CRYSTAL OSCILLATOR

Kit of parts: $9.85
PC Board: $2.10
Complete: $11.95

CONVERTS THE TEC TO REAL-TIME CAPABILITY

CRYSTAL OSCILLATOR CIRCUIT

This project is a crystal oscillator for the TEC. It turns the TEC into a fixed-frequency computer in which each of the Machine Codes takes up a precise period of time.

This means programs such as controller programs or timing programs will run for a precise time span and will not vary from one day to the next due to speed control adjustments.

As you know, the TEC was originally designed with an adjustable clock and its frequency could be altered by turning the speed control.

This served a valuable purpose as the games of skill (contained in the MONitor ROM) could be adjusted according to the skill of the player.

It also proved that the Z-80 could be run at very low speeds and even adjusted while operating and still execute the programs correctly.

The only disadvantage of a variable speed control is its inability to create accurate REAL-TIME programs.

This is highlighted by the clock program (as presented in issue 12). Everyone expects a clock to keep accurate time as even 'two dollar' watches are accurate to two seconds a month. The clock program could only approach this accuracy as it had to be manually adjusted via the speed control.

To remedy this situation Paul has produced a crystal oscillator module that plugs into the 4049 socket.

It contains an inverter chip (74LS04) and a divider chip so that a 4MHz crystal or colour-burst (3.5795MHz) can be used (because they are cheap) and a divider chip (7473) to divide the frequency by two so that the TEC will run at about the maximum speed permissible for a Z-80 CPU.

The 7473 is wired in TOGGLE mode to provide a divide-by-two output.

Some of the earlier model TEC's used a Z-80 CPU (later models used a Z-80A as these were cheaper than the Z-80!!) and the maximum operating speed for a Z-80 is about 2.5MHz.

Almost any crystal can be used in this circuit providing it is in the range 1MHz to 5MHz for a Z-80 or up to 8MHz for a Z-80A. If a crystal other than 4MHz or colour-burst is used, it will be necessary for you to carry out your own conversion for timing etc, if a real-time situation is required.

An inverter is also necessary to invert the Data Available line from the keyboard encoder to the NMI line of the Z-80 so that the NMI line goes low when data is available from the keyboard encoder. This is provided via one of the unused inverters of the 74LS04.

The oscillator circuit is a simple twin inverter using feedback resistors.

A 100pf capacitor at the front end provides guaranteed start-up and the crystal provides a capacitive feedback that is a maximum at the fundamental frequency of the crystal.

This is why the oscillator circuit operates at the frequency as specified on the crystal.

A 100n capacitor on the oscillator module reduces noise on the power rails and a 330R pull-up resistor in the clock line guarantees a full amplitude waveform for the Z-80.

To convert the TEC to crystal control, remove the 4049 and plug in the crystal oscillator board. The speed control pot will have no effect and the speed of execution of the monitor will be about double.

This will too fast for many of the games and you may have to convert back to the adjustable speed by replacing the 4049 by pressing the reset button and keeping it pressed while changing over the clocks.

PARTS

1 - 330R
2 - 1k

1 - 100pf ceramic
1 - 100n monoblock

1 - 3.5795MHz crystal

1 - 74LS04 IC

1 - 7473 IC

2 - 14 pin IC sockets
1 - 16 pin dip header

1 CRYSTAL OSCILLATOR PC BOARD

All future programs will have to be written especially for the new speed and this will mean delay values etc will have to be lengthened accordingly.

ASSEMBLY

Assembly is very simple and we suggest, as always, that the two chips be fitted via IC sockets. The two 1k resistors stand upright and the 330R lays flat against the PC board. The leads of the crystal must be left long enough to allow the crystal to lay over after it has been soldered and a wire strap placed over the body to prevent it being damaged, as the leads are very thin.

The 100pf and 100n are fitted against the PC board and soldered in the positions shown. Don't get them swapped over or the oscillator won't work!

The module is connected to the TEC via a 16 pin dip header soldered under the board.

If the cermet pot on the TEC is a stand-up version, it will be necessary to include a wire-wrap socket between the dip header and the board to create additional clearance for the pot. This is not supplied in the kit as you can fold the cermet pot over slightly to allow the clock board to fit.

When you have the new board in place, the first program you can try is the Clock in issue 12, P.23. The best idea is to type it into the non-volatile RAM at **1000** and down-load it to **0900** via a block-transfer program:

```
11 00 10
21 00 09
01 A0 00
ED B0
C7
```

To convert the program to operate with 4MHz crystal, two of the inbuilt delay values must be altered and a 'fine tune' delay added to the end of the program. This will create a clock that is accurate to within a second a day.

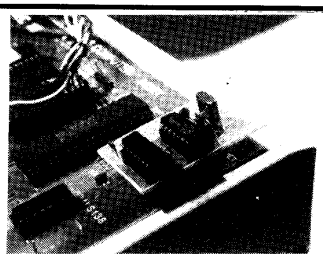
Type the complete program as per issue 12 then change the following locations and also add the extra 7 bytes:

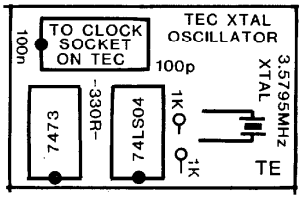
For a 4MHz crystal:

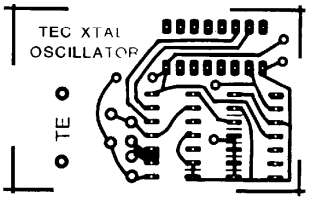
```
94C  06 FA
962  1E 41
970  C3 93 09
993  06 55
995  10 FE
997  C3 00 09
```

For a 3.5795MHz crystal:

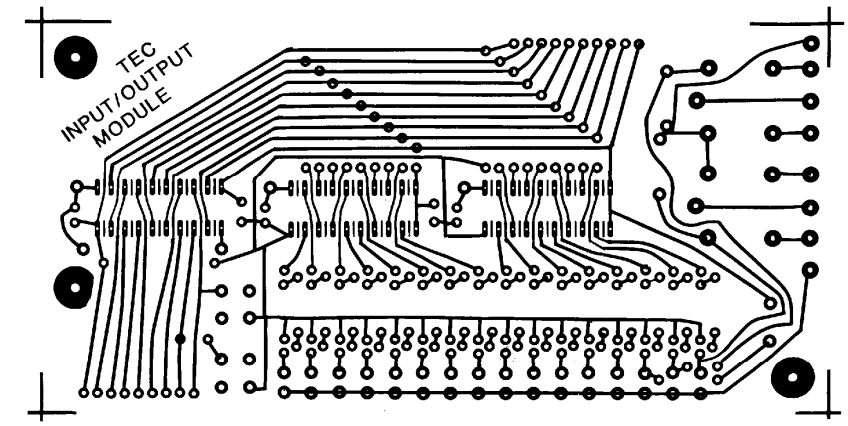
```
94C  06 FC
962  1E 39
970  C3 93 09
993  06 37
995  10 FE
997  C3 00 09
```

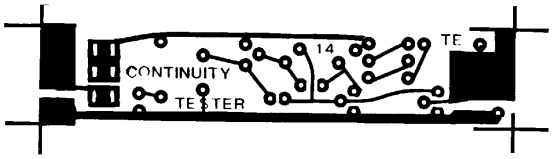


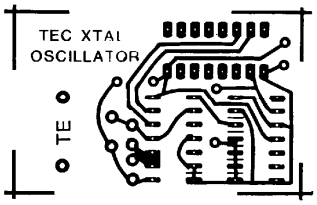


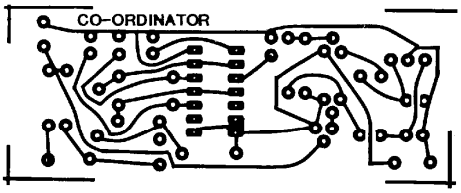


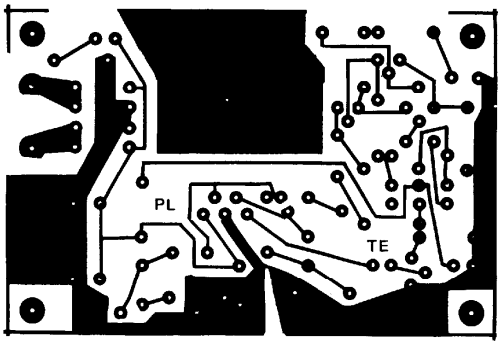
PC ARTWORK:


TEC
INPUT/OUTPUT
MODULE


CONTINUITY
TESTER
14
TE


TEC XTAL
OSCILLATOR
TE


CO-ORDINATOR


PL
TE