FAST88

USER'S GUIDE

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Section 1 — Introduction to *Fast88*

Congratulations on the purchase of your new ***Fast88*** PC speed accelerator from **MicroSpeed**! ***Fast88*** can speed up program execution on your standard PC or PC-XT by up to 60%, allowing you to use it more efficiently ***Fast88*** enhances the performance of your computer, extends its useful life, and preserves compatibility with your existing investment in hardware and software.

This manual contains a ***Fast88*** product description, installation instructions, software considerations, applications information, troubleshooting information, and answers to common questions about ***Fast88*** If you will take a few minutes to read through it you should be able to install and use ***Fast88*** to maximum advantage.

1.1 Also Included With Your *Fast88*

In addition to this manual, your ***Fast88*** package includes: A) an up to date list of computers with which ***Fast88*** works (including any special installation requirements), B) a current list of software and hardware which have been found to have incompatibilities with ***Fast88***, C) your warranty registration card, D) a money back guarantee card, and E) any other important material we somehow didn't get into this manual. Please complete and send in the warranty card; save the rest of the materials with your manual and shipping box.

1.2 How To Use Your User's Manual

This manual contains information on installing and using ***Fast88*** Basic troubleshooting procedures are also included to allow you to diagnose and correct any problems you may encounter.

Section 1 Introduction to *Fast88*

The rest of this section contains a summary of the contents of the various parts of this manual so that you can become familiar with ***Fast88*** before you begin to use it. It also includes illustrations pointing out the important parts of ***Fast88*** so that you can easily identify them before you begin installation or use.

Section 2 How *Fast88* Works

Read **Section 2** to gain a general understanding of the functional parts of ***Fast88***, some background technical information on how it speeds up your computer, and what is included in your ***Fast88*** package.

Section 3 ***Fast88*** Installation

If you are installing ***Fast88*** on your own, **Section 3** contains the detailed, step by step instructions for installing ***Fast88*** in your computer and the instructions for testing your computer with ***Fast88*** to set the highest speed at which your system is capable of operating. It also includes step by step instructions for removing ***Fast88*** in the event you need to re-configure your system at a later time.

Section 4 Using ***Fast88***

Section 4 describes how to use ***Fast88*** to maximum advantage. It also discusses how ***Fast88*** interacts with software, possible anomalies you may encounter, what causes them, and what you can do about them.

Section 5 Accelerator Applications

Section 5 is primarily intended for users, dealers, OEMs, and VARs users who are evaluating accelerators for use with their systems. It contains some interesting information on PC acceleration and the advantages of using ***Fast88*** in accelerator applications. It also explains the features and benefits that users, dealers, and OEMs can expect from using ***Fast88*** in their applications.

Section 6 ***Fast88*** Trouble Shooting Guide

Hopefully you won't have any problems with ***Fast88***, but if you do, **Section 6** goes over some of the problems, the possible causes, and the ways in which you can correct or minimize them.

Section 7 ***Fast88*** Questions and Answers

Section 7 gives you answers to the questions we most commonly get about ***Fast88***.

Appendix A Specifications

This appendix contains ***Fast88's*** hardware specifications, including crystal frequencies, dimensions, weight, etc.

Appendix B Warranty statement

Read this appendix for information concerning service and **MicroSpeed**'s standard limited warranty.

Appendix C Parts List

This appendix contains a list of everything supplied with your ***Fast88*** unit. Check to make sure everything is present before beginning installation. If anything is missing, contact the dealer where you purchased the product.

Appendix D System Record

Use this table to keep track of DIP switch settings, ***Fast88*** module settings, and the type and access time of the individual RAM devices installed in your system motherboard and expansion cards. Table space is provided for up to 640K of RAM.

Index

Use the index for quick referencing of information when you need to know more about a specific subject.

1.3 *Fast88* Familiarization Figures

The following figures show the major components of your ***Fast88*** unit. **Figure 1-1** shows the ***Fast88*** circuit board itself. **Figure 1-2** shows the outline of an 8088-2 microprocessor with two different ways in which pin 1 of the device may be marked. **Figure 1-3** shows the ***Fast88*** external control module, and **Figure 1-4** shows the ***Fast88*** header cable used to connect the ***Fast88*** circuit board to the computer motherboard.

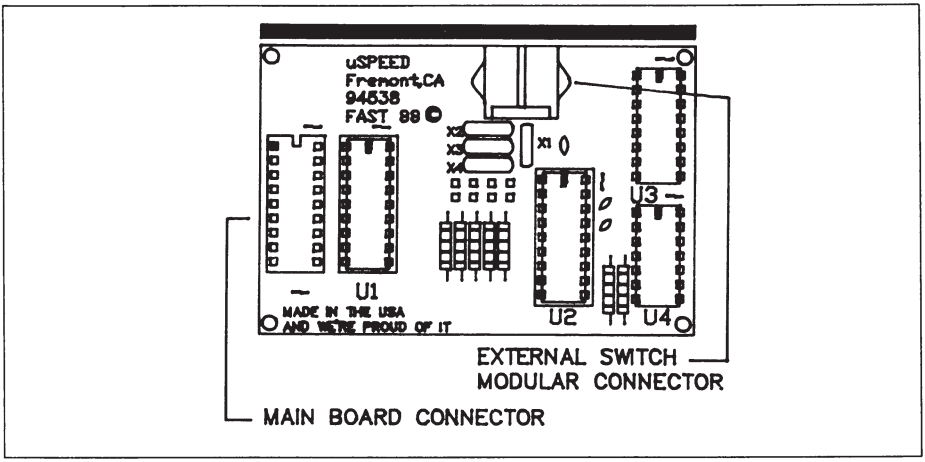


Figure 1-1. *Fast88* Circuit Board

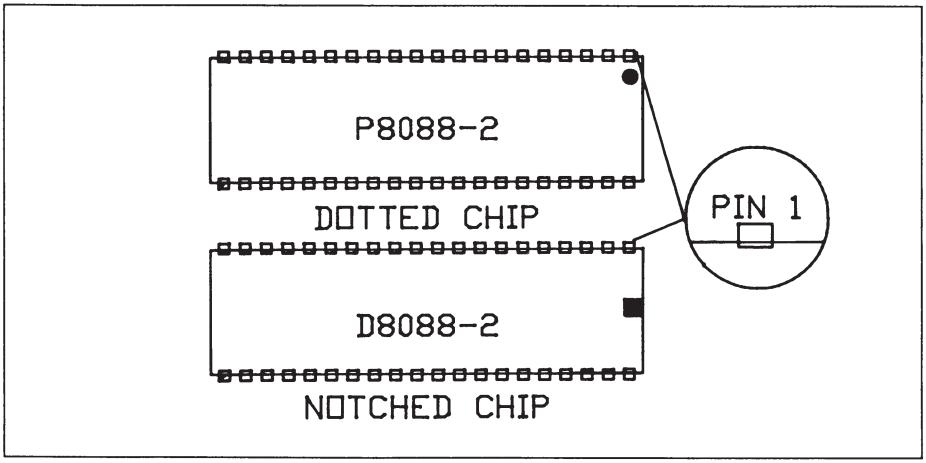


Figure 1-2. 8088 Devices with Pin 1 Markings

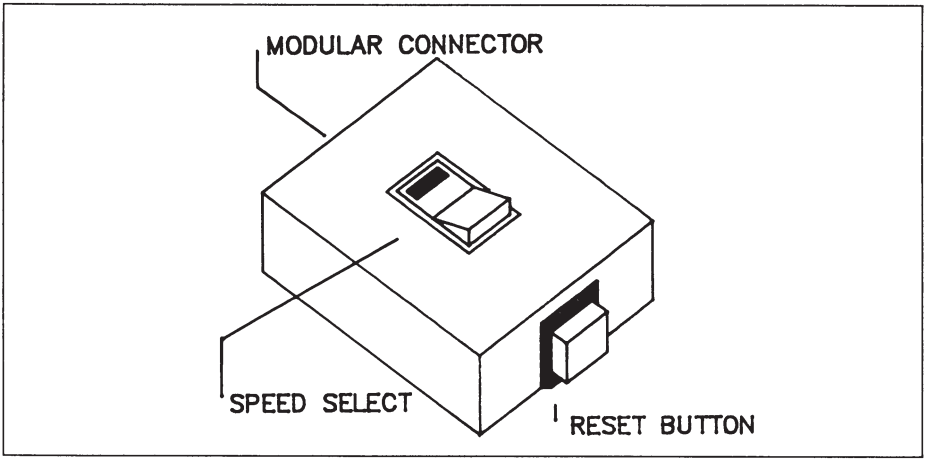


Figure 1-3. *Fast88* External Control Module

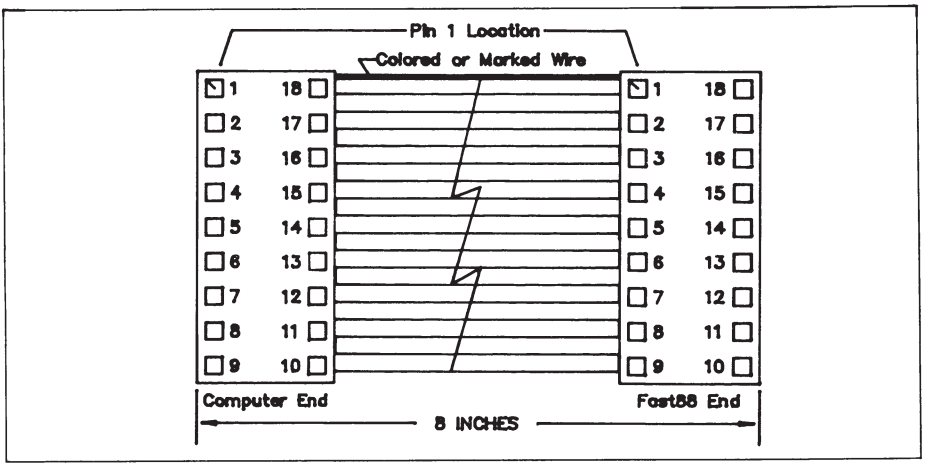


Figure 1-4. *Fast88* Header Cable Assembly

Section 2 — How *Fast88* Works

Fast88 increases the performance of a standard PC, PC/XT, or compatible computer by replacing its CPU with a higher speed 8088-2 (or optional NEC 70108D-8 V-20 enhanced CPU) and by selectively increasing the system's clock frequency ***Fast88*** is installed inside the cabinet of your PC and its external control module allows you to switch between the normal 4.77 Mhz system clock frequency and a selected higher frequency.

Functionally, the main sections of ***Fast88*** are:

8088-2 CPU chip (or optional 70108D-8 V-20 CPU chip)

The ***Fast88*** internal PC board attached to its mounting bracket

The external control module with high/low speed select switch, speed indicator, and computer reset button

A faster 8 Mhz capable 8088 or V-20 device is required because the 8088 CPU supplied in a standard PC is only rated for operation up to 5 Mhz. The ***Fast88*** board contains the clock logic, an oscillator with 3 slide on jumper selectable crystals for 6.1 Mhz, 6.7 Mhz, and 7.4 Mhz operation, an oscillator for 4.77 Mhz operation, clock synchronization logic, and reset logic; the reset button is enabled or disabled by a slide on jumper on the ***Fast88*** board for users who do not want external reset capability.

Three selectable high frequencies are provided because not all PC's are able to run at the highest frequency. The lower 6.14 Mhz frequency Mhz works on virtually all PC's, while the 7.4 Mhz high frequency is close to the practical limit for most standard production machines. (See **Section 5** for more information on the acceleration limitations inherent in the basic PC architecture.)

The key to ***Fast88***'s operation is its dual mode clock generator. In the normal PC, the 8284A oscillator runs at 14.31818 Mhz. This fundamental frequency is used to generate three separate clock signals. One, PCLK, is a divide by six, 2.3864 Mhz, 50% duty cycle clock used to drive the 8253 counter/timer and other standard "TTL" type logic in the PC. The second, CLK8088, is a divide by three, 4.7727 Mhz, 33% duty cycle "NMOS" clock used to drive the 8088, 8087, and their related logic. The third, OSC, is the buffered 14.31818 Mhz oscillator used by some expansion cards to generate other timing (for example, it is divided by four to produce the 3.579 Mhz color burst on color cards.)

In speeding up the PC, only CLK8088 should be increased. If PCLK is speeded up, internal timing is effected and the real time clock, file date stamping, and sound generator pitch will all go up too! If OSC is speeded up, some expansion cards may not work properly. The clock systems on many so called "turbo clones" and some PC

accelerators exhibit these problems. ***Fast88***'s clock generator has the two independent clocks required to properly speed up CLK8088 while leaving PCLK and OSC alone.

With two independent clocks operating in the system, clock synchronization must be provided to allow frequency changes while the computer is running; if this is not done correctly the processor will receive an incorrect clock cycle and hang up. In many two speed computers and accelerators this means that the system must be either powered down or re-booted to change speeds. On ***Fast88***, special logic is provided to allow speeds to be changed while the system is running (**NOTE:** even though logic is present for CPU clock synchronization, during program execution other hardware in the system may be using the clock for timing. Therefore, to avoid possible timing problems, it is only recommended that you change frequencies when the system is waiting for input at the command prompt.)

The ***Fast88*** board is mounted on the back panel of the computer using an aluminum bracket. This bracket has mounting holes and hardware for use with most popular computers; it can also be attached using double sided tape or RTV cement. The PC board is connected to the external control module by a 24", 4 wire modular phone cable. The external control module contains the high/low speed selection switch, the speed indicator, and the computer reset button. The module can be mounteanywhere it is convenient for user access during normal system operations.

In operation, the ***Fast88*** external control module is used to switch CPU speeds between the 4.77 Mhz standard speed and the user selected higher speed. An indicator on the module lights to show when the system is in the high speed mode. Pushing the reset button, if enabled, performs a hard reset on the system.

Section 3 — *Fast88* Installation

This section discusses installation of ***Fast88*** in your computer. If your ***Fast88*** was installed by an authorized dealer, you can skip this section. If you panic at the sight of computer innards, we recommend you skip this section and have your ***Fast88*** installed by an authorized dealer. If, on the other hand, you are a veteran power user, build your electronics projects from a kits, and in general have no fear of problems because you designed and built your computer from scratch anyway, get out your tools and go for it.

Like most of us, you probably fall somewhere in between these extremes; you can install an expansion card, are moderately comfortable working on your system, but are not quite sure whether or not you want to install ***Fast88*** yourself. In that case, read the entire installation procedure described in this section completely **before** making your decision or starting installation. In most cases, installing ***Fast88*** is no more difficult than installing a hard disk unit or an expansion card. In those occasional cases where it may be complicated, however, it's a lot easier (and less embarrassing!) to take a complete, still functional system to the installer than it is to carry in a partially installed mess created before changing your mind in the middle of installation. The basic rule here is: if you're not comfortable installing ***Fast88***, take it to an authorized dealer.

3.1 Installation Overview

Fast88 installs in the target computer by:

1. Replacing the standard 8088 device with either the faster 8088-2 or the 70108D-8 V-20 CPU device.
2. Replacing the standard 8284A clock chip in the PC with a header cable that connects to the ***Fast88*** board.
3. Plugging the modular cable between the ***Fast88*** back panel connector and the external control module.
4. Setting the correct high speed for your system.
5. Mounting the ***Fast88*** board to the inside of the back panel of your computer.

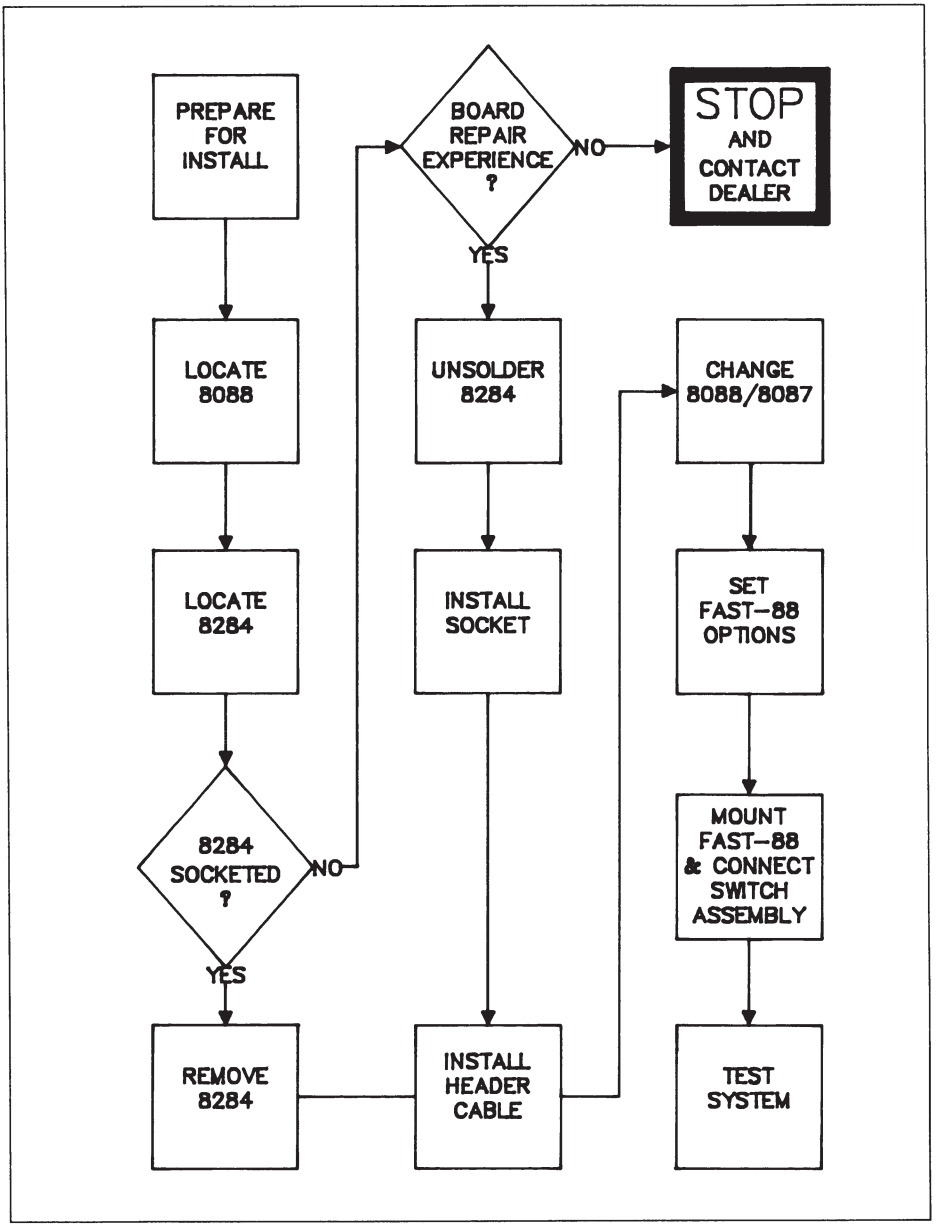


Figure 3-1. *Fast88* Installation Procedure Flow Chart

The ease of installation of ***Fast88*** is directly related to the type of computer in which it is installed. In computers which have the 8284A clock chip in a socket (this includes the majority of those from IBM, many domestic compatibles, and most foreign manufactured compatibles), ***Fast88*** can be easily installed in 10 - 20 minutes by practically any user. Installation of ***Fast88*** in computers which have the 8284A soldered in, on the other hand, should be attempted only by experienced power users or by authorized dealers equipped with the proper tools. **Figure 3-1** shows the overall flow chart for the complete installation and checkout procedure.

The following steps take you through the complete ***Fast88*** installation and set up procedure one step at a time. Read the **entire** procedure completely **before** you begin.

3.2 Initial Installation

The initial installation steps will help you get your ***Fast88*** installed and ready for system testing and speed selection.

Step 1 — Prepare for Installation

NOTE: We strongly recommend that you back up your hard disk and that you work with a backup copy of DOS when installing ***Fast88*** (or any other accessory you have not tested before).

Unplug the computer from the line cord. Remove cover from computer. Note the settings of all positions of computer DIP switches on the motherboard (you can record the DIP switch settings on the system record in **Appendix E**).

Step 2 — Locate 8088

The 8088 is a forty pin device in a plastic or ceramic package. **Figure 3-2** shows the location of the device on the standard IBM PC and PC-XT. The location is normally similar on other computers.

Step 3 — Locate 8284A

The 8284A is an eighteen pin device (normally in a ceramic package); the device label may be 8284, 8284A, or 8284A-1. **Figure 3-2** shows the location of the 8284A on the standard IBM PC and PC-XT. On other computers the location varies some, but it will always be located near the 8088.

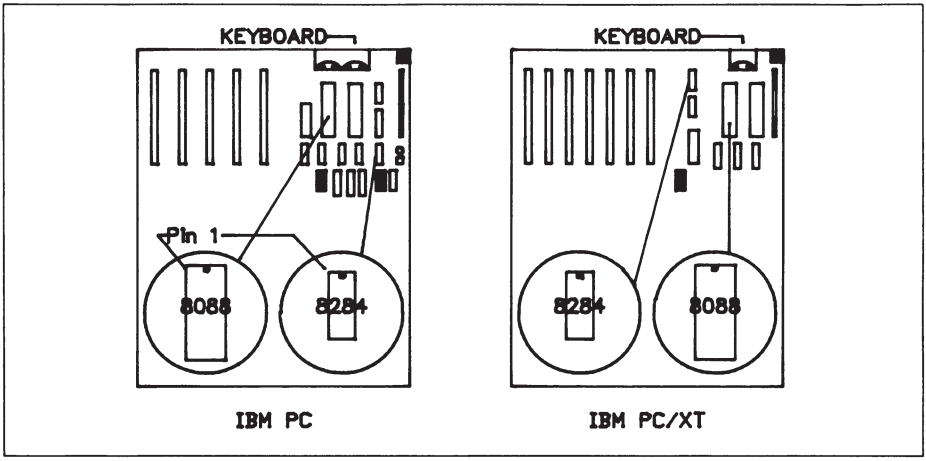


Figure 3-2. 8088 and 8284 Locations on PC and PC-XT

After locating the 8284A, determine if it is in a socket. This will be the case with most computers. If your 8284A is in a socket, proceed to **Step 4** of the installation procedure. If your 8284A is not in a socket, proceed to **Step 6** of the installation procedure.

Step 4 — Change 8088, 8087

NOTE: Prior to beginning this step, make sure you are properly grounded. Normally it will be sufficient to remove shoes with leather soles and simply touch the chassis with your hand to discharge any static buildup. After this, do not get up and walk around until after you have completed the 8088 change. Be particularly careful during dry weather.

NOTE: Before you change CPUs, see if your 8088 CPU is already an 8088-2 or an 8088-1. Many systems are shipped with higher speed devices installed. If one of these faster devices is already installed in your computer you may skip CPU replacement.

Using an IC removal tool, remove the 8088 from its socket, being careful to note the pin 1 orientation. This is the end of the CPU with a notch in it as shown in **Figure 1-2**; in PCs, PC-XTs, and most compatibles this will be the end of the 8088 closest to the back panel of the computer. Carefully install the 8088-2 (or the optional V-20 device) in the socket, being careful to match the pin 1 orientation of the original 8088. This is best done by lining up all 20 pins on one side of the device in the socket and then “rolling” the device down and in to seat the pins on the other side as shown in **Figure 3-3**.

NOTE: If your system has an 8087 numeric data processor installed, check to see if it is an 8087-2 device. If it is, you can leave it in. If it is not, you must either remove it or replace it with and 8087-2 to prevent system timing problems. If you need an 8087-2, they are normally available from your authorized ***Fast88*** dealer.

If you are installing an 8087-2 numeric data processor, install it now, following the same procedure you used for the 8088, and being careful that the pin 1 orientation of the 8087

matches the pin 1 orientation of the 8088.

Step 5 — Remove 8284, Install Header Cable

Using an IC removal tool, remove the 8284A from its socket, being careful to note the pin 1 orientation. Save the 8284A in a safe place in case you ever need to remove ***Fast88*** from your system.

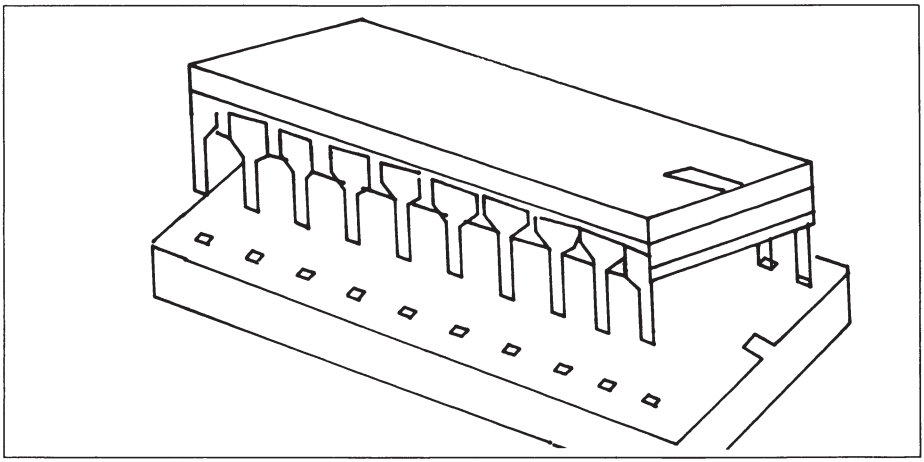


Figure 3-3. Installing IC into Socket

Plug the 18 pin header cable into the 18 pin socket, carefully to matching the pin 1 orientation of the 8284A just removed. The colored or marked wire on the outside edge of the cable is pin 1, and the cable should be oriented so that pin 1 of the cable header plugs into pin 1 of the socket; **Figure 1-4** shows the correct cable orientation. For now, leave the header cable sticking up from the computer motherboard.

NOTE: Please double check to make sure that the header cable is oriented properly; installing the cable backwards may damage your ***Fast88*** and void its warranty. Make sure that all pins are properly seated in the socket and that the pin 1 orientation is correct.

Please go to **Step 11** of the installation procedure at this time.

Step 6 — Disassemble System

NOTICE: This portion of the installation should only be attempted by personnel experienced with electronics assembly and board repair techniques and equipped with the proper electronics tools. This is a minor board modification but, like anything else, if you aren't familiar with the basic techniques you can get into trouble. Improper installation may damage your *Fast88* module and void its warranty. Refer installation to qualified service personnel if you are not experienced in this type of work.

Take precautions to verify that your work area is properly grounded and take all static

discharge precautions for working with MOS devices prior to beginning this step.

Disconnect all cables from expansion card connectors, then remove all expansion cards from the computer. Disconnect the keyboard from the computer keyboard connector. Remove the P8 and P9 power connectors from the edge of the computer board. Remove the board mounting hardware and remove the motherboard from the computer; on most computers you should not have to remove the floppy disk(s) or the hard disk unit to remove the motherboard.

Step 7 — Remove 8284A

Note the pin 1 orientation of the 8284A device. Not all boards have silkscreens, so it is important to note the proper device orientation for installation of the replacement socket.

Using a fine tip diagonal cutter, cut off all 18 pins of the 8284A as close as possible to the body of the device. Remove the device body Turn the board over. Carefully remove each pin from the board by heating it with a high quality electronics soldering iron, using a solder evacuation tool to remove the heated solder from the hole, and then pulling the pin out with a fine tipped needle nose pliers. After removing all 18 pins, clean the board area with braided solder remover and inspect the board to make sure there are no solder splashes creating hairline shorts between traces.

Step 8 — Install Socket and Header Cable

Get the 18 pin socket included with the installation materials. Install this socket in the position where the 8284A was removed, making sure the pin 1 orientation on the socket matches the pin 1 orientation noted in **Step 7** before the 8284A was removed. Solder all 18 pins of the socket to the board, using the minimum amount of solder (included with the installation materials) required to make a good joint. Visually inspect the board to make sure there are no solder splashes creating hairline shorts between traces.

Plug the 18 pin header cable into the 18 pin socket just installed. The colored or marked wire on the outside edge of the cable is pin 1, and the cable should be oriented so that pin 1 of the cable plugs into pin 1 of the socket; **Figure 1-4** shows the correct able orientation. Make sure the header cable feeds up so that when the motherboard is re-installed the cable will stick up from the motherboard.

Step 9 — Change 8088, 8087

NOTE: Before changing CPUs, see if your 8088 CPU is already an 8088-2 or an 8088-1. Many systems are shipped with higher speed devices installed. You may skip CPU replacement if one of these faster devices is already installed in your computer.

Using an IC removal tool, remove the 8088 from its socket, carefully noting the pin 1 orientation. This is the end of the CPU with a notch in it; in PCs, PC-XTs, and most compatibles this end of the CPU is closest to the back panel of the computer. Carefully install the 8088-2 (or optional V-20 device) in the socket, carefully matching the pin 1 orientation of the original 8088. This is best done by lining up all 20 pins on one side of the device in the socket and then “rolling” the device down and in to seat the pins on the other side as shown in **Figure 3-3**.

NOTE: If your system has an 8087 numeric data processor installed, check to see if it is

an 8087-2 device. If it is, you can leave it in. If it is not, you must either remove it or replace it with and 8087-2 to prevent system timing problems. If you need an 8087-2, it is available from your authorized ***Fast88*** dealer.

If you are installing an 8087-2 numeric data processor, install it now, following the same procedure as you used for the 8088, and being careful that the pin 1 orientation of the 8087 matches the pin 1 orientation of the 8088.

Step 10 — Re-Configure System

Re-install the motherboard in the cabinet. Reconnect the P8 and P9 power connectors (P8 is closest to the back panel). Re-connect the keyboard, re-install the expansion cards, and re-connect the cables to the expansion card connectors. Make sure the 18 pin header cable is still connected and sticking up from the motherboard.

Step 11 — Connect Header Cable

Hold the ***Fast88*** board component side up so that the empty header socket is on your left (toward the expansion card cage). Plug the loose end of the header cable into the header socket, making sure all 18 pins are properly seated and observing the pin 1 orientation as shown in **Figure 3-4**.

Step 12 — Set *Fast88* Options

Fast88 is shipped from the factory with the high frequency set for 6.14 Mhz and with the external reset function enabled. If you have used ***Fast88*** before on a similar system and know it to work at higher speed, select that speed now. Otherwise, leave the speed selection alone for now.

If you do not want the external reset button enabled, remove the reset jumper from the board as shown in **Figure 3-5**.

Step 13 — Connect External Control Module

Plug one end of the modular cable included with ***Fast88*** into the connector on the back panel. Plug the other end into the connector on the ***Fast88*** external control module.

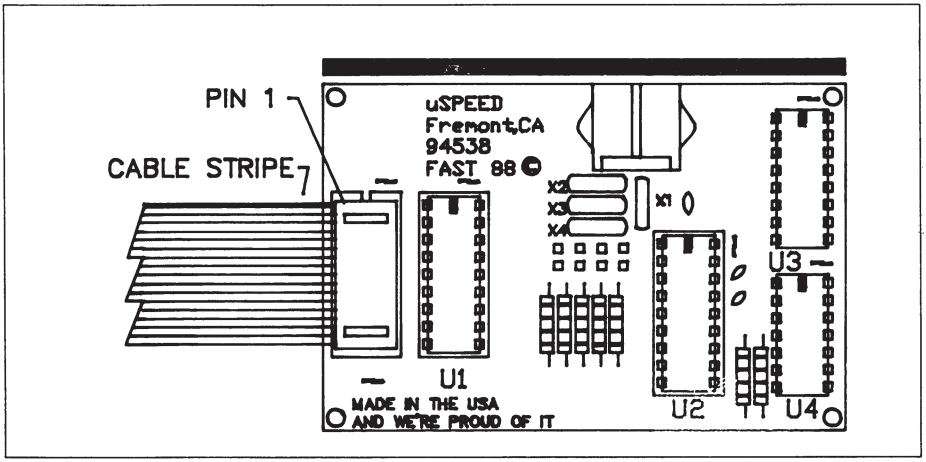


Figure 3-4. *Fast88* Header Cable Orientation

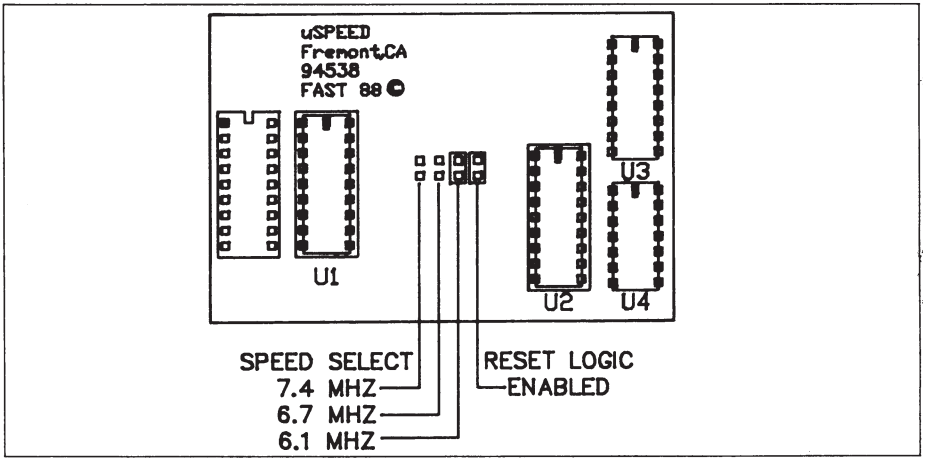


Figure 3-5. *Fast88* Option Settings

Step 14 — Work Check

With the cover still off the computer, check to make sure that all cables are properly connected and that the motherboard DIP switches are set correctly Also check to make sure that the 8088-2 and 8087-2 (if installed) are properly oriented and that the ***Fast88*** header cable is properly oriented and connected.

This completes the initial portion of ***Fast88*** installation. We will now perform speed selection before actually mounting ***Fast88*** to your back panel. Make sure the ***Fast88*** circuit board does not contact the chassis or any active circuitry of the computer during

speed selection.

3.3 *Fast88* Setup, Testing, and Speed Selection

Fast88 is shipped from the factory ready to run at 6.14 Mhz. We have found virtually all computers can be speeded up to this clock rate. Most will also run at 6.7 Mhz, and many newer units run well at 7.4 Mhz. T?øo select the best frequency requires that you perform a couple of simple system tests.

3.3.1 Initial Checkout

With the cover still off the computer, re-connect your system to the line cord. Before powering up, check one last time to make sure that the CPU, 8087-2 (if installed), and the ***Fast88*** header cable are all properly installed.

Set the external control module speed select switch for low speed (off). Turn on your computer. The indicator on the external control module should be off. Your computer should boot normally. If it does not, see Section 6.

With the system booted up and waiting at the system command prompt (normally "A" for floppy disk systems, normally "C" for hard disk systems) switch the ***Fast88*** module to high speed (on). The indicator in your control module should now come on. If the indicator does not come on, see **Section 6**.

NOTE: We normally recommend that you boot your system with ***Fast88*** off and that you switch it to high speed after boot up is completed. The reason for this is that some systems display error messages during bootup that would seem to indicate an error condition, when in reality the error only occurs on boot up and is due to the boot routine on a disk controller or a device driver in ROM. After the system is booted it will work fine at higher speed. After checkout shows that your system is running properly at high speed, you may want to see if your system will boot up properly at high speed. If it boots correctly without displaying any error messages, it is perfectly acceptable to leave ***Fast88*** on high speed and boot the system at high speed for normal use.

With the system booted and sitting at the command prompt and still in high speed mode, execute the command:

```
DIR *.*/P
```

This command should list all files on your disk, pausing after every full screen. If this does not happen, see **Section 6**.

Get out your **DOS** disk which contains **BASIC**. This can be **BASIC**, **BASICA**, **GW BASIC**, or any other **BASIC** supplied with your computer. Run **BASIC** and enter the following simple program:

```
10 CLS
20 TIMES = "00:00:00"
30 FOR N = 1 TO 10000
40 IF MID$(TIME$,7,2) = "29" THEN 100
50 NEXT N
100 PRINT "Passes = ";N
110 STOP
```

After entering the program, execute the command:

```
SAVE "SETUP1"
```

to save the program under the file name **"SETUP1";** you will need it again later to check out higher ***Fast88*** speed settings. Switch ***Fast88*** to low speed. The indicator on the control module should go off. Enter **RUN** to run the program. After 30 seconds or so the program should stop and print out the number of loop passes; with **BASICA** this will be around 4000, with minor variations for other versions of **BASIC**. Now switch ***Fast88*** to high speed. The indicator on the control module should come on. Run the program again. This time the program should print out a number of passes equal to approx. 1.3 times the low speed number; for **BASICA** this will be around 5200.

Now test the reset logic. Switch ***Fast88*** to low speed. Press the reset button. If you have the reset logic enabled, pressing reset should cause the system to re-boot. (Remember, this is a hard reset; most computers will go through the full memory test and system initialization, just like on power up.) If you disabled the reset logic by removing the jumper, pressing the reset button should have no effect. If reset does not operate as described, refer to **Section 6**.

If these tests execute correctly, the odds are very good that your ***Fast88*** is operating properly with 4.77 Mhz and 6.14 Mhz as the low and high system clock speeds. As an optional test, with ***Fast88*** at high speed use **COPY** with verify **OFF** to copy a large data file to a floppy disk. Now use **COMP** to compare the copy to the original. In comparing the files, the system will fill memory from one file and compare it to the other; with a large file this will test most of the RAM in your system. For example, if your data file is A:TEST.DAT, the commands:

```
COPY TEST.DAT B:
COMP TEST.DAT B:
```

will make the copy and perform the test.

Now that you have verified that the basic operation of your ***Fast88*** is correct, the following sections will help you determine if you can get even more performance out of your system. After you complete speed selection record your ***Fast88*** settings in the system record in **Appendix E**, and proceed to **Section 3.4** to complete installation of ***Fast88*** in your system.

3.3.2 Checking Out Higher Speeds

The limits on PC speed are typically related to memory timing. Problems can be caused by slow devices, bad memory timing design, or a combination of the two. The PC's own RAMs, ROMs, EPROMs, and DMA controller, and peripheral card RAMs, ROMs and EPROMs can all cause problems if their timing requirements are violated.

The first thing to inspect is your system RAM, including RAM on any expansion cards you use. The lowest speed RAM in the system will determine the maximum safe speed for the system, so look at all of them. Use the system record in **Appendix D** to record the type and access times of all RAM in your system.

The tops of the RAMs will indicate the access times of the devices. RAMs with designations like "4164-25" are 250 nSec. access time devices. RAMs with designations like

"4164-2" or "4564-20" are 200 nSec. access time devices. RAMs with designations like "4164-15" are 150 nSec. access time devices.

Assuming everything else in the system is capable of high speed operation, we've found that systems with 250 nSec. RAM always work at 6.14 Mhz and usually work at 6.7 Mhz; systems with 200 nSec. RAM always work at 6.7 Mhz and usually work at 7.4 Mhz; and systems with 150 nSec. RAM work at 7.4 Mhz. While not absolute, these are good guidelines.

If your system RAM is socketed, you may want to install faster 150 nSec. RAM to increase system performance. These are available from most electronics distributors; simply remove the old RAMs from their sockets and replace them with the faster devices. Note, however, that on many PCs the first 64K page of RAM is soldered into the board; changing these devices may require shop work.

The ROMs and EPROMs on the main board of the IBM PC and PC-XT typically cause fewer speed problems because these computers have wait state generators for ROM accesses. Some compatibles omit this logic, however, so the ROM must be as fast as the RAM to ensure proper operation at higher speed. Also, the EPROMs and ROMs on many expansion cards do not have wait states and they need to be fast to ensure proper operation.

As with RAMs, ROMs and EPROMs can be speeded up. Faster devices are available, and most distributors can copy the contents of your devices into pin compatible replacements for the ones that came with your system.

To test your system at the 6.7 Mhz intermediate speed, first power down your computer. Now move the ***Fast88*** slide on speed select jumper from 6.14 Mhz to 6.7 Mhz as shown in **Figure 3-5**. Set the external control module speed select switch for low speed (off). Turn on your computer. The indicator on the external control module should be off. Your computer should boot normally.

With the system booted and sitting at the command prompt, switch ***Fast88*** to high speed (on), then execute the command:

```
DIR *.*/P
```

to list all files on your disk, pausing after every full screen. If this does not happen, and it worked properly at 6.1 Mhz, there is probably some sort of fundamental system hardware speed limitation. The best plan would probably be to set the system to 6.1 Mhz and use it at that speed.

Run **BASIC** and execute the command:

```
LOAD "SETUP1"
```

to load the program you created and saved during the initial setup. With ***Fast88*** still at high speed, run the program. After about 30 seconds, the program should print out a number of passes equal to approx. 1.45 times the low speed number; for **BASICA** this will be around 5800.

If the program ran correctly with no system error messages, your system is probably running correctly at a 6.7 Mhz high speed. As an optional test, with ***Fast88*** at high

speed run the **COMP** program test with the data file as described in **Section 3.3.1** to test most of the RAM in your system.

Finally, to test your system at the 7.4 Mhz highest speed, first power do2wn your computer. Now move the ***Fast88*** slide on speed select jumper from 6.7 Mhz to 7.4 Mhz as shown in **Figure 3-5**. Set the external control module speed select switch for low speed (off). Turn on your computer. The indicator on the external control module should be off. Your computer should boot normally as it did before.

With the system booted and sitting at the command prompt, switch ***Fast88*** to high speed (on), then execute the command:

```
DIR *.*/P
```

to list all files on your disk, pausing after every full screen. If this does not happen, and it worked properly at the 6.7 Mhz, there is probably some sort of fundamental system hardware speed limitation. The best plan would probably be to set the system to 6.7 Mhz and use it at that speed.

Run **BASIC** and execute the command:

```
LOAD "SETUP1"
```

to load the program you saved during the initial setup. With ***Fast88*** still in high speed, run the program. After about 30 seconds, the program should print out a number of passes equal to approx 1.6 times the low speed number; for **BASICA** this will be around 6400.

If the program ran correctly with no system error messages, it is probable that your system will run correctly with 7.4 Mhz as its high speed. As an optional test, with ***Fast88*** at high speed run the **COMP** program test with the data file as described in **Section 3.3.1**. This will test most of the RAM in your system.

3.4 Final Installation

Now that ***Fast88*** is tested and speed selected we will complete the installation so you can get back to using your computer.

Step 15 — Mount *Fast88* Board to Back Panel

Your ***Fast88*** board is shipped attached to its universal mounting bracket. This bracket is drilled for attachment in a number of ways. The following paragraphs discuss mounting in most common applications; special mounting adapters may be required for other models of computer.

Standard IBM PC

Detach the external control module from the modular cable. In the back panel of the PC there is a hole filled by a plastic plug. Remove the plug. Thread the loose end of the modular cable out through the hole and mount the bracket in the hole using spacers as shown in **Figure 3-6**.

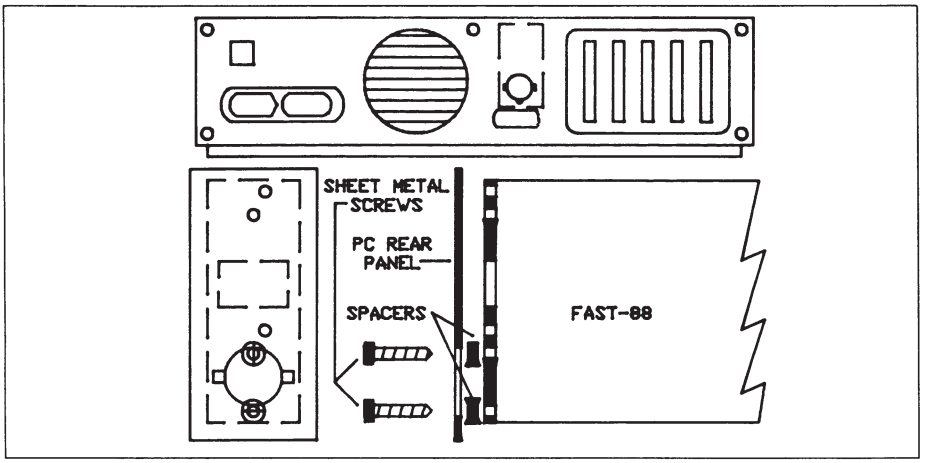


Figure 3-6. *Fast88* Installation in Standard PC

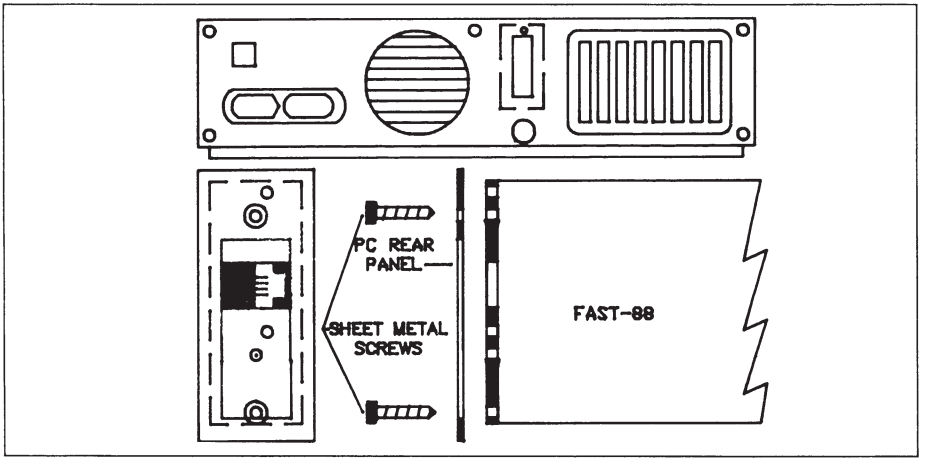


Figure 3-7. *Fast88* Installation in Standard PC-XT

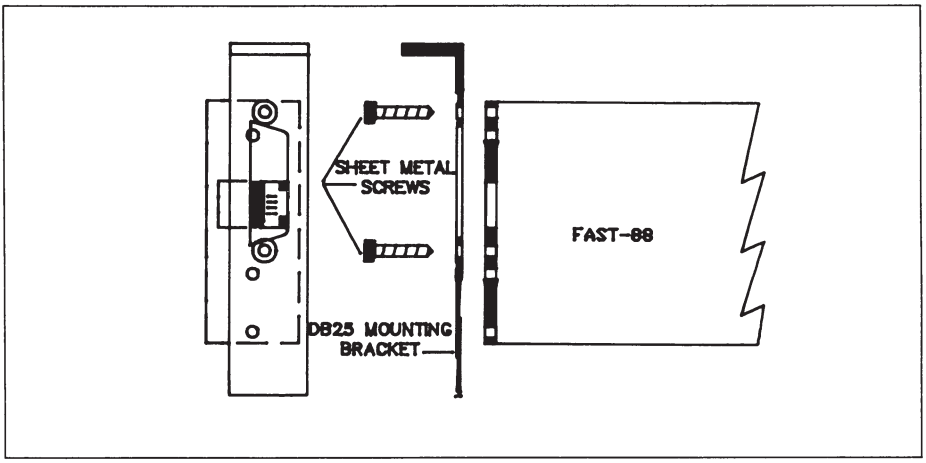


Figure 3-8. *Fast88* Installation in DB-25 Mounting Hole

Standard IBM PC-XT

Disconnect the modular cable at the ***Fast88*** board end. In the center of the back panel of the PC-XT there is a removable bracket. Remove the bracket and mount the ***Fast88*** bracket in the hole using a #6 screw as shown in **Figure 3-7**. Re-connect the modular cable to the ***Fast88*** connector through the back panel.

Compatible with DB-25 Mounting Hole in Back Panel

Disconnect the modular cable at the ***Fast88*** board end. In many compatible computers the back panel has extra DB-25 connector drill patterns for mounting RS-232C communication connectors; also, many users have extra expansion card mounting brackets which are drilled for DB-25 connector mounting. To mount ***Fast88*** in a DB-25 bracket or hole, align the ***Fast88*** mounting bracket in the DB-25 connector hole opening in the back panel of the computer. Secure in place with two #6 screws as shown in **Figure 3-8**. Re-connect the modular cable to the ***Fast88*** connector through the back panel.

Step 16 — Complete Installation

After making a final check of all cable connections and positions, replace the cover on your computer.

If you plan to have the external control module stand alone, mount the four mounting feet on the four corners of the module. If you want to mount it to your computer cabinet, use the included double sided tape.

Installation of your ***Fast88*** unit is now complete. Read **Section 4** for instructions on using ***Fast88*** in your day to day operations.

3.5 *Fast88* Removal

Unlike installation, removal of ***Fast88*** does not effect the CPU, and never requires any soldering. The procedure is similar for all computers.

Step 1 — Prepare for Removal

Unplug the computer from the line cord. Remove cover from computer. Note the positions of all computer DIP switches on the motherboard.

Step 2 — Remove the *Fast88* Board

Disconnect the modular cable, remove the mounting hardware, disconnect the header cable, and remove the ***Fast88*** board from the computer.

Step 3 — Remove Header Cable, Re-install 8284A

Gently remove the header cable from the ***Fast88*** board. Re-install the 8284A you saved (you did save it didn't you!) in the socket, being careful to observe proper pin 1 orientation. If your 8284A was destroyed during installation, check your local dealer or write **MicroSpeed** and we'll send you a replacement.

Step 4 — Complete Removal

Check to make sure all DIP switches on the motherboard are in the same position they were in prior to the removal. Replace the cover on the computer. Plug the computer back into the line cord.

Section 4 — Using *Fast88*

For the most part, ***Fast88*** is a transparent, trouble free addition to any computer system. There are, however, some areas of operation that need to be mentioned so that you can avoid any surprises.

4.1 Normal System Operation

In most cases, using a computer equipped with ***Fast88*** is a simple task. The number of speed changes required is typically minimal, and can be easily accommodated by using the external control module. The following sections describe some of the most common system operations and how ***Fast88*** is used with them.

4.1.1 System Boot Operation

We recommend that you boot the system with ***Fast88*** off, then switch to high speed after the system has completed its bootup procedure. As we mentioned earlier, the reason for this is that some systems display error messages during bootup that would seem to indicate an error condition, when in reality the error only occurs on boot up and is due to the boot routine on a disk controller or a device driver in ROM. If experimentation shows that your system is working fine and boots properly at high speed, it is perfectly acceptable to leave ***Fast88*** on high speed all the time and to boot the system at high speed for normal use.

4.1.2 Changing Speeds

Since most operations simply run faster with ***Fast88***, you will often go through entire sessions without changing speeds at all. When you do need to change speeds, we recommend that you only change when the system is waiting for input, not while it is actually executing a program. This is being really conservative (we're all engineers by background), and we have changed speed hundreds of times in the middle of program execution—including disk accesses to floppy and hard disks—with no problems. Still, there is really no good reason to ever need to change speed in the middle of a program and, since CPU clocks can be a bit finicky, why take any chances?

4.2 Programs Requiring Low Speed

Some programs utilize software timing in such a way that they cannot run at higher speed. These programs must be run with ***Fast88*** at low speed, or at least loaded at low speed and switched to high speed once they are running. Included with your ***Fast88*** is a listing of applications programs which have been reported to us as having some problems running at high speed; the list will have been current as of the date your

Fast88 was shipped. If in the future you want a current list, send us a note with a self addressed stamped envelope and we'll send you the current list.

4.2.1 DOS Programs Which Require Low Speed

Several of the basic **DOS** programs must always be run with ***Fast88*** off. This is because they use software timing loops embedded in the BIOS ROM of the system. They will not work correctly with any accelerator which speeds up the system 8088. To run the programs simply turn ***Fast88*** off before execution of the command and then back on when the command is completed. The **DOS** commands which require the system at low speed are:

FORMAT
DISKCOPY

In addition, in some systems the **COPY** command may not work when copying to floppy disks with the verify option selected—either by a **/V** in the command or by execution of a **VERIFY ON** command. In these systems **COPY** with verify must be run at low speed; **COPY** without verify should run properly at high speed.

Also, the **DISKCOMP** command in **DOS** 3.1 and later must be run at low speed. It works correctly at high speed in **DOS** 2.1 and **DOS** 3.0.

Another group of standard routines which are internal timing intensive are the standard IBM system diagnostics routines. These routines have a large number of hardware timed tests and they must be run at low speed on most systems.

If you accidentally try to run these commands at high speed the failure modes encountered are benign and non-destructive—ie. no damage to any system files or data. Simply switch ***Fast88*** to low speed and the commands will operate correctly.

4.2.2 Other Programs Which May Require Low Speed

Some programs which use internal software timing loops may not work properly with ***Fast88*** at the high speed. In particular, some copy protection schemes and the programs designed to circumvent them will often fail. In these cases, run the system at low speed until the copy protection has verified the key disk then switch to high speed to run the program.

Game programs which use software timing loops may become impossible to play at higher speed. In these cases either select a lower difficulty level or run the system at low speed.

If you discover a program that behaves incorrectly at high speed, please call or drop us a line so that we can add it to our current sheet of programs. The first person to report a new bonafide speed problem will be credited with the find when the new edition of the sheet is published.

NOTE: The V-20 processor has been reported to have compatibility problems with some programs. In these cases the program will probably not run correctly even at low speed. If your program worked before at 4.77 Mhz and will not run with a V-20 at 4.77 Mhz it is probably the V-20 ad not ***Fast88*** causing the problem. In that case, you will be better

off changing to an 8088-2 and using ***Fast88***, as its performance even at 6.1 Mhz far exceeds that of the V-20 at 4.77 Mhz.

4.3 Automating *Fast88* Speed Changes

DOS batch files can be used to make it easier to remember to change ***Fast88*** speeds. For example, if your system boots on low speed, you will want to switch ***Fast88*** to high speed after boot. This can be made easier by adding the following statement to the end of your AUTOEXEC.BAT file:

```
PAUSE Boot Complete. Switch Fast88 to high speed now
```

A similar approach can be used to remind you to change ***Fast88*** back to low speed before running a program that does not run properly at high speed. For example, the **DOS FORMAT** program must be run at low speed. First, with ***Fast88*** at low speed, use the following command to make a copy of your **DOS FORMAT** program:

```
COPY FORMAT.COM FORMATF.COM/V
```

Next, use your editor to create the following **FORMAT.BAT** file which will prompt you to switch to low speed before proceeding with the **FORMAT** operation:

```
ECHO OFF
ECHO Switch Fast88 to low speed before proceeding with FORMAT
PAUSE
FORMATF %1
ECHO FORMAT Complete. Switch Fast88 back to high speed now.
PAUSE
```

Similarly, to make a batch version of **DISKCOPY**, with ***Fast88*** at low speed, use the following command to make a copy of your **DOS DISKCOPY** program:

```
COPY DISKCOPY.COM DISKCOPY.COM/V
```

Next, use your editor to create the following **DISKCOPY.BAT** file which will prompt you to switch to low speed before proceeding with the **DISKCOPY** operation:

```
ECHO OFF
ECHO Switch Fast88 to low speed before proceeding with DISKCOPY
PAUSE
DISKCOPF %1 %2
ECHO DISKCOPY Complete. Switch Fast88 back to high speed now.
PAUSE
```

The same approach can be used to create auto prompting batch files for use with any program that must be run with ***Fast88*** at low speed.

Section 5 — Accelerator Applications

PC accelerators offer users significant advantages in a number of applications areas. To a large extent these advantages are dependent upon the fundamental PC architecture, the actual system speed obtainable, the amount of I/O required by the application, the choice of CPU, and the availability of the numeric data processor.

These considerations are significant to users, dealers, and OEMs/VARs. Understanding where and how an accelerator can (and can't) help will increase the effectiveness o accelerating in the user's target application. The following sections discuss the implications of some of these issues in various computer application areas. They also discuss the significant limitations on how much any accelerator can increase PC performance. The last section also presents some of the general features and benefits of ***Fast88*** for end users.

5.1 PC Architecture

The basic architecture of the IBM PC type computer imposes one of the most significant limitations on how much performance any accelerator can deliver. The basic system is constructed around the 8088 CPU architecture, and no matter what goes on on the accelerator basic disk I/O, display I/O, communications, and so on must all take place via the PC's inherent resources. Thus the PC itself presents the most insurmountable obstacle to increasing its own performance.

Probably the largest bottle neck is floppy disk I/O, with the eight bit internal memory bus structure constraints on data transfers a close second. Another major bottle neck is getting data into (and out of) the display RAM.

Accelerators which add increased logic, higher performance CPUs, and wider local memory circumvent the architecture problems to some extent, but it is often at the expense of software difficulties and greatly increased cost. With the rapid decline in the price of AT type computers with inherently higher performance it becomes increasingly difficult to justify a high accelerator price in trying to force up the performance of the slower machine.

Some accelerator manufacturers would have you believe that plugging an accelerator board into a standard PC makes it as fast as a PC-AT. A careful choice of benchmarks can even make it look to be the case. Overall, however, the AT is a machine designed to be fast, while the PC is being forced into it. In terms of usable, day to day, high performance we have rarely seen a PC with any accelerator compare to the standard 6 Mhz AT, and with a speeded up 8 Mhz AT it is no contest at all.

Here at **MicroSpeed** our attitude is that if you need an AT's performance, buy an AT, don't

stuff a bunch of patches into a PC or a PC-XT. The machines fulfill different functions and we see no reason for the PCs and PC-XTs to apologize for their limitations; they cost a lot less. The strategy we have adopted is to get the most out of the PC or PC-XT inherent capabilities at a minimum cost. We don't claim to offer the highest absolute performance; we do claim to be among the best at delivering usable performance increase per dollar spent.

5.2 System Speed

Not all PCs are created equal. In particular, some of the older units have slow RAM and ROM. These devices, along with the CPU speed limitations, place constraints upon how much an internal product like ***Fast88*** can speed up computer operation.

Fast88 is supplied with an 8 Mhz CPU and you may have wondered why we chose 7.4 Mhz (as opposed to 8 Mhz) as the top speed. It comes down to two things: RAM speed and CPU architecture.

The RAM speed constraint comes from leaving adequate timing margin for commonly available RAM devices. Our three frequencies were selected to meet the timing requirements of systems with 250 nSec., 200 nSec., and 150 nSec. access time RAMs. The 6.1 Mhz, 6.7 Mhz, and 7.4 Mhz speeds enable us to insure reliable operation with these standard RAM types.

The CPU architecture constraint comes from using the 8087-2 numeric data processor with an 8 Mhz V-20. The V-20 is a CMOS processor which uses a 50% duty cycle clock. 8086/8087/8088 family devices are NMOS parts which use a 33% duty cycle clock. Without going into great and grisly timing detail, about the highest frequency that keeps both the 8087-2 and the V-20 happy is around 7.4 Mhz. Because of the clock duty cycle mis-match it turns out that to run an 8087-2 at the full 8 Mhz will often require a 10 Mhz V-20. (**Note:** for a fine overview article on using the NEC V-20 and V-30 devices in a variety of PC environments, see the excellent article by Stephen R. Davis in the December 24, 1985 issue of PC magazine.)

5.3 Application I/O Requirements

An absolute limitation on the performance increase any accelerator can offer is the amount of disk I/O required during program execution. Floppy disks are by far the biggest bottle neck, but some hard disk implementations are really not much better. Graphics display cards, particularly color cards, are also a major source of system overhead.

If an application requires a high amount of disk I/O (data base programs like dBASE II, dBASE III, and R:base 5000 are notorious disk accessors) the performance of all accelerators drops noticeably.

Interestingly enough, ***Fast88*** actually outdoes some of the much more expensive accelerators in disk and I/O intensive operations. This is because many of the accelerators do all I/O via the "native" 8088 running at an unmodified 4.77 Mhz. These offer no increase in the speed of actual I/O operations. ***Fast88*** because it speeds up native code execution, speeds up execution of I/O operations. Unfortunately, this same speed

up occasionally leads to difficulties with software timed code - as usual, there is no such thing as a free lunch.

Another interesting fact is that ***Fast88*** can actually offer more of a performance increase than the simple clock rate increase would indicate. This is because some of the PC's real time I/O interrupts intrude on foreground tasks a fixed number of times per second. ***Fast88*** speeds up processing of these interrupts and frees up CPU time for other activities.

For example, an interrupt that occurs 120 times/second and takes 1 mSec. to service at 4.77 Mhz loads the system at 120 * 1 mSec. = 120 mSec/sec. or about 12%. With ***Fast88*** at 7.4 Mhz, the interrupt rate remains the same, but the service time drops to 0.63 mSec. and loading drops to 120 * 0.63 mSec. = 75 mSec/sec. or about 7.5%; an additional 4.5% of the computer's total time is now available for your foreground tasks.

Since the magnitude of this benefit varies somewhat depending upon the real time content of what the computer is doing, our conservative engineers stopped the marketing guys from claiming this extra performance increase in our data sheets. In some cases, however, it can add up to a significant performance increase above the indicated clock rate increase. It is also a performance increase that most 80286 accelerators can't offer.

5.4 Choice of CPU

The significance of the CPU (standard 8088 vs V-20 type device) is strongly dependent upon application requirements. Right now, let's cut through all the BS about the V-20. In normal use, running at the same clock rate, a V-20 is around 4-5% faster than an 8088—its really no big deal. The increase comes from a newer, more complex device design with a better instruction pre-fetch algorithm, more efficient effective memory address computation, and a better ALU with hardware integer multiply and divide capability.

In some cases, however, these relatively minor differences can become very significant, particularly the integer arithmetic operations. The V-20 uses a hardware ALU, where the 8088 uses microcoded algorithms. In integer arithmetic intensive applications this makes a big difference. Also, the better pre-fetch algorithms and faster effective memory address computation make V-20s more efficient than 8088s in badly fragmented programs which jump around a lot.

It turns out that the popular Norton Utilities SysInfo test is highly sensitive to the V-20's differences; at 7.4 Mhz its rating of 2.8 (compared to the stock PC's rating of 1.0) is far in excess of the actual performance seen in real applications. Unfortunately, this 2.8 SysInfo rating has resulted in outrageous claims for the V-20 in some mail order ads. A similar sensitivity is found with the 80286 used in the PC-AT and some other accelerators. The AT's 5.9 SysInfo rating, for example, significantly exceeds its useable performance increase over a normal PC or PC-XT.

Overall, as a general purpose speed upgrade, we've found the V-20 to be pretty underwhelming. Even a standard 8088-2 using ***Fast88*** at 6.1 Mhz is faster than a 4.77 Mhz V-20 in usable performance. The 8 Mhz V-20s we supply work fine at higher speeds, but if you're considering it for several systems check out your application to see if they're

worth the extra cost. Also, as noted earlier, there are some potential software and hardware compatibility problems with the V-20. (Again Note: for reference data on the V-20, see Stephen R. Davis's article in the December 24, 1985 issue of PC magazine.)

5.5 Numeric Data Processor Availability

The 8087-2 numeric data processor (NDP) is an absolute number crunching terror in applications designed to support it. While 8087 support was initially slow in coming, it is much more common now and it is rapidly becoming standard on all spreadsheets and language processors.

An interesting fact is that a ***Fast88*** equipped PC with an 8087-2 running at 7.4 Mhz gives a PC-AT with an 80287 a real run for its money. The PC's 8087-2 and 8088-2 both run at 7.4 Mhz, while the standard PC-AT's 80286 and 80287 run at 6 Mhz and 3 Mhz respectively. Thus on a percentage basis the 8087 increases the 8088's performance far more than the 80287 increases the 80286's performance. (An excellent reference on the 8087/80287 is presented by Stephen R. Freid in the Fall 1985 Special IBM PC issue of Byte magazine.)

If your application has any possibility of requiring extensive arithmetic, you should not consider any accelerator which cannot support a numeric data processor. A key ***Fast88*** design consideration was complete compatibility with the 8087-2.

5.6 *Fast88* User Features and Benefits

Previous sections discussed some of the boundaries of where accelerators are and are not effective. In most cases ***Fast88*** offers you significant advantages in all system operations. Accelerators fall far short of being universal panaceas but ***Fast88*** is able to offer a high degree of accelerator benefits while being simpler, lower cost, and easier to use.

Feature: Speed enhancement

Benefit: Users can expect significant speed improvement in most applications. With 7.4 Mhz frequency selected a ***Fast88*** equipped PC is 60% faster than a conventional PC.

Feature: Low cost

Benefit: Compared to other accelerators, users can achieve a significant system performance increase with minimum extra investment.

Feature: Easy to install

Benefit: Most users can install ***Fast88*** themselves or installation can be done by authorized dealers.

Feature: Selectable high speed

Benefit: Users with slower system memory can obtain speed improvement without having to change any components. Systems with faster components can get benefit of maximum increased system speed.

Feature: 100% software compatibility

Benefit: With standard 4.77 Mhz available at all times via the control module there is no need to change system software. No special install program required.

Feature: Computer reset button

Benefit: Users can reset their systems without turning the computer power off and on.

Feature: Reset button enable/disable jumper

Benefit: Users concerned about accidental system reset can inhibit operation of the reset button.

Feature: External switch selectable CPU speed

Benefit: Users can use standard 4.77 Mhz frequency at any time and without running any special programs.

Feature: No effect on computer real time clock

Benefit: ***Fast88*** always drives system PCLK at 4.77 Mhz — does not effect programs that use the system clock for time and date information

Feature: No effect on system oscillator clock

Benefit: ***Fast88*** always drives system OSC at 14.3181 Mhz — does not effect hardware such as video cards and serial card baud rate generators that may use the system oscillator for timing.

Feature: Does not require expansion slot

Benefit: User has all slots available. This is a major plus for systems with a limited number of expansion slots.

Feature: Easy removal

Benefit: User can return computer to completely standard configuration by removing ***Fast88***

Section 6 — *Fast88* Trouble Shooting Guide

Hopefully you are not going to need this section. There are, however, some common problems that come up from time to time when installing and using ***Fast88*** Also, be sure to check the materials included with your ***Fast88*** for the current list of problems we may have discovered subsequent to the printing of this manual.

This section is organized as a trouble shooting guide, starting with the symptom in bold face type followed by possible problem(s) that could cause the symptom, and the possible solutions. The possible problems and solutions are presented in roughly the order of probability of occurrence. If you rule them out in order it will help you isolate the problem or at least narrow down the possibilities before you call for help. If you need help, call your dealer or call **MicroSpeed** Technical Support at 415/490-1403.

Symptom:	**System will not power up and appears completely dead.**
Possible Problem:	Line cord not plugged in or plugged into a non-energized socket.
Solution:	Plug line cord into energized socket. Check all power connections and, if system connected to power line conditioner, make sure all fuses or breakers are on line.

Symptom:	**System powers up, but otherwise appears completely dead. Monitor cursor does not blink, System makes no attempt to boot after 1 minute.**
Possible Problem:	***Fast88*** not connected to external control module.
Solution:	Make sure ***Fast88*** connected properly
Possible Problem:	External control module not set for low speed.
Solution:	Make sure ***Fast88*** speed selector is in low speed (off) position.
Possible Problem:	System motherboard switch settings accidentally changed during ***Fast88*** installation.
Solution:	Make sure motherboard switch settings are the same as they were prior to ***Fast88*** installation.
Possible Problem:	System motherboard power connectors accidentally loosened or removed during ***Fast88*** installation.

Solution:	Make sure motherboard P8 and P9 power connectors are properly connected.
Possible Problem:	System expansion card(s) not properly seated in socket.
Solution:	Make sure all expansion cards are properly seated in connectors.
Possible Problem:	***Fast88*** installed incorrectly
Solution:	Make sure ***Fast88*** header cable plugged into 18 pin socket on computer motherboard in same orientation as original 8284A. Make sure all 18 pins are plugged in and that the header is not offset. Make sure ***Fast88*** header cable plugged into 18 pin socket on ***Fast88*** board in correct orientation. Make sure all 18 pins are plugged in and that the header is not offset.
Possible Problem:	8088-2 (or V-20 Device) installed incorrectly
Solution:	Make sure 8088 or V-20 device plugged into 40 pin socket on computer motherboard in same orientation as original 8088. Make sure all 40 pins are plugged in.
Possible Problem:	Defective modular cable
Solution:	Replace modular cable.
Possible Problem:	Defective 18 pin header cable
Solution:	Replace header cable.
Possible Problem:	Defective ***Fast88*** external control module
Solution:	Return external control module to dealer for service.
Possible Problem:	Defective ***Fast88*** board
Solution:	Remove ***Fast88*** and re-install 8284A as described in **Section 3.5**. If system boots properly, return ***Fast88*** board to dealer for service.
Possible Problem:	Defective or damaged CPU device (very low probability)
Solution:	Remove 8088 (or V-20) CPU device and replace with original 8088. With ***Fast88*** on low speed, if system boots properly, return CPU to dealer for replacement.

Symptom:	**System powers up, monitor cursor blinks, but during boot up error messages or error codes appear during power on self test**
Possible Problem:	External control module not set for low speed.
Solution:	Make sure ***Fast88*** speed selector is in low speed (off) position.

Possible Problem:	System motherboard switch settings accidentally changed during ***Fast88*** installation.
Solution:	Make sure motherboard switch settings are the same as they were prior to ***Fast88*** installation.
Possible Problem:	Defective modular cable
Solution:	Replace modular cable.
Possible Problem:	Defective ***Fast88*** external control module
Solution:	Return external control module to dealer for service.
Possible Problem:	Defective ***Fast88*** board
Solution:	Remove ***Fast88*** and re-install 8284A as described in **Section 3.5**. If system boots properly return ***Fast88*** board to dealer for service.
Possible Problem:	Defective or damaged CPU device (very low probability)
Solution:	Remove 8088 (or V-20) CPU and replace with original 8088. With ***Fast88*** on low speed, if system boots properly, return CPU to dealer for replacement.

Symptom:	**System powers up, power on self test passes, no abnormal memory test or boot messages appear, but system will not boot up properly from floppy disk (or hard disk) with *Fast88* at low speed**
Possible Problem:	System floppy disk and/or hard disk data cables or power connectors loosened or removed during ***Fast88*** installation.
Solution:	Make sure floppy disk and hard disk cables and connectors are properly connected.
Possible Problem:	External control module not set for low speed.
Solution:	Make sure ***Fast88*** speed selector is in low speed (off) position.
Possible Problem:	Defective modular cable
Solution:	Replace modular cable
Possible Problem:	Defective ***Fast88*** external control module
Solution:	Return external control module to dealer for service.

Symptom:	**System powers ups, boots normally, and operates normally with *Fast88* at low speed, but during system high speed selection system crashes and must be rebooted after attempting any operation with *Fast88* at 6.14 Mhz (minimum high speed)**

Possible Problem: ***Fast88*** high speed jumper missing

Solution: Check to make sure the jumper is in place to select 6.14 Mhz ***Fast88*** high speed.

Possible Problem: Defective modular cable

Solution: Replace modular cable

Possible Problem: Defective ***Fast88*** external control module

Solution: Return external control module to dealer for service.

Possible Problem: Old 8087 in system

Solution: Remove 8087 or replace with 8087-2 device

Possible Problem: Old system with 300 nSec. RAM

Solution: A few very old systems have 300 nSec. RAM which is marginal even at ***Fast88***'s lowest speed. Check your system motherboard (and all expansion cards which have system RAM) for these slow devices. Replace these devices with faster RAM.

Possible Problem: Defective ***Fast88*** board

Solution: Remove ***Fast88*** and re-install 8284A as described in **Section 3.5**. Return ***Fast88*** board to dealer for service.

Possible Problem: Incompatible computer.

Solution: ***Fast88*** was developed and tested on standard IBM PCs and PC-XTs. It has also been tested out with many different brands of "compatible" computers. There are lots of compatibles out there, however, and it is quite possible that some are sufficiently different from the original that they will not work with ***Fast88*** The sheet included with your ***Fast88*** will have a list of all known incompatibilities. If your computer is not on the list and you still suspect an incompatibility, please contact your dealer so that we can find out what the problem is.

Possible Problem: Speed marginal DMA controller

Solution: Some AMD AM9517-5PC and AM8237A-5 DMA controller devices with date codes earlier than 1985 are marginal above 5 Mhz (in fact, many are even marginal at 4.77 Mhz). Replace with a new 8237A-5 from AMD, Intel, or NEC. If this 40 pin device is soldered in, replacing it will probably require shop work; contact your dealer.

Possible Problem: Speed marginal CPU device (very low probability)

Solution: Remove 8088 (or V-20) CPU device and replace with original 8088. With ***Fast88*** on low speed, boot system. Try running with CPU on 6.14 Mhz. If it works, return ***Fast88*** CPU to dealer for replacement.

NOTE: Many standard 8088s will work fine at 6.14 Mhz. Indeed, many will work at 6.7 Mhz or even 7.4 Mhz! However, since they are not actually certified for that rate, they may not be fully reliable over all operating conditions, particularly when it gets warm inside of the cabinet. We recommend you always use a device certified and tested for use at higher clock frequencies.

Symptom:	**System powers ups, boots normally, operates normally with *Fast88* at low speed, operated normally with *Fast88* at 6.14 Mhz, but during speed selection system crashes and must be re-booted after attempting any operation at 6.7 Mhz.**
Possible Problem:	***Fast88*** high speed jumper missing
Solution:	Check to make sure the jumper is in place to select 6.7 Mhz ***Fast88*** high speed.
Possible Problem:	Old 8087 in system
Solution:	Remove 8087 or replace with 8087-2 device
Possible Problem:	System with 250 nSec. RAM
Solution:	Some systems have 250 nSec. RAM which is marginal at ***Fast88*** s 6.7 Mhz medium high speed. Check your system motherboard (and all expansion cards which have system RAM) for these slow devices. Either use ***Fast88*** at 6.14 Mhz or replace with 150 nSec. RAM.
Possible Problem:	***Fast88*** set for too high a speed for system
Solution:	In general, some systems simply will not run at 6.7 Mhz without changing some hardware. Decide on how much effort (and money) you are willing to put into upgrading your system; your system is running properly at 6.14 Mhz, a 30% performance improvement over the standard PC. It's inability to run faster is probably an indication that it is near some fundamental performance limit that will require effort to improve.
Possible Problem:	Speed marginal DMA controller
Solution:	Some AMD AM9517-5PC and AM8237A-5 DMA controller devices with date codes earlier than 1985 are marginal above 5 Mhz (in fact, many are even marginal at 4.77 Mhz). Replace with a new 8237A-5 from AMD, Intel, or NEC. If this 40 pin device is soldered in, replacing it will probably require shop work; contact your dealer.
Possible Problem:	Speed marginal CPU device (very low probability)

Solution: At this speed, the only real way to check this out is to remove the 8088 (or V-20) CPU device and replace it with a known good 8088-2 device. With ***Fast88*** on low speed, boot system. Then try running with CPU on 6.7 Mhz. If it works, return ***Fast88*** CPU to dealer for replacement.

Symptom: **System powers ups, boots normally, operates normally with *Fast88* at low speed, operates normally with *Fast88* at 6.14 Mhz, operates normally with *Fast88* at 6.7 Mhz, but during speed selection system crashes and must be re-booted after attempting any operation at 7.4 Mhz.**

Possible Problem: ***Fast88*** high speed jumper missing

Solution: Check to make sure the jumper is in place to select 7.4 Mhz ***Fast88*** high speed.

Possible Problem: Old 8087 in system

Solution: Remove 8087 or replace with 8087-2

Possible Problem: 8087/V-20 device interaction

Solution: At 7.4 Mhz a very small percentage of 8087-2s are marginal with an equally small percentage of V-20s. If this is the case, you can: 1) run your system at 6.7 Mhz, 2) try a different 8087-2, 3) replace the V-20 with an 8 Mhz 8088-2, 4) replace the 8 Mhz V-20 device with a 10 Mhz, 70108-10 V-20, or 5) remove the 8087.

Possible Problem: System with 200 nSec. RAM

Solution: Some systems have 200 nSec. RAM which is marginal at ***Fast88***'s 7.4 Mhz maximum high speed. Check your system motherboard (and all expansion cards which have system RAM) for these slow devices. Either use ***Fast88*** at 6.7 Mhz or replace with 150 nSec. RAM.

Possible Problem: ***Fast88*** set for too high a speed for system

Solution: In general, some systems simply will not run at 7.4 Mhz without changing some hardware. Decide on how much effort (and money) you are willing to put into upgrading your system; your system is running properly at 6.7 Mhz, a 45% performance improvement over the standard PC. Its inability to run faster is probably an indication that it is near some fundamental performance limit that will require effort to improve.

Possible Problem: Speed marginal DMA controller

Solution: Some AMD AM9517-5PC and AM8237A-5 DMA controller devices with date codes earlier than 1985 are marginal above 5 Mhz (in fact, many are even marginal at 4.77 Mhz). Replace with a new 8237A-5 from AMD, Intel, or NEC. If this 40 pin device is soldered in, replacing it will probably require shop work; contact your dealer.

Possible Problem: Speed marginal CPU device (very low probability)

Solution: At this speed, the only real way to check this out is to remove the 8088 (or V-20) CPU and replace it with a known good 8088- 2. With ***Fast88*** on low speed, boot system. Then try running with CPU on 7.4 Mhz. If it works, return ***Fast88*** CPU to dealer for replacement.

Symptom: **System powers ups, boots normally, operates normally with *Fast88* at low speed, operates normally with *Fast88* at selected high speed, but when attempting to boot with *Fast88* at high speed system gets a 301 (keyboard) error.**

Possible Problem: Keyboard timeout

Solution: At high speed some keyboards can not respond fast enough during power up self test. Boot system at low speed and change to high speed after the system has booted.

Symptom: **System powers ups, boots normally, operates normally with *Fast88* at low speed, operates normally with *Fast88* at selected high speed, but generates a variety of keyboard, display, and disk errors when attempting to run standard IBM Diagnostics at high speed.**

Possible Problem: Hard timing in Diagnostics

Solution: Routines in the the IBM Diagnostics call code in the ROMs and, as a result, produce errors. Run the diagnostics at low speed.

Symptom: **System powers ups, boots normally, operates normally with *Fast88* at low speed, operates normally with *Fast88* at selected high speed, but will not boot with *Fast88* at high speed.**

Possible Problem: Slow boot ROM on disk controller

Solution: This is common with some hard disk controllers. Boot at low speed and change to high speed after the system has booted.

Symptom: **System operates normally with *Fast88* at low speed and at selected high speed, but will not run a specific program at high speed.**

Possible Problem: Software timing loop in program.

Solution: This is a fairly common problem for programs which use timing loops based on instruction execution, particularly **BASIC** programs. The most common manifestation of the problem is that screen messages or prompts will not stay on the screen long enough. If the problem is severe run the program at low speed.

Possible Problem: Program uses direct calls to ROM BIOS

Solution: This is a fairly common problem for older programs which were written for compatibility with **DOS 1.0**; **FORMAT** and **DISKCOPY** are examples of this problem. Run the program with ***Fast88*** at low speed.

Possible Problem: V-20 device compatibility

Solution: The 8088 and V-20 have significant timing differences. It is possible, although unlikely, that a program which runs properly with the V-20 at low speed may become unreliable at high speed. You can 1) replace the V-20 with an 8088-2 or 2) run the program at low speed.

Symptom: **System operates normally with *Fast88* at low speed and at selected high speed, but will not run a specific program at low or high speed.**

Possible Problem: V-20 device compatibility

Solution: The 8088 and V-20 have significant timing differences. Some programs which run properly with the 8088 simply do not work correctly with the V-20. You can 1) replace the V-20 with an 8088-2 or 2) see if the program supplier has a more recent revision which works with the V-20.

Symptom: **System operates normally with *Fast88* at low speed and at selected high speed, but fails when attempting to run a program with a key disk at high speed.**

Possible Problem: Key disk timing

Solution: This is a fairly common problem for programs which use separate key disks to verify licensed users. Key disks use special timing or direct calls to ROM drivers. In most cases, this can be circumvented by running the program at low speed until the key disk has been verified, then switching to high speed.

Possible Problem: V-20 device compatibility

Solution: The 8088 and V-20 have significant timing differences. Some keylock programs which run properly with the 8088 simply do not work correctly with the V-20. You can 1) replace the V-20 with an 8088-2,2) run the program at low speed, or 3) see if the program supplier has a more recent revision which works with the V-20.

Symptom: **System operates normally with *Fast88*, but does not reset when external control module reset button is pushed.**

Possible Problem: ***Fast88*** Reset jumper missing

Solution: Place a jumper on the connector to enable reset.

Possible Problem: Defective modular cable

Solution: Replace modular cable

Possible Problem: Defective ***Fast88*** external control module

Solution: Have external control module serviced.

Possible Problem: Defective ***Fast88*** board (low probability)

Solution: Remove ***Fast88***, re-install 8284A as described in **Section 3.5.**, and return ***Fast88*** board to dealer for service.

Symptom: **System operates normally with *Fast88*, but when external control module reset button is pushed system shows error codes, does not re-boot properly, or hangs up completely.**

Possible Problem: ***Fast88*** on high speed

Solution: Switch ***Fast88*** to low speed and reset again.

Possible Problem: Hardware lock up

Solution: Some expansion cards (particularly older cards and some hard disk controllers) do not respond properly to the system reset line; they may remain hung up even when reset. If system does not re-boot properly after switching to low speed and pressing reset button, power down system, wait for 30 seconds, follow your normal cold boot procedure.

Section 7 — *Fast88* Questions and Answers

The following are the answers to the questions we hear most often from users, dealers, or OEM/VARs; they are also the questions you will most likely hear when your friends ask you about ***Fast88*** Naturally we don't have space for all of them here, so if you need more information or have a special problem, please feel free to write:

Customer Support
MicroSpeed, Inc.
5307 Randall Place
Fremont, CA 94538

or call us direct at 415/490-1403. If we don't have the answer, we'll find it out and get back to you as soon as possible.

What is *Fast88*?

Fast88 is a PC accelerator which achieves its high performance by using an approach different from other available accelerators. Because of its fundamental differences, it is able to offer users a significant processor speed improvement at a very low cost.

Who builds *Fast88*?

Fast88 ts build by **MicroSpeed, Inc.**, a start up company located in Fremont, Caliornia. **MicroSpeed, Inc.** was founded by three veteran engineer/entrepreneurs, all of whom have been involved in various other company startups. The company was founded specifically to design, build, and market ***Fast88*** and other PC accessory products.

Who sells *Fast88*?

Fast88 is available from authorized dealers, OEMs, VARs, and system integrators. Each of these distribution channels has special requirements, and **MicroSpeed** has programs available for each of them.

Besides costing less, how is *Fast88* different from other accelerators?

Fast88 adds a higher performance 8 Mhz 8088-2 (or optionally an 8 Mhz NEC 8088 V-20) in combination with a higher frequency clock generating circuit with selectable output frequencies controlled from an external module. This approach gives you a significant computer performance increase with complete software compatibility at a much lower cost.

Most accelerators plug into an expansion slot and essentially replace the 8088 with a complete computer and RAM. This creates some software and hardware compatibility

problems, increases system power consumption, and generally costs from $600 to over $2000!

What computers does *Fast88* work with?

Fast88 is designed to work with standard IBM PCs, PC-XTs, and most compatible computers. It has been tested with many different models, and the list continues to expand. Included with each ***Fast88*** is a sheet which lists the currently checked out computers and what, if any, special requirements they have for using ***Fast88***

Basically any computer using the 8088 and running at 4.77 Mhz has a very high probability of being completely usable with ***Fast88***

What does the V-20 processor buy me?

The V-20 is a newer high performance CPU which has a high compatibility with the 8088 device. It is particularly good at integer arithmetic and at instructions which make extensive use of indexed operations. Most users have reported a 4-5% overall performance increase when they replace their 8088 with a V-20 device. There are minor incompatibilities between the V-20 and the 8088, however, and not all programs that run on the 8088 can be guaranteed to work with the V-20. There are also minor timing differences that can lead to problems with the 8087 numeric data processor. See **Section 5.4** for more information on the V-20.

How is *Fast88* installed in my computer?

Fast88 is installed by replacing the normal 8088 with the new CPU and by removing the 8284A clock generator from its socket on the main CPU board and replacing it with a header cable which runs to the ***Fast88*** board.

How does the *Fast88* board mount to the back panel?

A universal bracket that allows the board to mount in a number of locations is provided. Also, for the rare case with no appropriate hole pattern, double sided mounting tape can be used.

What if the devices to be replaced are not socketed?

The 8088 device is always socketed. The 8284A is socketed over 80% of the time on PCs and PC-XTs and it varies a lot on the compatibles. If the 8284A is socketed, installation is a simple task of removing the device from the socket and installing the header cable in the socket. If it is soldered, it is removed from the board, a socket (included) is installed and the header is installed in the socket. This is a minor board modification, but it is recommended that it be performed by an experienced technician.

Do you provide the installation materials?

Yes. Every ***Fast88*** package includes solder, a new header socket, and complete instructions.

Can my computer dealer install *Fast88*?

Yes. ***Fast88*** dealers are encouraged to provide full installation and service to customers. We recommend that you have the unit installed by a local dealer if you are not familiar

with computers. If installation requires soldering, you should only attempt to install the unit if you are experienced in electronics board repair techniques.

After *Fast88* is installed can it be removed easily?

Yes. Simply unplug the cable and replace the 8284A.

How much does dealer installation cost?

The suggested dealer price for installation of ***Fast88*** is $60. The actual charges are at dealer discretion and may vary some from area to area.

Does *Fast88* require any expansion slots?

No. ***Fast88*** leaves all of your computer's expansion slots available, a real advantage compared to accelerators which require a full sized expansion slot for installation.

How fast is *Fast88*?

Fast88 allows you to select from three high speeds: 6.1 Mhz, 6.7 Mhz, or 7.4 Mhz (representing 30%, 45%, and 60% improvements over the standard 4.77 Mhz rate). The high speed to be used is selected by a jumper on the ***Fast88*** board.

Why are there three high speeds available?

Not all PCs can take full advantage of ***Fast88*** without changing to faster RAMs and EPROMs. The lower speeds allow all users to get some speed enhancement without a major system overhaul. If you want to install faster RAM ***Fast88*** can take full advantage of the performance increase.

With *Fast88* installed how much speed improvement will I see?

It varys somewhat with the operation being performed. Most users report smoother screen scrolling, faster disk operations, and faster execution of CPU intensive programs like spreadsheets, data bases, and word processors. For example, a ***Fast88*** equipped computer with the 7.4 Mhz frequency selected is 60% faster than a standard PC. See the March 11, 1986 issue of PC WEEK for a performance review of ***Fast88***

Once *Fast88* is installed does it mean that normal 4.77 Mhz operation is impossible?

No. To guarantee 100% compatibility with existing software, ***Fast88*** also has a 4.77 Mhz speed available.

How do I switch between high speed and the 4.77 Mhz speed?

Fast88 s external control module has a speed select switch. When the switch is off, your computer operates at the normal 4.77 Mhz rate; when the switch is on, your computer is in the high speed mode. An indicator on the module shows you when ***Fast88*** is in the high speed mode.

When *Fast88* is in the high speed mode does it cause the system clock to run at the wrong rate?

No. To keep all system timing normal, ***Fast88*** supplies the 4.77 Mhz PCLK signal to the system clock to insure that it keeps time properly. The higher speed clock is only used to drive the CPU and its related logic.

When can I switch between low and high speed?

You can change frequencies any time the system is waiting at the command prompt. This is really being conservative—during testing frequencies were often changed right in the middle of program operations, including while the system was accessing hard disks and floppy disks, with no ill effects. To be safe, however, it is recommended that the speed only be changed at the command prompt.

Does the external control module do anything else?

Yes. It also has a hardware reset button that allows you to reset your computers without turning power on and off.

I use my computer in an application where it is not desirable to have it reset easily. Can I can disable the reset button?

Yes. A jumper on the ***Fast88*** board can be removed to disable the reset button.

Where is the external control module located?

Anywhere you want it. The module is connected to the main ***Fast88*** board by standard modular phone cable and plugs. It can sit on the cabinet or on the table. Double sided tape can also be used to mount it to the side of the cabinet.

Does *Fast88* **require any special software?**

No. ***Fast88*** is a "pure" hardware accessory. Once installed it should run perfectly with all existing software. For booting and those occasional programs with software timing loops, the user can switch back to 4.77 Mhz operation at the flick of a switch.

Can you name some of the software that has been tested with *Fast88*?

Fast88 has been found to work completely and enhance the performance of 1-2-3, Symphony, dBASE II & III, Wordstar, Framework, AutoCAD, and numerous other popular software packages.

Can you name some software that definitely doesn't work with *Fast88*?

Because some BIOS drivers are located in EPROM, Basic and Advanced Basic programs have occasionally been found to not always work properly at high speed. Also, some **DOS** utilities which use direct calls to the BIOS with software timing loops do not work properly. The **DOS DISKCOPY** and **FORMAT** programs fall into this category. Some programs which require key disks with hardware timing may need to be loaded at low speed and then switched to high speed after the key disk has been verified. Also, many games become unplayble because of the increased speed of operation and, as mentioned earlier, programs which use software timing loops may not work properly. (See **Section 4** for a complete discussion of software issues.)

Remember, however, that flipping the speed select switch returns the system to normal 4.77 Mhz operation so that any programs with timing problems will all work normally, while allowing other programs to take advantage of the availability of the higher speed.

Appendix A

Fast88 Specifications

Standard CPU:	8088-2	
Optional CPU:	NEC 70108D-8 (V20) or equivalent	
Optional Co-Processor:	8087-2 (not included)	
Standard Frequency:	Crystal	True Clock Rate
	14.3181 Mhz	4.77.27
High Frequencies:	Crystal	True Clock Rate
Low:	18.4320 Mhz	6.1440 Mhz
Middle:	20.0000 Mhz	6.6667 Mhz
High:	22.1184 Mhz	7.3728 Mhz
Power Consumption:	750 mW, typical; 2 W, max.	
Operating Temperature:	32 to 95 degrees Fahrenheit (0 to 35 degrees Celsius)	
Humidity:	10% to 80% relative humidity non-condensing	
Dimensions:		
PC board:	2.5”d x 3.0”w x 0.7”h (63.5 mm x 76.2 mm x 17.8 mm)	
Control Module:	2.1”dx2.0”wx0.8”a10(53.3mmx50.8mmx20.3mm)	
Shipping wt.:	1 lb. (0.45 kg)	

ALL SPECIFICATIONS HEREIN ARE PROVIDED FOR INFORMATION ONLY AND ARE SUBJECT TO CHANGE WITHOUT NOTICE

Appendix B

MicroSpeed, Incorporated 1 year Limited Warranty

MicroSpeed, Inc. ("**MicroSpeed**") warrants its hardware products against defects in materials and workmanship for a period of one year from receipt by the user. During the warranty period, MicroSpeed, will either, at its option, repair or replace products which prove to be defective.

Should **MicroSpeed** be unable to repair or replace the product within a reasonable amount of time, Customer's alternate exclusive remedy shall be a refund of the purchase price upon return of the product.

Customer Responsibilities

This warranty shall not apply to defects resulting from improper installation, unauthorized modification, misuse, or improper or inadequate maintenance.

Obtaining Service

To obtain warranty service, products must be returned to the **MicroSpeed** authorized dealer from which the products were purchased. Customer shall prepay all charges for shipping products to dealer for warranty service and the dealer shall pay for the return of the products to customer. If dealer is unable to provide service or is no longer in business, products may be returned directly to the **MicroSpeed** factory for repair, provided that prior authorization is obtained. In the event factory repair is authorized, customer shall prepay all charges for shipping products to factory and **MicroSpeed** shall pay for the return of the products to the customer.

Limitation of Warranty

MicroSpeed makes no other warranty, either expressed or implied, with respect to this product. **MicroSpeed** specifically disclaims the implied warranties of merchantability and fitness for a particular purpose.

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

Exclusive Remedies

The remedies provided herein are customer's sole and exclusive remedies. In no event shall **MicroSpeed** be liable for any direct, indirect, special, incidental, or consequential damages, whether based on contract, tort, or any other legal theory.

APPENDIX C

Fast88 Shipping List

Included with your ***Fast88*** should be:

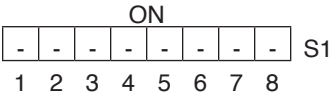
Check	Qty	Description
( )	1	***Fast88*** circuit board with attached bracket
( )	1	8088-2 Microprocessor (optionally, NEC 70108D-8 V-20 or equivalent enhanced 8088 Microprocessor)
( )	1	External control module
( )	1	24", 4 conductor modular phone cable
( )	1	8.5", 18 pin dip header cable
( )	1	Set of 4 feet for external control module
( )	1	Double sided tape for mounting external control module to computer case
( )	1	Installation kit including: solder 18 pin socket 2 board spacers 2 sheet metal screws for mounting bracket
( )	1	***Fast88*** User's manual
( )	1	Money back guarantee card
( )	1	Warranty registration card

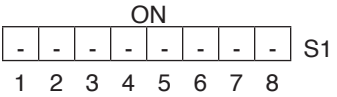
Check the contents of the package against this list. If any of these items are missing, contact your dealer immediately.

APPENDIX D

System Record

Motherboard Switch Settings





***Fast88* Settings**

H = 7.4 Mhz, M = 6.7 Mhz, L = 6.1 Mhz
R = reset enabled

System RAM

Motherboard: ____K **Expansion Cards:** _____K **Total:** ____K

Motherboard

Bank 0 16K ____ 64K ____ 256K ____

Device No.

	0	1	2	3	4	5	6	7	8
Type									
Acc. Tm									

Bank 1 16K ____ 64K ____ 256K ____

Device No.

	0	1	2	3	4	5	6	7	8
Type									
Acc. Tm									

Bank 2 16K ____ 64K ____ 256K ____

Device No.

	0	1	2	3	4	5	6	7	8
Type									
Acc. Tm									

Bank 3 16K ____ 64K ____ 256K ____

Device No.

	0	1	2	3	4	5	6	7	8
Type									
Acc. Tm									

Expansion Boards

Bank 0 16K ____ 64K ____ 256K ____

Device No.

	0	1	2	3	4	5	6	7	8
Type									
Acc. Tm									

Bank 1 16K ____ 64K ____ 256K ____

Device No.

	0	1	2	3	4	5	6	7	8
Type									
Acc. Tm									

Bank 2 16K ____ 64K ____ 256K ____

Device No.

	0	1	2	3	4	5	6	7	8
Type									
Acc. Tm									

Bank 3 16K ____ 64K ____ 256K ____

Device No.

	0	1	2	3	4	5	6	7	8
Type									
Acc. Tm									

Bank 4 16K ____ 64K ____ 256K ____

Device No.

	0	1	2	3	4	5	6	7	8
Type									
Acc. Tm									

Bank 5 16K ____ 64K ____ 256K ____

Device No.

	0	1	2	3	4	5	6	7	8
Type									
Acc. Tm									

INDEX

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