



US007982650B2

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

(10) Patent No.: **US 7,982,650 B2**
(45) Date of Patent: **Jul. 19, 2011**

(54) **DIGITAL-TO-ANALOG CONVERTER (DAC) AND AN ASSOCIATED METHOD**

(75) Inventors: **Tai-Cheng Lee, Taipei (TW); Cheng-Hsiao Lin, Taipei (TW)**

(73) Assignee: **National Taiwan University, Taipei (TW)**

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

(21) Appl. No.: **12/571,519**

(22) Filed: **Oct. 1, 2009**

(65) **Prior Publication Data**
US 2010/0141498 A1 Jun. 10, 2010

(30) **Foreign Application Priority Data**
Dec. 10, 2008 (TW) 97148083 A

(51) Int. Cl. **H03M 1/66 (2006.01)**

(52) U.S. Cl. **341/144; 341/138**

(58) Field of Classification Search **341/144, 341/138, 153, 140, 142**

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,795,063 B2 9/2004 Endo et al.
7,696,909 B2 * 4/2010 Oberhuber 341/119

* cited by examiner

Primary Examiner — **Peguy JeanPierre**

(74) *Attorney, Agent, or Firm* — **Tim Tingkang Xia; Morris, Manning & Martin, LLP**

(57) **ABSTRACT**

The digital-to-analog converter in accordance with the present invention comprises an R-2R transistor-only ladder converter and a digital controller. The controller connects to the R-2R transistor-only ladder converter and comprises at least one regulating transistor and at least one shifting transistor. The at least one regulating transistor has an aspect ratio of $k_R(W/L)$. The at least one shifting transistor has an aspect ratio of $k_S(W/L)$. Setting the aspect ratios $k_R(W/L)$ and $k_S(W/L)$ of the shifting and regulating transistors adjusts a linear output current waveform to a non-linear waveform. The method to output a non-linear current comprises acts of determining an optimum non-linear output current, dividing a linear output current into multiple sections, determining slopes of the waveform of the output current, adding a controller corresponding to an R-2R transistor-only ladder converter, setting aspect ratios $k_R(W/L)$ of regulating transistors and setting an aspect ratios $k_S(W/L)$ of shifting transistors.

11 Claims, 8 Drawing Sheets

