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A Conference & Exposition on Personal & Home Computers

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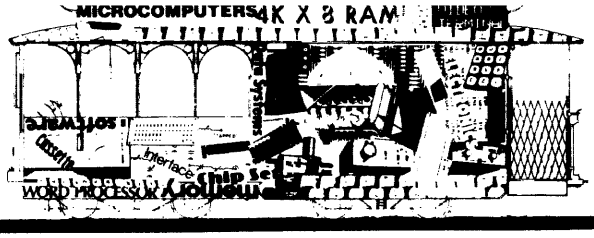
Jim C. Warren, Jr., Editor

March 3 - 4 - 5, 1978 San Jose, California

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# TWO CHEAP VIDEO SECRETS

Don Lancaster
Synergetics

## CHEAP VIDEO

Cheap Video is a brand new collection of hardware and software ideas that dramatically slash the cost and complexity of both alphanumeric and graphics microprocessor based video displays.

A typical cheap video system (A-1) lets you do things like a 12 X 80 scrolling display using only seven ordinary IC's with a total circuit cost as low as $20, and transparently running on a microcomputer system that still has as much as 2/3 of its throughput remaining for other programs.

Cheap video displays run on an ordinary TV set with unmodified video bandwidth, even when doing 64 or 80 character lines. Changing a single IC switches you between upper or combined case alphanumerics or high resolution or color graphics modes.

The basic idea behind cheap video is to totally eliminate any TVT system timing and let the microprocessor do all the work. As (A-2) through (A-4) show us, the object is to use both the existing microcomputer and tv set with a minimum of modifications, putting as little dedicated hardware as possible between the two.

There are two key secrets involved in cheap video. One is a software secret called a Scan Microinstruction. The other is its hardware companion called an Upstream Tap.

Together, the scan microinstruction and the upstream tap cause the microcomputer to output characters at a rate fast enough for direct video use.

## THE SCAN MICROINSTRUCTION

A Scan Microinstruction is a subroutine combination of ordinary instructions running at ordinary speed that tricks the computer into putting its program counter on the address bus and sequentially advancing the addresses fed to all memory in the computer at a one word per microsecond rate.

For the 6502, a suitable scan microinstruction looks like this:

```
Enter Via
Subroutine
     ↓
     └─ 6000 LDY A0 A0
        6002 LDY A0 A0
        6004 LDY A0 A0
          .
          .
        601C LDY A0 A0
     ┌─ 601E RTS 60
     ↓
Exit to main
Scan Program
```

As (A-5) shows us, the address lines on a 6502 are normally a mix of "go fetch" values and program counter values. When the program counter is on the address bus, the bus will typically advance at a one or two microsecond rate.

When we do a scan microinstruction, the program counter appears continuously on the address lines (A-6) and advances the address bus binary counter style, once per microsecond.

The scan microinstruction is usually stored in a small 32 x 8 PROM. The length of the sequence decides the total number of characters or graphics chunks output per line.

As the address bus advances during the scan microinstruction, each and every memory in the entire computer is sequentially addressed. By using a redundant calling of the scan microinstruction, the subroutine becomes portable and can be moved around as needed to pick up various lines stored in display memory, or can call the various dot combinations needed for a particular part of an alphanumeric character.

Usually, a scan microinstruction will last 32,40,64, or 80 microseconds, the normal length of a selected character or graphics line. The scan microinstruction is called over and over again as part of a larger main scan program. It is this larger scan program that causes TVT refresh, while the scan microinstruction causes individual characters to be output at a proper rate.

With some add-ons, the TVT refresh process can be made totally transparent, letting you run other computer programs at the same time you provide a continuous display.

THE UPSTREAM TAP

Normally, while the scan microinstruction is controlling the computer, nothing else is allowed data bus access. This means we are addressing everything else in the computer, but preventing everything else from doing anything useful at the same time.

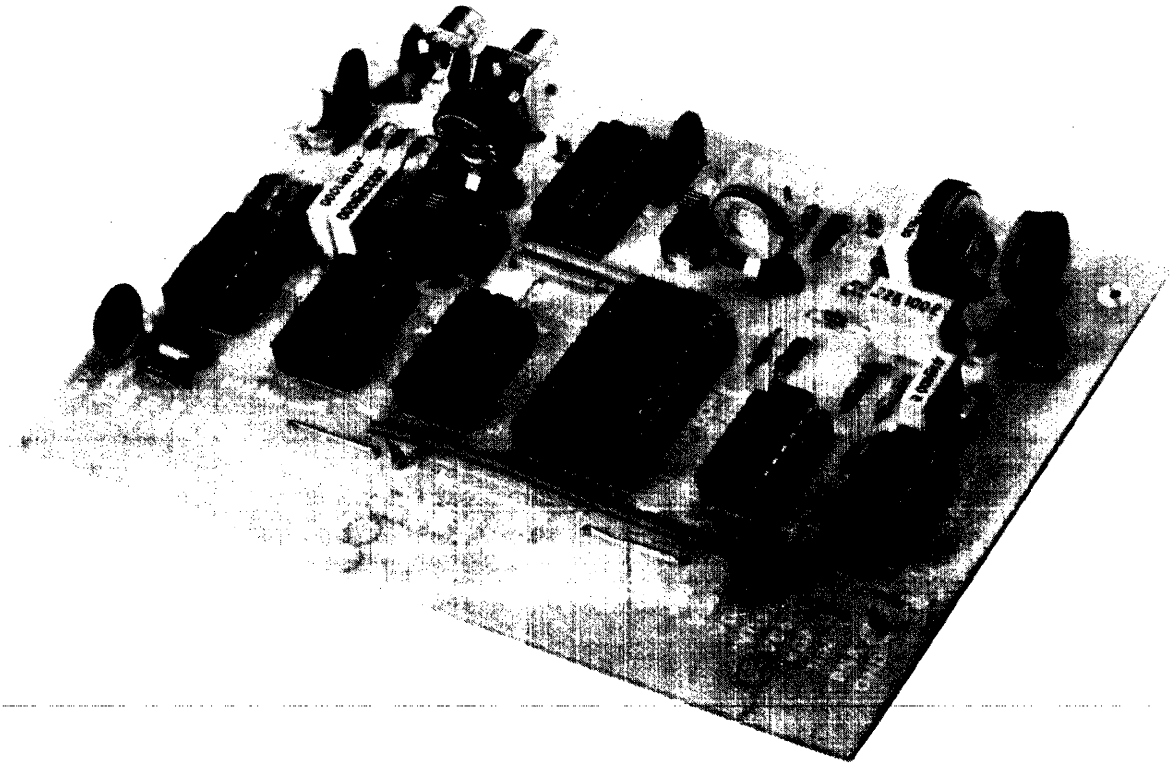
Somehow, we have to get characters out of the display memory when the memory does NOT have data bus access. This is done with the upstream tap of (A-7).

An upstream tap is nothing but eight pieces of wire at the output of the display memory but before the output bus drivers. Extra enable logic activates the otherwise normal display memory RAM during a scan microinstruction but does so only as far as the upstream tap.

The upstream tap in turn is connected to the interface hardware for conversion to serial video.

FOR MORE READING

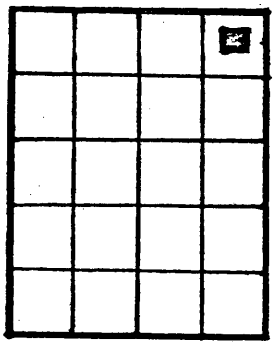
Complete details on cheap video techniques appear in the Sams Cheap Video Cookbook.



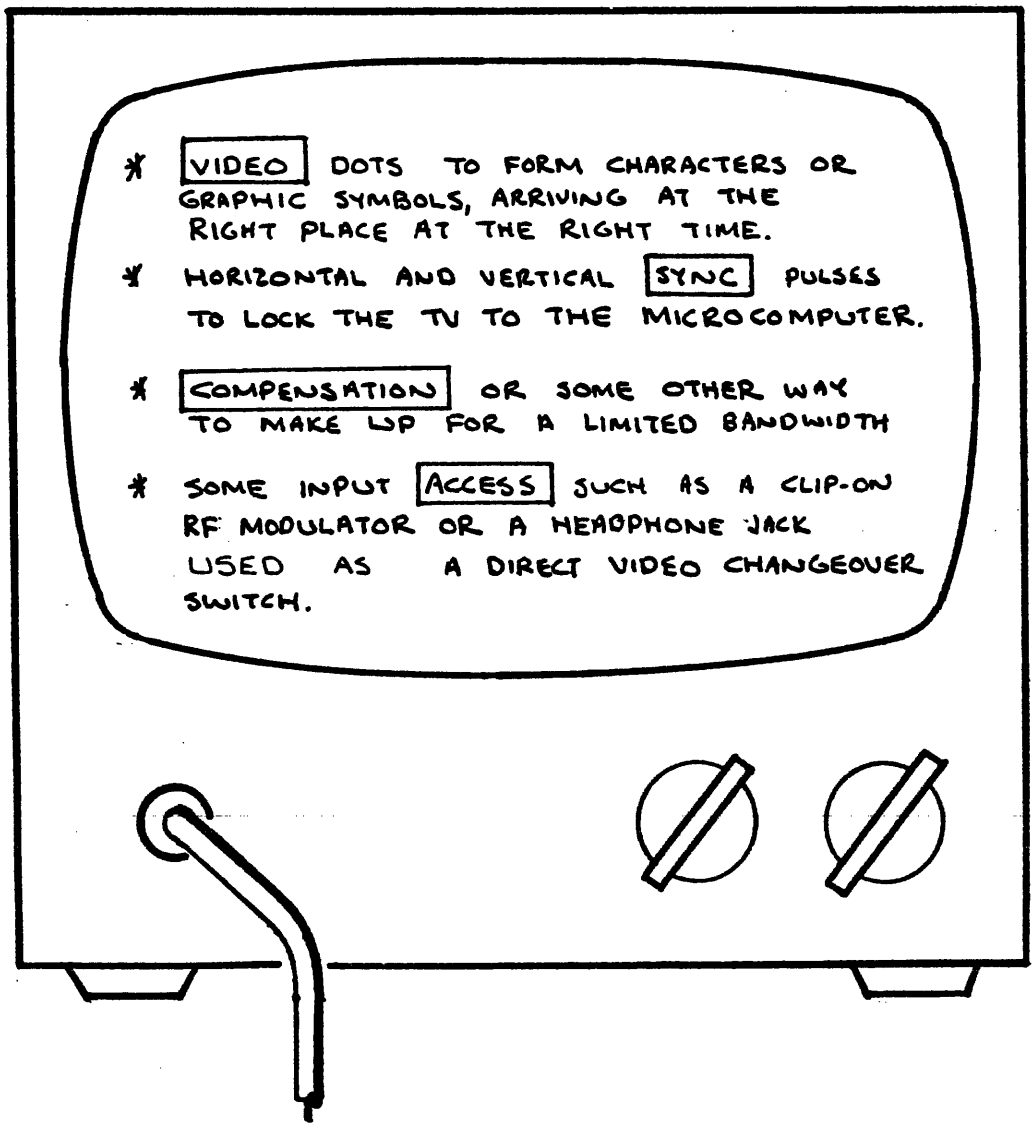
A-1 This PAIA TVT 6-5/8 is a typical cheap video system. Only seven low cost integrated circuits are needed for a high performance alphanumeric or graphics video display.

# A MICROCOMPUTER HAS .....

* A CLOCK THAT CAN BE USED FOR ALL SYSTEM TIMING.
* A MEMORY THAT CAN BE USED TO STORE CHARACTERS, OP-CODE, OR GRAPHIC SYMBOLS.
* SOME ADDRESS LINES THAT CAN SEQUENTIALLY ACCESS CHARACTERS.
* SOME DATA LINES THAT CAN CONTROL HOW WE ACCESS MEMORY.
* AND CONTROL LINES THAT LET US SWITCH BETWEEN VIDEO AND NORMAL OPERATION.

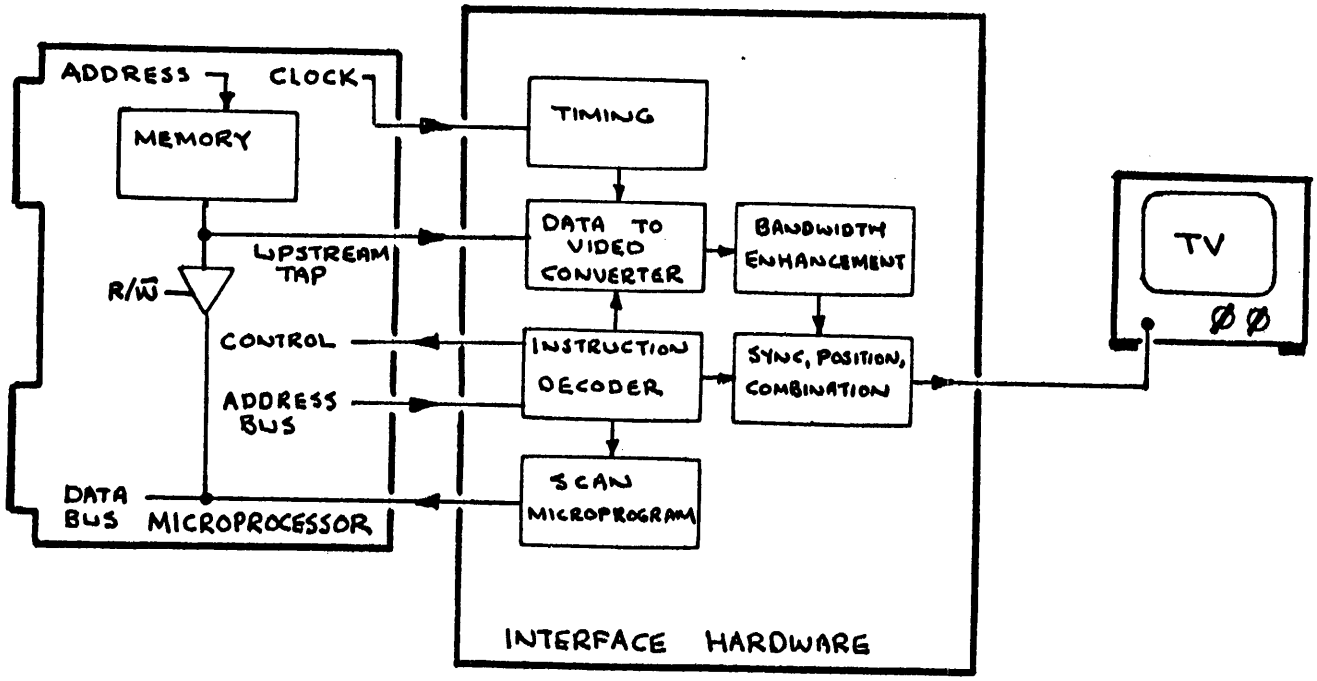


# A TV SET NEEDS.....

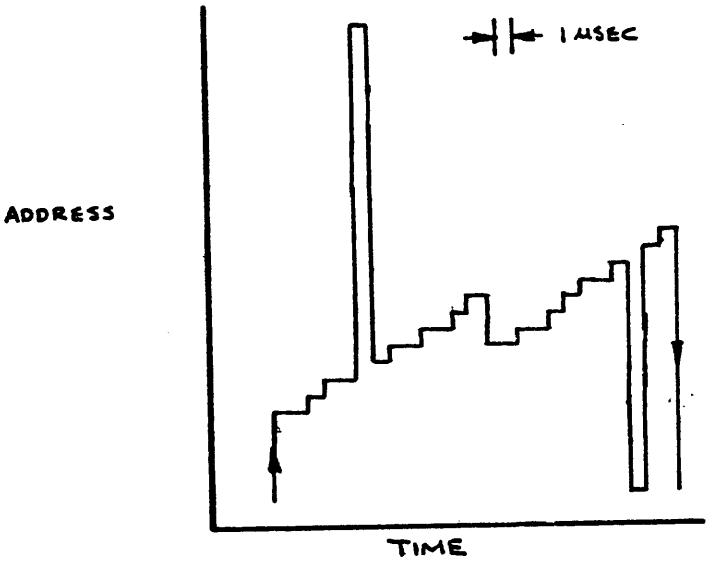



A-3 . . . . To here with . . . . . .

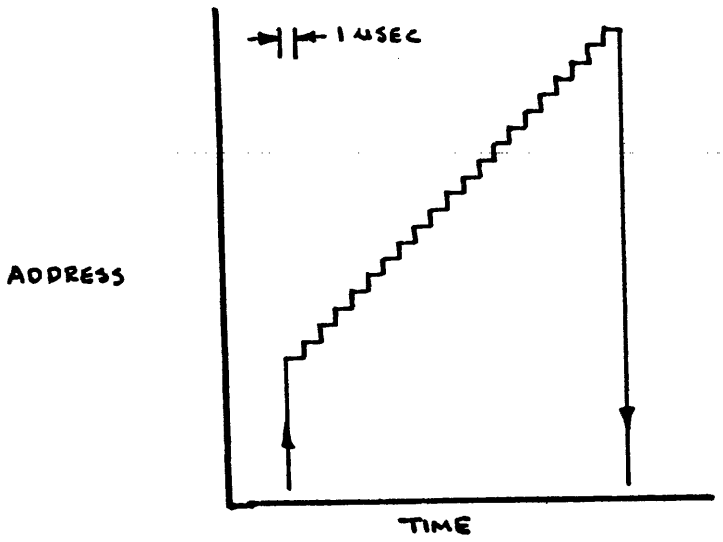
COMBINE THEM WITH INTERFACE HARDWARE TO BUILD A MICROPROCESSOR BASED CHEAP VIDEO DISPLAY.



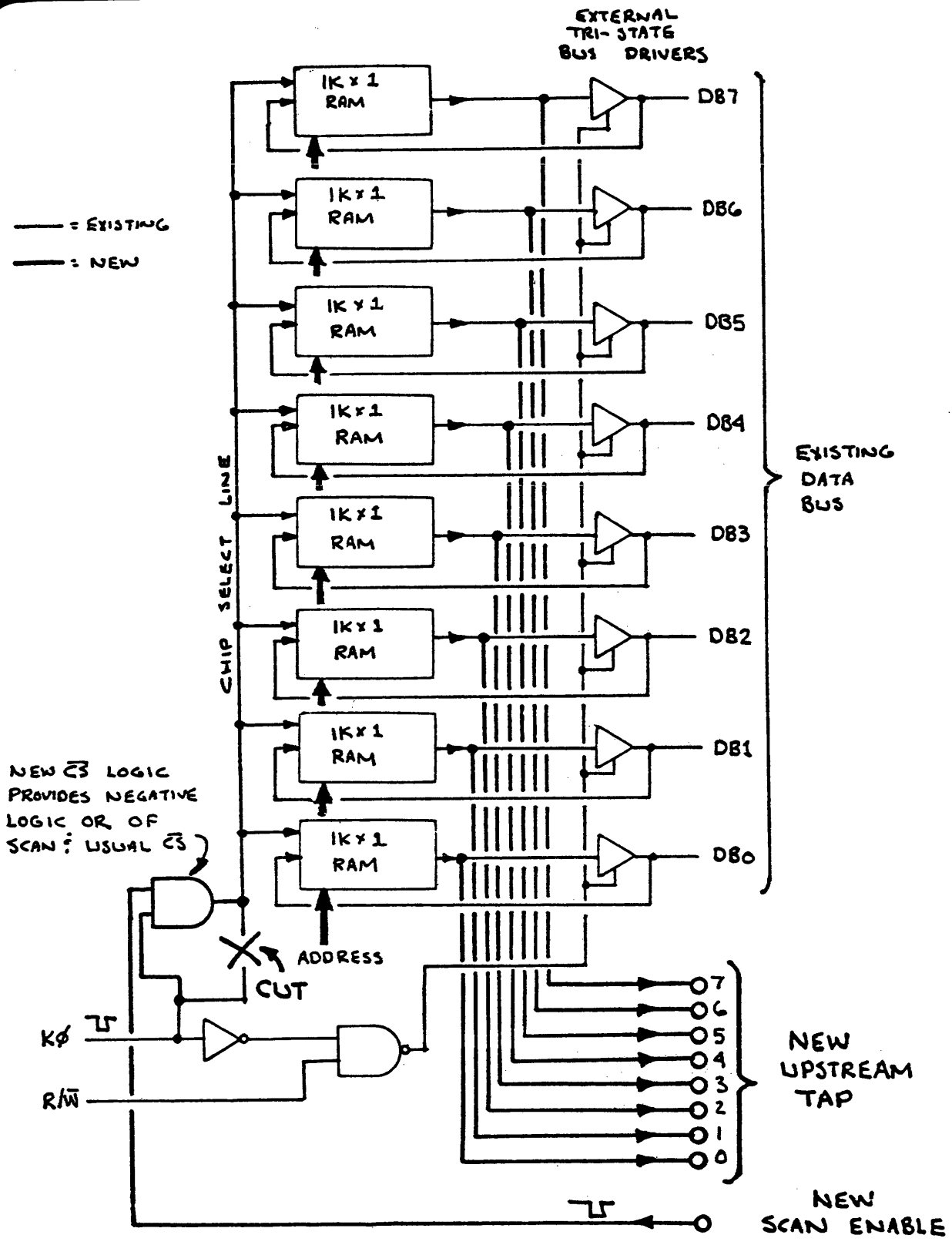

A-4 . . . . . As little of this as is possible.




A-5 Typical behavior of a 6502 address bus during a normal program. Bus may advance at a one or two microsecond rate, can loop, or can fetch higher or lower memory values.




A-6 A secret cheap video scan microinstruction forces the 6502 to uniformly advance addresses once each microsecond from a starting address. This sequentially accesses a block of display memory corresponding to a horizontal character line or its graphics equivalent.




A-7 A secret upstream tap works with the scan microinstruction to output characters. Total DMA hardware consists of eight pieces of wire.