US009332944B2

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

(10) **Patent No.: US 9,332,944 B2**
(45) **Date of Patent: *May 10, 2016**

(54) **METHOD AND SYSTEM FOR PROVIDING DATA MANAGEMENT IN DATA MONITORING SYSTEM**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 34 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **14/170,317**

(22) Filed: **Jan. 31, 2014**

(65) **Prior Publication Data**

US 2014/0148670 A1 May 29, 2014

Related U.S. Application Data

(63) Continuation of application No. 13/924,527, filed on Jun. 21, 2013, now Pat. No. 8,653,977, which is a continuation of application No. 13/341,853, filed on Dec. 30, 2011, now Pat. No. 8,471,714, which is a

(Continued)

(51) **Int. Cl.**

G08B 23/00	(2006.01)
A61B 5/00	(2006.01)
A61B 5/145	(2006.01)

(Continued)

(52) **U.S. Cl.**
CPC ***A61B 5/746*** (2013.01); ***A61B 5/0002*** (2013.01); ***A61B 5/145*** (2013.01); ***A61B 5/14532*** (2013.01); ***A61B 5/14546*** (2013.01); ***G01N 33/48792*** (2013.01); ***G06F 19/3418*** (2013.01)

(58) **Field of Classification Search**
CPC A61B 5/746
USPC 340/573.1
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,915,579	A	12/1959	Mendelsohn
3,374,337	A	3/1968	Burley
3,510,747	A	5/1970	Petrides

(Continued)

FOREIGN PATENT DOCUMENTS

CA	2143172	7/2005
CA	2413148	8/2010

(Continued)

OTHER PUBLICATIONS

"An Electrochemical Slow Flow Meter", http://gore.ocean.washington.edu/research/slow_flow_meter.html, 2005, 3 pages.

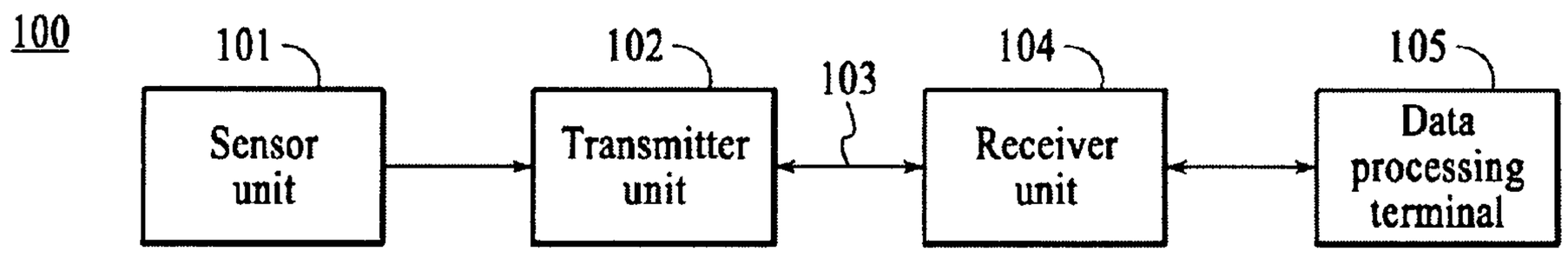
(Continued)

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(57) **ABSTRACT**

Method and system for providing a fault tolerant data receiver unit configured with a partitioned or separate processing units, each configured to perform a predetermined and/or specific processing associated with the one or more substantially non-overlapping functions of the data monitoring and management system is provided.

15 Claims, 3 Drawing Sheets



Related U.S. Application Data

continuation of application No. 13/022,610, filed on Feb. 7, 2011, now Pat. No. 8,089,363, which is a continuation of application No. 12/849,007, filed on Aug. 2, 2010, now Pat. No. 7,884,729, which is a continuation of application No. 11/383,945, filed on May 17, 2006, now Pat. No. 7,768,408.

(60) Provisional application No. 60/681,942, filed on May 17, 2005.

(51) **Int. Cl.**
G06F 19/00 (2011.01)
G01N 33/487 (2006.01)

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,541,892 A 11/1970 Kubinek et al.
3,606,592 A 9/1971 Madurski et al.
3,750,687 A 8/1973 Williams
3,843,455 A 10/1974 Bier
3,923,060 A 12/1975 Ellinwood
3,930,493 A 1/1976 Williamson
3,938,140 A 2/1976 Garcia et al.
3,994,799 A 11/1976 Yao et al.
4,001,604 A 1/1977 Parks et al.
4,018,547 A 4/1977 Rogen
4,048,551 A 9/1977 Bosik
4,121,282 A 10/1978 Ohsawa
4,146,029 A 3/1979 Ellinwood
4,172,770 A 10/1979 Semersky et al.
4,193,397 A 3/1980 Tucker et al.
4,268,173 A 5/1981 Barnard et al.
4,288,793 A 9/1981 Lotscher
4,309,156 A 1/1982 Gonner et al.
4,360,019 A 11/1982 Portner et al.
4,362,052 A 12/1982 Heath et al.
4,401,122 A 8/1983 Clark, Jr.
4,439,197 A 3/1984 Honda et al.
4,441,968 A 4/1984 Emmer et al.
4,447,224 A 5/1984 DeCant, Jr. et al.
4,458,686 A 7/1984 Clark, Jr.
4,467,811 A 8/1984 Clark, Jr.
4,472,113 A 9/1984 Rogen
4,474,309 A 10/1984 Solomon
4,486,190 A 12/1984 Reinicke
4,494,950 A 1/1985 Fischell
4,512,348 A 4/1985 Uchigaki et al.
4,524,343 A 6/1985 Morgan et al.
4,529,401 A 7/1985 Leslie et al.
4,531,235 A 7/1985 Brusen
4,562,751 A 1/1986 Nason et al.
4,563,249 A 1/1986 Hale
4,570,492 A 2/1986 Walsh
4,573,994 A 3/1986 Fischell et al.
4,574,809 A 3/1986 Talish et al.
4,633,878 A 1/1987 Bombardieri
4,655,880 A 4/1987 Liu
4,678,408 A 7/1987 Nason et al.
4,685,903 A 8/1987 Cable et al.
4,686,624 A 8/1987 Blum et al.
4,736,748 A 4/1988 Nakamura et al.
4,755,173 A 7/1988 Konopka et al.
4,811,564 A 3/1989 Palmer
4,850,959 A 7/1989 Findl
4,851,827 A 7/1989 Nicholas
4,866,396 A 9/1989 Tamura
4,883,409 A 11/1989 Strohmeier et al.
4,890,621 A 1/1990 Hakky
4,953,552 A 9/1990 DeMarzo
4,976,590 A 12/1990 Baldwin
4,979,509 A 12/1990 Hakky
4,984,581 A 1/1991 Stice
5,004,532 A 4/1991 Hale et al.
5,012,667 A 5/1991 Kruse
5,019,974 A 5/1991 Beckers
5,036,861 A 8/1991 Sembrowich et al.
5,051,880 A 9/1991 Harm et al.
5,061,914 A 10/1991 Busch et al.
5,078,683 A 1/1992 Sancoff et al.
5,079,920 A 1/1992 Whitehead et al.
5,081,421 A 1/1992 Miller et al.
5,101,814 A 4/1992 Palti
5,124,661 A 6/1992 Zelin et al.
5,139,023 A 8/1992 Stanley et al.
5,155,695 A 10/1992 Stein
5,190,041 A 3/1993 Palti
5,205,819 A 4/1993 Ross et al.
5,207,666 A 5/1993 Idriss et al.
5,211,371 A 5/1993 Coffee
5,211,626 A 5/1993 Frank et al.
5,223,822 A 6/1993 Stommes et al.
5,262,305 A 11/1993 Heller et al.
5,264,104 A 11/1993 Gregg et al.
5,267,026 A 11/1993 Kawahara et al.
5,278,997 A 1/1994 Martin
5,284,423 A 2/1994 Holdsworth et al.
5,284,425 A 2/1994 Holtermann et al.
5,291,614 A 3/1994 Baker et al.
5,291,887 A 3/1994 Stanley et al.
5,320,725 A 6/1994 Gregg et al.
5,324,599 A 6/1994 Oyama et al.
5,325,280 A 6/1994 Tortola et al.
5,349,852 A 9/1994 Kamen et al.
5,356,786 A 10/1994 Heller et al.
5,366,292 A 11/1994 Voss
5,368,028 A 11/1994 Palti
5,371,687 A 12/1994 Holmes, II et al.
5,372,133 A 12/1994 Hogen Esch
5,376,070 A 12/1994 Purvis et al.
5,382,331 A 1/1995 Banks
5,390,671 A 2/1995 Lord et al.
5,391,250 A 2/1995 Cheney, II et al.
5,398,681 A 3/1995 Kupershmidt
5,404,585 A 4/1995 Vimpari et al.
5,406,301 A 4/1995 Ravid
5,428,307 A 6/1995 Dendinger
5,445,611 A 8/1995 Eppstein et al.
5,448,992 A 9/1995 Kupershmidt
5,458,140 A 10/1995 Eppstein et al.
5,469,025 A 11/1995 Kanemori et al.
5,479,486 A 12/1995 Saji
5,494,562 A 2/1996 Maley et al.
5,497,772 A 3/1996 Schulman et al.
5,505,713 A 4/1996 Van Antwerp
5,507,288 A 4/1996 Bocker et al.
5,515,390 A 5/1996 Benton
5,517,434 A 5/1996 Hanson et al.
5,526,844 A 6/1996 Kamen et al.
5,527,288 A 6/1996 Gross et al.
5,532,686 A 7/1996 Urbas et al.
5,533,389 A 7/1996 Kamen et al.
5,543,678 A 8/1996 Hoiberg
5,559,528 A 9/1996 Ravid
5,568,400 A 10/1996 Stark et al.
5,568,806 A 10/1996 Cheney, II et al.
5,573,506 A 11/1996 Vasko
5,575,770 A 11/1996 Melsky et al.
5,576,535 A 11/1996 Oosterwijk et al.
5,586,553 A 12/1996 Halili et al.
5,593,852 A 1/1997 Heller et al.
5,594,906 A 1/1997 Holmes, II et al.
5,596,261 A 1/1997 Suyama
5,601,435 A 2/1997 Quy
5,604,404 A 2/1997 Sahara
5,615,671 A 4/1997 Schoonen et al.
5,620,579 A 4/1997 Genshaw et al.
5,622,413 A 4/1997 Kim et al.
5,622,482 A 4/1997 Lee
5,634,468 A 6/1997 Platt et al.
5,640,954 A 6/1997 Pfeiffer et al.
5,645,709 A 7/1997 Birch et al.
5,660,163 A 8/1997 Schulman et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,661,643	A	8/1997	Blakely et al.
5,662,461	A	9/1997	Ono
5,665,222	A	9/1997	Heller et al.
5,671,301	A	9/1997	Kupershmidt
5,685,844	A	11/1997	Marttila
5,695,949	A	12/1997	Galen et al.
5,703,928	A	12/1997	Galloway et al.
5,707,502	A	1/1998	McCaffrey et al.
5,708,247	A	1/1998	McAleer et al.
5,711,861	A	1/1998	Ward et al.
5,711,868	A	1/1998	Maley et al.
5,722,397	A	3/1998	Eppstein
5,724,030	A	3/1998	Urbas et al.
5,738,220	A	4/1998	Geszler
5,741,211	A	4/1998	Renirie et al.
5,748,872	A	5/1998	Norman
5,749,907	A	5/1998	Mann
5,759,510	A	6/1998	Pillai
5,771,890	A	6/1998	Tamada
5,774,254	A	6/1998	Berlin
5,786,439	A	7/1998	Van Antwerp et al.
5,790,297	A	8/1998	Berlin
5,791,344	A	8/1998	Schulman et al.
5,804,047	A	9/1998	Karube et al.
5,812,102	A	9/1998	Sprole et al.
5,814,020	A	9/1998	Gross
5,814,599	A	9/1998	Mitragotri et al.
5,815,303	A	9/1998	Berlin
5,822,715	A	10/1998	Worthington et al.
5,825,488	A	10/1998	Kohl et al.
5,833,603	A	11/1998	Kovacs et al.
5,848,990	A	12/1998	Cirelli et al.
5,851,197	A	12/1998	Marano et al.
5,856,631	A	1/1999	Julien
5,858,001	A	1/1999	Tsals et al.
5,873,026	A	2/1999	Reames
5,875,417	A	2/1999	Golden
5,885,211	A	3/1999	Eppstein et al.
5,891,049	A	4/1999	Cyrus et al.
5,899,855	A	5/1999	Brown
5,913,833	A	6/1999	Elstrom et al.
5,918,603	A	7/1999	Brown
5,919,167	A	7/1999	Mulhauser
5,923,512	A	7/1999	Brownlow et al.
5,931,814	A	8/1999	Alex et al.
5,947,921	A	9/1999	Johnson et al.
5,948,512	A	9/1999	Kubota et al.
5,951,485	A	9/1999	Cyrus et al.
5,951,582	A	9/1999	Thorne et al.
5,951,836	A	9/1999	McAleer et al.
5,954,643	A	9/1999	Van Antwerp et al.
5,965,380	A	10/1999	Heller et al.
5,968,011	A	10/1999	Larsen et al.
5,971,922	A	10/1999	Arita et al.
5,972,199	A	10/1999	Heller et al.
5,993,411	A	11/1999	Choi
5,994,878	A	11/1999	Ostergaard et al.
5,997,501	A	12/1999	Gross et al.
6,001,067	A	12/1999	Shults et al.
6,002,961	A	12/1999	Mitragotri et al.
6,011,486	A	1/2000	Casey
6,014,577	A	1/2000	Henning et al.
6,017,328	A	1/2000	Fischell et al.
6,018,678	A	1/2000	Mitragotri et al.
6,023,629	A	2/2000	Tamada
6,024,539	A	2/2000	Blomquist et al.
6,026,320	A	2/2000	Carlson et al.
6,027,459	A	2/2000	Shain et al.
6,027,496	A	2/2000	Loomis et al.
6,027,692	A	2/2000	Galen et al.
6,032,059	A	2/2000	Henning et al.
6,041,253	A	3/2000	Kost et al.
6,041,665	A	3/2000	Hussain
6,059,546	A	5/2000	Brenan et al.
6,063,039	A	5/2000	Cunningham et al.
6,064,368	A *	5/2000	Kang 345/158
6,066,243	A	5/2000	Anderson et al.
6,067,017	A	5/2000	Stewart et al.
6,067,463	A	5/2000	Jeng et al.
6,071,249	A	6/2000	Cunningham et al.
6,071,251	A	6/2000	Cunningham et al.
6,073,031	A	6/2000	Helstab et al.
6,077,660	A	6/2000	Wong et al.
6,081,104	A	6/2000	Kern
6,082,289	A	7/2000	Cavallaro
6,083,710	A	7/2000	Heller et al.
6,085,871	A	7/2000	Karamata
6,086,575	A	7/2000	Mejslov
6,091,975	A	7/2000	Daddona et al.
6,091,987	A	7/2000	Thompson
6,093,156	A	7/2000	Cunningham et al.
6,093,172	A	7/2000	Funderburk et al.
6,103,033	A	8/2000	Say et al.
6,120,676	A	9/2000	Heller et al.
6,121,009	A	9/2000	Heller et al.
6,129,823	A	10/2000	Hughes et al.
6,130,623	A	10/2000	MacLellan et al.
6,132,371	A	10/2000	Dempsey et al.
6,134,461	A	10/2000	Say et al.
6,142,939	A	11/2000	Eppstein et al.
6,143,164	A	11/2000	Heller et al.
6,144,303	A	11/2000	Federman
6,144,869	A	11/2000	Berner et al.
6,144,871	A	11/2000	Saito et al.
6,144,922	A	11/2000	Douglas et al.
6,147,342	A	11/2000	Kucher
6,154,855	A	11/2000	Norman
6,155,992	A	12/2000	Henning et al.
6,157,442	A	12/2000	Raskas
6,160,449	A	12/2000	Klomsdorf et al.
6,162,202	A	12/2000	Sicurelli et al.
6,162,611	A	12/2000	Heller et al.
6,164,284	A	12/2000	Schulman et al.
6,173,160	B1	1/2001	Liimatainen
6,175,752	B1	1/2001	Say et al.
6,180,416	B1	1/2001	Kurnik et al.
6,185,452	B1	2/2001	Schulman et al.
6,186,982	B1	2/2001	Gross et al.
6,192,891	B1	2/2001	Gravel et al.
6,200,265	B1	3/2001	Walsh et al.
6,201,721	B1	3/2001	Suranyi et al.
6,201,980	B1	3/2001	Darrow et al.
6,203,288	B1	3/2001	Kottke
6,206,841	B1	3/2001	Cunningham et al.
6,208,894	B1	3/2001	Schulman et al.
6,212,416	B1	4/2001	Ward et al.
6,215,206	B1	4/2001	Chitayat
6,222,514	B1	4/2001	DeLuca
6,228,100	B1	5/2001	Schraga
6,232,370	B1	5/2001	Kubota et al.
6,233,471	B1	5/2001	Berner et al.
6,233,539	B1	5/2001	Brown
6,242,961	B1	6/2001	Liu et al.
6,245,060	B1	6/2001	Loomis et al.
6,248,067	B1	6/2001	Causey, III et al.
6,262,708	B1	7/2001	Chu
6,272,364	B1	8/2001	Kurnik
6,278,425	B1	8/2001	DeLuca
6,280,587	B1	8/2001	Matsumoto
6,283,926	B1	9/2001	Cunningham et al.
6,283,951	B1	9/2001	Flaherty et al.
6,284,478	B1	9/2001	Heller et al.
6,288,653	B1	9/2001	Shih
6,291,200	B1	9/2001	LeJeune et al.
6,293,925	B1	9/2001	Safabash et al.
6,294,997	B1	9/2001	Paratore et al.
6,295,506	B1	9/2001	Heinonen et al.
6,298,254	B2	10/2001	Tamada
6,298,255	B1	10/2001	Cordero et al.
6,299,578	B1	10/2001	Kurnik et al.
6,301,499	B1	10/2001	Carlson et al.
6,306,104	B1	10/2001	Cunningham et al.
6,309,351	B1	10/2001	Kurnik et al.
6,312,888	B1	11/2001	Wong et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,315,721	B2	11/2001	Schulman et al.
6,326,160	B1	12/2001	Dunn et al.
6,329,161	B1	12/2001	Heller et al.
6,331,244	B1	12/2001	Lewis et al.
6,338,790	B1	1/2002	Feldman et al.
6,341,232	B1	1/2002	Conn et al.
6,356,776	B1	3/2002	Berner et al.
6,360,888	B1	3/2002	McIvor et al.
6,366,793	B1	4/2002	Bell et al.
6,368,141	B1	4/2002	VanAntwerp et al.
6,368,274	B1	4/2002	Van Antwerp et al.
6,372,371	B1	4/2002	Iarochenko et al.
6,375,344	B1	4/2002	Hanson et al.
6,375,638	B2	4/2002	Nason et al.
6,377,894	B1	4/2002	Deweese et al.
6,379,301	B1	4/2002	Worthington et al.
6,381,496	B1	4/2002	Meadows et al.
6,387,048	B1	5/2002	Schulman et al.
6,393,318	B1	5/2002	Conn et al.
6,400,974	B1	6/2002	Lesho
6,403,944	B1	6/2002	MacKenzie et al.
6,405,066	B1	6/2002	Essenpreis et al.
6,408,402	B1	6/2002	Norman
6,413,393	B1	7/2002	Van Antwerp et al.
6,416,471	B1	7/2002	Kumar et al.
6,417,074	B2	7/2002	Kopley et al.
6,418,332	B1	7/2002	Mastrototaro et al.
6,418,346	B1	7/2002	Nelson et al.
6,419,642	B1	7/2002	Marchitto et al.
6,421,389	B1	7/2002	Jett et al.
6,425,829	B1	7/2002	Julien
6,427,088	B1	7/2002	Bowman, IV et al.
6,432,585	B1	8/2002	Kawakami et al.
6,437,379	B2	8/2002	Kopley et al.
6,438,385	B1	8/2002	Heinonen et al.
6,438,414	B1	8/2002	Conn et al.
6,442,413	B1	8/2002	Silver
6,445,374	B2	9/2002	Albert et al.
6,461,329	B1	10/2002	Van Antwerp et al.
6,462,162	B2	10/2002	Van Antwerp et al.
6,464,848	B1	10/2002	Matsumoto
6,466,807	B1	10/2002	Dobson et al.
6,466,810	B1	10/2002	Ward et al.
6,468,222	B1	10/2002	Mault et al.
6,471,980	B2	10/2002	Sirhan et al.
6,472,991	B1	10/2002	Schulman et al.
6,475,196	B1	11/2002	Vachon
6,478,736	B1	11/2002	Mault
6,480,730	B2	11/2002	Darrow et al.
6,482,158	B2	11/2002	Mault
6,482,176	B1	11/2002	Wich
6,484,045	B1	11/2002	Holker et al.
6,484,046	B1	11/2002	Say et al.
6,485,138	B1	11/2002	Kubota et al.
6,485,461	B1	11/2002	Mason et al.
6,485,465	B2	11/2002	Moberg et al.
6,492,180	B2	12/2002	Brown et al.
6,496,729	B2	12/2002	Thompson
6,497,655	B1	12/2002	Linberg et al.
6,498,043	B1	12/2002	Schulman et al.
6,506,168	B1	1/2003	Fathallah et al.
6,513,532	B2	2/2003	Mault et al.
6,514,460	B1	2/2003	Fendrock
6,514,689	B2	2/2003	Han et al.
6,514,718	B2	2/2003	Heller et al.
6,520,326	B2	2/2003	McIvor et al.
6,522,530	B2	2/2003	Bang
6,525,330	B2	2/2003	Paolini et al.
6,526,298	B1	2/2003	Khalil et al.
6,529,772	B2	3/2003	Carlson et al.
6,530,915	B1	3/2003	Eppstein et al.
6,535,753	B1	3/2003	Raskas
6,537,243	B1	3/2003	Henning et al.
6,540,675	B2	4/2003	Aceti et al.
6,540,891	B1	4/2003	Stewart et al.
6,543,224	B1	4/2003	Barooah
6,544,212	B2	4/2003	Galley et al.
6,546,269	B1	4/2003	Kurnik
6,549,796	B2	4/2003	Sohrab
6,551,276	B1	4/2003	Mann et al.
6,554,798	B1	4/2003	Mann et al.
6,558,320	B1	5/2003	Causey, III et al.
6,558,321	B1	5/2003	Burd et al.
6,558,351	B1	5/2003	Steil et al.
6,560,471	B1	5/2003	Heller et al.
6,561,975	B1	5/2003	Pool et al.
6,561,978	B1	5/2003	Conn et al.
6,562,001	B2	5/2003	Lebel et al.
6,564,105	B2	5/2003	Starkweather et al.
6,564,807	B1	5/2003	Schulman et al.
6,565,509	B1	5/2003	Say et al.
6,565,738	B1	5/2003	Henning et al.
6,569,157	B1	5/2003	Shain et al.
6,571,128	B2	5/2003	Lebel et al.
6,571,200	B1	5/2003	Mault
6,574,510	B2	6/2003	Von Arx et al.
6,576,117	B1	6/2003	Iketaki et al.
6,577,899	B2	6/2003	Lebel et al.
6,579,231	B1	6/2003	Phipps
6,579,498	B1	6/2003	Eglise
6,579,690	B1	6/2003	Bonnecaze et al.
6,582,393	B2	6/2003	Sage, Jr.
6,585,644	B2	7/2003	Lebel et al.
6,586,971	B1	7/2003	Naffziger et al.
6,587,705	B1	7/2003	Kim et al.
6,589,229	B1	7/2003	Connelly et al.
6,594,514	B2	7/2003	Berner et al.
6,595,919	B2	7/2003	Berner et al.
6,596,016	B1	7/2003	Vreman et al.
6,600,997	B2	7/2003	Deweese et al.
6,602,469	B1	8/2003	Maus et al.
6,607,509	B2	8/2003	Bobroff et al.
6,610,012	B2	8/2003	Mault
6,612,306	B1	9/2003	Mault
6,615,061	B1	9/2003	Khalil et al.
6,615,074	B2	9/2003	Mickle et al.
6,618,603	B2	9/2003	Varalli et al.
6,620,106	B2	9/2003	Mault
6,623,501	B2	9/2003	Heller et al.
6,629,934	B2	10/2003	Mault et al.
6,633,095	B1	10/2003	Swope et al.
6,633,772	B2	10/2003	Ford et al.
6,635,014	B2	10/2003	Starkweather et al.
6,635,167	B1	10/2003	Batman et al.
6,641,533	B2	11/2003	Causey, III et al.
6,645,142	B2	11/2003	Braig et al.
6,648,821	B2	11/2003	Lebel et al.
6,650,064	B2	11/2003	Guthrie et al.
6,653,091	B1	11/2003	Dunn et al.
6,656,158	B2	12/2003	Mahoney et al.
6,656,159	B2	12/2003	Flaherty
6,659,948	B2	12/2003	Lebel et al.
6,659,980	B2	12/2003	Moberg et al.
6,668,196	B1	12/2003	Villegas et al.
6,669,663	B1	12/2003	Thompson
6,669,669	B2	12/2003	Flaherty et al.
6,670,806	B2	12/2003	Wendt et al.
6,679,841	B2	1/2004	Bojan et al.
6,687,522	B2	2/2004	Tamada
6,687,546	B2	2/2004	Lebel et al.
6,692,457	B2	2/2004	Flaherty
6,694,191	B2	2/2004	Starkweather et al.
6,695,885	B2	2/2004	Schulman et al.
6,699,218	B2	3/2004	Flaherty et al.
6,702,857	B2	3/2004	Brauker et al.
6,723,072	B2	4/2004	Mahoney et al.
6,728,560	B2	4/2004	Kollias et al.
6,730,200	B1	5/2004	Stewart et al.
6,731,976	B2	5/2004	Penn et al.
6,733,446	B2	5/2004	Lebel et al.
6,735,183	B2	5/2004	O'Toole et al.
6,736,777	B2	5/2004	Kim et al.
6,736,797	B1	5/2004	Larsen et al.
6,738,654	B2	5/2004	Sohrab

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,740,059	B2	5/2004	Flaherty
6,740,075	B2	5/2004	Lebel et al.
6,741,877	B1	5/2004	Shults et al.
6,743,635	B2	6/2004	Neel et al.
6,746,582	B2	6/2004	Heller et al.
6,749,587	B2	6/2004	Flaherty
6,752,785	B2	6/2004	Van Antwerp et al.
6,752,787	B1	6/2004	Causey, III et al.
6,758,810	B2	7/2004	Lebel et al.
6,764,581	B1	7/2004	Forrow et al.
6,768,425	B2	7/2004	Flaherty et al.
6,770,030	B1	8/2004	Schaupp et al.
6,770,729	B2	8/2004	Van Antwerp
6,773,563	B2	8/2004	Matsumoto
6,779,984	B2	8/2004	Lilie et al.
6,789,195	B1	9/2004	Prihoda et al.
6,790,178	B1	9/2004	Mault et al.
6,794,195	B2	9/2004	Colvin, Jr.
6,799,861	B2	10/2004	Naghi et al.
6,804,558	B2	10/2004	Haller et al.
6,809,653	B1	10/2004	Mann et al.
6,810,290	B2	10/2004	Lebel et al.
6,811,533	B2	11/2004	Lebel et al.
6,811,534	B2	11/2004	Bowman, IV et al.
6,813,519	B2	11/2004	Lebel et al.
6,816,742	B2	11/2004	Kim et al.
6,818,348	B1	11/2004	Venkatesan et al.
6,830,558	B2	12/2004	Flaherty et al.
6,832,114	B1	12/2004	Whitehurst et al.
6,833,540	B2	12/2004	MacKenzie et al.
6,835,553	B2	12/2004	Han et al.
6,837,858	B2	1/2005	Cunningham et al.
6,839,596	B2	1/2005	Nelson et al.
6,840,912	B2	1/2005	Kloepfer et al.
6,849,237	B2	2/2005	Housefield et al.
6,850,790	B2	2/2005	Berner et al.
6,859,831	B1	2/2005	Gelvin et al.
6,862,465	B2	3/2005	Shults et al.
6,872,200	B2	3/2005	Mann et al.
6,873,268	B2	3/2005	Lebel et al.
6,878,112	B2	4/2005	Linberg et al.
6,881,551	B2	4/2005	Heller et al.
6,892,085	B2	5/2005	McIvor et al.
6,893,396	B2	5/2005	Schulze et al.
6,895,265	B2	5/2005	Silver
6,898,451	B2	5/2005	Wuori
6,899,683	B2	5/2005	Mault et al.
6,899,684	B2	5/2005	Mault et al.
6,904,301	B2	6/2005	Raskas
6,907,127	B1	6/2005	Kravitz et al.
6,908,535	B2	6/2005	Rankin et al.
6,916,159	B2	7/2005	Rush et al.
6,918,874	B1	7/2005	Hatch et al.
6,922,576	B2	7/2005	Raskas
6,922,578	B2	7/2005	Eppstein et al.
6,923,764	B2	8/2005	Aceti et al.
6,927,749	B1	8/2005	Klemm
6,931,327	B2	8/2005	Goode, Jr. et al.
6,936,029	B2	8/2005	Mann et al.
6,940,403	B2	9/2005	Kail, IV
6,941,163	B2	9/2005	Ford et al.
6,949,816	B2	9/2005	Brown et al.
6,950,708	B2	9/2005	Bowman IV et al.
6,952,603	B2	10/2005	Gerber et al.
6,955,650	B2	10/2005	Mault et al.
6,958,129	B2	10/2005	Galen et al.
6,958,705	B2	10/2005	Lebel et al.
6,960,192	B1	11/2005	Flaherty et al.
6,961,448	B2	11/2005	Nichols et al.
6,974,437	B2	12/2005	Lebel et al.
6,979,326	B2	12/2005	Mann et al.
6,990,366	B2	1/2006	Say et al.
6,990,372	B2	1/2006	Perron et al.
6,997,911	B2	2/2006	Klitmose
6,997,920	B2	2/2006	Mann et al.
6,999,810	B2	2/2006	Berner et al.
7,003,340	B2	2/2006	Say et al.
7,003,341	B2	2/2006	Say et al.
7,005,857	B2	2/2006	Stiene et al.
7,006,858	B2	2/2006	Silver et al.
7,009,511	B2	3/2006	Mazar et al.
7,010,356	B2	3/2006	Jog et al.
7,011,630	B2	3/2006	Desai et al.
7,018,360	B2	3/2006	Flaherty et al.
7,020,508	B2	3/2006	Stivoric et al.
7,024,236	B2	4/2006	Ford et al.
7,024,245	B2	4/2006	Lebel et al.
7,024,249	B2	4/2006	Weisner et al.
7,025,743	B2	4/2006	Mann et al.
7,029,444	B2	4/2006	Shin et al.
7,029,455	B2	4/2006	Flaherty
7,034,677	B2	4/2006	Steinthal et al.
7,041,468	B2	5/2006	Drucker et al.
7,043,287	B1	5/2006	Khalil et al.
7,043,305	B2	5/2006	KenKnight et al.
7,052,251	B2	5/2006	Nason et al.
7,058,437	B2	6/2006	Buse et al.
7,058,453	B2	6/2006	Nelson et al.
7,060,031	B2	6/2006	Webb et al.
7,067,498	B2	6/2006	Wolf et al.
7,070,591	B2	7/2006	Adams et al.
7,072,738	B2	7/2006	Bonney et al.
7,074,307	B2	7/2006	Simpson et al.
7,077,328	B2	7/2006	Krishnaswamy et al.
7,079,901	B1	7/2006	Loftin et al.
7,081,195	B2	7/2006	Simpson et al.
7,082,334	B2	7/2006	Boute et al.
7,083,593	B2	8/2006	Stultz
7,086,277	B2	8/2006	Tess et al.
7,092,762	B1	8/2006	Loftin et al.
7,097,983	B2	8/2006	Markovsky et al.
7,098,803	B2	8/2006	Mann et al.
7,108,711	B2	9/2006	Vogel et al.
7,108,778	B2	9/2006	Simpson et al.
7,110,803	B2	9/2006	Shults et al.
7,114,502	B2	10/2006	Schulman et al.
7,123,206	B2	10/2006	Hess et al.
7,125,382	B2	10/2006	Zhou et al.
7,133,710	B2	11/2006	Acosta et al.
7,134,999	B2	11/2006	Brauker et al.
7,136,689	B2	11/2006	Shults et al.
7,136,704	B2	11/2006	Schulman
7,137,964	B2	11/2006	Flaherty
7,144,384	B2	12/2006	Gorman et al.
7,149,581	B2	12/2006	Goedeke
7,153,212	B1	12/2006	Karten et al.
7,154,398	B2	12/2006	Chen et al.
7,163,511	B2	1/2007	Conn et al.
7,167,818	B2	1/2007	Brown
7,171,274	B2	1/2007	Starkweather et al.
7,181,261	B2	2/2007	Silver et al.
7,186,566	B2	3/2007	Qian
7,186,791	B2	3/2007	Bruno et al.
7,192,450	B2	3/2007	Brauker et al.
7,193,521	B2	3/2007	Moberg et al.
7,198,603	B2	4/2007	Penner et al.
7,202,734	B1	4/2007	Raab
7,203,549	B2	4/2007	Schommer et al.
7,205,409	B2	4/2007	Pei et al.
7,207,974	B2	4/2007	Safabash et al.
7,208,119	B1	4/2007	Kurtock et al.
7,211,048	B1	5/2007	Najafi et
7,218,017	B1	5/2007	Chitayet et al.
7,225,535	B2	6/2007	Feldman et al.
7,226,278	B2	6/2007	Nason et al.
7,226,442	B2	6/2007	Sheppard, Jr. et al.
7,226,978	B2	6/2007	Tapsak et al.
7,228,182	B2	6/2007	Healy et al.
7,237,712	B2	7/2007	DeRocco et al.
7,258,666	B2	8/2007	Brown
7,266,400	B2	9/2007	Fine et al.
7,267,665	B2	9/2007	Steil et al.
7,276,029	B2	10/2007	Goode, Jr. et al.
7,283,867	B2	10/2007	Strother et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,291,497	B2	11/2007	Holmes et al.	
7,295,867	B2	11/2007	Berner et al.	
7,299,080	B2	11/2007	Acosta et al.	
7,303,549	B2	12/2007	Flaherty et al.	
7,310,544	B2	12/2007	Brister et al.	
7,318,816	B2	1/2008	Bobroff et al.	
7,323,091	B1	1/2008	Gillette et al.	
7,324,850	B2	1/2008	Persen et al.	
7,324,949	B2	1/2008	Bristol et al.	
7,343,188	B2	3/2008	Sohrab	
7,347,819	B2	3/2008	Lebel et al.	
7,354,420	B2	4/2008	Steil et al.	
7,364,592	B2	4/2008	Carr-Brendel et al.	
7,366,556	B2	4/2008	Brister et al.	
7,371,247	B2	5/2008	Boecker et al.	
7,379,765	B2	5/2008	Petisce et al.	
7,384,397	B2	6/2008	Zhang et al.	
7,387,010	B2	6/2008	Sunshine et al.	
7,399,277	B2	7/2008	Saidara et al.	
7,419,573	B2	9/2008	Gundel	
7,424,318	B2	9/2008	Brister et al.	
7,436,511	B2	10/2008	Ruchti et al.	
7,460,898	B2	12/2008	Brister et al.	
7,467,003	B2	12/2008	Brister et al.	
7,471,972	B2	12/2008	Rhodes et al.	
7,480,138	B2	1/2009	Kogan et al.	
7,492,254	B2	2/2009	Bandy et al.	
7,494,465	B2	2/2009	Brister et al.	
7,497,827	B2	3/2009	Brister et al.	
7,510,526	B2	3/2009	Merry et al.	
7,519,408	B2	4/2009	Rasdal et al.	
7,565,197	B2	7/2009	Haubrich et al.	
7,570,018	B2	8/2009	Waguespack	
7,574,266	B2	8/2009	Dudding et al.	
7,583,190	B2	9/2009	Reggiardo et al.	
7,583,990	B2	9/2009	Goode, Jr. et al.	
7,591,801	B2	9/2009	Brauker et al.	
7,599,726	B2	10/2009	Goode, Jr. et al.	
7,602,310	B2	10/2009	Mann et al.	
7,604,178	B2	10/2009	Stewart	
7,613,491	B2	11/2009	Boock et al.	
7,615,007	B2	11/2009	Shults et al.	
7,620,437	B2	11/2009	Reggiardo	
7,632,228	B2	12/2009	Brauker et al.	
7,637,868	B2	12/2009	Saint et al.	
7,640,048	B2	12/2009	Dobbles et al.	
7,651,596	B2	1/2010	Petisce et al.	
7,654,956	B2	2/2010	Brister et al.	
7,657,297	B2	2/2010	Simpson et al.	
7,659,823	B1	2/2010	Killian et al.	
7,668,596	B2	2/2010	Von Arx et al.	
7,711,402	B2	5/2010	Shults et al.	
7,713,574	B2	5/2010	Brister et al.	
7,715,893	B2	5/2010	Kamath et al.	
7,741,734	B2	6/2010	Joannopoulos et al.	
7,768,408	B2 *	8/2010	Reggiardo et al.	340/573.1
7,771,352	B2	8/2010	Shults et al.	
7,774,145	B2	8/2010	Brauker et al.	
7,778,795	B2	8/2010	Fukushima et al.	
7,779,332	B2	8/2010	Karr et al.	
7,782,192	B2	8/2010	Jeckelmann et al.	
7,783,333	B2	8/2010	Brister et al.	
7,791,467	B2	9/2010	Mazar et al.	
7,792,562	B2	9/2010	Shults et al.	
7,826,981	B2	11/2010	Goode, Jr. et al.	
7,831,310	B2	11/2010	Lebel et al.	
7,850,621	B2	12/2010	Briggs et al.	
7,860,574	B2	12/2010	Von Arx et al.	
7,882,611	B2	2/2011	Shah et al.	
7,884,729	B2 *	2/2011	Reggiardo et al.	340/573.1
7,899,511	B2	3/2011	Shults et al.	
7,899,545	B2	3/2011	John	
7,905,833	B2	3/2011	Brister et al.	
7,911,010	B2	3/2011	Stetter	
7,912,674	B2	3/2011	Killoren Clark et al.	
7,914,450	B2	3/2011	Goode, Jr. et al.	
7,916,013	B2	3/2011	Stevenson	
7,922,458	B2	4/2011	Rush et al.	
7,954,385	B2	6/2011	Raisanen	
7,955,258	B2	6/2011	Goscha et al.	
7,970,448	B2	6/2011	Shults et al.	
7,974,672	B2	7/2011	Shults et al.	
7,999,674	B2	8/2011	Kamen	
8,047,811	B2	11/2011	Rush et al.	
8,072,310	B1	12/2011	Everhart	
8,089,363	B2 *	1/2012	Reggiardo et al.	340/573.1
8,090,445	B2	1/2012	Ginggen	
8,093,991	B2	1/2012	Stevenson et al.	
8,094,009	B2	1/2012	Allen et al.	
8,098,159	B2	1/2012	Batra et al.	
8,098,160	B2	1/2012	Howarth et al.	
8,098,161	B2	1/2012	Lavedas	
8,098,201	B2	1/2012	Choi et al.	
8,098,208	B2	1/2012	Ficker et al.	
8,102,021	B2	1/2012	Degani	
8,102,154	B2	1/2012	Bishop et al.	
8,102,263	B2	1/2012	Yeo et al.	
8,102,789	B2	1/2012	Rosar et al.	
8,103,241	B2	1/2012	Young et al.	
8,103,325	B2	1/2012	Swedlow et al.	
8,111,042	B2	2/2012	Bennett	
8,115,488	B2	2/2012	McDowell	
8,116,681	B2	2/2012	Baarman	
8,116,683	B2	2/2012	Baarman	
8,117,481	B2	2/2012	Anselmi et al.	
8,120,493	B2	2/2012	Burr	
8,124,452	B2	2/2012	Sheats	
8,130,093	B2	3/2012	Mazar et al.	
8,131,351	B2	3/2012	Kalgren et al.	
8,131,365	B2	3/2012	Zhang et al.	
8,131,565	B2	3/2012	Dicks et al.	
8,132,037	B2	3/2012	Fehr et al.	
8,135,352	B2	3/2012	Langsweirdt et al.	
8,136,735	B2	3/2012	Arai et al.	
8,138,925	B2	3/2012	Downie et al.	
8,140,160	B2	3/2012	Pless et al.	
8,140,168	B2	3/2012	Olson et al.	
8,140,299	B2	3/2012	Siess	
8,150,321	B2	4/2012	Winter et al.	
8,150,516	B2	4/2012	Levine et al.	
8,179,266	B2	5/2012	Hermle	
8,192,394	B2	6/2012	Estes et al.	
8,471,714	B2 *	6/2013	Reggiardo et al.	340/573.1
8,653,977	B2 *	2/2014	Reggiardo et al.	340/573.1
2001/0016682	A1	8/2001	Berner et al.	
2001/0016683	A1	8/2001	Darrow et al.	
2001/0016710	A1	8/2001	Nason et al.	
2001/0020124	A1	9/2001	Tamada	
2001/0023095	A1	9/2001	Kopley et al.	
2001/0024864	A1	9/2001	Kopley et al.	
2001/0029340	A1	10/2001	Mault et al.	
2001/0034502	A1	10/2001	Moberg et al.	
2001/0034617	A1	10/2001	Kimata	
2001/0037060	A1	11/2001	Thompson et al.	
2001/0037069	A1	11/2001	Carlson et al.	
2001/0041830	A1	11/2001	Varalli et al.	
2001/0044581	A1	11/2001	Mault	
2001/0044588	A1	11/2001	Mault	
2001/0049470	A1	12/2001	Mault et al.	
2001/0053891	A1	12/2001	Ackley	
2001/0056255	A1	12/2001	Kost et al.	
2002/0002326	A1	1/2002	Causey, III et al.	
2002/0002328	A1	1/2002	Tamada	
2002/0004640	A1	1/2002	Conn et al.	
2002/0010414	A1	1/2002	Coston et al.	
2002/0019022	A1	2/2002	Dunn et al.	
2002/0019612	A1	2/2002	Watanabe et al.	
2002/0026937	A1	3/2002	Mault	
2002/0027164	A1	3/2002	Mault et al.	
2002/0028995	A1	3/2002	Mault	
2002/0032374	A1	3/2002	Holker et al.	
2002/0040208	A1	4/2002	Flaherty et al.	
2002/0042090	A1	4/2002	Heller et al.	
2002/0042561	A1	4/2002	Schulman et al.	

(56) **References Cited**

U.S. PATENT DOCUMENTS

2002/0045808 A1 4/2002 Ford et al.
2002/0047867 A1 4/2002 Mault et al.
2002/0053637 A1 5/2002 Conn et al.
2002/0062069 A1 5/2002 Mault
2002/0065682 A1 5/2002 Goldenberg
2002/0068858 A1 6/2002 Braig et al.
2002/0072784 A1 6/2002 Sheppard et al.
2002/0077765 A1 6/2002 Mault
2002/0077766 A1 6/2002 Mault
2002/0087056 A1 7/2002 Aceti et al.
2002/0091312 A1 7/2002 Berner et al.
2002/0091454 A1 7/2002 Vasko
2002/0103425 A1 8/2002 Mault
2002/0107433 A1 8/2002 Mault
2002/0107476 A1 8/2002 Mann et al.
2002/0109600 A1 8/2002 Mault et al.
2002/0118090 A1 8/2002 Park et al.
2002/0119711 A1 8/2002 VanAntwerp et al.
2002/0124017 A1 9/2002 Mault
2002/0133378 A1 9/2002 Mault et al.
2002/0161286 A1 10/2002 Gerber et al.
2002/0169394 A1 11/2002 Eppstein et al.
2002/0169439 A1 11/2002 Flaherty et al.
2002/0177764 A1 11/2002 Sohrab
2002/0193679 A1 12/2002 Malave et al.
2003/0009133 A1 1/2003 Ramey
2003/0023182 A1 1/2003 Mault et al.
2003/0023317 A1 1/2003 Brauker et al.
2003/0028089 A1 2/2003 Galley et al.
2003/0028120 A1 2/2003 Mault et al.
2003/0032868 A1 2/2003 Graskov et al.
2003/0032874 A1 2/2003 Rhodes et al.
2003/0040683 A1 2/2003 Rule et al.
2003/0050546 A1 3/2003 Desai et al.
2003/0050575 A1 3/2003 Diermann et al.
2003/0055380 A1 3/2003 Flaherty et al.
2003/0060692 A1 3/2003 Ruchti et al.
2003/0060765 A1 3/2003 Campbell et al.
2003/0065254 A1 4/2003 Schulman et al.
2003/0065257 A1 4/2003 Mault et al.
2003/0065273 A1 4/2003 Mault et al.
2003/0065274 A1 4/2003 Mault et al.
2003/0065275 A1 4/2003 Mault et al.
2003/0065308 A1 4/2003 Lebel et al.
2003/0078560 A1 4/2003 Miller et al.
2003/0100040 A1 5/2003 Bonnecaze et al.
2003/0100821 A1 5/2003 Heller et al.
2003/0105407 A1 6/2003 Pearce, Jr. et al.
2003/0107487 A1 6/2003 Korman et al.
2003/0108976 A1 6/2003 Braig et al.
2003/0118460 A1 6/2003 Lilie et al.
2003/0130616 A1 7/2003 Steil et al.
2003/0134347 A1 7/2003 Heller et al.
2003/0135100 A1 7/2003 Kim et al.
2003/0135333 A1 7/2003 Aceti et al.
2003/0153820 A1 8/2003 Berner et al.
2003/0153821 A1 8/2003 Berner et al.
2003/0154405 A1 8/2003 Harrison
2003/0158472 A1 8/2003 Sohrab
2003/0158707 A1 8/2003 Doi
2003/0167035 A1 9/2003 Flaherty et al.
2003/0175806 A1 9/2003 Rule et al.
2003/0176933 A1 9/2003 Lebel et al.
2003/0181851 A1 9/2003 Mann et al.
2003/0181852 A1 9/2003 Mann et al.
2003/0187338 A1 10/2003 Say et al.
2003/0187525 A1 10/2003 Mann et al.
2003/0191376 A1 10/2003 Samuels et al.
2003/0191431 A1 10/2003 Mann et al.
2003/0195403 A1 10/2003 Berner et al.
2003/0195462 A1 10/2003 Mann et al.
2003/0198558 A1 10/2003 Nason et al.
2003/0199825 A1 10/2003 Flaherty
2003/0199837 A1 10/2003 Vachon
2003/0208110 A1 11/2003 Mault et al.
2003/0208113 A1 11/2003 Mault et al.
2003/0208133 A1 11/2003 Mault
2003/0208154 A1 11/2003 Close et al.
2003/0208409 A1 11/2003 Mault
2003/0212346 A1 11/2003 Yuzhakov et al.
2003/0212364 A1 11/2003 Mann et al.
2003/0212379 A1 11/2003 Bylund et al.
2003/0214304 A1 11/2003 Karinka et al.
2003/0217966 A1 11/2003 Tapsak et al.
2003/0225360 A1 12/2003 Eppstein et al.
2003/0225361 A1 12/2003 Sabra
2003/0226695 A1 12/2003 Mault
2003/0232370 A1 12/2003 Trifiro
2003/0235817 A1 12/2003 Bartkowiak et al.
2004/0010207 A1 1/2004 Flaherty et al.
2004/0011671 A1 1/2004 Shults et al.
2004/0015131 A1 1/2004 Flaherty et al.
2004/0018486 A1 1/2004 Dunn et al.
2004/0019321 A1 1/2004 Sage et al.
2004/0027253 A1 2/2004 Marsh et al.
2004/0030226 A1 2/2004 Quy
2004/0039256 A1 2/2004 Kawatahara et al.
2004/0041749 A1 3/2004 Dixon
2004/0045879 A1 3/2004 Shults et al.
2004/0054263 A1 3/2004 Moerman et al.
2004/0059201 A1 3/2004 Ginsberg
2004/0059284 A1 3/2004 Nash et al.
2004/0064088 A1 4/2004 Gorman et al.
2004/0064096 A1 4/2004 Flaherty et al.
2004/0064133 A1 4/2004 Miller et al.
2004/0072357 A1 4/2004 Stiene et al.
2004/0073095 A1 4/2004 Causey, III et al.
2004/0085215 A1 5/2004 Moberg et al.
2004/0096959 A1 5/2004 Stiene et al.
2004/0100376 A1 5/2004 Lye et al.
2004/0106858 A1 6/2004 Say et al.
2004/0106859 A1 6/2004 Say et al.
2004/0106860 A1 6/2004 Say et al.
2004/0108226 A1* 6/2004 Polychronakos et al. 205/792
2004/0115067 A1 6/2004 Rush et al.
2004/0116847 A1 6/2004 Wall
2004/0116866 A1 6/2004 Gorman et al.
2004/0122353 A1 6/2004 Shahmirian et al.
2004/0132220 A1 7/2004 Fish
2004/0133092 A1 7/2004 Kain
2004/0152622 A1 8/2004 Keith et al.
2004/0153032 A1 8/2004 Garribotto et al.
2004/0158137 A1 8/2004 Eppstein et al.
2004/0162473 A1 8/2004 Sohrab
2004/0164961 A1 8/2004 Bal et al.
2004/0167383 A1 8/2004 Kim et al.
2004/0167464 A1 8/2004 Ireland et al.
2004/0167801 A1 8/2004 Say et al.
2004/0171921 A1 9/2004 Say et al.
2004/0176913 A1 9/2004 Kawatahara et al.
2004/0186362 A1 9/2004 Brauker et al.
2004/0186365 A1 9/2004 Jin et al.
2004/0193025 A1 9/2004 Steil et al.
2004/0193090 A1 9/2004 Lebel et al.
2004/0199059 A1 10/2004 Brauker et al.
2004/0202576 A1 10/2004 Aceti et al.
2004/0207054 A1 10/2004 Brown et al.
2004/0208780 A1 10/2004 Faries, Jr. et al.
2004/0210184 A1 10/2004 Kost et al.
2004/0223877 A1 11/2004 Kim et al.
2004/0225338 A1 11/2004 Lebel et al.
2004/0236200 A1 11/2004 Say et al.
2004/0248204 A1 12/2004 Moerman
2004/0249250 A1 12/2004 McGee et al.
2004/0249253 A1 12/2004 Racchini et al.
2004/0249254 A1 12/2004 Racchini et al.
2004/0249999 A1 12/2004 Connolly et al.
2004/0253736 A1 12/2004 Stout et al.
2004/0254429 A1 12/2004 Yang
2004/0254434 A1 12/2004 Goodnow et al.
2004/0254884 A1 12/2004 Haber et al.
2004/0263354 A1 12/2004 Mann et al.
2004/0264396 A1 12/2004 Ginzburg et al.
2005/0003470 A1 1/2005 Nelson et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2005/0009126	A1	1/2005	Andrews et al.	
2005/0010269	A1	1/2005	Lebel et al.	
2005/0016276	A1	1/2005	Guan et al.	
2005/0027179	A1	2/2005	Berner et al.	
2005/0027180	A1	2/2005	Goode, Jr. et al.	
2005/0027181	A1	2/2005	Goode, Jr. et al.	
2005/0027462	A1	2/2005	Goode, Jr. et al.	
2005/0027463	A1	2/2005	Goode, Jr. et al.	
2005/0031689	A1	2/2005	Shults et al.	
2005/0033132	A1	2/2005	Shults et al.	
2005/0038332	A1	2/2005	Saidara et al.	
2005/0038674	A1	2/2005	Braig et al.	
2005/0038680	A1	2/2005	McMahon	
2005/0043598	A1	2/2005	Goode, Jr. et al.	
2005/0043894	A1	2/2005	Fernandez	
2005/0045476	A1	3/2005	Neel et al.	
2005/0049473	A1	3/2005	Desai et al.	
2005/0051580	A1	3/2005	Ramey	
2005/0053365	A1	3/2005	Adams et al.	
2005/0054909	A1	3/2005	Petisce et al.	
2005/0059926	A1	3/2005	Sage, Jr. et al.	
2005/0065464	A1	3/2005	Talbot et al.	
2005/0090607	A1	4/2005	Tapsak et al.	
2005/0090808	A1	4/2005	Malave et al.	
2005/0112169	A1	5/2005	Brauker et al.	
2005/0113653	A1	5/2005	Fox et al.	
2005/0113657	A1	5/2005	Alarcon et al.	
2005/0113658	A1	5/2005	Jacobson et al.	
2005/0118726	A1	6/2005	Scultz et al.	
2005/0121322	A1	6/2005	Say et al.	
2005/0124873	A1	6/2005	Shults et al.	
2005/0137471	A1	6/2005	Haar et al.	
2005/0143635	A1	6/2005	Kamath et al.	
2005/0143636	A1	6/2005	Zhang et al.	
2005/0148003	A1	7/2005	Keith et al.	
2005/0154271	A1	7/2005	Rasdal et al.	
2005/0161346	A1	7/2005	Simpson et al.	
2005/0171503	A1	8/2005	Van Den Berghe et al.	
2005/0171512	A1	8/2005	Flaherty	
2005/0171513	A1	8/2005	Mann et al.	
2005/0173245	A1	8/2005	Feldman et al.	
2005/0176136	A1	8/2005	Burd et al.	
2005/0177036	A1	8/2005	Shults et al.	
2005/0181012	A1	8/2005	Saint et al.	
2005/0182306	A1	8/2005	Sloan	
2005/0182358	A1	8/2005	Veit et al.	
2005/0182366	A1	8/2005	Vogt et al.	
2005/0182451	A1	8/2005	Griffin et al.	
2005/0187720	A1	8/2005	Goode, Jr. et al.	
2005/0192557	A1	9/2005	Brauker et al.	
2005/0195930	A1	9/2005	Spital et al.	
2005/0199494	A1	9/2005	Say et al.	
2005/0203360	A1	9/2005	Brauker et al.	
2005/0203461	A1	9/2005	Flaherty et al.	
2005/0214892	A1	9/2005	Kovatchev et al.	
2005/0215871	A1*	9/2005	Feldman et al.	600/309
2005/0215872	A1	9/2005	Berner et al.	
2005/0218880	A1	10/2005	Ioffe	
2005/0235732	A1	10/2005	Rush	
2005/0238503	A1	10/2005	Rush et al.	
2005/0238507	A1	10/2005	DiIanni et al.	
2005/0239154	A1	10/2005	Feldman et al.	
2005/0239518	A1	10/2005	D'Agostino et al.	
2005/0245795	A1	11/2005	Goode, Jr. et al.	
2005/0245799	A1	11/2005	Brauker et al.	
2005/0245839	A1	11/2005	Stivoric et al.	
2005/0249506	A1	11/2005	Fuse	
2005/0249606	A1	11/2005	Rush	
2005/0251083	A1	11/2005	Carr-Brendel et al.	
2005/0261660	A1	11/2005	Choi	
2005/0267550	A1	12/2005	Hess et al.	
2005/0267780	A1	12/2005	Ray et al.	
2005/0271546	A1	12/2005	Gerber et al.	
2005/0271547	A1	12/2005	Gerber et al.	
2005/0272640	A1	12/2005	Doyle, III et al.	
2005/0272985	A1	12/2005	Kotulla et al.	
2005/0277844	A1	12/2005	Strother et al.	
2005/0287620	A1	12/2005	Heller et al.	
2006/0001538	A1	1/2006	Kraft et al.	
2006/0001550	A1	1/2006	Mann et al.	
2006/0001551	A1	1/2006	Kraft et al.	
2006/0003398	A1	1/2006	Heller et al.	
2006/0004271	A1	1/2006	Peyser et al.	
2006/0004603	A1	1/2006	Peterka et al.	
2006/0007017	A1	1/2006	Mann et al.	
2006/0015020	A1	1/2006	Neale et al.	
2006/0015024	A1	1/2006	Brister et al.	
2006/0016700	A1	1/2006	Brister et al.	
2006/0017923	A1	1/2006	Ruchti et al.	
2006/0019327	A1	1/2006	Brister et al.	
2006/0020186	A1	1/2006	Brister et al.	
2006/0020187	A1	1/2006	Brister et al.	
2006/0020188	A1	1/2006	Kamath et al.	
2006/0020189	A1	1/2006	Brister et al.	
2006/0020190	A1	1/2006	Kamath et al.	
2006/0020191	A1	1/2006	Brister et al.	
2006/0020192	A1	1/2006	Brister et al.	
2006/0025663	A1	2/2006	Talbot et al.	
2006/0031094	A1	2/2006	Cohen et al.	
2006/0036139	A1	2/2006	Brister et al.	
2006/0036140	A1	2/2006	Brister et al.	
2006/0036141	A1	2/2006	Kamath et al.	
2006/0036142	A1	2/2006	Brister et al.	
2006/0036143	A1	2/2006	Brister et al.	
2006/0036144	A1	2/2006	Brister et al.	
2006/0036145	A1	2/2006	Brister et al.	
2006/0036187	A1	2/2006	Vos et al.	
2006/0040402	A1	2/2006	Brauker et al.	
2006/0041229	A1	2/2006	Garibotto et al.	
2006/0052679	A1	3/2006	Kotulla et al.	
2006/0058602	A1	3/2006	Kwiatkowski et al.	
2006/0058627	A1	3/2006	Flaherty et al.	
2006/0063218	A1	3/2006	Bartkowiak et al.	
2006/0074564	A1	4/2006	Bartkowiak et al.	
2006/0094986	A1	5/2006	Neel et al.	
2006/0154642	A1	7/2006	Scannell	
2006/0161078	A1	7/2006	Schraga	
2006/0166629	A1	7/2006	Reggiardo	
2006/0173259	A1	8/2006	Flaherty et al.	
2006/0173444	A1	8/2006	Choy et al.	
2006/0173712	A1	8/2006	Joubert	
2006/0178633	A1	8/2006	Garibotto et al.	
2006/0202805	A1	9/2006	Schulman et al.	
2006/0222566	A1	10/2006	Brauker et al.	
2006/0224141	A1	10/2006	Rush et al.	
2006/0240403	A1	10/2006	List et al.	
2006/0247508	A1	11/2006	Fennell	
2006/0247710	A1	11/2006	Goetz et al.	
2006/0253085	A1	11/2006	Geismar et al.	
2006/0253086	A1	11/2006	Moberg et al.	
2006/0273759	A1	12/2006	Reggiardo	
2006/0282290	A1	12/2006	Flaherty et al.	
2006/0287691	A1	12/2006	Drew	
2006/0293577	A1	12/2006	Morrison et al.	
2007/0016381	A1	1/2007	Kamath et al.	
2007/0032717	A1	2/2007	Brister et al.	
2007/0055799	A1	3/2007	Koehler et al.	
2007/0073129	A1	3/2007	Shah et al.	
2007/0078323	A1	4/2007	Reggiardo et al.	
2007/0078818	A1	4/2007	Zivitz et al.	
2007/0100222	A1	5/2007	Mastrototaro et al.	
2007/0106135	A1	5/2007	Sloan	
2007/0118405	A1	5/2007	Campbell et al.	
2007/0135697	A1	6/2007	Reggiardo	
2007/0156033	A1	7/2007	Causey, III et al.	
2007/0163880	A1	7/2007	Woo et al.	
2007/0173711	A1	7/2007	Shah et al.	
2007/0176867	A1	8/2007	Reggiardo et al.	
2007/0203966	A1	8/2007	Brauker et al.	
2007/0219480	A1	9/2007	Kamen et al.	
2007/0219597	A1	9/2007	Kamen et al.	
2007/0232880	A1	10/2007	Siddiqui et al.	
2007/0235331	A1	10/2007	Simpson et al.	
2007/0244383	A1	10/2007	Talbot et al.	

(56) **References Cited**

U.S. PATENT DOCUMENTS

2007/0253021	A1	11/2007	Mehta et al.
2007/0255531	A1	11/2007	Drew
2007/0258395	A1	11/2007	Jollota et al.
2007/0270672	A1	11/2007	Hayter
2007/0285238	A1	12/2007	Batra
2008/0018433	A1	1/2008	Pitt-Pladdy
2008/0021666	A1	1/2008	Goode, Jr. et al.
2008/0030369	A1	2/2008	Mann et al.
2008/0033254	A1	2/2008	Kamath et al.
2008/0045824	A1	2/2008	Tapsak et al.
2008/0058773	A1	3/2008	John
2008/0061961	A1	3/2008	John
2008/0064941	A1	3/2008	Funderburk et al.
2008/0064943	A1	3/2008	Talbot et al.
2008/0071156	A1	3/2008	Brister et al.
2008/0071328	A1	3/2008	Haubrich et al.
2008/0081977	A1	4/2008	Hayter et al.
2008/0083617	A1	4/2008	Simpson et al.
2008/0086042	A1	4/2008	Brister et al.
2008/0086044	A1	4/2008	Brister et al.
2008/0086273	A1	4/2008	Shults et al.
2008/0097918	A1	4/2008	Spector et al.
2008/0103447	A1	5/2008	Reggiardo et al.
2008/0108942	A1	5/2008	Brister et al.
2008/0119703	A1	5/2008	Brister et al.
2008/0119705	A1	5/2008	Patel et al.
2008/0139910	A1	6/2008	Mastrototaro et al.
2008/0167572	A1	7/2008	Stivoric et al.
2008/0183061	A1	7/2008	Goode et al.
2008/0183399	A1	7/2008	Goode et al.
2008/0188731	A1	8/2008	Brister et al.
2008/0189051	A1	8/2008	Goode et al.
2008/0194935	A1	8/2008	Brister et al.
2008/0194936	A1	8/2008	Goode et al.
2008/0194937	A1	8/2008	Goode et al.
2008/0194938	A1	8/2008	Brister et al.
2008/0195049	A1	8/2008	Thalmann et al.
2008/0195232	A1	8/2008	Carr-Brendel et al.
2008/0195967	A1	8/2008	Goode et al.
2008/0197024	A1	8/2008	Simpson et al.
2008/0200788	A1	8/2008	Brister et al.
2008/0200789	A1	8/2008	Brister et al.
2008/0200791	A1	8/2008	Simpson et al.
2008/0200838	A1	8/2008	Goldberger et al.
2008/0200897	A1	8/2008	Hoss et al.
2008/0208025	A1	8/2008	Shults et al.
2008/0214915	A1	9/2008	Brister et al.
2008/0214918	A1	9/2008	Brister et al.
2008/0228051	A1	9/2008	Shults et al.
2008/0228054	A1	9/2008	Shults et al.
2008/0228055	A1	9/2008	Sher
2008/0235469	A1	9/2008	Drew
2008/0242961	A1	10/2008	Brister et al.
2008/0255438	A1	10/2008	Saidara et al.
2008/0262469	A1	10/2008	Brister et al.
2008/0275313	A1	11/2008	Brister et al.
2008/0287764	A1	11/2008	Rasdal et al.
2008/0287765	A1	11/2008	Rasdal et al.
2008/0287766	A1	11/2008	Rasdal et al.
2008/0296155	A1	12/2008	Shults et al.
2008/0306368	A1	12/2008	Goode et al.
2008/0306434	A1	12/2008	Dobbles et al.
2008/0306435	A1	12/2008	Kamath et al.
2008/0306444	A1	12/2008	Brister et al.
2008/0312518	A1	12/2008	Jina et al.
2008/0312844	A1	12/2008	Hayter et al.
2009/0005666	A1	1/2009	Shin et al.
2009/0012379	A1	1/2009	Goode et al.
2009/0018424	A1	1/2009	Kamath et al.
2009/0030294	A1	1/2009	Petisce et al.
2009/0036758	A1	2/2009	Brauker et al.
2009/0036763	A1	2/2009	Brauker et al.
2009/0043181	A1	2/2009	Brauker et al.
2009/0043182	A1	2/2009	Brauker et al.
2009/0043525	A1	2/2009	Brauker et al.
2009/0043541	A1	2/2009	Brauker et al.
2009/0043542	A1	2/2009	Brauker et al.
2009/0045055	A1	2/2009	Rhodes et al.
2009/0062633	A1	3/2009	Brauker et al.
2009/0062635	A1	3/2009	Brauker et al.
2009/0063196	A1	3/2009	Frederickson
2009/0063402	A1	3/2009	Hayter
2009/0068954	A1	3/2009	Reggiardo et al.
2009/0069750	A1	3/2009	Schraga
2009/0076356	A1	3/2009	Simpson et al.
2009/0076358	A1	3/2009	Reggiardo et al.
2009/0076360	A1	3/2009	Brister et al.
2009/0076361	A1	3/2009	Kamath et al.
2009/0083003	A1	3/2009	Reggiardo et al.
2009/0085768	A1	4/2009	Patel et al.
2009/0093687	A1	4/2009	Telfort et al.
2009/0099436	A1	4/2009	Brister et al.
2009/0105554	A1	4/2009	Stahmann et al.
2009/0105636	A1	4/2009	Hayter et al.
2009/0112478	A1	4/2009	Mueller, Jr. et al.
2009/0124877	A1	5/2009	Goode et al.
2009/0124878	A1	5/2009	Goode et al.
2009/0124879	A1	5/2009	Brister et al.
2009/0124964	A1	5/2009	Leach et al.
2009/0131768	A1	5/2009	Simpson et al.
2009/0131769	A1	5/2009	Leach et al.
2009/0131776	A1	5/2009	Simpson et al.
2009/0131777	A1	5/2009	Simpson et al.
2009/0137886	A1	5/2009	Shariati et al.
2009/0137887	A1	5/2009	Shariati et al.
2009/0143659	A1	6/2009	Li et al.
2009/0143660	A1	6/2009	Brister et al.
2009/0150186	A1	6/2009	Cohen et al.
2009/0156919	A1	6/2009	Brister et al.
2009/0156924	A1	6/2009	Shariati et al.
2009/0163790	A1	6/2009	Brister et al.
2009/0163791	A1	6/2009	Brister et al.
2009/0178459	A1	7/2009	Li et al.
2009/0182217	A1	7/2009	Li et al.
2009/0189738	A1	7/2009	Hermle
2009/0192366	A1	7/2009	Mensinger et al.
2009/0192380	A1	7/2009	Shariati et al.
2009/0192722	A1	7/2009	Shariati et al.
2009/0192724	A1	7/2009	Brauker et al.
2009/0192745	A1	7/2009	Kamath et al.
2009/0192751	A1	7/2009	Kamath et al.
2009/0203981	A1	8/2009	Brauker et al.
2009/0204341	A1	8/2009	Brauker et al.
2009/0216103	A1	8/2009	Brister et al.
2009/0216553	A1	8/2009	Cellura
2009/0234200	A1	9/2009	Husheer
2009/0240120	A1	9/2009	Mensinger et al.
2009/0240128	A1	9/2009	Mensinger et al.
2009/0240193	A1	9/2009	Mensinger et al.
2009/0242399	A1	10/2009	Kamath et al.
2009/0242425	A1	10/2009	Kamath et al.
2009/0247855	A1	10/2009	Boock et al.
2009/0247856	A1	10/2009	Boock et al.
2009/0247931	A1	10/2009	Damgaard-Sorensen
2009/0259118	A1	10/2009	Feldman et al.
2009/0267765	A1	10/2009	Greene et al.
2009/0287073	A1	11/2009	Boock et al.
2009/0287074	A1	11/2009	Shults et al.
2009/0289796	A1	11/2009	Blumberg
2009/0299155	A1	12/2009	Yang et al.
2009/0299156	A1	12/2009	Simpson et al.
2009/0299162	A1	12/2009	Brauker et al.
2009/0299276	A1	12/2009	Brauker et al.
2010/0190435	A1	7/2010	Cook et al.
2010/0241447	A1	9/2010	Siniaguine et al.
2011/0004276	A1	1/2011	Blair et al.
2011/0077493	A1	3/2011	Shadforth et al.
2011/0152637	A1	6/2011	Kateraas et al.

FOREIGN PATENT DOCUMENTS

EP	0455455	11/1991
EP	0465708	1/1992
EP	0724859	8/1996

(56) **References Cited**

FOREIGN PATENT DOCUMENTS

EP	0878707	11/1998
EP	0678308	5/2000
EP	0543916	7/2001
EP	1130638	9/2001
EP	0980688	12/2002
EP	1292218	3/2003
EP	1077634	7/2003
EP	1755443	11/2005
EP	1666091	6/2006
EP	1703697	9/2006
EP	1704893	9/2006
EP	1783536	5/2007
EP	1897487	11/2009
EP	1897492	11/2009
EP	2113864	11/2009
EP	1897488	12/2009
EP	1681992	4/2010
EP	1448489	8/2010
EP	1971396	8/2010
JP	2001-177423	6/2001
JP	2001-056673	11/2001
WO	WO-97/33513	9/1997
WO	WO-99/22236	5/1999
WO	WO-99/56613	11/1999
WO	WO-00/74753	12/2000
WO	WO-01/41849	6/2001
WO	WO-01/52727	7/2001
WO	WO-01/54753	8/2001
WO	WO-02/058537	8/2002
WO	WO-02/084860	10/2002
WO	WO-03/053503	7/2003
WO	WO-2004/028337	4/2004
WO	WO-2004/032994	4/2004
WO	WO-2004/061420	7/2004
WO	WO-2005/045744	5/2005
WO	WO-2005/089103	9/2005
WO	WO-2005/101994	11/2005
WO	WO-2006/003919	1/2006
WO	WO-2006/032653	3/2006
WO	WO-2006/079114	7/2006
WO	WO-2006/102412	9/2006
WO	WO-2006/110913	10/2006
WO	WO-2006/113408	10/2006
WO	WO-2006/113521	10/2006
WO	WO-2006/118947	11/2006
WO	WO-2006/124099	11/2006
WO	WO-2006/132884	12/2006
WO	WO-2007/041072	4/2007
WO	WO-2007/090037	8/2007
WO	WO-2008/055037	5/2008
WO	WO-2008/086541	7/2008
WO	WO-2008/110267	9/2008
WO	WO-2011/022418	2/2011

OTHER PUBLICATIONS

Barbosa, R. M., et al., "Electrochemical Studies of Zinc in Zinc-Insulin Solution", *Journal of the Royal Society of Chemistry, Analyst*, vol. 121, No. 12, 1996, pp. 1789-1793.

Bard, A. J., et al., "Methods Involving Forced Convection—Hydrodynamic Methods", *Electrochemical Methods—Fundamentals and Applications*, 2001, pp. 331-367.

Kissinger, P. T., "Introduction to Analog Instrumentation", *Laboratory Techniques in Electroanalytical Chemistry, Second Edition, Revised and Expanded*, 1996, pp. 165-194.

Ursino, M, et al., "A Mathematical Model of Cerebral Blood Flow Chemical Regulation—Part I: Diffusion Processes", *IEEE Transactions on Biomedical Engineering*, vol. 36, No. 2, 1989, pp. 183-191.

U.S. Appl. No. 11/383,945, Notice of Allowance mailed Jun. 18, 2010.

U.S. Appl. No. 11/383,945, Office Action mailed Dec. 16, 2009.

U.S. Appl. No. 11/383,945, Office Action mailed Jun. 8, 2009.

U.S. Appl. No. 11/383,945, Office Action mailed Oct. 31, 2008.

U.S. Appl. No. 12/849,007, Notice of Allowance mailed Nov. 16, 2010.

U.S. Appl. No. 12/849,007, Office Action mailed Oct. 18, 2010.

U.S. Appl. No. 13/022,610, Notice of Allowance mailed Nov. 15, 2011.

U.S. Appl. No. 13/022,610, Office Action mailed Oct. 20, 2011.

U.S. Appl. No. 13/341,853, Notice of Allowance mailed Mar. 21, 2013.

U.S. Appl. No. 13/341,853, Office Action mailed Sep. 25, 2012.

U.S. Appl. No. 13/924,527, Notice of Allowance mailed Nov. 8, 2013.

U.S. Appl. No. 13/924,527, Office Action mailed Aug. 20, 2013.

U.S. Appl. No. 13/924,527, Office Action mailed Oct. 16, 2013.

* cited by examiner

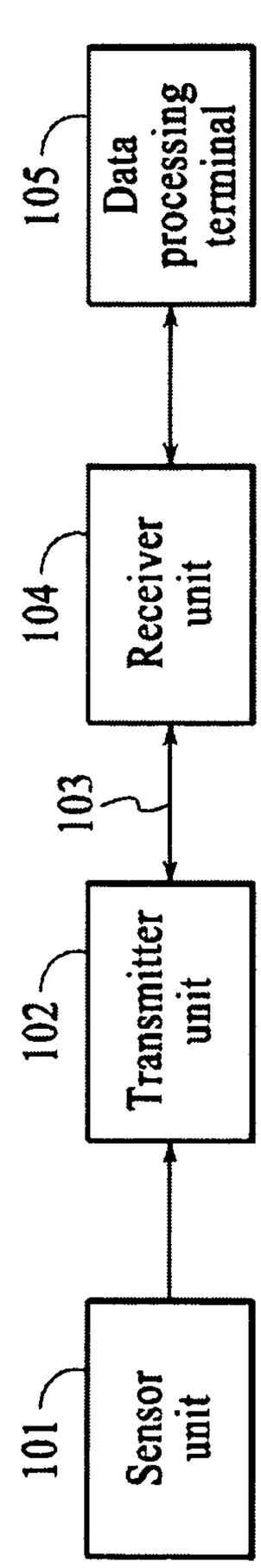

100
Sensor unit
101
Transmitter unit
102
Receiver unit
104
103
Data processing terminal
105

FIG. 1

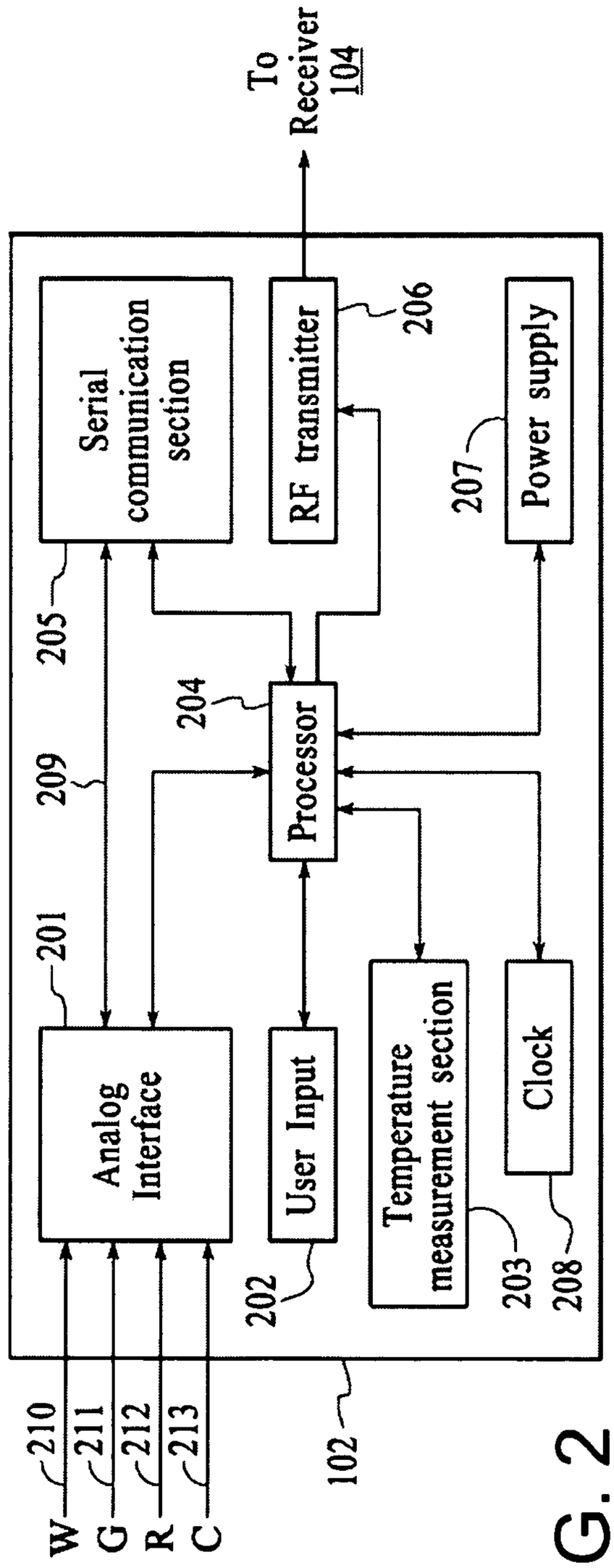

To Receiver 104
Serial communication section
205
RF transmitter
206
207
Power supply
209
204
Processor
201
Analog Interface
User Input
202
Temperature measurement section
203
Clock
208
W
G
R
C
210
211
212
213
102

FIG. 2

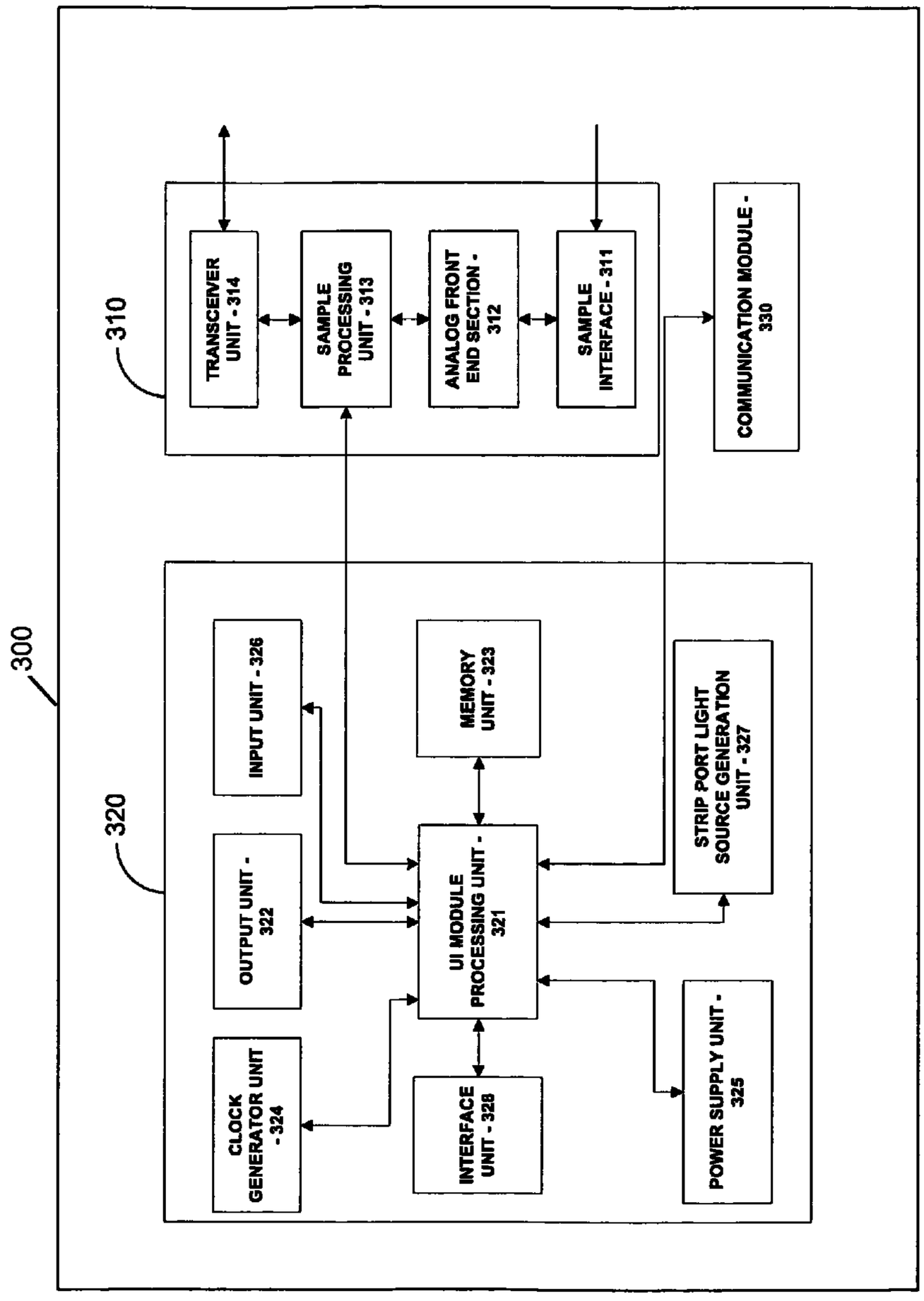

300
310
TRANSCEIVER UNIT - 314
SAMPLE PROCESSING UNIT - 313
ANALOG FRONT END SECTION - 312
SAMPLE INTERFACE - 311
COMMUNICATION MODULE - 330
320
INPUT UNIT - 326
MEMORY UNIT - 323
STRIP PORT LIGHT SOURCE GENERATION UNIT - 327
OUTPUT UNIT - 322
UI MODULE PROCESSING UNIT - 321
CLOCK GENERATOR UNIT - 324
INTERFACE UNIT - 328
POWER SUPPLY UNIT - 325

FIG. 3

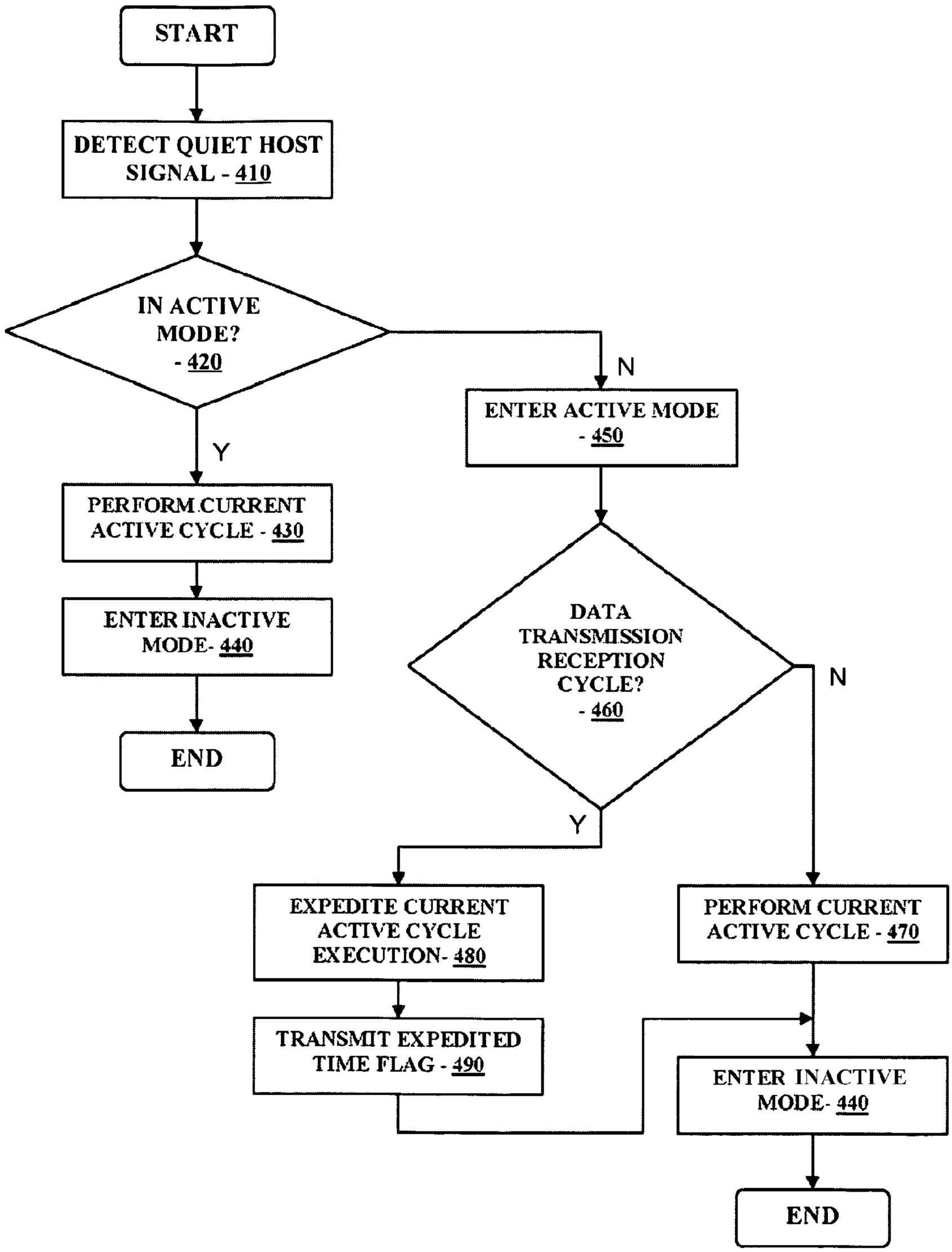

START
DETECT QUIET HOST SIGNAL - 410
IN ACTIVE MODE? - 420
Y
N
PERFORM CURRENT ACTIVE CYCLE - 430
ENTER INACTIVE MODE- 440
END
ENTER ACTIVE MODE - 450
DATA TRANSMISSION RECEPTION CYCLE? - 460
Y
N
EXPEDITE CURRENT ACTIVE CYCLE EXECUTION- 480
TRANSMIT EXPEDITED TIME FLAG - 490
PERFORM CURRENT ACTIVE CYCLE - 470
ENTER INACTIVE MODE- 440
END

FIG. 4

METHOD AND SYSTEM FOR PROVIDING DATA MANAGEMENT IN DATA MONITORING SYSTEM

RELATED APPLICATIONS

This application is a continuation of U.S. application Ser. No. 13/924,527 filed Jun. 21, 2013, now U.S. Pat. No. 8,653,977, which is a continuation of U.S. application Ser. No. 13/341,853 filed Dec. 30, 2011, now U.S. Pat. No. 8,471,714, which is a continuation of U.S. application Ser. No. 13/022,610 filed Feb. 7, 2011, now U.S. Pat. No. 8,089,363, which is a continuation of U.S. application Ser. No. 12/849,007 filed Aug. 2, 2010, now U.S. Pat. No. 7,884,729, which is a continuation of U.S. application Ser. No. 11/383,945 filed May 17, 2006, now U.S. Pat. No. 7,768,408, which claims the benefit of U.S. Provisional Application No. 60/681,942 filed on May 17, 2005, entitled "Method and System for Providing Data Management in Data Monitoring System", the disclosures of each of which are incorporated herein by reference for all purposes.

BACKGROUND

Data monitoring and management systems such as continuous or semi-continuous analyte monitoring systems are typically configured to process a large amount of data and/or transmit the data over a network via a cabled or wireless connection. Such systems typically include devices such as data transmission devices and data reception devices which are configured to communicate with each other in a time sensitive fashion (e.g. to provide substantially real-time data). For the data monitoring and management system to properly function, each device or unit in the system needs to be in operational mode. That is, when one component or device is not properly functioning, or is not optimized for performance in the system, the entire system may be adversely impacted.

Typical devices or components in such systems generally are under the control of a microprocessor or an equivalent device which controls the functionality and maintenance of the device. As more features and functions are added and incorporated into the device or component in the data monitoring and management system, the microprocessor is required to handle the additional processing which imposes a heavy load upon the microprocessor, and in addition, increases the potential for failure modes, effectively disabling the device or component in the system.

In view of the foregoing, it would be desirable to have a fault tolerant data monitoring and management system such as in continuous analyte monitoring systems for efficient data monitoring and management.

SUMMARY OF THE INVENTION

In view of the foregoing, in accordance with the various embodiments of the present invention, there is provided a fault tolerant data receiver unit configured with partitioned or separate processing units, each configured to perform a predetermined and/or specific processing associated with the one or more substantially non-overlapping functions of the data monitoring and management system. In one embodiment, the data receiver unit includes a communication module, a user interface module and a sample analysis module, and each module is provided with a separate processing unit. In this manner, in one embodiment, each module is configured to perform predetermined functions associated with the data

monitoring and management system to provide a modular, objected oriented processing architecture.

These and other objects, features and advantages of the present invention will become more fully apparent from the following detailed description of the embodiments, the appended claims and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates a data monitoring and management system such as, for example, an analyte monitoring system **100** for practicing one embodiment of the present invention;

FIG. **2** is a block diagram of the transmitter unit of the data monitoring and management system shown in FIG. **1** in accordance with one embodiment of the present invention;

FIG. **3** illustrates the receiver unit of the data monitoring and management system shown in FIG. **1** in accordance with one embodiment of the present invention; and

FIG. **4** is a flowchart illustrating the quiet host procedure in the receiver unit of the data monitoring and management system of FIG. **3** in accordance with one embodiment of the present invention.

DETAILED DESCRIPTION

As described in detail below, in accordance with the various embodiments of the present invention, there is provided a fault tolerant data receiver unit configured with a partitioned or separate processing units, each configured to perform a predetermined and/or specific processing associated with the one or more substantially non-overlapping functions of the data monitoring and management system. In one embodiment, the data receiver unit includes a communication module, a user interface module and a sample analysis module, and each module provided with a separate processing unit. In this manner, in one embodiment, each module is configured to perform predetermined functions associated with the data monitoring and management system to provide a modular, object oriented processing architecture.

FIG. **1** illustrates a data monitoring and management system such as, for example, an analyte monitoring system **100** for practicing one embodiment of the present invention. In such embodiment, the analyte monitoring system **100** includes an analyte sensor **101**, a transmitter unit **102** coupled to the sensor **101**, and a receiver unit **104** which is configured to communicate with the transmitter unit **102** via a communication link **103**. The receiver unit **104** may be further configured to transmit data to a data processing terminal **105** for evaluating the data received by the receiver unit **104**.

Only one sensor **101**, transmitter unit **102**, communication link **103**, receiver unit **104**, and data processing terminal **105** are shown in the embodiment of the analyte monitoring system **100** illustrated in FIG. **1**. However, it will be appreciated by one of ordinary skill in the art that the analyte monitoring system **100** may include one or more sensor **101**, transmitter unit **102**, communication link **103**, receiver unit **104**, and data processing terminal **105**, where each receiver unit **104** is uniquely synchronized with a respective transmitter unit **102**. Moreover, within the scope of the present invention, the analyte monitoring system **100** may be a continuous monitoring system, or a semi-continuous or discrete monitoring system.

In one embodiment of the present invention, the sensor **101** is physically positioned on the body of a user whose analyte level is being monitored. The sensor **101** may be configured to continuously sample the analyte level of the user and convert the sampled analyte level into a corresponding data signal for transmission by the transmitter unit **102**. In one embodiment,

the transmitter unit **102** is mounted on the sensor **101** so that both devices are positioned on the user's body. The transmitter unit **102** performs data processing such as filtering and encoding on data signals, each of which corresponds to a sampled glucose level of the user, for transmission to the receiver unit **104** via the communication link **103**.

Additional analytes that may be monitored or determined by sensor **101** include, for example, acetyl choline, amylase, bilirubin, cholesterol, chorionic gonadotropin, creatine kinase (e.g., CK-MB), creatine, DNA, fructosamine, glucose, glutamine, growth hormones, hormones, ketones, lactate, peroxide, prostate-specific antigen, prothrombin, RNA, thyroid stimulating hormone, and troponin. The concentration of drugs, such as, for example, antibiotics (e.g., gentamicin, vancomycin, and the like), digitoxin, digoxin, drugs of abuse, theophylline, and warfarin, may also be determined.

In one embodiment, the analyte monitoring system **100** is configured as a one-way RF communication path from the transmitter unit **102** to the receiver unit **104**. In such embodiment, the transmitter unit **102** transmits the sampled data signals received from the sensor **101** without acknowledgement from the receiver unit **104** that the transmitted sampled data signals have been received. For example, the transmitter unit **102** may be configured to transmit the encoded sampled data signals at a fixed rate (e.g., at one minute intervals) after the completion of the initial power on procedure. Likewise, the receiver unit **104** may be configured to detect such transmitted encoded sampled data signals at predetermined time intervals. Alternatively, the analyte monitoring system **100** may be configured with a bidirectional RF communication between the transmitter unit **102** and the receiver unit **104**.

Additionally, in one aspect, the receiver unit **104** may include two sections. The first section is an analog interface section that is configured to communicate with the transmitter unit **102** via the communication link **103**. In one embodiment, the analog interface section may include an RF receiver and an antenna for receiving and amplifying the data signals from the transmitter unit **102**, which are thereafter, demodulated with a local oscillator and filtered through a band-pass filter. The second section of the receiver unit **104** is a data processing section which is configured to process the data signals received from the transmitter unit **102** such as by performing data decoding, error detection and correction, data clock generation, and data bit recovery.

In operation, upon completing the power-on procedure, the receiver unit **104** is configured to detect the presence of the transmitter unit **102** within its range based on, for example, the strength of the detected data signals received from the transmitter unit **102** or a predetermined transmitter identification information. Upon successful synchronization with the corresponding transmitter unit **102**, the receiver unit **104** is configured to begin receiving from the transmitter unit **102** data signals corresponding to the user's detected analyte level. More specifically, the receiver unit **104** in one embodiment is configured to perform synchronized time hopping with the corresponding synchronized transmitter unit **102** via the communication link **103** to obtain the user's detected analyte level.

Referring again to FIG. **1**, the data processing terminal **105** may include a personal computer, a portable computer such as a laptop or a handheld device (e.g., personal digital assistants (PDAs)), and the like, each of which may be configured for data communication with the receiver via a wired or a wireless connection. Additionally, the data processing terminal **105** may further be connected to a data network (not shown) for storing, retrieving and updating data corresponding to the detected analyte level of the user.

Within the scope of the present invention, the data processing terminal **105** may include an infusion device such as an insulin infusion pump (external or implantable), which may be configured to administer insulin to patients, and which is configured to communicate with the receiver unit **104** for receiving, among others, the measured analyte level. Alternatively, the receiver unit **104** may be configured to integrate an infusion device therein so that the receiver unit **104** is configured to administer insulin therapy to patients, for example, for administering and modifying basal profiles, as well as for determining appropriate boluses (e.g., correction bolus, carbohydrate bolus, dual wave bolus including normal and extended bolus such as square wave bolus, and so on) for administration based on, among others, the detected analyte levels received from the transmitter unit **102**.

FIG. **2** is a block diagram of the transmitter of the data monitoring and detection system shown in FIG. **1** in accordance with one embodiment of the present invention. Referring to the Figure, the transmitter unit **102** in one embodiment includes an analog interface **201** configured to communicate with the sensor **101** (FIG. **1**), a user input **202**, and a temperature detection section **203**, each of which is operatively coupled to a transmitter processor **204** such as a central processing unit (CPU). As can be seen from FIG. **2**, there are provided four contacts comprised of the working electrode (W) **210**, the guard contact (G) **211**, the reference electrode (R) **212**, and the counter electrode (C) **213**, each operatively coupled to the analog interface **201** of the transmitter unit **102** for connection to the sensor unit **101** (FIG. **1**). In one embodiment, the working electrode (W) **210** and reference electrode (R) **212** may be made using a conductive material that is either printed or etched, for example, such as carbon which may be printed, or metal foil (e.g., gold) which may be etched.

Further shown in FIG. **2** are a transmitter serial communication section **205** and an RF transmitter **206**, each of which is also operatively coupled to the transmitter processor **204**. Moreover, a power supply **207** such as a battery is also provided in the transmitter unit **102** to provide the necessary power for the transmitter unit **102**. Additionally, as can be seen from the Figure, clock **208** is provided to, among others, supply real time information to the transmitter processor **204**.

In one embodiment, a unidirectional input path is established from the sensor **101** (FIG. **1**) and/or manufacturing and testing equipment to the analog interface **201** of the transmitter unit **102**, while a unidirectional output is established from the output of the RF transmitter **206** of the transmitter unit **102** for transmission to the receiver **104**. In this manner, a data path is shown in FIG. **2** between the aforementioned unidirectional input and output via a dedicated link **209** from the analog interface **201** to serial communication section **205**, thereafter to the processor **204**, and then to the RF transmitter **206**. As such, in one embodiment, via the data path described above, the transmitter unit **102** is configured to transmit to the receiver **104** (FIG. **1**), via the communication link **103** (FIG. **1**), processed and encoded data signals received from the sensor **101** (FIG. **1**). Additionally, the unidirectional communication data path between the analog interface **201** and the RF transmitter **206** discussed above allows for the configuration of the transmitter unit **102** for operation upon completion of the manufacturing process as well as for direct communication for diagnostic and testing purposes.

As discussed above, the transmitter processor **204** is configured to transmit control signals to the various sections of the transmitter unit **102** during the operation of the transmitter unit **102**. In one embodiment, the transmitter processor **204** also includes a memory (not shown) for storing data such as the identification information for the transmitter unit **102**, as

well as the data signals received from the sensor **101**. The stored information may be retrieved and processed for transmission to the receiver **104** under the control of the transmitter processor **204**. Furthermore, the power supply **207** may include a commercially available battery.

The transmitter unit **102** is also configured such that the power supply section **207** is capable of providing power to the transmitter for a minimum of three months of continuous operation after having been stored for 18 months in a low-power (non-operating) mode. In one embodiment, this may be achieved by the transmitter processor **204** operating in low power modes in the non-operating state, for example, drawing no more than approximately 1 μA of current. Indeed, in one embodiment, the final step during the manufacturing process of the transmitter unit **102** may place the transmitter unit **102** in the lower power, non-operating state (i.e., post-manufacture sleep mode). In this manner, the shelf life of the transmitter unit **102** may be significantly improved.

Referring yet again to FIG. **2**, the temperature detection section **203** of the transmitter unit **102** is configured to monitor the temperature of the skin near the sensor insertion site. The temperature reading is used to adjust the analyte readings obtained from the analog interface **201**. The RF transmitter **206** of the transmitter unit **102** may be configured for operation in the frequency band of 315 MHz to 322 MHz, for example, in the United States. Further, in one embodiment, the RF transmitter **206** is configured to modulate the carrier frequency by performing Frequency Shift Keying and Manchester encoding. In one embodiment, the data transmission rate is 19,200 symbols per second, with a minimum transmission range for communication with the receiver **104**.

Additional detailed description of the analyte monitoring system, its various components including the functional descriptions of the transmitter unit are provided in U.S. Pat. Nos. 6,175,752 and 7,811,231, the disclosures of each of which are incorporated herein by reference for all purposes.

FIG. **3** illustrates the receiver unit of the data monitoring and management system shown in FIG. **1** in accordance with one embodiment of the present invention. Referring to FIG. **3**, the receiver unit **300** in one embodiment of the present invention includes a sample analysis module **310**, a user interface (UI) module **320**, and a communication module **330**. In one embodiment, the sample analysis module **310** includes a sample interface **311** which is configured to receive a discrete sample for processing. For example, the sample interface **311** may in one embodiment include a strip port configured to receive a blood glucose strip with a blood sample provided thereon for processing.

Referring back to FIG. **3**, the sample analysis module **310** is also provided with an analog front end section **312** which is configured to, among others, process the sample received from the sample interface **311** to convert one or more analog signals associated with the acquired sample characteristics (such as blood glucose level determined from the blood sample received by the sample interface **311**) into a corresponding one or more digital signals for further processing.

The analog front end section **312** in one embodiment is further operatively coupled to a sample analysis processing unit **313** which is configured, in one embodiment, to process the data received from the analog front end section **312**. Within the scope of the present invention, the sample analysis processing unit **313** is configured to perform data processing associated with sample related data. For example, in one embodiment of the present invention, the sample analysis processing unit **313** may be configured to perform substantially all of the data processing associated with the discretely measured blood glucose data in addition to the continuous glucose data received from the transmitter unit **102** (FIG. **1**).

In one embodiment of the present invention, the transceiver unit **314** of the sample analysis module **310** is configured to receive analyte related data from the transmitter unit **102** (FIG. **1**) which is coupled to the sensor **101** that is positioned in fluid contact with the patient's analytes. The transceiver unit **314** may be configured for unidirectional or bidirectional communication.

Referring still to FIG. **3**, the sample analysis processing unit **313** in one embodiment is operatively coupled to a transceiver unit **314** to transmit data to a remote device, for example, to the data processing terminal **105** (or an infusion device, or a supplemental receiver/monitor) over a data connection including, for example, a wireless RF communication link, or a cabled connection such as a USB connection.

As discussed in further detail below, in one embodiment of the present invention, the sample analysis processing unit **313** of the sample analysis module **310** may include an MSP430 microprocessor (or any other functionally equivalent processing unit) to handle data processing associated with glucose data, in addition to RF data reception including performing data decoding on data received from the transmitter unit **102** (FIG. **1**). In one aspect of the present invention, communication with the sample analysis module **310** is achieved with an asynchronous serial interface, and where the sample analysis module **310** may be configured to handle real time clock, power management, processing of continuous and discrete glucose data, monitoring and/or performing processing associated with the internal temperature, or as the UI watchdog.

Referring back to FIG. **3**, the sample analysis processing unit **313** is operatively coupled to a UI module processing unit **321** of the UI module **320**. In addition, the UI module processing unit **321** of the UI module **320** is also operatively coupled to the communication module **330**. In one embodiment of the present invention, the communication module **330** includes a Bluetooth® module configured to communicate under the Bluetooth® transmission protocol and otherwise configured to meet the Bluetooth® communication protocol standard. Such Bluetooth® module has, for example, a built-in ARM processor to handle all aspects of the Bluetooth® protocol in an independent fashion from the sample analysis module **310**, and the user interface (UI) module **320**. In one embodiment, the UI module processing unit **321** is configured to communicate with the communication module **330** over an asynchronous serial interface.

Referring again to FIG. **3**, the communication module **330** in another embodiment of the present invention include other types of communication devices that may be configured to provide communication functions compatible to the Bluetooth® module as described above. For example, a USB interface may be implemented with a TIUSB3410 chip available from Texas Instruments. The TIUSB3410 has a built-in R8051 processor to handle all aspects of the USB protocol in an independent fashion from the sample analysis module **310**, and the user interface (UI) module **320**. Other interface methods are available in modular form (i.e. with built-in processors that handle all aspects of the given protocol) such as, but not limited to WiFi, Home RF, various infrared such as IrDA, and various networking such as Ethernet

Referring back again to FIG. **3**, the UI module **320** in one embodiment of the present invention includes a UI module processing unit **321** which is configured to control the functionalities of the components of the UI module **320**, as well as to communicate with the sample analysis module **310** and the communication module **330**. The UI module **320** also includes an input unit **326**, and output unit **322**, a memory unit

323 (including, for example, both volatile and non-volatile memories), a strip port light source generation unit **327**, a power supply unit **325**, an interface unit **328**, and a clock generator unit **324**. As shown in FIG. **3**, in one embodiment, each of these components of the UI module **320** are configured to perform the predetermined routines and/or processes under the control of the UI module processing unit **321**.

For example, in one embodiment, the UI module processing unit **321** is configured to communicate with the sample analysis module **310** when a strip is inserted into the sample interface **311**, and also with the communication module **330** for data communication. In addition, within the scope of the present invention, the UI module processing unit **321** in one embodiment is configured to update the output display on the output unit **322**, process the received glucose data, maintain a data log (or device operational status log including error or failure mode logs), and perform power management in conjunction with the power supply unit **325**.

More specifically, in one embodiment of the present invention, the UI module **320** is configured to operate as a peripheral device of the sample analysis module **310** with respect to power management. That is, the sample analysis module **310** power is not switched and remains valid as long as a power supply such as a battery with a predetermined signal level (for example, 1.8V) is installed, or alternatively, a supercapacitor is provided and configured to maintain the predetermined signal level. Further, the UI module **320** power is switched off when the power is low (for example, when the power signal level falls below a predetermined threshold level (such as 2.1 volts, for example)).

Additionally, in one embodiment, the sample analysis module **310** is configured to maintain the UI module **320** in a reset status until the operating state of all UI signals has been established. As such, the sample analysis module **310** may be configured to reset the UI module **320** each time it boots so that the sample analysis module **310** and the UI module **320** remain synchronized. In other words, in one embodiment of the present invention, the sample analysis module **310** may be configured as a microprocessor supervisor circuit with respect to the UI module **320**.

In this manner, in one embodiment of the present invention, the data monitoring and management system **100** (FIG. **1**) may include a modular configuration where data processing functions such as analyte related data processing and management of blood glucose data from a discrete sample acquisition device (such as a blood glucose meter) and continuous data stream received from the transmitter unit **102** coupled to the analyte sensor **101** (FIG. **1**) are processed and analyzed by the sample analysis processing unit **313**, while communication functions are handled by a separate communication module **330**. Moreover, in one embodiment, other functionalities of the data monitoring and management system **100** (FIG. **1**) such as user interface, clock signal generation and the like are handled by the UI module processing unit **321**.

Referring yet again to FIG. **3**, in one embodiment, the UI module processing unit **321** may be configured to run between approximately 5 MHz and 33.3 MHz. The output unit **322** may include a display unit which in one embodiment is a liquid crystal display (LCD). In one embodiment, the LCD display unit may be coupled to the bus on the UI module processing unit **321** as a memory mapped peripheral device. Likewise, in one aspect, the memory unit **323** may include an SRAM which is connected to the bus on the UI module processing unit **321** as a memory mapped peripheral device. In addition, the memory unit **323** may also include a non-volatile memory which may be configured to store the log information associated with the receiver unit **300**. In one embodiment, the non-volatile memory may include an EEPROM with a serial peripheral interface to connect to the serial communication interface of the UI module processing unit **321**.

Referring still to FIG. **3**, the clock generator unit **324** of the receiver unit **300** may be configured to act as a supervisor and a clock generator to provide spread spectrum processor clock frequency dithering to lower the radiated emissions (EMC) of the user interface (UI) module **320**. While the real time clock signals may be received from the sample analysis module **310**, in one aspect, in the absence of the sample analysis module **310**, the clock generator unit **324** may be configured to provide the real time clock signal in conjunction with, for example, a crystal oscillator.

Referring still to FIG. **3**, the power supply unit **325** in one embodiment may include a disposable battery with fusing and ESD protection. When the disposable power supply reaches a near end of life status, a predefined signal may be generated which will trigger when the battery voltage signal falls below a predetermined level, for example, 2.1 Volts. Moreover, to recover from a severe processing load such as for example, when the communication module **330** (e.g., Bluetooth® module) triggers such signal for communication, a predetermined trigger level may be lowered so as to allow the UI module processing unit **321** to recover and maintain its functionality.

In addition, since the signals from the power supply unit **325** is used primarily for the UI module **320**, the receiver unit **300** power consumption may be lowered significantly when the predefined signal associated with the power supply nearing end of life status is active, so that the sample analysis module **310** may be provided with substantially the maximum amount of power to maintain the real time clock and for failure mitigation. Moreover, the output signal from the power supply unit **325** in one embodiment is used by the communication module **330** and may be turned off when the communication module **330** is not in active communication mode to reduce quiescent current and to potentially increase the battery life.

Referring yet again to FIG. **3**, the power supply unit **325** may be configured in one embodiment to supply power to the components of the receiver unit **300** as shown in the Figure. Referring yet again to FIG. **3**, the input unit **326** may include buttons, touch sensitive screen, a jog wheel or any type of input device or mechanism to allow a user to input information or data into the receiver unit **300**. In one embodiment, the input unit **326** may include a plurality of buttons, each of which are operatively coupled to the UI module processing unit **321**. In one embodiment, the patient or the user may manipulate the input unit **326** to enter data or otherwise provide information so as to be responsive to any commands or signals generated by the receiver unit **300** that prompts for a user input.

In addition, the output unit **322** may include a backlight component which is configured to illuminate at least a portion of the output unit **322** in the case where the receiver unit **300** is used in a substantially dark environment. As shown, the output unit **322** is operatively coupled to the UI module processing unit **321**, and accordingly, the output unit **322** may be configured to output display generated or analyzed data under the control of the UI module processing unit **321**. Moreover, upon user activation or by automatic sensing mechanism, the output display **322** such as an LCD display unit may turn on the backlight feature so as to illuminate at least a portion of the output unit **322** to enable the patient to view the output unit **322** in substantially dark environment.

Furthermore, the output unit **322** may also include an audible output section such as speakers, and/or a physical output section, such as a vibratory alert mechanism. In one embodiment, the audio and vibratory alert mechanisms may be configured to operate under the control of the UI module processing unit **321**, and also, under backup control by the sample analysis processing unit **313** of the sample analysis module **310**. In this manner, even if the UI module processing unit fails, the sample analysis module **310** may be configured as a backup unit to control the output unit **322** for certain predetermined types of alarms and/or alerts thus providing a measure of fault tolerance for the system.

Referring yet still again to FIG. **3**, the receiver unit **300** includes the strip port light source generation unit **327** which is operatively coupled to the UI module processing unit **321**, and is configured in one embodiment to illuminate the sample interface **311** of the sample analysis module **310** such that, in substantially dark settings, the patient may still be able to check for blood glucose level easily by inserting the test strip with the blood sample thereon, into the sample interface **311** which may be illuminated by the strip port light source generation unit **327**. The strip port light source generation unit **327** may also be used as a visual alert mechanism and may be configured to operate under the control of the UI module processing unit **321**, and also, under backup control by the sample analysis processing unit **313** of the sample analysis module **310**.

In addition, the interface unit **328** of the receiver unit **300** in one embodiment of the present invention may be configured as a cradle unit and/or a docking station. In addition, the interface unit **328** of the receiver unit **300** may be configured for test and/or diagnostic procedure interface to test or otherwise configure the receiver unit **300** via the interface unit **328** during or post manufacturing to ensure that the receiver unit **300** is properly configured.

FIG. **4** is a flowchart illustrating the quiet host procedure in the receiver unit of the data monitoring and management system of FIG. **3** in accordance with one embodiment of the present invention. In one embodiment of the present invention, the sample analysis module **310** may be configured to assert a quiet host signal prior to an RF reception by the receiver unit **300** to trigger the UI module processing unit **321** to reduce activity and enter a quiet mode and to suspend all activity by the communication module **330**. Referring to FIG. **4**, at step **410** when a quiet host signal is asserted by the sample analysis module processing unit **313**, it is determined at step **420** whether the UI module processing unit **321** is in active processing mode. If it is determined that the UI module processing unit **321** is in active processing mode, then at step **430** the current cycle such as the current housekeeping cycle is performed, and the UI module processing unit **321** returned to the inactive mode at step **440**, and the routine terminates. If the activity is user interface or communications related, then the brief pause while the quiet host signal is asserted will not be noticed by the user or affect communications.

On the other hand, referring back to FIG. **4**, if at step **420** it is determined that the UI module processing unit **321** is not in an active mode, then at step **450**, the UI module processing unit **321** is returned to the active mode, and at step **460** it is determined whether the UI module processing unit **321** is scheduled to execute some activity such as housekeeping during the reception of the data transmitted from the transmitter unit **102** (FIG. **1**) by the analysis module **310**. If at step **460** it is determined that the UI module processing unit **321** is not scheduled to be executing the housekeeping routine, then at step **470** the current active cycle is performed, and again, the UI module processing unit **321** is configured to enter the inactive mode at step **440** so as to maintain a quiet state during data reception by the analysis module **310**.

Referring back to FIG. **4**, at step **460** if it is determined that the UI module processing unit **321** is scheduled to execute some activity such as housekeeping during the reception of the data transmitted from the transmitter unit **102** (FIG. **1**), then at step **480**, the scheduled activity (e.g. housekeeping) is executed on an expedited basis, and at step **490** a time flag is generated which is associated with the expedited activity. The time flag in one embodiment is configured to modify the wakeup timer in the receiver unit **300** such that the UI module processing unit **321** may be configured to not wakeup during the RF transmission, again so as to maintain a quiet state during data reception by the analysis module **310**.

In the manner described above, in accordance with the various embodiments of the present invention, there is provided a fault tolerant data receiver unit configured with a partitioned or separate processing units, each configured to perform a predetermined and/or specific processing associated with the one or more substantially non-overlapping functions of the data monitoring and management system. In one embodiment, the data receiver unit includes a communication module, a user interface module and a sample analysis module, and each module provided with a separate processing unit. In this manner, in one embodiment, each module is configured to perform predetermined functions associated with the data monitoring and management system to provide a modular, objected oriented processing architecture.

An analyte monitoring and management system in one embodiment of the present invention includes an analyte sensor, a transmitter unit coupled to the analyte sensor and configured to receive one or more analyte related signals from the analyte sensor, and a receiver unit configured to receive the one or more analyte related signals from the transmitter unit, the receiver unit including a sample analysis module and a user interface module operatively coupled to the sample analysis module.

The receiver unit may also further include a communication module operatively coupled to the user interface module, where the communication module may include a wired or a wireless communication module.

In one aspect, the wireless communication module may include one or more of a Bluetooth® communication module, a local area network data module, a wide area network data module, or an infrared communication module.

The analyte sensor may include a glucose sensor, where at least a portion of the analyte sensor is in fluid contact with an analyte of a patient.

The analyte may include one or more of an interstitial fluid, blood, or oxygen.

In one embodiment, the sample analysis module may be configured to receive one or more data associated with a respective one or more analyte samples for processing. Further, the one or more analyte samples are received from a respective one or more glucose test strips.

The sample analysis module may include a sample analysis module processing unit configured to process the one or more data associated with the respective one or more analyte samples, where the one or more analyte samples include blood glucose measurements.

In a further aspect, the sample analysis module processing unit may be further configured to process one or more analyte related signals from the transmitter unit.

In yet another aspect, the user interface module may include an output unit configured to display one or more signals associated with a condition of a patient.

The output unit may be configured to display one or more of a visual, auditory or vibratory output associated with the condition of the patient.

The visual output may include one or more of a directional arrow indicator, a color indicator, or a size indicator.

The auditory output may be configured to progressively increase or decrease the associated sound signal over a predetermined time period.

The vibratory output may be configured to progressively increase or decrease the associated vibratory signal over a predetermined time period.

In addition, the user interface module may include a user interface module processing unit operatively coupled to the output unit, where the user interface module processing unit may be configured to control the operation of the output unit.

In still another aspect, the user interface module may include an input unit configured to receive one or more input commands from a patient.

A data receiver unit in another embodiment of the present invention includes a first processing unit configured to perform a first predetermined processing, a second processing unit operatively coupled to the first processing unit, the second processing unit configured to perform a second predetermined processing, and a third processing unit operatively coupled to the second processing unit, the third processing unit configured to perform a third predetermined processing, where the first predetermined processing, the second predetermined processing and the third predetermined processing are substantially non-overlapping functions.

The receiver unit may also include a power supply unit operatively coupled to the second processing unit, the power supply unit configured to provide power to the first, second and third processing units.

In another aspect, the receiver unit may include a memory unit operatively coupled to the second processing unit, where the memory unit may include a non-volatile memory.

The memory unit may be configured to store one or more programming instructions for execution by one or more of the first processing unit, the second processing unit or the third processing unit.

A method in still another embodiment of the present invention includes configuring a first processing unit to perform a first predetermined processing, operatively coupling a second processing unit to the first processing unit, configuring the second processing unit to perform a second predetermined processing, operatively coupling a third processing unit to the second processing unit, and configuring the third processing unit to perform a third predetermined processing, where the first predetermined processing, the second predetermined processing and the third predetermined processing are substantially non-overlapping functions.

The method may also include operatively coupling a power supply to the second processing unit, and configuring the power supply unit to provide power to the first, second and the third processing units.

In another aspect, the method may also include further operatively coupling a memory unit to the second processing unit.

In yet another aspect, the method may also include configuring the memory unit to store one or more programming instructions for execution by one or more of the first processing unit, the second processing unit or the third processing unit.

The various processes described above including the processes performed by the UI module processing unit **321** and the sample analysis module **310** in the software application execution environment in the receiver unit **300** including the processes and routines described in conjunction with FIG. **4**, may be embodied as computer programs developed using an object oriented language that allows the modeling of complex systems with modular objects to create abstractions that are representative of real world, physical objects and their interrelationships. The software required to carry out the inventive process, which may be stored in the memory unit **323** (for example) of the receiver unit **300** and may be developed by a person of ordinary skill in the art and may include one or more computer program products.

Various other modifications and alterations in the structure and method of operation of this invention will be apparent to those skilled in the art without departing from the scope and spirit of the invention. Although the invention has been described in connection with specific preferred embodiments, it should be understood that the invention as claimed should not be unduly limited to such specific embodiments. It is intended that the following claims define the scope of the present invention and that structures and methods within the scope of these claims and their equivalents be covered thereby.

What is claimed is:

1. A method, comprising:

generating, by an analyte data receiver, a quiet host signal prior to a data reception period; and

in response to the generated quiet host signal, completing, by the analyte data receiver, a current processing cycle, if any, and entering, by the analyte data receiver, an inactive mode during the data reception period.

2. The method of claim **1**, further including receiving, by the analyte data receiver, one or more analyte related signals during the data reception period.

3. The method of claim **2**, wherein the one or more analyte related signals are received from a transmitter communicatively coupled with an analyte sensor, wherein at least a portion of the analyte sensor is in contact with a fluid in a user's body.

4. The method of claim **3**, wherein the analyte sensor is a glucose sensor.

5. The method of claim **1**, further including receiving, by the analyte data receiver, data associated with an analyte sample.

6. The method of claim **5**, wherein the analyte sample is received from a glucose test strip.

7. The method of claim **2**, further including processing the one or more analyte related signals by the analyte data receiver.

8. The method of claim **5**, wherein the analyte sample includes a blood glucose measurement.

9. The method of claim **1**, further including outputting one or more signals associated with a physiological condition including one or more of a directional arrow indicator, a color indicator, or a monitored condition level indicator.

10. The method of claim **9**, wherein outputting the one or more signals associated with the physiological condition includes progressively increasing or decreasing an associated outputted signal over a predetermined time period.

11. A method, comprising:

completing a first processing cycle and subsequently entering an inactive mode if a predetermined signal is received during the first processing cycle, or entering an active mode and determining whether a second processing cycle is to be performed during a data reception period if the predetermined signal is received other than during the first processing cycle;

expediting the second processing cycle, and entering the inactive mode if it is determined that the first processing cycle is to be performed during the data reception period; and

performing the second processing cycle and subsequently entering the inactive mode if it is determined that the first processing cycle is to be performed during the data reception period.

12. The method of claim **11**, wherein the second processing cycle includes a housekeeping routine.

13. A method, comprising:

performing, using a first processing unit, a first predetermined processing routine, and performing, using a second processing unit, a second predetermined processing routine, wherein the first and the second predetermined processing routines are non-overlapping; and

prior to a start of a data reception cycle, placing one of the first or the second processing units in an inactive mode, wherein the inactive mode includes suspending all activity of another one of the first or second processing units; and

receiving one or more analyte related signals during the data reception cycle.

14. The method of claim **13**, further comprising providing medication information based on the received one or more analyte related signals for administration.

15. The method of claim **14**, wherein the medication information includes an insulin amount.

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