



# SIMCOM WCDMA Wireless Module

## SIM52xx **Charger Application Note**



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## Version history

Date	Version	Description of change	Author
2010-04-06	01.00	Origin	3G team
2010-07-12	01.02	Add USB charger and related AT command	3G team

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## 1 Introduction

SIM5213 and SIM5214 provide a charger interface. SIM5213 and SIM5214 only support charging of lithium-ion and lithium-ion polymer battery.

This document describes the charger interface of SIM5213/SIM5214.

## 2 Scope of the document

This document is intended for the following versions of the SIMCOM modules

- SIM5213/SIM5214

## 3 SIM5213/SIM5214 Charger function

### 3.1 Charger input pin

SIM5213/SIM5214 has provided a charger input interface. They are VCHG (VCHG charger input) and BATTEMPADC (battery temperature ADC input). SIM5213/SIM5214 support Wall charger and USB charger. User can select one from two charger mode by AT+CCHGS. User can use AT command (AT+CCHGI) to set the max current when wall charging and use the AT command (AT+CBC) to monitor the voltage of battery (VBAT).

Because of the impedance of wires used as route between SIM5213/SIM5214 and battery, it should be as short and wide as possible.

#### 3.1.1 Wall charger

VCHG is the charger input pin, with which one can connect a wall charger. The reference circuit is as the following figure 2.

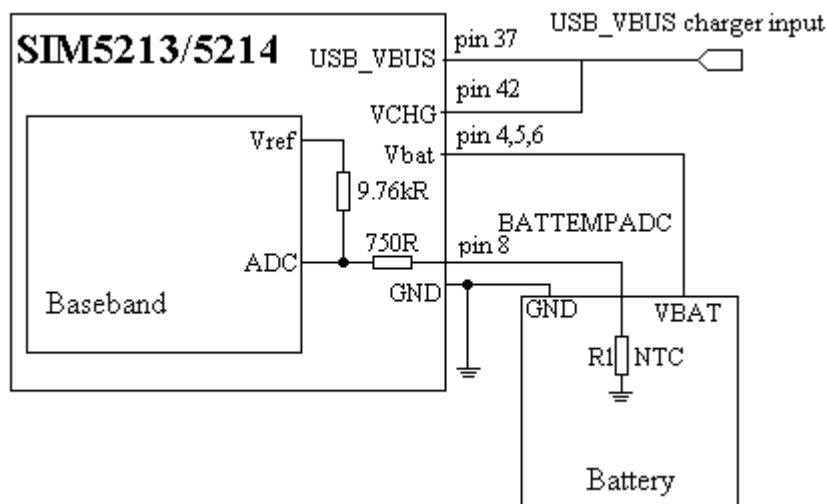
Table 1: VCHG input range

Recommended operating conditions	Min	Type	Max
VCHG	4.2V	5V	14.5V

Too big VCHG input may lead to large power dissipation, so 5V input is suggested. The maximum current on VCHG input can be up to 550mA, the width of VCHG on host board should meet the requirement of current.

### 3.1.2 USB charger

User can choose USB charger mode if have no adapter. Standard USB interface can only support 500ma, so the maximum default charging current must be 500ma. Figure 1 is reference circuit.

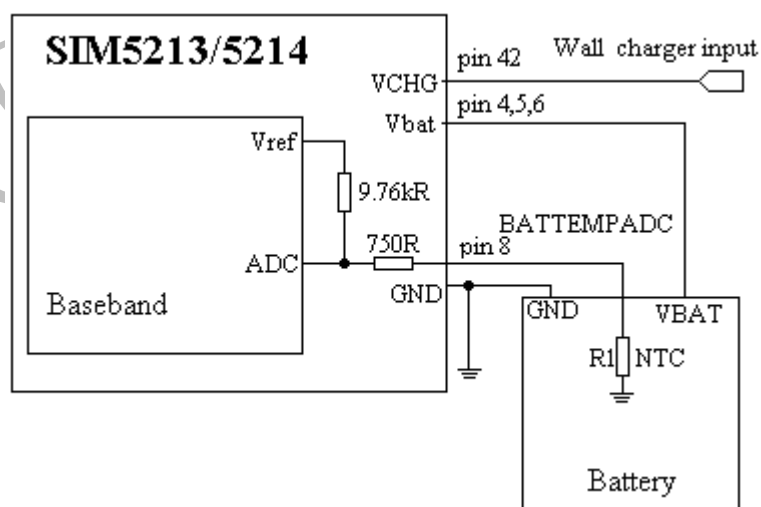


**Figure 1: USB charger mode Connection**

### 3.1.2 BATTEMPADC

BATTEMPADC is the battery temperature ADC input pin. Here is the internal circuit in SIM5213 of BATTEMPADC pin.

**Note:** Battery temperature ADC function default is disabled. If one use fast charge, must connect BATTEMPADC pin to a NTC resistor and enable Battery temperature ADC function by AT+CBTMPS.



**Figure 2: Default BATTEMPADC Connection (Wall charger mode)**

In normal Li battery of handset, there is a NTC resistor for battery temperature sensor. And in SIM5213, a resistors network are used for battery temperature ADC input.

From figure above, the input voltage can be calculated below.

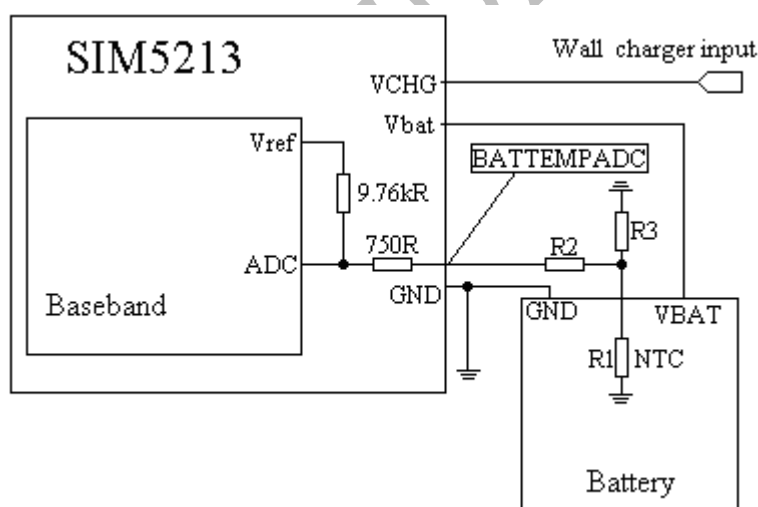
$$V_{adc} = (V_{ref} * 9.76kR) / (9.76kR + 0.75kR + R1)$$

The default temperature vs ADC input voltage table is shown below.

**Table 2: The default temperature VS ADC input voltage**

Temperature degree(°C)	ADC input voltage after calculating (mV)
-30	1887
-20	1814
-10	1711
0	1574
10	1408
20	1224
30	1035
40	856
50	695
60	558
70	446
80	355

So please make sure that the battery you choose can meet the requirement in the table above, or one can add some resistors (R2 R3) as below to get desired voltage. The value of R2 R3 can be calculated according to the NTC curve and table above.



**Figure 3: BATTEMPADC Connection(Wall charger mode)**

### 3.2 Charging mode

Battery with different voltage may use different charger mode. There are 3 charger modes for SIM5213/SIM5214.

**Table 3: Charging mode**

Voltage of battery	Charging mode
Vbat < 3.2V	Trickle charging

$3.2V \leq V_{bat} \leq 4.1V$	Constant current charging (up to 550mA)
$4.1V < V_{bat} \leq 4.2V$	Constant voltage charging

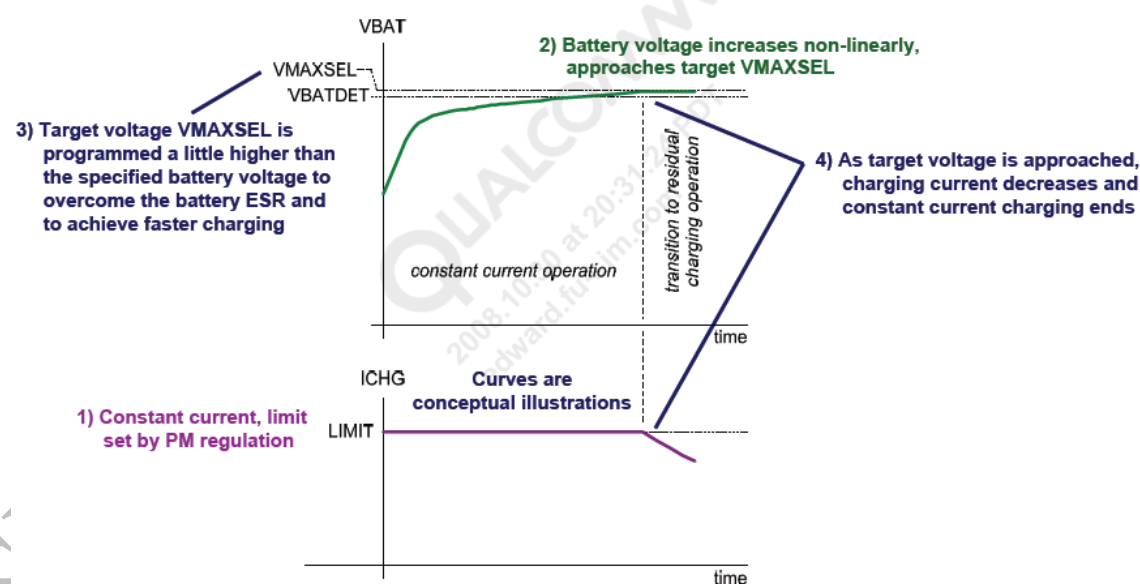
### 3.2.1 Trickle Charging

When the battery voltage is below 3.2V, the battery will be protected and can not discharge. In this situation, trickle charging is adopted.

This mode is used to raise a severely depleted battery's voltage to a level sufficient to begin fast charging (constant current charging). Fast charging with a high-current supply should not be attempted on a deeply discharged battery-the battery would draw excessive current, pull the  $V_{bat}$  voltage down, and possibly cause a handset malfunction or shutdown due to an undervoltage lockout condition.

### 3.2.2 Constant current charging

When the battery voltage is above 3.2 V and trickle charging finish, SIM5213/SIM5214 will enter constant current charging mode. The constant current will be up to 550mA. So the width of VCHG should meet the requirement of 550mA. When the voltage of battery is up to 4.1V, the SIM5213/SIM5214 will enter to constant voltage charging.



**Figure 4: Constant Current Charging**

### 3.2.3 Constant voltage charging

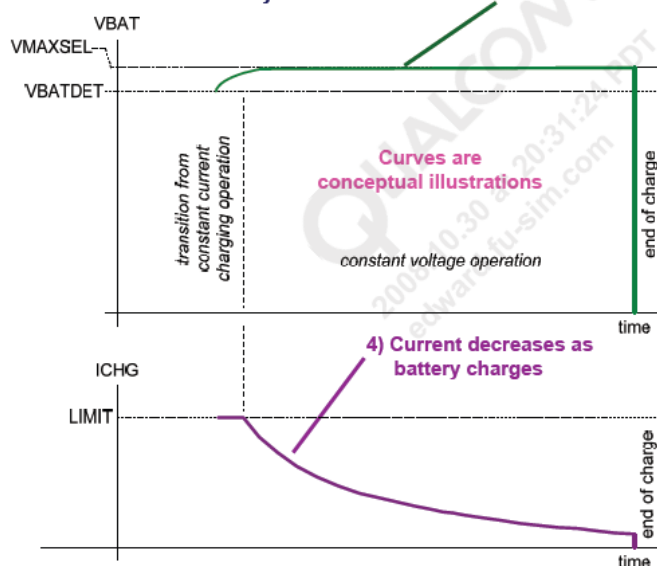
When the battery voltage is above 4.1 V, SIM5213/SIM5214 will enter constant voltage charging mode. As constant voltage charging goes, the current of VCHG will decrease. When the current decrease to a threshold, SIM5213/5214 will stop charging.



1) VBAT is regulated by PM circuits to match the target voltage VMAXSEL as discussed earlier

2) VBAT is regulated rather than VDD for better final accuracy

3) Battery voltage is nearly constant



5) End of charge is implemented by customer software (not QCT software), detected in 1 of 2 ways:

- Monitor charging current using the HKADC and terminate charge when it decreases to desired value
- Allow constant voltage operation for a predetermined duration after crossing the VBATDET threshold (approximately one-half to two hrs)

**Figure 5: Constant Voltage Charging**

### 3.2.4 Call back charging

After SIM5213/SIM5214 finish charging, the battery voltage may drop a little after a period time. So call back charging will happen to keep the battery on 4.2V.

## 4 AT command about Charger

### 4.1 AT+CCHGI Set max charging current

#### Description

You can use this command to set the max current when wall charging

SIM PIN	References
NO	Vendor

#### Syntax

Test Command	Responses
AT+CCHGI=?	+CCHGI: (100-950),(0-1) OK
Read Command	Responses
AT+ CCHGI?	+CCCHGI: <imax>

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	OK
Write Command	Responses
AT+ CCHGI =<imax>[,<save>]	OK
	ERROR

### Defined values

<imax>
100-950: the max current value which user can set
<save>
0 : do not save the value
1 : save the value

### Examples

AT+ CCHGI =550
OK
AT+ CCHGI =550,1
OK
AT+ CCHGI?
+ CCHGI: 550
OK
AT+ CCHGI =?
+ CCHGI: (100-950), (0-1)
OK

*Note: the default current value is 550mA when user use wall charger.*

## 4.2 AT+CBTMPS Battery temperature auto detection

### Description

You can use this command to set battery temperature auto detection enable or disable

SIM PIN	References
NO	Vendor

### Syntax

Test Command	Responses
AT+CBTMPS=?	+CBTMPS: (0-1)
	OK
Read Command	Responses
AT+CBTMPS?	+CBTMPS: <enable>

	OK
Write Command	Responses
AT+CBTMPS=<enable>	OK
	ERROR

### Defined values

<enable>

0 : disable battery temperature auto detection

1 : enable battery temperature auto detection

### Examples

AT+ CBTMPS =1

OK

AT+ CBTMPS?

+ C SPISETCLK: 1

OK

AT+ CBTMPS =?

+ C SPISETCLK: (0-1)

OK

## 4.3 AT+CBC Battery charge

### Description

Execution command returns battery connection status <bcs> and battery charge level <bcl> of the MT.

Test command returns values supported as compound values.

SIM PIN	References
NO	3GPP TS 07.07

### Syntax

Test Command	Responses
AT+CBC=?	+CBC: (list of supported <bcs>s),(list of supported <bcl>s) OK
Execution Command	Responses
AT+CBC	+CBC: <bcs>,<bcl>,<vol>V  OK  +CME ERROR: <err>

### Defined values

<bc>	
0	ME is powered by the battery
1	ME has a battery connected, but is not powered by it
2	ME does not have a battery connected
3	Recognized power fault, calls inhibited
<bcl>	
0	battery is exhausted, or ME does not have a battery connected
1...100	battery has 1 100 percent of capacity remaining
<vol>	
Current voltage value (V).	

## Examples

```

AT+CBC=?
+CBC: (0-3),(0-100)
OK
AT+CBC
+CBC: 0,75,3.810V
OK

```

## 4.3 AT+CCHGS Enable USB charger or Wall charger

### Description

You can use this command to select enable USB charger or Wall charger.

SIM PIN	References
NO	Vendor

### Syntax

Test Command	Responses
AT+CCHGS=?	+CCHGS: (0-1) OK
Read Command	Responses
AT+ CCHGS?	+CCCHGS: <enable> OK
Write Command	Responses
AT+CCHGS =<enable>	OK ERROR

### Defined values

<enable>
0: enable USB charger and disable Wall charger

1: enable Wall charger and disable USB charger

### Examples

*AT+ CCHGS=0*

*OK*

*AT+ CCHGS?*

*+ CCHGS: 0*

*OK*

*AT+ CCHGS=?*

*+ CCHGS: (0-1)*

*OK*

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