

NitrOS-9

Enhanced OS-9 Level II Replacement
Modules for use with the HD6309 CPU

From

Mustang Professional Software

Reference Manual

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NOTE: This manual describes NitrOS-9 v1.20 and higher releases.

Many hours have gone into the preparation of NitrOS-9. Please help support quality software by not pirating this commercial package.

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1. Introduction

Thank you for purchasing NitroS-9.

Please see the 'read.me' file on the distribution disk for any updates or changes to the information included in this manual.

NitroS-9 is a set of replacement modules for Microware's OS-9 Level II Operating System when used with the Hitachi HD6309 microprocessor. These modules have been written to maintain near-100% compatibility with OS-9, with the added bonus of extra speed and additional features.

This is done by using undocumented features in the Hitachi CMOS 6309 microprocessor. The 6309 is 100% compatible with the Motorola 6809 when running in 6809 mode. However a second mode on the 6309, called Native Mode, uses additional registers and instructions on the chip for greatly improved performance:

Benchmark	Stock System (6809)	NitroS-9 v1.21 (6309)
List 40k text file		
Text Screen	45 seconds	21 seconds
Graphics Screen	135 seconds?	45 seconds?
Format 360K Floppy		
Megaread		
Graphics Demo		

Almost all applications will work without modification under NitroS-9. Those few that don't, such as Home Publisher, have patches freely available. If you encounter a module that won't run under NitroS-9, please contact your distributor at the address listed in Section 5.

NitroS-9 is intended for use on the Tandy Color Computer 3 and Frank Hogg Laboratories TomCat TC9 computers which have a Hitachi HD6309 CPU installed. Contact the authors (Section 5.7) for information on use with other 6809 systems that run OS-9 Level II.

1.1 The Hitachi 6309

Hitachi licensed the rights to reproduce Motorola's M6809 CPU. Two versions of the chip were produced by Hitachi -- the HD6809, and the HD6309. The HD6809 is an exact duplicate of the Motorola chip.

The 6309 was produced using a CMOS technique called microcoding, rather than the bit-decoded technique used to create the 6809. As a result, there was room available on the chip for additional registers and instructions. These were added by Hitachi's engineers, but due to the licensing arrangement, the documentation for these features was never released to the public by Hitachi.

These instructions were eventually printed in the Japanese publication Oh!FM, and first came to the attention of North America on March 5 1992, when Hirotsugu Kakugawa posted them on Internet.

Not long after that information was released, Burke & Burke released the first edition of its PowerBoost package. Using a technique called "stack massaging" (discussed later), PowerBoost patched sections of OS-9 to use 6309 instructions in Native Mode. This resulted in a noticeable increase in speed.

1.2 Development of NitroS-9

Inspired by the performance of the PowerBoost package, the authors of NitroS-9 began to wonder what would be involved in getting OS-9 to run on the 6309 completely in native mode, so that the advantages offered by the 6309 could be fully utilized.

When a interrupt (IRQ) occurs on a 6809 CPU, copies of all the registers are pushed onto the hardware stack like this:

```

CC A B DP X Y U PC [Rest of Stack]
|
| New Stack Pointer | Stack Pointer before IRQ

```

To access data pushed onto the hardware stack, OS-9 will use an offset from the new stack pointer to access either the register values just pushed onto the stack, or the values that were on the stack before the IRQ occurred.

With the 6309 running in Native Mode, two additional registers (E and F) are also pushed onto the stack when an interrupt occurs:

```

               | New Registers
               |
CC A B E F DP X Y U PC [Rest of Stack]
|
| New Stack Pointer | Incorrect Pointer

```

If unmodified OS-9 system modules try to access the stack, they will quickly run into difficulty using the original offsets from the new stack pointer. Since there are now two unexpected 8-bit registers on the stack, any pointers to DP, X, Y, U, or PC will be off by 16 bits, or two bytes. For example, unmodified code would calculate the pointer to PC as pointing at U, rather than the correct position. This will cause strange results on any computer!

Two techniques can be used to overcome this problem:

- Stack Massaging; and
- Modifying all the register stack offsets

Stack Massaging involves rearranging the order of the information on the stack and resetting the stack pointer so that the stack appears in the order expected with a 6809. This has to happen each time an interrupt occurs, and has to be undone before returning from the interrupt.

The second technique is straightforward, but also somewhat more involved. To modify all the register stack offsets, each module must be disassembled, and the stack offset adjusted for each system call supported by the module.

Armed with this information, the authors set about the task of disassembling, documenting, and modifying OS-9. In the process, in addition to modifying all the stack offsets, the authors discovered a great deal about OS-9.

These discoveries included previously unnoticed bugs in OS-9 (mostly small ones), sections of code that would benefit greatly from being rewritten for the 6309, the need for some new system calls, and undocumented features in current system calls.

The result so far has been several megabytes of source code, extensive modifications to most of the original OS-9 modules, and several improved replacement modules that were created from scratch. In addition, a majority of the most popular patches to OS-9 have been incorporated in NitrOS-9.

The authors are still actively developing NitrOS-9.

2. Hitachi HD6309 Installation

Using NitrOS-9 with your Tandy Color Computer 3 or Frank Hogg Laboratories Tomcat TC9 computer requires the installation of a Hitachi HD6309 CPU. If you aren't comfortable working inside your computer with a soldering iron, section 2.4 lists some vendors that will do the installation for you.

Ensure that the HD6309 used is appropriate for your machine. For a 2MHz Tandy Color Computer 3 or FHL TC9, a HD63B09E or HD63C09E model chip should be used.

As always when working with electrical equipment, ensure it is unplugged, and read the instructions completely before you begin the installation.

2.1 Replacing the MC6809

The quickest method of replacing the 6809 with a 6309 is to cut out the existing 6809, desolder the leftover pins from the motherboard, install a socket, and put the 6309 in the socket.

2.2 Piggyback Installation

A slightly simpler method of installing the 6309 is to install it on top of the existing 6809, and disable the 6309:

1. Take a 40 pin IC socket and cut off pins 5, 6, 33, 36, and 38. Bend pin 39 inwards.
2. Solder a length of 30 gauge wire across the bottom of the socket between pin 39 and pin 1.
3. Cut pin 39 of the 6809 cpu on the motherboard (IC1).
4. Solder a piece of 30 gauge wire between pin 7 (+5vdc) and pin 39 of the 6809 to shut it off (See Section 2.3)
5. Place the socket on top of the 6809 (IC1). Make sure the socket pins make firm contact with the corresponding 6809 pins.

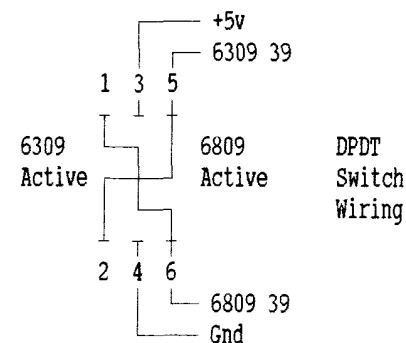
6. Join each pair of corresponding pins with solder.
(Except 5, 6, 33, 36, 38 and 39.)

7. Plug in the 6309.

2.3 Switchable Installation

By adding a DPDT switch, it is possible to switch between the 6809 and the 6309. Naturally, NitroS-9 won't work with the 6809 enabled, but a switchable installation can be useful to check the operation of software with a 6809.

1. Take a 40 pin IC socket and cut off pins 5, 6, 33, 36, and 38. Bend pin 39 outwards, so that it can later be connected to the switch.
2. Cut pin 39 of the 6809 cpu on the motherboard (IC1). Bend the pin upwards, and solder a piece of wire to it. Connect the wire now, as the pin is easier to access at this point.
3. Place the socket on top of the 6809 (IC1). Make sure the socket pins make firm contact with the corresponding 6809 pins.
4. Join each pair of corresponding pins with solder.
(Except 5, 6, 33, 36, 38 and 39.)
5. Connect Pins 1 and 6 of a Double-Pole, Double-Throw (DPDT) switch to pin 39 of the 6809 on the motherboard as shown in the diagram below.
6. Connect Pins 2 and 5 of the switch to pin 39 of the socket.
7. Connect Pin 3 of the switch to +5 volts (6809 Pin 7), and Pin 4 of the switch to Ground (6809 Pin 1).



8. Finally, plug in the 6309.

2.4 Third-Party Installation

Most electronic repair stores will do the installation for a minimal fee, if you provide the CPU and socket. This is the simplest and fastest method of getting your 6309 installed by a third-party. The Tandy/Radio Shack repair centers in Canada will also do this installation for you, at their regular repair rate.

In the United States, CoNect will install a Hitachi 63B09E CPU and a socket into your CoCo. The machine MUST be in working condition! The 68B09E will be returned unharmed. This service includes a 90 day limited warranty. chip and installation. Contact CoNect, listed in Appendix B.

The same service is available from Northern Xposure (Appendix B). The 68B09E will not be returned. Due to Customs charges, this service is only offered within Canada.

In Australia, contact RemComs for more information.

3. Software Installation

We highly recommend that you produce a NitroOS-9 Boot floppy before you attempt to install NitroOS-9 on your hard drive system!

Get your current bootlist (ident -s /dd/os9boot).

Collect NitroOS-9 versions of all the needed system modules, and use your current descriptors.

Modify any programs that need patching, as detailed in Appendix C Third-Party Software Compatibility. Keep these separate from your regular (6809) versions.

Create a bootfile on the disk, using OS9Gen. If you are creating this disk using a stock OS-9 boot disk, this will give you a disk with a stock kernel track, and NitroOS-9's OS9Boot.

To install the NitroOS-9 Kernel track in memory, use the CHBOOT command. It will replace rel, boot, and os9pl, and reboot the machine. Then use COBBLER to create a new boot disk with the NitroOS-9 kernel track and OS9Boot file.

Use Tuneport to patch /p, if necessary.

See the Fine-Tuning information in Section 4.2 for suggestions about fine-tuning your system.

4. Technical Information

Information on the Hitachi 6309 is contained in Appendix A.

Additional Technical Information is contained in other appendices.

Information on specific modules is contained in the Release History, Appendix F. Modules that have been rewritten to work with NitroOS-9 generally fall into three categories:

- o Modules that have simply been recompiled to handle the new stack offsets.
- o Modules that have been optimized to work with the 6309. These modules are based on the original Microware modules, but have been partially rewritten to take advantage of the 6309 instructions.
- o Modules that have been completely rewritten. These modules have been completely rewritten to take advantage of the 6309 instructions, and often their function has been extensively modified to improve the performance of NitroOS-9.

4.1 OS-9 Compatibility

How compatible is NitroOS-9 with Microware's OS-9?

As far as possible, complete compatibility has been maintained with OS-9 Level II. Generally speaking, anything that will run on a stock OS-9 system will run on a NitroOS-9 system.

The exceptions to this rule fall into three categories that are detailed below, along with solutions:

1. Programs that use software timing loops.

Tuneport is used to adjust the speed of the 'bitbanger' serial port on the Color Computer. Other programs such as UltiMusE 3 can be patched to allow for the increased speed of NitroOS-9.

2. Programs that use instructions that are illegal on the 6809, but are legal on the 6309. On the 6809, these illegal instructions are treated as NOPs, and are used on very rare occasions in timing loops. This is an example of one of the few incompatibilities between the 6809 and the 6309.

Patches are available for some programs, and most others have already been rewritten to work with the 6309. These programs are very rare, and have generally already been modified to work with the 6309.

3. Third-party modules that have not yet been converted to use NitroOS-9.

Conversion of programs so that they are compatible with NitroOS-9 is usually a simple and straight forward process. Send a copy of the module to Northern Exposure at the address in Section 5.7, and it will be converted. Those that wish to tackle the conversion themselves should see Section 4.3.

4.2 Fine-Tuning

This section describes some additional steps that you can take to obtain optimum performance from your system.

Hard Drive Interleave should be reduced for optimum performance. The exact value to use will depend on your system.

If you are having problems with disk fragmentation, change your SAS settings on your disk device (hard or floppy disk) to a higher number. This means it will allocate bigger contiguous chunks when you create or append to a file, particularly if you are multi-tasking with several programs creating/extending files at once.

Floppy Drive Interleave can be reduced from 3 to 2. You may wish to leave this alone however, if you will be using the floppies with another system.

Parking joysticks in the upper left corner will greatly speed up your system if you have a program trying to read the joysticks and/or mouse in the current active window.

Get/Put buffers are much faster on wide (horizontal images) than on narrow but tall ones.

Write & Read are a fair bit faster than WritLn & ReadLn, if you can substitute. Even in BASIC09, PUT is much faster than PRINT, even to the screen.

When writing programs, the number of system calls should be minimized. When optimizing some programs, the authors of NitroOS-9 discovered routines which performed a system call (ISWrite) for every character the program displayed. After adding a few lines of code to internally buffer the characters before outputting them, the program doubled in speed.

4.3 Writing NitroOS-9 Compatible Modules

The best reference for writing OS-9 user mode programs is the technical reference that comes included in the OS-9 manual. In addition, a good 6309 assembler reference, or a C language reference such as K&R will make writing programs much easier.

If you wish to modify an existing OS-9 kernel module to work with NitroOS-9, familiarity with 6809 assembly language is a must. The module may be disassembled, and labels added where necessary in order to verify that the disassembly in fact re-assembles identical to the original module. Care must be taken to add all system definitions (PD.OPT, V\$DESC, etc) where required. Failure to do so may result in unusual crashes, as NitroOS-9 contains some changes to these definitions. If an OS-9 defs file is used in place of a NitroOS-9 defs file, compatibility cannot be guaranteed.

Most modules, however, do not require extensive changes. Once a correct disassembly is produced, the module may simply be re-assembled with a NitroOS-9 'os9defs' file to produce the correct register stack offsets. The module may then be added to the system with the knowledge that it will work. Further optimizations may be performed as desired.

This method of converting OS-9 to NitroOS-9 modules is strongly recommended, as it is the one used by the authors of NitroOS-9.

Authors creating new applications will probably wish to use the stock OS-9 assembler. This will allow your applications to be used on stock system. There are some things that should be considered though, in order to maintain compatability with NitroS-9.

When writing new OS-9 programs, it is possible to write them in such a way as to assure compatibility with NitroS-9. The two conditions are that time-critical loops must depend on hardware and signals rather than software loops, and the register stack for interrupts should not be accessed. Simplistically, stay away from software timing loops and the F\$SSWI system call.

Software timing loops may be used, however, if care is taken to verify that the system is running NitroS-9. A copy of D.Native may be obtained from the system by using F\$CpyMem, and a non-zero value indicates NitroS-9 is running. This value may be checked before entering software timing loops, and a 6809 or 6309 loop counter can be chosen as appropriate.

The F\$SSWI system call should be avoided if at all possible. There are generally other, simpler, methods of performing internal subroutine calls.

5. Credits and Other Information

5.1 Credits

NitroS-9 v1.16 and earlier were primarily written by Curtis Boyle and Bill Nobel of Mustang Professional Software, with additional programming and production of the distribution package by Wes Gale of Gale Force Enterprises.

NitroS-9 v1.20 and higher were written by Curtis Boyle of Mustang Professional Software, and Alan DeKok of Intelligent Algorithms.

This manual was written by Colin McKay.

Thanks also go to the following individuals:

Wes Gale of Gale Force Enterprises for his contributions to earlier versions of NitroS9.

Bruce Isted: Cart IRQ toggle patches; improved interrupt handling, both in CC3IO and CLOCK, F\$PrsNam system call.

Kevin Darling: Improvements in GRFDRV which speed up the get/put buffers. Improved memory sensing in OS9p1. Improved SCF line editing. Patches for GrfDrv and VDGInt for use on systems with more than 512k of ram.

Ken Scales: Keytable patches for using CC3IO with DynaStar.

Doug Fraser: FRMEM utility, MMAP patch for use with up to 2MB of ram, RAM drive patches for use with 2MB upgrades.

Boisy Pitre: SCF non-sharable device patches.

Dave Wiens of Sardis Technologies: DMC no-halt floppy disk controller driver source.

Any other contributors who aren't mentioned here, but are mentioned in the release notes.

All the Beta testers: For all their generous quantities of patience and skill in testing NitroOS-9.

5.2 Copyright Notices

NitroOS-9 and the NitroOS-9 Reference Manual are Copyright
(C) 1994 by Mustang Professional Software

NitroOS-9 is a trademark of Mustang Professional Software
OS-9 is a trademark of Microware Systems Corporation
Color Computer 3 and CoCo are trademarks of Tandy Corporation
Tomcat and TC9 are trademarks of Frank Hogg Laboratories
PowerBoost is a trademark of Burke & Burke

NitroOS-9 is distributed by:

World: Northern Xposure	Australia: REMCOMS
7 Greenboro Cres	100 Whitsunday Dr
Ottawa, ON	KIRWAN. Qld.
Canada	4817
K1T 1W6	Australia
(613)736-0329	+61 77 734884

5.3 Warranty

The distributor warrants the product against defects in material or workmanship for a period of ninety days from the date of purchase by the original owner. This warranty is limited to repair or replacement of product which proves defective during this period.

This warranty specifically excludes software defects and defects caused by negligence, abuse, accident, and tampering.

If your disk becomes defective during this warranty period, mail it to the distributor (Section 5.7.2), postage paid. A new disk will be returned to you at the expense of the distributor. Disks that become defective outside this warranty period will be replaced for a \$5.00 handling charge.

5.4 License

This entire manual, any accompanying computer programs, and any accompanying storage media, constitute a product of Mustang Professional Software. The product is supplied for the personal use of the purchaser. One copy of this product must be purchased for every machine on which it is installed.

License is granted for the accompanying program to be copied onto the machine on which it is to be used, disks used on that machine, and to be backed up for archival purposes.

5.5 Disclaimer

Every effort has been made to ensure the accuracy of this manual and the quality of the product it describes. Mustang Professional Software makes no warranties, whether expressed, statutory, or implied, of any kind whatsoever as to the merchantability of the product or its fitness for a particular use, except as set forth above as the Warranty. Neither Mustang Professional Software nor the distributors are responsible for any loss or damage resulting from the use or misuse of NitroOS-9.

5.6 Upgrades

Upgrades to future releases of NitroOS-9 v1.xx, if and when they become available, will be offered for a handling charge. Upgrades will include an updated manual or manual pages, if appropriate. Registered users of NitroOS-9 will be notified by mail when upgrades become available.

NitroOS-9 v2.xx, if and when it becomes available, will be offered at a reduced cost to registered v1.xx owners. You will be notified by mail when v2.xx becomes available.

5.7 Support

NitroOS-9 has been designed to work with as wide a variety of hardware and software as possible, however some problems are inevitable in a project of this scope.

If you find a bug in NitroOS-9, software that is incompatible, or drivers that need "souped-up", please contact your distributor or any of the individuals listed in the next section for assistance.

5.7.1 Technical Assistance

Curtis Boyle: Mail: c/o Northern Xposure

Alan DeKok: Mail: c/o Northern Xposure
Internet: aland@physics.carleton.ca

Colin McKay: Mail: c/o Northern Xposure
Internet: cmckay@northx.isis.org
Fidonet: Colin McKay @ 1:163/306

Please include as much detail as is necessary to duplicate the problem, including module CRCs and hardware type if appropriate.

5.7.2 Order Assistance

For any problems with orders, defective disks or the manual, please contact your distributor at:

World: Northern Xposure	Australia: REMCOMS
7 Greenboro Cres	100 Whitsunday Dr
Ottawa, ON	KIRWAN. Qld.
Canada	4817
K1T 1W6	Australia
(613)736-0329	+61 77 734884
Tuesday, 8-11pm EST	
is the best time.	

Internet: cmckay@northx.isis.org
Fidonet : Colin McKay @ 1:163/306