

On Guard

LOOP ALARM

by Mark Price

PART 2 OF A CLASSIC PROJECT FIRST PUBLISHED IN ISSUE 109 JANUARY 1997. THIS MONTH WE LOOK AT CONSTRUCTION AND WIRING.

The circuit is constructed on a single-sided PCB which is designed to fit into the guides in the recommended case – refer to the PCB legend and track drawing, shown in Figure 4. PCB assembly should be carried out following the normal guidelines and recommendations.

There are several wire links which should be fitted first. IC sockets should be used for the ICs, as they are static sensitive. Do not fit the ICs into the sockets until all other components have been fitted.

SK1 to SK5 are PCB mounting terminals, and should be fitted with the cable entries towards the edge of the PCB. The LED needs to protrude through a hole in the case, so you may prefer to wait until after the case has been drilled so that you can get the

leads the right length.

AWD1 must be fitted with the correct polarity. You may prefer to leave this out until after the circuit has been tested as the noise can become rather irritating (particularly for others). If the relay output is not required, omit RLY1 and R21.

When construction is complete, the PCB should be cleaned with a suitable solvent to remove the flux. At this stage, it is a good idea to check your work, in particular, the soldering.

Assembly

The general layout of the components in the case may be seen from the photographs.

Looking from the rear, the alarm sounder is positioned as close as possible to the left to leave sufficient room for the battery to stand beside it.

The sounder is held to the base of the case with two M3 countersunk screws and nuts. Part of one of the PCB guides should be removed so that the sounder sits level. Fitting the sounder will require a pair of long-nosed pliers to hold the nuts – and some patience! A pattern of holes should be drilled in the case in front of the sounder (before the sounder is finally fitted) to



Project Spec

Number of zones	2 (Entry/Exit with Loop Cables)
Maximum Loop Length	Unlimited
Exit Time	5 to 30, seconds (set by internal preset)
Entry Time	5 to 30, seconds (set by internal preset)
Alarm Time	7.5 minutes (typical)
Entry/Exit Warning	Pulsed Buzzer and Flashing Status LED
Alarm Sounder	Piezo-Siren (110dB @ 1m)
Supply Voltage	9V nominal (PP3 Battery)
Low Battery Indicator	Status LED extinguished below 6.5V
Supply Current (Armed)	1mA (typical)
Battery Life	6 months (typical)
Remote Output	Optional changeover relay
PCB Size	172 x 75mm
Overall Size	177 x 120 3-8.3mm
Weight	500g

let the sound out.

The PCB is fitted in the second set of slots from the top with the components downwards. A 5mm hole is required for the LED. The keyswitch may be fitted midway between the PCB and the sounder. On the prototype, the phono sockets for the Loop were fitted to the side of the case above the sounder.

Additional holes will be needed for the cables connecting to the remote sensors. The layout of the components within the case is not critical and may be varied to suit individual needs. Check that everything will fit inside as you intend before drilling any holes.

The prototype was attached to the wall by means of two keyhole shaped holes in the rear panel (lid) of the case. The unit can,

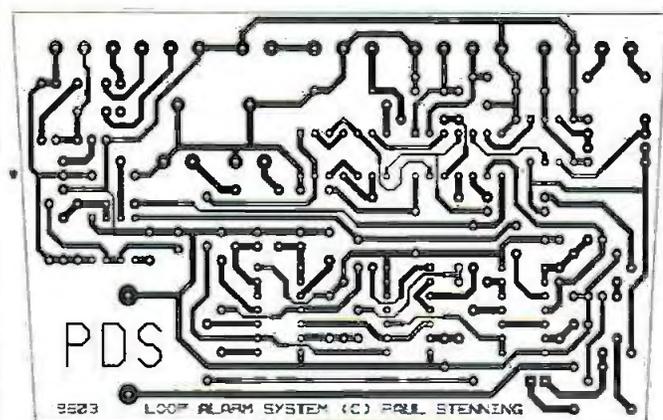
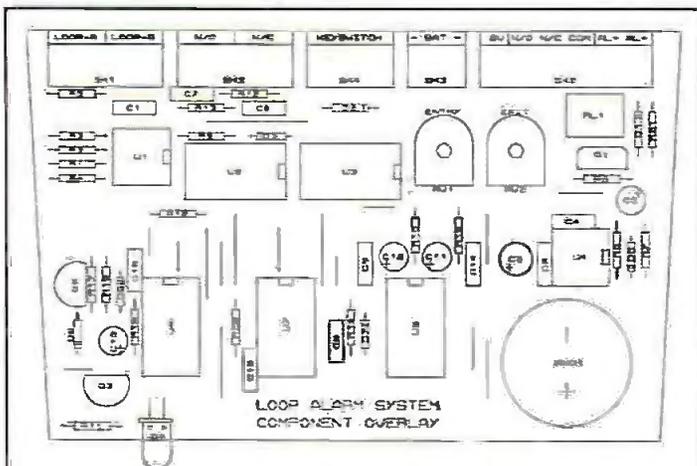


Figure 4. PCB legend and track.

therefore, be fitted over two suitable screws once the back is fitted.

Wiring

The interwiring is shown in Figure 5. The leads from the alarm sounder will probably be excessively long and may be shortened to suit. Because of the noise, you may prefer to leave this disconnected until after the rest of the unit has been tested.

The battery is connected using a pair of PP9 type battery connection leads, ensuring correct polarity. All other connections are made with 7/0 2mm hook-up wire as shown.

The connections on the keyswitch can be confusing. In any position, the centre contact is connected to the pin towards the back (flat) edge of the key. On the prototype, the first (anticlockwise) and third positions were Off, so the relevant tags were not connected. The second position is 'Loop & Entry', so the relevant tag is connected to terminal 1 of SK4. The fourth position (fully clockwise) is 'Loop Only', and the relevant tag is connected to terminal 2. The centre tag on the switch connects to terminal 3. The two operating positions on the key-switch MUST be separated by an 'Off' position to ensure the unit resets correctly when changing mode.

You will also need to make-up a lead for the loop cable. This should be made using cheap single-core screened cable, fitted with a phono plug at either end. To prevent an intruder from simply unscrewing the covers of the plugs to link out the cable, secure the covers with a small amount of super-glue once the unit and cable have been tested. If a long length is required, it may be more convenient and flexible to make up two or three shorter leads, and join them with in-line connectors having a phono socket at either end.

Testing

The unit does not require any setting up, apart from adjusting the entry and exit delay periods to suit your installation. The testing, therefore, involves nothing more than checking the various functions of the unit.

Connect a loop cable between the two Loop sockets. Also, link terminals 1 and 2 of SK5 (The N/C entry sensor) with a short piece of tinned copper wire. Set RV1 and

RV2 fully anticlockwise.

With the keyswitch set to one of the Off positions, connect a PP9 battery to the battery connector leads. Set the key-switch to the 'Loop and Entry' position. The LED (D4) should flash and the warning sounder (AWD1) should beep in time with it, for about five seconds (this is the Exit period). After this time, the sounder should be quiet and the LED should be off. The unit is now armed, and waiting for someone to break in!

Momentarily link terminals 3 and 4 of SK5 with a piece of wire. The LED and warning

socket inside the case with a screwdriver). Again, the alarm sounder and relay should operate immediately.

Switch off, then switch to 'Loop Only'. After the exit period, link terminals 3 and 4 of SK5. This should have no effect. Now unplug the loop cable, which should trigger the alarm as previously.

If you wish you can leave the alarm sounding, and check the timing of the alarm timer – which should be between 15 and 20 minutes. At the end of this time, the sounder should silence and the relay should release,

but the LED should remain lit to tell the user that the alarm has been set off.

Installation

Since every installation is different, I can only give some general comments about installation. The main unit should be wall mounted if possible. Alternatively, it may be free standing in a steady position. You may wish to hide it so that it is not immediately visible but can still be accessed quickly for disarming.

Cables need to be run from the main unit to the entry/exit sensors being used. In many cases, one or two normally closed magnetic reed switch sensors mounted on the entry doors and possibly windows would be

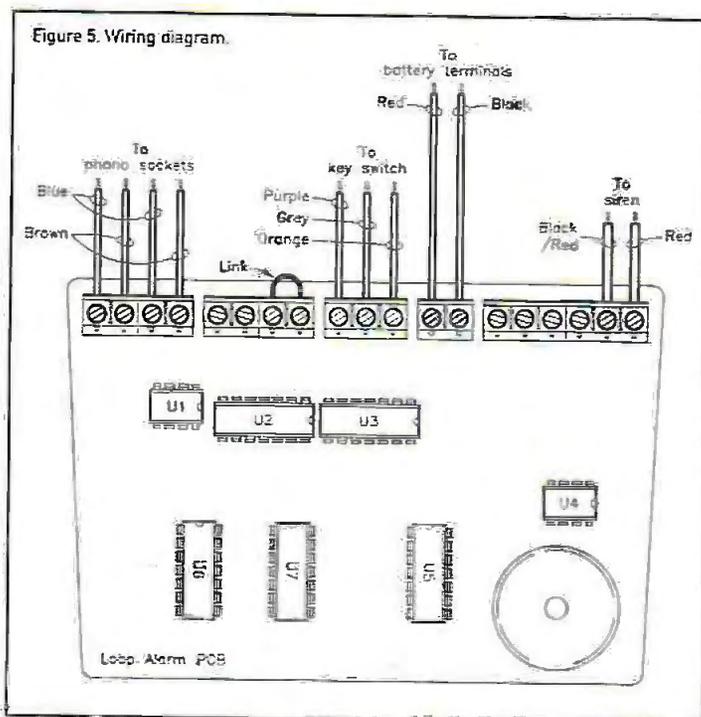
adequate. Normally closed sensors must be connected in series, so that if any operate, the circuit becomes open. Connect to terminals 1 and 2 of SK5.

If it is not possible or desirable to screw sensors to the doors, pressure mats may be used underneath carpets or rugs. These generally have normally open contacts, and must, therefore, be connected in parallel to terminals 3 and 4 of SK5.

The connections should ideally be made with 4-core alarm cable, which will fit tidily into the sensors. Alternatively, you could use any convenient thin two-core cable. Hide the cable out of sight where possible.

The loop cable should be threaded through or attached to the items to be protected. For example, with bicycles, thread the cable through both wheels and the frame.

Some items, such as televisions and Hi-Fi equipment have no obvious gaps to thread the cable through, and will, therefore, call for some ingenuity. If you are sure you know what you are doing, and the item is out of guarantee, you may be able to remove the



sounder should operate as before, for five seconds (the Entry period). After this time, the main alarm sounder should operate, the relay (RL1) should pull in and the LED should remain on (not flashing). Set the keyswitch to off.

Try this again, but this time, trigger the alarm by disconnecting the link between terminals 1 and 2 of SK5. The unit should operate as before.

Set the keyswitch back to the 'Loop and Entry' position, and wait until the end of the Exit period. Now unplug one end of the loop cable. The alarm sounder and relay should operate immediately (no entry delay).

Switch off, and then back to 'Loop and Entry' without reconnecting the loop cable. This time, the Exit delay will not operate, and the LED should remain on (not flashing) to indicate that something is amiss.

Switch off, reconnect the loop cable, and switch back to 'Loop and Entry'. After the Exit period, trigger the alarm by short circuiting the inner and screen of the loop cable at one end (bridge the terminals of the

back or cover and thread a piece of cable through a couple of the ventilation slots before fitting plugs to the ends.

Alternatively, you could fix a section of the cable to the item with a suitable adhesive such as Araldite.

If you don't want to mark the item, the best option might be to securely tie the loop cable to the unit's mains cable. A few cable ties can be useful here. Another possibility is a P-clip under a suitable screw on the unit.

External Alarm or Sounder

The relay contacts may be connected to an additional sounder or a separate household alarm system if required. The additional sounder may be a similar type to that used in the unit, mounted in an outdoor enclosure and powered by its own battery.

The unit may be connected to any convenient zone on an alarm panel, depending on the type of protection required. The Panic button input would be suitable if you wish the alarm to operate whether or not the main alarm is set. If you have a monitored alarm system, you may need to contact the monitoring company before connecting this unit to the system.

Greater Tamper Resistance

No alarm system is 100% secure and completely resistant to any attempt to defeat it, and this unit is certainly no exception. However, it should be adequate in most cases.

The following suggestions are offered to more experienced constructors who may wish to customise their system and installation to suit their individual circumstances.

If the unit is connected to an external alarm system, as described earlier, this will continue to sound if an intruder attempts to smash this unit once it has triggered.

The main concern will probably be attempts to defeat the unit to prevent it being triggered. Normally, this would involve trying to bypass the loop, close to the alarm unit, so that it may be disconnected. The system operates by sensing the resistance of the terminating resistance via the loop. This resistance need not be a single component at the far end, it could be made up of a number of resistors along the loop.

If R5 is reduced to 33k Ω , and two additional 33k Ω resistors are added inside connection plugs along the length of the loop, any attempt to bypass the loop at the alarm end would trigger the unit. I would suggest that one of the additional resistors is in the core connection and the other is in the screen. The only drawback of this is that you

Parts List			
<u>Resistors:</u> All 1% 0.6W Metal Film (Unless Stated)			
R1,3-5,12.			
13,15,16,18	100k	9	
R2,10,17	22k	3	
R6,14,20	10k	3	
R7	3M9	1	
R8	4k7	1	
R9	220k	1	
R11	330 Ω	1	
R19	1M0	1	
RV1,2	470k Horizontal Preset Potentiometer	2	
<u>Capacitors:</u>			
C1,2,4.			
6-9,14	10nF Ceramic Plate	8	
C3	220 μ F 16V Radial	1	
C5	10 μ F 63V Radial	1	
C10,11	47 μ F 16V Radial	2	
C12	100pF Ceramic Plate	1	
C13	4 μ 7F 63V Radial	1	
C15	100nF Disc Ceramic	1	
<u>Semiconductors</u>			
U1	LPC662IN Dual Op-Amp	1	
U2,6	4093 Quad NAND Gate	2	
U3,7	4001 Quad NOR Gate	2	
U4	1CM7555IPA Timer	1	
U5	1CM7556IPD Dual Timer	1	
Q1	ZTX651 Transistor	1	
Q2	BC548 Transistor	1	
Q3	BC558 Transistor	1	
D1,2	1N4001 Rectifier	2	
D3,5-7	1N4148 Diode	4	
D4	5mm Red LED	1	
D8	4V7 500mW Zener	1	
<u>Miscellaneous</u>			
AWD1	PCB Buzzer	1	
SK1,5	4-way 5mm PCB-mounting Terminal Block	2	
SK2	6-way 5mm PCB-mounting Terminal Block	1	
SK3	2-way 5mm PCB-mounting Terminal Block	1	
SK4	3-way 5mm PCB-mounting Terminal Block	1	
Case MB7		1	
Battery PP9		1	
PP9 Clips		1	
4-way Keyswitch		1	
Micro Piezo Siren		1	
Chassis Phono Socket		2	
Single-core Screened Cable		As Req	
Tinned Copper Wire		As Req	
Hook-up Wire 16/0.2mm		As Req	
M3 3 10mm Countersunk Screw		2	
M3 Nut		2	
PCB		1	
<u>Optional</u>			
R21	68 Ω	1	
RL1	1A 5V Micro-miniature Relay	1	
In-line Phono Connector		As Req	
Phono Plug Black		As Req	
Reed Switch Surface		1	
Pressure Mat		1	
Alarm Cable 4-core		As Req	

have to remember to use all the pieces of loop cable, but this could be ensured by using a different type of connector for each joint. You could use any number of resistors, providing the total resistance is between 90 and 110k Ω .

The other likely tampering method would be to disassemble the box and disconnect the battery. This could be sensed by either a tilt switch or micro-switch suitably positioned within the box. The micro-switch would be held operated by the lid, such that it is released when the lid is removed. Fix it inside the case with glue, as the screw-heads

on the outside of the box would be a give-away! In either case, the connections that are closed when everything is OK are connected in series with the loop connections inside the box.

Did you make this alarm?

Did you re-work this old project with new components?

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