



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

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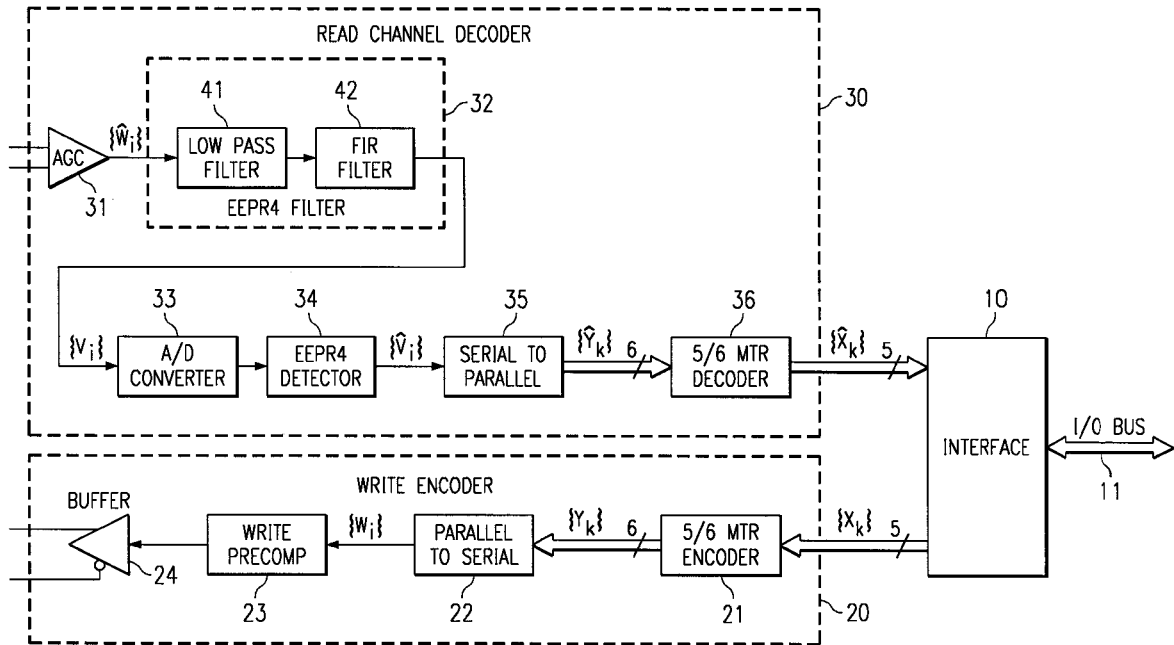
- (54) **RATE 5/6 MAXIMUM TRANSITION RUN CODE FOR READ CHANNELS**
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- (73) Assignee: **Texas Instruments Incorporated, Dallas, TX (US)**
- (\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.
- (21) Appl. No.: **09/070,438**
- (22) Filed: **Apr. 30, 1998**
- (51) Int. Cl.<sup>7</sup> ..... **H03D 1/00; H04L 27/06; H04L 5/12; H04L 23/02; H03M 7/00**
- (52) U.S. Cl. .... **375/341; 375/263; 375/262; 341/59; 341/61**
- (58) **Field of Search** ..... **375/263, 341, 375/340, 290, 262, 265; 360/39, 40, 48; 714/759, 746, 794, 795, 792; 341/59, 50, 61, 58, 68, 94, 106**

- (56) **References Cited**
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(57) **ABSTRACT**

A method and apparatus encoding and decoding data for storage on a mass storage device is described. The code used is a 5/6 rate code in which a maximum transition run constraint is imposed. This code is designed for use with an EEPR4 read channel and provides a Euclidian squared free distance,  $d^2_{free}$ , of 10 when used with an EEPR4 partial response filter and a Viterbi decoder.

**3 Claims, 5 Drawing Sheets**



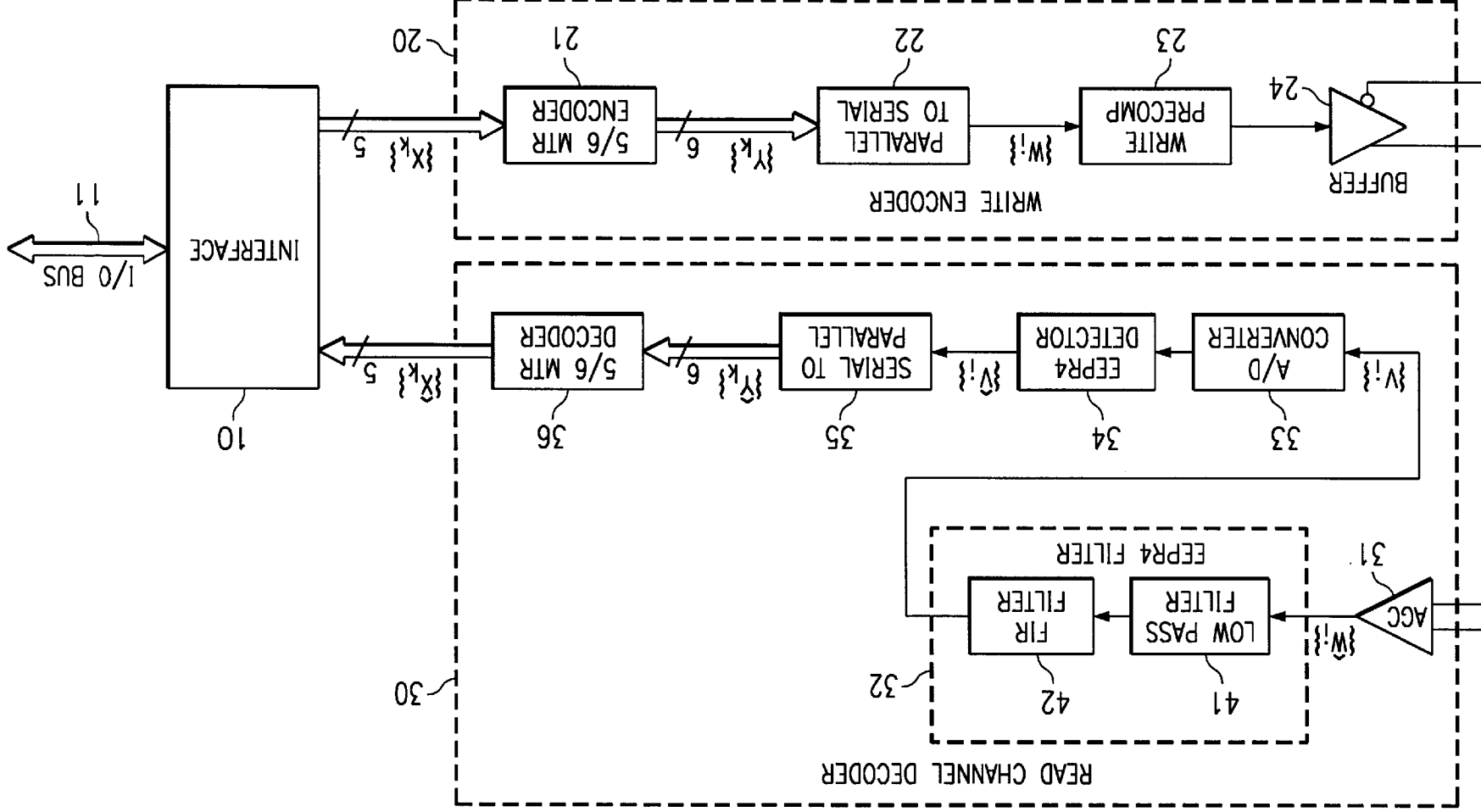
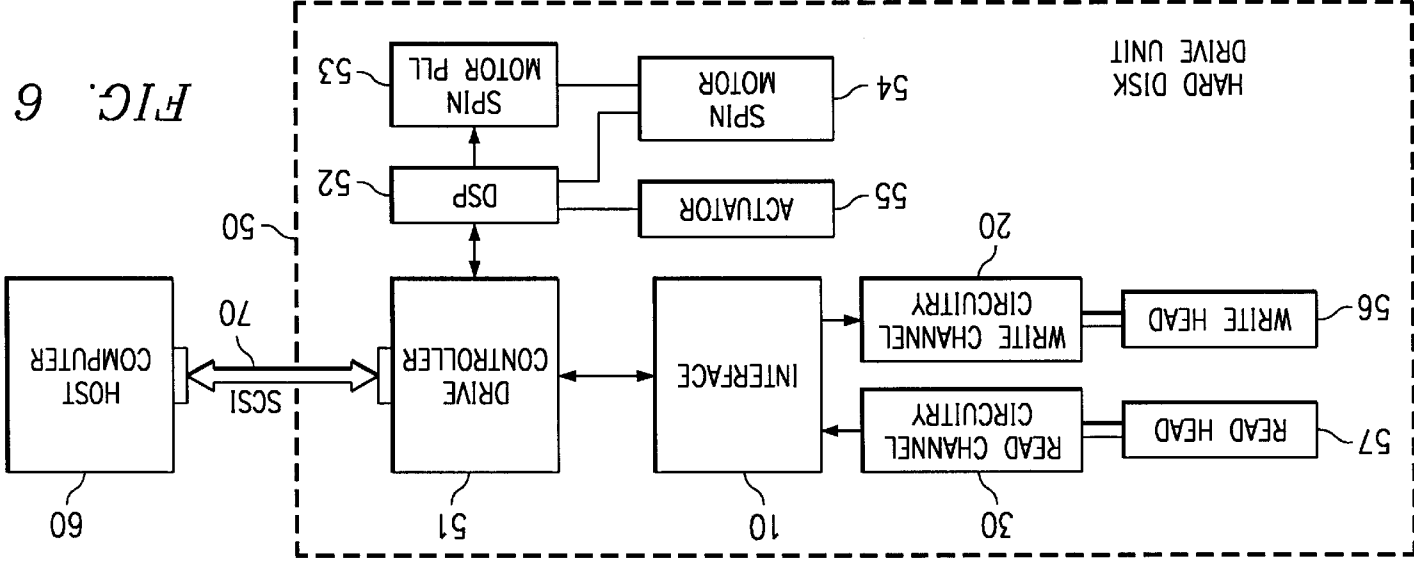
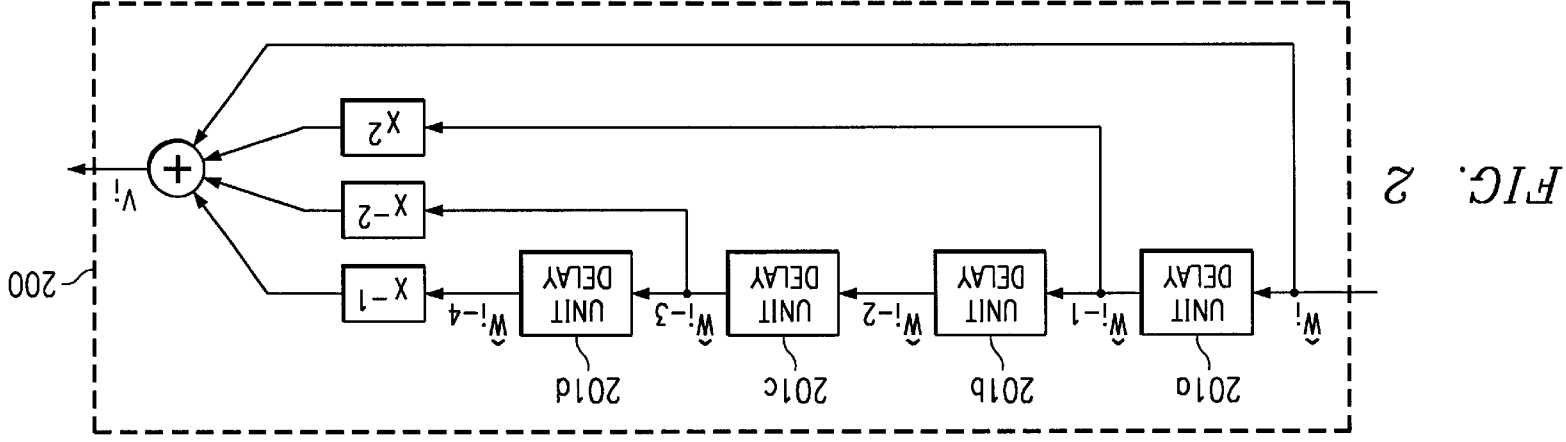


FIG. 1



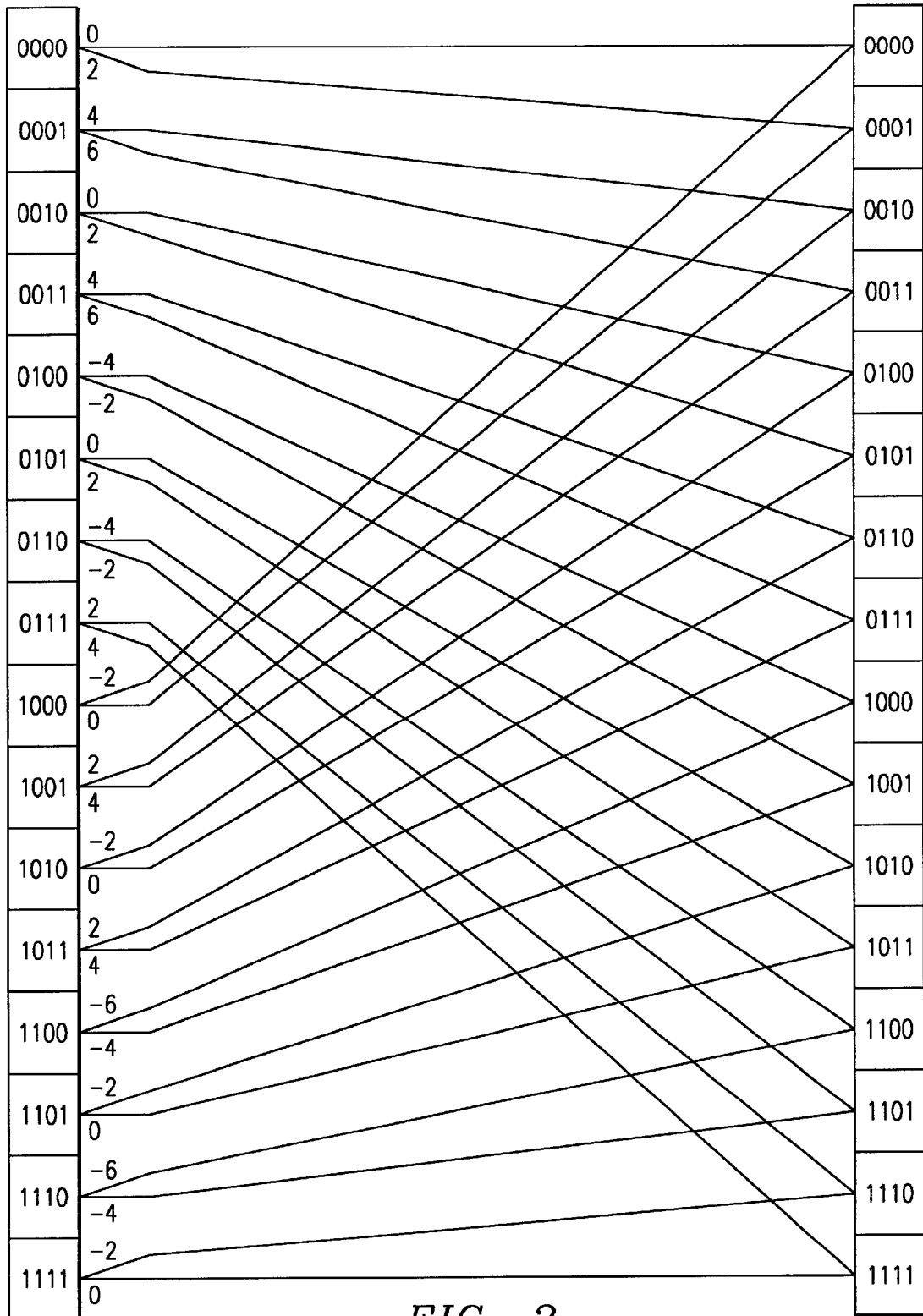


FIG. 3

$$A_{k+1} = x^4_{k+1} \cdot x^5_{k+1} + x^1_{k+1} \cdot x^2_{k+1} \cdot x^3_{k+1} + x^2_{k+1} \cdot x^3_{k+1} \cdot x^4_{k+1}$$

$$B_{k+1} = x^1_{k+1} \cdot x^2_{k+1} \cdot x^3_{k+1} \cdot x^4_{k+1}$$

$$Z4 = \overline{(x^1_k + x^2_k + x^3_k + x^4_k)}$$

$$Z5 = Z4 \cdot \overline{x^5_k}$$

$$C = A_k \cdot \overline{B_k}$$

$$D = Z5 \cdot \overline{A_{k+1}}$$

$$E = Z4 \cdot D \cdot \overline{u_k}$$

$$g^1_k = C + B_k + E$$

$$g^2_k = \overline{A_k} \cdot x^1_k + B_k + E$$

$$g^3_k = \overline{A_k} \cdot x^2_k + C \cdot x^1_k$$

$$g^4_k = \overline{A_k} \cdot x^3_k + C \cdot [x^2_k \cdot x^3_k + x^1_k \cdot x^2_k (x^3_k \oplus x^4_k)] + x^1_k \cdot x^2_k \cdot x^4_k + \overline{B_k} (S_k + S_k \cdot x^5_k)$$

$$g^5_k = \overline{A_k} \cdot x^4_k + C \cdot x^2_k (x^4_k \oplus x^5_k) + B_k \cdot S_k + D$$

$$S_{k+1} = \overline{A_k} \cdot x^5_k + C \cdot \overline{x^2_k} + B_k \cdot \overline{S_k} \cdot x^5_k$$

$$g^6_k = \overline{B_{k+1}} \cdot S_{k+1} + D$$

$$u_{k+1} = g^6_k$$

$$P3 = \overline{(g^4_{k-1} + g^5_{k-1} + g^6_{k-1})}$$

$$P4 = \overline{g^3_{k-1}} \cdot P3$$

$$P5 = \overline{g^2_{k-1}} \cdot P4$$

$$P6 = \overline{g^1_{k-1}} \cdot P5$$

$$Q2 = \overline{(g^1_k + g^2_k)}$$

$$Q3 = \overline{g^3_k} \cdot Q2$$

$$Q4 = \overline{g^4_k} \cdot Q3$$

$$F = P3 \cdot Q4 + P4 \cdot Q3 + P5 \cdot Q2 + P6 \cdot \overline{g^1_k}$$

$$y^1_{k-1} = g^1_{k-1}$$

$$y^2_{k-1} = g^2_{k-1}$$

$$y^3_{k-1} = g^3_{k-1}$$

$$y^4_{k-1} = g^4_{k-1}$$

$$y^5_{k-1} = g^5_{k-1} + F$$

$$y^6_{k-1} = g^6_{k-1} + F$$

FIG. 4

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