

Approved Crystals for NanoBeacon SoC IN100

Control number: Revision: V1.0



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1. Summary

This document describes some strategies for developers to properly select and configure 26MHz crystals when developing InPlay NanoBeacon SoC IN100-based systems, explains which crystal parameters affect the system, and provides a list of several verified recommended reference crystal manufacturers and their part numbers.

Three parameters are critical to the stable operation of the IN100 based system. Figure 1 shows the IN100 default settings for the 26MHz crystal.

cycles

Figure 1: NanoBeacon Config Tool for Crystal Setting

Internal Capacitor Code: It is used for frequency bias calibration. Adjusting this value is the process of adjusting the frequency of the crystal oscillator to match to an exact reference frequency. The accuracy of the crystal oscillator depends on the accuracy of the crystal resonator itself and the temperature stability of the oscillator circuit. Note: Adjusting the capacitance value of the on-chip crystal oscillator will affect the start-up time and drive strength.

Stable Time: Crystal stabilization time is the time required for a crystal oscillator to reach its stable operating frequency after power is applied. A long stabilization time will result in longer system start-up time and will consume more power, while a short stabilization time will reduce the reliability of the system and cause the chip to fail to start. The stabilization time of a crystal oscillator is affected by various factors, such as the drive strength (the amount of current applied to the crystal), the type and size of the crystal, and the oscillator circuit design. Optimizing the crystal start-up time requires a careful balance between drive strength, crystal specifications, and oscillator circuit design.

Strength Code: The drive strength is the amount of current applied to the crystal to drive it to oscillate at its resonant frequency. A higher drive strength reduces the crystal's stabilization time, but it also increases power consumption and may damage the crystal. The optimal drive strength of a crystal oscillator depends on various factors, such as the type and size of the crystal, and the operating conditions.

This document applies to the following products:



Table 1: IN100 Product list

Applicable products	Product status	
IN100-D1-R-RC1I	Mass production	
IN100-D1-R-YC1I	Mass production	
IN100-Q1-R-RC1I	Mass production	
IN100-Q1-R-YC1I	Mass production	
IN100-Q1-R-YC1F	Mass production	
IN100-W10-R-SC1I	Engineering sample	



2. Approved 26MHz Crystal

For all approved crystals, no external load caps are required. Frequency calibration only requires trimming the internal cap code of IN100. **Do not install C4 and C5** when using approved crystals.

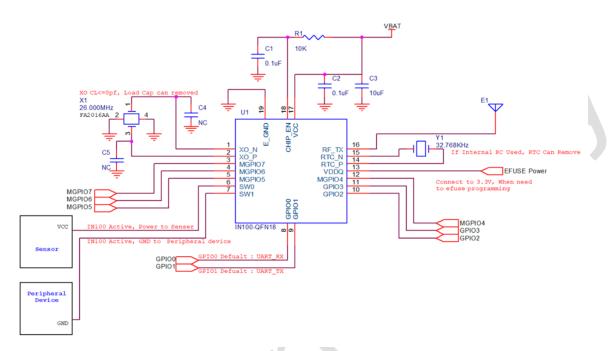


Figure 2: IN100 QFN18 reference design

The following is the list of approved crystals:

Table 2: Approved 26MHz crystals.

No	Part number	Vender	Package Size	CL	CO	ESR	Temp Range
1	CN4026M00006BE840000	JWT	2.0 x 1.6 x 0.5 mm	6pF	≤2pF	≤40ohm	-40°C ~ +125°C
2	CN4026M000067A840000	JWT	2.0 x 1.6 x 0.5 mm	6pF	≤2pF	≤40ohm	-40°C ~ +85°C
3	XRCGB26M000F1SBLR0	Murata	2.0 x 1.6 x 0.7 mm	7pf	≤3pF	≤40ohm	-40°C ~ +105°C
4	ABM12L-0000-T3	Abracon	1.6 x 1.2 x 0.33 mm	8pf	≤2pF	≤80ohm	-40°C ~ +85°C
5	ABM11W-0018-T3	Abracon	2.0 x 1.6 x 0.5 mm	8pf	≤2pF	≤80ohm	-40°C ~ +85°C
6							
7							

For more test result, please refer appendix A and B.

Note:



- 1* All test setups are at room temperature using IN100. 3.3V supply voltage is used.
- 2* Default settings are used for XO setting of stabilization time and drive intensity code.
- 3* Frequency is calibrated by the IN100's internal cap code

The following is the list of approved crystals XO setting for IN100. User needs to adjust according to the actual hardware situation.

Performance below was measured at the following condition with IN100 DK board: $Ta = 25^{\circ}C$, VCC = 3.0V, unless otherwise noted.

Table 3: Approved 26MHz Crystal Setting on IN100DK

No	Part number	Vender	IN100 Capacitor Code	Stable Time	Strength Code
1	CN4026M00006BE840000	JWT	5	36	16
2	CN4026M000067A840000	JWT	5	36	16
3	XRCGB26M000F1SBLR0	Murata	7	36	16
4	ABM12L-0000-T3	Abracon	11	45	16
5	ABM11W-0018-T3	Abracon	11	45	16
6					
7					_

3. Vendor Contact information

JWT

Company: HEFEI JINGWEITE ELECTRONICS CO.,LTD.

Website: http://www.hfjwt.cn

Address: No.2569, Yungu Road, Economy & Technology Area, Hefei, Anhui, China

Telephone: +86 0551-63350130,63350092

Contact: Aaron Guo Mobile: +86-156 5656 9669 Email: gxc@hfjwt.cn

Murata

Company: AVNET

Website: avnet.co/apac **Telephone:** +86 21 3416 7152 **Mobile:** +86 180 1865 3160 **Contact:** Jenny Wang



Email: jenny.wang2@avnet.com

Abracon

Company: ABRACON LLC **Website:** <u>www.abracon.com</u>

Address: 5101 Hidden Creek Lane Spicewood, TX 78669

Telephone: +1(512)371-6159

Fax: (512) 351-8858



4. Revision History

Revision	Description	Update date	Owner
V1.0	Preliminary Version		

5. Disclaimer

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6. Appendix A

JWT CN4026M00006T2998001 test results as follows:

频率测试 (Measure the FREQ. of crystal on PCB board):

初始测试 (Original)

1、在PCB上测试输出频率(Measure the output frequency on PCB board)Fout1:

输出频率(Fout1) = ____25.999908 ____ MHz, __-3.54 ___ ppm

2、晶振性能测试(室温) Crystal characteristic test (at room tei 26℃

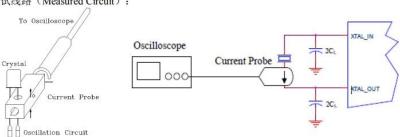
Specification(CL1) = 6 pF

FL1	FL1	Rs	C0	C1	Ts
(MHz)	(ppm)	(ohm)	(pF)	(fF)	(ppm/pF)
26.000034	1.29	18. 53	0.65	1.67	

$$3 \cdot \triangle F = | Fout1 - FL1 | = -4.83 ppm$$

驱动功率测试 (Measure the drive level of crystal on PCB board):

1、测试线路 (Measured Circuit):



2、测试方法 (Measured Method):

使用电流探头进行Vrms测量(Tek CT-1, 50 Ω)

Use AC current probe to conduct Vrms measuring (Tek CT-1, 50 ohms terminated)

Irms = Vrms/5(mA)

3、计算方法 (Calculation Method):

Irms =
$$0.63$$
 mA
RL = Rs (1+ C0/CL)²
= 18.53 *(1+ (0.65 / 6))² = 22.76 ohms
Drive Level = Irms2 * RL
= 0.63 ²* 22.76 = 9.09 μW Data sheet Max Leve 200 μW

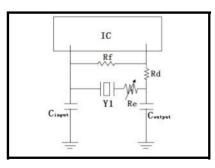
Drive Level < Data sheet Max Level Good

Drive Level ≥ Data sheet Max Level Not matching



振荡电路负阻测试(Measure the negative resistance (- R) value of chip set):

1、测试线路(Measured Circuit):



2、计算方法 (Calculation Method):

$$| -R | = Re + RL = 270$$
 + 22.76 = 292.76 ohms
 $| -R | -R | / R = 292.76$ / 40 = 7.32

n:

Poor -R value: n < 3

Normal -R value: 3 < n < 5

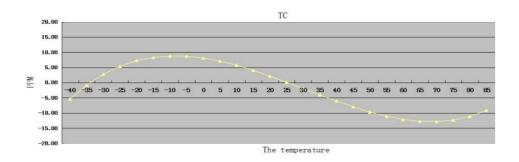
Good -R value: n > 5

RL: 负载电阻 (Load Resistance)	
R: 等效电阻 (ESR)	
Re: 可调电阻 (Variable Resistor)	

Measured oscillation characteristics

Parameter	Measured Typical Results		
Work the amplitude	558 [mv]		
Maximum operating amplitude	520 [mv]		
Minimum operating amplitude	620 [mv]		
Drive level	6.32 [uW]		
The actual load capacitance	6.0 [pF]		
Temperature frequency drift	See chart below		
Crystal start time	0.408 [ms]		

Measured frequency drift by temperature





7. Appendix B

Murata XRCGB26M000F1SBLR0 test results as follows:

Item				Condition
IC name		IC名		IN100
Parts Number of Crystal Unit		村田型号		XRCGB26M000F1SBLR0
Circuit Parameter	External	负载电容	CL1	Open
	load capacitance	负载电容	CL2	Open
	Feedback resistance	反馈电阻	Rf	No mount
	Damping resistance	阻尼电阻	Rd	0ohm
Supply Voltage Range		电源电压范围		1.6 to 3.6V
Temp. Range		温度范围		-40 to 105deg.C

Test Circuit Set : 3.3 V

7 7/1

Evaluation board : Bluetooth Rd≷ Crystal Unit ᅦ마 CL1 CL2

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Murata standard Measurement equipment

Oscilloscope DSO6052(K) CT-6(T) P5100A(T) Passive probe (40Mohm/2.5pF) DC supply E3631A(K) Sepectrum analyzer N9010A(K)

(K) Keysight (T) Tektronix

Circuit Characteristics 特性	Value 测定值			Remarks 备注
Center Frequency and Difference 起振回路上起振频率与偏差量(*1)	25.99	9905	[MHz]	Oscillating frequency and its shift against nominal frequency 在起振回路上的频率以及相对于公称频率之间的偏差量
(Typical sample at Set=3.3V,+25deg.C)	_	4	[ppm]	
Load Capacitance on your PCB 负载容量值 (Typical sample at Set=3.3V,+25deg,C)	1		[pF]	This value shows load capacitance the evaluated circuit has 在起振回路上等价于连接在谐振器两端的容量
Negative Resistance and Oscillation margin 负性电阻/起振余裕度	-R	317	[Ω]	The details is explained in page 2 详细内容参见下页说明
(at Set=3.3V,+25deg.C)		5.3	[Times]	
Drive Level 激励功率 (Typical sample at Set=3.3V,+25deg,C)	1	1	[u W]	Drive power of crystal under circuit condition 起振回路在工作状态下谐振器消耗的功率
Oscillating Voltage 起振电压	VINp-p	0.5	[V]	Swing level at input side 输入端起振振幅 (VIN_H - VIN_L)
(Typical sample at Set=3.3V,+25deg.C)	VOUTp-p	0.5	[V]	Swing level at output side 输出端起振振幅 (VOUT_H - VOUT_L)
Oscillation Start up Time 启动时间 (*2) (Typical sample at Set=3.3V,+25deg.C)	0.	54	[ms]	Time to reach 90% of the oscillation level under steady state 达到稳定状态振幅的90%所需要时间

^{*1} Frequency difference means the oscillating frequency difference between your PCB and Murata's frequency sorting circuit. 频率偏差指在贵公司基板上的测定频率与本公司标准回路上测定频率间的偏差。
*2 The measurement results is affected by the rise-up characteristics of supplied voltage on your PCB. 测定结果受实装基板上电源启动方式的影响。



8. Appendix C

Abracon ABM12L-0000-T3 test results as follows:

Series-Parallel resonance & motional parameters @ (+25°C ± 3°C)

Crystal Parameters			
Nominal Frequency	Fnom	26,000,000	Hz
Parallel Resonance	FL	25,999,937	Hz
Motional resistance	Rm	24.64	Ω
Motional inductance	Lm	34.17	mH
Motional capacitance	Cm	1.10	fF
Static capacitance	CO	0.91	pF

In-Circuit Frequency

Basic Oscillator Parameters			
Nominal Frequency	Fnom	26,000,000	Hz
Crystal Parallel Resonance	FL	25,999,937	Hz
Operating Frequency	F	25,999,926	Hz
Internal Capacitor Code	(0~15)	11	

Negative Resistance and Safety Factor

Basic Oscillator Parameters			
Crystal Motional resistance	Rm	24.7	Ω
Maximum Crystal Resistance	Max ESR	80	Ω
Added Series Resistance	Rs	400	Ω
Negative Resistance	I-RI	>424	Ω
Safety Factor (Ratio)	SF	>5	

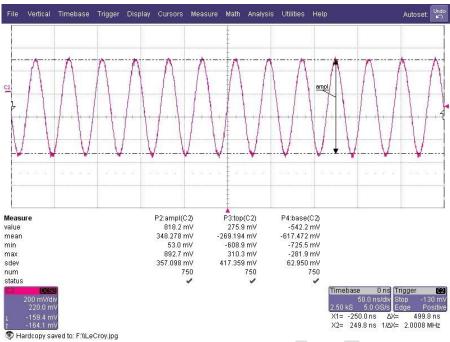
Oscillator loop continues to operate beyond an added series resistance of 400 ohms.

Drive Level

Basic Oscillator Parameters			
Crystal Effective Series Resistance	ESR	26.3	Ω
Through-Crystal Current	1	0.7	mΑ
Drive Level	DL	11.5	μW

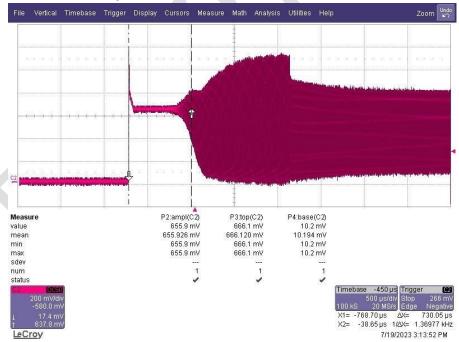






Passed Waveform Testing: Amplitude > 550 mV

Oscillation Start-up Waveform



Passed Startup Testing: Amplitude > 400mV in 730µs (Stable Time = 45)