SENASIC 琻捷电子

SNP736 Datasheet

High performance dual mode TPMS with BLE & sub-1Ghz RF transmitter

2020-04-21

Description

The SNP736 is a sensor for air pressure measurements designed for TPMS (Tire Pressure Monitoring System) applications.

Features

- Calibrated pressure sensor for absolute pressure measurement
- Temperature and supply voltage sensor
- 8051 based microcontroller
- Standby current 0.9uA
- RF Transmitter 433MHz/315MHz/2.4GHz integrated
- External/Internal accelerometer
- Support LF programming
- Absolute Pressure range: 450kPa/900kPa/1500kPa

RF1			**Comment**
Frequency		315 / 433.92	MHz – programmable about centre freq
PA		On chip	3.5 ~10 dBm output power
Modulation		ASK / FSK	
FSK deviation		90	kHz – programmable
Format		Manchester	Mark/space also supported
RF2			**Comment**
Frequency		2.4GHz	MHz – programmable about centre freq
PA		On chip	4 dBm maximum output power
Modulation		GFSK	
LF (Wakeup, Programming)			
Format		Manchester	OOK & PWM also supported
Format speed		3.9/6.5	Kbps
Pressure			
Sensor resistance		20 to 3.3	kOhm
Main measure		ADC	12 bit
Temperature		-40~125℃	
Main measure		ADC	12 bit
On chip oscillator			
frequency		8/39/2000	KHz
Micro			
LF decoder		Fuzzy	Improves noise and distortion performance.
Flash		16	Kbytes
RAM		384	Bytes

GPIO		3	
Other			
Package		LGA 24Pin	SIP (System In Package)
Battery Supply		2.1~3.6	Volts

Applications

- Tire Pressure Monitoring System
- MEMs sensor

Functional Description

SNP736 consists of 16KB Flash memory, interrupt bus, configuration registers and control bus which operate the analogue circuitry all of which are controlled via an 8-bit integrated microcontroller. The micro is clocked by a tunable oscillator with a selectable center frequency. The motion detection is achieved via internal accelerometer.

Measurements of pressure, temperature, and battery voltage are performed under software control, and the data can be formatted and prepared for RF transmission by the microcontroller. A software defined wakeup mechanism is developed for minimizing power consumption. An Interval timer controls the timing of measurements and transmissions. The circuitry can be programmed to wake up at regular intervals or it can be woken up by the integrated LF Receiver, which furthermore enables the sensor to receive data.

The LF receiver supports wireless Flash programming to the chip with no need of I2C communication which demonstrates high efficiency in customer firmware development phase.

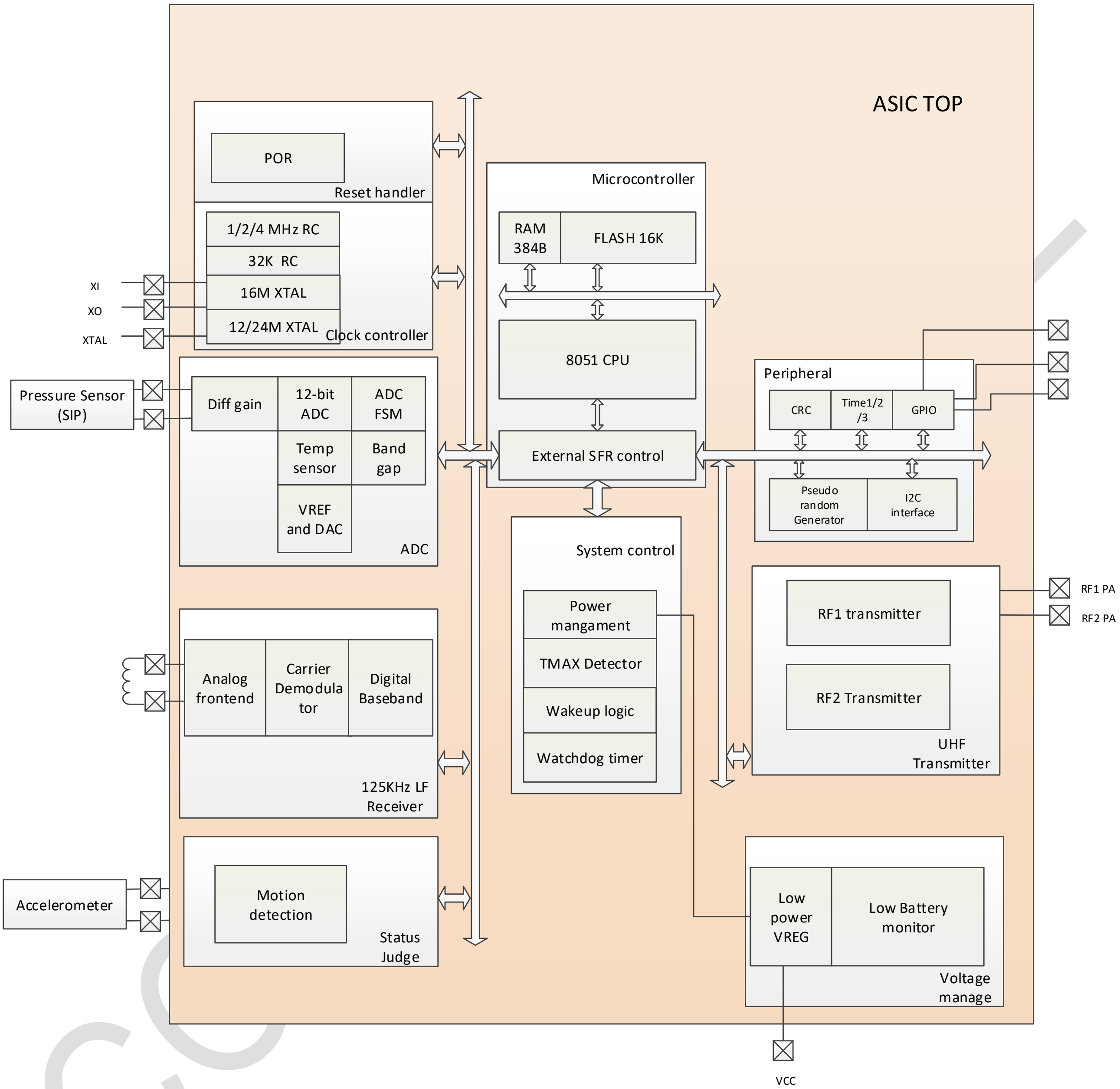
The integrated microcontroller is instruction set compatible to the standard 8051 processor. It is equipped with hardware Manchester, bi-phase encoder/decoder and CRC generator and checker, which enable easy implementations of customer specific applications.

The low-power RF1 Transmitter for 315 and 434 MHz contains a fully integrated PLL synthesizer, an ASK/FSK modulator and an efficient power amplifier.

The low-power RF2 Transmitter for 2.4GHz contains a fully integrated PLL synthesizer, an GFSK modulator and an efficient power amplifier.

On-chip Flash memory is integrated to store the customer specific application program code, the unique ID-number of the sensor and the calibration data for the sensor. Additionally, flash embedded library functions developed by SENASIC cover standard tasks used by the application.

Block Diagram



SNP736 Function Diagram for ASIC

Electrical Characteristics

Table 1 Absolute Maximum Ratings

Parameter	Symbol	Values			Unit	Note/Test Condition	Num.
		Min.	Typ.	Max.			
Supply Voltage	V_{bat}	-0.3	—	+3.8	V		1.1
Operating Temperature	T_j	-40	—	+125	℃	Normal mode	1.2
		-40	—	+150	℃	Idle mode	1.3
Storage Temperature	$T_{storage}$	-40	—	+150	℃	Device not powered	1.5
ESD HBM	$V_{ESD,HBM}$	-2000	—	+2000	V	All pins according to JS-001-2014	1.6
		-4000	—	+4000	V	RF pin according to JS-001-2014	1.7
ESD CDM	$V_{ESD,CDM}$	-500	—	+500	V	All pins according to JS-002-2014	1.8
Latch up	I_{LU}	-100	—	+100	mA	All pins according to JEDEC 78D	1.9
Input Voltage	Vin	-0.3	—	V_{bat}+0.3	V	GPIO0, GPIO1, GPIO2	1.10
		-0.3	—	V_{bat}+0.3	V	XTAL,XI,XO	1.11
		-0.3	—	V_{bat}+0.3	V	LFA, LFB	1.12
		-0.3	—	+0.3	V	GSA, GSB	1.13
Input and Output Current (digital IO pins)	$I_{io,dig}$	-10	—	+10	mA	GPIO0, GPIO1, GPIO2	1.14
	I_{in}	-10	—	+10	mA	LFA, LFB, XTAL, GSA, GSB	1.15

Table 2 Operating Range

Parameter	Symbol	Values			Unit	Note/Test Condition	Num.
		Min.	Typ.	Max.			
Supply Voltage	V_{bat1}	2.1	3.0	3.6	V	Measurement of pressure, acceleration, temperature and battery	2.1
	V_{bat2}	2.1	3.0	3.6	V	Operation of LF receiver	2.2
	V_{bat3}	2.1	3.0	3.6	V	RF transmission	2.3
	V_{bat4}	2.1	3.0	3.6	V	MCU, FLASH reading/ programming/erasing	2.4
Ambient Temperature	$T_{operating}$	-40	—	125	℃	Normal operation	2.6
	T_{Flash}	-20	—	90	℃	Flash programming/erasing	2.7

Table 3 Pressure Sensor

Parameter	Symbol	Values			Unit	Note/Test Condition	Num.
		Min.	Typ.	Max.			
Measurement Error	P_{Error}	-7	—	+7	KPa	T = 0…70℃, V_{bat}=2.1….3.6V	3.2
		-15	—	+15	KPa	T = -40…125℃, V_{bat}=2.1….3.6V	3.5
RAW LSB resolution	$P_{LSB, RAW}$		—	2.1	KPa	T = -40℃, V_{bat}=2.1….3.6V	3.6
			—	2.3	KPa	T = 25℃, V_{bat}=2.1….3.6V	3.7
			—	2.5	KPa	T = 125℃, V_{bat}=2.1….3.6V	3.8
Pressure Measurement Stability Range	P_{sta}	-2.75		2.75	KPa	Minimum 95% of the measurement	3.9

1) Above pressure error result was tested based on SNP736-3,SNP736-5 has a larger pressure error due to large pressure range ;about more information of SNP36-5 ,please contact with SENASIC FAE
2) For different pressure range SNP736-3 (900Kpa)detail pressure error is as below :

Temperature condition	0℃~70℃		-40~0℃；70~125℃	
Absolute Pressure(kPa)	100~500	500~900	100~500	500~900
Measurement Error(kPa)	±5	±7	±10	±15

3）SNP736-5 (1500Kpa)detail pressure error is as below :

Temperature condition	0℃~70℃			-40~0℃；70~125℃		
Absolute Pressure(kPa)	100~500	500~900	900~1500	100~500	500~900	900~1500
Measurement Error(kPa)	±7	±12	±20	±15	±25	±40

Table 4 Temperature Sensor

Parameter	Symbol	Values			Unit	Note/Test Condition	Num.
		Min.	Typ.	Max.			
Measurement Error	T_{Error}	-2	—	+2	℃	T = -20…70℃, V_{bat}=2.1….3.6V	6.1
		-3	—	+3	℃	T = -40…125℃,V_{bat}=2.1….3.6V	6.2
Temp Measurement Stability Range	T_{stab}	-1	—	+1	℃	Minimum 95% of the measurement	6.3

Table 5 Battery Sensor

Parameter	Symbol	Values			Unit	Note/Test Condition	Num.
		Min.	Typ.	Max.			
Measurement Error	V_{Error}	-3	—	+3	%	Percentage of measurement value	7.1

Table 6 Supply Currents

Parameter	Symbol	Values			Unit	Note/Test Condition	Num.
		Min.	Typ.	Max.			
Supply current at RF1 transmission (FSK, 433.92MHz)	$I_{RF433\_L2\_3V}$		9.67		mA	V_{bat}=3V, T=-40℃, Z_{load}= X ohm, RFout matched P_{out} ~ 8dBm	8.1
			9.38		mA	V_{bat}=3V, T=25℃, Z_{load}=X ohm, RFout matched P_{out} ~ 8dBm	8.2
			8.89		mA	V_{bat}=3V, T=125℃, Z_{load}= X ohm, RFout matched P_{out} ~ 8dBm	8.3
Supply current at RF1 transmission (FSK, 433.92MHz)	$I_{RF433\_L1\_3V}$		6.1		mA	V_{bat}=3V, T=-40℃, Z_{load}= X ohm, RFout matched P_{out} ~ 5dBm	8.4
			5.9		mA	V_{bat}=3V, T=25℃, Z_{load}= X ohm, RFout matched P_{out} ~ 5dBm	8.5
			5.6		mA	V_{bat}=3V, T=125℃, Z_{load}= X ohm, RFout matched P_{out} ~ 5dBm	8.6
Supply current at RF1 transmission (FSK, 433.92MHz)	$I_{RF433\_L3\_3V}$		12.5		mA	V_{bat}=3V, T=-40℃, Z_{load}= X ohm, RFout matched P_{out} ~ 10dBm	8.7
			11.8		mA	V_{bat}=3V, T=25℃, Z_{load}= X ohm, RFout matched P_{out} ~ 10dBm	8.8
			11.3		mA	V_{bat}=3V, T=125℃, Z_{load}= X ohm, RFout matched P_{out} ~ 10dBm	8.9
Supply current at RF2 transmission (GFSK, 2.4GHz)	I_{RFtx2}		12		mA	Vbat=3V, T=-40℃~85℃, Zload= X ohm, RFout matched Pout ~ 4dBm	8.10

Table 6.1 Supply Currents(cont'd)

Parameter	Symbol	Values			Unit	Note/Test Condition	Num.
		Min.	Typ.	Max.			
Supply current in power down state	I_{PWD_3V}		-	0.3	uA	V_{bat}=3V, T=25℃	8.13
			-	0.9	uA	V_{bat}=3V, T=90℃	8.14
			1.6	3.5	uA	V_{bat}=3V, T=125℃	8.15
				0.2	uA	V_{bat}=3V, T=-40℃	
Supply current in idle state	I_{IDLE_3V}		-	59	uA	V_{bat}=3V, T=25℃	8.21
			-	77	uA	V_{bat}=3V, T=90℃	
			88	152	uA	V_{bat}=3V, T=125℃	8.22
			-	64	uA	V_{bat}=3V, T=-40℃	
Supply current in run state (Peripheral units in active state, 32KHz)	I_{RUN_3V}		-	618	uA	V_{bat}=3V, T=25℃	8.23
			-	566	uA	V_{bat}=3V, T=90℃	
			-	576	uA	V_{bat}=3V, T=125℃	8.24
			-	695	uA	V_{bat}=3V, T=-40℃	
Supply current in run state (PLL enabled)	$I_{RUN\_3V,PLL}$		2.6		mA	V_{bat}=3V, T=25℃, P_{out} ~ 8dBm, Power Level 2	8.25
					mA	V_{bat}=3V, T=90℃, P_{out} ~ 8dBm, Power Level 2	
			2.4		mA	V_{bat}=3V, T=125℃, P_{out} ~ 8dBm, Power Level 2	8.26
			2.2		mA	V_{bat}=3V, T=-40℃, P_{out} ~ 8dBm, Power Level 2	
Supply current in thermal shutdown	I_{TSHD_3V}		2.8	4.6	uA	V_{bat}=3V, T=125℃	8.19
LF Receiver current	I_{LF_3V}			9	uA	V_{bat}=3V, T=25℃	8.27
				11	uA	V_{bat}=3V, T=90℃	
				12	uA	V_{bat}=3V, T=125℃	
				8	uA	V_{bat}=3V, T=-40℃	

Table 7 RF1 Transmitter

Parameter	Symbol	Values			Unit	Note/Test Condition	Num.
		Min.	Typ.	Max.			
Transmit Frequency	$f_{TX,433.92MHz}$	432	433.92	444	MHz		9.2
Output Power transformed into 50 Ohm	$P_{O,L1,433.92MHz}$		5.6		dBm	V_{bat}=3.0V, T=25℃ Z_{load}=50 ohm RF matched Power Level=1	9.5
Output Power transformed into 50 Ohm	$P_{O,L2,433.92MHz}$		7.7		dBm	V_{bat}=3.0V, T=25℃ Z_{load}=50 ohm RF matched Power Level=2	9.6
Output Power transformed into 50 Ohm	$P_{O,L3,433.92MHz}$		9.8		dBm	V_{bat}=3.0V, T=25℃ Z_{load}=50 ohm RF matched Power Level=3	
Output Power change over temp.	$dP_{-40℃}$		0.6		dB	V_{bat}=3.0V, T=-40℃	9.13
Output Power change over temp.	$dP_{125℃}$		-1.1		dB	V_{bat}=3.0V, T=125℃	9.14
Output Power change over supply	$dP_{1.9V}$	-10.1	-7.1		dB	V_{bat}=1.9V, T=25℃	9.15
Output Power change over supply	$dP_{2.1V}$	-5.5	-4.8		dB	V_{bat}=2.1V, T=25℃	9.17
Output Power change over supply	$dP_{3.6V}$	1.6	1.9		dB	V_{bat}=3.6V, T=25℃	9.18
Datarate	DR_{RF}			19.6	Kbit/s	Manchester coded	9.19
Datarate accuracy	dDR_{RF}	-1		+1	%		9.20
Reference Spur	$P_{spur,433.92MHz}$			-50	dBc		9.22
Carrier Harmonics	$P_{h2,433.92MHz}$	-33		-28	dBc	2nd harmonics	9.21
Phase Noise	$P_{PN,10KHz}$			-80	dBc/Hz		9.25
	$P_{PN,100KHz}$			-80	dBc/Hz		9.26
	$P_{PN,1MHz}$			-90	dBc/Hz		9.27
	$P_{PN,10MHz}$			-120	dBc/Hz		9.28
FSK frequency shift		0	+/-45		KHz	Programmable	
RF Data Duty Cycle	$DC_{RF,ASK}$	45	50	55	%	Valid only for ASK[1)]	
ASK Mod depth	$MD_{RF,ASK}$	90			%		

1) ASK duty cycle is defined at -3dB of the max. RF power during ASK is on

Table 8 LF Receiver Characteristics

Parameter	Symbol	Values			Unit	Note/Test Condition	Num.
		Min.	Typ.	Max.			
LF Carrier Frequency	f_{LF}	-5%	125	+5%	KHz		
LF Data Rate	DR_{LF}	-3%	3.9	+5%	Kbit/s		10.6
LF input differential capacitance	$C_{LF,diff}$	2	3.9	10	pF	At 125KHz	
LF input differential resistance	$R_{LF,diff}$	1			Mohm	At 125KHz, -40℃ to 90℃	
LF Receiver settling time after power on	t_{ON_set}			15	ms	After LF receiver power-on till passing MLF preamble	
LF Detection Sensitivity	S_{nodet}	0.1			mVpp	DR_{LF}=3.9KHz, 100% modulation depth	10.12
	S_{det}				mVpp	DR_{LF}=3.9KHz, 100% modulation depth, -20℃ to 90℃	
				2	mVpp	DR_{LF}=3.9KHz, 100% modulation depth, -40℃ to 125℃	10.13

Table 9 Crystal Oscillator1

Parameter	Symbol	Values			Unit	Note/Test Condition	Num.
		Min.	Typ.	Max.			
Crystal frequency range	f_{XTAL}		24		MHz	12MHz optional	12.0
Crystal tolerance		-50		+50	ppm		
Crystal load capacitance			6		pF		12.2
Crystal Oscillator startup time	t_{XTAL_start}			2	ms		12.1

Table 10 Crystal Oscillator2

Parameter	Symbol	Values			Unit	Note/Test Condition	Num.
		Min.	Typ.	Max.			
Crystal frequency range	f_{XTAL}		32		MHz		13.0
Crystal tolerance		-50		+50	ppm		
Crystal load capacitance			12/9		pF		13.2
Crystal Oscillator startup time	t_{XTAL_start}			2	ms		13.1

Table 10 Power On Reset

Parameter	Symbol	Values			Unit	Note/Test Condition	Num.
		Min.	Typ.	Max.			
Power on reset level	V_{POR}	1.0		1.65	V	Measured at Pin V_{bat}	16.1
Power on reset release level	V_{THR}	1.1		1.7	V	Measured at Pin V_{bat}	16.3
Power on reset time	t_{POR}			0.5	ms		16.4

Table 11 Voltage Regulator

Parameter	Symbol	Values			Unit	Note/Test Condition	Num.
		Min.	Typ.	Max.			
Regulated output voltage	V_{REG}		1.8		V	V_{bat}=2.1V – 3.6V	17.1
External Capacitance at Vreg Pin	C_{VREG}		1		uF		17.6

Table 12 Battery Monitor

Parameter	Symbol	Values			Unit	Note/Test Condition	Num.
		Min.	Typ.	Max.			
Low battery threshold warning level	TH_{LBAT}	2.2	2.3	2.4	V	Used by ROM Library functions only	18.1

Table 13 FLASH Memory

Parameter	Symbol	Values			Unit	Note/Test Condition	Num.
		Min.	Typ.	Max.			
Erase/Program temperature	T_{FL}	-20		90	℃		19.1
Erase/Program supply voltage	V_{bat}	2.1	3.0	3.6	V		19.2
Flash memory data retention time	$t_{RetFlash}$	10			y	Defect rate < 1ppm over lifetime for typical mission temperature profile	

Flash write cycles (Endurance)	N_{write}	1K			cycles	Programming/erase cycles per wordline	19.3
Flash line write time	t_{write_line}			7.8	ms		19.5

Table 14 Thermal Shutdown

Parameter	Symbol	Values			Unit	Note/Test Condition	Num.
		Min.	Typ.	Max.			
Thermal shutdown HOT threshold	$T_{HOT,TH}$			125	℃	Used by Library functions only	20.2
Thermal shutdown HOT release	$T_{HOT,RE}$	95			℃		20.1

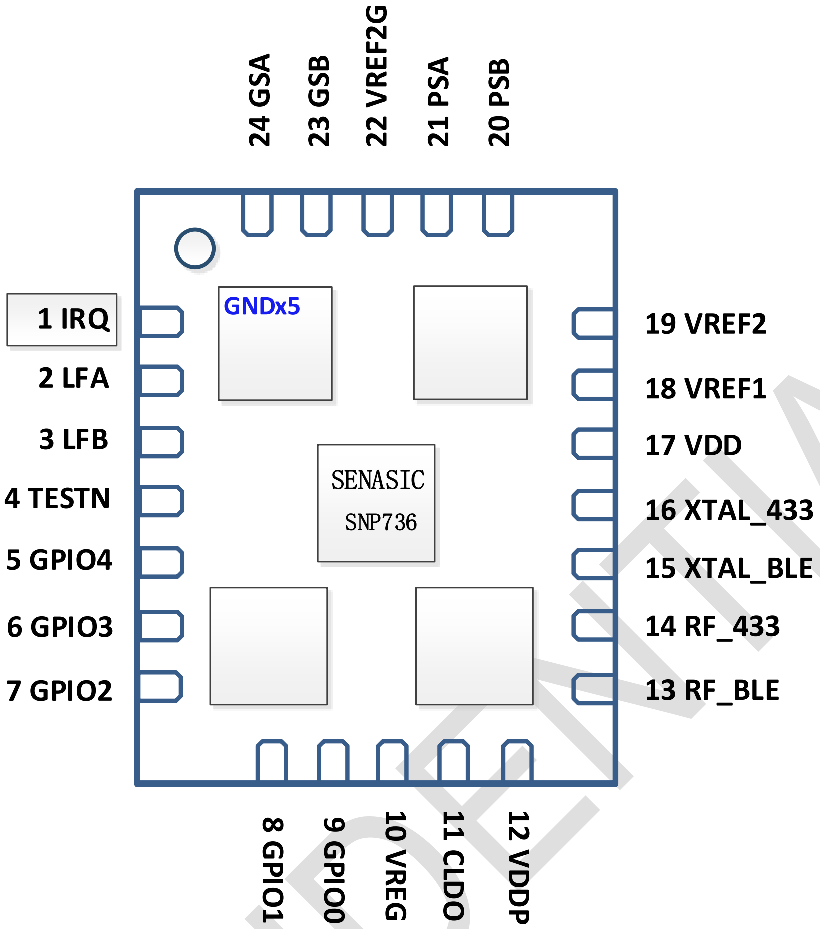
Table 15 Digital I/O pins

Parameter	Symbol	Values			Unit	Note/Test Condition	Num.
		Min.	Typ.	Max.			
Input Low voltage	V_{IL}			$0.2V_{bat}$	V		22.1
Input High voltage	V_{IH}	$0.8V_{bat}$			V		22.2
Output Low voltage	V_{OL}			$0.2V_{bat}$	V	I_{OL}=4mA/6mA	22.3
Output High voltage	V_{OH}	$0.8V_{bat}$			V	I_{OL}=4mA/6mA	22.4
Digital Pin Output Current	$I_{in,DIG}$	-4		4	mA	Programmable, 6mA optional	
Digital Pin Input Capacitance	$C_{in,DIG}$			10	pF		22.6

Table 16 I^{2}C Interface

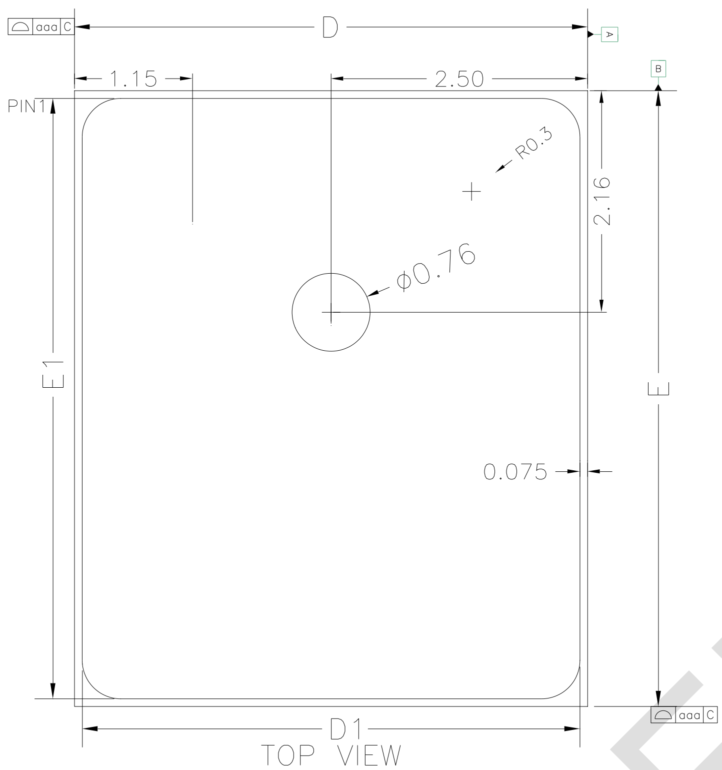
Parameter	Symbol	Values			Unit	Note/Test Condition	Num.
		Min.	Typ.	Max.			
I^{2}C bitrate	DR_{I2C}			400	Kb/s		23.1

Package Dimensions

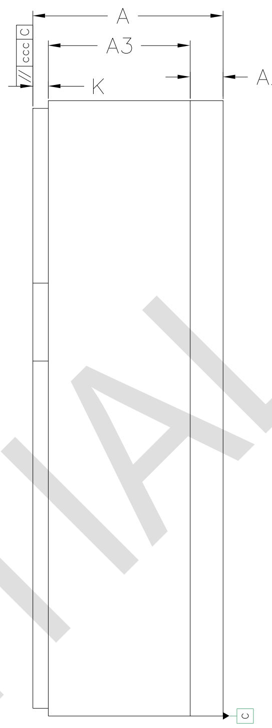


Pin Assignment Table

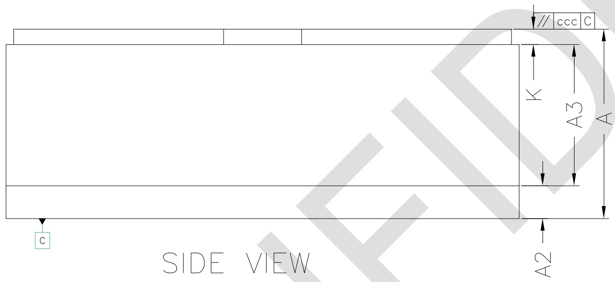
Pin	Name	Type	Function
1	IRQ	N.C.	N.C., just place a test point on board
2	LFA	Analog IO	LF channel coil connection
3	LFB	Analog IO	LF channel coil connection
4	TESTN	Digital In	Active high, test mode entry. Pull down by default
5	GPIO4	Digital IO	General purpose IO
6	GPIO3	Digital IO	General purpose IO
7	GPIO2	Digital IO	General purpose IO (for BLE internal used)
8	GPIO1	Digital IO	GPIO / I2C data (for BLE internal used)
9	GPIO0	Digital IO	GPIO / I2C Clock
10	VREG	Supply	Supply 1.8V from internal regulator
11	CLDO	Analog IO	Internal LDO bypass capacitor
12	VDDP	Supply	Supply for BLE and 433/315Mhz RF port
13	RF_BLE	Analog IO	RF2 output
14	RF_433	Analog IO	RF1 output (for 433Mhz and 315Mhz)
15	XTAL_BLE	Analog IO	Crystal for BLE , it should be 32Mhz
16	XTAL_433	Analog IO	Crystal for sub-1Ghz, it could be 16Mhz/24Mhz
17	VDD	Supply	Battery supply 3V
18	VREF1	Analog IO	100nF to ground
19	VREF2	Analog IO	Reference voltage for internal pressure sensor
20	PSB	Analog IO	Differential input from pressure, not used
21	PSA	Analog IO	Differential input from pressure, not used
22	VREF2G	Analog IO	Accelerometer common end
23	GSB	Analog IO	Differential input from accelerometer, not used
24	GSA	Analog IO	Differential input from accelerometer, not used
25~29	GNDx5	Supply	Ground(EPAD) five ground pad are connected together



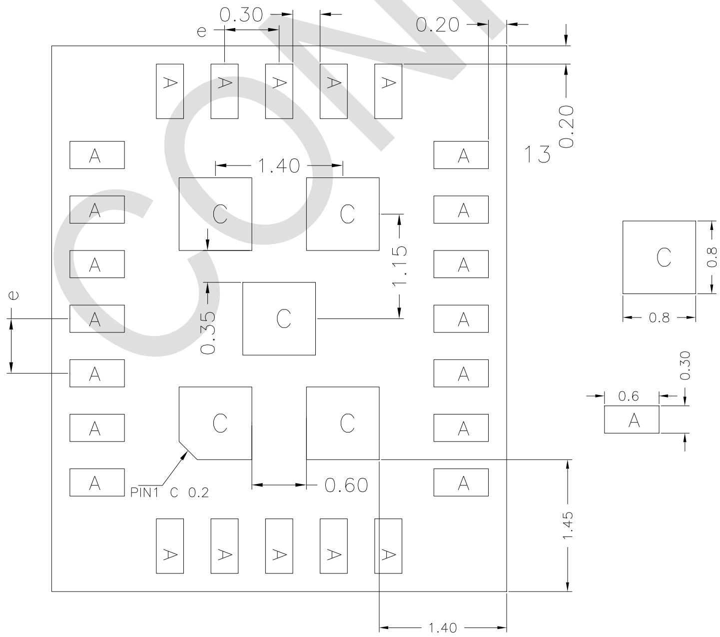
TOP VIEW



SIDE VIEW



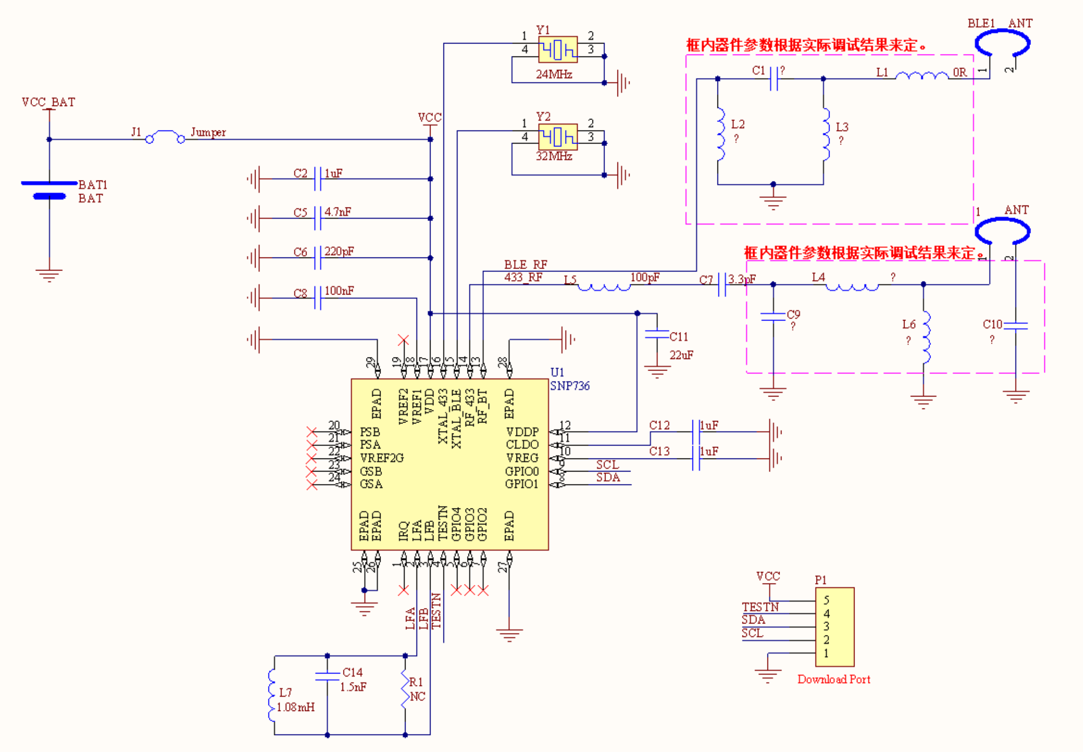
SIDE VIEW



BOTTOM VIEW

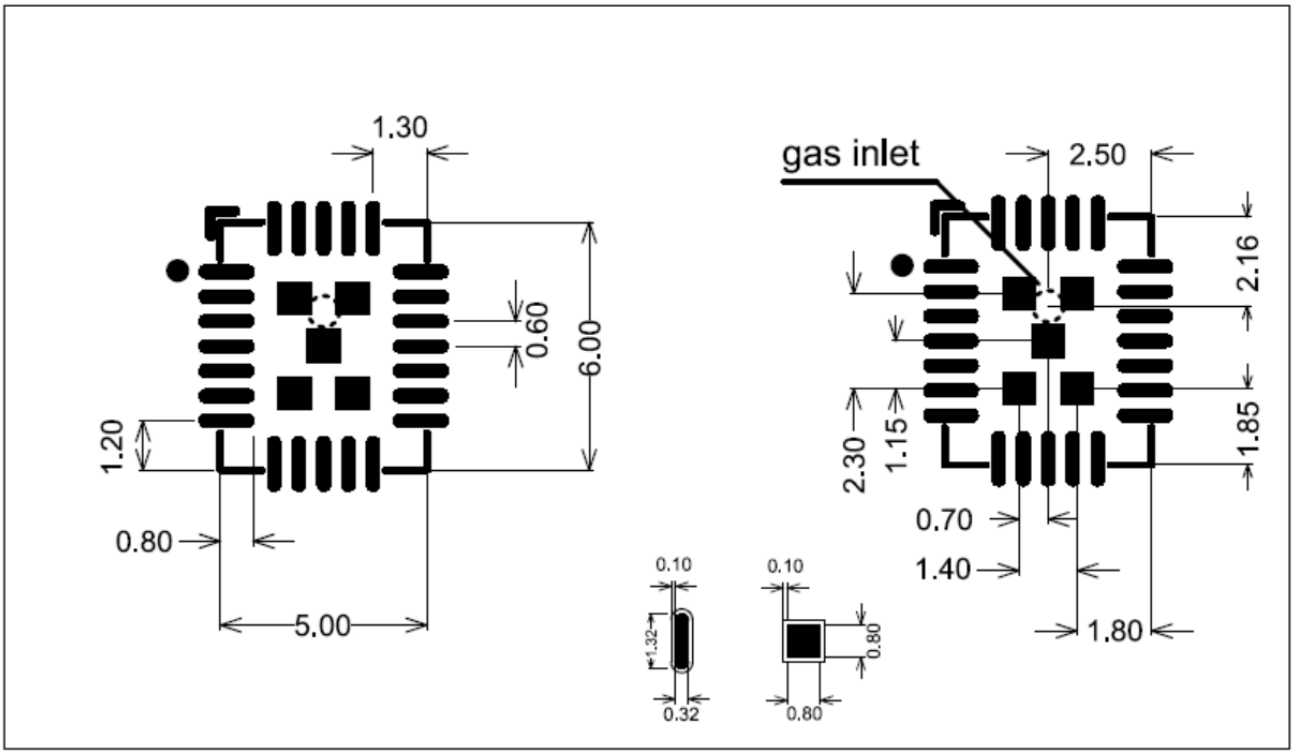
MILLIMETER			
SYMBOL	MIN	NOR	MAX
A	1.75	1.85	1.95
A2	0.27	0.32	0.37
A3	1.33	1.38	1.43
K	0.12	0.15	0.18
D	4.90	5.00	5.10
D1	4.80	4.85	4.90
E	5.90	6.00	6.10
E1	5.80	5.85	5.90
e	BSC 0.6		
aaa	0.10		
ccc	0.05		

Application Circuit



Dual mode: RF-BLE and RF315MHz/433MHz

Footprint



Revision history

VERSION	DATE	NOTE
1.0	2020/02/08	Initial version
1.1	2020/04/20	Update pin description, add typical application schematic