US006456044B1

(12) **United States Patent**
Darmawaskita

(10) **Patent No.: US 6,456,044 B1**
(45) **Date of Patent: *Sep. 24, 2002**

(54) **MICROCONTROLLER WITH INTEGRAL SWITCH MODE POWER SUPPLY CONTROLLER**

(75) Inventor: **Hartono Darmawaskita**, Chandler, AZ (US)

(73) Assignee: **Microchip Technology Incorported**, Chandler, AZ (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.: **09/773,439**

(22) Filed: **Jan. 31, 2001**

Related U.S. Application Data

(63) Continuation-in-part of application No. 09/250,756, filed on Feb. 16, 1999, now Pat. No. 6,184,659.

(51) **Int. Cl.**[7] **H02J 7/04**
(52) **U.S. Cl.** **320/139**; 320/137
(58) **Field of Search** 320/139, 137, 320/141, 127, 129

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,751,139 A * 5/1998 Jordan et al. 323/222
5,789,903 A * 8/1998 Young et al. 320/161
5,945,806 A * 8/1999 Faulk 320/127
6,184,659 B1 * 2/2001 Darmawaskita 320/139

* cited by examiner

Primary Examiner—Gregory J. Toatley, Jr.
Assistant Examiner—Lawrence Luk
(74) *Attorney, Agent, or Firm*—Baker Botts L.L.P.

(57) **ABSTRACT**

A single integrated circuit package for controlling the charging circuits of a battery charger. The single integrated circuit package comprises a microcontroller, switch mode power supply controller(s), analog to digital converter and analog input multiplexer which may be fabricated on a single integrated circuit die, or the microcontroller may be on one integrated circuit die, and the remaining aforementioned circuits may be on a second integrated circuit die. The switch mode power supply controller is adapted for connection to a power converter which is used to control the voltage and/or current to a battery being charged. The power converter may also be on the same integrated circuit die as the switch mode power supply controller, or may be on a separate semiconductor die but included in the single integrated circuit package. Single or multiple batteries may be charged using charging algorithms specifically tailored to each battery. Batteries being charged may have a different capacity, voltage, or chemistry type. State of charge and time to reach a fully charged condition for each battery may also be different.

29 Claims, 7 Drawing Sheets

