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**SNP705**

**Highly integrated tire pressure monitoring sensor**

# SNP705 Datasheet

Release version: Version 2.6

Release date: 2022-12-30

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## Features

- Calibrated pressure sensor for absolute pressure measurement
- Temperature and supply voltage sensor
- 8051 based microcontroller
- Standby current 0.25uA
- RF Transmitter 433MHz/315MHz integrated
- External accelerometer
- Support LF programming
- Absolute Pressure range:900kPa/1900kPa

## General Description

The SNP705X is a sensor for air pressure measurements designed for TPMS (Tire Pressure Monitoring System) applications.

## Applications

- Tire Pressure Monitoring System
- MEMs sensor

## Key Parameters

Key Parameters		Comment
<b>RF</b>		
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
<b>LF (Wakeup, Programming)</b>		
Format	Manchester	OOK & PWM also supported
Format speed	3.9/6.5	Kbps
<b>Pressure</b>		
Sensor resistance	20 to 3.3	KOhm
Main measure	ADC	12 bit
<b>Temperature</b>		
Temperature	-40~125°C	
<b>On chip oscillator</b>		
frequency	4/39/2000	KHz
<b>Micro</b>		
LF decoder	Fuzzy	Improves noise and distortion performance.
Flash	16	Kbytes
RAM	384	Bytes
GPIO	3	
<b>Other</b>		
Package	LGA 24Pin	SIP (System In Package)
Battery Supply	2.1~3.6	Volts

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**List of Abbreviations(keyword:TPMS )**

Abbreviations	Full spelling	Chinese explanation
PA	Power Amplifier	功率放大器
AON	Always Online	始终在线
LGA	Land Grid Array	栅格阵列封装
WAM	Wheel Auto Mapping	车轮自动定位
MCU	Microcontroller Unit	微控制单元
FLASH	Flash Memory	闪存
ADC	Analog to Digital Converter	模数转换器
RAM	Random Access Memory	随机存取存储器
RF	Radio Frequency	射频
LF	Low Frequency	低频
UART	Universal Asynchronous Receiver/Transmitter	通用异步收发传输器
SPI	Serial Peripheral Interface	串行外围设备接口
I2C	Inter Integrated Circuit	两线式串行总线
TPMS	Tire Pressure Monitoring System	胎压监测系统
MEMS	Micro Electromechanical System	微机电系统
ASK	Amplitude Shift Keying	幅移键控
FSK	Frequency Shift Keying	频移键控
CRC	Cyclic Redundancy Check	循环冗余校验
POR	Power On Reset	上电复位
BOR	Brown Out Reset	欠电复位
XTAL	External Crystal Oscillator	外部晶振
SFR	Special Function Register	特殊功能寄存器
IRAM	Internal RAM	内部RAM
XRAM	External RAM	外部RAM
PWM	Pulse Width Modulation	脉冲宽度调制
PLL	Phase Locked Loop	锁相环
CPU	Central Processing Unit	中央处理单元

## 1 Introduction

SNP705X consists of 16KB Flash memory, interrupt bus, configuration registers and control bus which operate the analogue circuitry all of which are controlled via a 8-bit integrated microcontroller. The micro is clocked by a tunable oscillator with a selectable center frequency. The motion detection is achieved via external 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 RF Transmitter for 315 and 434 MHz contains a fully integrated PLL synthesizer, an ASK/FSK modulator and an efficient power amplifier.

The accelerometer interface can support external dual-axis accelerometer to detect tire roll status.

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.

**Table 1-1 Order Information**

Model	Pressure Range	Package	Ordering Number	Packing Option
SNP705H	100 ~ 900	LGA24	SNP705H	3000ea/Reel
SNP705N	100 ~ 1500		SNP705N	3000ea/Reel

## 2 Block Diagram

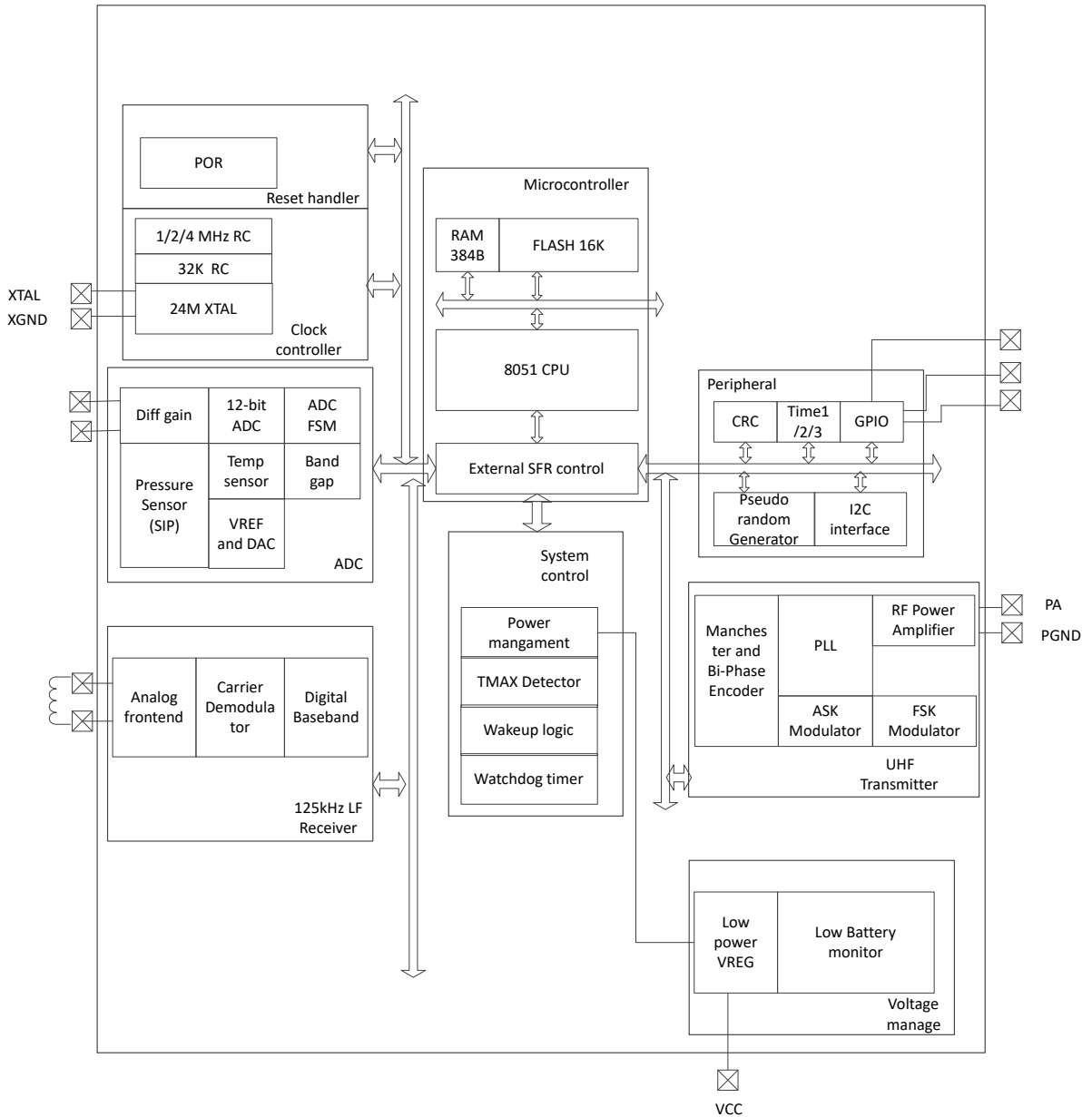


Figure 2-1 Block Diagram



### 3 Pin Description

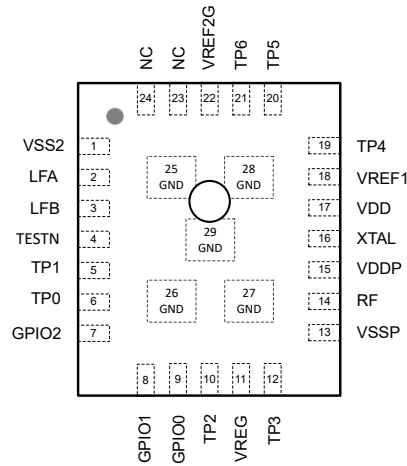


Figure 3-1 Pin Configuration(Top View)

Table 3-1 Pin Description

Pin No.	Name	Pin Type	Function
1	VSS2	Supply	Ground
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	TP1		N.C., just place a test point on board
6	TP0		N.C., just place a test point on board
7	GPIO2	Digital IO	GPIO / Test mode output
8	GPIO1	Digital IO	GPIO / I2C data
9	GPIO0	Digital IO	GPIO / I2C Clock
10	TP2		N.C., just place a test point on board
11	VREG	Supply	Supply 1.8V from internal regulator
12	TP3		N.C., just place a test point on board
13	VSSP	Supply	Ground
14	RF	Analog IO	RF output
15	VDDP	Supply	Battery supply 3V
16	XTAL	Analog IO	XTAL pin(12/24MHz)
17	VDD	Supply	Battery supply 3V
18	VREF1	Analog IO	100nF to ground
19	TP4		N.C., just place a test point on board
20	TP5		N.C., just place a test point on board
21	TP6		N.C., just place a test point on board
22	VREF2G	Analog IO	Accelerometer common end
23	NC	Analog IO	N.C., just place a test point on board
24	NC	Analog IO	N.C., just place a test point on board
25~29	EPAD	Supply	Ground

## 4 Specification

### 4.1 Absolute Maximum Ratings

Table 4-1 Absolute Maximum Ratings

Parameter	Symbol	Values			Unit	Note/Test Condition
		Min.	Typ.	Max.		
Max. Supply Voltage	$V_{DDmax}$	-0.3		+3.8	V	
Operating Temperature	$T_j$	-40		+125	°C	Normal mode
		-40		+150	°C	Idle mode
Storage Temperature	$T_{storage}$	-40		+150	°C	Device not powered
ESD robustness HBM	$V_{ESD\_HBM}$	-2000		+2000	V	All pins according to JS-001-2014
		-4000		+4000	V	RF pin according to JS-001-2014
ESD robustness CDM	$V_{ESD\_CDM}$	-500		+500	V	All pins according to JS-002-2014
Latch up	$I_{LU}$	-100		+100	mA	All pins according to JEDEC 78D
Input Voltage	$V_{in}$	-0.3		$V_{DD}+0.3$	V	GPIO0, GPIO1, GPIO2
		-0.3		$V_{DD}+0.3$	V	XTAL
		-0.3		$V_{DD}+0.3$	V	LFA, LFB
Input and Output Current (digital IO pins)	$I_{io,dig}$	-10		+10	mA	GPIO0, GPIO1, GPIO2
	$I_{in}$	-10		+10	mA	LFA, LFB, XTAL

### 4.2 Operating Range

Table 4-2 Operating Range

Parameter	Symbol	Values			Unit	Note/Test Condition
		Min.	Typ.	Max.		
Supply Voltage	$V_{DD}$	2.1	3.0	3.6	V	
Ambient Temperature	$T_{operating}$	-40		125	°C	Normal operation
	$T_{Flash}$	-40		90	°C	Flash programming/erasing

### 4.3 Characteristics

#### 4.3.1 Pressure Sensor

Table 4-3 Pressure Sensor

Parameter	Symbol	Values			Unit	Note/Test Condition
		Min.	Typ.	Max.		
Measurement Error	$P_{Error}$	-7		7	kPa	0°C to +70°C, $V_{DD}=2.1\dots3.6V$
		-15		15	kPa	-40°C to 125°C, $V_{DD}=2.1\dots3.6V$
RAW LSB resolution	$P_{LSBr}, RAW$			2.1	kPa	T = -40°C, $V_{DD}=2.1\dots3.6V$
				2.3	kPa	T = 25°C, $V_{DD}=2.1\dots3.6V$
				2.5	kPa	T = 125°C, $V_{DD}=2.1\dots3.6V$
Pressure Measurement Stability Range	$P_{sta}$	-2.75		2.75	kPa	Minimum 95% of the measurement

**Note:**

[1] Above pressure error result was tested based on SNP705H,SNP705N has a larger pressure error due to large pressure range ;about more information of SNP705N ,please contact with SENASIC FAE.

[2] SNP705H (900kpa)detail pressure error is as below :

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

[3] SNP705N (1500kpa)detail pressure error is as below :

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

### 4.3.2 Temperature Sensor

Table 4-4 Temperature Sensor

Parameter	Symbol	Values			Unit	Note/Test Condition
		Min.	Typ.	Max.		
Measurement error	$T_{Error}$	-3		+3	°C	-20...70°C, $V_{DD}=2.1...3.6V$
		-5		+5	°C	-40...125°C, $V_{DD}=2.1...3.6V$
Random error	$T_{stab}$	-1		+1	°C	Minimum 95% of the measurement

### 4.3.3 Battery Sensor

Table 4-5 Battery Sensor

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

### 4.3.4 Supply Currents

Table 4-6 Supply Currents

Parameter	Symbol	Values			Unit	Note/Test Condition
		Min.	Typ.	Max.		
Supply current in power down state	$I_{PWD\_3V}$			0.3	μA	+25°C
			1.6	3.5	μA	+125°C
				0.2	μA	-40°C
Supply current in idle state	$I_{IDLE\_3V}$			59	μA	+25°C
			88	152	μA	+125°C
				64	μA	-40°C
Supply current in run state (Peripheral units in active state, 32kHz)	$I_{RUN\_3V}$			0.618	mA	+25°C
				0.576	mA	+125°C
				0.695	mA	-40°C
Supply current in run state (PLL enabled)	$I_{RUN\_3V,PLL}$		2.6		mA	+25°C
			2.4		mA	+125°C
			2.2		mA	-40°C

Parameter	Symbol	Values			Unit	Note/Test Condition
		Min.	Typ.	Max.		
Supply current at thermal shutdown	$I_{TSHD\_3V}$		2.8	4.6	$\mu A$	+125°C
LF Receiver current	$I_{LF\_3V}$			9	$\mu A$	+25°C
				12	$\mu A$	+125°C
				8	$\mu A$	-40°C
Supply current at RF transmission (FSK, 433.92MHz)	$I_{RF433\_L2\_3V}$		9.67		mA	+40°C
			9.38		mA	+25°C
			8.89		mA	+125°C
Supply current at RF transmission (FSK, 433.92MHz)	$I_{RF433\_L1\_3V}$		6.1		mA	+40°C
			5.9		mA	+25°C
			5.6		mA	+125°C
Supply current at RF transmission (FSK, 433.92MHz)	$I_{RF433\_L3\_3V}$		12.5		mA	+40°C
			11.8		mA	+25°C
			11.3		mA	+125°C

### 4.3.5 RF Transmitter

Table 4-7 RF Transmitter Characteristics

Parameter	Symbol	Values			Unit	Note/Test Condition
		Min.	Typ.	Max.		
Transmit Frequency	$f_{TX,433M,XTAL24M}$	432		444	MHz	XTAL 24MHz
	$f_{TX,315M,XTAL24M}$	312		324	MHz	XTAL 24MHz
Output Power transformed into 50 ohm	$P_{O,L1,433.92MHz}$		5.6		dBm	$V_{DD}=3.0V, T=25^{\circ}C, Z_{load}=50\text{ ohm}$ RF matched Power Level=1
	$P_{O,L2,433.92MHz}$		7.7		dBm	$V_{bat}=3.0V, T=25^{\circ}C, Z_{load}=50\text{ ohm}$ RF matched Power Level=2
	$P_{O,L3,433.92MHz}$		9.8		dBm	$V_{bat}=3.0V, T=25^{\circ}C, Z_{load}=50\text{ ohm}$ RF matched Power Level=3
Output Power change over temp	$dP_{-40^{\circ}C}$		0.6		dB	$V_{bat}=3.0V, T=-40^{\circ}C$
	$dP_{125^{\circ}C}$		-1.1		dB	$V_{bat}=3.0V, T=125^{\circ}C$
Output Power change over supply	$dP_{1.9V}$	-10.1	-7.1		dB	$V_{bat}=1.9V, T=25^{\circ}C$
	$dP_{2.1V}$	-5.5	-4.8		dB	$V_{bat}=2.1V, T=25^{\circ}C$
	$dP_{3.6V}$	1.6	1.9		dB	$V_{bat}=3.6V, T=25^{\circ}C$
RF Datarate	$DR_{RF}$			19.6	kbit/s	Manchester coded
RF Data Rate tolerance	$dDR_{RF}$	-1		+1	%	
Reference Spur	$P_{spur,433.92MHz}$			-50	dBc	
Carrier Harmonics	$P_{spur,433.92MHz}$	-33		-28	dBc	2 <sup>nd</sup> harmonics
Phase Noise	$P_{PN,10KHz}$			-80	dBc/Hz	
	$P_{PN,100KHz}$			-80	dBc/Hz	
	$P_{PN,1MHz}$			-90	dBc/Hz	
	$P_{PN,10MHz}$			-120	dBc/Hz	
FSK frequency shift		0	+/-45		kHz	Programmable
RF Data Duty Cycle	$DC_{RF,ASK}$	45	50	55	%	Valid only for ASK
ASK Mod depth	$MD_{RF,ASK}$	90			%	

Table 4-8 RF Crystal Oscillator

Parameter	Symbol	Values			Unit	Note/Test Condition
		Min.	Typ.	Max.		
Crystal Frequency	$f_{XTAL}$		24		MHz	
Crystal tolerance		-50		50	ppm	
Crystal load capacitance			6		pF	
Crystal Oscillator startup time	$t_{Xtal\_start}$		2		ms	

### 4.3.6 LF Receiver

Table 4-9 LF Receiver Characteristics

Parameter	Symbol	Values			Unit	Note/Test Condition
		Min.	Typ.	Max.		
LF Carrier Frequency <sup>[1]</sup>	$f_{LF}$	118	125	131	kHz	
LF Data Rate	$DR_{LF}$	3.8	3.9	4.1	kbit/s	
Input differential capacitance	$C_{LF\_diff}$	2	3.9	10	pF	At 125kHz
Input differential resistance	$R_{LF\_diff}$	1			MOhm	At 125kHz, -40°C to 90°C
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	
	$S_{det}$			2	mVpp	

**Note:** [1] LF sensitivity levels are only valid for the specified carrier frequency range.

### 4.3.7 Power On Reset

Table 4-10 Power On Reset

Parameter	Symbol	Values			Unit	Note/Test Condition
		Min.	Typ.	Max.		
Power on Reset level	$V_{POR}$	1.0		1.65	V	Measured at Pin $V_{DD}$
Power On Reset Release Level	$V_{THR}$	1.1		1.7	V	Measured at Pin $V_{DD}$
Power on reset time	$t_{POR}$			0.5	ms	

### 4.3.8 Voltage Regulator

Table 4-11 Voltage Regulator

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

### 4.3.9 Battery Monitor

Table 4-12 Battery Monitor

Parameter	Symbol	Values			Unit	Note/Test Condition
		Min.	Typ.	Max.		
Low battery threshold warning level	TH <sub>LBAT</sub>	2.2	2.3	2.4	V	Used by ROM Library functions only

### 4.3.10 FLASH Memory

Table 4-13 FLASH Memory

Parameter	Symbol	Values			Unit	Note/Test Condition
		Min.	Typ.	Max.		
Erase/Program temperature	T <sub>FL</sub>	-20		90	°C	
Erase/Program supply voltage	V <sub>DD</sub>	2.1	3.0	3.6	V	
Flash memory data retention time	t <sub>Ret Flash</sub>	10			y	Defect rate < 1ppm over lifetime for typical mission temperature profile
Flash write cycles (Endurance)	N <sub>write</sub>	1K			cycles	Programming/erase cycles per wordline
Flash line write time	t <sub>write_line</sub>			7.8	ms	

### 4.3.11 Thermal Shutdown

Table 4-14 Thermal Shutdown

Parameter	Symbol	Values			Unit	Note/Test Condition
		Min.	Typ.	Max.		
Thermal Shutdown HOT threshold	T <sub>HOT,TH</sub>			125	°C	
Thermal shutdown HOT release	T <sub>HOT,RE</sub>	95			°C	

### 4.3.12 Digital I/O pins

Table 4-15 Digital I/O pins

Parameter	Symbol	Values			Unit	Note/Test Condition
		Min.	Typ.	Max.		
Input Low voltage	V <sub>IL</sub>			0.2V <sub>DD</sub>	V	
Input High voltage	V <sub>IH</sub>	0.8V <sub>DD</sub>			V	
Output Low voltage	V <sub>OL</sub>			0.2V <sub>DD</sub>	V	I <sub>OL</sub> =4mA/6mA
Output High voltage	V <sub>OH</sub>	0.8V <sub>DD</sub>			V	I <sub>OL</sub> =4mA/6mA
Digital Pin Output Current	I <sub>in,DIG</sub>	-4		4	mA	Programmable, 6mA optional
Digital Pin Input Capacitance	C <sub>in,DIG</sub>			10	pF	

### 4.3.13 I2C Interface

Table 4-16 I2C Interface

Parameter	Symbol	Values			Unit	Note/Test Condition
		Min.	Typ.	Max.		
I2C bitrate	DR <sub>I2C</sub>			400	kb/s	

## 5 Application Circuit

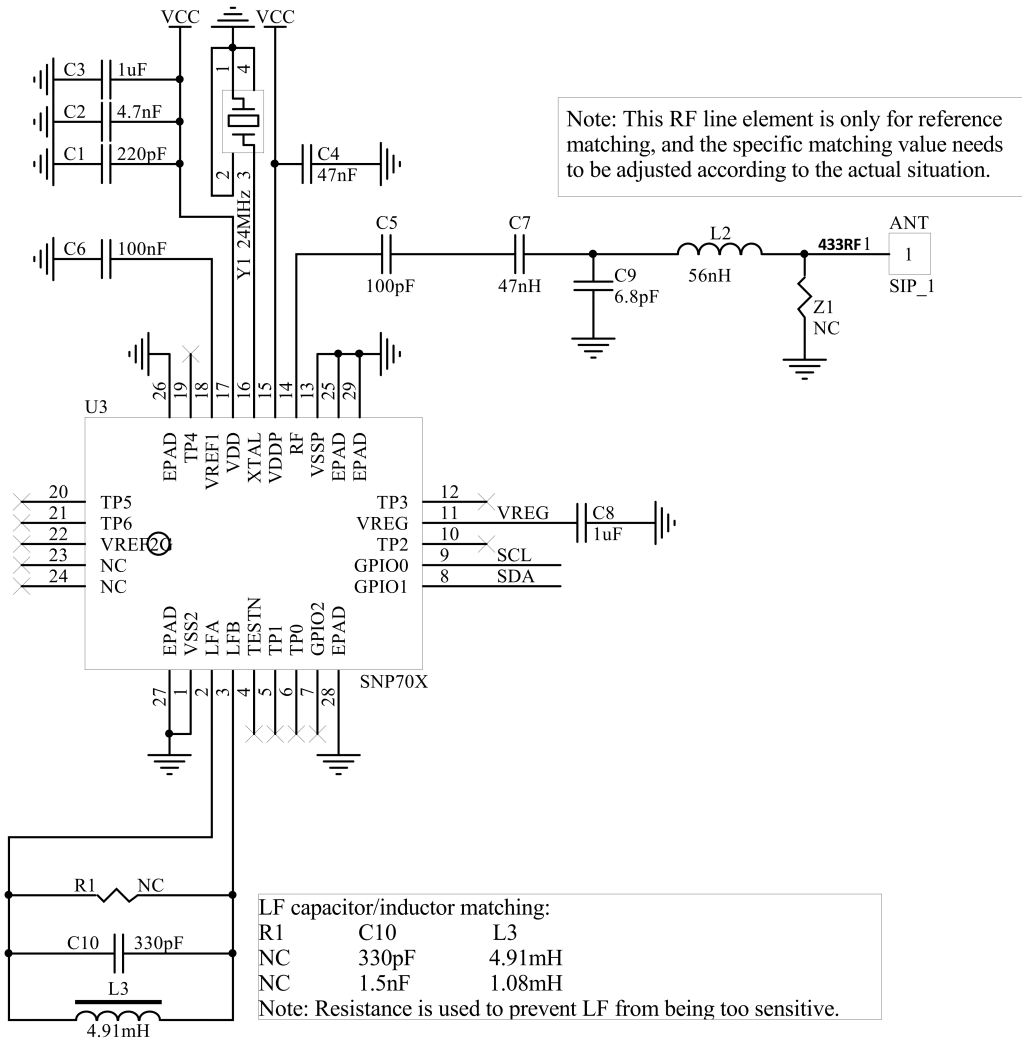


Figure 5-1 Application Circuit

**Note:** C5/C7/C9/L2/Z1 value might be changed according to different antenna.

## 6 Package Outline

### 6.1 Package Outline

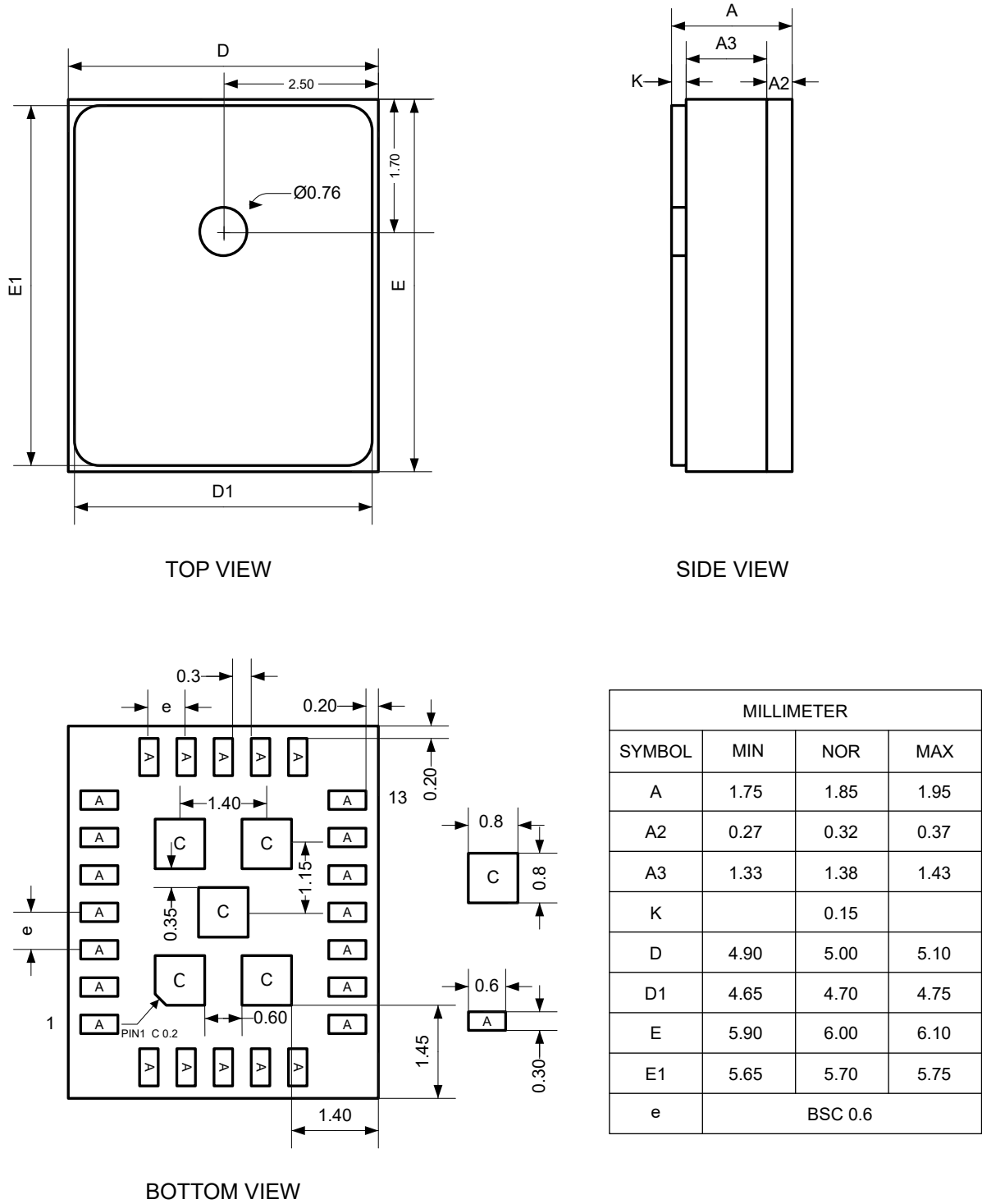


Figure 6-1 Package Outline



## 7 Revision history

Table 7-1 Revision history

VERSION	DATE	NOTE
1.0	2020/08/26	Initial version
2.6	2022/12/30	Delete absolute Pressure range:450kPa.