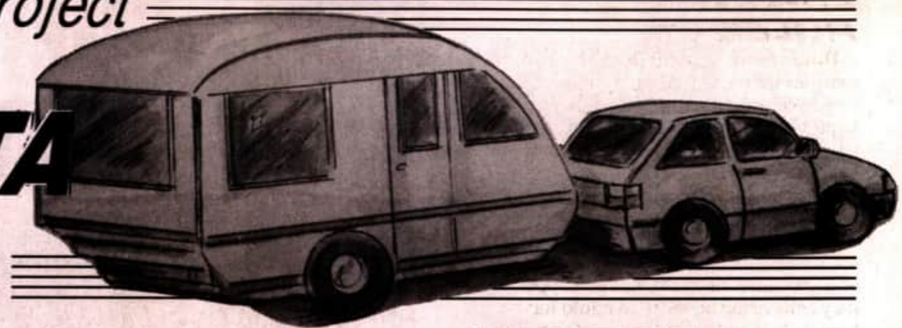
Constructional Project



VANDATA

PETER UNWIN

Tow and know! Make sure your caravan or trailer is still on tow with its multiple lighting network intact and functional, and understand more about high current monitoring.

VANDATA is a repeater and monitor system designed to interface between a towcar and a caravan. It should be suitable for most cars with 12V, negative earth electrical systems, and any Caravan or Trailer that has on-board battery charging.

There are two parts to Vandata, a Boot unit, and a smaller Dash Display unit which has light emitting diodes on a remote ribbon cable extension to permit mounting in a restricted space.

In addition to indicating the correct operation of all exterior lights and indicators (except Reverse), it confirms that the caravan refrigerator has been set to 12V operation.

It is not an Alarm system, but a constant monitor giving a pre-journey "cockpit check" and reassurance en route.

DESIGN CONSIDERATIONS

Many points were considered in the design. Reliability was paramount – in some instances, the unit might only be required for a few hours on a handful of days each year. It must impose a low load on the existing wiring, so that normal in-car fault indicating circuits are not confused. The voltage repeaters and current detectors should introduce no appreciable loss, and the complete unit when not in actual use should ideally consume no current.

Any modification to the caravan must be of a very minor nature and not render it incapable of being towed by any non-equipped vehicle. Conversely, the equipment should permit any caravan to be towed, although the full facilities offered by the unit may not then be fully realised.

COMPONENT CHOICES

When considering what form the Vandata design should take, the author first examined what he could achieve using modern semiconductor technology. Matters were not straightforward!

In the field of automobile electrics, many major changes have taken place in the past few years, but one of the more subtle is the increasing use of sealed, or semi-sealed batteries, together with very high current output alternators. This has resulted in many manufacturers applying to the system a lower charging voltage with closer control.

The Continentals in particular often work in the 13·6V to 14·2V bracket, i.e. virtually toleranced around the accepted voltage at which lead-acid batteries can be left on permanent charge. Low-voltage, high-current circuits such as those with which we are dealing have a rather intrusive associated problem, namely voltage drop. With a starting voltage of, for example, 13·9V it is quite difficult to ensure a 12·6V supply at the back-end of a caravan, let alone insert additional electronics whilst in transit!

This ruled out the use of emitter-follower devices in the Vandata design, the inherent 0·7V base-emitter drop being unacceptable. Power MOSFETs have a very low saturation voltage when used in common-source mode, but in common-drain, source-follower mode they suffer from an even less acceptable gate-source limit. Although *pnp* power MOSFETs work beautifully in common-source mode and feeding from the positive supply, they require additional circuitry in the form of inverting drivers, and are frightfully expensive.

HIGH SIDE POWER DRIVERS

A fairly recent arrival on the component market, certainly as far as the home constructor is concerned, is the High Side Power Driver. This type of device provides an interface between low power control logic and high current loads. From a first study it has everything one could ask for in the Vandata application, and a prototype was constructed using VN05 and VN20 devices. Several problems soon became obvious.

For the design in mind, nine devices were required together with additional circuitry where change-over functions were planned. The in-built load detection facility would have been useful had the loads been single, but apart from the fridge, all the loads were multiple.

For example, many caravans have one or more low wattage side repeaters in addition to the 21W direction indicators. The high-density 5-pin lead-outs would have made a double-sided p.c.b. virtually essential when planning input and output tracks of between 3A and 10A capacity. Together with the need to heatsink all nine devices, the budget ran at double that for electromechanical relays.

Similarly, load-detector i.c. UL2455 appeared to be the logical choice for current detection, and would have been ideal had the loads been in the range of 5W to 25W, as would be the case within the caravan itself. However, to detect, for example, two 21W Stop lights required a "sense" resistor of the order of only six milliohms. Any higher loads would require "cable drop" sensing, i.e. outside the unit.

Furthermore, an automobile can be a rather hazardous environment for semiconductor devices: reversed batteries, open circuit batteries causing abnormal alternator output, and (you had better believe it!) 24V batteries used for jump-starts are but a few of the problems to be considered.

LO-TECH RULES OK

However, the author had six reed relay switches left over from a burglar alarm design completed some 12 years ago. Consequently, needing to monitor so many amps, he decided to see how they would behave as current detectors.

Although their specifications look wider than the proverbial barn door – 20 to 40 amp-turns (AT) for make, and 8 to 25 AT for break – in the near perfect inductance of a few turns of heavy gauge copper wire, they behave far better than could have been hoped. Not only did they perform almost identically, but a further supply purchased this year were indistinguishable from the twelve year old "spares".

Tests using a simple coil of 16 s.w.g. enamelled wire, single layered on a 9/64in. former around a reed switch, gave reliable "make" at 12 AT, making it straightforward to determine the coils required. The caravan fridge, a single load of approximately 8A (100W) presented no problem, nor did the detection of the presence or absence of one 21W bulb out of two, as represented by the Stop and Fog lamp circuits.

The failure of one 21W bulb when in parallel with a 5W one, as represented by the right and left indicators with a side repeater light fitted, was also reliably detected. In fact, the relays performed every bit as well in this application as the semiconductor circuit.

Furthermore, when not in actual use a relay design need not be connected across the car battery supply, and so draws no quiescent current. Also, open-circuit relay contacts are largely self-protecting.

RIDING LIGHT

The Riding light load presented an entirely different problem. Whereas the lamp circuits already mentioned are fairly standard for a large number of caravans, the low wattage of the individual bulbs and the variable mix of wattages involved in the riding circuits made the loss of one bulb unpredictable.

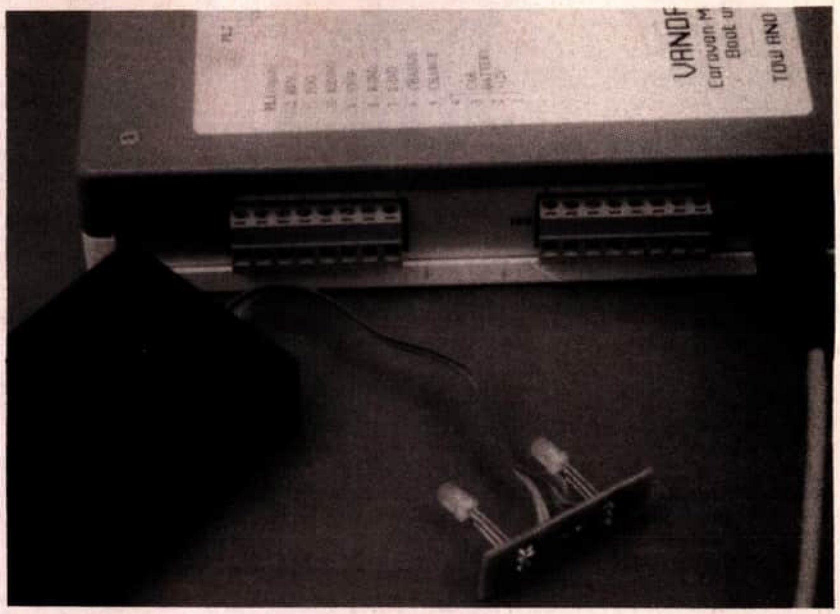
Caravan input connections are separated into left and right hand sides. The front and rear bulbs are 5W each, but the number plate may be illuminated by one or two bulbs of either 3W or 5W, usually fed from the left. In addition, many makes are fitted with 5W white/red repeaters on the sides. Some rear clusters also incorporate two 5W rear Riding lights on each side, in line with current automobile practice.

The total number of Riding lights on different caravans can vary, some having eight, others might have five, for example. Then it was discovered that four bulbs of one make drew more current than five equally rated bulbs of another. Obviously it would be an extremely complex task to design a current monitor to cope with such varied lighting circumstances.

It was decided, therefore, to settle for a straightforward "Circuit Fail" limit of approximately 2A to the left and right circuits combined. A compromise perhaps, but one which should suit all caravans. A small element of customising was not to be ruled out, but the basic remit was first and foremost a "fit and forget" unit, with doubtful indications being worse than none.

REVERSE ENGINEERING

Already it had been decided that no cockpit monitoring was required for lights



which are visible in the driver's rear view mirrors. Reversing lights remained the only circuit left to be considered.

Only recently have caravans started to appear with reversing lamps in the rear clusters, but it is by no means universal and some manufacturers only fit them on certain models. The author does not have them on his caravan, using instead an audible bleeper fitted under its rear, operated by the selection of reverse gear, an arrangement which requires no visual indication.

Consequently, Vandata has been designed without provision for monitoring reversing lights. If they do become mandatory, the author suggests that two Xenon strobe lights and either a bleeper or a recorded message would satisfy all parties – perhaps a good use for the *EPE Voxbox* of July 1994?

TOWING CONNECTIONS

Details of the connections to the two interfacing plug/socket units, usually situated adjacent to the towball, are shown in Table 1. The connectors are mechanically identical, only a different arrangement of "pins" and "tubes" prevents them being interconnected. The 12S connector ("Supplementary") is white (or grey) and the 12N ("Normal") is black.

Note that the 12N terminals 5 and 7 give separate access to the left and right riding lights of the caravan. As far as the author is aware, only cars produced in Germany have this facility fitted as standard. The Vandata unit only offers combined control of these two terminals.

In order that the Vandata unit is only operative when a caravan is coupled, and also as proof to the driver that it IS electrically coupled, it is required that connector 12S/7 (black), currently unallocated, is coupled to the caravan's battery charging circuit via connector 12S/2 (blue). As a short term measure, this could be done at the 12S plug, but is best accomplished at the junction/fuse box, usually in one of the front lockers, where the 12S cable terminates and the interior caravan wiring takes over.

If the connection between these two wires is made at the caravan side of the fuses, two functions may be achieved. Firstly, a check is automatically made on the charging voltage reaching the battery circuit (a battery does not have to be fitted). Secondly, the link may be anything from a few centimetres of wire to several metres, in which case it can be used to convey some additional item of information to the car driver: the author has fitted a magnetic switch adjacent to the caravan handbrake mechanism, only closed when the hand brake is fully off. He used to have a habit of driving away with the brakes not fully released!

Conventionally, 12S/4 and 12S/2 are separately wired: 12S/4 directly from the car battery and 12S/2 via a split-charge relay which also feeds, through separate contacts, the fridge connection on 12S/6. The author is unfamiliar with the device, never having used one, but understands that the recommended circuit is prone to several pitfalls, such as the fridge operating itself from the caravan battery if the common supply fuse blows, and the caravan battery discharging into the car starting circuit if the relay cannot be operated from the alternator.

Table 1. 12N and 12S connector wiring.

12N	Terminal	Colour Code	12S
L-IND	1	Yellow	Reversing Lights
Rear Fog	2	Blue	Batt. Charge
Earth (return)	3	White	Earth
R-IND	4	Green	Int. Lights
R-Side/Tail/Number plate	5	Brown	Not used
Stop Lights	6	Red	Refrigerator
L-Side/Tail	7	Black	Not used

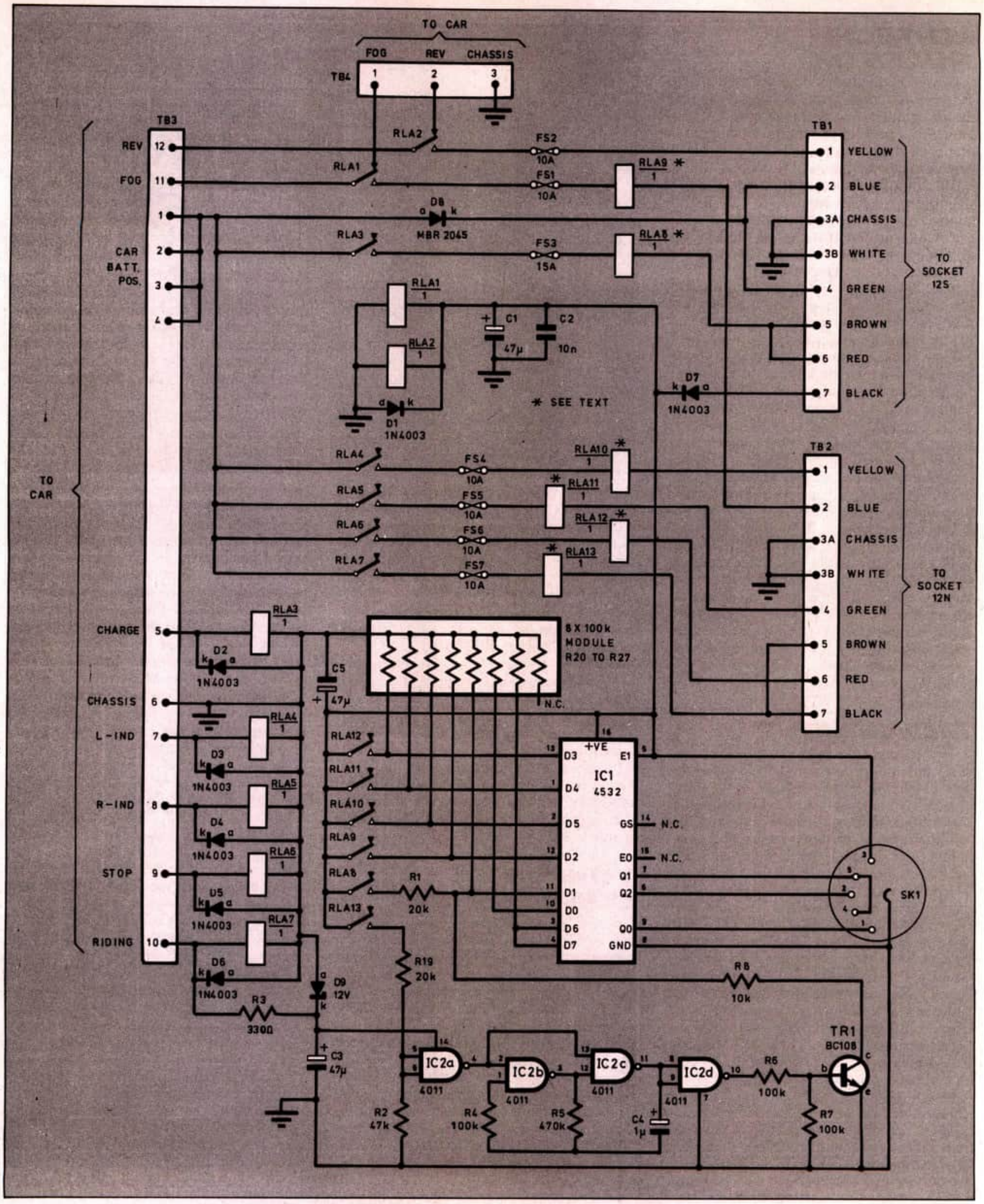


Fig. 1. Circuit diagram details for the current sensing system of Vandata.

The author has always used a diode in the caravan charge/lighting circuit, previously a high-current germanium type (a rare bird these days), but changing to a Schottky diode as soon as their advantages became apparent. These include a lower V_f than conventional silicon diodes, particularly at less than rated current, and a robust ability to withstand surges. With such a diode in circuit there is no possibility of any reverse feed from the caravan battery and connector 12S/2/4 can be commoned in the Vandata unit.

CIRCUIT DESCRIPTION

Generally speaking, from hereon connections to the terminal blocks TB1 and TB2 will be referred to by their destination (towing) socket numbers, 12S and 12N respectively. This enables the same tests quoted to be carried out on the terminal blocks and the car sockets when fully wired up.

Thus a reference to 12S/1, for example, will refer to terminal block TB1 pin 1 when testing the unit in the workshop, but will refer to the car socket 12S pin 1 connection if testing at that end is required. Similarly, 12N/1/2/4 refers to terminal block TB2 pins 1, 2 and 4 as well as the same pins of connector 12N.

Referring to the circuit diagram in Fig. 1, the car battery and associated charging circuits supply power to the Boot Unit via connector TB3 pins 1 to 4. This is a permanent connection, but no current will flow in the quiescent state. When the caravan 12S plug is mated with its connector, usually adjacent to the towing hitch, the car's +12V supply is fed to the caravan battery terminals via Schottky diode D8.

Charging of the caravan battery will only take place when the car alternator (i.e. the engine) is running. The diode prevents any chance of the caravan battery supplying current to the car. By virtue of a wired addition to the caravan already mentioned, and irrespective of whether a caravan battery is actually fitted, this supply is returned to the car and Boot Unit by connector 12S/7. Diode D7 protects against caravan battery reversal.

The returned supply, only present when the caravan is actually coupled, powers the supervisory circuit in the Boot Unit and supplies the dashboard mounted Display Unit via socket SK1. It also operates relays RLA1 and RLA2. The relays provide the optional facility to disconnect the towing vehicle's rear fog and reversing lights when actually towing, to prevent a disconcerting glare reflected from the front of the caravan.

The caravan's rear fog and reversing lights (if the latter are fitted) will be operated irrespective of whether this option is invoked by the car supplies being redirected from inputs TB3/11 and TB3/12 to connections 12N/2 and 12S/1.

When the alternator is running, the charge output is applied to TB3/5 and operates RLA3 supplying current to the fridge, (connections 12S/6 and 12S/5).

It should be noted that the electrical systems of certain cars, notably those of French manufacture, do not always produce this additional voltage output, and RLA3 must therefore be operated from another source. Relays RLA4 to RLA7 are each operated, individually or in combination, when the car's right indicator (R-Ind), left indicator (L-Ind), footbrake (Stop) and side/rear (Riding) lights are respectively selected.

These inputs are on TB3 pins 7 to 10 with the corresponding relayed outputs on connector 12N pins 1, 4, 6 and 5/7. Diodes D1 to D6 limit back e.m.f. from the relay solenoids. All relayed outputs are fused, and although the fuse ratings may seem somewhat high, they are there to protect printed circuit tracks and cableforms, reduce fire risks and introduce as little voltage drop as possible.

REED RELAYS

Reed relays RLA8 to RLA13 have their coils inserted in the current paths of the outputs to be monitored. Satisfactory loading of any selected circuit operates the associated reed switch. The switches have one side commoned to the +12V supply from the caravan. When either or several of these relays are operated, the switches connect the inputs of IC1 (normally grounded by resistors R20 to R26) to a logic 1 level.

Component IC1 is an 8-bit to BCD (binary coded decimal) priority encoder, with only inputs D1 to D5 used. Table 2 shows how the inputs are interpreted, the outputs Q0 to Q2 representing the address of the highest active input, irrespective of the state of the other inputs. This action is used so that only one condition or state, and therefore indication, is displayed by the dashboard unit.

Table 2. Consequential truth table for IC1

CONDITION	INPUT STATE	Q2 OUTPUT STATES	Q1	Q0
IC1 powered	All low	0	0	0
Fridge On	D1 high	0	0	1
Fog lights	D2 high	0	1	0
Stop lights	D3 high	0	1	1
R-Ind	D4 high	1	0	0
L-Ind	D5 high	1	0	1

The selection of Riding lights (TB3/10 and RLA7) also powers IC2, via resistor R3. Capacitor C3 provides local decoupling and diode D9 a measure of overvoltage protection.

IC2 is a quad 2-input NAND gate of which two gates, IC2b and IC2c, are configured as a square-wave oscillator running at about 1Hz. The oscillator is normally inhibited by a third gate, IC2a, inverting the logic 1 applied to its pins 5 and 6 by the contacts of RLA13. Oscillation frequency is set by resistor R5 and capacitor C4.

In the event of insufficient or no current in the RLA13 coil, its contacts will not close and so IC2a has its inputs biased low via resistor R2. The high output from IC2a thus allows IC2b/c to oscillate. The output from IC2c, buffered and inverted by IC2d and transistor TR1, modulates the voltage on the D1 input of IC1 (pin 11) provided by the fridge current detector RLA8, resistors R1 and R8 being the effective components.

Note that IC2d output pin 10 is low in both the unpowered and inhibited states. TR1 is required so that IC1 pin 11 is unaffected when IC1 is not powered. Outputs Q0, Q1, Q2 are taken to SK1 terminals 1, 4/5 and 2 respectively.

It could be argued that R-Ind should have a higher priority than L-Ind, but this is of no significance since they are not selectable simultaneously, both having equal status. In the event of Hazard selection, both rear indicators will flash correctly, although the supervisory indication will be L-Ind.

Normal driving, day or night, will be with IC1 output Q0 high. In the event of Riding light failure, it will alternate high and low.

DISPLAY STRATEGY

The overall Display Indication strategy can best be appreciated after considering the circuit diagram of the Display Unit itself, as shown in Fig. 2. The Display Unit is powered from the Boot Unit, via a DIN-to-DIN cable between sockets SK1 and SK2, and therefore is only powered when the caravan connection is complete. The BCD outputs from IC1 of the Boot Unit in Fig. 2 are applied to pins 10, 13 and 12

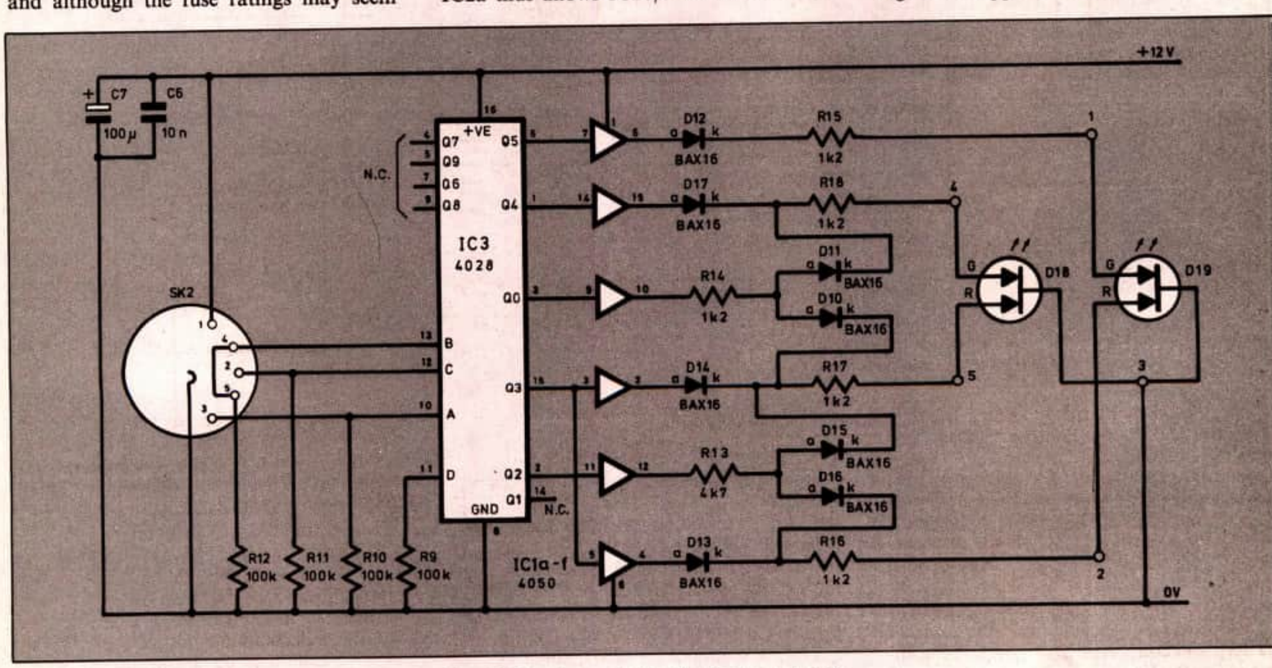


Fig. 2. Display unit circuit diagram details.

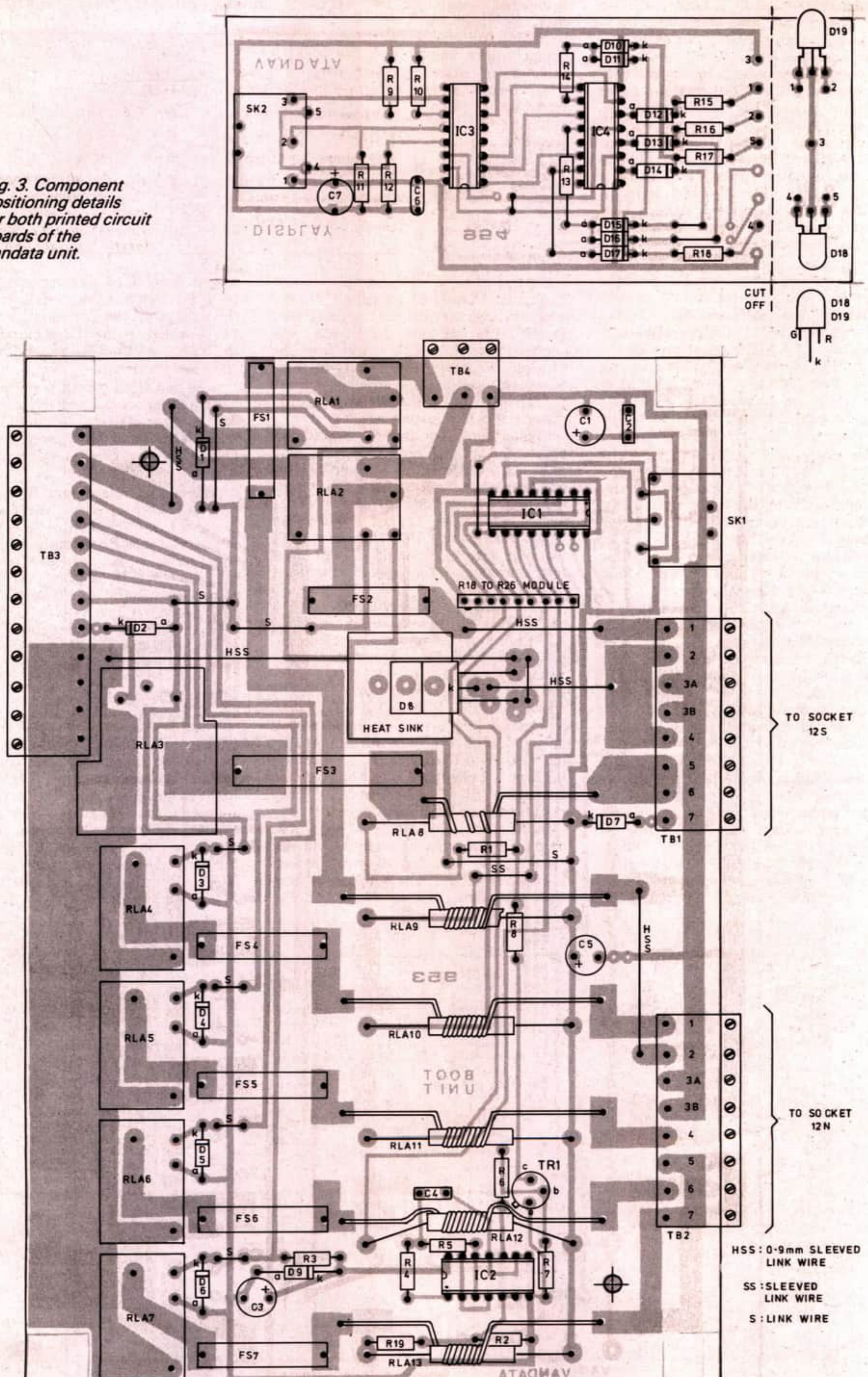
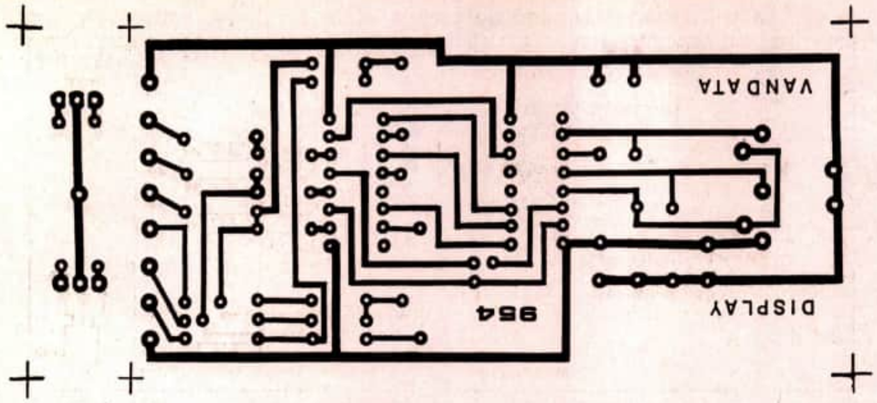


Fig. 3. Component positioning details for both printed circuit boards of the Vandata unit.



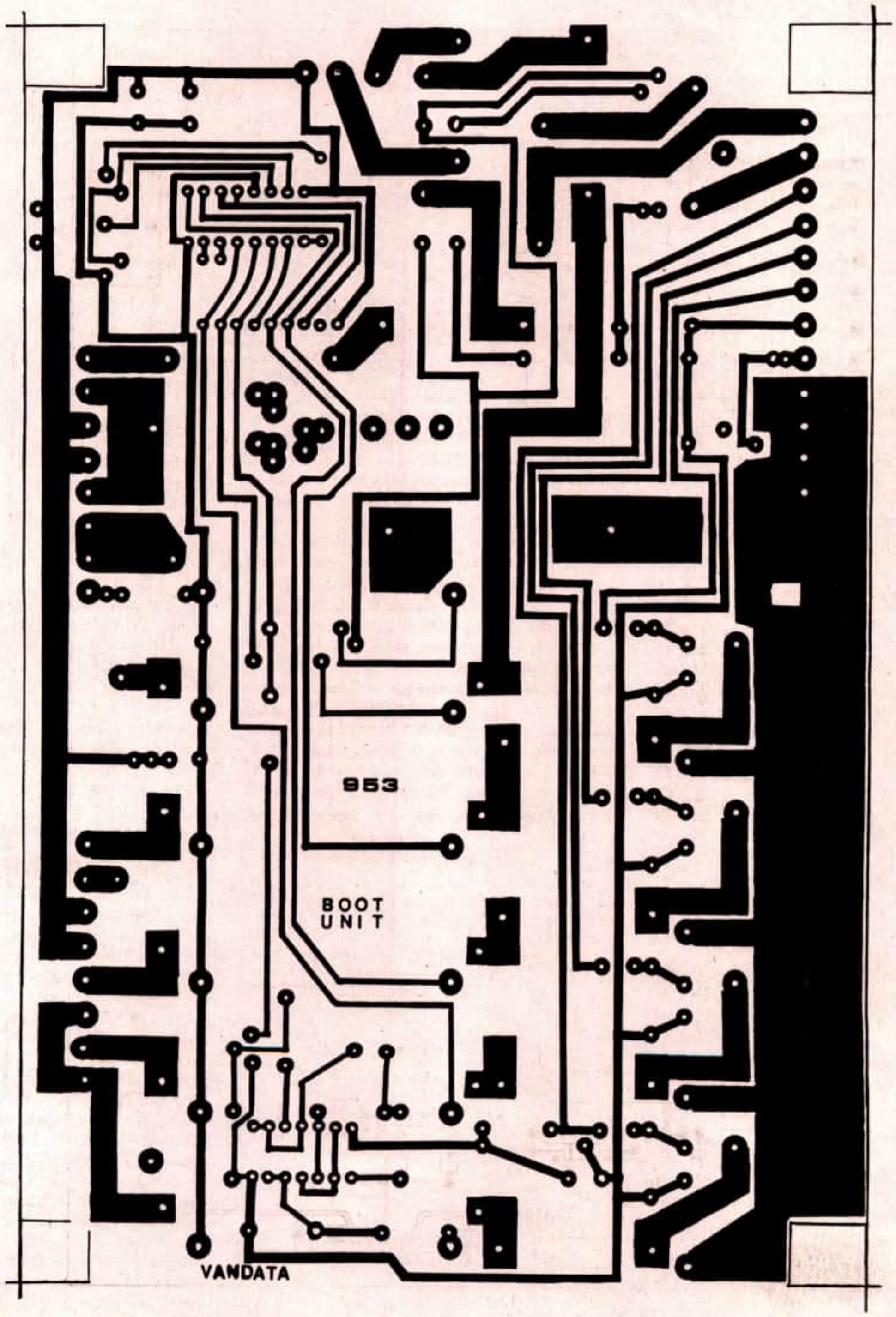


Fig. 4. Full size copper foil track master pattern for both printed circuit boards of the Vandata unit.

(in increasing order of significance) of the BCD to decimal decoder IC3. All of the inputs are normally held low, including the unused pin 11, by resistors R9 to R12. With all inputs low, output Q0 (pin 3) is held high.

Subsequent input code changes will cause the appropriate outputs Q1 to Q5 to go high, only one output being active at a time. The outputs are coupled via hex buffer IC4 to operate the tricolour light emitting diodes (l.e.d.s) D18 and D19 via a series of resistors/diodes. Readers may spot that diode D12 is not really necessary, but it simplifies the calculation for resistor R15!

The display combinations available are shown in Table 3. The centre column describes the output states of IC3 and the component path from IC4.

CONSTRUCTION

Details of the component and track layouts for the Boot Unit and Display Unit printed circuit boards (p.c.b.s) are shown in Fig. 3 and Fig. 4. These boards are available from the *EPE PCB Service*, codes 953 and 954, respectively.

The large copper areas on the Boot Unit p.c.b., and the gauge of some component pins make a soldering iron of reasonable wattage essential, the author suggests 45W minimum.

First, carefully cut off the small section of the Display p.c.b. which holds the l.e.d.s. Next, fit the Boot Unit link wires, noting that some should be of heavier duty wire and that some must be sleeved. All small components can now be soldered in. All the i.c.s are CMOS devices and the normal precautions should be taken, ensuring that you discharge static electricity from yourself before handling them, by touching a grounded item first, for example. The use of sockets for the i.c.s. is recommended.

Schottky diode D8 is in a DO220a case and should be mounted flat to the board on its heatsink.

COIL WINDING

The winding of the reed relay coils needs a little care and patience. Coils for RLA9 to RLA13 use 0·9mm (20 s.w.g.) enamelled copper wire, close wound on a 4mm former (drill shank), then slid onto an 18mm length of plastic tubular drinking straw and doped up with 5-minute epoxy. Fig. 5 shows the final shaping. RLA9 and RLA12 require six full turns, RLA13 eight full turns, and RLA10 and RLA11 eleven full turns. The reed switches themselves are slid into the tube of the coil assembly.

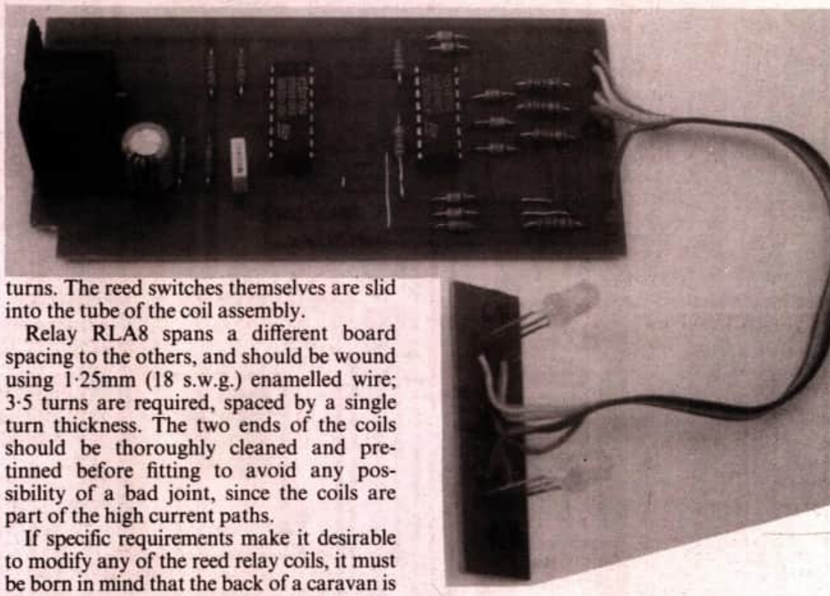
Relay RLA8 spans a different board spacing to the others, and should be wound using 1·25mm (18 s.w.g.) enamelled wire; 3·5 turns are required, spaced by a single turn thickness. The two ends of the coils should be thoroughly cleaned and pretinned before fitting to avoid any possibility of a bad joint, since the coils are part of the high current paths.

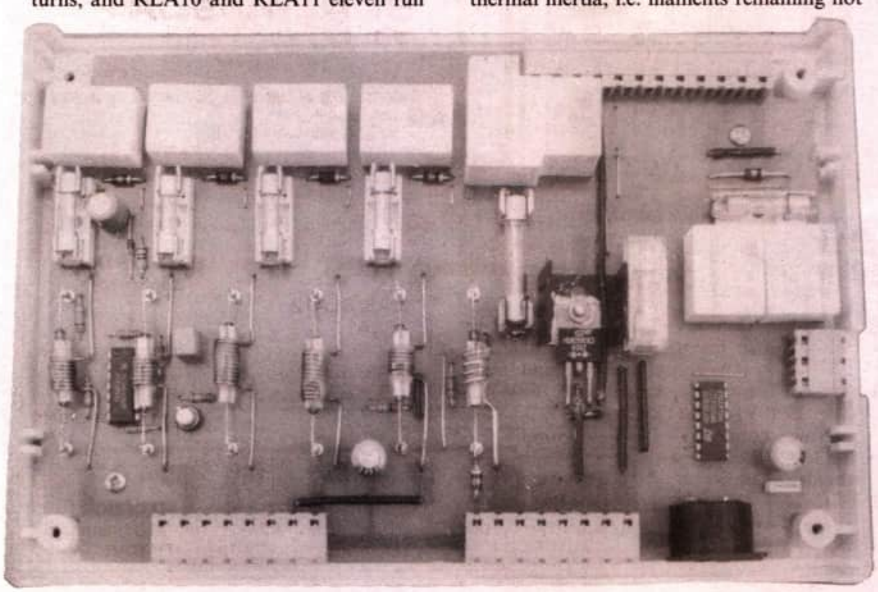
If specific requirements make it desirable to modify any of the reed relay coils, it must be born in mind that the back of a caravan is a long way from the test bench. Variable voltages under different load conditions, lamps from alternative manufacturers with different consumption, installation variations, cable resistance (and inductance), and thermal inertia, i.e. filaments remaining hot from a previous operation make it prudent to have a minimum current/turns product of about 17.

The reed switches should be soldered directly to the turret pins, not wrapped, and positioned centrally within the coils.

Table 3. Connector condition, signal state/routing and display indications

	CONDITION	SIGNAL/ROUTING	INDICATION 1
1	Caravan connected Engine Off	output 0 (pin 3) high R14, D10, R17, D18 (red) R14, D11, R18, D18 (green)	D18 amber
2	Engine running Fridge On	output 1 (pin 14) high not used	None
3	Riding Fail	Alternate Cond 1/Cond 2	D18 Flashing
4	Fog lights	output 2 (pin 2) High R13, D15, R17, D18 (red) R13, D16, R16, D19 (red)	D18 + D19 red (Low intensity)
5	Stop lights	Output 3 (pin 15) High D13, R16, D19 (red) D14, R17, D18 (red)	D18 + D19 red (High intensity)
6	R-Ind	Output 4 (pin 1) D17, R18, D18 (green)	D18 green (High intensity)
7	L-Ind	Output 5 (pin 6) high D12, R15, D19 (green)	D19 green (High intensity)





CASE ASSEMBLY

The Boot Unit box should be employed "upside-down", the p.c.b. mounted in the white half. The p.c.b. needs rectangles removed from each corner to make it fit. Cut slots in the box to suit the board mounted connectors.

With the Display Unit box, a slot should be cut to allow the ribbon cable to pass through to the two tricolour l.e.d.s. on their small board. Cable length will depend on the installation requirements.

The interconnecting braided cable between the two units, from SK1 to SK2, uses the same DIN plugs at each end. To enable the lead to work any way round they should be wired "mirror image", i.e. 1-3, 2-2, 3-1, 4-5. On both p.c.b.s, SK1 and SK2 pins 4 and 5 are common. The braiding connects the metal shells of the sockets as a screened Earth connection. To ensure satisfactory Earthing, link the two half shells with a short length of soldered braid.

COMPONENTS

See SHOP TALK Page

Resistors

R1, R19	20k (2 off)
R2	47k
R3	330Ω
R4, R6, R7, R9 to R12	100k (7 off)
R5	470k
R8	10k
R13	4k7
R14 to R18	1k2 (5 off)
R20 to R27	100k x 8 resistor module

All 0·25W 5% carbon film or better

Capacitors

C1, C3, C5	47μ elect. 63V (3 off)
C2, C6	10n polyester 63V (2 off)
C4	1μ polyester 63V
C7	100μ elect. 16V

Semiconductors

D1 to D7	1N4003 rectifier diode (7 off)
D8	MBR2045 Schottky diode
D9	12V 1W Zener diode
D10 to D17	BAX16 signal diode or similar (8 off)
D18, D19	tricolour l.e.d. (2 off)
TR1	BC108 *npn* transistor, or similar
IC1	4532B 8-bit priority encoder
IC2	4011B quad 2-input NAND gate
IC3	4028B BCD to decimal decoder
IC4	4050B hex buffer

Miscellaneous

RLA1, RLA2, RLA4 to RLA7	s.p.c.o. 12V 10A p.c.b. mounting relay (6 off)
RLA3	s.p.c.o. 12V 16A p.c.b. mounting relay
RLA8 to RLA13	reed relay switches (6 off) (see text)
FS1, FS2, FS4 to FS7	10A 20mm fuse (6 off)
FS3	25A 1·25in fuse
TB1	12-way p.c.b. mounting screw terminal block
TB2	3-way p.c.b. mounting screw terminal block
TB3, TB4	8-way p.c.b. mounting screw terminal block (2 off)
SK1, SK2	5-pin DIN p.c.b. mounting socket (2 off)

Printed circuit boards for Boot and Display unit (pair) available from the EPE PCB service, code 953 and 954; 14-pin d.i.l. socket; 16-pin d.i.l. socket (3 off); turret pins for reed switches (12 off); dual-tone case for Boot Unit 205mm x 140mm x 40mm; case for Display unit 110mm x 56mm x 22mm; p.c.b. mounting fuse clips, 20mm (6 off); p.c.b. mounting fuse clips, 1·25in (2 off); 4-way braided cable, length to suit; 5-way ribbon cable, length to suit; 7-way cable, length to suit; slotted heat sink for diode D8, 19mm x 17mm x 20.5mm; 5-pin DIN line plugs (2 off); 18 s.w.g. and 20 s.w.g. enamelled copper wire for coils (see text); interconnecting link wire; solder etc.

Approx cost guidance only **£57** *excl. cables*

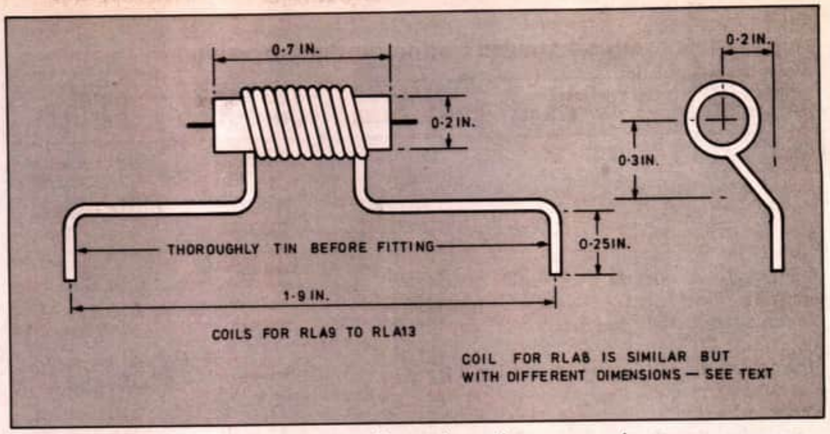
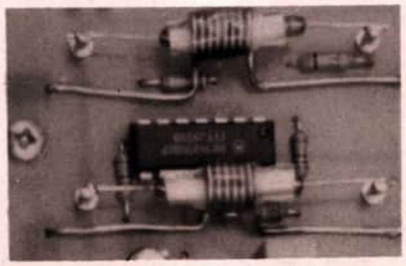


Fig. 5. Details of how the coils are wound.



Close-up detail of two of the coils wound around their reed switches with a plastic former in between.

FIRST TESTS

When installed, the unit will, in all probability be rather inaccessible, and the high currents involved may easily damage a faulty board. A short time spent on some straightforward checks is therefore worthwhile. After cleaning the boards (I.P.A. or Meths) give them a thorough visual inspection. Dry joints are a particular problem with heavy-gauge pins and wire.

Connect a low current 12V supply directly to the Display board, 0V to the Earthy end of one of resistors R9 to R12, and +VE to pin 1 of the DIN socket. Diode D18 should light, amber. With these connections retained, momentarily make the connections between the +12V supply and the following pins of socket SK2, and check that the results are as shown:

Pin 3	No l.e.d.s on
Pin 4	Both l.e.d.s red, low brightness
Pins 3 and 4	Both l.e.d.s red, high brightness
Pin 2	D18 green, high brightness
Pins 2 and 3	D19 green, high brightness

MAIN TESTING

Connect the two boards together using the DIN-to-DIN lead. Examination of the track of the Boot p.c.b. will show that there is no continuity between the Input Earth (TB3/6) and the Output Earths, TB4/3, 12S/3A and 12N/3A. Damage to p.c.b. tracks may result if Earth return currents flow in other than their intended paths. The above mentioned connections should therefore be taken, independently, to the negative side (0V) of the 12V supply.

Now connect a +12V supply to TB3/1/2/3/4. If the source is not protected, the use of an in-line fuse of about 5A is a wise precaution. The units should draw no current at this time and no l.e.d.s should light.

With a multimeter set to the appropriate mode and range check the following connections and results:

CONNECTION	RESPONSE
TB3/12 to TB4/2	continuity
TB3/11 to TB4/1	continuity
TB3/12 to 12S/1	open circuit
TB3/11 to 12N/2	open circuit
12S/1/5/6/7	no voltage*
12N/1/2/4/5/6/7	no voltage*

(*with respect to common negative)

Temporarily connect 12S/2 to 12S/7 and establish that:

Relays RLA1 and RLA2 operate (audible click); D18 lights amber.

Check now:

CONNECTION	RESPONSE
TB3/12 to 12S/1	continuity
TB3/11 to 12N/2	continuity
TB3/12 to TB4/2	open circuit
TB3/11 to TB4/1	open circuit

A selection of short croc-clip to croc-clip jump leads will prove most useful for the following tests:

CONNECTION	RESPONSE
+12V to TB3/5	+12V at 12S/5/6
+12V to TB3/7	+12V at 12N/1
+12V to TB3/8	+12V at 12N/4
+12V to TB3/9	+12V at 12N/6
+12V to TB3/10	+12V at 12N/5/7

Audible indication of relay operation should be heard at each test.

SUPERVISORY TESTS

Temporarily link a bridge wire between the mounting pins of the reed switches as follows:

BRIDGE	RESPONSE
RLA8	D18 extinguishes
RLA8, RLA9	D18, D19 Low brightness red
RLA8, RLA9, RLA12	D18, D19 High brightness red
RLA8, RLA12, RLA11	D19 High brightness green
RLA8, RLA12, RLA10	D18 High brightness green
RLA10 and RLA12 unbridged	D18, D19 off

CONNECTION	RESPONSE
+12V to TB3/10	D18 flashes
RLA13 contacts bridged	D18 off

Table 4. Loaded testing checks and results.

FUNCTION SIMULATED	LOAD WATTS	LOAD CONNECTION	+12V SUPPLY CONNECTION	DISPLAY RESULT
Fridge	21 + 21	12S/6	TB3/5	No change
	add 21	12S/6	TB3/5	D18, D19 off
Fog light	21	12N/2	TB3/11	D18 amber
	add 5 + 5	12N/2	TB3/11	D18, D19 red
Stop	21	12N/6	TB3/9	D18 amber
	add 5 + 5	12N/6	TB3/9	D18, D19 red
L-ind	5	12N/1	TB3/7	D18 amber
	add 5 + 5	12N/1	TB3/7	D19 green
R-Ind	5	12N/4	TB3/8	D18 amber
	add 5 + 5	12N/4	TB3/8	D18 green
Riding	5	12N/5	TB3/10	D18 flashing
	add 21	12N/5	TB3/10	D18, D19 off
	5	12N/7	TB3/10	D18 flashing
	add 21	12N/7	TB3/10	D18, D19 off
Final Riding check – RLA8 contacts bridged:				D18, D19 off

If the supervisory tests all prove to be satisfactory, then it is very unlikely that any fault exists.

LOADED TESTING

Further tests to check the sensitivity of the reed relay coils and switches can now be made. Car bulbs are the best source of high wattage test loads, a selection of 5W and 21W being necessary.

Testing now requires either a regulated power supply capable of delivering 12·6V at up to 20A, or a 12V car battery. A battery charger is not suitable.

Maintain the Earth connections and connect the +12V supply to TB3/1/2/3/4. Ensure 12S/2 is linked to 12S/7. D18 should light amber.

Connect the loads as detailed in Table 4 using several bulbs in parallel where shown. The bulbs are connected between the designated load connection and 0V (Earth). Remove the bulbs after each path is proved to be satisfactory. **Note: bulbs get HOT!**

At this stage it may be worth considering customising RLA13. If the unit is to be used exclusively for one caravan only, then the exact number of bulbs and total wattage of the Riding lights will be known and the number of coil turns can be re-evaluated. As commented on earlier, though, be aware that bulbs from different manufacturers may draw different currents even though they nominally have the same wattage.

CAUTION

The manufacturer's recommendations on such matters as disconnection of the battery before undertaking any electrical work should be studied, particularly where alarms, immobilisers and processor-controlled engine management systems are concerned.

INSTALLATION

Only general advice can be given about siting the Boot Unit because of the variety of vehicles into which it may be fitted. It should be within the boot or rear area of the vehicle which provides the shortest cable run to the ball hitch, or to the bracket on which the 12S and 12N sockets are fitted. Keep the two runs of 7-core cable as short as possible.

If the muting facility available on Fog and Reversing lights (either or both) is required then these feeds must be located, cut and reconnected to TB4. Any existing split-charge relays or supplementary indicator relays used in a previous installation should be removed.

If efficient operation of the fridge and caravan lights is to be achieved, voltage drop must be kept to a minimum. The four Earth points of the Boot unit should be taken to the nearest manufacturer's Earth point(s) using 28 x 0·3mm cable (offcuts of 12S white), and soundly terminated (TB3/6, TB4/3, 12S/3A and 12N/3A).

CABLING FACTS

Under some circumstances, the current into the unit can be up to 15A, increasing to 18A if fog lights become necessary, plus a further 5A to 6A if an indicator and the stop lights are invoked. The following cable facts become relevant:

For a length of up to four metres, the maximum currnt recommended in either 35 × 0·3mm or 19 × 0·1mm cable is 5A, rising to 10A if the run is two metres or less, even though the nominal rating of either is 21A, with a resistance of 0·0075 ohms/metre. Therefore, a minimum of three runs of such cable should be adequate for most installations, assuming the run to be under four metres.

However, a highly suitable cable is currently available (see Shop Talk) which is primarily intended for in-car hi-fi installations (NOT suitable for starter motors!) but perfect for this application.

It consists of 700 strands of 0·12mm copper, giving a cross section area of 8 sq. mm. Theoretically this gives a rating of 80A, but more importantly a resistance of only 0·002/metre. Connection to this is best made by several pigtails of say 21 × 0·3 or 28 × 0·3 (off-cuts of 12S 7-core) soldered and taped at each end. Connector TB3 accepts four such pigtails.

VEHICLE CONNECTIONS

Connection to the battery positive line should be via a 25A fuse. Any cable runs must be clear of moving parts, sharp edges etc., and should be secured at regular intervals. The author's vehicle has plastic trunking from front to rear under the floor, which makes an ideal path for such cables.

The "Charge" connection also needs to be run to the engine compartment. Any sensible cable (9 × 0·3mm) is suitable, and may well be run alongside the power cable. It should be connected to the supplementary output of the alternator. Some expansion may be required here, in view of more "subtle changes" the automobile industry are springing on the unsuspecting.

The so called "Ignition Warning Light" is usually connected between the ignition switch and the supplementary low current output on the alternator. When the ignition is switched on, the battery circuit is completed through the lamp and the effective ground of the idle alternator. When the alternator starts producing current, this "backs-off" the battery supply, and the lamp goes out. It is this low current source that is conventionally used to provide the current to operate the fridge relay, so that this load is not in circuit unless the engine is running.

Unfortunately, as mentioned above, certain manufacturers, Ducellier, Valeo, SEV Marschal, Paris-Rhone and possibly others, produce alternators with a "Simulated Warning Light" connection in place of the one previously mentioned. This consists of (effectively) a transistor, normally biased on when the alternator is idle, but cut off when the alternator is generating. The effect on the warning light is the same, but obviously it is no longer a source that can be used in the same way.

Note that the makes mentioned do not automatically imply a "Simulated" output. Only examination can ensure a positive identification. (Beware of measuring the leakage through the warning bulb itself!)

OFFICIAL ADVICE

The advice currently being offered by Caravan Associations for conventional fridge/charge relay connections in these circumstances is to operate the relay from the ignition switch. This means that the fridge is in operation if ignition is selected for any one of many car accessories, it also

means that the caravan battery is already in parallel before cranking commences. Without the protection of a suitable diode, very high currents could flow in conductors not designed for starter motor supplies!

Vandata *is ideal under these conditions*, since the Schottky diode (D8) prevents the latter and more serious of the two problems. Dash indications remain as described, except that D18 (amber) should extinguish at "Ignition On" instead of when charging commences.

DISPLAY MOUNTING

The Display unit has been designed with a ribbon cable extension to the two l.e.d.s so that space for the complete box is not required immediately behind the fascia. The l.e.d.s should be fitted in any suitable position on the dash board or centre console where they can be seen at a glance, and the plastic box tucked away into any available nearby space.

The DIN-to-DIN cable also needs to be run from the boot to the rear of the dash area, concealed under the carpet and trims. Because of the design variety of vehicles, it is difficult to be more specific. On completion, one quick check is worth while: if a temporary short is applied between 12S/2 and 12S/7 at the coupling connector the right hand l.e.d. D18 should light amber.

CARAVAN WIRING IMPROVEMENTS

There are two improvements that can be made to conventional caravan wiring. The fridge, operating on 12V, draws between 7A and 10A, depending on size and type. All this current is allocated to one connector 12S/6 and one conductor. Voltage drop and impaired efficiency are inevitable in such a connection, and yet there is connector 12S/5 adjacent to it, unallocated and unused. The Vandata unit commons these two connections, so that anyone wishing to join them (at the locker fuse box) will improve the fridge efficiency.

The second tip concerns the Earth wiring. Both connector 12S/3 and 12N/3 are designated as Earth connections. Both are sourced at the car chassis, yet very few manufacturers actually wire them together in the caravan. Apart from being electrically sloppy, this is a complete waste of good copper. The 12N Earth wire returns for much of the time only the occasional indicator or brake light currents, but if commoned at the caravan it can help to reduce the voltage drop in the 12S Earth from the steady fridge load. It also paves the way for simple refinements. For example, operating any of the exterior lights from the caravan battery.

However, the important point is that the only basic modification actually required for the satisfactory operation of Vandata is the strap, or loop from 12S/2 (blue) to 12S/7 (black), somewhere caravan-side of the plug. □

Ohm Sweet Ohm

Max Fidling

Salad days

The glorious summer weather always tempts me away from the workshop and my attention turns to the garden here at *Fidling Acres*. Standing proudly in one corner of the plot is my beloved glasshouse, by now a veritable production line of juicy red tomatoes! You would think that there was little scope to spice up my horticultural hobby with the addition of a few electronic gadgets, but you'd be wrong . . . and my four-legged fiend Piddles, a member of the animal species *Felinus Cleverdickus Maximus*, still does his best as usual to thwart my latest project!

Pondering this, my mind set to the task of inventing a way to keep my greenhouse well supplied with water – especially as holiday time loomed and my greenhouse would need to look after itself for a spell! Having given the tomato plants a lavish watering with the garden hose, I retired to the workshop to examine the prospects of automating the watering, while Piddles played around near the garden sprinkler which was aimed carefully at the melon patch nearby – strange because he loathed water!

I sought a way of automatically monitoring the dampness of the tomato plants, and turning on the water supply at the appropriate moment. I did have a further incentive because I wanted to cock a snook at my neighbours, and prove just how ingenious and self sufficient we Fidlings are! I could be the envy of my friends at the local horticultural society, too!

Setting to work in the 'shop, I leafed through my pile of yellowing magazines, in search of inspiration. In one of my overflowing boxes of bits I had gathered together a motley collection of washing machine spares, including quite a few water solenoid valves which I recall I had plundered from a defunct dishwasher. I always stored such stuff carefully away, since you never knew when it would come in useful, so I had tons of bits stored in old biscuit tins which were rusting away gradually on the shelves.

The solenoid valves were 240V mains operated, which deterred me not a jot. A simple solid-state moisture sensor, based on a rain alarm design I found in a magazine, was adapted to power the solenoid valve via an old Octal-base mains relay. A probe was assembled from a pointed piece of stripboard offcut.

The valve turned on like a good 'un when the resistance of the probe fell below a certain level. Good! Bridging the copper strips with water (I used my soldering iron sponge) switched the valve off with a loud click.

Gleefully, I fitted the gizmo into an aluminium box, replete with a large bakelite control knob to enable me to set the watering level precisely (well, sort of precisely). The prototype was then fitted into the greenhouse, high up out of harm's way. A water supply was laid on and a variety of valves, all heavily swathed in gaffer tape, was installed via a web of green hosepipe.

Melon-choly

Over the next week or so the system gradually became more elaborate. Very cleverly, I thought, I added an extra circuit which enabled the garden sprinkler to turn on automatically and water the melon patch outside! I had prodded a moisture probe into the greenhouse soil, and another one in the melon patch.

Soon the system settled down so that the tomato plants received an automatic supply of water when the going got hot. I could almost hear them slurping it up in appreciation! Things were not so good in the melon patch nearby, though. Wilting leaves told me that the plumtious plants were not getting in on the act, and melons like nothing more than water – *lots of it!*

Piddles had become accustomed to the sight of the tangle of wiring and hosepipe, this certainly hadn't prevented him from indulging in his daily mousing, and one morning he was rummaging around amongst the melon patch, much to my chagrin, while I was twiddling with the electronics in the greenhouse, trying to coax the sprinkler system into operation. I'd suspected that one of the solenoid valves was misbehaving, so after some ferreting in the workshop I'd searched out another.

Meanwhile, out of the corner of my eye I could see the tail of a certain moggie scooting amongst the melons erratically, like a submarine's periscope searching urgently for a kill. A plan formed . . .

Quickly fitting the hosepipe to the replacement valve and screwing the box back together, I switched on the mains supply and the water again, not wanting to miss this golden opportunity. With a flourish, I twirled the bakelite knob on the controller deftly and the solenoid valve clicked gratifyingly.

Water sputtered out of the sprinkler outside as the melons began to bask in the glorious water. The cat's tail drooped, a head popped up and then Piddles realising what I'd done, shot out of the melon patch at a grand rate of knots! A soggy moggie indeed! If only I'd got my Polaroid, the picture would have had pride of place above the bench!

One of my better days.