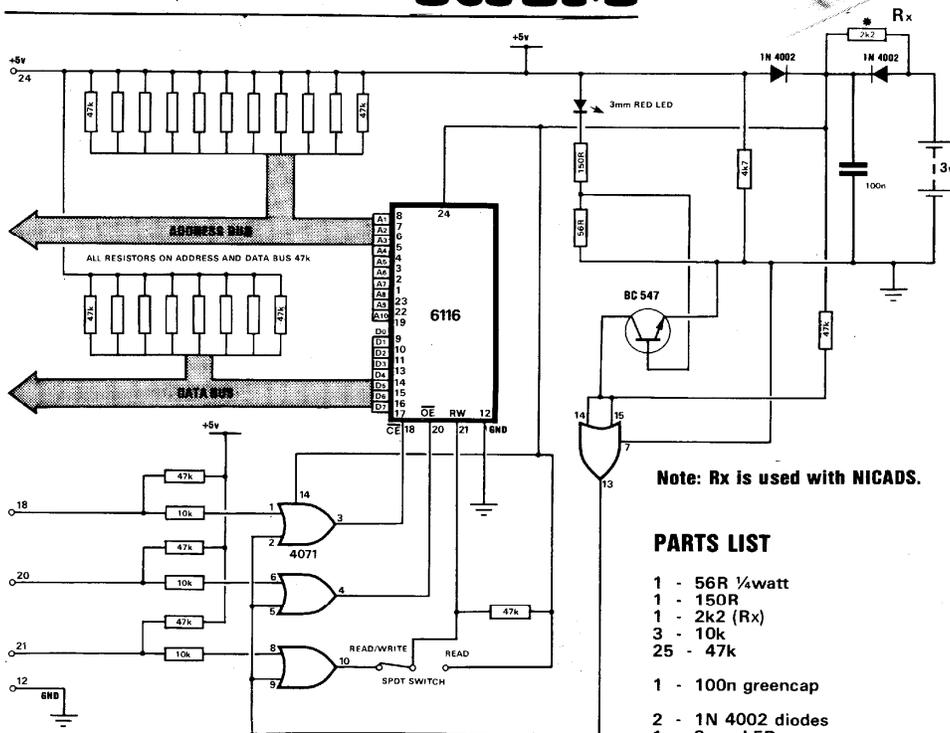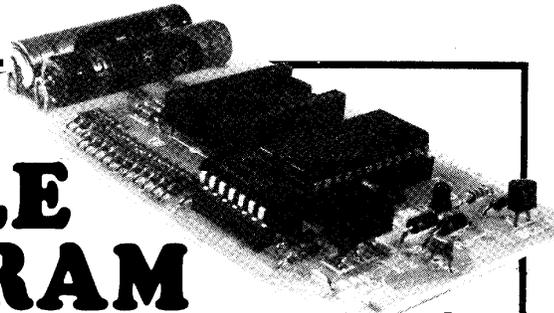# NON-VOLATILE RAM

PC Board: $3.60
Parts: $19.60

Note: Rx is used with NICADS.

PARTS LIST

1 - 56R ¼watt
1 - 150R
1 - 2k2 (Rx)
3 - 10k
25 - 47k

1 - 100n greencap

2 - 1N 4002 diodes
1 - 3mm LED

1 - BC 547 transistor
1 - CD 4071 IC
1 - 6116 RAM

1 - 14 pin IC socket
1 - 24 IC socket
1 - 24 pin wire-wrap socket
1 - 24 pin DIP header

1 - SPDT switch

2 - AAA cells

20cm tinned copper wire

1 - **NON-VOLATILE RAM PC BOARD**

Many constructors have requested some means of saving the programs they produce on their TEC'c.

Most suggested a TAPE SAVE facility whereby they could load their program onto a cassette and hold it until required. This would allow the TEC to be turned off / or used for other tasks.

Tape save is a project which will appear as a future add-on and has certain advantages. Before we present a tape save we have designed a storage project using a 6116 CMOS RAM chip, which will be the next best thing.

It is a battery backed-up RAM which can be written into and then protected via a switch to become a Read Only Memory. It can be left connected to the TEC or removed at any time and the battery automatically takes over, keeping the contents in an unchanged state.

The 6116 RAM takes an amazing 2 microamps in the storage state (power-down state) and this represents little more than the natural deterioration of the cells.

Under these conditions the two back-up cells should last about 1 year.

The main advantage of this form of memory is information is immediately accessible and does not have any loading delays as experienced with tape.

When producing Machine Code programs, it is not necessary to have a large RAM memory and a single 6116 will be sufficient for even quite a long program.

We have called this project NON-VOLATILE RAM and have already found it to be invaluable when developing programs for other computers and dedicated systems. It is easy to use and can be written into directly or filled from TEC memory.

Once the data has been deposited, the switch is changed to 'ROM' position and the information is protected.

HOW IS THIS DONE?

The 6116 RAM chip is the centre of the design. It is a low-power CMOS device with exceptionally low stand-by current. Many of the TEC owners will already have one of these chips. It is important to note that only the 6116 can be used as the N-MOS version 58725 consumes 4,000 times more current in stand-by mode.

The 6116 draws about 2 micro-amps whereas the 58725 consumes 8 milli-amps. If you have one of each, use the 6116 for the non-volatile project and retain the 58725 as the TEC RAM.

Theoretically the RAM in the TEC can be converted to battery back-up but this poses a problem as the control lines must be taken HIGH or LOW to prevent the RAM being written over during the time when the TEC is powering down.

We had difficulty in achieving a guaranteed result and opted for a separate RAM card. This allows the card to be transferred to other projects, enabling programs to be generated and corrected until they operate perfectly.

When the RAM card is plugged into the TEC it draws power via diode D1 while diode D2 prevents the voltage from charging the batteries. When the TEC is switched off, the batteries supply a potential to the chip via diode D2. Diode D1 prevents the TEC from drawing on the batteries.

The 2.4volts from the batteries (.6v is lost across diode D2) is sufficient to hold the data.

The LED and resistors R1, R2 form a voltage-loss detection circuit to switch the non-volatile RAM into stand-by mode.

They form a voltage-divider circuit for the base of the BC 547 transistor. When the voltage across the LED and resistor R1 is below 4v, the transistor switches OFF, allowing the inputs of the OR gate to go HIGH, via a buffer. This takes the Chip Enable, Output Enable and Read/Write lines HIGH, protecting the RAM contents from erasure.

All address and data lines are taken LOW to prevent them floating and thus wasting power.

USING THE RAM CARD
The 'on-board' cells will provide power to the chip for about 1 year and this makes it an ideal storage medium for saving programs.

When inserting and removing the RAM from the TEC, the RESET button must be pressed. This will freeze the address and data bus and prevent any glitches from entering either the RAM or TEC. Remove and insert the RAM card quickly to prevent excess voltage appearing on the pins of the 6116.

If this does occur, the circuitry inside the 6116 may heat up excessively and cause the TEC to crash. The RAM will also lose its contents, but may not be permanently damaged.

CONSTRUCTION
All the components are mounted on the top of the board in positions as shown by the overlay. The ROM/RAM SELECT is a slide switch and it is best to keep to a slide switch so that the writing on the board reads correctly.

The RAM card is connected to the TEC via a 24 pin wire wrap socket and component header plug soldered together to form a stand-off. The 6116 faces towards the switch as does the 4071 and this may mean the writing on the chip(s) is up-side-down.
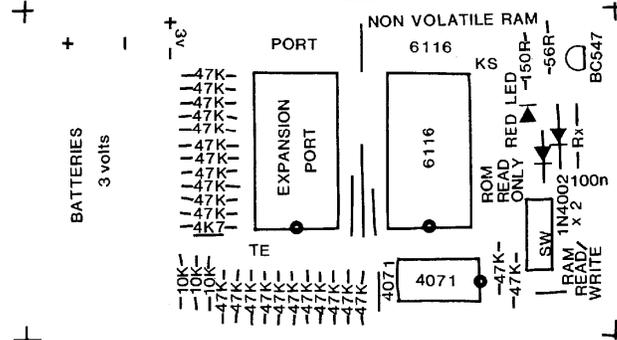
See P. 75 for PC artwork.
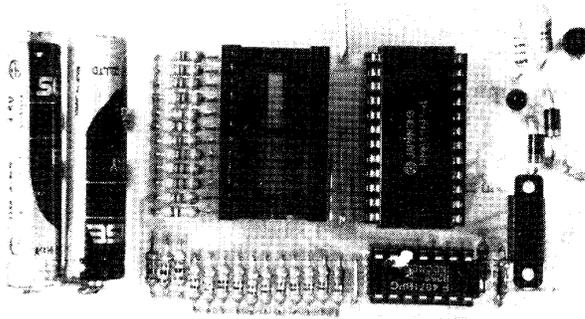
The RAM card is accessed at the address of the socket in which it is placed. This means it is addressed at **1000** to **17FF** in the expansion port socket. It can also be placed in the RAM socket and is addressed at **0800** to **0FFF**. If placed in the EPROM socket it must already contain a start-up routine for the TEC and is addressed at **0000** to **07FF**.

When placed in the expansion port socket, it can be addressed at higher values by cutting pin 18 of the wire-wrap socket and taking a lead to one of the Chip Select pins near the edge of the board. The lowest of these is addressed as **1800** the next as **2000** and the next as **2800** etc.

If the RAM card is used in the monitor socket it can only be used in the READ MODE as this socket does not have a READ/WRITE line.

This situation also applies when using the RAM card in our dedicated computer project as described in the book: **ELECTRONICS FOR MODEL RAILWAYS.**

The RAM CARD can also be used to create programs for the Microcomp. Any of the programs described in the Microcomp article can be typed into the RAM and executed on the 'comp.

Remember, the Microcomp programs are designed exclusively for the 'comp as it has only a single output latch - the TEC has two output latches.

DUMP ROUTINE

You can use the RAM CARD for many other applications and also transfer up to 2k of program into the card by loading the following into the TEC at **0800:**

```
         TO 11 00 10
       FROM 21 XX XX
No of BYTES 01 YY YY
            ED B0
            C7
```

Where **XX XX** is the start of the program you wish to copy and **YY YY** is the number of bytes you wish to transfer. e.g: If the program to be copied is at **0900** and 80 bytes long, the program at **0800** is:

```
11 00 10
21 00 09
01 80 00
ED B0
C7
```

Note: If the program starts at **0900** and finishes at **090F**, you must insert **01 10 00** into the program because 0900 to 090F contains 16 bytes of program (10 hex bytes) Not **0F** bytes!
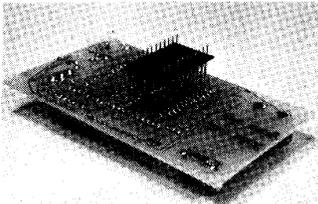
The wire-wrap and DIP header are soldered together to form a stand-off.

If you have written the program at **0800**, you can place the DUMP ROUTINE at **0900**. This is how to do it. Load the program, go back to the start of the program (0900) and push GO. Do not push RESET. The dump program will then be executed. The dump routine can be placed anywhere in RAM by using this method.

Suppose you want to copy the MONITOR ROM. Load the following Dump Routine into the TEC at 0800:

```
11 00 10
21 00 00
01 FF 07
ED B0
C7          Push RESET, GO.
```

Within a fraction of a second the monitor program will be loaded into the CARD. Change the Read/Write switch to READ and the contents will be protected. Remove the Monitor ROM from the TEC. Insert the CARD and turn the TEC on. It will start up as normal.

To remove a program from the CARD, it is best to fill it with FF's. This will be needed in later programming, when you want to transfer a program from the CARD to an EPROM.

The unused locations will contain FF and these can be burnt to any other value. A value such as 00 cannot be 'burnt down'. For more detail on this, see the EPROM PROGRAMMER project.

TO FILL THE CARD WITH FF's:

at 0800:

LD BC 07FF	01 FF 07
LD HL 1000	21 00 10
LD A,FF	3E FF
LD (HL)A	77
INC HL	23
DEC BC	0B
LD A,B	78
OR C	B1
JRNZ	20 F7
RESTART 0000	C7

TO FILL THE TEC WITH FF's:

The TEC RAM can be filled with **FF's** by loading the following into **0800:**
11 FF FF
D5
C3 03 08
Reset, GO.

This puts **FF FF** onto the stack and the stack increments downwards to **0800!** - until the computer crashes.

Both TEC and CARD can be filled at the same time by changing the first two lines to:

01 00 10
21 10 08

Using these programs, any number of locations can be filled, anywhere in RAM. They can be filled with any value such as **BB, CC, or 33** etc.

Programs can be transferred from the TEC to CARD and from CARD to TEC via the DUMP ROUTINE. Some examples are given in the EPROM BURNER article.

IF THE RAM CARD FAILS TO WORK:
There are three major faults which may occur with this project:

1. **You cannot write into memory.**
2. **Information in the RAM card is lost.**
3. **The TEC starts to play up.**

If it is not possible to write directly into the RAM card or dump into it via a DUMP ROUTINE, the fault will lie in the READ/WRITE line. This is pin 21 of the 6116. It must be low to be able to change the data. Test it with a logic probe or high impedance multimeter. Don't forget to address the RAM correctly (via the addresses given previously).

If the information in the RAM card gets lost, the fault will lie with pin 21 of the 6116. It may be floating or go LOW for brief periods so that noise and glitches enter the address and data lines to change the stored data. This problem can also be due to weak batteries or poor contact between the cell and the disk on the bottom of the cell. Try a different brand.

If the TEC starts to play up, it may be due to the RAM card drawing too much current. Feel the RAM chip. If it is getting hot, remove it immediately and let it cool down. The fault may be due to the way you inserted the CARD into the TEC.

Make sure you push the RESET button while inserting the card so that the buses are in a non-active state. If the TEC continues to play up when the card is re-fitted, replace the 4071 and/or the 6116 chip. ●

PC ARTWORK:

NON-VOLATILE RAM

TE

KS

ISSUE 13

LOGIC PULSER

KS

TEC
POWER
SUPPLY

MICRO COMP-1

(03) 584 2386

© 1985

A TE DESIGN

PL