APPLICATION NOTE

Atmel AT2200: ZigBee PRO to Ethernet and Wi-Fi Gateway Kit - Hardware User's Guide

32-bit Atmel Microcontroller

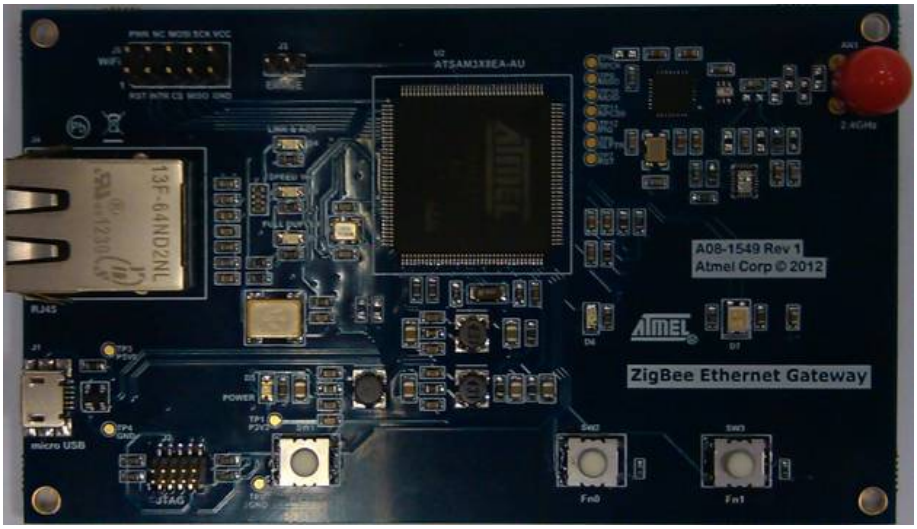
Features

- Atmel® ATSAM3X8E microcontroller
- Atmel AT86RF231 2.4GHz radio transceiver
- 2.4GHz ZigBee® front end module SE2431L integrated PA and LNA
- 10/100Mbps Ethernet with LED indicators
- 8M bit PSRAM
- Three LEDs and two mechanical buttons are user controllable
- External power supply 5VDC via micro USB AB connector
- Program/debug interface: JTAG, USB, COM port
- Wi-Fi module connector

Introduction

The Atmel ZigBee PRO to Ethernet and Wi-Fi Gateway Kit is a hardware platform to demonstrate built-in functions with ZigBee and Ethernet/Wi-Fi. It is a bridge between wireless network (ZigBee) and wired network (Ethernet), and also a bridge between wireless (ZigBee) and wireless (Wi-Fi).

Figure 1. ZigBee PRO to Ethernet and Wi-Fi Gateway Kit.



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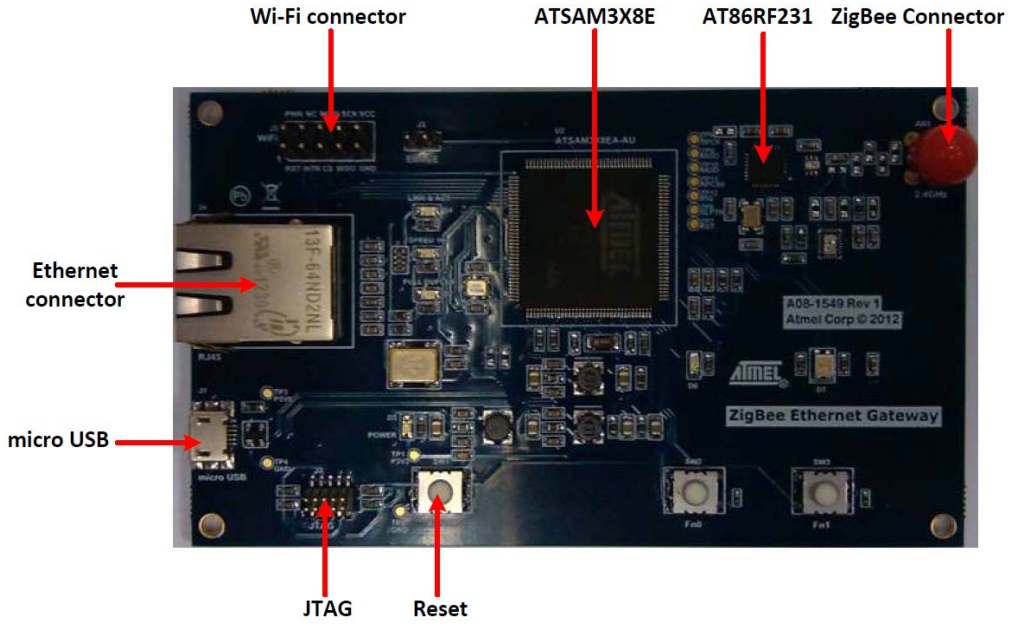
1. General Information

The Atmel ZigBee PRO to Ethernet and Wi-Fi Gateway Kit is intended to demonstrate Atmel low cost ZigBee to Ethernet and Wi-Fi gateway solution. Figure 1-1 shows the available peripherals on the board.

Figure 1-1. Overview of ZigBee PRO to Ethernet and Wi-Fi Gateway Kit.



1.1 Components for set up

To fully perform all functions of the kit, it should have below components which are shown in Table 1-1.

Table 1-1. Components for set up.

Component	Function
Kit	The main board
Antenna	Used for ZigBee
micro USB cable	Power for the kit and USB connection
RJ45 cable	Used for Ethernet connection
RS232 cable	Used for RS232 connection
SAM-ICE™	Debug and programming
SAM-ICE adapter	Used for connecting with SAM-ICE and PC

1.2 Power supply

The kit needs an external power supply that can deliver 5V and up to 500mA. The actual current requirement for the board is much less than 500mA but in order to be able to power optional expansion boards this margin is recommended.

The power can only be applied to the board via the USB micro AB connector.

The 5V (USB supply voltage) is regulated down to 3.3V with an onboard LDO regulator, which provides power to the entire board.

1.3 Programming the kit

The kit can be programmed through JTAG, COM port or USB interfaces.

How a programmer can be connected to the kit is described in “Atmel AT2242: ZigBee PRO to Ethernet and Wi-Fi Gateway Kit - Getting Started Guide”.

2. Connectors

The Atmel ZigBee PRO to Ethernet and Wi-Fi Gateway Kit has three header connectors which are shown in Table 2-1.

Table 2-1. Connector and functions.

Connector	Function
J2	JTAG for programming
J3	Chip Erase
J6	Wi-Fi connector

2.1 Programming headers

The Atmel ZigBee PRO to Ethernet and Wi-Fi Gateway Kit can be programmed and debugged by connecting an external programming/debugging tool to the JTAG header shown in Figure 1-1. It can be connected with SAM-ICE through SAM-ICE adapter. UART can also be connected to PC through SAM-ICE Adapter.

For more details of SAM-ICE adapter, please refer to "Atmel AVR2033: SAM-ICE Adapter – Hardware User Manual".

Table 2-2. Programming and debugging interface – JTAG.

Pin on programming header	JTAG
1	TCK
2	GND
3	TDO
4	P3V3
5	TMS
6	RST
7	P3V3
8	RXD
9	TDI
10	TXD

Note: RXD, TXD are used for UART.

2.2 Chip erase header

The chip erase header J3 is used to erase flash content. ERASE is connected to PC0. When performing a flash erase operation, PC0 must be tied high during more than 220ms after power on.

2.3 Wi-Fi connector

The header J6 in Atmel ZigBee PRO to Ethernet and Wi-Fi Gateway Kit offers SPI interface to connect with external Wi-Fi module.

Table 2-3 shows the connection between Wi-Fi module and MCU pins.

Note: The available Wi-Fi add-on card is RS-SAM3S-220X designed by REDPINE SIGNALS. It can be found at: http://www.redpinesignals.com/Atmel/rs-sam3s.html.

Table 2-3. Wi-Fi connector J6.

Pin on J6	Name on J6	MCU pin
1	RST	PA11
2	PWR	PA17
3	INTR	PA15
4	-	-
5	CS	PA14
6	MOSI	PA13
7	MISO	PA12
8	SCK	PA16
9	GND	-
10	P3V3	-

3. Peripherals

3.1 Radio transceiver

The Atmel ZigBee PRO to Ethernet and Wi-Fi Gateway Kit has a low power 2.4GHz transceiver AT86RF231 for ZigBee. It is a true SPI-to-antenna solution. All RF-critical components except the antenna, crystal and de-coupling capacitors are integrated on chip. Table 3-1 shows the MCU pin connection with AT86RF231.

Table 3-1. ZigBee connections.

Pin on MCU	AT86RF231	Test point	Function
PA27	SCK	TP9	SPI interface
PA25	MISO	TP8	
PA26	MOSI	TP10	
PA28	CS	TP11	
PA1	IRQ	TP12	Interrupt request signal from AT86RF231
PB21	SLPTR	TP6	Control sleep, transmit start, receive states
PB20	RST	TP7	Reset AT86RF231

3.2 Front end module

The Atmel ZigBee PRO to Ethernet and Wi-Fi Gateway Kit contains 2.4GHz ZigBee/802.15.4 front end module SE2431L. It integrates PA with up to 24dBm output power and LNA with programmable bypass. It can be controlled by AT86RF231 shown in Table 3-2.

Table 3-2. SE2431L connections.

Pin on SE2431L	Pin on AT86RF231
ANT_SEL	DIG1
CSD	AVDD
CTX	DIG3

3.3 Ethernet

The Atmel ZigBee PRO to Ethernet and Wi-Fi Gateway Kit uses DM9161A as the Ethernet transceiver. The DM9161A is a physical layer, single-chip, and low power transceiver for 100BASE-TX and 10BASE-T operations. The Ethernet connection on the Atmel ZigBee PRO to Ethernet and Wi-Fi Gateway Kit is shown in Table 3-3.

Table 3-3. Ethernet connections.

Pin on MCU	DM9161A	Function
PB13	ETH_CRY	Control crystal
PB12	ETH_RST	Reset DM9161A
PB0	EREFCK	EMAC interface
PB3	ETX1	
PB2	ETX0	
PB1	ETXEN	
PB6	ERX1	
PB5	ERX0	
PB4	ECRSDV	
PB7	ERXER	
PB8	EMDC	
PB9	EMDIO	
PA5	MDINTR	Interrupt signal from DA9161A

3.4 Mechanical buttons

There are three mechanical buttons on Atmel ZigBee PRO to Ethernet and Wi-Fi Gateway Kit. One is for system reset and others are for user purpose. All user purpose buttons have external pull-ups so there is no need to activate internal pull-ups in order to use them. When a button is pressed it will drive the I/O line to GND.

Table 3-4. Mechanical button connections.

Pin on MCU	Silkscreen text on PCB
NRSTB	SW1
PA18	SW2
PA19	SW3

3.5 LEDs

There are six LEDs available on the board that can be turned on and off.

D5 is used for power indicator. D2, D3, D4 are used for Ethernet indicator which are controlled by DM9161A.

Table 3-5. Hardware LED functions.

LED	Function
D2	Full duplex
D3	Speed 100
D4	Link and act
D5	Power indicator

D6 is used for user purpose on or off. D7 is a bi-color LED for user purpose.

Table 3-6. User controllable LED connections.

Pin on MCU	LED
PA20	D6
PB17	D7 (Red)
PB18	D7 (Green)

3.6 PSRAM

The ZigBee PRO to Ethernet and Wi-Fi Gateway Kit contains 8M bit PSRAM. The part number is IS66WV51216DBLL-55TLI. More detailed information, see the web site: http://www.issi.com/products-asynchronous-sram.htm.

Table 3-7. PSRAM connections.

Pin on MCU	PSRAM
PC2	D0
PC3	D1
PC4	D2
PC5	D3
PC6	D4
PC7	D5
PC8	D6
PC9	D7
PC10	D8
PC11	D9
PC12	D10
PC13	D11
PC14	D12
PC15	D13
PC16	D14
PC17	D15
PC22	A0
PC23	A1
PC24	A2
PC25	A3
PC26	A4
PC27	A5
PC28	A6
PC29	A7
PC30	A8
PD0	A9
PD1	A10
PD2	A11
PD3	A12
PD4	A13
PD5	A14
PD6	A15

Pin on MCU	PSRAM
PD7	A16
PB10	A17
PB11	A18
PB24	CS
PA29	OE
PC18	WE
PC21	LB
PD10	UB

3.7 Temperature sensor

The temperature sensor circuitry consists of a serial connection of a normal and a NTC resistor. The NTC sensor is from Murata and some part details are shown in Table 3-8. More information can be obtained from the manufacturer's website.

Table 3-8. NTC characteristics.

Global part number	NCP18WF104J03RB
Resistance (25°C)	100kΩ ±5%
B-Constant (25/50°C) (reference value)	4250K ±2%
B-Constant (25/80°C) (reference value)	4303K
B-Constant (25/85°C) (reference value)	4311K
B-Constant (25/100°C) (reference value)	4334K

Table 3-9 shows the temperature vs. resistance characteristic. The values are available from Murata in the datasheet of the NTC.

Table 3-9. Resistance vs. temperature (from Murata).

Temp. [°C]	NTC resistance [kΩ]	Temp. [°C]	NTC resistance [kΩ]	Temp. [°C]	NTC resistance [kΩ]	Temp. [°C]	NTC resistance [kΩ]
-30	2197.225	0	357.012	30	79.222	60	22.224
-29	2055.558	1	338.006	31	75.675	61	21.374
-28	1923.932	2	320.122	32	72.306	62	20.561
-27	1801.573	3	303.287	33	69.104	63	19.782
-26	1687.773	4	287.434	34	66.061	64	19.036
-25	1581.881	5	272.500	35	63.167	65	18.323
-24	1483.100	6	258.426	36	60.415	66	17.640
-23	1391.113	7	245.160	37	57.797	67	16.986
-22	1305.413	8	232.649	38	55.306	68	16.360
-21	1225.531	9	220.847	39	52.934	69	15.760
-20	1151.037	10	209.710	40	50.677	70	15.184
-19	1081.535	11	199.196	41	48.528	71	14.631
-18	1016.661	12	189.268	42	46.482	72	14.101
-17	956.080	13	179.890	43	44.533	73	13.592
-16	899.481	14	171.028	44	42.675	74	13.104
-15	846.579	15	162.651	45	40.904	75	12.635
-14	797.111	16	154.726	46	39.213	76	12.187
-13	750.834	17	147.232	47	37.601	77	11.757

Temp. [°C]	NTC resistance [kΩ]	Temp. [°C]	NTC resistance [kΩ]	Temp. [°C]	NTC resistance [kΩ]	Temp. [°C]	NTC resistance [kΩ]
-12	707.524	18	140.142	48	36.063	78	11.344
-11	666.972	19	133.432	49	34.595	79	10.947
-10	628.988	20	127.080	50	33.195	80	10.566
-9	593.342	21	121.066	51	31.859	81	10.200
-8	559.931	22	115.368	52	30.584	82	9.848
-7	528.602	23	109.970	53	29.366	83	9.510
-6	499.212	24	104.852	54	28.203	84	9.185
-5	471.632	25	100.000	55	27.091	85	8.873
-4	445.772	26	95.398	56	26.028	86	8.572
-3	421.480	27	91.032	57	25.013	87	8.283
-2	398.652	28	86.889	58	24.042	88	8.006
-1	377.193	29	82.956	59	23.113	89	7.738

Two common approximations can be used to model the temperature vs. resistance characteristic; these are the B parameter and the Steinhart-Hart equations. Coefficients for both formulas can be calculated from Table 3-9.

When the reference 3.3V is used and the ADC is measuring in signed single ended mode the codes in Table 3-10 can be read from the ADC at the various temperatures. The calculation is based on Table 3-9.

Table 3-10. ADC codes vs. temperature (signed single ended mode with 3.3V reference).

ADC input [V]	Temp. [°C]	ADC codes	ADC input [V]	Temp. [°C]	ADC codes
2.076	-14	644	0.347	38	108
2.030	-13	630	0.334	39	104
1.983	-12	615	0.321	40	100
1.936	-11	601	0.309	41	96
1.889	-10	586	0.297	42	92
1.841	-9	571	0.286	43	89
1.794	-8	557	0.275	44	85
1.747	-7	542	0.264	45	82
1.700	-6	527	0.254	46	79
1.653	-5	513	0.244	47	76
1.606	-4	498	0.235	48	73
1.560	-3	484	0.226	49	70
1.514	-2	470	0.218	50	68
1.469	-1	456	0.209	51	65
1.425	0	442	0.202	52	63
1.380	1	428	0.194	53	60
1.337	2	415	0.187	54	58
1.294	3	402	0.180	55	56
1.252	4	389	0.173	56	54
1.211	5	376	0.167	57	52
1.171	6	363	0.161	58	50
1.131	7	351	0.155	59	48
1.093	8	339	0.149	60	46
1.055	9	327	0.144	61	45
1.018	10	316	0.138	62	43

ADC input [V]	Temp. [°C]	ADC codes	ADC input [V]	Temp. [°C]	ADC codes
0.982	11	305	0.133	63	41
0.947	12	294	0.128	64	40
0.913	13	283	0.124	65	38
0.880	14	273	0.119	66	37
0.848	15	263	0.115	67	36
0.817	16	254	0.111	68	34
0.787	17	244	0.107	69	33
0.758	18	235	0.103	70	32
0.730	19	226	0.100	71	31
0.702	20	218	0.096	72	30
0.676	21	210	0.093	73	29
0.650	22	202	0.090	74	28
0.626	23	194	0.086	75	27
0.602	24	187	0.083	76	26
0.579	25	180	0.081	77	25
0.557	26	173	0.078	78	24
0.535	27	166	0.075	79	23
0.515	28	160	0.073	80	23
0.495	29	154	0.070	81	22
0.476	30	148	0.068	82	21
0.458	31	142	0.065	83	20
0.440	32	137	0.063	84	20
0.423	33	131	0.061	85	19
0.407	34	126	0.059	86	18
0.391	35	121	0.057	87	18
0.376	36	117	0.055	88	17
0.361	37	112	0.053	89	17

4. Code examples

The example application is based on the Atmel BitCloud®. More detailed information about BitCloud can be found at: http://www.atmel.com/tools/bitcloud-zigbeepro.aspx.

For more information about the code example, see the application note “Atmel AT2242: ZigBee PRO to Ethernet and Wi-Fi Gateway Kit - Getting Started Guide”.

5. Revision history

Rev.	Date	Comments
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