consumer mobile device and wallet application for capturing magnetic stripe card data, storing the data securely, and transmitting such data to merchants' point of sale (POS) or checkout systems, in the physical and virtual environments.

[0005] The Magnetic Secure Transmission (MST) technique magnetically couples simulated magnetic stripe data into a POS magnetic stripe reader (MSR) **101** from a distance of 30 to 40 mm. An alternating polarity magnetic field **102** is generated by driving alternating polarity current through a suitably designed inductor. The MSR head, which contains an inductor, picks up the magnetic pulses and converts them to voltage pulses, which in turn are decoded by the reader circuit and terminal logic. This is schematically shown in **FIG. 1.**

However, in real life, inductors, including NFC inductors, do not have isotropic fields. Flat inductors, for example, tend to have doughnut shaped fields. Other inductors generate different field shapes.

The overlapping field patterns of the MST transmitter inductor and the reader head inductor result in one or more nulls: narrow areas where no signal transfer takes place. Depending on the inductor topology, these nulls can be either on the center-line of the reader head, or along the edges off to the sides. Nulls affect the reliability of card data transmissions. While users quickly learn in which position their LoopPay device works best, some inconvenience and the need for two or three tries results at times. When MST is integrated into a smart-phone, which is larger than a LoopPay device, precise placement is less likely and therefore first-time MST transmission success rate suffers.

SUMMARY OF INVENTION

According to a first aspect of the present invention, there is provided a transmitter to generate a signal to be read by a reader, comprising: a driver circuit; and at least two inductors connected to the driver circuit; wherein the driver circuit controls the current flow through the inductor that results in a signal; wherein each inductor has at least one null region, wherein the signal strength is below the detection limit of the reader; and wherein the inductors are positioned such that the null regions of the inductors do not overlap.

According to a second aspect of the present invention, there is provided a transmitter to generate a signal to be read by a reader, comprising: a driver circuit; and an inductor connected to the driver circuit; wherein the driver circuit controls the current flow through the inductor that results in a signal transmission; and wherein the driver circuit passes the current through the inductor multiple times while the inductor is moved relative to the reader head passing through a number of positions; and wherein at least one of the number of positions the inductor passes

through the inductor produces a transmission signal that is greater than the reader threshold for a good data read.

According to a third aspect of the present invention, there is provided a method of driving the transmitter in accordance with the first aspect, wherein the method comprises flowing current through only one inductor at a given time.

According to a fourth aspect of the present invention, there is provided a method of driving a transmitter that includes a driver circuit and at least two inductors connected to the driver circuit with each inductor having at least one null region with a signal strength below the detection limit of a signal reader, wherein the driver circuit controls the current flow through the inductor that results in a signal, said method comprising the steps of: positioning the at least two inductors in the transmitter so that the null regions of the inductors do not overlap; and flowing current through the at least two inductors to generate a composite signal.

According to a fifth aspect of the present invention, there is provided a method to generate a signal to be read by a reader by a transmitter including a driver circuit and an inductor connected to the driver circuit, said method comprising the steps of: flowing a current through the inductor multiple times to produce repeated signals for transmission; moving the inductor relative to the reader head passing through a number of positions while the current is being passed through he inductor; wherein at least one of the number of positions the inductor passes through, the inductor produces a transmission signal that is greater than the reader threshold for a good data read.

In ~~an aspect~~some embodiments, a transmitter to generate a signal to be read by a reader is described. The transmitter includes a driver circuit; and at least two inductors connected to the driver circuit. The driver circuit controls the current flow through the inductor and the current flow results in a signal such that the signal strength is above the detection limit of the reader for each of the inductors which may have at least one null region. Additionally, the inductors are positioned such that the null regions of the inductors do not overlap.

In some embodiments, the inductors are positioned to produce regions where the signal strength is greater than the detection limit of the reader to result in good data read.

In some embodiments, the transmitter has only two inductors.

In some embodiments, the transmitter has at least one inductor that is an L-mode inductor and in other embodiments, the transmitter has at least one inductor that is an X-mode inductor.

In some embodiments, the L-mode inductor further comprises a conductive material. The conductive material may be selected from a group consisting of a metal wire, a printed circuit board, and stamped sheet metal shapes. The conductive material maybe plated or coated with a material selected from a group consisting of enamel, acrylic or plastic. In yet other embodiments, the conductive material is shaped in the form selected from the group consisting of irregular, circle, polygon, rectangle, square, and triangle.

In some embodiments, the X-mode inductor further comprises a core, which may be made of ferrite. In some other embodiments, the core has a cross-sectional shape selected from the group consisting of irregular, circle, polygon, rectangle, square, and triangle.

In some embodiments, at least one inductor is an L-mode inductor and at least one inductor is an X-mode inductor. In other embodiments, all the inductors are L-mode inductors or, all the inductors are X-mode inductors.

In some embodiments, at least one inductor does not have its null region, where the signal strength is below the detection limit of the reader, positioned above the reader.

In some embodiments, the regions of the inductors where the signal strength is greater than the detection limit of the reader are contiguous and increase the total area where the signal strength is greater than reader detection limit. In some embodiments, the driver circuit flows the current through multiple inductors at the same time. In other embodiments, the driver circuit flows the current through multiple inductors at the separate times.

In ~~another aspect~~some embodiments, a method of driving a transmitter is described that includes a driver circuit and at least two inductors connected to the driver circuit with each inductor having at least one null region with a signal strength below the detection limit of a signal reader, wherein the driver circuit controls the current flow through the inductor that results in a signal, said method includes the steps of:

(a) positioning the at least two inductors in the transmitter so that the null regions of the inductors do not overlap; and

(b) flowing current through the at least two inductors to generate a composite signal.

In some embodiments, the method of driving the transmitter includes, flowing current through only one inductor at a given time. In some other embodiments, the composite signal has a null region wherein the signal strength is below the detection limit of the reader. In some embodiments, the composite signal has a signal strength skewed towards one side of the reader. In some embodiments, the null region of the composite signal is located at a unique location with no overlap with the null regions of the individual inductors of the transmitter.

In some embodiments, the method of driving the transmitter includes the step of flowing current through the at least two inductors. The flowing of the current further includes alternating between flowing current through a plurality of the inductors at a given time and flowing current through only one inductor at a given time. In some embodiments, the step of flowing current through the at least two inductors includes having the current flow in the same direction through all the inductors. In some other embodiments, the step of flowing current through the al least two inductors includes having at least one inductor having the current flow in the opposite direction as compared with all the other inductors.

In ~~an aspect~~some embodiments the transmitter includes a single inductor connected to a driver circuit. The driver circuit controls the current flowing through the inductor resulting in a transmission and the driver circuit passes the current through the inductor multiple times while the inductor is moved relative to a card reader head passing through a number of positions. At at least one of the number of positions the inductor passes through, the inductor produces a transmission signal that is greater than the card reader threshold for a good data read.

In ~~an aspect~~some embodiments, the method includes passing current multiple times, controlled by a driver circuit, through a transmitter including a single inductor to produce a signal for transmission while the inductor is moved relative to a card reader head passing through a number of positions. At at least one of the number of positions the inductor passes through, the inductor produces a transmission signal that is greater than the card reader threshold for a good data read.

BRIEF DESCRIPTION OF DRAWINGS

The following Figures are provided for the purpose of illustration only and are not intended to be limiting.

FIG. 1 shows a schematic of Magnetic Secure Transmission (MST) system utilized in the present invention.

FIG. 2 shows a schematic of the transmitter according to the present invention.

FIG. 3 shows a schematic of the voltages induced by a flat, horizontal inductor into a typical POS terminal's card reader-head from different relative positions along the card reader swipe slot.

FIG. 4 shows the mutual magnetic coupling between the MST transmitter inductor shown in **FIG. 2** and the magnetic stripe reader head inductor to transfer simulated track data to the POS terminal **403** where the coupling is very low or zero **401** and the reader threshold below which transmissions fail.