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(54) **REGIONAL OXIMETRY USER INTERFACE**

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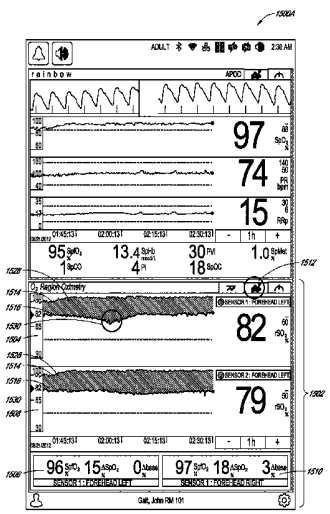
(57) **ABSTRACT**

A regional oximetry system has a display and at least one processor causing a plurality of views to be displayed on the display, each configured to occupy at least a portion of the display. The views are adapted to present data responsive to at least one physiological signal. A first sensor port is configured to receive at least a first physiological signal representative of a regional tissue oxygenation level, and a second sensor port is configured to receive at least a second physiological signal representative of an arterial oxygen saturation level. One view presents a first trend graph of the first physiological signal and a second trend graph of the second physiological signal. An area between the first trend graph and the second trend graph can include a differential analysis of regional-to-central oxygen saturation.

12 Claims, 38 Drawing Sheets



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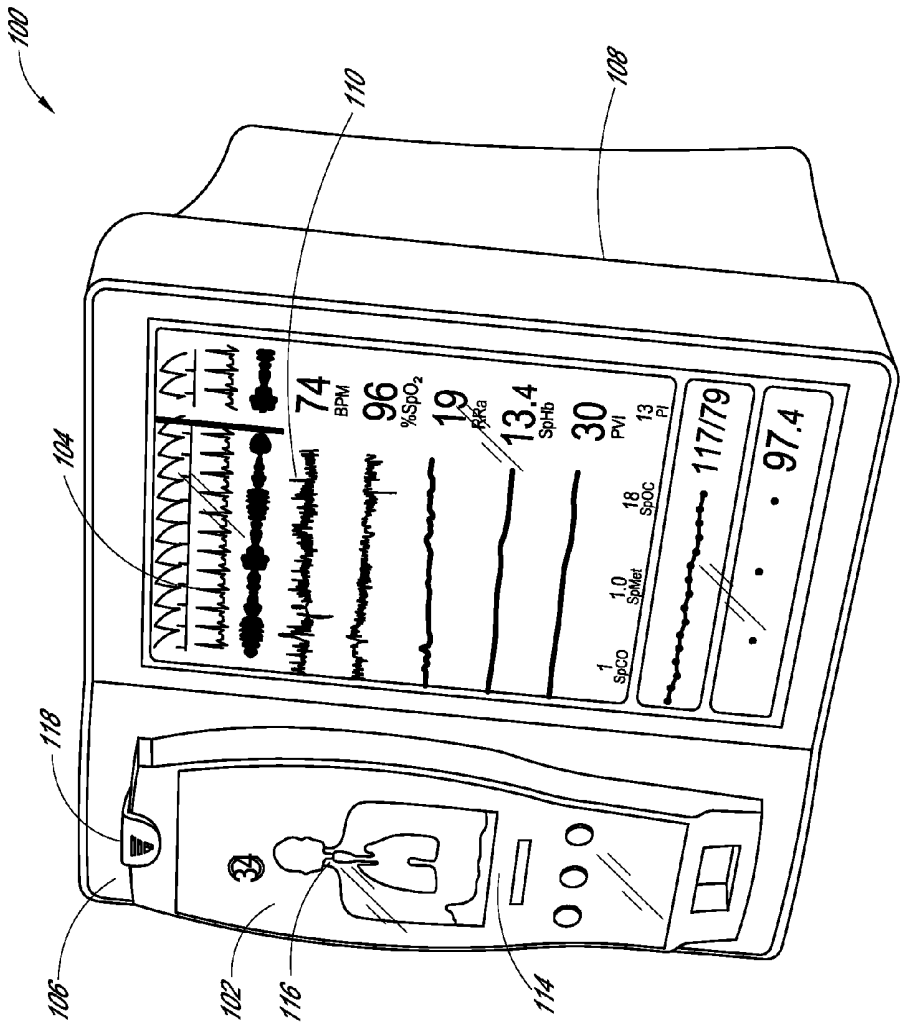
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FIG. 1A

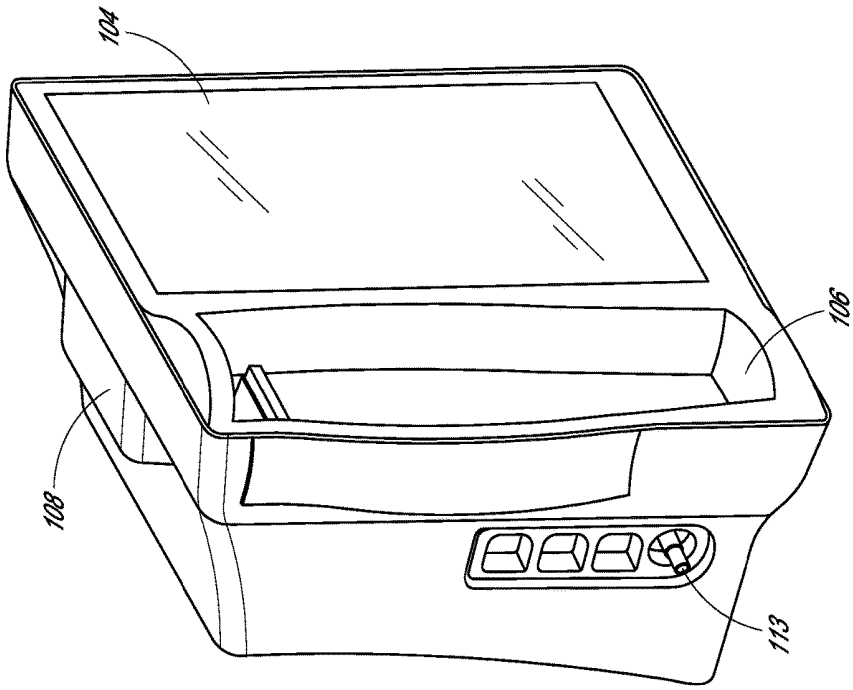

FIG. 1B

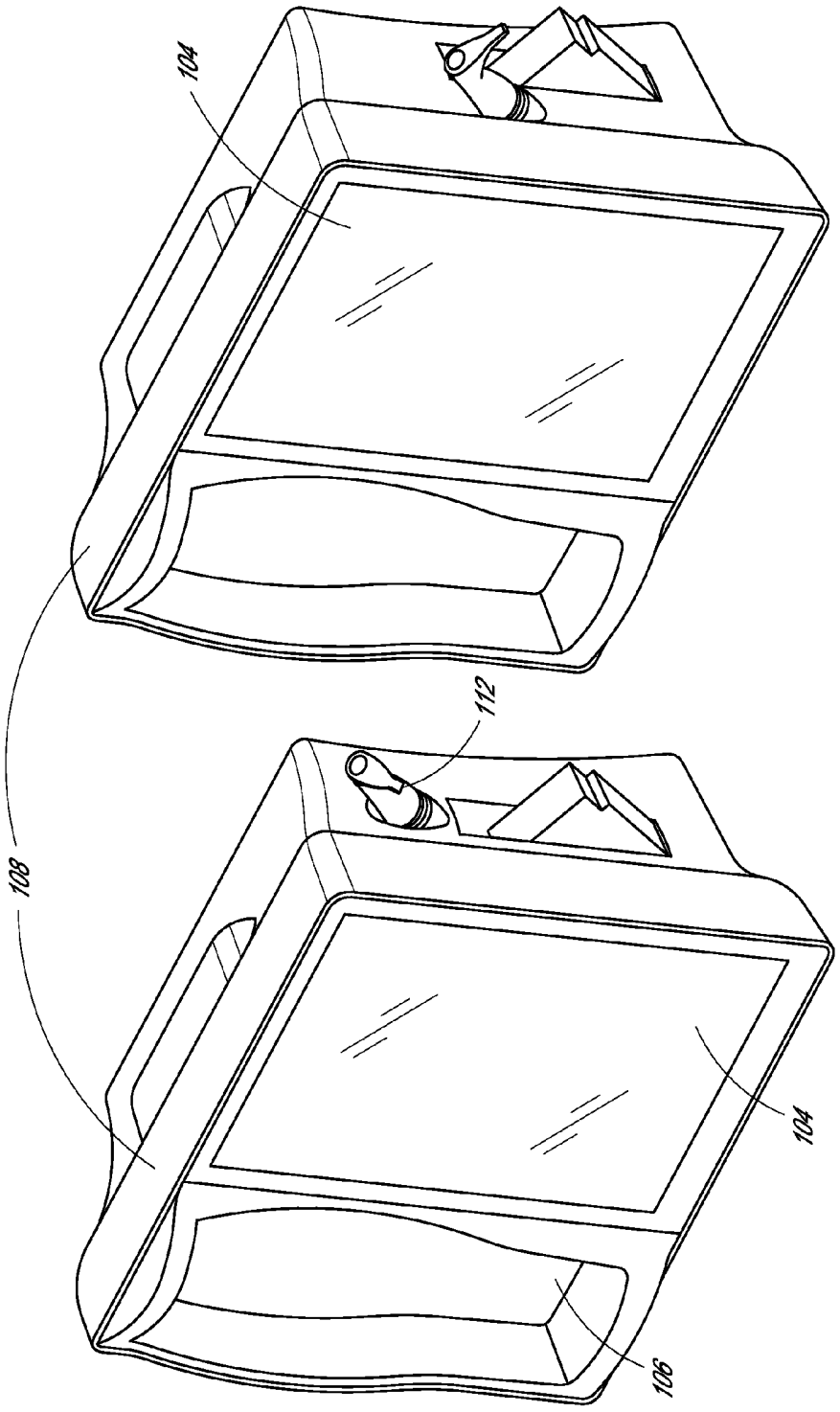

FIG. 1C

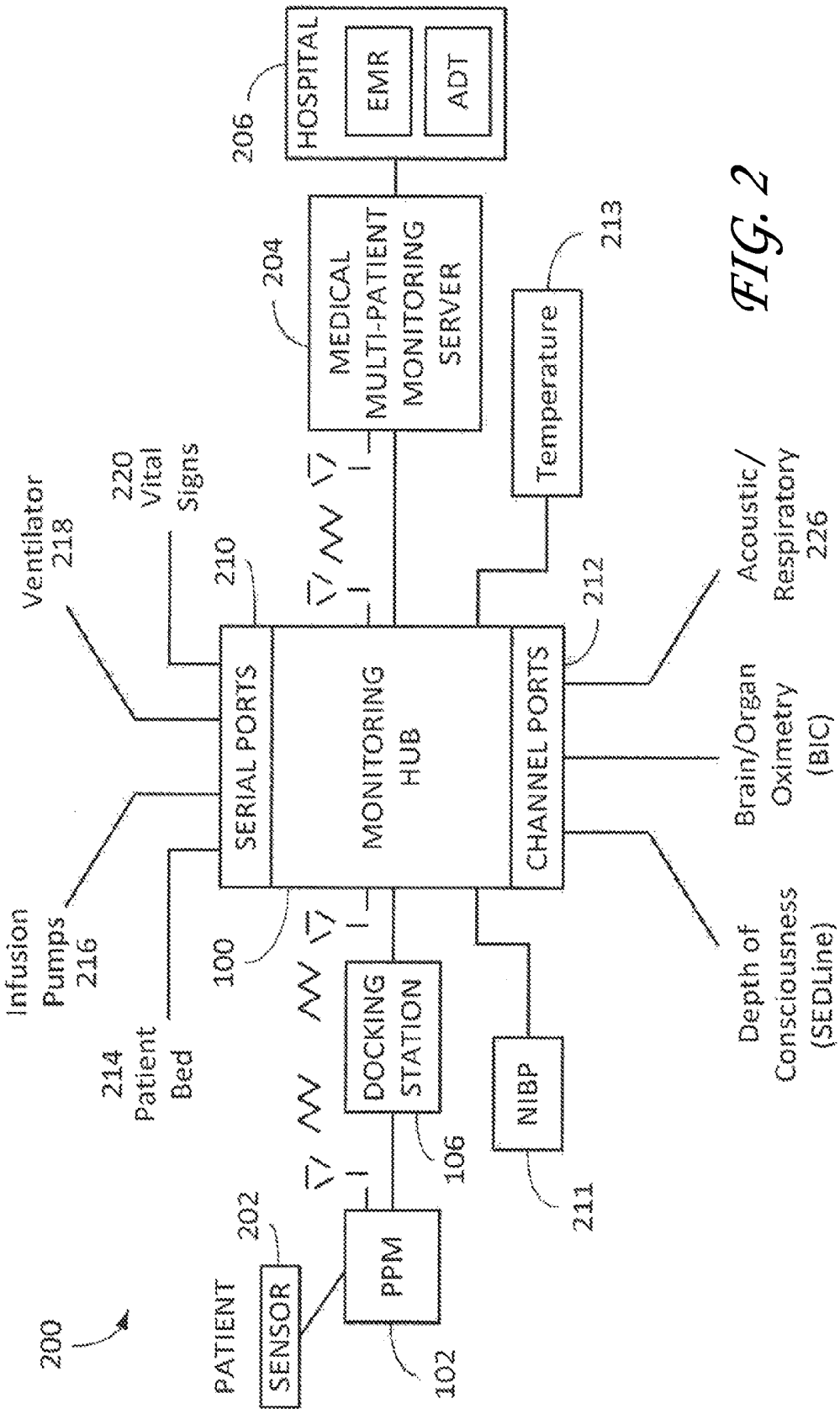
200
PATIENT
SENSOR
202
PPM
102
DOCKING STATION
106
NIBP
211
MONITORING HUB
100
SERIAL PORTS
210
CHANNEL PORTS
212
MEDICAL MULTI-PATIENT MONITORING SERVER
204
HOSPITAL
EMR
ADT
206
Temperature
213
Ventilator
218
220 Vital Signs
Infusion Pumps
216
214 Patient Bed
Acoustic/ Respiratory
226
Brain/Organ Oximetry (BIC)
224
Depth of Consciousness (SEDLine)
222

FIG. 2

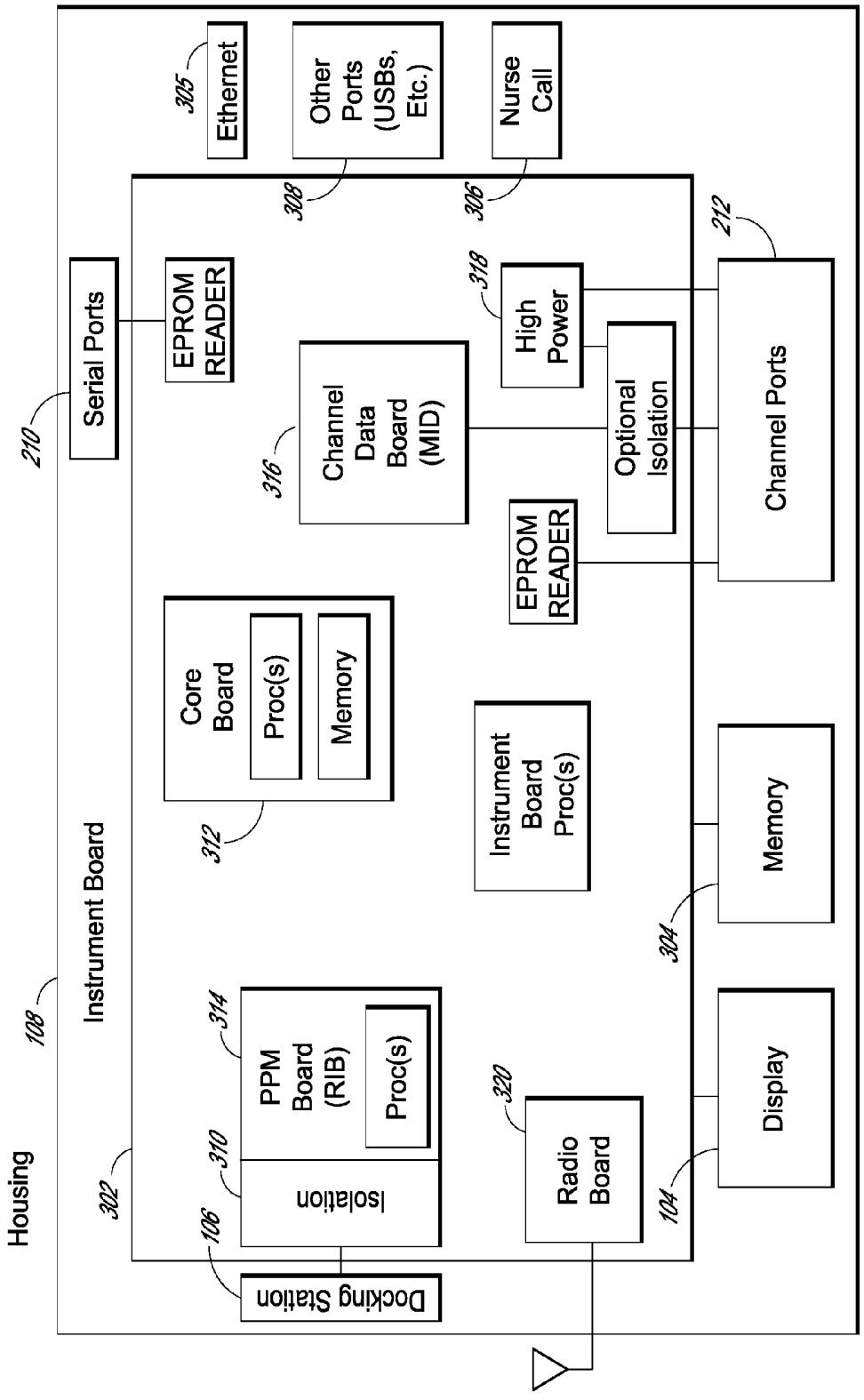
Housing
108
Instrument Board
302
Serial Ports
210
EPROM READER
Ethernet
305
Other Ports (USBs, Etc.)
308
Nurse Call
306
212
Channel Ports
318
High Power
Optional Isolation
316
Channel Data Board (MID)
EPROM READER
Core Board
Proc(s)
Memory
312
Instrument Board Proc(s)
304
Memory
314
PPM Board (RIB)
Proc(s)
310
Isolation
106
Docking Station
320
Radio Board
104
Display

FIG. 3

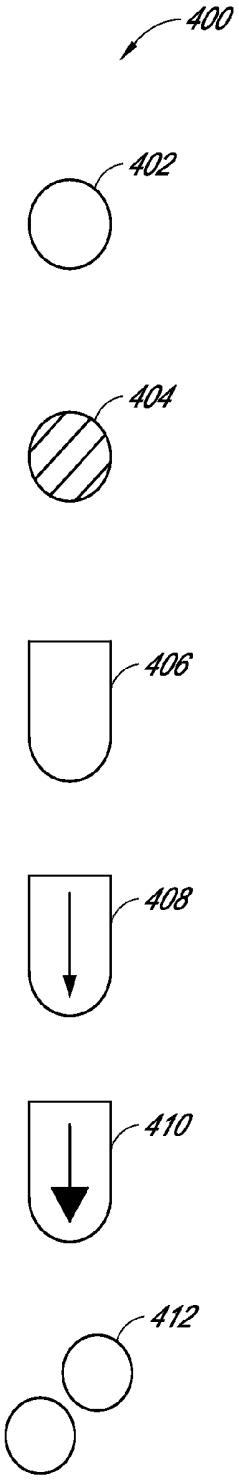

FIG. 4

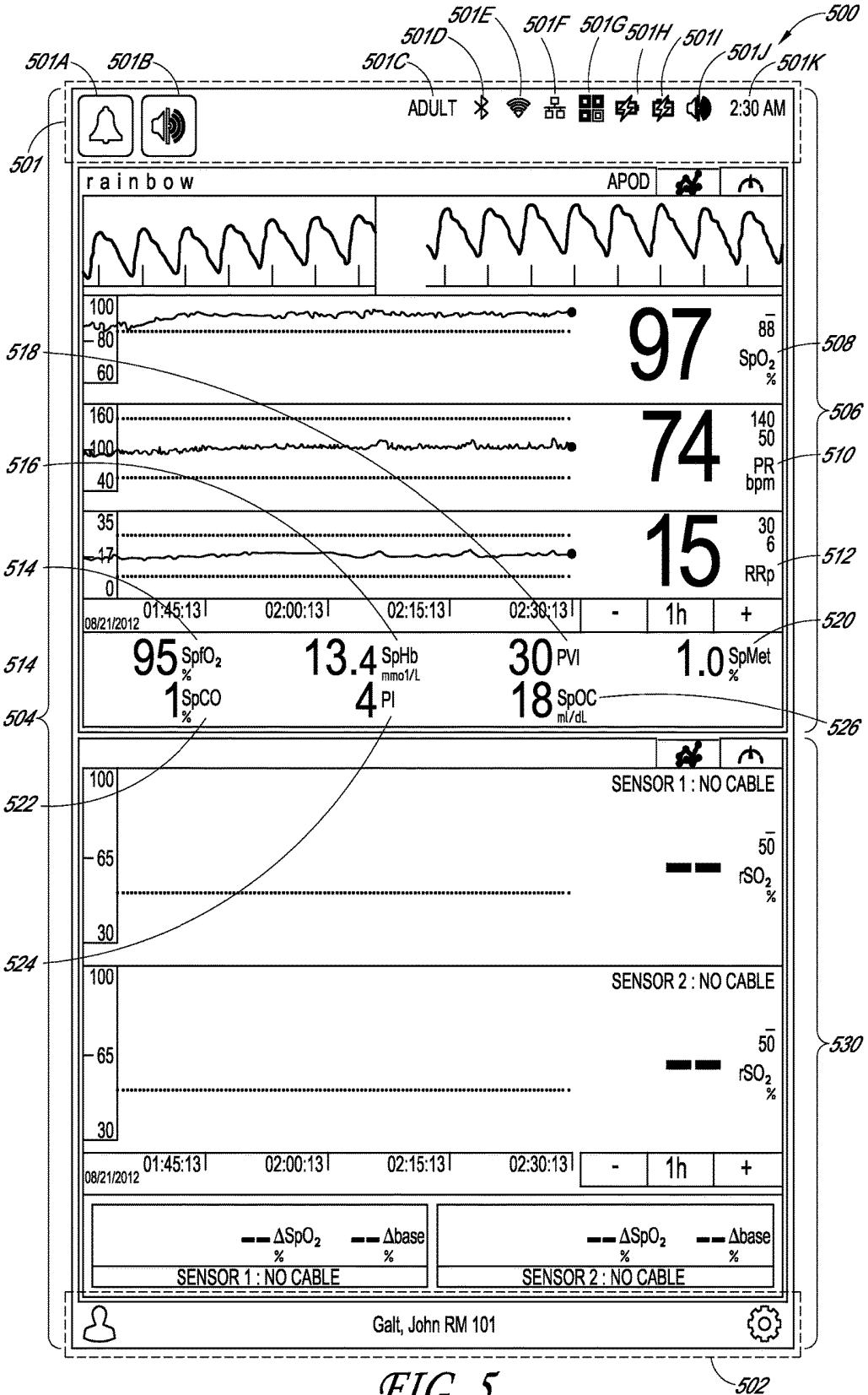
501A
501B
501C
501D
501E
501F
501G
501H
501I
501J
501K
500
501
ADULT
2:30 AM
rainbow
APOD
97
88
SpO2
%
508
506
74
140
50
PR
bpm
510
518
516
15
30
6
RRp
512
514
01:45:13
02:00:13
02:15:13
02:30:13
08/21/2012
-
1h
+
520
95 SpfO2
13.4 SpHb
mmol/L
30 PVI
1.0 SpMet
1 SpCO
4 PI
18 SpOC
ml/dL
526
504
522
524
SENSOR 1 : NO CABLE
50
rSO2
SENSOR 2 : NO CABLE
530
ΔSpO2
Δbase
SENSOR 1 : NO CABLE
SENSOR 2 : NO CABLE
Galt, John RM 101
502

FIG. 5

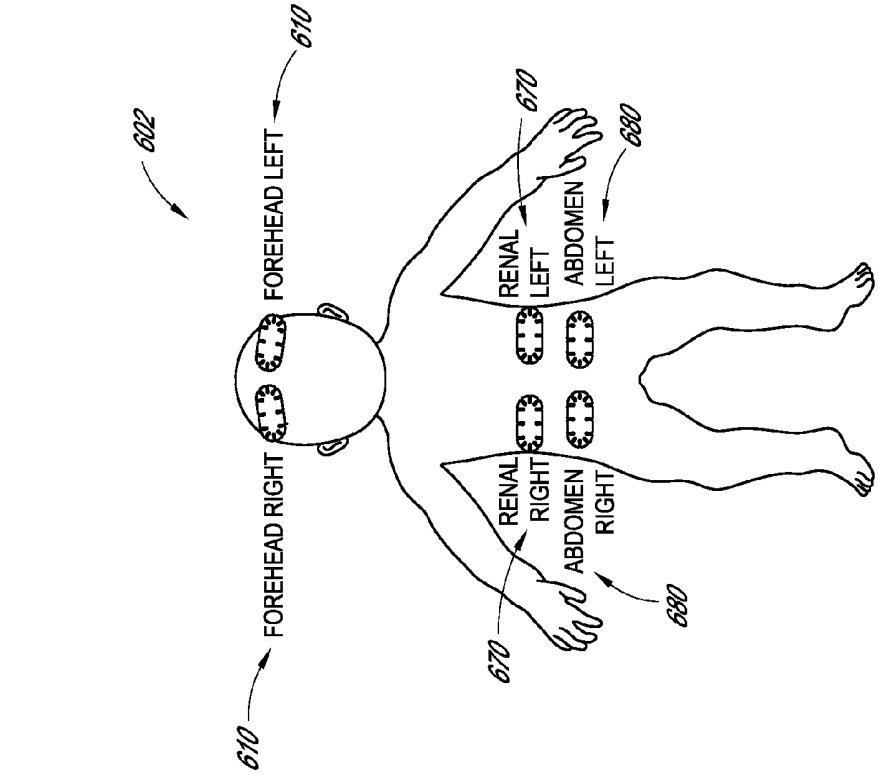
602
610
FOREHEAD LEFT
610
FOREHEAD RIGHT
670
RENAL LEFT
680
ABDOMEN LEFT
RENAL RIGHT
670
ABDOMEN RIGHT
680

FIG. 6B

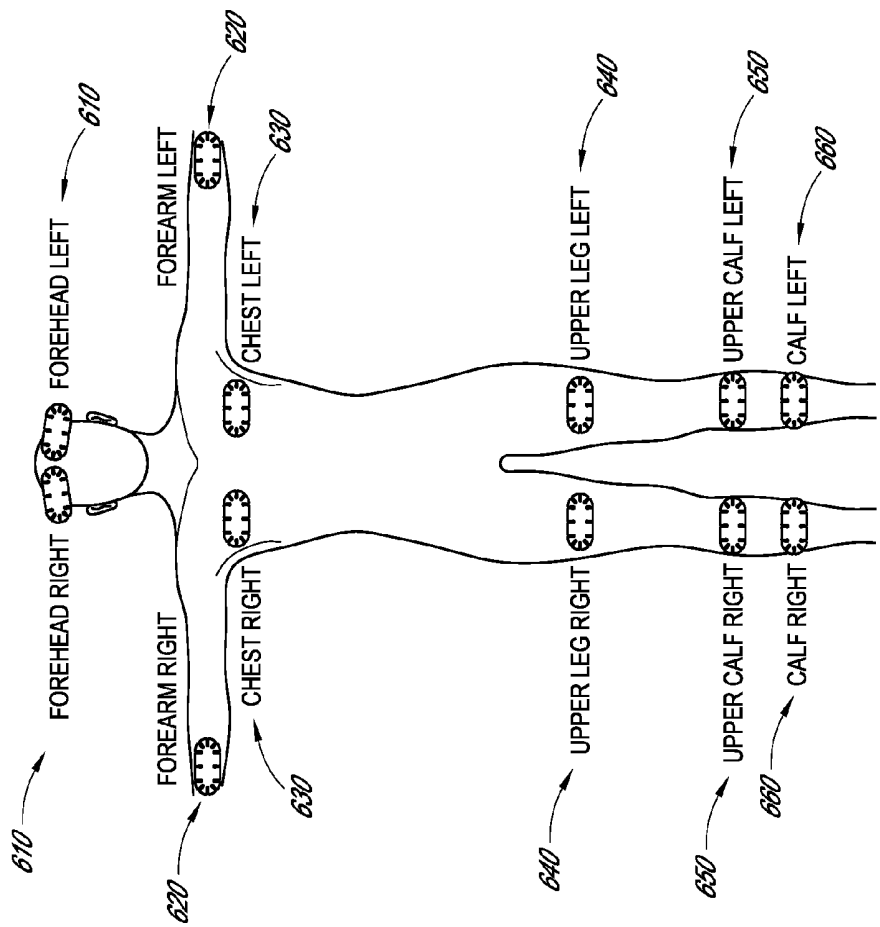
601
610
FOREHEAD LEFT
610
FOREHEAD RIGHT
620
FOREARM LEFT
620
FOREARM RIGHT
630
CHEST LEFT
630
CHEST RIGHT
640
UPPER LEG LEFT
640
UPPER LEG RIGHT
650
UPPER CALF LEFT
650
UPPER CALF RIGHT
660
CALF LEFT
660
CALF RIGHT

FIG. 6A

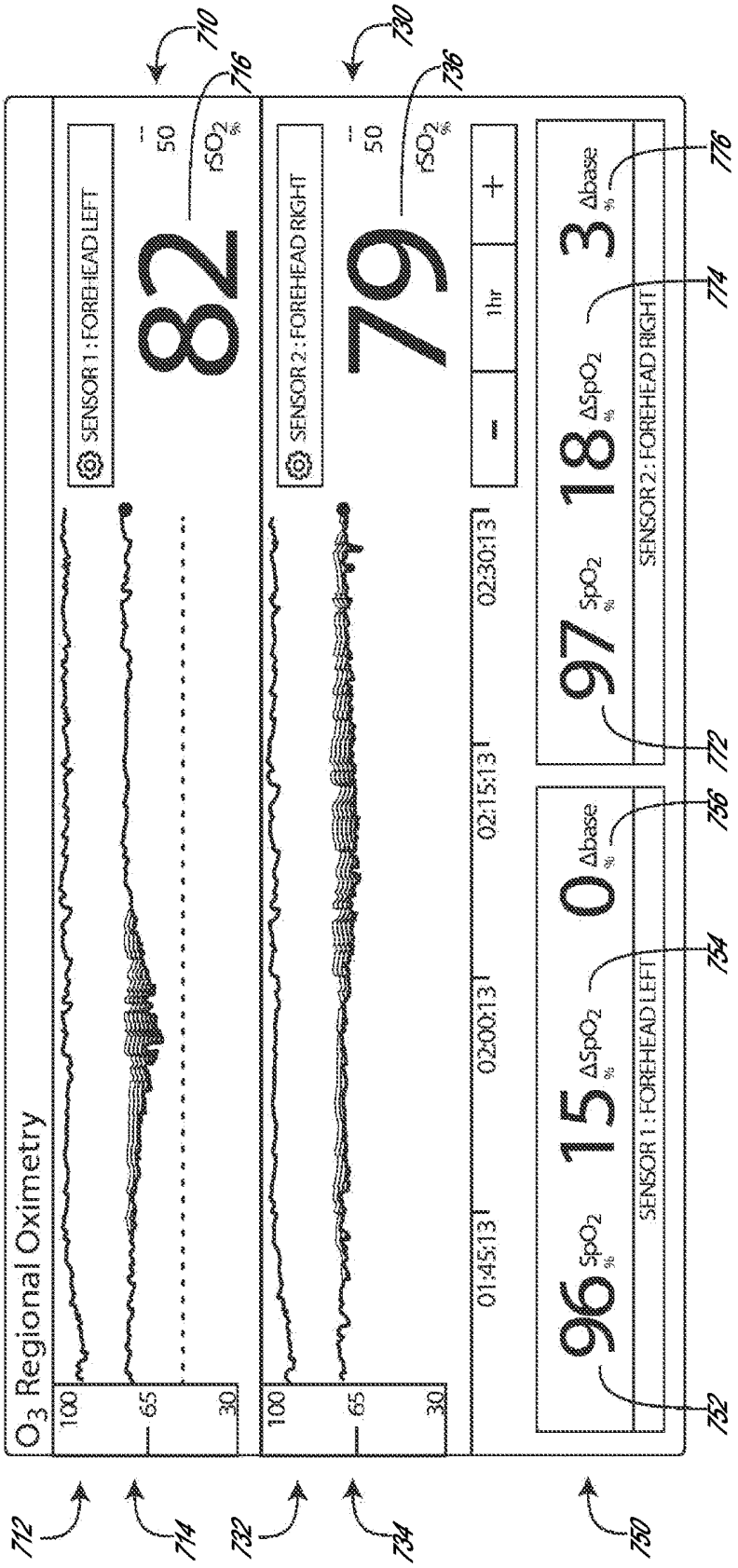
700
O3 Regional Oximetry
SENSOR 1 : FOREHEAD LEFT
82
rSO2 %
SENSOR 2 : FOREHEAD RIGHT
79
rSO2 %
100
65
30
01:45:13
02:00:13
02:15:13
02:30:13
1hr
96 SpO2 %
15 ΔSpO2 %
0 Δbase %
SENSOR 1 : FOREHEAD LEFT
97 SpO2 %
18 ΔSpO2 %
3 Δbase %
SENSOR 2 : FOREHEAD RIGHT
710
716
730
736
712
714
732
734
750
752
754
756
772
774
776

FIG. 7

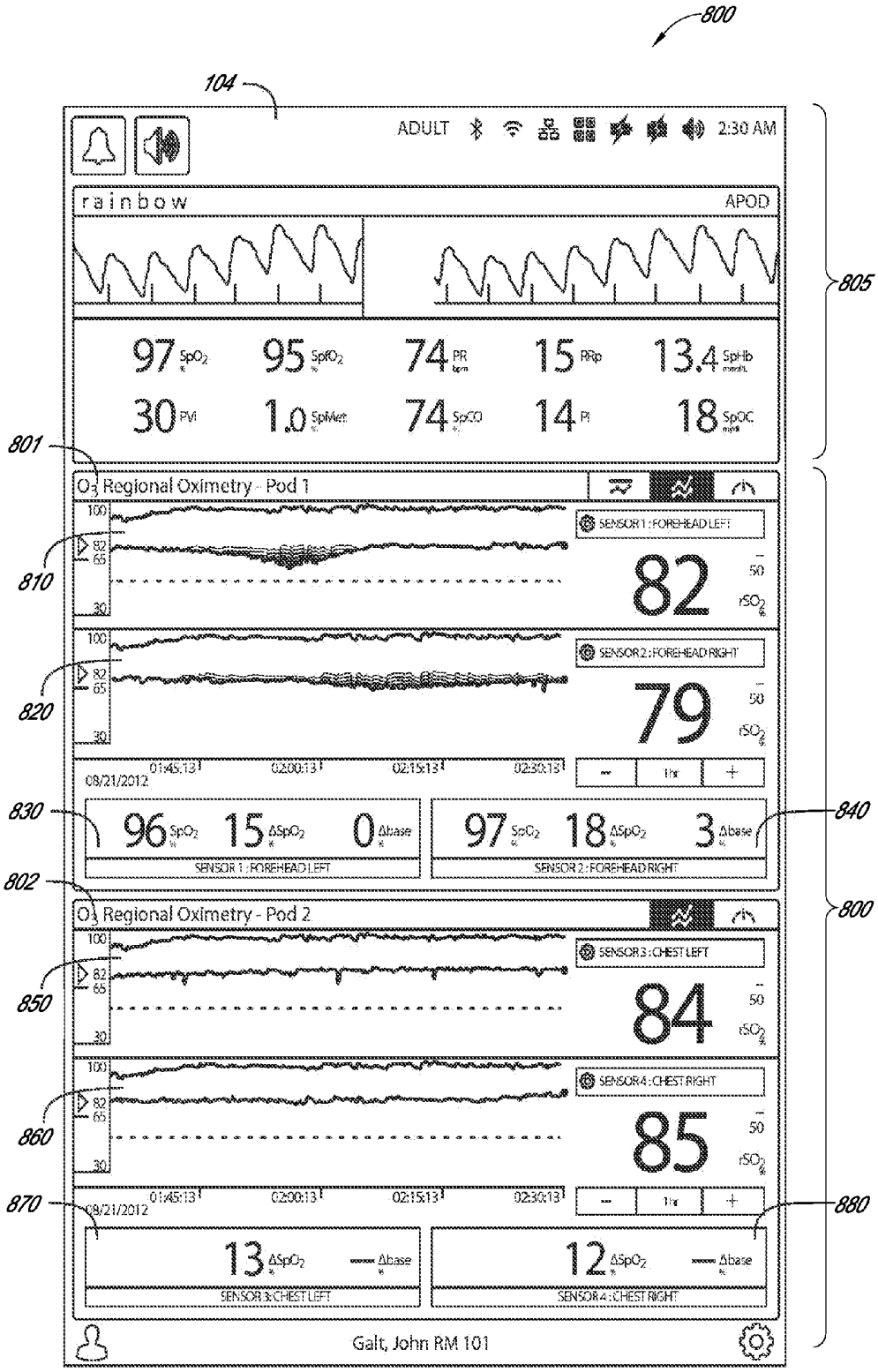
800
104
ADULT
2:30 AM
rainbow
APOD
805
97 SpO2
95 SpO2
74 PR
15 RRp
13.4 SpHb
30 PVI
1.0 SpMet
74 SpCO
14 PI
18 SpOC
801
Regional Oximetry - Pod 1
SENSOR 1 : FOREHEAD LEFT
82
SENSOR 2 : FOREHEAD RIGHT
79
810
820
08/21/2012
01:45:13
02:00:13
02:15:13
02:30:13
1hr
830
96 SpO2
15 ΔSpO2
0 Δbase
SENSOR 1 : FOREHEAD LEFT
97 SpO2
18 ΔSpO2
3 Δbase
SENSOR 2 : FOREHEAD RIGHT
840
802
Regional Oximetry - Pod 2
SENSOR 3 : CHEST LEFT
84
SENSOR 4 : CHEST RIGHT
85
850
860
870
13 ΔSpO2
Δbase
SENSOR 3 : CHEST LEFT
12 ΔSpO2
Δbase
SENSOR 4 : CHEST RIGHT
880
Galt, John RM 101

FIG. 8

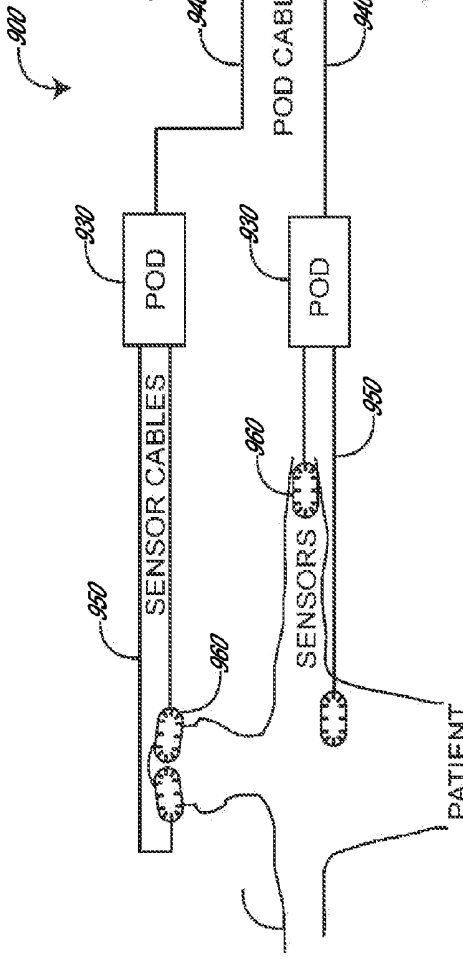
900
910
920
100
PHYSIOLOGICAL PARAMETER MONITOR
940
940
POD CABLES
930
930
POD
POD
SENSOR CABLES
950
950
960
960
SENSORS
PATIENT

FIG. 9A

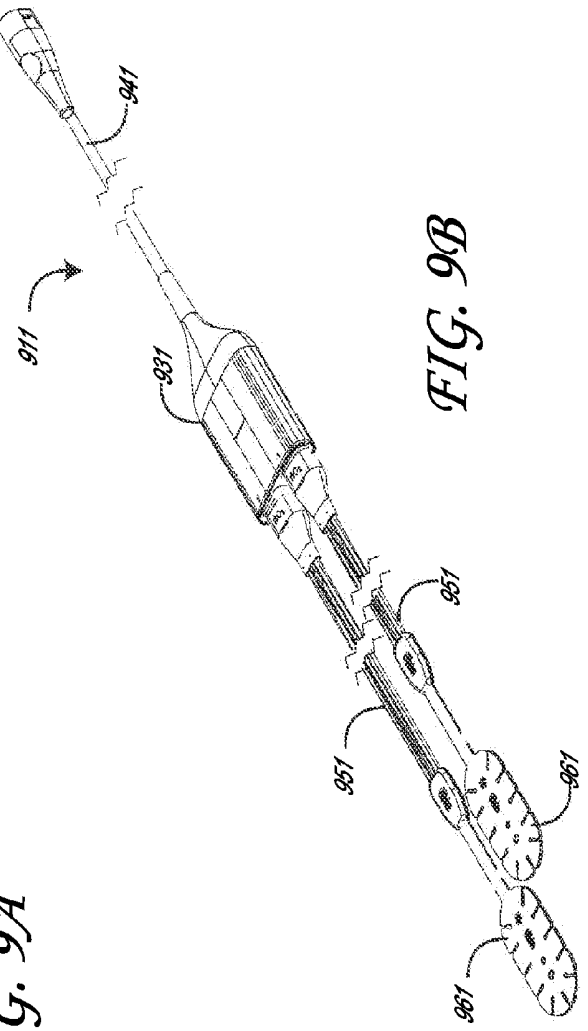
941
911
931
951
951
961
961

FIG. 9B

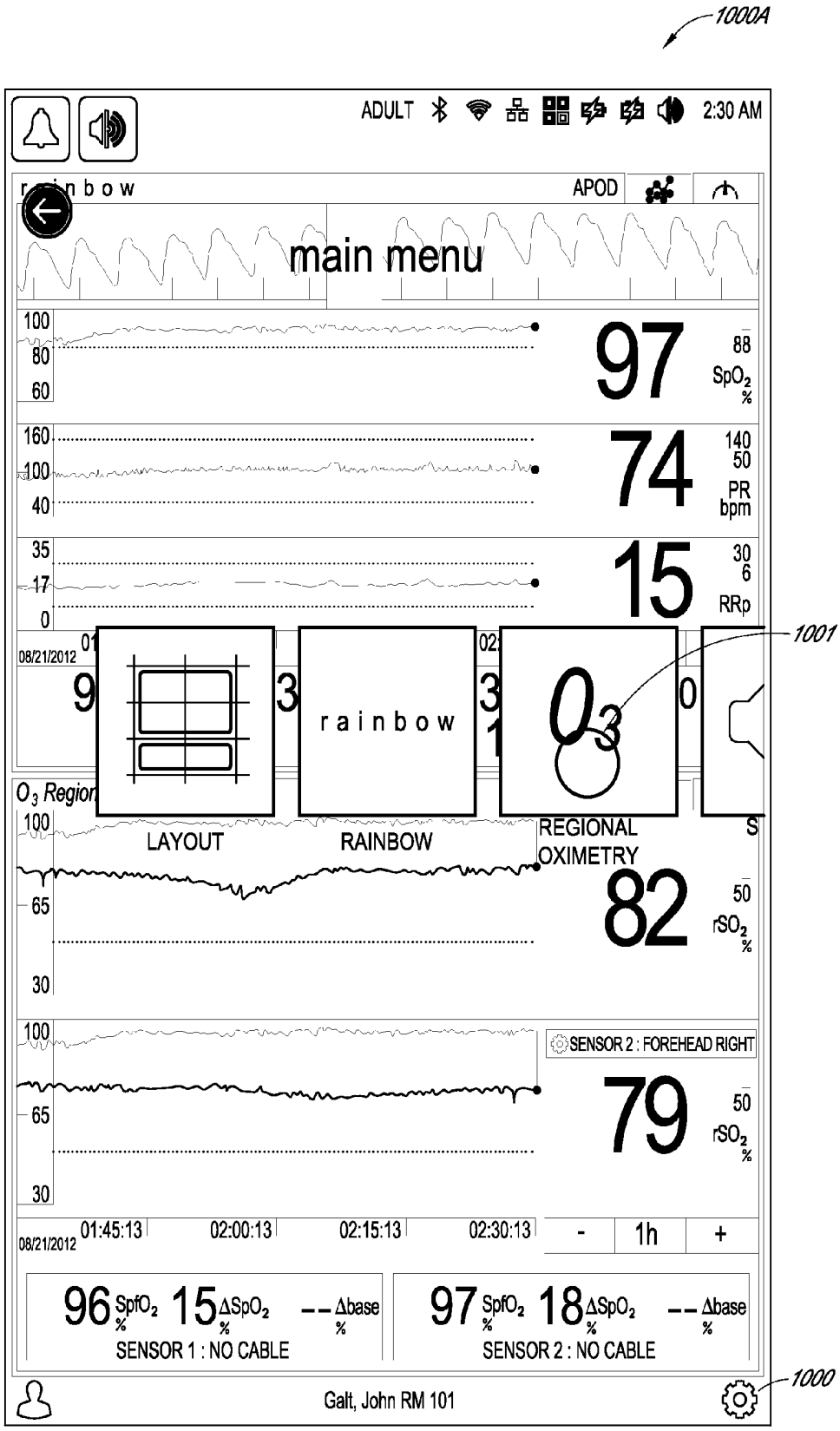
1000A
ADULT
2:30 AM
APOD
main menu
97
88
SpO2 %
74
140
50
PR bpm
15
30
6
RRp
1001
rainbow
LAYOUT
RAINBOW
REGIONAL OXIMETRY
82
50
rSO2 %
SENSOR 2 : FOREHEAD RIGHT
79
50
rSO2 %
08/21/2012
01:45:13
02:00:13
02:15:13
02:30:13
-
1h
+
96 SpfO2 % 15 ΔSpO2 % --Δbase %
SENSOR 1 : NO CABLE
97 SpfO2 % 18 ΔSpO2 % --Δbase %
SENSOR 2 : NO CABLE
Galt, John RM 101
1000

FIG. 10A

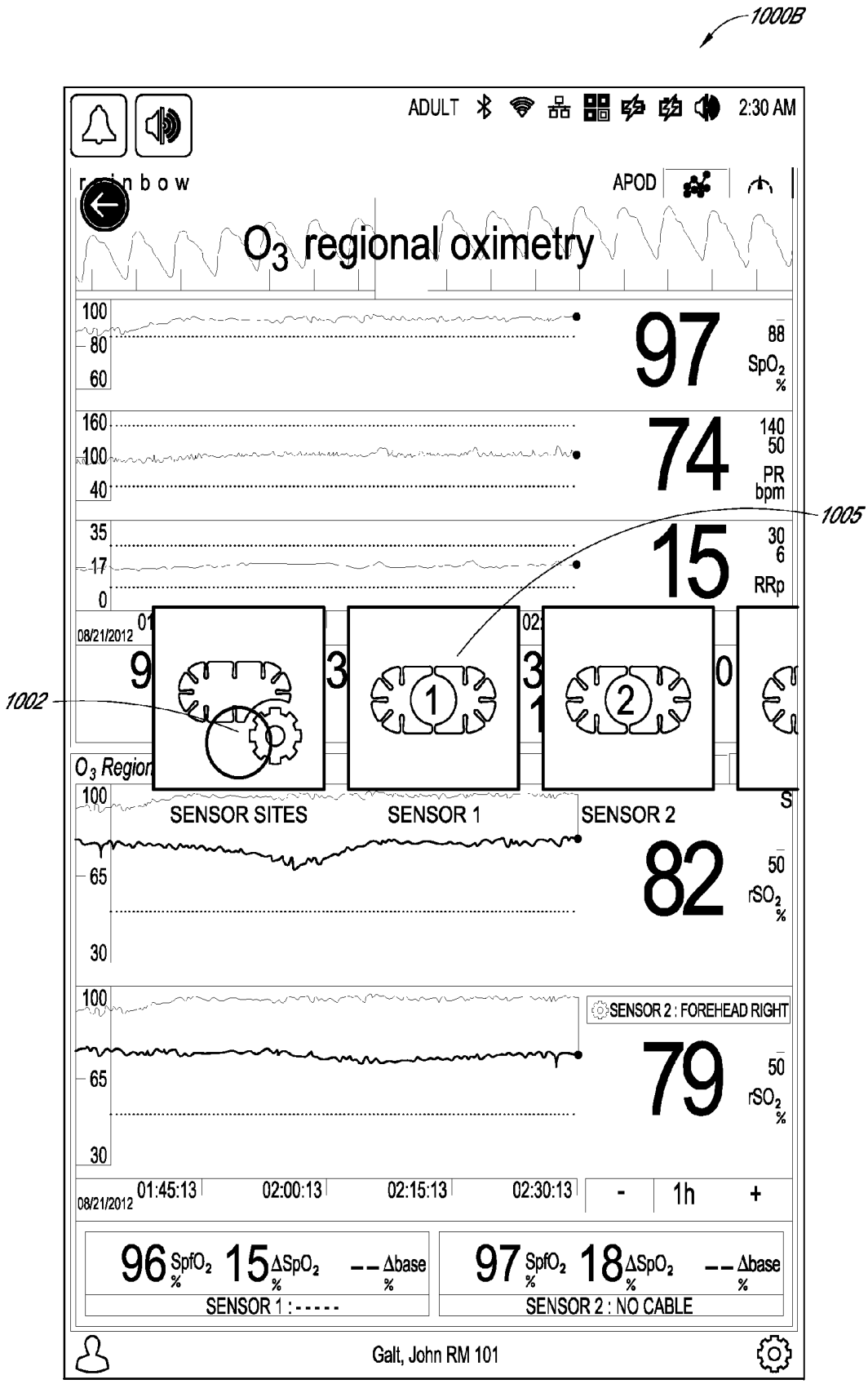
1000B
ADULT
2:30 AM
APOD
O_3 regional oximetry
97
88
SpO_2 %
74
140
50
PR
bpm
1005
15
30
6
RRp
1002
08/21/2012
SENSOR SITES
SENSOR 1
SENSOR 2
82
50
rSO_2 %
SENSOR 2 : FOREHEAD RIGHT
79
50
rSO_2 %
01:45:13
02:00:13
02:15:13
02:30:13
1h
96 $SpfO_2$ % 15 ΔSpO_2 % --Δbase %
SENSOR 1 : -----
97 $SpfO_2$ % 18 ΔSpO_2 % --Δbase %
SENSOR 2 : NO CABLE
Galt, John RM 101

FIG. 10B

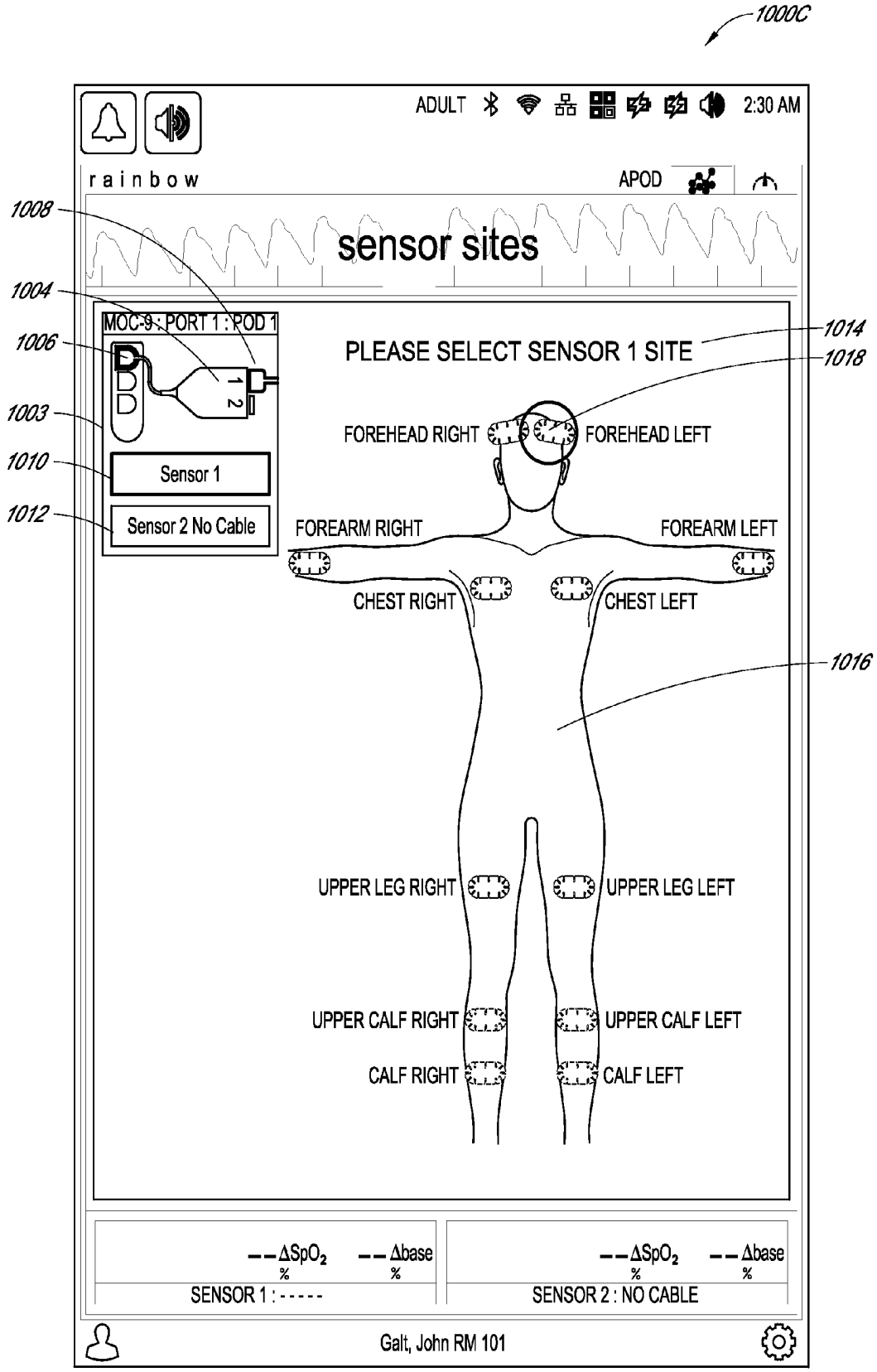
1000C
ADULT
2:30 AM
rainbow
APOD
1008
sensor sites
1004
MOC-9 : PORT 1 : POD 1
1006
1003
1010
Sensor 1
1012
Sensor 2 No Cable
PLEASE SELECT SENSOR 1 SITE
1014
1018
FOREHEAD RIGHT
FOREHEAD LEFT
FOREARM RIGHT
FOREARM LEFT
CHEST RIGHT
CHEST LEFT
1016
UPPER LEG RIGHT
UPPER LEG LEFT
UPPER CALF RIGHT
UPPER CALF LEFT
CALF RIGHT
CALF LEFT
--ΔSpO2 %
--Δbase %
SENSOR 1 : -----
--ΔSpO2 %
--Δbase %
SENSOR 2 : NO CABLE
Galt, John RM 101

FIG. 10C

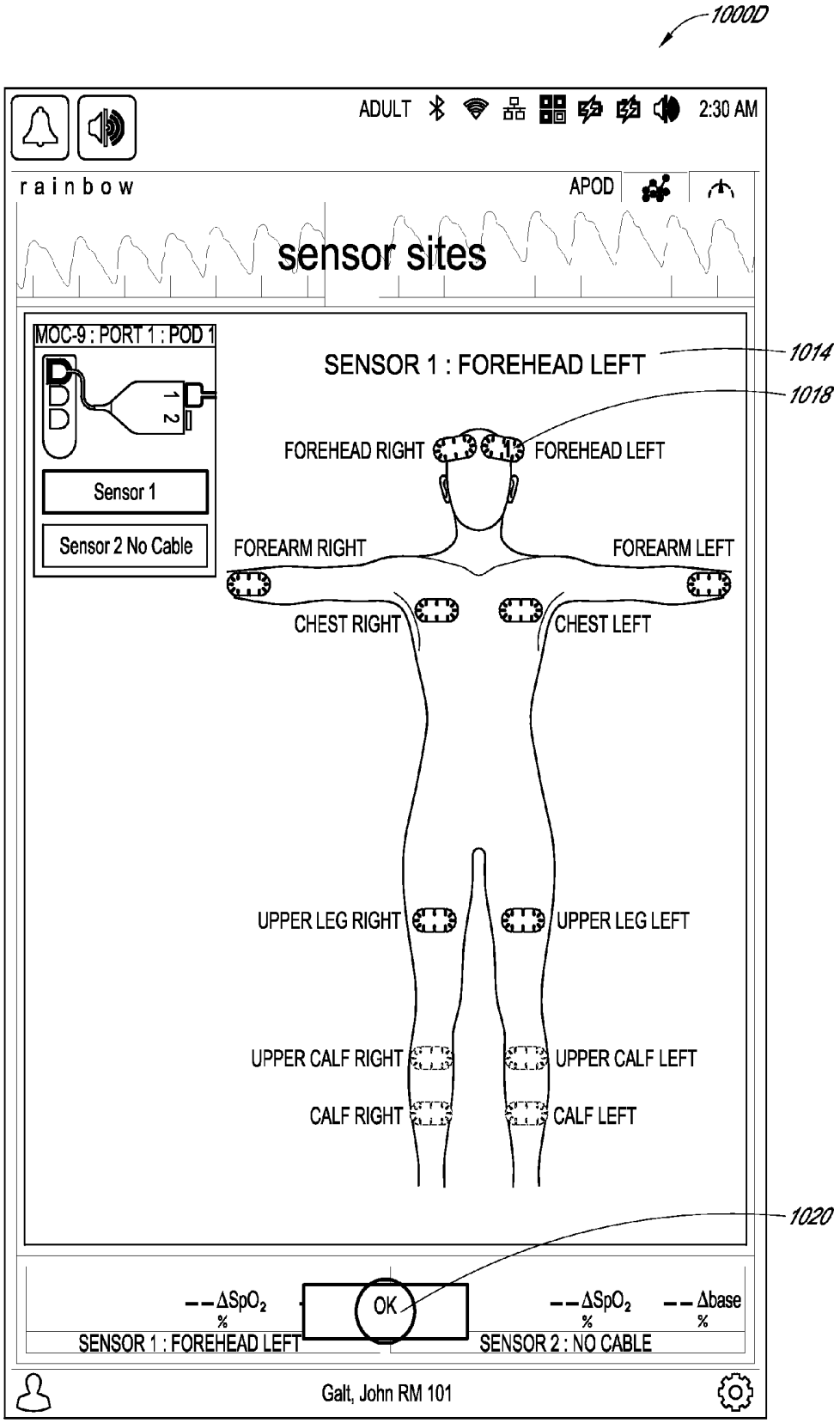
1000D
ADULT
2:30 AM
rainbow
APOD
sensor sites
MOC-9 : PORT 1 : POD 1
Sensor 1
Sensor 2 No Cable
SENSOR 1 : FOREHEAD LEFT
1014
1018
FOREHEAD RIGHT
FOREHEAD LEFT
FOREARM RIGHT
FOREARM LEFT
CHEST RIGHT
CHEST LEFT
UPPER LEG RIGHT
UPPER LEG LEFT
UPPER CALF RIGHT
UPPER CALF LEFT
CALF RIGHT
CALF LEFT
1020
--ΔSpO2 %
OK
--ΔSpO2 %
--Δbase %
SENSOR 1 : FOREHEAD LEFT
SENSOR 2 : NO CABLE
Galt, John RM 101

FIG. 10D

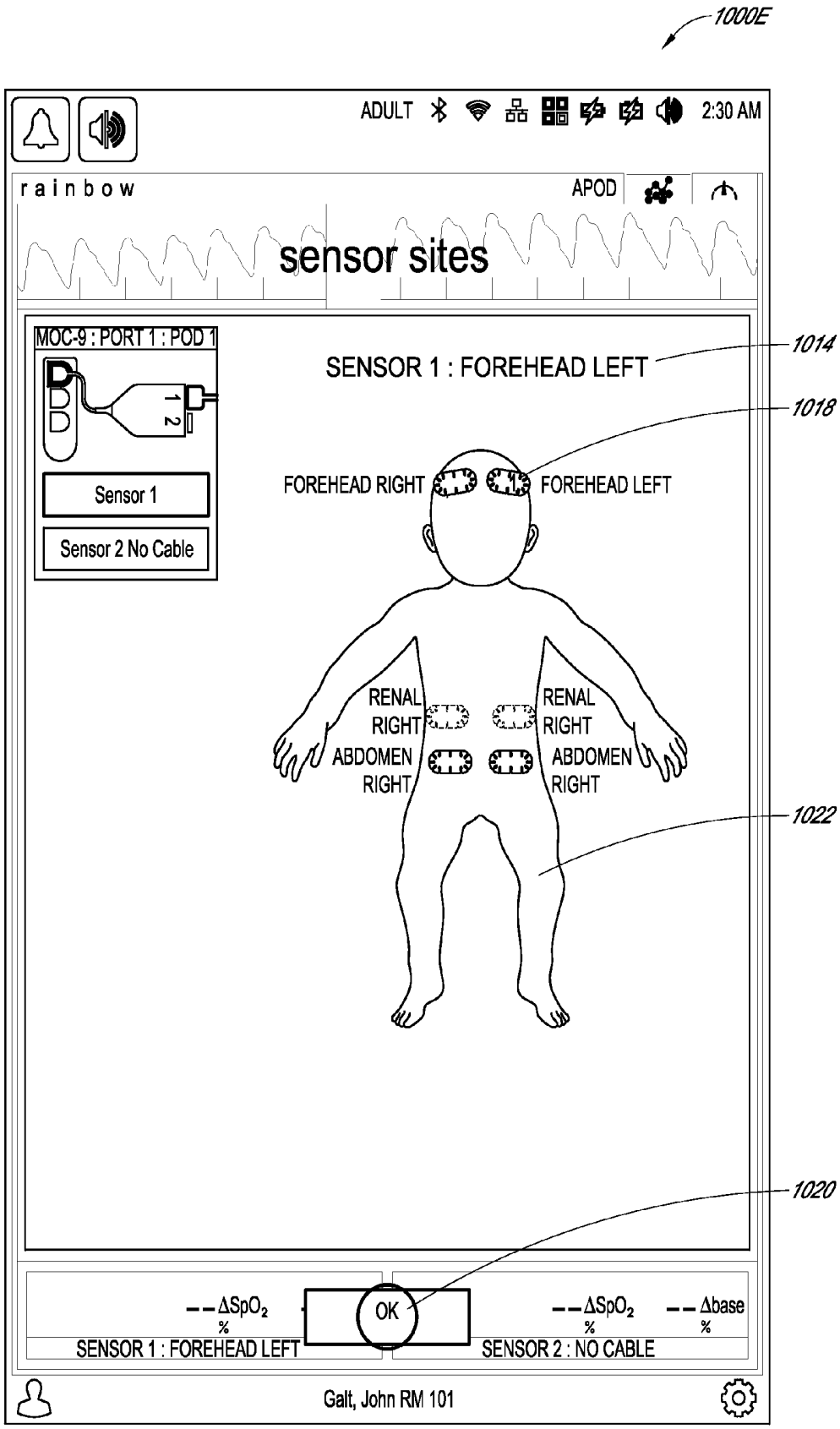
1000E
ADULT
2:30 AM
rainbow
APOD
sensor sites
MOC-9 : PORT 1 : POD 1
Sensor 1
Sensor 2 No Cable
SENSOR 1 : FOREHEAD LEFT
1014
1018
FOREHEAD RIGHT
FOREHEAD LEFT
RENAL RIGHT ABDOMEN RIGHT
RENAL RIGHT ABDOMEN RIGHT
1022
1020
--ΔSpO2 %
OK
--ΔSpO2 %
--Δbase %
SENSOR 1 : FOREHEAD LEFT
SENSOR 2 : NO CABLE
Galt, John RM 101

FIG. 10E

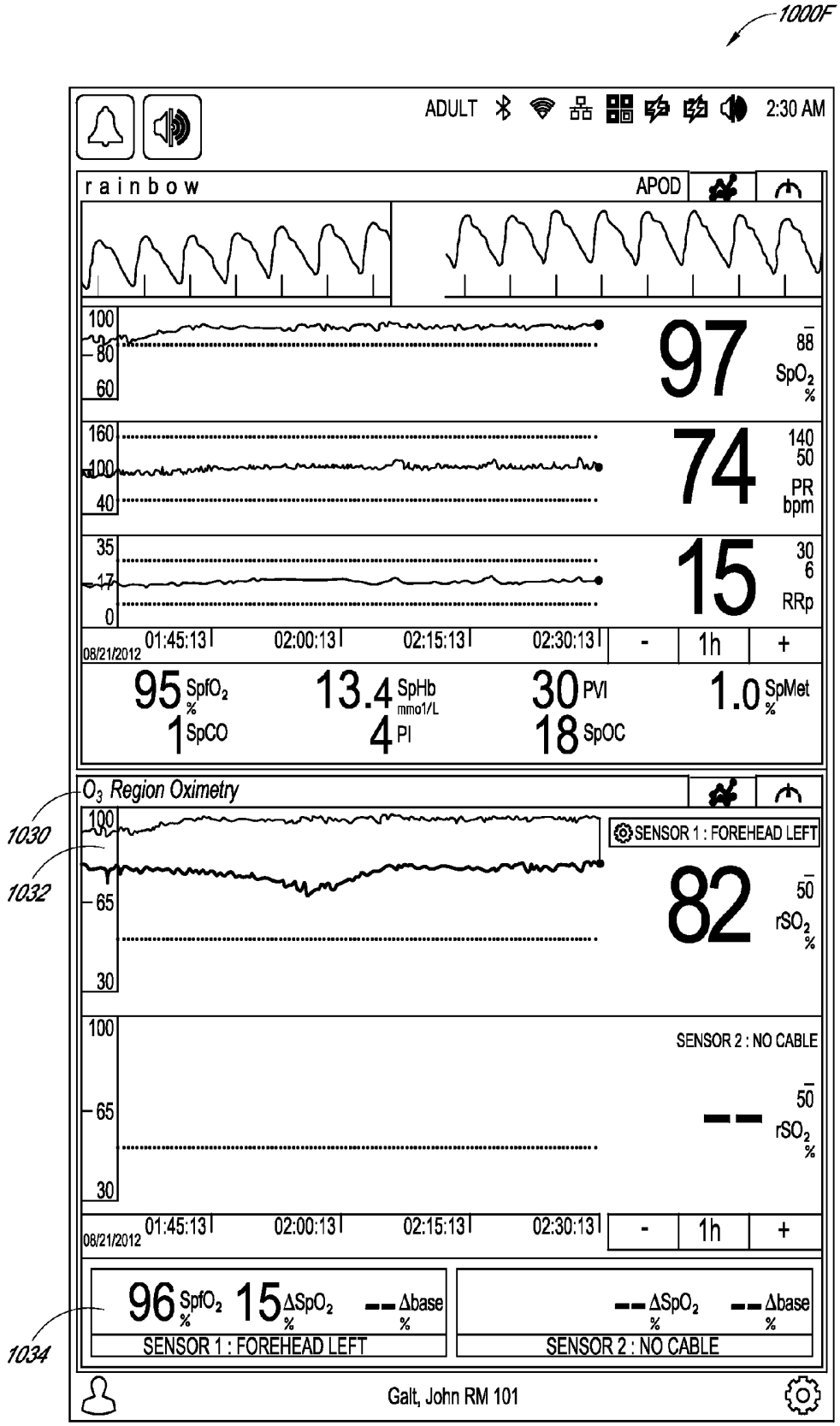
1000F
ADULT
2:30 AM
rainbow
APOD
97
88
SpO2 %
74
140
50
PR bpm
15
30
6
RRp
08/21/2012
01:45:13
02:00:13
02:15:13
02:30:13
1h
95 SpfO2 %
13.4 SpHb mmol/L
30 PVI
1.0 SpMet %
1 SpCO
4 PI
18 SpOC
O3 Region Oximetry
1030
1032
SENSOR 1 : FOREHEAD LEFT
82
50
rSO2 %
SENSOR 2 : NO CABLE
96 SpfO2 %
15 ΔSpO2 %
-- Δbase %
-- ΔSpO2 %
-- Δbase %
1034
SENSOR 1 : FOREHEAD LEFT
SENSOR 2 : NO CABLE
Galt, John RM 101

FIG. 10F

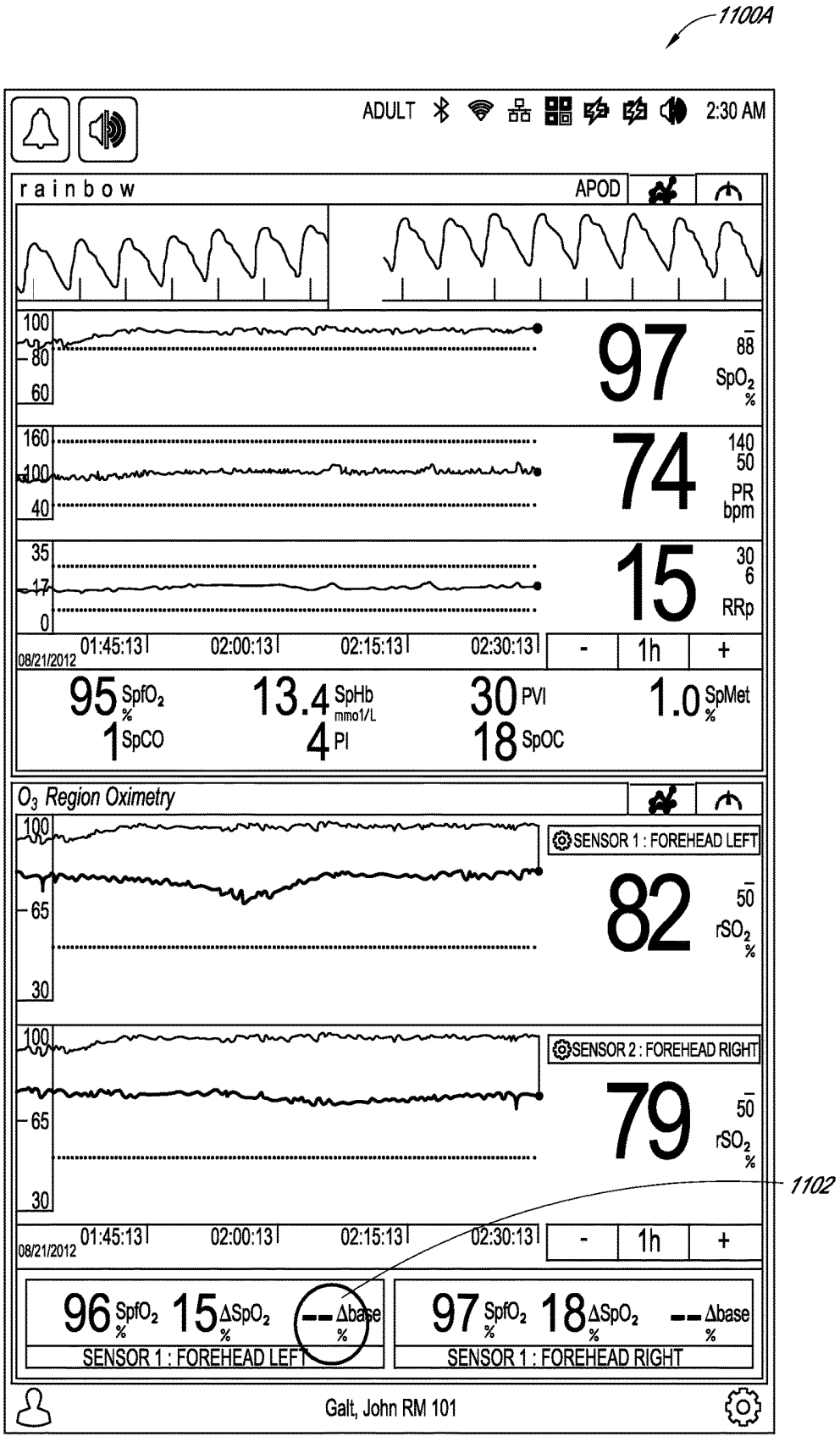
1100A
ADULT
2:30 AM
rainbow
APOD
100
80
60
97
88
SpO2
%
160
100
40
74
140
50
PR
bpm
35
17
0
15
30
6
RRp
08/21/2012
01:45:13
02:00:13
02:15:13
02:30:13
-
1h
+
95 SpfO2 %
13.4 SpHb mmol/L
30 PVI
1.0 SpMet %
1 SpCO
4 PI
18 SpOC
O3 Region Oximetry
SENSOR 1 : FOREHEAD LEFT
65
30
82
50
rSO2
%
SENSOR 2 : FOREHEAD RIGHT
79
1102
96 SpfO2 % 15 ΔSpO2 % -- Δbase %
SENSOR 1 : FOREHEAD LEFT
97 SpfO2 % 18 ΔSpO2 % -- Δbase %
SENSOR 1 : FOREHEAD RIGHT
Galt, John RM 101

FIG. 11A

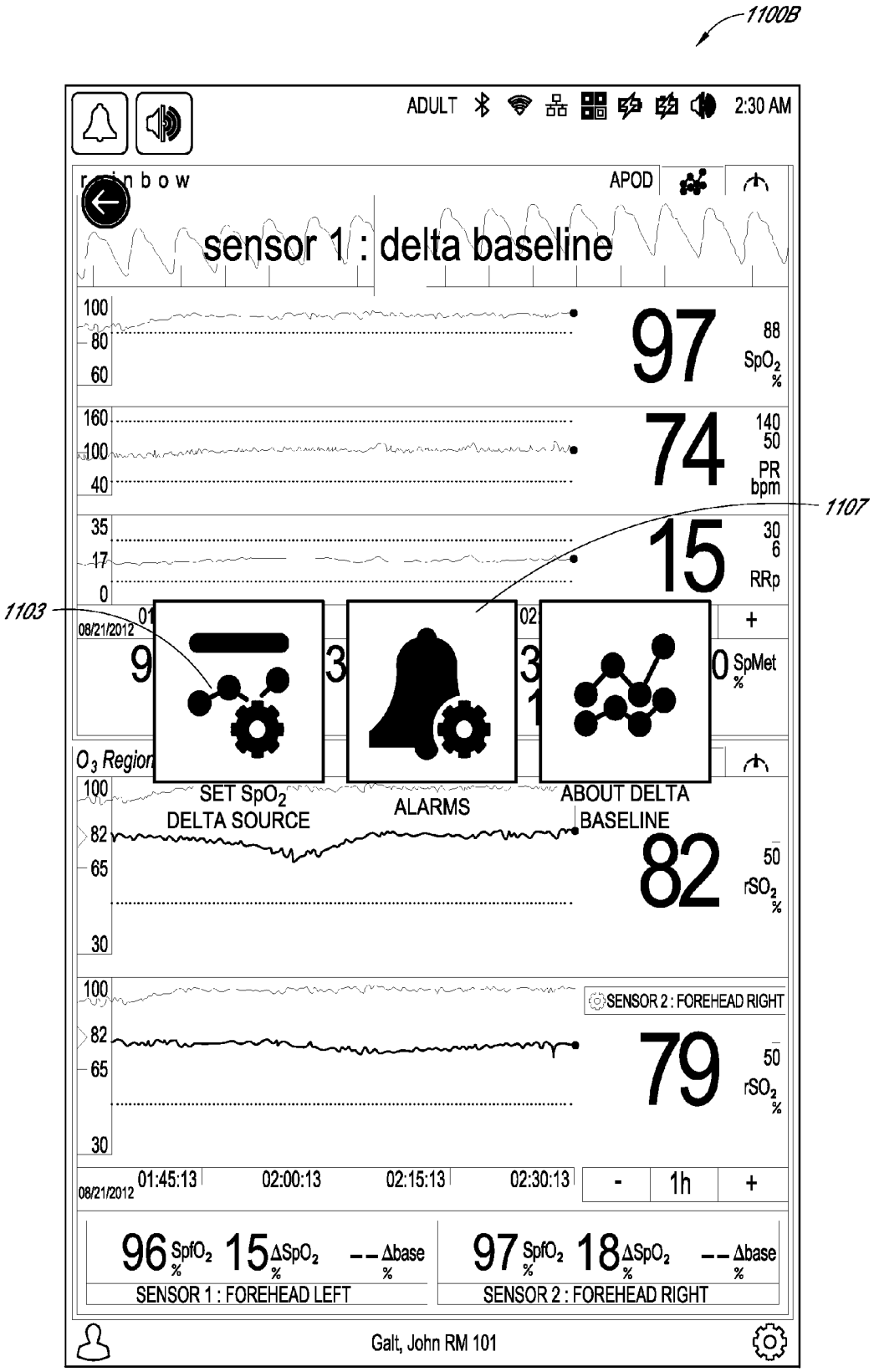
1100B
ADULT
2:30 AM
APOD
sensor 1 : delta baseline
97
88
SpO2 %
74
140
50
PR bpm
1107
15
30
6
RRp
1103
08/21/2012
9
3
3
1
0 SpMet %
SET SpO2 DELTA SOURCE
ALARMS
ABOUT DELTA BASELINE
82
50
rSO2 %
SENSOR 2 : FOREHEAD RIGHT
79
50
rSO2 %
08/21/2012
01:45:13
02:00:13
02:15:13
02:30:13
1h
96 SpfO2 % 15 ΔSpO2 % -- Δbase %
SENSOR 1 : FOREHEAD LEFT
97 SpfO2 % 18 ΔSpO2 % -- Δbase %
SENSOR 2 : FOREHEAD RIGHT
Galt, John RM 101

FIG. 11B

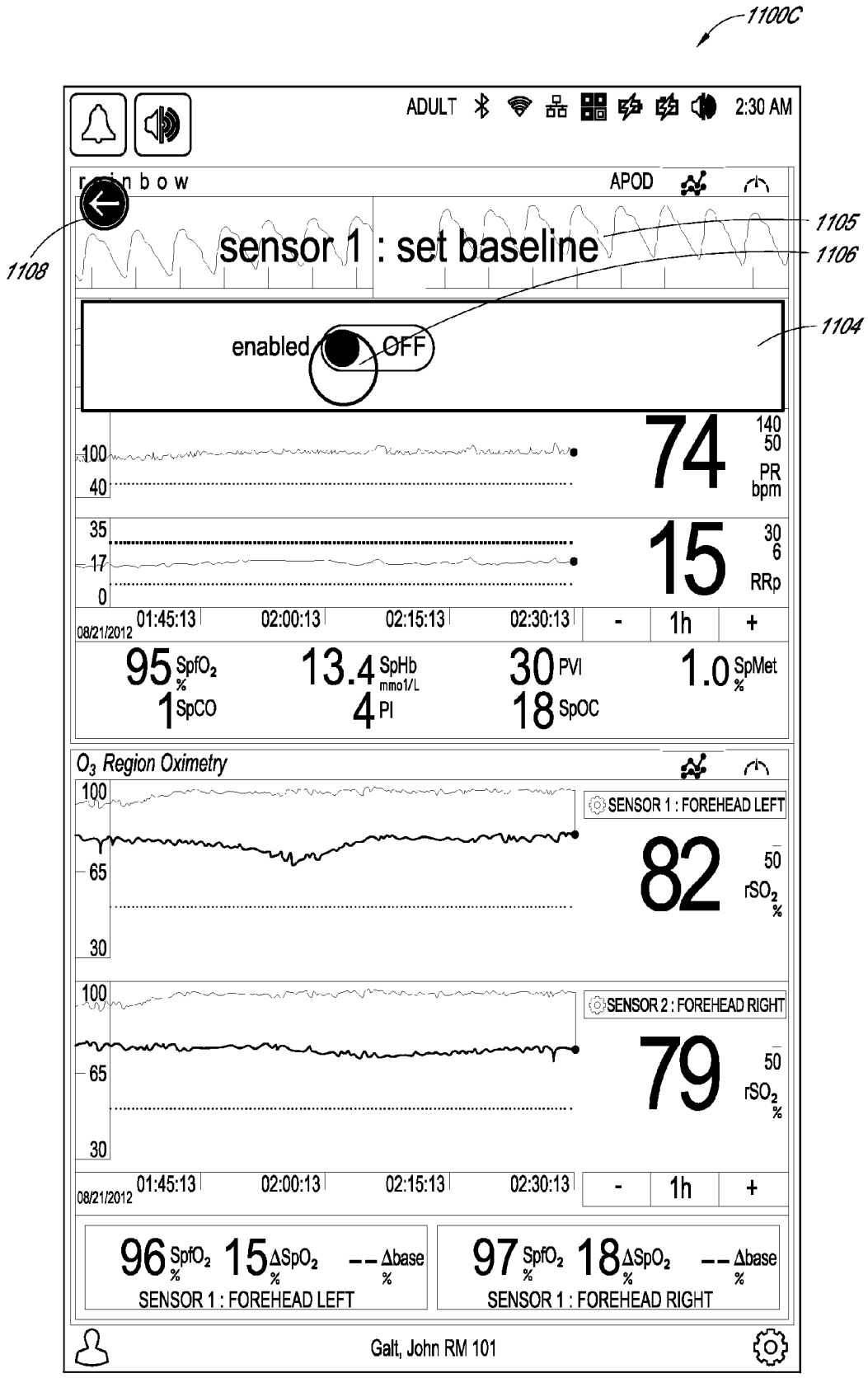
1100C
ADULT
2:30 AM
APOD
sensor 1 : set baseline
1105
1106
1108
1104
enabled
OFF
74
140
50
PR
bpm
100
40
15
30
6
RRp
35
17
0
08/21/2012
01:45:13
02:00:13
02:15:13
02:30:13
-
1h
+
95 SpfO2 %
13.4 SpHb mmol/L
30 PVI
1.0 SpMet %
1 SpCO
4 PI
18 SpOC
O3 Region Oximetry
SENSOR 1 : FOREHEAD LEFT
82
50
rSO2 %
100
65
30
SENSOR 2 : FOREHEAD RIGHT
79
96 SpfO2 % 15 ΔSpO2 % -- Δbase %
SENSOR 1 : FOREHEAD LEFT
97 SpfO2 % 18 ΔSpO2 % -- Δbase %
SENSOR 1 : FOREHEAD RIGHT
Galt, John RM 101

FIG. 11C

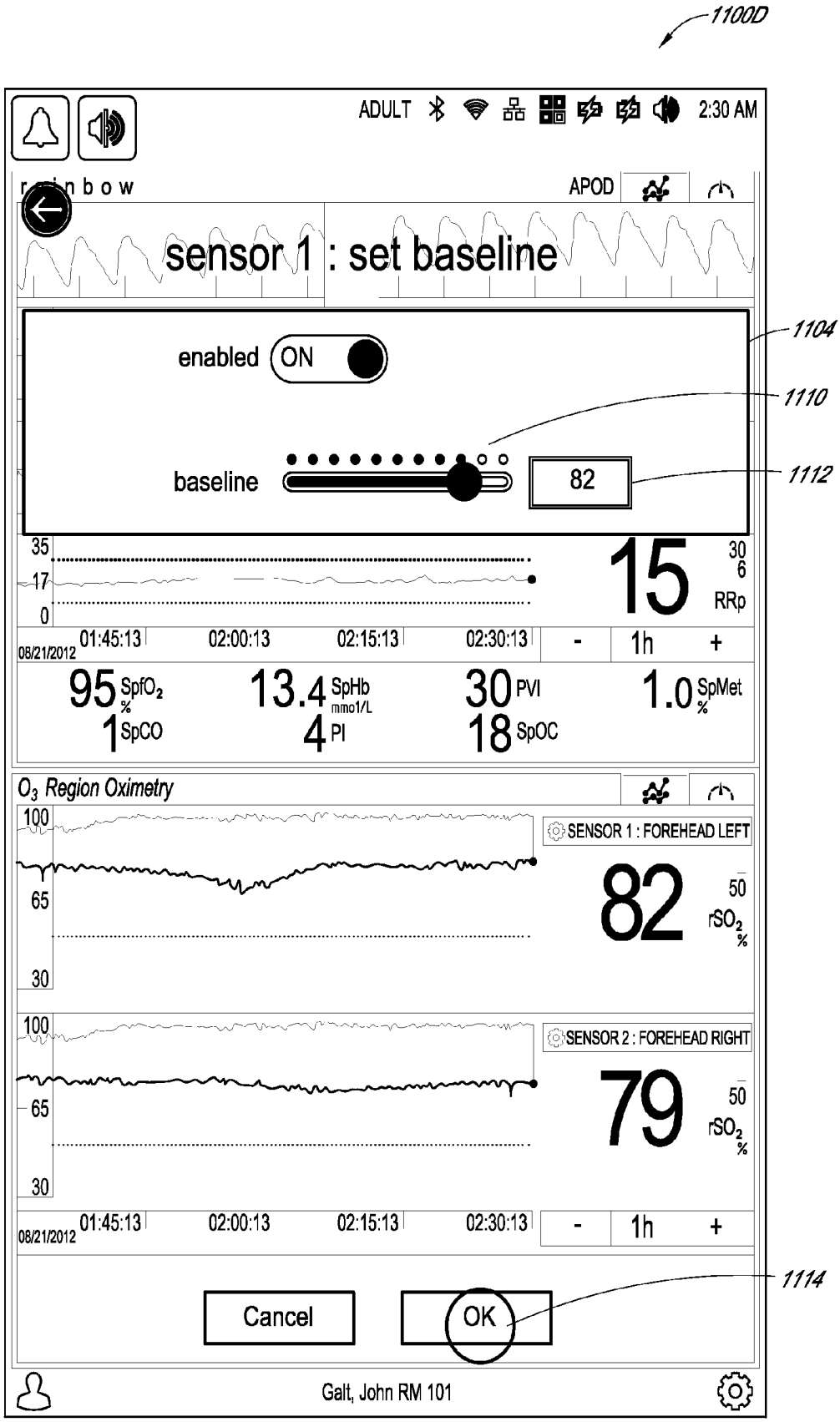
1100D
ADULT
2:30 AM
APOD
sensor 1 : set baseline
1104
enabled ON
1110
baseline
82
1112
15
30
6
RRp
01:45:13
02:00:13
02:15:13
02:30:13
1h
95 SpfO2 %
13.4 SpHb mmol/L
30 PVI
1.0 SpMet %
1 SpCO
4 PI
18 SpOC
O3 Region Oximetry
SENSOR 1 : FOREHEAD LEFT
82 rSO2 %
SENSOR 2 : FOREHEAD RIGHT
79 rSO2 %
1114
Cancel
OK
Galt, John RM 101

FIG. 11D

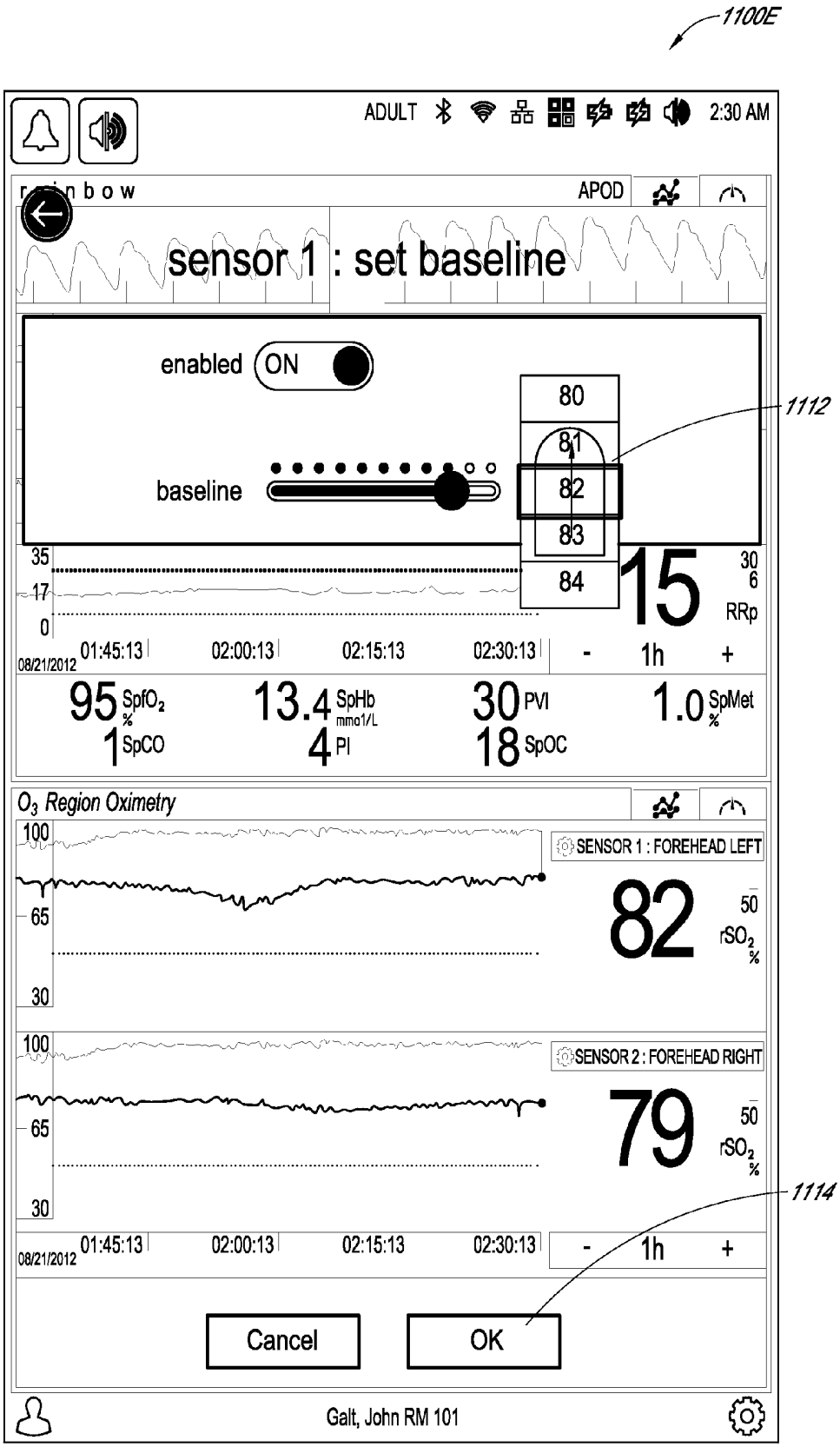
1100E
ADULT
2:30 AM
APOD
sensor 1 : set baseline
enabled ON
baseline
80
81
82
83
84
1112
15
RRp
01:45:13
02:00:13
02:15:13
02:30:13
1h
95 SpfO2 %
13.4 SpHb mmol/L
30 PVI
1.0 SpMet %
1 SpCO
4 PI
18 SpOC
O3 Region Oximetry
SENSOR 1 : FOREHEAD LEFT
82 rSO2 %
SENSOR 2 : FOREHEAD RIGHT
79 rSO2 %
1114
Cancel
OK
Galt, John RM 101

FIG. 11E

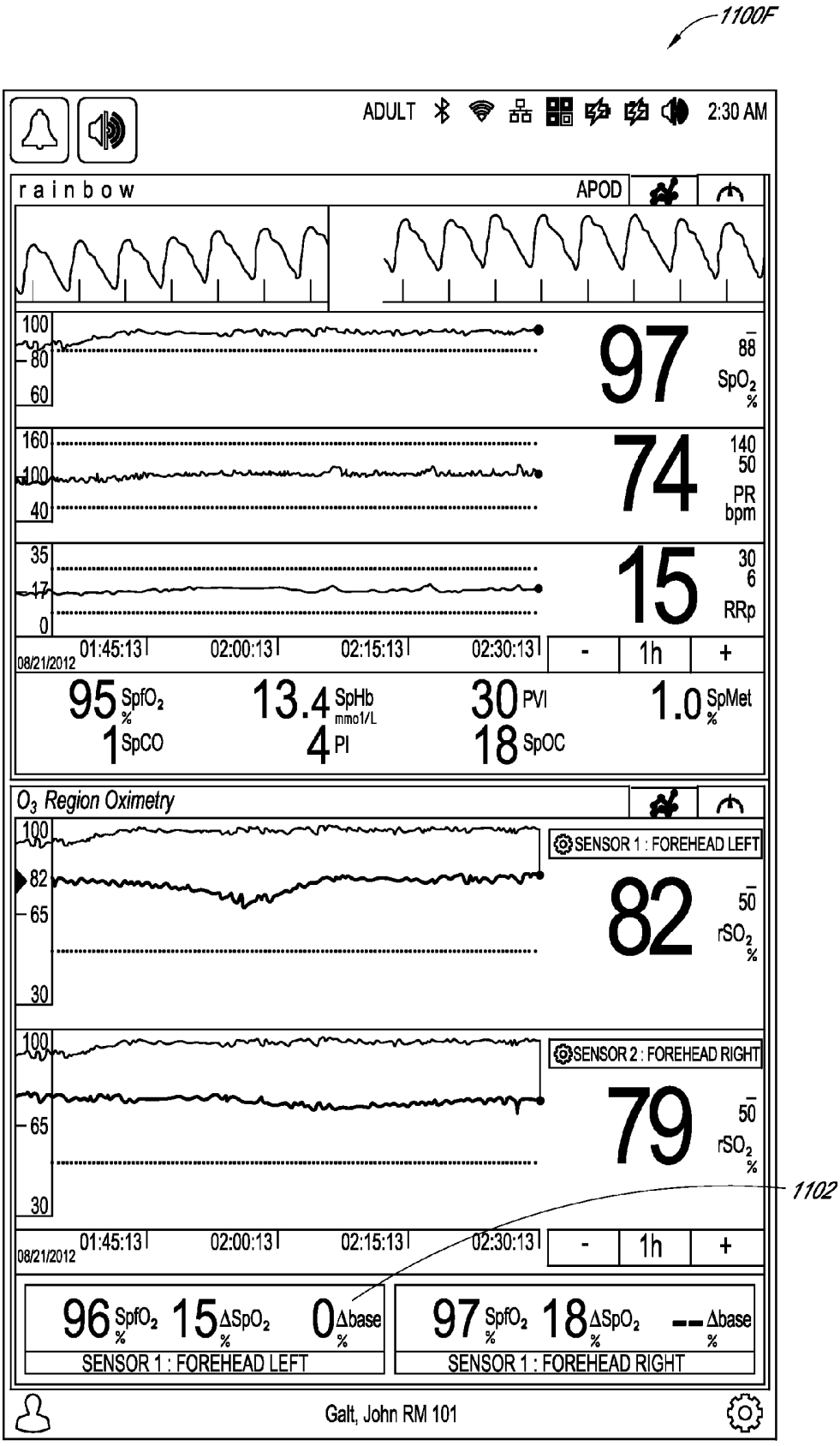
1100F
ADULT
2:30 AM
rainbow
APOD
97
88
SpO2 %
74
140
50
PR bpm
15
30
6
RRp
08/21/2012
01:45:13
02:00:13
02:15:13
02:30:13
1h
95 SpfO2 %
13.4 SpHb mmol/L
30 PVI
1.0 SpMet %
1 SpCO
4 PI
18 SpOC
O3 Region Oximetry
SENSOR 1 : FOREHEAD LEFT
82
50
rSO2 %
SENSOR 2 : FOREHEAD RIGHT
79
50
rSO2 %
1102
96 SpfO2 % 15 ΔSpO2 % 0 Δbase %
SENSOR 1 : FOREHEAD LEFT
97 SpfO2 % 18 ΔSpO2 % -- Δbase %
SENSOR 1 : FOREHEAD RIGHT
Galt, John RM 101

FIG. 11F

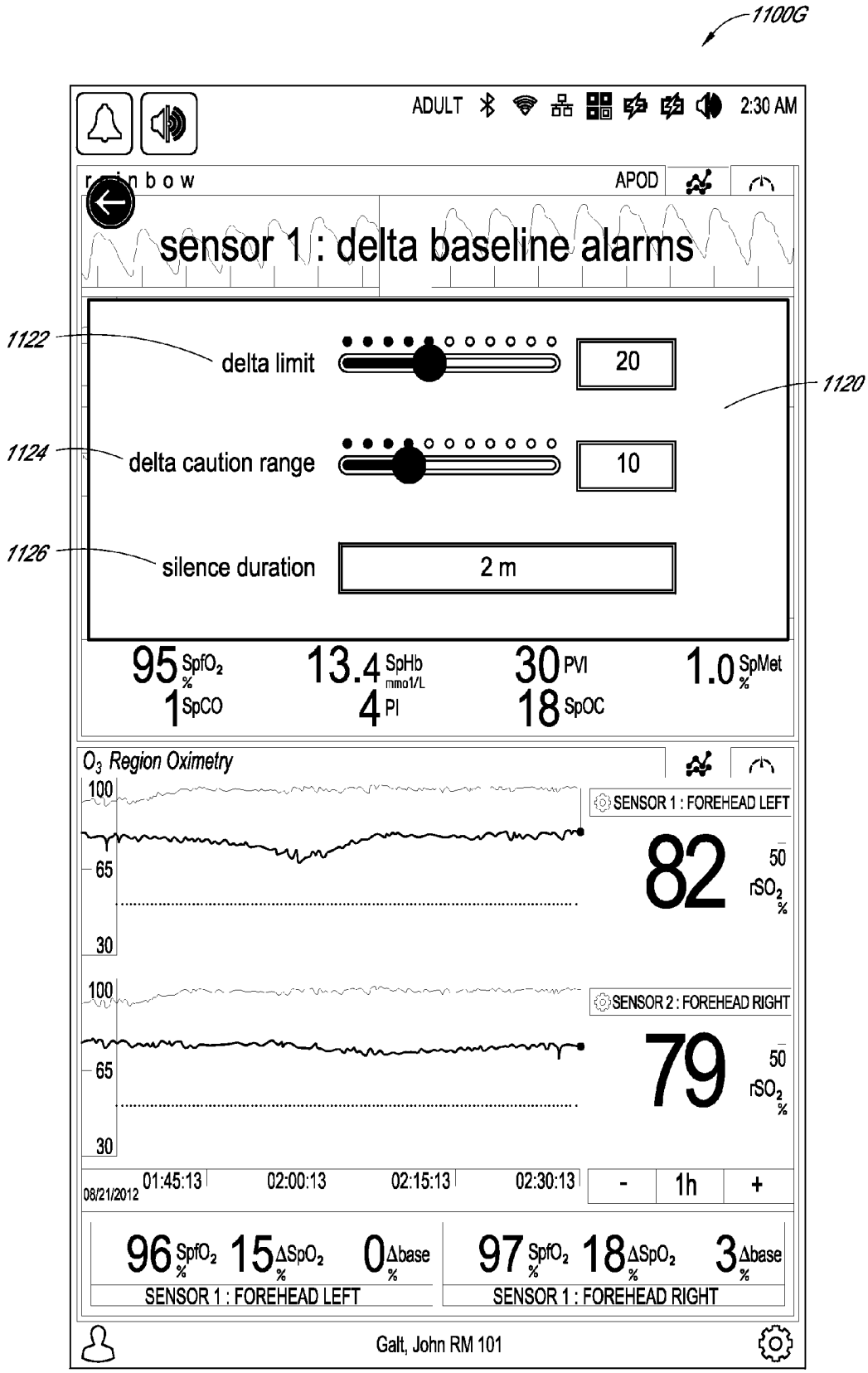
1100G
ADULT
2:30 AM
APOD
sensor 1 : delta baseline alarms
1122
delta limit
20
1120
1124
delta caution range
10
1126
silence duration
2 m
95 SpfO2 %
13.4 SpHb mmol/L
30 PVI
1.0 SpMet %
1 SpCO
4 PI
18 SpOC
O3 Region Oximetry
100
65
30
SENSOR 1 : FOREHEAD LEFT
82
50
rSO2 %
SENSOR 2 : FOREHEAD RIGHT
79
08/21/2012
01:45:13
02:00:13
02:15:13
02:30:13
-
1h
+
96 SpfO2 % 15 ΔSpO2 % 0 Δbase %
SENSOR 1 : FOREHEAD LEFT
97 SpfO2 % 18 ΔSpO2 % 3 Δbase %
SENSOR 1 : FOREHEAD RIGHT
Galt, John RM 101

FIG. 11G

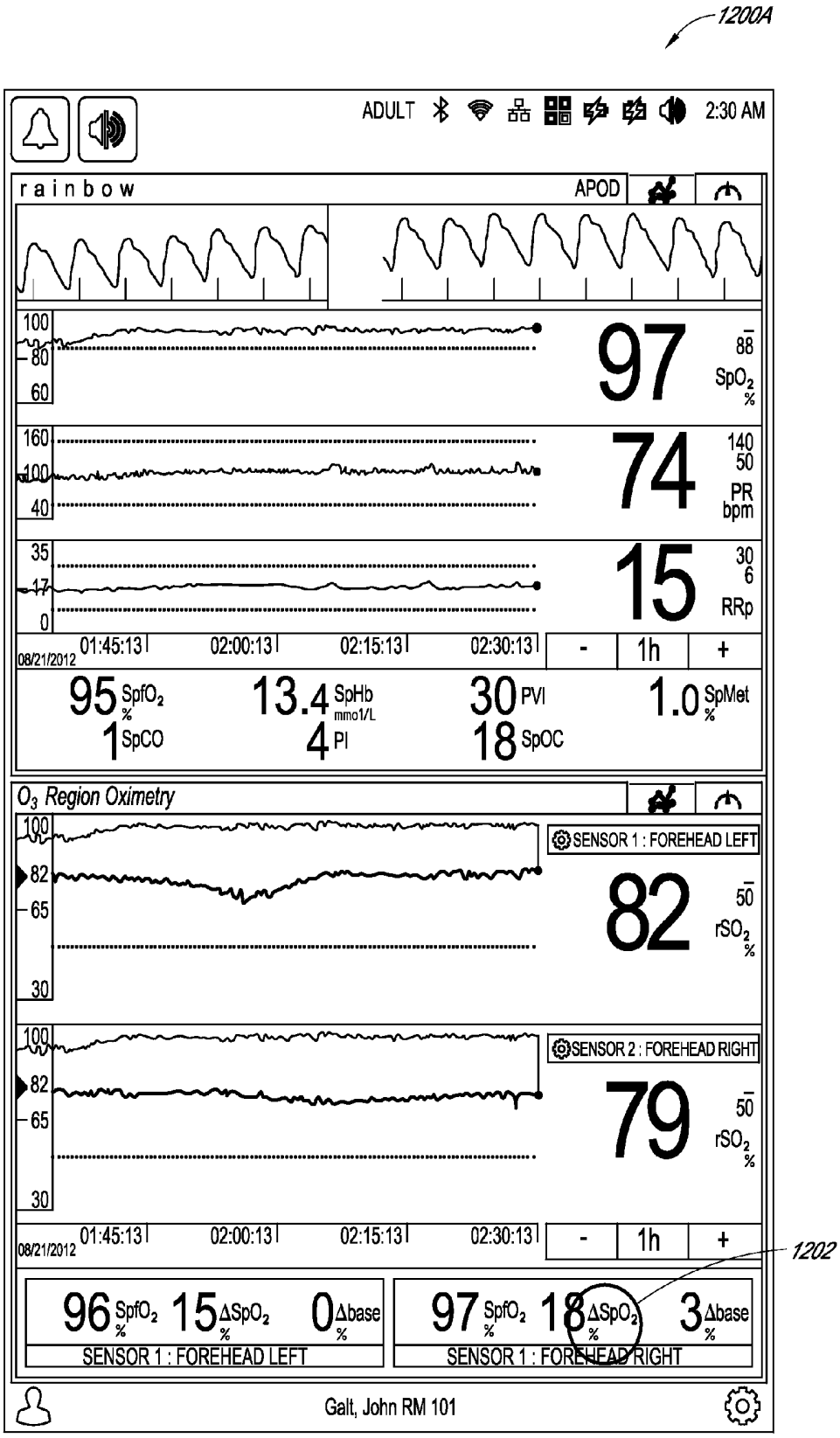
1200A
ADULT
2:30 AM
rainbow
APOD
97
88
SpO2 %
74
140
50
PR bpm
15
30
6
RRp
08/21/2012
01:45:13
02:00:13
02:15:13
02:30:13
-
1h
+
95 SpfO2 %
13.4 SpHb mmol/L
30 PVI
1.0 SpMet %
1 SpCO
4 PI
18 SpOC
O3 Region Oximetry
SENSOR 1 : FOREHEAD LEFT
82
50
rSO2 %
SENSOR 2 : FOREHEAD RIGHT
79
50
rSO2 %
1202
96 SpfO2 % 15 ΔSpO2 % 0 Δbase %
SENSOR 1 : FOREHEAD LEFT
97 SpfO2 % 18 ΔSpO2 % 3 Δbase %
SENSOR 1 : FOREHEAD RIGHT
Galt, John RM 101

FIG. 12A

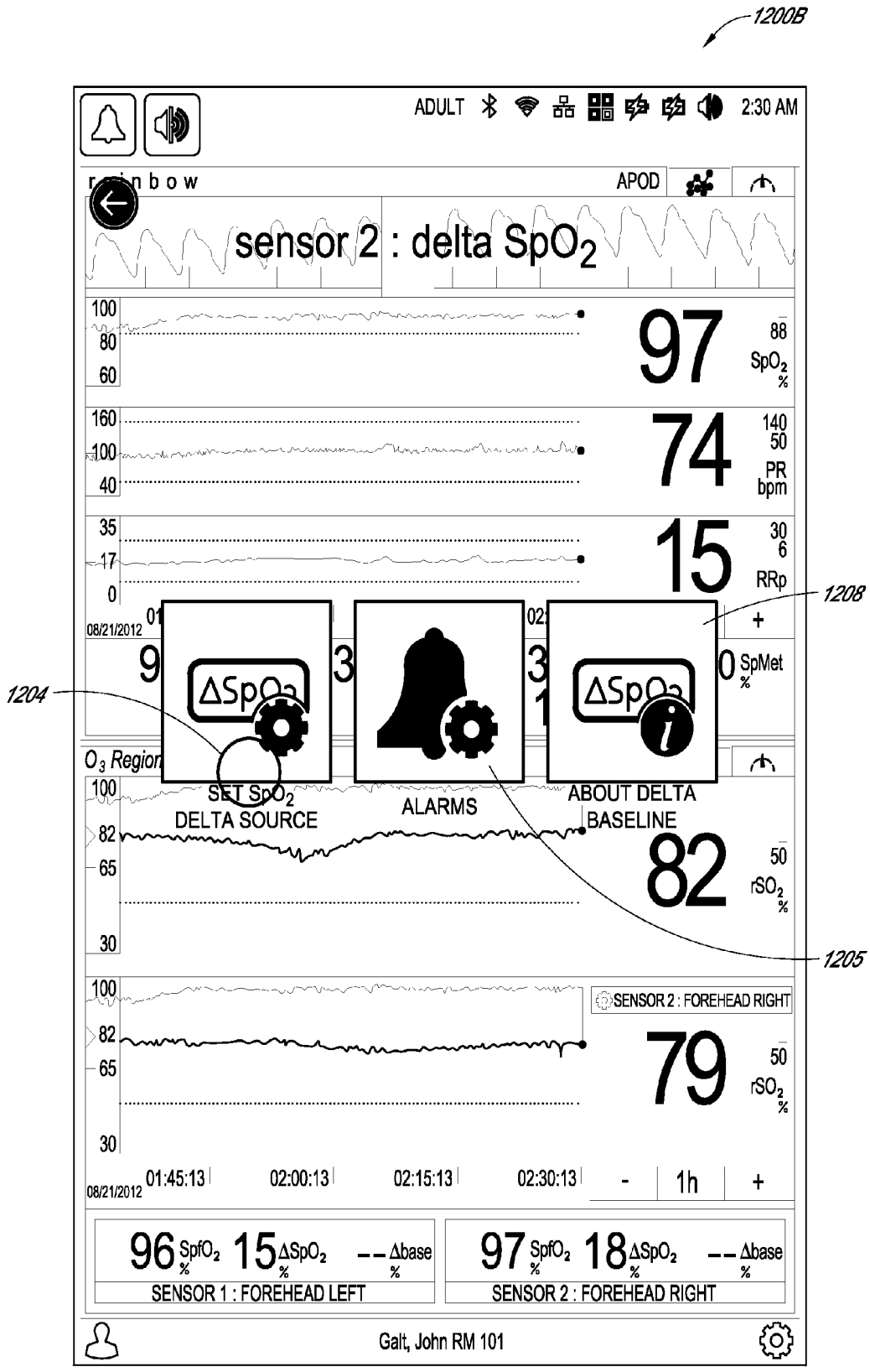
1200B
ADULT
2:30 AM
APOD
sensor 2 : delta SpO2
97
88
SpO2 %
74
140
50
PR
bpm
15
30
6
RRp
1208
08/21/2012
+
SpMet %
1204
SET SpO2 DELTA SOURCE
ALARMS
ABOUT DELTA BASELINE
82
50
rSO2 %
1205
SENSOR 2 : FOREHEAD RIGHT
79
01:45:13
02:00:13
02:15:13
02:30:13
1h
96 SpfO2 % 15 ΔSpO2 % -- Δbase %
SENSOR 1 : FOREHEAD LEFT
97 SpfO2 % 18 ΔSpO2 % -- Δbase %
SENSOR 2 : FOREHEAD RIGHT
Galt, John RM 101

FIG. 12B

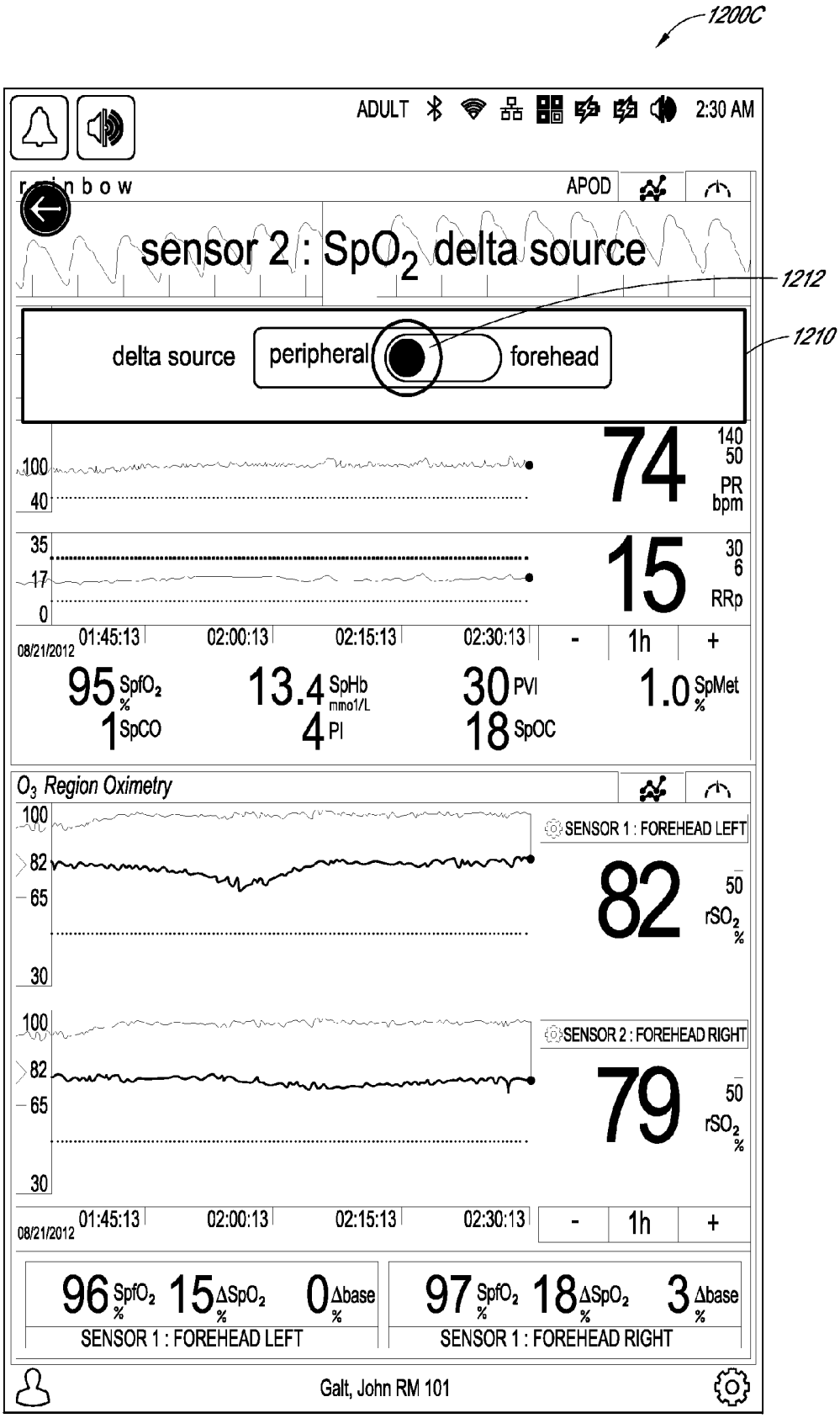
1200C
ADULT
2:30 AM
APOD
sensor 2 : SpO2 delta source
1212
1210
delta source
peripheral
forehead
74
140
50
PR
bpm
100
40
15
30
6
RRp
35
17
0
08/21/2012
01:45:13
02:00:13
02:15:13
02:30:13
-
1h
+
95 SpfO2 %
1 SpCO
13.4 SpHb mmol/L
4 PI
30 PVI
18 SpOC
1.0 SpMet %
O3 Region Oximetry
SENSOR 1 : FOREHEAD LEFT
82
50
rSO2 %
100
82
65
30
SENSOR 2 : FOREHEAD RIGHT
79
96 SpfO2 % 15 ΔSpO2 % 0 Δbase %
SENSOR 1 : FOREHEAD LEFT
97 SpfO2 % 18 ΔSpO2 % 3 Δbase %
SENSOR 1 : FOREHEAD RIGHT
Galt, John RM 101

FIG. 12C

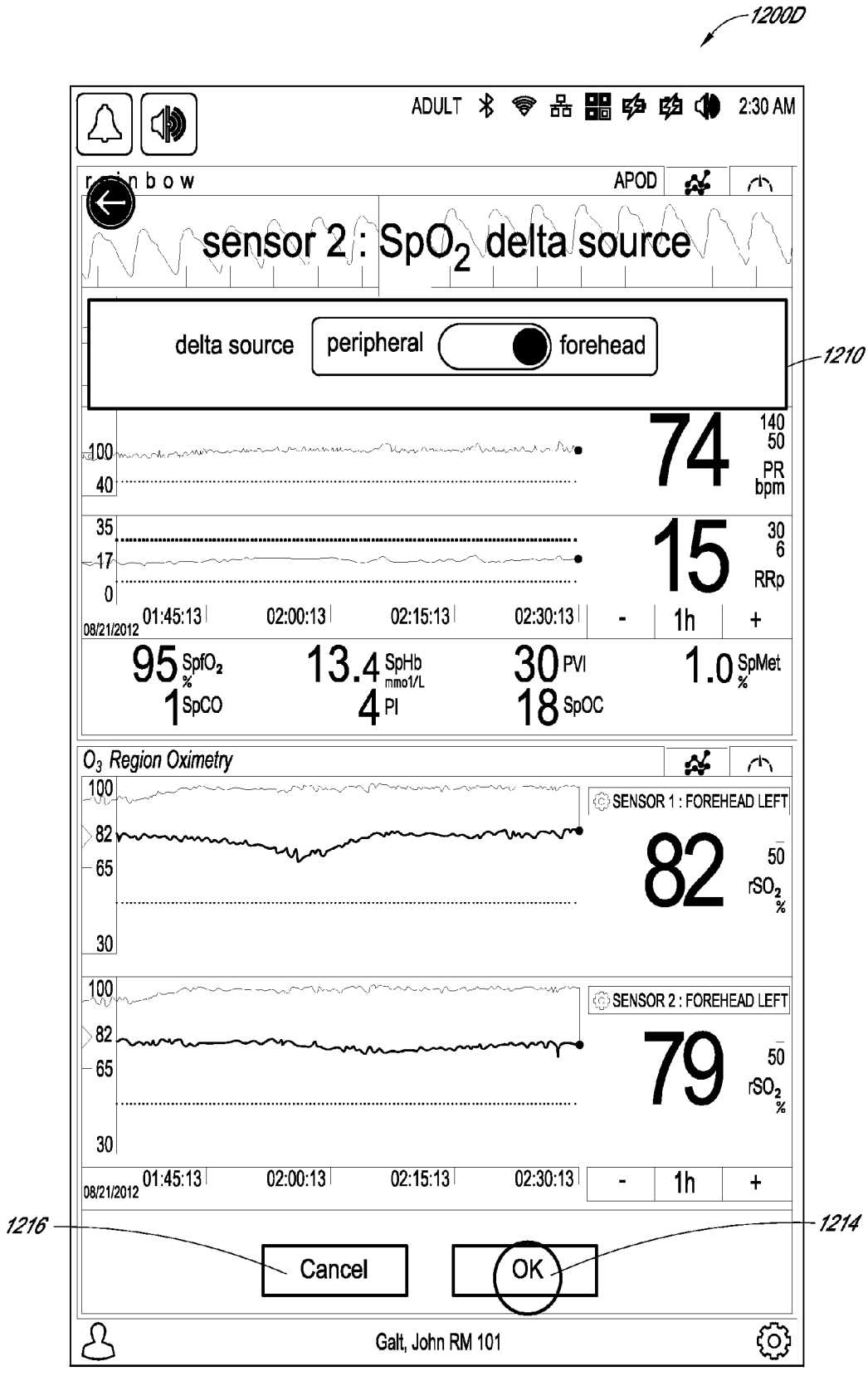
1200D
ADULT
2:30 AM
APOD
sensor 2 : SpO2 delta source
delta source
peripheral
forehead
1210
74
PR
bpm
15
RRp
08/21/2012
01:45:13
02:00:13
02:15:13
02:30:13
1h
95 SpfO2
1 SpCO
13.4 SpHb
4 PI
30 PVI
18 SpOC
1.0 SpMet
O3 Region Oximetry
SENSOR 1 : FOREHEAD LEFT
82
rSO2
SENSOR 2 : FOREHEAD LEFT
79
rSO2
1216
Cancel
OK
1214
Galt, John RM 101

FIG. 12D

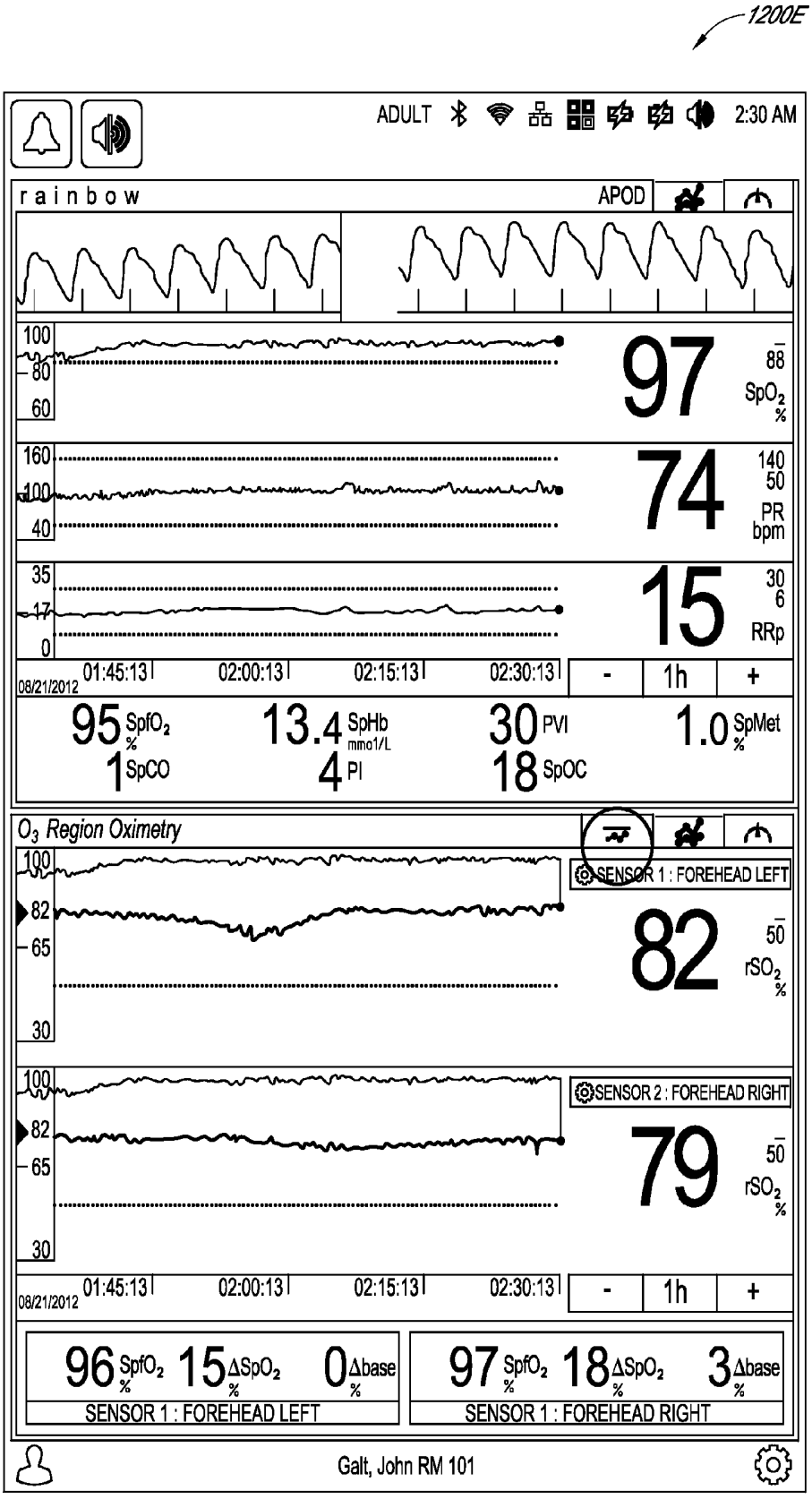
1200E
ADULT
2:30 AM
rainbow
APOD
97
88
SpO2 %
74
140
50
PR bpm
15
30
6
RRp
08/21/2012
01:45:13
02:00:13
02:15:13
02:30:13
-
1h
+
95 SpfO2 %
13.4 SpHb mmol/L
30 PVI
1.0 SpMet %
1 SpCO
4 PI
18 SpOC
O3 Region Oximetry
SENSOR 1 : FOREHEAD LEFT
82
50
rSO2 %
SENSOR 2 : FOREHEAD RIGHT
79
50
rSO2 %
96 SpfO2 % 15 ΔSpO2 % 0 Δbase %
SENSOR 1 : FOREHEAD LEFT
97 SpfO2 % 18 ΔSpO2 % 3 Δbase %
SENSOR 1 : FOREHEAD RIGHT
Galt, John RM 101

FIG. 12E

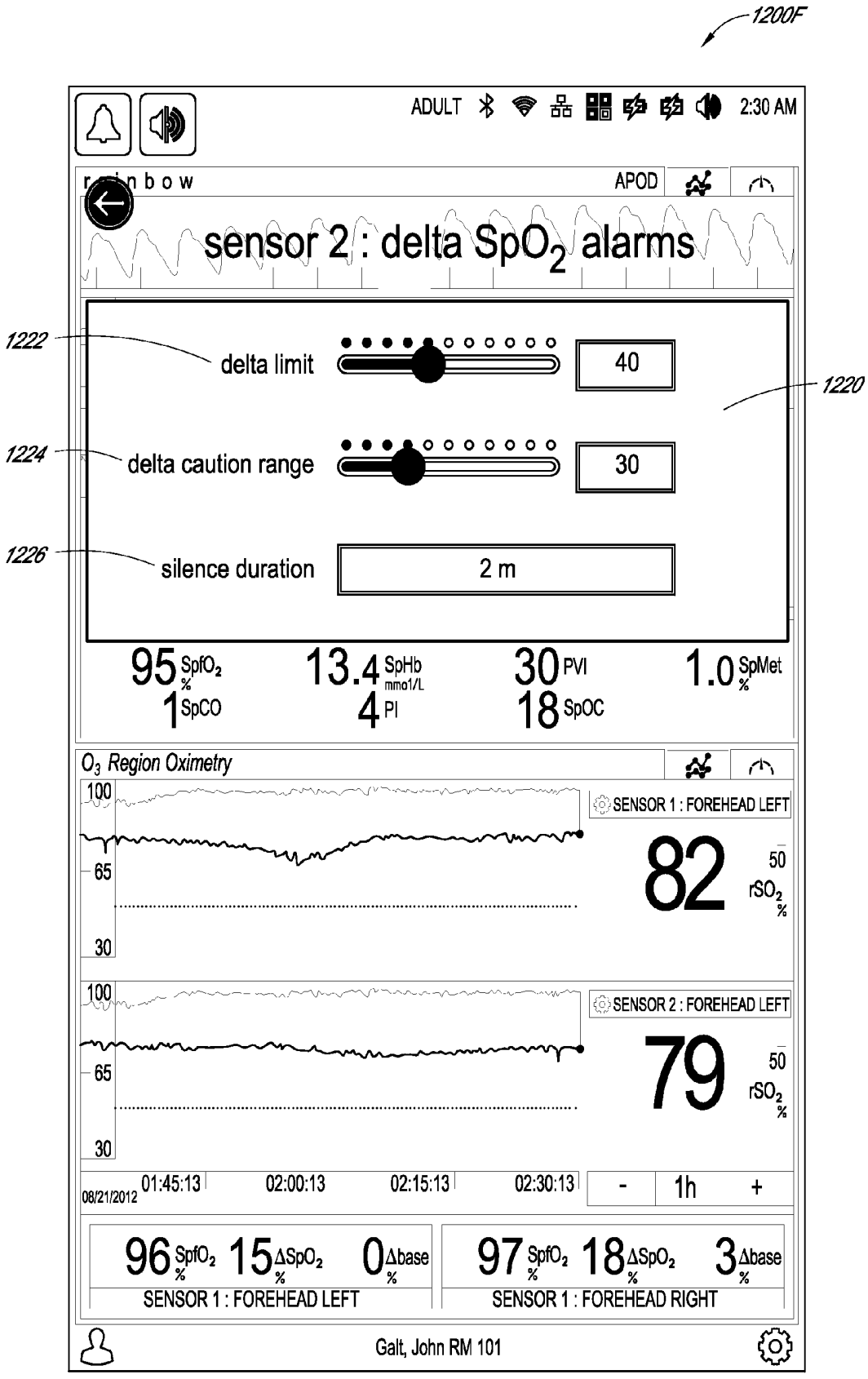
1200F
ADULT
2:30 AM
rainbow
APOD
sensor 2 : delta SpO2 alarms
1222
delta limit
40
1220
1224
delta caution range
30
1226
silence duration
2 m
95 SpfO2 %
13.4 SpHb mmol/L
30 PVI
1.0 SpMet %
1 SpCO
4 PI
18 SpOC
O3 Region Oximetry
100
65
30
SENSOR 1 : FOREHEAD LEFT
82
50
rSO2 %
SENSOR 2 : FOREHEAD LEFT
79
08/21/2012
01:45:13
02:00:13
02:15:13
02:30:13
-
1h
+
96 SpfO2 % 15 ΔSpO2 % 0 Δbase %
SENSOR 1 : FOREHEAD LEFT
97 SpfO2 % 18 ΔSpO2 % 3 Δbase %
SENSOR 1 : FOREHEAD RIGHT
Galt, John RM 101

FIG. 12F

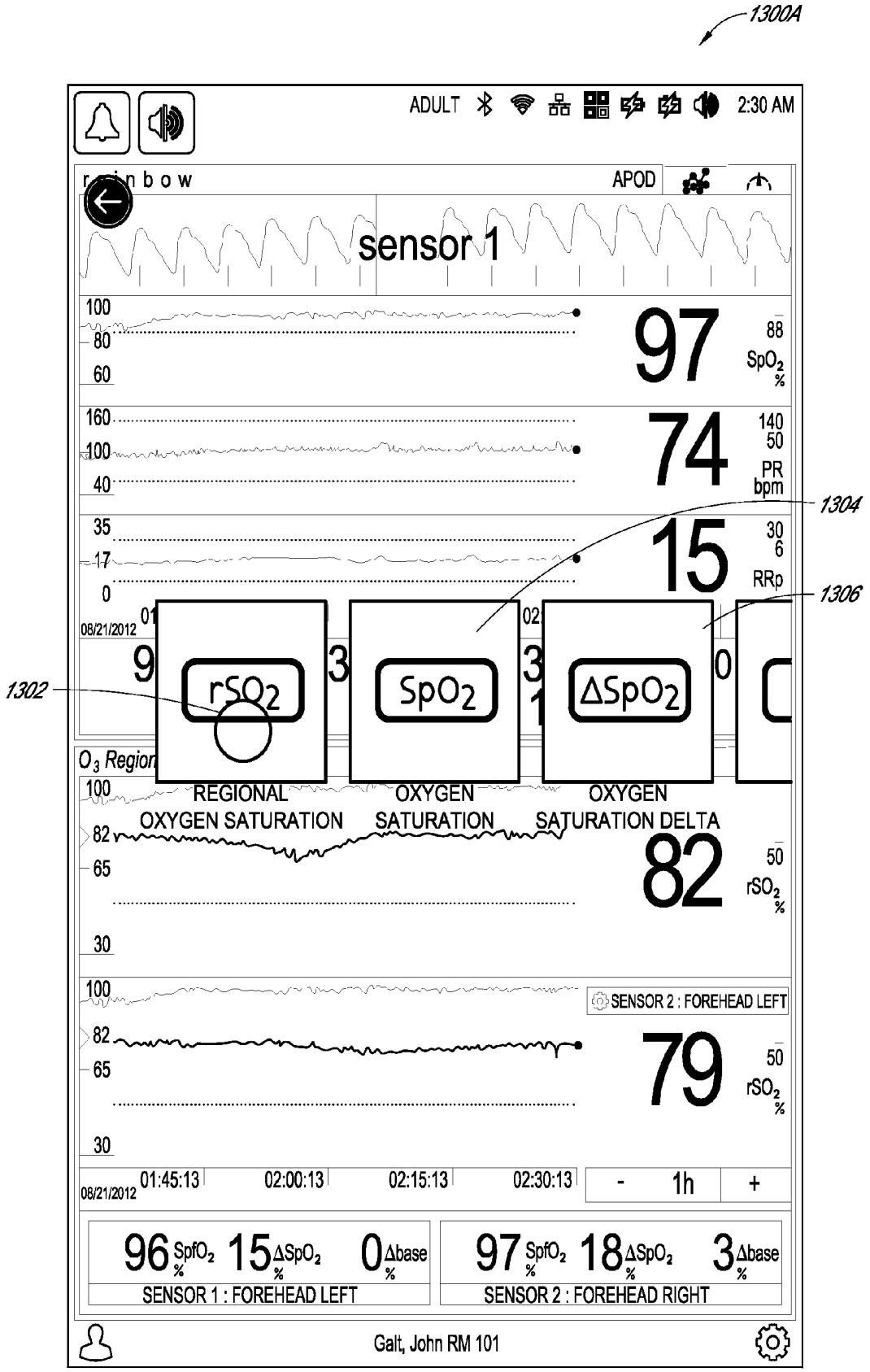
1300A
ADULT
2:30 AM
APOD
sensor 1
97
88
SpO2 %
74
140
50
PR bpm
15
30
6
RRp
1304
1306
1302
08/21/2012
rSO2
SpO2
ΔSpO2
REGIONAL OXYGEN SATURATION
OXYGEN SATURATION
OXYGEN SATURATION DELTA
82
50
rSO2 %
SENSOR 2 : FOREHEAD LEFT
79
01:45:13
02:00:13
02:15:13
02:30:13
- 1h +
96 SpfO2 % 15 ΔSpO2 % 0 Δbase %
SENSOR 1 : FOREHEAD LEFT
97 SpfO2 % 18 ΔSpO2 % 3 Δbase %
SENSOR 2 : FOREHEAD RIGHT
Galt, John RM 101

FIG. 13A

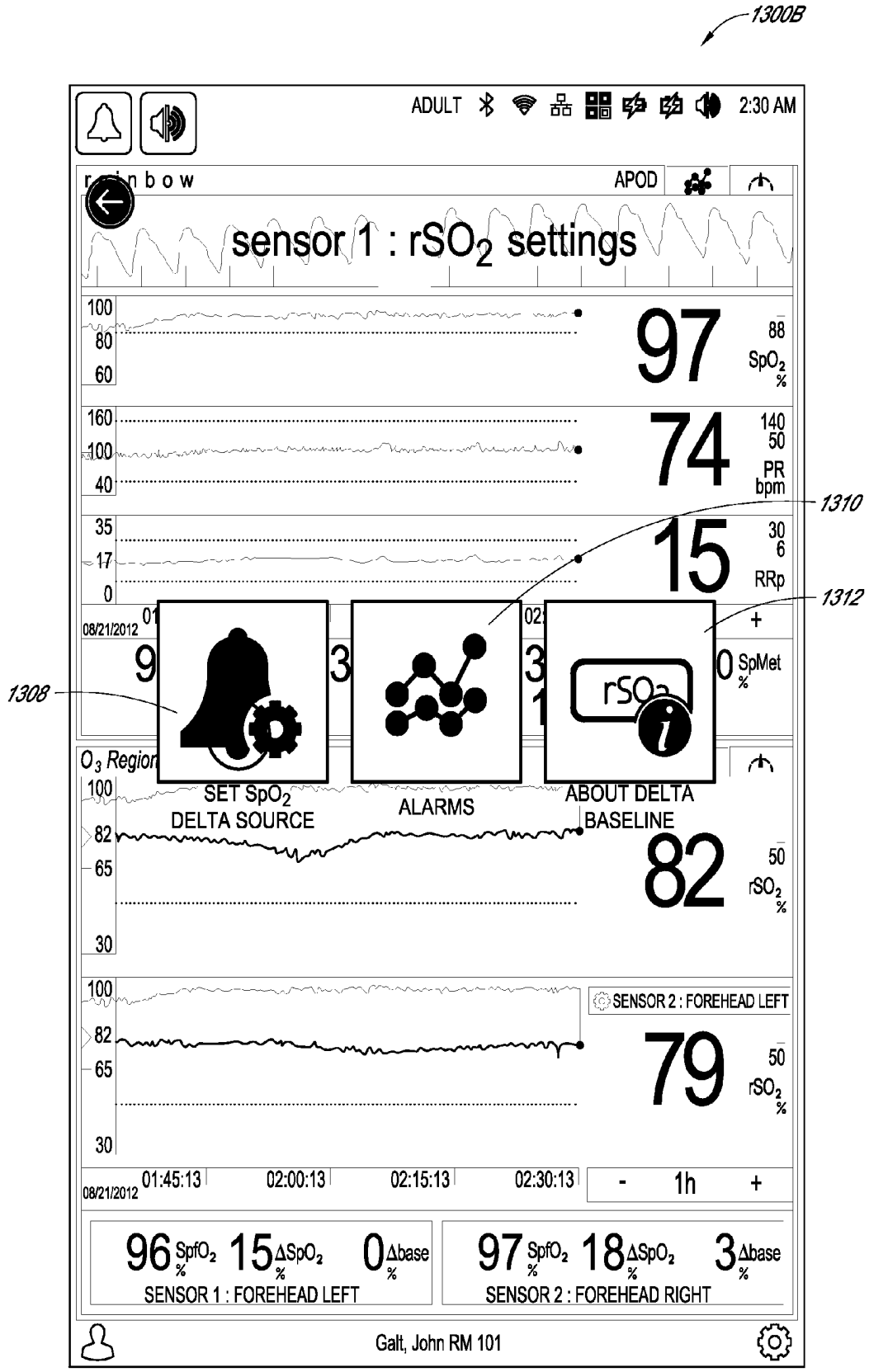
1300B
ADULT
2:30 AM
APOD
sensor 1 : rSO2 settings
97
SpO2 %
74
PR bpm
15
RRp
1310
1312
1308
SET SpO2 DELTA SOURCE
ALARMS
ABOUT DELTA BASELINE
82
rSO2 %
SENSOR 2 : FOREHEAD LEFT
79
01:45:13
02:00:13
02:15:13
02:30:13
1h
96 SpfO2 % 15 ΔSpO2 % 0 Δbase %
SENSOR 1 : FOREHEAD LEFT
97 SpfO2 % 18 ΔSpO2 % 3 Δbase %
SENSOR 2 : FOREHEAD RIGHT
Galt, John RM 101

FIG. 13B

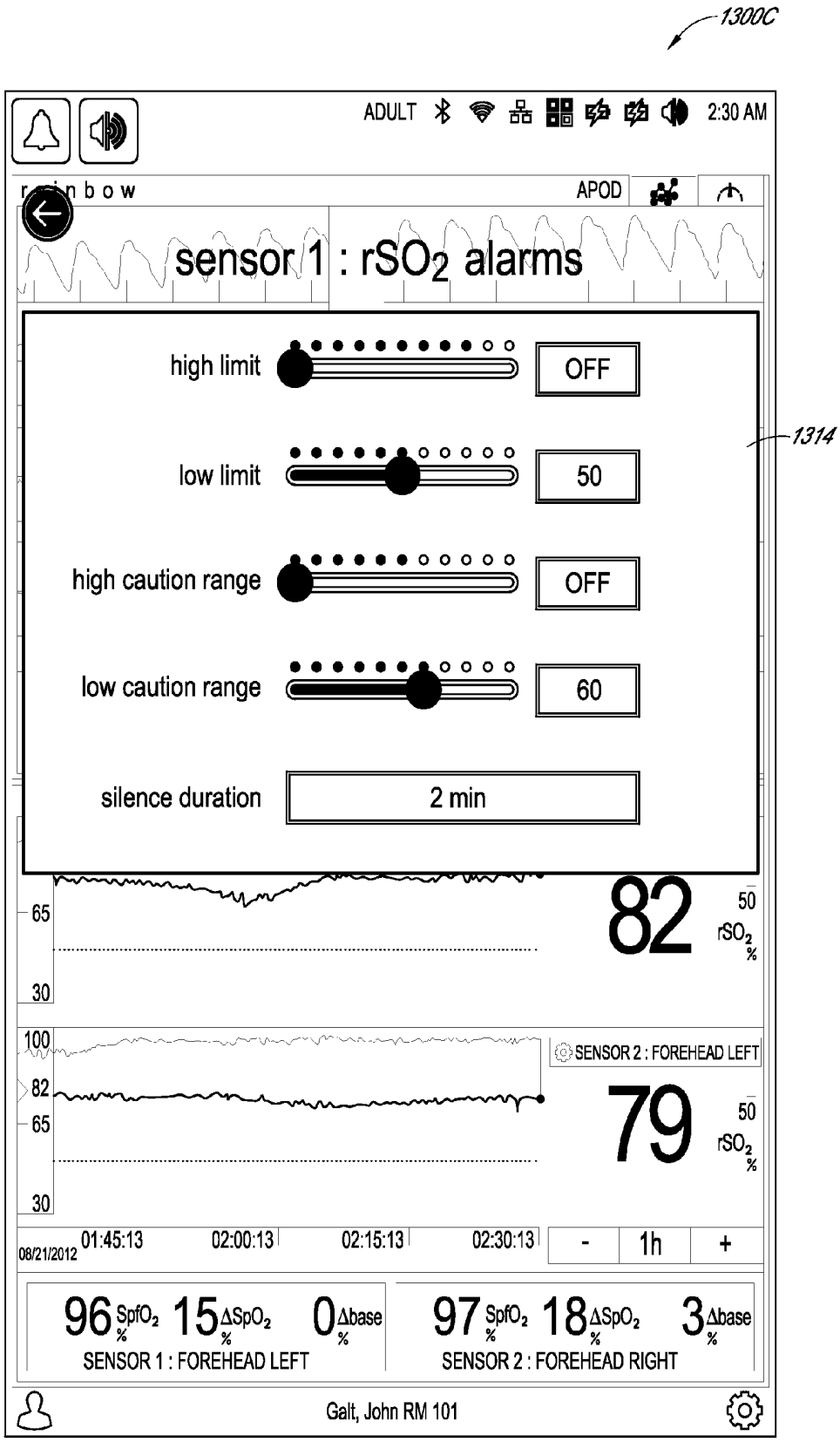
1300C
ADULT
2:30 AM
APOD
sensor 1 : rSO2 alarms
high limit
OFF
low limit
50
high caution range
OFF
low caution range
60
silence duration
2 min
1314
82
50
rSO2
%
65
30
100
82
65
30
SENSOR 2 : FOREHEAD LEFT
79
50
rSO2
%
08/21/2012
01:45:13
02:00:13
02:15:13
02:30:13
-
1h
+
96 SpfO2 % 15 ΔSpO2 % 0 Δbase %
SENSOR 1 : FOREHEAD LEFT
97 SpfO2 % 18 ΔSpO2 % 3 Δbase %
SENSOR 2 : FOREHEAD RIGHT
Galt, John RM 101

FIG. 13C

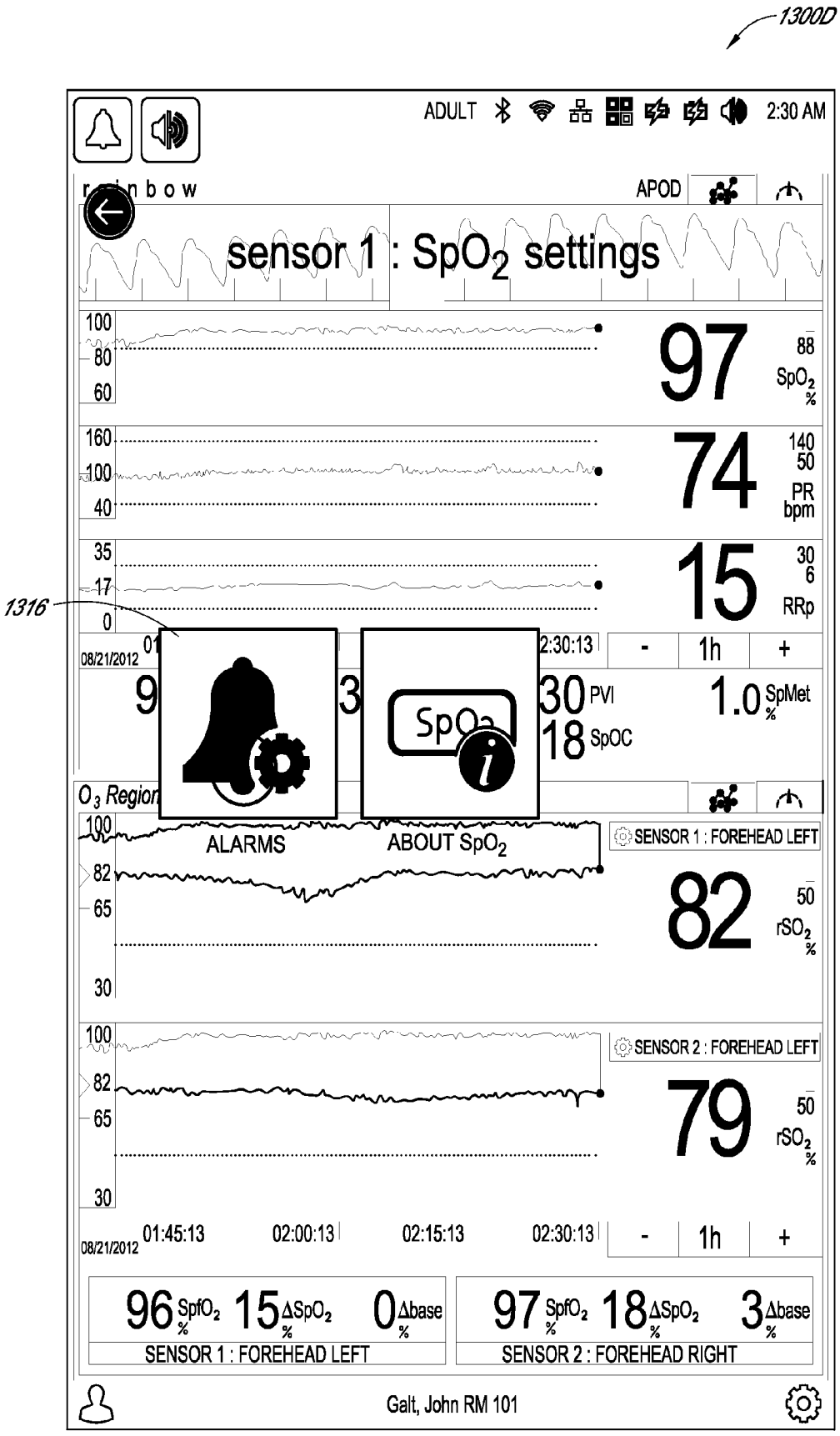
1300D
1316
ADULT
2:30 AM
APOD
sensor 1 : SpO2 settings
97
88
SpO2 %
74
140
50
PR bpm
15
30
6
RRp
08/21/2012
2:30:13
1h
30 PVI
18 SpOC
1.0 SpMet %
ALARMS
ABOUT SpO2
SENSOR 1 : FOREHEAD LEFT
82
50
rSO2 %
SENSOR 2 : FOREHEAD LEFT
79
50
rSO2 %
01:45:13
02:00:13
02:15:13
02:30:13
96 SpfO2 % 15 ΔSpO2 % 0 Δbase %
SENSOR 1 : FOREHEAD LEFT
97 SpfO2 % 18 ΔSpO2 % 3 Δbase %
SENSOR 2 : FOREHEAD RIGHT
Galt, John RM 101

FIG. 13D

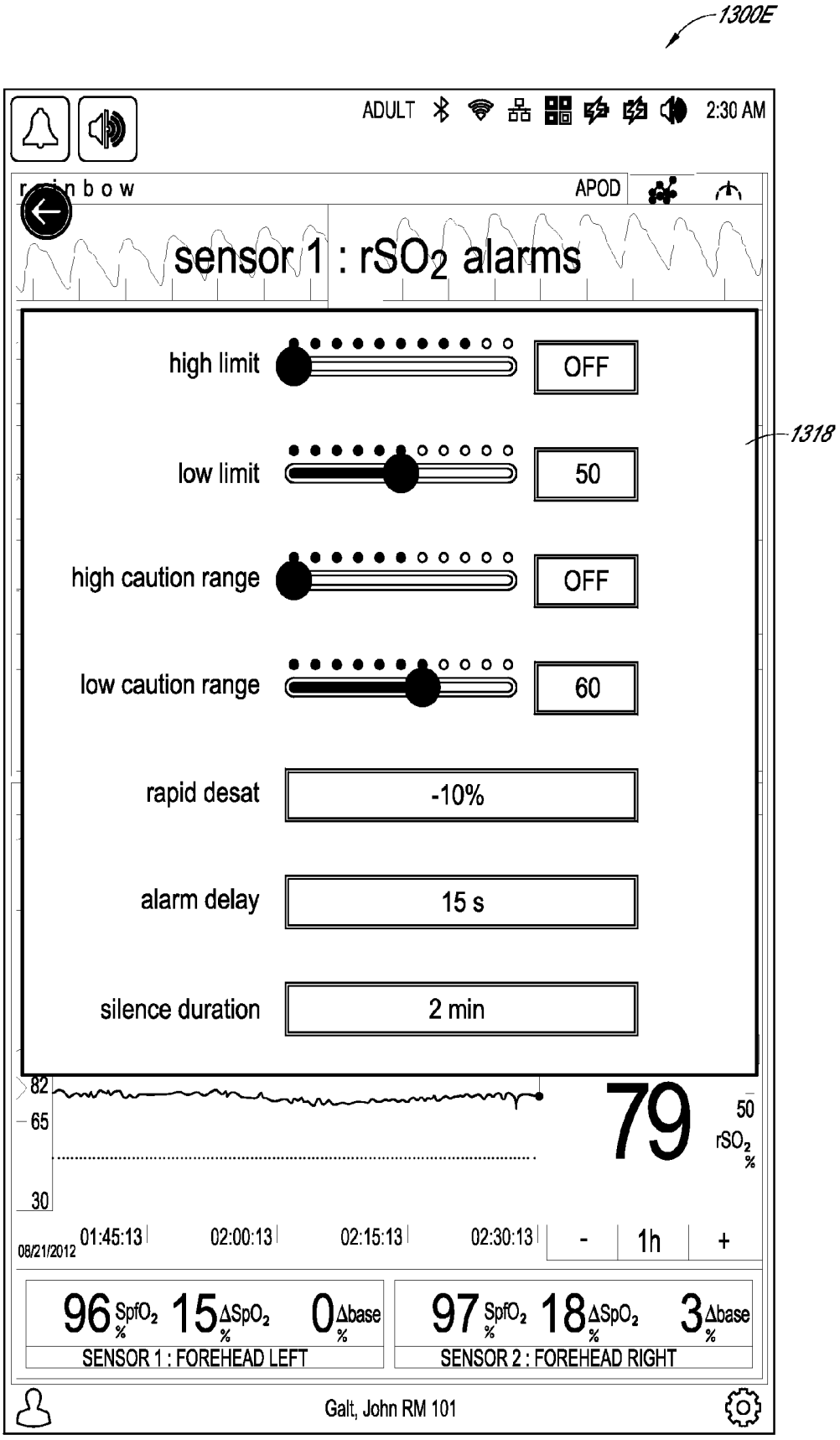
1300E
ADULT
2:30 AM
APOD
sensor 1 : rSO2 alarms
high limit
OFF
low limit
50
high caution range
OFF
low caution range
60
rapid desat
-10%
alarm delay
15 s
silence duration
2 min
1318
82
65
30
79
50
rSO2
%
08/21/2012
01:45:13
02:00:13
02:15:13
02:30:13
-
1h
+
96 SpfO2 % 15 ΔSpO2 % 0 Δbase %
SENSOR 1 : FOREHEAD LEFT
97 SpfO2 % 18 ΔSpO2 % 3 Δbase %
SENSOR 2 : FOREHEAD RIGHT
Galt, John RM 101

FIG. 13E

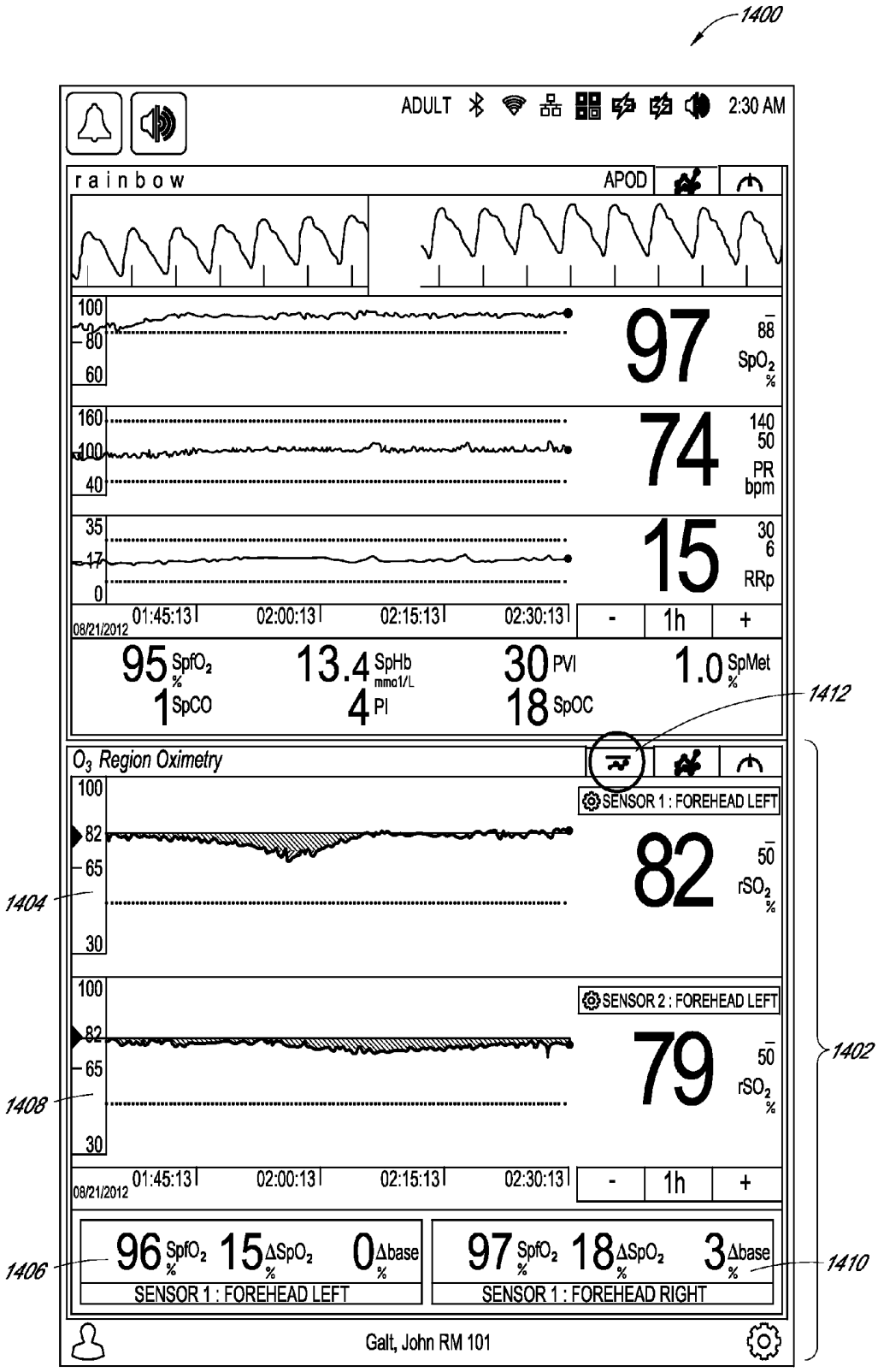
1400
ADULT
2:30 AM
rainbow
APOD
97
88
SpO2
%
74
140
50
PR
bpm
15
30
6
RRp
08/21/2012
01:45:13
02:00:13
02:15:13
02:30:13
-
1h
+
95 SpfO2
1 SpCO
13.4 SpHb
4 PI
30 PVI
18 SpOC
1.0 SpMet
1412
O3 Region Oximetry
SENSOR 1 : FOREHEAD LEFT
82
50
rSO2
SENSOR 2 : FOREHEAD LEFT
79
1404
1408
1402
96 SpfO2 15 ΔSpO2 0 Δbase
SENSOR 1 : FOREHEAD LEFT
97 SpfO2 18 ΔSpO2 3 Δbase
SENSOR 1 : FOREHEAD RIGHT
1406
1410
Galt, John RM 101

FIG. 14

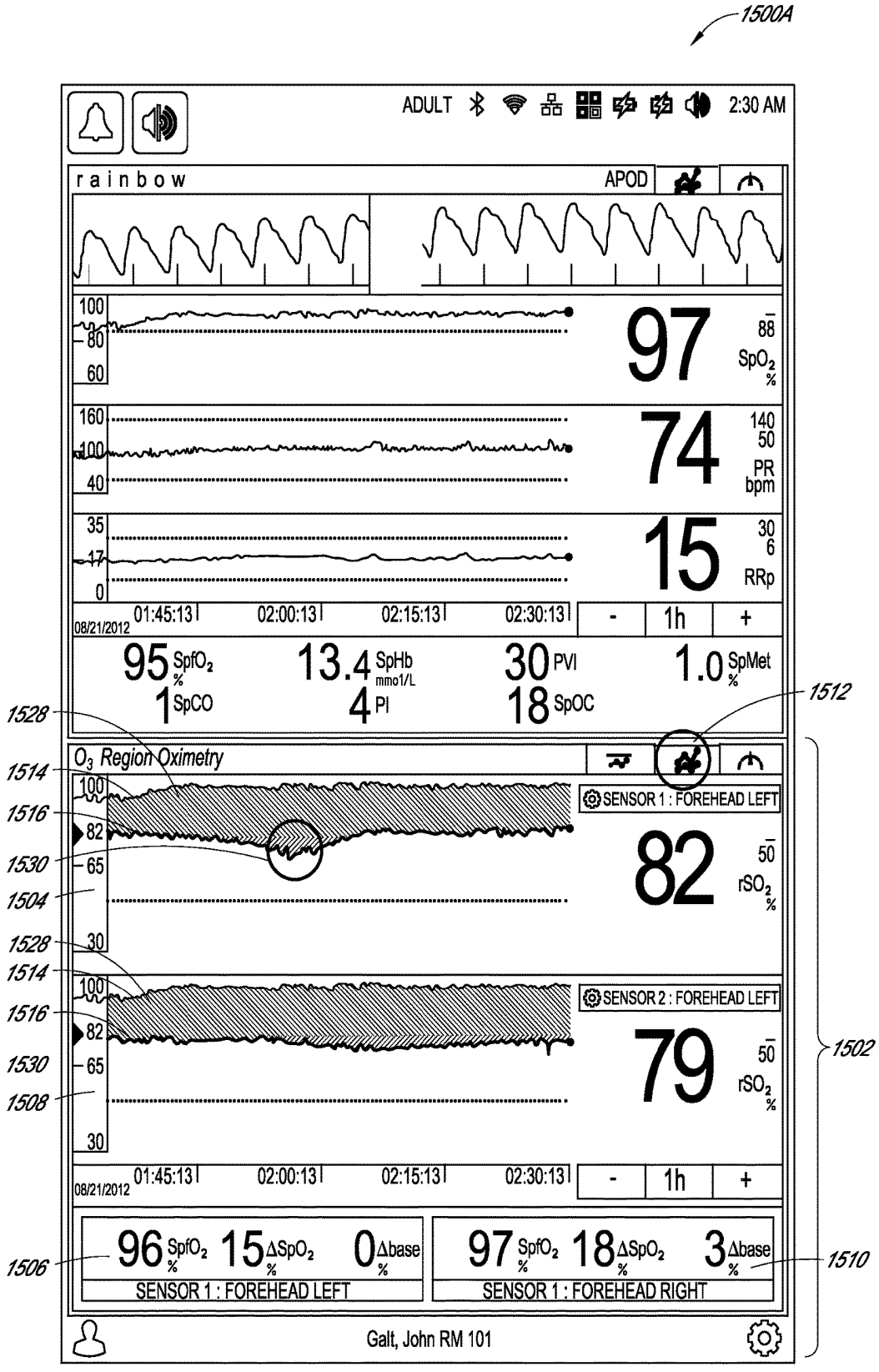
1500A
ADULT
2:30 AM
rainbow
APOD
97
88
SpO2 %
74
140
50
PR
bpm
15
30
6
RRp
08/21/2012
01:45:13
02:00:13
02:15:13
02:30:13
-
1h
+
95 SpfO2 %
1 SpCO
13.4 SpHb mmol/L
4 PI
30 PVI
18 SpOC
1.0 SpMet %
1512
1528
1514
1516
1530
1504
1508
O3 Region Oximetry
SENSOR 1 : FOREHEAD LEFT
82
50
rSO2 %
SENSOR 2 : FOREHEAD LEFT
79
1502
96 SpfO2 % 15 ΔSpO2 % 0 Δbase %
SENSOR 1 : FOREHEAD LEFT
97 SpfO2 % 18 ΔSpO2 % 3 Δbase %
SENSOR 1 : FOREHEAD RIGHT
1506
1510
Galt, John RM 101

FIG. 15A

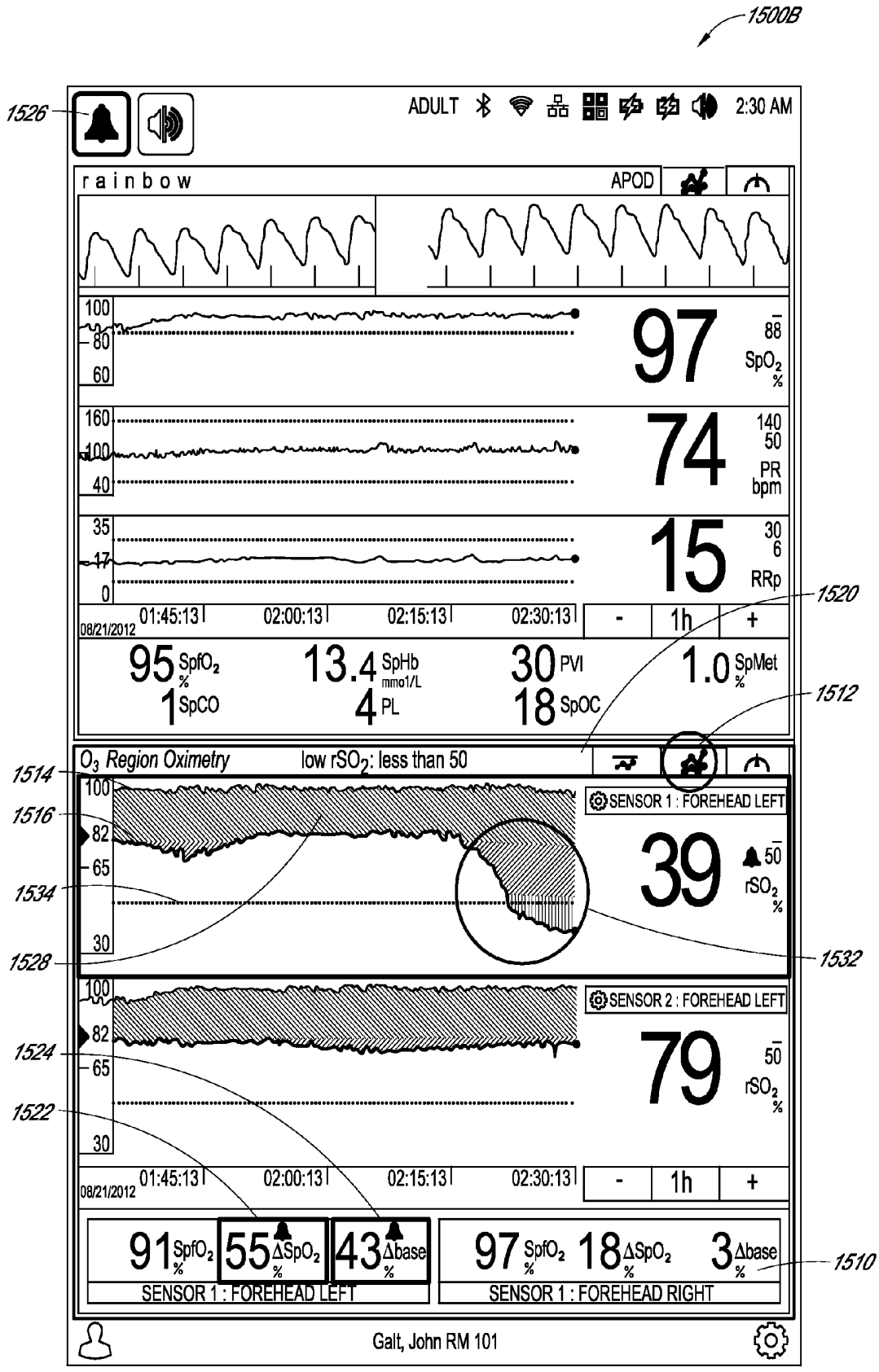
1500B
1526
ADULT
2:30 AM
rainbow
APOD
97
88
SpO2 %
74
140
50
PR bpm
15
30
6
RRp
08/21/2012
01:45:13
02:00:13
02:15:13
02:30:13
1h
95 SpfO2 %
13.4 SpHb mmol/L
30 PVI
1.0 SpMet %
1 SpCO
4 PL
18 SpOC
1520
1512
O3 Region Oximetry
low rSO2: less than 50
1514
1516
1534
1528
SENSOR 1 : FOREHEAD LEFT
39
50
rSO2 %
1532
SENSOR 2 : FOREHEAD LEFT
79
1524
1522
91 SpfO2 %
55 ΔSpO2 %
43 Δbase %
97 SpfO2 %
18 ΔSpO2 %
3 Δbase %
1510
SENSOR 1 : FOREHEAD LEFT
SENSOR 1 : FOREHEAD RIGHT
Galt, John RM 101

FIG. 15B

REGIONAL OXIMETRY USER INTERFACE

PRIORITY CLAIM AND RELATED APPLICATIONS

Any and all applications for which a foreign or domestic priority claim is identified in the Application Data Sheet as filed with the present application are hereby incorporated by reference under 37 CFR 1.57.

This application claims a priority benefit under 35 U.S.C. § 119 to the following U.S. Provisional Patent Applications:

Ser. No.	Date	Title
61/887,856,	Oct. 7, 2013,	Regional Oximetry Sensor,
61/887,878,	Oct. 7, 2013,	Regional Oximetry Pod,
61/887,883	Oct. 7, 2013,	Regional Oximetry User interface, and
62/012,170	Jun. 13, 2014	Peel-Off Resistant Regional Oximetry Sensor

Each of the foregoing disclosures is incorporated by reference herein in its entirety.

FIELD OF THE DISCLOSURE

The present disclosure relates generally to patient monitoring devices and systems, and specifically to improving user interaction with a patient monitor and medical data communication hub.

BACKGROUND OF THE DISCLOSURE

Regional oximetry, also referred to as tissue oximetry and cerebral oximetry, enables the continuous assessment of the oxygenation of tissue. The measurement is taken by placing one or more sensors on a patient, frequently on the patient's left and right forehead. Regional oximetry estimates regional tissue oxygenation by transcutaneous measurement of areas that are vulnerable to changes in oxygen supply and demand. Regional oximetry exploits the ability of light to penetrate tissue and determine hemoglobin oxygenation according to the amount of light absorbed by hemoglobin.

Regional oximetry differs from pulse oximetry in that tissue sampling represents primarily (70-75%) venous, and less (20-25%) arterial blood.

The technique uses two photo-detectors with each light source, thereby allowing selective sampling of tissue beyond a specified depth beneath the skin. Near-field photo-detection is subtracted from far-field photo-detection to provide selective tissue oxygenation measurement beyond a predefined depth. Moreover, regional oximetry monitoring does not depend upon pulsatile flow.

Regional oximetry is a useful patient monitoring technique to alert clinicians to dangerous clinical conditions. Changes in regional oximetry have been shown to occur in the absence of changes in arterial saturation or systemic hemodynamic parameters.

SUMMARY

The present disclosure provides a regional oximetry system with improved user interaction. In one aspect of the regional oximetry system, a display is provided, and a processor is provided causing a plurality of views to be displayed on the display. The views are configured to occupy at least a portion of the display. In some embodiments a first sensor port is configured to receive a first physiological signal representative of a regional tissue oxygenation level. In some embodiments a second sensor port is configured to receive a second physiological signal representative of an arterial oxygen saturation level. In some embodiments, the views are adapted to present data responsive to at least one physiological signal. In some embodiments, one view presents a first trend graph of a first physiological signal representative of a regional tissue oxygenation level, and a second trend graph of a second physiological signal representative of an arterial oxygen saturation level. In some embodiments an area between the first trend graph and the second trend graph can include a differential analysis of regional-to-central oxygen saturation.

Another aspect of a regional oximetry system includes obtaining a first waveform responsive to a physiological signal representative of a regional tissue oxygenation level, obtaining a second waveform responsive to a physiological signal representative of an arterial oxygen saturation level, determining, using at least one processor, a data trend responsive to the first physiological signal, determining, using at least one processor, a data trend responsive to the second physiological signal, and determining, using the at least one processor, a difference between the data trend responsive to the first physiological signal and the data trend responsive to the second physiological signal. In some embodiments, the regional oximetry system further presents, in a first display view, the determined data trends responsive to the first and second physiological signals, and in a second display view, the determined difference between the data trend responsive to the first and second physiological signals.

Yet another aspect of a regional oximetry system is a display and a processor causing a plurality of views to be displayed on the display. In some embodiments the views are configured to occupy at least a portion of the display. The views are adapted to present data responsive to at least one physiological signal. In some embodiments a first sensor port is configured to receive a first physiological signal representative of a regional tissue oxygenation level. In some embodiments the processor is configured to set a baseline level representative of an acceptable state of the regional tissue oxygenation. One view, for example, can present a differential analysis of a physiological signal representative of a regional tissue oxygenation level and a baseline level representative of an acceptable state of regional tissue oxygenation.

In yet another aspect of a regional oximetry system a display is provided, a sensor port is provided that is adapted to communicate with at least one sensor, and a processor is provided causing a plurality of views to be displayed on the display. The views are configured to occupy at least a portion of the display. A set sensor menu view is configured to occupy at least a portion of the display and is adapted to present a connectivity status of the sensor port and the at least one sensor.

For purposes of summarizing the disclosure, certain aspects, advantages, and novel features have been described herein. Of course, it is to be understood that not necessarily all such aspects, advantages, or features will be embodied in any particular embodiment.

BRIEF DESCRIPTION OF THE DRAWINGS

The following drawings and the associated descriptions are provided to illustrate embodiments of the present disclosure and do not limit the scope of the claims.

FIGS. **1A-1C** are perspective views of a medical monitoring hub;

FIG. **2** is a simplified block diagram of a medical monitoring environment;

FIG. **3** is a simplified hardware block diagram of a medical monitoring system;

FIG. **4** is a finger control gesture legend for a touchscreen interface;

FIG. **5** is an illustration of a display view;

FIGS. **6**A-**6**B are illustrations of potential regional oximetry sensor site locations for an adult and for a child, respectively;

FIG. **7** is an illustration of a regional oximetry display;

FIG. **8** is an illustration of a medical monitoring hub display;

FIGS. **9**A-**9**B illustrate embodiments for regional oximetry monitoring;

FIGS. **10**A-**10**F illustrate embodiments of a user interface for selecting a regional oximetry sensor site;

FIGS. **11**A-**11**G illustrate embodiments of a user interface for setting a baseline for a regional oximetry sensor;

FIGS. **12**A-**12**F illustrate embodiments of a user interface for setting a source for measuring arterial oxygen saturation;

FIGS. **13**A-**13**E illustrate embodiments of a user interface for setting parameters of a sensor used in a regional oximetry system;

FIG. **14** illustrates an embodiment of a display of regional oximetry baseline delta measurements; and

FIGS. **15**A-**15**B illustrate embodiments of a display of regional-to-central oxygenation saturation measurements.

While the foregoing "Brief Description of the Drawings" references generally various embodiments of the disclosure, an artisan will recognize from the disclosure herein that such embodiments are not mutually exclusive. Rather, the artisan would recognize a myriad of combinations of some or all of such embodiments.

DETAILED DESCRIPTION

The following description is merely illustrative in nature and is in no way intended to limit the disclosure, its application, or uses. For purposes of clarity, the same reference numbers will be used in the drawings to identify similar elements. It should be understood that steps within a method may be executed in different order without altering the principles of the present disclosure.

The present disclosure relates to a user interface for a medical monitoring hub configured to be the center of monitoring activity for a given patient. An example of a medical monitoring hub is disclosed in U.S. patent application Ser. No. 13/651,167 assigned to the assignee of the present disclosure, and is incorporated by reference herein.

In an embodiment, the hub comprises a large, easily-readable display, such as an about ten (10) inch display dominating the majority of real estate on a front face of the hub. The display could be much larger or much smaller depending upon design constraints. However, for portability and current design goals, the preferred display is roughly sized proportional to the vertical footprint of one of the dockable portable patient monitors. Other considerations are recognizable by those skilled in the art from the disclosure herein.

The display provides measurement data for a wide variety of monitored parameters for the patient under observation in numerical or graphic form. In various embodiments, the measurement data is automatically configured based on the type of data and information being received at the hub. In an embodiment, the hub is moveable, portable, and mountable so that it can be positioned to convenient areas within a caregiver environment. For example, the hub is collected within a singular housing.

In an embodiment, the hub may advantageously receive data from a portable patient monitor while docked or undocked from the hub. Typical portable patient monitors, such as oximeters or co-oximeters can provide measurement data for a large number of physiological parameters derived from signals output from optical and/or acoustic sensors, electrodes, or the like. The physiological parameters include, but are not limited to oxygen saturation (including arterial blood oxygenation, regional oximetry (also known as tissue oximetry and cerebral oximetry), carboxyhemoglobin, methemoglobin, total hemoglobin, glucose, pH, bilirubin, fractional saturation, pulse rate, respiration rate, components of a respiration cycle, indications of perfusion including perfusion index, signal quality and/or confidences, plethysmograph data, indications of wellness or wellness indexes or other combinations of measurement data, audio information responsive to respiration, ailment identification or diagnosis, blood pressure, patient and/or measurement site temperature, depth of sedation, organ or brain oxygenation, hydration, measurements responsive to metabolism, combinations of the same or the like, to name a few. In other embodiments, the hub may output data sufficient to accomplish closed-loop drug administration in combination with infusion pumps or the like.

In an embodiment, the hub communicates with other devices that are interacting with the patient in a number of ways in a monitoring environment. For example, the hub advantageously receives serial data from other devices without necessitating their reprogramming or that of the hub. Such other devices include pumps, ventilators, all manner of monitors monitoring any combination of the foregoing parameters, ECG/EEG/EKG devices, electronic patient beds, and the like. Moreover, the hub advantageously receives channel data from other medical devices without necessitating their reprogramming or that of the hub. When a device communicates through channel data, the hub may advantageously alter the large display to include measurement information from that device. Additionally, the hub accesses call systems, such as those used by nurses or other attendants, to ensure that call situations from the device are passed to the appropriate nurse or attendant call system.

The hub also communicates with hospital systems to advantageously associate incoming patient measurement and treatment data with the patient being monitored. For example, the hub may communicate wirelessly or otherwise to a multi-patient monitoring system, such as a server or collection of servers, which in turn may communicate with a caregiver's data management systems, such as, for example, an Admit, Discharge, Transfer ("ADT") system and/or an Electronic Medical Records ("EMR") system. The hub advantageously associates the data flowing through it with the patient being monitored, thereby providing the electronic measurement and treatment information to be passed to the caregiver's data management systems without the caregiver associating each device in the environment with the patient.

In an embodiment, the hub advantageously includes a reconfigurable and removable docking station. The docking station may dock additional layered docking stations to adapt to different patient monitoring devices. Additionally, the docking station itself is modularized so that it may be removed if the primary dockable portable patient monitor changes its form factor. Thus, the hub is flexible in how its docking station is configured.

In an embodiment, the hub includes a large memory for storing some or all of the data it receives, processes, and/or associates with the patient, and/or communications it has with other devices and systems. Some or all of the memory may advantageously comprise removable SD memory.

The hub communicates with other devices through at least (1) the docking station to acquire data from a portable monitor, (2) innovative universal medical connectors to acquire channel data, (3) serial data connectors, such as RJ ports to acquire output data, (4) Ethernet, USB, and nurse call ports, (5) Wireless devices to acquire data from a portable monitor, and (6) other wired or wireless communication mechanisms known to an artisan. The universal medical connectors advantageously provide optional electrically-isolated power and communications, and are designed to be smaller in cross section than other commonly-used isolation configurations. The connectors and the hub communicate to advantageously translate or configure data from other devices to be usable and displayable for the hub. In an embodiment, a software developers kit ("SDK") is provided to a device manufacturer to establish or define the behavior and meaning of the data output from their device. When the output is defined, the definition is programmed into a memory residing in the cable side of the universal medical connector and supplied as an original equipment manufacturer ("OEM") to the device provider. When the cable is connected between the device and the hub, the hub understands the data and can use it for display and processing purposes without necessitating software upgrades to the device or the hub. In an embodiment, the hub can negotiate the schema and even add additional compression and/or encryption. Through the use of the universal medical connectors, the hub organizes the measurement and treatment data into a single display and alarm system effectively and efficiently, bringing order to the monitoring environment.

As the hub receives and tracks data from other devices according to a channel paradigm, the hub may advantageously provide processing to create virtual channels of patient measurement or treatment data. In an embodiment, a virtual channel may comprise a non-measured parameter that is, for example, the result of processing data from various measured or other parameters. An example of such a parameter includes a wellness indicator derived from various measured parameters that give an overall indication of the wellbeing of the monitored patient. An example of a wellness parameter is disclosed in U.S. patent application Ser. Nos. 13/269,296, 13/371,767 and 12/904,925, by the assignee of the present disclosure and incorporated by reference herein. By organizing data into channels and virtual channels, the hub may advantageously time-wise synchronize incoming data and virtual channel data.

The hub also receives serial data through serial communication ports, such as RJ connectors. The serial data is associated with the monitored patient and passed on to the multi-patient server systems and/or caregiver backend systems discussed above. Through receiving the serial data, the caregiver advantageously associates devices in the caregiver environment, often from varied manufacturers, with a particular patient, avoiding a need to have each individual device associated with the patient communicating independently with hospital systems. Such association is vital as it reduces caregiver time spent entering biographic and demographic information about the patient into each device. Moreover, in an embodiment, through the SDK the device manufacturer may advantageously provide information associated with any measurement delay of their device, thereby further allowing the hub to advantageously time-wise synchronize serial incoming data and other data associated with the patient.

In an embodiment, when a portable patient monitor is docked, and it includes its own display, the hub effectively increases its display real estate. For example, in an embodiment, the portable patient monitor may simply continue to display its measurement and/or treatment data, which may be now duplicated on the hub display, or the docked display may alter its display to provide additional information. In an embodiment, the docked display, when docked, presents anatomical graphical data of, for example, the heart, lungs, organs, the brain, or other body parts being measured and/or treated. The graphical data may advantageously animate similar to and in concert with the measurement data. For example, lungs may inflate in approximate correlation to the measured respiration rate and/or the determined inspiration/expiration portions of a respiration cycle; the heart may beat according to the pulse rate or along generally understood actual heart contraction patterns; the brain may change color or activity based on varying depths of sedation; or the like. In an embodiment, when the measured parameters indicate a need to alert a caregiver, a changing severity in color may be associated with one or more displayed graphics, such as the heart, lungs, brain, organs, circulatory system or portions thereof, respiratory system or portions thereof, other body parts or the like. In still other embodiments, the body portions may include animations on where, when or how to attach measurement devices.

The hub may also advantageously overlap parameter displays to provide additional visual information to the caregiver. Such overlapping may be user definable and configurable. The display may also incorporate analog-appearing icons or graphical indicia.

In the interest of clarity, not all features of an actual implementation are described in this specification. An artisan will of course appreciate that in the development of any such actual implementation (as in any development project), numerous implementation-specific decisions must be made to achieve a developer's specific goals and sub-goals, such as compliance with system and business-related constraints, which will vary from one implementation to another. Moreover, it will be appreciated that such a development effort might be complex and time-consuming, but would nevertheless be a routine undertaking of device and systems engineering for those of ordinary skill having the benefit of this disclosure.

To facilitate a complete understanding of the disclosure, the remainder of the detailed description describes the disclosure with reference to the drawings, wherein like reference numbers are referenced with like numerals throughout.

FIG. **1**A illustrates a perspective view of an embodiment of a medical monitoring hub **100** with an embodiment of a docked portable patient monitor **102** according to an embodiment of the disclosure. The hub **100** includes a display **104**, and a docking station **106**, which in an embodiment is configured to mechanically and electrically mate with the portable patient monitor **102**, each housed in a movable, mountable and portable housing **108**. The housing **108** includes a generally upright inclined shape configured to rest on a horizontal flat surface, although the housing **108** can be affixed in a wide variety of positions and mountings and comprise a wide variety of shapes and sizes.

In an embodiment, the display **104** may present a wide variety of measurement and/or treatment data in numerical, graphical, waveform, or other display indicia **110**. In an

embodiment, the display **104** occupies much of a front face of the housing **108**, although an artisan will appreciate the display **104** may comprise a tablet or tabletop horizontal configuration, a laptop-like configuration or the like. Other embodiments may include communicating display information and data to a table computer, smartphone, television, or any display system recognizable to an artisan. The upright inclined configuration of FIG. **1**A presents display information to a caregiver in an easily viewable manner.

FIG. **1**B shows a perspective side view of an embodiment of the hub **100** including the housing **108**, the display **104**, and the docking station **106** without a portable monitor docked. Also shown is a connector for noninvasive blood pressure (NIBP) **113**.

In an embodiment, the housing **108** may also include pockets or indentations to hold additional medical devices, such as, for example, a blood pressure monitor or temperature sensor **112**, such as that shown in FIG. **1**C.

The portable patient monitor **102** of FIG. **1**A may advantageously comprise an oximeter, co-oximeter, respiratory monitor, depth of sedation monitor, noninvasive blood pressure monitor, vital signs monitor or the like, such as those commercially available from Masimo Corporation of Irvine, Calif., and/or disclosed in U.S. Pat. Pub. Nos. 2002/0140675, 2010/0274099, 2011/0213273, 2012/0226117, 2010/0030040; U.S. Pat. App. Ser. Nos. 61/242,792, 61/387457, 61/645,570, 13/554,908 and U.S. Pat. Nos. 6,157,850, 6,334,065, and the like. The portable patient monitor **102** may communicate with a variety of noninvasive and/or minimally invasive devices such as optical sensors with light emission and detection circuitry, acoustic sensors, devices that measure blood parameters from a finger prick, cuffs, ventilators, and the like. The portable patient monitor **102** may include its own display **114** presenting its own display indicia **116**. The display indicia **116** may advantageously change based on a docking state of the portable patient monitor **102**. When undocked, the display indicia **116** may include parameter information and may alter orientation based on information provided by, for example, a gravity sensor or an accelerometer.

In an embodiment, the docking station **106** of the hub **100** includes a mechanical latch **118**, or a mechanically releasable catch to ensure that movement of the hub **100** doesn't mechanically detach the portable patient monitor **102** in a manner that could damage the same.

Although disclosed with reference to particular portable patient monitors **102**, an artisan will recognize from the disclosure herein there is a large number and wide variety of medical devices that may advantageously dock with the hub **100**. Moreover, the docking station **106** may advantageously electrically and not mechanically connect with the monitor **102**, and/or wirelessly communicate with the same.

FIG. **2** illustrates a simplified block diagram of a monitoring environment **200** including the hub **100** of FIGS. **1**A-**1**C, according to an embodiment of the disclosure. As shown in FIG. **2**, the environment may include the portable patient monitor **102** communicating with one or more patient sensors **202**, such as, for example, oximetry optical sensors, acoustic sensors, blood pressure sensors, respiration sensors or the like. In an embodiment, additional sensors, such as, for example, a NIBP sensor or system **211** and a temperature sensor or sensor system **213** may communicate directly with the hub **100**. The sensors **202**, **211** and **213** when in use are typically in proximity to the patient being monitored if not actually attached to the patient at a measurement site.

As disclosed, the portable patient monitor **102** communicates with the hub **100**, in an embodiment, through the docking station **106** when docked and, in an embodiment, wirelessly when undocked, however, such undocked communication is not required. The hub **100** communicates with one or more multi-patient monitoring servers **204** or server systems, such as, for example, those disclosed with in U.S. Pat. Pub. Nos. 2011/0105854, 2011/0169644, and 2007/0180140. In general, the server **204** communicates with caregiver backend systems **206** such as EMR and/or ADT systems. The server **204** may advantageously obtain through push, pull or combination technologies patient information entered at patient admission, such as demographical information, billing information, and the like. The hub **100** accesses this information to seamlessly associate the monitored patient with the caregiver backend systems **206**. Communication between the server **204** and the monitoring hub **100** may be accomplished by any technique recognizable to an artisan from the disclosure herein, including wireless, wired, over mobile or other computing networks, or the like.

FIG. **2** also shows the hub **100** communicating through its serial data ports **210** and channel data ports **212**. As disclosed in the forgoing, the serial data ports **210** may provide data from a wide variety of patient medical devices, including electronic patient bed systems **214**, infusion pump systems **216** including closed-loop control systems, ventilator systems **218**, blood pressure or other vital sign measurement systems **220**, or the like. Similarly, the channel data ports **212** may provide data from a wide variety of patient medical devices, including any of the foregoing, and other medical devices. For example, the channel data ports **212** may receive data from depth of consciousness monitors **222**, such as those commercially available from Masimo Corporation of Irvine, Calif. under the SEDLine® and under the O_3™ Regional Oximetry for the Root™ Patient Monitoring and Connectivity Platform™ brand names, brain or other organ oximetry devices **224**, noninvasive blood pressure or acoustic devices **226**, or the like. In an embodiment, a device that is connected to the hub **100** through one or more of the channel data ports **212** may include board-in-cable ("BIC") solutions, where the processing algorithms and the signal processing devices that accomplish those algorithms are mounted to a board housed in a cable or cable connector, which in some embodiments has no additional display technologies. The BIC solution outputs its measured parameter data to the channel port **212** to be displayed on the display **104** of hub **100**. In an embodiment, the hub **100** may advantageously be entirely or partially formed as a BIC solution that communicates with other systems, such as, for example, tablets, smartphones, or other computing systems.

Although illustrated with reference to a single docking station **106**, the environment **200** may include multiple, stacked docking stations where a subsequent docking station mechanically and electrically docks to a first docking station to change the form factor for a different portable patent monitor. Such stacking may include more than 2 docking stations, and may reduce or increase the form factor for mechanical compliance with mating mechanical structures on a portable device.

FIG. **3** illustrates a simplified hardware block diagram of the hub **100** of FIGS. **1**A-**1**C, according to an embodiment of the disclosure. As shown in FIG. **3**, the housing **108** of the hub **100** positions and/or encompasses an instrument board **302**, the display **104**, memory **304**, and the various communication connections, including the serial ports **210**, the channel ports **212**, Ethernet ports **305**, nurse call port **306**, other communication ports **308** including standard USB or

the like, and the docking station interface **310**. The instrument board **302** comprises one or more substrates including communication interconnects, wiring, ports and the like to enable the communications and functions described herein, including inter-board communications. A core board **312** includes the main parameter, signal, and other processor(s) and memory. A portable patient monitor board ("RIB") **314** includes patient electrical isolation for the portable patient monitor **102** and one or more processors. A channel board ("MID") **316** controls the communication with the channel ports **212**, including optional patient electrical isolation and power supply **318**. A radio board **320** includes components configured for wireless communications. Additionally, the instrument board **302** may advantageously include one or more processors and controllers, busses, all manner of communication connectivity and electronics, memory, memory readers including EPROM readers, and other electronics recognizable to an artisan from the disclosure herein. Each board comprises substrates for positioning and support, interconnect for communications, electronic components including controllers, logic devices, hardware/software combinations and the like to accomplish the tasks designated above and others.

An artisan will recognize from the disclosure herein that the instrument board **302** may comprise a large number of electronic components organized in a large number of ways. Using different boards such as those disclosed above advantageously provides organization and compartmentalization to the complex system.

Attention is now directed to embodiments of a user interface by which a user may interact with the hub **100**. In particular, a touchscreen display **104** is integral to the hub **100**. An example of a physiological monitor touchscreen interface is disclosed in U.S. patent application Ser. No. 13/850,000, assigned to the assignee of the present disclosure, and is incorporated by reference herein.

In general, the touchscreen interface provides an intuitive, gesture-oriented control for the hub **100**. The touchscreen interface employs interface constructs on the touchscreen display **104** that are particularly adapted to finger control gestures so as to change at least one of a physiological monitor operating characteristic and a physiological touchscreen display characteristic. In particular, the touchscreen display **104** presents a user with interface constructs responsive to finger control gestures so as to change displays and settings, such as monitor operating characteristics, display contents and display formats.

FIG. **4** illustrates a legend of finger control gestures **400** for use with a touchscreen display **104** according to an embodiment. The finger control gestures **400** include a touch **402**, a touch and hold **404**, a touch and move **406**, a flick **408**, a drag and drop **410**, and a pinch **412**. A touch **402** is a finger control gesture that executes the desired action once the user's finger is released from the screen. A touch and hold **404** is a finger control gesture that executes the desired action once the user has held his or her finger on the screen continuously for a predetermined duration (e.g., a few seconds), received a "hold completion" notification, and has released his or her finger from the screen. A touch and move **406** is a finger control gesture that manipulates and/or translates objects across the display **104** in the desired and permitted direction to a deliberate stopping point. To execute a touch and move finger control gesture **406**, the user touches an object, moves the object (left, right, up, down, diagonally, etc.), and releases the object. A flick **408** is a finger control gesture comprising contact of an object on the display **104** in conjunction with a quick finger movement in a particular direction, typically along a single vector. To execute a flick **408** finger control gesture the user touches an object on the display **104**, moves the object (typically, but not necessarily in a single direction) and releases the finger from the display **104** quickly, in a manner such that the contact point has a velocity throughout its path of motion. A drag and drop **410** is a finger control gesture by which the user moves an object to another location or to another object (e.g., a folder) and positions it there by releasing it. To execute a drag and drop **410** finger control gesture, the user touches, holds, drags and drops the object. A pinch **412** is a finger control gesture that expands or contracts the field of view on the display **104**. To execute a pinch **412** finger control gesture, the user touches the display **104** at two touch points using two fingers, for example, the thumb and index finger of a user's hand. Moving the touch points apart from each other zooms in on the field of view, enlarging it, while moving the touch points together zooms out on the field of view, contracting it.

In an embodiment the user interface includes multiple controls. For example, a toggle control enables a user to slide a knob to switch between toggle states. The toggle control also enables the user to press left or right of the toggle to quickly move the toggle left or right. If the toggle control is labeled, the user can press the label to quickly move the knob left or right.

The following paragraphs include a description of additional touch screen controls that can be used with the system of the present disclosure. The system can include any combination of the following controls and the present disclosure is not intended to be limited by the following descriptions of various controls.

In some embodiments, a spinner control enables the user to press a center (focused) tile to expand a spinner when the spinner is closed and to collapse a spinner when the spinner is opened. The spinner control enables the user to swipe up or down which, when the spinner is open, scrolls through spinner tiles. The spinner control enables the user to press an unfocused tile which then scrolls the tile into a center, focused position. And the spinner control enables the user to collapse an open spinner by pressing anywhere outside the spinner.

A slider control enables the user to move a knob by sliding the knob. The slider control also enables the user to quickly move the knob to a specific position by pressing anywhere along the slider path.

A slider spinner control combines the control capabilities of the spinner control and the slider control.

A button control enables a user to perform an action, as defined by the button description, by pressing the button.

An icon menu control enables the user to open a specified menu by pressing a tile. The icon menu control enables the user to scroll icons left or right by swiping left or right anywhere on the display. The icon menu control enables the user to quickly center a tile corresponding to an indicator icon by pressing an indicator button.

A window control enables the user to open a parameter or measurement window when no parameter or measurement alarm is present, by pressing the parameter or measurement. The window control enables the user to silence a parameter or measurement alarm when a parameter or measurement alarm is present, by pressing the parameter or measurement. The window control enables a parameter or measurement to be moved to a different location on the display **104** by using a drag and drop **410** finger control gesture.

A well control enables the user to open a parameter or measurement menu when no parameter or measurement

alarm is present, by pressing the parameter or measurement. The well control enables the user to silence a parameter or measurement alarm when a parameter or measurement alarm is present, by pressing the parameter or measurement.

A live waveform control enables the user to separate waveforms by swiping down. The live waveform control enables the user to combine waveforms by swiping up.

A trend line control enables the user to zoom in by pinching in, zoom out by pinching out, change a time range by panning, and open a parameter or measurement trend menu by pressing the y-axis.

An alarm silence icon control enables the user to silence all alarms by pressing the alarm silence icon.

An audio pause icon control enables the user to pause audio for a predetermined period of time, by pressing the audio pause icon.

Other status bar icon controls enable the user to open the relevant menu, by pressing the relevant status bar icon.

A back arrow control enables the user to exit a menu or abandon any changes made, by pressing a back arrow icon.

A confirm-or-cancel control enables the user to confirm changes to settings by pressing an OK button. The confirm-or-cancel control enables the user to cancel changes to settings by pressing a cancel button.

A home control enables the user to navigate to the main screen at any time by pressing a home button.

FIG. **5** illustrates an embodiment of a user interface **500** displayed on the display **104** of the hub **100**. In an embodiment the display **104** comprises a color, modular, touch-screen integral to the hub **100**. Positioned horizontally along the top of the display **104** is a top status line **501** that displays system status as well as that provide shortcuts to menu items or actions. In an embodiment the icons presented on the top status line **501** include alarm silence **501**A, audio pause **501**B, profiles **501**C, Bluetooth **501**D, Wi-Fi **501**E, Ethernet **501**F, connectivity gateway **501**G, portable patient monitor battery status **501**H, monitoring hub battery status **501**I, sounds **501**J, and current time **501**K. The alarm silence icon **501**A displays alarm status and mutes all audible alarms for monitoring devices connected to the hub **100**. The audio pause icon **501**B displays audio pause status and temporarily silences an alarm event. The profiles icon **501**C provides access to a profiles screen; the example shown illustrates that the profile is set to "Adult" for an adult patient. The Bluetooth icon **501**D provides access to a Bluetooth screen. If this icon is visible on the status line **501**, then Bluetooth connectivity has been enabled. The Wi-Fi icon **501**E provides access to a Wi-Fi screen. If this icon is visible on the status line **501**, then Wi-Fi connectivity has been enabled. The icon itself also indicates the strength of the wireless signal. The Ethernet icon **501** F provides access to an Ethernet screen. If this icon is visible on the status line **501**, then Ethernet connectivity has been enabled. The connectivity gateway icon **501**G provides access to a connectivity gateway screen. The example illustrated indicates that standalone devices are connected to three of the available four ports. The color of the icon matches the status colors of the connected standalone devices. The portable patient monitor battery status icon **501**H displays the charging status of the portable patient monitor **102** and provides access to a portable patient monitor battery screen. The example illustrates that the battery is currently charging. The monitoring hub battery status icon **501**I displays the charging status of the monitoring hub **100** and provides access to a monitoring hub battery screen. The example illustrates that the battery is currently charging. The sounds icon **501**J provides access to a sounds screen to adjust alarm and pulse tone volume. In an embodiment the sounds icon **501**J does not indicate the actual volume level of the alarm and the pulse tone. The current time icon **501**K displays the current time and provides access to a localization screen which contains settings related to local time, language and geography.

Positioned horizontally along the bottom of the display **104** is a bottom status line **502** that displays additional icons and information including a main menu icon, a gender icon, and a patient identifier that includes patient-specific information, such as, for example, the patient's name and room location. Although the disclosed embodiment employs status lines **501**, **502** oriented horizontally along the top and bottom of the display **104**, one skilled in the art would readily appreciate that information of the type presented in the top status line **501** and in the bottom status line **502** may be presented in numerous different formats, combinations and configurations, including without limitation, one or more status bars positioned vertically on the display **104**. Moreover a skilled artisan will appreciate that other useful information may be displayed in status bars **501**, **502**.

In an embodiment the user interface creates a window for every monitoring device connected to the hub **100**. Parameters or measurements can be expanded within a window to customize views. A central portion **504** of the display **104** presents patient measurement data, in this example, in two windows **506**, **530**. An upper window **506** presents patient data measured by an a noninvasive monitoring platform—such as the rainbow® Pulse CO-Oximetry™ monitoring platform by Masimo Corporation of Irvine, Calif.—which enables the assessment of multiple blood constituents and physiologic parameters including oxygen saturation (SpO_2) **508**, pulse rate (PR) **510**, respiration rate (RRp) **512**, fractional arterial oxygen saturation ($SpfO_2$) **514**, total hemoglobin (SpHb) **516**, plethysmograph variability index (PVI) **518**, methemoglobin (SpMet) **520**, carboxyhemoglobin (SpCO) **522**, perfusion index (PI) **524**, and oxygen content (SpOC) **526**.

Advantageously, the display **104** is configurable to permit the user to adjust the manner by which the physiologic parameters are presented on the display **104**. In particular, physiologic measurements of greater interest or importance to the clinician may be displayed in larger format and may also be displayed in both numerical and graphical formats to convey the current measurement as well as the historical trend of measurements for a period of time, such as, for example, the preceding hour. In an embodiment the oxygen saturation **508**, pulse rate **510**, and respiration rate **512** measurements are displayed in such a manner, taking up a larger portion of the upper portion **506** of the display **104**, while the fractional arterial oxygen saturation **514**, total hemoglobin **516**, plethysmograph variability index **518**, methemoglobin **520**, carboxyhemoglobin **522**, perfusion index **524**, and oxygen content **526** measurements are displayed as numbers, taking up a smaller portion of the upper portion **506** of the display **104**.

In an embodiment the presentation of measurement information may be adjusted easily by using the finger control gestures **400**. For example, the touch and move **406** finger control gesture may be used to move an object on the display **104** representing a measurement from one location of the display **104** to another location of the display **104**. Advantageously, when the object is moved, the display **104** automatically scales its presentation of information based upon the parameters that are active. For example, fewer parameters result in the presentation of larger digits, trend lines, and waveform cycles. In an embodiment the location to

which an object is moved determines, at least in part, the manner by which that object will be presented on the display **104**.

A lower window **530** of the display **104** presents patient data measured by a regional oximetry platform—such as the O_3™ regional oximetry module by Masimo Corporation of Irvine, Calif.—which allows the continuous assessment of tissue oxygenation beneath one or more sensors placed on the patient's skin to help clinicians detect regional hypoxemia. Regional oximetry—also referred to as tissue oximetry and cerebral oximetry—enables the continuous assessment of the oxygenation of tissue beneath the sensor. Simultaneous measurement of both tissue oxygen saturation (rSO_2) and arterial blood oxygenation (SpO_2) provides clinicians, such as anesthesiologists or perfusionists, a differential analysis of regional-to-central oxygen saturation monitoring, which helps the clinician to maintain brain oxygenation and safe cerebral perfusion during procedures.

In an embodiment the regional oximetry module is configured by applying one or more regional oximetry sensors to the patient, for example, the patient's forehead, and by connecting the module(s) to the hub **100**. In an embodiment the regional oximetry module has as few as one and as many as four sensors. In an embodiment the regional oximetry module is connected to the hub **100** through the hub's **100** channel ports **212**.

In an embodiment the regional oximetry platform uses near-infrared spectroscopy (NIRS) to continuously and simultaneously measure regional oxygen saturation (rSO_2) and arterial oxygen saturation (SpO_2), enabling the regional oximetry platform to automatically derive the differential analysis of a patient's regional-to-central oxygen saturation. In an embodiment the hub **100** derives the differential analysis of a patient's regional-to-central oxygenation saturation by comparing measurements provided to the hub **100** from two sources, such as a pulse oximetry measurement device and a regional oximetry measurement device.

FIGS. **6**A-**6**B illustrate regional oximetry monitor user interface embodiments for designating adult and child sensor placement sites. As shown in FIG. **6**A, an adult form **601** is generated on a user interface display. In an embodiment, between one and four sensor sites can be designated on the adult form **601**, including left and right forehead **610**, left and right forearm **620**, left and right chest **630**, left and right upper leg **640**, left and right upper calf **650** and left and right calf **660** sites. Accordingly, between one and four sensors can be located on various combinations of these sites. The hub **100**, which is in communication with these sensors, displays between one and four corresponding regional oximetry graphs and readouts, as described with respect to FIGS. **7** and **8**, below. In other embodiments, any number of sensors and sensor sites can be used, including all of the sensor sites illustrated in FIG. **6**A and/or other sensor sites as well.

As shown in FIG. **6**B, a child form **602** is generated on a user interface display. In an embodiment between one and four sensor sites can be designated on the child form **602**, including left and right forehead **610**, left and right renal **670**, and left and right abdomen **680** sites. Accordingly, between one and four sensors can be located on these sites. The hub **100**, which is in communication with these sensors, displays between one and four corresponding regional oximetry graphs and readouts, as described in FIGS. **7** and **8** bellow. In other embodiments, any number of sensors and sensor sites can be used, including all of the sensor sites illustrated in FIG. **6**B and/or other sensor sites as well.

FIG. **7** illustrates an embodiment of a regional oximetry window display **700** for monitoring parameters derived from one or more regional oximetry sensors. This particular example is a two-sensor display for monitoring, for example, a forehead left **710** site and a forehead right **730** site. In an upper portion of the display **700**, the forehead left **710** site displays, for example, an $Sp0_2$ graph **712**, an $rS0_2$ graph **714** and an $rS0_2$ readout **716**. Similarly, the forehead right **730** site displays, for example, an $Sp0_2$ graph **732**, an $rS0_2$ graph **734** and an $rS0_2$ readout **736**. In other embodiments, any number of sensors and sensor sites can be used.

Also shown in FIG. **7**, in a lower portion of the display **700**, is a forehead left display well **750** that displays, for example, an $Sp0_2$ readout **752**, a $\Delta Sp0_2$ readout **754** and a Δbase readout **756**. Similarly, the forehead right display well **730** displays, for example, an $Sp0_2$ readout **772**, a $\Delta S0_2$ readout **774** and a Δbase readout **776**.

FIG. **8** illustrates an embodiment of the user interface **800** in which a regional oximetry parameter display **104** accommodates four regional oximetry sensor inputs. In this example, a first two-sensor display **801** is enabled for monitoring a forehead left site **810**, **830** and a forehead right site **820**, **840**. A second two-sensor display **802** is enabled for monitoring a chest left site **850**, **870**, and a chest right site **860**,**880**. Notably, a pulse oximetry parameter display **805** is allocated less display space than the regional oximetry parameter display **806** to accommodate the graphical area needed to display the regional oximetry parameter data. In an embodiment the display **800** automatically scales to allocate display space according to preferences set by the user. In other embodiments, any number of sensors and sensor sites can be used.

FIGS. **9**A-**9**B generally illustrate embodiments for regional oximetry monitoring. As shown in FIG. **9**A, a regional oximetry pod array **900** has a first pod assembly **910** and a second pod assembly **920**. Each pod assembly **910**, **920** communicates with an array of one or two regional oximetry sensors **960** via sensor cables **950**. In other embodiments the pod assemblies **910**, **920** can communicate with any number of regional oximetry sensors **960**. The sensors **960** are attached to various patient locations, with one or two regional oximetry pods **930** and a corresponding number of pod cables **940** providing communications between the pods **930** and the hub **100**. In other embodiments any number of sensors, positioned at any number of sensor sites on the patient's body can be used, and any number of pod assemblies can be used to connect the sensors to the hub **100**. The pods **930** perform the physiological sensor signal processing normally associated with a monitoring device, which advantageously allows regional oximetry pods **930** to easily integrate with third party monitors **100** ranging from relatively "dumb" display devices that perform little or no signal processing to relatively "intelligent" multi-parameter patient monitors, which communicate with a variety of sensors and which perform sophisticated signal processing at the monitor level.

As shown in FIG. **9**B, a regional oximetry pod assembly **911** embodiment has a pod **931** that communicates with up to two regional oximetry sensors **961** via sensor cables **951**. In other embodiments the pod **931** can communicate with any number of regional oximetry sensors **961**. In turn, the pod **931** communicates with an attached monitor hub **100** via a pod cable **941**. In an embodiment the pod cable **941** connects to one of the channel ports **212** of the hub **100**.

Embodiments of user interfaces for configuring a regional oximetry system to operate with a hub **100** follow.

When multiple regional oximetry sensors **960** are positioned on a patient's body and connected to the hub **100**, there is a potential for confusion as to where each sensor is positioned on the patient. This potential for confusion is increased when, as in some embodiments, pod assemblies **920**, **930** are used to connect multiple sensors **960** to the hub **100** because embodiments of pod assemblies **920**, **930** can connect multiple sensors **960** to a single channel port **212** of the hub **100**. Inadvertent mislabeling of sensor location can lead to misreading of the physiological data being displayed, thereby posing a risk to the patient. Advantageously embodiments of the user interface for configuring a regional oximetry system to operate with a hub **100**, disclosed herein, address this concern by displaying information describing the connectivity status and configuration of sensors **960**, pod assemblies **920**, **930** and channel ports **212**. In some embodiments the information describing the connectivity status and configuration includes visual representations to assist clinicians in properly labeling and configuring the hub **100** to work appropriately with a regional oximetry system.

FIGS. **10**A-**10**F illustrate embodiments of a user interface for selecting a first sensor site employing a menu-based, hierarchical navigation structure. FIG. **10**A illustrates a main menu **1000**A which is accessed by pressing a main menu icon **1000**. The main menu presents several options for the user to select. The main menu options permit the user to navigate to various features of the user interface. Main menu options include, without limitation, device settings, information, trend settings, profiles, connectivity, layout, and sounds. As depicted in FIG. **10**A, a regional oximetry device icon **1001** is selected using a touch **402** finger control gesture, which causes the display **104** to replace the main menu with a regional oximetry menu **1000**B, illustrated in FIG. **10**B. Selection of the sensor sites icon **1002** opens a sensor sites menu **1000**C shown in FIG. **10**C. As illustrated in FIG. **10**C a connectivity window **1003** graphically displays the connectivity state of the channel ports **212** of the hub **100**. In this illustrative example, pod **1** **1004** is connected to port **1** **1006**, and sensor cable **1** **1008** is connected to pod **1** **1004**. A sensor **1** button **1010** is illuminated to indicate that sensor **1** is connected. In contrast, a sensor **2** button **1012** is not illuminated (or grayed-out), indicating that no sensor cable is connected to it. An information line **1014** instructs the user to select a sensor **1** site. As illustrated, an adult form **1016** is generated to display potential sites of the patient's body where a regional oximetry sensor can be placed, including right and left forehead, right and left forearm, right and left chest, right and left upper leg, right and left upper calf, and right and left calf. With the touch finger control gesture **402** the user selects a sensor location on the adult form **1016** to identify where, on the patient, the regional oximetry sensor has been placed. As illustrated in FIG. **100** the left forehead sensor site **1018** is selected.

FIG. **10**D illustrates a confirmation user interface display **1000**D for selecting a first sensor site. The left forehead sensor site **1018** changes color, for example from white to blue, and the numeral "1" appears on the left forehead sensor site **1018**, indicating that the sensor **1** site has been selected. Additionally the information line **1014** indicates that the sensor site has been selected by stating "SENSOR **1**: FOREHEAD LEFT." The user is prompted to confirm the sensor site selection by touching an OK button **1020**.

FIG. **10**E illustrates an embodiment of a user interface in which the patient is a child **1000**E. A child form **1022** is generated to display potential sites of the patient's body where a regional oximetry sensor can be placed, including right and left forehead, right and left renal and right and left abdomen. In this example, the left forehead sensor site **1018** changes color, for example from white to blue, and the numeral "1" appears on the left forehead sensor site **1018**, indicating that the sensor **1** site has been selected. Additionally the information line **1014** indicates that the sensor site has been selected by stating "SENSOR **1**: FOREHEAD LEFT." The user is prompted to confirm the sensor site selection by touching an "OK" button **1020**.

FIG. **10**F illustrates an embodiment of a user interface display in which a sensor **1** is configured and monitoring the patient's regional oximetry of the left forehead **1000**F. In this example, a two-sensor window **1030** is enabled for monitoring a forehead left site **1032**,**1034**. Configuration of additional pods, selection of additional sensor sites, and modification of sensor sites can be performed in a similar manner to that described with respect to FIGS. **10**A-F.

FIGS. **11**A-**11**D illustrate embodiments of a user interface for setting a baseline for a regional oximetry sensor. The baseline is a reading of the patient's regional oximetry level before a patient is sedated. The baseline is compared with the patient's sedated regional oximetry measurements to assess whether the patient is being adequately oxygenated during, for example, a procedure.

FIG. **11**A illustrates an embodiment of a graphical display **1100**A in which two regional oximetry sensors are positioned on the patient, where sensor **1** is positioned on the left forehead and sensor **2** is positioned on the right forehead. To initiate the process of setting a baseline for, say, sensor **1**, the user selects a Δbase icon **1102** using a touch finger gesture **402**. As illustrated in FIG. **11**B, a sensor **1** delta baseline menu **1100**B appears. By selecting the set baseline icon **1103**, a set baseline display **1100**C appears as illustrated in FIG. **11**C. A baseline action screen **1104** appears with an information line **1105** instructing the user to set a baseline for sensor **1**. The user enables the baseline feature for sensor **1** by sliding a toggle switch **1106** into the "on" position using, for example, a touch and move **406** finger control gesture. An arrow icon **1108** allows the user to navigate back to the previous screen if desired. Advantageously, while the user is engaged in configuring the hub **100** by engaging action screens, monitored data is displayed in the background with brightness reduced. FIG. **11**D illustrates an updated set baseline display **1100**D. The action screen **1104** expands to include a baseline setting slider **1110** and a numerical display **1112**. As the user slides the baseline setting slider **1112** left or right, using for example the touch and move **406** finger control gesture, a corresponding numerical value is indicated on the numerical display **1112**. FIG. **11**E illustrates an embodiment **1100**E in which the baseline is set by using a flick **408** finger control gesture on the numerical display **1112**. In this example the user confirms the sensor site selection by touching an "OK" button **1114**, and the action screen **1104** closes returning the user interface display **1100**F to its previous level of brightness, as illustrated in FIG. **11**F. The Δbase object **1102** now displays a numerical value, indicating that the baseline feature has been enabled and set. Setting baselines for additional sensor sites can be performed in a similar manner as to that described herein.

Referring back to FIG. **11**B, by selecting the alarms icon **1107**, the user navigates to a menu to set sensor **1** delta baseline alarms **1100**G, illustrated in FIG. **11**G. A delta baseline alarms action screen **1120** appears in which the user can set alarm conditions for the monitoring of sensor **1** delta baseline information. In an embodiment the alarm conditions include a delta limit **1122**, a delta caution range **1124**, and a silence duration **1126**. Advantageously the alarm

conditions can be used to graphically represent the status of the delta baseline metric on a trend view, as described below with respect to FIGS. **15**A-B.

In an embodiment the hub **100** displays a differential analysis of a patient's regional-to-central oxygen saturation, also referred to as ΔSpO_2, where measurement of the patient's arterial oxygen saturation is compared with one or more measurements of regional oxygen saturation. The source of measurements of the patient's arterial oxygen saturation used to determine the patient's regional-to-central oxygen saturation can be provided by the regional oximetry sensor or by a peripheral arterial oxygen sensor. FIGS. **12**A-**12**E illustrate embodiments of a user interface for setting a source for measuring arterial oxygen saturation for determining a patient's regional-to-central oxygen saturation. FIG. **12**A illustrates an embodiment of a user interface **1200**A in which two regional oximetry sensors are positioned on the patient, where sensor **1** is positioned on the left forehead and sensor **2** is positioned on the right forehead. To initiate the process of setting a delta SpO_2 source for, say, sensor **2**, the user selects a ΔSpO_2 icon **1202** using a touch finger gesture **402**. As illustrated in FIG. **12**B, a delta SpO_2 screen **1200**B appears with three delta SpO_2 menu icons on the display including a "set SpO_2 delta source" icon **1204**, an "alarms" icon **1206**, and an "about delta baseline" icon **1208**. When the user selects the "set SpO_2 delta source" icon **1204**, an SpO2 delta source display **1200**C appears. A delta source action screen **1210** appears, as illustrated in FIG. **12**C. The information line instructs the user to select an SpO2 delta source for sensor **2**. The user selects the SpO2 delta source for sensor **2**, in this case, by sliding a toggle switch icon **1212** either to the regional oximetry sensor location—which in this case is identified as forehead—or to a peripheral setting, using a touch and move **406** finger control gesture. As illustrated in FIG. **12**D, once the SpO2 delta source is selected (to forehead in this illustration) the user is prompted to confirm the delta source selection by touching an "OK" button **1214**. Alternatively, the user can cancel the delta source selection by touching a "cancel" button **1216**. The action screen **1210** then closes returning the main display **1200**E to its previous level of brightness, as illustrated in FIG. **12**E, indicating that in this embodiment, the sensor **2** SpO_2 delta source is set.

Referring back to FIG. **12**B, by selecting the alarms icon **1205**, the user navigates to a menu to set sensor **2** delta SpO_2 alarms **1200**F, illustrated in FIG. **12**F. A delta baseline alarms action screen **1220** appears in which the user can set alarm conditions for the monitoring of sensor **2** delta baseline information, including a delta limit **1222**, a delta caution range **1224**, and a silence duration **1226**.

FIGS. **13**A-**13**E illustrate embodiments of a user interface for setting parameters of a sensor used in a regional oximetry system to operate with the hub **100**. The user navigates from the main menu and the regional oximetry menu (described above with respect to FIGS. **10**A-B) to arrive at, say, a sensor **1** menu **1300**A, as illustrated in FIG. **13**A. By selecting a regional oxygen saturation icon **1302**, the user navigates to a menu for sensor **1** regional oxygen saturation (rSO_2) settings **1300**B as illustrated in FIG. **13**B. Similarly, by selecting an alarms icon **1308**, the user navigates to a screen for setting sensor **1** rSo_2 alarms **1300**C which displays an action screen **1314** for setting sensor **1** regional oxygen saturation (rSO_2) alarms, as illustrated in FIG. **13**C. In an embodiment the alarms include high limit, low limit, high caution range, low caution range, and silence duration. The action screen **1314** features buttons to turn on or off various alarms and sliders by which the user can set parameters, such as limits, ranges and durations, to establish alarm triggering conditions for a given sensor positioned on a patient.

Referring back to the sensor menu of FIG. **13**A, the user can select the oxygen saturation icon **1304** to navigate to, for example, the sensor **1** oxygen saturation (SpO_2) settings menu **1300**D, illustrated in FIG. **13**D. By selecting an alarms icon **1316**, the user navigates to a sensor **1** SpO2 alarms menu **1300**E displaying an action screen **1318** for setting sensor **1** oxygen saturation (SpO_2) alarms, as illustrated in FIG. **13**E. In an embodiment the alarms include high limit, low limit, high caution range, low caution range, rapid desaturation, alarm delay and silence duration. The action screen **1318** features buttons to turn on or off various alarms, sliders by which the user can set parameters, such as limits, ranges and durations, to establish alarm triggering conditions for a given patient. Advantageously the alarm conditions can be used to graphically represent the status of the delta baseline metric on a trend view, as described below with respect to FIGS. **15**A-B.

FIG. **14** illustrates an embodiment of a monitor display **1400** in which regional oximetry baseline delta measurements are presented. In this embodiment a two-sensor display **1402** is configured to present monitored patient data from the patient's left forehead **1404**, **1406** and from the patient's right forehead **1408**, **1410**. A baseline view icon **1412** is selected which results in formatting the patient's measured data to be presented graphically, with a baseline that has been set by the user, at the trend displays **1404**,**1408**. In the present example illustrated in FIG. **14** the baseline is set to **82** for both sensor **1** (positioned on the patient's left forehead) and sensor **2** (positioned on the patient's right forehead). Accordingly the user readily sees differences between the measured regional oximetry and a baseline level. Additionally, the present difference between the measured regional oximetry and the baseline is displayed numerically at well displays **1406**,**1410** next to the Δbase label.

FIG. **15**A illustrates an embodiment of a monitor display **1500**A in which, among other things, the patient's regional-to-central oxygenation saturation measurements, or SpO_2 delta, are presented. In this embodiment a two-sensor window display **1502** is configured to present monitored patient data from the patient's left forehead **1504**, **1506** and from the patient's right forehead **1508**, **1510**. A trend view icon **1512** is selected which, in this example, results in formatting the patient's measured data to be presented graphically with two trend lines: a first line representing measured arterial oxygen saturation **1514** and a second line representing regional oxygen saturation **1516** thereby visually reflecting the difference between the two measurements. In an embodiment the first line **1514** is displayed in a first color, for example, white, and the second line **1516** is displayed in a second color, for example, blue. Accordingly the user readily sees differences between the measured arterial oxygen saturation and the measured regional oxygen saturation and is able to distinguish one measurement form the other. Additionally, the present difference between the measured arterial oxygen saturation and measured regional oxygen saturation is displayed numerically at well displays **1506**,**1510** next to the ΔSpO_2 label.

Advantageously the area **1528** between the first line representing measured arterial oxygen saturation **1514** and the second line representing regional oxygen saturation **1516** is shaded with varying colors to visually indicate the state of the metric, in this case, the patient's regional-to-central oxygenation saturation measurements, or SpO_2 delta. In an

embodiment the area **1528** is shaded with, for example, a green color when no alarm or caution range is met, a yellow color when a caution range is met, and a red color when an alarm limit is met or exceeded, thereby visually alerting the user to circumstances that might require attention or clinical action. As illustrated in FIG. **15**A a portion **1530** of the area **1528** between the first line representing measured arterial oxygen saturation **1514** and the second line representing regional oxygen saturation **1516** for sensor **1** is shaded to indicate that the regional oximetry measurement of the patient's left forehead entered into the caution range.

FIG. **15**B illustrates an embodiment of a monitor display **1500**B configured as the one in FIG. **15**A, however multiple alarms are triggered. These include an alarm that the patient's left forehead regional oxygen saturation is less than 50 percent **1520**, an alarm that the regional-to-central oxygen saturation measurements of the patient's left forehead region differ by 55 percentage points **1522**, and an alarm that the patient's left forehead regional oxygen saturation is 43 percentage points below the patient's baseline **1524**. In an embodiment the alarm conditions are highlighted visually with bold borders that are, for example, bright red in color. Additionally the alarm silence icon **1526** is illuminated in, for example, bright red. The alarm silence icon **1526** is an indicator as well as a functional button. It always indicates the presence (or lack of presence) of alarms, and it can be used to temporarily suspend audible alarms for a predetermined amount of time, known as the silence duration. When the alarm silence icon is illuminated red, it signals that there is currently at least one active alarm that has not been silenced.

As previously described the area **1528** between the first line representing measured arterial oxygen saturation **1514** and the second line representing regional oxygen saturation **1516** is shaded with varying colors to visually indicate the state of the metric, in this case, the patient's regional-to-central oxygenation saturation measurements, or SpO_2 delta. As illustrated in FIG. **15**B a portion **1532** of the area **1528** between the first line representing measured arterial oxygen saturation **1514** and the second line representing regional oxygen saturation **1516** for sensor **1** is shaded to indicate that the regional oximetry measurement of the patient's left forehead entered into the caution range and into the alarm limit range. For easy reference, a dotted line **1534** indicates the alarm limit as set by the user.

A regional oximetry user interface has been disclosed in detail in connection with various embodiments. These embodiments are disclosed by way of examples only and not to limit the scope of the claims that follow. One of ordinary skill in the art will appreciate from the disclosure herein any variations and modifications.

The term "and/or" herein has its broadest least limiting meaning which is the disclosure includes A alone, B alone, both A and B together, or A or B alternatively, but does not require both A and B or require one of A or one of B. As used herein, the phrase "at least one of" A, B, "and" C should be construed to mean a logical A or B or C, using a non-exclusive logical or.

As used herein, the term module may refer to, be part of, or include an Application Specific Integrated Circuit (ASIC); an electronic circuit; a combinational logic circuit; a field programmable gate array (FPGA); a processor (shared, dedicated, or group) that executes code; other suitable components that provide the described functionality; or a combination of some or all of the above, such as in a system-on-chip. The term module may include memory (shared, dedicated, or group) that stores code executed by the processor.

The apparatuses and methods described herein may be implemented by one or more computer programs executed by one or more processors. The computer programs include processor-executable instructions that are stored on a non-transitory tangible computer readable medium. The computer programs may also include stored data. Non-limiting examples of the non-transitory tangible computer readable medium are nonvolatile memory, magnetic storage, and optical storage.

Although the foregoing has been described in terms of certain preferred embodiments, other embodiments will be apparent to those of ordinary skill in the art from the disclosure herein. Additionally, other combinations, omissions, substitutions and modifications will be apparent to the skilled artisan in view of the disclosure herein. Accordingly, the present invention is not intended to be limited by the description of the preferred embodiments, but is to be defined by reference to the claims.

Additionally, all publications, patents, and patent applications mentioned in this specification are herein incorporated by reference to the same extent as if each individual publication, patent, or patent application was specifically and individually indicated to be incorporated by reference.

What is claimed is:

1. A regional oximetry system comprising:

a display; and

at least one processor, the processor causing a plurality of views to be displayed on the display, each view configured to occupy at least a portion of the display, each of the views adapted to present data responsive to at least one physiological signal;

a first sensor port configured to receive at least a first physiological signal representative of a regional tissue oxygenation level;

a second sensor port configured to receive at least a second physiological signal representative of an arterial oxygen saturation level;

wherein a first view presents a first trend graph of the first physiological signal and a second trend graph of the second physiological signal, and wherein the first trend graph and the second trend graph are aligned such that an area between the first trend graph and the second trend graph is representative of a differential analysis of regional-to-central oxygen saturation,

wherein the processor determines a numerical representation of a currently-measured differential analysis of regional-to-central oxygen saturation, and wherein a second view presents the numerical representation of the currently-measured differential analysis of regional-to-central oxygen saturation.

2. The regional oximetry system according to claim **1** wherein the first trend graph is presented in a first color and the second trend graph is presented in a second color.

3. The regional oximetry system according to claim **1** wherein the display presents both the first view and the second view at the same time.

4. The regional oximetry system according to claim **1** wherein the processor determines whether a regional-to-central saturation measurement is within an acceptable range, a caution range, or an alarm range, and wherein the area between the first trend graph and the second trend graph is shaded a first color when the regional-to-central oxygen saturation measurement is within the acceptable range, a second color when the regional-to-central oxygen saturation

measurement is within the caution range, and a third color when the regional-to-central oxygen saturation measurement is in the alarm range.

5. The regional oximetry system according to claim **4** wherein the first color is a shade of green, the second color is a shade of yellow, and the third color is a shade of red.

6. The regional oximetry system according to claim **4** wherein the acceptable range, caution range, and alarm range are configurable.

7. The regional oximetry system according to claim **1** wherein the first view presents an alarm limit line.

8. The regional oximetry system according to claim **1** further comprising a sensor module, and wherein the first physiological signal and the second physiological signal are provided from the sensor module.

9. The regional oximetry system according to claim **1** further comprising a first sensor module and a second sensor module, and wherein the first physiological signal is provided from the first sensor module and the second physiological signal is provided from the second sensor module.

10. A regional oximetry user interface method comprising:

obtaining a first waveform responsive to a physiological signal representative of a regional tissue oxygenation level;

obtaining a second waveform responsive to a physiological signal representative of an arterial oxygen saturation level;

determining, using at least one processor, a data trend responsive to the first physiological signal;

determining, using the at least one processor, a data trend responsive to the second physiological signal;

determining, using the at least one processor, a difference between the data trend responsive to the first physiological signal and the data trend responsive to the second physiological signal;

presenting, in a first display view, the determined data trends responsive to the first and second physiological signals; and

presenting, in a second display view, the determined difference between the data trend responsive to the first and second physiological signals.

11. The regional oximetry user interface method according to claim **10** further comprising determining whether the difference between the data trend responsive to the first and second physiological signals is in an acceptable range, in a caution range, or in an alarm range.

12. The regional oximetry user interface method according to claim **11** further comprising shading with at least one color, in the first display view, an area between the data trends responsive to the first and second physiological signals, wherein the at least one color of the shading is determined by the determined range in which the difference between the data trend responsive to the first and second physiological signals is located.

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[标]申请(专利权)人(译)	梅西莫股份有限公司		
申请(专利权)人(译)	Masimo公司		
当前申请(专利权)人(译)	Masimo公司		
[标]发明人	AL ALI AMMAR INDORF KEITH WARD KASHIF FAISAL		
发明人	AL-ALI, AMMAR INDORF, KEITH WARD KASHIF, FAISAL		
IPC分类号	A61B5/1455 A61B5/145 A61B5/00 H01R13/52		
CPC分类号	A61B5/14542 A61B5/14552 A61B5/14553 A61B5/6833 A61B5/7275 A61B5/742 A61B5/746 A61B5/1455 H01R2201/12 A61B5/14551 A61B5/14557 A61B2562/22 A61B2562/222 A61B2562/225 A61B2562/227 A61B2562/228 H01R13/5224		
优先权	62/012170 2014-06-13 US 61/887878 2013-10-07 US 61/887856 2013-10-07 US 61/887883 2013-10-07 US		
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摘要(译)

区域血氧测定系统具有显示器和至少一个处理器，使得多个视图显示在显示器上，每个视图被配置为占据显示器的至少一部分。视图适于响应于至少一个生理信号呈现数据。第一传感器端口被配置为接收表示区域组织氧合水平的至少第一生理信号，并且第二传感器端口被配置为接收表示动脉氧饱和度水平的至少第二生理信号。一个视图呈现第一生理信号的第一趋势图和第二生理信号的第二趋势图。第一趋势图和第二趋势图之间的区域可以包括区域到中心氧饱和度的差异分析。