

Appendix 6.

User manual



PMA(Power Measurement Adapter) Hardware Description

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2012-05-26

Contents

1. Hardware Description	4
1.1 Introduction.....	4
1.2 Overall System Configuration	4
1.3 PMA Introduction	5
1.3.1. Front View	5
1.4 Block Description	6
1.4.1. Overall Block	6
1.4.3. BlueBird-XP206	7
1.4.2 GT-ZBM(ZigBee).....	8
1.4.3 SPS-PMA-ZBB-PS206.....	9
1.5 Schematics.....	10
1.5.1 BLUEBIRD-XP206	10
1.5.2 SPS-PMA-ZBB-PS206.....	11
1.5.3 GT-ZBM	12
1.6 Part List.....	13
1.6.1 BLUEBIRD-XP206	13
1.6.2 SPS-PMA-ZBB-PS206.....	14
1.6.3 ZBM(ZigBee).....	15
1.7 Circuits Description.....	16
1.7.1 Power Supply.....	16
1.7.2 ZigBee.....	17

1.7.3 MCU	18
1.7.4 Serial Flash EEPROM.....	19
1.8 RF MODEM Specification.....	20
1.8.1 ZigBee.....	20
1.8.2 ZigBee Antenna Specification and Characteristic.....	22
2. How to setup PMA.....	25
2.1 ZigBee.....	25
2.1.1. Zigbee Channel Setup	25

Caution : Any changes or modifications in construction of this device which are not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

1. Hardware Description

1.1 Introduction

PMA (Power Measurement Adaptor) is a kind of smart plug that is connected to the outlet of home electricity AC220V to measure the power consumption through the plug. The measured statistics can be transferred to PCAP(Power Control Access Point) via ZigBee wireless protocol and stores the polled statistics into internal storage device until it was retrieved by the remote smart phone user. A registered user can retrieve the statistics or control the AC line connectivity by using smart phone application. A user can also directly access PMA to read real time power consumption information.

1.2 Overall System Configuration

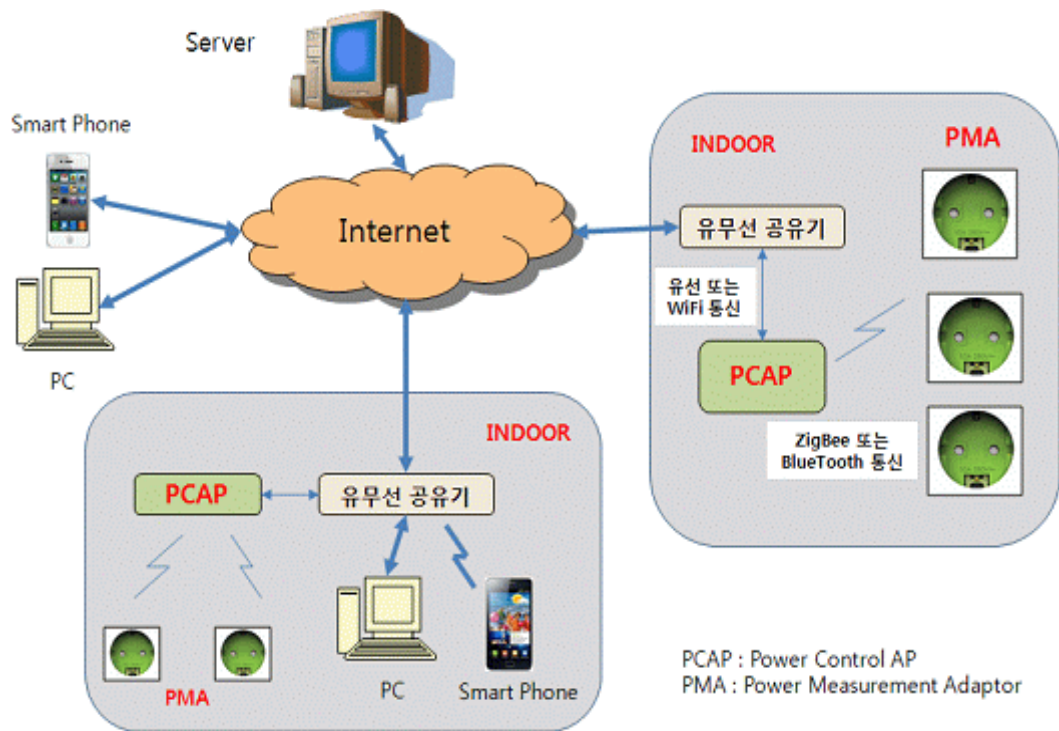


Figure 1 Overall System Configuration

1.3 PMA Introduction

1.3.1. Front View

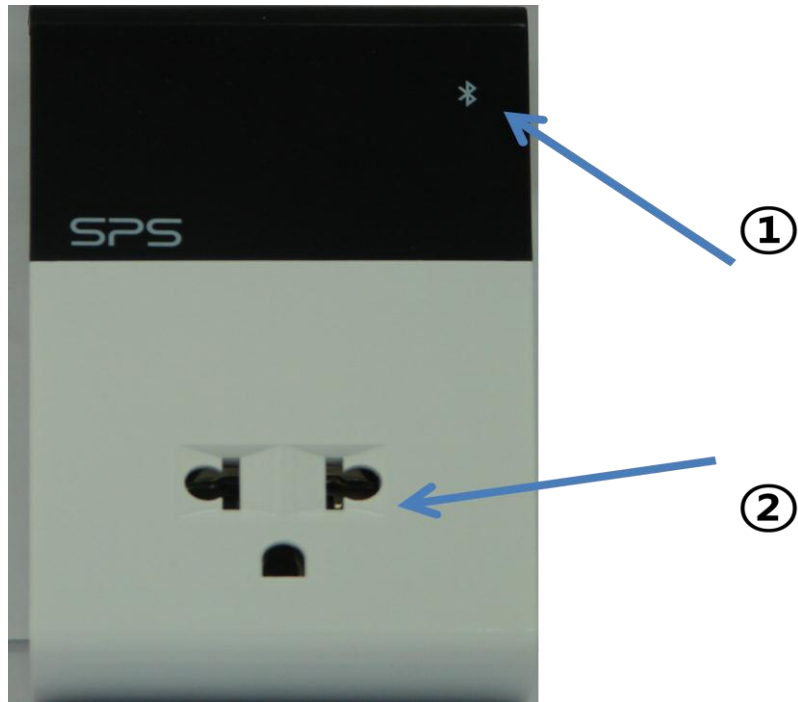


Figure 2 PMA Front View

No.	Description
①	LED(ZigBee Transmit Status, Active= LED ON)
②	AC 220V Connection Plug

1.3.2. Rear View



Figure 3 PMA Rear View

1.4 Block Description

1.4.1. Overall Block

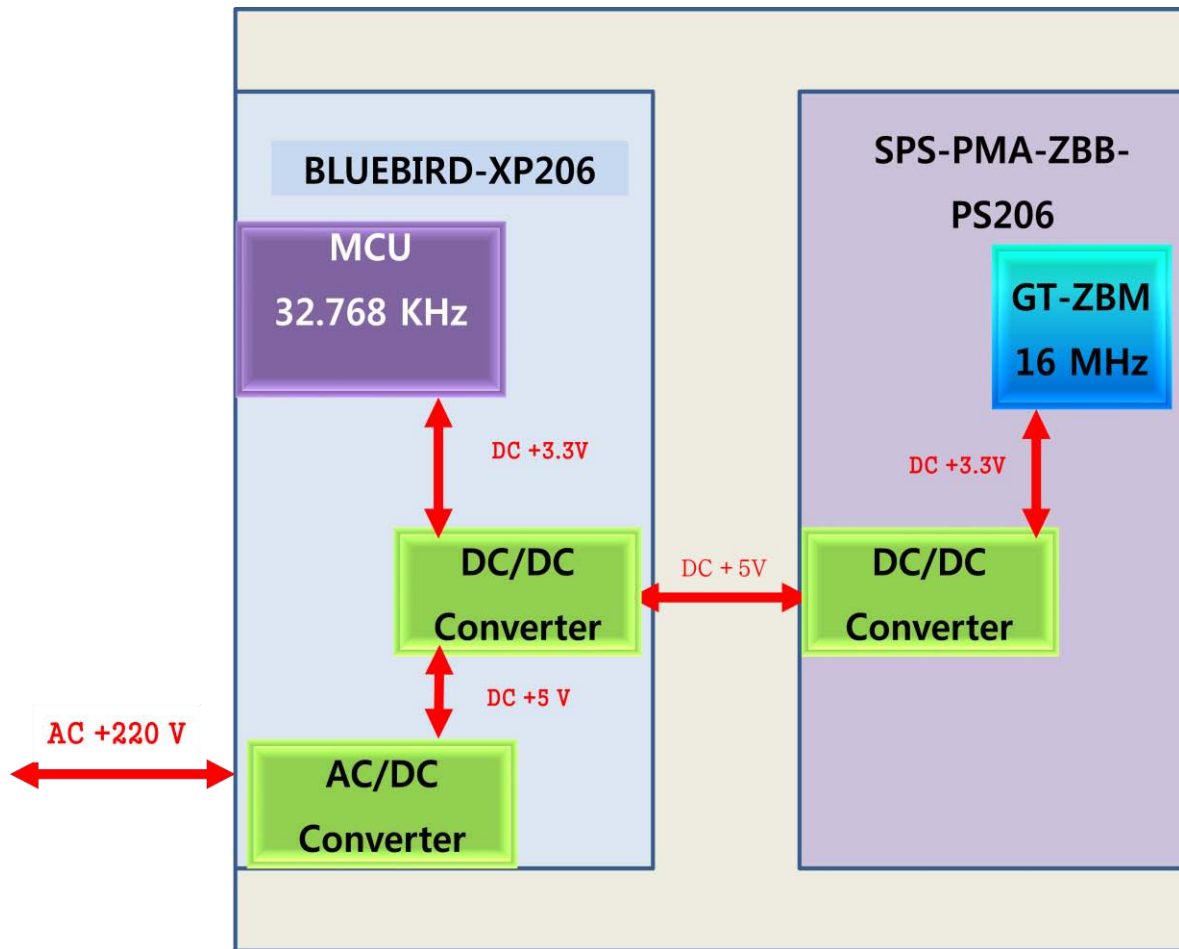


Figure 4 Overall Block Configuration

DC power required for PMA is DC 5.0V is converted from home electricity AC220 to DC +5.0V using AC/DC adaptor. The +5.0V is used for both BLUEBIRD-XP206 and SPS-PMA-ZBB-PS206 which are the composed of PMA. BLUEBIRD-XP206 is carrier board for SPS-PMA-ZBB-PS206 and its function is to measure AC power consumption and maintain connection with PCAP through ZigBee protocol.

1.4.3. BlueBird-XP206

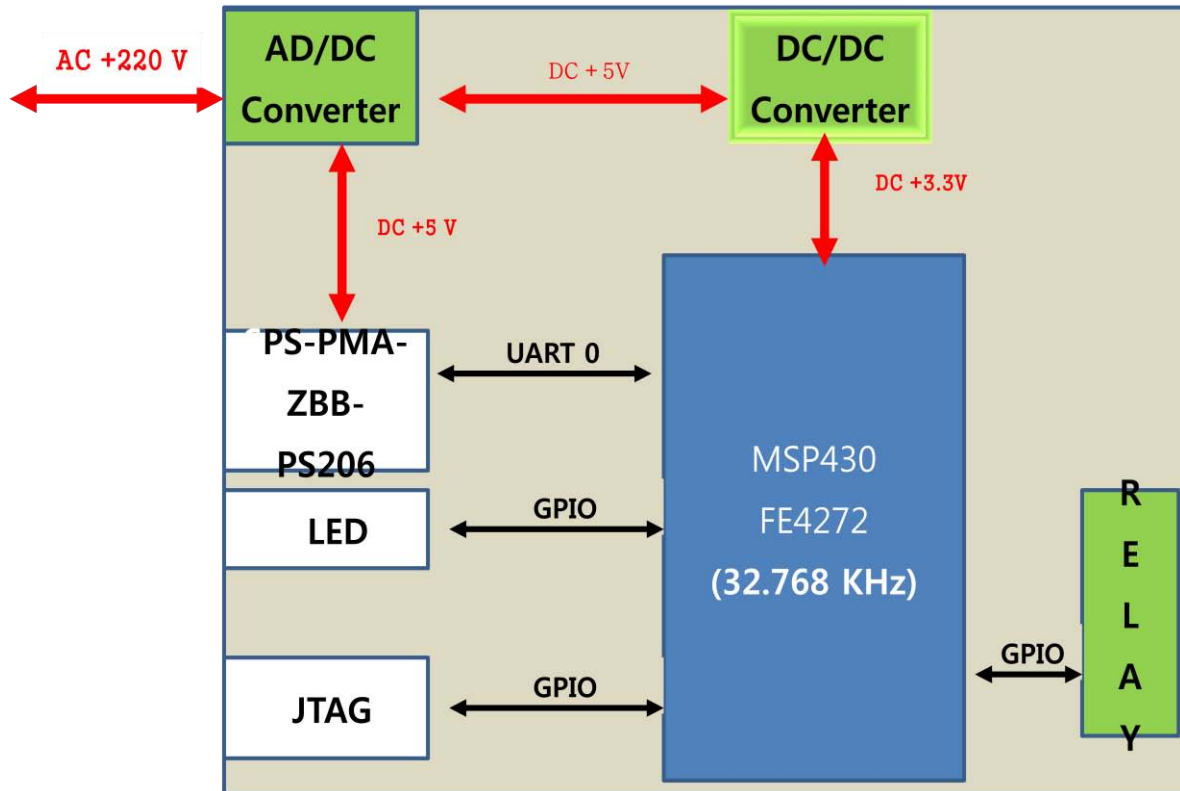


Figure 5 BlueBird-XP206

BLUEBIRD-XP206 is carrier board for SPS-PMA-ZBB-PS206 and its function is to measure AC power consumption and maintains connection with PCAP through ZigBee protocol. The core of the board is microcontroller, MSP430. It measures AC input voltage and current to calculate power consumption and controls relay to block AC electricity for the electrical goods which power was supplied through PMA. The core microcontroller communicates with PCAP by using ZigBee wireless protocol. The ZigBee protocol is handled by ZBM, a ZigBee module on SPS-PMA-ZBB-206.

1.4.2 GT-ZBM(ZigBee)

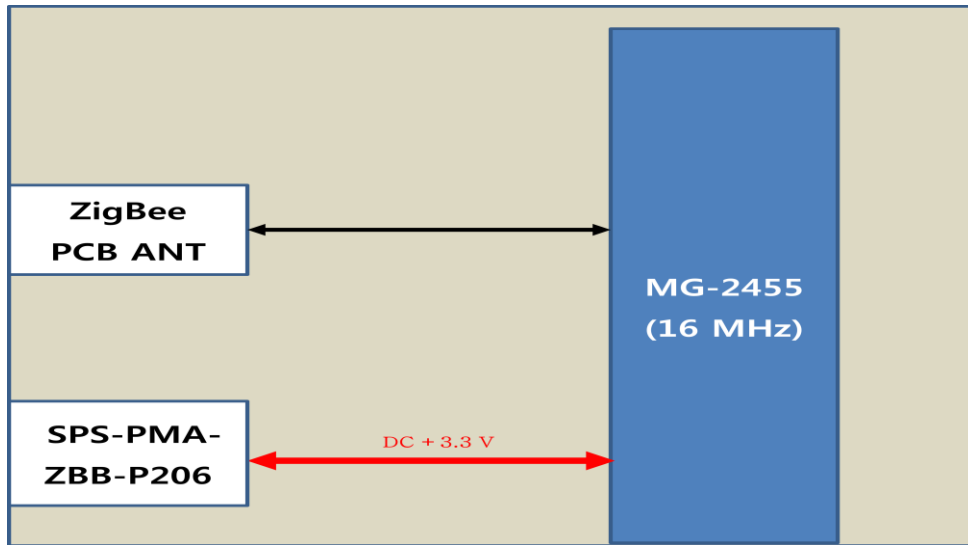


Figure 6 GT-ZBM Block Diagram

ZBM(ZigBee Module) is a module with ZigBee controller that is used to communicate with PCAP.

1.4.3 SPS-PMA-ZBB-PS206

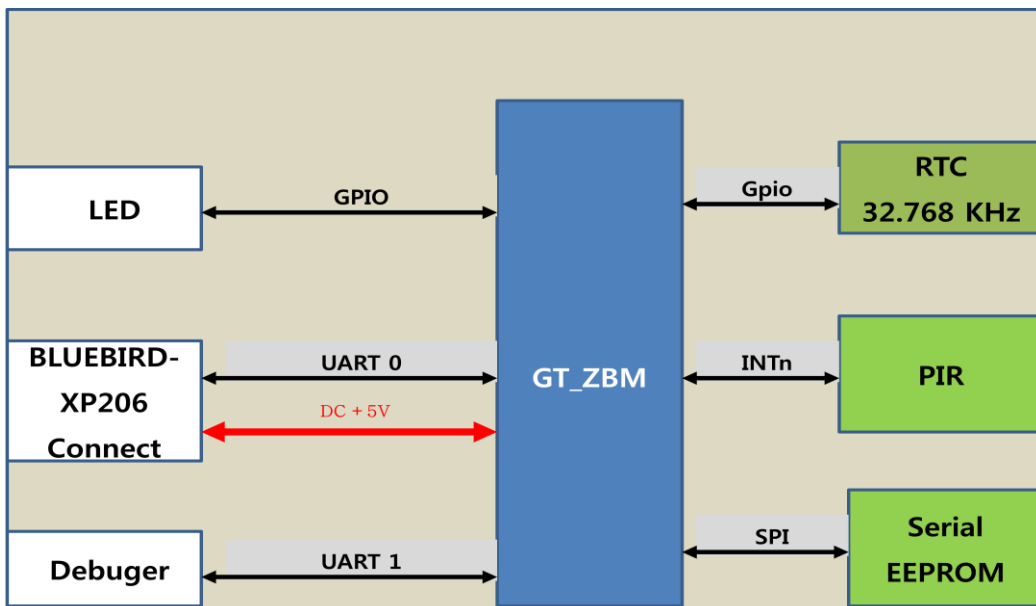


Figure 7 SPS-PMA-ZBB-PS206

SPS-PMA-ZBB-PS206 is a module which can be assembled with SPS-PBLUEBIRD-XP206. Two main circuits are ZigBee wireless communication and PIR sensor circuit. . SPS-PMA-ZBB-PS206 communicates with PCAP through UART serial interface but PIR sensor is controlled directly by microcontroller on carrier board. It has its own storage device to store measured sensor data and can be retrieved by PCAP when it was accessed. ZigBee controller MG2455 has real time clock so it

store sensor data with time information. SPS-PMA-ZBB-PS206 board an ability to upgrade firmware to improve or modify its functions.

1.5 Schematics

1.5.1 BLUEBIRD-XP206

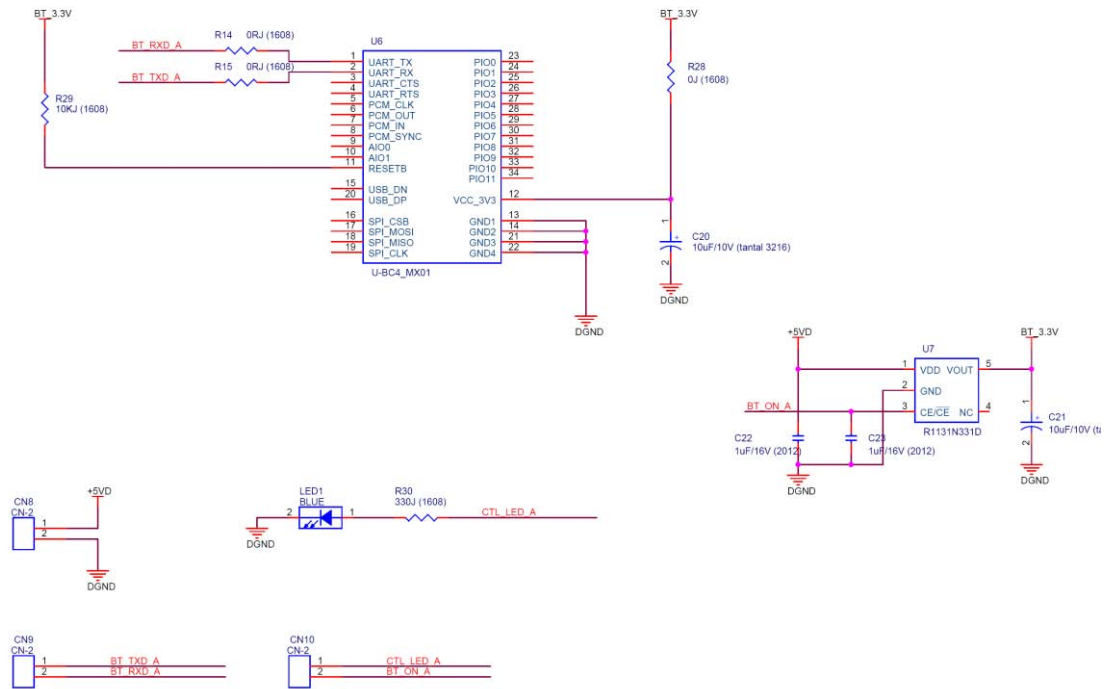


Figure8 BLUEBIRD-XP206 Schematic 1 of 2

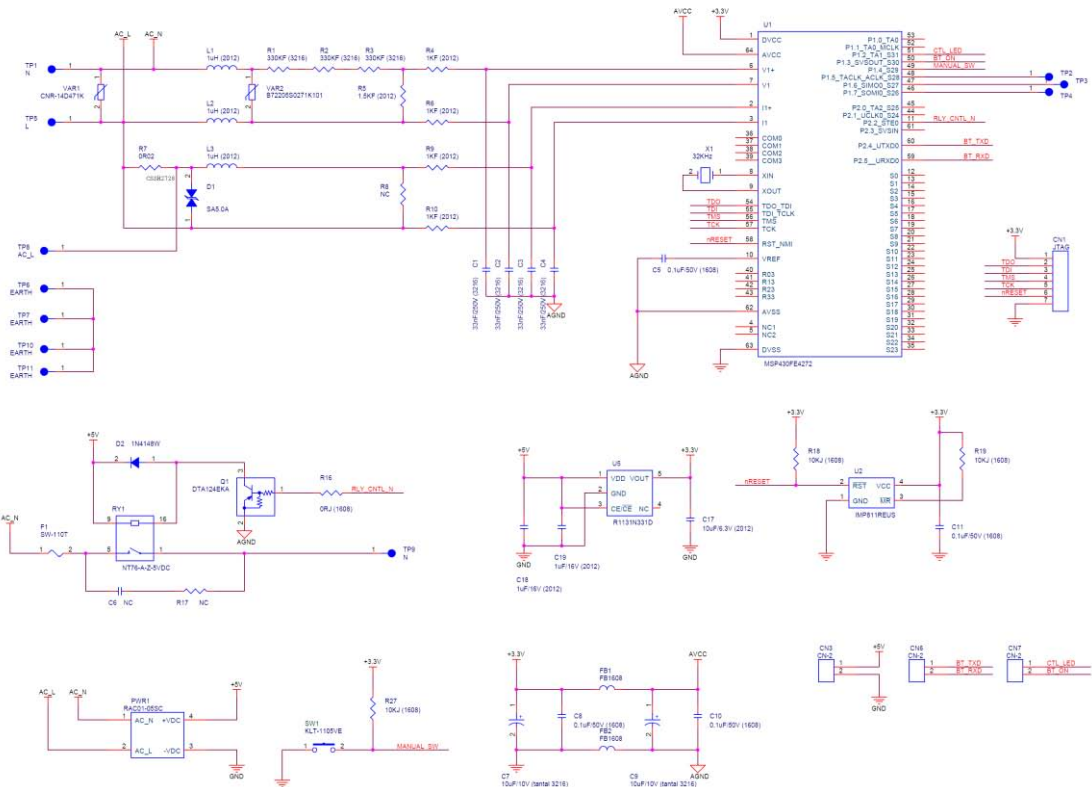


Figure 9 BLUEBIRD-XP206 Schematic 2 of 2

1.5.2 SPS-PMA-ZBB-PS206

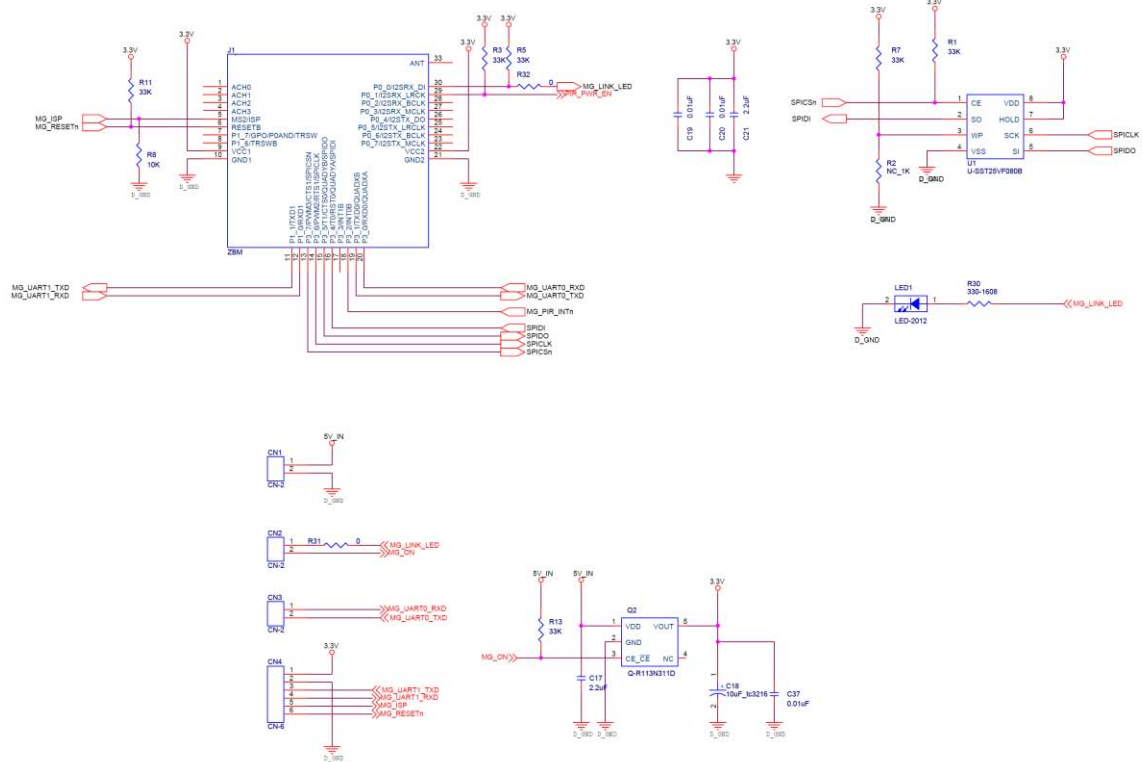


Figure 10 SPS-PMA-ZBB Schematic 1 of 2

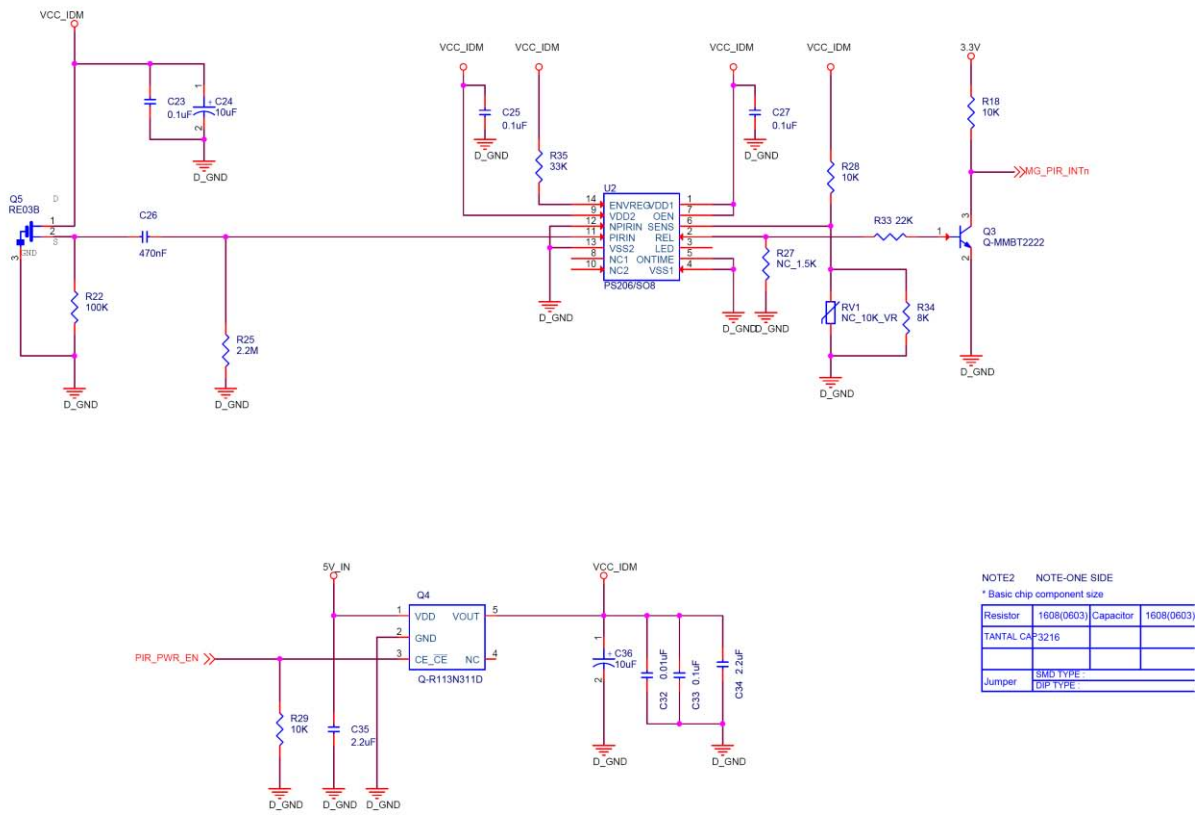


Figure 11 SPS-PMA-ZBB Schematic 2 of 2

1.5.3 GT-ZBM

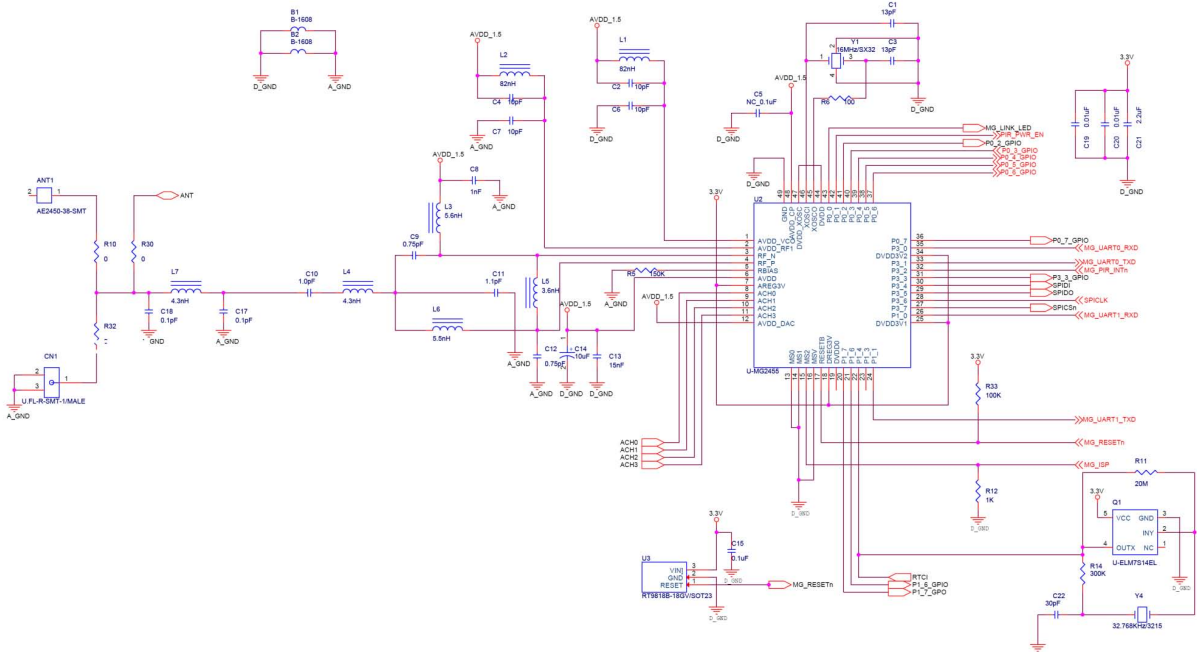


Figure 12 GT-ZBM Schematic 1 of 1

1.6 Part List

1.6.1 BLUEBIRD-XP206

NO	Part No	Description	Vendor	Q'ty	Reference
1	PIN HEADER SOCKET(1x7, 1.27mm)	PIN HEADER SOCKET FEMALE 1.27	SAMTEC	1	CN1
2	PIN HEADER SOCKET (1x2, 2.54mm 높이 8.2mm)	PIN HEADER SOCKET FEMALE 2.54	SAMTEC	3	CN3,CN6,CN7,
3	1206B333K251	CAP 33nF/250V 3216	WALSIN	4	C1,C2,C3,C4
4	CL10B104KB8NNNC	CAP 0.1uF 50V 1608	SAMSUNG	4	C5,C8,C10,C11
5	TMCMA1C106MTRF	T/T CAP 10uF 10V(16V) 3216	HITACHI	2	C7,C9
6	CL21F106ZPFNNNC	CAP 10uF 6.3V 2012	SAMSUNG	1	C17
7	CL21B105KOFNNNE	CAP 1uF 16V 2012	SAMSUNG	2	C18,C19
8	SA5.0A	DIODE TVS	KD	1	D1
9	1N4148W	SWITCHING DIODE	ROHM	1	D2
10	BLM18PG300SN1D	BEAD 1608 300ohm 1000mA 0.05 DCR	MURATA	2	FB1,FB2
11	SW-114T-139	Thermal Fuse 139°C	SUNG WOO	1	F1
12	LQM21PN1R0MC0D	INDUCTOR 1.0UH 800mA 2012	MURATA	3	L1,L2,L3
13	RAC01-05SC	AC-DC module	RECOM	1	PWR1
14	2N7002	N-channel Trench MOSFET	IXP	1	Q1
15	NT76-A-Z-5VDC	Relay	FORWARD	1	RY1
16	WR12X3303FTL	RES 330K F 3216	WALSIN	3	R1,R2,R3
17	WR08X1001FTL	RES 1K F 2012	WALSIN	4	R4,R6,R9,R10
18	WR08X1501FTL	RES 1.5K F 2012	WALSIN	1	R5
19	LR2728-24R020F1	RES 0R02 (6871, 3W, F)	라라전자	1	R7
20	RC1608J000CS	RES 0ohm J 1608	SAMSUNG	3	R14,R15,R16
21	RC1608J103CS	RES 10K J 1608	SAMSUNG	3	R18,R19,R27
22	KLT-1105VE	TACK S/W R/A	KOREANA	1	SW1
23	MSP430FE4272IPM	MCU 16BIT 32KB	TI	1	U1
24	IMP811REUS	Reset generator	IMP	1	U2
25	R1131N331D	LDO regulator	RICOH	1	U5
26	CNR-14D471K	varistor	CNR	1	VAR1
27	B72205S0271K101	varistor 275V 400A	EPCOS	1	VAR2
28	TFC-32.768KHz (12.5pF)	X-TAL CFS308 32.768KHz 12.5pF	SNK	1	X1
29	PCB BLUEBIRD-XP202	53 x 95 x 1.6T x 2L	JM일렉트로닉스	1	
30	NC RES CAP	NC RES CAP		3	C6,R8,R17

1.6.2 SPS-PMA-ZBB-PS206

NO	PartNo	Description	Geom	Vendor	Q'ty	Reference
1	RC1608J000CS	RES 0, J 1608	r1608	SAMSUNG	1	R32
2	CL10B103KB8NNNC	CAP 0.01UF, 1608	c1608	SAMSUNG	2	C32 C37
3	CL10B103KB8NNNC	CAP 0.01UF, 1608	c1608	SAMSUNG	1	C19
4	CL10B103KB8NNNC	CAP 0.01UF, 1608	c1608	SAMSUNG	1	C20
5	CL10B104KB8NNNC	CAP 0.1UF, 1608	c1608	SAMSUNG	4	C23 C25 C27 C33
6	WR06X1003FTL	RES 100K, F 1608	r1608	WALSIN	1	R22
7	RC1608J103CS	RES 10K, J 1608	r1608	SAMSUNG	4	R8 R18 R28 R29
8	TMCMA1C106MTRF	T/T 10UF 16V 3216	tc3216	HITACHI	2	C24 C36
9	TMCMA1C106MTRF	T/T 10UF 16V 3216	tc3216	HITACHI	1	C18
10	WR06X225JTL	RES 2.2M J 1608	r1608	WALSIN	1	R25
11	CL21F225Z0FNNNC	CAP 2.2UF, 2012	c2012	SAMSUNG	3	C21 C34 C35
12	CL21F225Z0FNNNC	CAP 2.2UF, 2012	c2012	SAMSUNG	1	C17
13	WR06X223JTL	RES 22K, J 1608	r1608	WALSIN	1	R33
14	RC1608J331CS	RES 330 J 1608	r1608	SAMSUNG	1	R30
15	RC1608J333CS	RES 33K J 1608	r1608	SAMSUNG	6	R1 R3 R7 R11 R13 R35
16	RC1608J333CS	RES 33K J 1608	r1608	SAMSUNG	1	R5
17	CL10F474Z08NNNC	CAP 470NF 1608	c1608	SAMSUNG	1	C26
18	WR06X8201KJTL	RES 8.2K J 1608	r1608	WALSIN	1	R34
19	MTSW-102-07-G-S-100	PIN HEADER 1X2 2.54mm FEMALE S/T	jump2	SAMTEC	3	CN1 CN2 CN3
20	SLW-106-01-T-S	PIN HEADER SOCKET 1X6 2.54 FEMALE S/T	jump1x6	SAMTEC	1	CN4
21	BL-HG035A-AV-TRB	SMD LED 2012 GREEN	led2012	BRIGHT LED	1	LED1
22	PS206	Digital Smart Detector Control IC	sop14_w0600_I084	코맨텍	1	U2
23	MMBT2222A	TRANSISTOR	sot23	FAIRCHILD	1	Q3
24	R1131N331D-TR-F	LDO REGULATOR	sot23_5	RICOH	2	Q2 Q4
25	RE03BCR	PIR SENSOR	re03b	코맨텍	1	Q5
26	SST25VF080B-80-4I-S2AE	Flash ser 8mb	soic8_w0800_I070	MICROCHIP	1	U1
27	PCB SPS-PMQA-ZBB-PS206 V1.1	38.4 x 57.3 x 1.2T x 4L	1.2T x 4L	세종전자	1	
28	GT-ZBM	GT-ZBM V1.0	zbm		1	J1
29	NC_RC1608J153CS	NC_1.5K	NC r1608	SAMSUNG	1	R27
30	NC_RC1608J102CS	NC_1K	NC r1608	SAMSUNG	1	R2
31	NC_RC1608J000CS	NC 0, J 1608	NC r1608	SAMSUNG	1	R31
32	NC GF063P-501 (500ohm)	NC Trimmer Potentiometer(Volume) 500ohm	NC gf063p_series	TOCOS	1	RV1

1.6.3 ZBM(ZigBee)

NO	PartNo	Description	Geom	Vendor	Q'ty	Reference
1	GRM1555C1HR50CA01D	CAP 0.5pF 1005	C1005	MURATA	2	R10 C17
2	CL05B103K05NNNC	CAP 0.01UF, 1005	c1005	SAMSUNG	1	C19
3	CL05B103K05NNNC	CAP 0.01UF, 1005	c1005	SAMSUNG	1	C20
4	CL05B104K05NNNC	CAP 0.1UF, 1005	c1005	SAMSUNG	1	C15
5	GRM1555C1HR75CZ01D	CAP 0.75PF, 1005	c1005	MURATA	1	C9
6	GRM1555C1HR75CZ01D	CAP 0.75PF, 1005	c1005	MURATA	1	C12
7	GRM1555C1HR0CA01D	CAP 1.0PF, 1005	c1005	MURATA	2	C10 L7
8	GJM1555C1HR1CB01D	CAP 1.1PF, 1005	c1005	MURATA	1	C11
9	RC1005J101CS	RES 100, 1005	r1005	SAMSUNG	1	R6
10	WR04X1003FTL	RES 100K, 1005	r1005	WALSIN	1	R33
11	CL05C100DB5NNNC	CAP 10PF, 1005	c1005	SAMSUNG	1	C4
12	CL05C100DB5NNNC	CAP 10PF, 1005	c1005	SAMSUNG	1	C6
13	CL05C100DB5NNNC	CAP 10PF, 1005	c1005	SAMSUNG	1	C2
14	CL05C100DB5NNNC	CAP 10PF, 1005	c1005	SAMSUNG	1	C7
15	TMCMA1C106MTRF	T/T 10UF, 16V 3216	tc3216	HITACHI	1	C14
16	0402N130J500	CAP 13PF, 1005	c1005	WALSIN	2	C1 C3
17	WR04X154JTL	CAP 150K_1005	r1005	WALSIN	1	R5
18	CL05B153K05NNNC	CAP 15NF, 1005	c1005	SAMSUNG	1	C13
19	SM325-16M-9D	XTAL SX-32 16MHz 9pF	smd sx-32	SNK	1	Y1
20	RC1005J103CS	RES 1K, 1005	r1005	SAMSUNG	1	R12
21	GRM155R71H102KA01D	CAP 1NF, 1005	c1005	MURATA	1	C8
22	CL05A225M05NSNC	CAP 2.2UF 1005	c1005	SAMSUNG	1	C21
23	WF04G206JTL	RES 20M 1005	r1005	WALSIN	1	R11
24	LQG15HN3N6S02D	INDUCTOR 3.6NH, 1005	bead1005	MURATA	1	L5
25	RC1005J304CS	RES 300K 1005	r1005	SAMSUNG	1	R14
26	0402N300J500	CAP 30PF 1005	c1005	SAMSUNG	1	C22
27	CM315A 32.768KHz	SMD 32.768KHZ/3215	xtal_nx3215sa-32	SNK	1	Y4
28	LQW15AN4N3C00D	IND 4.3nH 1005	bead1005	MURATA	1	L4
29	LQG15HS5N6S02D	IND 5.6NH, 1005	bead1005	MURATA	1	L6
30	LQG15HS5N6S02D	IND 5.6NH, 1005	bead1005	MURATA	1	L3
31	LQG15HS82NJ02D	IND 82nH_1005	bead1005	MURATA	2	L1 L2
32	AE-2450-SMT	AE2450-38-SMT	Chip Ant 3*8*1.6t	안테나엔진	1	ANT1
33	BLM18PG300SN1D	BEAD -1608	bead1608	MURATA	2	B1 B2
34	RT9818B-18GV	Volt detector 1.8v	sot23	RICHTEK	1	U3
35	ELM7S14BEL	CMOS LOGIC	sot23_5	ELM	1	Q1
36	MG2455-F48	SoC(System-on-Chip)	qlp48_w675_i040_050	RadioPulse	1	U2
37	U.FL-R-SMT-1(10)	UMCC U.FL CONNECTOR	U.FL-R-SMT-1	HIROSE	1	CN1
38	PCB GT-ZBM V1.0	27 x 21.5 x 1.2T X 4L	1.2T X 4L	세종전자	1	
39	ZBM	ZBM	zbm_th		1	J1
40	NC RC1005J000CS NC	NC R1005	NC r1005	SAMSUNG	2	R30 R32
41	NC C1005	NC C1005	NC c1005	SAMSUNG	2	C5 C18

1.7 Circuits Description

1.7.1 Power Supply

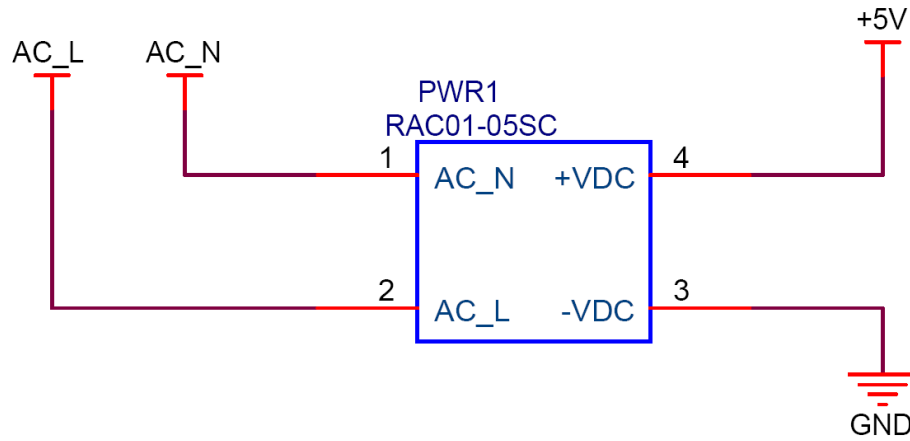


Figure 10 +5V Power Supply

AC/DC converter PWR1 inputs AC power through AC_L and AC_N terminals and outputs DC+5.0V for the PMA power.

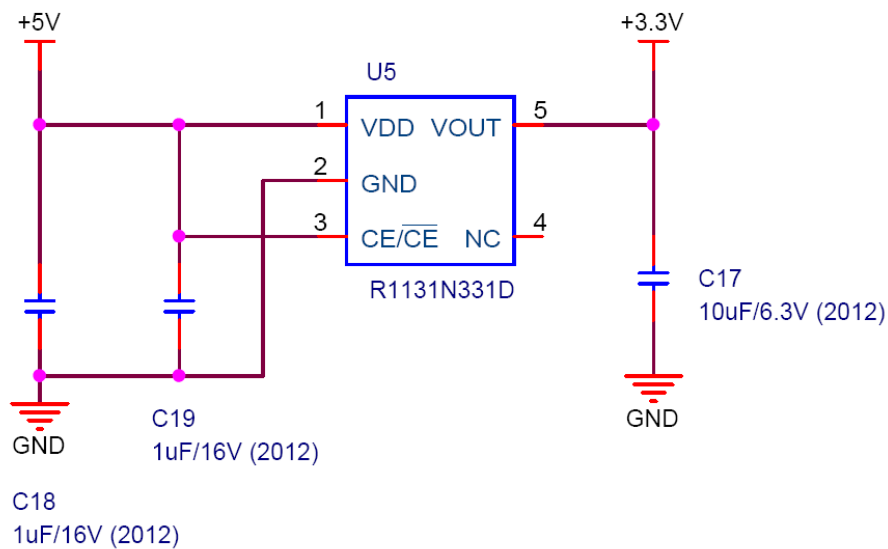


Figure 14 +3.3V Power Supply

U5 is a DC/DC regulator that converts DC+5V to DC +3.3V for the DC circuits installed on PMA.

1.7.2 ZigBee

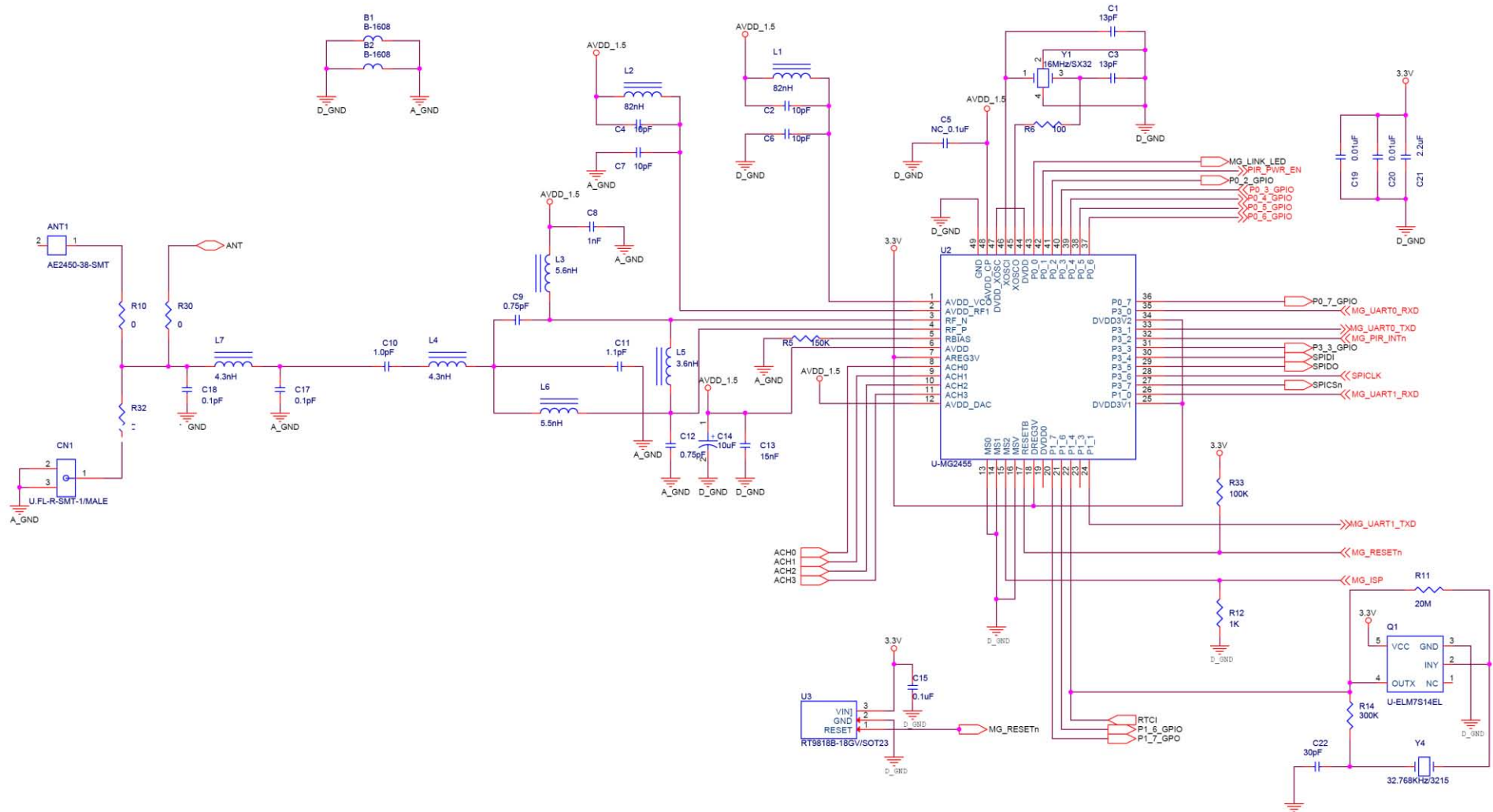


Figure 15 Zigbee

ZBM(ZigBee Module) uses a dedicated chip, MG2455 RadioPulse's ZigBee (Zigbee) for ZigBee wireless protocol handling. It accepts DC +3.3V for Digital interface logic and +1.5V for RF interface logic such as internal RF logic and external impedance matching circuits. The +1.5V is generated by internal regulator in MG2455, ZigBee wireless controller. Both 16Mhz and 32.768KHz are used for digital and RF circuit operation and for real time calendar operation. The MG2455 pin 4 is an output to the output matching circuit and the 2.4GHz frequency band antenna matching circuit. The radiated data is received by antenna and input to MG2455 through impedance matching circuits.

1.7.3 MCU

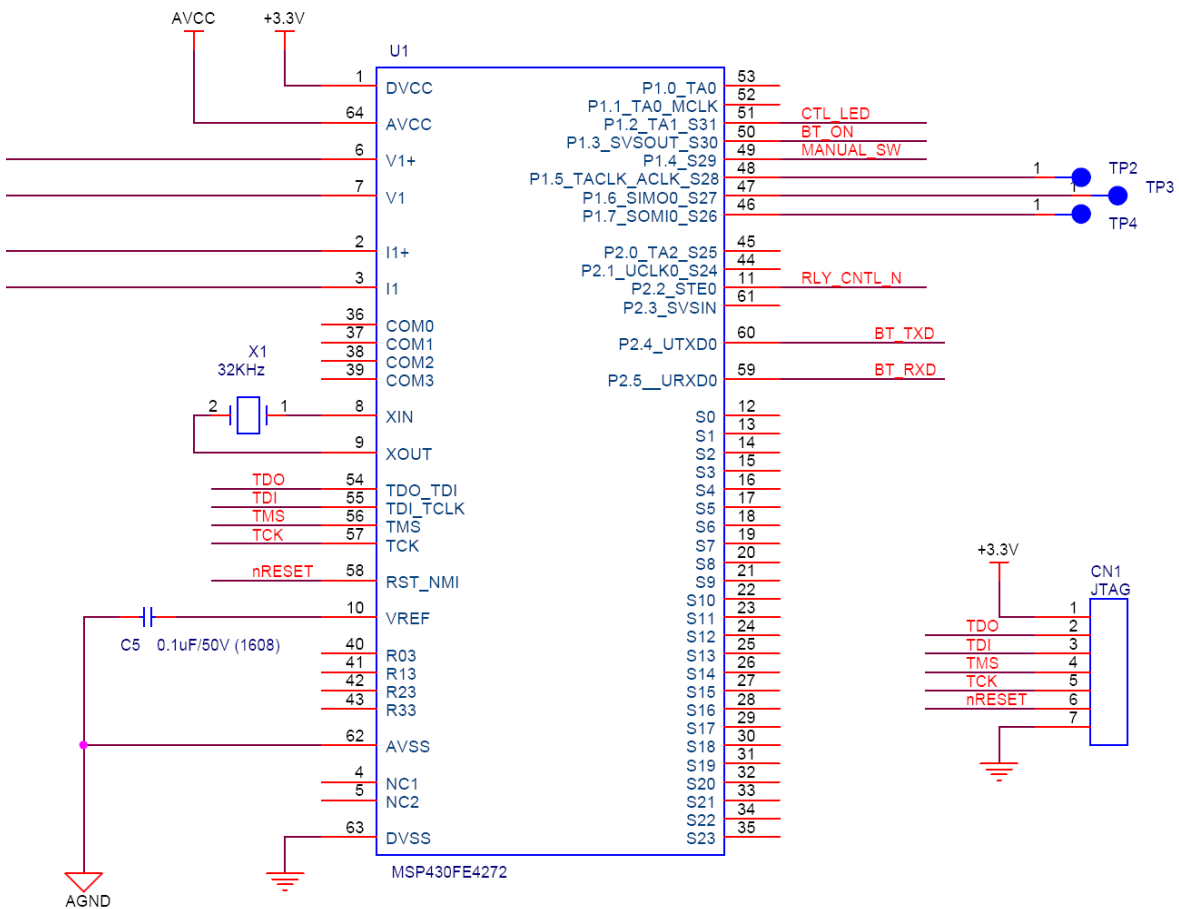


Figure 16 MCU

The MSP430FE4272 is used for the main controller of PMA and it incorporates a 16-bit RISC CPU, peripherals, and a flexible clock system that interconnect using a von Neumann common memory address bus (MAB) and memory data bus (MDB). Partnering a modern CPU with modular memory-mapped analog and digital peripherals, the MSP430 offers solutions for demanding mixed-signal applications. It inputs AC power through Analog interface circuits to measure AC input voltage and current and measured data can transfer to PCAP by using ZigBee wireless communication. It communicates with ZigBee controller using UART serial interface. Firmware can be upgraded through connector CN1.

1.7.4 Serial Flash EEPROM

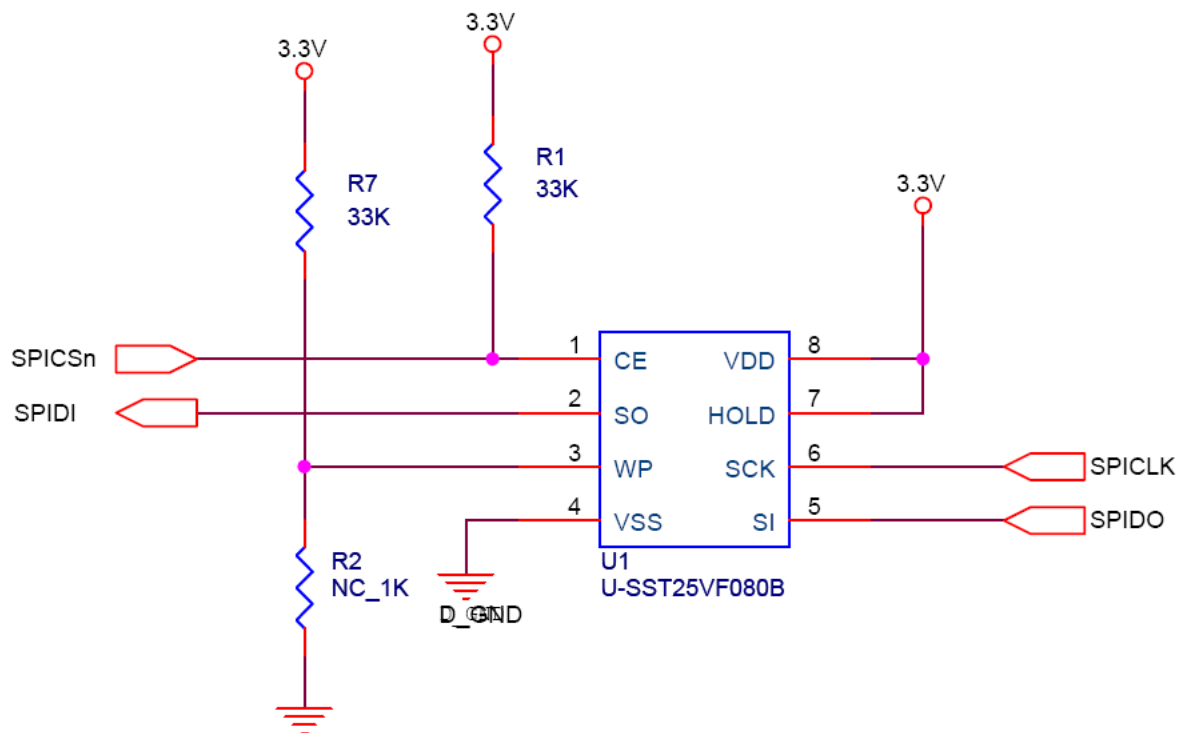


Figure 17 MCU Serial Flash

The measured power consumption, body sensing information can be stored in the storage device shown in Figure 17.

1.8 RF MODEM Specification

1.8.1 ZigBee

Item	Spec	Remark
Frequency Range	2400~2483.5MHz	
Frequency Tolerance	<±20ppm	
Occupied B.W	2MHz	
Output Power (Normal)	7dBm (±1dB)	
VSWR	<2.0 : 1	
Flatness	<1dB	
Spurious Emissions		
1GHz Under	<-30dBm	
1GHz ~ 2.4GHz	<-30dBm	
~ 12GHz	<-30dBm	
2nd Harmonic	<-45dBm	
3rd Harmonic	<-70dBm	
Inband Spurious	<-45dBm	
Adjacent Channel Rejection	±3.5MHz >40dBc	
Secondary Radiated Emission	<-58dBm	Limit of secondary radiated emissions.
Phase Noise	1MHz	-110dBc / Hz
	2MHz	-112dBc / Hz

RF Transceiver

Single-chip 2.4GHz RF Transceiver

Low Power Consumption

Low Operating Voltage of 1.5V

High Sensitivity of -98dBm@1.5V

No External T/R Switch and Filter needed

On-chip VCO, LNA, and PA

Programmable Output Power up to +8dBm@1.5V

Direct Sequence Spread Spectrum

O-QPSK Modulation

Scalable Data Rate: 250Kbps for ZigBee

RSSI Measurement

Compliant to IEEE802.15.4

128-byte CPU dedicated Memory

1KB Boot ROM

Dual DPTR Support

I2S/PCM Interface with two 128-byte FIFOs

Two High-Speed UARTs with Two 16-byte FIFOs (up to 1Mbps)

Quadrature Signal Decoder

On-chip Power-on-Reset

SPI Master/Slave Interface

Clock Inputs

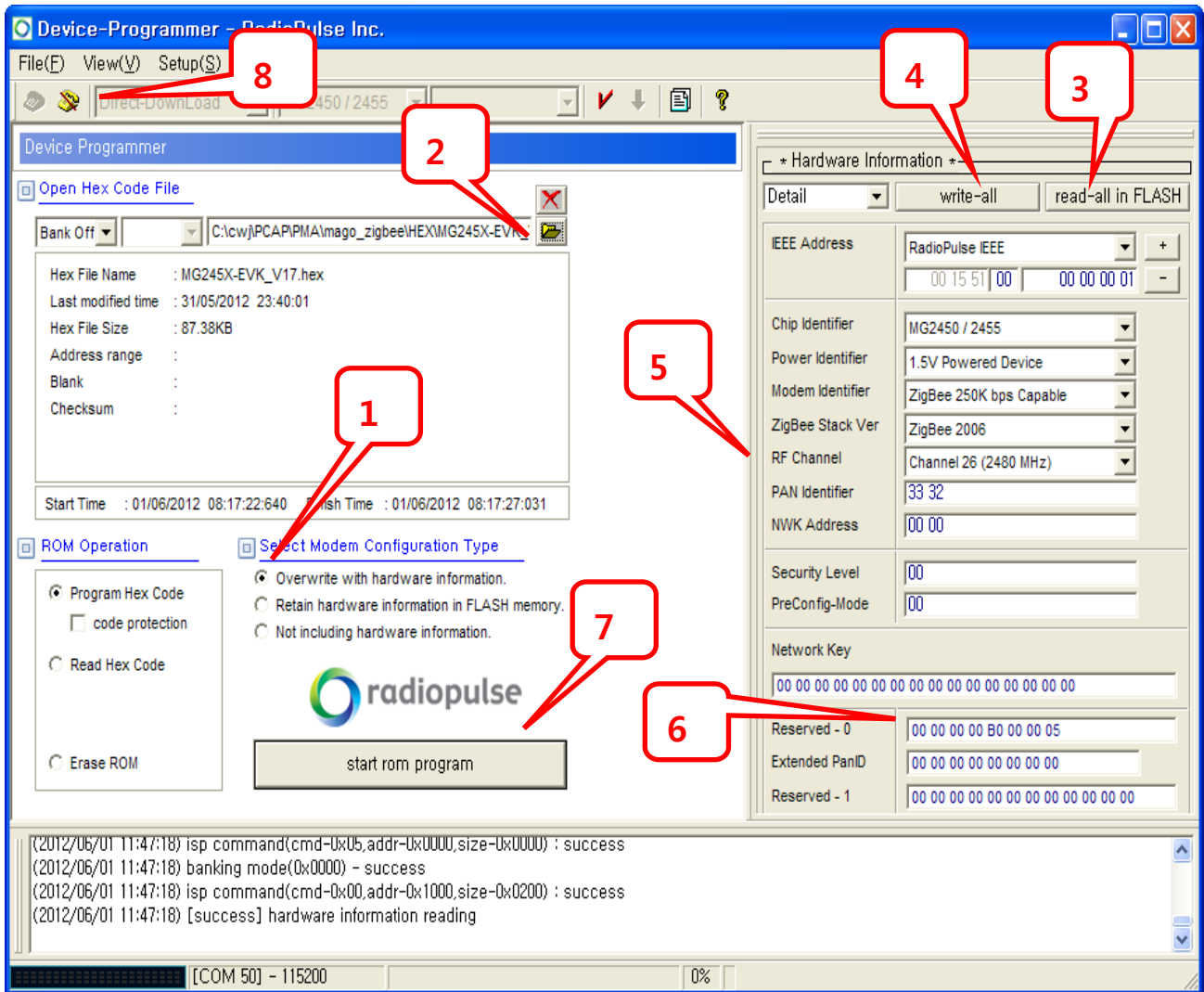
16MHz Crystal for System Clock

32.768kHz Oscillator for Sleep Timer

Power

Separate On-chip Regulators for Analog and Digital Circuitry.

Power Supply Range for Internal Regulator(1.9V(Min) ~ 3.6V(Max))



Sequence	Contents
1	Select "Overwrite with hardware information"
2	Select image path
3	Read current hardware status alarm
4	Select if Hardware setting is modified
5	Compare setting value to Figure
6	Reserved-0 Current board's address information Check if ZB MAC labeled in the board is same as read
7	Select when new image is to be upgraded
8	Program termination

1.8.2 ZigBee Antenna Specification and Characteristic

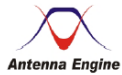


ANTENNA ENGINE

2.4GHz 칩안테나 규격서
[AE-2450-38-SMT]

2011. 03. 28.

ANTENNA ENGINE



- 목 차 -

1. SPECIFICATIONS
2. Radiation Pattern
3. 3D-Measurement
4. Input Impedance
5. 도면

ANTENNA ENGINE

1. SPECIFICATIONS

ELECTRICAL Char.	SPECIFICATIONS	REMARK
Model	AE-2450-38-SMT	
Frequency Range	2400~2500[MHz]	
V.S.W.R	2.0 : 1	
Gain	1 ± 0.5[dBi]	
Polarizations	Isotropic	
Input Impedance	50[Ω]	
Input Power	1[W]	
MECHANICAL Char.	SPECIFICATIONS	
Feed Type	SMT	
Size[W x H x D]	8 x 3 x 1.6[mm]	



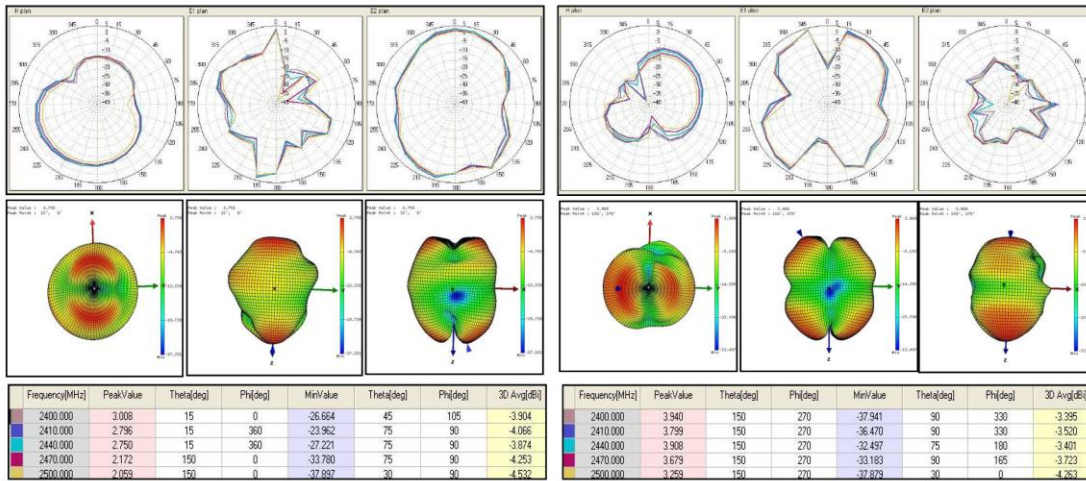
안테나 장착 위치

ANTENNA ENGINE

2. Radiation Pattern

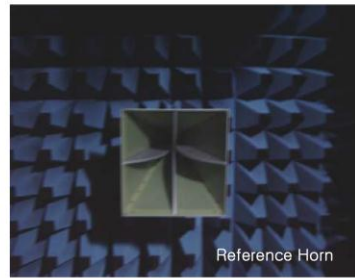
<Co Pol.>

<Cross Pol.>



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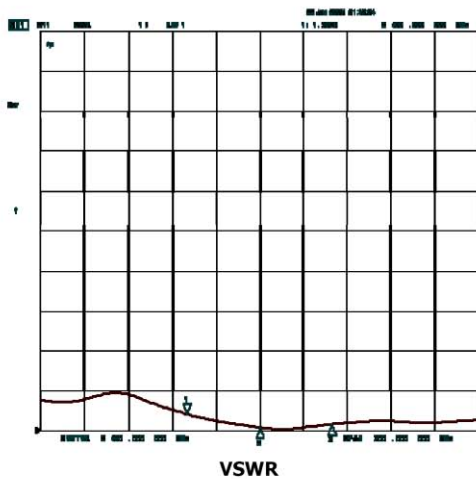
3. 3D-Measurement



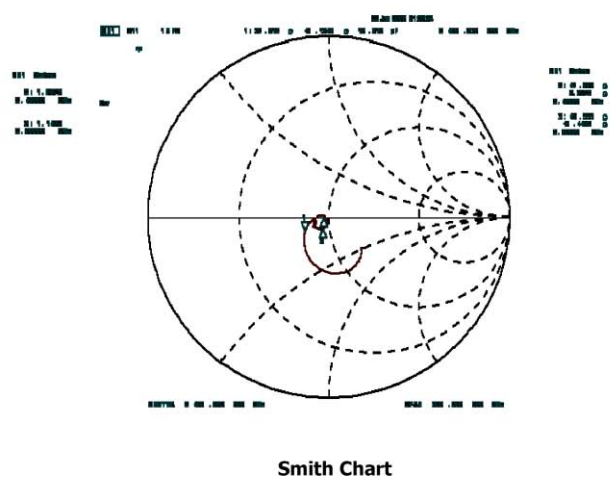
- Calibration 주파수 대역 : 2.4 ~ 2.5[GHz]
- 2D 복사패턴 Angle step : 05°
- 3D 복사패턴 Angle step : 15°
- 안테나의 이득과 복사 패턴을 정확히 측정하기 위해 챔버내에 설치된 혼안테나를 Calibration 하는 장면.
- 3D 복사패턴을 측정하기 위한 안테나의 설치.

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4. Input Impedance

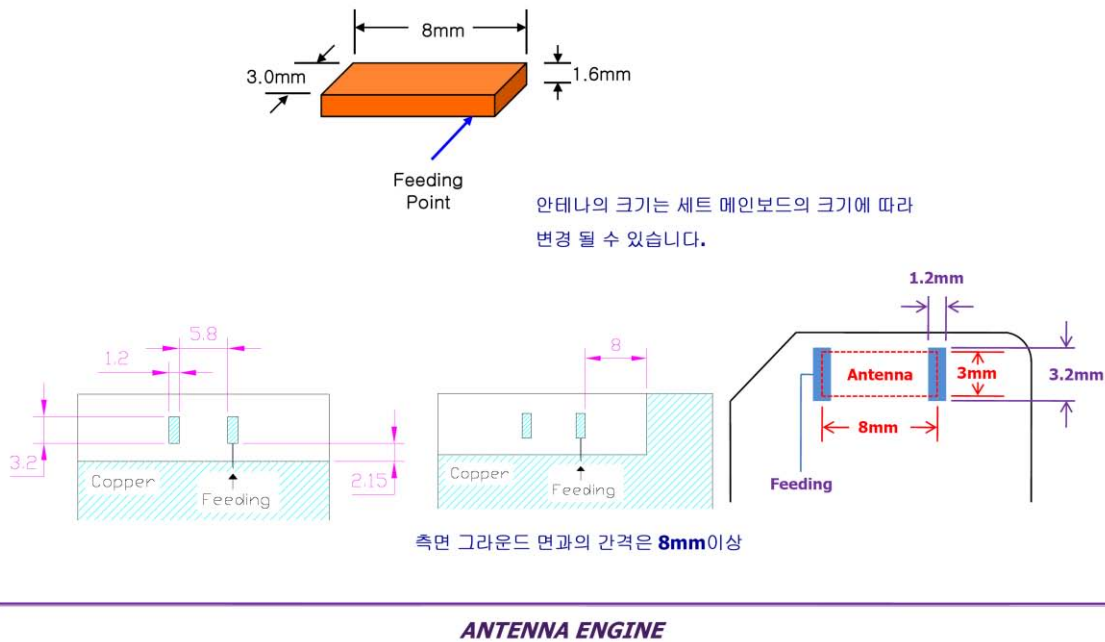


2.40 GHz : 1.3
 2.45 GHz : 1.0
 2.50 GHz : 1.1



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5. 도면



2. How to setup PM

2.1 ZigBee

2.1.1. Zigbee Channel Setup

2.1.1.1. UART Connection

- 1) Using serial cable or USB serial cable, connect serial cable to PCAP J6 header pins.
 - A) Connects "Serial Connecting Cable" between PC's USB connect and PCAP J6 connector.

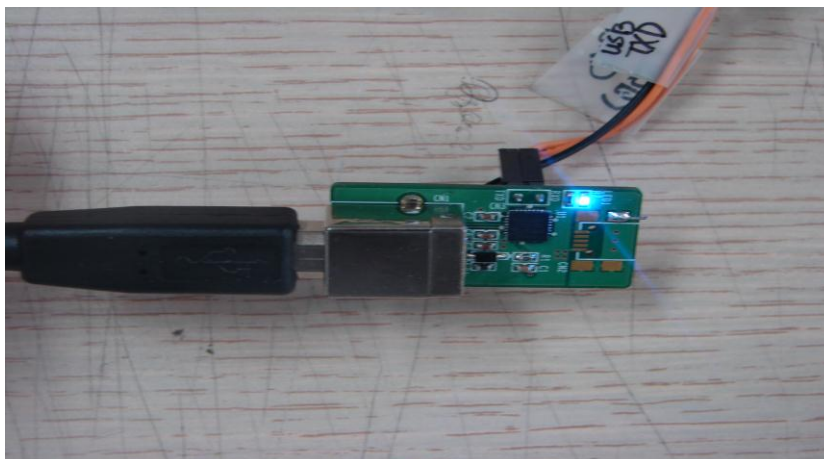


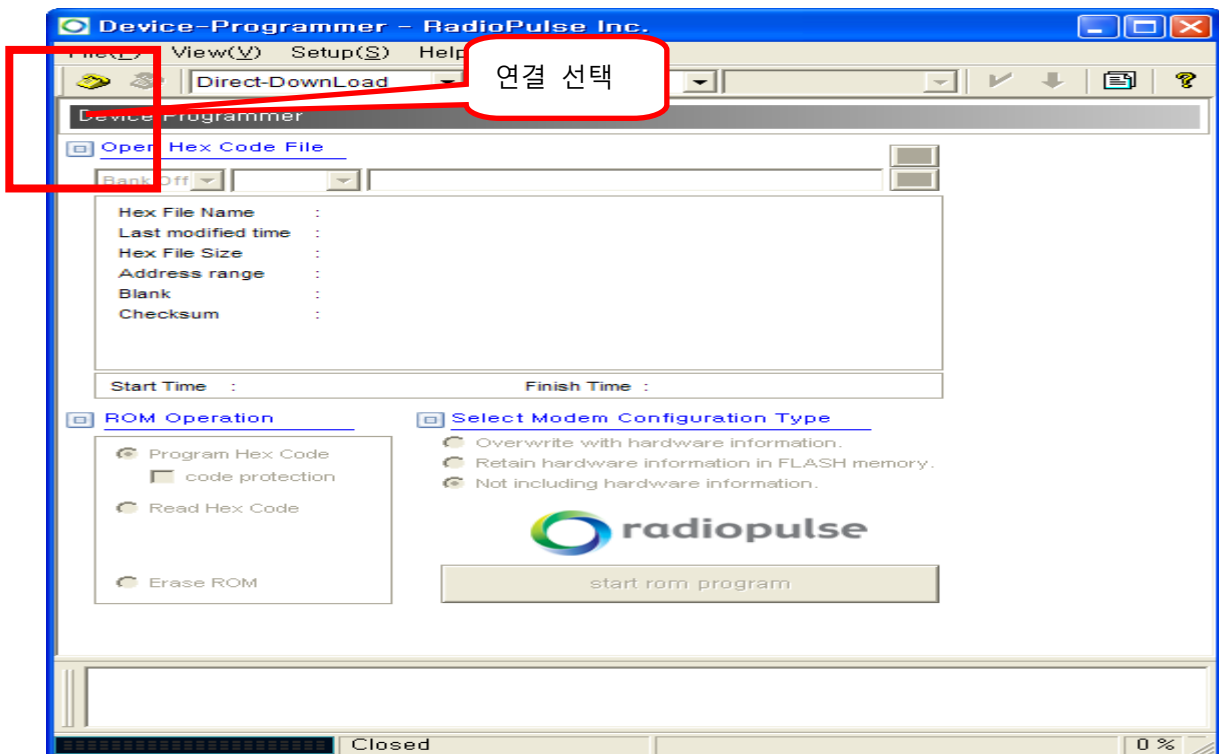
Figure Serial Connection Cable

B) CN4 Head Pin Configuration

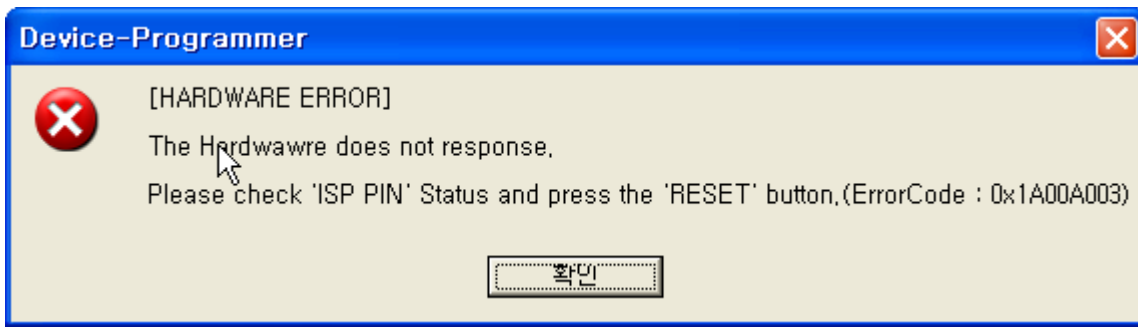
No.	Pin Name	Descriptions
1	+3.3 V	Connect to No. 5 pin during ISP programming
2	GND	
3	TXD(PCAP UART2)	
4	RXD(PCAP UART2)	
5	ISP Enable	Connect to No. 1 pin during ISP programming
6	Reset*	

2) Execute Windows Application

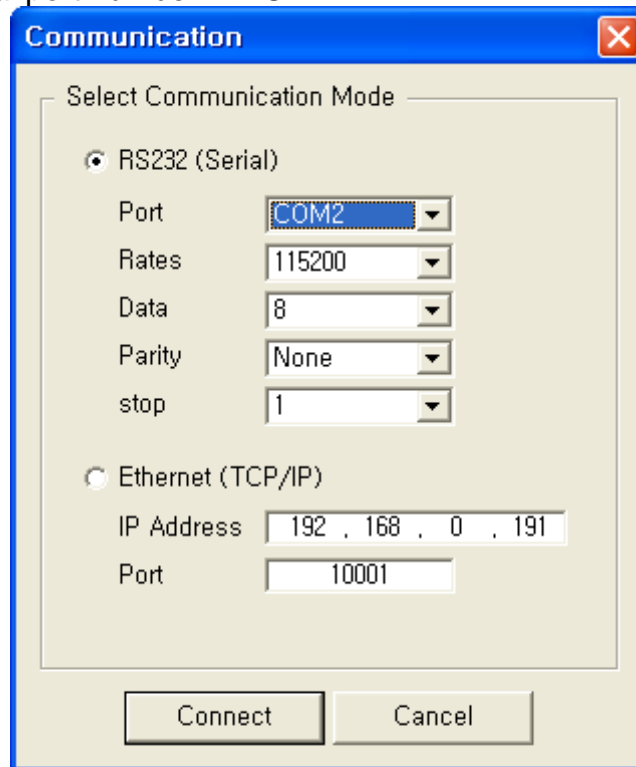
-Execute "Device-Programmer 3.50" program in PC



- If connection fail messages is output, connect No. 6 pin to No. 2 reset pin to reset chip.



- Select right serial port number in PC



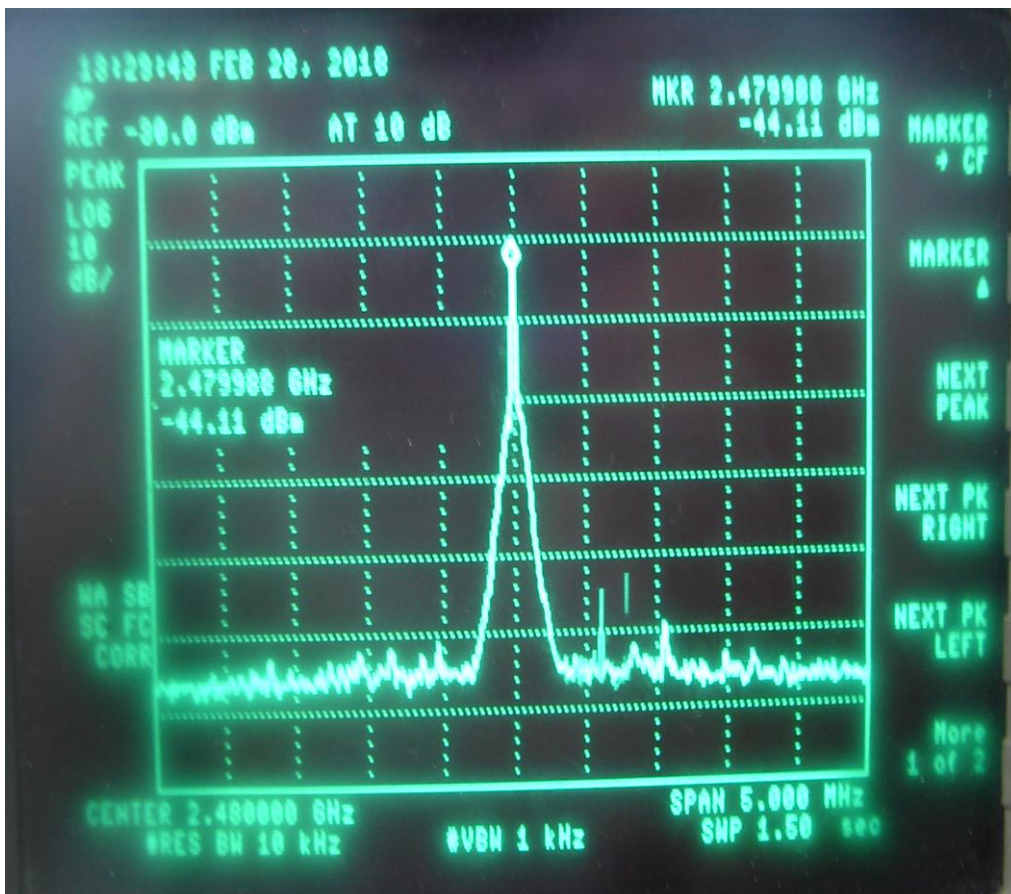
2.1.2. Un-modulated signal output

- 1) Terminate “Device-Programmer 3.50”
- 2) Starts any serial emulation program such as “TOKEN 2” and set appropriate serial port number and speed etc.
- 3) Input H, then Menu window will pop-up

```
=====PMA HELP =====
[CH] : HELP Menu

      [7] : WDT RESET
[CC] : Channel Change      [CD] : DataRate Change
[EE] : Energy Detection   [PJ] : PowerDown
[CV] : VERSION
[CM] : TEST_TXOUT : Modulation with IFS
[CN] : TEST_TXOUT : Modulation without IFS
[CU] : TEST_TXOUT : Unmodulated Carrier
[CB] : TEST_TXOUT : Back To Normal Mode
[CI] : Select Item
```

- 4) Select **U** “[U] : TEST_TXOUT : Unmodulated Carrier”, then check waveform by using spectrum analyzer.



2.1.3. Continuous Signal Output

- 1) Starts any serial emulation program such as "TOKEN 2" and set appropriate serial port number and speed etc.
- 2) Input H, then Menu window will pop-up

```
=====PMA HELP =====
[CH] : HELP Menu

      [7] : WDT RESET
[CC] : Channel Change    [CD] : DataRate Change
[EE] : Energy Detection [PP] : PowerDown
[CV] : VERSION
[CM] : TEST_TXOUT : Modulation with IFS
[CN] : TEST_TXOUT : Modulation without IFS
[CU] : TEST_TXOUT : Unmodulated Carrier
[CB] : TEST_TXOUT : Back To Normal Mode
[CI] : Select Item
```

- 3) Input "M, [M] : TEST_TXOUT : Modulation with IFS", check signal waveform by using instruments such as spectrum analyzer.

