

# Assembly Manual

## Versatile Message Recorder - 8 Channel (Short Form - PCB and components only)

### K - 5019

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Please read 'A Safety Guide to Mains  
Wiring & Handling' before assembling  
this kit



ACN 000 445 956

***Microprocessor based, this project is a lot more than just a solid state audio recorder. You can record up to eight short audio clips, and then have it replay different clips in response to different trigger input signals. This gives it the potential for use in a wide variety of applications - from reminding you to use your car's seatbelt and turn off your headlights, to delivering your amateur radio callsign at regular intervals.***

'Versatile Multiple Announcement Circuit', or 'VMAC' for short, was about the most descriptive name I could think up for this new project. It's an extremely flexible general-purpose circuit which allows you to record not just one, but up to eight different short voice messages, announcements, or maybe even sound effects, in a solid-state audio recorder IC. Then one or more of these recordings can be individually played back, by activating their corresponding 'trigger' inputs. It's up to you and your imagination to decide what external devices you'll connect to the inputs (and outputs).

The recorder IC will retain your recordings, even with power disconnected, for about 100 years(!). However, you can re-record on the chip at any time, should you decide to change or update it. This can be done as many times as you like, but you do need power for the recording operation.

Using simple 'DIP' switch settings, any of the high impedance, voltage-protected trigger inputs can be easily individually configured to respond to either a 'high' or a 'low' voltage level, or a simple contact make or break.

Also programmable by DIP switches, any recorded segment can be set to play just once, or repeat endlessly, if its input stays triggered. So VMAC can tell you

about a change in conditions, i.e., that a door you've fitted with a reed switch and magnet has opened or closed. Or it can keep repeating a warning about an abnormal condition, e.g., an engine oil pressure alarm.

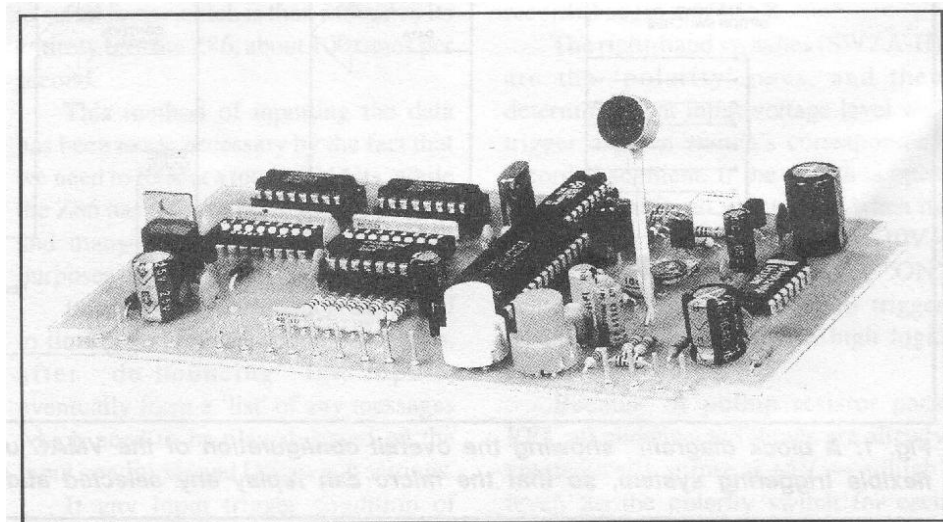
In addition, the circuit can generate a pleasant, attention-getting 'chime' sound prior to each announcement, if desired. VMAC has a loud on-board 2W amplifier to drive an eight ohm speaker, plus a line level output of about 200mV RMS which could feed a public-address amplifier, amateur radio transmitter, etc.

Provision has also been made for mounting a relay, which operates during

your announcements, on the board. This can be used to activate said PA amplifier or transmitter, or perform some other low voltage switching function you might have in mind.

The VMAC's power needs are reasonably flexible. It will operate from a DC supply of 10V to 20V and uses 25mA or so in its standby mode, but can draw several hundred milliamps when driving a speaker hard.

For most mains-powered situations, a nominal 12V/300mA plugpack supply (not supplied) should be more than adequate. Of course it will also work well from a car's electrical system (but



remember to put a 1A fuse in its supply lead).

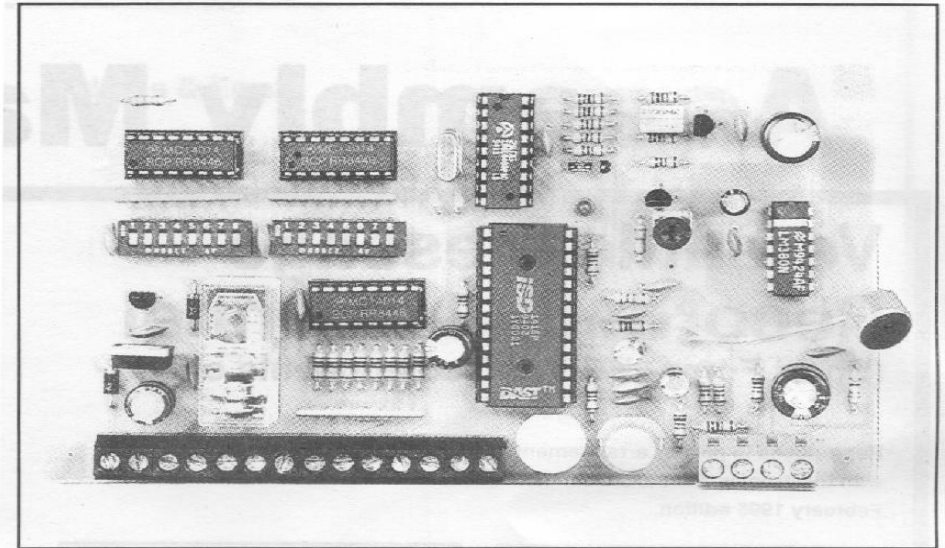
## Many applications

Before giving you some examples of possible applications for VMAC, I have to state that Winbond/ISD Inc, the manufacturers of the audio recorder chip, reserve the right to exclude the use of their devices from the following: medical equipment, greeting cards and Christmas ornaments. If you think you might want to use a VMAC in any of those areas, please contact Winbond's Australian agents, Adilam Electronics, for clarification of the situation.

Apart from the preceding, the uses for VMAC are many and varied. A large area of potential application would be in industry, telecommunications and security monitoring, where it could supplement or replace existing visual and/or acoustic alarms and indicators. A voice indication of exactly what the problem is would be much more useful than simple alarm beepers.

But there are lots of other possible uses, too. Radio 'hams' could record a couple of versions of a 'CQ' message and transmit them by pushing different buttons, or under control of a timer/sequencer - or use VMAC for repeater identification and status indications (instead of those robot-like speech synthesisers).

The VMAC could probably be of assistance to the visually-impaired, too.



*A top view of the 'ruggedised' version of the VMAC, with optional PCB mounting terminal strips fitted to the board instead of PCB pins (supplied) for the off-board connections. This board has also been fitted with the relay and its driver transistor.*

For example, a mate of mine suggested using one to help a blind person learn the controls for operating a mobile radio base station, while another has drawn attention to possible sight-impaired and multi-lingual uses in the tourism, accommodation and travel industries.

In your house you could connect each of several doorbell buttons to its own trigger input, and record an appropriate announcement for each one. Or install the circuit in your car and use it as an audible addition to the warning lights, plus a 'lights on' reminder, etc.

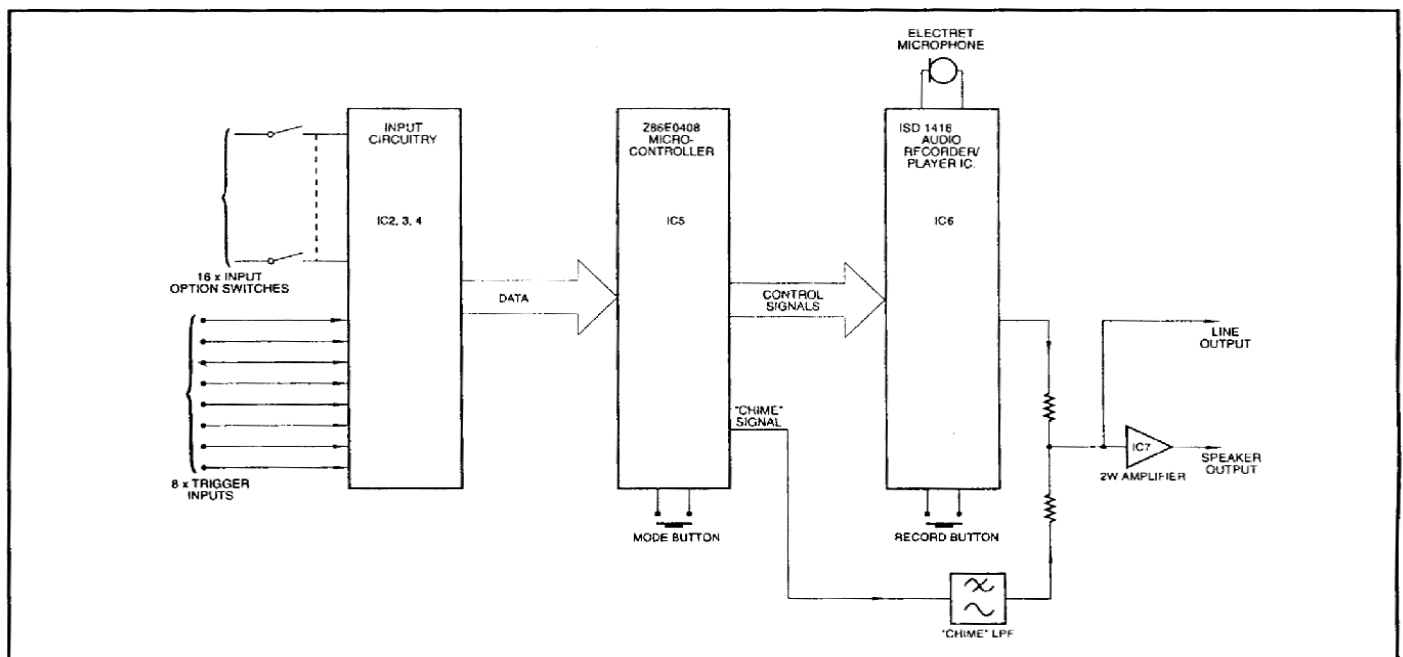
Model railway enthusiasts could

possibly 'dub' steam train sounds, etc., from tape recordings, and connect a VMAC to their layout - using the trains to trigger it via reed switches, opto sensors and so on.

So if you can think of uses for VMAC, keep reading. At the end of this are some suggestions ideas for using the VMAC.

## Recording time

Each of your announcements can be of any length you like, as long as they all add up to a **total** of no more than 16



**Fig. 1: A block diagram showing the overall configuration of the VMAC unit. The input circuitry provides a very flexible triggering system, so that the micro can replay any selected audio clip from the recorder chip IC6.**

seconds. This mightn't sound like much time, but make a list of announcements you might like to have, using a sensible number of words for each one (e.g., "There's someone at the front door!" or "Oil pressure warning!"), and use your faithful digital watch to measure how long it takes to say them all.

You'll probably be surprised, as I was, to find that you can fit a lot of words into 16 seconds if you're slightly careful. And naturally, the fewer announcements you need, the more time you have available for each of them.

## How it works

Referring to Fig. 1 (previous page), the heart of the circuit is IC6 - an ISDI416 audio recorder/player IC.

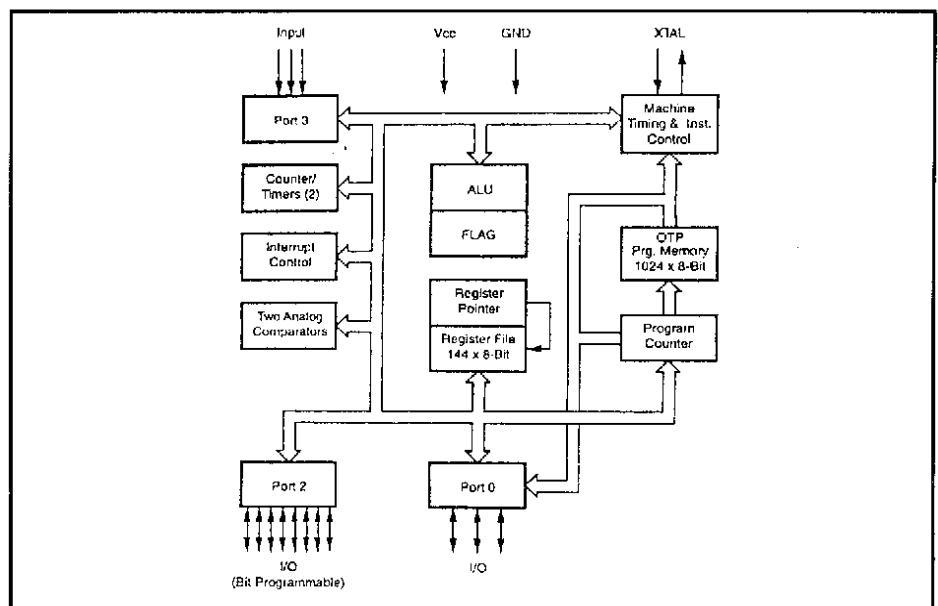
You've probably seen the ISD ICs in other projects, and may have gained the impression that all they can do is record just a single message then play it back again, with the possible options of pausing and repeating.

In fact these extremely sophisticated devices have also been designed to selectively record, play and 'fast-forward' through multiple messages. 'All' you need is the appropriate external control logic circuitry, to take advantage of these features. (Sounds easy enough, doesn't it? Needless to say, it took quite a bit of work...)

Now if you were to design this circuit around ordinary small or medium scale integrated chips, it would probably take two dozen or more of them to implement all the functions of VMAC, which would make it impractically large, expensive and complex. So I decided to take the more elegant approach, and use a micro.

In fact IC5 is 'the brains of the outfit', which replaces those dozens of simpler ICs. It's a Zilog Z86E0408 microcontroller ('Z8'), containing a program written by yours truly, which supervises and controls almost every aspect of VMAC's operation.

For those interested in the details, the Z86E0408 is the second smallest available member of Zilog's Z8 microcontroller family. Despite its little 18-pin package, this is a high performance eight-bit CMOS device containing 1KB of one-time PROM, 124 general-purpose registers plus numerous control and port registers, two versatile timer/counters, two analog comparators, a sophisticated interrupt system, power-on and 'watchdog' reset circuitry, and on-chip crystal oscillator. It has 14



**Fig. 2: The internal architecture of Zilog's Z86E0408 microcontroller chip, which is used as the 'brains' of this project.**

input/output lines available.

Its instruction set is quite simple and very efficient, and I'm constantly surprised by how few instructions it takes to perform even quite complex tasks.

All VMAC's timing, including the chime frequency and duration, is derived from the micro's master clock oscillator, which uses a cheap 3.58MHz NTSC 'colorburst' crystal.

A block diagram of the Z86E0408 device itself appears in Fig.2, while Fig.3 shows the full schematic for VMAC.

## Inputs and switches

As you can see in Fig.1 and Fig.3, the eight trigger inputs from the outside world, plus the logic 0's and 1's from the 16 input option DIP switches, arrive at IC4, 3 and 2. These are all eight-bit parallel-in/serial-out shift registers, which can be either 4014 or 4021 chips. These convert all 24 'bits' of information to serial form, which is then moved in its entirety into the Z8, about 100 times per second.

This method of inputting the data has been made necessary by the fact that we need to look at a total of 24 bits, while the Z8 has only 14 input/output pins and many of them are used for other purposes anyway.

Inside the Z8, the data is subjected to timing and logical operations which, after 'debouncing' the inputs, eventually form a 'list' of any messages which need to be played, based on the input conditions and DIP switch settings.

If any input trigger condition of more than 30ms duration occurs at any time,

the Z8 will 'grab' it and add it to its 'play list'.

## Playback sequence

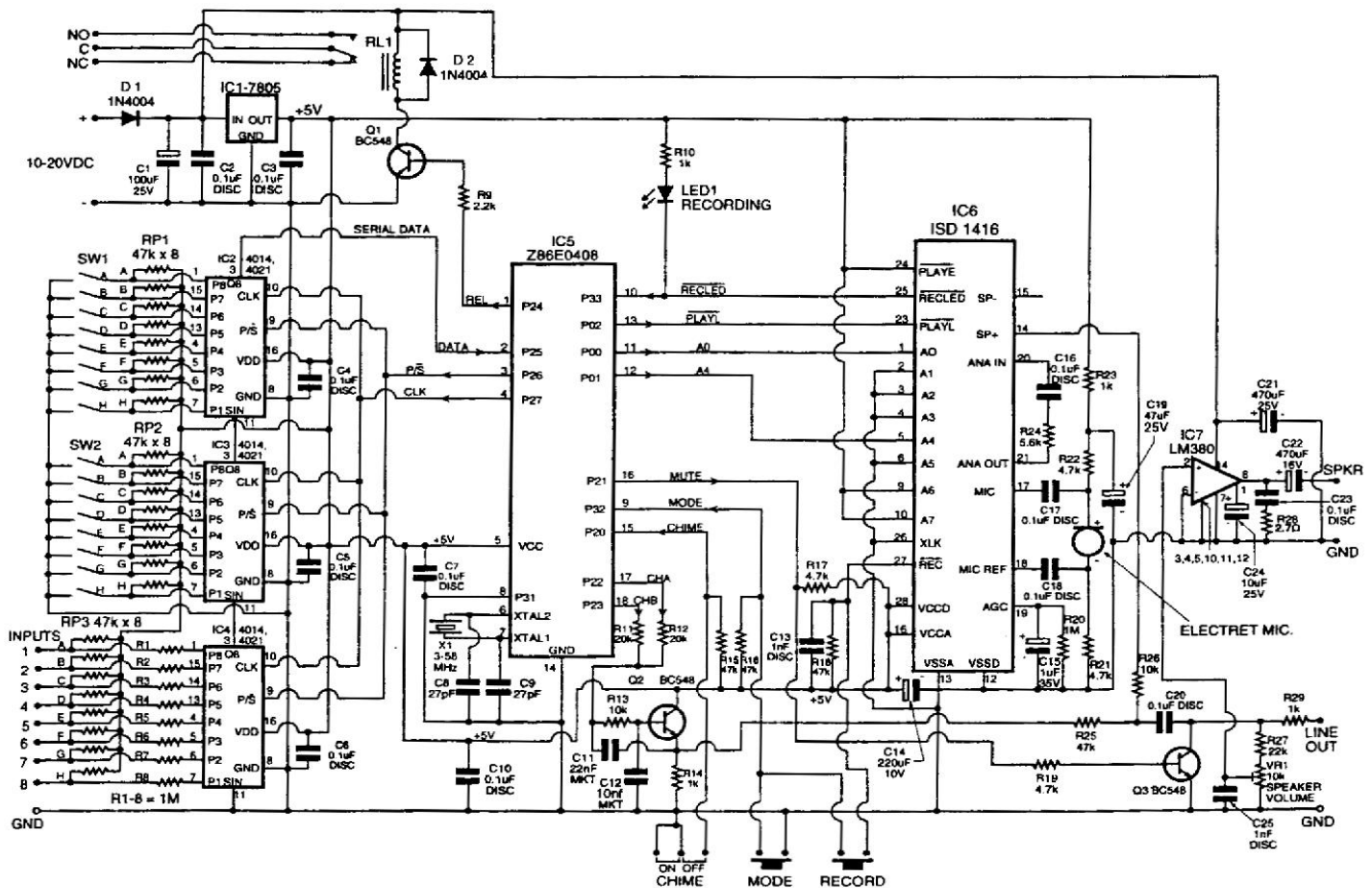
When triggered, the Z8 'fast forwards' IC6 through its memory from the first to the last recorded segment in sequence, dropping to normal speed and playing any segments which are on its 'list'. If lower numbered segments are triggered while a high-numbered segment is playing, it 'loops around' and starts the process again from segment one.

A side-effect of this process is that under rapidly-changing input conditions, messages mightn't be played back in exactly the order they were triggered in - so please keep this in mind.

As you can see in the photos, there are two 8-way 'DIP' switch packages on the board. On each, counting from left to right, the individual switches number 1 to 8, corresponding to trigger inputs and recorded segments 1 to 8.

The right-hand switches (SW2 A-H) are the 'polarity' ones, and they determine what input voltage level will trigger a given switch's corresponding recorded segment. If the switch is open ('OFF'), that input will trigger when its voltage drops to a low logic level (0V to +2V). Conversely a closed or 'ON' switch will cause an input to trigger when its voltage rises to a high logic level (+3V to +20V).

Because of pullup resistor pack RP3, all unconnected inputs are already automatically sitting at +5V = a 'high' level. So the polarity switch for each



**Fig. 3:** This is the full schematic for VMAC. It may look a little complex, but the hardware operation is fairly straightforward thanks to the 'intelligence' of the author's firmware – programmed into the microcontroller IC5.

## PARTS LIST

### Resistors

(All 0.25W unless noted)

R1,2,3,4,5,6,7,8,20,1M (brn-blk-grn)  
 R9 2.2k (red-red-red)  
 R10,14,23,29 1k (brn-blk-red)  
 R11,12 20k m/f (red-blk-org)  
 R13,26 10k (brn-blk-org)  
 R15,16,18,25 47k (yel-vio-org)  
 R17,19,21,22 4.7k (yel-vio-red)  
 R24 5.6k (gm-blu-red)  
 R27 22k (red-red-org)  
 R28 2.7R (red-vio-gld)  
 RP1, RP2, RP3 Resistor network  
 47k (9 pin)  
 VR1 10k trimpot, horiz mounting

### Capacitors

C1 100µF 25V-RB electro  
 C2,3,4,5,6,7,10,16,17,18,20,23  
 0.1µF/100n/104 disc ceramic

C8,9 27pF disc ceramic  
 C11 22nF/0.022µF/223 / MKT  
 C12 10nF/0.01µF/103 / MKT  
 C13,25 1nF/0.001µF/102 disc  
 ceramic  
 C14 220µF 16VW RB electro  
 C15 1µF 50VW RB electro  
 C19 47µF 10/25VW RB electro  
 C21 470µF 25VW RB electro  
 C22 470µF 16VW RB electro  
 C24 10µF 25VW RB electro

### Semiconductors

D1,2 1N4002/4 silicon power  
 diode  
 Q1,2,3 BC548 NPN bipolar tran -  
 sistor  
 IC1 7805 5V regulator

IC2,3,4 4014/4021 shift register  
 IC5 Z86E0408 microcontroller  
 IC6 ISD1416 audio recorder  
 IC7 LM380N audio amplifier  
 LED1 Red LED

### Miscellaneous

PCB, 145 x 84mm, code ZA 1274;  
 3.58MHz quartz crystal (XTAL1);  
 three-pin header and jumper link  
 (LK1); electret mic insert (MIC1);  
 two NO pushbuttons,  
 (PB1,2); two 8- way DIP switches  
 (SW1,2); three 16-pin DIL sockets  
 (IC2,3,4); 18- pin DIL socket (IC5);  
 28-pin DIL socket (IC6); 18 x PCB  
 terminal pins, 12V DC PCB mount-  
 ing relay (200 ohm coil, SPDT con-  
 tacts).

unused input should be left open ('OFF'). More about connecting the inputs to external devices, later...

## Repeat selection

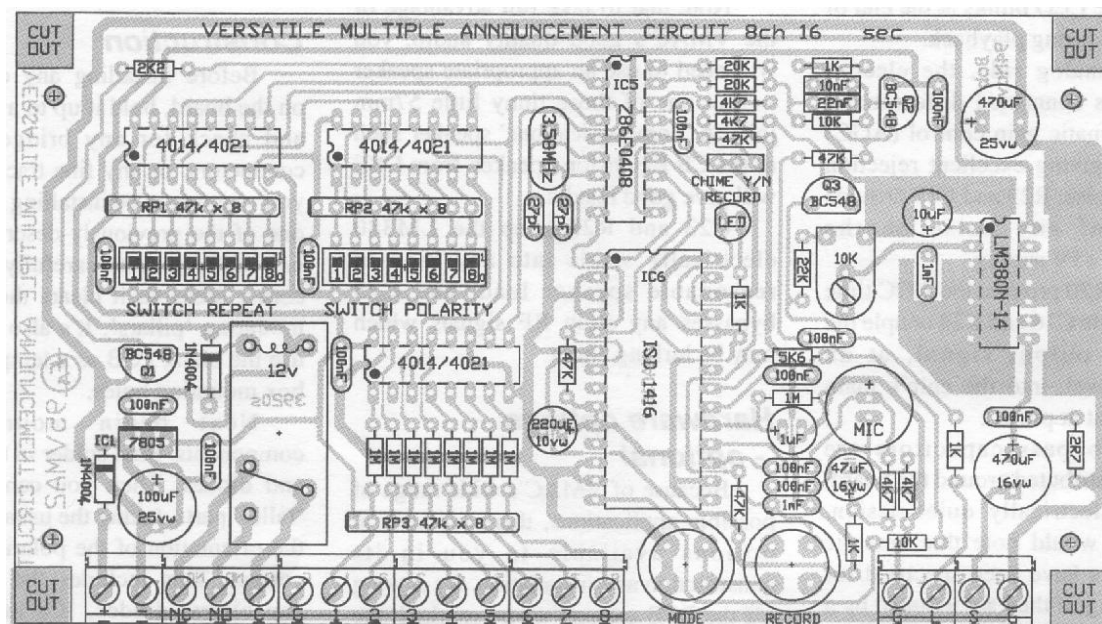
The left-hand DIP switches (SW1 A-H) are the 'repeat' option ones. If a switch is open ('OFF'), it means that when its corresponding input changes from its

normal to its triggered state, the VMAC will play back the recorded segment belonging to it, **once**. Then the Z8 will ignore that input until it has first returned to its normal condition, and again gone to its triggered state.

For example, say Input 1 was connected to your car's rear window demister, SW2A was closed (to trigger on a HIGH voltage level), and SW1A was

OPEN (for non-repeat). Then when you turn the demister on, the VMAC would say "Rear demister on" (or whatever) just once, despite the ongoing trigger condition.

If a repeat option switch is closed ('ON'), the VMAC will continue to (irritatingly) repeat the segment associated with that input, for as long as that input remains triggered.



***This complete overlay diagram for the VMAC unit shows the optional terminal strips.***

### **Chime option**

In contrast with the preceding, the chime option is absolutely straightforward. If you want VMAC to generate a chime prior to each message, simply park the 'jumper' between the centre and left-hand side pins. For no chime, place it between the centre and right-hand side pins.

### **Recording mode**

Now you know how VMAC plays back your announcements, messages or whatever, let's discuss how to record them in the first place.

In the photos you'll have noticed two control buttons; the one on the left is the MODE button, and the other is the RECORD one. The recording process begins with you making a list of your announcements, starting from segment number 1 up to the maximum segment number 8, in numerical sequence.

When you're ready, and with the VMAC currently not playing anything, press and continuously hold down the MODE button for the duration of the recording session. Then, pressing the RECORD button as well, speak your first message (segment 1) in a normal voice, about 150mm from the microphone. The LED will light to indicate that recording is taking place.

Immediately you finish speaking, release the RECORD button - but keep holding down the MODE button. Then continue this process with segment 2 etc, until all your announcements are safely stored in the chip. The MODE button

must remain pressed for the whole recording session, but the RECORD button is pressed only during the recording of each segment.

If the LED goes off while you're recording, it indicates you've used up all of IC6's storage space. Next time you're going to have to either speak faster, use less words - or build a second VMAC board.

When you release the MODE button, the VMAC will play back the entire contents of IC6 - or the first eight recorded segments, whichever comes first. A chime sound will precede each segment if that function is enabled, and the relay, if installed, will operate for the duration.

If you 'fluffed your lines' and want to cancel playback prior to another recording effort, hold the MODE button down until the end of the segment currently playing, then release it. This will return the system to its 'idle' mode.

A minor problem with the way the ISD1416 chip works in this application is that you can't re-record just one message and leave all the others as they are. You must record all of your messages again, if you make a mistake or want to add new ones. Any time the VMAC is idle, you can simply press the MODE button briefly without recording, to play everything back. This is handy for setting up audio levels, without the need to manually trigger any inputs.

### **In more detail**

Now let's have a closer look at some

details of the complete schematic diagram in Fig.3 (previous page).

Each of shift register IC4's inputs senses the logic level on its external trigger input pin through a 1M resistor, R1 - 8, and this allows any trigger input to be safely connected to an external voltage of even +/- 20V or so - because with only a few microamps flowing, the IC input protection diodes simply clamp the input pin voltages to essentially the IC supply rails.

Resistor pack RP3 has been provided to ensure that any unconnected inputs will be 'pulled up' to the +5V supply instead of 'floating' to indeterminate logic levels. In addition it allows any input to directly sense the condition of an external switch connected between it and circuit ground.

### **The ISD1416 chip**

The permanent +5V on IC6's A6 and A7 inputs tells it to interpret A0-A5 as mode control inputs; control is achieved by manipulating A0 (message cueing), A4 (consecutive addressing) and /PLAYL (level-activated playback).

A low level on /REC immediately places IC6 in the record mode, and it's worth noting that C13's function is to 'swamp' stray capacitance which could otherwise cause a momentary (disastrous) unwanted recording when power is first applied.

Going in the other direction, the /RECLED signal, which drives the 'recording' LED, also tells the Z8 when playback of a segment has concluded.

That's why the LED blinks at the end of each segment during playback.

On the analog side, the electret microphone is connected differentially to IC6's automatic gain control (AGC) stage inputs, giving excellent rejection of electrical noise; R23 and C19 provide bypassing of any noise on the microphone's +5V supply.

C15 and R20 provide the AGC time constants, while C16 and R24 couple the AGC stage output signal, at an appropriate level, into the chip's main recording input at pin 20.

Supply bypass capacitors are generously distributed around the board, for a very electrically quiet design. (Audiophiles would note that ceramic disc capacitors have been specified for signal coupling; if they are irritated by a perceived 'porcelain-like' sonic quality in VMAC, I understand that glass-dielectric capacitors have a much more 'transparent' acoustic imprint... ;-)

## Chime sound

If the chime option is active, prior to message playback the Z8 generates and feeds a 'chime-shaped square wave' into the chime low-pass filter - consisting of R11, R12, R13 and R14, C11 and C12, plus Q2. Its output, an approximate sine wave of decaying amplitude, is mixed with IC6's output via R25 which matches the chime level to the voice level.

Q3's function is to effectively short-circuit the audio output, under control of the Z8, except when a chime signal is being generated or IC6 is actually producing an output. Otherwise IC6's 'SP+' pin, alternating between 0V and +2.5V, causes very loud clicks to reach the output.

Q3's configuration might seem a bit strange, but this method of audio muting is quite common in hifi equipment such as tuners and compact disc players, and works very well. R29 protects Q3 from damage if the line output is accidentally connected to an external voltage or the speaker output.

For maximum versatility, VMAC uses an LM380 power amplifier chip. This can drive an eight-ohm speaker to more than 2W at a supply voltage of +20V, while it can still do better than 1W when operating from a car's 13.8V electrical system.

Although the LM380 can drive a 4 ohm speaker, the PCB's limited heatsinking might result in the LM380 overheating and shutting down, during

repeated loud announcements.

Note that to take full advantage of the VMAC's good quality audio, you will need to use an appropriate speaker - not one of those tinny little 57mm jobs. A 'communications' speaker such as the CB Extension Speaker from DSE will give good results.

C23 and R28 keep the LM380 electrically stable into any kind of reasonable speaker load, and C25 bypasses any stray RF signals which may be lurking about.

## Hardware options - optional

Because of VMAC's wide range of possible applications, there are several options available to you in its construction and installation. By sawing off the PCB corners where marked, the PCB will fit snugly into a common plastic 'UB1' size (150 x 90 x 50mm) utility box such as the H2851 from DSE.

If you want to be able to change your messages and adjust the speaker volume without removing the box's lid, install normally-open panel-mount pushbuttons (preferably the sort that don't click), an LED mounting sleeve, a 10mm inside diameter grommet for the electret mic and a 10k pot, all on the lid itself.

Then use long wires to extend the button and LED connections to the PCB, and a length of thin screened wire (shield to the negative terminal) to the microphone, which you push into the grommet. Use two more lengths of screened wire (shields to the ground pin) to connect the pot to where VR1 normally lives. The use of PCB pins will make this procedure considerably easier...

As previously mentioned, you can install a 12V SPDT relay (supplied) on the PCB to control an external circuit - but DO NOT attempt to switch 240V with it! The PCB is not designed or laid out for mains voltages, and in any case mains-borne electrical noise could hang up (or blow up) the Z8.

By all means control an external 240V-rated and appropriately wired relay with it, if you need to control a 240V load.

The last option is that PCB-mount screw terminal blocks can be fitted to the board if you wish, instead of ordinary PCB pins (as supplied in this kit), for connecting to the 'outside world'. The PCB has been designed to directly accept them, but you'll probably need to enlarge the holes a bit first.

## Construction

Before installing any components on the board, hold it up to a bright light and check for any bridges between conductors, or any fine track breaks. If you're going to be installing the board in one of the previously described boxes, now is the time to carefully cut off the corner areas so it clears the box's lid mounting 'pillars'. It's also the time to use the blank PCB as a template for the box mounting holes.

Next begin mounting the components. First solder in the resistors and diodes. Then you can install the 'taller' parts, taking the usual care to get the orientation of the polarised devices correct. This includes the electrolytic capacitors, diodes, ICs and sockets, LED, and transistors. The 'common' pin 1 on resistor packs RP1, 2 and 3 is identified by a dot, and this goes at the end furthest from IC5 and IC6.

The electret microphone should be mounted on thin flexible wires about 30 to 50mm long - otherwise it picks up loud 'clack' vibrations from the RECORD button. The negative terminal is the one connected to its case. Install the microphone last.

At this stage it's probably a good idea to place the chime-select 'jumper' on its centre and left-hand header pins, before you lose it.

Apart from IC1 and IC7, leave all the ICs in their antistatic packaging until you've completed the initial checks. I recommend you use IC sockets for all the DIP ones except IC7 - this needs to be soldered directly to the board to allow efficient heat transfer to the large copper area beneath it.

With everything but the socketed ICs on the board, hold it up to your bright light again and check very carefully that there are no solder bridges, especially where tracks run between IC pins. There are a few areas where a solder bridge would be catastrophic! Then double check that all components are properly soldered in their correct places and the right way around.

## Testing it

Before installing any of the socketed ICs, connect the power supply pins to a source of 12V or so and see that the current drawn is less than 30mA. If it's more, check again for misplaced or disoriented components.

Next check the IC sockets, and see that you're getting +5V on pin 16 of IC2,



3 and 4; pin 5 of IC5; and pins 9, 10, 16, 24 and 28 of IC6. You should see about half your supply voltage on pin 8 of IC7, and if not, start checking for problems in that area.

If everything's OK to here, disconnect the power. Then, (this is important) after discharging any static electricity by touching some nearby earthed object such as your power supply case, unpack and install the socketed ICs - making very sure that they're the right way around.

Now set all the DIP switches to their OPEN ('OFF') positions, connect a speaker between the 'S' and adjacent 'G' pins, and turn VR1 about 30% of the way around from full anticlockwise.

Reconnect the power and you should hear two chime sounds from the speaker, indicating that the Z8 is operating. If you've installed a relay, it should operate during the chimes then immediately release again.

At this point you can record and play back some test messages, as described earlier in 'Recording Your Announcements'.

Connect a clip lead or similar to the power supply negative terminal, and you should be able to trigger any of your messages separately by grounding their input pins.

If all's well, now you can record some real messages and familiarise yourself with the overall operation of your new VMAC.

## If it malfunctions

I truly hope you don't need to read this, because fault-finding a project like VMAC is not terribly easy.

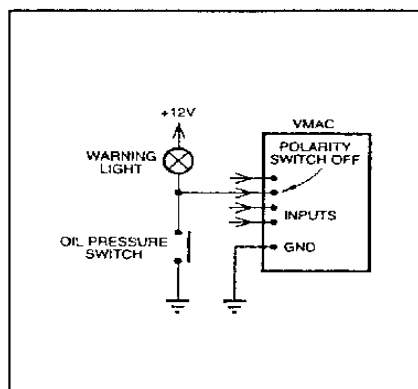
First I have to stress that the chances of a brand-new component being faulty are very low.

Assuming all the components are where they belong, the PCB has no apparent defects, and the +5V supply is appearing everywhere it should be, you could check the following:

If single recordings are getting broken into multiple segments, and other strange things are happening, check that neither of the buttons is intermittent when pushed; this happened on one of the prototypes...

Are all socketed IC pins correctly seated? Have you omitted to solder any joints?

Are any of the ICs getting hot (apart from IC1 and 7 getting slightly warm)? If yes, remove the power and recheck the soldering around it very thoroughly. If



**Fig.4: How to link the VMAC to your car's oil pressure switch.**

you do find a short, you might have to replace the IC anyway...

If the Z8 is operating normally, at switch-on its pin 1 will pulse to +5V for about a second, then drop to 0V again. If it doesn't, is the crystal OK? (They just hate being dropped). The Z8 is very unlikely to be faulty, unless it got zapped by static electricity when you were installing it.

If IC6 records, indicated by the LED illuminating, but there's no playback, check the electret microphone's polarity.

If there's +2.5V and an audio signal on IC6 pin 14 but it doesn't reach the outputs, is there a problem with mute transistor Q3? Its base voltage should go to 0V during playback. Did you connect your speaker to the right pins?

If you touch the wiper connection of VR1 at mid-adjustment, you should hear a slight buzz from the speaker. Check IC7 if you don't.

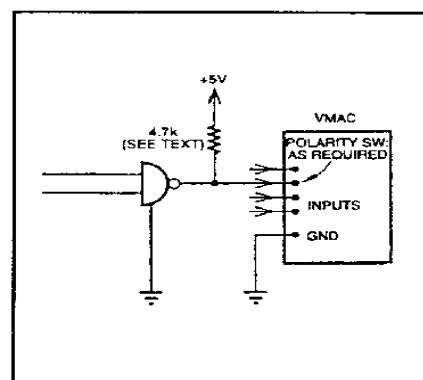
A loss of chime, with a 'gap' in playback where it should have been, suggests a problem around Q2 - is its emitter voltage about +2V?

If the VMAC isn't responding correctly or at all to its inputs and DIP switches, check for a 9.5ms high/500us low waveform on pin 9 of IC2, 3 and 4. With the DIP switches set randomly, there should be 100Hz bursts of high-frequency activity on pin 10 of those ICs, as well as on IC2 pin 3.

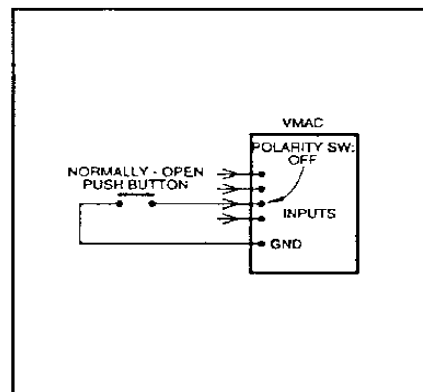
A loud 'machine-gun' sound between playback messages means the muting transistor Q3 isn't functioning: check its orientation and R19.

## Suggestions and ideas

One obvious use for the VMAC is in a car or other vehicle, to give warning messages when different problems arise. As a simple example, let's look at how you go about using it for warning of low oil pressure. Fig.4 is pretty self-



**Fig.5: Interfacing the VMAC to external logic is also quite easy.**



**Fig.6: A simple push button sensor can also be connected very easily.**

explanatory. If your car doesn't have one side of the oil pressure warning switch grounded to the engine block, you might have to use the opto-isolator input circuit in Fig.8, connected across the oil pressure warning light itself.

Of course a car is only one of many possible VMAC applications. As Fig.5 shows, the VMAC can be triggered by external logic circuitry which shares the VMAC's ground connection. CMOS devices operating from +5 to +15V can drive it directly, while TTL and LSTTL outputs should have a pullup resistor of about 4.7k to the +5V supply, to guarantee correct logic levels. And remember that an input must be stable for 30ms before the Z8 will accept it.

If you want to trigger a VMAC input from a simple normally-open pushbutton, connect it as shown in Fig.6. Set that input's polarity switch to OFF.

Reed and mercury switches can be handy for indicating the state of doors, gates, and other structures you might want to keep an eye (or ear) on. If the switch is normally closed, follow the example in Fig.7; but if you want to know when it both opens and closes, refer to Fig. 11 and its text for the details.

In some situations you might need to trigger a VMAC input from a light or

some other DC-operated component which has neither terminal grounded, or operates from a negative power supply etc. This is where the opto-isolator circuit in Fig.8 would be used. The value of resistor 'R' in ohms is given by  $R = (V - 1.5) \times 200$ , where V is the DC voltage across the device being sensed. The resistor's minimum power rating in watts is given by  $P = (V - 1.5) \times 0.005$

The 4N28 or similar cheap opto-isolator and its resistor could be mounted on a small piece of properly-insulated 'matrix board', perhaps in the same box as the VMAC board itself.

### Safe 240V triggering

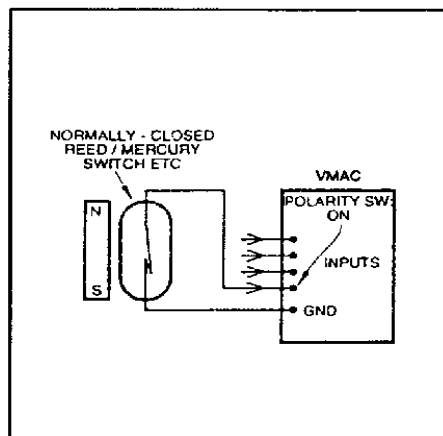
You could use the circuit in Fig.9 to trigger a message from the presence or absence of 240V AC in some mains operated system. Install a 240V neon bezel indicator at one end of a lightproof nonconductive tube, which illuminates a light-dependent resistor facing it - thus forming a kind of 'super opto-isolator'. Of course you'd have to keep the 240V wiring right away from the VMAC and its associated low voltage wiring, and people inexperienced with safe 240V wiring practices should NOT even think of attempting this.

As indicated in the first article, the VMAC can be triggered directly from an external positive voltage of +3V to about +20V as depicted in Fig.10. The 10k resistor would be necessary if the external circuit's resistance to ground exceeds about 20k ohms, and you should install the diode in circuits where the voltage exceeds about +20V. (We don't want too much current being injected to VMAC's +5V supply via its input pullup resistors.)

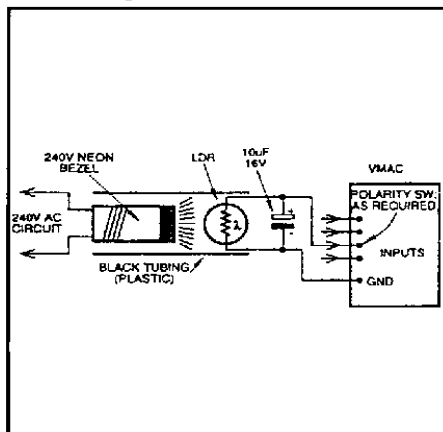
### Dual polarity triggering

Fig. 11 shows how you can use the VMAC to indicate both conditions of a trigger source. This is applicable to all of the preceding connection suggestions. You connect two inputs together and drive both of them from your switch or whatever. On one of these inputs you set the polarity switch to trigger on a 'high', and the other on a 'low' voltage condition. You'd probably set both inputs' repeat switches to OFF, too.

Then you record two appropriate messages, one for the 'high' trigger condition and one for the 'low'. Just remember that if the input is changing repeatedly and quickly, the VMAC can play the wrong message last, as explained



**Fig 7: How a normally - closed reed or mercury switch can be connected.**



**Fig. 9: A home made 'super isolator' can be used with a 240V source.**

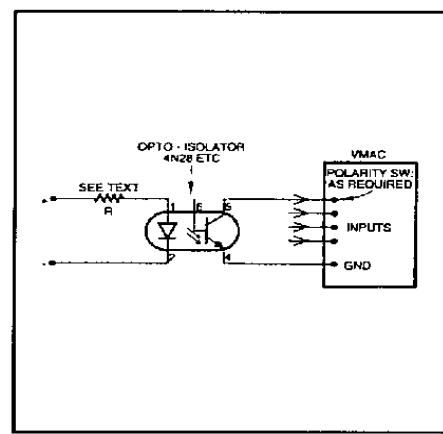
in the first article.

### 'Lights on' reminder

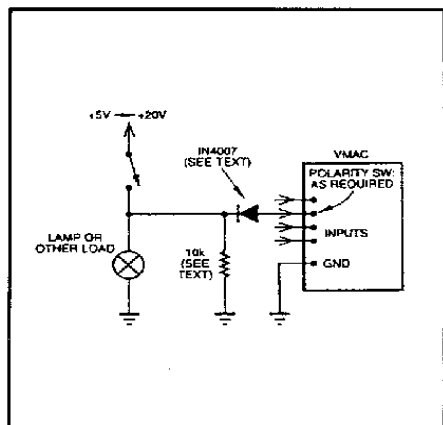
If you've installed a VMAC in your car, and would like it to warn you when the parking/headlights have been left on, follow the circuit in Fig. 12. As you can see, the ignition or 'accessories' supply not only provides +12V power via its diode to the VMAC board, but is connected as a 'low' triggering input as well.

While ever this supply is on, the VMAC regards it as a non-trigger condition and ignores it, and when it's turned off, with the lights off, the VMAC has no power to say anything at all. But when the parking lights supply is on, it can also power the VMAC board via its diode; if the ignition/ accessories rail is turned off now, it triggers that input and its associated "Lights still on!" message will play - admittedly accompanied by any other messages caused by the absence of the ignition/accessories supply.

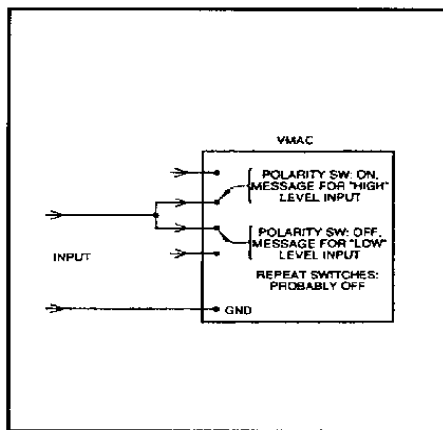
Unless you really want to be told more than once (especially in front of passengers) that you did something silly, leave the repeat switch for the lights



**Fig. 8 :Using an opto - isolator to get full isolation from a DC trigger source.**



**Fig 10: Triggering from a DC circuit which shares the VMAC's ground.**



**Fig. 11: How to get messages for both states of the same trigger input.**

reminder warning OFF.

As with all car electrical modifications, you must be careful not to damage the existing wiring/connections, or to create any kind of fire hazard. So insulate the diodes with heatshrink tubing, and don't omit to install the 1A line fuses. The 10k resistor (to positively 'pull down' the ignition/accessories rail) could be situated on the VMAC's terminal block, or between the appropriate PCB pins.



### ***'Borrowing' a speaker***

In some situations it might be possible to make use of an existing speaker, instead of installing a new one just for the VMAC's messages. Perhaps a 'VMAC doorbell' could use one speaker of a stereo system, or a VMAC in industry could 'borrow' a local PA system speaker to make its announcements in one specific area.

This may be a job for the optional onboard relay and Fig. 13's circuit, but first you have to be certain that the 'ground' of your VMAC board and its inputs is the same as the 'ground' of the audio system you want to break into.

Note that in many car audio systems both of each speaker's leads are driven, and a ground to either will destroy one output stage. The same goes for a few hifi amplifiers - so if you're not absolutely sure of what you're doing, it's safer to install a separate speaker for the VMAC.

By the way, the 10k resistor in Fig.13 keeps C22 charged, preventing speaker clicks when the relay operates.

### External line input

For those who are feeling adventurous, an external line-level audio signal can be fed into the VMAC for recording in lieu of the normal microphone, by using the circuit in Fig. 14.

First carefully tin the right-hand lead of R20 on the top of the board, then unsolder R24's left-hand lead and lift it up from the board. Now solder the shield of a length of thin audio coaxial cable to R20's right-hand lead, and the coax's centre conductor to R24's left-hand lead in 'mid air'.

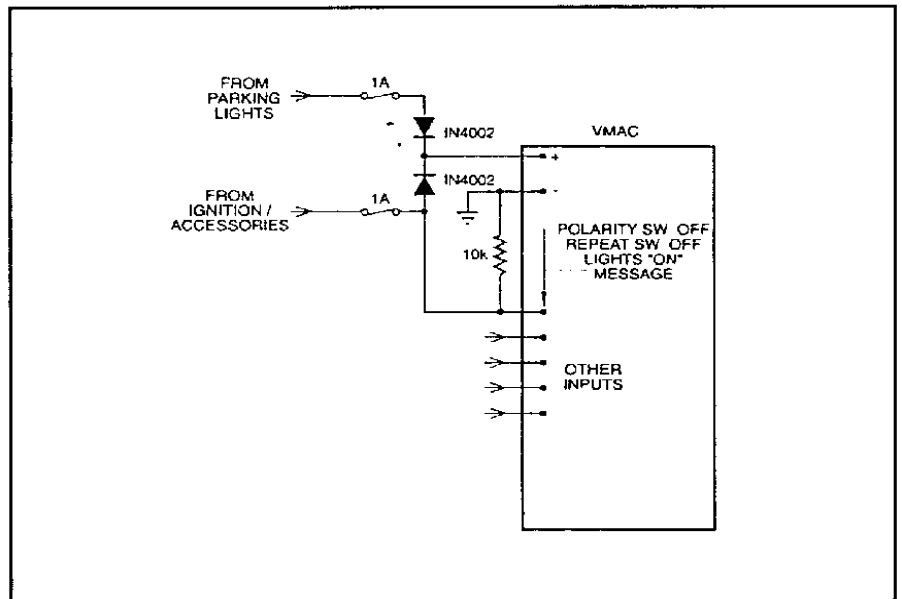
Connect the other end of the coax to a 10k logarithmic pot as shown, and feed your external signal into it. If you have an oscilloscope, adjust the pot for a level of 150 - 200mV peak to peak (about 50 - 70mV RMS) on its wiper. Otherwise make a few test recordings and set the level to a point a bit below where distortion on playback becomes noticeable.

Note that there is no automatic gain control when you're feeding a signal into IC6's 'Analog In' pin, in this way...

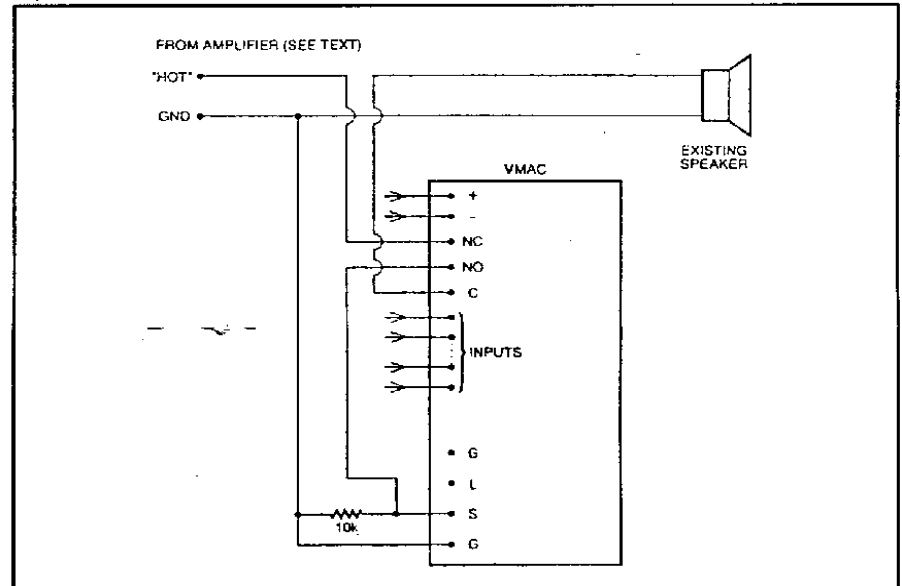
## Conclusion

I hope some of these little circuit ideas are of use to you as they are, or at least provide a starting point for other VMAC applications you might think of.

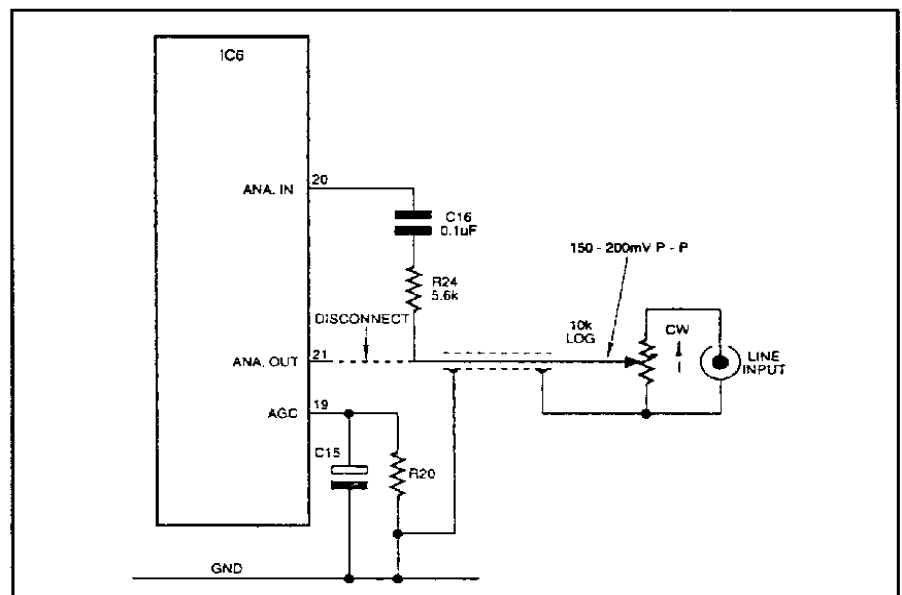
Good luck!



**Fig. 12: How to wire the VMAC as a 'lights on' reminder for your car**



**Fig. 13: Using the relay to allow the VMAC to share an existing speaker.**



**Fig . 14: How to fit an external line - level audio recording input to the VMAC.**