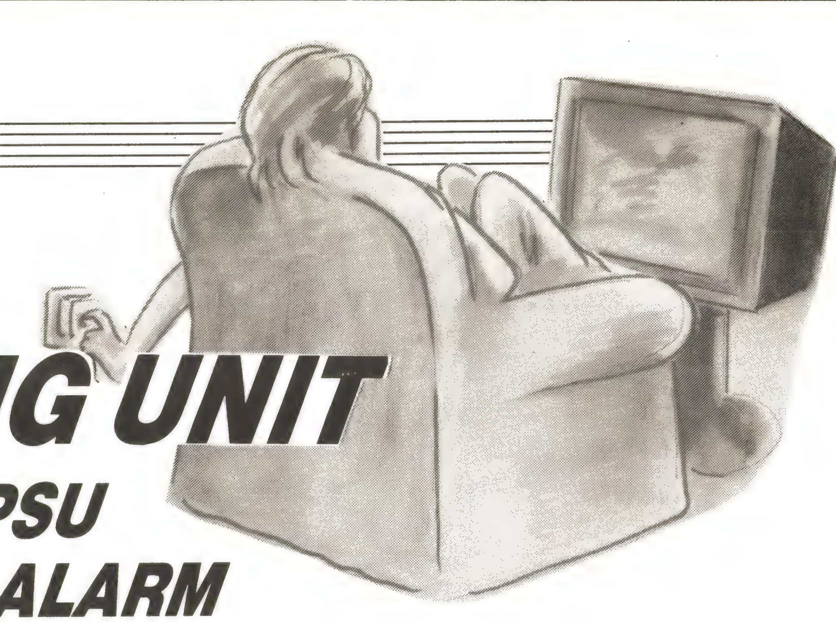
Constructional Project



# MAINS SIGNALLING UNIT

## 12V CAPACITIVE PSU
## TWO-TONE SIREN ALARM

ANDY FLIND

**Part 2**

*Adding a low cost power supply and alarm siren for the "through-the-mains" communications link.*

LAST month a simple system was described for using house mains wiring to transmit a signal. As this was originally intended to extend a doorbell, the Receiver module required the addition of a simple mains Power Supply Unit (PSU) and a Two-Tone Siren Alarm. Other applications for the system, such as a garage intruder alarm or relaying a smoke alarm from another floor, would need similar add-ons.

With a simple mains power supply and a low-current piezo sounder the entire Receiver system can be fitted into a small plastic box, creating a self-contained unit that can be plugged in anywhere in the house. This article describes the construction and use of these extra circuits.

Both simple circuits should find many other uses, especially the Two-Tone Siren Alarm Generator, though the Mains PSU is of the "capacitive dropper" type so circuits powered by it are ***hazardous and should NOT be touched.*** However, any circuits that are *totally enclosed and insulated* can use it, and experimenters wishing to try this type of supply in their own designs will find it a lot safer and more convenient to use one of these boards than normal bread-boarding techniques.

## CAPACITIVE PSU

Beginning with the power supply, the full circuit diagram for the simple 12V Capacitive PSU is shown in Fig. 1. It uses resistor R1 and capacitor C1 in place of the more common transformer to reduce the mains a.c. voltage. A constant current flows through these, the value being determined by the capacitance and supply voltage values.

The circuit is a "half-wave" type. When the "live" is positive of "neutral", current from C1 flows through diode D2 and Zener diode D3.

The 12 volts that develops across D3 is stored in capacitor C2 which continues to supply the output during the negative half-cycle, whilst current returns to C1 through diode D1. VDR1 is a 230V mains transient suppressor, which clips any brief high-voltage spikes in the mains supply to protect C1.

Resistor R1 restricts the brief but heavy current inrush that would occur if the circuit was plugged in at the exact instant where the mains voltage was at a high point in the cycle. A rugged two watt component is used for this. Resistor R2, a high-voltage type, discharges capacitor C1 when the circuit is disconnected to eliminate the possibility of shocks to the user from the plug. The capacitor C1 is a special "IS" type intended for suppression applications, designed to withstand *continuous* connection across the 230V mains supply.

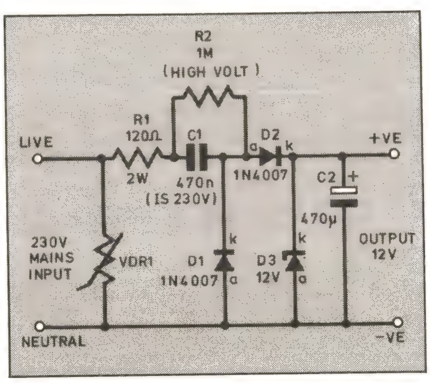
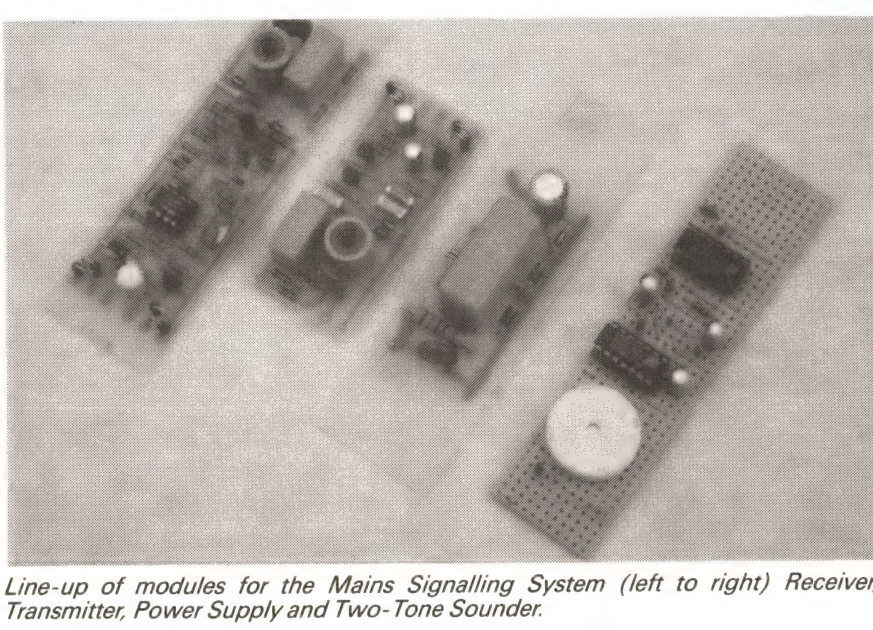



Fig. 1. Circuit diagram for the simple 12V Capacitive Power Supply.

The advantages of this circuit over a transformer are that it is smaller, lighter, cheaper, and does not generate any heat or noise. Transformers invariably warm up a little and can generate hum. The disadvantage is that circuits powered by it are in direct contact with the mains so they ***must be fully insulated.***

The maximum current available depends on the value of the capacitor C1 and in this case is about 10mA. Most of the current passing through the capacitor is "reactive", and does not appear on the electricity bill. Only the tiny part picked off by the resistive element of the circuit being supplied will register.

***This type of circuit has obvious hazards and should only be built by constructors with sufficient experience to recognise and avoid them. Those in doubt should use a small transformer instead; the receiver circuit will operate happily from either supply source.***



Line-up of modules for the Mains Signalling System (left to right) Receiver, Transmitter, Power Supply and Two-Tone Sounder.

## COMPONENTS

**Power Supply Board**

**Resistors**
R1 120Ω 2W metal film
R2 1M high-voltage metal film

See SHOP TALK Page

**Capacitors**
C1 470n "IS" 230 volt suppression type
C2 470μ radial elect. 35V

**Semiconductors**
D1, D2 1N4007 1A 1000V rectifier diode (2 off)
D3 BZX61C12 12V 1·3W Zener diode

**Miscellaneous**
VDR1 250V mains transient suppressor

Printed circuit board available from *EPE PCB Service,* code 975; plastic case, size to choice; cable clamps to suit input and output wires; multistrand connecting wire; solder pins; solder etc.

*Approx cost guidance only* **£8** *excl. case*

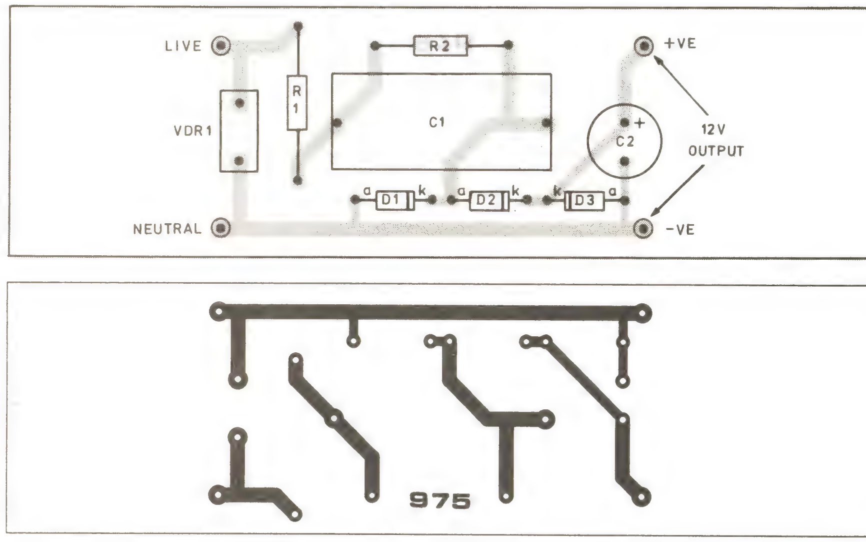



*Fig. 2. Printed circuit board component layout and full size foil master for the 12V Capacitive PSU. The extra board space at each end allows it to safely slot into its case.*

## PSU CONSTRUCTION

For safety, the simple 12V Capactive PSU is constructed on a small, robust printed circuit board (p.c.b.) with widely-spaced tracks. This board is available from the *EPE PCB Service,* code 975.

The components can all be fitted as shown in Fig. 2; working from the smallest component up to the large "continuous mains operation" IS capacitor C1. Take care with diode polarity, especially the Zener diode D3 which is the opposite way around to the other two.

Leads can now be fitted to the board for testing and a meter, set to the appropriate voltage range, connected to the output terminals *before* it is powered-up. The board *MUST* be connected to the mains supply through a suitable fuse – one with a rating of 3A or lower should always be used with this type of circuit.

At switch-on the "test" meter should read 12V, plus or minus about half-a-volt. If this is OK, construction and testing is complete.

It is perhaps worth mentioning that should a supply that is negative or "neutral" be required, this can be built by simply reversing the three diodes D1 to D3 and capacitor C2. This is sometimes useful in circuits where a triac is to be triggered with the low current available from a supply of this type as they tend to be more sensitive to negative gate current.

## ALARM SOUND GENERATOR

For the alarm, a distinctive sound was required. The world these days is full of things that go "bleep", especially in an electronics workshop, so something instantly recognisable was needed.

The circuit diagram shown in Fig. 3. produces a two-tone sound a bit like a panic-stricken police siren, using an ICM 7556 dual timer to generate the signal and a CMOS 4093B quad Schmitt NAND gate i.c. for control and output buffering functions.

## HOW IT WORKS

A positive input causes the output of IC1a to go low, discharging capacitor C1 through diode D1. When the input goes low, IC1a output returns high and recharges C1 through resistor R2.

Recharging of C1 takes four to five seconds so there is at least four seconds of positive output from IC1b. This was arranged so that brief presses of the Doorbell would result in substantial output from the remote repeater. If this feature is not required C1 can be omitted.

The output from IC1b powers IC2 which then generates the sound. This is a micropower version of the 556 dual timer and runs quite happily on the current available from the output of a single CMOS gate.

The two timers are connected as oscillators. The first, using resistor R3 and capacitor C3, runs at about 3Hz. The output of this, pin 5, is used to modulate the second by connection to its "control" input, pin 11, through resistor R4.

The centre frequency of this second oscillator is set to around 1·6kHz by resistor R5 and capacitor C4, but is modulated into a two-tone sound by the control voltage from the first. Its output, pin 9, is buffered and inverted by gates IC1c and IC1d to create a "bridge" output for the piezo sounder WD1, thereby obtaining maximum volume.

The output will be too loud for many applications so the resistor R6 can be added to reduce it. The value of 2·2 kilohms proved about right for the prototype but constructors can experiment with this.

## ALARM CONSTRUCTION

Construction of the Alarm unit is carried out on a small piece of stripboard, with 11 strips of 45 holes, although only a length of 33 holes is taken up by the circuit. The

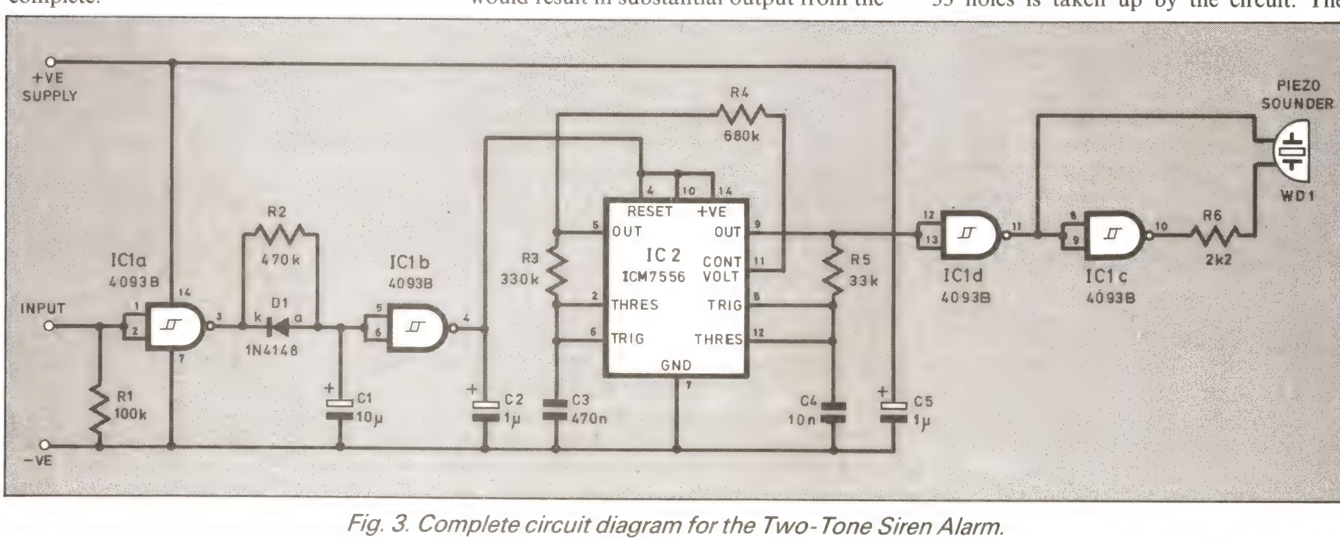



*Fig. 3. Complete circuit diagram for the Two-Tone Siren Alarm.*

## COMPONENTS

### Two-Tone Siren Alarm

**Resistors**

| | |
|---|---|
| R1 | 100k |
| R2 | 470k |
| R3 | 330k |
| R4 | 680k |
| R5 | 33k |
| R6 | 2k2 (see text) |

All 0·6W 1% metal film

**See SHOP TALK Page**

**Capacitors**

| | |
|---|---|
| C1 | 10µ radial elect. 50V |
| C2, C5 | 1µ radial elect. 100V (2 off) |
| C3 | 470n resin-dipped ceramic |
| C4 | 10n resin-dipped ceramic |

**Semiconductors**

| | |
|---|---|
| D1 | 1N4148 signal diode |
| IC1 | 4093B CMOS quad Schmitt NAND gate |
| IC2 | ICM7556 dual CMOS timer |

**Miscellaneous**

| | |
|---|---|
| WD1 | 3V to 24V d.c., p.c.b. mounting, piezoelectric sounder |

Stripboard, 0·1in. matrix, 11 strips of 45 holes; case, ABS box 118mm x 98mm x 45mm; 14-pin d.i.l. socket (2 off); multistrand connecting wire; solder pins; solder etc.

Approx cost guidance only **£8**

reason for the extra length of both this and the PSU is that they fit neatly into the moulded slots in the specified case used.

Underside breaks in the copper strips and board topside component layout are shown in Fig. 4. Construction should start with the cutting of the 23 breaks as shown, after which the 17 wire links can be fitted.

Following this the components can be inserted, care being taken to insert diode D1 correctly. As shown, it should have the marked (cathode) end facing down towards the board. As mentioned earlier, if the timed operation feature is not needed capacitor C1 should be omitted.

It is recommended that d.i.l. sockets be used for the two i.c.s. When inserting the i.c.s care is recommended as both are CMOS types and IC2, the ICM7556, has proved to be a trifle more sensitive than most to static. The sounder is a p.c.b. mounting type and is soldered directly onto the board.

Testing consists of applying a suitable supply voltage, anywhere between 5V and 12V and touching the input to positive. The unit will normally sound immediately on power-up as capacitor C1 charges. Following this positive pulses to the input should trigger further operation. Current drain should be zero in the standby state, and about 2mA to 3mA when operating, though this may vary a little with supply voltage and the value of resistor R6 if fitted.

## IN USE

The wide supply voltage range and zero standby current features of this unit should ensure that it finds plenty of applications beyond the simple doorbell repeater it was designed for. However, if it is used with the Receiver of the Mains Signalling Unit described last month, it can be connected as shown in Fig. 5, which shows complete interwiring for the Alarm together with the PSU board.

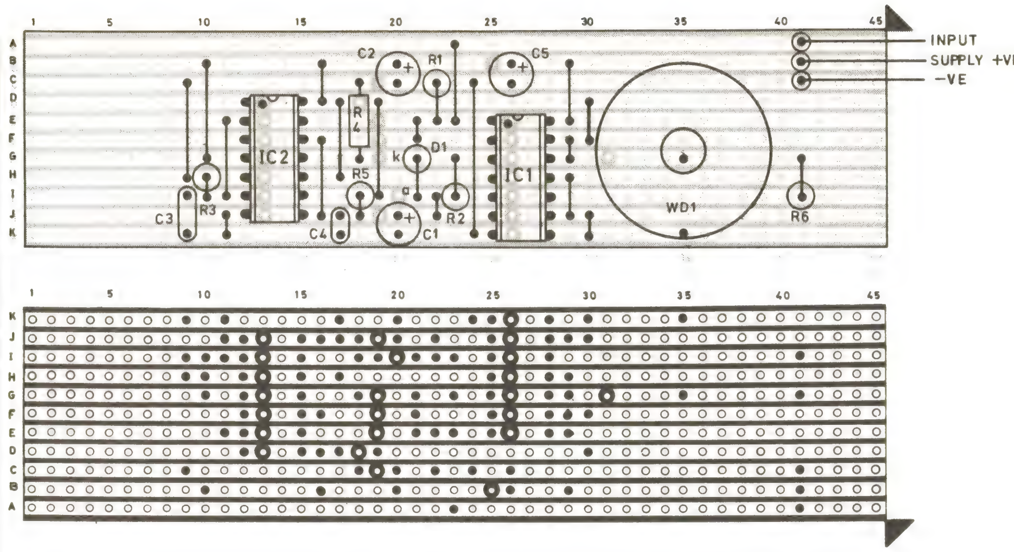



*Fig. 4. Two-Tone Siren Alarm stripboard component layout and underside copper break details.*

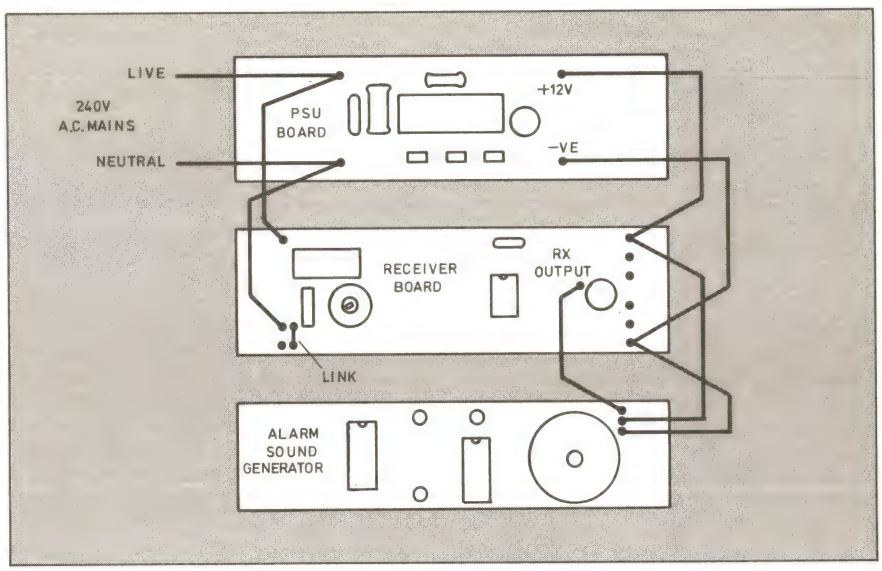



*Fig. 5. Linking the two boards to last month's Receiver to produce a "through-the-mains" alarm repeater.*

Constructors of the Mains Signalling System might be interested to know that the Receiver of the signalling project originally had a much shorter time constant in the section of the circuit following IC1a, but when used with the Alarm Sounder board, with its timed output feature, it proved susceptible to false triggering caused by noise in the mains supply. The time constant, set by resistor R14 and capacitor C9 on the Receiver board, was increased to the value shown last month and the problem disappeared.

This setting is inevitably something of a compromise. The longer the time constant the better the noise immunity, but if it is too long there will be a perceptible delay in operation. With the present values operation still has an "instant" feel to it.

If any constructors do experience problems of this nature and are not able to cure them by adjustment of preset VR1 on the Receiver board, the value of capacitor C9 can be increased. At 470n there is a slight delay in response, but it should respond to most inputs satisfactorily. □

*The completed Two-Tone Alarm and 12V Capacitive PSU boards.*