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# United States Patent [19] Rincon-Mora

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[54] **LOW VOLTAGE, CURRENT-MODE, PIECEWISE-LINEAR CURVATURE CORRECTED BANDGAP REFERENCE**

5,774,013 6/1998 Groe ..... 327/543  
5,821,741 10/1998 Brokaw ..... 323/311

[75] Inventor: **Gabriel A. Rincon-Mora**, Allen, Tex.

Primary Examiner—Timothy P. Callahan  
Assistant Examiner—An T. Luu  
Attorney, Agent, or Firm—W. James Brady, III; Richard L. Donaldson

[73] Assignee: **Texas Instruments Incorporated**, Dallas, Tex.

### [57] ABSTRACT

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A bandgap circuit (16) for supplying a reference voltage includes a first current source ( $I_{V_{be}}$ ) supplying a current proportional to a base-emitter voltage, a second current source ( $I_{PTAT}$ ) supplying a current proportional to absolute temperature, and a third current source ( $I_{NL}$ ) supplying a non-linear current. First (R3), second (R2), and third (R1) resistors are coupled in series between a first node (c) and ground. The first current source is coupled to the first node. The second current source is coupled to a second node (a) between the first and second resistors. The third current source is coupled to a third node (b) between the second and third resistors. An output coupled to the first node supplies the reference voltage  $V_{ref}$ . The bandgap circuit provides a low voltage reference with temperature compensation flexibility.

**Related U.S. Application Data**  
[60] Provisional application No. 60/042,959, Apr. 7, 1997.  
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[52] U.S. Cl. .... **327/539; 327/513; 323/313; 323/315**  
[58] Field of Search ..... **327/512, 513, 327/378, 538, 539; 323/313, 314, 315**

[56] **References Cited**  
U.S. PATENT DOCUMENTS

4,897,595 1/1990 Holle ..... 323/314  
5,325,045 6/1994 Sundby ..... 323/313

**2 Claims, 3 Drawing Sheets**













