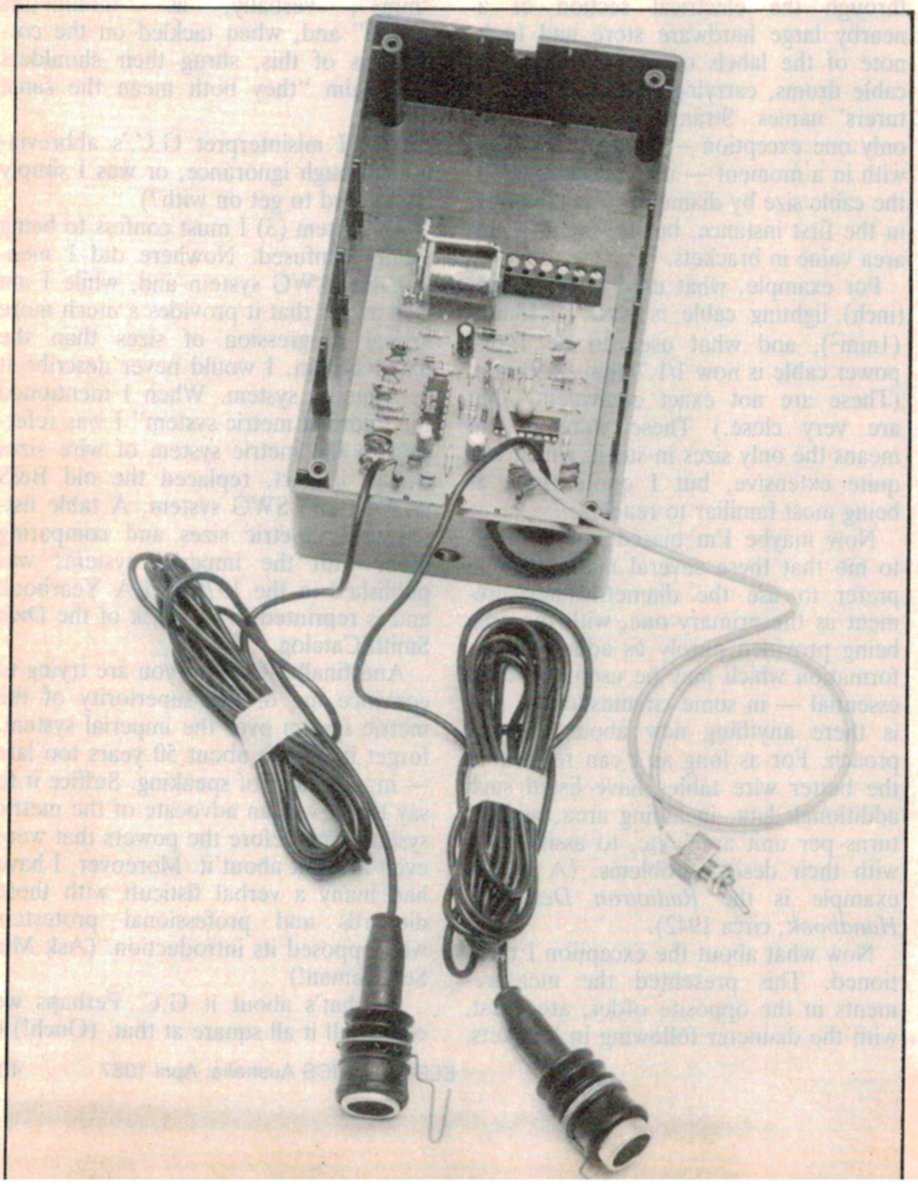
Protect your home or car with this

Ultrasonic burglar alarm

Here is an inexpensive and self-contained ultrasonic burglar alarm which offers excellent performance for your car or home. It can be activated by either a mechanical switch or the remote control switch described in January.

by BRANCO JUSTIC



Ultrasonic movement detectors are not new — in fact, probably the largest percentage of all movement detectors are ultrasonic. When properly installed and adjusted they provide a reliable and cost-effective burglar alarm in most situations.

Apart from ultrasonic movement detection, this unit also has provision for "hard wired" switches, making it much more versatile. For example, in the case of a vehicle, switches which are operated by the bonnet, boot etc can be wired in, making it extremely difficult to break in without instantly setting off the alarm.

This alarm is designed to be activated by either a switch or, in the case of a wireless remote switch, by relay contacts. If a simple mechanical switch is used, it will have to be located outside the protected area in order to prevent false triggering when you want to go in or out.

Hidden switch or remote control?

For simpler installations, an effective and economical solution would be to have the required switch hidden out of sight. In a vehicle, the switch could be hidden in the boot, under the fenders, or behind a bumper bar. In the home, the switch could be hidden outside the protected area.

In both cases, several switches wired in series could be used in order to improve security, or you can use "barrel key" switches.

The car burglar alarm version was built into a plastic case and the ultrasonic transducers connected to the PCB via long shielded leads. The transducers are mounted on opposite ends of the car dashboard and can be clipped to the trim on the windscreen pillars.

A somewhat classier solution to the switch problem is to use a wireless remote control switch, such as the one described in the January 1987 issue. Note that there is sufficient space inside the plastic case of the alarm to accommodate the UHF Remote Switch circuitry. The resultant alarm system is very easy to install — only two connections have to be made to your car's electrical system (+12V and ground).

Let's now take a look at the circuit and see how the alarm works.

Transmitter

The transmitter section of the circuit is very simple and is based on CMOS inverter stages IC2c-IC2f. A three gate oscillator (IC2c-IC2e) is used to generate a 40kHz square wave at the output of IC2e. The frequency of operation is mainly determined by C10 and the total resistance of R18 and trimpot VR2. VR2 is used to adjust the transmitter frequency to exactly 40kHz.

The output of IC2e drives one side of the transducer (Tx) and inverter IC2f, the output of which drives the other side of the transducer. Thus, by adding IC2f, the drive voltage to the transducer is doubled. Capacitors C11 and C12 (100pF) equalise the loading conditions for the outputs of IC2e and IC2f and thereby ensure that they produce waveforms which are exactly complementary.

Receiver

The 40kHz signal from the transmitter is picked up by the receiver transducer (Rx) and fed via a low pass filter section (R1, C1) to sensitivity control VR1. This allows the sensitivity to be adjusted to suit different applications. From there, the signal is AC-coupled via C2 and R2 to the inverting input of quad op amp stage IC1a. IC1 is a Norton amplifier, type LM3900 or LM3401.

IC1a and IC1b form two identical amplifier stages, each having a gain of approximately 20 at 40kHz as set by R4/R2 and R7/R5. Thus, the overall gain is approximately 400. Capacitors C3 and C5 (in parallel with the feedback resistors) roll off the response of the amplifiers above 70kHz.

The amplified output signal appears at pin 9 of IC1b and is fed to a detector-cum-filter stage consisting of D1, R8, R9 and C6. Thus, in the absence of amplitude changes in the received 40kHz, a steady DC signal appears on the positive terminal of C7.

If, however, there are sudden amplitude changes in the received signal (ie, when there is an intruder), the detector output level varies accordingly. These

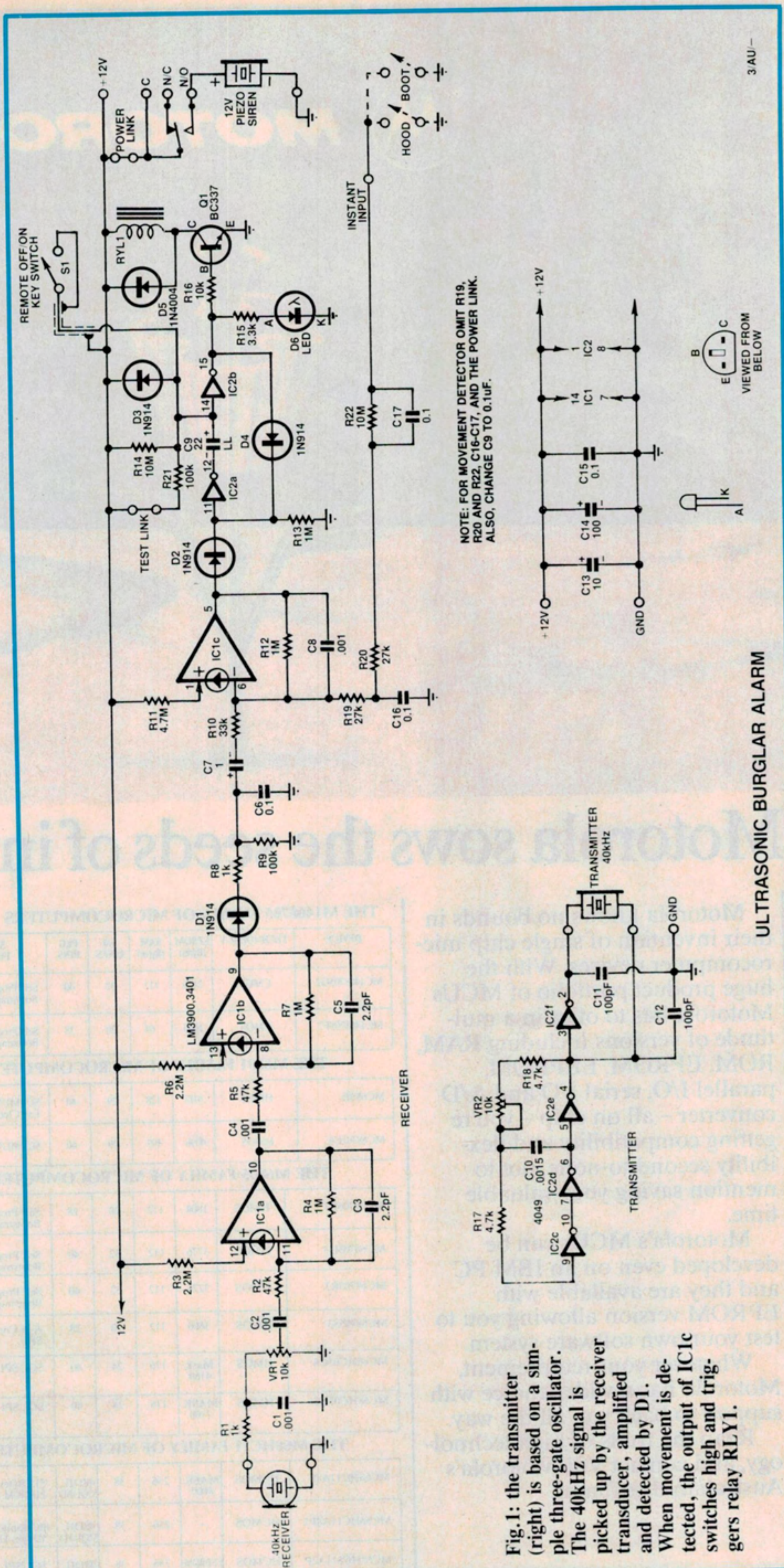


Fig.1: the transmitter (right) is based on a simple three-gate oscillator. The 40kHz signal is picked up by the receiver transducer, amplified and detected by D1. When movement is detected, the output of IC1c switches high and triggers relay RLY1.

amplitude variations are coupled via C7 to low frequency amplifier stage IC1c, the output of which is normally biased low. This stage has a gain of approximately 30 and its output is used to trigger a monostable via isolation diode D2.

The monostable consists of inverter gates IC2a and IC2b and their associated components. The "on" time for the monostable, as determined by the values of R14 and C9, is approximately two minutes (no test link). When the test link is included, the "on" time is reduced to approximately one second.

The test link is used when adjusting the sensitivity of the unit during the initial installation. It reduces the waiting time between adjustments from two minutes to one second.

The alarm on-time (without the test link) can easily be extended or shortened by using a different capacitor value for C9 (RBLL or tantalum). For example, a 10μF capacitor gives an alarm time of one minute, while a 47μF capacitor gives an alarm time of four minutes.

Normally, C9 is charged to the positive supply rail and the output of the monostable (pin 15 of IC2b) is low. When an intruder is detected, pin 5 of IC1c goes high and pulls pin 11 of IC2a high via D2. Thus, pins 12 and 14 go low, pin 15 switches high, and the monostable latches up via D4.

C9 now charges towards the positive supply rail via R14 and, after about two minutes, pin 15 switches low again to turn the alarm off. This also effectively resets the alarm so that it will be instantly retriggered if further movement is detected. D3 is included to ensure that the input of IC2b can not go more than 0.6V above the positive supply rail.

The output from the monostable is used to operate a relay via R16 and transistor switch (Q1). A LED indicator (D6) in series with a 3.3kΩ resistor is wired across the monostable output to indicate the "alarm on" condition.

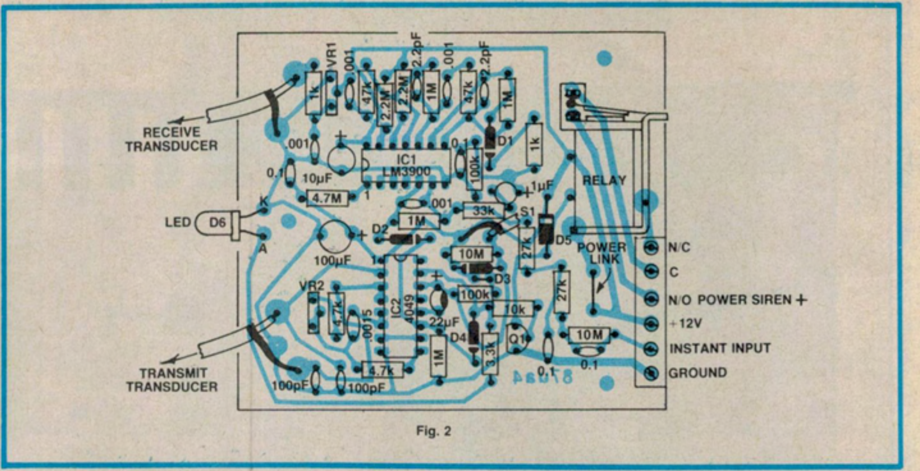


Fig.2: the parts can be installed in any order on the board but take care with the polarised components. Shielded cable is used to connect the transducers and the remote switch (or relay) terminals.

The alarm is turned on and off by a switch wired in parallel with the 10MΩ timing resistor in the monostable circuit. When the switch is closed, pin 14 of IC2b is held high and thus Q1 and the relay are off. As mentioned previously, this switch may be either a keyswitch, a simple toggle switch or a set of relay contacts from the UHF Remote Switch.

Note that the on-board relay contacts of the UHF Remote Switch cannot be used directly as the project was originally described, since the relay wiper was permanenly connected to the +12V rail. Fortunately, this potential problem was recognised in time for the PCB to be modified such that all commercial versions of the board include provision for a power link (just like the present project).

So the solution is quite simple. If you want to use the relay contacts on your remote receiver to switch your ultrasonic alarm on and off, just delete the power link on the receiver PCB. The on/off switch contacts of the ultrasonic alarm are wired across the normally open (N/O) contacts of the relay (ie, between N/O and COM).

Finally, a normally open (N/O) instant trip input is coupled via C17 and a low pass filter network (R19, R20 and C16) to the inverting input of IC1c. Shorting this input to ground instantly triggers the alarm, so it is ideal for protecting the bonnet and the boot. R22 discharges C17 so that the alarm can be instantly retriggered from other instant trip inputs.

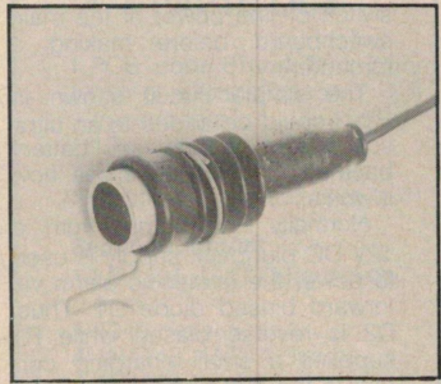
C17 ensures that the ultrasonic movement detection circuitry can retrigger the alarm regardless of the status of the instant trip switches.

Construction

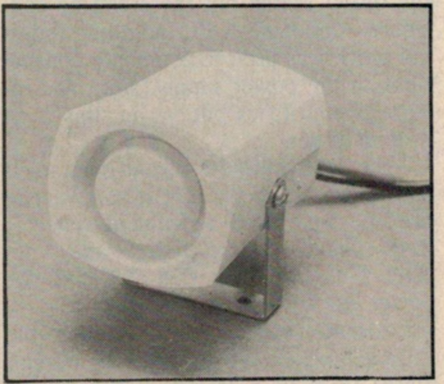
We built up two versions of the Ultrasonic Burglar Alarm, one for use in a car and the other for use as a movement detector to go with a home burglar alarm system.

Most of the parts are mounted on a printed circuit board (PCB) coded

The alternative movement detector version was built into a clip-together plastic case from Dick Smith Electronics.



The transducers are fitted into rubber spark plug covers. The wire clip enables attachment to the car windscreen pillars.



This compact piezoelectric siren can be hidden under the bonnet or inside the car and emits an ear-splitting modulated tone.

as soon as the Government completes its deliberations with all concerned parties.

While there has been no official government announcement, it is also intended that a 10-day week be introduced in 1988, leaving Sunday where it is. The new week would thus run Sunday, Monday, Blueday, Tuesday, Sicday, Wednesday, Pieday, Thursday, Friday and Saturday (alternatively, Sundie, Mundie, Bludie, Tuesdie, Wensdie, Piedie, Thursdie, Fridie and Satdie).

When this happens, the month will be deemed unwieldy and will be withdrawn.

A particular advantage with metric time is that there is no longer any AM or PM, so there can be no more confusion. The fortnight has been withdrawn. Provision for flexitime has been referred to a 10-member standing committee on which the ACTU will have representation.

Digital clock

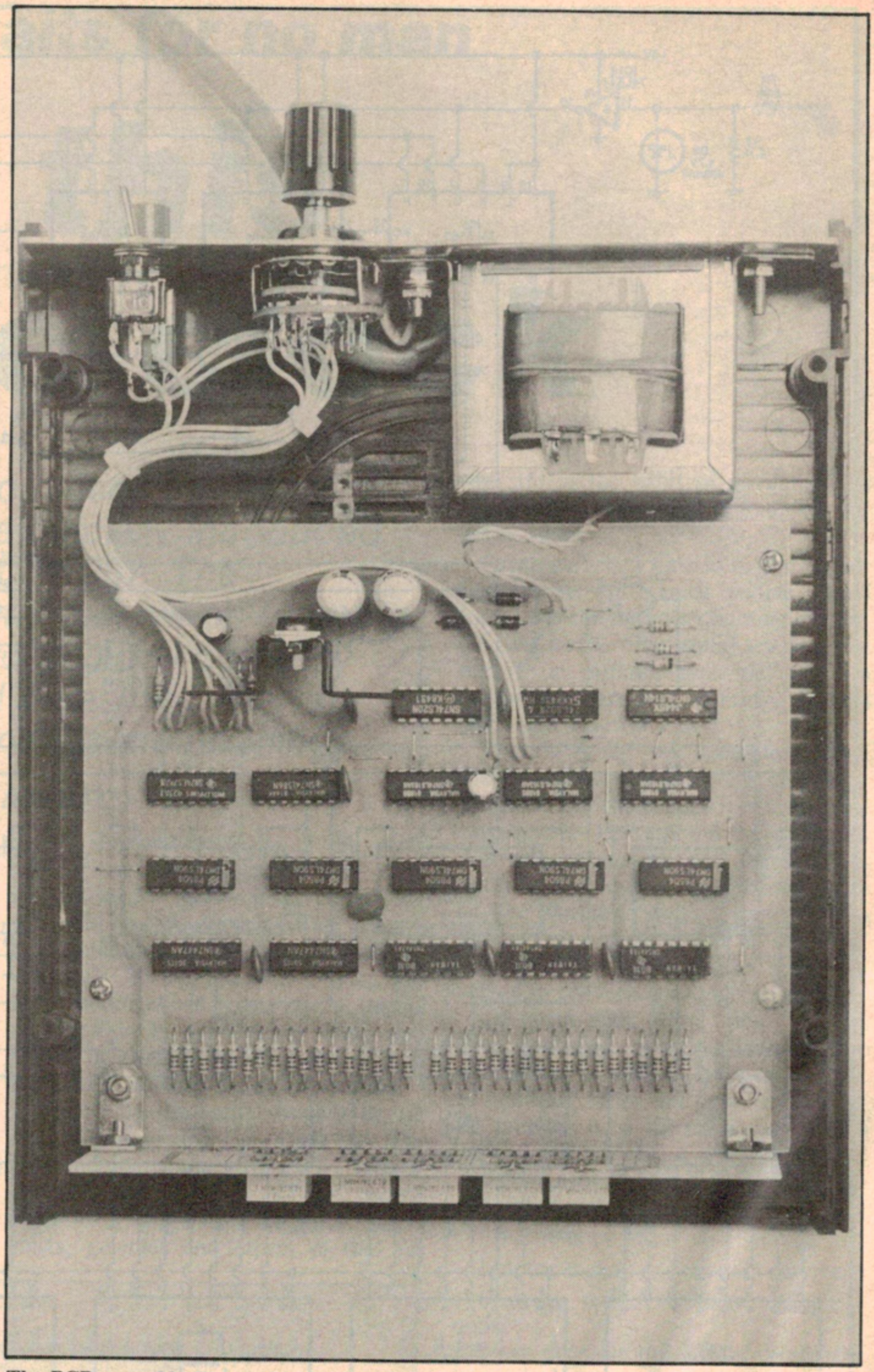
Now all the above may be very straightforward but how do we now tell the time? That's where this new project comes into the picture.

In view of the fact that all existing clocks will be obsolete, we have decided to be the first with the introduction of a metric digital clock (or MDC). We're very proud of the device because its the first metric clock design that we know of. Let's take a closer look at this new marvel of logical thought processes.

The first thing to note is that our new MDC has a 5-digit LED readout that counts up to 9 hours, 99 minutes and 99 seconds. The device is mains operated, is accurate to about ±5 metric seconds per metric day and should only take you about 1.26785 metric hours to build.

All controls are mounted on the rear panel. These consist of a Run/Halt switch, a Reset switch and a Pulse switch. All three are used for setting the time.

The prototype clock was designed and built by Dick Smith Electronics and they have a kit available at $59.95.



The PCB assembly fits neatly inside the DSE H-1895 instrument case. Note that the heatsink supplied with kit versions differs from that shown here and is soldered to the two holes in front of the regulator.

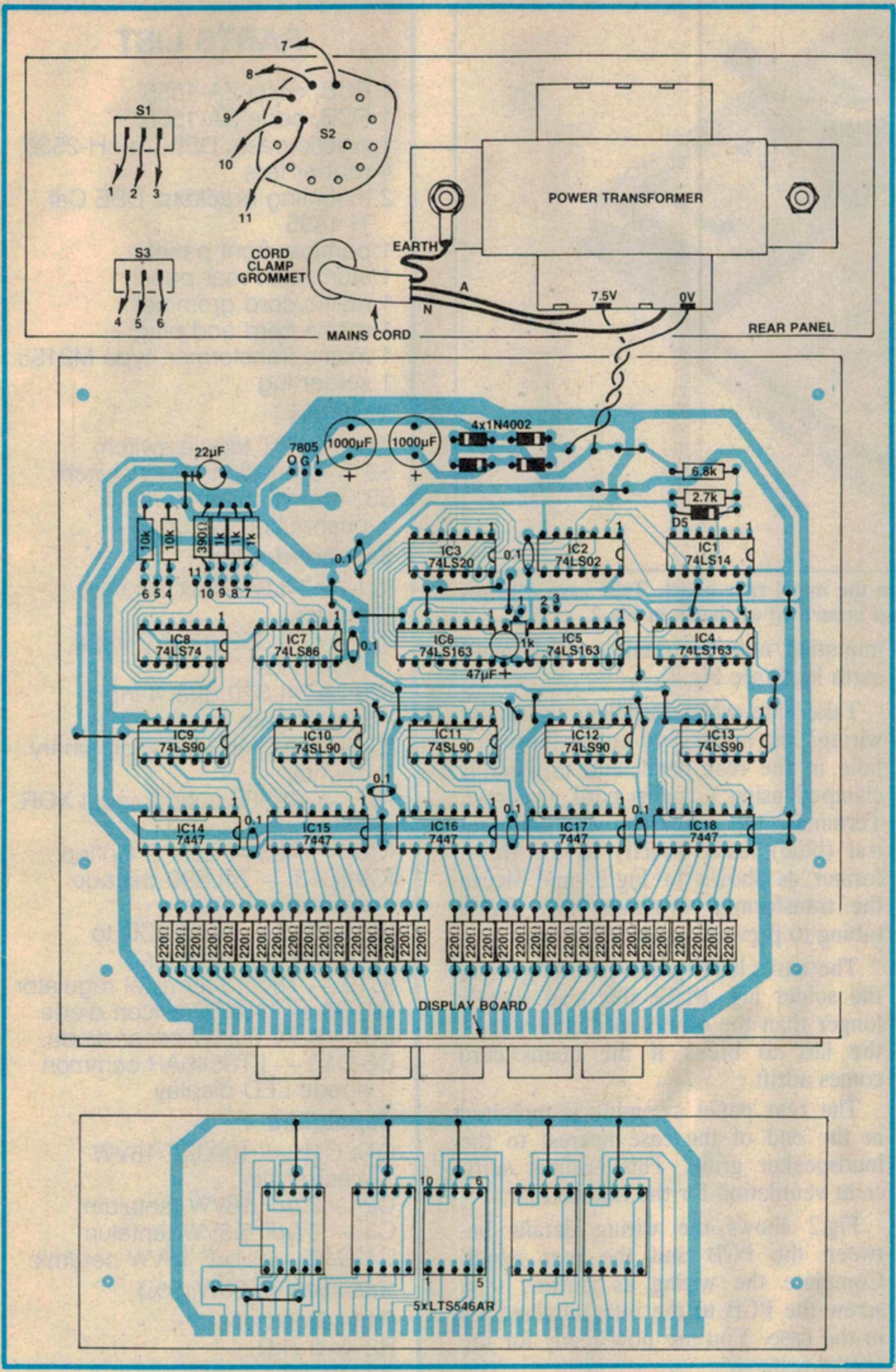
The circuit

Fig.1 shows the circuit of the MDC. It can be broken into three sections: a power supply, a timebase divider (IC1-IC6), and a 5-digit decade counter IC7-IC18. The circuit uses lots of ICs for a very simple reason — proprietary LSI chips for digital metric clocks are not yet available! However the ICs specified can be easily purchased and are reasonably cheap.

Power for the circuit is derived from the 7.5V secondary of mains transformer T1. Its output is rectified using diodes D1-D4 and filtered by two 1000μF electrolytic capacitors (C1a and C1b). The resulting DC is then applied to 3-terminal regulator IC1 which provides a regulated +5V rail to power the TTL ICs.

The 9.5V secondary of the mains transformer also provides the timebase signals for the clock. These pulses do not drive the counter circuit directly, however. Instead, the 50Hz mains pulses are divided by 43.2 to produce a 1.157Hz timebase so that the clock will correctly count in metric time.

This job is performed by the timebase divider circuitry which consists of ICs 1-6. The 50Hz mains pulses picked up from the transformer secondary are first attenuated by a voltage divider (R1,



You can mount the parts in any order on the PCB but take care to ensure that all polarised parts are correctly installed. The two PCBs are soldered together at right angles.

Where to buy the kit

This project was commissioned by the Research and Development Department at Dick Smith Electronics Pty Ltd. It is available as a kit of parts only and can be purchased by mail order or from your nearest DSE store.

The kit comes complete and includes fibreglass PCBs, predrilled metalwork, and screen-printed front and rear panels. The price is $59.95.

Mail orders should be addressed to: Dick Smith Electronics Pty Ltd, PO Box 321, North Ryde 2113. Phone (02) 888 2105.

Note: copyright of the PCB patterns for this project is owned by Dick Smith Electronics.

R2) and then squared up by Schmitt inverter stage IC1a. Diode D5 clips the negative voltage swings of the transformer and ensures that the input to IC1a cannot go above 4.7V.

The output from IC1a is fed to the clock inputs of IC4 and IC5 which are 4-bit synchronous counters. These ICs, together with IC1b, IC2, IC3 and IC6, effectively divide by 43.2 to produce the desired 1.157Hz timebase at the output of NOR gate IC2a. It is this timebase signal which is used to drive the counter circuit.

ICs 9-13 are TTL decade counters arranged in cascade fashion to produce a maximum BCD count of 9.99.99. This is achieved by connecting the Q_D output of each counter to the A input (pin 14) of the following counter. Note that for ICs 9-11, the signal from the preceding counter is gated through an exclusive-OR (XOR) gate (IC7a,b,c).

The counters automatically return to 0.00.00 (ie, metric midnight) after the maximum count of 9.99.99 is reached. ICs 14-18 are BCD to 7-segment decoders which decode the counter outputs. These, in turn, drive the five common anode LED displays via current limiting resistors R10-R44.

Switches S1, S2 and S3 are for time setting. Normally, S1 is in the Run position to enable the timebase divider circuitry, while S2 can be in either position 1 or position 2. S3 is a normally closed (NC) pushbutton switch.

When S1 is set to Halt, the timebase is disabled and the display remains static. To reset the display to 0.00.00, the R0(2) input of each decade counter must be pulled momentarily high. This is done by setting S2 to position 3 and pushing Pulse switch S3.

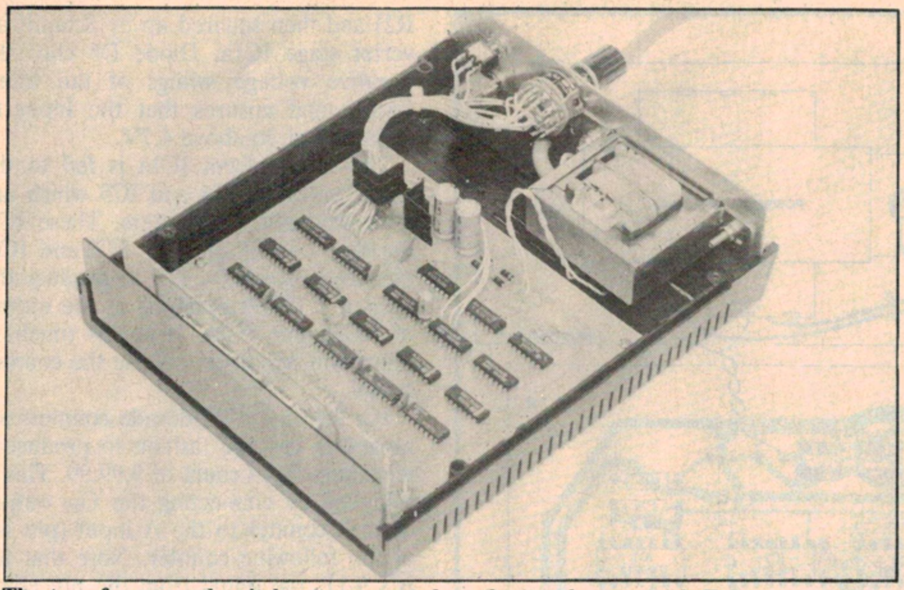
The hours, tens of minutes, and minutes are set by respectively selecting positions 4, 5 and 6 on S2 and repeatedly pushing S3. This clocks the A inputs of ICs 9-11 via the remaining inputs of the X-OR gates.

RS flipflop IC8 (74LS74) debounces the output of S3. Its Q output (pin 9) is normally low but goes high whenever S3 is pressed.

Construction

Most of the parts are mounted on a printed circuit board coded ZA-1555. A separate display board coded ZA-1556 accommodates the LED readouts and is soldered at right angles to the main board.

Begin construction by installing the parts on the main PCB as shown in Fig.2, but do not mount the regulator at this stage. The main thing to watch here



The transformer and switches are mounted on the metal rear panel. Take care with the mains wiring and make sure that the rear panel is earthed as shown in Fig.2.

is the orientation of the polarised components. These include the ICs, diodes and electrolytic capacitors.

Now for the regulator. Before mounting it on the board, it must first be bolted to its heatsink. This done, the assembly can be installed on the PCB as shown in Fig.2. Watch the orientation of the regulator — the metal tab goes towards the front of the PCB.

Note that the heatsink to be supplied with kits differs from that used in the prototype. It is soldered directly to the PCB via two mounting holes directly in front of the regulator.

The display PCB should only take a few minutes to assemble. Install the wire links first, then mount the five LED displays. Make sure that you install the displays the right way round, with the decimal point towards bottom right.

When the board assemblies have been completed, the two can be fastened together using the right angle brackets supplied with the kit. Next, carefully check that the solder pads along the edge of each PCB are correctly aligned. Adjust the two boards as necessary, then solder the matching pads together.

Hardware

The transformer and the three switches are all mounted on the aluminium rear panel of the case. In kit versions, this panel will be supplied predrilled and will feature screened lettering, so the job of mounting the hardware is really easy. Install the three switches first, then bolt the transformer into position.

Note that a solder lug must be secured under one of the transformer mounting nuts to terminate the mains earth lead (see Fig.2).

Take care when installing the mains wiring. The mains cord enters through a hole in the rear panel and is securely clamped using a mains cord grommet. Terminate the active (brown) and neutral (blue) leads directly to the transformer as shown in Fig.2, and sleeve the transformer terminals with plastic tubing to prevent accidental contact.

The earth lead (green/yellow) goes to the solder lug. Make this lead slightly longer than the others so that it will be the last to break if the mains cord comes adrift.

The rear panel assembly is mounted in the end of the case nearest to the loudspeaker grille. This ensures sufficient ventilation for the transformer.

Fig.2 shows the wiring details between the PCB and the rear panel. Complete the wiring as shown, then screw the PCB to the integral standoffs in the case. You are now ready for the smoke test.

Testing

Plug the clock into the wall, switch on and check for +5V at the output of the regulator. If this output is incorrect, switch off immediately and check for wiring errors.

Assuming all is well, you can now check the clock for correct operation. Set S1 to Run and S2 to position 1 (or 2) and check that the clock counts up correctly (it will initially display a random reading). The display should "freeze" when S1 is set to Halt.

Finally, check the timesetting switches (S2 and S3) for correct operation. First, set S2 to position 3 (Reset) and press the pulse switch — the display should reset to 0.00.00. It should now be possible to set the time by selecting the remaining positions on S2 and repeatedly pressing the pulse switch until the correct reading appears.

That's it — your metric digital clock is completed. Next April, we might describe a metric alarm to go with the new clock, but then again we might not.

PARTS LIST

1 PCB, code ZA-1555
1 PCB, code ZA-1556
1 plastic case, DSE Cat. H-2520
4 rubber feet
2 mounting brackets, DSE Cat. H-1895
1 perspex front panel
1 aluminium rear panel
1 mains cord grommet
1 mains cord and plug
1 mains transformer, type M2155
1 solder lug

Switches

S1 — SPDT toggle switch
S2 — 6-position rotary switch
S3 — momentary contact pushbutton switch

Semiconductors

IC1 — 74LS14 hex Schmitt trigger
IC2 — 74LS02 quad 2-input NOR gate
IC3 — 74LS20 dual 4-input NAND gate
IC4-IC6 — 74LS163 4-bit binary counter
IC7 — 74LS86 quad 2-input XOR gate
IC8 — 74LS74 dual D flipflop
IC9-IC13 — 74LS90 decade counter
IC14-IC18 — 7447 BCD to 7-segment decoder
IC19 — 7805 3-terminal regulator
D1-D4 — 1N4002 silicon diode
D5 — 4.7V 0.25W zener diode
D6-D10 — LTS546AR common anode LED display

Capacitors

C1a,C1b — 1000μF 16VW electrolytic
C2 — 22μF 16VW tantalum
C3 — 47μF 6.3VW tantalum
C4-C10 — 0.1μF 16VW ceramic

Resistors (0.25W, 5%)

R1 — 6.8kΩ
R2 — 2.7kΩ
R3, R5-R7 — 1kΩ
R4 — 390Ω
R8-R9 — 10kΩ
R10-R44 — 220Ω