

# **Improved Road Traffic Congestion Charging by Fairer Rates Based on Measurement of Local Congestion.**

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## **Technical Details**

### **Background**

A previous paper described an idea for traffic congestion charging based on the accumulated count of radio pulses from near vehicles. This gives a true measure of congestion at every time and place.

If estimates based on the cost of mobile phones can be carried it could be used over the entire UK at little more than the cost of the present central London scheme.

It does not require any ground equipment.

This system poses no threat to civil liberty.

Its obvious fairness will make it politically more acceptable.

This note gives an initial outline of a possible practical design.

## CIRCUIT OPERATION

The block diagram is shown in figure 1. A unit in each vehicle will generate short pulses of a range of amplitudes. These will be counted by other vehicles. During the intervals between the generation of pulses the unit must count all those pulses received from other vehicles which exceed a chosen threshold. The total count is used to calculate the congestion charge.

A pulse amplitude function generator 1 sets the size distribution of transmitted pulses to relate pulse count to the distances to nearby vehicles in a chosen way. Pulse rate and width are set by a second generator 2 to, say, a repetition period of 3 seconds and a width of, say, one microsecond. This signal also operates a transmit/receive switch 3. The resulting pulse switches on a 3 GHz typical oscillator 4 for the chosen period. This would continue for a few minutes after the engine was switched off so that long jams need not build up excessive charges.

The pulse of 3 GHz oscillations passes through the transmit/receive switch 3 to a 45-degree, partially polarised, 1/4 wavelength aerial 5. The partial polarisation allows a different count rate for vehicles moving with or counter to the main traffic stream.

During non-transmission times the aerial will receive modulated pulse signals from several or many other vehicles 6 and perhaps also from some calibration source 7. These go through RF amplification 8 designed for stable gain and a gain control block 9 to two mixers 10 and 11 driven by local oscillators 12 and 13 and tuned IF amplifiers 14 and 15, also with stable gain. The frequency of calibration source 7 is very slightly different from the modulation frequency of the modulated pulses. The two mixers and local oscillators allow the modulated pulse signals to be separated from the calibration signal. This allows the gain of the modulated pulse signal path to be standardised through a control level demodulator 16 feeding back to the gain control block 9. Gain should be reset only at rare intervals when signals suggest that the vehicle is in open country and the calibration source genuine.

The signals from near vehicles are demodulated by 17. Those large enough to exceed the chosen threshold level 18 are counted by the 48 bit non-volatile, non-resettable counter 19. This can have any arbitrary initial count which is centrally recorded when the vehicle is first registered.

From time to time counts are passed to a readout memory block 20 which can hold the entire historical record of counts related to calendar dates from clock calendar unit 21, power supply status 22 and a vehicle moving detector 23. The vehicle movement can be sensed by a piezo electric element 24 and or an electromagnetic generator 25. Either can be used to recharge a battery 26 for several hundred hours following disconnection of the feed from the vehicle battery 27. A third recharge mechanism could be a photo-voltaic cell 28.

Readout commands and data output can be controlled from an external source by circuitry 29 close-coupled induction loops 30 and 31 or photo-electric means not shown. Power drain for the outgoing signals will be minimised if a switch on the inboard side of the loop 30 can be opened or closed to vary the impedance of the outboard coil 31.

Attempts to reduce the count by a false calibration signal can be sensed by the Doppler shift of the calibration signal measured by circuitry 32. This can also be used to measure vehicle speed. Other information such as a 'vehicle XXX stolen' or 'congestion charge for YYY not paid since time TTT' messages etc. can be transmitted from an encoder 33.

Driver warnings can be given with audio speaker 34. The circuitry can be protected from damage due to excess supply voltage using a thyristor crowbar 35 and current-limiting resistor 36.

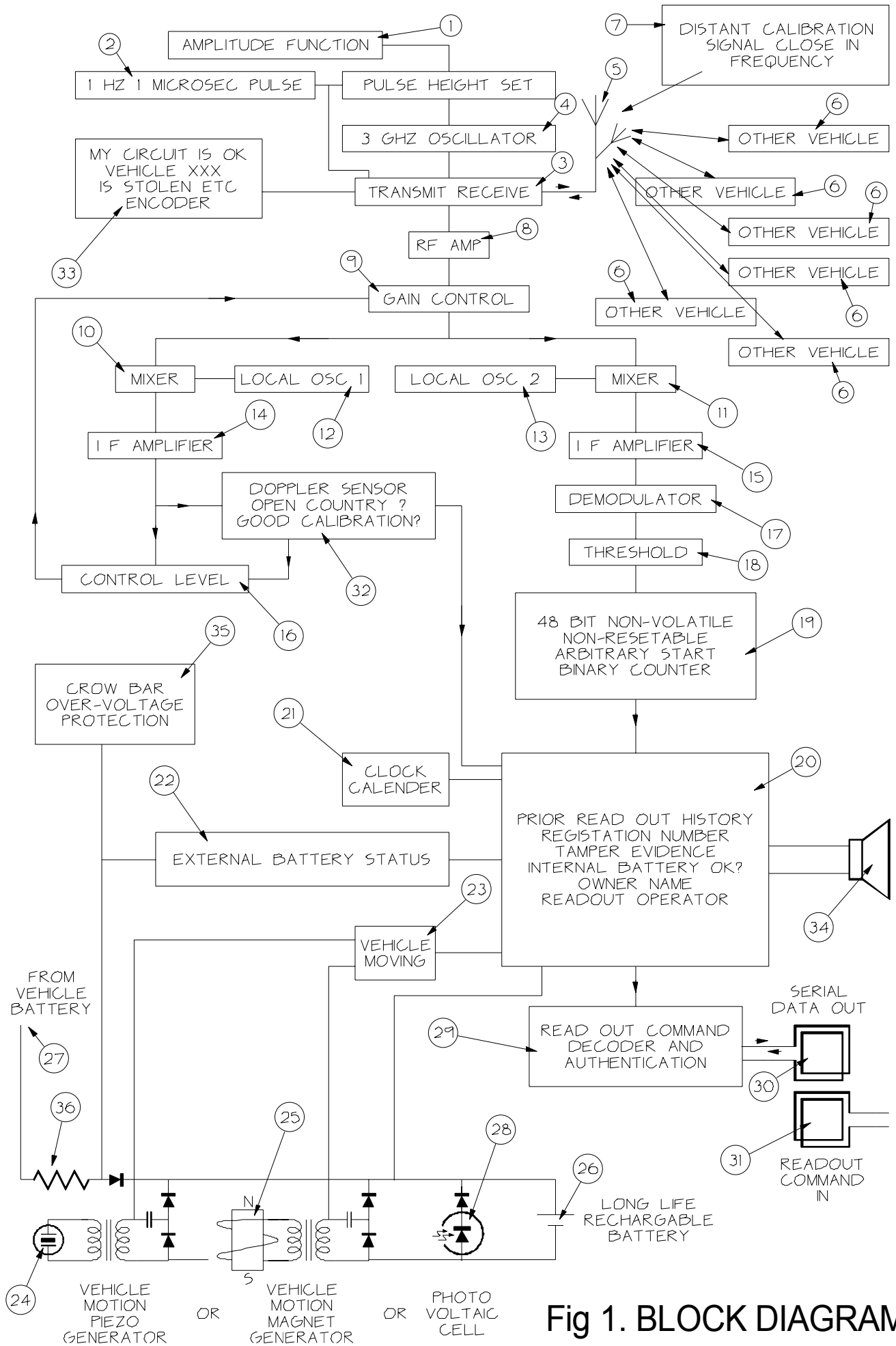


Fig 1. BLOCK DIAGRAM

## MECHANICAL OUTLINE

A layout is shown in figure 2. The equipment case 51 should be fitted high in the vehicle but must not obstruct driver vision more than is needed to view information on journey details. This means that it should fit mainly inside lines 52 drawn from the driver's eye position to the outline of the existing rear-view mirror 53 but with a strip 54 about 15 mm high above the mirror enough to give room for text to be read by people with vision corrected for distance. There may need to be a notch 55 to pass the present rear-view mirror support. In future designs a ball and socket support for the rear-view mirror can be built into the case.

The front of the case 56 should be angled approximately to suit the inclination of the vehicle windscreen 57. This will require a number of different moulds ranging from private cars which are now angled at about 30 degrees to the horizontal to coaches which are nearly vertical. All items can be potted in a hard-setting, tamper-resistant, tamper-evident resin provided that we can be sure that it does not present any greater hazard than the rear-view mirror. If this is not the case then we should concentrate on tamper-evident elastomers. The material of the case should pass the 3GHz transmissions. The faces of the case shown to the outside of the vehicle should have a colour to reflect solar heat.

The case 51 should be permanently attached to the windscreen 57 with a transparent, gap-filling flexible glue 58. The gap 59 between windscreen and case allows for the changes in screen curvature of different vehicles. The vehicle registration number 60 should be marked in the largest possible letters on the front face so as to be readable from other vehicles.

The underside of the case 51 presents a face 61 which can mate with the induction loop or optical data communication reader not shown. The high frequency circuit board 62 can be at 90 degrees to the readout face.

The main quarter-wavelength aerial 63 and 45-degree polarised aerial 64 should be housed close to the windscreen. Long-life rechargeable batteries 65 can fit between the high-frequency board and the vehicle driver.

All the statutory congestion-charging circuitry can be housed in one half of the case. The second compartment 66 is left free for additional optional items such as vehicle security, ice, fog and accident warnings.

If it turns out that satisfactory life of circuits and batteries cannot be achieved then a case can be used which allows replacement through the lower face 61 which would then be fitted with tamper-evident fastenings.

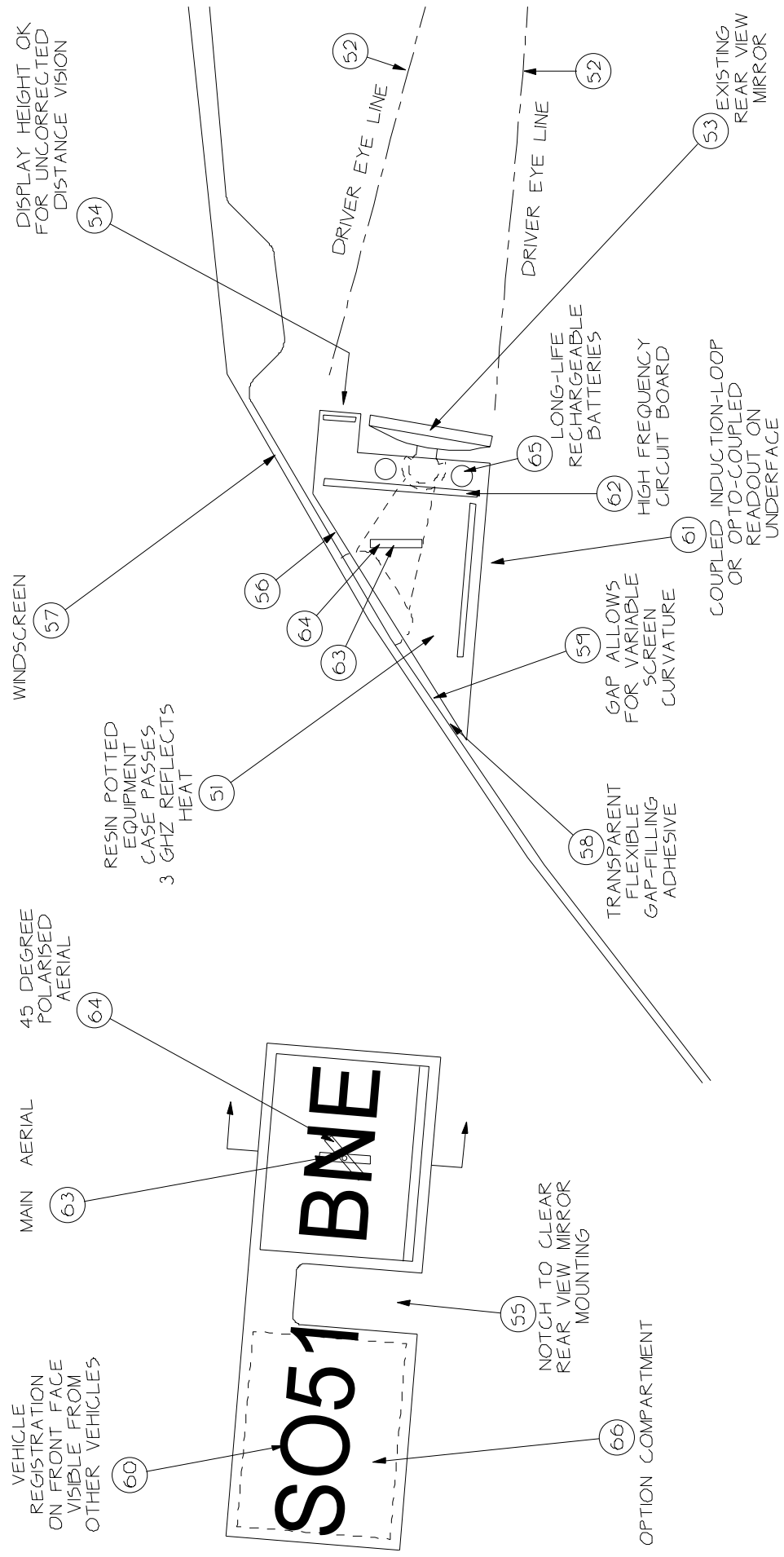


Fig 2. MECHANICAL LAYOUT