UM10911

OM15008 smart lighting module

Rev. 1.1 — 29 April 2016 **User manual**

Document information

Info	Content
Keywords	JN5169, remote control, lighting, SSL, LED, PCB antenna, ZigBee, NFC
Abstract	This user manual provides basic information about the OM15008 reference design. The OM15008 board contains a RF remote control for lighting applications. The board must be supplied with a low DC voltage of typical 2.5 V. The JN5169 has 512 kB internal flash memory so no external flash memory is needed.

Revision history

Rev	Date	Description
0.0	20150624	Initial version
0.1	20150624	Change NT3H1201 with NT3H1101, connect NFC Field Detect signal to JN5169
1.0	20151117	First released
1.1	20160419	Add the JN-AN-1221 reference for binary file
1.2	20160429	Add the new Production Flash Programmer JN-SW-4107

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1. Safety warning

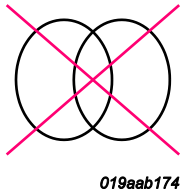
Warning

Lethal voltage and fire hazard

The non-insulated high voltages that are present when operating this product constitute a risk of electric shock, personal injury, death and/or ignition of fire.

This product is intended for evaluation purposes only. It shall be operated in a designated test area by personnel qualified according to local requirements and labor laws to work with non-insulated mains voltages and high-voltage circuits. This product shall never be operated unattended.

The board must be connected to (rectified) mains voltage. Avoid touching the demo board while it is connected to the mains voltage. An isolated housing is obligatory when used in uncontrolled, non-laboratory environments. Galvanic isolation, of the mains phase using a variable transformer is always recommended.



a. Isolated

b. Non isolated

Fig 1. Variable transformer isolation symbols

2. Introduction

The OM15008 smart lighting module is a highly versatile board that can be used in all kinds of applications but focuses on lighting applications. Because the board is so versatile, several components might left out in a specific application. The board is split up in two parts:

- RF part containing JN5169
- RF antenna

The board can be placed on top of a Large Signal Board (LSB) that containing a LED driver in order to create a fully functional remote controllable lamp.

The JN5169 is an ultra-low power, high performance wireless microcontroller suitable for ZigBee applications, remote control and Active RFID.

The PCB antenna can also be removed in order to connect an external antenna via a coaxial wire.

If the JN5169 with 512 kB memory is mounted on this board, then the antenna matching components need to be modified. More on this can be found in sections 6 and 7 of this manual.

3. Specification

- DC supply voltage of typically 2.5 V
- Integrated PCB antenna
- Minimum of external components needed
- Low standby power
- 4 digital outputs
- 1 digital input
- 1 analog input or digital input

Table 1. OM15008 module specification

Parameter	Comment	Min.	Typ.	Max.	Units
DC supply voltage		2	2.5	3.6	V
power consumption	measured at 2.5 V supply voltage	-	45	-	mW
ambient temperature		−25	-	+125	°C

4. Board connections

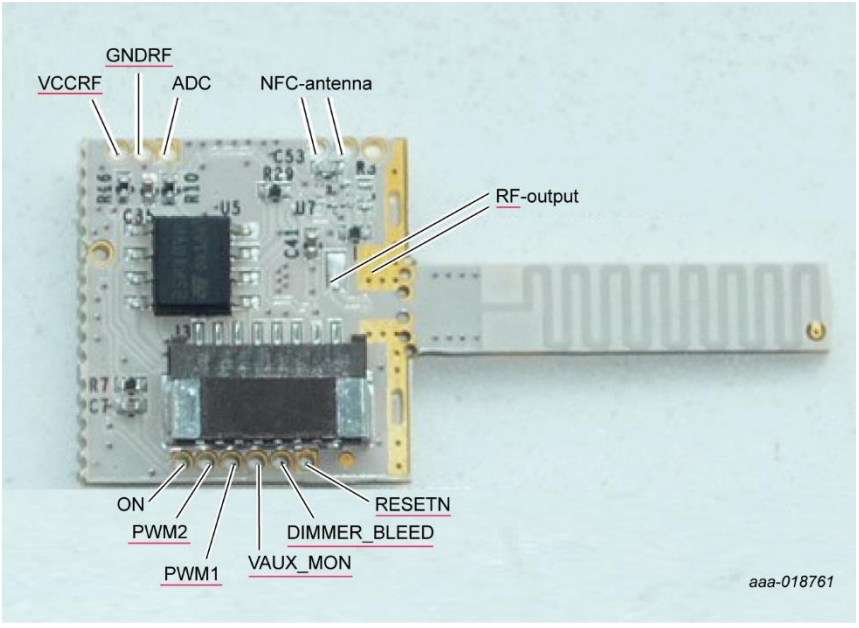


Fig 2. Board connections

5. Programming the board

The OM15008 board can be programmed using the Atomic USB programming dongle + OM15037 adapter board and a standard USB cable. The Atomic programming dongle can be ordered from www.atomicprogramming.com. Contact your local NXP support office for the OM15037 adapter board.

A flex foil is used to connect the OM15008 board to the OM15037 board. Suitable flex foils can be found in Table 2.

Table 2. Flex foils

Manufacturer	Manufacturer code	Supplier	Supplier code
Molex	98267-0233	Farnell	1079968
WURTH ELEKTRONIK	686608200001	Farnell	1908567

Note: the flex foil must be twisted when connecting the two boards. Twisted means that on board the metal contacts of the flex foil are facing up and on the other board the contacts are facing towards the board as is depicted in Fig 3.

Fig 3. Programming cable connections

The Atomic programming board supplies the OM15008 board with 3.3 V during the programming. The programming board contains a voltage regulator that derives 3.3 V from the 5 V that is supplied from the USB port.

Driver of USB serial interface and programming software can be found in the Production Flash Programmer JN-SW-4107, full details provided in Production Flash Programmer User Guide JN-UG-3099.

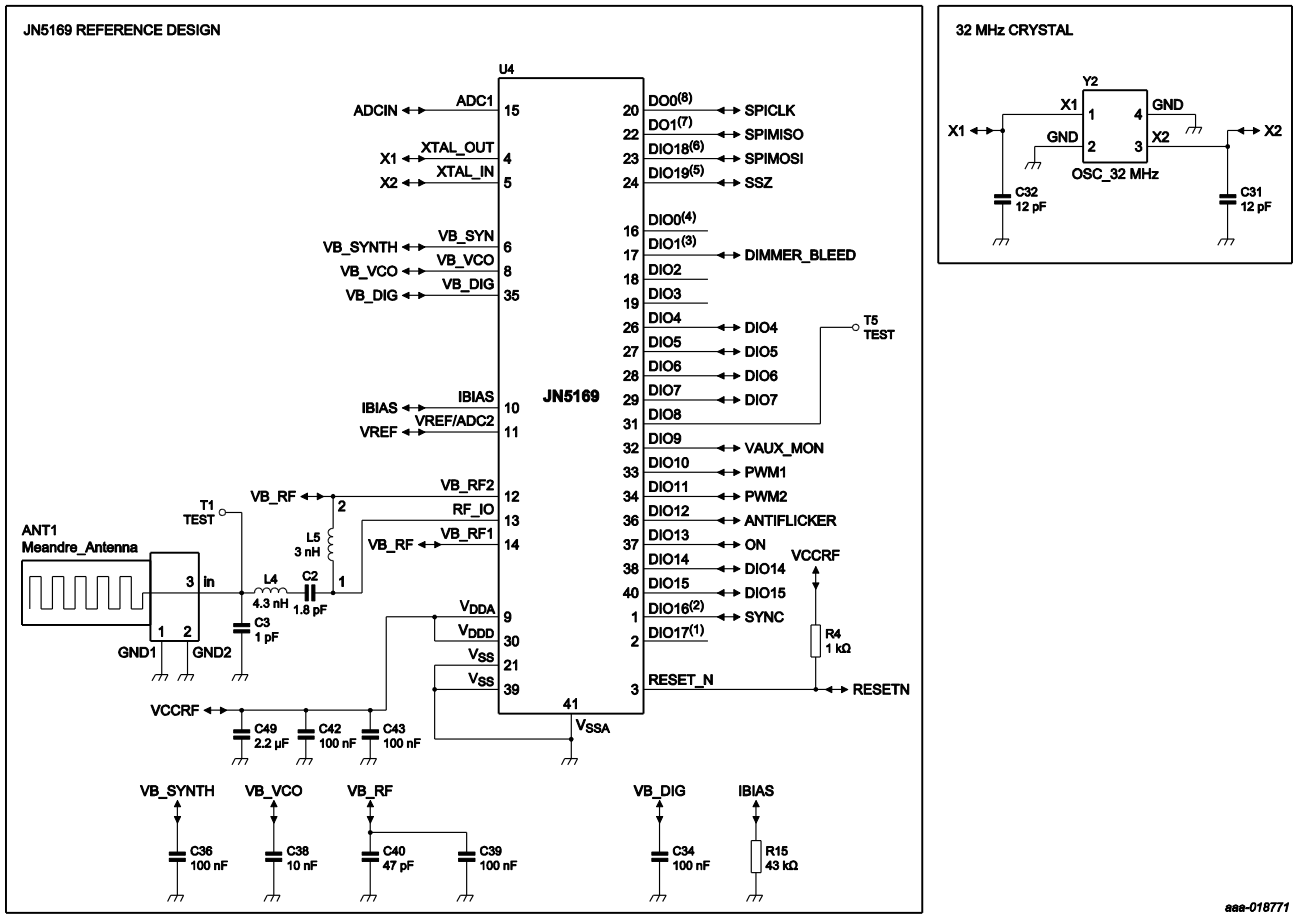
Do not supply the OM15008 board via an external supply during programming.

The programming method described here is suitable for use in prototypes. However, for mass production, either program the flash before assembly or after assembly use programming pads on the PCB and needles rather than a programming connector.

Refer to JN-AN-1221 for the binary file generation.

6. Schematic

The OM15008 board can also be fitted with a JN5169 which has 512 kB embedded flash, lower standby power and 10 dBm transmit power. The antenna matching circuit and crystal oscillator component value's must be changed when the JN5169 is mounted.



(1) DIO17/SPISMISO/SIF_D/COMP1M/PWM4.

(2) DIO16/SPISMOSI/SIF_CLK/COMP1P.

(3) DIO1/ADE/SPISEL2/ADC4/PC0.

(4) DIO0/ADO/SPISEL1/ADC3.

(5) DIO19/SPISEL0.

(6) DIO18/SPIMOSI.

(7) DO1/SPIMISO/PWM3.

(8) DO0/SPICLK/PWM2.

Fig 4. JN5169 design with minimum required external components

7. Bill of Material application

Table 3. Bill of material

Absolutely required	Reference	Description and values	Part number	Manufacturer
Yes	C2	1.8 pF	GRM1555C1H1R8CA01D	MURATA
Yes	C3	1 pF	GRM1555C1H1R0CA01D	MURATA
Yes	C31	12 pF	GRM1555C1H120JA01	MURATA
Yes	C32	12 pF	GRM1555C1H120JA01	MURATA
Yes	C34	100 nF	GRM155R71C104KA88D	MURATA
Yes	C36	100 nF	GRM155R71C104KA88D	MURATA
Yes	C38	10 nF	GRM155R71H103KA88D	MURATA
Yes	C39	100 nF	GRM155R71C104KA88D	MURATA
Yes	C40	47 pF	GRM1555C1H470JA01	MURATA
Yes	C42	100 nF	GRM155R71C104KA88D	MURATA
Yes	C43	100 nF	GRM155R71C104KA88D	MURATA
Yes	C49	2.2 μF	GRM188R71A225KE15D	MURATA
Yes	L4	4.3 nH	LQG15HN4N3S02	MURATA
Yes	L5	3.0 nH	LQG15HN3N0S02	MURATA
Yes	R15	43 kΩ	RC0402FR-0743KL	YAGEO
Yes	R4	1 kΩ	RC0402FR-071KL	YAGEO
Yes	U4	JN5169	JN5169	NXP
Yes	Y2	32 MHz Xtal	X32M000000S039A	AEL

8. Board layout

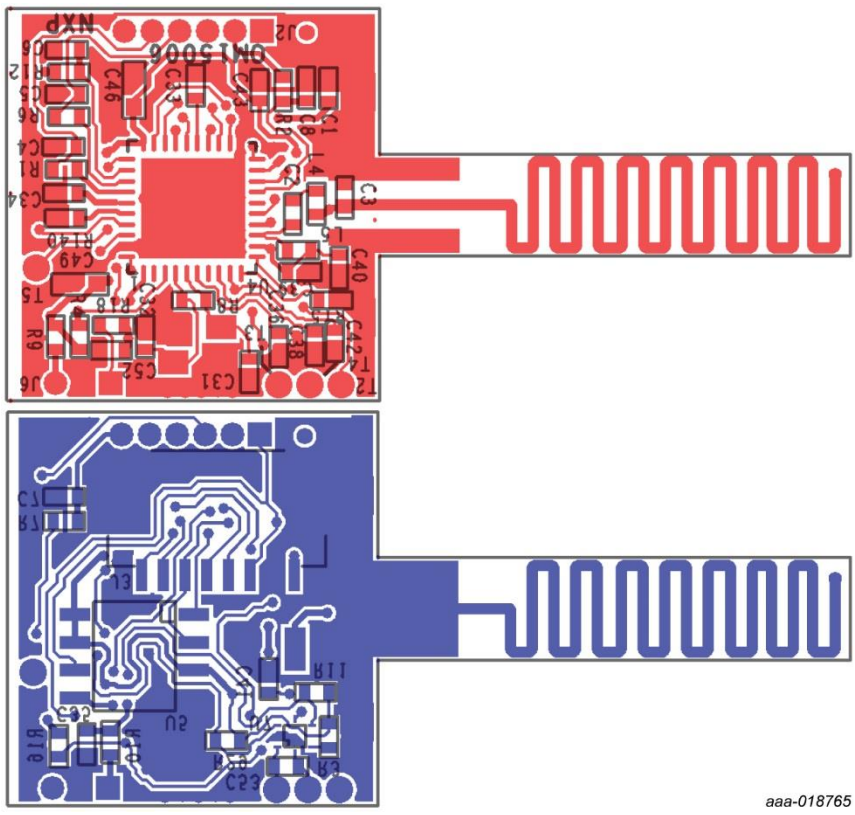


Fig 5. Top and bottom OM15008 layout

Note: the top side of the OM15008 board is facing towards the top side of the Large Signal Board (LSB).

9. Board dimensions

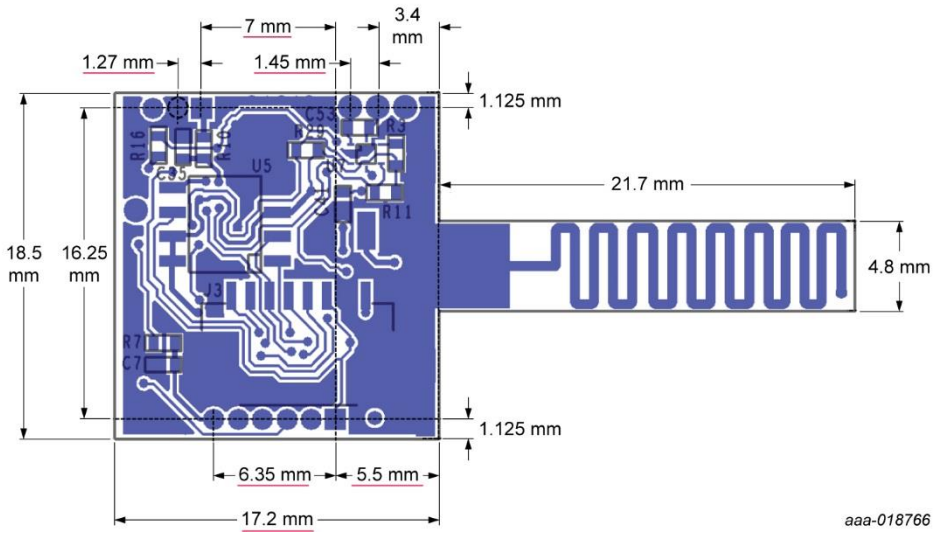


Fig 6. Board dimensions

10. Functional description

10.1 Pinout

The OM15008 board has a programming connector and two headers:

Table 4. Pin list for the programming connector

Pin	Pin name	JN5169 pin	Function	Electrical
J3.1	DIO5	27 (DIO5)		0 V to 3.6 V
J3.2	DIO4	26 (DIO4)		0 V to 3.6 V
J3.3	SPIMISO	22 (SPIMISO)		0 V to 3.6 V
J3.4	DIO7	29 (DIO7)	digital I/O (UART)	0 V to 3.6 V
J3.5	DIO6	28 (DIO6)	digital I/O (UART)	0 V to 3.6 V
J3.6	RESETN	3 (RESET_N)	digital I/O (Reset_not signal for microcontroller)	0 V to 3.6 V
J3.7	GND	-	ground	0 V
J3.8	VCCRF	9/30 (V_{DDA}/V_{DDD})	supply	0 V to 3.6 V

Table 5. Pin list for header J2

Pin	Pin name	JN5169 pin	Function	Electrical
J2.1	RESETN	3 (RESET_N)		0 V to 3.6 V
J2.2	DIMMER_BLEED	17 (DIO1)	bleeder output when the board is used in dimmer tolerant solutions	0 V to 3.6 V
J2.3	VAUX_MON	32 (DIO9)	V_{AUX} monitor input when the board is applied in low cost solutions	0 V to 3.6 V
J2.4	PWM1	33 (DIO10)	PWM1 output (Brightness control)	0 V to 3.6 V
J2.5	PWM2	34 (DIO11)	PWM2 output (CCT control when the board is used in tunable white solution)	0 V to 3.6 V
J2.6	ON	37 (DIO13)	ON/OFF output	0 V to 3.6 V

Table 6. Pin list for header J6

Pin	Pin name	JN5169 pin	Function	Electrical
J6.1	ADCIN	15 (ADC1) 1 (DIO16)	input for AD converter input for comparator	0 V to 3.6 V 0 V to 3.6 V
J6.2	GND	-		0 V
J6.3	VCCRF	9/30 (V_{DDA}/V_{DDD})		0 V to 3.6 V

The RESET_N pin of the JN5169 is connected to J3.6 and J2.1 and susceptible for noise. So do not connect a programming cable or long wires to these pins. The RESET_N pin is connected to VCCRF via a pull up resistor. The minimum value of this resistor depends on the programming board that is used: if for example the Atomic programming board is used, then the minimum value of the pull-up resistor depends on the maximum current that the FTDI chip on the Atomic programming board can sink.

Header J2 has 4 digital outputs to the LSB that can be used to control the LED driver on the LSB. The function of these pins depends on the LSB on which the OM15008 board is mounted and the software that is used.

The VAUX_MON input can be used for standby voltage control in combination with specific large signal boards.

There are RC-filters on the PWM outputs as the board is operating in a noisy environment. In this way is prevented that noise is injected from the LSB into the DIO's which might cause problems. The filters are placed as close as possible to the DIO pins of the JN5169. Ideally the 470 pF capacitors should have been placed directly between the DIO-pins and ground, but because the PWM output is switching this would result in switching spikes through the capacitors. For that reason the filter capacitors are placed between the pin's of J2 and ground and then they are connected to the DIO pins via a 2.2 kΩ resistor.

Header J6 is used for supplying the board and J6.2 is an input that can be routed to 2 different pins: ADC1 and DIO16. The first input is an ADC and it can be used to monitor e.g. the bus voltage. The second input is a comparator and this input can be used for synchronizing the PWM frequency with the mains frequency.

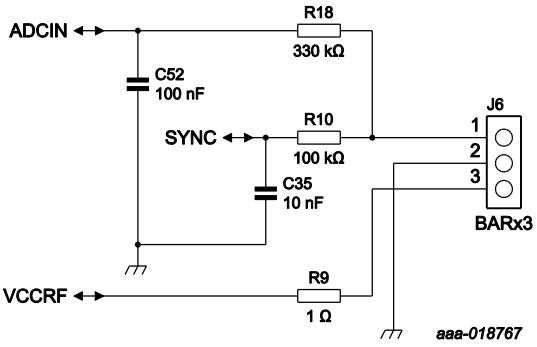


Fig 7. Header J6

VCCRF is connected via a resistor R9 (1 Ω) to V_{DDA}/V_{DDD} of the JN5169. This resistor in combination with the decoupling capacitors C42, C43, C46 and C49 form a low pass filter that filters out high frequency noise on the supply voltage.

10.2 Operation of the RF board

The JN5169 contains a complete wireless microcontroller and only a minimum of external components is needed. Things to add are:

- crystal oscillator
- antenna
- large signal board interface
- programming interface

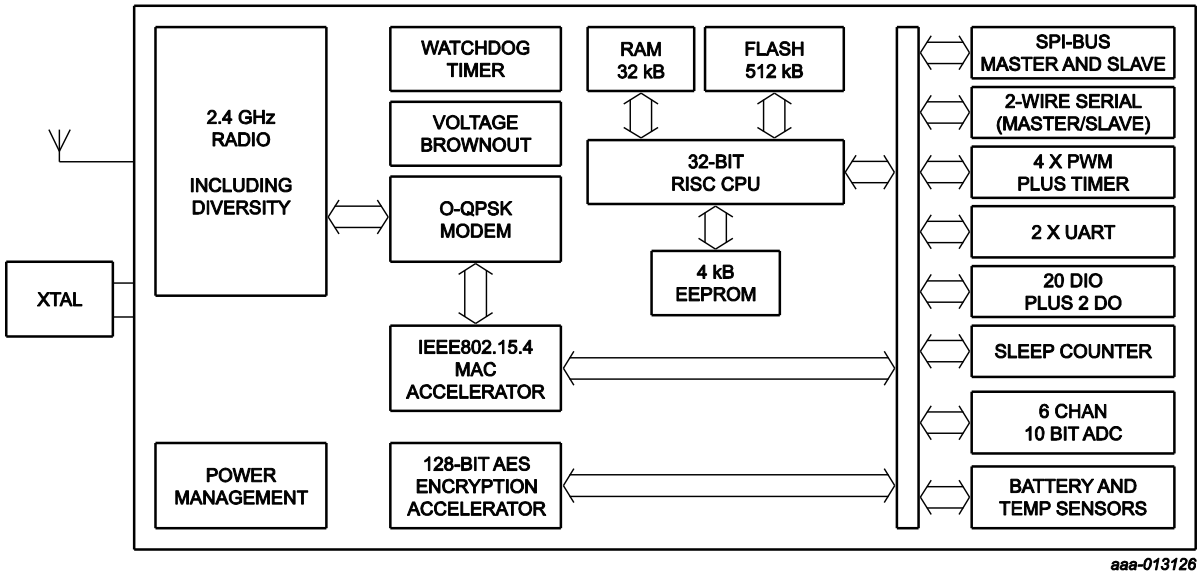


Fig 8. Block diagram of the JN5169

10.2.1 Crystal oscillator

The crystal oscillator is used for generating the system clock for the radio transceiver and the CPU. The stability of the clock frequency is especially important for the radio transceiver.

The JN5169 contains the necessary on chip components to build a 32 MHz reference oscillator with the addition of an external crystal resonator and two tuning capacitors. The schematic of these components are shown in Fig 8. The two capacitors, C1 and C2, should typically be 15 pF and use a COG dielectric. Due to the small size of these capacitors, it is important to keep the traces to the external components as short as possible. The on chip transconductance amplifier is compensated for temperature variation, and is self-biasing by means of the internal resistor R1. The crystal must be a pulling type.

Table 7. Preferred crystals for JN5169

Manufacturer	Manufacturer code	T (°C)	CL (pF)	ESR (Ω)	Size (mm)
AEL	X32M000000S039	125	9	40	3.2 x 2.5
NDK	NX2016A EXS00A-CS07977	85	10	30 to 60	
	NX3225SA EXS00A-CS08207	85	10	50	3.2 x 2.5
Murata	FXQR14005S XR16GD32M000KYQ01R0	85	8	50	2.0 x 1.6
KDS	DSX321G	85	9	50	3.2 x 2.5

At temperatures higher than 85 °C the oscillating frequency of the crystal will shift. However when the crystals mentioned in Table 7 are applied, then the JN5169 can

compensate for this shift by means of internal pulling capacitors. The switching of these pulling capacitors is controlled by the internal temperature measurement of the JN5169.

More development support on the crystal oscillator can be found in the JN5169 datasheet.

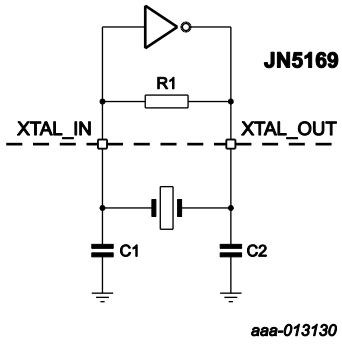


Fig 9. JN5169: 32 MHz crystal oscillator connections

10.2.2 RF antenna

The antenna operates at a frequency of typically 2.45 GHz. The (external) single ended matching network, which consists of two inductors and a capacitor, creates a 50 Ω port and removes the need for a balun. The integrated PCB antenna can be used or this antenna can be removed and then a 50 Ω single ended antenna can be connected to the antenna pads. When the PCB antenna is used, then a counterpoise can be connected to have optimum performance.

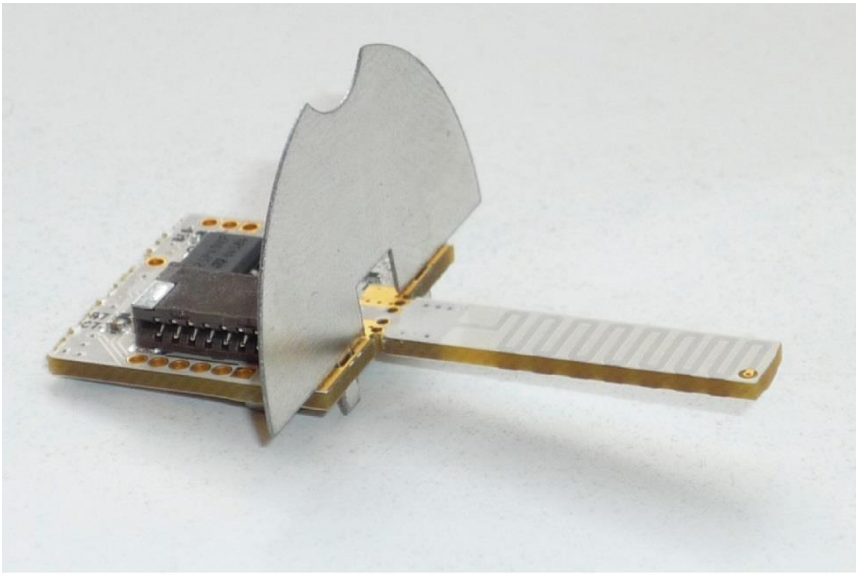


Fig 10. PCB with counterpoise

10.2.3 Serial flash memory

The JN5169 has an internal flash memory of 512 kB.

10.2.4 Near Field Communication (NFC) chip

The OM15008 board has the possibility to mount a NFC chip e.g. NTAG I^2C-bus NT3H1101 for simple, easy and secure commissioning of the lamp into the wireless network. If the NFC chip is used, then a loop antenna must be connected to pads T3 and T4. This antenna operates at a frequency of 13.56 MHz. More info on the NTAG I^2C-bus chips can be found on the NXP website.

10.2.5 Anti-flicker current bleed

The anti-flicker current bleeder is used when the OM15008 is used in a low cost solution where the LED driver is also used for supplying the OM15008 board. This only works in combination with the appropriate software. In all other cases this resistor should not be mounted.

11. Abbreviations

Table 8. Abbreviations

Acronym	Description
COG	
CPU	Central Processing Unit
DC	Direct Current
FTDI	Future Technology Devices International
LED	Light Emitting Diode
LSB	Large Signal Board
NFC	Near Field Communication
NTAG	
PCB	Printed Circuit Board
RFID	Radio Frequency IDentification
USB	Universal Serial Bus

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