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Communication system and display synchronization

Abstract

Various aspects of the disclosure generally relate to point-of-sale credit card processing devices. More specifically, the disclosure relates to synchronizing device communications with other device functions in order to reduce cross-platform interference and meet certification requirements.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS (1) This application claims the benefit of and priority to international application PCT/US2021/051970, filed Sep. 24, 2021, entitled COMMUNICATION SYSTEM AND DISPLAY SYNCHRONIZATION, and is hereby incorporated by reference in its entirety, which in turn claims the benefit of and priority to U.S.

Provisional Patent Application No. 63/082,749, filed Sep. 24, 2020, entitled Secure Point-of-Sale Device, and is hereby incorporated by reference in its entirety.

BACKGROUND

Field of the Disclosure

(1) The disclosure relates generally to point-of-sale credit card processing devices and more specifically to managing interference of communication systems.

Description of Related Art

(2) Fundamental to the functioning of the economy is the exchange of payment for goods and services. Throughout modern commercial history, payment has typically been rendered with money in the form of currency or cash such as banknotes and coins. Cash continues to be used to purchase goods and services, but it is becoming increasingly less common. In the United States, a study by Tufts University concluded that the cost of using cash amounts to around $200 billion per year. This is primarily the costs associated with collecting, sorting and transporting the physical currency, but also includes expenses like automated teller machine (ATM) fees. The study also found that the average American wastes five and a half hours per year withdrawing cash from ATMs, which is just one of the many inconvenient aspects of physical currency. Physical currency is often unhealthy too. Researchers in Ohio spot-checked cash used in a supermarket and found 87% contained harmful bacteria.

(3) Conventional financial transactions are fundamentally based on the value of currency, but often involve the transfer of funds that do not require the physical exchange of cash.

(4) In the United States, the Federal Reserve Bank's Automated Clearing House (ACH) Network is a processing and delivery system that provides for the distribution and settlement of electronic credits and debits among financial institutions, and functions as an electronic alternative to paper checks. Unlike a check, which is always a debit instrument, an ACH entry may be either a credit or a debit entry. The ACH Network is also widely used to settle consumer transactions made at ATMs and point-of-sale (POS) terminals.

(5) Physical currency is already being replaced by cryptocurrencies like Bitcoin. Bitcoin allows for direct transfers of funds between parties, without the need for a third party. A wide range of startups are now developing products based on the Bitcoin protocols, in the hope that it will compete with other global payment systems. Cash transactions worldwide rose just 1.75% between 2008 and 2012, to $11.6 trillion. Meanwhile, non-traditional payment methods rose almost 14% to total $6.4 trillion. This group includes online and mobile payment systems including PayPal, Google Wallet, Apple Passbook, and other cashless alternatives.

(6) Thrive Analytics 2014 Digital Wallet Usage Study revealed that, despite nearly 80% of consumers being aware of digital wallets, including major players like PayPal, Google Wallet, and Apple Passbook, security concerns remain the main barrier to adoption, followed by lack of usability versus credit cards/cash (37%) and not being top of mind as a form of payment at the time of purchase (32%). Meanwhile, MasterCard and Visa face obstacles as they try to become players in the digital wallet game.

(7) Other companies produce a point-of-sale credit card reader and app that provides transparent pricing, reliable technology and is available for major credit cards plus Google Pay and Apple Pay. Contrasting this with a traditional credit card terminal, which contains the hardware and software for generating an authorization request, these card readers work in conjunction with online systems to generate that request. Security and ensuring the secrecy of user credit card information is paramount in any credit card reader and strict standards apply to the construction and operation of these POS readers. While meeting security standards, the makers of these readers must design a product that is compact and meets international standards for credit card payments.

SUMMARY

(8) A point-of-sale credit card device may include a case and a display coupled to the case. The

display may have a plurality of pixels and be configured to be refreshed during a plurality of refresh periods. Each of the refresh periods includes a write phase in which at least one of the plurality of pixels is addressed, and a dormant phase in which none of the plurality of pixels are addressed. A printed circuit board (PCB) may be coupled to the case. A display controller may be coupled to the PCB. The display controller may be configured to provide addressing for at least some of the plurality of pixels during the write phase. A near-field-communication (NFC) system may be coupled to the PCB and be configured to broadcast an NFC signal for near-field communication. The NFC system may be synchronized to the display refresh period and configured to begin broadcasting the NFC signal during the dormant phase based on the synchronization. The NFC system may be configured to receive a signal as the synchronization to the display refresh period. The display may further comprise a liquid crystal display (LCD), the signal being a tearing signal, the LCD may be further configured to transmit the tearing signal during the write phase and not transmit the tearing signal during the dormant phase. The NFC system may be further configured to begin broadcasting the NFC signal when the NFC system stops receiving the tearing signal. The signal may be a dormant signal, the dormant signal being on during the dormant phase and being off during the write phase. The NFC system may be further configured to begin broadcasting the NFC signal after the dormant signal goes on. The NFC system may be further configured to receive a clock signal and be programmed to begin broadcasting the NFC signal at a specific time interval based on the clock signal. The NFC system may be configured to begin broadcasting the NFC signal during the dormant phase. The NFC system may be further configured to have an operating mode and a test mode, the operating mode having a polling phase. The NFC system may be further configured to synchronize the broadcasting of the NFC signal with the display refresh only during the test mode. The NFC system may be further configured to synchronize the broadcasting of the NFC signal with the display refresh during the polling phase. The NFC system may be further configured to begin broadcasting the NFC signal during the dormant phase, continue broadcasting in an approximately continuous manner during the dormant phase, and stop broadcasting during the same dormant phase in which the NFC system began broadcasting. The NFC system may be further configured to begin broadcasting the NFC signal during the dormant phase, continue broadcasting in an approximately continuous manner through the dormant phase, and continue broadcasting into at least the write phase of the following refresh period. The NFC system may be further configured to broadcast approximately at a frequency of 13.56 MHz and to experience distortion of the NFC signal, from the display, during the write phase. The above device may be a credit card reader.

(9) A method of reducing interference includes refreshing a display having a plurality of pixels by addressing at least one of the plurality of pixels during a write phase, entering a dormant phase in which none of the plurality of pixels is addressed, receiving a signal in a near field communication (NFC) system indicating that the dormant phase has been entered, and beginning a broadcast of an NFC signal during the dormant phase. Receiving a signal in an NFC system indicating that the dormant phase has been entered may include receiving a tearing signal until the end of the write phase, at which point the tearing signal stops, indicating an end to the write phase. Receiving a signal in an NFC system indicating that the dormant phase has been entered may include receiving a clock signal timed with an end to the write phase. The method may include any of: counting clock cycles in order to track the dormant phase, ending the broadcast of the NFC signal during the dormant phase, refreshing the display, after beginning a broadcast of an NFC signal, by addressing at least some of the plurality of pixels during the write phase, and ending the broadcast of the NFC signal after the beginning of the second display refresh.

(10) A method of reducing interference in a credit card processing device may include refreshing a display having a plurality of pixels by addressing at least one of the plurality of pixels during a write phase, entering a dormant phase in which none of the plurality of pixels is addressed, synchronizing a start for broadcasting in a near field communication (NFC) system with the

dormant phase, and broadcasting by the NFC system in the dormant phase. The method may include entering a test mode.
(11) The foregoing has outlined rather broadly the gestures and technical advantages of examples according to the disclosure in order that the detailed description that follows may be better understood. Additional features and advantages will be described hereinafter. The conception and specific examples disclosed may be readily utilized as a basis for modifying or designing other structures for carrying out the same purposes of this disclosure. Such equivalent constructions do not depart from the scope of the appended claims. Characteristics of the concepts disclosed herein, both their organization and method of operation, together with associated advantages will be better understood from the following description when considered in connection with the accompanying figures. Each of the figures is provided for the purposes of illustration and description, and not as a definition of the limits of the claims.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) So that the above-recited features of the disclosure can be understood in detail, a more particular description, briefly summarized above, may be had by reference to aspects, some of which are illustrated in the appended drawings. It is to be noted, however, that the appended drawings illustrate only certain typical aspects of this disclosure and are therefore not to be considered limiting of its scope, for the description may admit to other equally effective aspects. The same reference numbers in different drawings may identify the same or similar elements.
(2) FIG. **1** is a top right perspective view illustrating one example of a credit card reader.
(3) FIG. **2** is an exploded parts diagram illustrating one example of a credit card reader.
(4) FIG. **3** is a partial exploded parts diagram illustrating one example of a communications assembly from a credit card reader.
(5) FIG. **4** is a partial exploded parts diagram illustrating one example of a secure circuit assembly from a credit card reader.
(6) FIG. **5** is a partial exploded parts diagram illustrating one example of a rear assembly from a credit card reader.
(7) FIG. **6** is a block diagram illustrating components in a credit card reader.
(8) FIG. **7** is a waveform illustrating readout from a near field communication (NFC) system.
(9) FIG. **8** is a waveform illustrating readout from a near field communication (NFC) system with interference.
(10) FIG. **9** is a waveform graph comparing timing and signal effects from one aspect of a synchronized system.
(11) FIG. **10** is a flowchart illustrating one aspect of synchronizing a display with a communication system.
(12) FIG. **11** is a flowchart illustrating one aspect of synchronizing a display with a communication system.
DETAILED DESCRIPTION
(13) Various aspects of the disclosure are described more fully herein with reference to the accompanying drawings. This disclosure may, however, be embodied in many different forms and should not be construed as limited to any specific structure or function presented throughout this disclosure. Rather, these aspects are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the disclosure to those skilled in the art. Based at least in part on the teachings herein, one skilled in the art should appreciate that the scope of the disclosure is intended to cover any aspect of the disclosure disclosed herein, whether implemented independently of or combined with any other aspect of the disclosure. For example, an apparatus

may be implemented, or a method may be practiced using any number of the aspects set forth herein. In addition, the scope of the disclosure is intended to cover such an apparatus or method which is practiced using other structure, functionality, or structure and functionality in addition to or other than the various aspects of the disclosure set forth herein. Any aspect of the disclosure may be embodied by one or more elements of a claim.

(14) A point-of-sale (POS) credit card reader may physically interact with payment instruments such as magnetic stripe payment cards, Europay, MasterCard and Visa (EMV) payment cards, and short-range communication (e.g., near field communication (NFC), radio frequency identification (RFID), Bluetooth, Bluetooth® low energy (BLE), etc.) payment instruments. The reader may provide a rich user interface through the display, communicate with the payment reader, and communicate with a payment processing service server, which may communicate with payment processing service provider server(s). In this manner, the reader may collectively process transaction(s) between a merchant and customer(s).

(15) POS readers may be mobile, such that POS readers may process transactions in disparate locations across the world. For various reasons, a payment processing service provider may contract with a payment processing service regarding where the payment processing service is permitted to collectively process card-present transactions between merchants that utilize POS readers serviced by the payment processing service and customers. As a non-limiting example, a payment processing service provider may contract with a payment processing service such that the payment processing service is permitted to process card-present transactions on behalf of a merchant via a POS reader serviced by the payment processing service in one or more particular regions but is not permitted to process transactions on behalf of the merchant in any region that is not one of the one or more particular regions. For instance, a payment processing service provider may contract with a payment processing service such that the payment processing service is permitted to process card-present transactions on behalf of the merchant in the United States, Canada, and Australia, but is not permitted to process card-present transactions on behalf of the merchant in any other country. That is, if the merchant tries to transact with a customer in China via a card-present transaction using a POS reader serviced by the payment processing service and the payment processing service processes the card-present transaction, the payment processing service may breach its contract with the payment processing service provider. Accordingly, the payment processing service may refrain from processing the card-present transaction (i.e., the payment processing service may not transmit the card-present transaction to the payment processing service provider) to avoid breaking its contract with the payment processing service provider.

(16) For the purpose of this disclosure, a card-present transaction is a transaction where both a customer and their payment instrument are physically present at the time of the transaction. Card-present transactions may be processed by swipes, dips, and/or taps. A swipe is a card-present transaction where a customer slides a card having a magnetic strip through a payment reader that captures payment data contained in the magnetic strip. A dip is a card-present transaction where a customer inserts a card having an embedded microchip (i.e., chip) into a payment reader chip-side first. The card remains in the payment reader until the payment reader prompts the customer to remove the card. While the card is in the payment reader, the microchip creates a one-time code which is sent from the POS reader to a server associated with a payment processing service, a bank, and/or a card payment network (e.g., Mastercard, VISA, etc.) to be matched with an identical one-time code. A tap is a card-present transaction where a customer may tap or hover his or her electronic device such as a smart phone running a payment application over a payment reader to complete a transaction via short-range communication (e.g., NFC, RFID, Bluetooth®, BLE, etc.). Short-range communication enables the electronic device to exchange information with the payment reader. A tap may also be called a contactless payment. In some countries, a customer may engage in a tap using a TAP card instead of an electronic device.

(17) The phrases “in some examples,” “according to various examples,” “in the examples shown,”

"in one example," "in other examples," "various examples," "some examples," and the like generally mean the particular feature, structure, or characteristic following the phrase is included as at least one example, and may be included in more than one example without specifically being referred to as such. In addition, such phrases do not necessarily refer to the same examples or to different examples.

(18) If the specification states a component or feature "may," "can," "could," or "might" be included or have a characteristic, that particular component or feature is not required to be included or have the characteristic.

(19) The preceding summary is provided for the purposes of summarizing some examples to provide a basic understanding of aspects of the subject matter described herein. Accordingly, the above-described features are merely examples and should not be construed as limiting in any way. Other features, aspects, and advantages of the subject matter described herein will become apparent from the following description of Figures and Claims.

(20) FIG. **1** illustrates one example of credit card processing reader **100** such as a point-of-sale (POS) reader for on-premises credit card payments. Such readers typically meet industry requirements if used for processing Visa, Mastercard, American Express, JCB or Discover payments. The security standards are set by the Payment Card Industry Security Standards Council (PCI SSC), which also sets standards for personal identification number (PIN) transaction security (PTS). One of the security standards set is the Payment Card Industry Data Security Standard (PCI DSS). Other security standards are set by a European subgroup of the Joint Interpretation Library (JIL) working group, called the JIL Terminal Evaluation Methodology Subgroup, or JTEMS. The standards serve to protect against fraud and provide for secure entry and transmission of PIN and account data. POS terminals and readers are used in the retail, restaurant, entertainment, healthcare, and service industries, to name a few.

(21) Reader **100** may be a standalone device, or it may be mounted within or on to a cradle, bracket or other holder (not illustrated) and interface through port **102**. Port **102** may be any type of serial or parallel communication port, for example a universal serial bus (USB), or any other type of interface. In one example port **102** may be used to provide power to reader **100**. In one example port **102** may be used for communication and power to reader **100**. Other communication options for reader **100** are discussed below. On the side of reader **100** that is opposite port **102** is a slot (not visible in FIG. **1**) into which a credit card may be inserted and read by a payment reader (not illustrated in FIG. **1**). This describes a dip, but it should be understood that both a tap and a swipe are both included as potential transaction methods with an appropriately configured terminal, for example with near field communications(NFC). An NFC antenna (not shown in FIG. **1**) may be located behind, for example, a display and enable interaction with other NFC devices. Display **104** may be any type of emissive or reflective display, or a combination thereof, for example LED, LCD, OLED, MEMS, ELD, QLED, etc. Additionally display **104** may be touch sensitive such that a user may interact with images present on display **104**. Such interactions include viewing an amount to be charged to a card, transaction description, entry or selection of amounts for gratuity, signature input, transaction approval, and so on. Button **106** activates reader **100** and may be used to power down, power up, place reader **100** into a sleep/standby mode or awaken reader **100** from a sleep/standby mode.

(22) FIG. **2** is an exploded parts diagram illustrating one example of credit card processing reader **100**. The illustrated parts are broadly grouped into three groups plus a structural component. The groups are communications assembly **202**, secure circuit assembly **204** and rear assembly **206**. Frame **208** is the structural component. The naming convention with respect to each group is in no way limiting to that group or any other group, for example communications assembly **202** may include more than just communication components, or secure circuit assembly **204** does not mean or imply that other groups are not secure, or that communications may be engaged by rear assembly **206**, to name a few examples.

(23) The assembly of reader **100** may be completed by collapsing the parts illustrated in FIG. **2**, with communications assembly **202** attaching to the topmost section of frame **208**, then secure circuit assembly **204** inserting within frame **208** and underneath communications assembly **202**, with rear assembly inserting within frame **208** and under secure circuit assembly **204**. This top-down orientation is maintained in FIG. **3**, but reversed in FIGS. **4** and **5**.
(24) FIG. **3** is a partial exploded parts diagram illustrating communications assembly **202** from FIG. **2** in a top-down orientation, as well as frame **208**. Communications assembly **202** includes display **104** as previously described with respect to FIG. **1**. Also included in communications assembly **202** is shield **300**, reflector **302** and antennae **304**. Shield **300** attenuates electromagnetic impulses between display **104** and antenna **304**, as well as secure circuit assembly **204**.
(25) Shield **300** may be useful in reducing losses that occur from metal parts that are on the other side of shield **300** from display **104** (e.g. the PCB, the battery—conductive material that is near shield **300**) reducing interference of communications and circuit processing by display **104**. Shield **300** may be made from ferrite or other suitable shielding material for short range attenuation, for example NiZn, MnZn, etc.
(26) Reflector **302** reduces efficiency losses that otherwise would occur for the cellular antenna (see FIG. **5**). Reflector **302** may be made of a metal, for example copper, aluminum or steel.
(27) Antennae **304** in this example may be a near field communication (NFC) antenna. NFC is based on inductive coupling between two antennas present on NFC-enabled devices, for example a POS credit card processing reader and a credit card. An NFC system can be used for communicating in one or both directions, using a frequency of 13.56 MHz. One practice of providing a small form factor for a POS reader is by placing a communication coil used by the NFC system in close proximity to the readout display of the processing device. Because of the proximity of the coil and display, operating aspects of the display may cause distortion of the waveforms from the NFC system.
(28) Frame **208** provides structural support and integrity to reader **100** and may be made from injection molded plastic or any other suitable material and manufacturing method. From the perspective shown in FIG. **3**, communications assembly **202** stack together near the top of frame **208** once pressed into place.
(29) FIG. **4** is a partial exploded parts diagram illustrating secure circuit assembly **204** from FIG. **2** in a bottom-down orientation, as well as frame **208** and communications assembly **202**. FIG. **4** is in the reverse orientation of FIG. **3**, such that communications assembly **202** is pictured at the bottom of frame **208**. Secure circuit assembly **204** includes printed circuit board (PCB) **400**, battery **402**, card guide **404**, conductive tape **406**, seal tape card connector **408**, tamper switches **410**, foam display cables **412**, cover **414** and screws **416**.
(30) PCB **400** includes connector **418** (accessed through port **102**), battery bracket **420**, conductive LCD tape **406**, seal tape card connector **408** to help reduce shorting issues, and foam spacers **412**.
(31) In a POS credit-card processing terminal or reader, secure covers and anti-tamper rubber switches are commonly used to pass penetration tests that verify the resistance of the reader against physical attack methods. Secure covers may have grabbers (also referred to as ribs) (not illustrated in FIG. **4**) into which conductive rubber blocks are pressed to form a bridge between electrical pads. In one example, the conductive rubber blocks may be zebra connectors, or tamper switches **410**. Electrical pads (not illustrated in FIG. **4**) are respectively connected to electrical traces (not illustrated in FIG. **4**) and are located on PCB **400**. When cover **414** is tightened onto PCB **400** with screws **416**, the resistance of tamper switches **410** changes until it is within a determined range. Once reader **100** is in use, if a change in resistance is detected with respect to the circuit connected to tamper switches **410**, that is outside the determined range, then reader **100** registers that change as a tamper attempt and reader **100** may be blocked or disabled. Once activated, removing cover **414** dislodges tamper switches **410**, causing a change in resistance across the electrical contacts and triggering a tamper attempt. Drilling into cover **414** and connecting a trace from one of the

electrical pads, to a trace from another electrical pad (creating a short circuit), also causes a change in resistance and triggers a tamper attempt. This is one example of security for secure circuit assembly **204**.
(32) Battery **402** provides backup power for data retention in volatile memory in case of power loss as well as providing continuous power to security sensors. Card guide **404** assists in guiding a credit card at a proper place and angle into reader **100**.
(33) FIG. **5** is a partial exploded parts diagram illustrating rear assembly **206** from FIG. **2** in a bottom-down orientation, as well as frame **208** and secure circuit assembly **204**. FIG. **5** is in the reverse orientation of FIG. **3**, such that communications assembly **202** (not illustrated in FIG. **5**) is at the bottom of frame **208**, with secure circuit assembly **204** shown on top of communications assembly **202** and inside of frame **208**. Rear assembly **206** includes communications assembly **500**, button support assembly **502**, foam button support **504**, battery **506**, wireless charging pad **508**, adhesive **510**, rear support **512**, adhesive **514**, rear panel **516**.
(34) Communications assembly **500** may connect to PCB **400** and provide additional communication capability, for example one or more of the following: cellular, Bluetooth, Bluetooth LE, Wi-Fi, Zigbee, infrared, near field (NFC), etc. Button support assembly **502** and foam button support **504** in conjunction serve as button **106** (see FIG. **1**) for power and sleep operations. Button support assembly **502** may connect to PCB **400**. Battery **506** provides power to reader **100** and may be rechargeable or non-rechargeable. Examples of rechargeable battery types include lead-acid, nickel-cadmium (NiCd), nickel-metal hydride (NiMH), lithium-ion (Li-ion), lithium-ion polymer (LiPo), and rechargeable alkaline batteries. Wireless charging pad **508** may recharge battery **506** through wireless inductive charging. A magnetic loop antenna (copper coil) is used to create an oscillating magnetic field, which can create a current in one or more receiver antennas in wireless charging pad **508**. This current may be used to recharge battery **506**. Rear support **512** is bonded to wireless charging pad **508** with adhesive **510**. Rear panel **516** is bonded to rear support **512** with adhesive **514**. Rear panel **516** may be made from any suitable material, for example metal, glass, plastic, etc.
(35) FIG. **6** is a block diagram illustrating some of the components in reader **100**. Processor **600** may be any of several types of processors, for example a microprocessor, a central processing unit, a microcontroller, programmable or not, or may be a combination of different processors. Processor **600** receives signals from clock **610**, which may be any type of oscillating clock signal generator. Memory **620** provides programmable and non-programmable memory for reader **100** and may include dynamic random access memory, flash memory, embedded memory, memory controller(s), as well as non-programmable memory, for example. Memory **620** may be accessed by processor **600** as well as other components in reader **100**. Display controller **630** may function with display **640**. Display **640** may be any type of reflective, emissive, or combination reflective and emissive display, for example LED, LCD, OLED, MEMS, ELD, QLED. In one aspect, display **640** is liquid crystal display (LCD) **645**. Processor **600** may be connected to communications assembly **647**. In one aspect, communications assembly **647** may be communications assembly **500** (see FIG. **5**). Communications assembly **647** may include wireless communication systems, for example NFC system **650** and bluetooth **655**. NFC system **650** may include NFC controller **660** and NFC antenna **670**. In one aspect, NFC antenna **670** is NFC antenna **304** (see FIG. **3**). The above components may be connected through a shared platform, for example PCB **400**, or secured inside case **208** (see FIG. **4**).
(36) Specifications are published by a consortium of international credit card companies known as EMVCo. Within those specifications are recommendations for the tolerances of the NFC waveform and what level of distortion of the NFC waveform is acceptable during NFC broadcasting. Due to the proximity of antenna **304** with display **104**, distortion beyond the tolerances recommended by EMVCo is possible within reader **100**. Distortion is evident during the write phase of display **640**.
(37) FIG. **7** is a waveform illustrating a readout from NFC system **650**. The x-axis represents time

while the y-axis represents amplitude of an NFC broadcast, for example a polling operation during which reader **100** is searching for a chip-enabled credit card. Waveform **700** represents a non-distorted NFC broadcast.

(38) Displays may operate at a certain frame rate and have a corresponding refresh period, during which the display is either updated with new (changed) images, or entirely rewritten with changed or unchanged images. A variety of addressing schemes are possible depending on the desired frame rate, type of display technology, power consumption, and other factors. A typical display refresh period may include a write phase and a dormant phase, where display controller **630** (or a graphics card) addresses some or all of the pixels in display **640** during the write phase, and does not address pixels during the dormant phase. In one aspect, the write phase of display **640** causes distortion of an NFC broadcast.

(39) FIG. **8** is a waveform illustrating a readout from NFC system **650** with interference (distortion) caused by the write phase of display **640**. Waveform **800** represents an NFC broadcast with distortion present during time frame **810**. The distortion is evident by a drop in amplitude of waveform **800** during time frame **810**. In one aspect, time frame **810** corresponds to the write phase of display **640** and the distortion is caused by addressing pixels of display **640**. At the end of time frame **810**, the write phase ends and the remainder of the refresh period for display **640** is the dormant phase, where no pixels are addressed. A portion of this dormant period overlaps with time period **820**, with no distortion from pixel addressing evident for waveform **800** during time period **820**. Time period **830**, just prior to time period **810**, is part of the dormant phase in the prior refresh period. EMVCo publishes specifications for certifying readers and terminals according to its guidelines, and waveform **800** could result in a reader or terminal not passing certification due to the distortion present during time period **810**. In order to pass certification, a card reader or terminal may synchronize its display addressing with the NFC system in order to avoid the distortion. In one aspect, NFC broadcasting may occur only during the dormant phase of each refresh period. In one aspect, the NFC broadcasting may start during the dormant phase of one refresh period and continue into the next refresh period. EMVCo specifications may be more stringent with respect to an NFC broadcast waveform in the beginning of broadcasting, than later during a broadcast.

(40) In one aspect, NFC system **650** may have different operating modes, for example polling, card activation and transaction. Based on EMVCo specifications, reducing distortion in the beginning of polling may be more important than reducing it later, as polling continues, or during card activation or transaction periods. In one aspect, card readers and terminals may have a test mode into which they may be placed, for certification purposes. In one aspect, a test mode may replace polling. Reducing distortion in a test mode may be accomplished by synchronizing display addressing with NFC broadcasting.

(41) FIG. **9** is several waveform graphs comparing timing and signals from one aspect of a synchronized system. The signal and timing graphs are illustrative only, and not meant to represent any particular system. Modification to the timing, amplitude, clock signal and voltages would be expected in order to satisfy particular hardware configurations. For example, in FIG. **9** a refresh period is five clock cycles, with the write phase lasting one clock cycle. In a system using an LCD, for example, with a refresh rate at 120 Hz, the refresh period may be 1/120 of a second with the write phase lasting a relatively shorter period of time than the dormant phase. The y-axis represents time and the x-axis represents logic states 0 (off) and 1 (on) for display refresh **900**, tearing signal **910**, dormant signal **920**, and clock **940**. Logic states may correspond to whatever voltages are appropriate, given a particular hardware configuration. The x-axis represents amplitude for NFC signals **930**.

(42) Display refresh **900** illustrates refresh periods **902***a*, **902***b* and **902***c* (collectively referred to as refresh periods **902**) starting at time zero and each one may last five time periods. Refresh periods **902** include write phases **904***a*, **904***b* and **904***c* (collectively referred to as write phases **904**), each

one may last one time period, and dormant phases **906***a*, **906***b* and **906***c* (collectively referred to as dormant phases **906**), and each one may last four time periods. Refresh periods **902**, write phases **904** and dormant phases **906** may be shorter or longer than illustrated in this example. Refresh periods **902** represent addressing of display **640** by display controller **630** (see FIG. **6**), and may or may not represent an actual signal. Write phases **904** represent pixel addressing and dormant phases **906** represent time periods between pixel addressing.

(43) Tearing signal **910** may be present with a system having LCD **645**. Tearing signal **910** is transmitted by LCD **645** during write phases **904**. Tearing signal **910** may or may not be transmitted from other types of displays (for example OLED, MEMS, LED, etc.). Tearing signal **910** matches display refresh **900**, being "on" during write phases **904** and "off" during dormant phases **906**. Tearing signal **910** may be received by processor **600**, communications assembly **647**, NFC system **650**, or wherever else it may be used in order to synchronize NFC system **650** with LCD **645**.

(44) In reader **100** with display **640** other than an LCD, tearing signal **910** may not be present. Dormant signal **920** may be provided by display controller **630**, for example, as a means for synchronizing NFC system **650** with display **640**. Dormant signal **920** may be provided by other components of reader **100**. Dormant signal **920** is "off" during write phases **904** and "on" during dormant phases **906**. Dormant signal **920** may be received by processor **600**, communications assembly **647**, NFC system **650**, or wherever else it may be used in order to synchronize NFC system **650** with display **640**.

(45) NFC signals **930***a*, **930***b* and **930***c* (collectively referred to as NFC signals **930**) represent an NFC broadcast by NFC system **650** when synchronized to write periods **904**. NFC signals **930** may be the start of polling, or a test mode, for example. NFC signal **930***a* begins after the beginning of time period one. Write phase **904***a* ends at time period one, tearing signal **910** has transitioned from "on" to "off," and dormant signal **920** has transitioned from "off" to "on." NFC signal **930***a* begins during dormant phase **906***a* and ends during dormant phase **906***a*, lasting approximately two time periods, or two clock cycles, in this example. Because NFC signal **930***a* is broadcast during dormant period **906***a*, there is no distortion of NFC signal **930***a* by pixel addressing in display **640** (either in a system with LCD **645** or a system with a different type of display).

(46) NFC signal **930***b* begins after the beginning of time period six. Write phase **904***b* ends at time period six, tearing signal **910** has transitioned from "on" to "off," and dormant signal **920** has transitioned from "off" to "on." NFC signal **930***b* begins during dormant phase **906***b* and continues into dormant phase **906***c*, lasting approximately five time periods, or five clock cycles, in this example. NFC signal **930***b* is not distorted during dormant phase **906***b*. NFC signal **930***b* is distorted by pixel addressing during write phase **904***c*. The distortion ends at the end of write phase **904***c*, and NFC signal **930***b* returns to a non-distorted shape in dormant phase **906***c*. As previously mentioned, synchronizing NFC system **650** with pixel addressing may be more important at the start of NFC broadcasting, than after a refresh period has passed. In a test mode (for example, a loop-back application, which is a test mode that may be used during certification), for example, certification requirements may relax after the first refresh period, allowing NFC broadcasting to continue despite distortion from pixel addressing. In a non-test mode, for example polling, other factors may play a role in continuing an NFC signal broadcast either into a write phase **904**, through a write phase **904**, or through multiple write phases **904**.

(47) NFC signal **930***c* begins at time period **13** and ends at time period **14**, and lasts approximately one time period, or one clock cycle. NFC signal **930***c* begins and ends during dormant phase **906***c*. In one aspect and not illustrated, NFC signal **930***c* may have continued into the next refresh period.

(48) Clock signal **940** is illustrated with each clock cycle taking one time period. In one aspect, synchronization between NFC broadcasting and display writing may be managed with clock signal **940**. For example, NFC system **650** may be programmed to begin broadcasting an NFC signal after one clock cycle is completed and before a fifth clock cycle. Display controller **630** may be

synchronized to address pixels from the start of the first clock cycle to the end of the first clock cycle. After every five clock cycles (the length of one of refresh periods **902**), each one of display controller **630** and NFC system **650** may reset. In this example clock signal **940** is a common signal to each of display controller **630** and NFC system **650**. Rather than synchronize display controller **630** directly with NFC system **650** (with tearing signal **910** or dormant signal **920**, for example), an intermediary (clock signal **940**, for example) may be used.
(49) FIG. **10** is a flowchart illustrating a method of reducing interference with a communication system. In one aspect, refresh a display having a plurality of pixels by addressing at least one of the plurality of pixels during a write phase, block **1000**. Enter a dormant phase in which none of the plurality of pixels is addressed, block **1010**. Receive a signal in an NFC system indicating that the dormant phase has been entered, block **1020**. Begin broadcasting an NFC signal during the dormant phase, block **1030**. End the broadcast of the NFC signal during the dormant phase, block **1040**. In the case that the broadcast of the NFC signal did not end in block **1040**, refresh the display by addressing at least some of the plurality of pixels during the write phase, block **1050**. End the broadcast of the NFC signal after the beginning of the second display refresh, block **1060**.
(50) In one aspect, block **1020** may include receiving a tearing signal until the end of the write phase, at which point the tearing signal stops, indicating an end to the write phase. In one aspect, block **1020** may include receiving a clock signal timed with an end to the write phase.
(51) FIG. **11** is a flowchart illustrating one method of reducing interference in a credit card processing device. In one aspect, the credit card processing device may optionally enter a test mode, block **1100**. Refresh a display having a plurality of pixels by addressing at least one of the plurality of pixels during a write phase, block **1110**. Enter a dormant phase in which none of the plurality of pixels is addressed, block **1120**. Synchronize a start for broadcasting in an NFC system with the dormant phase, block **1130**. Broadcast by the NFC system in the dormant phase, block **1140**.
(52) This disclosure refers to the term “reader” throughout, and while specifically directed towards a credit card reader, the disclosure applies equally well to a traditional credit card terminal. Nothing in the disclosure should be taken as limiting to a reader over a terminal. Moreover, many aspects of the disclosure apply equally well to any electronic device, as would be recognized by one skilled in the art.
(53) The aspects and features mentioned and described together with one or more of the previously detailed examples and figures, may as well be combined with one or more of the other examples in order to replace a like feature of the other example or in order to additionally introduce the feature to the other example.
(54) Examples may further be or relate to a computer program having a program code for performing one or more of the above methods, when the computer program is executed on a computer or processor. Steps, operations or processes of various above-described methods may be performed by programmed computers or processors. Examples may also cover program storage devices such as digital data storage media, which are machine, processor or computer readable and encode machine-executable, processor-executable or computer-executable programs of instructions. The instructions perform or cause performing some or all of the acts of the above-described methods. The program storage devices may comprise or be, for instance, digital memories, magnetic storage media such as magnetic disks and magnetic tapes, hard drives, or optically readable digital data storage media. Further examples may also cover computers, processors or control units programmed to perform the acts of the above-described methods or (field) programmable logic arrays ((F)PLAs) or (field) programmable gate arrays ((F)PGAs), programmed to perform the acts of the above-described methods.
(55) The description and drawings merely illustrate the principles of the disclosure. Furthermore, all examples recited herein are principally intended expressly to be only for pedagogical purposes to aid the reader in understanding the principles of the disclosure and the concepts contributed by

the inventor(s) to furthering the art. All statements herein reciting principles, aspects, and examples of the disclosure, as well as specific examples thereof, are intended to encompass equivalents thereof.
(56) A functional block denoted as "means for . . . " performing a certain function may refer to a circuit that is configured to perform a certain function. Hence, a "means for s.th." may be implemented as a "means configured to or suited for s.th.", such as a device or a circuit configured to or suited for the respective task.
(57) Functions of various elements shown in the figures, including any functional blocks labeled as "means", "means for providing a sensor signal", "means for generating a transmit signal.", etc., may be implemented in the form of dedicated hardware, such as "a signal provider", "a signal processing unit", "a processor", "a controller", etc. as well as hardware capable of executing software in association with appropriate software. When provided by a processor, the functions may be provided by a single dedicated processor, by a single shared processor, or by a plurality of individual processors, some of which or all of which may be shared. However, the term "processor" or "controller" is by far not limited to hardware exclusively capable of executing software but may include digital signal processor (DSP) hardware, network processor, application specific integrated circuit (ASIC), field programmable gate array (FPGA), read only memory (ROM) for storing software, random access memory (RAM), and non-volatile storage. Other hardware, conventional and/or custom, may also be included.
(58) A block diagram may, for instance, illustrate a high-level circuit diagram implementing the principles of the disclosure. Similarly, a flow chart, a flow diagram, a state transition diagram, a pseudo code, and the like may represent various processes, operations or steps, which may, for instance, be substantially represented in computer readable medium and so executed by a computer or processor, whether or not such computer or processor is explicitly shown. Methods disclosed in the specification or in the claims may be implemented by a device having means for performing each of the respective acts of these methods.
(59) It is to be understood that the disclosure of multiple acts, processes, operations, steps, or functions disclosed in the specification or claims may not be construed as to be within the specific order, unless explicitly or implicitly stated otherwise, for instance for technical reasons. Therefore, the disclosure of multiple acts or functions will not limit these to a particular order unless such acts or functions are not interchangeable for technical reasons. Furthermore, in some examples a single act, function, process, operation or step may include or may be broken into multiple sub-acts, -functions, -processes, -operations or -steps, respectively. Such sub acts may be included and part of the disclosure of this single act unless explicitly excluded.
(60) Furthermore, the following claims are hereby incorporated into the detailed description, where each claim may stand on its own as a separate example. While each claim may stand on its own as a separate example, it is to be noted that—although a dependent claim may refer in the claims to a specific combination with one or more other claims—other examples may also include a combination of the dependent claim with the subject matter of each other dependent or independent claim. Such combinations are explicitly proposed herein unless it is stated that a specific combination is not intended. Furthermore, it is intended to include features of a claim to any other independent claim even if this claim is not directly made dependent to the independent claim.

Claims

1. A point-of-sale credit card device comprising: a case; a display coupled to the case, the display having a plurality of pixels and configured to be refreshed during a plurality of refresh periods, each of the refresh periods including a write phase in which at least one of the plurality of pixels is addressed, and a dormant phase in which none of the plurality of pixels are addressed; a printed circuit board (PCB) coupled to the case; a display controller coupled to the PCB, the display

controller configured to provide addressing for at least some of the plurality of pixels during the write phase; and a near-field-communication (NFC) system coupled to the PCB and configured to broadcast an NFC signal for near-field communication, the NFC system synchronized to the display refresh period and configured to begin broadcasting the NFC signal during the dormant phase based on the synchronization, continue broadcasting in an approximately continuous manner through the dormant phase, and continue broadcasting into at least the write phase of the following refresh period.

2. The point-of-sale credit card device of claim 1, comprising the NFC system configured to receive a signal as the synchronization to the display refresh period.

3. The point-of-sale credit card device of claim 2, comprising the display further comprising a liquid crystal display (LCD), the signal being a tearing signal, the LCD further configured to transmit the tearing signal during the write phase and not transmit the tearing signal during the dormant phase, the NFC system further configured to begin broadcasting the NFC signal when the NFC system stops receiving the tearing signal.

4. The point-of-sale credit card device of claim 2, comprising the signal being a dormant signal, the dormant signal being on during the dormant phase and being off during the write phase, the NFC system further configured to begin broadcasting the NFC signal after the dormant signal goes on.

5. The point-of-sale credit card device of claim 1, comprising the NFC system further configured to receive a clock signal and programmed to begin broadcasting the NFC signal at a specific time interval based on the clock signal, the NFC system configured to begin broadcasting the NFC signal during the dormant phase.

6. The point-of-sale credit card device of claim 5, comprising the NFC system further configured to have an operating mode and a test mode, the operating mode having a polling phase.

7. The point-of-sale credit card device of claim 6, comprising the NFC system further configured to synchronize the broadcasting of the NFC signal with the display refresh only during the test mode.

8. The point-of-sale credit card device of claim 6, comprising the NFC system further configured to synchronize the broadcasting of the NFC signal with the display refresh during the polling phase.

9. The point-of-sale credit card device of claim 8, comprising the NFC system further configured to begin broadcasting the NFC signal during the dormant phase, continue broadcasting in an approximately continuous manner during the dormant phase, and stop broadcasting during the same dormant phase in which the NFC system began broadcasting.

10. The point-of-sale credit card device of claim 8, comprising the NFC system further configured to broadcast approximately at a frequency of 13.56 MHz and to experience distortion of the NFC signal, from the display, during the write phase.

11. The point-of-sale credit card device of claim 10 where the point-of-sale credit card device is a credit card reader.

12. A method of reducing interference comprising: refreshing a display having a plurality of pixels by addressing at least one of the plurality of pixels during a write phase; entering a dormant phase in which none of the plurality of pixels is addressed; receiving a signal in a near field communication (NFC) system indicating that the dormant phase has been entered; beginning a broadcast of an NFC signal during the dormant phase; refreshing the display, after beginning a broadcast of an NFC signal, by addressing at least some of the plurality of pixels during the write phase; and ending the broadcast of the NFC signal after the beginning of the second display refresh.

13. The method of claim 12 wherein receiving a signal in an NFC system indicating that the dormant phase has been entered comprises receiving a tearing signal until the end of the write phase, at which point the tearing signal stops, indicating an end to the write phase.

14. The method of claim 12 wherein receiving a signal in an NFC system indicating that the dormant phase has been entered comprises receiving a clock signal timed with an end to the write phase.

15. The method of claim 14 further comprising: counting clock cycles in order to track the dormant phase.
16. A method of reducing interference in a credit card processing device comprising: refreshing a display having a plurality of pixels by addressing at least one of the plurality of pixels during a write phase; entering a dormant phase in which none of the plurality of pixels is addressed; synchronizing a start for broadcasting in a near field communication (NFC) system with the dormant phase; and broadcasting by the NFC system in the dormant phase and into another write phase.
17. The method of claim 16 further comprising: entering a test mode.