TEXAS INSTRUMENTS

Upgrading The 99/4A Pt. 1 — The TMS9995

by Randy Holcomb

A question on just about everybody's mind is "where do we go from here for more processing power?" Since TI withdrew from the market the **99/8, the only known available** upgrade to the home computer family was scrapped forcing 39/4A owners into an awkward position of having to make do with what they have or to sell their 99/4A systems and upgrade to a supported system such as an Apple, IBM or Commodore, usually at a much higher cost than what was originally paid for the 99/4A system.

The stillborn 99/8. Recently one of the prototype 99/8s (the infamous "Armadillo" codename) was shown at a recent 99/4A user's show in Chicago by Don Bynum, one of the original members of the home computer division of Texas Instruments. Some of its preliminary specs were revealed for the first time: a 10.7 MHz TMS 9995 processor, a full 65kbytes of user memory, a custom version of the TMS 9918A Video display processor and completely redesigned BASIC written entirely in machine code with full bitmap support and special graphics commands, and mapping support for over a megabyte of memory.

chines exist and it's further unlikely that TI will license its production. The 99/8 had a switch on it which placed the machine in "4A" mode which dropped it into the GPL monitor and looks like a /4A to maintain compatibility with the /4A software out in the market. However, it becomes apparent after looking at the specs that the 99/4A was just the entry mode for more grand plans.

First Steps in a New Machine. The 99/8 took many man-months to design and implement with some very talented people behind the project. To expect something of that magnitude from a handful of people in the /4A community would be expecting a lot; for starters, though, we CAN make a dent into the performance problems with just a little effort and some computer designed expertise. But first, some initial design criteria.

amount of heat dissipated will be greatly reduced because of lower power consumption. We all know how hot the /4A consoles can get!

(3) The new machine should provide provisions for additional memory beyond 65K and provide support for a new operating system environment. With the recent price drops in memory chips coupled with 256K DRAMs becoming available it's in everyone's best interest to take advantage of more memory. RAMDISK (simulation of a disk in memory) is also a consideration to be made.

The TMS9995 Processor. The heart of the 99/8 was the TMS9995, a third generation microprocessor in the TMS-9900 family. Unlike its grandfather the TMS9900, the 9995 uses an 8-bit data bus versus the 16-bit data bus used by the 9900. (See Figure 1 & 2) "How can the 9995 with its 8-bit bus be faster than the 9900 with a 16-bit bus?" I hear someone ask? The TMS9995 being a third generation processor is in reality a microcoded processor which is designed to walk and talk like a TMS9900 family member. Microcoded processors are processors that understand a special dialect of machine code called microcode. This microcode determines what instructions a processor can execute and describes the sequence in which the execution takes place. In large mainframe computers and in some micros the microcode can be altered to make a computer look like a completely different machine

with a new instruction set. (See Figure 3 and Table 1) Microcode processors are often referred to as a "Micro-Engine."

Besides being microcoded, the TMS9995 takes advantage of a technique called "prefetch" which is found on most third-generation processors. Prefetch involves using the time that the processor is performing an internal operation (such as adding two numbers in the processors ALU) to perform a fetch of the next instruction that is to be executed, and then to decode the prefetched instruction internally while the processor stores the result of the previous operation. In effect this cuts down on the number of clock cycles used by the processor to execute the instruction by maxmizing the microengine to do two operations at once. So, throwing all of this technobabble together gives us a processor that runs significantly faster than previously obtainable using standard implementations. In the case of

the 9995 versus the 9900 a **MOVB R0, R1** instruction would take 14 clock cycles on "

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Conservative estimates rank this machine's capabilities as being 6 to 8 times faster than the current 99/4A and in many respects would have given Commodore, Apple and IBM a run for their money in terms of performance per dollar. Of course this is all moot because only a handful of these ma-

(1) The new machine should be fully compatible with the current /4A environment. This means that the ROM monitor and the GROMs will need to be transplanted into the new machine. GROMs can't be altered because of their inherent design, but the console ROM presents us with a new look at its implementation, and will be dealt with later.

(2) The new machine should be designed with state-of-theart components with a slant towards providing increased reliability. Although this can increase the price of the unit, these costs are offset by higher reliability due to fewer components being used. Another offshoot of this is that the



Figure 2—TMS9995 Memory Map

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179 571 1.5 A2	477 80	: 17) C	4 57 57	4 5	814 R		474 •	ţ	191	87.11 -	. ET 13	ETT3 INFERIO	ET IA PT SAASK	D4 1F

Figure 3-Status Register Bit Assignments

-	CRU BIT ADORESS ¹	(aligned in them
PLAQO	1860	Bet ro 0: Déclementer configured sa Internet Timer.
•		Set to 1: Dearanteeper configured en Event Counter.
PLAD)	IEĘŻ	Set to 0: Occurrenter net enabled Easte 1: Occurrenter enabled (with decrements and can set in- senuel teach that requires a favor 3 interrupt).
FLAG7	1864	Level I Internet Interrupt Request Lech CRU Input (Input-only). 0: Level 1 requisitmet present 1: Level 1 request present
FLAG3	38.84	Lavel 3 Internet Internapt Request Lavel 3 Internet Internapt Request Lavel 3 request and projects 1: Cavel 3 request projects
PLAG4	1620	Level & Internet Interrupt Proposi Letch GHU Input (Imput-only). 0: Level 4 require out present 1: Level 4 require present.
PLAGS RLAGS PLAGS PLAGS PLAGS PLAGS PLAGS PLAGS PLAGS	186A 166C 1668 1669 1669 1669 1669 1669	Uper Callinad
PLAGE	16PC 16PC	



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9995 gives us. The CRU address (See Figure 4) space has

been increased from 4096 bits to 32,768 bits, allowing us to increase our available I/O space beyond >1FFF to >7FFF, but several patches will need to be applied to both ROM code and to some utility code to allow us to get at all of this new space. Two new instructions, signed multiply and signed divide, have been added

Upgrading the 99/4A

Continued from page 125

the 9900 but only 4 clock cycles

in a 9995. Since each clock cy-

cle is 333 ns the 9900 takes 4.6

usec to do the MOVB, the 9995

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Other 9995 Features. In-

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HOLD	10 Ē		READY
WE/CRUCLR	18 0	. 02	REFET
	¥Ö.	10.00	
<u> </u>			
Figure	5—	TMS9998	5 Pin

Assignments

to the 9900 instruction repertoire. Other hardware additions include a built-in interval timer/event counter residing at memory location >FFFA->FFFB, trapping of illegal instructions through a

Continued on page 137

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							·							Otherwise, divide signed, two's complement integer in WHO and WH's by the signed two's complement integer (BA) and place the signed posters) in WHO and the signed remainder, in WHS. The sign of the qua- tient is determined by significant	
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Figure 6—Signed Multiply and Divide Instructions

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facility known as Macro Instruction Detect (MID), and new interrupt bits have been added for arithmetic overflow and MID interrupts. Some of the new features of the 9995 are enabled by setting certain CRU addresses; these are

shown in Table 2. Some of these options if used in the 99/4A environment can cause problems or cause the system not to function properly, so care must be exercised when using one of the above facilities.



One little detail I forgot about the 9995: it has 256 bytes of on-chip RAM available (which is split into two segments from >F0.00 to >F0FB and from >FFFA to >FFFF) which can be used for small routines to further increase the execution speed as no external memory accessing is required: in our above MOVB example is the instruction and the operands were all in the on-chip RAM the time requires drops in half-to 666 ns. When on-chip memory or on-chip CRU locations are accessed, the 9995 tri-states the address and data lines (See Figure 5) off the system bus, so no conflict with other devices can occur.

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Continued on page 138

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Upgrading the 99/4A Continued from page 137

build a new board that replaces your present console to give your system new life and to keep things going in the /4A community. At this time a prototype is undergoing construction and testing using the 9995; our hope is to have the machine fully debugged and both bare boards and assembled and tested systems available shortly. Since this is a learning experience for all of us, we want to show you our progress and reveal the design trade-offs when engineering a computer. Most importantly, it will introduce you to the methods and procedures used in designing hardware for digital electronics which will become necessary for those people who will want to keep their 99/4As alive and healthy for the future. Until we are satisfied that we have a product that works with high-reliability we will **GRAPHICS - MENU DRIVEN - CHARACTER'S** not release the product to the public, so please hold off on re-ABILITIES IMPROVE AS GAME PROGRESSES questing information on when the system will be available---when it's ready it will be announced and advertised. Right now our intentions are to in-

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Randy's Ravings

by Randy Holeomb Well, it's a New Year, and that means resolutions. My resolution is to try and dig up even more information to make using your 99/4A a more pleasurable experience. Now on to this month's column and its contents: More TSG Software reviews and a look at sector-copying software, plus the latest TI News.

Other TSG Software: In a previous column I reviewed some software from Technologies Support Group of Spencer, MA., most notably the Pro-Mod and Multi-Sort packages. Both of these packages I found useful in their own peculiar way. Sektch-it, TSG's cellularbased graphics program, isn't easy to use, compared to the bit-mapping "Draw-a-Bit" from Data Force. Let's face it - it's easy to do GOOD graphics in Basic but if you can master graphics techniques in assembler, you're far better off, especially bit-map mode. I could not honestly get excited with Sketch-It. Along similar lines, the same goes to Auto-Type, even though its directoutput mode I find quite useful. The same effect can be achieved with a quick-anddirty Basic program, combined with the fact that TI-Writer does such a nice job and is perhaps the most popular piece of software that TI ever introduced. Even today, TI-

Writer is still readily available at a nominal price. As for all other software houses, the formula for those who want to succeed is to write something that is unique and that people want. Price it reasonably, and give good support. It's rare to find any one company that gives you all of the above.

Sector Copiers. In the last year, we have seen a plethora of software that makes backing up your diskettes a breeze rather than a hassle. The majority of this new-found wealth can be found in programs that backup disks by sector-copying rather than copying a disk file by file. Sector copying involves reading the diskette in its native storage mode (the sector) and writing the data back out in the exact same position on the backup. The advantages of sector copying is that the backup looks exactly like the source diskette (some of the more euphemistic terms are called cloning the disk or making a mirror-image of the disk). The other advantage is that the selection, Super-Duper takes over and prompts you for the parameters needed to perform the requisite function. Oddly enough, it will allow a value of drive zero, which will cause a program error during execution (anybody care to take a crack at WHY they allowed a drive zero as a valid

drive number? I haven't the foggiest).

Super-Duper will format the destination disk automatically if an unformatted disk is used as the copy, Super-Duper's operation is just plain and simple - nothing fancy, it just does the job. Suggested price is around \$30-35.

Floppy-Copy. This utility goes all out as far as utility goes: a built-in help file, a cataloger, a disk initializer, and of course backing up your diskettes. It also has a nasty protection scheme that revolves around some form of funny sectoring which caused the first release of Floppy-Copy to fail when using it with the Cor-Comp DSDD Controller (this has been fixed and it does work properly with the CorComp Card). Floppy-Copy runs thru sector copying is fast - typically a sector backup runs 3 to over 10 times faster than a filelevel backup. The disadvantage with a sector backup is that if the disk has a large number of small open gaps in-

its free disk area, a sector copy will not attempt to compress the disk and move all the free sectors together (a file level copy from a source disk to an empty disk will achieve the above effect).

Since the discovery of the sector I/O routines in the disk DSR, many diskette-backup programs have sprung up: "Super-Duper" from Navarone Industries; "Floppy-Copy" from the Soft-Spot, and "MassCopy," a FREEWAREtype program written by Stephen Lawless. It should be noted that all of these utility programs require an expanded

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system with disk (obviously) and 32K of memory. And now, a look at each of the programs. Super-Duper. To use the software, you plug in the Super-Duper cartridge (an 8K Romox cartridge) into the GROM port of your console. You will be presented with 3 selections: TI Basic, Duplicating disks and Verifying disks. After making

Continued on page 140

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This will include an RS-232 board, 1200/300 bau	d modem, and CopyLink.
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Randy's Ravings Continued from page 139

the Editor/Assembler, Mini-Memory or TI Extended Basic. After the initial load, it invokes its copy-protection check; once it's past that it proceeds to bring up a welcome screen (a pixel image of a floppy-copy building?l) and then drops you into a help-screen to ask for help. If you ask for help, a submenu appears and asks for the sub-menu item to select from. The actual main menu consists of cataloging, initializing and backing up the diskette. It can support multiple backups (making 2 backups at the same time if you have 3 drives).

MassCopy. Stephen Lawless of 2514 Maple Ave., Wilmington, DE 19808 took a bold step when he released Mass-Copy into the FREEWARE world. FREEWARE involves the release of software by the original author (who normally holds the copyright on the work) on a concept whereby if a recipient finds the software of

value, a "donation" is made to the original author; whereby, the author places his/her nameon a mailing list and sends them the latest version of the program (including documentation and updates to the documentation). In Stephen's case, his return hasn't been all that successful. In a letter I received with his latest version. he has had only .5% response since he released the original many months ago. The latest version of MassCopy acts much like Floppy-Copy except that it has no cataloging feature but can (and will) take advantage of the Foundation 128K card if installed on the system for assisting in the copying. The display that MassCopy uses is informative to say the least - it not only shows you what is going on but takes advantage of color as well to inform you of its operating mode (reading, writing, etc.). At present, Stephen is asking a \$10 donation for anyone who finds his program useful enough that they would use it.

PRICE BREAKTHROUGH

Going head-to-head. In terms of price, MassCopy wins this battle - it's free (that is, if you don't make a donation to the author) with Super-Duper being the most expensive at over \$30 (but it is in a cartridge, so it's impervious to a good magnetic pulsel). Only Super-Duper offers a verify command which reads both the source and object disks and compares the two; Floppy-Copy and MassCopy just have the standard read-after-write verify provided by the disk controller. Both MassCopy and Floppy-Copy provide help files on the disk, Super-Duper is very Spartan in this regard. Super-Duper and Floppy-Copy will not backup copy protected disks; MassCopy gives you a warning message but allows them to be backed up anyway. If you have the CorComp card, having a sector-copier utility is somewhat questionable, especially with the Turbo Option enabled. Really, you don't need one if you have the Cor-

Comp card, but if you have the TI (or Myarc, see the News below!) controller, you may want to look at any of the above utilities to make your floppy worries a little easier.

TI News. The Digital Systems Group scored a major coup with their new Explorer machine. Not your typical PC, this beast sports Lisp, megs of memory, and a \$50,000 price tag. It's designed for work in Artificial Intelligence. Nary a week went by when MIT (a big Artificial Intelligence research facility) placed a 200-unit order for the systems. Later on, it was learned that a number of the 200 machines were donations made by TI to MIT. Regardless, this places TI in a new area that they are going to aggressively pursue.

Myarc, who makes the Winchester disk system for the 99/4A, is now shipping their DSDD disk controller. Unlike the initial problems that plagued the CorComp controller, the Myarc controller works with the DM II cartridge and comes in a genuine TI clam-shell case. And speaking of CorComp, it has been learned (though unconfirmed) that they have filed for protection under Chapter 11. Cor-Comp has stated that they are

Shopper is providing. To rectify this, arrangements are being made to also distribute the source code on disk; watch this space for further details. For people who subscribe to CompuServe, I have uploaded the complete source code up the CompuServe where it can be downloaded into your computer. The file is called T99.ASM and can be found in the XA2 Reference Library of the TI Forum (G PCS27 at the menu prompt). In addition, due to the many requests for information on modifying the program, a forthcoming article will go into detail on how to upgrade T99 to capture to disk/printer as well as other topics.

The following addresses refer to software companies mentioned in the above article. For those addresses not given, contact your local TI dealer for more information.

Myarc, Inc. 241 Madisonville Road Basking Ridge, NJ 07920

SofSpot P.O. Box 8786 Silver Spring, MD 20907-0001 301-439-8084 Floppy-Copy price: \$25

