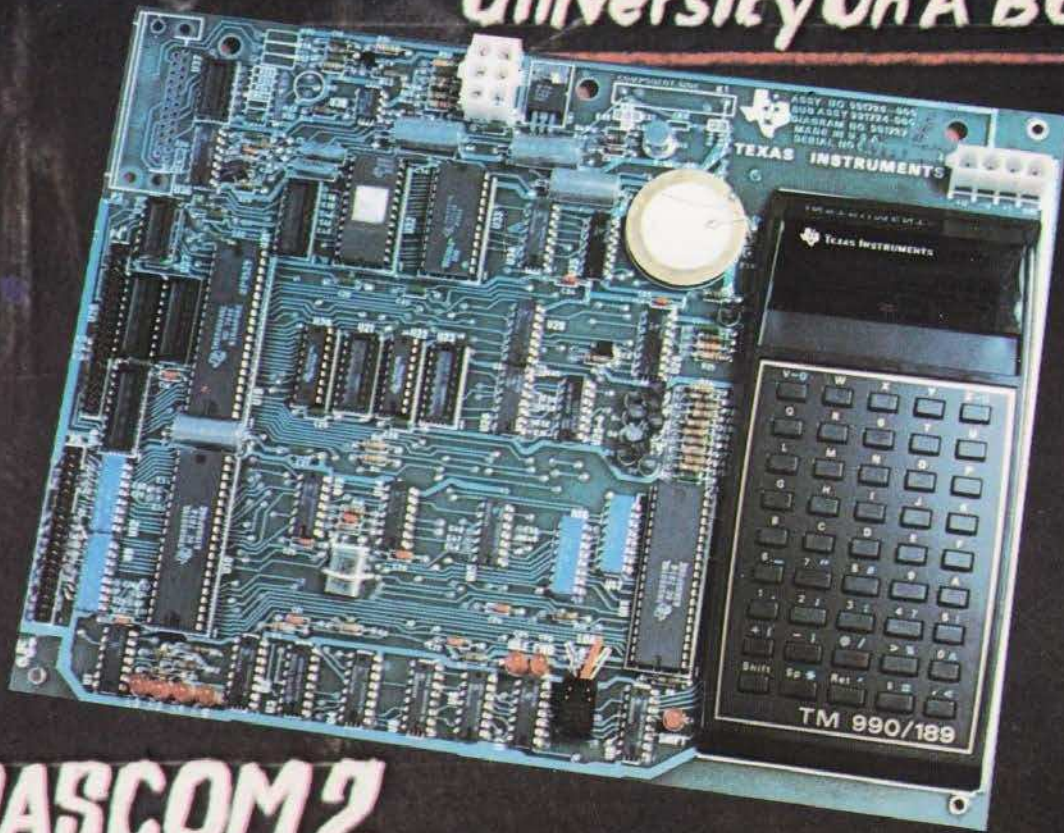


computing today

ISSN 0142-7210

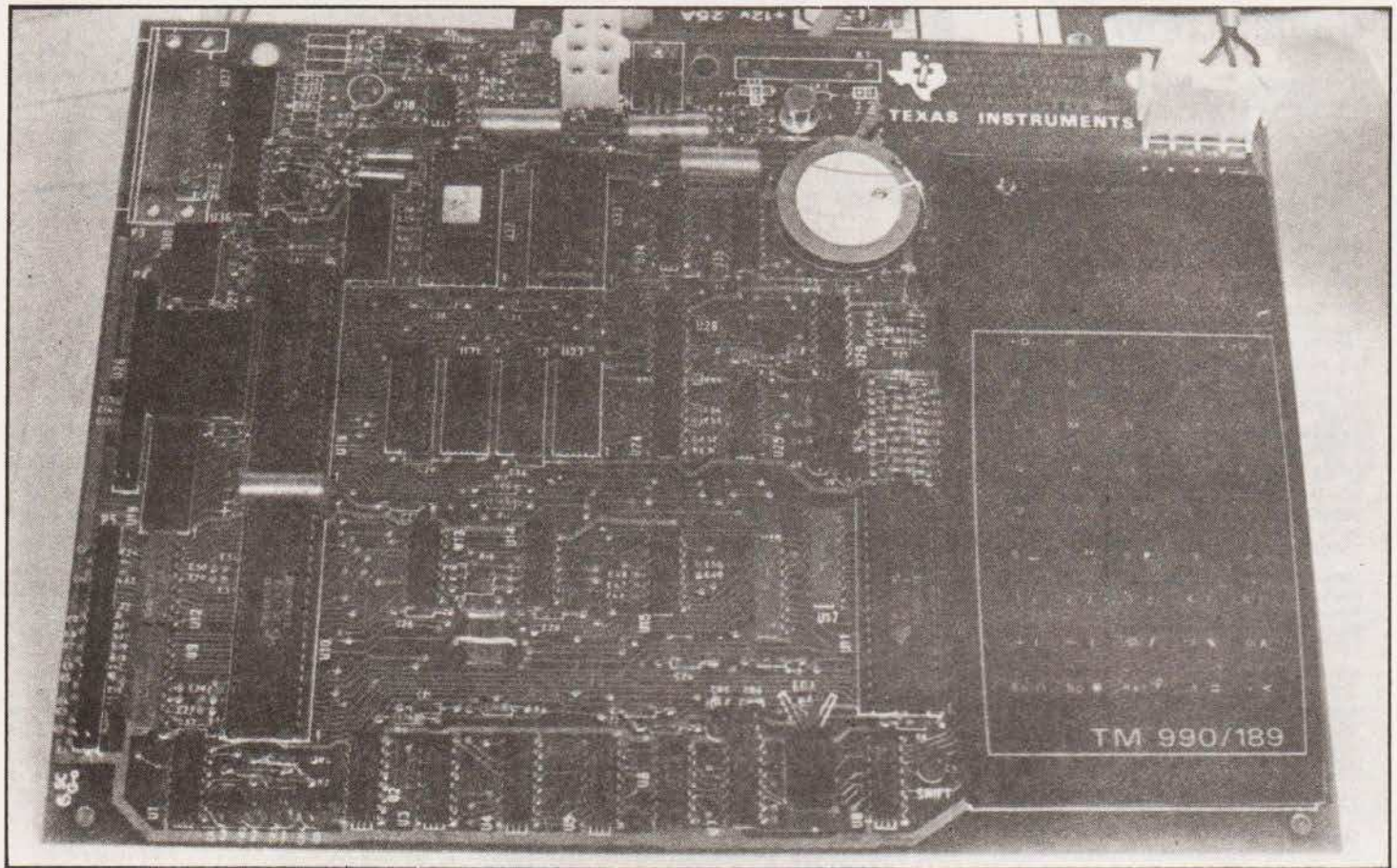
FEB 1980
50p

TEXAS TM990/189
University On A Board?



NASCOM2
REVIEWED
MICROLINK
TRS80 HINTS
LOGIC EMULATOR

Ron Harris B.Sc.



CT took a course in sixteen bit technology at the Texas University. Did we pass with flying colours.....

Tomewhat of an oddity this board. As you can see from the photographs, the most prominent feature is a calculator keyboard and display assembly mounted to the right of the main PCB. The pale disc is a piezo 'speaker' providing a sort of sound capability.

The TM 990/189 is one of the series from Texas based upon their unique TMS9980 (16-bit) MPU. It is designed to introduce a complete tyro to the art of assembly language programming and comes complete with a User Guide to the module, and a massive self-teach manual - some five hundred and seventy pages in all - which begins with a run down of computer architecture and hopes to have the reader well into modular programming techniques by Chapter 8.

A PSU is required to run the TM 990, and for £67.82 Texas will supply one. The specification required of the supply is +5V at 2A, and +/- 12V at 0A5 or thereabouts.

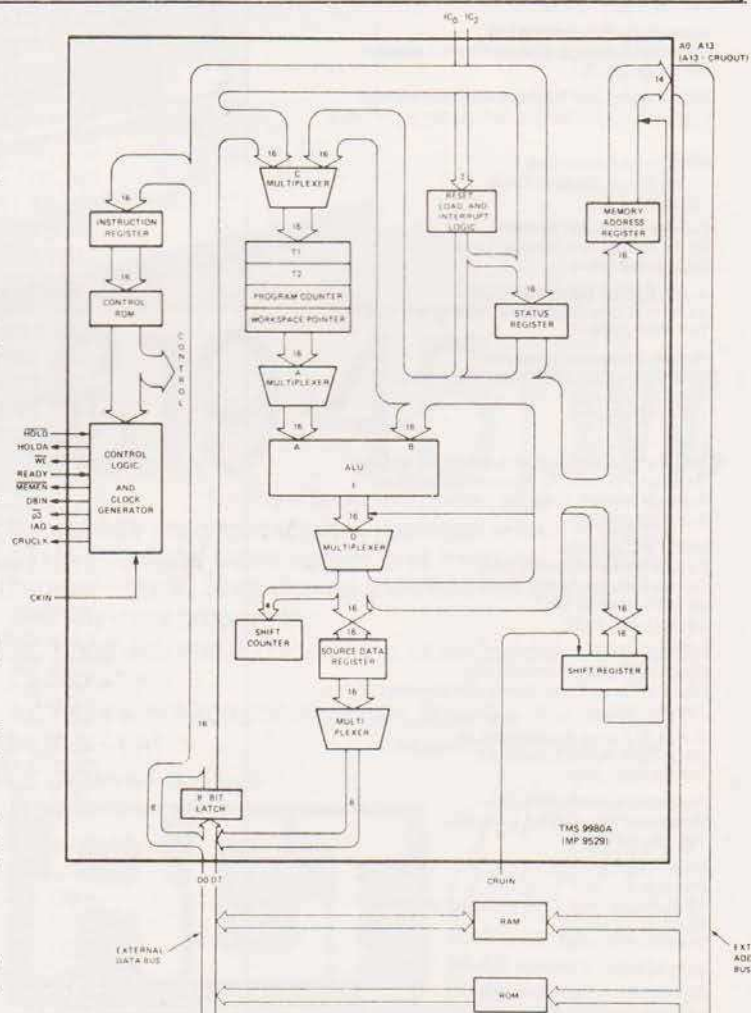
We used the Texas supply for our review, simply because it saved us building one and we were eager to find out what power lay behind that bleak keyboard.

However we suspect that most of our readers would be able to provide their own for considerably less than £67. Check it before connecting, though, if you intend to follow this course of action through. Regulation should be +/- 5% of nominal.

All fairly standard stuff.

Texas have pulled a little string by fitting a cable - reversible

Fig 1. (Right) The CPU architecture of the TMS 9980A



M990/189 UNIVERSITY MODULE

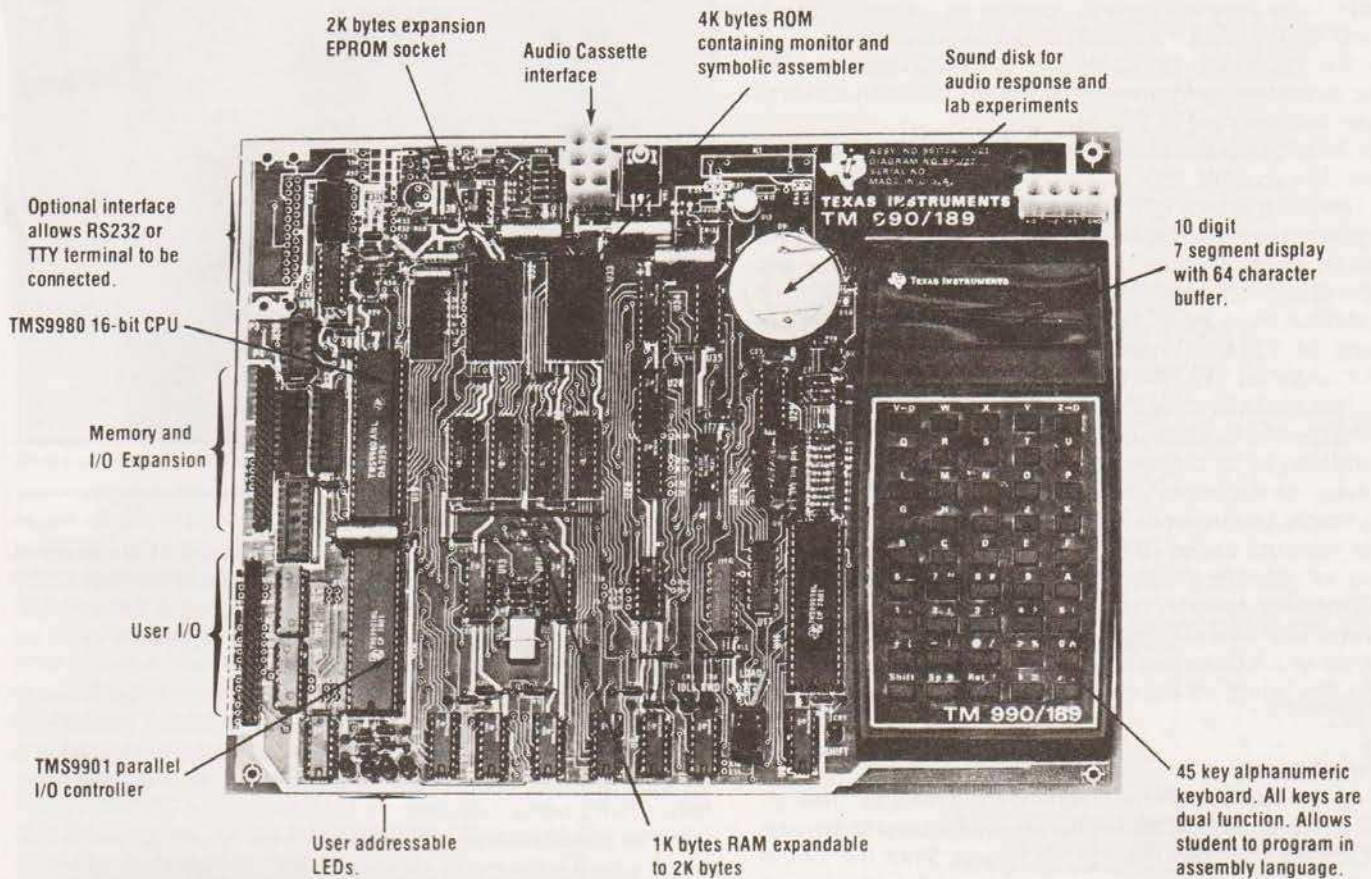


Fig 2. The module PCB and wot's on it!

and idiot proof - with the same weird plug on both ends, that will connect up a TM 990 to their own PSU in a second, but which might cause a few hours wandering around to component shops, vaguely waving plugs in the air in the hope of acquiring a match.

If thine plug offends thee - cut it off and solder 'in' a more common item.

Of the Texas PSU, number TM 990/519, there is little to say - it is superbly constructed, works perfectly and is overpriced. All in all a typical boring power supply!

On Board

The University module, with its 'software' costs a fulsome £256. As this is about £80 more than the likes of a Superboard II, with its BASIC and 8K of user RAM, we are entitled to ask searching questions of the Texas package. For a start what do you get for your £256?

Well, as you can see from our photos, the PCB is well produced and beautifully constructed. Its contents consists of:-

1. Alpha-numeric keyboard (45 keys)
2. Piezo-electric sound output device
3. TMS 9980A 16 bit MPU
4. 4K ROM (expandable to 6K)
5. 1K RAM (expandable to 2K)
6. 2M clock circuitry
7. Cassette I/O
8. 16-bit programmable I/O and interrupt monitor (type TMS 9901)
9. LED display (seven segment)

Keyboard:- 45 keys with a 'shift' facility which allows for 87 ASCII characters to be input.

Fig 3. (Right) Block diagram of the Texas system.

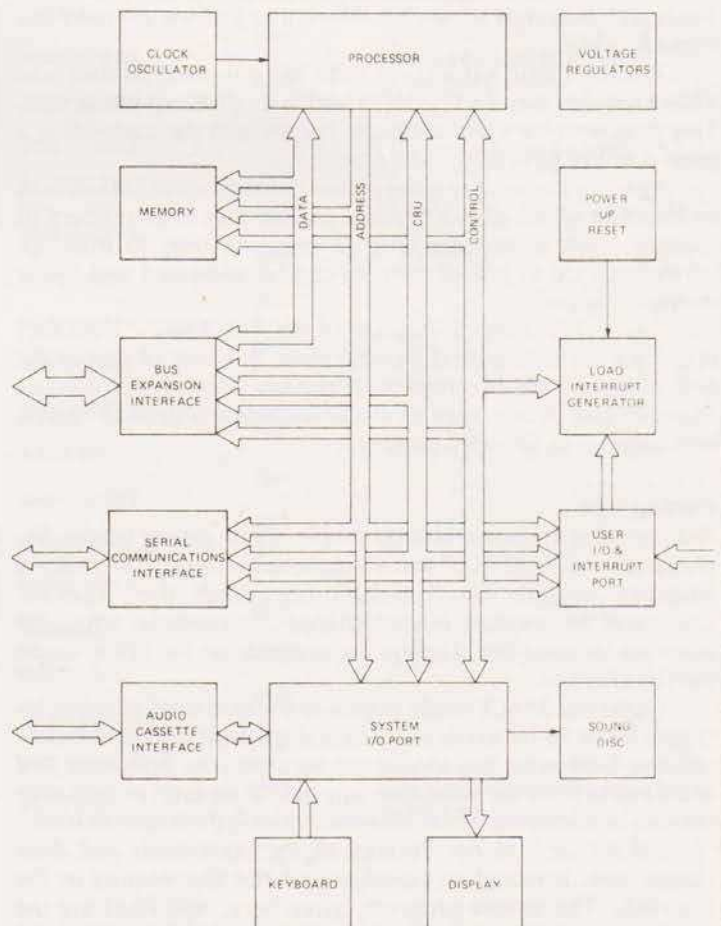


Figure 1-2. System Block Diagram

Speaker:- under program control, operates on command. Has a limited sound range, but is a useful peripheral nonetheless.

ROM:- the on-board 4K holds the UNIBUG monitor and 'symbolic assembler' as firmware. There is an expansion socket to hold a user programmed 2K PROM.

Cassette Interface:- use of the TM 990/802 Software Development Board is possible with this, and the cassette I/O is compatible. There is space on PCB for a control relay to be mounted.

LED Display:- the main display shows nine characters out of the 64-character string, and can be shifted left or right to show any nine of the string without affecting store contents.

In addition there are four LEDs on board for general purpose monitoring of CRU, (Communications Register Unit) which allows for single bit I/O, (the CRU is internal to the TM 9980A) and program control monitoring. Three of the four LEDs are for monitoring specific functions (SHIFT etc) under UNIBUG control.

In addition to all this there's a very important little switch hidden away on the board labelled 'LOAD' which is a lot more use than simply loading onto TAPE. The switch generates a non-maskable interrupt to the CPU. This causes discontinuation of execution of current program, and releases control to the UNIBUG monitor. Memory contents are not affected.

A sort of final override command, which can be used to bring the CPU out of a loop or just generally make it listen to you a bit better! As this brings us around to the monitor, lets take a look at UNIBUG.

Monitoring Around

Table 1 gives the list of the commands available through UNIBUG. In the same EPROM lies the assembler used to provide the TM 990's basic (no pun intended) language. Since the 9980A is a 16-bit beast, its instruction set is very powerful. In addition Texas architecture is somewhat different to that we are used to - to put it mildly.

The TM 9980A has a 16-bit CPU, but only an 8-bit data bus. Thus it requires two read cycles to fetch a single-word instruction. This does limit the chip, although Texas claim the trade-off is a good one. We have our doubts.

Memory-to-memory is the phrase coined for the TMS 9980A architecture which allows multiple register files to be resident in memory, with a resulting drop in response time to interrupt commands. Up to 16K of memory can be addressed and I/O is memory mapped.

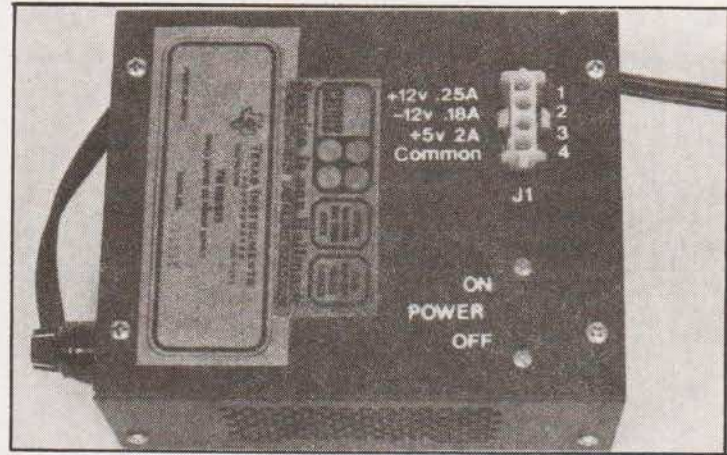
Figure 3 is a block diagram of the TM 9980A. UNIBUG could not fail to be a good monitor given this kind of start of life and it was no disappointment. It confers upon the University Board an ease of use - even given the limited on board I/O - that is well suited to its intended purpose.

Putting It In

Programming the board is fairly simple. Upon power up the display shows 'CPU READY' and a simple RETURN command allows keyboard control. The UNIBUG commands then operate. Command 'M' (memory inspect/change), for example, opens the specified location and displays the contents on the LEDs. It can then be changed.

Operating SPACE single steps into the next even number location. Since 16-bit words are used and are organised as two consecutive 8-bit bytes this should not surprise you. Both byte and word instructions are allowable, any byte at an even or odd address can be addressed by the different modes in the instruction set.

I don't wish to run through all the commands and their usages here, it would be pointless and not illuminating in the slightest. The sample program, given here, will illustrate the points necessary I believe. The program is to add 33₁₀ to 15₁₀ and display the result.



A Texas PSU. It is so efficient it's boring.

Does It Or Doesn't It?

It is not possible here to do more than simply scratch the surface of the TM 990 board, a detailed description would fill an issue all by itself. The important point, though, remains whether or not it fulfills its design aims and does it in a way which represents value for money to the purchaser.

The aim is to provide an introduction to the MPU technology and to open a door through which some hands-on experience can be gained for serious students. We suspect the pricing level is set thus in expectation of an industrial or academic purchaser rather than a home hobbyist.

The tuition manual is pretty good. Very American and a little vague who it is talking to sometimes, but very good nonetheless. The link to the TMS 990/189 is well forged, and the two complement each other well.

Drawbacks are few, but significant. For a start the keyboard does not have the SHIFTed designations marked on it, and they only exist at all on one page of the manual - incredible! Tsk tsk. Zero for usage there Texas.

The main drawback though, we feel, is simply the TMS 9980A itself. There is no doubt as to the power of this processor - indeed it shows very clearly how far these components have come since their introduction - but in this context it may be too atypical to be generally useful. Use of the board certainly taught me a lot about use of that CPU, and 16-bit hardware in general, but I feel it would be a difficult transition for a student to make from these giddy heights of flexibility and power down to the more usual 8-bit 6502s and the rest.

The TM 990/189 makes a superb evaluation kit though.

Summary

So that is it. A well constructed and thought out package with versatile on board I/O and a powerful processor. A board which makes an excellent tutorial tool - but only in teaching its own subject - the Texas Instruments CPUs. Fair enough, I suppose, but be

Input	Results	Paragraph
A	Assembler Execute	3.3.3
B	Assembler Execute With Current Symbol Table	3.3.4
C	CRU Inspect/Change	3.3.5
D	Dump Memory to Cassette	3.3.6
E	Execute to Breakpoint	3.3.7
F	Status Register Inspect/Change	3.3.8
J	Jump to EPROM	3.3.9
L	Load Memory from Cassette	3.3.10
M	Memory Inspect/Change	3.3.2
P	Program Counter Inspect/Change	3.3.11
R	Workspace Register Inspect/Change	3.3.12
S	Single Step	3.3.13
T	"Typewriter" Program	3.3.1
W	Workspace Pointer Inspect/Change	3.3.14
Ret	New Line Request	3.3.15

Fig 4. UNIBUG command set.

TM990/189 UNIVERSITY MODULE



Some of the software which arrived with the TM990/189

aware of the limitation. The tutorial manual is very good and possessed of only a few minor errors. These are two Fig 1-19s for example and no 1-29. Let he who is without printing error cast the first dictionary.

The final question - value for money? I think not compared to what else is available for the price, but then educational courses are always expensive. This one is good in its own way and in the end you must decide for yourself if it is worth your pounds.

Our thanks to the distributors, Celdis of 37/39 Loverock Road, Reading, Berks RG3 1ED for loaning us the TM 990/189 and PSU for this article. All enquiries concerning the module should be addressed to them.

a. Problem:
Write a program that will add 3310 and 1510 and display the answer.

b. Program Solution:

```
LWPI    ~-0300    Load immediate to workspace pointer.

LI      0,33     Load R0 with first number (3310)
LI      1,15     Load R1 with second number (1510)

A       1,0     Add, answer in R0 (memory address 30016)
XOP    0,10     Display contents of R0
XOP    1,13     Turn display on
```

c. Program	Address	Hex Contents
LWPI	~300	0200 02E0
		0202 0300
LI	0,33	0204 0200
		0206 0021
LI	1,15	0208 0201
		020A 000F
A	1,0	020C A001
XOP	0,10	020E 2E80
XOP	1,13	0210 2F41

d. To enter the previous program:

1. Apply power to the TM 990/189
2. The TM 990/189 will energize in a power up LOAD state and the display will show CPU READY.

DISPLAY	ENTER	COMMENTS
CPU READY_		
?_	(Ret)	UNIBUG commands can be entered now
?M_	M	Memory Inspect/Change
?M 200_	200	M.A. 0200
0200 = XXXX_	(Ret)	Current Contents M.A. 0200
XXXX 02E0_	02E0	Enter New Contents
0202 = XXXX_	(Sp)	Advance to Next M.A.
0202 0300_	0300	Current Contents M.A. 0202
XXXX 0021_	(Sp)	Enter New Contents
0204 = XXXX_	0200	
XXXX 0200	(Sp)	
0206 = XXXX_	0021	
XXXX 0021_	(Sp)	
0208 = XXXX_	0201	
XXXX 0201_	(Sp)	
020A = XXXX_	000F	
XXXX 000F_	(Sp)	
020C = XXXX_	A001	
XXXX A001_	(Sp)	
020E = XXXX	2E80	
XXXX 2E80	(Sp)	
0210 = XXXX	2F41	The entire program has been entered at this point
XXXX 2F41		

Fig 5. An example of how easy to use the TM990/189 can be. The UNIBUG monitor cannot be praised highly enough.

Micro-Computer Centre for the MIDLANDS

Nascom and Commodore Specialists

Business and Leisure Micro Computers, stockists of well known computer systems and micro processors. B&L Micros offer a user service which will be of special interest to the businessman as well as the hobbyist seeking a new and exciting challenge.

A full range of micro computers and peripherals are available, whether buying or browsing we can give helpful and friendly advice.

Nascom 2 complete kit ex. stock £295.00 + VAT or fully built and tested £335.00 + VAT.

Nascom 1 super new low prices £125.00 + VAT or fully built and tested £140.00 + VAT this has to be the best starting point for anyone interested in Micro Computing.

We are now sole distributors for the Micro Type case for your Nascom 1 & 2, also stockists of the William Stuart colour graphics and full range of add ons.



Business & Leisure Micro Computers

16 The Square, Kenilworth, Warwickshire CV8 1EB. Tel: (0926) 512127