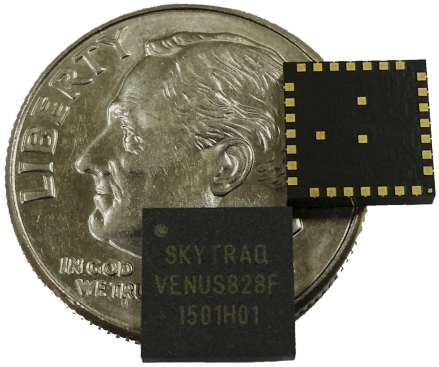
Venus828F

Multi-GNSS Receiver Module

Data Sheet



7mmx 7mm

FEATURES

- Smallest self-contained multi-GNSS module
- Supports GPS, Beidou, QZSS, SBAS
- 20Hz 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
- Self-aided ephemeris estimation
- Supports external SPI flash memory data logging
- Complete receiver in 7mm x 7mm x 1.4mm size
- Pb-free RoHS compliant

Venus828F is a high performance, low cost, single chip multi-GNSS receiver targeting mobile consumer and cellular handset applications. It offers very low power consumption, high sensitivity, and best in class signal acquisition and time-to-first-fix performance.

Venus828F contains all the necessary components of a complete multi-GNSS receiver, includes RF front-end, baseband processor, 0.5ppm TCXO, LDO regulator, DC/DC switching regulator and passive components. It requires few external components.

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.

The self-contained architecture keeps multi-GNSS signal processing off the host and allows integration into applications with very little resource.

Venus828F is very easy to use and offers very fast time to market.

TECHNICAL SPECIFICATIONS

Receiver Type	L1 GPS / QZSS / SBAS + B1 Beidou C/A code 167 channel Venus 8 engine
Accuracy	Position 2.5m CEP Velocity 0.1m/sec Timing 10ns
Open Sky TTFF	29 second cold start 3.5 second with AGPS 1 second hot start
Reacquisition	< 1s
Sensitivity	-165dBm tracking -148dBm cold start
Update Rate	1 / 2 / 4 / 5 / 8 / 10 / 20 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
Backup Voltage	2.5V ~ 3.6V

Current Consumption

Mode	Current Consumption (mA @ 3.3V)	External Switching Regulator (90% efficiency)	Internal Switching Regulator (75% efficiency)	Internal LDO Regulator
GPS/Beidou	Acquisition	31	36	68
	Tracking	27	31	56
GPS	Acquisition	24	28	54
	Tracking	16	19	36

Above is running full power, low power mode for reduced current consumption is in development

Operating Temperature	-40 ~ +85 deg-C
Storage Temperature	-40 ~ +125 deg-C
Package	LGA31 7mm x 7mm x 1.4mm, 0.8mm pitch

*1: COCOM limit, either may be exceeded but not both

BLOCK DIAGRAM

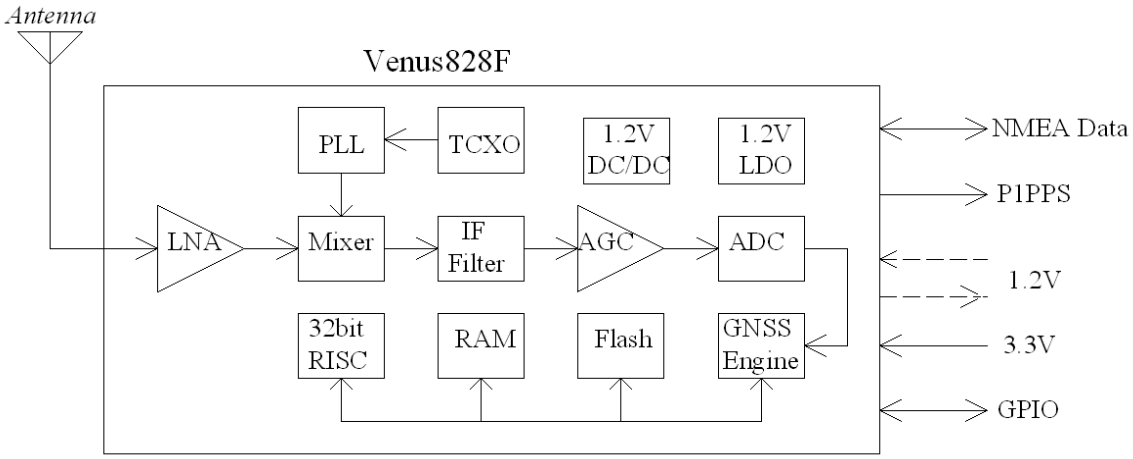


Figure-1 receiver block diagram

PIN-OUT DIAGRAM

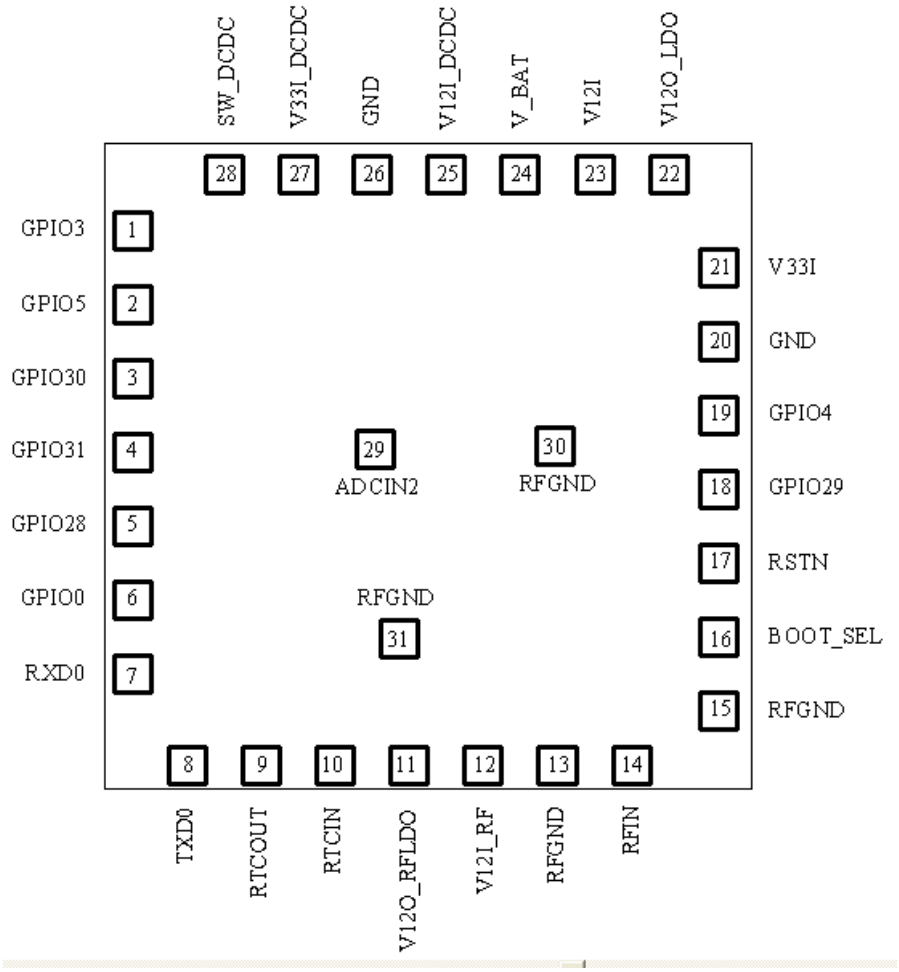


Figure-2 Venus828F Pin-Out Diagram, Top View

PIN-OUT DEFINITION

Pin Number	Signal Name	Type	Description
1	GPIO3 / P1PPS	bidir	1 pulse per second output. Active after position fix; goes HIGH for about 800usec, 3.3V LVTTL (default) Or general purpose I/O pin
2	GPIO5 / SDA	Bidir	General purpose I/O pin, 3.3V LVTTL Or I2C serial data Default not used
3	GPIO30 / MS_MOSI	Bidir	General purpose I/O pin, 3.3V LVTTL Or SPI master/slave data output Default not used
4	GPIO31 / MS_MISO	Bidir	General purpose I/O pin, 3.3V LVTTL Or SPI master/slave data input Default not used
5	GPIO28 / MS_CSN	Bidir	General purpose I/O pin, 3.3V LVTTL Or SPI master/slave chip select Default not used
6	GPIO0 / STS	Bidir	Navigation status indicator (default) Or General purpose I/O. 3.3V LVTTL
7	RXD0	Input	Received input of the asynchronous UART port. Used to input binary command to the GPS receiver. 3.3V LVTTL

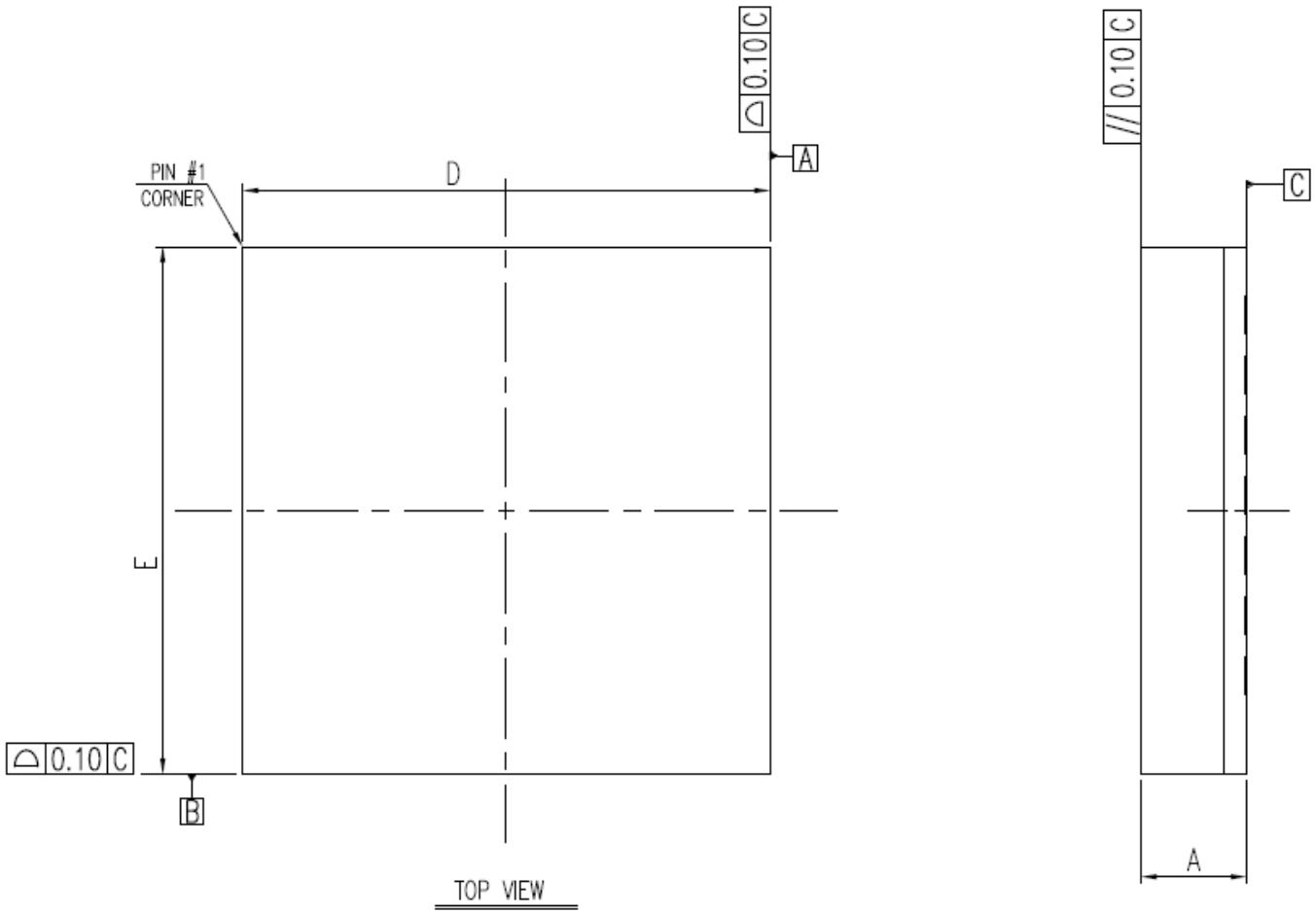
8	TXD0	Output	Transmit output of the asynchronous UART port. Used to output standard NMEA-0183 sentence or response to input binary command. 3.3V LVTTL
9	RTCOUT	Output	RTC inverting buffer output
10	RTCIN	Input	RTC inverting buffer input
11	V12O_RFLDO	Power Output	RF 1.2V LDO output
12	V12I_RF	Power Input	RF 1.2V input
13	RFGND	Power	RF section system ground
14	RFIN	Input	RF signal input
15	RFGND	Power	RF section system ground
16	BOOT_SEL	Bidir	Boot mode selection. Pull-high or pull-low 1: execute from internal Flash 0: execute from internal ROM
17	RSTN	Input	Active LOW reset input, 3.3V LVTTL
18	GPIO29 / MS_SCK	Output	General purpose output pin, 3.3V LVTTL Or SPI master/slave clock Default not used
19	GPIO4 / SCL	Bidir	General purpose I/O pin, 3.3V LVTTL Or I2C SCL clock Default not used
20	GND	Power	System ground
21	V33I	Power Input	Main voltage supply input, 3.0V ~ 3.6V
22	V12O_LDO	Power Output	1.2V LDO output
23	V12I	Power Input	1.2V power input
24	V_BAT	Power Input	Supply voltage for internal backup SRAM, 2.5V ~ 3.6V. V_BAT should be powered by non-volatile supply voltage to have optimal performance when 32kHz crystal also exists. Maximum V_BAT current draw when V33I is removed is 35uA. Must not be left unconnected.
25	V12I_DCDC	Input	Switching regulator 1.2V sense input
26	GND	Power	System ground
27	V33I_DCDC	Power Input	Switching regulator power input, 3.0V ~ 3.6V
28	SW_DCDC	Power Output	Switching regulator output
29	ADCIN2	Input	ADC input. Unused.
30	RFGND	Power	RF section system ground
31	RFGND	Power	RF section system ground

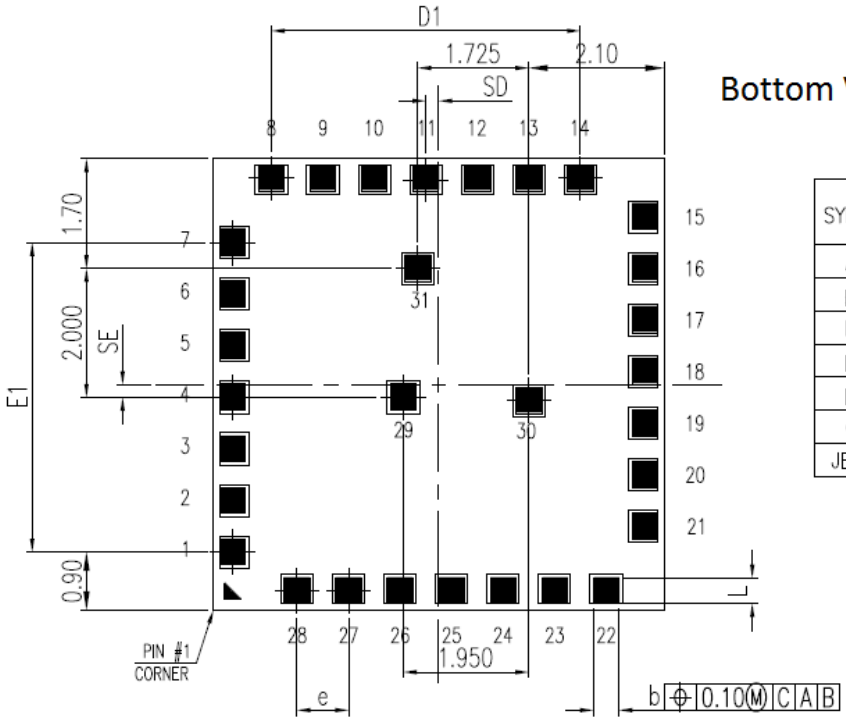
DC CHARACTERISTICS OF DIGITAL INTERFACE

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 = 4 ~ 7.8mA			0.4	Volt
Output High Voltage, Ioh = 4.6 ~ 15.4mA	2.4			Volt

MECHANICAL DIMENSION



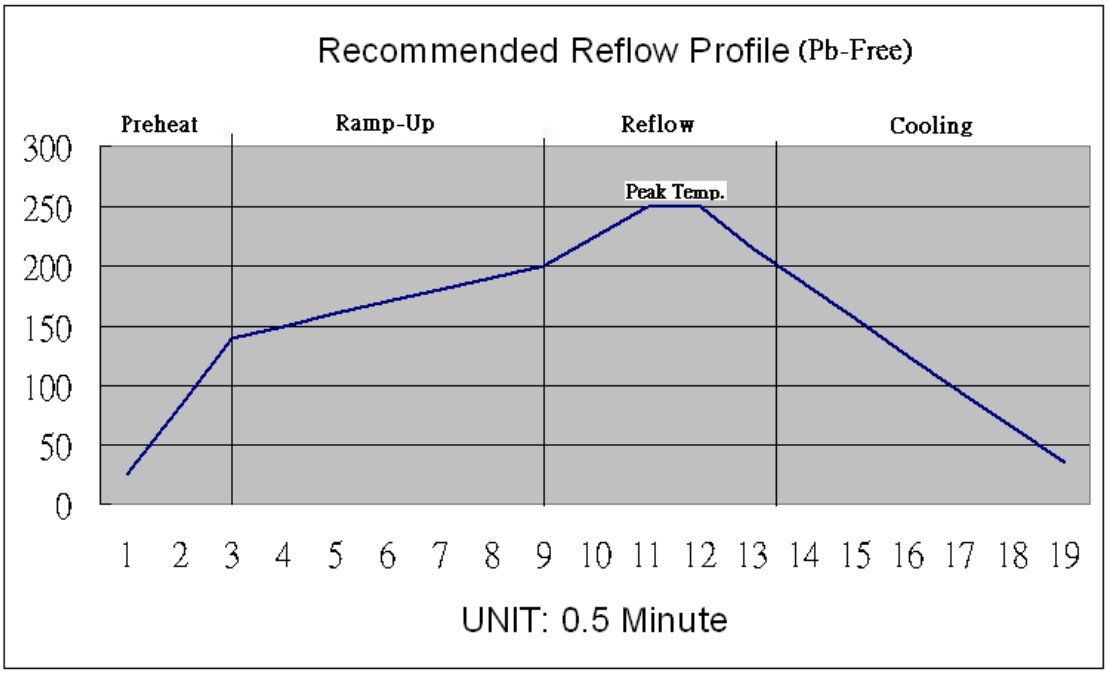


Bottom View

SYMBOL	DIMENSION IN MM			DIMENSION IN INCH		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	1.34	1.40	1.46	0.053	0.055	0.057
b	0.30	0.40	0.50	0.012	0.010	0.020
D	6.90	7.00	7.10	0.272	0.276	0.280
E	6.90	7.00	7.10	0.272	0.276	0.280
L	0.35	0.40	0.45	0.014	0.016	0.018
e	0.80 BSC.			0.031 BSC.		
JEDEC	N/A					

N	SE (mm)	SD (mm)	E1 (mm)	D1 (mm)	JEDEC(Ref.)
31	0.20 BSC.	0.20 BSC.	4.80 BSC.	4.80 BSC.	

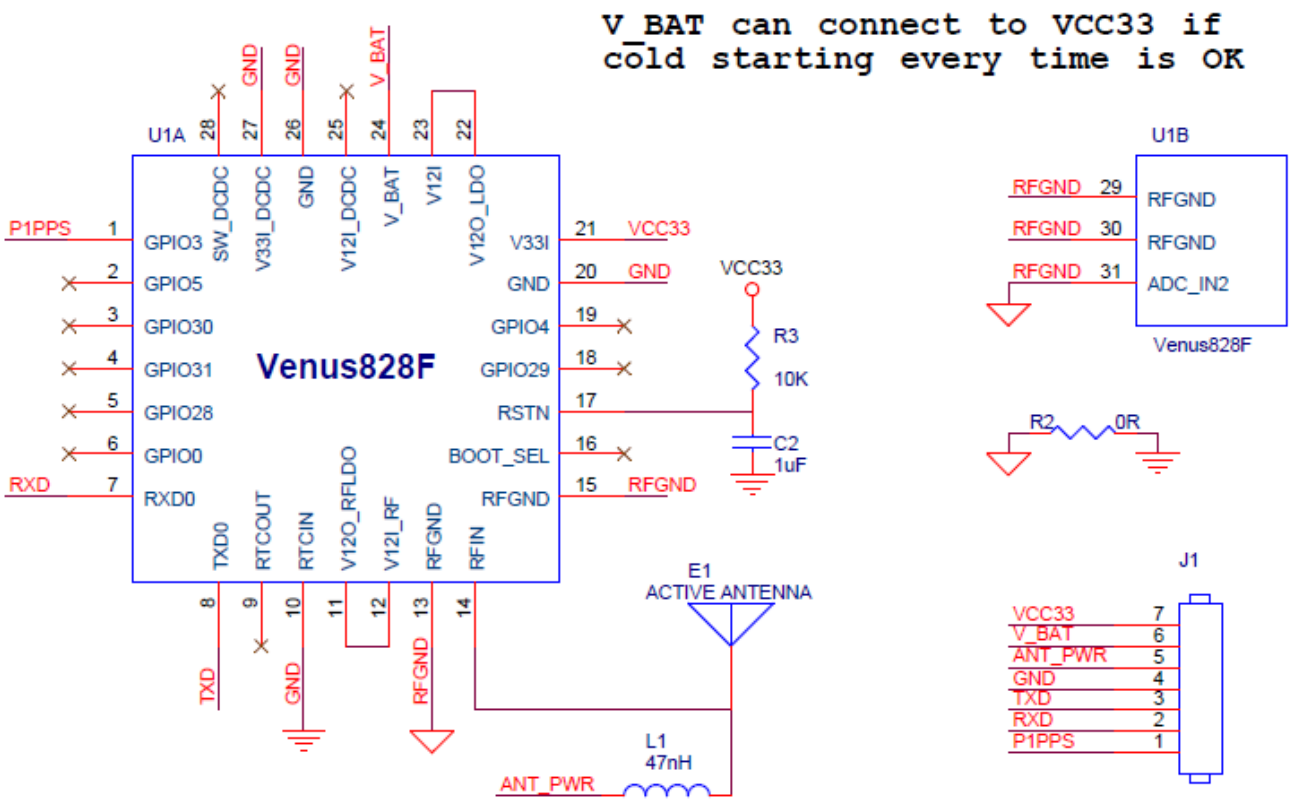
RECOMMENDED REFLOW PROFILE



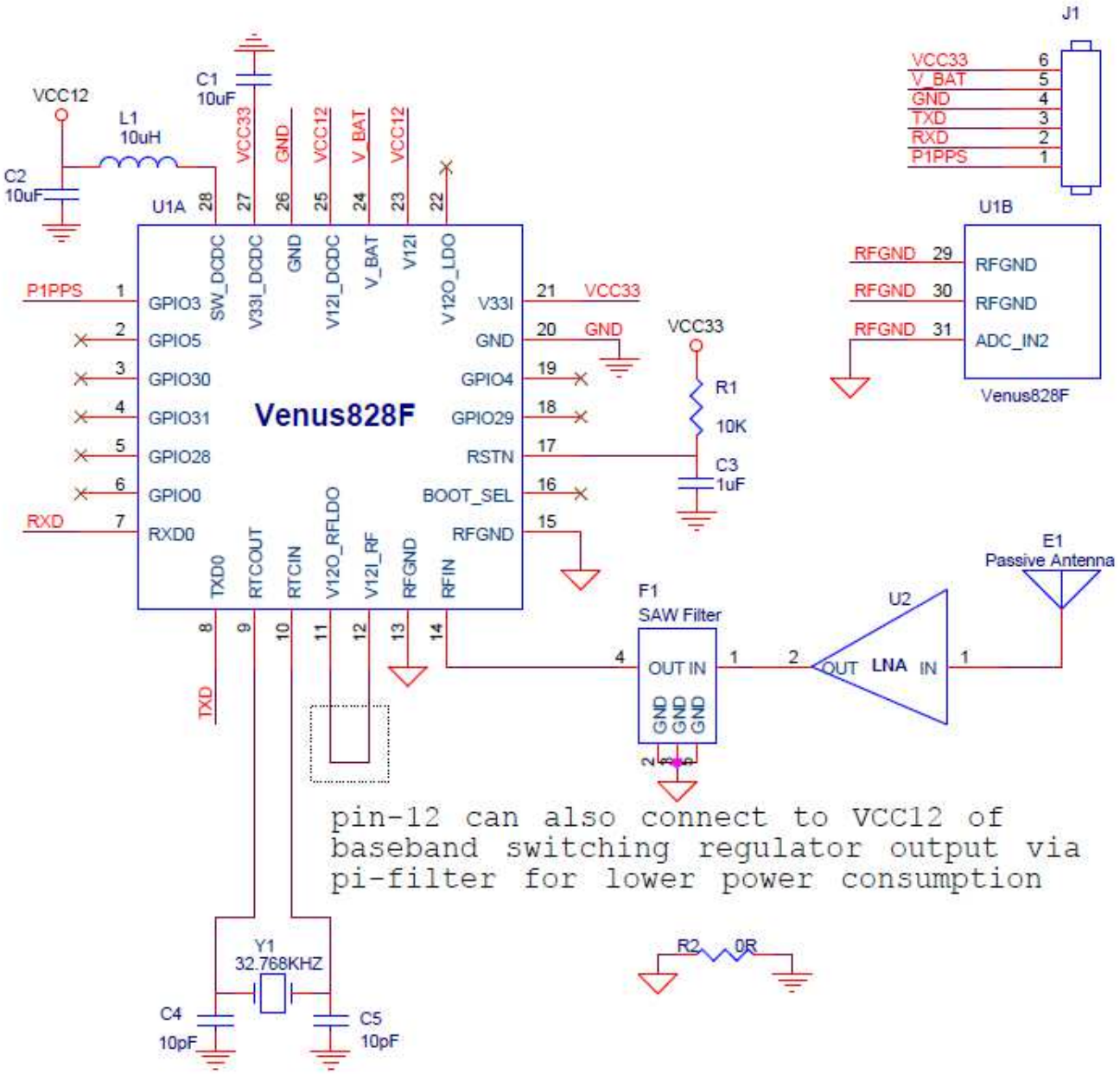
Temperature (℃)	25	82.5	140	150	160	170	180	190	200	225	250	250	215	185	155	125	95	65	35
Time(minute)	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8	8.5	9

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

VENUS828F APPLICATION CIRCUIT (minimum configuration)



VENUS828F APPLICATION CIRCUIT (maximum configuration)



APPLICATION CIRCUIT INTERFACE SIGNALS

P1PPS:	1 pulse per second time-mark (3.3V LVTTL)
RXD:	UART input (3.3V LVTTL)
TXD:	UART output (3.3V LVTTL)
VCC33:	Main 3.3V power input
V_BAT	Backup power supply
ANT_PWR	Active antenna bias voltage

APPLICATION INFORMATION

1. For fast-rising power supply, a simple series R/C reset delay to pin-17, 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. For using Venus828F with active antenna directly, one with gain in range of 15~20dB and noise figure < 2dB can be used.

3. When using passive antenna, an external LNA with gain in range of 15dB ~ 20dB and NF<1.5 should be used.

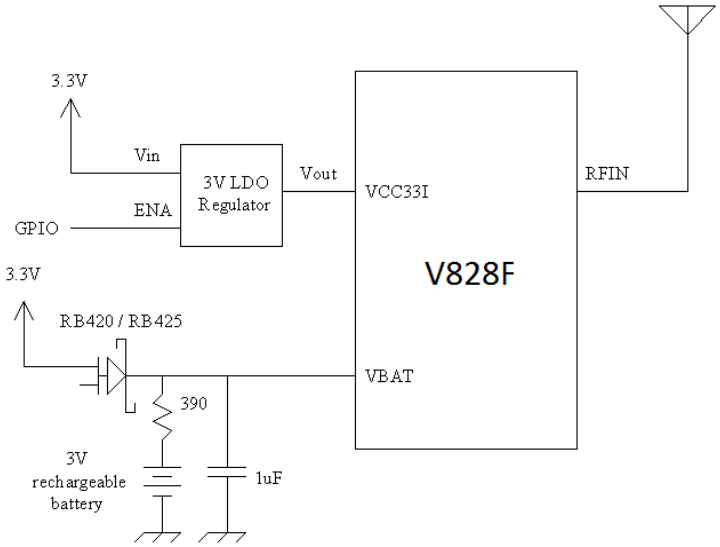
4. Like BGA device, the Venus828F is moisture sensitive. It needs to be handled with care to void damage from moisture absorption and SMT re-flow. The device should be baked for 24 hours at 125-degC before mounting for SMT re-flow if it has been removed from the protective seal for more than 48[*1]hours.

5. If hot plug/remove power and UART serial interface, add at least 1K-ohm series resistor to pin-42 RXD0 and pin-44 TXD0 to improve ESD protection.

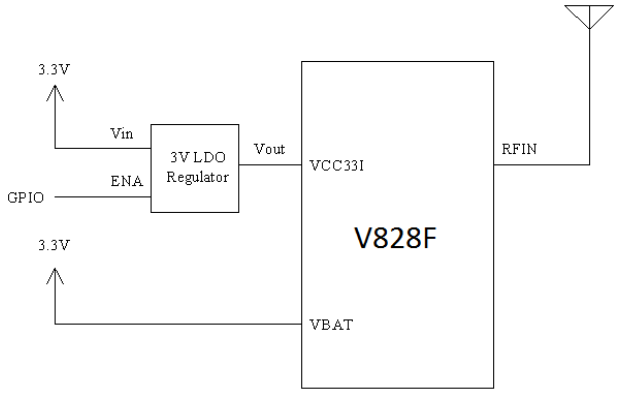
*1: Actual will be longer, moisture sensitivity level still undergoing verification.

SLEEP MODE

For application requiring sleep mode, it can be implemented using regulator with enable control as below figure shows. To put Venus828F to sleep, the power to Venus828F 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 Venus828F 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 Venus828F is put to sleep and awakened, but will cold start every time when the 3.3V supply voltage is removed and re-applied again.



Alternatively VBAT can also be connected to a MCU GPIO pin that always output HIGH of 3.3V if the MCU is always ON.

When using sleep mode, add 10K ~ 20K series resistor on pin-7 RXD0 to reduce leakage current.

NMEA Output Description

The output protocol supports NMEA-0183 standard. The implemented messages include GGA, GLL, GSA, GSV, VTG, RMC, ZDA and GNS messages. The NMEA message output has the following sentence structure:

$aaccc,c–c*hh<CR><LF>

The detail of the sentence structure is explained in Table 1.

Table 1: The NMEA sentence structure

character	HEX	Description
"$"	24	Start of sentence.
Aaccc		Address field. "aa" is the talker identifier. "ccc" identifies the sentence type.
","	2C	Field delimiter.
c–c		Data sentence block.
"*"	2A	Checksum delimiter.
Hh		Checksum field.
<CR><LF>	0D0A	Ending of sentence. (carriage return, line feed)

Table 2: Overview of SkyTraq receiver's NMEA messages for Venus828F

$GPGGA	Time, position, and fix related data of the receiver.
$GPGLL	Position, time and fix status.
$GPGSA **$BDGSA**	Used to represent the ID's of satellites which are used for position fix. When GPS satellites are used for position fix, $GPGSA sentence is output. When Beidou satellites are used for position fix, $BDGSA sentence is output.
$GPGSV **$BDGSV**	Satellite information about elevation, azimuth and CNR, $GPGSV is used for GPS satellites, while $BDGSV is used for Beidou satellites
$GPRMC	Time, date, position, course and speed data.
$GPVTG	Course and speed relative to the ground.
$GPZDA	UTC, day, month and year and time zone.

This is with GP pre-fix NMEA talker ID. Can use binary command 0x4B to set GP or GN pre-fix NMEA talker ID.

The formats of the supported NMEA messages are described as follows:

GGA – Global Positioning System Fix Data

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

Format:
$--GGA,hhmmss.sss,llll.llll,a,yyyyy.yyyy,a,x,uu,v.v,w.w,M,x.x,M,,zzzz*hh<CR><LF>

Field	Name	Description
hhmmss.sss	UTC Time	UTC of position in hhmmss.sss format, (000000.000 ~ 235959.999)
llll.llll	Latitude	Latitude in ddmm.mmmm format. Leading zeros are inserted.
A	N/S Indicator	'N' = North, 'S' = South
yyyyy.yyyy	Longitude	Longitude in dddmm.mmmm format. Leading zeros are inserted.
A	E/W Indicator	'E' = East, 'W' = West
x	GPS quality indicator	GPS quality indicator 0: position fix unavailable 1: valid position fix, SPS mode 2: valid position fix, differential GPS mode
uu	Satellites Used	Number of satellites in use, (00 ~ 24)
v.v	HDOP	Horizontal dilution of precision, (0.0 ~ 99.9)
w.w	Altitude	Mean sea level altitude (-9999.9 ~ 17999.9) in meter
x.x	Geoidal Separation	In meter
zzzz	DGPS Station ID	Differential reference station ID, 0000 ~ 1023 NULL when DGPS not used
hh	Checksum	

GLL – Geographic Position – Latitude/Longitude

Latitude and longitude of vessel position, time of position fix and status.

Format:
$--GLL,llll.llll,a,yyyyy.yyyy,b,hhmmss.sss,A,a*hh<CR><LF>

Field	Name	Description
llll.llll	Latitude	Latitude in ddmm.mmmm format. Leading zeros are inserted.
A	N/S Indicator	'N' = North, 'S' = South
yyyyy.yyyy	Longitude	Longitude in dddmm.mmmm format. Leading zeros are inserted.
B	E/W Indicator	'E' = East, 'W' = West
hhmmss.sss	UTC Time	UTC of position in hhmmss.sss format, (000000.000 ~ 235959.999)
A	Status	A= data valid, V= Data not valid
hh	Checksum	

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.

Format:

$--GSA,a,x,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,u.u,v.v,z.z*hh<CR><LF>

Field	Name	Description
a	Mode	Mode 'M' = Manual, forced to operate in 2D or 3D mode 'A' = Automatic, allowed to automatically switch 2D/3D
x	Mode	Fix type 1 = Fix not available 2 = 2D 3 = 3D
xx's	Satellite ID	01 ~ 32 are for GPS; 33 ~ 64 are for WAAS (PRN minus 87); 193 ~ 197 are for QZSS; 01 ~ 37 are for Beidou (BD PRN). GPS and Beidou satellites are differentiated by the GP and BD prefix. Maximally 12 satellites are included in each GSA sentence.
u.u	PDOP	Position dilution of precision (0.0 to 99.9)
v.v	HDOP	Horizontal dilution of precision (0.0 to 99.9)
z.z	VDOP	Vertical dilution of precision (0.0 to 99.9)
hh	Checksum	

GSV – GNSS Satellites in View

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

Format:

$--GSV,x,u,xx,uu,vv,zzz,ss,uu,vv,zzz,ss,...,uu,vv,zzz,ss*hh<CR><LF>

Field	**Name**	**Description**
x	Number of message	Total number of GSV messages to be transmitted (1-3)
u	Sequence number	Sequence number of current GSV message
xx	Satellites in view	Total number of satellites in view (00 ~ 12)
uu	Satellite ID	01 ~ 32 are for GPS; 33 ~ 64 are for WAAS (PRN minus 87); 193 ~ 197 are for QZSS; 01 ~ 37 are for Beidou (BD PRN). GPS and Beidou satellites are differentiated by the GP and BD prefix. Maximally 4 satellites are included in each GSV sentence.
vv	Elevation	Satellite elevation in degrees, (00 ~ 90)
zzz	Azimuth	Satellite azimuth angle in degrees, (000 ~ 359)
ss	SNR	C/No in dB (00 ~ 99) Null when not tracking
hh	Checksum	

RMC – Recommended Minimum Specific GNSS Data

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

Format:
$--RMC,hhmmss.sss,x,llll.llll,a,yyyyy.yyyy,a,x.x,u.u,xxxxxx,,,v*hh<CR><LF>

Field	Name	Description
hhmmss.sss	UTC time	UTC time in hhmmss.sss format (000000.000 ~ 235959.999)
x	Status	Status 'V' = Navigation receiver warning 'A' = Data Valid
llll.llll	Latitude	Latitude in dddmm.mmmm format. Leading zeros are inserted.
A	N/S indicator	'N' = North; 'S' = South
yyyyy.yyyy	Longitude	Longitude in dddmm.mmmm format. Leading zeros are inserted.
A	E/W Indicator	'E' = East; 'W' = West
x.x	Speed over ground	Speed over ground in knots (000.0 ~ 999.9)
u.u	Course over ground	Course over ground in degrees (000.0 ~ 359.9)
xxxxxx	UTC Date	UTC date of position fix, ddmmyy format
v	Mode indicator	Mode indicator 'N' = Data not valid 'A' = Autonomous mode 'D' = Differential mode 'E' = Estimated (dead reckoning) mode
hh	checksum	

VTG – Course Over Ground and Ground Speed

The actual course and speed relative to the ground.

Format:
$--VTG,x.x,T,y.y,M,u.u,N,v.v,K,m*hh<CR><LF>

Field	Name	Description
x.x	Course	Course over ground, degrees True (000.0 ~ 359.9)
y.y	Course	Course over ground, degrees Magnetic (000.0 ~ 359.9)
u.u	Speed	Speed over ground in knots (000.0 ~ 999.9)
v.v	Speed	Speed over ground in kilometers per hour (0000.0 ~ 1800.0)
m	Mode	Mode indicator 'N' = not valid 'A' = Autonomous mode 'D' = Differential mode 'E' = Estimated (dead reckoning) mode
hh	Checksum	

ZDA – Time and Date

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

Format:
$--ZDA,hhmmss.sss,dd,mm,yyyy,xx,yy*hh<CR><LF>

Field	Name	Description
hhmmss.sss	UTC time	UTC time in hhmmss.sss format (000000.000 ~ 235959.999)
dd	UTC day	01 to 31
mm	UTC month	01 to 12
yyyy	UTC year	Four-digit year number
xx	Local zone hours	00 to +-13
yy	Local zone minutes	00 to +59
hh	Checksum	

ORDERING INFORMATION

Part Number	Description
Venus828F	Flash version multi-GNSS receiver module

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Email: info@skytraq.com.tw

Change Log

Version 0.4, January 19, 2015

1. Changed default NMEA talker ID to GP, so NMEA output is compatible with GPS NMEA and GPS application software require no change to work with Venus828F.

Version 0.3, January 7, 2015

1. Updated current consumption numbers
2. Update antenna gain and LNA gain description

Version 0.2, November 27, 2014

1. Added bottom view to page-7, removed non-existent active antenna detection message

Version 0.1, November 25, 2014

1. Initial release