In contrast, by using the memory-to-memory DMA on the GMX 6809 CPU III to transfer the data to the CRC GENERATOR BOARD, CRC values can be computed and accumulated at 1 Byte per microsecond in a 2 MHz. system, or approximately 8.2 milliseconds for 8K. The software method also requires additional time to fetch each byte from memory and pass it to the CRC algorithm as a subroutine call. This additional overhead nearly doubles the time required to process each byte by the software method. The only additional overhead when using the hardware method is the few microseconds needed to initialize the DMA registers on the CPU III (once for the entire module).

The following timing comparison was made, using the same 2 MHz. system with and without the CRC board. In each test, an OS-9 procedure file was used to "load" Basic09 into memory 100 times. The procedure file consisted of the command "date t" followed by "load basic09" 100 times, and finally "date t" again. The time required to run the procedure was divided by 100 to obtain the load times shown. NOTE: In each case the "date" and "load" commands were already in memory when the test procedure was run. The times include the overhead required to process the procedure file. Also note that load time is affected by the position of the file being loaded within the directory structure of the disk, the type of disk, and the amount of other activity on the system.

TIME REQUIRED TO LOAD Basic09
(from a 47 Mbyte hard disk)

With software CRC:	With hardware CRC:
3.84 Seconds	1.09 Seconds

SECTION 1: HARDWARE INSTALLATION

The GIMIX CRC GENERATOR BOARD occupies one 30-pin I/O bus slot. The slot used is determined by the operating system kernel module "OS9p1". The system disk supplied with the board includes two versions of OS9p1; one configured for I/O slot #6 ($E060) and one for slot #7 ($E070). (See the section on software requirements for more information.) If neither of these two slots is available, the device presently occupying one of the two slots will have to be relocated. It is not possible to modify the kernel to move the CRC board to a different location.

The CRC board has no configuration options, and is simply plugged into the selected I/O slot.

SECTION 2: SOFTWARE REQUIREMENTS

In order for OS-9 to use the CRC board, a special version of the kernel module "OS9p1" must be included in the OS9boot file on the disk used to boot the system. The OS9boot on the system disk supplied with the board, or with systems that include the board, DOES NOT include the hardware CRC version of OS9p1 and does not make use of the CRC board. The system will boot and function normally with the supplied system disk, even if the CRC board is not installed. This provides the user with a means of using the system, should the CRC board ever fail for any reason. The user MUST create a new boot file in order to use the CRC board.

Included on the system disk are two versions of OS9p1, configured for different I/O slots. The file "OS9p1.hcrc_6" is configured for installation of the CRC board in I/O slot #6 on the motherboard, "OS9p1.hcrc_7" is configured for I/O slot #7. Use the file that matches the slot in which the board is installed to create a boot file for the system. Systems shipped by GIMIX with a CRC board installed, will have the board installed in I/O slot #7. NOTE: As with all boot files for systems using the OS-9 Support ROM, OS9p1 MUST be the first module in OS9Boot. See the OS-9 GMX III MANUAL ADDENDA and the OS-9 USER'S MANUAL for information on creating a new boot file.

Once a new boot file has been created and used to boot the system, the CRC board is used for all of the CRC computations normally performed by OS-9 or through OS-9 system calls.

SECTION 3: FAULT INDICATOR (LED 1)

Normally, the fault indicator located at the top of the board (LED 1) will remain OFF. It will only come on if a CRC board fault occurs. When a fault occurs the board will not function until it is cleared by reseting the system (front panel reset). If a fault occurs while the system is in use, any modules already loaded and verified

will remain usable until unlinked; however, once a fault has occurred, no additional modules can be loaded and any modules created by programs such as the assembler or Basic09 will have incorrect CRCs.

There are two possible causes of a fault indication. The first (and most likely) cause, is an illegal access attempt. Normally, the user need not, and should not attempt to access the CRC hardware directly. Any attempt to do so can cause a fault, and prevent the board from working. All access to the board should be through the standard OS-9 system calls. An illegal access can occur if there is a device device descriptor pointing to the port in which the board is installed, and an attempt is made to initialize or use that device. If a fault occurs (fault indicator lit) be sure that nothing in the system is accessing the board directly.

The second potential cause for a fault is an actual hardware failure on the board. (Only certain types of hardware failure cause the fault indicator to light. Hardware failures can occur that do not light the indicator.) If a hardware failure occurs, with or without a fault indication, the system can still be used by booting from the original system disk (which does not use the CRC board) or from a disk made with the software CRC version of OS9p1. Defective boards must be returned to the factory for repair/replacement. GIMIX does not provide documentation or support for field repair of this board.

SECTION 4: INTERRUPT RESPONSE CONSIDERATIONS

When the CRC board is used to validate a module that has been loaded into memory, the entire module is checked in a single burst using the memory-to-memory DMA on the CPU III. During the time that the module is being checked, the system interrupts remain masked. In the majority of applications this will not pose any problems, even when large modules are being loaded. However, some additional delay in interrupt response is possible if the interrupt occurs while the validation of a large module is in progress.

In certain special applications where real-time interrupt response is extremely critical, especially if the interrupting device is a standard (non-intelligent) I/O board or device, it may be preferable to use the software CRC rather than the CRC board, or to keep large modules in memory at all times so that they do not need to be repeatedly loaded and validated.