Digital stylus timer for hifi systems

has 3 digits & records up to 999 hours

How do you know when the stylus on your cartridge is due to be replaced? How many hours of service has it given? These two questions are important for anyone with a large and valuable record collection but most people can only vaguely estimate how long their stylus has been in use. We have solved that problem with our stylus timer. It keeps a record of stylus use up to 999 hours.

by GERALD COHN

It is really quite difficult to estimate the service life of a typical diamond stylus. It will depend on the type of stylus – whether it is spherical, bi-radial (elliptical) or one of the newer Shibata, Ichikawa or similar refined bi-radial profiles. Stylus wear also depends on the tracking force and to some extent on the condition of the records.

In general, spherical styli have the lowest rate of wear, followed by the Shibata-types of styli. While it would not be unreasonable to expect a life of 1000 hours from a spherical stylus operating at 1.5 grams tracking force, considerably lower figures could be expected from other styli, especially if they are operated at two grams or more. It is best to play safe and have the stylus inspected at after 300 to 400 hours and at shorter intervals after that. Once the stylus starts to develop flattened "shoulders" record wear and deterioration proceeds rapidly.

So for the sake of your record collection, you really should have some means of keeping tabs on the service hours of your stylus. Some enthusiastic souls make use of a manual counter and clock it on after each hour of use. For those of us with human foibles this method is just not practical. Far better to have a device which keeps a count of hours while ever the turntable is in use. Our timer does just that.

It is connected in parallel with the turntable mains supply and advances the count while ever the turntable motor is running. There are other ways of achieving this. You could, for example, monitor for the presence of signal from the phono preamplifier and use this as a control for advancing the counter stages. If this method was used, great care would have to be taken to avoid injection of digital "hash" into the audio system. But we're getting ahead of ourselves . . .

We opted for a simple scheme which did not involve any connections to the audio signal system. By sensing the presence of AC power at the turntable motor, the timer is enabled and powered at the same time. Standby batteries maintain the count while the turntable or the whole system is turned off. In this way, it is possible to avoid using the hifi system for months at a time and still have an accurate record of stylus service hours.

The same system could be employed to keep a record of service hours for any other piece of mains powered equipment.

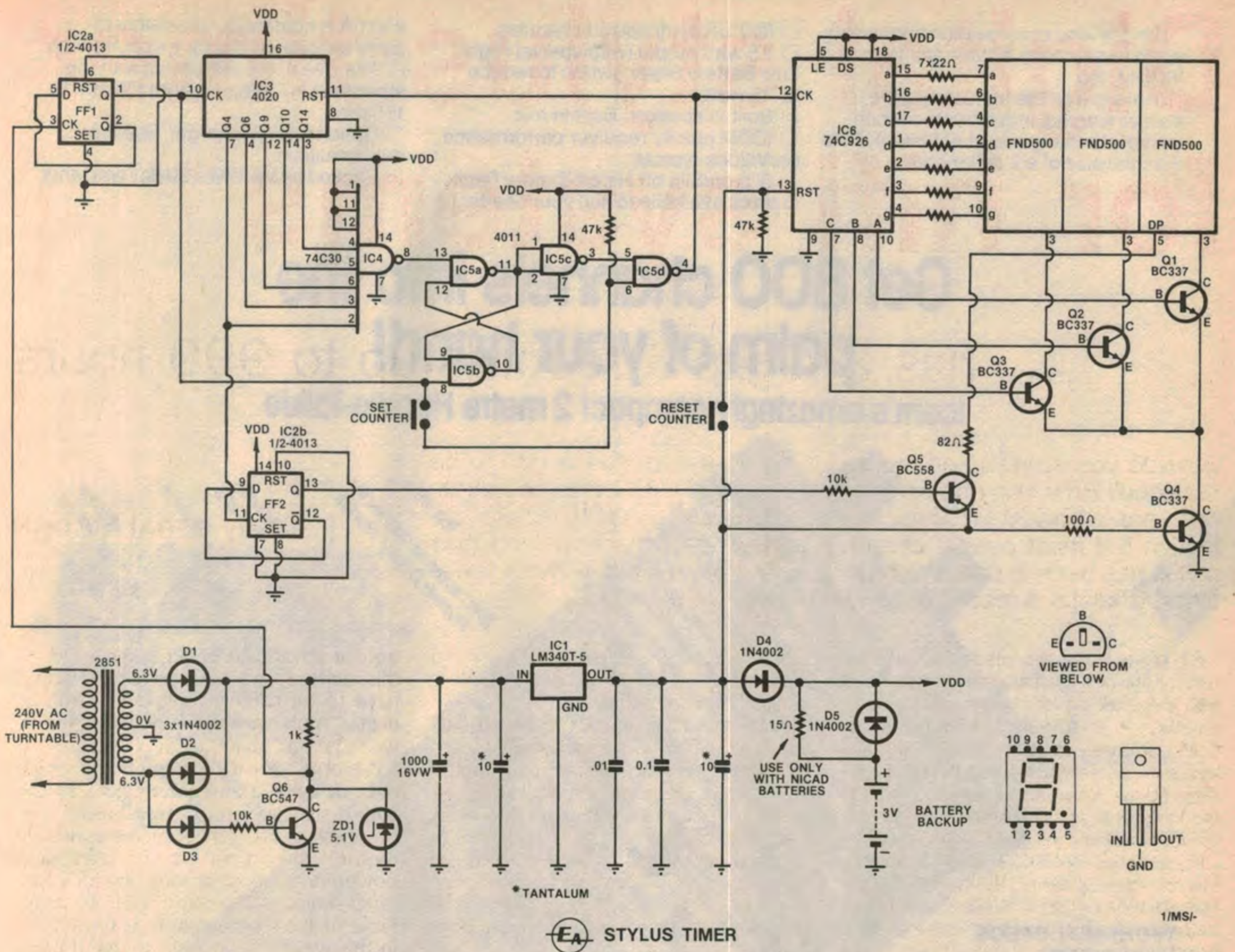
The stylus timer counts the number of hours that the turntable is in use. Standby batteries maintain the count while the turntable is turned off.

HOW IT WORKS

The circuit is quite straightforward and uses six integrated circuits, five transistors and a few other parts. The action begins at the power supply part of the circuit. A small transformer feeds a full-wave rectifier, D1 and D2 and thence a 1000uF capacitor which supplies a three-terminal 5V regulator, IC1.

Diode D3 feeds half-wave rectified 50Hz to transistor Q6 which has a 5.1 volt zener diode connected to its collector. This produces a 50Hz square wave signal suitable for feeding into the following counter circuitry. The first stage of division takes place in flipflop IC2a. From there, the signal is fed to a 14-stage ripple counter, IC3, which has an eight-input NAND gate, IC4, connected to it to decode state 18000.

The output of NAND gate IC4 is a negative going pulse, lasting half a clock-period which sets the RS flipflop consisting of IC5a and IC5b. The output of



A 4013 dual flipflop, a 4020 14-stage binary ripple counter, and a 74C926 4-decade counter form the heart of the circuit.

IC5a then goes high and low again as the flipflop is reset by the negative-going half of the clock signal. The output of IC5a is thus high for only half a clock period, and is used to reset the 4020 via IC5c and IC5d.

Since the reset pulse is only half a clock period long, the most significant output of the 4020 (Q14) is only high for one half a clock period. As a result, we find that the effective division of the 4020 is only 9000 despite the fact that the binary division ratio is 18000. It is for this reason that we have added a divide by two flipflop before the 4020, therefore providing us with an overall count of 18000.

Thus, when combined with flipflop IC2a, IC3 gives a total division of the 50Hz input of 18000. This means that the following 74C926 four-digit counter, IC6, is fed with one pulse every six minutes.

Note that the reset pulse applied to the reset input (pin 11) of the 4020 is also used as the clock pulse for the 74C926 (IC6).

Since only three digits are required to indicate a reading up to 1000 hours (or 999, in this case) the first decade counter in the 74C926 is not used to drive a digit. Instead, it just provides another decade of division, necessary in order to provide one pulse per hour to what is really a three-digit hour counter.

To enable the three-digit counter to be reset (which is necessary when a new diamond stylus is installed in your cartridge), a pushbutton is provided on the rear of the case. This connects the reset pin of IC6 to the five-volt line, which resets all four internal decade counters. Resetting can only take place when mains power is applied, not when the unit is on battery standby.

Presetting the counter is also possible, via another pushbutton on the rear of the case. As with digital clocks, presetting means that the counters are sped up markedly so that you don't have to stand around for three days. In this case, the 25Hz signal from IC2a is used to drive the 74C926 directly via IC5d. This enables any value from 000 to 999 to be quickly preset, with the display being incremented at a 2.5Hz rate.

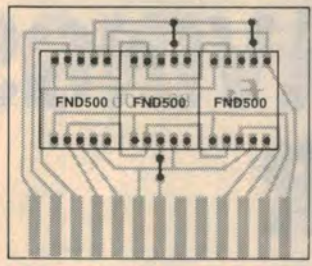
Since the three digit display is multiplexed, all segment lines are connected in parallel while each digit has a separate driver transistor, Q1, Q2 or Q3. FND500 common-cathode displays are used, as they give a bright display with an integral red filter and they are low in cost.

The decimal point of the least significant digit flashes at a rate of 0.78Hz. This lets you know the device is working and not just sitting there like a "shag on a rock".

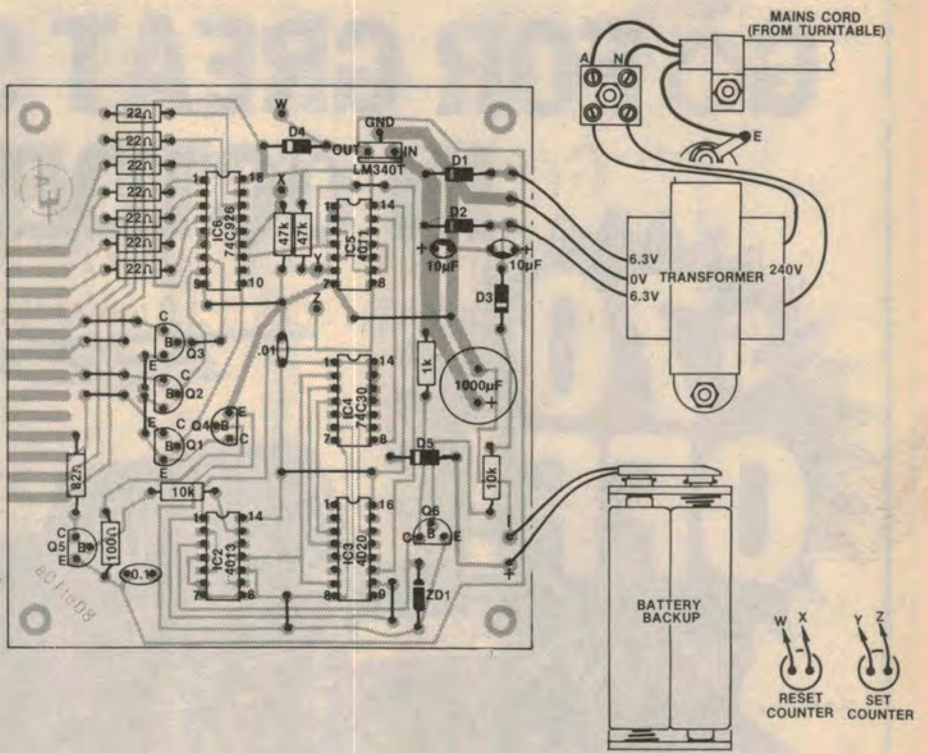
Q5 and IC2b provide this "activity indicator". Flipflop IC2b divides down the Q4 output of IC3, which runs at 1.56Hz. The divided output is then fed to transistor Q5 via a 10k resistor. Q5 drives the decimal point anode of the last digit.

When the mains power is turned off, the recorded "count" of the circuit must be maintained. This is achieved by a battery backup circuit which can use

> We estimate that the cost of parts for this project is approximately
>
> **$36.00**
>
> This includes sales tax.



The display board is easy to build. Don't forget the three wire links.



Follow this overlay diagram in conjunction with the circuit when wiring up the Stylus Timer. Note the orientation of Q4 with respect to adjacent transistors.

alkaline cells or nickel-cadmium cells. To keep the battery current drain very low, the three-digit display is disabled via Q4, which is connected to the emitters of the three cathode-driver transistors, Q1, Q2 and Q3.

Whenever the mains supply is present, Q4 is able to conduct by virtue of the 100 ohm base resistor connected to the 5V supply. The 5V supply drops to zero, when the mains goes off, and Q4 turns off and extinguishes the display.

When the display is off, the current drain of the rest of the circuit is typically just a few microamps or so, which means that the batteries should last a long time – or effectively, their "shelf" life.

Two diodes, D4 and D5, are used to isolate the battery supply from the 5V regulated supply when the mains is on. With the 5V supply present, D4 is forward-biased, allowing current to flow through to the circuit. At the same time, D5 is reversed-biased, by virtue of the fact that the voltage at the junction of the two diodes is higher than the battery voltage.

If alkaline cells are used, only two are required, giving a nominal battery voltage of 3.0 volts. If nickel-cadmium cells are used, three will be required, giving a nominal voltage of 3.6 volts and D5 may be replaced by a 22 ohm resistor to give a charging current suitable for 450 millamp-hour cells (ie, penlites).

CONSTRUCTION

So much for the operation of the circuit. Let us now take a look at the construction and presentation of the unit.

We have designed a printed circuit board (PCB) which measures 110 x 113mm and is coded 80st10a for the main part of the circuit, and a second PCB measuring 58 x 48mm (80st10b) for the displays. The boards are mounted at right angles to each other with the display board soldered directly to the main one.

Construction is straightforward and should only take a few hours or so. The best starting point would be to place the links on the board and solder these into place. Follow these up with the resistors and the capacitors, and then finally the diodes and the transistors. The last items to go on the board are the ICs. They are all CMOS types and should therefore be handled with the usual precautions being taken.

We recommend the use of PC pins for all the external connections such as the transformer, the pushbuttons and the battery standby supply.

The display board is simple to assemble requiring only three links and the displays to be soldered to it. Make sure that you do not install the displays upside down.

The next step now is to prepare the case that is to house the unit. The case we used came from Dick Smith Electronics and measures 186mm deep x 160mm wide x 70mm high.

We have prepared a front panel artwork for this case which was made using the "Scotchcal" process. The cutout for the three displays measures 46 x 17mm and is the only hole required in the front panel. The set and reset pushbuttons are mounted on the rear panel of the unit.

Once the chassis of the case has been suitably prepared, all that remains to be done is to mount the electronics into it. The display board is first held in place on the front panel by the displays, which are pushed through the cutout. The main board is then fitted with four 15mm threaded spacers and butted up against the display board to find the level at which it is to be soldered. We suggest that when you have found the correct level you mark it with pencil line so that you have a reference to work against during soldering.

It is important when soldering the two boards together to make sure that they are perpendicular to one another. This is best achieved by first soldering the two outermost connections and then with the aid of the soldering iron, make any adjustments that may be required. When the geometry of the assembly is correct, go ahead and solder the remaining connections.

Now, place the completed assembly back into the case and allow approximately three millimetres of the display bodies to protrude through the front panel. Using a pencil or some other suitable instrument, mark out the locations of the four holes that hold the assembly in place. Drill the holes to the required clearance size for the screws used but don't fasten the PCBs into place yet.

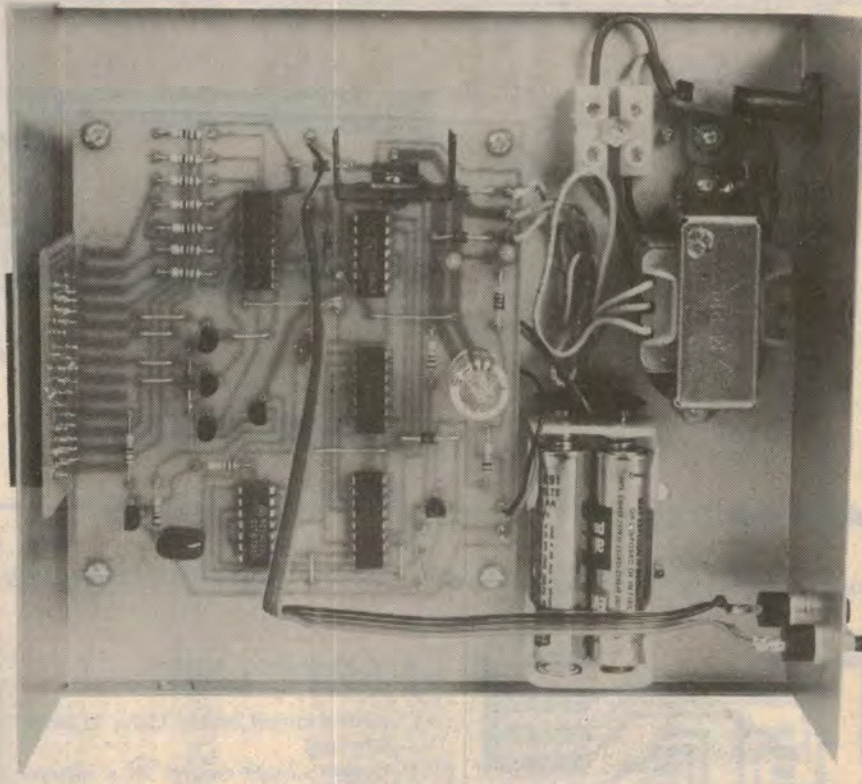
Now place the transformer and the terminal block into place and mark out their mounting holes. Drill these out and then mount the transformer and the terminal block into place. Feed the mains cable into the chassis via a suitably grommeted hole.

The next step is to anchor the mains cable with the retaining clip and to terminate it into the terminal block. The earth wire is connected onto the body of the transformer using a solder lug that is placed under one of the nuts holding the transformer in place.

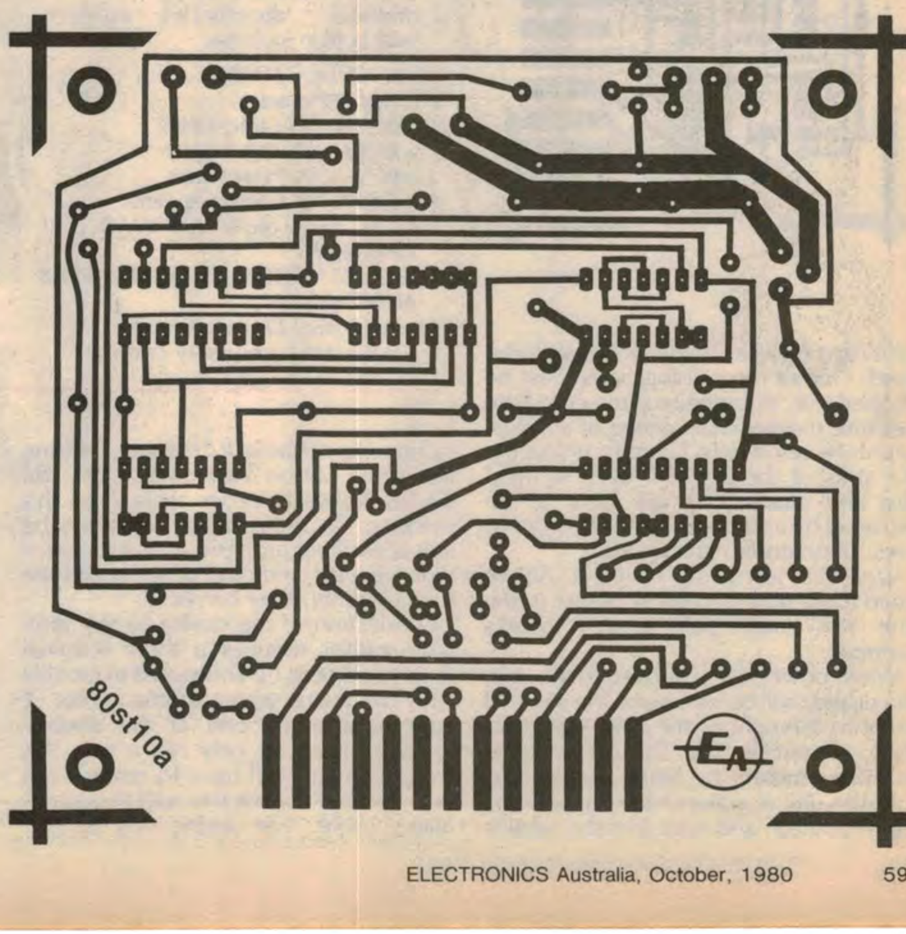
Mount the set and reset pushbutton switches on the rear panel as shown in the wiring diagram. Having done this, mount the PCB assembly into the chassis and start wiring the transformer and the pushbuttons to the board.

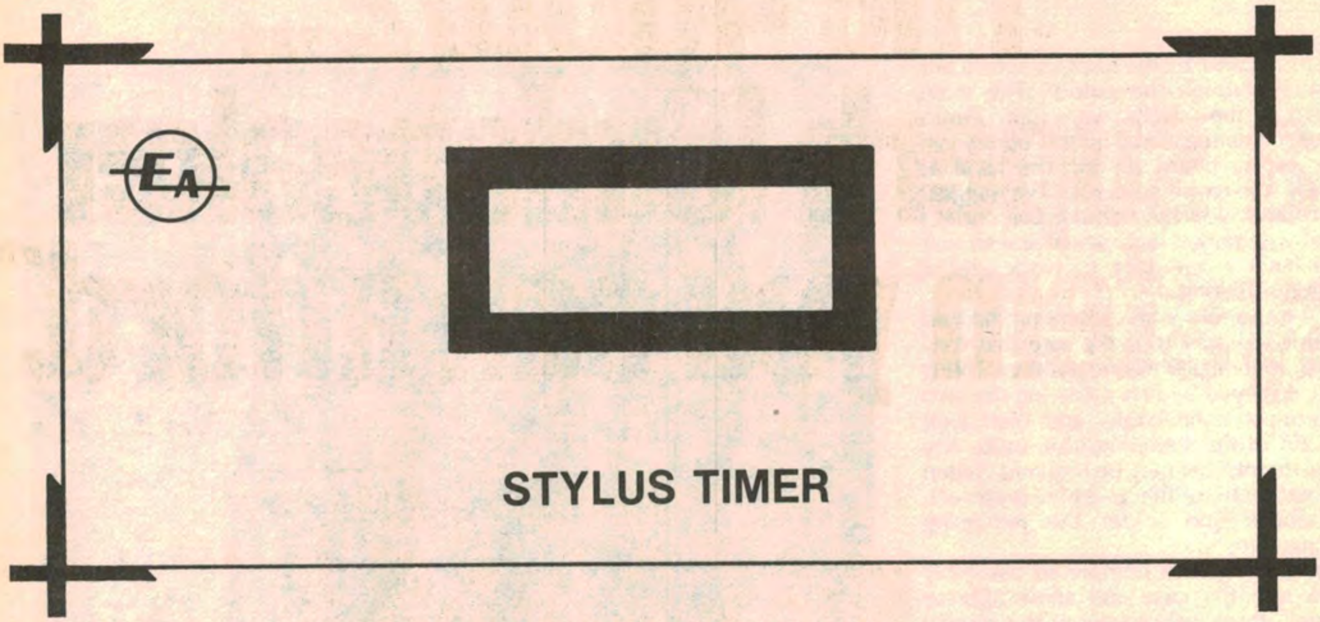
The battery standby supply can now be placed into the chassis. Since we only require two cells (in the case of dry cell backup) we will also need a holder for these. These are available with the connection to them being made with a clip, this being the same clip as the one required for the miniature nine volt battery. The battery holder in the prototype unit was held in place with double sided tape, but a bracket fashioned from a scrap of sheet metal will do just as well.

If you elect to use nickel-cadmium batteries, then you will require a larger battery holder, capable of holding at least three batteries. It is quite difficult (if not impossible) to obtain holders for three

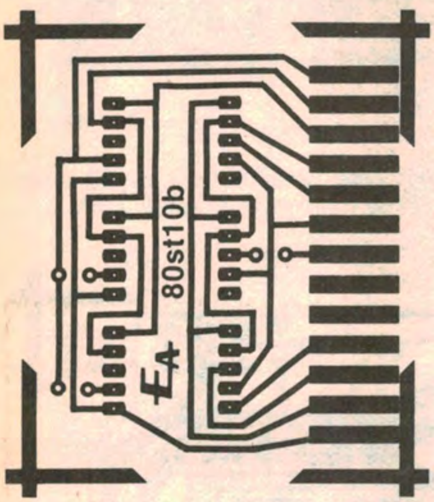


Above is an inside view of the completed prototype, while below is an actual size reproduction of the PCB artwork. Be sure to keep mains wiring neat and tidy.





Above and below are actual size artworks for the front panel and the display PCB.



PARTS LIST

1 printed circuit board 110 x 113mm (80st10a)
1 printed circuit board 58 x 48mm (80st10b)
1 transformer, type 2851 240V to 12.6V c.t.
1 terminal block, two-way
2 miniature momentary contact pushbutton switches

SEMICONDUCTORS
5 x 1N4002 diodes
4 x BC337 NPN transistors
1 x BC547 NPN transistor
1 x BC558 PNP transistor
1 x LM340T-5 5 volt regulator
1 x 5.1V zener diode 400mW (1N751 or similar
1 x 4011 CMOS IC quad 2-input NAND gate
1 x 4013 dual D-type flipflop
1 x 4020 14-stage binary counter
1 x 74C926 4-decade counter/display driver
1 x 74C30 8-input NAND gate
3 x FND500 common-cathode seven-segment displays

CAPACITORS
1 x 1000uF 16VW electrolytic (PC type)
2 x 10uF 25VW tantalum electrolytic
1 x 0.1uF metallised polyester
1 x .01uF metallised polyester

RESISTORS (¼ or ½W, 5% tolerance)
2 x 47k, 2 x 10k, 1 x 1k, 1 x 100 ohm, 1 x 82 ohm, 7 x 22 ohm, 1 x 15 ohm (see circuit)

MISCELLANEOUS
1 x battery holder to suit 3 AA-size nickel-cadmium cells or two alkaline cells
1 x clip to suit battery holder

cells, so a four cell holder will have to be used. One of the cell locations must be shorted out. We require three cells here because the nominal voltage of a nickel-cadmium cell is only 1.2 volts, unlike the 1.5 volts of the dry cell. Keep in mind that the diode (D5) will have to be replaced by a 22 ohm resistor in order to keep the batteries charged up.

Well, that just about covers it. All we need to do now is to apply power to the unit and make sure that it works properly.

When power is first applied to the unit, the display will come on and the decimal point to the right of the least significant digit will start flashing. This is to indicate that the counters are being clocked and that the unit is active. Now try pressing the set button and note that the display increments at about a 2Hz rate. Pressing the reset button now will make the display show all zeroes again. If all this works so far then chances are that the unit is working properly. The acid test is to leave it for a number of hours and see that it counts these correctly.

Connection of the device to the turntable motor requires a three terminal mains socket to be connected in parallel with the mains wiring to the motor. If your turntable is one of the double-insulated types or only has a twin flex lead, then you will have to remove the twin flex and replace this with three core mains cable. The wiring can be terminated in the turntable base using a three-way terminal block.

The mains socket can be either a panel mounting type or, if you prefer, an extension lead type. If the turntable is a double-insulated type then you will only need the earth wire for the timer. The terminal block is just used as a transition connector in this case. The earth wire is most important since the Stylus Timer has a metal case.

There you have it! A unit that will keep track of the number of hours that the stylus has been working for, and as such it should prove a valuable piece of equipment to all audio enthusiasts.