AT139 Hardware Design Manual_V1.3

ATwin

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Version History：

Date	Author	Version	Description
2011.01.14	Loukanghua	1.0	Create
2011.04.06	Colin	1.1	Modify the definition of Pins and figures
2011.06.17	JinYi	1.2	Modify power specifications
2011.06.20	Steven Shao	1.3	Add description about some chapters

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Contents

1. AT139 Overview

AT139 is an ultra compact and high quality wireless module base on Infineon UCL2 platform with industry-standard interface. This is a SMT package with small dimension, low power consumption, quad-band (AT139) and dual-band(AT139D) GSM/GPRS module, it can provide with voice,SMS, Fax, data applications for customers.

2. AT139 Features

Features	Description	
Network	**GSM/GPRS**	
Frequency Bands	AT139: GSM850/ GSM900/DCS1800/PCS1900 MHz	AT139D: GSM900/DCS1800MHz
RF Output Power	AT139 GSM850/GSM900: 33dBm, DCS1800/PCS1900: 30dBm	AT139D GSM900: 33dBm, DCS1800: 30dBm
RF Receive Sensitivity	<-108dBm	
Speech codec modes	FR、EFR、HR、AMR	
SMS	TEXT/PDU	
GPRS Connectivity	GPRS Class 10	
	Coding Scheme：CS1，CS2，CS3，CS4	
Physical Characteristics		
Package	SMT	
Dimensions	24(±0.1)*24(±0.1)*3(±0.1)mm	
Weight	4g	
Performance		
Power Supply	3.3V~4.5V	
Antenna	External Antenna	
MCP	64Mb NOR + 32Mb PSRAM	
Audio	Two input/output Audio channels	
SIM Card Application	Support SIM Card: 1.8V/3.0V	
Pin amounts	38 PINs	
Firmware		
Operating System	OSE	

3. Top and Bottom View of AT139

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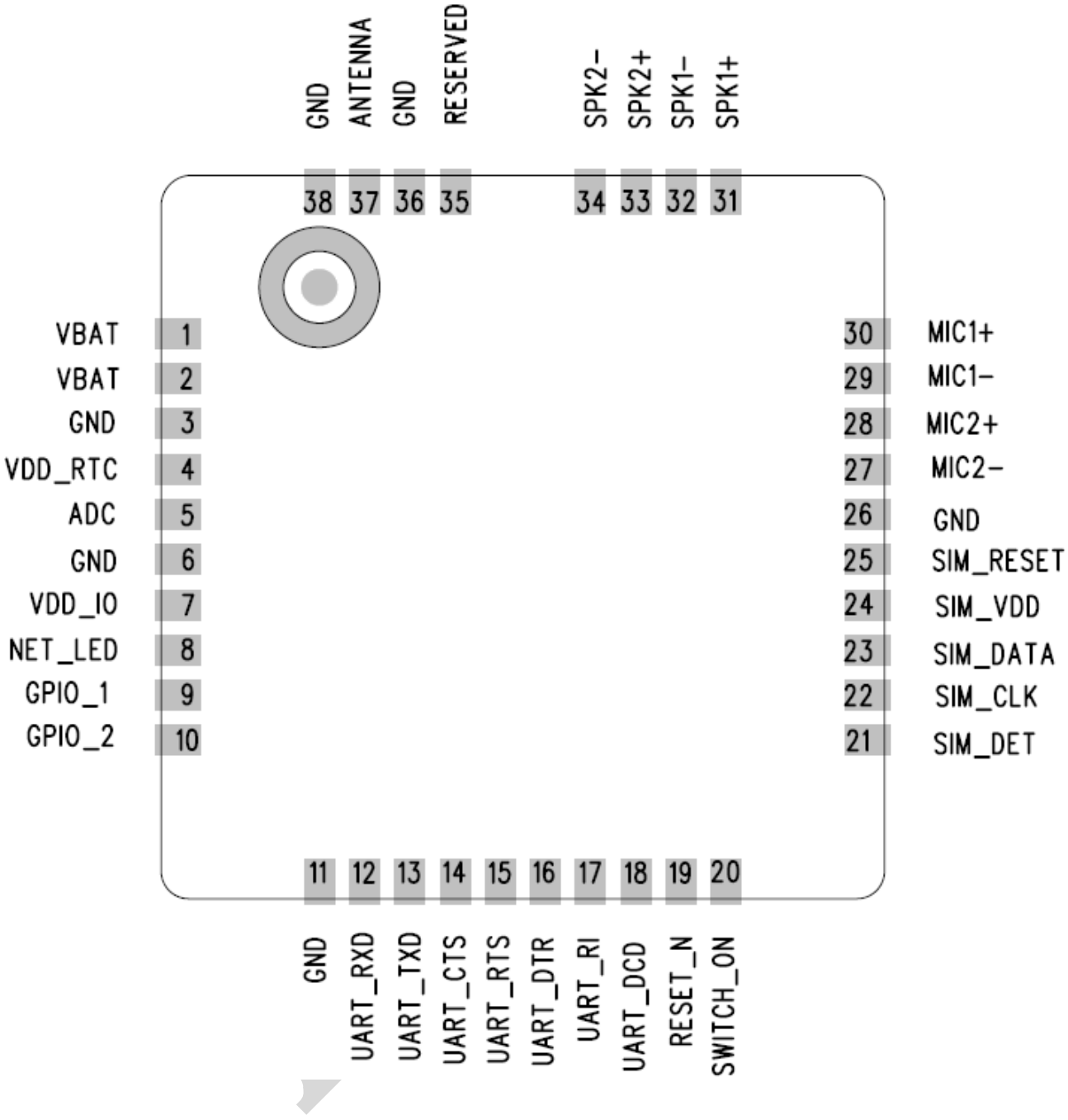
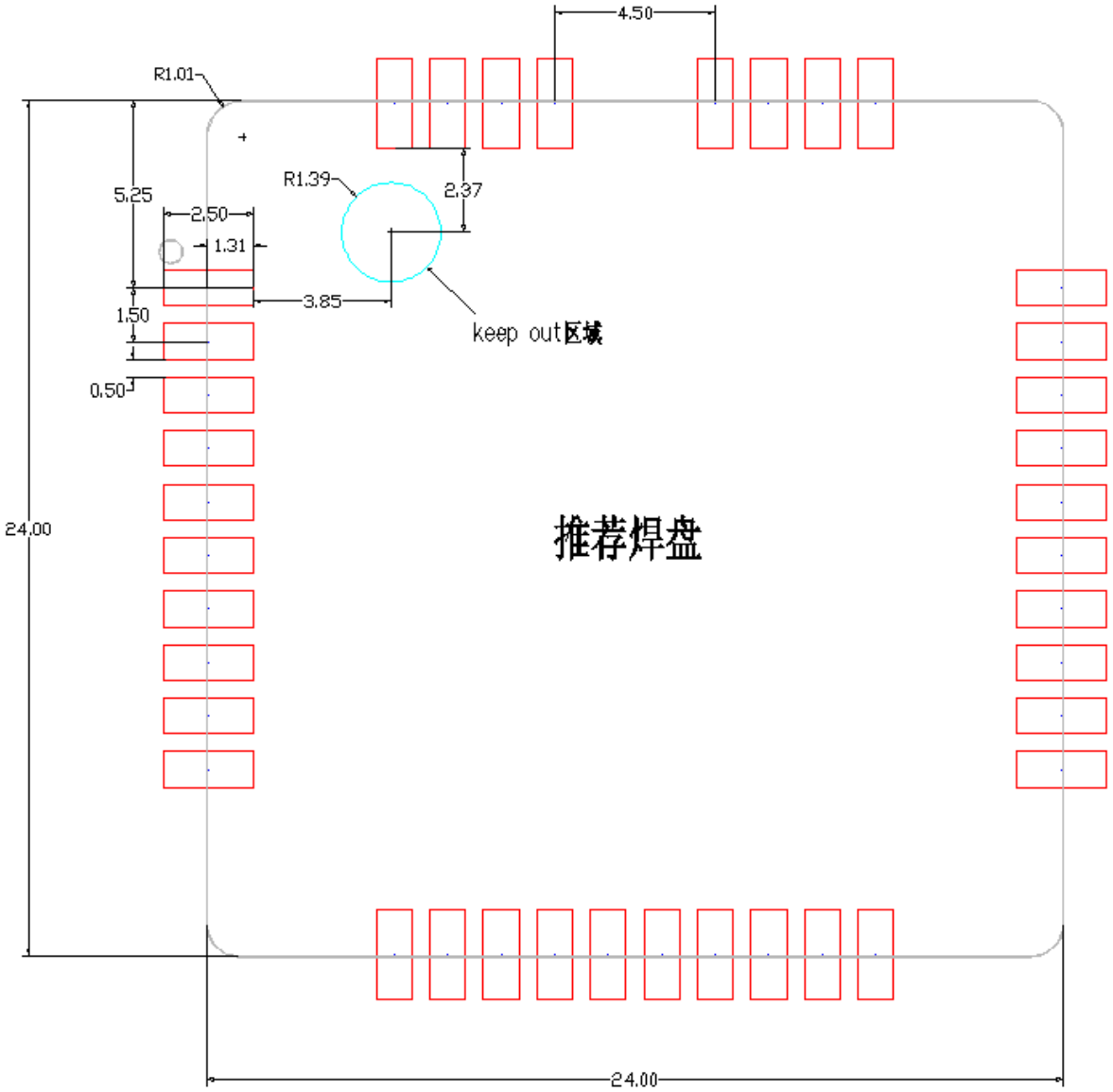
4. Pin Assignment of AT139（top view）



TOP VIEW

5. Recommended Pads dimensions



TOP VIEW

6. AT139 Pin Description

PIN NO.	Pin Name	Type	Description	GPIO	Reset level	IO Votlage	Comment
Audio							
29	MIC1-	I	Microphone1 input -				
30	MIC1+	I	Microphone1 input+				
27	MIC2-	I	Microphone2 input-				
28	MIC2+	I	Microphone2 input+				
31	SPK1+	O	Audio1 output+				
32	SPK1-	O	Audio1 output-				
33	SPK2+	O	Audio2 output+				
34	SPK2-	O	Audio2 output-				
SIM Card							
24	SIM_VDD	O	SIM Card Power output(18V/3.0V)			SIM_VDD	
22	SIM_CLK	O	SIM Card Clock			SIM_VDD	
23	SIM_DATA	O	SIM Card Data I/O			SIM_VDD	
25	SIM_RESET	O	SIM Card Reset			SIM_VDD	
21	SIM_DET	I	SIM Card detect				
Power On							
20	SWITCH_ON	I	Power on/off detect, active high			VDD_RTC	
Reset							
19	RESET_N	I	Module reset, active low			VDD_RTC	
UART（DCE）							
12	UART_RXD	I	Receive Data	GPIO_10	3 states	VDD_IO	
13	UART_TXD	O	Transmit Data	GPIO_11	3 states	VDD_IO	
14	UART_CTS	O	Clear to send	GPIO_12	3 states	VDD_IO	

15	UART_RTS	I	Request to send	GPIO_13	Pull-up	VDD_IO	
16	UART_DTR	I	Data terminal Ready	GPIO_37	Pull-down	VDD_IO	
17	UART_RI	O	Ring Indicator	GPIO_36	Pull-down	VDD_IO	
18	UART_DCD	O	Data carrier detect	GPIO_34	Pull-down	VDD_IO	
GPIO							
8	NET_LED	O	Network status Indication	GPIO_14	3 states	VDD_IO	
9	GPIO_1	IO	GPIO_1	GPIO_15	3 states	VDD_IO	
10	GPIO_2	IO	GPIO_2	GPIO_16	3 states	VDD_IO	
ADC							
5	ADC	I	ADC detect				
Antenna							
37	ANTENNA	I	Antenna Pin				
Power							
7	VDD_IO		LDO output,2.85V,10mA				
4	VDD_RTC		LDO output,2.0V ,4mA Or connect a coin battery as backup				
1、2	VBAT		Power supply: 3.3-4.2V				
3, 6, 11, 26, 36, 38	GND		GND				
35	RESERVED		Reserved Pin				

7. Absolute maximum ratings

Parameter	Min	Max	Unit
VBAT	-0.15	5.5	V
VDD_RTC	-0.15	2.5	V
Voltage at digit pins	-0.3	3.2	V
Voltage at analog pins	-0.3	3.2	V

8. Power Supply Ratings

Parameter	Description	Conditions	Min	Typical	Max	Unit
V_{BAT}	Supply voltage		3.3	4	4.5	V
	Voltage drop during transmit burst	Power control level for Pout max			200	mV
I_{BAT}	Power down mode			100	120	uA
	Average current Sleep mode	DRX=2		3.8		mA
		DRX=5		2.4		
		DRX=9		2.0		
	Average current Talk mode	$GSM850_{1)3)}$		250		mA
		$EGSM900_{1)3)}$		280		
		$DCS1800_{2)3)}$		220		
		$PCS1900_{2)3)}$		210		
	DATA mode, GPRS（4RX ,1TX)	$GSM850_{1)3)}$		230		mA
		$EGSM900_{1)3)}$		260		
		$DCS1800_{2)3)}$		200		
		$PCS1900_{2)3)}$		200		

	DATA mode, GPRS（3RX ,2TX)	GSM850		370		mA
		EGSM900		420		
		DCS1800		350		
		PCS1900		350		
	Peak supply current			2		A

1): Power control level PCL 5
2): Power control level PCL 0
3): Test conditions for the typical values: 50ohm antenna

9. Operating temperatures

Test Condition: VBAT=4.0V

Parameter	Min	Typ	Max	Unit
Ambient temperature	-40	25	85	℃
Storage temperature	-45		+90	℃

10. General Purpose Input&output(GPIO)

Parameters	Description	MIN	Typical	MAX	Unit
VIL	Minimum input voltage	0		0.3Vpad	V
VIH	Maximum input voltage	0.7Vpad		Vpad	V
VOL	Minimum output voltage	0		0.1Vpad	V
VOH	Maximum output voltage	0.9Vpad		Vpad	V

11. LDO output

AT139 has one LDO output, and the LDO has been used in internal, so the external power supply ability is limited. The LDO parameters Characteristic is shown as following table:

LDO	Function	Voltage	Maximum Output Current
VDD_IO	Power supply for I/O	2.85 V	10mA

12. Electro-Static Discharge (ESD)

Parameter	Air	Contact	Unit
VBAT,GND	+-10	+-6	KV
IO pin	+-1	+-1	KV

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13. Reference Circuit Design

AT139 has 38 pins in total, and the following interfaces and functionalities are provided on AT139:

① Audio: two MIC inputs; one receiver output, one speaker output.

② SIM Card: Supports 1.8V/3.0V voltage.

③ External Reset: External reset module, active low.

④ UART: One UART asynchronous serial interface

⑤ GPIO: Two GPIO inputs/outputs

⑥ ADC: One ADC converter input

⑦ Power supply: Two VBAT and VDD_RTC inputs, one VDD_IO output.

⑧ External Antenna：Need to solder on PCB

Following is the detailed description about related reference design:

13.1. Power Supply

The AT139 has 3 VBAT pin on I/O pins, its normal operating voltage is from 3.3V to 4.5V. The peak working current can rise up to 2A during maximum power transmitting period, which will cause a voltage drop. So the power supply must be able to provide sufficient peak current.

When the input is a power adapter, the adapter and related circuit must satisfy the following conditions:

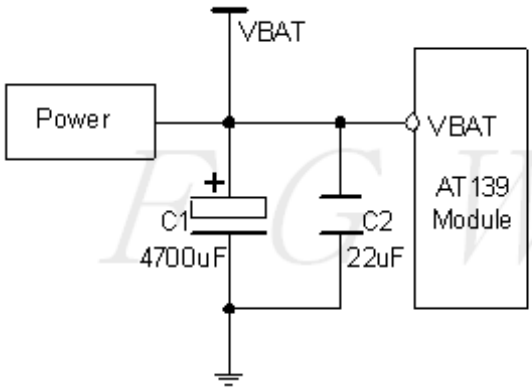
1） The adapter output current more than 2A;

2） A local bypass capacitor is recommended.

A low cost choice may be a big value aluminum capacitor with small MLCC capacitors in parallel, which is illustrated as following figure.

For example, for an adapter with 800mA, the 2200uF aluminum capacitor and 22uF MLCC capacitor are recommended.

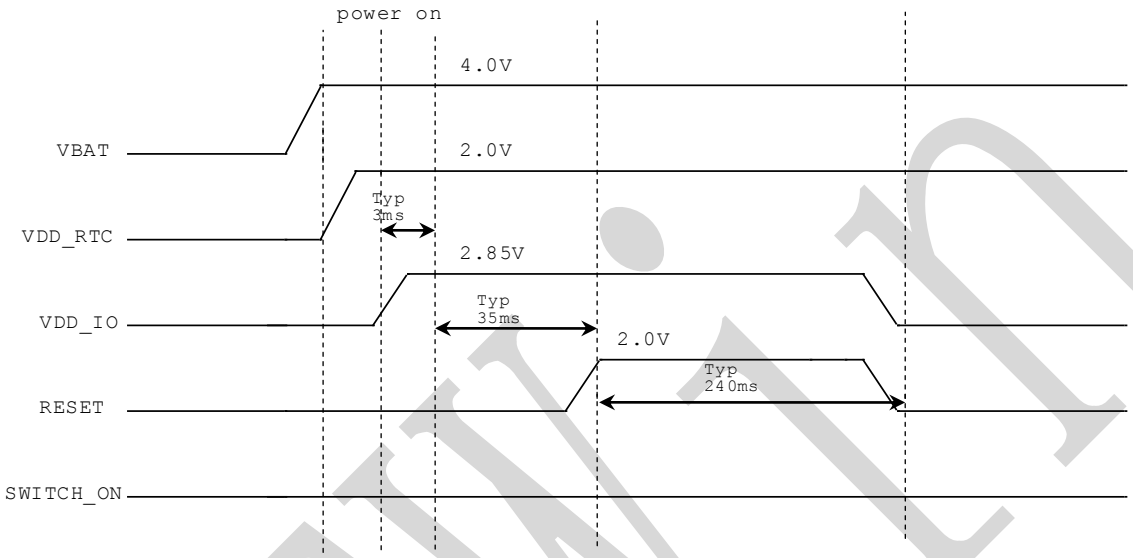
At the same time, the capacitors should be placed as close to the AT139 VBAT pins as possible.



13.2. Power on and Power off scenarios

The AT139 basic blocks will start to function immediately once the module VBAT power is supplied, and then the module will check if the SWITCH_ON pin is low, if so the module will be turned off automatically, otherwise the module will be powered on automatically.

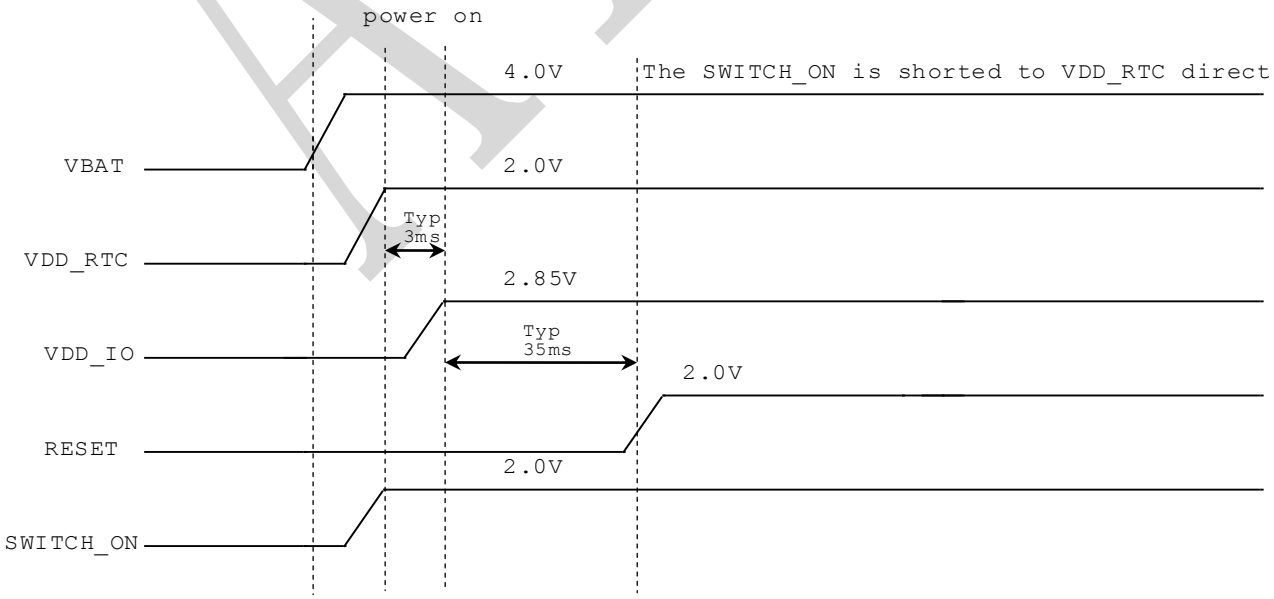
The timing illustrates as the following figure:



13.2.1 Turn on AT139 automatically

The AT139 can be turned on automatically once the VBAT power supplied if the SWITCH_ON is shorted to VDD_RTC directly.

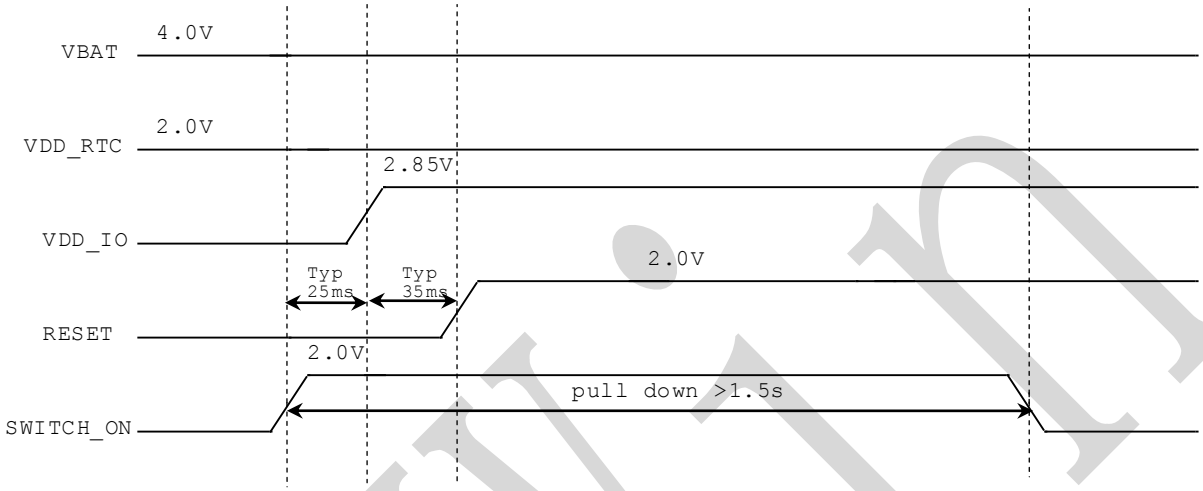
The timing illustrates as the following figure:



13.2.2 Turn on AT139 via SWITCH_ON

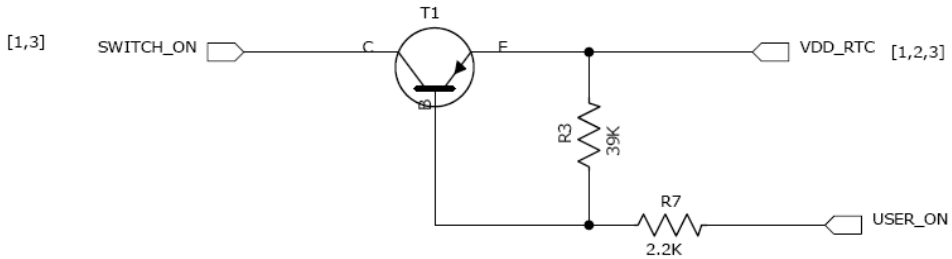
Trigger the SWITCH_ON key to a high level for at least 1.5s and then release, the module will be turned on.

The timing illustrates as the following figure:



The SWITCH_ON input pin of module can control module to power on/off, active high. And it has been weakly pulled low in module.

If the SWITCH_ON input pin of the module is connected to a MCU, it is suggested to use an open drain of external MCU to control the power on and power off. The reference circuit as the following figure:



13.2.3. Working status indication

The VDD_IO pin of AT139 can supply 2.85V voltage for external circuit. (Load current 10mA). It is suggested to only supply for UART level shifter IC.

By measuring this pin, user can judge whether the system is power on or power off, sleep mode. When the voltage is low, the system is power off, otherwise, the system is power on or sleep mode.

13.2.4. Turn off AT139

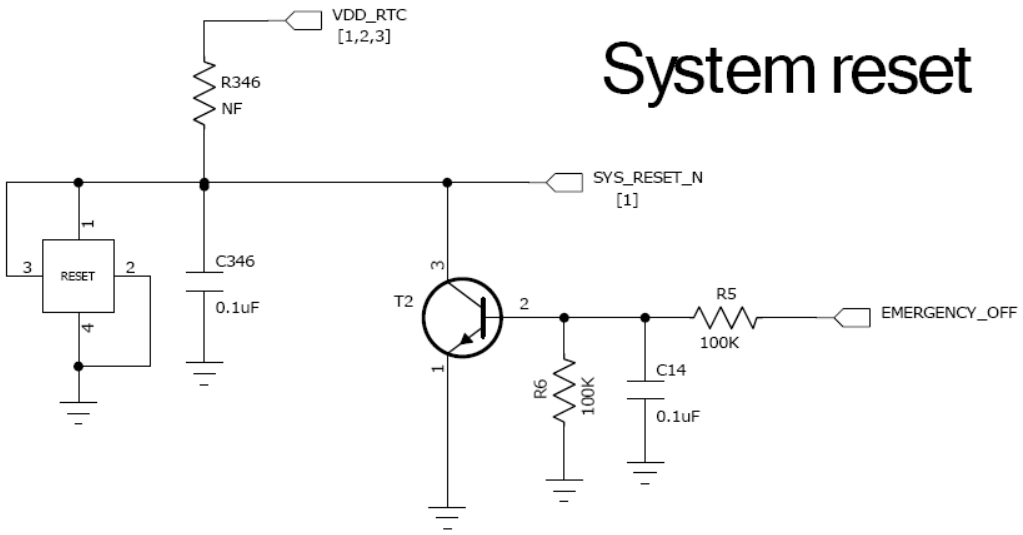
The AT139 can be turned off by driving the SWITCH_ON pin to a high level voltage for at least 1s and then release (or left floating), the module will be powered off.

13.3. Emergency Power off

The external RESET_N pin provides a means for external circuitry to force the device into a reset state. This signal has to be considered as an emergency reset only. Asserting an active-low signal on the RESET_N pin generates a reset; already pulled up to VDD_RTC in module.

If the RESET_N input pin of the module is connected to an external device like a MCU, it is suggested to use an open drain output of the external device since the RESET_N is internally pulled-up to the VDD_RTC domain.

Notes: A decoupling of the RESET_N pin may be necessary to avoid erroneous noise-induced resets.



13.4. Wake up & Sleep mode

AT139 can enter into low current consumption status, called sleep mode, in which it sets module into minimum functionality mode.

User can control AT139 module to enter or quit the sleep mode through DTR signal. When the DTR is in high level and there is no on air and hardware interrupt for about 25s, the AT139 will enter sleep mode automatically. If the DTR pin is pulled down to a low level, this signal will wake up AT139 from sleep mode. The serial port will be active after DTR changed to low level.

When sending any AT commands to UART port, the module will be waked up also, but in the case, the first and second AT characters will be lost.

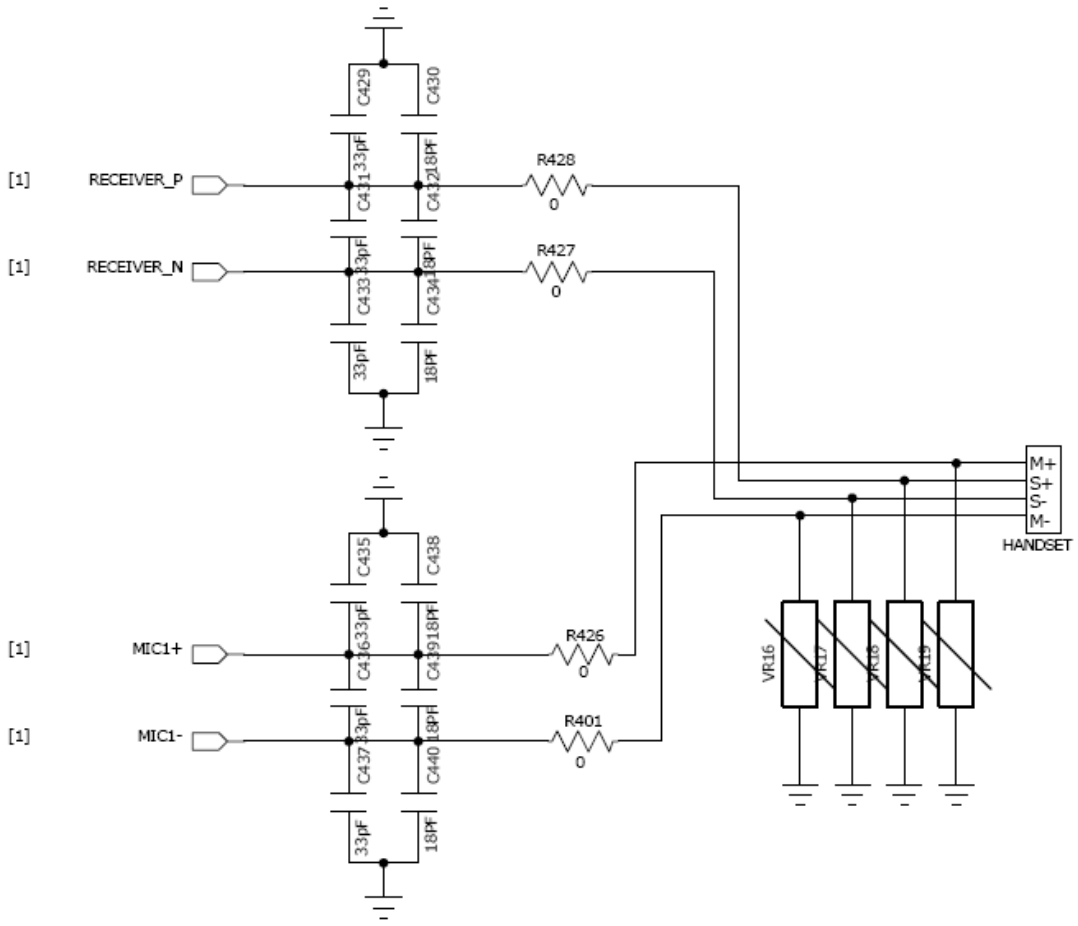
13.5. Audio Interface

AT139 has two (MIC1, MIC2) inputs and two (RECEIVER, SPEAKER) outputs. ATWin software provides some tuning parameters to help user to improve audio quality, echo suppression etc.

In general, the following application combination is recommended:

PIN NO.	Pin name	Description	comments
32	RECEIVER-	Handset receive output, it is designed as a differential output with RECIVER+	Handset channel，it can driver maximum 16ohm receiver.
31	RECEIVER +	Handset receive output, it is designed as a differential output with RECIVER+	
29	MIC1-	Handset Microphone input, it is designed as a differential input with MIC+	
30	MIC1+	Handset Microphone input, it is designed as a differential input with MIC-	
34	SPK-	Handfree speaker output, it is designed as a differential output with SPK+	Handfree channel，it can driver maximum 8ohm speaker
33	SPK+	Handfree speaker output, it is designed as a differential output with SPK-	
27	MIC2-	Handfree Microphone input, it is designed as a differential input with MIC2+	
28	MIC2+	Handfree Microphone input, it is designed as a differential input with MIC2-	

MIC1 and RECEIVER form the handset circuit, the reference circuit as the following figure:

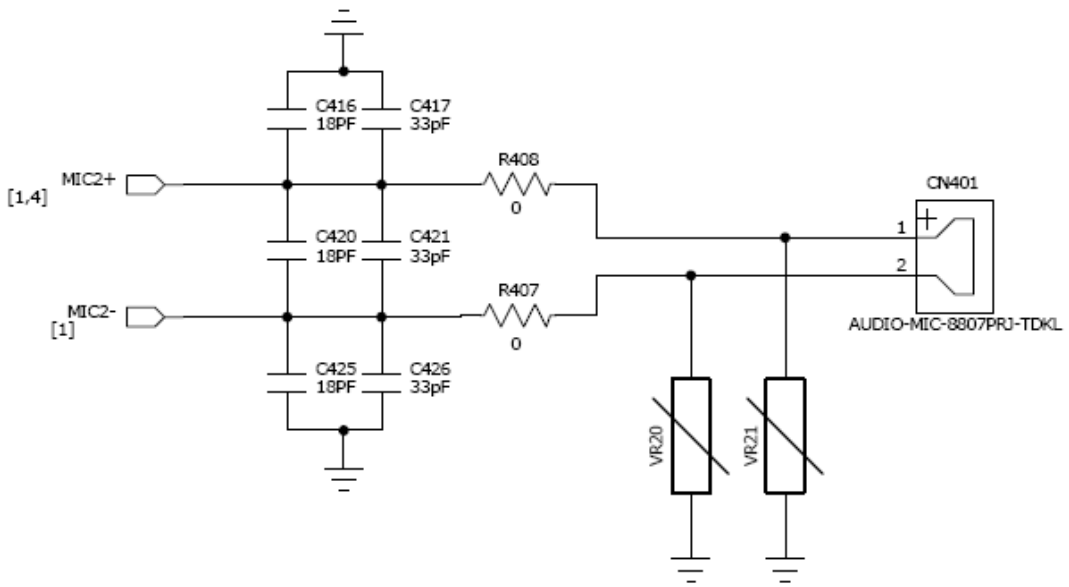


Notes:

1） The filter capacitor should be located as close to the handset connector as possible;

2） MIC1+ & MIC- and RECEIVER+ & RECEIVER- should be designed as a couple of differential output respectively.

MIC2 and SPEAKER form handfree circuit, the reference circuit as the following figure：

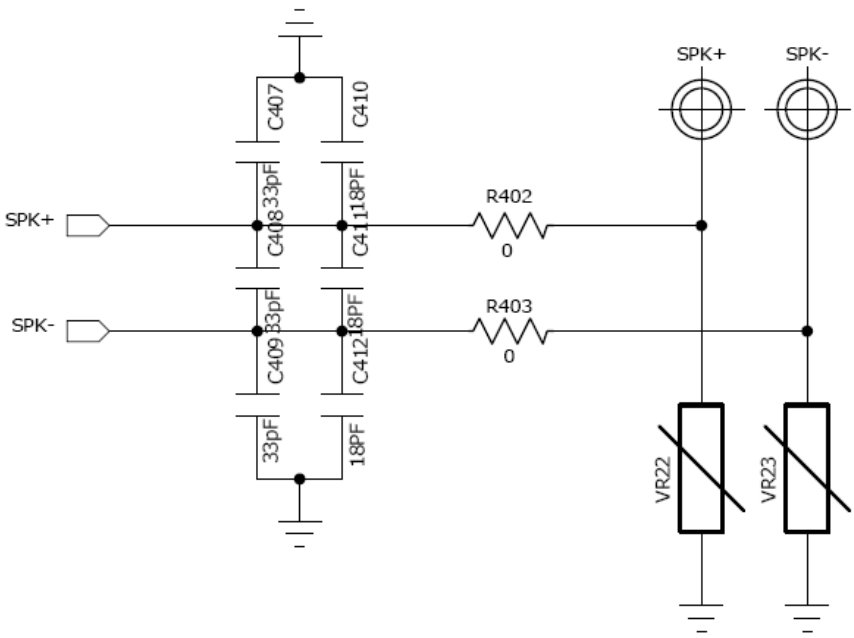


Notes:

1） The capacitor should be located as close to MIC as possible;

2） MIC2+ & MIC2- should be designed as a couple of differential inputs.

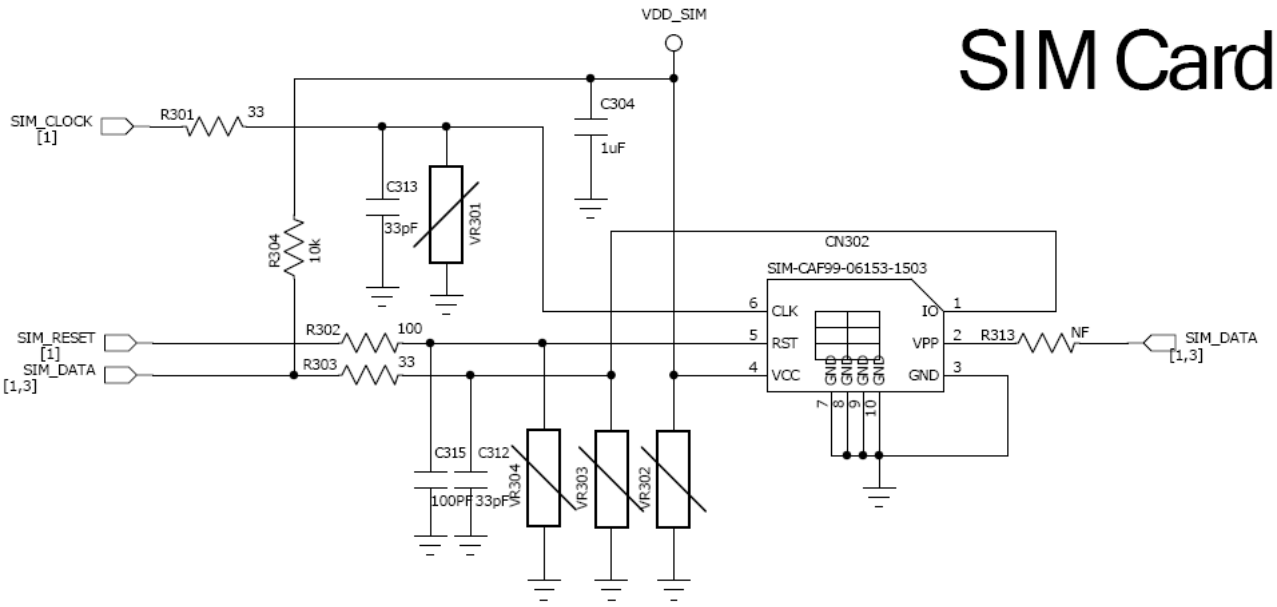
AT139 integrates internally the Audio Power Amplifier, which can driver an 8ohm speaker directly. The maximum output power is 350mW.



Notes:
1): The filter capacitor should be closed to speaker as far as possible;
2): SPK+ & SPK- should be designed as a couple of differential outputs;

13.6. SIM Card Interface

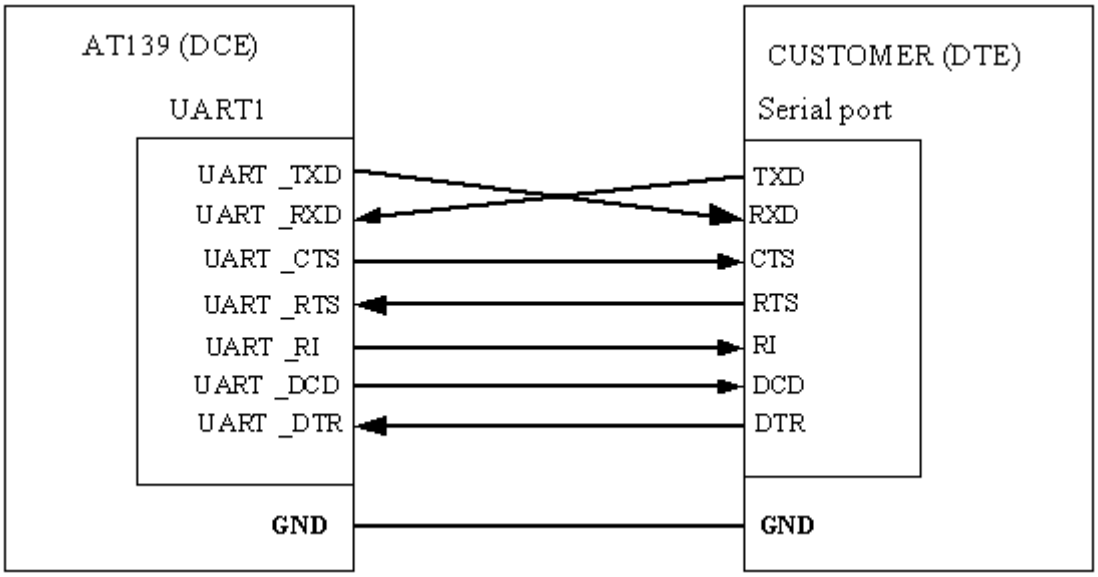
AT139 can support both 1.8V/3.0V SIM Card, the reference circuit is shown as the following figure: SIM_DATA should add 10K pull-up resistance to VDD_SIM.



13.7. Serial Port Interface

AT139 integrates one URAT port which is used for capturing trace, GPRS service and send AT command of controlling module. Serial port supports the communication rates from 1200bps to 115200bps, and also autobauding is supported. The default setting is 115200bps.

The module is designed as a DCE, and the following is the traditional DCE-DTE connection. The module and the DTE are connected with the following signals, (as following figure)



DCE（Module）			DTE	
Pin No.	**Pin Name**	**I/O**	**Description**	**I/O**
13	UART_TXD	O	Receive data	I
12	UART_RXD	I	Transmit data	O
14	UART_CTS	O	Clear to send	I
15	UART_RTS	I	Request to send	O
17	UART_RI	O	Ring Indicator	I
18	UART_DCD	O	Data carrier detect	I
16	UART_DTR	I	Data terminal ready	O

Behaviors of the UART_RI：
1) Voice call: Change to low (Pulse width 5s, pulse period 1s) when receive a call and change to HIGH after establish the call；
2) SMS: Change to low and hold low level 500ms when receive a SMS；

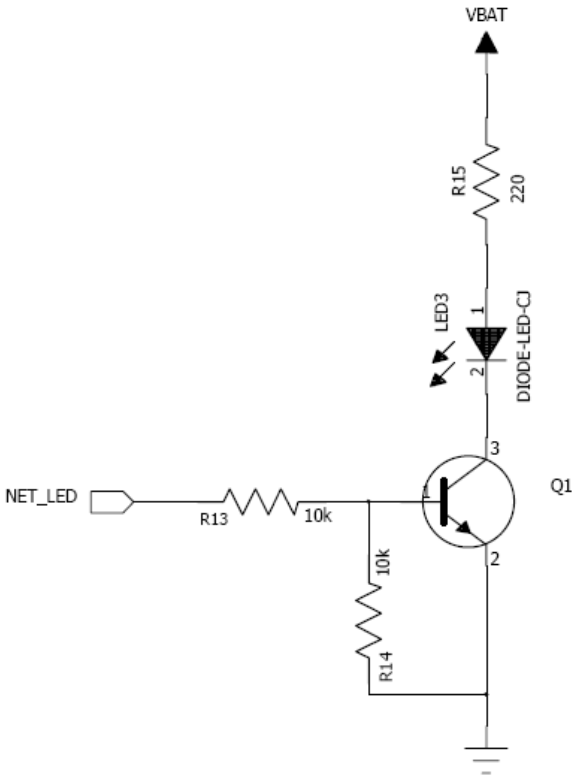
Notes: All serial interface signals must add the 1K series resistance between 3V MCU and serial port of module except the UART_TXD, UART_RXD, UART_DTR signals as they have been added the series resistance already in internal.

13.8. Network Status Indication LED

AT139 can support the network status indication and the NET_LED pin can be used to driver a network status indication LED lamp. The working state of this pin is listed in the following table:

State	Blinking Frequency
AT139 finds the network	50ms ON/750ms OFF
Standby	50ms ON/2500ms OFF
Sleep mode	OFF
Power down	OFF

The reference circuit is shown as the following figure:



13.9. Trace

AT139 uses the SPI port to capture trace log as the module has one serial port only. ATWIN can provide a SPI to USB converter board for customers for getting debug log. It is suggested to reserve these ports while designing a PCB. The related interface is shown as the following table:

PIN NO.	Default	Type	Description	SPI interface	Type	Description
10	GPIO_2	IO	GPIO_2	SPI_DIN	I	SPI input
9	GPIO_1	IO	GPIO_1	SPI_DOUT	O	SPI output
8	NET_LED	O	Network indication LED control	SPI_CLK	O	SPI clock
7	VDD_IO	O	LDO output,2.85V,10mA	VDD_IO	O	SPI power supply
18	UART_DCD	O	Data carrier detect	SPI_CS	O	SPI chip select
3,6, 11, 26, 36, 38	GND		GND	GND		GND

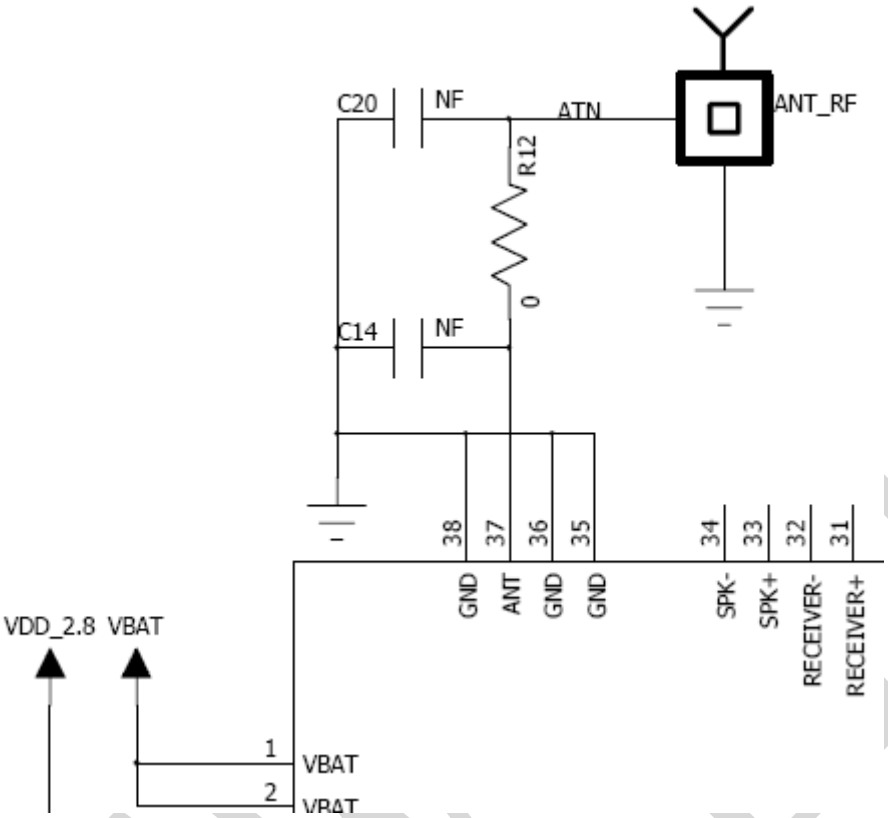
13.10. Antenna Interface

AT139 antenna can be soldered on feed pad of antenna directly. In a product's PCB design, it is should be noted that the space between GND and RF trace on the same plane should be two times more than the width of RF trace.

Because the module's RF part is working in a 50ohm system, so its output load impedance should be 50ohm, to meet this requirement, the all RF signal traces should be impedance controlled, and its characteristic impedance should be 50ohm.

To get the best RF performance and meet 50ohm requirement, an additional Pi type antenna matching circuit should be needed.

The following figure shows the recommended reference design;


C20
NF
ATN
ANT_RF
R12
0
C14
NF
38
37
36
35
34
33
32
31
GND
ANT
GND
GND
SPK-
SPK+
RECEIVER-
RECEIVER+
VDD_2.8
VBAT
1
VBAT
2
VBAT