Appendices

Modular Requirements

::GPS::	
Requirement	Verification
1.1 Must receive coordinates from global positioning satellites.	1.1 We will first test the GPS on the breadboard observing the output on the oscilloscope. Using the NMEA-0183 serial protocol and a website such as Google Maps for reference, we will cross check that the coordinates received from the Venus and observed on the Oscilloscope coincide with the results from Google Maps.
1.2 Must update coordinates with movement.	1.2 As our collar will not be mobile at this point in time, we will need a very long extension cable. For this verification we will have had to have set up the communication between the microcontroller and the GPS unit. A small subroutine will be written for the microcontroller that strictly stores the current GPS coordinates received in to the EEPROM as they change from location to location. Using the long extension cable we will walk down the hallways of Everitt as the microcontroller should be storing the updated coordinates.
1.3 Must be accurate enough for reasonable boundary detection.	1.3 By now the rig should be mobile and attachable to a pet's collar, Using the same code subroutine as in 1.2 we will test the GPS's ability to update coordinates and its accuracy in between coordinate updates.

	While the GPS is rated at 2.5m accuracy, we will measure the exact accuracy for determining a proper refresh rate as outlined in the Calculations section. We will need to determine the significant figures for exact accuracy of the GPS coordinates.
::Transceiver::	
Requirement	Verification
2.1 Must communicate with the same model of transceiver. 2.2 Must transmit only enough power to be received within a small radius similar to the interaction of pets.	2.1 We will set up both transceivers on the breadboard each properly grounded and powered at 5V with a signal generator attached to the input of one and an oscilloscope attached to the output of the other. Using a 2.785 GHz (our selected frequency of operation so as not to coincide with other bandwidths) square wave at the input and observing the output at the oscilloscope connected to the out of the second transceiver. 2.2 This will take rigorous trial and error of various transmit and supply powers to each of the transceivers so that they barely sense each other at roughly 1'6" apart. After ensuring 2.1, we will set up the transceivers roughly a foot and a half apart and reduce the output of the first transceiver until it is not detected by the second transceiver. This will dictate the power output threshold needed to achieve short range communication.
::Microcontroller::	
Requirement	Verification

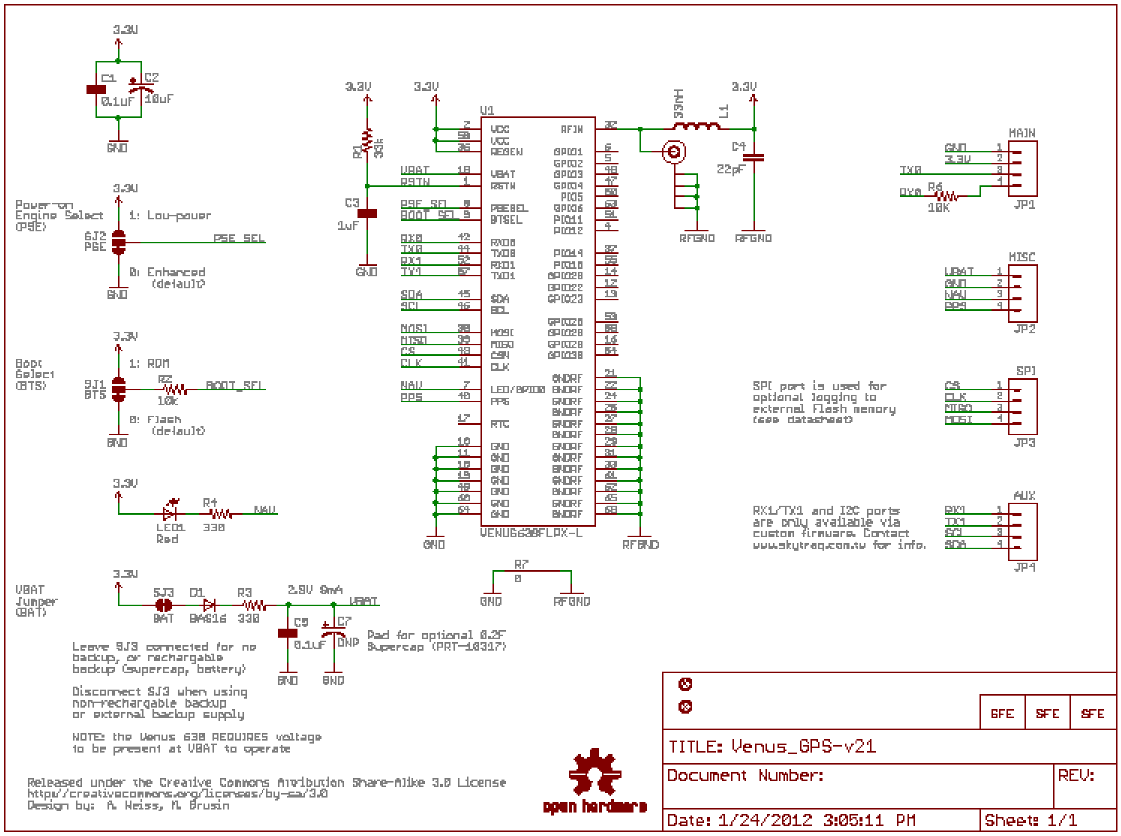
3.1 Must be reprogrammable onboard.	3.1 A code subroutine will be written that can increment the contents of a specific location in EEPROM. This can simply be tested by making a push button command subroutine that will increment a counter in EEPROM. The results will be observed by connecting the microcontroller to the computer via USB and checking the contents of EEPROM.
3.2 Must accept and receive all proper I/O from other components. - 3.2(a) GPS	3.2(a) Using the same subroutine programmed for 1.2, this will be the portion where we see if the actual coordinates are written in to the EEPROM. We will walk around with our semi-mobile rig and examine the contents to see if they update with new coordinates.
- 3.2(b) Transceiver	3.2(b) Using a similar technique as in 2.1 except now with the addition of the microcontroller. Replacing the oscilloscope from 2.1 with the microcontroller and observing the input via the USB connection ensures proper output from the transceiver. Replacing the signal generator with a pre-specified square wave as programmed onto the microcontroller with insure proper input into the transceiver.
- 3.2(c) Buttons & Switches	3.2(c) First proceed with 4.1 to make sure that all of the switches are in physical working order. Using the same code subroutine as in 3.1, implement each button and switch individually as a means of incrementing a counter in the EEPROM. Try

	each button with its respectively assigned I/O port on the microcontroller and change the subroutine accordingly.
- 3.2(d) Power	3.2(d) This should be easily testable as the microcontroller specifications list specific power supply values for microcontroller operation. Simply set up accordingly and see if the microcontroller turns on using the preprogrammed LED confirmation included with the Arduino programming when the microcontroller is booted for the first time.
::Physical Interface::	
Requirement	Verification
4.1 Physical switches must properly relay decision choices to microcontroller in a reliable and predictable fashion.	4.1 Simple breadboard checking of proper connections between DC sources at the input of the switches and multimeters at the output. All of the switches function by making a physical connection in place of a short and are therefore easily tested with the breadboard.
4.2 Must be configurable in such a way as to be aesthetically reasonable to a customer and configurable on a PCB.	4.2 This will require EAGLE testing to see how compact we can fit the switches without interfering with necessary space for the GPS, transceiver, and microcontroller portions. Aesthetics will suffer for the sake of functionality.
::Virtual Interface::	
Requirement	Verification
5.1 Must properly communicate decisions through the USB driver to the microcontroller.	5.1 Simple testing to see if input on virtual interface can store values in the EEPROM of the microcontroller. This will require

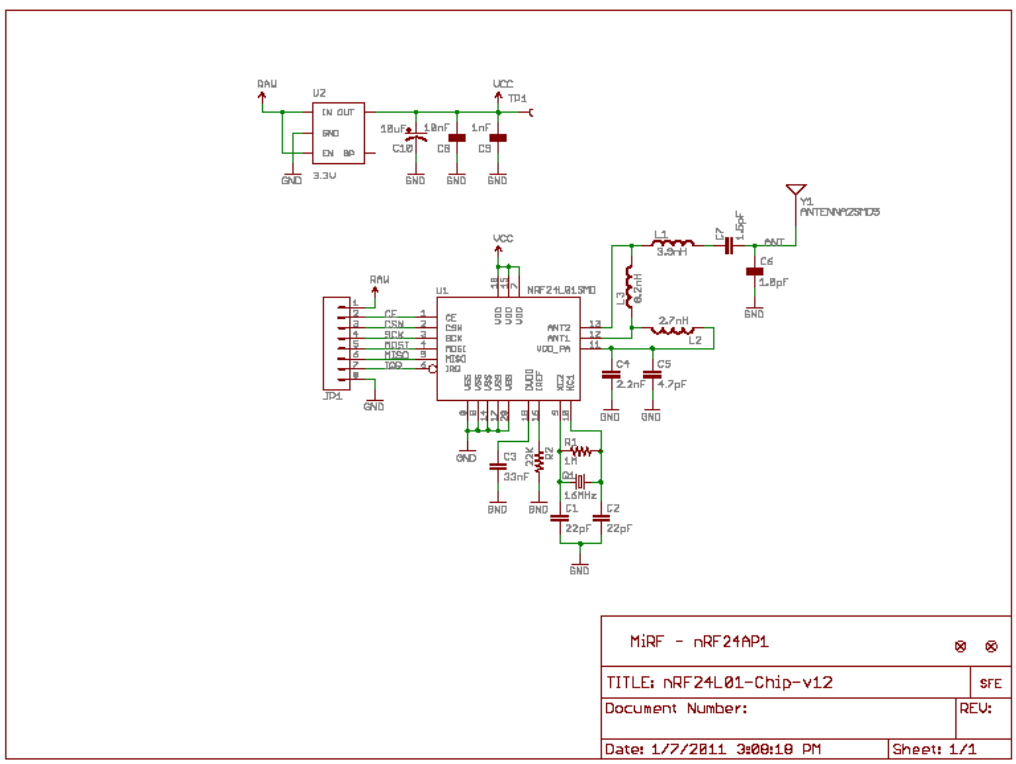
	verification from the virtual interface running in parallel with the Arduino programming interface. A change in the virtual interface should reflect changes in the EEPROM as viewed from the Arduino interface.
5.2 Must be user-friendly.	5.2 This will require the help of outside criticism to aid us in deciding, by popular poll, whether some features are too complicated or simple for the pet-owner's needs. The virtual user interface will be designed and programmed, test-users will evaluate its functionality and ease-of-use, and we will reprogram as necessary.
::Power::	
Requirement	Verification
6.1 Must properly supply power to all components in need.	6.1 Virtual simulations point out that we should be fine in terms of power, but if not, then we will simply get a larger, more expensive power source. Testing will consist of replacing the breadboard-supplied power with our simple AAA battery holder and observing the results. As needed, various multimeter readings will help determine any source of over-usage of power. The power values supplied in the power allocation table are when the components are pushed to the extreme. As is the case with the transceivers, we will not be running our components at anywhere near maximum capacity (except maybe the LEDs for maximum visibility).

Parts Schematics

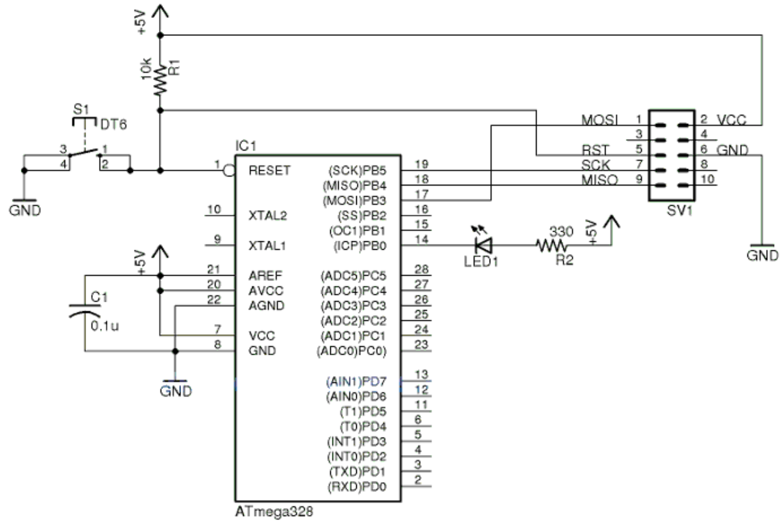
GPS

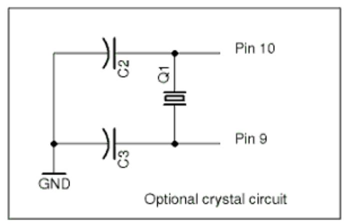


Transceiver



Microcontroller





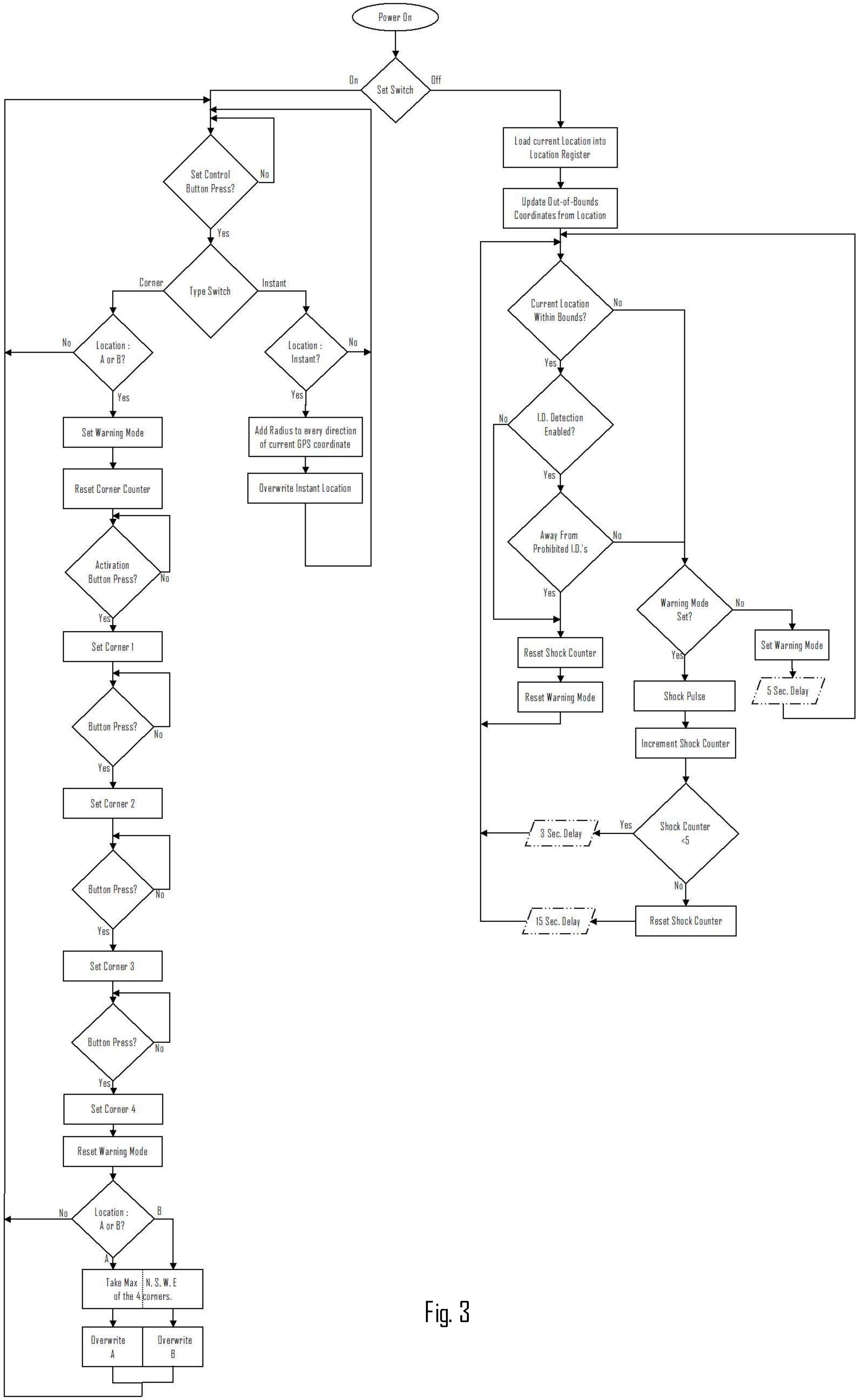

Power On
Set Switch
On
Off
Set Control Button Press?
No
Yes
Type Switch
Corner
Instant
Location : A or B?
No
Yes
Location : Instant?
No
Yes
Set Warning Mode
Add Radius to every direction of current GPS coordinate
Reset Corner Counter
Overwrite Instant Location
Activation Button Press?
No
Yes
Set Corner 1
Button Press?
No
Yes
Set Corner 2
Button Press?
No
Yes
Set Corner 3
Button Press?
No
Yes
Set Corner 4
Reset Warning Mode
Location : A or B?
No
B
A
Take Max of the 4
N, S, W, E corners.
Overwrite A
Overwrite B
Load current Location into Location Register
Update Out-of-Bounds Coordinates from Location
Current Location Within Bounds?
No
Yes
I.D. Detection Enabled?
No
Yes
Away From Prohibited I.D.'s
No
Yes
Warning Mode Set?
No
Yes
Set Warning Mode
5 Sec. Delay
Reset Shock Counter
Reset Warning Mode
Shock Pulse
Increment Shock Counter
Shock Counter <5
Yes
No
3 Sec. Delay
15 Sec. Delay
Reset Shock Counter

Fig. 3

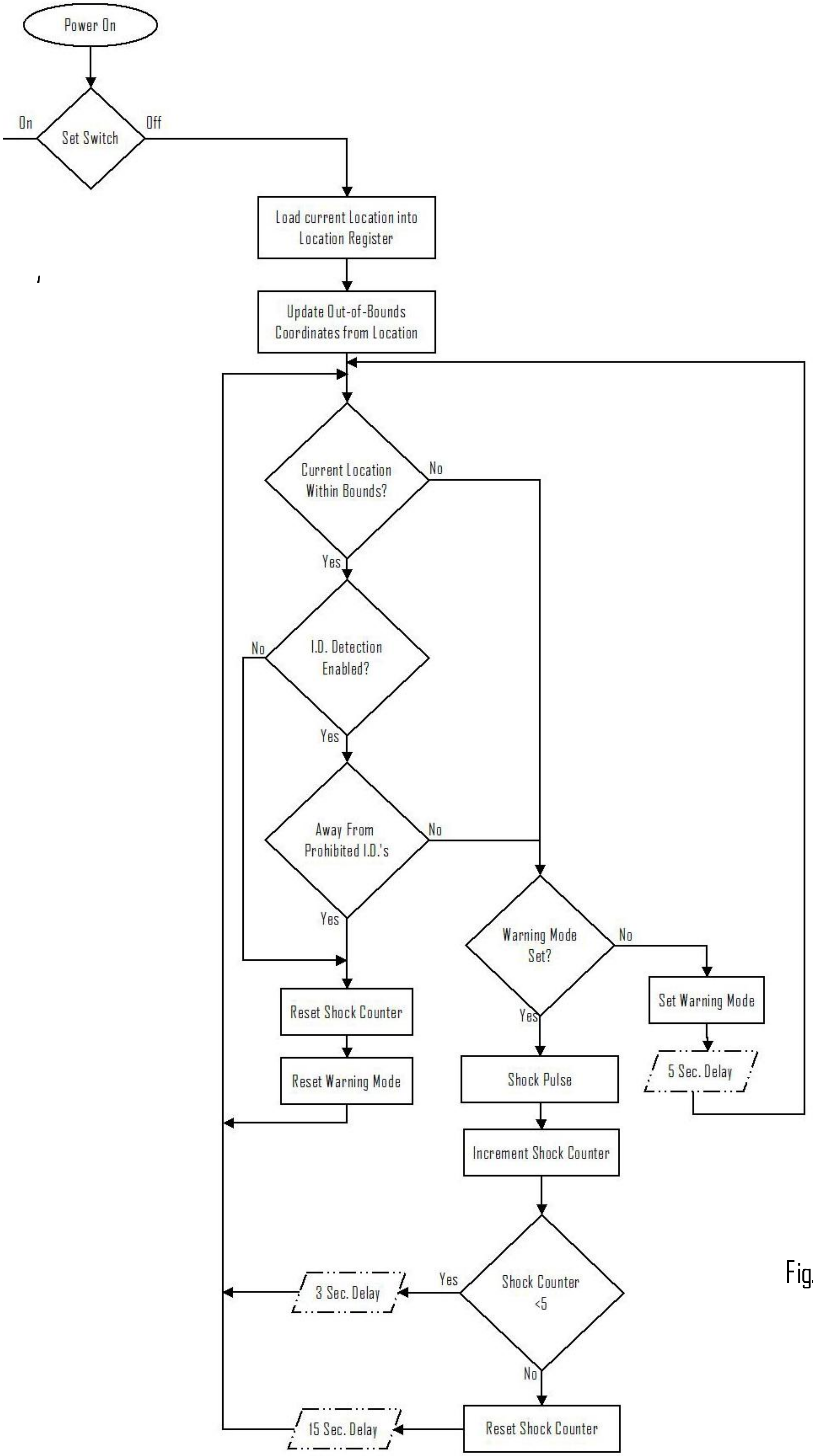
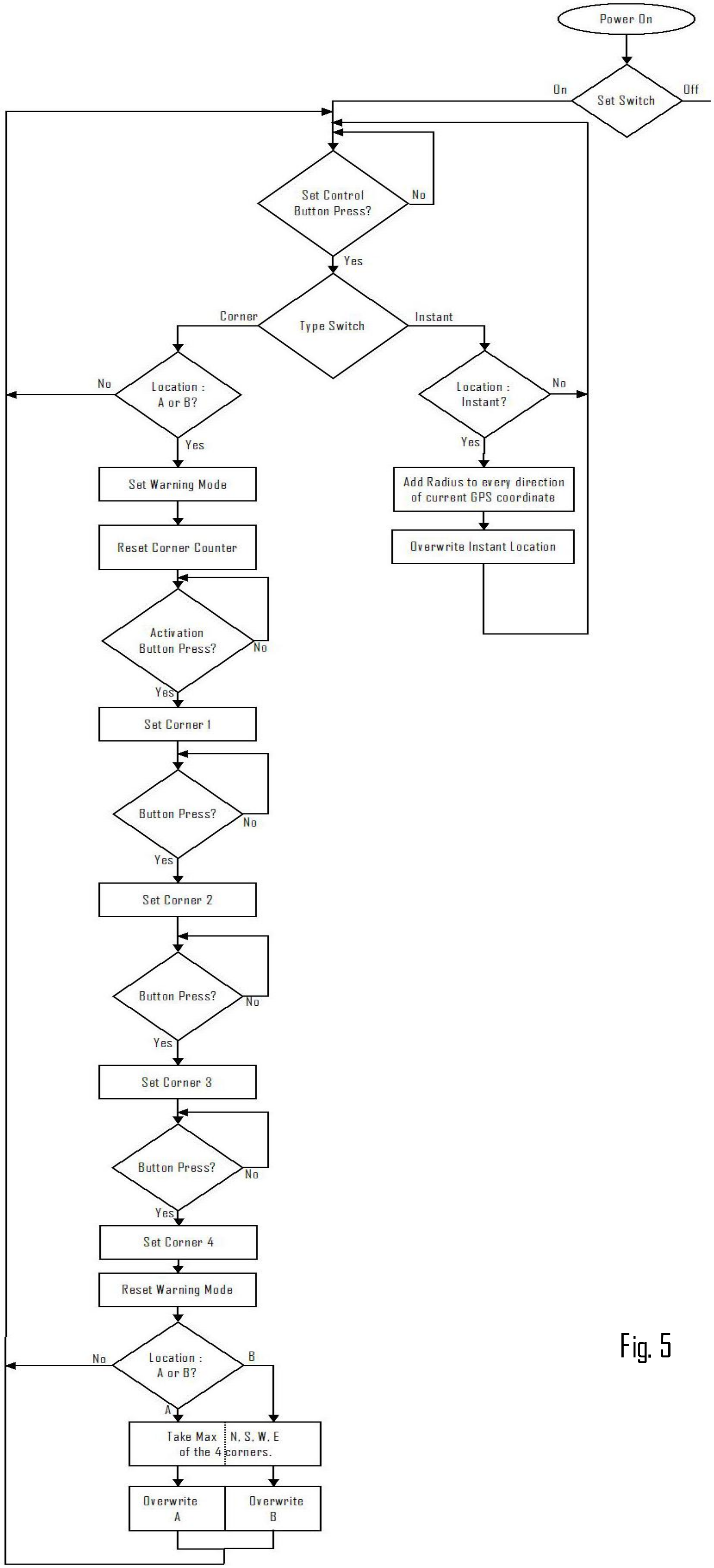

Power On
Set Switch
On
Off
Load current Location into Location Register
Update Out-of-Bounds Coordinates from Location
Current Location Within Bounds?
No
Yes
I.D. Detection Enabled?
No
Yes
Away From Prohibited I.D.'s
No
Yes
Reset Shock Counter
Reset Warning Mode
Warning Mode Set?
No
Yes
Set Warning Mode
5 Sec. Delay
Shock Pulse
Increment Shock Counter
Shock Counter <5
Yes
No
3 Sec. Delay
Reset Shock Counter
15 Sec. Delay

Fig. 4


Power On
Set Switch
On
Off
Set Control Button Press?
No
Yes
Type Switch
Corner
Instant
Location : A or B?
No
Yes
Location : Instant?
No
Yes
Set Warning Mode
Add Radius to every direction of current GPS coordinate
Reset Corner Counter
Overwrite Instant Location
Activation Button Press?
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Yes
Set Corner 1
Button Press?
No
Yes
Set Corner 2
Button Press?
No
Yes
Set Corner 3
Button Press?
No
Yes
Set Corner 4
Reset Warning Mode
Location : A or B?
No
B
A
Take Max of the 4
N, S, W, E corners.
Overwrite A
Overwrite B

Fig. 5

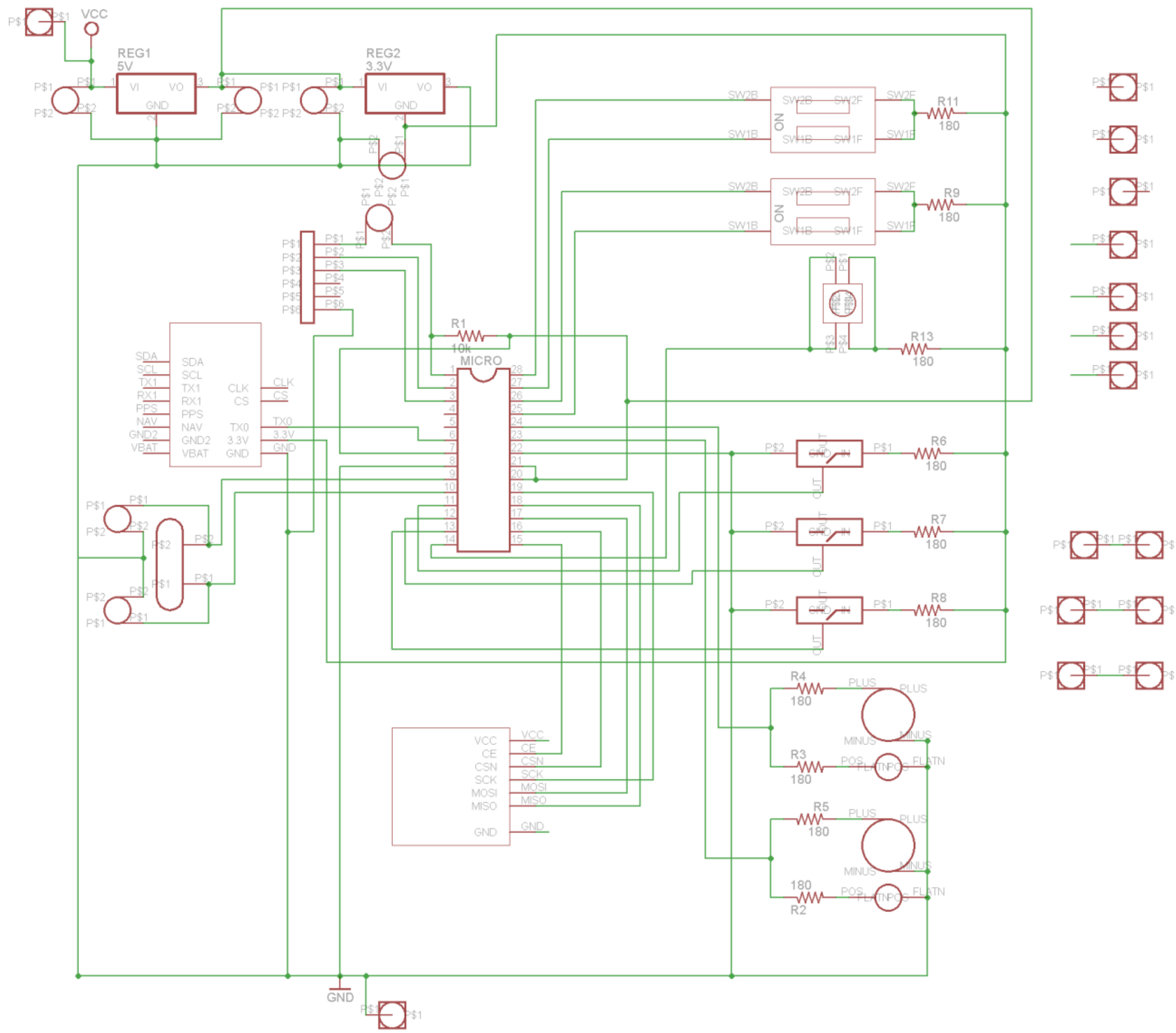
VCC
REG1
5V
REG2
3.3V
R1
10k
MICRO
R11
180
R9
180
R13
180
R6
180
R7
180
R8
180
R4
180
R3
180
R5
180
R2
180
VCC
CE
CSN
SCK
MOSI
MISO
GND
SDA
SCL
TX1
RX1
PPS
NAV
GND2
VBAT
CLK
CS
TX0
3.3V
GND

Fig. 6

Sats	HDOP	Latitude (deg)	Longitude (deg)	Fix Age	Date	Time	Date Age	Alt (m)	Course ---	Speed from	Card GPS ----	Distance ----	Course to London	Card ----	Chars RX	Sentences RX	Checksum Fail
9	90	40.11150	-88.22724	123	12/04/2012	12:30:38	141	218.10	241.00	0.00	WSW	6524	46.74	NE	518	2	1
9	80	40.11150	-88.22724	202	12/04/2012	12:30:39	221	218.10	241.00	0.00	WSW	6524	46.74	NE	973	4	1
10	80	40.11150	-88.22724	267	12/04/2012	12:30:40	285	218.10	241.00	0.00	WSW	6524	46.74	NE	1430	6	1
9	80	40.11150	-88.22724	352	12/04/2012	12:30:41	369	218.10	241.00	0.00	WSW	6524	46.74	NE	1885	8	1
10	80	40.11150	-88.22724	402	12/04/2012	12:30:42	420	218.10	241.00	0.00	WSW	6524	46.74	NE	2342	10	1
10	80	40.11150	-88.22724	479	12/04/2012	12:30:43	498	218.10	241.00	0.00	WSW	6524	46.74	NE	2799	12	1
10	80	40.11150	-88.22724	575	12/04/2012	12:30:44	616	218.10	241.00	0.00	WSW	6524	46.74	NE	3361	15	1
10	80	40.11152	-88.22731	84	12/04/2012	12:30:46	120	217.20	241.00	0.00	WSW	6524	46.74	NE	3903	17	1
10	80	40.11151	-88.22731	189	12/04/2012	12:30:47	226	217.10	242.20	2.04	WSW	6524	46.74	NE	4453	19	1
10	80	40.11151	-88.22731	303	12/04/2012	12:30:48	338	217.10	240.90	2.59	WSW	6524	46.74	NE	5012	21	1
10	80	40.11151	-88.22731	422	12/04/2012	12:30:49	62	217.00	248.40	2.78	WSW	6524	46.74	NE	5541	24	1
10	80	40.11151	-88.22731	89	12/04/2012	12:30:50	110	217.00	245.50	2.78	WSW	6524	46.74	NE	5998	26	1
10	80	40.11151	-88.22731	163	12/04/2012	12:30:51	181	217.00	245.60	2.78	WSW	6524	46.74	NE	6455	28	1
9	90	40.11151	-88.22731	258	12/04/2012	12:30:52	275	216.90	246.90	2.96	WSW	6524	46.74	NE	6910	30	1
10	80	40.11151	-88.22731	312	12/04/2012	12:30:53	330	217.00	217.70	2.59	SW	6524	46.74	NE	7367	32	1
10	80	40.11150	-88.22731	391	12/04/2012	12:30:54	409	217.20	228.80	2.41	SW	6524	46.74	NE	7824	34	1
10	80	40.11150	-88.22732	453	12/04/2012	12:30:55	471	217.40	242.90	2.78	WSW	6524	46.74	NE	8281	36	1
9	90	40.11149	-88.22734	544	12/04/2012	12:30:56	562	217.70	226.10	2.04	SW	6524	46.74	NE	8771	38	1
10	80	40.11149	-88.22734	619	12/04/2012	12:30:57	663	218.10	243.70	2.59	WSW	6524	46.74	NE	9324	41	1
10	80	40.11148	-88.22735	129	12/04/2012	12:30:59	167	219.10	222.70	2.04	SW	6524	46.74	NE	9881	43	1
10	80	40.11148	-88.22737	237	12/04/2012	12:31:00	273	219.70	234.50	2.41	SW	6524	46.74	NE	10432	45	1
10	80	40.11148	-88.22737	362	12/04/2012	12:31:01	400	220.20	241.90	2.22	WSW	6524	46.74	NE	11006	48	1
10	80	40.11148	-88.22737	67	12/04/2012	12:31:02	104	220.80	239.00	2.22	WSW	6524	46.74	NE	11478	50	1
10	80	40.11147	-88.22738	150	12/04/2012	12:31:03	167	221.70	233.80	2.22	SW	6524	46.74	NE	11935	52	1
10	80	40.11147	-88.22738	220	12/04/2012	12:31:04	238	222.60	229.40	2.59	SW	6524	46.74	NE	12392	54	1
10	80	40.11147	-88.22739	296	12/04/2012	12:31:05	314	223.80	243.30	2.22	WSW	6524	46.74	NE	12849	56	1
10	80	40.11146	-88.22740	366	12/04/2012	12:31:06	385	224.80	249.20	2.41	WSW	6524	46.74	NE	13306	58	1
10	80	40.11146	-88.22741	441	12/04/2012	12:31:07	458	225.50	255.10	3.15	WSW	6524	46.74	NE	13763	60	1
10	80	40.11146	-88.22743	514	12/04/2012	12:31:08	533	226.50	252.30	2.78	WSW	6524	46.74	NE	14221	62	1
10	80	40.11145	-88.22744	600	12/04/2012	12:31:09	646	227.50	246.40	2.41	WSW	6524	46.74	NE	14797	65	1
10	80	40.11145	-88.22747	117	12/04/2012	12:31:11	154	229.60	250.90	2.96	WSW	6524	46.74	NE	15354	67	1
10	80	40.11144	-88.22748	225	12/04/2012	12:31:12	261	230.70	253.80	3.15	WSW	6524	46.74	NE	15905	69	1
10	80	40.11144	-88.22750	333	12/04/2012	12:31:13	368	231.60	259.30	3.15	W	6524	46.74	NE	16463	71	1
10	80	40.11144	-88.22750	49	12/04/2012	12:31:14	88	232.50	224.50	2.04	SW	6524	46.74	NE	16962	74	1
10	80	40.11144	-88.22751	122	12/04/2012	12:31:15	140	233.20	228.10	3.15	SW	6524	46.74	NE	17419	76	1
10	80	40.11144	-88.22751	202	12/04/2012	12:31:16	220	233.80	228.10	0.00	SW	6524	46.74	NE	17876	78	1
10	80	40.11144	-88.22751	273	12/04/2012	12:31:17	292	234.30	228.10	0.00	SW	6524	46.74	NE	18333	80	1
10	80	40.11143	-88.22753	343	12/04/2012	12:31:18	361	234.50	230.10	2.22	SW	6524	46.74	NE	18790	82	1
10	80	40.11142	-88.22753	420	12/04/2012	12:31:19	438	234.50	220.20	2.78	SW	6524	46.74	NE	19247	84	1
10	80	40.11141	-88.22753	494	12/04/2012	12:31:20	512	234.50	231.10	3.33	SW	6524	46.74	NE	19704	86	1
10	80	40.11141	-88.22753	569	12/04/2012	12:31:21	591	234.30	223.00	2.96	SW	6524	46.74	NE	20238	89	1
10	80	40.11140	-88.22754	76	12/04/2012	12:31:23	113	233.80	209.20	2.78	SSW	6524	46.74	NE	20802	91	1
10	80	40.11139	-88.22755	181	12/04/2012	12:31:24	217	233.60	192.20	3.33	SSW	6524	46.74	NE	21350	93	1
10	80	40.11137	-88.22755	294	12/04/2012	12:31:25	331	233.50	190.40	3.70	S	6524	46.74	NE	21906	95	1
10	80	40.11136	-88.22756	403	12/04/2012	12:31:26	441	233.10	186.30	3.15	S	6524	46.74	NE	22446	98	1
10	80	40.11135	-88.22757	101	12/04/2012	12:31:27	118	232.80	186.30	3.33	S	6524	46.74	NE	22903	100	1
10	80	40.11134	-88.22757	175	12/04/2012	12:31:28	193	232.60	178.40	3.89	S	6524	46.74	NE	23360	102	1
10	80	40.11133	-88.22758	246	12/04/2012	12:31:29	265	232.50	184.10	3.33	S	6524	46.74	NE	23817	104	1
10	80	40.11132	-88.22760	318	12/04/2012	12:31:30	336	232.20	193.60	3.15	SSW	6524	46.74	NE	24274	106	1

Fig. 7