US006922167B2

(12) **United States Patent**
Gerein

(10) Patent No.: **US 6,922,167 B2**
(45) Date of Patent: **Jul. 26, 2005**

(54) **HARDWARE ARCHITECTURE FOR PROCESSING GALILEO ALTERNATE BINARY OFFSET CARRIER (ALTBOC) SIGNALS**

(75) Inventor: **Neil Gerein**, Okotoks (CA)

(73) Assignee: **European Space Agency**, Paris (FR)

(*) 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.: **10/681,689**

(22) Filed: **Oct. 8, 2003**

(65) **Prior Publication Data**

US 2005/0012664 A1 Jan. 20, 2005

Related U.S. Application Data

(60) Provisional application No. 60/487,180, filed on Jul. 14, 2003.

(51) Int. Cl.^{7} **G01S 5/02**; H04B 7/185
(52) U.S. Cl. **342/357.12**; 342/357.06; 701/213
(58) Field of Search 342/357.12, 357.06; 701/213

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,894,662 A	*	1/1990	Counselman	....	342/357.12
4,894,842 A	*	1/1990	Broekhoven et al.	....	375/150
5,736,961 A		4/1998	Fenton et al.		
2003/0231580 A1	*	12/2003	Martin et al.	....	370/203
2004/0071200 A1	*	4/2004	Betz et al.	....	375/152

OTHER PUBLICATIONS

F. Bastide, et al., "Analysis of LS/RS Acquisition, Tracking and Data Demodulation Thresholds" Proceedings of the Institute of Navigation, (ION), GPS, Sep. 2002, pp. 2196–2207.

(Continued)

Primary Examiner—Gregory C. Issing
(74) *Attorney, Agent, or Firm*—Cesari and McKenna, LLP

(57) **ABSTRACT**

A GNSS receiver tracks the AltBOC (**15,10**), or composite E5a and E5b, codes using hardware that locally generates the complex composite signal by combining separately generated real and the imaginary components of the complex signal. To track the dataless composite pilot code signals that are on the quadrature channel of the AltBOC signal, the receiver operates PRN code generators that produce replica E5a and E5b PRN codes and square wave generators that generate the real and imaginary components of the upper and lower subcarriers, and combines the signals to produce a locally generated complex composite code. The receiver removes the complex composite code from the received signal by multiplying the received signal, which has been downconverted to baseband I and Q signal components, by the locally generated complex composite code. The receiver then uses the results, which are correlated I and Q prompt signal values, to estimate the center frequency carrier phase angle tracking error. The error signal is used to control a numerically controlled oscillator that operates in a conventional manner, to correct the phase angle of the locally generated center frequency carrier. The receiver also uses early and late versions of the locally generated complex composite pilot code in a DLL, and aligns the locally generated composite pilot code with the received composite pilot code by minimizing the corresponding DLL error signal. Once the receiver is tracking the composite pilot code, the receiver determines its pseudorange and global position in a conventional manner. The receiver also uses a separate set of correlators to align locally generated versions of the in-phase composite PRN codes with the in-phase channel codes in the received signal, and thereafter, recover the data that is modulated thereon.

11 Claims, 11 Drawing Sheets
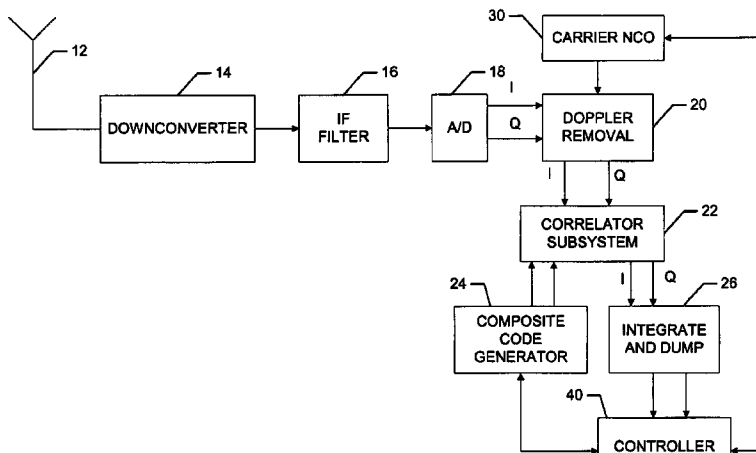
OTHER PUBLICATIONS

L. Ries, et al., "A Softare Simulation Tool for GNSS2 BOC Signals Analysis" Proceedings of the Institute of Navigation, GPS, Sep. 2002, pp. 2225–2239.

F. Dovis et al., "SDR Technology Applied to Galileo Receivers", Proceedings of the Institute of Navigation, GPS, Sep. 2002, pp. 2566–2575.

G.W. Hein, et al., "Status of Galileo Frequency and Signal Design", Proceedings of the Institute of Navigation, GPS, Sep. 2002, pp. 266–277.

Hein, Gunther et al, "Status of Galileo Frequency and Signal Design," ION GPS 2002, Sep. 2002.*

Ganguly, Dr. Suman, "Real–time Dual Frequency Software Reciever," 2003 IEEE Plans, Apr. 2004, pp. 366–374.*
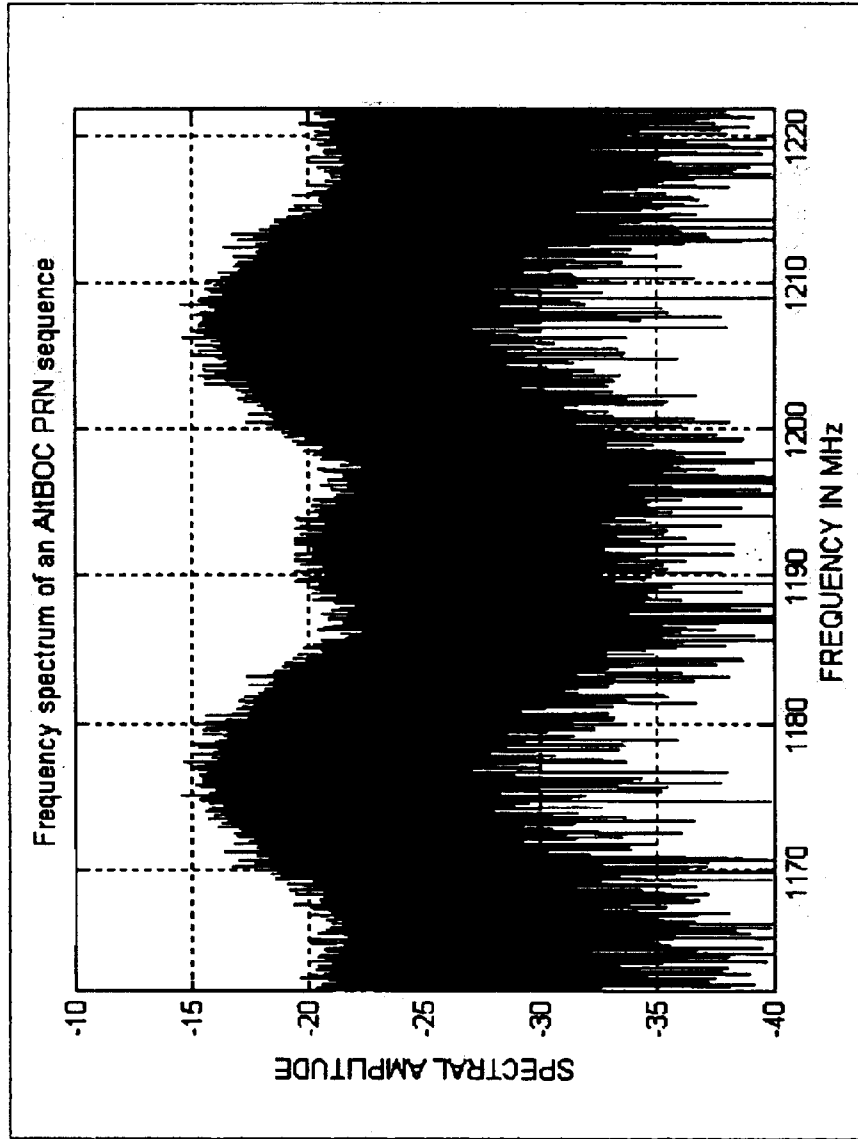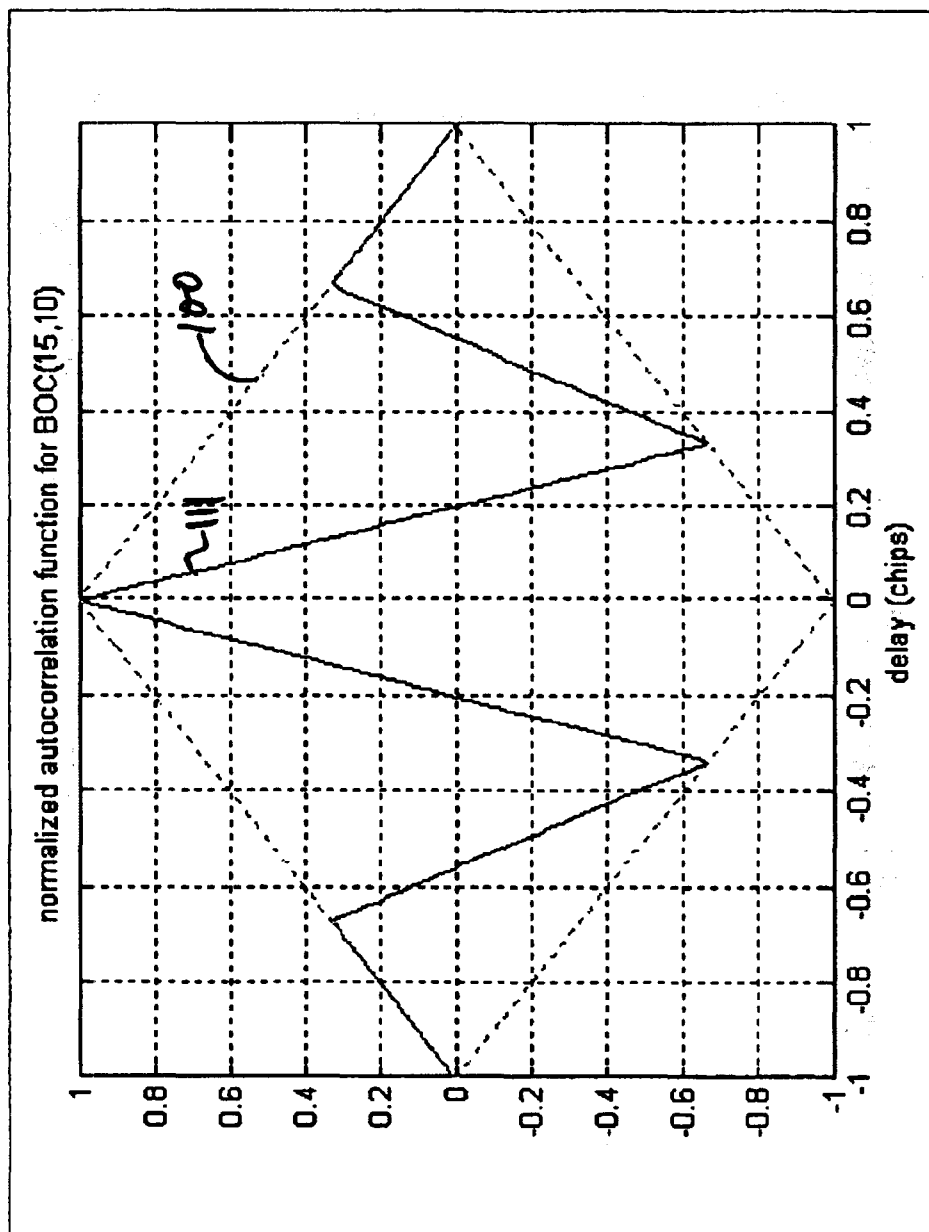
* cited by examiner

FIG. 1

normalized autocorrelation function for BOC(15,10)
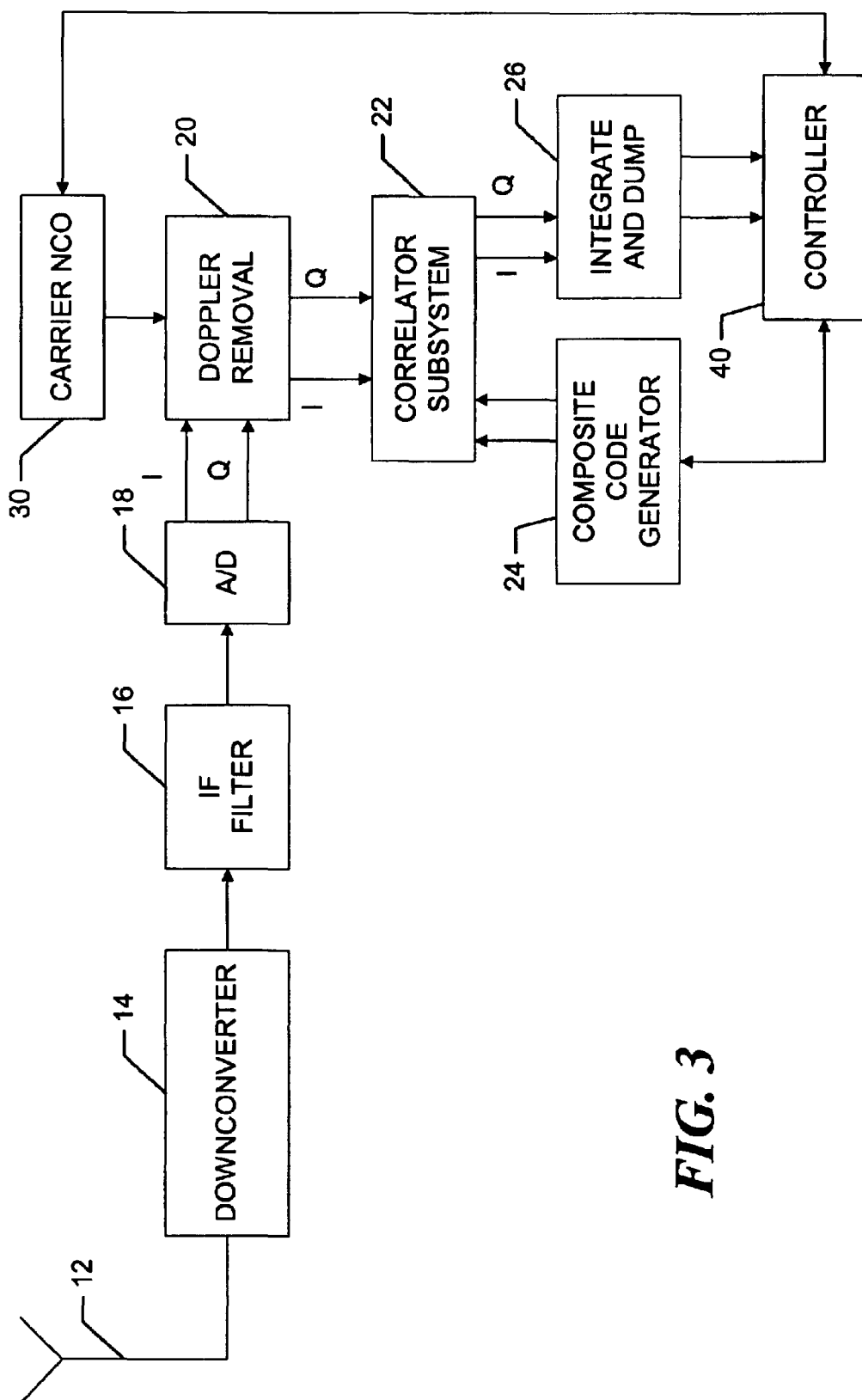
delay (chips)

FIG. 2

FIG. 3

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.

fastcase®
Smarter legal research.