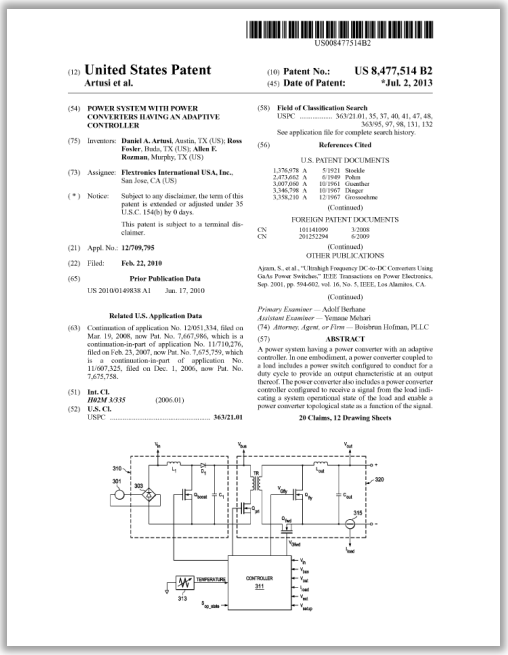
U.S. Patent No. 8,477,514 – Dell LA90PM170



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(12) **United States Patent**
Artusi et al.

(10) **Patent No.: US 8,477,514 B2**
(45) **Date of Patent: *Jul. 2, 2013**

(54) **POWER SYSTEM WITH POWER CONVERTERS HAVING AN ADAPTIVE CONTROLLER**

(75) Inventors: **Daniel A. Artusi**, Austin, TX (US); **Ross Fosler**, Buda, TX (US); **Allen F. Rozman**, Murphy, TX (US)

(73) Assignee: **Flextronics International USA, Inc.**, San Jose, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **12/709,795**

(22) Filed: **Feb. 22, 2010**

(65) **Prior Publication Data**

US 2010/0149838 A1 Jun. 17, 2010

Related U.S. Application Data

(63) Continuation of application No. 12/051,334, filed on Mar. 19, 2008, now Pat. No. 7,667,986, which is a continuation-in-part of application No. 11/710,276, filed on Feb. 23, 2007, now Pat. No. 7,675,759, which is a continuation-in-part of application No. 11/607,325, filed on Dec. 1, 2006, now Pat. No. 7,675,758.

(51) **Int. Cl.**
H02M 3/335 (2006.01)

(52) **U.S. Cl.**
USPC **363/21.01**

(58) **Field of Classification Search**
USPC 363/21.01, 35, 37, 40, 41, 47, 48, 363/95, 97, 98, 131, 132
See application file for complete search history.

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(57) **ABSTRACT**

A power system having a power converter with an adaptive controller. In one embodiment, a power converter coupled to a load includes a power switch configured to conduct for a duty cycle to provide an output characteristic at an output thereof. The power converter also includes a power converter controller configured to receive a signal from the load indicating a system operational state of the load and enable a power converter topological state as a function of the signal.

20 Claims, 12 Drawing Sheets

Title: POWER SYSTEM WITH POWER CONVERTERS HAVING AN ADAPTIVE CONTROLLER

Priority Date: Dec. 01, 2006

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Expiration Date: Dec. 01, 2026

Inventors: Daniel A. Artusi; Ross Fosler; Allen F. Rozman

Claims: 16, 17, 19, 20

MYPAQ-DELL
EXHIBIT
7

· All the claim elements identified herein are literally and equivalently present in the Accused Instrumentalities.

· For clarity, the portion of a cited reference that is relied upon for support may also be reproduced in the chart. Also, earlier, later or otherwise different versions of the reference may be available but not specifically cited.

· The portion of the Accused Instrumentality covered by a claim element is typically identified by an arrow and/or outlined in color. Such identification is exemplary, not exclusive or exhaustive. The Asserted Claims are open ended, close ended or improperly restricted. Additional portions of the Accused Instrumentality might also be covered by the claim element but might not be identified in the chart.

· All quantitative figures, qualitative figures and data cited in the chart are subject to measurement and/or computatio variation.

Claim 16

A method of operating a **(SYS) power system**, comprising:
enabling operation of components of a **(PRO) processor system** to establish a **(DRN) state of power drain** thereof;
providing a **(COM) signal** to identify **(OPN) operation** of said **(PRO) processor system** in said **(DRN) state of pow drain**;
sensing a **(PL) power level** of said **(DRN) state of power drain** in response to said **(COM) signal**; and
controlling an **(IOC) internal operating characteristic** of a **(PC) power converter** as a function of said **(PL) power**

Claim 17

The method as recited in claim 16, further comprising:
inducing a **(PS) power switch** of said **(PC) power converter** to conduct for a **(DC) duty cycle** to provide an **(OC) ou characteristic** at an **(OUT) output** thereof; and
controlling said **(DC) duty cycle** of said **(PS) power switch** dependent on said **(OC) output characteristic** and in accordance with said **(PL) power level**.

Claim 19

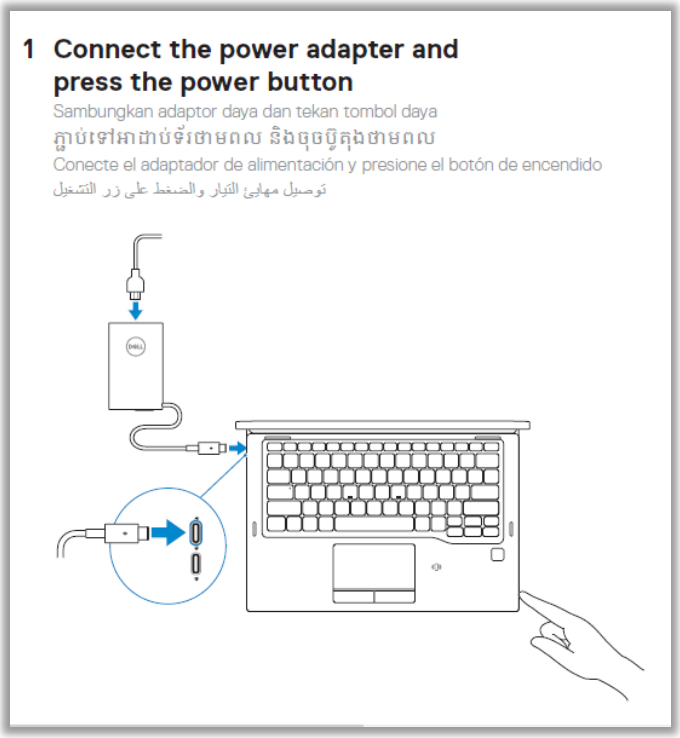
The method as recited in claim 16 wherein said controlling said **(IOC) internal operating characteristic** comprises o over a **(TTIM) period of time**.

Claim 20

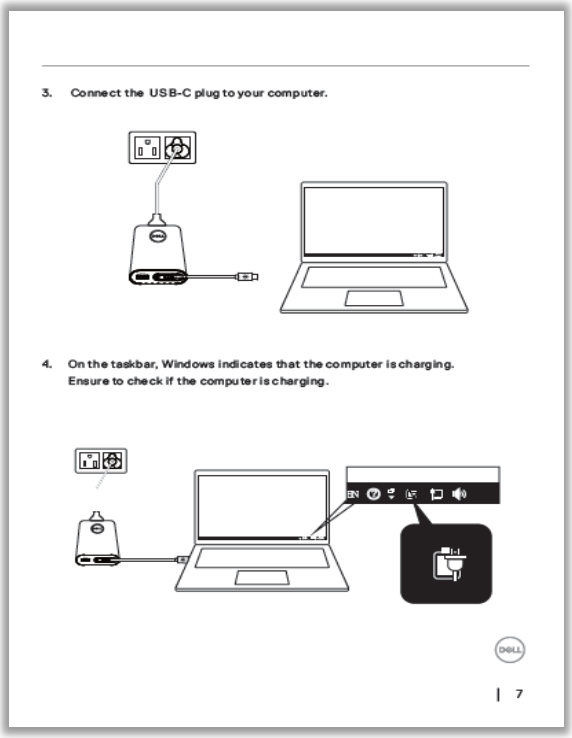
The method as recited in claim 16 wherein said **(IOC) internal operating characteristic** is selected from the group consisting of:
a **(GDV) gate drive voltage level** of said **(PS) power switch** of said **(PC) power converter**,
a switching frequency of said **(PC) power converter**, and
an **(DCBV) internal direct current bus voltage** of said **(PC) power converter**.

Claim 16

A method of operating a **(SYS) power system**, comprising:



Dell Inc., Quick Start Guide for Latitude 5289 2-in-1 at p. 1 (2016)



Dell Inc., User's Guide for Dell USB-C Power Adapter Plus-90W PA901C at p. 7 (2020)

These are typical examples of Dell generally instructing users of its power converters to couple them to loads.

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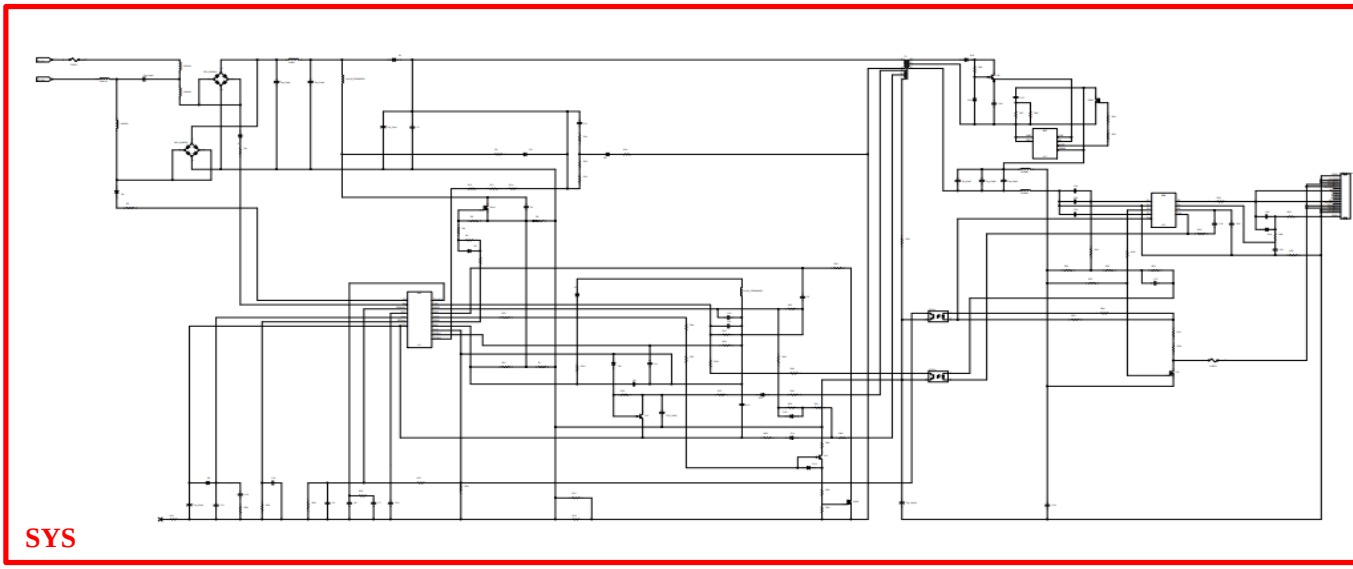
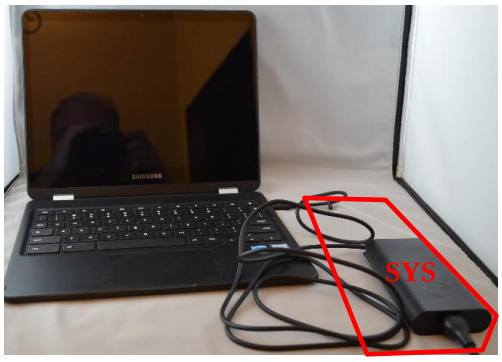
Claim 16
A method of operating a **(SYS) power system**, comprising:





Claim 16

enabling operation of components of a **(PRO) processor system** to establish a **(DRN) state of power drain** thereof;

4.5.2.2 Connection State Machine Requirements **PRO**

Entry into any unattached state when "directed from any state" shall not be used to override tDRP toggle.

A DRP or a Sink may consume default power from VBUS in any state where it is not required to provide VBUS.

DRN

The following two tables define the electrical states for a CC pin in both a Source and a Sink. Every port has CC1 and CC2 pins, each with its own individual CC pin state. The combination of a port's CC1 and CC2 pin states are be used to define the conditions under which a port transitions from one state to another.

Table 4-14 Source Port CC Pin State

CC Pin State	Port partner CC Termination	Voltage Detected on CC when port asserts Rp
SRC.Open	Open, Rp	Above vOPEN
SRC.Rd	Rd	Within the vRd range (i.e., between minimum vRd and maximum vRd)
SRC.Ra	Ra	Below maximum vRa

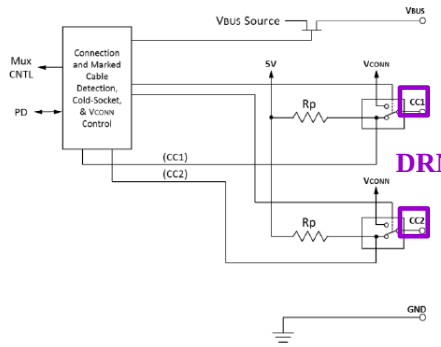
Table 4-15 Sink Port CC Pin State

CC Pin State	Port partner CC Termination	Voltage Detected on CC when port asserts Rd
SNK.Rp	Rp	Above minimum vRd-Connect
SNK.Open	Open, Ra, Rd	Below maximum vRa

Sink	Port asserting Rd on CC and when attached is consuming power from VBUS; most commonly a Device.

DRN

Figure 4-7 Source Functional Model for CC1 and CC2



DRN

Referring to Figure 4-7, a port that behaves as a Source has the following functional characteristics:

1. The Source uses a FET to enable/disable power delivery across VBUS and initiall Source has VBUS disabled.
2. The Source supplies pull-up resistors (Rp) on CC1 and CC2 and monitors both t detect a Sink. The presence of an Rd pull-down resistor on either pin indicates Sink is being attached. The value of Rp indicates the initial USB Type-C Current supported by the host.
3. The Source uses the CC pin pull-down characteristic to detect and establish the correct routing for the SuperSpeed USB data path and determine which CC pin i intended for supplying VCONN.
4. Once a Sink is detected, the Source enables VBUS and VCONN.
5. The Source can dynamically adjust the value of Rp to indicate a change in availa USB Type-C Current to a Sink.

The source functional model detects CC1/CC2 and dynamica adjusts the current, voltage x current is the state of power dra

Source(s): [1]

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