

MOBILE COMPUTING DEVICE AND METHOD OF TRANSMITTING DATA THEREFROM

BACKGROUND

[1] The field of the present disclosure relates generally to mobile computing devices and, more specifically, to hardware that facilitates increasing the functionality of a mobile computing device.

[2] Mobile computing devices, such as smartphones, cellular phones, and personal digital assistants (PDAs), have grown in use and popularity among a variety of different types of users. At least some known mobile computing devices use a cable medium to transfer data between the mobile computing device and other electronic devices. Generally, connectors that are coupled to opposing ends of the cable medium and docking ports defined in the mobile computing device support predetermined standard protocols that enable data to be transferred therebetween. More specifically, the connectors and docking ports include a pinout that is arranged in a predetermined configuration to support the standard protocols. Exemplary standard protocols include universal serial bus (USB), firewire (IEEE 1394), high-definition multimedia interface (HDMI), DisplayPort (e.g., 2-Lane and 4-Lane), and portable digital media interface (PDMI).

[3] The functionality of at least some known mobile computing devices is based at least partially on the amount and types of docking ports included in the mobile computing device. For example, a mobile computing device will generally have a dedicated USB docking port and a dedicated HDMI docking port to support USB and HDMI functionality. Further, at least some known docking ports support multiple functionalities. For example, a docking port that supports the PDMI standard protocol has both 2-Lane DisplayPort and USB functionality. Increasing the functionality of a mobile computing device is becoming increasingly important to those in the electronics industry. As such, it may be desirable to modify the pinout configuration of an existing docking port to facilitate increasing the functionality of a mobile computing device.

BRIEF DESCRIPTION

[4] In one aspect, a mobile computing device is provided. The device includes a first port configured with a first pinout to support a first data format, a data source configured to provide data in a second data format different from the first data format, and a first multiplexer configured to selectively transmit data from the data source to the first port. The first port is reconfigured with a second pinout to support the second data format. The device further includes a second multiplexer configured to selectively transmit data from one of a data source configured to provide data in the first data format and an output from said first multiplexer that includes data in the second data format, the data selectively transmitted to said first port.

[5] In another aspect, a method of transmitting data from a mobile computing device is provided. The method includes selecting a data source from which to provide data to a first port in the mobile computing device, wherein the first port is configured with a first pinout to support a first data format and the data source is configured to transmit data in a second data format that is different from the first data format, and wherein the data source configured to transmit data in the second format is selected using a first multiplexer. The method further includes selectively transmitting, using a second multiplexer, data from one of a data source configured to provide data in the first data format and an output from the first multiplexer that includes data in the second data format to the first port. The method also includes reconfiguring the first pinout with a second pinout that enables the first port to support the second data format and transmitting data from the second multiplexer through the first port.

[6] In yet another aspect, a mobile computing device is provided. The device includes a first port comprising a first pinout that is configured to support a portable digital media interface, a plurality of data sources that are each configured to provide data in a data format, wherein a bias is selectively asserted on a first pin of said first port to facilitate selecting the data format to transmit to the first port from one of the plurality of data sources, and a multiplexer configured to selectively

transmit data from the one of the plurality of data sources to the first port, wherein the first pinout is reconfigured with a second pinout to support the selected data format.

BRIEF DESCRIPTION OF THE DRAWINGS

[7] Figure 1 is a front perspective view of an exemplary mobile computing device.

5 [8] Figure 2 is a back perspective view of the mobile computing device shown in Figure 1.

[9] Figure 3 is a schematic illustration of an exemplary hardware architecture that may be used with the mobile computing device shown in Figure 1.

[10] Figure 4 is a schematic illustration of an alternative exemplary hardware architecture that may be used with the mobile computing device shown in Figure 1.

[11] Figure 5 illustrates an alternative exemplary pinout for a docking port shown in Figure 1 in the first operational mode.

5 [12] Figure 6 illustrates an alternative exemplary pinout for a docking port shown in Figure 1 in the second operational mode.

[13] Figure 7 illustrates an alternative exemplary pinout for a docking port shown in Figure 1 in the third operational mode.

DETAILED DESCRIPTION

10 [14] The implementations described herein relate to devices and methods that may be used to transmit data to and/or from a mobile computing device. In the exemplary implementation, the mobile computing device uses hardware-based switching mechanisms to direct data from a data source to more than one docking port in the mobile computing device. For example, the switching mechanisms facilitate selectively transmitting data of a predetermined data format either to a first docking port that supports the predetermined data
15 format or a second docking port that may be reconfigured to support the predetermined data format. More specifically, the pinout of the second docking port may be reconfigured to support the predetermined data format. As such, the switching mechanisms facilitate increasing the functionality of the mobile computing device.

20 [15] Figures 1 and 2 illustrate an exemplary mobile computing device 10. In the exemplary implementation, mobile computing device 10 is provided for supporting communication with another device, such as another mobile computing device and/or an electronic display device. Moreover, mobile computing device 10 may include a variety of other functionalities, including network access, SMS messaging, hosting of one or more applications, data processing, encryption, and/or other functions. In the exemplary implementation, mobile
25 computing device 10 is a smartphone, configured to communicate through one or more cellular networks.

[16] As shown, mobile computing device 10 includes a housing 12 and multiple presentation devices 14 disposed at least partially within housing 12. Presentation device 14

outputs information such as, but not limited to, data related to operation of mobile computing device 10, commands, requested data, messages, one or more input devices (such as, a virtual keyboard), and/or any other type of data to a user. In several examples, presentation device 14 may include, for example, a liquid crystal display (LCD), a light-emitting diode (LED) display, a light-emitting diode (LED), a camera flash, an organic LED (OLED) display, and/or an “electronic ink” display. Multiple presentation devices 14 may be included to present data to a user visually and/or audibly, and presentation device 14 may include an audio output for use in voice communication.

[17] Mobile computing device 10 further includes multiple input devices 16 disposed at least partially within housing 12. Each input device 16 may be configured to receive selections, requests, commands, information, data, and/or any other type of inputs, according to one or more of the methods and/or processes described herein. Input devices 16 may include, for example, buttons, a keyboard, a microphone, a pointing device, a stylus, a touch sensitive panel (e.g., a touch pad or a touch screen), a gyroscope, an accelerometer, a digital compass, a position detector, a camera, a second camera, and/or an audio input interface. A single component, such as a touch screen 18, may function as both presentation device 14 and input device 16.

[18] Mobile computing device 10 also includes multiple docking ports disposed at least partially within housing 12 and that support a predetermined standard protocol. As such, each docking port supports at least one data format for use in transmitting data to and/or from mobile computing device 10. In the exemplary implementation, mobile computing device 10 includes a portable digital media interface (PDMI) port 22, a Universal Serial Bus (USB) port 24, and a high-definition multimedia interface (HDMI) port 26.

[19] Mobile computing device 10 includes a back panel 20 engaged with housing 12. Back panel 20 defines a cross-section substantially consistent with housing 12, thereby forming a substantially integral unit with housing 12 when coupled thereto. Back panel 20 is removable from mobile computing device 10 to provide access to one or more aspects of mobile computing device 10.

[20] Figure 3 is a schematic illustration of an exemplary hardware architecture 100 that may be used with mobile computing device 10. In the exemplary implementation, hardware architecture 100 includes a processor 102, a multiplexer 104, and multiple power switches 106 and 108. Multiplexer 104 and power switches 106 and 108 are each coupled in

communication with processor 102. Hardware architecture 100 also includes a first docking port 110 that supports the USB standard protocol and a second docking port 112 that supports the PDMI standard protocol. In an alternative implementation, first docking port 110 and second docking port 112 may be configured to support any standard protocol.

5 [21] Processor 102 may include one or more processing units (e.g., in a multi-core configuration). Further, processor 102 may be implemented using one or more heterogeneous processor systems in which a main processor is present with secondary processors on a single chip. As another illustrative example, processor 102 may be a symmetric multi-processor system containing multiple processors of the same type. Further, processor 102 may be
10 implemented using any suitable programmable circuit including one or more systems and microcontrollers, microprocessors, reduced instruction set circuits (RISC), application specific integrated circuits (ASIC), programmable logic circuits, field programmable gate arrays (FPGA), and any other circuit capable of executing the functions described herein.

 [22] Multiplexer 104 sends and receives data frames between processor 102,
15 first docking port 110, and second docking port 112, and may be used as both a multiplexer and a demultiplexer. More specifically, multiplexer 104 is configured to split a data frame into multiple data frames and configured to combine multiple data frames into one data frame. In some implementations, multiplexer 104 is configured to act as a switch in that multiplexer 104 is configured to route data frames through a particular channel (not shown) based on a desired or
20 predetermined destination.

 [23] An attachment sensor 118 is coupled in communication with second docking port 112, multiplexer 104, and power switches 106 and 108. More specifically, attachment sensor 118 is coupled in communication with second docking port 112 via a sensing line 120, and is coupled in communication with multiplexer 104 via a command line 122, power
25 switch 106 via a command line 124, and power switch 108 via a command line 126. Attachment sensor 118 may be implemented as a hardware circuit including custom very large scale integration ("VLSI") circuits or gate arrays, off-the-shelf semiconductors such as logic chips, transistors, or other discrete components. Attachment sensor 118 may also be implemented in programmable hardware devices such as field programmable gate arrays (FPGAs),
30 programmable array logic, and/or programmable logic devices (PLDs).

[24] Power switches 106 and 108 are coupled in communication between processor 102 and first and second docking ports 110 and 112. More specifically, first power switch 106 is coupled between processor 102 and first docking port 110, and second power switch 108 is coupled between processor 102 and second docking port 112. Power switches 106 and 108 may be fabricated from field effect transistors (FET), such as metal oxide semiconductor field effect transistors (MOSFET), bipolar transistors, such as insulated gate bipolar transistors (IGBT), bipolar junction transistors (BJT), and gate turn-off thyristors (GTO).

[25] Power switches 106 and 108 facilitate routing USB power into and/or out of a selected docking port. As such, a corner condition may be mitigated by enabling hardware architecture 100 to allow the standard USB method of port detection to have continued functionality. Further, power switches 106 and 108 operate independently from processor 102 because processor 102 would not be operable when mobile computing device 10 is off. As such, the charging function of the USB connection continues to work even when mobile computing device 10 is off and/or if mobile computing device 10 has a low battery.

[26] In operation, mobile computing device 10 is in a first operational mode when an interface connector is disconnected from second docking port 112, and is in a second operational mode when an interface connector couples with second docking port 112. More specifically, the second operational mode may be actuated when attachment sensor 118 detects a bias asserted on second docking port 112 via sensing line 120. For example, in one implementation, a sink device (e.g., a monitor) (not shown) may assert a non-zero voltage on at least one pin of second docking port 112 to request data to be transmitted through second docking port 112. In an alternative implementation, the sink device may ground the at least one pin to request to receive data.

[27] Upon detection of the bias asserted on second docking port 112, attachment sensor 118 directs multiplexer 104 to transmit data from processor 102 towards second docking port 112. More specifically, multiplexer 104 is configured to route data based on a command received from attachment sensor 118 via command line 122. Attachment sensor 118 may also direct, via command lines 124 and 126, power switches 106 and 108 to channel power from processor 102 to second docking port 112.

[28] Figure 4 is a schematic illustration of an alternative exemplary hardware architecture 150 that may be used with mobile computing device 10. In the exemplary

implementation, hardware architecture 150 includes data sources such as a USB 3.0 Super Speed source (USB source) 130, a DisplayPort source 132, and an HDMI source 134. DisplayPort source 132 and HDMI source 134 produce a desired data and/or video format using processor 102 (shown in Figure 3) and an interface chip (not shown). In an alternative implementation, the data sources may provide data in any suitable data format that enables mobile computing device 10 to function as described herein.

[29] Hardware architecture 150 also includes second docking port 112 and a third docking port 114 that may each channel data from selected data sources therethrough. Second docking port 112 supports the PDMI standard protocol, and third docking port 114 supports the HDMI standard protocol. In an alternative implementation, second docking port 112 and third docking port 114 may be configured to support any standard protocol.

[30] A first multiplexer 140 and a second multiplexer 142 are located between data sources 130, 132, and 134, and second and third docking ports 112 and 114. First multiplexer 140 sends and receives data frames between HDMI source 134, second multiplexer 142, and third docking port 114, and second multiplexer 142 sends and receives data frames between USB source 130, DisplayPort source 132, first multiplexer 140, and second docking port 112.

[31] Attachment sensor 118 is coupled in communication with second docking port 112, first multiplexer 140, and second multiplexer 142. More specifically, attachment sensor 118 is coupled in communication with second docking port 112 via sensing line 120, is coupled in communication with first multiplexer 140 via a command line 144, and is coupled in communication with second multiplexer 142 a via command line 146.

[32] In operation, mobile computing device 10 is in a first operational mode when an interface connector is disconnected from second docking port 112, and is in a second operational mode when an interface connector couples with second docking port 112. More specifically, the second operational mode may be actuated when attachment sensor 118 detects a bias asserted on second docking port 112 via sensing line 120. For example, in one implementation, a sink device may assert a bias on at least one pin of second docking port 112 to request data and/or video to be transmitted through second docking port 112.

[33] When mobile computing device 10 is in the first operational mode, first multiplexer 140 transmits data from HDMI source 134 towards third docking port 114, and second multiplexer 142 channels data from one of data sources 130 and 132 to second docking port 112. When mobile computing device 10 is in the second operational mode, either first multiplexer 140 transmits data from HDMI source 134 to second docking port 114 or second multiplexer 142 transmits data from DisplayPort source 132 to second docking port 112 at an increased data rate when compared to the first operational mode. Further, as will be explained in greater detail below, the pinout of second docking port 112 may be reconfigured in the second operational mode such that second docking port 112 can support the additional bandwidth supplied from HDMI source 134 and/or DisplayPort source 132.

[34] Multiplexers 140 and 142 are configured to route data based on commands received from attachment sensor 118 via command lines 144 and 146. More specifically, a sink device provides a request to receive data in a selected data format through the connector that interfaces with second docking port 112, and attachment sensor 118 receives the request and directs multiplexers 140 and 142 to transmit the data from HDMI source 134 and/or DisplayPort source 132 to second docking port 112. In such an implementation, the pinout of second docking port 112 is reconfigured with a second pinout to support the HDMI standard protocol and/or the 4-Lane DisplayPort standard protocol.

[35] Figures 5, 6, and 7 illustrate exemplary pinouts of second docking port 112 (shown in Figures 3 and 4) in first, second, and third operational modes. In the exemplary implementation, the pinout of second docking port 112 (shown in Figures 3 and 4) may be reconfigured to enable second docking port 112 to support multiple data formats. For example, the pinout may be reconfigured to enable second docking port 112 to be in first, second, and third operational modes based on a bias detected on at least one pin of second docking port 112. More specifically, second docking port 112 is in the first operational mode when a bias is not detected on one of the pins, second docking port 112 is in the second operational mode when a first bias is detected on one of the pins, and second docking port 112 is in the third operational mode when a second bias is detected on one of the pins. The first bias may be a ground applied to the pin, and the second bias may be a non-zero voltage detected on the pin. Attachment sensor 118 (shown in Figures 3 and 4) may detect the first bias and/or the second bias and then command multiplexer 104 (shown in Figure 3) and/or multiplexers 140 and 142 (shown in Figure 4) to transmit data from a selected data source to second docking port 112. In an

alternative implementation, the first bias and the second bias may be any bias that enables second docking port 112 to function as described herein. Moreover, in an alternative implementation, second docking port 112 may be in the first operational mode when the bias is detected on a first pin, second docking port 112 may be in the second operational mode when the bias is detected on a second pin, and second docking port 112 may be in the third operational mode when the bias is detected on a third pin.

[36] The type of bias and/or the lack thereof detected on pin 7 facilitates determining the data format to transmit to second docking port 112. Referring now to Figure 5, mobile computing device 10 configures second docking port 112 to operate in the first operational mode when a bias is not detected on pin 7 and upon detection of a bias on pin 10. More specifically, detecting a bias on pin 10 may provide an indication to attachment sensor 118 that a sink device is requesting USB service. Further, leaving pin 7 open may provide an indication to attachment sensor 118 that the sink device is requesting 2-Lane DisplayPort service via pins 20-30. As such, the pinout of second docking port 112 does not need to be reconfigured to facilitate supporting and transmitting the 2-Lane DisplayPort data format therethrough. In an alternative implementation, when a bias is not detected on pin 7 and detecting a bias on pin 10 may provide an indication that the sink device is requesting data in any suitable data format to be transmitted through second docking port 112.

[37] Referring now to Figure 6, mobile computing device 10 configures second docking port 112 to operate in the second operational mode upon detection of a ground on pin 7 and upon detection of a bias on pin 10. More specifically, detecting a ground on pin 7 and detecting a bias on pin 10 may provide an indication to attachment sensor 118 that a sink device is requesting USB service and/or HDMI service. The pinout may then be modified to support the HDMI data format because second docking port 112 may be unable to support both 2-Lane DisplayPort and HDMI data formats simultaneously. For example, second docking port 112 supports USB 2.0, USB 3.0, and 2-Lane DisplayPort service when in the first operational mode. In the second operational mode, pins 11-14 and pins 17-30 are reallocated from USB 3.0, Consumer Electronic Control, and 2-Lane DisplayPort to enable second docking port 112 to support transmitting the HDMI data format. In an alternative implementation, detecting a ground on pin 7 and detecting a bias on pin 10 may provide an indication that the sink device is requesting data in any suitable data format to be transmitted through second docking port 112.

[38] Referring now to Figure 7, mobile computing device 10 configures second docking port 112 to operate in the third operational mode upon detection of a non-zero voltage on pin 7 and upon detection of a bias on pin 10. More specifically, detecting a non-zero voltage on pin 7 and detecting a bias on pin 10 may provide an indication to attachment sensor 118 that a sink device is requesting USB service and/or 4-Lane DisplayPort service. The pinout may then be reconfigured to support the 4-Lane DisplayPort data format because second docking port 112 may be unable to support both 2-Lane DisplayPort and 4-Lane DisplayPort data formats simultaneously. For example, second docking port 112 supports USB 2.0, USB 3.0, and 2-Lane DisplayPort service when in the first operational mode. In the third operational mode, pins 11-14 and pins 17-30 are re-allocated from USB 3.0, Consumer Electronic Control, and 2-Lane DisplayPort to enable second docking port 112 to support transmitting the 4-Lane DisplayPort data format. Further, the non-zero voltage is supplied to pin 7 from pin 23 of the pinout configuration. In an alternative implementation, detecting a non-zero voltage on pin 7 and detecting a bias on pin 10 may provide an indication that the sink device is requesting data in any suitable data format to be transmitted through second docking port 112. Further, in an alternative implementation, the non-zero voltage may be supplied from any suitable power source that enables second docking port 112 to function as described herein.

[39] Moreover, in an alternative implementation, any pin of second docking port 112 may be configured to receive the bias and facilitate video mode detection for second docking port 112.

[40] The devices and methods described herein facilitate increasing the functionality of a mobile computing device. More specifically, the devices described herein include a hardware architecture that enables data of a selected data format to be selectively provided to docking ports at least partially disposed in the mobile computing the device. An interface at the docking ports is detected when a sink device asserts a bias on the ports, and the pinout of one of the ports may be reconfigured to support the selected data format. As such, the mobile computing device described herein includes docking ports that are compatible with popular connectors used by consumers, and a docking port that may be reconfigured to have increased functionality and to transmit multiple data formats therethrough.

[41] Further, the disclosure comprises embodiments according to the following clauses:

Clause 1. A mobile computing device comprising:

a first port comprising a first pinout that is configured to support a portable digital media interface;

5 a plurality of data sources that are each configured to provide data in a data format, wherein a bias is selectively asserted on a first pin of said first port to facilitate selecting the data format to transmit to said first port from one of said plurality of data sources; and

a multiplexer configured to selectively transmit data from said one of said plurality of data sources to said first port, wherein the first pinout is reconfigured with a second pinout to support the selected data format.

10 Clause 2. The device in accordance with Clause 1, wherein said first multiplexer transmits data in a first data format when a first bias is asserted on the first pin and transmits data in a second data format when a second bias is asserted on the first pin.

15 Clause 3. The device in accordance with Clause 2, wherein the first bias comprises a ground applied to the first pin and the second bias comprises a non-zero voltage asserted on the first pin.

Clause 4. The device in accordance with Clause 3, wherein the non-zero voltage is supplied to the first pin from a second pin of said first port.

Clause 5. The device in accordance with Clause 1, wherein a default data format is selected when a bias is not asserted on the first pin.

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[42] This written description uses examples to disclose various implementations, including the best mode, and also to enable any person skilled in the art to practice the various implementations, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the disclosure is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they have structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal language of the claims.

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WHAT IS CLAIMED IS:

1. A mobile computing device comprising:

a first port configured with a first pinout to support a first data format;

5 a data source configured to provide data in a second data format different from the first data format;

a first multiplexer configured to selectively transmit data from said data source to said first port, wherein said first port is reconfigured with a second pinout to support the second data format; and

10 a second multiplexer configured to selectively transmit data from one of a data source configured to provide data in the first data format and an output from said first multiplexer that includes data in the second data format, the data selectively transmitted to said first port.

15 2. The device in accordance with Claim 1, wherein said first port comprises a portable digital media interface (PDMI) port.

3. The device in accordance with Claim 1, wherein the second data format is one of a universal serial bus (USB) data format, a high-definition multimedia interface (HDMI) data format, and a 4-Lane DisplayPort data format.

4. The device in accordance with Claim 1 further comprising:

a second port configured with a third pinout to support the second data format;

and

25 an attachment sensor configured to detect a bias asserted on said first port and configured to command said first multiplexer to selectively transmit data in the second data format between said second port and said first port.

5. The device in accordance with Claim 4, wherein the bias is asserted on at least one pin of said first port to facilitate selecting the data format to be transmitted to said first port.

6. The device in accordance with Claim 4, wherein said first multiplexer transmits data in the second data format to said second port when a bias is not detected, and transmits data in the second data format to said first port when the bias is detected.

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7. The device in accordance with Claim 1 further comprising at least one power switch coupled to said first port.

8. A method of transmitting data from a mobile computing device, said
10 method comprising:

selecting a data source from which to provide data to a first port in the mobile computing device, wherein the first port is configured with a first pinout to support a first data format and the data source is configured to transmit data in a second data format that is different from the first data format, and wherein the data source
15 configured to transmit data in the second format is selected using a first multiplexer;

selectively transmitting, using a second multiplexer, data from one of a data source configured to provide data in the first data format and an output from the first multiplexer that includes data in the second data format to the first port;

reconfiguring the first pinout with a second pinout that enables the first port to
20 support the second data format; and

transmitting data from the second multiplexer through the first port.

9. The method in accordance with Claim 8, wherein selecting a data source comprises detecting a bias on at least one pin of the first port.

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10. The method in accordance with Claim 9, wherein detecting a bias comprises detecting at least one of a ground and a non-zero voltage on the at least one pin, the data source selected based on the bias asserted on the at least one pin.

11. The method in accordance with Claim 10, wherein detecting a non-zero voltage comprises detecting the non-zero voltage that is supplied to the at least one pin from a second pin of the first port.

12. The method in accordance with Claim 9, wherein selecting a data source comprises selecting a default data source when a bias is not detected on the at least one pin.

5 13. The method in accordance with Claim 8, wherein reconfiguring the first pinout comprises allocating at least one pin of the first pinout to support the second data format.

14. The method in accordance with Claim 13, wherein allocating at least one pin comprises reallocating the at least one pin from at least one pin that facilitated supporting the first data format.

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