



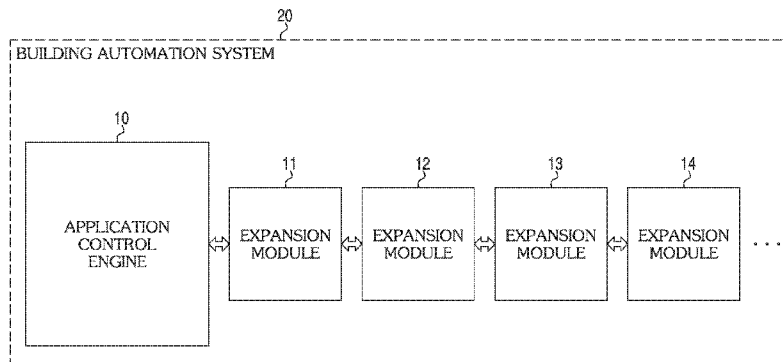
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(54) Title: AN EXPANSION MODULE SYSTEM

FIG. 1



(57) Abstract: A system and approach that may connect communication modules together in a daisy chain fashion as an expansion bus. A communication module may be connected with a data bus and a voltage bus to a baseboard having a controller. The communication module may have a multi-port universal serial bus hub connected to the data bus from the expansion connector, an electronic device connected to the hub and the voltage regulator. Another communication module having a similar structure as the first communication module may be connected to the first communication module via a data bus between the multiport hub of the first expansion module and a universal serial bus hub of the other communication module, and may have a voltage bus connected to the voltage bus of the first communication module. More communication modules may be connected in a daisy chain or serial fashion to a preceding module, and so on in a similar manner.



AN EXPANSION MODULE SYSTEM

Background

5 The present disclosure pertains to communications and particularly to groups of communication modules.

Summary

10 The disclosure reveals a system and approach that may connect communication modules together in a daisy chain fashion as an expansion bus. The present system may be a part of a building automation or management system. An expansion module may be connected with a data bus to an expansion connector on a baseboard having a controller. Also, the expansion module may be connected to a voltage or power source via a pre-regulated voltage bus. The expansion module may have a multi-port universal serial bus
15 hub connected to the data bus from the expansion connector, an electronic device connected to the hub and the voltage regulator. Another expansion module having a similar structure as the first expansion module may be connected to the first expansion module via a data bus between the multiport hub of the first expansion module and a hub of the other expansion module, and may have a pre-regulated voltage bus connected to
20 the voltage or power bus of the first expansion module. More expansion modules may be connected in a daisy chain or serial fashion to a preceding module, and so on in a similar manner.

Brief Description of the Drawing

25 Figure 1 is a diagram of a basic daisy chain expansion bus system;
 Figure 2 is a diagram of a baseboard of the daisy chain expansion bus expansion bus system; and
 Figure 3 is a diagram of the several expansion modules of the daisy chain expansion system.

30

Description

The present system and approach may incorporate one or more processors, computers, controllers, user interfaces, wireless and/or wire connections, and/or the like, in an implementation described and/or shown herein.

5 This description may provide one or more illustrative and specific examples or ways of implementing the present system and approach. There may be numerous other examples or ways of implementing the system and approach.

In the building automation controller, daisy chain expansion modules with specific functionality may provide a way to easily add on a variety of communication modules. Communication or expansion modules may be connected to a main processor
10 via a parallel bus which requires many I/O lines and thus a large connector. The present approach may utilize a universal serial bus (USB) which provides a high speed connection, low pin count, and ease of expansion. To accommodate multiple modules, one may run a dedicated USB pair for each module. A USB hub may be added to each module.

15 The benefits of the present approach may incorporate no USB hub needed on a base board, fewer connections required in the board to a board interconnect, and an improved signal integrity because each hub restores the signal and each signal on it passes through one connector pair.

A four port USB hub (e.g., USB2514BI-AEZG) may be used on each module.
20 The hub input may come from a previous module. One hub output may go to an on module USB device (e.g., Atmel ATSAM4S16BA) and additional devices can be added if desired or needed. One hub output may exit the module and be passed to the next module in the line.

Figure 1 is a diagram of the present system. The system may be a part of a
25 building automation or management system 20. Block 10 may represent an application control engine (ACE) such as a Tridium™ JACE-8000™ Java™ application control engine (JACE™). Blocks 11, 12, 13 and 14 may indicate communication or expansion modules. There may be more or less than the four expansion modules shown.

Figure 2 is a diagram that reveals more details of a baseboard or block 10. It may
30 incorporate a Titan™ JACE that has processor 21 with a USB connection 22 to an

expansion connector 23. Processor 21 may, for example, be a TI™ AM335X processor available from Texas Instruments Inc. A DC power source 27 may also be available.

Expansion connector 23 as an output (JACE side) expansion connector may be a Hirose™ FX18-40P-0.8SH. Hirose FX18-40P-0.8SH may be the output (next module) expansion connector. In Figure 2, expansion connector 23 may have a USB data connection 25 to a multi-port hub such as a dual port hub 31 of expansion module 11 in Figure 3. An input connector on each expansion module may be a Hirose FX18-40S-0.85SH. DC power source 27 at baseboard 10 may be connected to a pre-regulated voltage bus 32. A voltage regulator 33 may have an input connected to bus 32. A regulated voltage output may be provided by regulator 33 to hub 31 and to a USB device 34. A USB data connection 35 may be between hub 31 and device 34. No USB hub is necessarily needed on baseboard 10 since USB signals come directly from processor 21.

A USB data connection 36 may go from a hub 31 of expansion module 11 to a multi-port hub such as a dual port hub 41 of expansion module 12. A pre-regulated voltage bus 42 may be connected to voltage bus 32 of expansion module 11. A voltage regulator 43 of expansion module 12 may have an input connected to bus 42. A regulated voltage output may be provided by regulator 43 to hub 41 and to a USB device 44. A USB data connection 45 may be between hub 41 and device 44.

A USB data connection 46 may go from hub 41 of expansion module 12 to a multi-port hub such as a dual port hub 51 of expansion module 13. A pre-regulated voltage bus 52 may be connected to voltage bus 42 of expansion module 12. A voltage regulator 53 of expansion module 13 may have an input connected to bus 52. A regulated voltage output may be provided by regulator 53 to hub 51 and to a USB device 54. A USB digital connection 55 may be between hub 51 and device 54.

A USB data connection 56 may go from hub 51 of expansion module 13 to a multi-port hub such as a dual port hub 61 of expansion module 14. A pre-regulated voltage bus 62 may be connected to voltage bus 52 of expansion module 13. A voltage regulator 63 of expansion module 14 may have an input connected to bus 62. A regulated voltage output may be provided by regulator 63 to hub 61 and to a USB device 64. A USB digital connection may be between hub 61 and device 64. Device or devices 64 may consist of electronic circuits having various functionalities. There may be one or

more devices 64 in each expansion module. In a situation where there may be several devices 64 in one expansion module, the devices can have different functionalities. The present description of device or devices 64 may also be applicable to devices 34, 44 and 54.

5 A USB data connection 66 may go from hub 61 of expansion module 14 to still another expansion module in the same manner as expansion modules 12, 13 and 14 were added to preceding modules 11, 12 and 13, respectively.

 A high speed USB signal may be buffered and resent at each expansion module and pass through only one set of connectors thereby improving signal integrity over that
10 of other multiple expansion module configurations. There may be a decreased pinout in the expansion connector because just a single USB signal needs to pass through.

 To recap, a module system may incorporate a baseboard, a first expansion module connected to the baseboard, a second expansion module connected to the first expansion module, and one or more additional expansion modules. The baseboard may incorporate
15 a controller, and an expansion connector connected to the controller. The first expansion module may incorporate a universal serial bus (USB) device, and a multi-port hub having a first port connected to the expansion connector, a second port connected to the USB device, and a third port connected to the second expansion module. The one or more
20 additional expansion modules may be connected in a daisy chain to the second expansion module in a manner that the second expansion module is connected to the first expansion module. Each expansion module of the one or more expansion modules may incorporate a voltage regulator having an input connected to a voltage supply line, and an output connected to a multi-port hub and to a USB device respectively of each expansion
 module.

25 The first expansion module may incorporate a voltage regulator having an input connected to a voltage supply line that is connected to a voltage source at the baseboard, and an output connected to the multi-port hub and the USB device.

 The controller may provide a USB signal via the expansion connector to the multiport hub of the first expansion module.

30 The USB signal may be buffered and resent at each expansion module through one set of connectors to virtually maintain an integrity of the USB signal.

The expansion connector may have a minimal pinout since just a single USB signal needs to pass through the expansion connector.

The USB device may incorporate a microcontroller. The microcontroller may process a signal from the multi-port USB hub and provide a processed signal to the multi-
5 port USB hub.

Each USB device of the first expansion module, of the second expansion module, and of the one or more additional expansion modules may be selected from a group consisting of microprocessors, converters, amplifiers, databases, and memories.

One or more of the first expansion module, the second expansion module, and the
10 one or more additional expansion modules may incorporate one or more additional USB devices. Each of the one or more additional USB devices may be selected from a group consisting of microprocessors, converters, amplifiers, databases, and memories.

An approach for connecting expansion modules, may incorporate connecting a first expansion module to a baseboard, and connecting a second expansion module to the
15 first expansion module. The baseboard may incorporate a microcontroller, and an expansion connector connected to the microcontroller. The first expansion module may incorporate a universal serial bus (USB) device, and a multi-port hub having a first port connected to the expansion connector, a second port connected to the USB device, and a third port connected to the second expansion module.

The second expansion module may incorporate a USB device, and a multi-port
20 hub having a first port connected to the third port of the multi-port hub of the first expansion module, a second port connected to the USB device, and a third port connected to the third expansion module.

The approach may further incorporate connecting a third expansion module to the
25 second expansion module in a manner that the second expansion module is connected to the first expansion module.

USB devices of the first, second, and third expansion modules may be selected from a group consisting of microprocessors, converters, amplifiers, databases, and memories.

The approach may further incorporate connecting the hub and USB device of the
30 first expansion module to a voltage bus, connecting the hub and USB device of the

second expansion bus to a voltage bus, connecting the hub and USB device of the third expansion bus to a voltage bus, connecting the voltage bus of the first expansion module to a voltage supply at the baseboard, connecting the voltage bus of the second expansion module to the voltage bus of the first expansion module, and connecting the voltage bus of the third expansion module to the voltage bus of the second expansion module.

The approach may further incorporate connecting a third expansion module of one or more of N additional expansion modules to the second expansion module, a $N-2$ expansion module of the additional expansion modules to the third expansion module, an $N-3$ expansion module of the additional expansion modules to the $N-2$ expansion module, an $N-4$ expansion module of the additional expansion modules to the $N-3$ expansion module, and so on in a daisy chain fashion through connecting an $N-(N-1)$ expansion module to an $N-(N-2)$ expansion module, in a manner that the second expansion module is connected to the first expansion module.

An expansion bus mechanism may incorporate a baseboard having a microcontroller and an expansion connector connected to the controller, and a daisy chain of a number (N) of expansion modules having a first expansion module connected to the expansion connector.

Each expansion module of the N expansion modules may incorporate a multi-port hub, and one or more devices connected to the multi-port hub. Each of the second through N expansion modules may have a first port of its multiport hub connected to a preceding expansion module and a second port connected to a first port of a succeeding expansion module. A preceding expansion module may be an $n-1$ expansion module and a succeeding expansion module may be an $n+1$ expansion module of an n module. An n module may be any module selected from the second through $N-1$ expansion modules. The N th expansion module may have a preceding ($N-1$) expansion module.

The multi-port hub of each of the N expansion modules may have a third port connected to a device.

One or more devices may be selected from a group consisting of microprocessors, converters, amplifiers, databases, and memories.

Each expansion module may further incorporate a voltage regulator having an output connected to the multi-port hub and to one or more devices.

The multi-port hub may be a universal serial bus (USB) hub. The one or more devices may be USB devices.

The voltage regulator of an expansion module may be connected to a voltage line. The voltage line of an expansion module may be connected to a voltage line of a preceding expansion module. The voltage line of the first expansion module may be connected to a voltage supply.

Any publication or patent document noted herein is hereby incorporated by reference to the same extent as if each individual publication or patent document was specifically and individually indicated to be incorporated by reference.

In the present specification, some of the matter may be of a hypothetical or prophetic nature although stated in another manner or tense.

Although the present system and/or approach has been described with respect to at least one illustrative example, many variations and modifications will become apparent to those skilled in the art upon reading the specification. It is therefore the intention that the appended claims be interpreted as broadly as possible in view of the related art to include all such variations and modifications.

What is claimed is:

1. A module system comprising:
 - a baseboard;
 - a first expansion module connected to the baseboard;
 - a second expansion module connected to the first expansion module; and
 - one or more additional expansion modules; and
 - wherein:
 - the baseboard comprises:
 - a controller; and
 - an expansion connector connected to the controller;
 - the first expansion module comprises:
 - a universal serial bus (USB) device; and
 - a multi-port hub having a first port connected to the expansion connector, a second port connected to the USB device, and a third port connected to the second expansion module;
 - the one or more additional expansion modules are connected in a daisy chain to the second expansion module in a manner that the second expansion module is connected to the first expansion module; and
 - each expansion module of the one or more expansion modules comprises a voltage regulator having an input connected to a voltage supply line, and an output connected to a multi-port hub and to a USB device respectively of each expansion module.
2. The system of claim 1, wherein the first expansion module comprises a voltage regulator having an input connected to a voltage supply line that is connected to a voltage source at the baseboard, and an output connected to the multi-port hub and the USB device.
3. The system of claim 1, wherein the controller provides a USB signal via the expansion connector to the multiport hub of the first expansion module.

4. The system of claim 3, wherein the USB signal is buffered and resent at each expansion module through one set of connectors to virtually maintain an integrity of the USB signal.
5. The system of claim 3, wherein the expansion connector has a minimal pinout since just a single USB signal needs to pass through the expansion connector.
6. The system of claim 1, wherein:
 - the USB device comprises a microcontroller; and
 - the microcontroller processes a signal from the multi-port USB hub and provides a processed signal to the multi-port USB hub.
7. The system of claim 6, wherein each USB device of the first expansion module, of the second expansion module, and of the one or more additional expansion modules, is selected from a group consisting of microprocessors, converters, amplifiers, databases, and memories.
8. The system of claim 6, wherein one or more of the first expansion module, the second expansion module, and the one or more additional expansion modules comprise one or more additional USB devices.
9. The system of claim 8, wherein each of the one or more additional USB devices is selected from a group consisting of microprocessors, converters, amplifiers, databases, and memories.
10. A method for connecting expansion modules, comprising:
 - connecting a first expansion module to a baseboard; and
 - connecting a second expansion module to the first expansion module; and
 - wherein:
 - the baseboard comprises:

a microcontroller; and
an expansion connector connected to the microcontroller; and
the first expansion module comprises:
a universal serial bus (USB) device; and
a multi-port hub having a first port connected to the expansion
connector, a second port connected to the USB device, and
a third port connected to the second expansion module.

11. The method of claim 10, wherein the second expansion module comprises:
a USB device; and
a multi-port hub having a first port connected to the third port of the multi-port hub of the first expansion module, a second port connected to the USB device, and a third port connected to a third expansion module.
12. The method of claim 11, further comprising:
connecting the third expansion module to the second expansion module in a manner that the second expansion module is connected to the first expansion module; and
wherein USB devices of the first, second, and third expansion modules are selected from a group consisting of microprocessors, converters, amplifiers, databases and memories.
13. The method of claim 12, further comprising:
connecting the hub and USB device of the first expansion module to a voltage bus;
connecting the hub and USB device of the second expansion bus to a voltage bus;
connecting the hub and USB device of the third expansion bus to a voltage bus;

connecting the voltage bus of the first expansion module to a voltage supply at the baseboard;
connecting the voltage bus of the second expansion module to the voltage bus of the first expansion module; and
connecting the voltage bus of the third expansion module to the voltage bus of the second expansion module.

14. An expansion bus mechanism comprising:
a baseboard comprising:
a controller; and
an expansion connector connected to the controller; and
a daisy chain of a number (N) of expansion modules having a first expansion module connected to the expansion connector; and
wherein:
each expansion module of the N expansion modules comprises:
a multi-port hub; and
one or more devices connected to the multi-port hub;
each of the second through N expansion modules has a first port of its multiport hub connected to a preceding expansion module and a second port connected to a first port of a succeeding expansion module;
a preceding expansion module is an n-1 expansion module and a succeeding expansion module is an n+1 expansion module of an n module;
an n module is any module selected from the second through N-1 expansion modules; and
the Nth expansion module has a preceding (N-1) expansion module.
15. The mechanism of claim 14, wherein:
the multi-port hub of each of the N expansion modules has a third port connected to a device;

each expansion module further comprises a voltage regulator having an output connected to the multi-port hub and to one or more devices;
the multi-port hub is a universal serial bus (USB) hub;
the one or more devices are USB devices;
the voltage regulator of an expansion module is connected to a voltage line;
the voltage line of an expansion module is connected to a voltage line of a preceding expansion module; and
the voltage line of the first expansion module is connected to a voltage supply.

FIG. 1

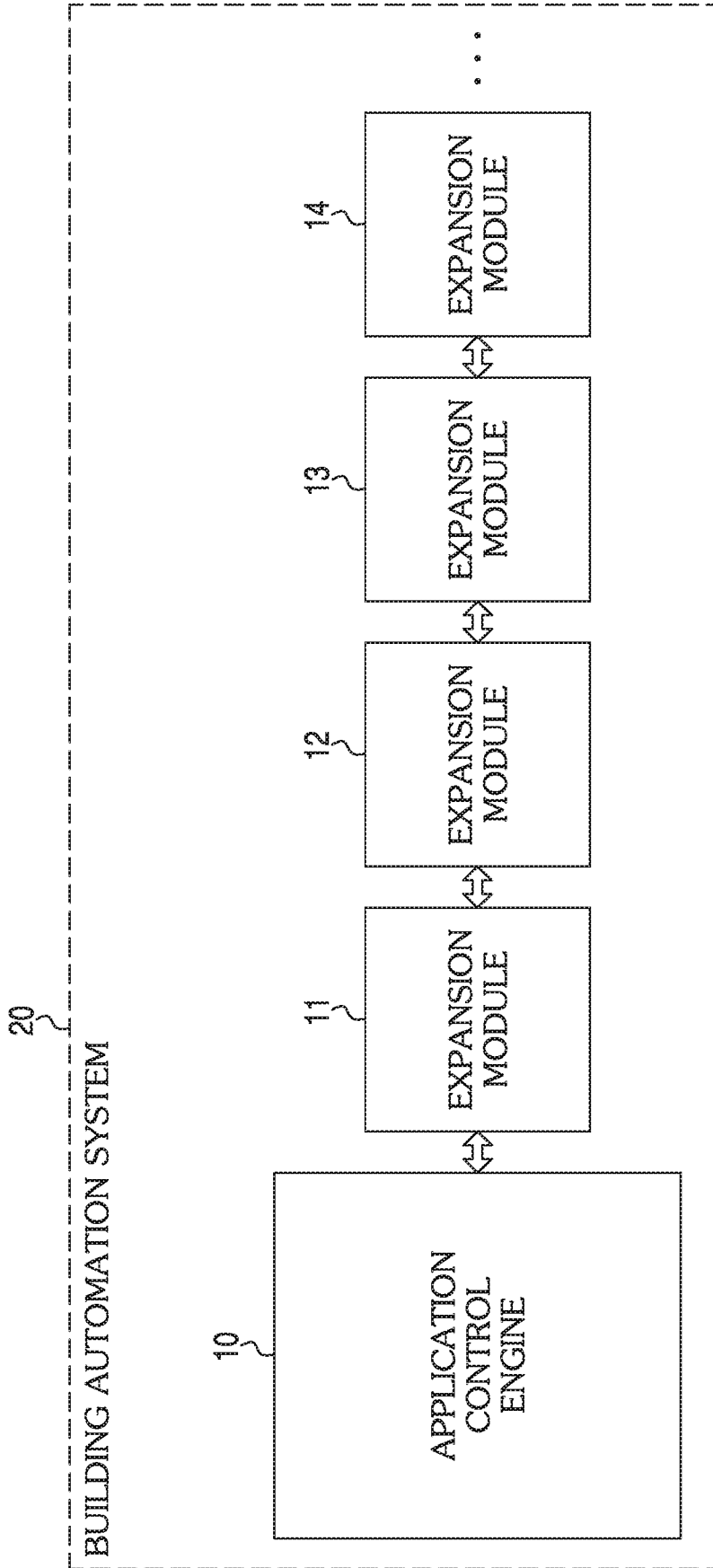


FIG. 2

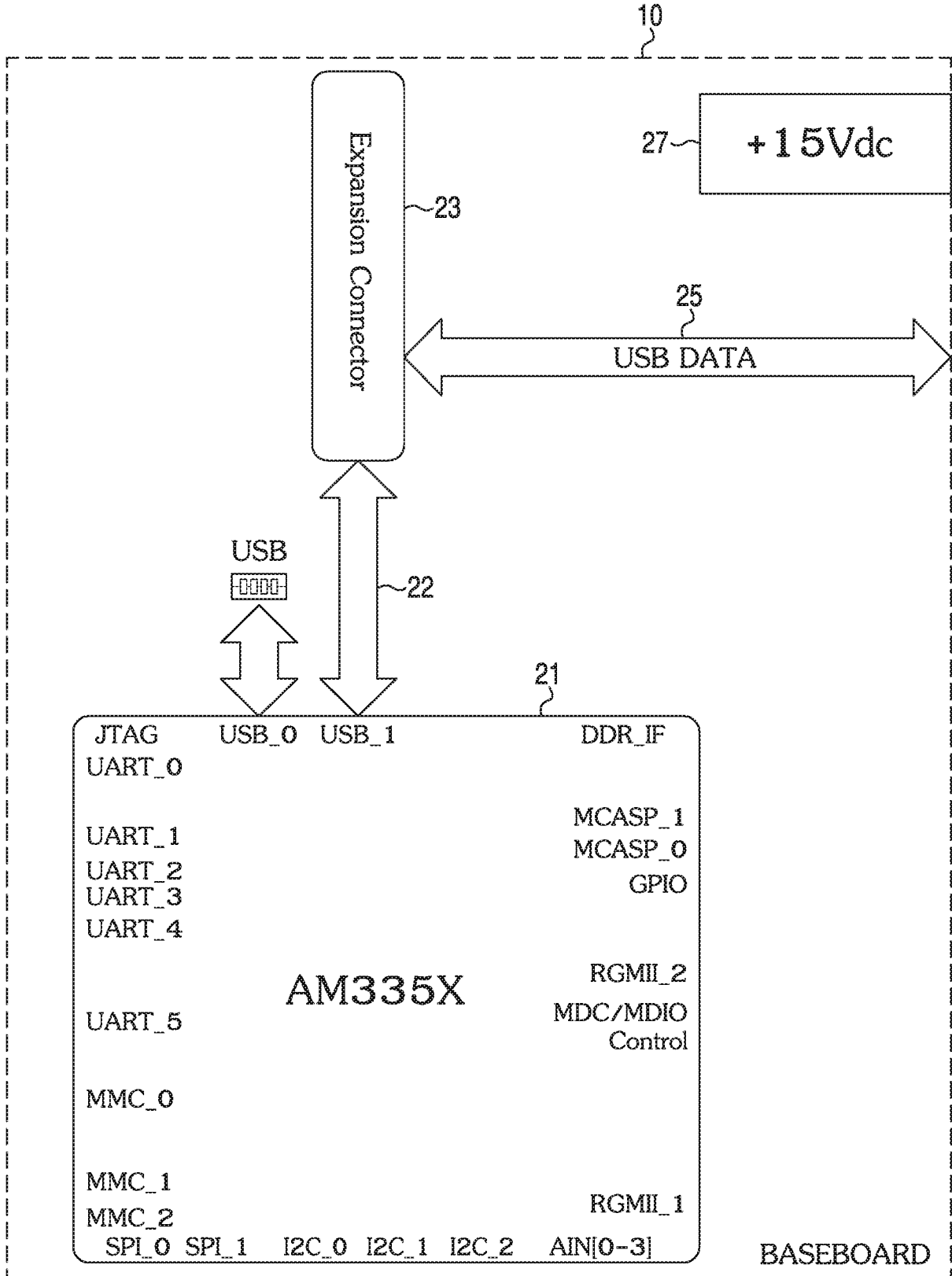
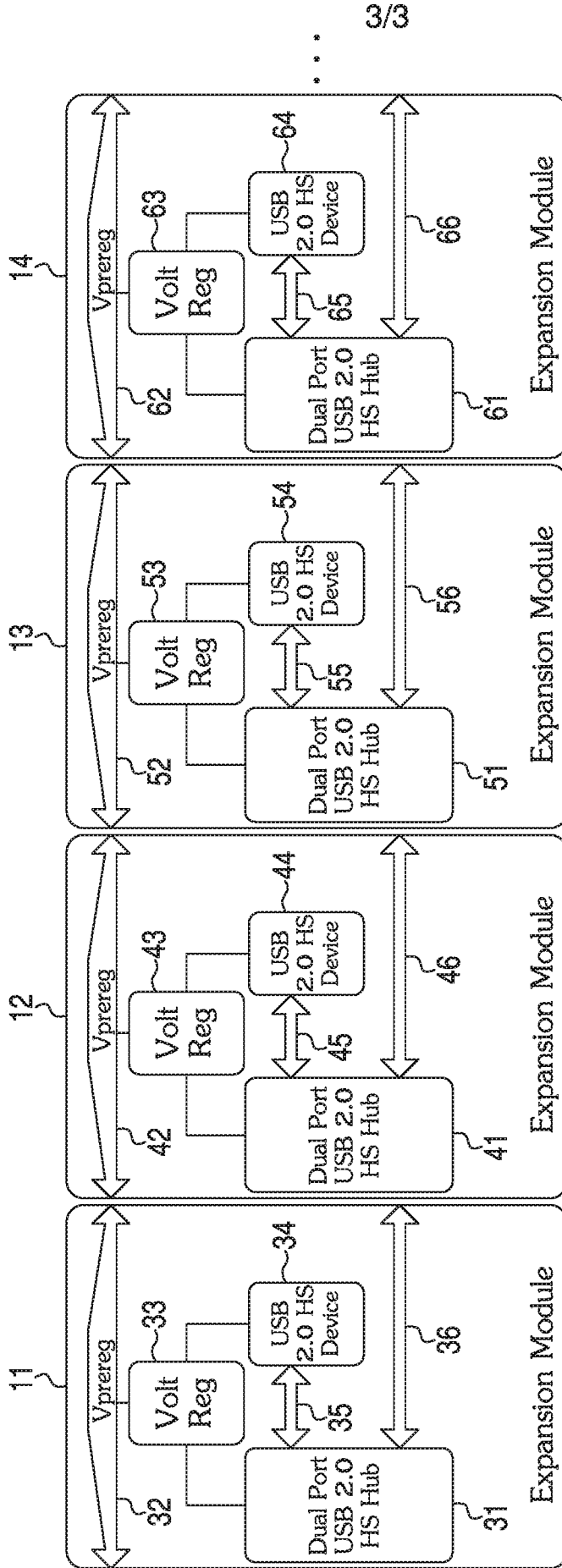


FIG. 3



A. CLASSIFICATION OF SUBJECT MATTER**G06F 13/38(2006.01)i, G06F 13/40(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHEDMinimum documentation searched (classification system followed by classification symbols)
G06F 13/38; G06F 1/26; G06F 13/36; H05K 5/00; G06F 13/20; G06F 1/16; G06F 13/00; G06F 13/40Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility modelsElectronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords: expansion, module, USB, port, hub, component, daisy, regulator, and similar terms.**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 7,706,136 B1 (GARY D. DOTSON et al.) 27 April 2010 See column 2, lines 47-49; column 4, lines 23-30; column 5, lines 25-32; column 5, line 65 - column 6, line 1; column 6, lines 6-34 and 49-63; column 7, lines 42-46 and 56-61; column 13, lines 6-9; claims 1 and 24; and figures 2 and 4.	1-15
A	US 2014-0047138 A1 (ACER INCORPORATED) 13 February 2014 See paragraphs [0027]-[0031] and figure 2.	1-15
A	US 2005-0086413 A1 (EDWARD W. LEE et al.) 21 April 2005 See paragraphs [0021]-[0024] and figures 2-3C.	1-15
A	EP 1096359 A2 (FUJITSU LIMITED) 02 May 2001 See paragraphs [0009]-[0013] and figure 1.	1-15
A	US 7,028,126 B1 (PING LIANG) 11 April 2006 See column 2, lines 27-62; and figure 3.	1-15

 Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2016/024721

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 7706136 B1	27/04/2010	None	
US 2014-0047138 A1	13/02/2014	EP 2696291 A1 TW 201407379 A TW I483123 B US 8966136 B2	12/02/2014 16/02/2014 01/05/2015 24/02/2015
US 2005-0086413 A1	21/04/2005	None	
EP 1096359 A2	02/05/2001	EP 1096359 A3 JP 2001-125688 A US 6917989 B1	19/01/2005 11/05/2001 12/07/2005
US 7028126 B1	11/04/2006	None	