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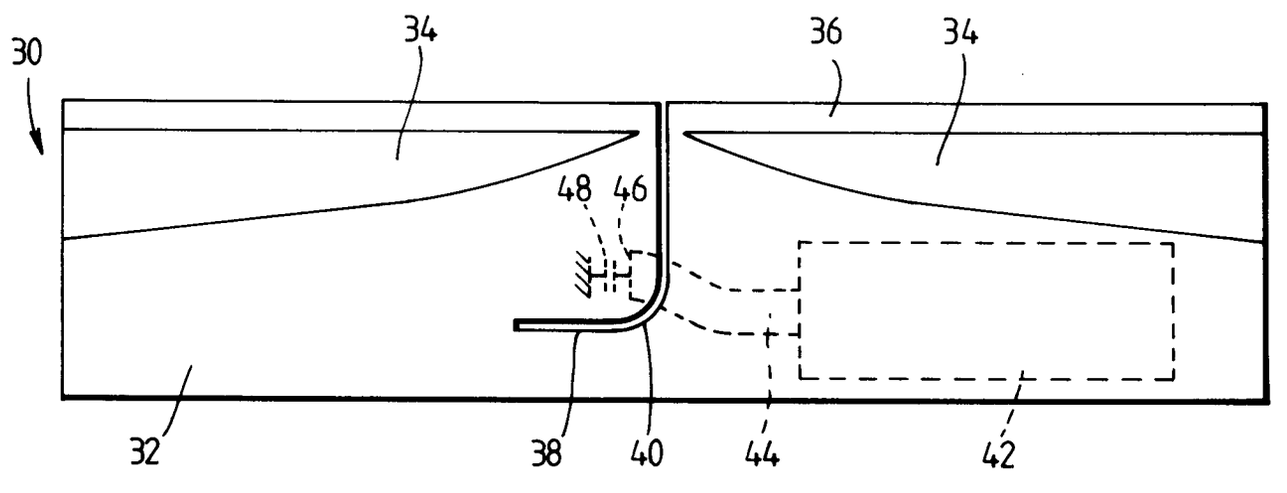
(54) Moving vehicle transponder.

(57) A transponder tag operative in the UHF range and including a substrate of dielectric material having formed on one side a conductive surface providing a ground plane and a dipole antenna, a slot line within the ground plane forming a balanced antenna feeder and leading to the centre of the dipole antenna, and the substrate having mounted on the side of the substrate opposite to said one side a transmission line feeder positioned for electromagnetic coupling with said slot line, the transmission line feeder being coupled to transceiver circuit means and processing means mounted on the opposite side for performing a transponding function.

Fig. 3.

DETAIL OF TRANSPONDING TAG ANTENNA COUPLER



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Field of the Invention

This invention relates to tag transponders, particularly though not exclusively for attaching to vehicles.

Background Art

A system has been devised which allows road toll fees to be collected automatically.

The system comprises an interrogator device buried in the carriageway and a transponding tag fitted to vehicles.

When a suitably equipped vehicle approaches a toll point its presence is detected by an inductive loop detector (similar to that used at traffic lights) and the interrogator is energised. This device transmits a signal at 915 MHz to the vehicle, the transmission carries a code which is recognised by the vehicle "tag" as a command to turn on its transmitter. The tag transmitter then sends a coded signal to the interrogator in the carriageway. The coded information contains the vehicle registration number. It is therefore possible to collect toll fees without the need for manned toll booths and without the need for vehicles to slow down so that money could be transferred.

It will be understood for the purposes of this specification, "transponder tag" is intended to mean a unitary device which includes elements necessary for its operation in receiving radiated signals and transmitting signals in response thereto.

Summary of the Invention

It is an object of the present invention to provide a transponder tag which is of a particularly simple, inexpensive and reliable construction.

The present invention is intended to operate in the UHF range, and specifically 915 MHz. However for the purpose of this specification "UHF range" is intended to mean any frequency below 2 GHz and excluding frequencies which would normally be regarded as microwave.

The present invention provides a transponder tag operative in the UHF range and including a substrate of dielectric material having formed on one side a conductive surface providing a ground plane and a dipole antenna, a slot line within the ground plane forming a balanced antenna feeder and leading to the centre of the dipole antenna, and the substrate having mounted on the side of the substrate opposite to said one side a transmission line feeder positioned for electromagnetic coupling with said slot line, the transmission line feeder being coupled to transceiver circuit means and processing means mounted on the opposite side for performing a transponding function.

Thus in accordance with the invention a transponder of particularly simple construction is provided operating in the UHF range including an antenna and balanced feeder arrangement formed in a particularly simple manner on opposite sides of a dielectric substrate.

As preferred the dipole antenna is formed by removing for example by etching selected parts of said conductive surface, leaving a strip defining a dipole antenna which is connected to the ground plane at the central region of the strip.

As preferred the transmission line feeder comprises a conductive strip, /4 long and terminating at a position generally opposite the slot line for maximum coupling to the slot line.

The transceiver means comprises an oscillator coupled via a buffer (power) amplifier to the transmission line feeder, the collector of an RF transistor of the amplifier being directly coupled to the feeder. As preferred the oscillator and amplifier are CW modulated by switching of the power supplied to the oscillator and amplifier by means of output data signals from the processor.

The receiver is capacitively coupled to the feeder with the base of a receiver transistor being directly connected to the AC coupling. The receiver demodulates received RF signals and provides the demodulated data to the processing means, which preferably comprises a processor and memory including stored programs, all provided in a single ASIC.

Brief Description of the Drawings

A preferred embodiment of the invention will now be described with reference to the accompanying drawings, wherein :-

Figure 1 is a block diagram of the transponder according to the invention;

Figure 2 is a circuit diagram of the transceiver of Figure 1; and

Figure 3 is a plan view of the transponder showing the antenna and antenna feed arrangement.

Description of the Preferred Embodiment

Referring now to the drawings Figure 1 is a block diagram of the tag according to the invention and shows a dipole antenna 2 coupled via an antenna coupler 6 to a receiver detector 8 which demodulates data received by the antenna and passes the demodulated data to a data processor 10 formed as an ASIC. Output data provided by processor 10 is coupled to an RF oscillator 12 which oscillates a 915 MHz and to a buffer (power) amplifier 14 which amplifies the oscillator signals and feeds the signals to antenna coupler 6. The data on output line 16 from processor 10 modulates the oscillator and buffer amplifer in a CW modulation mode wherein both the oscillator and amplifier are switched on/off directly by the output data.

Referring now to Figure 3, this is a plan view of

the tag transponder comprising a substrate block 30 a relatively low dielectric value polyester resin and having on its upper side a conductive surface 32 (for example copper) coated thereon. The surface 32 forms a ground plane and portions of the surface 32 are removed as at 34 to provide on one side of the surface a dipole antenna strip 36 having an input impedance of 75 ohms at its centre. A slot line 38 is formed in the ground plane extending from the mid point of the antenna 36 and forming a right angled bend as at 40. On the other side of the dielectric body as indicated in dotted lines, the electrical components indicated in Figure 1 are mounted as at 42, preferably by means of surface mount technology on an array of solder bumps. The electronic components 42 are coupled to the antenna by means of a transmission line 44. Transmission line 44 is formed as a strip of conductive metal coated on dielectric block 30 and having a length $\lambda/4$ with the free end of the strip 46 terminating close to a position directly opposite slot line 38. The end of strip 46 is coupled via a capacitive coupling 48 to ground plane 42. This arrangement provides a maximum electromagnetic coupling between the end of strip 46 and slot line 40, the radiation being coupled to slot line 40 and then being conductive in a balanced feed arrangement on either side of the slot line to the dipole antenna to provide a balanced feed to the dipole antenna.

The dipole antenna is printed on the same PWB (printed wiring board) as the tag electronics.

Referring now to Figure 2, this shows a circuit diagram of the transceiver arrangement as comprising a receiver or detector 50 coupled to transmission line 44 via a capacitance 52, the base of an RF detector transistor 54 being directly coupled to capacitor 52. The collector of transistor 54 is coupled to the base and, via a diode 56, to the emitter of a further transistor 58. A tuning circuit for the detector is formed by the quarter-wave transmission line 44, while transistors 65, 66, capacitor C1 and inductor L1 provide active bias for the detector transistor 54. The combination of transistor 54 diode 56 and transistor 58 provide a means of demodulating the data from the input RF signal and the demodulated data is fed to processor 10. Processor 10 responds to the input data by providing data on output line 16 for modulation of an oscillator 12 comprising a transistor 60 and a resonant circuit arrangement L2, C3, C4, the frequency of oscillation being determined by a micro strip 62. The oscillator is coupled to buffer amplifier 14 comprising an RF transistor 64 coupled in common base mode to oscillator 12 and having its collector directly coupled to feeder 44.

The processor circuit 10 is powered by a lithium battery (not shown) and the battery and transponder tag are housed in an overall plastics encapsulation.

Claims

1. A transponder tag operative in the UHF range and including a substrate of dielectric material having formed on one side a conductive surface providing a ground plane and a dipole antenna, a slot line within the ground plane forming a balanced antenna feeder and leading to the centre of the dipole antenna, and the substrate having mounted on the side of the substrate opposite to said one side a transmission line feeder positioned for electromagnetic coupling with said slot line, the transmission line feeder being coupled to transceiver circuit means and processing means mounted on the opposite side for performing a transponding function.

2. A transponder according to Claim 1 wherein the dipole antenna is formed by removing parts of said conductive surface leaving a strip defining said dipole antenna which is connected to the ground plane at the central region of the strip.

3. A transponder according to Claim 1, wherein the transmission line feeder comprises a conductive strip, /4 long and terminating at a position generally opposite the slot line for optimum electromagnetic coupling.

4. A transponder according to Claim 1, wherein the transceivr circuit means comprises an oscillator and output amplifier, both of which are CW modulated by output data from the processing means.

5. A transponder as claimed in Claim 1 wherein the transceiver circuit means includes a transmitter output RF transistor whose collector is directly coupled to the transmission line feeder.

6. A transponder as claimed in Claim 1 wherein the transceiver circuit means includes receiver means including a detecting transistor coupled to the transmission line feeder via a capacitor.

7. A transponder as claimed in Claim 1 wherein said processing means is comprised in an ASIC.

8. A transponder substantially as described with reference to the accompanying drawings.

Fig. 1. TRANSPONDING TAG BLOCK DIAGRAM

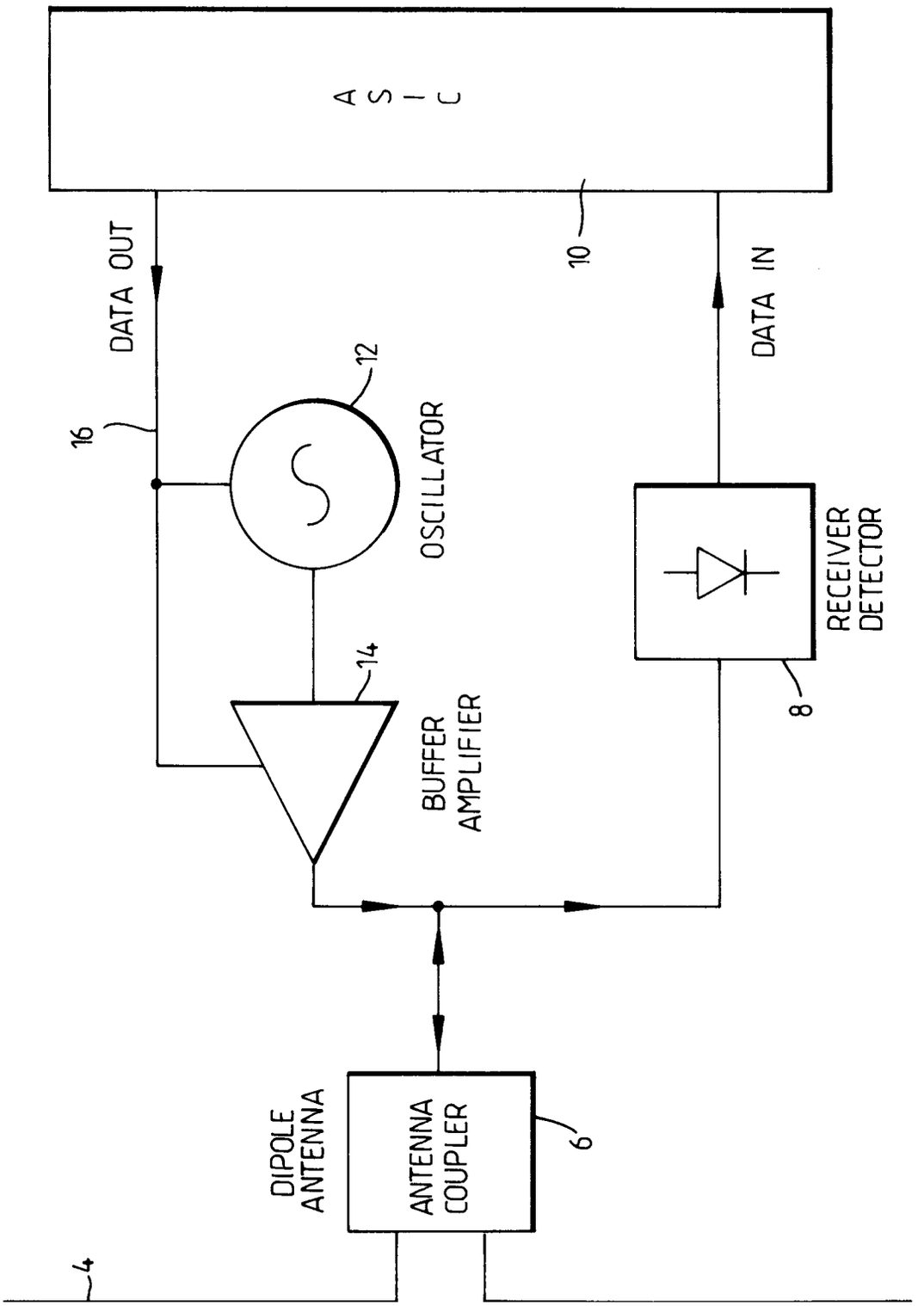

Fig.2. TRANSPONDING TAG CIRCUIT DIAGRAM

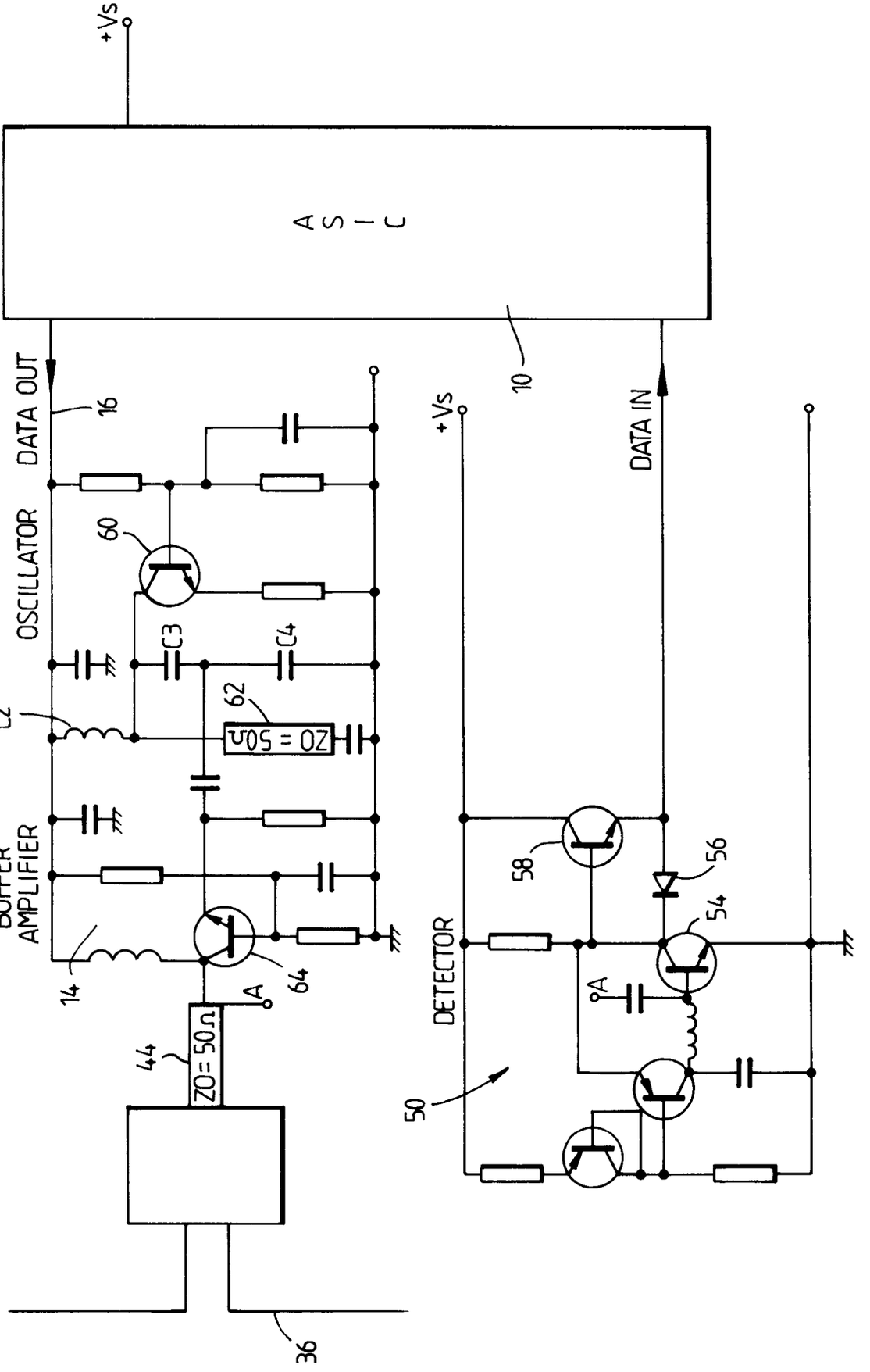

Fig. 3.

DETAIL OF TRANSPONDING TAG ANTENNA COUPLER