IN100

Ultra-Low Power Bluetooth Sensor Beacon SoC

Key Features

- **Bluetooth Low Energy 5.0 Compliant**
  - Enhanced privacy mode support
- **Beacon Mode**
  - Proprietary
  - iBeacon/Eddystone/Altbeacon compliant*
- **Ease of Use**
  - Ready-to-advertise out-of-box experience
  - No software programming required
- **Memory**
  - 4Kb eFuse memory
    - Adv payload storage
    - Manufacturer ID
  - 4KB SRAM
    - Dynamic payload storage
- **Low Power Mode Advertising**
  - Periodic advertising
  - Event triggered advertising
- **RF Radio**
  - 2.4GHz frequency band RF transmitter
  - MedRadio band support
  - Programmable Tx output power, up to +5dBm
- **System Power Consumption**
  - System starts as low as 0.8V
  - Sub-uW power consumption for multi-year operation on a tiny battery
  - Sleep mode < 500nA with 32KHz RC ON
- **Peripheral**
  - 1 UART
  - 1 I2C
  - Pulse Count Interface for digital sensor input
  - Built-in ultra-low leakage load switch x 2
  - Sensor ADC, 11bit
    - Chip temperature measurement
    - VCC voltage measurement
    - 4 channels for customer use
- **Clock Sources**
  - 26MHz XO Crystal
  - 32.768KHz RTC Crystal (optional)
- **Security and Privacy**
  - AES-128 based authentication
  - AES-128 based encryption
  - Privacy protection: resolvable private address
  - Anti-Cloning: time-varying payload in the beacon
- **Power Supply**
  - Integrated low leakage LDO
  - 1.1 - 3.6V input
  - Single cell 1.5V battery support
- **Operating temperature**
  - -40°C ~ +85°C (industrial, see ordering info)
  - -40°C ~ +125°C (full range industrial, see ordering info)
- **Packaging**
  - DFN8 2.5mm x 2.5mm
  - QFN18 3.0mm x 3.0mm

Typical Applications

- Standalone retail beacon
- Wireless sensor
- Asset tracking
- Beacon tag for RTLS (Real Time Location System)
- Active RFID
- Low power alarm system
- Wireless ID tag for healthcare
- Wireless industrial application
- Fitness and wellness

* iBeacon is a trademark of Apple Inc.
* Eddystone is a trademark of Google Inc.

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1. Product Overview

IN100 is a member of InPlay's NanoBeacon™ SoC product family, which supports Bluetooth low energy beacon in ISM 2.4GHz frequency band and proprietary beacon mode in either 2.4GHz ISM frequency band or MedRadio frequency band. This SoC device features an efficient and configurable state machine, non-volatile memory for user pre-defined data payload and data SRAM for dynamic data storage , analog to digital converter, security engine and power management in a QFN form factor package as small as 2.5mm x 2.5mm. The device has very low power consumption and low overall BOM material. It is ideal for coin cell battery or single cell 1.4V/1.5V battery-powered applications such as disposable beacon tags or wireless smart sensors.

Software programming free Bluetooth: IN100 is designed for maximum ease of use. There's no need to do any Bluetooth related software programming in order to use this device. Once the device is properly configured it automatically transmits Bluetooth low energy advertising packet or proprietary format advertising packet. The advertising data payload can be predefined user data stored on-chip or dynamic data acquired from sensors or an external microcontroller. User can refer to BeaconConfig PC GUI tool provided by InPlay to configure the advertising mode and data payload.

Single cell (sub-1.5V) battery operation, Nanowatt power consumption: IN100 device can operate at battery voltages as low as 1.1V, so a popular 1.5V single cell battery is sufficient to power the device. When the device is operating in sleep mode, it consumes less than 500nA from the battery.

Flexible features for pairing with MCU & sensors: In addition to the standalone beacon mode, the device is designed to pair with a companion MCU and/or sensors. When the device is used with a microcontroller, the adverting data payload and control mode can be changed on-the-fly via the UART interface. Sensors with either analog or digital outputs can be used with the device. It supports multiple ADC input channels with 11-bits resolution. It has a linear scaling post-processing unit to condition readings before transmitting them wirelessly. In addition, there are two low-leakage load switches that turn power on or off to any external circuitry, including the sensor ICs.

Low system BOM material: The IN100 does not require external RF matching components when interfacing to a 50Ω impedance. It does require a 26MHz crystal for accurate local oscillator generation. For applications that require an accurate real-time clock, a 32.768kHz crystal must be installed on-board. For both the 26MHz and 32.768kHz crystal interfaces there is a programmable on-chip capacitors that eliminates the need for on-board load capacitors for most crystals.

Security engine: A built-in hardware security engine supports AES128 and EAX encryption and decryption algorithms with/without authentication. A built-in True Random Number Generator (TRNG) facilitates secure applications.

Figure 1 shows System block diagram of NanoBeacon™ SoC IN10x product family. Features available will vary by part number. For more information on available features of different devices, please refer to Ordering Information.

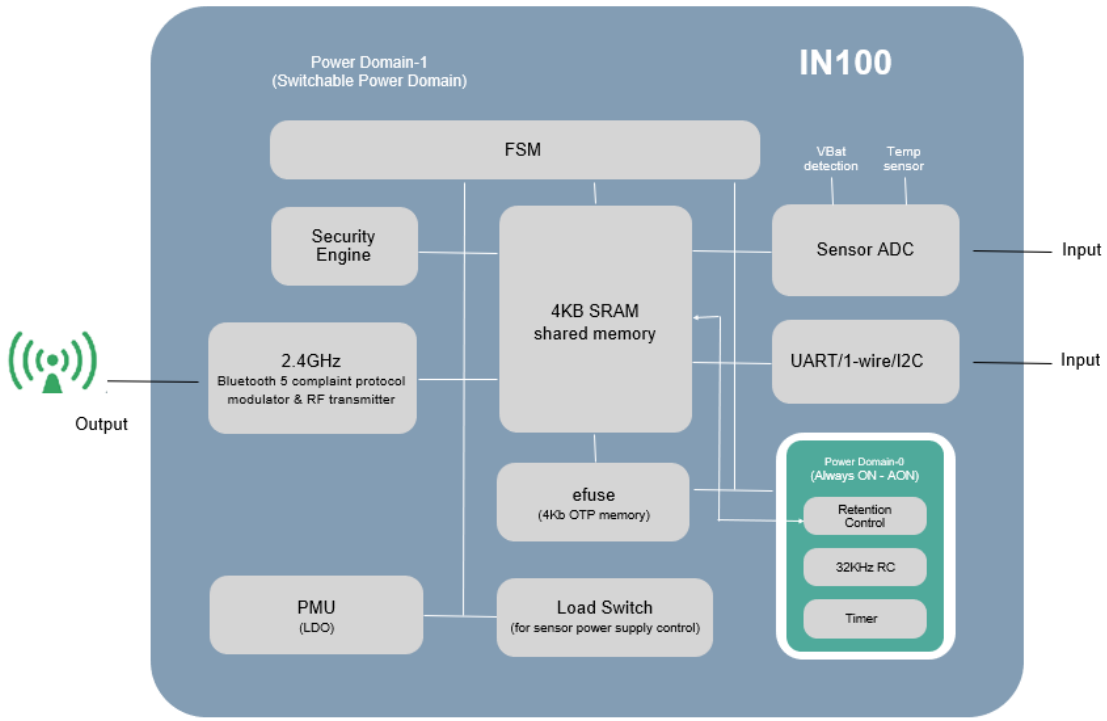


Figure 1 System Block Diagram

Memory: This device has two types of memory built-in:

- 4Kb OTP memory (eFuse): To store user advertising data payload, security key and predefined register settings with one-time programming prior to usage.
- 4KB SRAM: For dynamic advertising data storage. Data in SRAM can be retained in memory during sleep mode when only the always on (AON) domain is active.

Advertising data: IN100 can do non-connected advertising.

- Predefined data: Data is either stored in eFuse OTP memory or on-chip SRAM.
- Real time measurement data: Measurements come from internal on-chip sensors or external sensors with either analog or digital outputs to the IN100.

Types of advertising & data encryption: Periodic advertising and event driven advertising with data be encrypted or unencrypted with/without authentication.

- Periodic advertising: The advertising happens in every advertising interval, which is configurable.
- Event driven advertising: The advertising only happens when some external events have happened. An example event is when a sensor ADC measurement is larger or smaller than a predefined threshold.

The device supports privacy with random/resolvable advertising address. It supports enhanced privacy of user data payload as well thanks to its built-in hardware security engine.

Load switch control: Two power supply switches are available to provide the power on or OFF to any external circuitry including sensor ICs. These two switches can be event-driven or timer-driven.

- Switch 0 (SW0), when it is being configured or turned to be ON, the device will be tied the power supply to the corresponding switch PIN of the device.
- Switch 1 (SW1), when it is being configured or turned to be ON, the device will be tied the GND to the corresponding switch PIN of the device.

Power domain: There are two power domains, Always-ON (AON) domain and Dynamic ON/OFF Power Domain (DOOPD).

Figure 2 shows workflow and features of NanoBeacon™ SoC IN10x product family.

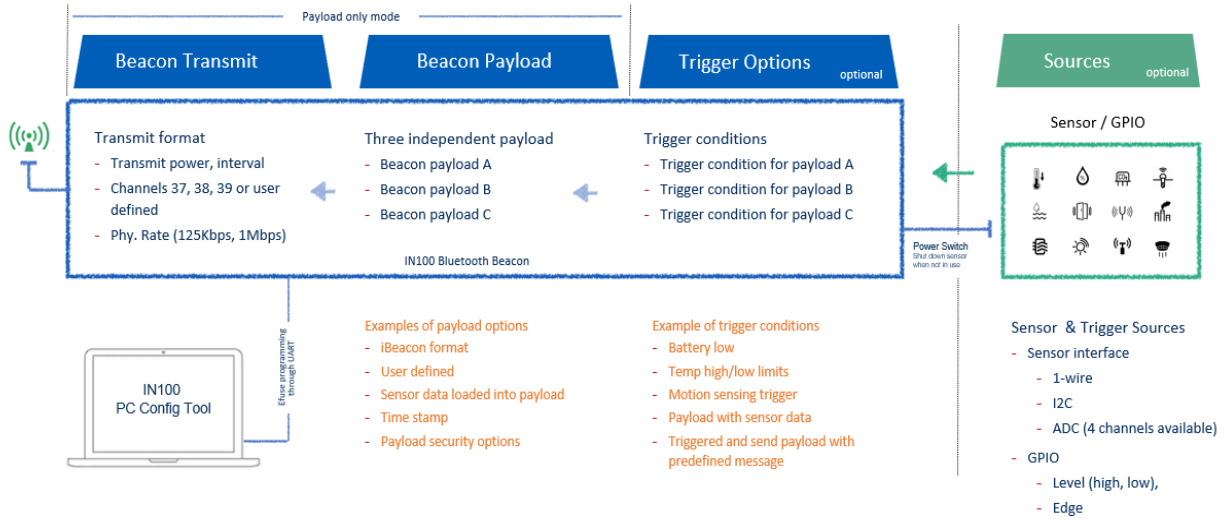


Figure 2 NanoBeacon™ Features Overview

2. Package Pin Out Information

IN100 is offered in both DFN8 & QFN18 packages. This package has an exposed paddle that must be connected to the system board ground.

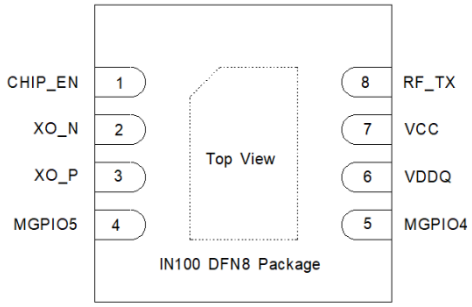


Figure 3 IN100-D1-R-RC0I(F) Pin Assignment

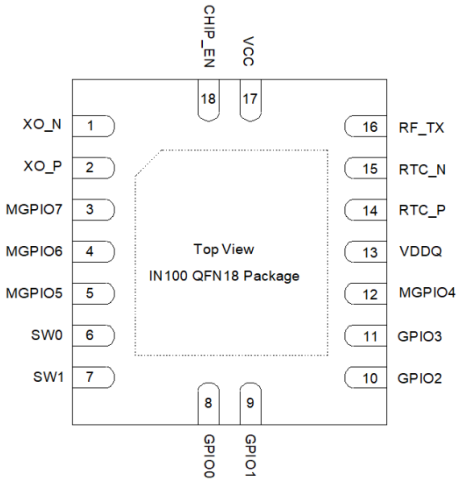


Figure 4 IN100-Q1-R-RC0I(F) Pin Assignment

2.1. Pin Definition

Table 1 IN100 Pin & Pinmux Info

QFN18 Pin #	DFN8 Pin #	Pin name	Pin Type	Description	UART	I2C	Pulse Counting	ADC
1	2	XO_N	Analog	26MHz XO N				
2	3	XO_P	Analog	26MHz XO P				
3		MGPIO7	MGPIO	Mixed Signal GPIO		Any GPIO 0~5 & 7	Any GPIO	ADC CH3
4		MGPIO6	MGPIO	Mixed Signal GPIO			Any GPIO	ADC CH2
5	4	MGPIO5	MGPIO	Mixed Signal GPIO	UART TXD	Any GPIO 0~5 & 7	Any GPIO	ADC CH1
6		SW0	Switch	IO Power Switch				
7		SW1	Switch	IO Ground Switch				
8		GPIO0	DGPIO	Digital Signal GPIO	UART RXD (backup)	Any GPIO 0~5 & 7	Any GPIO	
9		GPIO1	DGPIO	Digital Signal GPIO	UART TXD (backup)	Any GPIO 0~5 & 7	Any GPIO	
10		GPIO2	DGPIO	Digital Signal GPIO		Any GPIO 0~5 & 7	Any GPIO	
11		GPIO3	DGPIO	Digital Signal GPIO		Any GPIO 0~5 & 7	Any GPIO	
12	5	MGPIO4	MGPIO	Mixed Signal GPIO	UART RXD	Any GPIO 0~5 & 7	Any GPIO	ADC CH0
13	6	VDDQ	I/O Power	EFUSE Programming Power Supply				
14		RTC_XO_P	Analog	32.768K RTC P				
15		RTC_XO_N	Analog	32.768K RTC N				
16	8	RF_TX	Analog RF	2.4G RF TX output				
17	7	VCC	Power	Power Supply & IO Reference Voltage				
18	1	CHIP_EN	Analog	Chip Enable				

Note: The GPIOs and MGPIOs (when used as digital I/Os) are in the VCC power supply domain.

3. Electrical characteristic

3.1. Absolute Maximum Ratings

The values listed in this section are ratings that can be peaked by the device, but not sustained without causing irreparable damage to the device

Table 2 Absolute Maximum Ratings

Description	Comments	Min.	Max.	Unit
Supply voltage (VCC)		-0.3	3.9	V
Digital GPIO input	All digital GPIO pins	-0.3	VCC+0.3	V
CHIP_EN PIN		-0.3	VCC	V
Analog LV input	XO_N, XO_P, RTC_XO_N, RTC_XO_P, MGPIOs	-0.3	Min (2,VCC)	V
ESD Human Body Model	All pins	-4000	4000	V
Storage Temperature		-65	150	C

3.2. Recommended Operating Conditions

Table 3 Recommended Operating Conditions

Description	Min.	Typ.	Max.	Unit
VCC supply voltage	1.1	1.5	3.6	V
Operating temperature*	-40		125	C

*Note: for full range industrial grade product only. See ordering info.

3.3. GPIO PAD Characteristics

Measured at the following condition: Ta = 25C, VCC = 3.0V, unless otherwise noted.

Table 4 GPIO PAD Characteristics

Parameter	Description	Min.	Typ.	Max.	Unit
VIL	Input low voltage			0.3*VCC	V
VIH	Input High voltage	0.7*VCC			V
VOL	Output low voltage			0.4	V
VOH	output high voltage	VCC-0.4V			V
IOH	Output high drive current		4		mA
IOS	Output standard drive current		4		mA

tLH/tHL (standard drive)	Rising time/Falling time @standard drive with 12pf load10%~90%			4	ns
RPU	GPIO Pull-up resistance		25K		Ohm
RPD	GPIO Pull-down resistance		25K		Ohm

Note: The data measured are preliminary and subject to change

3.4. RF Performance Characteristics

Characteristics are measured over recommended operating conditions unless otherwise specified. Typical value is referred to at TA = 25°C and VCC = 3.0V. The specifications are valid for -45°C ≤ TA ≤ +85°C and 1.1V ≤ VCC ≤ 3.6V. All performance data are measured via an evaluation board with a 50 Ohm antenna connector.

3.4.1. General RF Characteristics

Table 5 General RF Characteristics

Parameter	Description	Min.	Typ.	Max.	Unit
Radio frequency range		2250		2550	MHz
RF PLL channel spacing	channel spacing is user programmable		1		MHz
Frequency modulation deviation	1Mbps BLE		±250		kHz
Data Rate		125		1000	kbps

3.4.2. RF Transmitter Performance Characteristics

Measured at: Ta = 25C, VCC=3.0V, fRF=2440MHz, unless otherwise noted

Table 6 RF Transmitter Performance Characteristics

Parameter	Condition	Test Conditions	Min.	Typ.	Max.	Unit
Maximum output power		Averaged over band and build		5		dBm
Minimum output power				-50		dBm
Output power variation over band		2402MHz - 2480MHz	-0.5		0.5	dB
Output power build-to-build variation		Chip variation + matching component variation	-0.5		0.5	dB
In-band spurious emission	1Mbps, @ Pout,max	N +/- 2MHz		-54		dBm
		N +/- ≥3MHz		-44		dBm
Out-of-band spurious emission	@ Pout,max	f<1GHz, outside restricted bands		-50		dBm
		f<1GHz, restricted bands ETSI		-50		dBm
		f<1GHz, restricted bands FCC		-50		dBm

		f>1GHz, including harmonics		-44		dBm
		HD2		-44		dBm
		HD3		-61		dBm

3.5. System Power Consumption

Currents are measured at Ta = 25C, VCC = 3.0V, CPU running at 8MHz, unless otherwise noted.

Table 7 System Power Consumption

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_VCC	Current consumption	Chip disabled, CHIP EN=0V		10		nA
		Sleep with 32kHz RC, sleep timer (*1)		0.52 (*2)		uA
		Sleep with 32.768kHz RTC, sleep timer (*1)		0.64 (*2)		uA
		Sleep with 32.768kHz RTC, sleep timer, 4kB retention (*1)		0.69 (*2)		uA
		Sleep with 32.768kHz RTC, sleep timer, 4kB retention, BOD enabled (*1)		0.99 (*2)		uA
		2.4GHz TX mode - 1Mbps, Pout=0dBm		TBD		mA
		2.4GHz TX mode - 1Mbps, Pout=max		TBD		mA

Note: (1*): VDD_AON is in dynamic mode (2*): Number is based on E/S measurement

3.6. ESD Characteristics (all pins)

IN100 device pass all following ESD requirements.

HBM (human body model): Sensitivity pass +/-4500V, Class-3A (Reference ESDA/JEDEC JS-001-2017)

CDM (charge device model): TBA

4. Reference design

4.1. IN100 QFN18 Reference Schematic

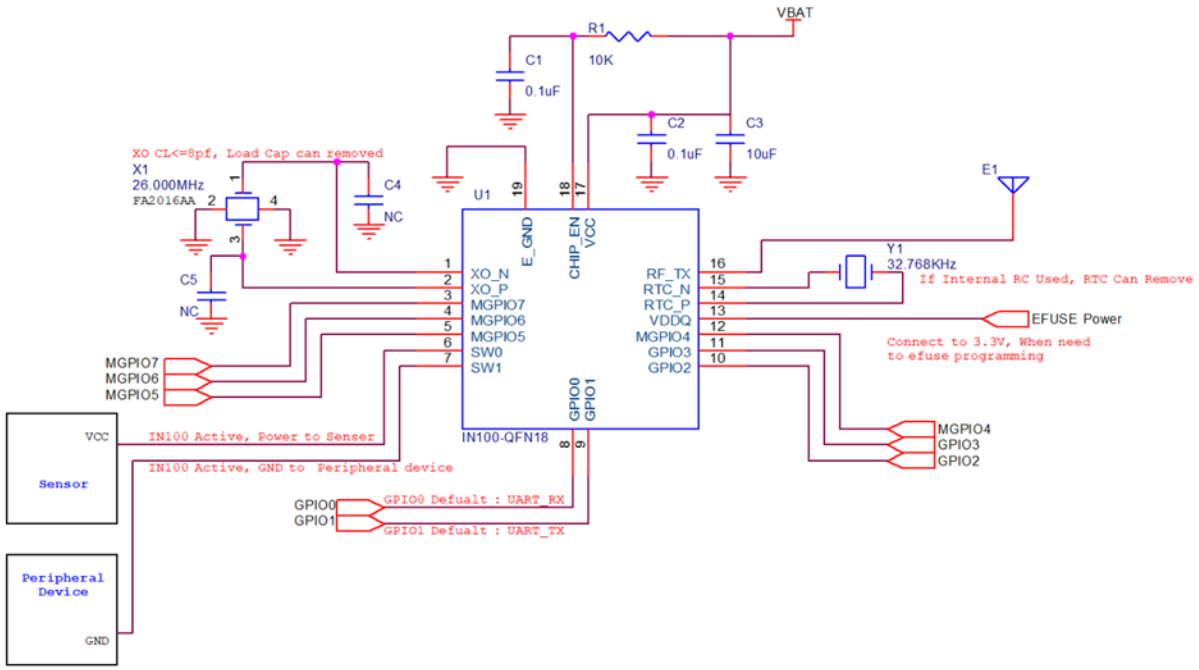


Figure 5 IN100 QFN18 Reference Design

4.2. IN100 DFN8 Reference Schematic & BOM

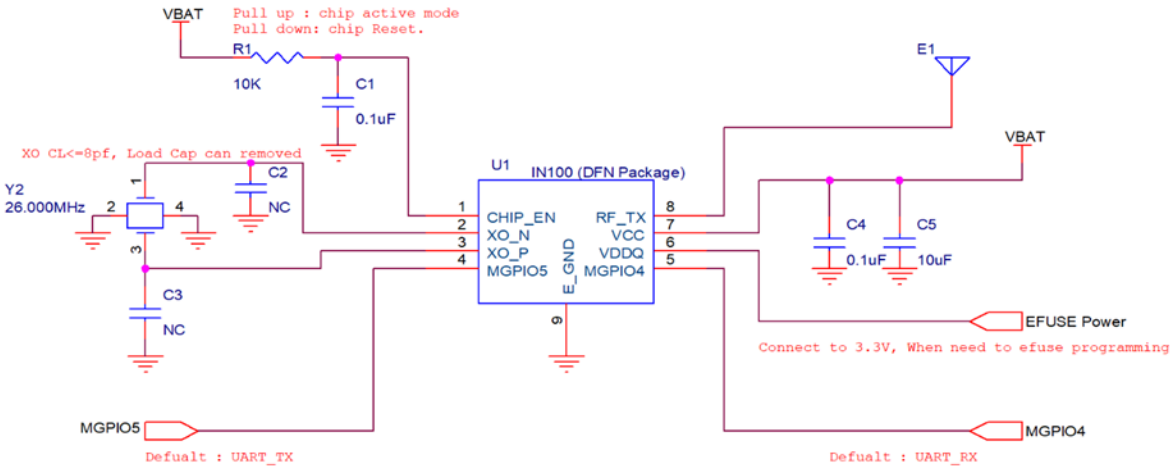
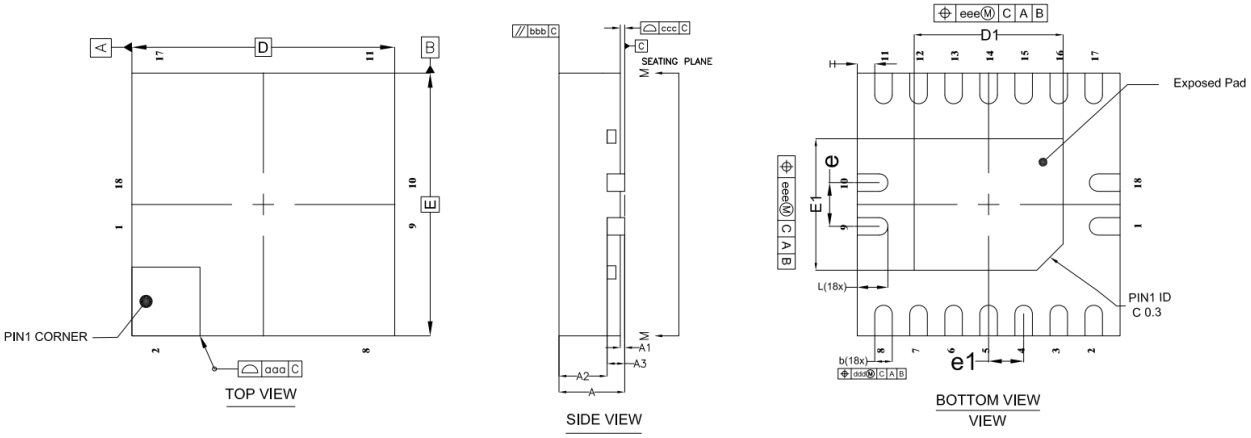


Figure 6 IN100 DFN8 Reference Design

5. Package Dimension

The device will be offered in QFN18 and DFN8 packages. Both packages are RoHS/green compliant.

5.1. QFN18



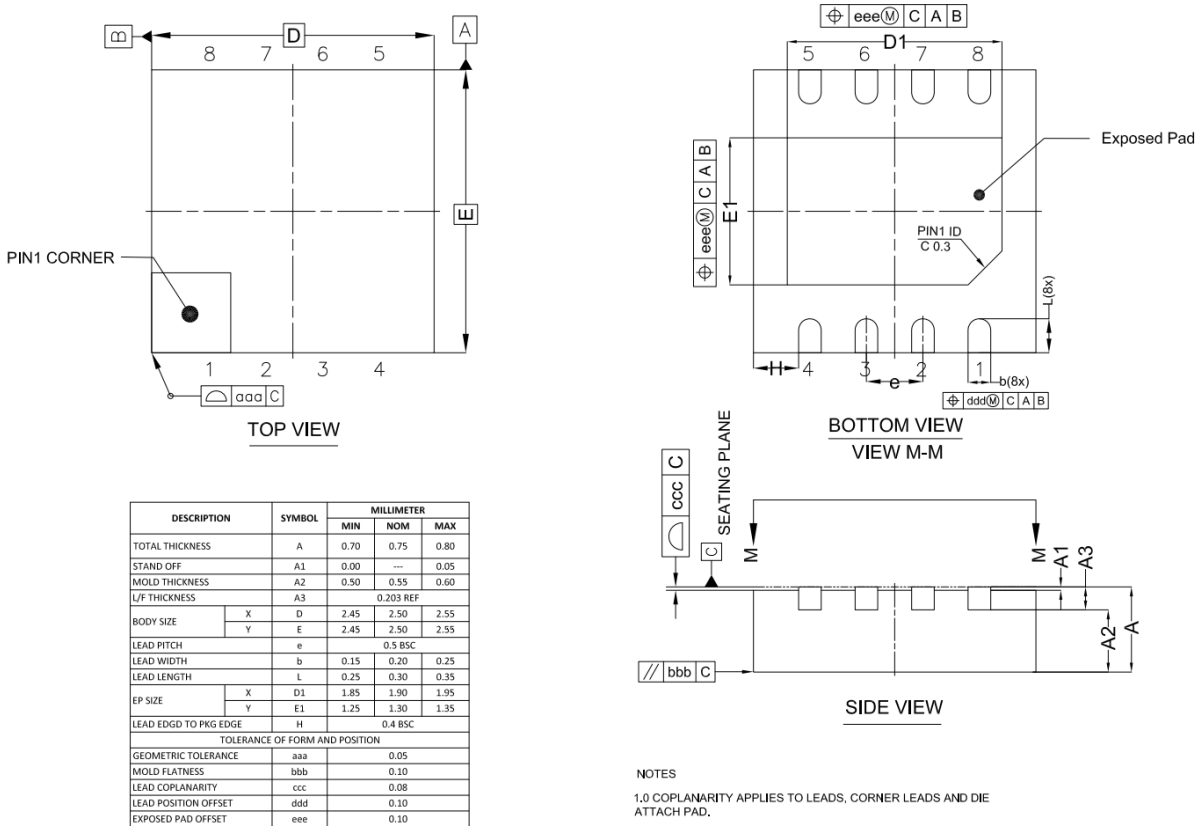
DESCRIPTION		SYMBOL	MILLIMETER		
			MIN	NOM	MAX
TOTAL THICKNESS		A	0.70	0.75	0.80
STAND OFF		A1	0.00	---	0.05
CAVITY THICKNESS		A2	0.50	0.55	0.60
L/F THICKNESS		A3	0.203 REF		
BODY SIZE	X	D	2.95	3.00	3.05
	Y	E	2.95	3.00	3.05
LEAD PITCH		e	0.50 BSC		
		e1	0.40 BSC		
LEAD WIDTH		b	0.15	0.20	0.25
LEAD LENGTH		L	0.30	0.35	0.40
EP SIZE	X	D1	1.65	1.70	1.75
	Y	E1	1.45	1.50	1.55
LEAD EDGD TO PKG EDGE		H	0.285C		
TOLERANCE OF FORM AND POSITION					
GEOMETRIC TOLERANCE		aaa	0.05		
MOLD FLATNESS		bbb	0.10		
LEAD COPLANARITY		ccc	0.08		
LEAD POSITION OFFSET		ddd	0.10		
EXPOSED PAD OFFSET		eee	0.10		

NOTES

1.0 COPLANARITY APPLIES TO LEADS, CORNER LEADS AND DIE ATTACH PAD.

Figure 7 QFN18 POD

5.2. DFN8



DESCRIPTION		SYMBOL	MILLIMETER		
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TOTAL THICKNESS		A	0.70	0.75	0.80
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L/F THICKNESS		A3		0.203 REF	
BODY SIZE	X	D	2.45	2.50	2.55
	Y	E	2.45	2.50	2.55
LEAD PITCH		e		0.5 BSC	
LEAD WIDTH		b	0.15	0.20	0.25
LEAD LENGTH		L	0.25	0.30	0.35
EP SIZE	X	D1	1.85	1.90	1.95
	Y	E1	1.25	1.30	1.35
LEAD EDGD TO PKG EDGE		H		0.4 BSC	
TOLERANCE OF FORM AND POSITION					
GEOMETRIC TOLERANCE		aaa		0.05	
MOLD FLATNESS		bbb		0.10	
LEAD COPLANARITY		ccc		0.08	
LEAD POSITION OFFSET		ddd		0.10	
EXPOSED PAD OFFSET		eee		0.10	

Figure 8 DFN8 POD

5.3. IC marking

IN100 IC is marked like described below.

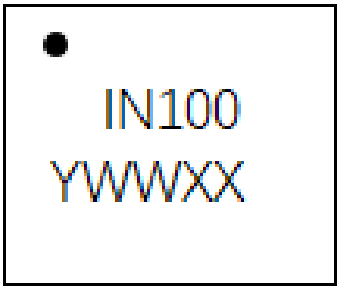

Figure 9 DFN8 Marking

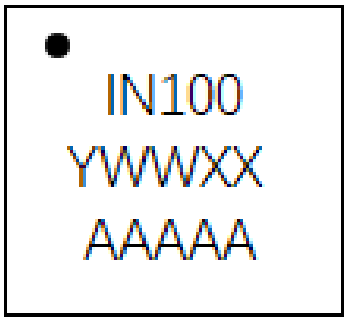

Figure 10 QFN18 Marking

Table 8 IN100 Marking Description

Abbreviation	Definition and implemented codes
IN1	INPLAY NanoBeacon SoC product family name
00	Part Number code
AAAAAA	Factory Control Code
XX	Chip Version & Temp Code
Y	Year code
WW	Week code

6. Ordering information

Contains information on IC marking, ordering codes, and package sizes.

Table 9 Ordering Information

Ordering Part Number	Package
IN100-D1-R-RC0I	DFN8 (-40°C ~ +85°C)
IN100-Q1-R-RC0I	QFN18 (-40°C ~ +85°C)
IN100-D1-R-RC0F	DFN8 (-40°C ~ +125°C)
IN100-Q1-R-RC0F	QFN18 (-40°C ~ +125°C)

Box Package Dimension

Defined here are the IN100 package size for reel, inner box and outer box.

Table 10 Size for Reel, Inner box and Outer box

Package	Reel Size	QTY / Reel	QTY / Inner Box	QTY / Outer Box
QFN	13”	5,000	5,000	50,000
DFN	13”	5,000	5,000	50,000

7. Disclaimer

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