G115 MODULE User Guide V1.0

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COTHINKING Incorporated

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Revision history

Revision	Date	Description
V0.1	July 2009	Initial release
V1.0	March 2010	Added label information in compliance details

1 Introduction

1.1 Documentation overview

The G115 MODULE is a GSM quad-band Module with excellent RF performance. It also support GPRS class 12 with low power consumption, in a single package.

The complete G115 MODULE solution includes all hardware and software necessary for embedded wireless connectivity according GPRS.

This G115 MODULE user guide is organized as follows:

Chapter 1 Provides an overview of G115 MODULE documentation, presents a functional block diagram for an example application, gives a high-level functional description of the G115 MODULE device, and defines terms and acronyms used throughout this document.

Chapter 2 Provides pin assignments and detailed descriptions.

Chapter 3 Defines how to power and control the G115 MODULE platform and describes its operating modes.

Chapter 4 Provides RF integration guidelines.

Chapter 5 Provides standards compliance and regulatory information.

1.2 Application description

As a wireless Module, The G115 MODULE supported airlinks are as follows:

■ Quad-band GSM (GSM, GPRS):

GSM850 band
- 869 to 894 MHz reception; 824 to 849 MHz transmission

GSM900 band
- 925 to 960 MHz reception; 880 to 915 MHz transission

GSM1800 band
- 1805 to 1880 MHz reception; 1710 to 1785 MHz transmission

GSM1900 band
- 1930 to 1990 MHz reception; 1850 to 1910 MHz transmission

The on-board G115 MODULE ICs include:

■ MT6223D: GSM Base band IC with Power management integrated
■ AD6548. GSM RF Transceiver IC
■ SKY77531. RF PA IC with ASM integrated
■ K5L6331CAA: 64M NOR+32M SRAM MCP

Key connectivity support includes:

■ UART SPI Interface for LCD display
■ Keypad interface
■ Audio interface
■ SIM Card interface
■ DC power supply input, Status LED driver output

A high-level hardware block diagram is shown in Figure 1-1.

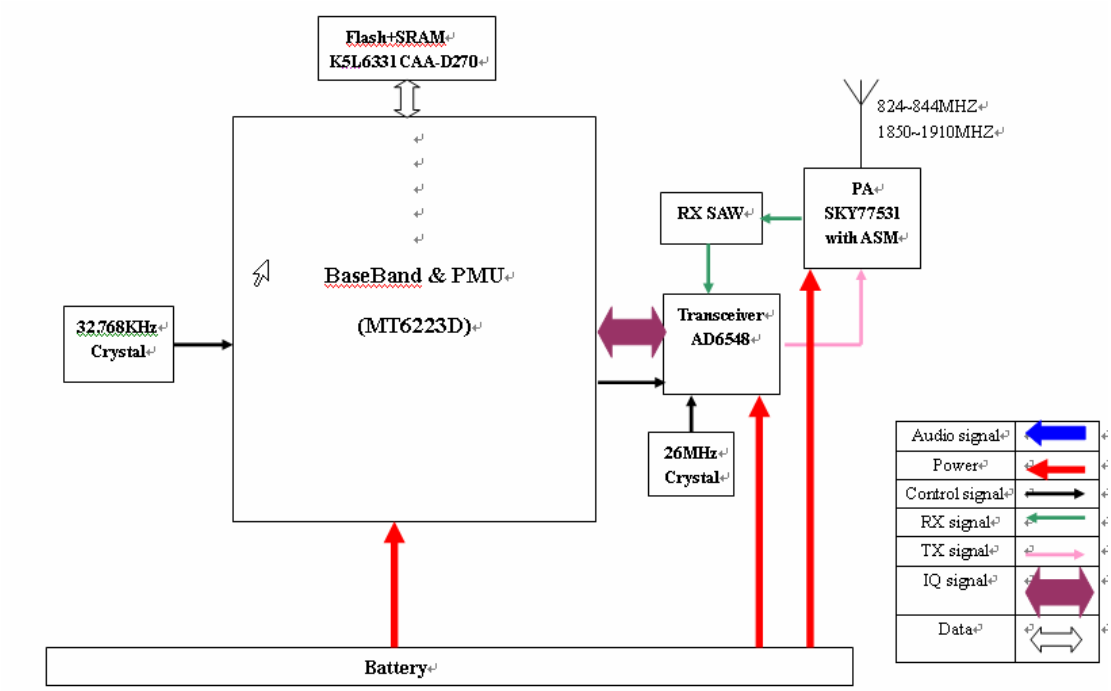

Figure 1-1

There is a GSM antenna feedback terminal on board, GSM antenna is assembled outside.

In the transmit direction, MT6223D IC process speech and data signal to IQ signal ,then routed to front-end AD6548 IC, on the control of MT6223D under SPI interface, AD6548 modulate the IQ signal to RF signal, support GSM low and high bands (GSM850 + GSM900 and GSM1800 + GSM1900) operation, then route to SKY77531, RF signal is amplified here and then switched to Antenna feedback terminal. An antenna switch Module is integrated in SKY77531 IC controlled by MT6223D.

In the receive direction, GSM antenna feedback terminal receive the RF signal, then route to SKY77531 antenna switched Module part, under the control of MT6223D, the RF signal is route to each saw filter, then route to the AD6548 IC for processing. Transform to IQ signal and route to MT6223D for final processing

The MT6223D IC provides all the digital baseband processing, Integrated MT6223D functions include one 32bit ARM7EJ-S processor cores, two low-power, high-performance digital signal processor (DSP) cores; on-chip boot ROM for factory FLASH programming and 32 kbits on-chip SRAM

With on-board 64 Mbits of NOR flash memory and 32 Mbits of RAM, NOR flash memory contains a boot image to support the initialization and configuration of the G115 MODULE hardware system, including the RF calibration items, Audio items and so on.

1.3 Terms and acronyms

Table 1-1 defines the terms and acronyms used throughout this document.

Term	Definition
ASM	Antenna switch Module
CC	Constant current
CE	Mandatory conformity marking on many European products
CV	Constant voltage
ESD	Electrostatic Discharge
FCC	Federal Communications Commission
GPRS	General Packet Radio Service
GSM	Global System for Mobile communications
PA	Power Amplifier
PD	Pull Down
PMIC	Power Management, PM Integrated Circuit
PU	Pull Up
RoHS	RoHS Restriction of Hazardous Substances
RF	Radio Frequency
RTC	Real Time Clock
USB	Universal Serial Bus
UART	Universal Asynchronous Receiver-Transmitter
USIM	Universal Subscriber Identity Module
VCTCXO	Voltage Controlled Temperature-compensated Crystal Oscillator

Table 1-1 Terms and Acronyms

2. Electric Characteristics

2.1Absolute Maximum Ratings

Parameter below are stress rating only, Prolonged exposureto absolute maximum rating may reduce device reliability, functional operation at these maximum ratings is not implied

Item	Symbol	Min	Max	Unit
Main power supply	Vbat	3.2	5	V
Charger input voltage	VCHG	4.2	6.8	V
Storage temperature range	Tstg	-55	125	Celsius
Free air temperature range	Tfat	-40	85	Celsius

Table 2-1 Absolute Maximum Ratings

2.2 Recommended operating range

Item	Symbol	Min	typical	Max	Unit
Main power supply	Vbat	3.4	3.9	4.3	V
Charger input voltage	VCHG	4.6	5	6.0	V
RTC input/output voltage	Vrtc	1.5	2	3.5	V
Operating temperature range	Tstg	-20	25	75	Celsius

Table 2-2 Recommended operating range

2.3 pin assignment and description

Pin	Symbol	IO or analog(A)	PD/PU	Description
1	SYSRST	I	PU	System reset signal input, low active, last 50ms
2	GPIO22/KCOL5	IO	PU	GPIO Port 25 or keypad matrix column signal 5
3	GPIO20	IO	PD	General purpose input/output port
4	GPIO25/PWM	IO	PD	General purpose input/ output port or PWM control signal
5	ADC2_MIC_HOOK	I		Voltage A/D Converter port, range up to 2.8V
6	LED_KEY	A		Open drain port, low active, current capacity 75mA
7	VIB-	A		Open drain port, low active, current capacity 250mA
8	VDD	A/O		2.8V LDO output, current capacity 80mA
9	GND			Ground
10	EAR_MICN1	A/I		handset microphone input negative signal－
11	EAR_MICP1	A/I		handset microphone input positive signal＋
12	MICBIASP	A/O		Microphone bias positive voltage ＋
13	MICBIASN	A/O		Microphone bias negative voltage -

14	MICP1	A/I		Normal microphone input positive signal +
15	MICN1	A/I		Normal microphone input negative signal -
16	RECN	A/O		Receiver output negative signal－
17	RECP	A/O		Receiver output positive signal+
18	MP3_OUTR	A/O		Audio output signal channel R
19	PWRON	I	PU	Power on/down keypad signal input, active low, last about 2s
20	LED-	A		Open drain port, low active, current capacity 150mA
21	CHG_DRV	A	PU	External Charge MOSFET control signal, charge current control
22	VCHG	A/I		Charger input and ADC detection，usually 5V input
23	CHG_ISENSE	A		Charge current ADC detection and feedback
24	BAT_SENSE	A		Battery voltage ADC detection, also coordinate with the CHG_Isense to detect charging current
25	SIM_CLK	O		SIM Card clock output signal
26	SIM_RST	O		SIM Card reset signal
27	SIM_IO	I/O		SIM Card Data output/input signal
28	VSIM	O		SIM Card power supply，1.8V or 3V output，it up to the SIM Card type
29	VRTC/VBACK	I/O		Power supply of Real-Time-Clock Module, 1.5V above active, A backup battery or one big capacitor such as 100uF is used
30	GPIO45/SCL/CTS1	I/O	PU	GPIO45 or IIC clock signal or Uart1 port CTS signal
31	GPIO46/SDA/RTS1	I/O	PU	GPIO46 or IIC data signal or Uart1 port RTS signal
32	TXD3/GPIO47	I/O	PU	Uart3 port data transmit signal or GPIO47
33	RXD3/GPIO48	I/O	PU	Uart3 port data receive signal or GPIO48
34	EINT2/GPIO42	I/O	PU	External interrupt signal 2 input or GPIO42
35	TXD1/GPIO44	I/O	PU	Uart1 port data transmit signal or GPIO44
36	RXD1/GPIO50	I/O	PU	Uart1 port data receive signal or GPIO50
37	KROW2			Keypad matrix row signal 2
38	KROW1			Keypad matrix row signal 1
39	KCOL0		PU	Keypad matrix column signal 0
40	KROW4			Keypad matrix row signal 4
41	EINT3/GPIO43	I/O	PU	External interrupt signal 3 input or GPIO43
42	KROW0			Keypad matrix row signal 0
43	KCOL1		PU	Keypad matrix column signal 1
44	KCOL4		PU	Keypad matrix column signal 4
45	KCOL3		PU	Keypad matrix column signal 3
46	KROW3			Keypad matrix row signal 3
47	EINT0		PU	External interrupt signal 0 input
48	LCD_CS0	O	PU	SPI chip select 0 output
49	LCD_SA0	I/O	PD	SPI data or command select signal
50	LCD_SDA	I/O	PD	SPI data signal

51	LCD_CLK	I/O	PD	SPI clock signal
52	LCD_RST	O	PU	SPI reset output signal
53	VBAT	A		Main power supply of G115 MODULE, Usually a Li-on Battery or external 4V DC power is used
54	VBAT			
55	GND			Ground
56	GND			
57	GND			
58	GND			
59	GND			
60	ANT			GSM RF input/output terminal, 50 ohm impedance
61	GND			Ground
62	GND			
63	GND			
64	GND			
65	GND			
66	GND			
67	GND			

Table 2-3 Pin assignment and description

2.4General Electric Characteristics

Item	Min	Typical	Max	Unit
Pwron_pin19 Input				
High voltage level	0.7*Vbat			V
Low voltage level			0.3*Vbat	V
GPIOs / EINTs Input/output				
High logic level	2.0			V
Low logic level			0.5	V
VDD LDO output				
VDD output voltage	2.7	2.8	2.9	V
VDD current capacity		50	80	mA
Line regulation			5	mV
Load regulation			20	mV
VSIM LDO output				
Voltage output(3V SIM Card)	2.82	3	3.18	V
Voltage output(1.8V SIM Card)	1.71	1.8	1.89	V
Current capacity		20	30	mA
ADC Interfaces operating range				
Mic_hook_pin5	0		2.8	V
Vbatsense_pin24	0		1.01*Vbat	V
CHG_Isense_pin23	0		1.01*Vbat	V
Open drain interfaces current capacity				

VIB-_pin7			250	mA
LED_Key_pin6			75	mA
LED-_Pin20			150	mA
Charge interface				
VCHG	4.6	5	6	V
Max charge current			800	mA
Precharge current		50		mA
Precharge mode to CC mode threshold		3.2	3.6	V
Constant current(CC) mode charger current(depending on software set)	62.5	450	800	mA
CC mode to CV(constant voltage)mode threshold		4.2		V
Over voltage protection threshold (OVP)		4.3		V

Table 2-4 General Electric Characteristics

3. Module DC Power, RESET and Operating Modes State

3.1 Module state descriptions

State	Definition
Power off	Main power supply Vbat is not provided, or Vbat <3.3V; In this state, 2.5V<Vbat<3.3V, only RTC block run; Vbat<2.5V, even RTC block is disabled. The Module can't power on
Switched off	Main power supply Vbat is provided and Vbat>3.3V, but the Module is switched off. In this state, Module can be switched to active mode if power on key pressed to low level for 2 second above or a charger plug-in, or Alarm time arrived ; No LDO is enabled except Vrtc
Pre-charging	Main power supply Vbat is provided and charger is plug-in, but Vbat<3.3V; In this state, slow charging is activated by the PMIC charge circuits, 50mA charge current, as long as Vbat is up to 3.3V, LDO VDD enables and LCD display run, switched to S witched off / charge mode
Active	Main power supply Vbat is provided and Vbat>3.3V, Module is power up and running on the 13M reference clock, LDO VDD is enabled, and the Radio task is running
Standby	Module is power up but the 13M reference clock is disabled, part of Baseband chip runs on the 32k crystal clock, it also calls deep sleep mode, current consumption is very low, about 1mA, if an incoming call , or external interrupt, or keypad pressed happens, Module will be waken up and go to active mode, LCD display and backlight will be on
Active alarm	Module is woken up from switched off mode via RTC alarm, VDD is enabled, but only alarm task is scheduled, no any radio activities are scheduled.
Switch off, charging	The mobile has charger connected, base band is active and running on13MHz reference clock but only charging software is scheduled, no any Radio nor MMI task was activated, LCD screen should only show battery charging status.
Active / Charging	The mobile has charger connected, base band is active and running on 13MHz reference clock with regular mobile radio and MMI task activated, LCD screen show battery charging status plus all normal tasks.

Table 3-1 Module state descriptions

3.2 Main DC Power supply

Pin53 & Pin54 Vbat are the main power supply terminal of the Module, usually a Li-on Battery or external 4V DC power is used, The voltage range is 3.4~4.2V and 4V is recommend if external DC power supply is used, it must be able to withstand a sufficient current in a transmission burst which typically rises to 2A instantly. For the

Vbat input, a 100uF above bypass capacitor（low ESR）is recommended and placed near by the pin 53&pin54, it is helpful to minimize Vbat power ripple at power transmit phase.

To minimize the voltage drop on the Vbat trace, trace width of Vbat signal between the power supply and Pin 53/54 is 1.5mm above, 2mm is recommend, 6 vias above if the trace switch to another layer..

3.3 RTC backup power supply

Pin 29 VRTC is Real-Time-Clock block power supply. when main power supply Vbat exists and 2.5V above, it is supplied by internal dedicated voltage regulator output.

To reserve data and time information without main power supply for a long time, one backup Coin-cell battery is recommended. In addition , a big capacitor such as 47uF can be used as backup battery, RTC unit can runs about 5minutes after main power supply gets away. Bigger the capacitor is, longer the RTC runs.

3.4Power on and reset

To power on the Module from switched off mode , normally Pin19 PWRON is used. The PWRON signal is pulled down to low level for 2s controlled by external MCU or according to a keypad pressed.

The second method to power on the Module from switched mode is the charger plugging in. when pin22 VCHG detect charger plug in, it will enter into switched off /charger mode, but software can be set to run up and enter into active mode

The third method is alarm scheduled. On the alarm active mode, software can be set to run up , enter into active mode, it depends on software configuration

Pin 1 SYSRST is used to reset the whole Module system, once SYSRST signal is pull down to low level for about 10ms, Module will be reset immediately, whether the Module restart is determined by software configuration. External MCU can control it if need. But leave it alone if not used, it is internal pulled up , need to avoid external interfere

4 RF Integration

4.1 RF operating frequencies

The G115 MODULE RF operatingGSM frequencies are summarized in Table 4-1.

Item	GSM850	PGSM900	EGSM900	DCS1800	PCS1900
RF Frequency	TX: 824~849MHZ	TX: 890～915MHZ	TX: 880~915MHZ	TX:1710~1785MHZ	TX: 1850~1910MHZ
	RX: 869~894MHZ	RX: 935~960MHZ	RX: 925~960MHZ	RX:1805~1880MHZ	RX: 1930~1990MHZ
Channel	128～251	1~124	975~1023 1~124	512~885	512~810
TX Power class	4(2W,33DB)	4(2W,33DB)	4(2W,33DB)	1(1W, 30DB)	1(1W,30DB)

Table 4-1 RF operating frequencies

4.2 RF connections

The G115 MODULE RF impedance line are designed to operate in 50 Ω systems,their inband source and load characteristic impedances are always 50 Ω nominal. A 10 dB return loss or better should be maintained over all operating bands throughout the antenna plus cabling systems.

one additional points is worth highlighting:

■ To minimize loss，from the RF feedback point of G115 MODULE to antenna line should be routed 50ohm , and as short as possible, use short 50 Ω cables for host-to-G115 MODULE RF interconnections.

4.3 Ground connections

Grounding is extremely important to G115 MODULE performance. There are 13 GND Pins on G115 MODULE, all the Pins should be connected to host PCB ground separately and directly. Routing line should be as short as possible, line width should be big enough.

4.4 Shielding and interference

Shielding is an extension of the system ground and must be installed to prevent interference between the host PCB and the G115 MODULE. The Module is fully shielded (Figure 4-1)

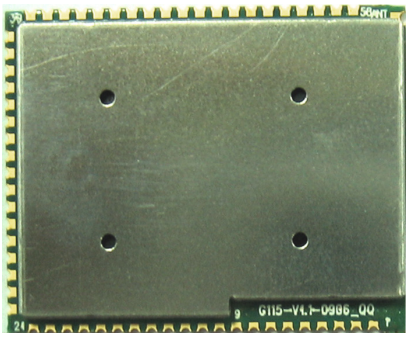

Figure 4-1 G115 MODULE shields

NOTE These G115 MODULE shields must not be removed.

G115 MODULE User Guide RF Integration

Careful design is required to minimize the interference. G115 MODULE performance parameters, such as receiver sensitivity and transmitter spurious signals, should be evaluated to confirm adequate grounding and shielding, location of the G115 MODULE antennas, and perhaps even placement and routing of other host PCB functions. This evaluation should be performed for all G115 MODULE operating bands.

4.5 Antenna considerations

As mentioned in Section 4.4, the location of the antenna elements is critical to G115 MODULE RF performance. Routing the connecting coaxial cables could also impact G115 MODULE performance; they should be routed away from corruptive noise sources (like the main power supplies, LCD assemblies, memory, etc).

Antenna RF signal can also impact other sensitive signal, like audio signal, clock signal, SIM Card signal , these traces should be routed away from antennal RF traces and protected by GND properly.

5 Standards and Regulatory Compliance

5.1 Standards and certification

The G115 MODULE platform conforms to the following standards and certification requirements:

■ GSM TS 45.005

■ FCC 47 CFR Part 1 - RF radiation exposure limits
47 CFR Part 2 - Equipment authorization
47 CFR Part 22 - Cellular
47 CFR Part 24 - PCS

■ CE EMC protection requirements
- EN 301 489-1 - Common technical requirements
- EN 301 489-7 - GSM and DCS

Effective use of spectrum to avoid unwanted interference requirements

- EN 301 511 - GSM900/GSM1800
- EN 301 607-1 - GSM900/GSM1800

■ CTIA/GCF/PTCRB

■ Safety EN 50360/61 full carrier certification (carriers TBD)

■ Microsoft. WHQL certification

■ RoHS compliance

5.2 Regulatory information

5.2.1 Safety warnings

Do not operate the G115 MODULE platform in the following environments:

■ In active blasting areas

■ In potentially explosive environments such as refuelling points, fuel depots, or chemical plants

■ Near medical equipment, especially life support equipment that might be susceptible

to radio interference

■ In an aircraft as follows:

G115 MODULE transmissions could interfere with aircraft electrical and communication systems. Like cell phones, using the G115 MODULE platform in an aircraft is illegal in some jurisdictions.

If cell phone usage is permitted while the aircraft is on the ground, normal G115 MODULE operation is permitted as well.
G115 MODULE User Guide Standards and Regulatory Compliance

5.2.2 North American compliance

The G115 MODULE has been authorized for mobile operation in North America. The initial authorization grant does not permit end user installation.

A permissive change will be submitted to add end user installation and/or portable usage conditions. The permissive change application includesdetailed information on G115 MODULE's two-way authentication procedure preventing use of the Module in unauthorized G115 MODULEs.

For mobile applications, the following conditions must be met:

1. Maintain at least a 20 cm separation between the antenna and the user's body.

2. Radiated transmit power must be equal to or lower than that specified in the FCC Grant of Equipment Authorization for FCC ID: X7ICTG115

3. To comply with FCC/IC regulations limiting both maximum RF output power and human exposure to RF radiation, maximum antenna gain (including cable loss) must not exceed:
Cellular band <2dBi
PCS band <2.5dBi

4. Independent G115 MODULE operation — the G115 MODULE must not be co-located or jointly operated with any other transmitter or antenna within the host device.

5. A label with the following statements must be attached to the host end product:
This device contains Tx FCC ID: X7ICTG115

6. The end product must include a user manual that clearly defines operating requirements and conditions that must be observed to ensure compliance with current FCC RF exposure guidelines.

7. The end product must also pass the FCC Part 15 unintentional emission testing requirement and be properly authorized per FCC Part 15.