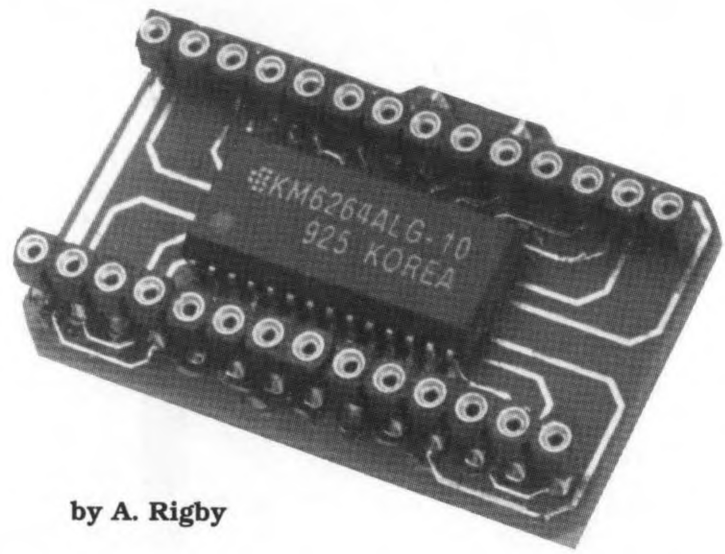
RAM EXTENSION FOR MINI Z80 SYSTEM

The Z80 card described last month will be perfectly suitable for many applications. There are cases, however, in which RAM is a must, and that is why we now present a simple extension circuit for 8, 16 or 24 Kbyte of static RAM.



by A. Rigby

CHALLENGING, this Z80 programming without RAM, but the amount of data that may have to be stored at one time during the execution of a machine code program soon exceeds the capacity of the registers contained in the Z80. In that case, RAM (random access memory) must be used, although it is possible to go a long way without it.

Some applications, for instance, a data logger, simply can not work without RAM because it is required to store amounts of data that can not possibly be 'crammed' into the registers, even if the Z80 sports so many.

RAM in an EPROM socket

The RAM extension developed for the mini Z80 system (Ref. 1) is suitable for other

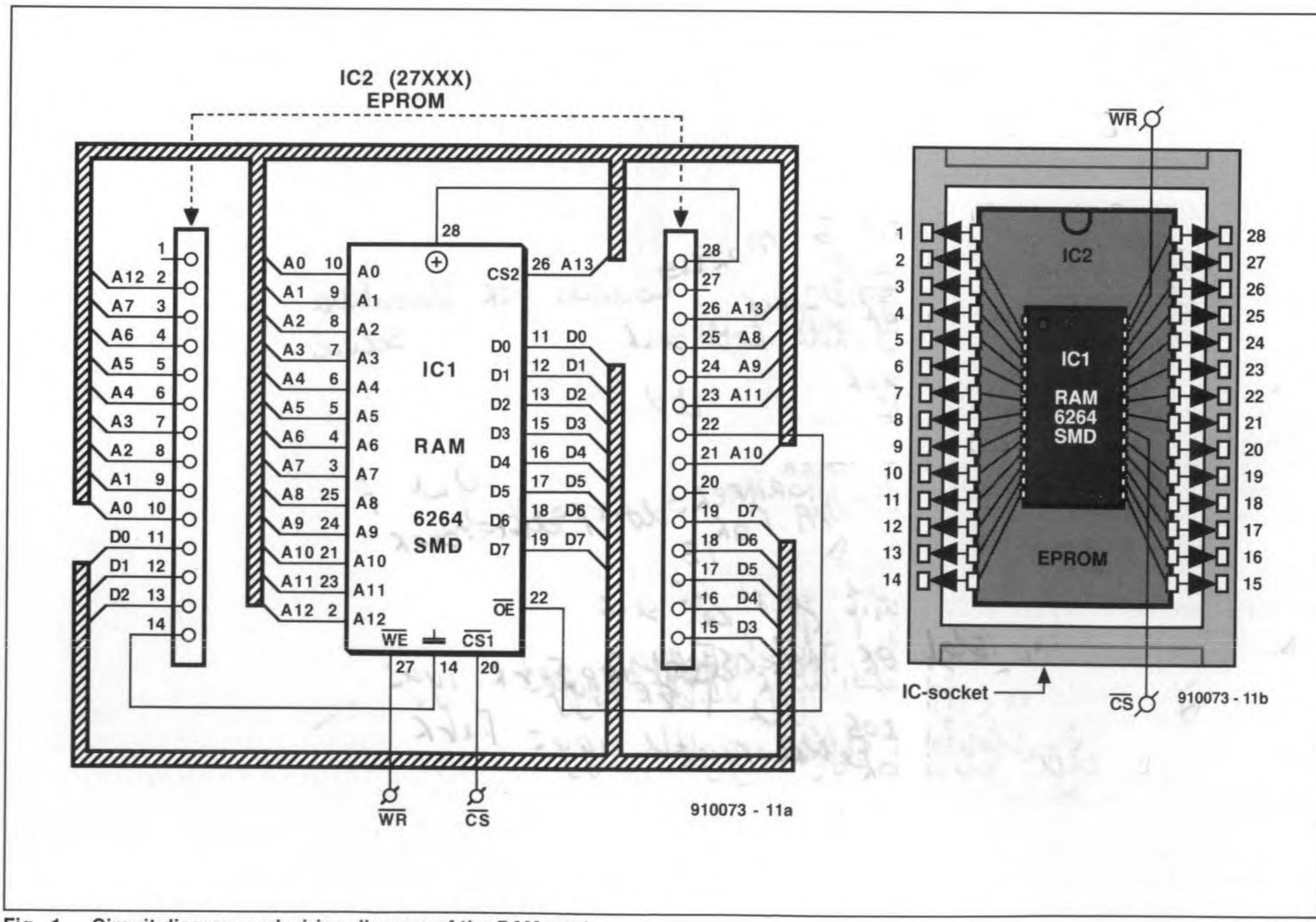


Fig. 1. Circuit diagram and wiring diagram of the RAM card.

microprocessor systems also. The RAM unit is hardly larger than a 27128 EPROM, and has the same pinning. It is simply plugged into the socket provided for the EPROM on the mini Z80 board. To reduce the size of the computer even further, it is possible to do without the socket altogether, and fit the RAM extension direct on to the Z80 board.

Figure 1 shows the circuit diagram of the RAM extension, as well as a kind of wiring diagram that indicates (approximately) what the connections look like in practice. The PCB accommodates two ICs: a RAM and an EPROM. The socket for the EPROM is very important in this plug-on assembly because it functions as the connector between the Z80 board and the RAM board. The EPROM originally fitted on the Z80 board is removed and relocated to the 'first floor', i.e., on the RAM extension board. All 28-pin EPROMs in the 27xxx series can be used, provided they are electrically suitable, and 'fit' in the available memory space.

Unfortunately, two signals are required by the RAM that are not available on the EPROM socket on the Z80 board. These signals are $\overline{WR}$ (write) and $\overline{CS}$ (chip select). The first is never required by an EPROM, and the

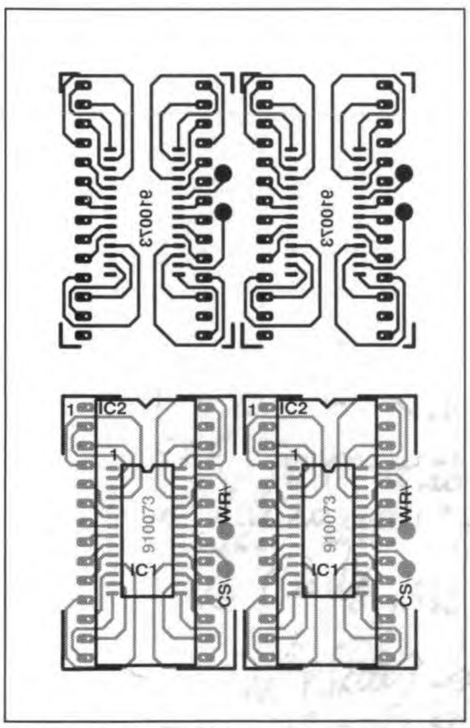


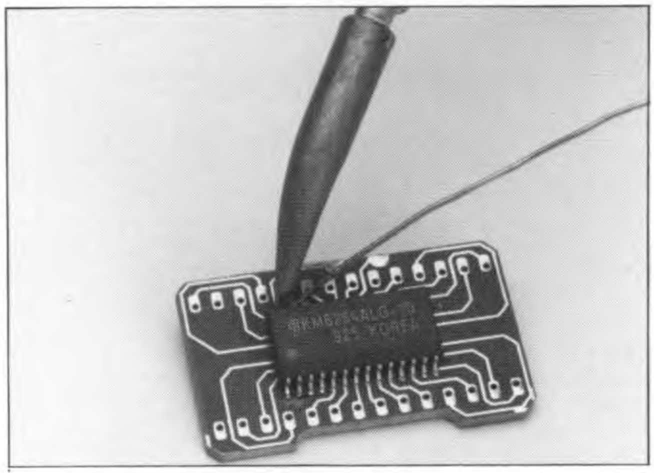
Fig. 2. Track layout (mirror image) of the printed circuit board. Note that the components are fitted at the track side.

COMPONENTS LIST

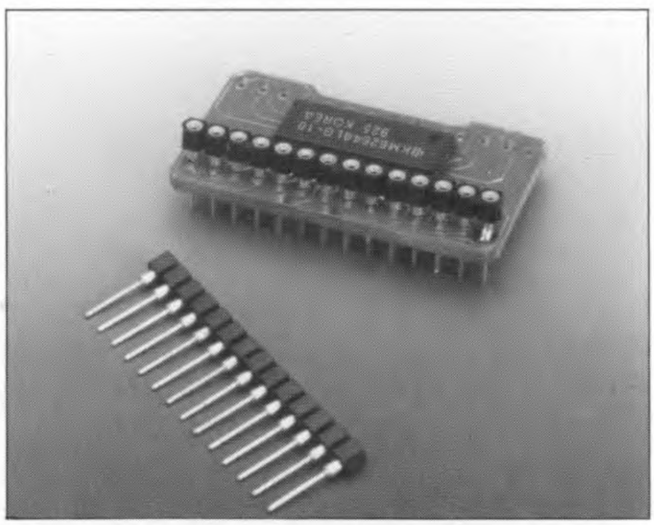
Semiconductors:
1 6264 RAM (SMA) IC1
1 2764/27128 EPROM (see text)

Miscellaneous:
2 14-way pin strip with 1-cm long pins K1;K2
1 Printed circuit board (for two RAM modules) 910073

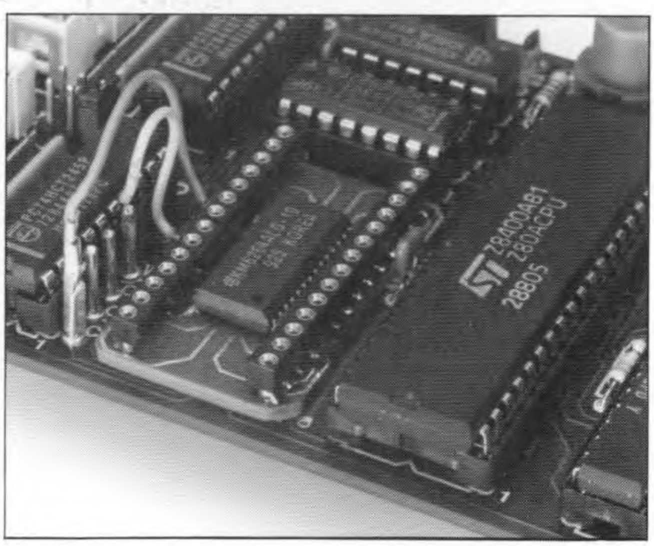
The terminals of the RAM IC must be bent as close as possible to the enclosure to enable the chip to be fitted in between the two pin rows.



The RAM is secured by first soldering two diagonally opposite pins to the copper spots. Next, align the remaining pins with the copper spots underneath, and solder carefully using thin solder wire and a low-power solder bit with a small tip.



The IC socket/connector is made from two 14-way strips with extra long pins (approx. 1 cm).



The RAM extension may be inserted into an IC socket, or fitted direct on to a computer board. If 8 KBytes are not sufficient, further modules are simply stacked.

second can not be used simply because it selects the EPROM. Fortunately, the connection for the $\overline{CS}$ signal required for the RAM already exists on the Z80 board.

The circuit diagram indicates that the second chip select signal of the RAM, CS2, is connected to address line A13. This means that the RAM is selected at all addresses with A13 at '1', and has the advantage of avoiding 'image' areas where the RAM contents are duplicated. Remember, the $\overline{CS}$ signal available on the Z80 card selects blocks of 16 KBytes, and, when used on its own, would cause the RAM contents to appear double in the memory addressed by the Z80. If you use the RAM extension in another system, and you are bothered by the fixed link between A13 and the CS input, simply break this connection between the two ICs, and connect pin 26 of IC1 to pin 28 (+5 V). If necessary, this modification can be carried out on a completed RAM unit also.

Construction

The RAM is built on a single-sided printed circuit board shown in Fig. 2. The PCB is supplied double, so you have to cut it in two.

First, make the PCB as narrow as you can. To keep the Z80 computer as compact as possible, reduce the size of the RAM board such that there is virtually no PCB material outside the outer copper tracks. The board may also be made narrower between pins 4 and 11 with the aid of a jig-saw. At the other side, it may be made narrower locally, leaving the spots for $\overline{CS}$ and $\overline{WR}$ to protrude.

The components are mounted on to the board as illustrated in Fig. 3. The RAM module so made may be mounted on to any circuit board as if it were a 28-pin memory IC. If it is soldered, it can be fitted flush on to the PCB surface because there are no copper tracks at the underside.

When the RAM extension is to be plugged into a socket, pins are used which are slightly longer than IC socket pins. These pins are supplied on 36-way or 72-way strips, and are inserted into the respective holes from the component side. Solder at the component side.

When it is intended to fit the RAM board direct on to a motherboard, the longer pins are not required, and push-through pins with a standard length may be used. The length of the pins should enable soldering at the component side of the RAM board, and make the pins protrude 2–3 mm at the underside of the board for soldering to the motherboard. Figure 3 shows a RAM card made in this way.

RAM cards may be stacked via the EPROM socket. The system EPROM, if used, is always fitted in the EPROM socket on the RAM board at the top of the stack.

Mini Z80 card with RAM

The connections for the $\overline{WR}$ and $\overline{CS}$ signals are available on the Z80 board. There are, in fact, three chip select signals, so that a maximum of three RAM cards may be connected.

```
;************************************************************
;          SIMPLE RAM TEST PROGRAM FOR MINI Z80 BOARD
;************************************************************
;          IC5 and IC6 jumpers set for input only
;          Be careful: a write can be destructive
;************************************************************

output1:   equ  0                    ;address for K1
output2:   equ  1                    ;address for K2
input1:    equ  2                    ;address for K3
input2:    equ  3                    ;address for K4

           org  00h

;************************************************************
;          NON DESTRUCTIVE RAMTEST
;          CHECKS THE ADDRESS AREAS 0E000H...0FFFFH,
;          0A000H...0BFFFH AND 06000H...07FFFH FOR RAM
;************************************************************
ramcheck:  ld   hl,0e000h            ;first RAM address of CS3\
           ld   de,02000h            ;size of one RAM module
           ld   c,2
next$:     ld   a,(hl)               ;load contents of RAM address
           ld   b,(hl)
           cpl  a                    ;complement the contents
           ld   (hl),a               ;write to RAM
           ld   a,(hl)               ;reload contents
           and  b                    ;compare with old value
           ld   (hl),b               ;restore contents
           jr   nz,noram$            ;if not zero then no RAM
                                     ;location
           inc  hl                   ;increment address counter
           dec  e                    ;decrement counter
           jr   nz,next$
           dec  d
           jr   nz,next$
           jr   endram$
noram$:    ld   hl,0a000h            ;first RAM address of CS2\
           ld   de,02000h            ;size of one RAM module
           dec  c
           cp   1
           jr   z,next$
           ld   hl,06000h            ;first RAM address of CS1\
           cp   0
           jr   z,next$
           jr   ramcheck

endram$:   dec  hl
           ld   sp,hl                ;load stack pointer with
                                     ;highest RAM location
           call begin                ;initialization
again$:    call test                 ;copy input inverted to output
           jr again$


;************************************************************
;          OUTPUT INITIALIZATION ROUTINE
;************************************************************
begin:     ld   a,0
           out  (output1),a
           out  (output2),a
           ret
;************************************************************
;          READ INPUT AND OUTPUT INVERTED
;************************************************************
test:      in   a,(input3)
           cpl
           out  (output1),a
           in   a,(input4)
           cpl
           out  (output2),a
           ret
                                            910073-12
```

Fig. 4. This program for the mini Z80 system can be used to test the freshly installed RAM extension.

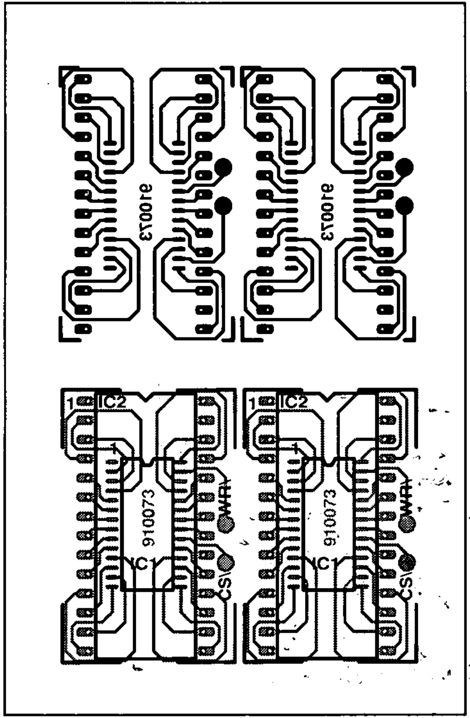
Although this gives a total of 24 Kbytes of RAM, 8 KBytes will be sufficient in most cases. The address ranges available for the RAM modules are:

CS1: 6000_H to $6FFF_H$
CS2: $A000_H$ to $BFFF_H$
CS3: $E000_H$ to $FFFF_H$

The presence of RAM allows all Z80 instructions to be used, i.e., it does away with the restrictions listed in Table 2 in Ref. 1. To help you get started, Fig. 4 shows a little program that tests the RAM, and makes the stack pointer point to the highest RAM address. ■

Reference:

1. "Mini Z80 system", *Elektor Electronics* January 1992.



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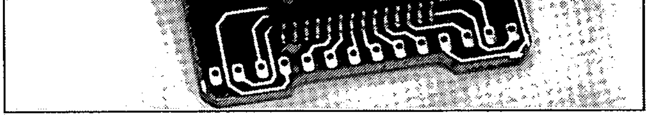
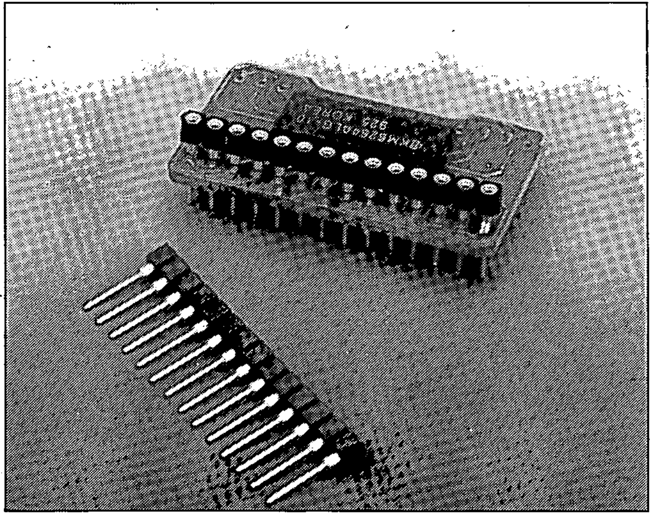


per spots underneath, and solder carefully using thin solder wire and a low-power solder bit with a small tip.



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