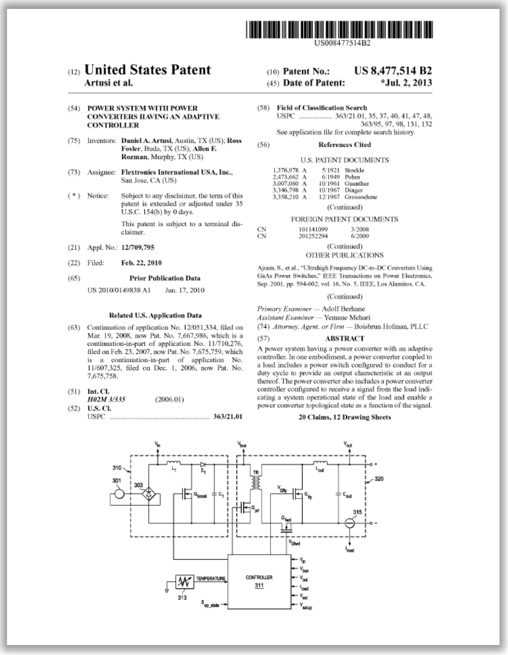
U.S. Patent No. 8,477,514 – Dell LA90PM170



US008477514B2

(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.

(56) **References Cited**

U.S. PATENT DOCUMENTS

1,376,978 A 5/1921 Stoekle
2,473,662 A 6/1949 Pohm
3,007,060 A 10/1961 Guenther
3,346,798 A 10/1967 Dinger
3,358,210 A 12/1967 Grossoehme

(Continued)

FOREIGN PATENT DOCUMENTS

CN 101141099 3/2008
CN 201252294 6/2009

(Continued)

OTHER PUBLICATIONS

Ajram, S., et al., "Ultrahigh Frequency DC-to-DC Converters Using GaAs Power Switches," IEEE Transactions on Power Electronics, Sep. 2001, pp. 594-602, vol. 16, No. 5, IEEE, Los Alamitos, CA.

(Continued)

Primary Examiner — Adolf Berhane
Assistant Examiner — Yemane Mehari
(74) *Attorney, Agent, or Firm* — Boisbrun Hofman, PLLC

(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

Filed Date: Feb. 22, 2010

Issued Date: Jul. 02, 2013

Expiration Date: Dec. 01, 2026

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

Claims: 6, 7, 8, 10

· 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 computation variation.

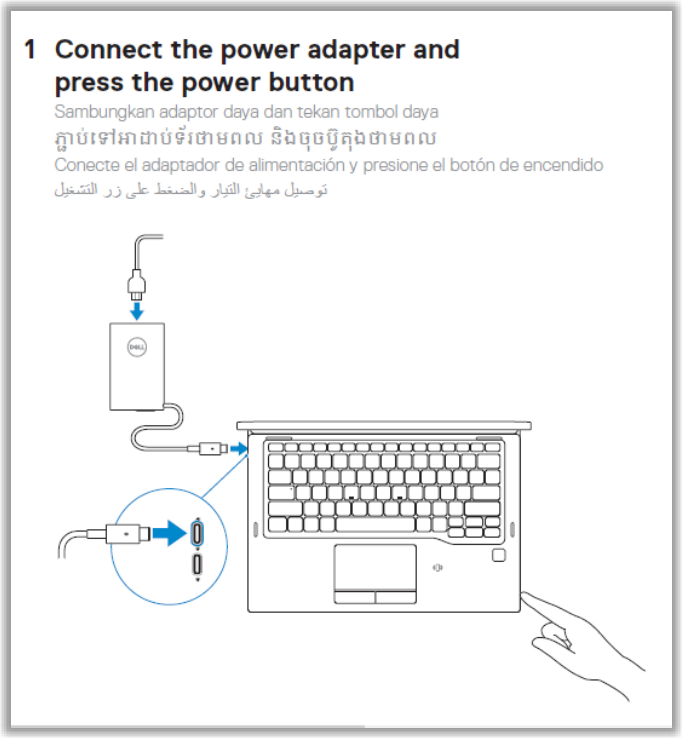
Claim 6
A **(SYS) power system**, comprising:
a **(PSC) power system controller** configured to provide a **(COM) signal** characterizing a **(PREQ) power requirement** of a **(PRO) processor system**; and
a **(PC) power converter** coupled to said **(PRO) processor system**, comprising:
a **(PS) power switch** configured to conduct for a **(DC) duty cycle** to provide an **(OC) output characteristic** a **(OUT) output** thereof, and
a **(CON) power converter controller** configured to receive a **(COM) signal** from said **(PSC) power system controller** to control an **(IOC) internal operating characteristic** of said **(PC) power converter** as a functior said **(COM) signal**.

Claim 7
The **(SYS) power system** as recited in claim 6 wherein
said **(CON) power converter controller** is further configured to provide another **(OS) signal** to control said (**duty cycle** of said **(PS) power switch** as a function of said **(OC) output characteristic** and in accordance wi said **(COM) signal**.

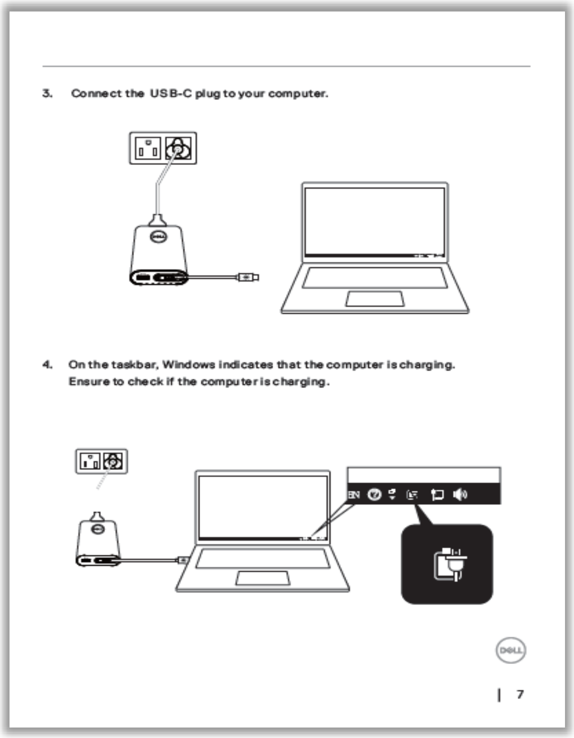
Claim 8
The **(SYS) power system** as recited in claim 6 wherein said **(CON) power converter controller** is configure adjust said **(IOC) internal operating characteristic** over a **(TTIM) period of time**.

Claim 10
The **(SYS) power system** as recited in claim 6 wherein said **(IOC) internal operating characteristic** is selec 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 6
A **(SYS) power system**, comprising:



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

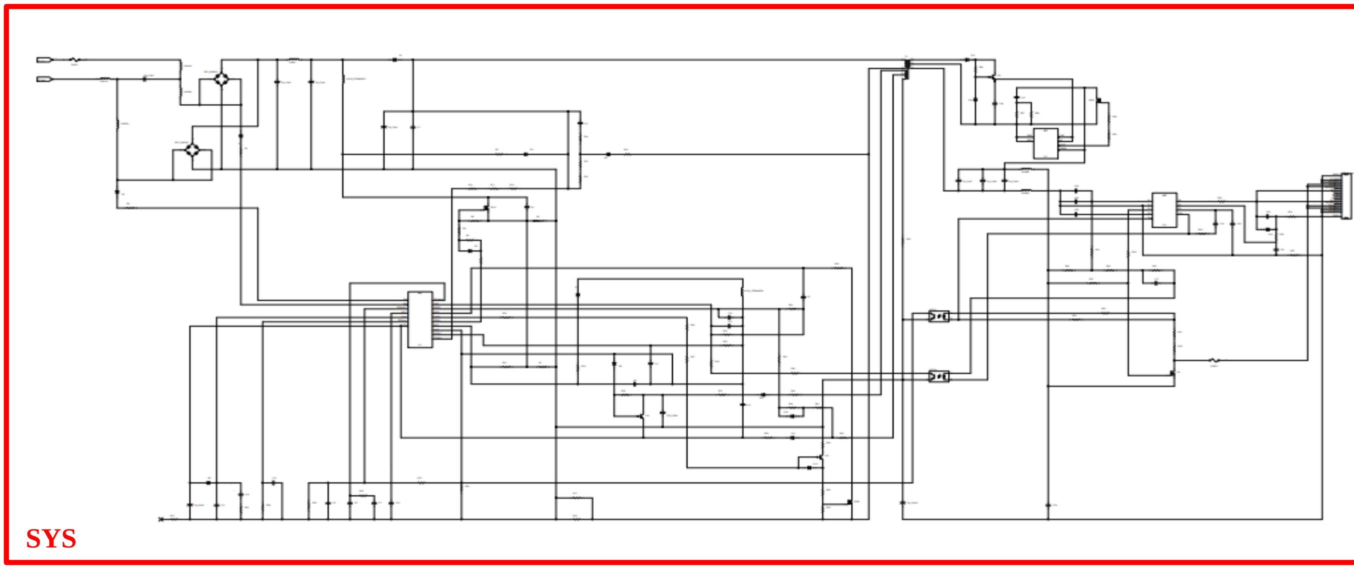


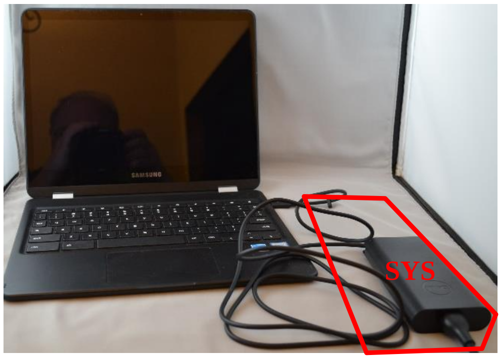
Dell Inc., User's Guide for Dell USB-C Power Adapter Plus-90W PA901C at p. 7 (2020)

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

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

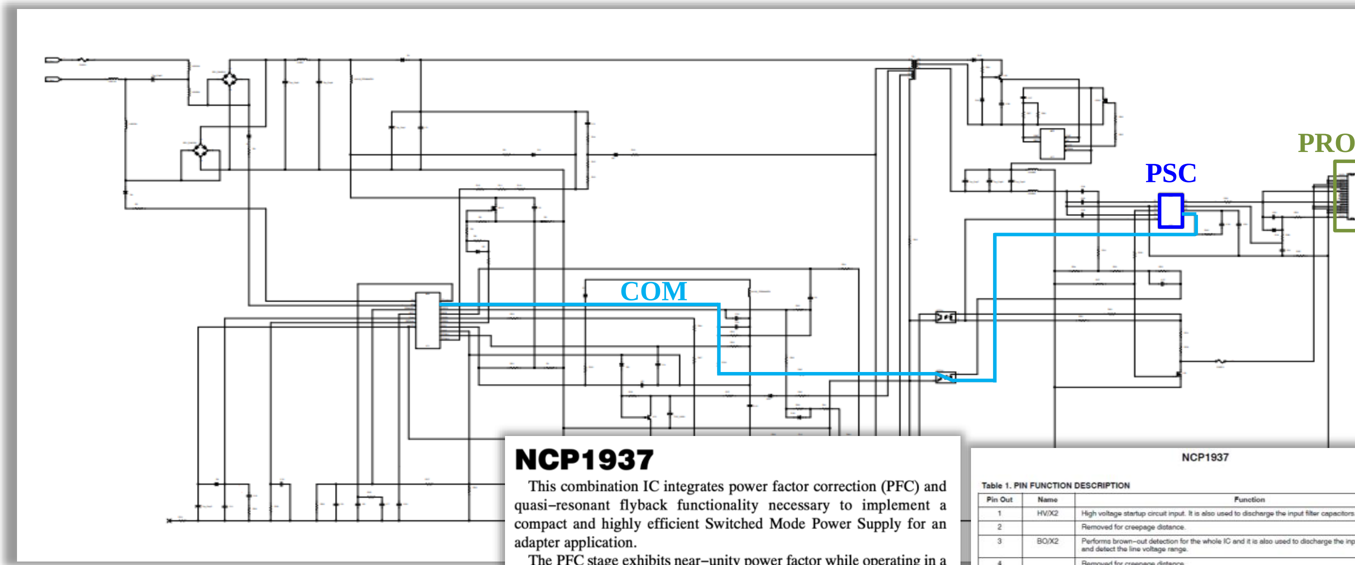
Claim 6
A **(SYS) power system**, comprising:





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

Claim 6
a **(PSC) power system controller** configured to provide a **(COM) signal** characterizing a **(PREQ) power requirement** of a **(P processor system**; and



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 initially the Source has VBUS disabled.
2. The Source supplies pull-up resistors (Rp) on CC1 and CC2 and monitors both to detect a Sink. The presence of an Rd pull-down resistor on either pin indicates that a Sink is being attached. The value of Rp indicates the initial USB Type-C Current level 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 is 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 available USB Type-C Current to a Sink.

PREQ

NCP1937

This combination IC integrates power factor correction (PFC) and quasi–resonant flyback functionality necessary to implement a compact and highly efficient Switched Mode Power Supply for an adapter application.

The PFC stage exhibits near–unity power factor while operating in a Critical Conduction Mode (CrM) with a maximum frequency clamp. The circuit incorporates all the features necessary for building a robust and compact PFC stage while minimizing the number of external components.

The quasi–resonant current–mode flyback stage features a proprietary valley–lockout circuitry, ensuring stable valley switching. This system works down to the 4th valley and toggles to a frequency foldback mode with a minimum frequency clamp beyond the 4th valley to eliminate audible noise. Skip mode operation allows excellent efficiency in light load conditions while consuming very low standby power consumption.

The supply capacitor provides power to the controller during power up. The capacitor must be sized such that a V_{CC} voltage greater than $V_{CC(off)}$ is maintained while the auxiliary supply voltage is building up. Otherwise, V_{CC} will collapse and the controller will turn off. The operating IC bias current, I_{CC4}, and gate charge load at the drive outputs must be considered to correctly size C_{CC}. The increase in current consumption due to external gate charge is calculated using Equation 1.

NCP1937

Table 1. PIN FUNCTION DESCRIPTION

Pin Out	Name	Function
1	HV/X2	High voltage startup circuit input. It is also used to discharge the input filter capacitors
2		Removed for creepage distance.
3	BO/X2	Performs brown–out detection for the whole IC and it is also used to discharge the inp and detect the line voltage range.
4		Removed for creepage distance.
5	PControl	Output of the PFC transconductance error amplifier. A compensation network is conne pin and ground to set the loop bandwidth.
6	PONOFF	A resistor between this pin and ground sets the PFC turn off threshold. The voltage on pared to an internal voltage signal proportional to the output power. The PFC disable t termined by the resistor on this pin and the internal pull–up current source, I_{PONOFF}.
7	QCT	An external capacitor sets the frequency in VCO mode for the QR flyback controller.
8	Fault	The controller enters fault mode if the voltage of this pin is pulled above or below the f precise pull up current source allows direct interface with an NTC thermistor. Fault det latch or auto–recovery depending on device option.
9	PSTimer	Power savings mode (PSM) control and timer adjust. Compatible with an optocoupler trol of PSM. The device enters PSM if the voltage on this pin exceeds the PSM thresh citor between this pin and GND sets the delay time before the controller enters power Once the controller enters power savings mode the IC is disabled and the current con duced to a maximum of 70 µA. The input filter capacitor discharge function is available savings mode. The controller is enabled once $V_{PSTimer}$ drops below V_{PS_out}.
10	QFB	Feedback input for the QR Flyback controller. Allows direct connection to an optocoup
11	QZCD	Input to the demagnetization detection comparator for the QR Flyback controller. Also overpower compensation.
12	VCC	Supply input.
13	QCS	Input to the cycle–by–cycle current limit comparator for the QR Flyback section.
14	QDRV	QR flyback controller switch driver.
15	PDRV	PFC controller switch driver.
16	PCS/PZCD	Input to the cycle–by–cycle current limit comparator for the PFC section. Also used to magnetization detection for the PFC controller.
17	GND	Ground reference.
18	PFBLV	Low voltage PFC feedback input. An external resistor divider is used to sense the PF divider low side resistor connects to this pin. This voltage is compared to an internal r ence voltage is 2.5 V at low line and 4 V at high line. An internal high–voltage switch d side resistor from the high side resistor chain when the PFC is disabled in order to red
19		Removed for creepage distance.
20	PFBHV	High voltage PFC feedback input. An external resistor divider is used to sense the PF divider high side resistor chain from the PFC bulk voltage connects to this pin. An inte switch disconnects the high side resistor chain from the low side resistor when the PF order to reduce input power.

COM

Source(s): [1], [2]

DOCKET ALARM

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts

Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research

With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips

Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.

WHAT WILL YOU BUILD? | **sales@docketalarm.com** | **1-866-77-FASTCASE**

fastcase®
Smarter legal research.