

通过恩智浦ZIGBEE3.0 MCU实现IOT产品的快速开发

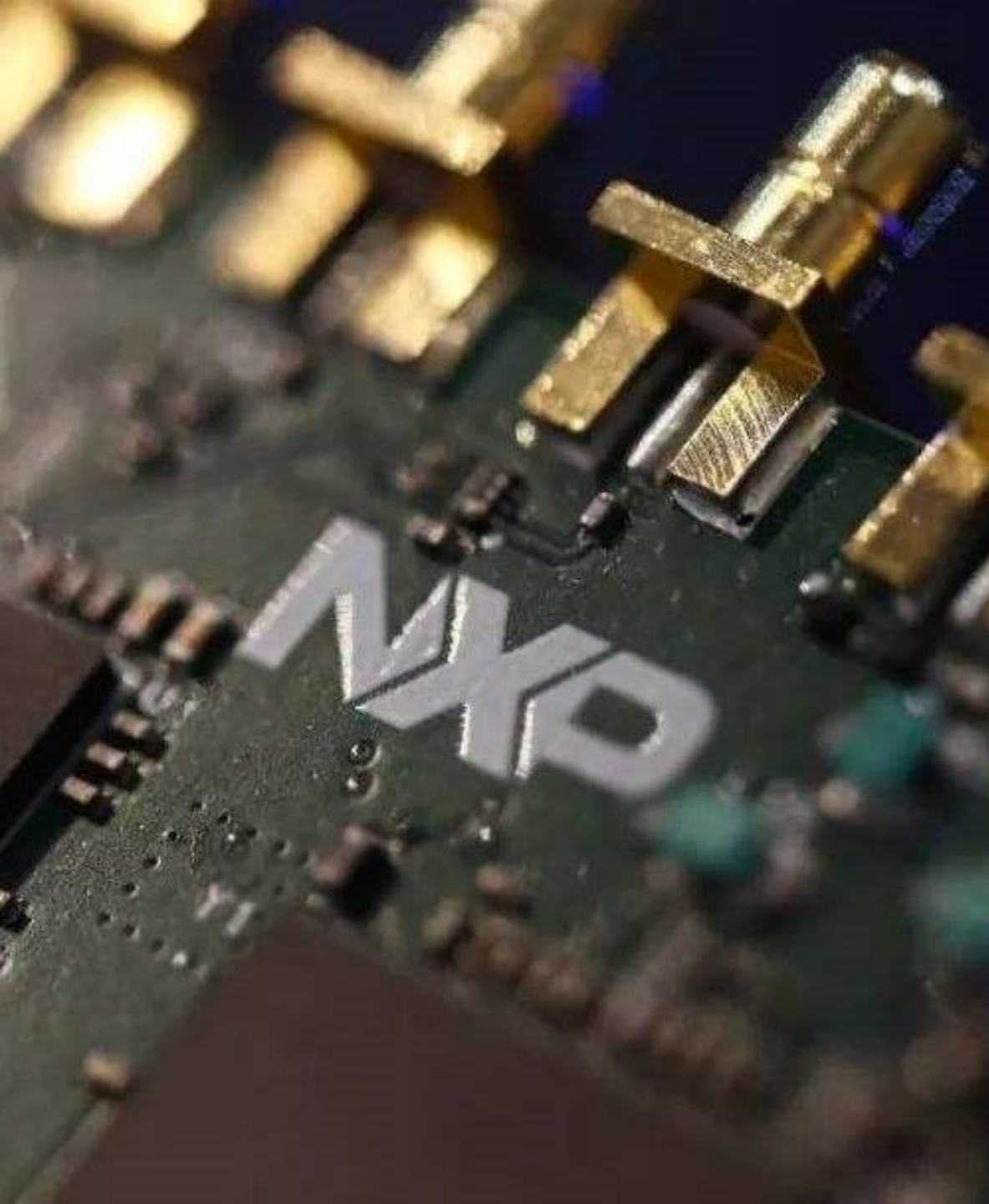
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15/4/2020



PUBLIC



SECURE CONNECTIONS
FOR A SMARTER WORLD



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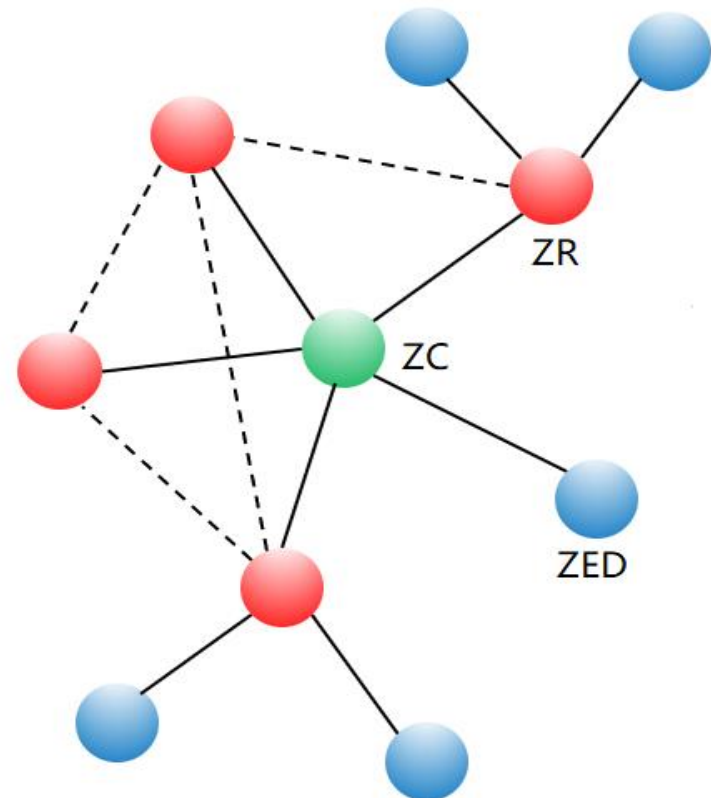
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- 基于JN5189快速实现IoT产品和应用的开发

ZIGBEE 3.0在IOT设备 互联通信中的优势



ZigBee简介

- 基于IEEE 802.15.4的低功耗短距无线通信
- 设备类型：
 - 协调器Coordinator (ZC)：网关功能，通常只有 1 个
 - 路由Router (ZR)：路由功能，如灯等常电设备
 - 终端EndDevice (ZED)：可休眠的低功耗设备，如各种电池供电的传感器
- **亮点: Mesh网络**
 - 自组织，自愈
 - 通过路由，可使网络节点规模达到200



Zigbee3.0的特点

统一了以前的各种应用 (Profile)

- ZHA
- ZLL

引入了BDB (Base Device Behaviour) 的概念

- Network Formation
- Network Steering
- Finding and Binding
- Touch link

加强了安全性

- Installation Codes

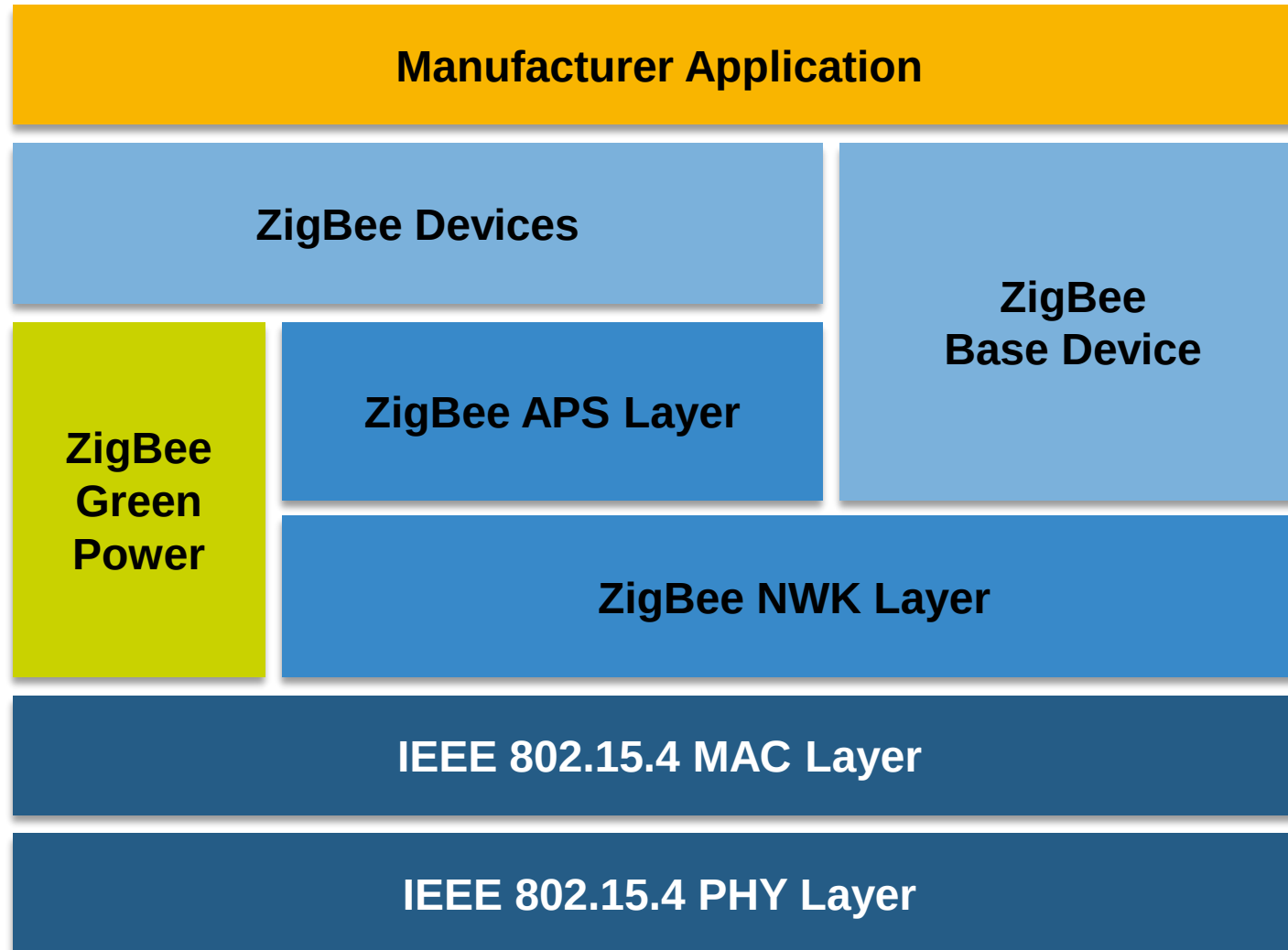
支持Green Power超低功耗应用



ZigBee® 3.0
Better Together



ZigBee3.0协议栈

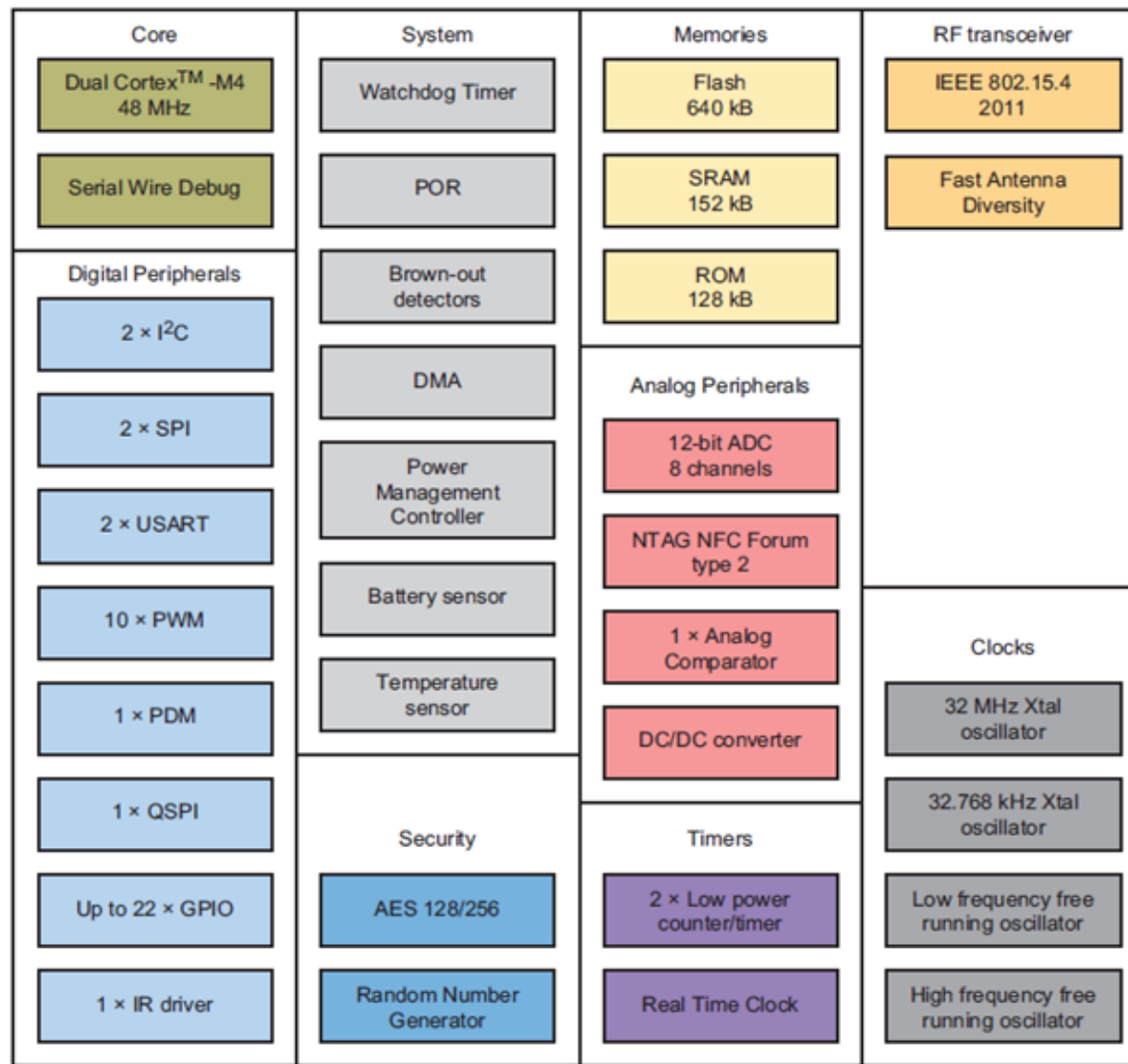


恩智浦最新ZIGBEE 3.0 MCU JN5189特性解读



JN5189参数

- Cortex-M4核, 48M主频,
- 152KB RAM, 640KB FLASH
- Tx最大输出: 10dBm
- Rx灵敏度: -100dBm
- RF发送电流:
 - 7.4mA@0dBm
 - 20.3mA@10dBm
- RF接收电流: 4.3mA
- 内置NTAG
- 温度: -40 ~ 125
- 面积: 6mmx6mm
- 引脚: 40
 - 22个PIO



JN5189灵活的引脚配置

- 2路UART/SPI/I2C, 8通道12bit ADC, 10路PWM, 内置NTAG等

I/O Names	FUNC0	FUNC1	FUNC2	FUNC3	FUNC4	FUNC5	FUNC6	FUNC7	Default at reset / during boot	Default internal pull-up / pull-down	ISP mode
PIO0_0	GPIO 0	USART0_SCK	USART1_TXD	GPIOSEC 0	PWM0-PU	SPI1_SCK	PTA0	PDM0_DATA	GPIO0 (I)	pull-up	
PIO0_1	GPIO 1	FLICKER_CTRL	USART1_RXD	GPIOSEC 1	PWM1-PD	SPI1_MISO	PTA1	PDM0_CLK	GPIO1 (I)	pull-down	
PIO0_2	GPIO 2	SPI0_SCK	USART0_RXD	GPIOSEC 2	PWM2-PD	SPI1_MOSI	ISO7816_RST	MCLK	GPIO2 (I)	pull-down	
PIO0_3	GPIO 3	SPI0_MISO	USART0_TXD	GPIOSEC 3	PWM3-PU	SPI1_SSELN0	ISO7816_CLK	PTA2	GPIO3 (I)	pull-up	
PIO0_4	GPIO 4	SPI0_MOSI	USART0_CTS	GPIOSEC 4	PWM4-PU	SPI1_SSELN1	ISO7816_IO	RFTX	GPIO4 (I)	pull-up	
PIO0_5	GPIO 5	SPI0_SSELN	USART0_RTS	GPIOSEC 5	SPI1_MISO	SPI1_SSELN2	PTA3	RFRX	GPIO5 (I)	pull-up	ISP_ENTRY
PIO0_6	GPIO 6	SPI0_SCK	USART0_RTS	CT32B1_MAT0	PWM6-PD	I2C1_SCL	USART1_TXD	ADE	GPIO6 (I)	pull-down	
PIO0_7	GPIO 7	SPI0_MISO	USART0_CTS	CT32B1_MAT1	PWM7-PD	I2C1_SDA	USART1_RXD	ADO	GPIO7 (I)	pull-down	
PIO0_8	GPIO 8	SPI0_MOSI	USART0_TXD	CT32B0_MAT0	PWM8-PU	ANA_COMP_OUT	RFTX	PDM1_DATA	USART0_TXD	pull-up	UART_ISP
PIO0_9	GPIO 9	SPI0_SSELN	USART0_RXD	CT32B1_CAP1	PWM9-PU	USART1_SCK	ADO	PDM1_CLK	USART0_RXD	pull-up	UART_ISP
PIO0_10	GPIO 10	CT32B0_CAP0	USART1_TXD	GPIOSEC 10	RFTX	I2C0_SCL	SPI0_SCK	PDM0_DATA	GPIO10 (I)	external pull-up	
PIO0_11	GPIO 11	CT32B1_CAP0	USART1_RXD	GPIOSEC 11	RFRX	I2C0_SDA	SPI0_MISO	PDM0_CLK	GPIO11 (I)	external pull-up	
PIO0_12	GPIO 12	IR_BLASTER	SWCLK	GPIOSEC 12	PWM0-PU	I2C1_SCL	SPI0_MOSI	ANA_COMP_OUT	SWCLK	pull-up	
PIO0_13	GPIO 13	SPI1_SSELN2	SWDIO	GPIOSEC 13	PWM2-PU	I2C1_SDA	SPI0_SSELN	FLICKER_CTRL	SWDIO	pull-up	
PIO0_14/ADC	GPIO 14	SPI1_SSELN1	USART0_SCK	CT32B0_CAP1	PWM1-PU	SWO	MCLK	RFTX	GPIO14 (I)	pull-up	
PIO0_15/ADC	GPIO 15	SPI1_SCK	ANA_COMP_OUT	FLICKER_CTRL	PWM3-PU	I2C0_SCL	PDM1_DATA	RFRX	GPIO15 (I)	pull-up	
PIO0_16/ADC	GPIO 16	SPI1_SSELN0	ISO7816_RST	GPIOSEC 16	PWM5-PU	I2C0_SDA	PDM1_CLK	SPIFI_CSN	GPIO16 (I)	pull-up	
PIO0_17/ADC	GPIO 17	SPI1_MOSI	ISO7816_CLK	SWO	PWM6-PD	CLK_OUT	PTA0	SPIFI_IO3	GPIO17 (I)	pull-down	
PIO0_18/ADC	GPIO 18	SPI1_MISO	ISO7816_IO	CT32B0_MAT1	PWM7-PD	USART0_TXD	PTA1	SPIFI_CLK	GPIO18 (I)	pull-down	
PIO0_19/ADC	GPIO 19	ADO	USART1_RXD	CLK_IN	PWM4-PD	USART0_RXD	PTA2	SPIFI_IO0	GPIO19 (I)	pull down	
PIO0_20/ACM	GPIO 20	IR_BLASTER	USART1_TXD	GPIOSEC 20	PWM8-PD	RFTX	PTA3	SPIFI_IO2	GPIO20 (I)	pull-down	
PIO0_21/ACP	GPIO 21	IR_BLASTER	USART1_SCK	FLICKER_CTRL	PWM9-PU	RFRX	SWO	SPIFI_IO1	GPIO21 (I)	pull-up	

JN5189的低功耗实现

- 休眠期保存(Retention)的RAM由小到大放置 (Block7...6...0)
- 休眠期可放弃(Discard)的RAM由大到小放置 (Block0...1...7)
- 休眠期电流
- 4K RAM Retention : 1.2uA
- 16K RAM Retention : 1.8uA
- 32K RAM Retention : 2.6uA

- 附注:
- 休眠时芯片内部32K时钟仍在运行, 可定时
- 唤醒设备而无需ColdStart的HW初始化步骤

0x0401_5FFF	SRAM 7 (4 KB)
0x0401_5000 0x0401_4FFF	SRAM 6 (4 KB)
0x0401_4000 0x0401_3FFF	SRAM 5 (8 KB)
0x0401_2000 0x0401_1FFF	SRAM 4 (8 KB)
0x0401_0000 0x0400_FFFF	SRAM 3 (16 KB)
0x0400_C000 0x0400_BFFF	SRAM 2 (16 KB)
0x0400_8000 0x0400_7FFF	SRAM 1 (16 KB)
0x0400_4000 0x0400_3FFF 0x0400_0000	SRAM 0 (16 KB)

JN5189的推荐应用

- 智能家居/智能照明/智能楼宇/工业物联网的网关及各类智能控制器
- 尤其适用于各类低功耗应用
 - 电池供电的各类传感器及Green Power设备
 - 机械能取电（Energy Harvesting）设备



Smoke Sensor



Motion Sensor



Door Lock



On-Off Switch

JN5189平台兼容性认证

芯片已通过Zigbee联盟的兼容性平台(Compliant Platform)认证

https://zigbeealliance.org/zigbee_products/nxp-jn518x-zbpro-r22-gp-proxy-basic/

https://zigbeealliance.org/zigbee_products/nxp-jn518x-zbpro-r22/



NXP JN518x ZBPro R22 + GP Proxy Basic

By NXP Semiconductors Netherlands B.V.

The JN518x is an ultra-low power, high performance wireless microcontroller supporting Zigbee 3.0, Thread, Zigbee PRO networking stacks to facilitate the development of Home Automation, Light Link and Remote Control applications. The device also supports Bluetooth.

The JN518x embeds an ARM Cortex-M4 to run the customer application code and the connectivity stacks. The product has 640 kB embedded Flash, 152 kB RAM and 128 kB ROM memory. The embedded flash can support Over The Air (OTA) code download of SW stacks. The JN518x includes a 2.4 GHz IEEE802.15.4 and Bluetooth Low Energy compliant transceiver and a comprehensive mix of analog and digital peripherals. Ultra-low current consumption in both radio receive and transmit modes allow use of coin cell batteries.

visit [NXP Semiconductors Netherlands B.V. website](https://www.nxp.com).



NXP JN518x ZBPro R22

By NXP Semiconductors Netherlands B.V.

The JN518x is an ultra-low power, high performance wireless microcontroller supporting Zigbee 3.0, Thread, Zigbee PRO networking stacks to facilitate the development of Home Automation, Light Link and Remote Control applications. The device also supports Bluetooth.

The JN518x embeds an ARM Cortex-M4 to run the customer application code and the connectivity stacks. The product has 640 kB embedded Flash, 152 kB RAM and 128 kB ROM memory. The embedded flash can support Over The Air (OTA) code download of SW stacks. The JN518x includes a 2.4 GHz IEEE802.15.4 and Bluetooth Low Energy compliant transceiver and a comprehensive mix of analog and digital peripherals. Ultra-low current consumption in both radio receive and transmit modes allow use of coin cell batteries.

visit [NXP Semiconductors Netherlands B.V. website](https://www.nxp.com).

基于JN5189快速实现 IOT产品的开发



JN5189 DK6开发套件

- ZC : Control Bridge (带NFC Reader)
- ZR : 灯 (亮度可调LED及RGB三色灯)
- ZED: 按键开关及传感器 (照度/温度)
- USB Dongle



JN5189的软件开发工具包SDK

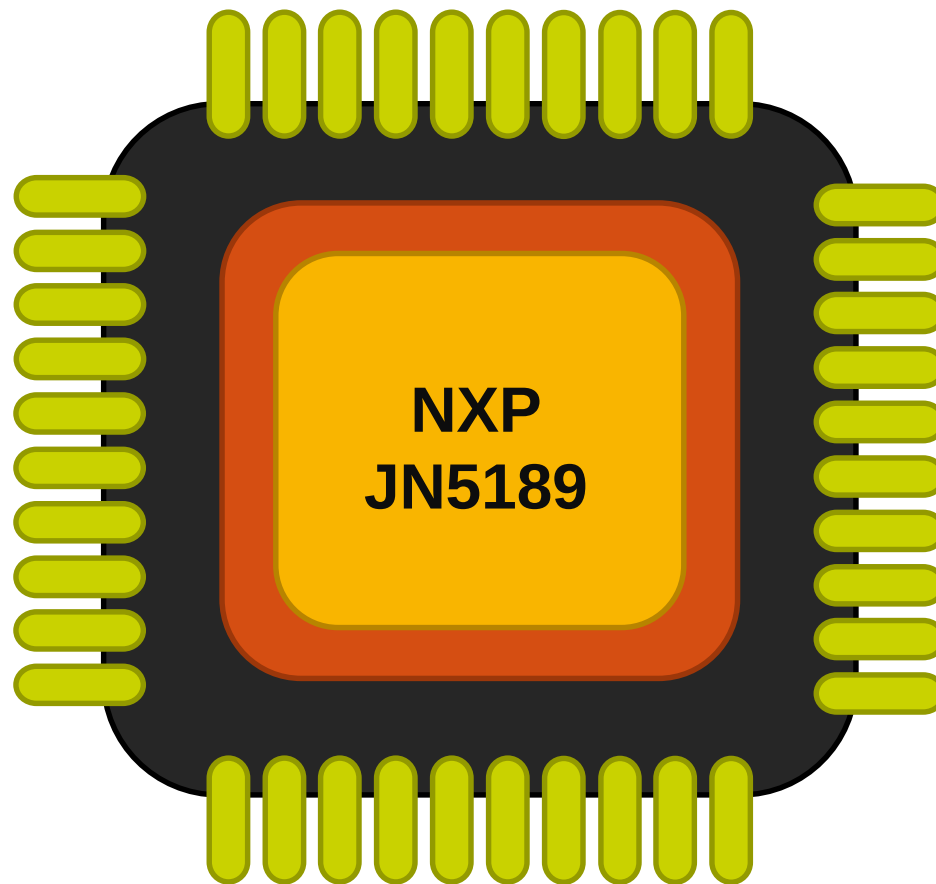
IDE: MCUExpresso_v11.1.0_3209

交叉编译工具链: GCC

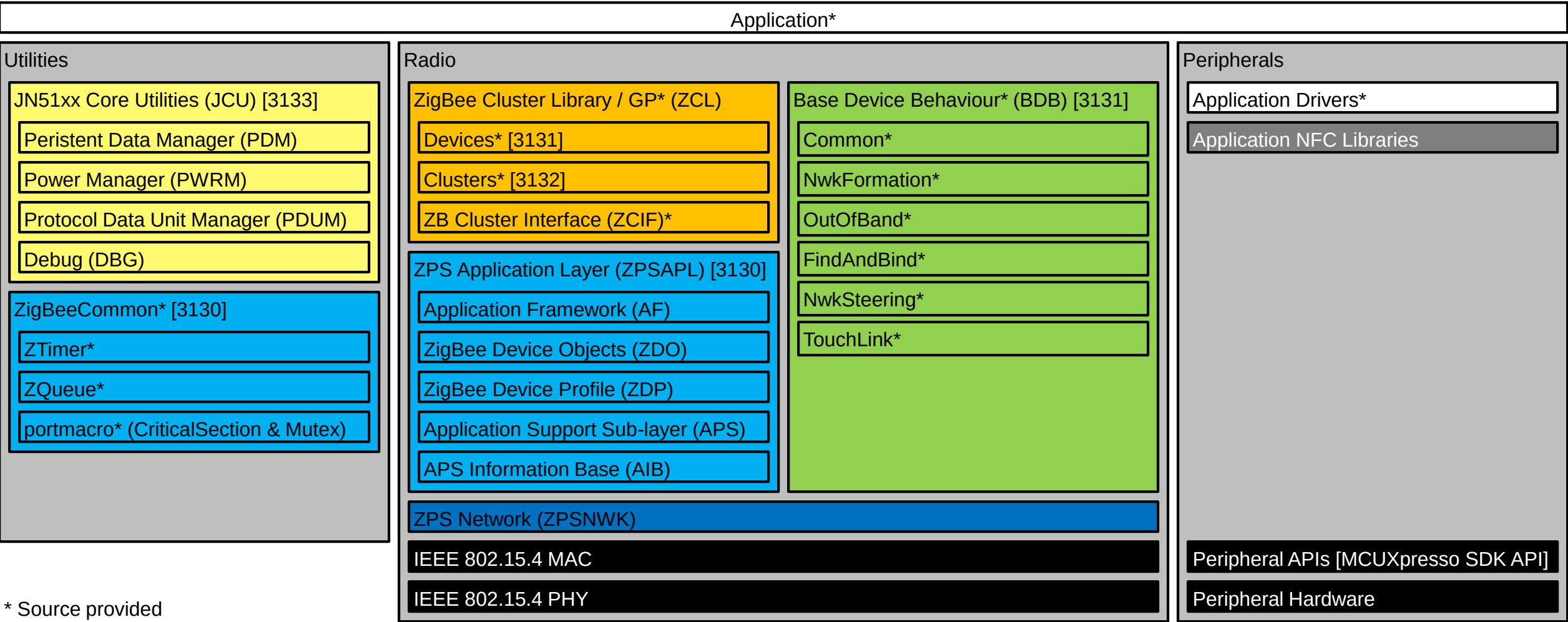
无操作系统 (Bare Metal)

SDK包: JN5189DK6

- ZCL与BDB源码
- MAC/NWK/APL库
- IEEE802.15.4库
- 外设参考例程源码



JN5189的SDK软件结构



JN5189参考应用例程

AN	应用实例说明
AN1242	CMET(Customer Module Evaluation Tool), 评估用户射频性能, PER及不同休眠模式下的功耗等
AN1243	Zigbee3.0 BDB功能模板, ZC支持NCI, ZR/ZED支持NTAG, GP Proxy, NFC OTA等功能
AN1244	Dimmable,ColorTemperature和ExtendedColor三种灯, 支持GP Proxy,GP Combo和OTA功能
AN1245	DimmerSwitch和ColorSceneController, 支持深度休眠(DeepSleep)和普通休眠及OTA功能
AN1246	Light,Occupancy和LTO(Light/Temperature/Occupancy)Sensor, 支持深度休眠和普通休眠及OTA功能
AN1247	ControlBridge, 网关参考设计, 支持GP及NFC, 提供基于C#的ZGWUI代码便于用户二次开发
AN1261	提供Green Power的OnOff Sensor和DimmerSwitch示例

JN5189用户参考指南

UG	用户参考指南
JN-UG-3130	Zigbee协议栈 (R22)
JN-UG-3131	Zigbee设备 (Zigbee Basic Device及ZLO设备)
JN-UG-3132	Zigbee Cluster Library (R8)
JN-UG-3133	JN5189软件模块: PDM/PDUM/PWRM等
JN-UG-3134	Zigbee Green Power
JN-UG-3135	JN5189加密工具使用
JN-UG-3127	JN5189烧录工具使用

Zigbee产品开发必不可少的环节 - 大网络测试环境

- Zigbee Mesh特性及网络规模决定了大网络测试环节十分重要
 - 验证Zigbee网络整体性能，如长期运行的可靠性及稳定性
 - 基于不同芯片方案的产品兼容性测试与验证
 - 某些问题只能在大网络环境下才容易复现
- 便捷大网络：ezLNT

	优势	缺点
传统LNT	立足涵盖Zigbee协议栈的各项测试，网络连接各模块，整体数据分析功能较强	投入大，系统复杂，安装布局困难： 以200节点为例，节点分布区域大，通常需要数百平方米的一层楼面，管控难度较高
ezLNT	立足于用户产品开发阶段涉及的各类相关应用性能测试；既能空口抓包，又可以通过节点串口发送命令及获取信息	投入少，占用空间小，系统安装及管理便捷： 单台PC连接5个USB Hub可控制110个节点，两台PC就可以组成200个节点的网络规模

ezLNT系统实例

- 200个USB Dongle节点
- Zigbee基本功能验证
- 系统长期可靠性测试
- 系统极限运行测试
- 数据的统计分析
 - 空中接口 (Ubiqua抓包)
 - 串口 (UART打印数据)
- 基于C#平台的二次开发



ezLNT工具界面

SettingsClose PortAbout

Basic ClusterGroup ClusterIdentify ClusterLevel ClusterOn/Off ClusterScenes ClusterColor ClusterDoor Lock ClusterIAS Zone ClusterIAS WD ClusterZLL TouchlinkZLL On/Off ClusterZLL Color ClusterOTA ClusterPoll ControlLST LocalLST RemoteLH

ALL

Refresh COMCloseProgramLoad RemoteSave LocalSend Cmd

As ClientAs ServerSocket clientSocket server

COMIndex	NwkAddr	MACAddr	Channel	Type	Ver	Loc	Chip	Profile	IP	PANID	
0	COM112	0xd2ab	0x00158400011d4e2e	11	DimmableLight	1.0	Local	JN5169	ZB3	192.168.56.1	0x0eal
1	COM185	0xb43d	0x00158400011d4ca1	11	DimmableLight	1.0	Local	JN5169	ZB3	192.168.56.1	0x0eal
2	COM162	0xad93	0x00158400011d4a37	11	DimmableLight	1.0	Local	JN5169	ZB3	192.168.56.1	0x0eal
3	COM200										
4	COM71	0x543c	0x0015840001153a22	11	DimmableLight	1.0	Local	JN5169	ZB3	192.168.56.1	0x0eal
5	COM195	0x121a	0x00158400011d4b84	11	DimmableLight	1.0	Local	JN5169	ZB3	192.168.56.1	0x0eal
6	COM109	0xa377	0x00158400011d4c0b	11	DimmableLight	1.0	Local	JN5169	ZB3	192.168.56.1	0x0eal
7	COM4	0x179f	0x00158400011d4b0b	11	DimmableLight	1.0	Local	JN5169	ZB3	192.168.56.1	0x0eal
8	COM91	0x46ab	0x00158400011d4a02	11	DimmableLight	1.0	Local	JN5169	ZB3	192.168.56.1	0x0eal
9	COM58	0xd4b4	0x0015840001153a5e	11	DimmableLight	1.0	Local	JN5169	ZB3	192.168.56.1	0x0eal
10	COM191	0xffeb	0x0015840001152854	11	DimmableLight	1.0	Local	JN5169	ZB3	192.168.56.1	0x0eal
11	COM13	0x746f	0x00158400011d4cf7	11	DimmableLight	1.0	Local	JN5169	ZB3	192.168.56.1	0x0eal
12	COM9	0x4c5e	0x00158400011d4c76	11	DimmableLight	1.0	Local	JN5169	ZB3	192.168.56.1	0x0eal
13	COM190	0xf151	0x001584000115285b	11	DimmableLight	1.0	Local	JN5169	ZB3	192.168.56.1	0x0eal
14	COM6	0xb495	0x0015840001153a20	11	DimmableLight	1.0	Local	JN5169	ZB3	192.168.56.1	0x0eal
15	COM165	0x7a3b	0x00158400011d480c	11	DimmableLight	1.0	Local	JN5169	ZB3	192.168.56.1	0x0eal
16	COM77	0xe9da	0x00158400011528ee	11	DimmableLight	1.0	Local	JN5169	ZB3	192.168.56.1	0x0eal
17	COM228	0x6381	0x0015840000d33a1c	11	DimmableLight	1.0	Local	JN5169	ZB3	192.168.56.1	0x0eal
18	COM101	0xba13	0x00158400011d4b57	11	DimmableLight	1.0	Local	JN5169	ZB3	192.168.56.1	0x0eal
19	COM94	0x2cc5	0x00158400011d4b27	11	DimmableLight	1.0	Local	JN5169	ZB3	192.168.56.1	0x0eal
20	COM7	0x003a	0x00158400011d4c30	11	DimmableLight	1.0	Local	JN5169	ZB3	192.168.56.1	0x0eal
21	COM24	0xac3f	0x00158400011528a2	11	DimmableLight	1.0	Local	JN5169	ZB3	192.168.56.1	0x0eal
22	COM221	0xb898	0x0015840001152894	11	DimmableLight	1.0	Local	JN5169	ZB3	192.168.56.1	0x0eal
23	COM10	0x2c7c	0x00158400011d44ee	11	DimmableLight	1.0	Local	JN5169	ZB3	192.168.56.1	0x0eal
24	COM131	0xa7a3	0x00158400011d4495	11	DimmableLight	1.0	Local	JN5169	ZB3	192.168.56.1	0x0eal

ALL

nwkAddrJoinedStatusLoca

00xd2abLocal

10xb43dLocal

20xad93Local

30x543cLocal

40x121aLocal

50xa377Local

60x179fLocal

70x46abLocal

80xd4b4Local

90xffebLocal

100x746fLocal

110x4c5eLocal

120xf151Local

130xb495Local

140x7a3bLocal

150xe9daLocal

160x6381Local

170x2cc5Local

180xba13Local

190x003aLocal

200x2cc5Local

210xb898Local

220x2c7cLocal

230xa7a3Local

240x2c7cLocal

Loop Timers0

Set15050stopdir

Reset To FDPermitDisableJoin

Readcluster IIattribute 1Stop Read Loop

Writecluster IIattribute 1data type 1data 0x0

UnicastOnOFFOn/OFFStop On/OFFToggle

BroadcastOnOFFToggleStop Toggle Loop

Bindcluster ID 0x0Unbindcluster ID 0x0

Leave

Config Rptcluster IDdata typeattribute 1Timer int 1Timer int 1Time out 1

Read Rptcluster IDattribute 1

Identify Sendtime 0x0Stop Identify

Add Groupgroup addressRemove Groupgroup addressView Group

Move to LevelUnicastlevel 0x0time 0x0

MoveToHuehue 0x0direction 0x0time 0x0Stop

MoveToColorcolor X 0x0color Y 0x0time 0x0Stop

MoveToSat sat 0x0time 0x0Stop Loop

MoveToTemp temp 0x0time 0x0Stop Loop

入网节点的串口号，网络短地址，MAC地址，PANID，基于网络短地址的可控节点

频道，IP地址，设备类型，软件版本，芯片系列等信息

空口控制命令

各节点的串口打印信息

Received Message ViewView Additional Debug?Clear

0x19f2:Toggle (Green=1, Red=0)

0x543c:Toggle (Green=1, Red=0)

0xd4b4:Toggle (Green=1, Red=0)

0xf151:Toggle (Green=1, Red=0)

0xb43d:Toggle (Green=1, Red=0)

0x1c42:Toggle (Green=1, Red=0)

0xe559:Toggle (Green=1, Red=0)

0x2519:Toggle (Green=1, Red=0)

0x604f:Toggle (Green=1, Red=0)

0x4552:Toggle (Green=1, Red=0)

0x16bb:Toggle (Green=1, Red=0)

0x74f5:Toggle (Green=1, Red=0)

0x121a:Toggle (Green=1, Red=0)

0x4c5e:Toggle (Green=1, Red=0)

0xba13:Toggle (Green=1, Red=0)

0x8ff3:Toggle (Green=1, Red=0)

0x2969:Toggle (Green=1, Red=0)

0xf12a:Toggle (Green=1, Red=0)

0xa40e:Toggle (Green=1, Red=0)



JN5189相关资料

- JN5189快速入门（含视频教程）

<https://www.nxp.com/document/guide/getting-started-with-jn5189:GS-JN5189>

- JN5189规格书，用户手册及应用例程

https://www.nxp.com/products/wireless/thread/jn5189-88-t-high-performance-and-ultra-low-power-mcus-for-zigbee-and-thread-with-built-in-nfc-option:JN5189_88_T?tab=Documentation_Tab

- JN5189软件开发工具包(SDK)及原理图,PCB版图

https://www.nxp.com/products/wireless/thread/jn5189-88-t-high-performance-and-ultra-low-power-mcus-for-zigbee-and-thread-with-built-in-nfc-option:JN5189_88_T?tab=Design_Tools_Tab



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