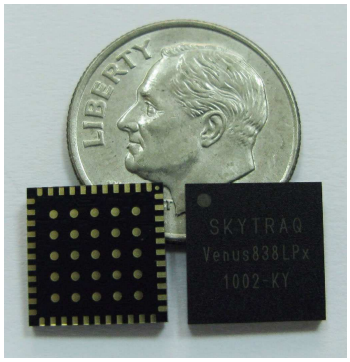
Venus838LPx GPS Module

Data Sheet



10mmx 10mm

Venus838LPx-L / Venus838LPx-D

FEATURES

- 40Hz maximum update rate
- -148dBm cold start sensitivity
- -165dBm tracking sensitivity
- 29 second cold start TTFF
- 3.5 second TTFF with AGPS
- 1 second hot start
- 2.5m accuracy
- Multipath detection and suppression
- Jamming detection and mitigation
- QZSS and SBAS support
- 7-day extended ephemeris AGPS
- 60mW full power navigation
- Works directly with active or passive antenna
- Complete receiver in 10mm x 10mm x 1.3mm size
- Contains LNA, SAW Filter, TCXO, RTC Xtal, LDO
- Requires only antenna and power to work
- Pb-free RoHS compliant

The Venus838LPx is a high performance, low cost, single chip GPS module targeting camera, handset, MID, gaming, fitness, and asset tracking applications. It offers very low power consumption, high sensitivity, and best in class signal acquisition and time-to-first-fix performance.

Venus838LPx contains all the necessary components of a complete GPS receiver, includes GPS RF front-end, GPS baseband signal processor, 0.5ppm TCXO, 32.768kHz RTC crystal, RTC LDO regulator, and passive components. It takes up only 100mm^2 PCB footprint.

Dedicated massive-correlator signal parameter search engine within the baseband enables rapid search of all the available satellites and acquisition of very weak signal. An advanced track engine allows weak signal tracking and positioning in harsh environments such as urban canyons and under deep foliage.

Venus838LPx is very easy to use, minimizes RF layout design issues and offers very fast time to market.

Product Series	**Product Description**
Venus838LPx-L	ROM version GPS receiver module (internal 1.2V LDO version) Suitable for lower cost application using internal 1.2V LDO regulator
Venus838LPx-D	ROM version GPS receiver module (external 1.2V version) Suitable for lower power application using external 1.2V supply

TECHNICAL SPECIFICATIONS

Receiver Type	L1 C/A Code GPS, QZSS, SBAS 167 Channel Venus 8 Engine
Accuracy	Position 2.5m CEP Velocity 0.1m/sec Timing 10ns
Open Sky TTFF	Hot start 1 second Cold start 29 seconds average
Reacquisition	< 1s
Sensitivity	Tracking -165dBm Cold start -148dBm
Update Rate	1 / 2 / 4 / 5 / 8 / 10 / 20 / 40 Hz (default 1Hz)
Dynamics	4G
Operational Limits	Altitude < 18,000m[*1], Velocity < 515m/s[*1]
Datum	Default WGS-84
Interface	UART LVTTL level
Baud Rate	4800 / 9600 / 38400 / 115200
Protocol	NMEA-0183 V3.01, GGA, GLL, GSA, GSV, RMC, VTG, ZDA SkyTraq Binary
Main Supply Voltage	2.8V ~ 3.6V (Venus838LPx-L) 2.8V ~ 3.6V, 1.08V ~ 1.32V (Venus838LPx-D)
Backup Voltage	2.5V ~ 3.6V

Current Consumption

	Enhanced Acquisition	Low Power Acquisition	Tracking
Venus838LPx-L	45mA @ 3.3V	30mA @ 3.3V	27mA @ 3.3V
Venus838LPx-D	15mA @ 3.3V 30mA @ 1.2V	15mA @ 3.3V 18mA @ 1.2V	15mA @ 3.3V 12mA @ 1.2V

Assuming 90% efficiency switch-mode 3.3V-to-1.2V regulator is used, then

	Enhanced Acquisition	Low Power Acquisition	Tracking
Venus838LPx-D	27mA @ 3.3V	22mA @ 3.3V	20mA @ 3.3V

Operating Temperature	-40 ~ +85 deg-C
Storage Temperature	-40 ~ +125 deg-C
Package	LGA69 10mm x 10mm x 1.3mm, 0.8mm pitch

*1: Either must not be exceeded

BLOCK DIAGRAM

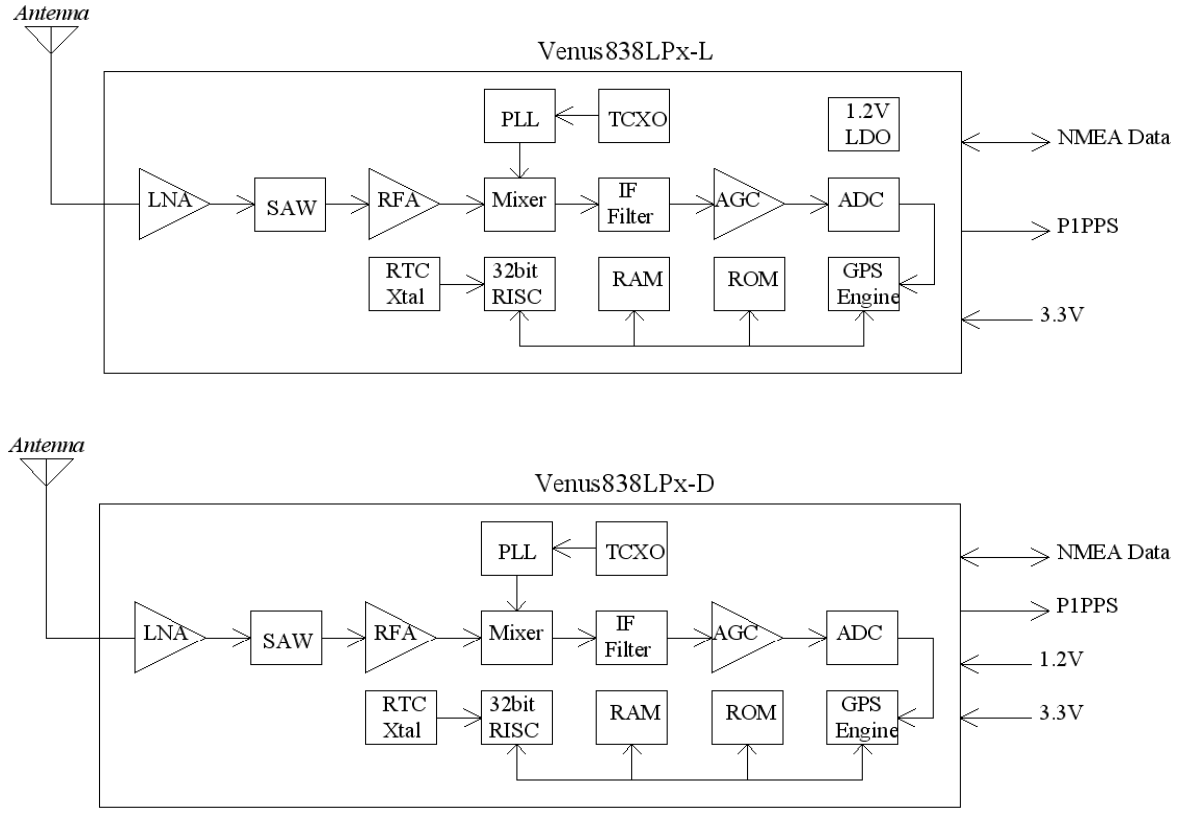


Figure-1 GPS Receiver based on Venus838LPx

Venus838LPx PIN-OUT DIAGRAM

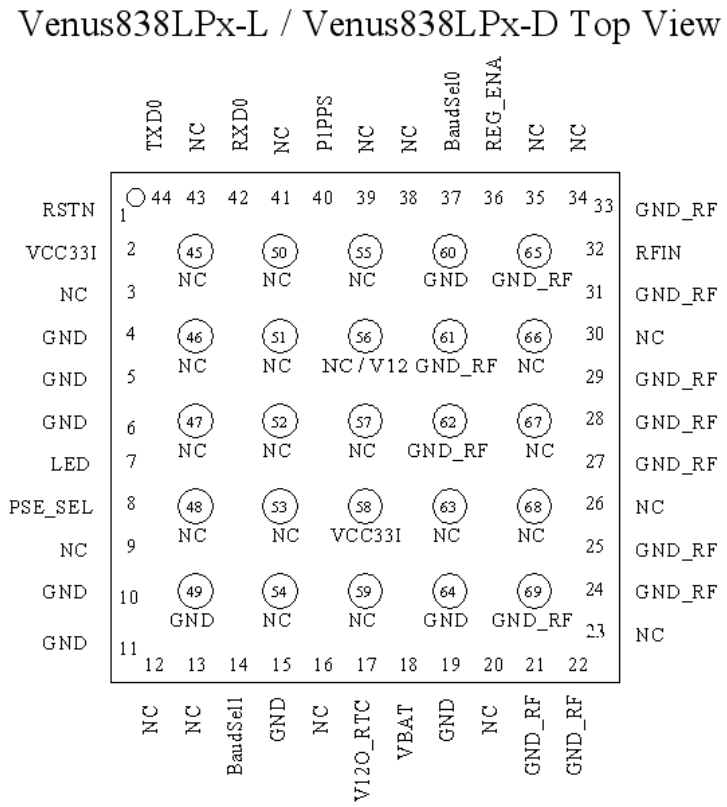


Figure-2a Venus838LPx Pin-Out Diagram

Venus838LPx PIN DEFINITION

Pin Number	Signal Name	Type	Description
1	RSTN	Input	Active LOW reset input. 3.3V LVTTL
2	VCC33I	Power Input	Main voltage supply input, 2.8V ~ 3.6V
3	NC		Not connected, empty pin
4	GND	Power	System ground
5	GND	Power	System ground
6	GND	Power	System ground
7	LED	Output	Navigation status indicator.
8	PSE_SEL	Input	Search engine mode selection. 3.3V LVTTL 1: low power mode 0: enhanced acquisition mode
9	NC		Not connected, empty pin
10	GND	Power	System ground
11	GND	Power	System ground
12	NC		Not connected, empty pin
13	NC		Not connected, empty pin
14	BAUDSEL1	Input	Hardware baud rate selection, used with BaudSel0. 3.3V LVTTL BaudSel[1:0] = 00 for 9600 baud, 01 for 4800 baud, 10 for 38400 baud, 11 for 115200 baud
15	GND	Power	System ground
16	NC		Not connected, empty pin
17	V12O_RTC	Power Output	1.2V LDO output for RTC & backup memory. Normally unused.
18	VBAT	Power Input	Supply voltage for internal RTC and backup SRAM, 2.5V ~ 3.6V. VBAT should be powered by non-volatile supply voltage to have optimal performance. Maximum VBAT current draw when VCC33I is removed is 35uA. If VBAT is connected to VCC33I, powered off as VCC33I power is removed, then it'll cold start

			every time. For applications that do not care lesser performance cold starting every time, this pin can be connected to VCC33I.
19	GND	Power	System ground
20	NC		Not connected, empty pin
21	GND_RF	Power	RF section system ground
22	GND_RF	Power	RF section system ground
23	NC		Not connected, empty pin
24	GND_RF	Power	RF section system ground
25	GND_RF	Power	RF section system ground
26	NC		Not connected, empty pin
27	GND_RF	Power	RF section system ground
28	GND_RF	Power	RF section system ground
29	GND_RF	Power	RF section system ground
30	NC		Not connected, empty pin
31	GND_RF	Power	RF section system ground
32	RFIN	Input	GPS signal input, connect to GPS antenna.
33	GND_RF	Power	RF section system ground
34	NC		Not connected, empty pin
35	NC		Not connected, empty pin
36	REG_ENA	Input	Tie to pin-2 VCC33I
37	BAUDSEL0	Input	Hardware baud rate selection. See BaudSel1. 3.3V LVTTL
38	NC		Not connected
39	NC		Not connected
40	P1PPS	Output	1 pulse per second output. Active after position fix; goes HIGH for about 4msec. 3.3V LVTTL
41	NC		Not connected, empty pin
42	RXD0	Input	Received input of the asynchronous UART port. Used to input binary command to the GPS receiver. 3.3V LVTTL
43	NC		Not connected, empty pin
44	TXD0	Output	Transmit output of the asynchronous UART port. Used to output standard NMEA-0183 sentence or response to input binary command. 3.3V LVTTL
45	NC		Not connected, empty pin
46	NC		Not connected, empty pin
47	NC		Not connected, empty pin
48	NC		Not connected, empty pin
49	GND		System ground
50	NC		Not connected, empty pin
51	NC		Not connected, empty pin
52	NC		Not connected, empty pin
53	NC		Not connected, empty pin
54	NC		Not connected, empty pin
55	NC		Not connected, empty pin
56	NC / V12		NC pin for Venus838LPx-L 1.2V supply input pin for Venus838LPx-D
57	NC		Not connected, empty pin
58	VCC33I	Power Input	Main voltage supply input, 2.8V ~ 3.6V
59	NC		Not connected, empty pin
60	GND	Power	System ground
61	GND_RF	Power	RF section system ground
62	GND_RF	Power	RF section system ground
63	NC		Not connected, empty pin
64	GND	Power	System ground
65	GND_RF	Power	RF section system ground
66	NC		
67	NC		
68	NC		
69	GND_RF	Power	RF section system ground

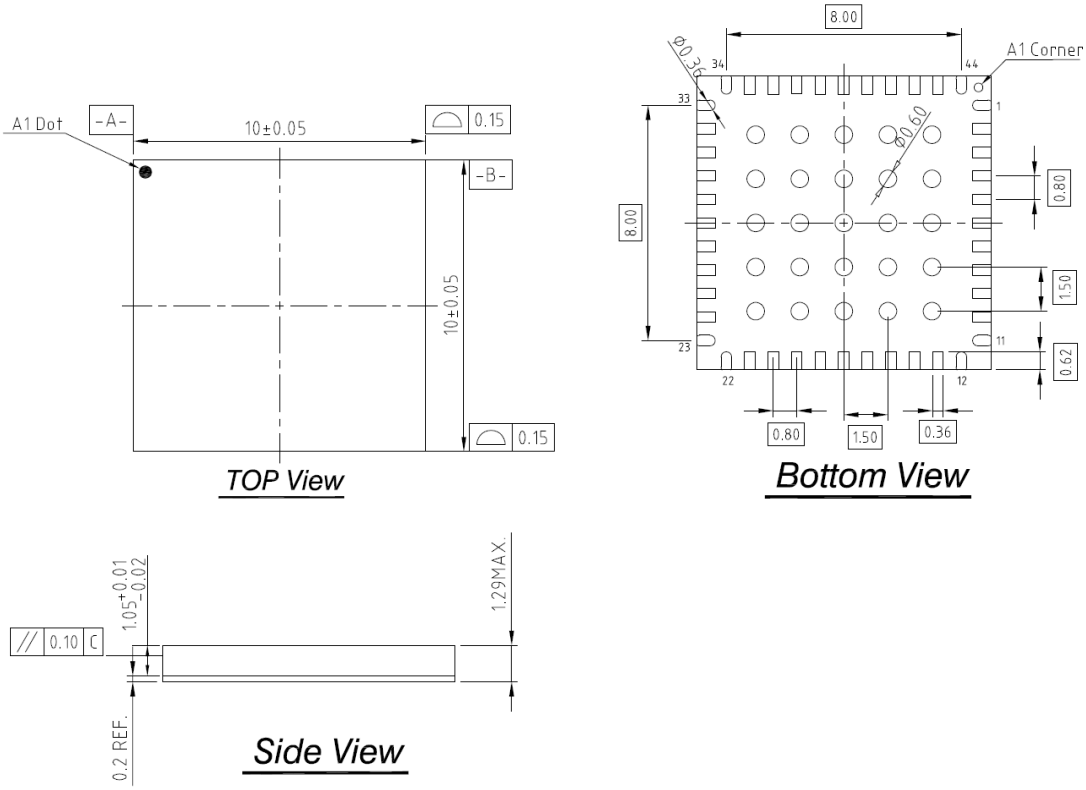
When using Venus838LPx-D, 1.2V need to be supplied at pin-56
The NC pins are to be left unconnected.

DC CHARACTERISTICS OF DIGITAL INTERFACE

Below is when VCC3I is at nominally 3.3V

Parameter	Min.	Typ.	Max.	Units
Input Low Voltage			0.8	Volt
Input High Voltage	2.0			Volt
Output Low Voltage, Iol = 2 ~ 16mA			0.4	Volt
Output High Voltage, Ioh = 2 ~ 16mA	2.9			Volt

MECHANICAL DIMENSION



RECOMMENDED PCB FOOTPRINT

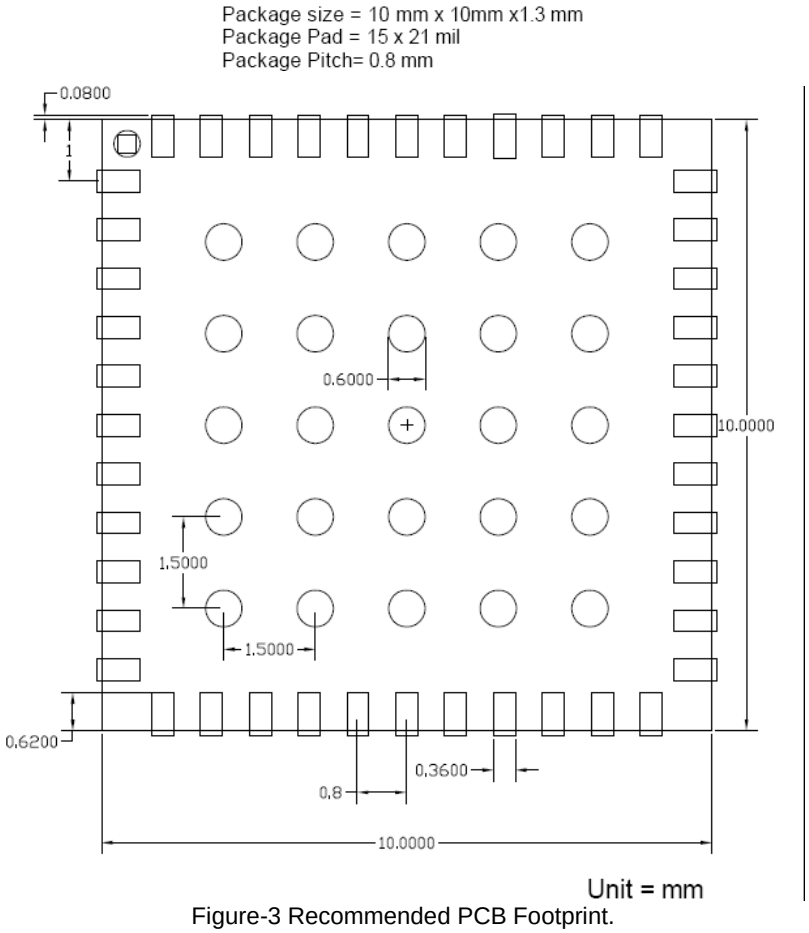
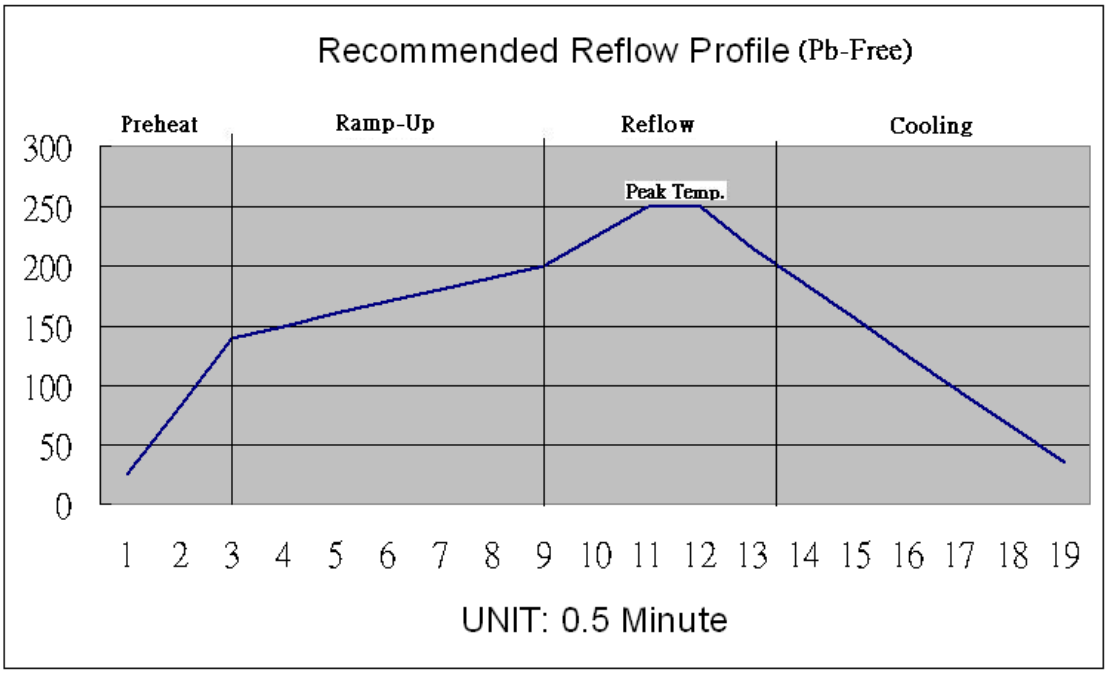


Figure-3 Recommended PCB Footprint.

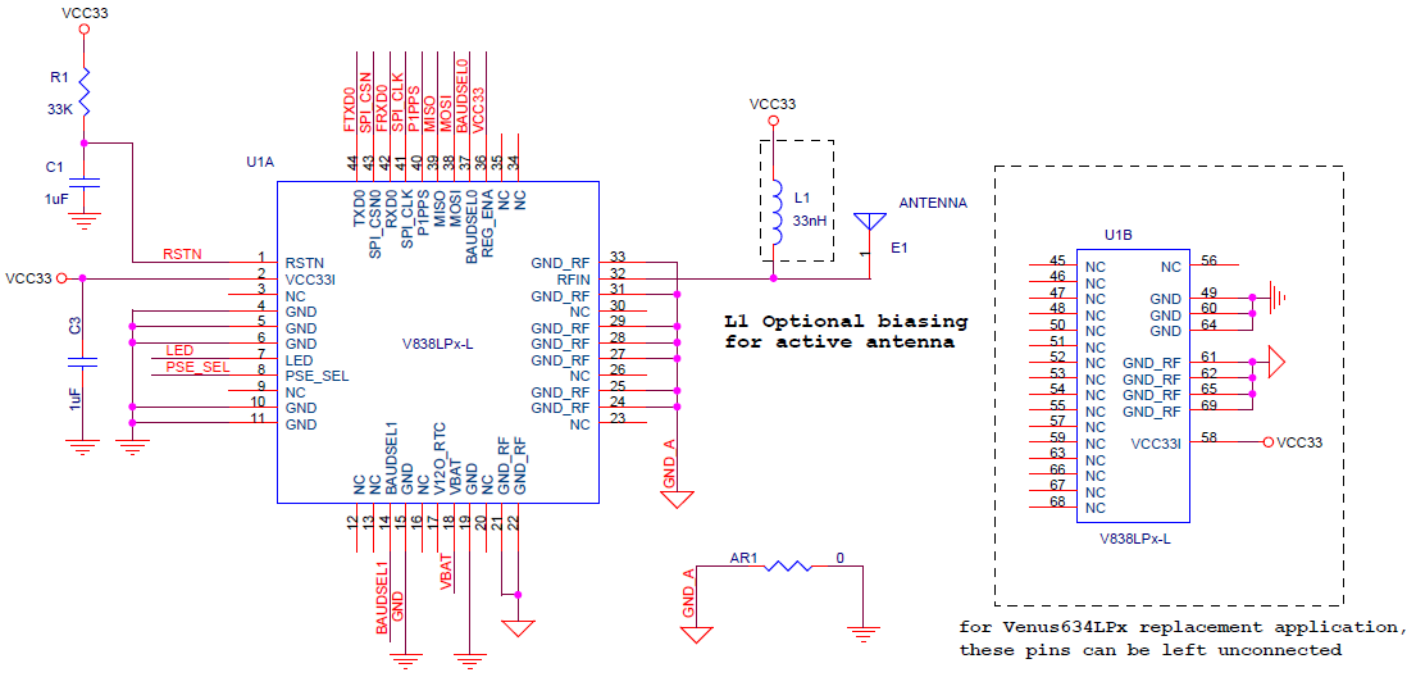
RECOMMENDED REFLOW PROFILE

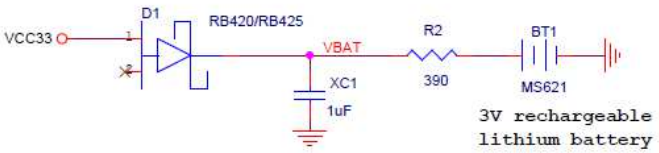


Temperature (℃)	25	82.5	140	150	160	170	180	190	200	225	250	250	215	185	155	125	95	65	35
Time(minute)	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8	8.5	9

Profile Description	SnPb Eutectic Process	Lead Free Process
Preheat		
Maximum Temperature	100+/-10 ℃	140+/-10 ℃
Time(ΔT)	40~60s	50~70s
Ramp-Up		
Ramp-Up Rate	1 ℃/s Max.	1 ℃/s Max.
Time(ΔT)	120~150s	160~200s
Reflow		
Maximum Temperature	Peak Temp.	Peak Temp.
Minimum Temperature	180+/-5℃	200+/-10℃
Peak Temperature	220+/-2℃	250+/-2℃
Time(ΔT) during Peak Temp.+/-2℃	10~30s	20~40s
Reflow Time(ΔT)	120~150s	120~150s
Cooling		
Cooling Rate	1.5 ℃/s Max	1.5 ℃/s Max
Time(ΔT)	60~120s	150~180s

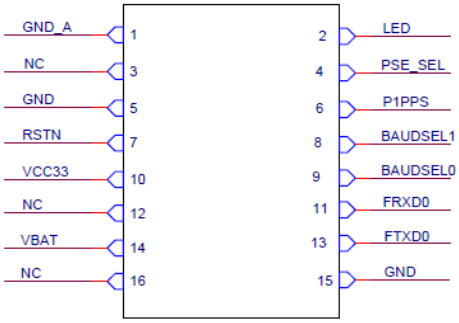
Venus838LPx-L Application Circuit



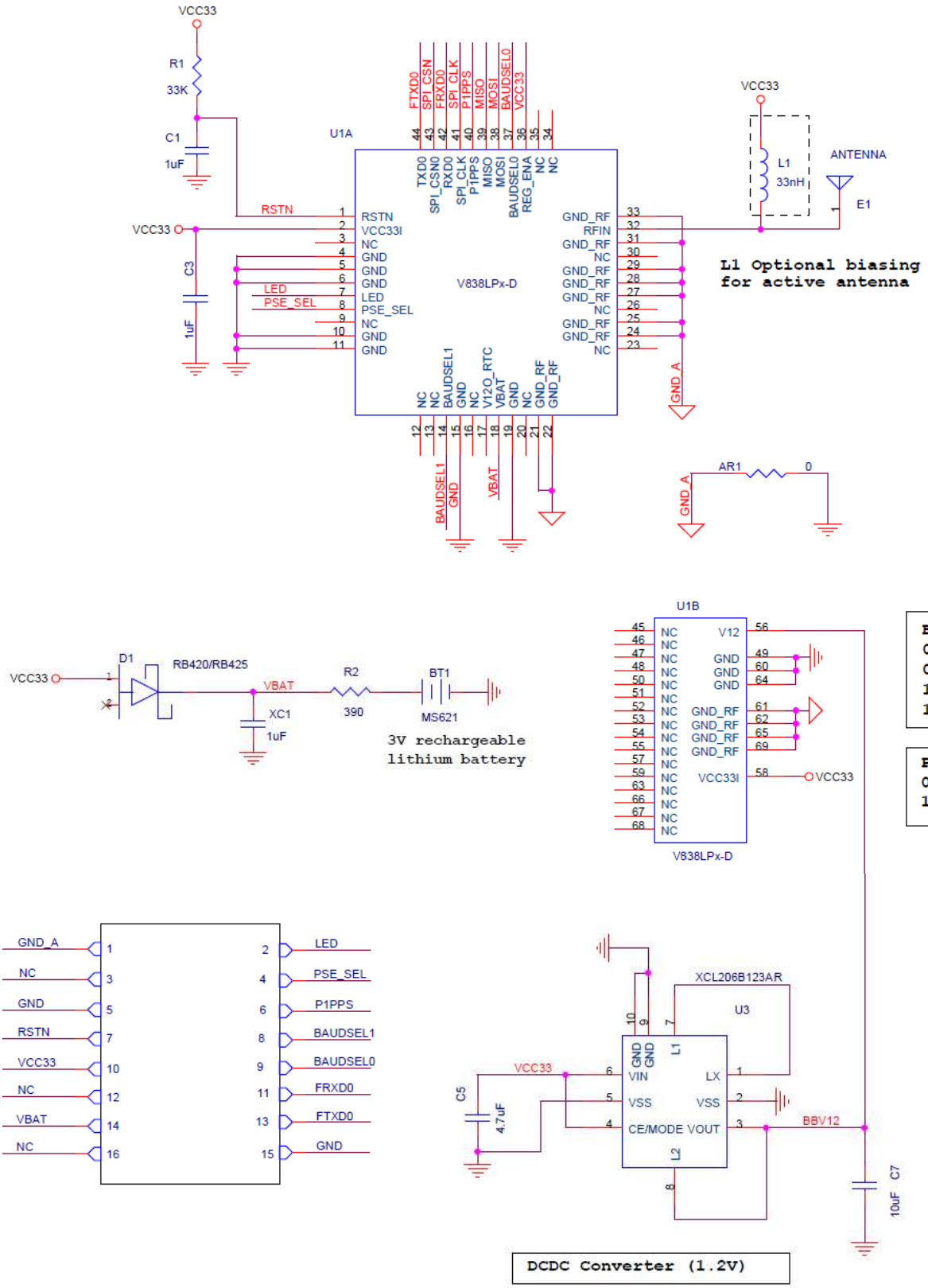


BAUDSEL[1:0]:
0 0:9600
0 1:4800
1 0:38400
1 1:115200

PSE_SEL:
0: Enhanced acquisition
1: Low power acquisition



Venus838LPx-D Application Circuit



APPLICATION CIRCUIT INTERFACE SIGNALS

GND_A:	RF ground
LED:	Signal to indicate GPS position status, 3.3V LVTTL. Active low for no-fix, toggle every second after position fix.
PSE_SEL:	Search engine mode selection, sampled only at end of power-on reset cycle 1: Low power acquisition mode 0: Enhanced acquisition mode
GND:	Digital ground
P1PPS:	1 pulse per second time-mark (3.3V LVTTL)
RSTN:	Active low reset input
VCC33:	3.3V power input
FRXD0:	UART input (3.3V LVTTL)
FTXD0:	UART output (3.3V LVTTL)
VBAT:	Battery-backed RTC and SRAM supply input, 2.5V ~ 3.6V, must not be unconnected.

APPLICATION INFORMATION

1. For fast-rising power supply, a simple series R/C reset delay to pin-1, RSTN, as indicated in the application circuit is suitable. For system having slow-rising power supply, a reset IC providing 2~5ms reset duration may be necessary.

2. The RF input of Venus838LPx is already matched to 50-ohm. Passive antenna matched to 50-ohm can be directly applied.

3. For using Venus838LPx with active antenna, one with gain in range of 10~30dB and noise figure < 2dB can be used. Power to the active antenna needs to be applied externally.

4. Pin-18 VBAT supplies backup power to the real-time clock and backup SRAM for fast startup. If VBAT is connected to main power VCC33I, no supply voltage is applied as Venus838LPx is powered off, then it'll cold start every time and GPS performance will not be optimal.

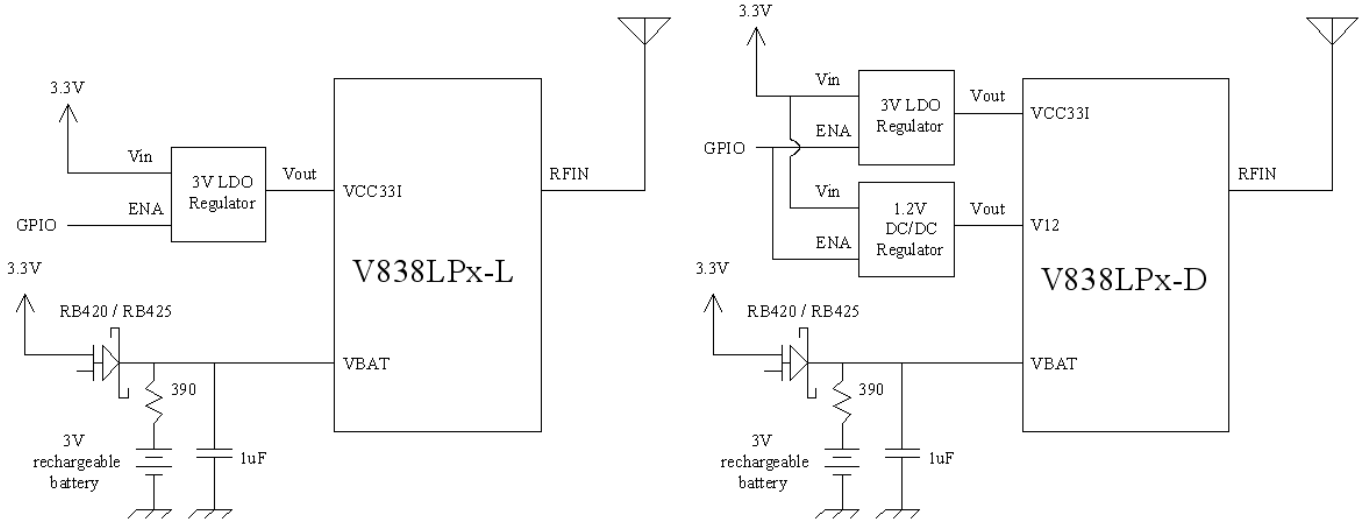
5. Like BGA device, the Venus838LPx is moisture sensitive. It needs to be handled with care to void damage from moisture absorption and SMT re-flow. The device should be baked for 24 hours at 125-degC before mounting for SMT re-flow if it has been removed from the protective seal for more than 48[*1]hours.

6. Adding a 10Kohm pull-up resistor to pin-9 allows future compatibility for Flash type Venus838FLPx. Leave pin-9 NC when using Venus838LPx.

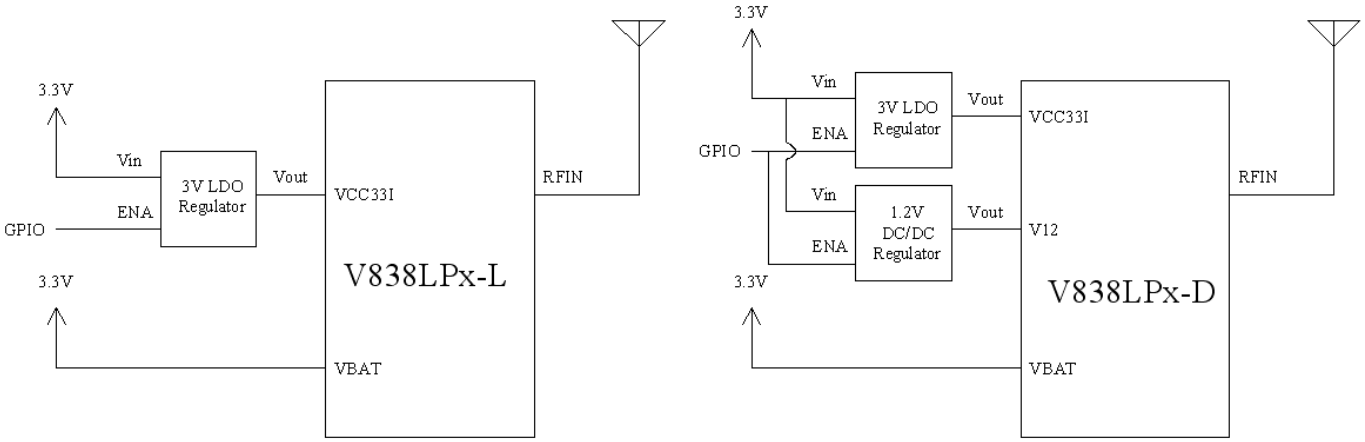
*1: Actual will be longer, moisture sensitivity level still undergoing verification.

SLEEP MODE

For application requiring sleep mode, it can be implemented using regulator with enable control as below figure shows. To put Venus838LPx to sleep, the power to Venus838LPx is cut off by disabling the regulator via host processor GPIO pin. In sleep mode, VBAT consume less than 40uA. Fast start up operation is provided by keeping supply voltage to VBAT constant, retaining the internal data and keep RTC running while Venus838LPx is put to sleep or when supply 3.3V power is removed.

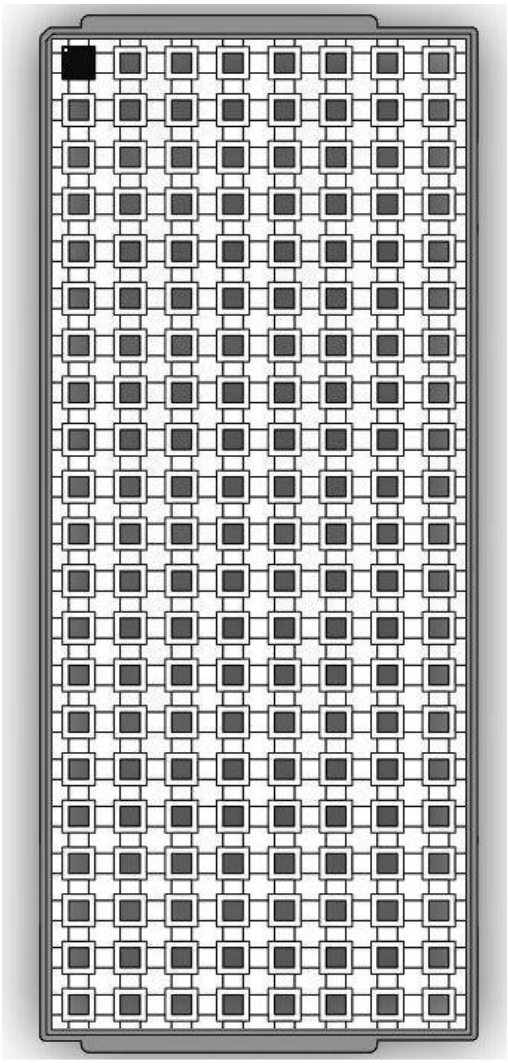


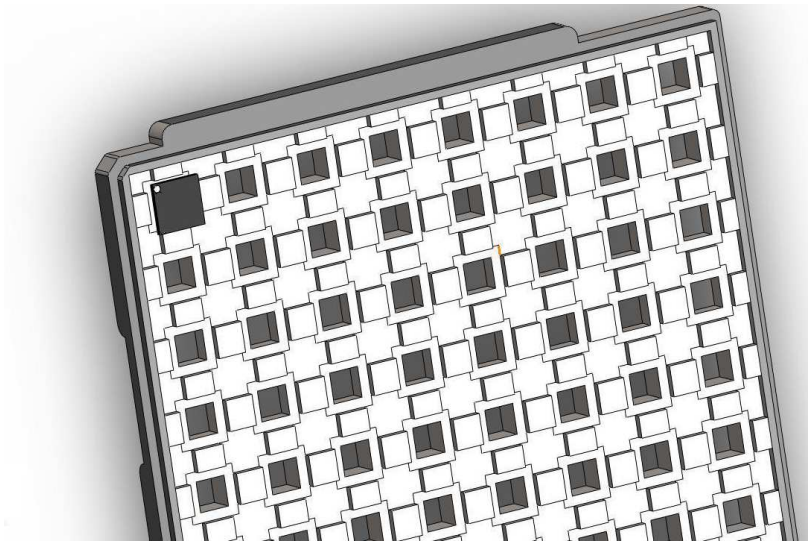
For applications needing sleep mode but cannot have extra cost of adding a rechargeable backup supply battery, it can be implemented as below figure shows. It will provide fast start up when Venus838LPx is put to sleep and awakened, but will cold start every time when the 3.3V supply voltage is removed and re-applied again.



When using sleep mode, add 10K series resistor on pin-42 RXD0 and pin-44 TXD0.

PACKAGE





NMEA MESSAGES

The full descriptions of supported NMEA messages are provided at the following paragraphs.

GGA - Global Positioning System Fix Data

Time, position and fix related data for a GPS receiver.

Structure:

$GPGGA,hhmmss.sss,ddmm.mmmm,a,dddmm.mmmm,a,x,xx,x.x,x.x,M,,,,xxxx*hh<CR><LF>

1 2 3 4 5 6 7 8 9 10 11

Example:

$GPGGA,111636.932,2447.0949,N,12100.5223,E,1,11,0.8,118.2,M,,,,0000*02<CR><LF>

Field	Name	Example	Description
1	UTC Time	111636.932	UTC of position in hhmmss.sss format, (000000.000 ~ 235959.999)
2	Latitude	2447.0949	Latitude in ddmm.mmmm format Leading zeros transmitted
3	N/S Indicator	N	Latitude hemisphere indicator, 'N' = North, 'S' = South
4	Longitude	12100.5223	Longitude in dddmm.mmmm format Leading zeros transmitted
5	E/W Indicator	E	Longitude hemisphere indicator, 'E' = East, 'W' = West
6	GPS quality indicator	1	GPS quality indicator 0: position fix unavailable 1: valid position fix, SPS mode 2: valid position fix, differential GPS mode 3: GPS PPS Mode, fix valid 4: Real Time Kinematic. System used in RTK mode with fixed integers 5: Float RTK. Satellite system used in RTK mode. Floating integers 6: Estimated (dead reckoning) Mode 7: Manual Input Mode 8: Simulator Mode
7	Satellites Used	11	Number of satellites in use, (00 ~ 12)
8	HDOP	0.8	Horizontal dilution of precision, (00.0 ~ 99.9)
9	Altitude	108.2	mean sea level (geoid), (-9999.9 ~ 17999.9)
10	DGPS Station ID	0000	Differential reference station ID, 0000 ~ 1023 NULL when DGPS not used
11	Checksum	02	

GLL – Latitude/Longitude

Latitude and longitude of current position, time, and status.

Structure:

$GPGLL,ddmm.mmmm,a,dddmm.mmmm,a,hhmmss.sss,A,a*hh<CR><LF>

1 2 3 4 5 6 7 8

Example:

$GPGLL,2447.0944,N,12100.5213,E,112609.932,A,A*57<CR><LF>

Field	Name	Example	Description
1	Latitude	2447.0944	Latitude in ddmm.mmmm format Leading zeros transmitted
2	N/S Indicator	N	Latitude hemisphere indicator 'N' = North 'S' = South
3	Longitude	12100.5213	Longitude in dddmm.mmmm format Leading zeros transmitted
4	E/W Indicator	E	Longitude hemisphere indicator 'E' = East 'W' = West
5	UTC Time	112609.932	UTC time in hhmmss.sss format (000000.000 ~ 235959.999)
6	Status	A	Status, 'A' = Data valid, 'V' = Data not valid
7	Mode Indicator	A	Mode indicator 'N' = Data not valid 'A' = Autonomous mode 'D' = Differential mode 'E' = Estimated (dead reckoning) mode 'M' = Manual input mode 'S' = Simulator mode
8	Checksum	57	

GSA – GNSS DOP and Active Satellites

GPS receiver operating mode, satellites used in the navigation solution reported by the GGA or GNS sentence and DOP values.

Structure:

$GPGSA,A,x,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,x.x,x.x,x.x*hh<CR><LF>

1 2 3 3 3 3 3 3 3 3 3 3 3 3 4 5 6 7

Example:

$GPGSA,A,3,05,12,21,22,30,09,18,06,14,01,31,,1.2,0.8,0.9*36<CR><LF>

Field	Name	Example	Description
1	Mode	A	Mode 'M' = Manual, forced to operate in 2D or 3D mode 'A' = Automatic, allowed to automatically switch 2D/3D
2	Mode	3	Fix type 1 = Fix not available 2 = 2D 3 = 3D
3	Satellite used 1~12	05,12,21,22,30,09,18,06,14,01,31,,	Satellite ID number, 01 to 32, of satellite used in solution, up to 12 transmitted
4	PDOP	1.2	Position dilution of precision (00.0 to 99.9)
5	HDOP	0.8	Horizontal dilution of precision (00.0 to 99.9)
6	VDOP	0.9	Vertical dilution of precision (00.0 to 99.9)
7	Checksum	36	

GSV – GNSS Satellites in View

Number of satellites (SV) in view, satellite ID numbers, elevation, azimuth, and SNR value. Four satellites maximum per transmission.

Structure:

$GPGSV,x,x,xx,xx,xx,xxx,xx,…,xx,xx,xxx,xx *hh<CR><LF>

1 2 3 4 5 6 7 4 5 6 7 8

Example:

$GPGSV,3,1,12,05,54,069,45,12,44,061,44,21,07,184,46,22,78,289,47*72<CR><LF>

$GPGSV,3,2,12,30,65,118,45,09,12,047,37,18,62,157,47,06,08,144,45*7C<CR><LF>

$GPGSV,3,3,12,14,39,330,42,01,06,299,38,31,30,256,44,32,36,320,47*7B<CR><LF>

Field	Name	Example	Description
1	Number of message	3	Total number of GSV messages to be transmitted (1-3)
2	Sequence number	1	Sequence number of current GSV message
3	Satellites in view	12	Total number of satellites in view (00 ~ 12)
4	Satellite ID	05	Satellite ID number, GPS: 01 ~ 32, SBAS: 33 ~ 64 (33 = PRN120)
5	Elevation	54	Satellite elevation in degrees, (00 ~ 90)
6	Azimuth	069	Satellite azimuth angle in degrees, (000 ~ 359)
7	SNR	45	C/No in dB (00 ~ 99) Null when not tracking
8	Checksum	72	

RMC – Recommended Minimum Specific GNSS Data

Time, date, position, course and speed data provided by a GNSS navigation receiver.

Structure:

$GPRMC,hhmmss.sss,A,dddmm.mmmm,a,dddmm.mmmm,a,x.x,x.x,ddmmyy,,,a*hh<CR><LF>

1 2 3 4 5 6 7 8 9 10 11

Example:

$GPRMC,111636.932,A,2447.0949,N,12100.5223,E,000.0,000.0,030407,,,A*61<CR><LF>

Field	Name	Example	Description
1	UTC time	0111636.932	UTC time in hhmmss.sss format (000000.00 ~ 235959.999)
2	Status	A	Status 'V' = Navigation receiver warning 'A' = Data Valid
3	Latitude	2447.0949	Latitude in dddmm.mmmm format Leading zeros transmitted
4	N/S indicator	N	Latitude hemisphere indicator 'N' = North 'S' = South
5	Longitude	12100.5223	Longitude in dddmm.mmmm format Leading zeros transmitted
6	E/W Indicator	E	Longitude hemisphere indicator 'E' = East 'W' = West
7	Speed over ground	000.0	Speed over ground in knots (000.0 ~ 999.9)
8	Course over ground	000.0	Course over ground in degrees (000.0 ~ 359.9)
9	UTC Date	030407	UTC date of position fix, ddmmyy format
10	Mode indicator	A	Mode indicator 'N' = Data not valid 'A' = Autonomous mode 'D' = Differential mode 'E' = Estimated (dead reckoning) mode 'M' = Manual input mode 'S' = Simulator mode
11	checksum	61	

VTG – Course Over Ground and Ground Speed

The Actual course and speed relative to the ground.

Structure:

GPVTG,x.x,T,,M,x.x,N,x.x,K,a*hh<CR><LF>

1 2 3 4 5

Example:

$GPVTG, 000.0,T,,M,000.0,N,0000.0,K,A*3D<CR><LF>

Field	Name	Example	Description
1	Course	000.0	True course over ground in degrees (000.0 ~ 359.9)
2	Speed	000.0	Speed over ground in knots (000.0 ~ 999.9)
3	Speed	0000.0	Speed over ground in kilometers per hour (0000.0 ~ 1800.0)
4	Mode	A	Mode indicator 'N' = not valid 'A' = Autonomous mode 'D' = Differential mode 'E' = Estimated (dead reckoning) mode 'M' = Manual input mode 'S' = Simulator mode
5	Checksum	3D	

ZDA – Time & Date

UTC, day, month, year and local time zone.

Structure:

$GPZDA,hhmmss.sss,xx,xx,xxxx,xx,xx*hh<CR><LF>

1 2 3 4 5 6 7

Example:

$GPZDA,052633.376,13,07,2012,00,00*51<CR><LF>

Field	Name	Example	Description
1	UTC time	0111636.932	UTC time in hhmmss.sss format (000000.000 ~ 235959.999)
2	Day	13	Day, 01 to 31
3	Month	07	Month, 01 to 12
4	Year	2012	Year in yyyy format
5	Local zone hours	00	Local zone hours, 00 to +/- 13 hrs
6	Local zone minutes	00	Local zone minutes, 00 to +59
7	checksum	51	

ORDERING INFORMATION

Part Number	Description
Venus838LPx-L	ROM version GPS receiver module (internal 1.2V LDO version)
Venus838LPx-D	ROM version GPS receiver module (external 1.2V version)

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Change Log

Version 0.2, February 19, 2014

1. Update VBAT description

Version 0.1, November 15, 2013

1. Initial release