MediaTek

6318 PMIC Specification

MediaTek Inc.

Confidential Information

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1 Revised History

Version	Data	Prepared by	Note
Ver. 0.1	Aug.3 2004	Chao-Chih Chiu	Initial Release

2 Introduction

This document describes the power management IC's (hereafter called PMIC) specification including its functional requirements and electrical characteristics. 6318 supports MT621x series base band – i.e. for multimedia phone, GPRS phone and color LCD GSM only phone.

To complete a GSM/GPRS mobile handset, where power saving is a paramount issue, a device which support power related function and under proper MMI control is required, this functional block should have the following main features:

1. Lowdrop-out regulators.
2. Switching DC/DC and charge pump with high operation efficiency and low stand-by currents.
3. Power-on Reset and start-up timer.
4. Battery Charging circuits.
5. Thermal Overload Protection.
6. Under-VoltageLock-up protection.
7. Over-VoltageLock-up protection.

For MT621x series base band, PMIC requires following power supply voltage/current and functionality to complete a GSM/GPRS mobile handset:

A. Power source: one 3.6V Li-ion cell.
B. Charger for Li-ion battery (maximum input voltage 6.5V).
C. Power-up sequencer and Protection Logic.
D. Eleven Regulator Outputs:

item	LDO	Voltage	Current	Description
1	VD	*1.8V/1.5/1.2V /**0.9V	200mA	Digital core
2	VMC	2.8V	200mA	Memory card (MS, SD, MMC)
3	VIO	2.8V	100mA	Digital IO
4	VA	2.8V	150mA	Analog and Mixed Signal
5	VSW_A	2.8V/3.3V	50mA	Auxiliary Analog circuit.
6	VRTC	*1.5/1.2V	0.2mA	Real Time Clock
7	VM	1.8/2.8V	150mA	External Memory, selectable
8	VSIM	1.8/3.0V	20mA	SIM Card, selectable
9	VTCXO	2.8V	20mA	13/26MHz reference clock
10	VUSB	3.3V	20mA	USB IO
11	VIBR	1.8V/2.8V	200mA	Vibrator

* There are bonding options for VDLDO and VRTC LDO. VD output voltage can be configured as 1.8/1.5/1.2 V options and VRTC output voltage can be configured as 1.5/1.2V options.

** VD output voltage = 0.9V (Only for VD = 1.2V option) is controlled by BB software through SPI

E. Four LED drivers

Regulator	Type	Current	Description
LED_R	Currentregulator	12/16/20/24 mA	Drive red LED
LED_G	Currentregulator	12/16/20/24 mA	Drive green LED
LED_B	Currentregulator	12/16/20/24 mA	Drive blue LED
LED_KP	Voltagefeedback currentregulator	200mA	Drive keypad LEDs

For the above regulator's output current rating, 50% margin already add up for their nominal current consumption, i.e. this means when a regulator output is required to output 150mA, the peak consumption current is 100mA. During Active state, the phone consumes peak output current at each regulator, the thermal design should consider accordingly.

F.LCD backlight white LED driver control
Only control part is implemented in this PMIC for the sake of not to use high voltage process, the external driver capability is specified as following.

Driver	Type	Current	Description
V_BL	Switching DC/DC useinductor	80mA	Drive backlight white LEDs

G. 400 mW single channel audio amplifier
H. SPI 3 wires interface

3 Functional Description

3.1 General

Power management is one of the most important functions in this PMIC. The power management function is to implement proper management procedure and control function on battery, charger and power supply in the Mobile handset. To make it clear, the management criterion is to provide the power for a mobile phone while extending the standby/active time as long as possible.

To make following description clearly understood, we first show here the operation state diagram of a typical mobile phone and the block diagram implemented in PMIC is further shown below to describe the relationships between different states.

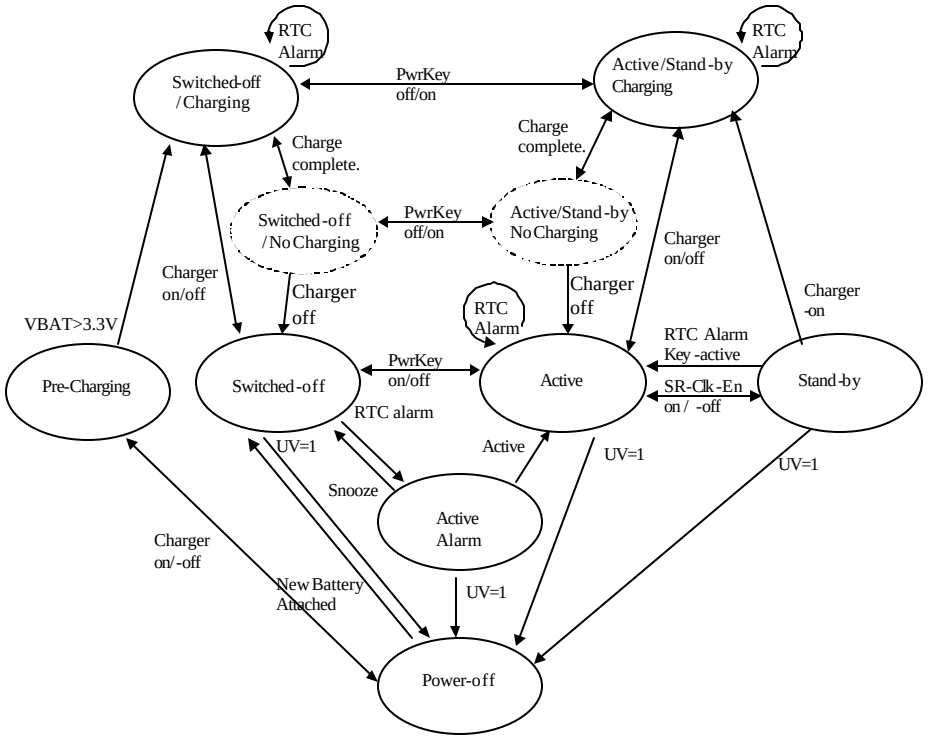


Figure 1 Power Management State Diagram

Note the above diagram including many software activities, PMIC reacts to only part of the states and could be simplified as follows:

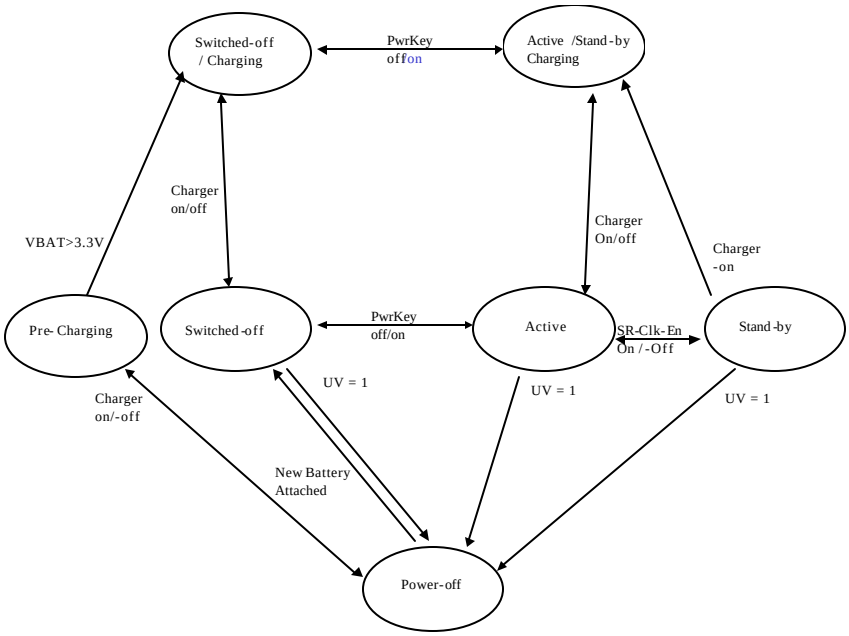


Figure 2 PMIC Hardware State

Table 1 Phone State Description

States	Description
Power Off	No battery connected or Battery connected but the battery was deep discharged, i.e. VBAT < 3.3V, at this state, no LDO should be enabled except VRTC. VRTC should only be disabled when VBAT<2.5V.
Switched Off	Phone was connected with battery but was switched off. The battery voltage is higher than 3.3V, at this state, VRTC was enabled, and all other LDO was disabled.
Pre-Charging	The charger was connect to mobile, but VBAT<3.3V. Slow charging is activated with charger circuits in PMIC. Upon VBAT is charged up to 3.3V, then detection circuit in PMIC will enable normal charging and pull UV signal low, also enable all LDO outputs. Charging at 50mA constant current.
Stand-by	Phone was powered up but the 13MHz reference Clock was disabled, part of Base band runs on 32K clock. At this state : LDO of VA, VTCXO, are disabled. LDO of VD, VIO, VM and VRTC are enabled.
Active	Phone was power up and running on 13MHz reference clock. All LDOs are enabled, Mobile radio task running.
Active Alarm	Phone was waked-up via RTC alarm, all LDOs were enabled, but only alarm task is scheduled, no any radio activities are scheduled.
Switched Off / Charging	The mobile has charger connected, base band is active and running on 13MHz 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 2 Extreme case definition

Terms	Description
UV	When PWRIN<2.9V in switch on condition (active or idle). PMIC should go to

	power off state.
OV	**Once Vbat > 4.3V+/-50mV (Li-ion), a hardware over voltage protection circuit (OV) should be activated to turn off charging. Charger status register D7 shall set to 1 when OV occurred. PMIC shall keep turn off charging until this bit (D7) OV was rest to 0 by BB software. Normally VBAT would not exceed 4.2V during charging, but if there is something wrong in the charging control OV can protect the battery pack from over-charged.**
TRM	**Thermal overload protection function, when phone is in active state and PMIC reach over-heat condition then PMIC should shut down completely.**

Table 3 LDO Turn On Table

Condition							Operation							
THR	UV (PWRIN)	CH DET	PWRKEY	PWRBB	SRCLKEN	PWRIN <2.5V	VTCXO	VRTC	VA	VD,VIO, VM	Vusb	VMC	VSIM	Vsw_a
L	H	X	X	X	X	H	Off	Off	Off	Off	Off	Off	Off	Off
L	H	X	X	X	X	L	Off	On	Off	Off	Off	Off	Off	Off
L	L	L	H	L	X	L	Off	On	Off	Off	Off	Off	Off	Off
L	L	H	X	X	H	L	On	On	VASEL/VB_OUT = 0, VA = VD VASEL/VB_OUT = 1, VA = VTCXO	On	USB_PWR & USB_DET & ~BAT_ON	VMC	SIMVCC	VA_SW = 0 Off VA_SW = 1, VA
					L	L	Off	On	VASEL/VB_OUT = 0, VA = VD VASEL/VB_OUT = 1, VA = VTCXO	On	USB_PWR & USB_DET & ~BAT_ON	VMC	SIMVCC	VA_SW = 0 Off VA_SW = 1, VA
L	L	X	L	X	H	L	On	On	VASEL/VB_OUT = 0, VA = VD VASEL/VB_OUT = 1, VA = VTCXO	On	USB_PWR & USB_DET & ~BAT_ON	VMC	SIMVCC	VA_SW = 0 Off VA_SW = 1, VA
					L	L	Off		VASEL/VB_OUT = 0, VA = VD VASEL/VB_OUT = 1, VA = VTCXO	On	USB_PWR & USB_DET & ~BAT_ON	VMC	SIMVCC	VA_SW = 0 Off VA_SW = 1, VA
L	L	X	X	H	H	L	On	On	VASEL/VB_OUT = 0, VA = VD VASEL/VB_OUT = 1, VA = VTCXO	On	USB_PWR & USB_DET & ~BAT_ON	VMC	SIMVCC	VA_SW = 0 Off VA_SW = 1, VA
					L	L	Off		VASEL/VB_OUT = 0, VA = VD VASEL/VB_OUT = 1, VA = VTCXO	On	USB_PWR & USB_DET & ~BAT_ON	VMC	SIMVCC	VA_SW = 0 Off VA_SW = 1, VA
H	X	X	X	X	X	X	Off	Off	Off	Off	Off	Off	Off	Off

- **During pre-charging, an external switch can be used to supply the power for LDOs (VD, VIO, VM, VRTC, VTCXO).**
- **X means no change. Don't care.**

3.2 State Timing

In this chapter we will describe the power on/off, wake up, charging and reset sequences in detail. For the following timing diagrams, the phone state is shown in the X-axis, Y axis shows the related signals and text in upper represents the transition events.

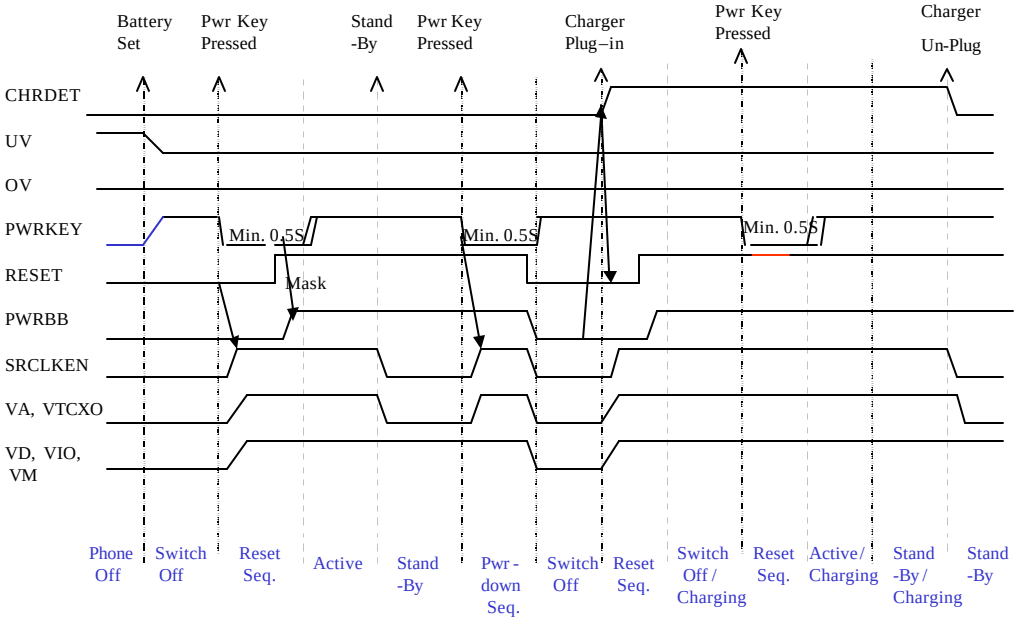


Figure 3 Power key State Timing

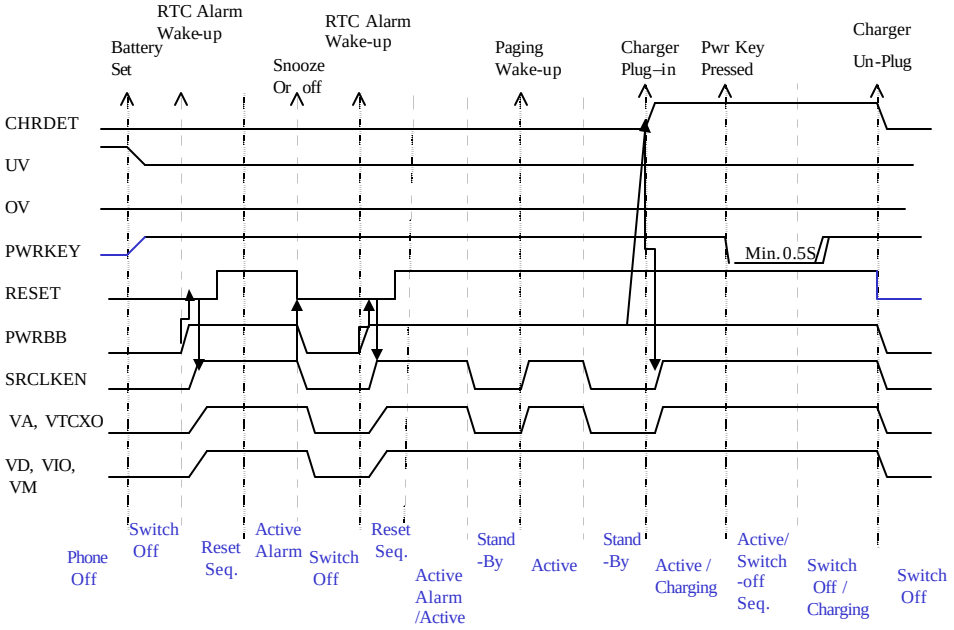
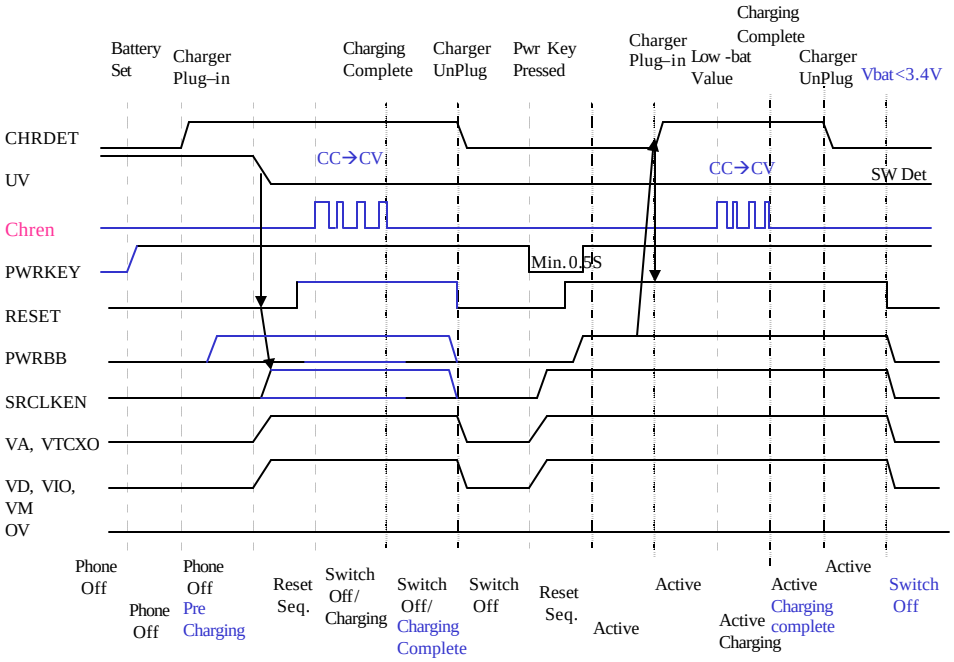


Figure 4 State Timing for Wake up, Paging and Stand-by



*Chren is PMIC internal signal

Figure 5 Charger State Timing

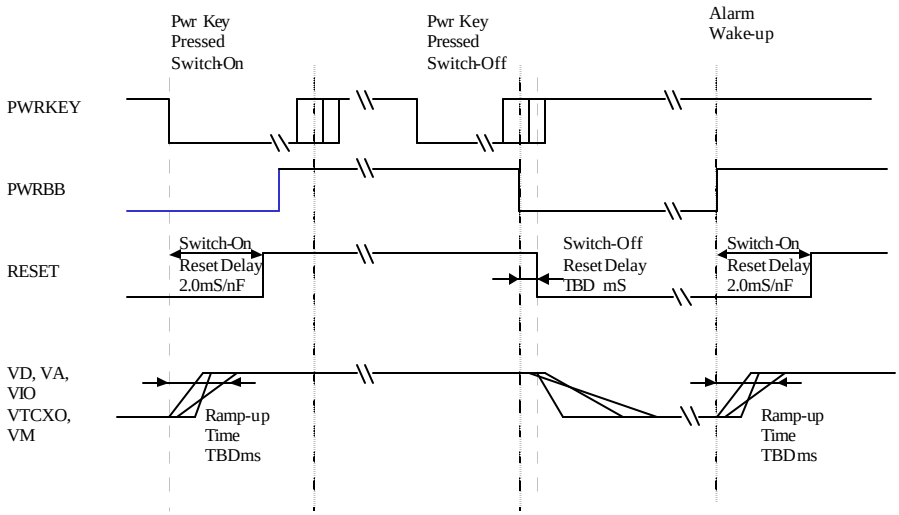


Figure 6 Reset Timing

3.3 PMIC Functional Blocks

In order to describe each block of PMIC into detail the overall hardware block diagram of PMIC is depicted as Figure 3. More detail description for each sub-blocks will be found in the following paragraphs.

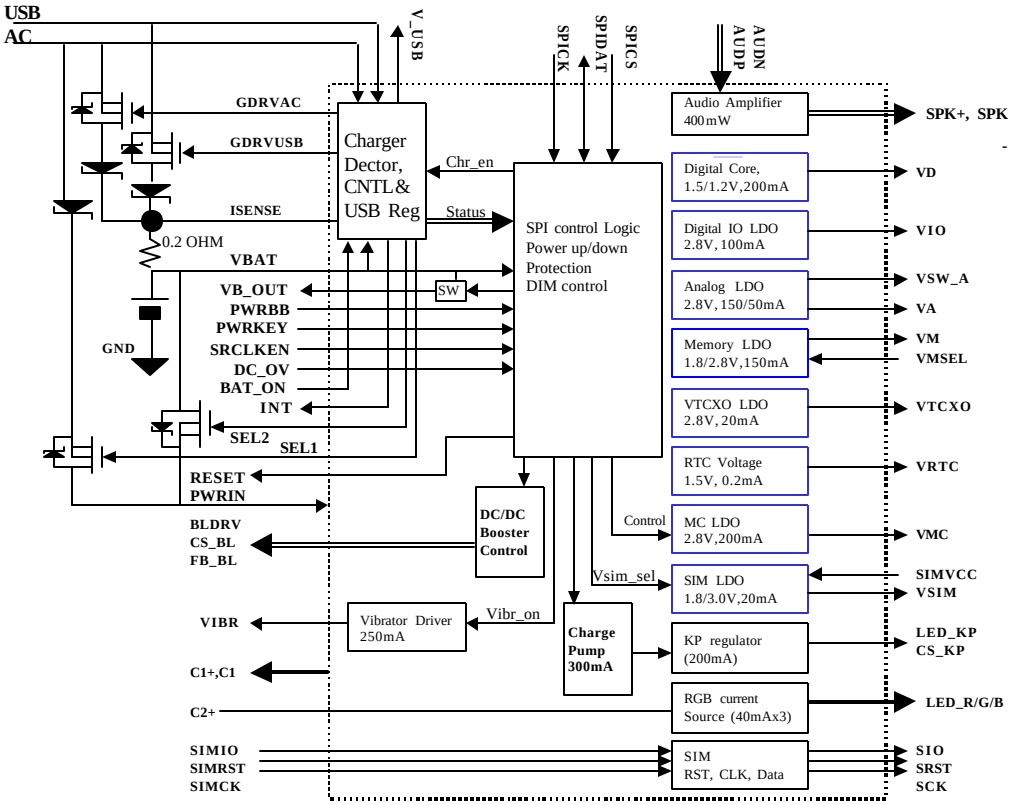


Figure 7 PMIC Block Diagrams

3.3.1 Charger Circuit

The charger circuit in PMIC is mainly comprised of 4 sub-functions:

1. **Charger detector:**
   Sense the charging voltage from either a standard AC-DC adaptor or USB connection, once the charging
   Input voltage is greater than 4.2V will trigger the charging process. This detector should resist higher input voltage than other part of PMIC, i.e. if excess charging source detected (>6.5V) it could stop the charging process to avoid burn out the whole chip even the whole phone.
   In case both AC and USB are detected, the charging source should use AC source.
   Once detection of charger voltage (Either AC or USB) present, an interrupt output pin "INT" should be active (pull LOW). The "INT" is also active when AC or USB regulator was removed
   The PMIC shall reset "INT" to HIGH after BB read the PMIC through SPI.

2. **Charger control:**
   When charger is on, control the charging phase and turn on related LDOs according to the battery status. It should keep monitoring the battery voltage, if it' s greater than 4.3V then stop charging immediately to keep battery from permanent damage.
   Due to the process variation, the charging current may vary form chip to chip. In order to compensate this variation, an offset value (+12%~-16%) will be set to PMIC. PMIC should read this compensation value and do the charging current offset when phone is in charging state. This compensation value may be calculated in phone production calibration process or always monitor by BB during phone is in charging. Offset value will be set by BB software (Register 10 bit D2~D0).

3. **USB regulator:**
   Regulate the charger input from USB power to 3.3V for BB (USB IO). The AC input is not use for this regulator. The V_USB 3.3V LDO output on/off should follow the control bit USB_PWR (Register Index 1 D3).
   When USB regulator is unplugged or the USB_PWR control bit is set to "off", the V_USB output voltage should drop below 0.3V within 1 msec. (With V_USB output shunt with 1 uF capacitor)

   The charging control should first clamp the charging current to 90mA, after the BB talk with the USB host and if the power class announced as 450mA then BB should set the register via SPI and PMIC charger will release the charging current limit to 450mA. For more detail please refer to Table 11.

   BB can disable the USB task by setting the D1 (USB_PWR) of register 1 to 0 via SPI, after USB regulator shut off the USB host is virtually disconnected while the charging process should keep going as previous state. In case the phone is in switch off state before USB power inserted, then the BB should be wake up to determine the USB power class. The other case is the phone is in switch on state before USB power inserted, then the already wake up BB should also determine the USB power class for proper charging also the USB data transfer operation. MMI should allow user to utilize USB simply as charger only as described above.

4. **Control for Pre-charge indication:**
   PMIC should provide 2 control signals (SEL1, SEL2) for the application that could show pre-charge status in LCD. In normal case VBAT is selected (SEL2 is turned on) as the power input to PMIC, while under battery low condition (VBAT<3.3V), charger source (AC) is selected (SEL1 is turned on), to substitute the power normally provided by VBAT, then allow BB powered up and at least light up the LED to show the charging status. However, if customers don't connect the two external switches and the pre-charging status will not be displayed.

   SEL1 is turn on only in pre-charging state, SEL1/SEL2 should not be turned on simultaneously in any time. During pre-charging state and when VBAT is passing 3.3V, the PMIC should handle to switch SEL1 off and SEL2 on to have the VBAT supply the whole system as normal condition.

   Table 4 describes the SEL 1/SEL 2 on/off for each phone state :

Table 4 SEL 1/SEL 2 setting in each phone state

Initial Phone state	Initial Charging State	Condition	Description	PMIC setting	
Not in charge					
Switch on idle	X (Not in charge)	Vbat >= 3.3V	可以打電話	Select 2 on	X
		Vbat < 3.3V	低電壓警示 per 30sec		
		Vbat = 3.3V	軟體關機		
		PWRIN = 2.9V	PMIC shutdown		
Switch on talking	X (Not in charge)	Vbat >= 3.3V	In talk		
		Vbat = 3.3V	Drop call → 低電壓警示 per 30sec		
Power off & Switch off	X (Not in charge)	X	X		
Switch on charging					
Switch on talking	Normal Charge	Vbat >= 3.3V	In talk	Select 2 on	You can select a different charging current via SPI in CC mode.
	CC mode Charge	Vbat < 3.3V	Turn back to idle		
Switch on idle	Normal Charge	PWRIN >= 2.9V	In idle		
Switch off charging					
Poweroff	Precharge	Vbat < 3.3V	Pre-charge & power on keydisable	Select 1 on	CC mode charging 50mA
Power off → Switch off transient	Precharge	Vbat = 3.3V	Pre-charge & power on key enable	Select 1 off → after delay → select 2 on. (During this transient, precharge is still ongoing.	CC mode charging 50mA

Switch off	Normal charge	Vbat > 3.3V	Only charger task is activated.	Select 2 on	You can select a different charging current via SPI in CC mode.

When in charging the PMIC use "*GRVAC/GDRVUSB*" to control the current flow through the external MOSs, at the same time maintains the current control loop by sensing the voltage drop ("*ISENSE*") across the external current sense resistor (0.2 Ohm). Note that the charging current limit for USB is 450mA and is 800mA for AC.

Battery charging states including *No Charge Mode*, *Constant Current (CC) Charge Mode (pre-charge, constant current)*, and *Constant Voltage(CV)* Charge Mode. No matter what status the phone is in, PMIC charger should handle the charging state transition and reflect the status in register 0 (charger status) for BB to read.

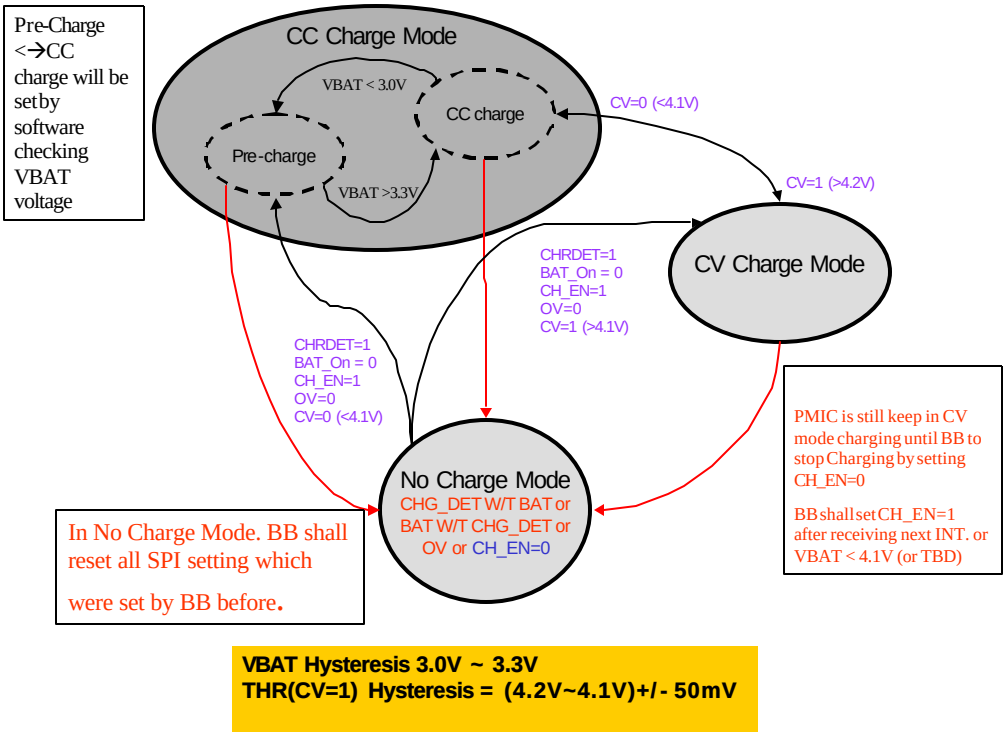


Figure 8 Charging states diagram

Table 5 Charger State transition

Current State	Transition conditions	Next State
No charge	CHRDET=1, CV=0, BAT_On = 0	CC Charge mode
	CHRDET=1,CV=1 BAT_On = 0	CV Charge mode
CC charge mode	CHRDET=0 BAT_On=1	No-charge
	CV= 1	CV Charge
CV charge mode	CHRDET=0 BAT_On=1	No-charge
	CV= 0	CC Charge

Note: CHRDET is internal used bit in PMIC, which is related to USB_DET or AC_DET according to the table in below:

CHR_DET	AC_DET	USB_DET
No Charging	0	0
AC Reg. for charging	1	0
USB Reg. For charging	0	1
AC Reg. For charging	1	1
No Charging	Illegal Charger	0
No Charging	Illegal Charger	1

The BB can stop the charging by setting "*Chr_en*" to "0" via SPI interface, this means that although PMIC handle the charging process automatically, BB is the true master to manage the charging process. This control mechanism allows the BB to command the PMIC doing elegant trickling charging if necessary.

One pin called "BAT_ON" should turn off the charger immediately if it goes high (>2.45+/-0.05V). This function is designated to block the charger input in case battery is accidentally pull out. When during charging the disconnection of battery might cause the VBAT voltage surge damage the chip before the over-voltage protection turn on. BAT_ON = 1 should also shut down USB regulator in case they are turned on.

Note that "*UV*" is the internal signal which will equal to "1" when PWRIN < 3.2 V in, the threshold for "*UV*" should has a 300mv hysteresis margin in states other than pre-charge, i.e., "UV" = 1 for 2.9V<PWRIN. The reason is to avoid state bouncing back and forth between pre-charge and other states. Recall that "*UV*" serves as the under voltage lock up signal (refer Fig2), when *UV=1* it means the battery is too weak to sustain an eligible phone call therefore PMIC should go to power off state. To provide a pleasant user interface, in switch on condition the BB should keep monitoring the battery voltage, once VBAT is lower than 3.3V MMI should issue alert sound and/or display battery low message on LCD to inform the user. For phone use this PMIC the alert sound might be any user specified chime rather than screak by traditional alerter.

The charging state is turned on/off or paused can be shown as the following table.

Table 6 Charging control

State	CHREN	CHRDET (CHRIN> 4.2V)	VBAT< 3.3/3.0V	CV (VBAT >4.2V)	Bat_on→BATON (batteryinsert)	Operation
No charging	X	L	X	X	L	Wait chr_det transition
Charger detection	L	H	L	X	L	WaitCHREN
Pre-charge	X	H	H	L	L	Monitor UV, CHRDET Note 1
CCcharge	H	H	L	L	L	Monitor CV, CHRDET
CVcharge	H	H	L	H	L	Monitor CHRDET
Pause - charging	L	H	X	X	L	Nocharge, keepcurrent state (For BB to emulate trickle charge)
Emergent stop	X	H	X	X	H	Turn off charger → power off state

Note 1: The threshold of voltage to determine VBAT signal is 3.3V for pre-charge state, and 3.0V for the other states. This hysteresis is designated to prevent the state from bouncing back and forth in occasion such as surge of current demanded.

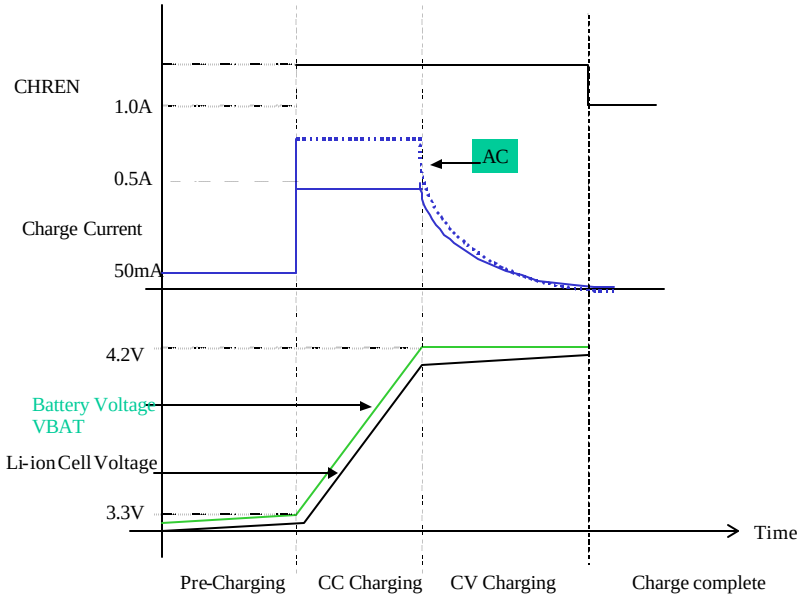


Figure 9 I-V curve of Li-Ion Battery Charging

Table 7 Operation for different charging sources

AC	USB	Phone state	Operation
Off	Off	Any state	No charging.

On	Off	Power off	Start pre-charge, use SEL1 to select AC charger source for PWRIN then turn on (VTCXO, VM, VD, VIO, VA) LDOs. BB run charging management task to display charging state.
		Switch off	Turn on (VTCXO, VM, VD, VIO, VA) LDOs, BB run charging management task to display charging state.
		Switch on	Follow normal charging procedure.
Off	On	Power off	Use USB to start pre-charge (90mA limit) and turn on USB regulator. No matter what power class the USB attached can provided, PMIC just charge the battery with constant pre-charge current. Since the BB is still off, no charge status is shown.
		Switch off	Use USB as charging source. First turn on (VTCXO, VM, VD, VIO, VA) LDOs and USB regulator, then BB trigger USB function to determine the host's power class, after BB had set the appropriate current limit (90/450 mA) then PMIC start normal charging procedure and BB run charging management task to display charging state.
		Switch on	Use USB as charging source. First initiate USB function to determine the host's power class, after BB had set the appropriate current limit (90/450 mA) then PMIC start normal charging procedure and BB run charging management task to display charging state.
On	On	Power off	Use AC to start pre-charge, can also use SEL1 to select AC charger source for PWRIN then turn on (VTCXO, VM, VD, VIO, VA) LDOs. BB run charging management task to display charging state. Turn on USB regulator.
		Switch off	Use AC as charging source. Turn on (VTCXO, VM, VD, VIO, VA) LDOs to start normal charging procedure and BB run charging management task to display charging state. USB regulator is turn on also.
		Switch on	Use AC as charging source to start normal charging procedure. USB regulator is turn on also.

***Note the LDOs (VTCXO, VM, VD, VIO, VA) listed here are turned on/off by PMIC itself, other drivers like BL and RGB can be turned on via BB through SPI.**

3.3.2 LED Drivers

PMIC provides 4 independent drivers, 3 of them uses identical structure to drive 3 different LEDs (R/G/B). The other one is dedicated to drive key pad LEDs. The reason to separate LED drivers to 2 groups is phone feature oriented. First, because of the prevailing of displaying colorful backlight when a call is coming, 3 independent drivers can easily used to mingle a lot of illuminating colors. Second, LEDs for bar type LCD and key pad normally will not turn on at the same time. Therefore a 2 step architecture is beneficial for pin count saving and power efficiency.

The first hence common block for KP and R/G/B LED drivers is a switching capacitor type DC/DC (charge pump circuit), it boost VBAT to 4.5V (note VBAT<4.2V). This charge pump circuit features driving capability control option for reduce current consumption and start-up inrush current.

KP LED driver should be a voltage feedback type regulator available to supply 200mA for up to 8 parallel KP LEDs. External ballast resistors are necessary serial connected to each LED, but only one provide the feedback voltage to PMIC. As well understood that moderate variation of light intensity for different LEDs in KP is not a critical issue. Therefore this configuration is simpler and save PMIC pin count.

R/G/B LED drivers are 3 identical current regulators, the three external LEDs connect their anodes to three pins of PMIC ("LED_R/G/B") while with their cathode connected to ground. No ballast resistor is needed for these 3 LEDs, each current regulator should be capable of setting its current to 12,16,20 or 24mA via control registers.

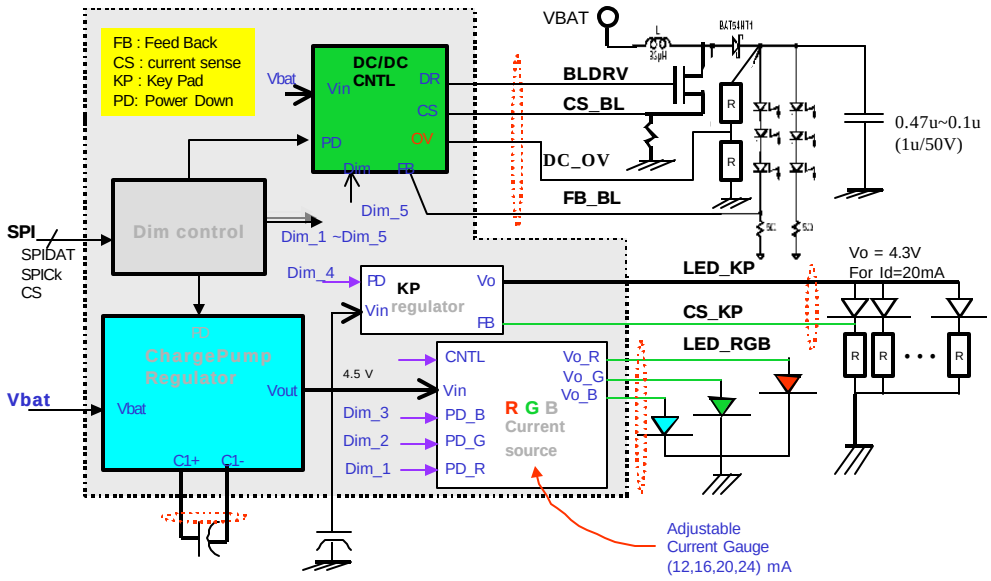


Figure 10 LED Drivers Block Diagram

3.3.3 Control for Backlight driver

This part of circuit is responsible to control the external boost DC/DC converter which is required to drive up to 6 white LEDS (2 legs, 3 in series). "BLDRV" should connect to the gate of external MOSFET, "CS_BL" is used to sense the current flow through the MOSFET and "FB_BL" feedback the voltage drop on ballast resistor for LED light intensity control. "DC_OV" is to prevent the over-voltage of output.

3.3.4 Dimming Control

Brightness can be controlled by programming 6318's internal registers to change the driver's output pulse duty cycle and frequency.

Pulse duty cycle:

For all drivers, the output duty cycle is adjusted by selecting the corresponding driver's PWM_D value according to the following relationship:

(R/G/B/KP) PWM duty cycle = (PWM_D + 1) low's , and 32 - (PWM_D +1) high's.
, where PWM_D ranges from 0 to 31.

Frequency:

For R/G/B and KP, the output frequency is adjusted by adjusting Register 9 [3:0] DIV value. These 4 LED drivers share the same DIV setting. The output frequency is governed by:

(R,G,B,KP) PWM frequency = 800k/25/(DIV +1)/32
, where DIV ranges from 0 to15

For BL, the output frequency is adjusted by adjusting Register 9 [7:4] BL_DIV value and also Register 7 [5] bypass value. The output frequency is governed by:

when bypass = 0,
(BL) PWM frequency = 800k/25/(BL_DIV +1)/32

when bypass = 1,
(BL) PWM frequency = 800k/(BL_DIV +1)/32
, where BL_DIV =0~15

Figure 11 LED Dimming Control

3.3.5 Battery Voltage Monitor

PMIC features to output either VBAT or ISENSE voltage or to VB_OUT pin. In addition, divided by two option is support. This function facilitate baseband chip to monitor VBAT and/or ISENSE voltage to control the charger process.

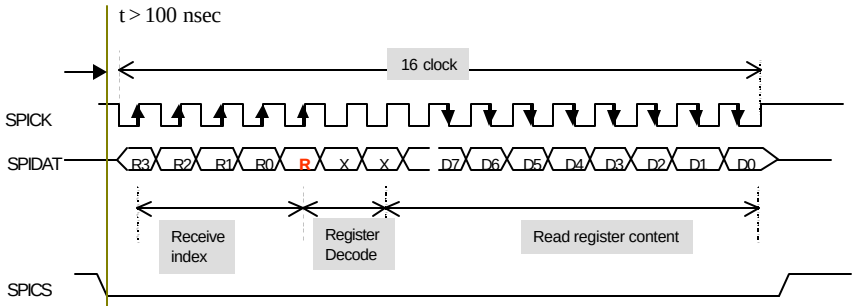
3.3.6 SPI interface

PMIC uses 3 wire interface to connect to BB. This bi-directional serial bus interface allows BB to write command to and read status from PMIC. The bus protocol utilizes a 16 bits proprietary format, the description for the 3 signals are listed as following table.

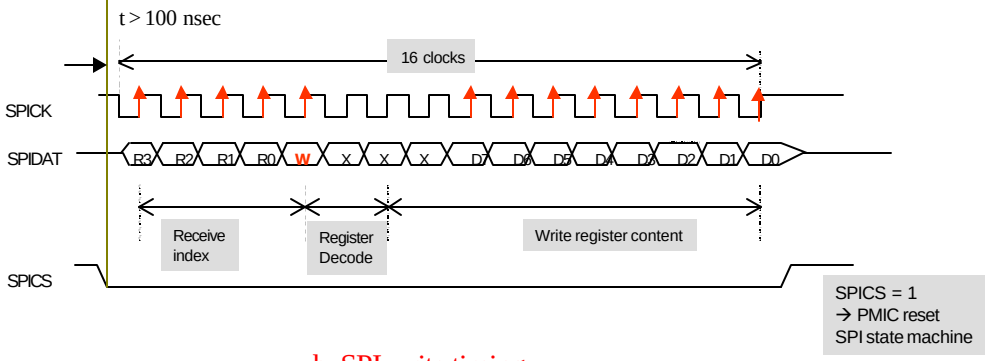
Table 8 SPIdefinition

Signal Name	Attribute	Direction	Description
SPICK	Edge trigger	BB→PMIC	Serial bus clock
SPIDAT	Level	BB←→ PMIC	Serial data
SPICS	Active low	BB→PMIC	PMIC SPI bus selection

Once SPICS goes low, this bus is active, BB start to transfer the 4 register index bits followed by a read/write bit, then wait for 3 clock for PMIC SPI state machine to decoded the operation for succeeding 8 data bits. The state machine should count for 16 clocks to complete the data transfer, if there are less than 16 clocks received during SPICS = 0 then just part of the data been transferred, on the other hand if more than 16 clocks received then the extra data will be ignored.
The first SPICK will be started 100 nsec after the SPICS is asserted low.



a. SPI read timing



b. SPI write timing

***Read = BB reading from PMIC, Write= BB writing to PMIC**

Figure 12 SPI Bus Timing

3.3.7 PMIC Registers

There are 10 registers in PMIC for the purpose to receive BB commands and reflect PMIC status.

Table 9 PMIC Register

Index	Name	D7	D6	D5	D4	D3	D2	D1	D0
0	Charger Status	OV_SPI	CHRDET	BAT_ON	AC_DET	USB_DET	Pwrkey_deb	CV	CHRG_DIS
		R	R	R	R	R	R	R	R
1	Charger / Speaker Control	CHREN	AMPGAIN_2	AMPGAIN_1	AMPGAIN_0	USB_PWR	CLASS_D2	CLASS_D1	CLASS_D0
		RW	RW	RW	RW	RW	RW	RW	RW
		1	0	0	0	0	0	0	0
2	LDO Status	VD	VA	VM	VRTC	VTCXO	VSIM	Reserved	
		R	R	R	R	R	R		
3	R LED Driver	On	CURLIM1	CURLIM0	PWM_D4	PWM_D3	PWM_D2	PWM_D1	PWM_D0
		RW	RW	RW	RW	RW	RW	RW	RW
		0	0	0	0	0	0	0	0
4	G LED Driver	On	CURLIM1	CURLIM0	PWM_D4	PWM_D3	PWM_D2	PWM_D1	PWM_D0
		RW	RW	RW	RW	RW	RW	RW	RW
		0	0	0	0	0	0	0	0
5	B LED Driver	On	CURLIM1	CURLIM0	PWM_D4	PWM_D3	PWM_D2	PWM_D1	PWM_D0
		RW	RW	RW	RW	RW	RW	RW	RW
		0	0	0	0	0	0	0	0
6	KP LED Driver	On	Reserved		PWM_D4	PWM_D3	PWM_D2	PWM_D1	PWM_D0
		RW			RW	RW	RW	RW	RW
		0			0	0	0	0	0
7	BL LED Driver	On	Reserved	bypass	PWM_D4	PWM_D3	PWM_D2	PWM_D1	PWM_D0
		RW		RW	RW	RW	RW	RW	RW
		0		0	0	0	0	0	0
8	Miscellaneous	CHR_PUMP_EN	VA_SW	Pwr_save	Vasel	VMC	VSIMSEL	SPEAKER	VIBRATOR
		RW	RW	RW	RW	RW	RW	RW	RW
		0	1	0	0	0	0	0	0
9	DIM clock	BL_DIV3	BL_DIV2	BL_DIV1	BL_DIV0	DIV_3	DIV_2	DIV_1	DIV_0
		RW	RW	RW	RW	RW	RW	RW	RW
		0	0	0	0	0	0	0	0
A	Charger ctrl2	Reserved				Ov_spi_clr	Chofst[2]	Chofst[1]	Chofst[0]
						W	R/W	R/W	R/W
							0	1	1
B	Bandgap Setting	Rsel1	Rsel0	Oscen	cksel	Ise11	Isel0	Reserved	
		RW	RW	RW	RW	RW	RW		
		0	0	0	0	0	0		
C	LDO_TEST1EN	Reserved							
D	LDO_TEST2EN	Reserved		Int_drv	Reset_drv	Reserved			
				RW	RW				
				1	1				
E	Charge pump ctrl	pumpclctrl	Pumpdsel_1	Pumpdsel_0	Pumpssel_1	Pumpssel_0	Dc_sel	vibsel	Usb_chren
		RW	RW	RW	RW	RW	RW	RW	RW
		0	1	1	0	0	0	0	1
F	Extras	Vsw_a_sel	Vbssel_spi[1]	Vbssel_spi[0]	Vbhsel	Reserved	Simlstype	Pumpdelay[1]	Pumpdelay[0]
		RW	RW	RW	RW		RW	RW	RW
		0	0	0	0		0	1	1

Table 10 Charger Status Register

Register Index 0: Charger Status (R only)			
Bit	**Name**	**Value**	**Description**
D7	(R/W) OV	0	OV has not occurred
		1	OV has occurred, need to wait for BB to clear
D6	CHRDET	0	Charger not detected
		1	Charger detected
D5	BAT_ON	0	Battery is connected
		1	Battery is not connected
D4	AC_DET	0	AC power not detected
		1	AC power detected
D3	USB_DET	0	USB power not detected
		1	USB power detected
D2	PWRKEY_DEB	0	Debounced pwrkey is asserted.
		1	Debounced pwrkey is not asserted.

D1	CV	0	Not in CV mode.
		1	In CV mode.
D0	CHRG_DIS	0	Charging.
		1	Not charging.

Note: If CV = 0, and CHARG_DIS=0, then this implies that it is in CC mode.

Table 11 Charger/Speaker Amp Control Register

Register Index 1: Charger /Speaker Control			
Bit	**Name**	**Value**	**Description**
D7	CHREN	0	Pause charging
		1	Enable charging (Default)
D6~D4	AMPGAIN[2:0]	0~7	Speaker Amplifier Gain setting 0~14 dB (Default = 000)
D3	USB_PWR	0	Turn off USB regulator (Default)
		1	Turn on USB regulator
D2~D0	CLASS_D(2:0)	0	Charge current clamp to 50mA
		1	Charge current clamp to 90mA
		2	Charge current clamp to 150mA
		3	Charge current clamp to 225mA
		4	Charge current clamp to 300mA
		5	Charge current clamp to 450mA
		6	Charge current clamp to 650mA
		7	Charge current clamp to 800mA

Table 12 LDO Status Register

Register Index 2: LDO Status (R only)			
Bit	**Name**	**Value**	**Description**
D7	VD	0	Digital LDO off
		1	Digital LDO on
D6	VA	0	Analog LDO off
		1	Analog LDO on
D5	VM	0	Memory LDO off
		1	Memory LDO on
D4	VRTC	0	RTC LDO off
		1	RTC LDO on
D3	VTCXO	0	13/26 MHZ VTCXO LDO off
		1	13/26 MHZ VTCXO LDO on
D2	VSIM	0	SIM LDO off
		1	SIM LDO on
D1~D0	Reserved		

Table 13 R LED Driver Register

Register Index 3: R LED Driver			
Bit	**Name**	**Value**	**Description**
D7	On	0	Power down (Default)
		1	Power On
D6~D5	CURLIM(1:0)	0	Current limit = 12 mA (Default)
		1	Current limit = 16 mA
		2	Current limit = 20mA
		3	Current limit = 24mA
D4~D0	PWM_D(4:0)	0~31	Duty cycle =(PWM_D(4:0)+1)/32 (Default = 0)

Table 14 G LED Driver Register

Register Index 4: G LED Driver			
Bit	**Name**	**Value**	**Description**
D7	On	0	Power down (Default)
		1	Power On

D6~D5	CURLIM(1:0)	0	Current limit = 12 mA (Default)
		1	Current limit = 16 mA
		2	Current limit = 20mA
		3	Current limit = 24mA
D4~D0	PWM_D(4:0)	0~31	Duty cycle =(PWM_D(4:0)+1)/32 (Default = 0)

Table 15 B LED Driver Register

Register Index 5: B LED Driver			
Bit	**Name**	**Value**	**Description**
D7	On	0	Power down (Default)
		1	Power On
D6~D5	CURLIM(1:0)	0	Current limit = 12 mA (Default)
		1	Current limit = 16 mA
		2	Current limit = 20mA
		3	Current limit = 24mA
D4~D0	PWM_D(4:0)	0~31	Duty cycle =(PWM_D(4:0)+1)/32 (Default = 0)

Table 16 KP LED Driver Register

Register Index 6: KP LED Driver			
Bit	**Name**	**Value**	**Description**
D7	On	0	Power down (Default)
		1	Power On
D6~D5	*Reserved*		
D4~D0	PWM_D(4:0)	0~31	Duty cycle =(PWM_D(4:0)+1)/32 (Default = 0)

Table 17 BL LED Driver Register

Register Index 7: BL LED Driver			
Bit	**Name**	**Value**	**Description**
D7	On	0	Power down (Default)
		1	Power On
D6	*Reserved*		
D5	BYPASS	0	No bypass (Default)
		1	Bypass divide-by-25 counter.
D4~D0	PWM_D(4:0)	0~31	Duty cycle =(PWM_D(4:0)+1)/32 (Default = 0)

Note:

when bypass = 0,

PWM frequency = 800k/25/(bl_div+1)/32 , div=0~15

when bypass = 1,

PWM frequency = 800k/(bl_div +1)/32 , div=0~15

Table 18 Miscellaneous Register

Register Index 8: MiscellaneousDriver			
Bit	**Name**	**Value**	**Description**
D7	CHR_PUMP_EN	0	*Power down (Default)*
		1	Power on
D6	VA_SW	0	Auxiliary Analog output switch off
		1	Auxiliary Analog output switch on (Default)
D5	PWR_SAVE	0	VD = Normal Voltage output (Default)
		1	VD = 0.9V When in Sleep Mode
D4	VASEL	0	VA enable signal determination, same as VD(Default)
		1	VA enable signal determination, same as VTCXO
D3	VMC	0	VMC power off (Default)
		1	VMC power on
D2	VSIMSEL	0	VSIM = 1.8V (Default)
		1	VSIM = 3.0V
D1	SPEAKER	0	Audio amplifier power off (Default)
		1	Audio amplifier power on

D0	VIBRATOR	0	Vibrator driver power off (Default)
		1	Vibrator driver power on

***When turn on VA_SW is the same as VA. Application like use this pin to provide power for external photo sensor can save power by making this pin floating.**
****When turned on VB_OUT is actually same as VBAT. VB_OUT is floating when phone is switched off in order to stop current leak to BB.**

Table 19 DIM Clock Register

Register Index 9: DIM Clock			
Bit	**Name**	**Value**	**Description**
D7~D4	BL_DIV	15~0	Backlight frequency division control (Default=0)
D3~D0	DIV	15~0	R,G,B,KP frequency division control (Default=0)

Table 20 Charger Control_2 Register

Register Index A: Charger Control 2			
Bit	**Name**	**Value**	**Description**
D7~D4	*Reserved*		
D3	OV_SPI_CLR (W only)	0	When written with 0, clears OV condition.
		1	No effect.
D2~D0	Chofst[2:0]	7~0	Charging current offset. (Default is b'100 = 4)

Note:
When OV_SPI_CLR is written with a 0, it clears the ov_spi condition.
Writing with a 1, has no effect.
If read, it returns the same value as bit 7 of Register 0 (ov_spi).

Table 21 Bandgap Setting Register

Register Index B: Bangap Setting			
Bit	**Name**	**Value**	**Description**
D7~D6	RSEL[1:0]	0	Bandgap Setting (Default)
		1	
D5	OSCEN	0	Bandgap Setting (Default)
		1	
D4	CKSEL	0	Bandgap Setting (Default)
		1	
D3~D2	ISEL[1:0]	0	Bandgap Setting (Default)
		1	
D1~D0	RESERVED		

Table 22 LDO Test 1 En Register

Register Index C: LDO TEST1 EN			
Bit	**Name**	**Value**	**Description**
D7~D0	Reserved		

Table 23 LDO Test 2 En Register

Register Index D: LDO TEST2 EN			
Bit	**Name**	**Value**	**Description**
D7~D6	Reserved		
D5	INT_DRV	0	Set Interrupt pad driving strength (Default = 1)
		1	
D4	RESET_DRV	0	Set Reset pad driving strength (Default = 1)
		1	
D3~D0	Reserved		

Table 24 Charge Pump Register

Register Index E: Charge Pump Control

Bit	Name	Value	Description
D7	PUMPCLCTRL	0	Charge Pump Control Signal (Default = 0)
		1	
D6~D5	PUMPDSEL[1:0]	3~0	Charge Pump Control Signal (Default = b'11 = 3)
D4~D3	PUMPSSEL[1:0]	3~0	Charge Pump Control Signal (Default = 0)
D2	DC_SEL	0	DC – DC select
		1	
D1	VIBSEL	0	Vibrator select
		1	
D0	USB_CHREN	0	Disable USB charging. For OTG.
		1	Enable USB charging (Default)

Table 25 Extras Register

Register Index F: Extras			
Bit	**Name**	**Value**	**Description**
D7	VSW_A_SEL	0	Vsw_a = 3.3V (Default)
		1	Vsw_a = 2.8V
D6~D5	VBSSEL_SPI[1:0]	0~3	Vbout select (Default = 0)
D4	VBHSEL	0	Vbout select (Default = 0)
		1	
D3	RESERVE		
D2	SIMLSTYPE	0	Sim Level Shifter type select (Default = 0)
		1	
D1~D0	PUMPDELAY[1:0]	3	Charge pump softstart time delay = 600us (Default = 3)
		2	Charge pump softstart time delay = 500us
		1	Charge pump softstart time delay = 400us
		0	Charge pump softstart time delay = 200us

Note:
- Charge pump delay is controlled as follows:

  When Chr_pump_en = 1,
  after pumpdelay (200, 400, 500, or 600 us),
  pumpdsel will change from the default value (b'11) to the new pumpdsel value.

  When Chr_pump_en =0, or reset is asserted, pumpdsel will change back to default b'11 value.

- Vbssel_spi – this is used to control the VBOUT selection.

Vbssel_Spi	vbssel (actual signal to analog)
00	00
01	01
10	10
11	00

3.3.8 Connection to BB

Following schematic illustrate a typical application for this PMIC to connect with 621X BB. Please refer to application paragraph for other possible connections.

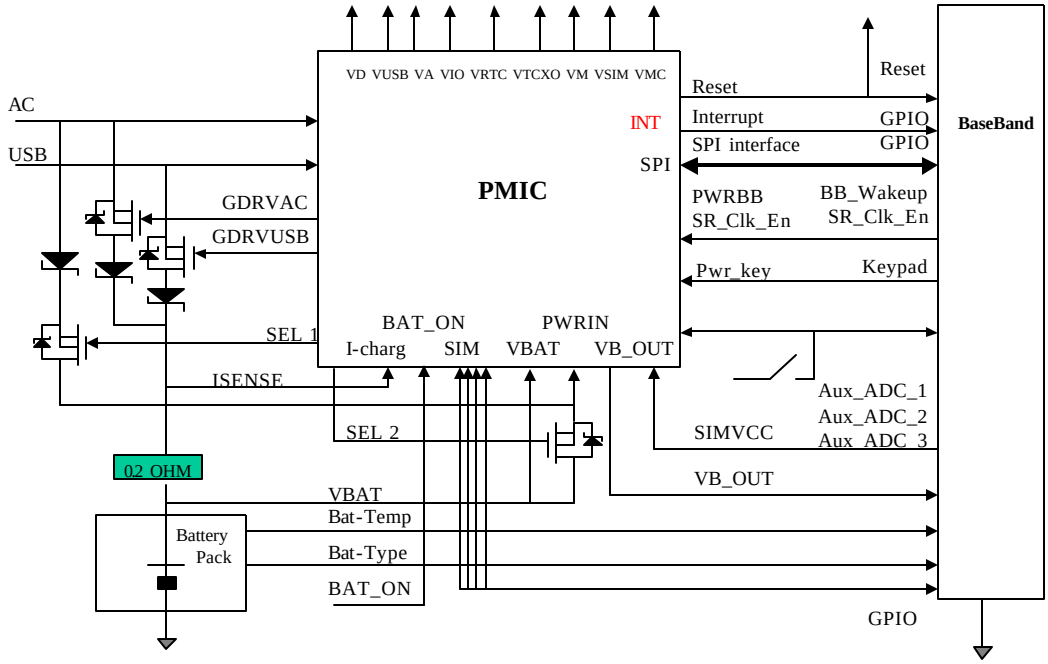


Figure 13 Connection to BB

4 Specifications

4.1 Absolute maximum ratings over operating free-air temperature range

Table 20 Absolute Maximum Ratings

Parameter	Conditions	Min	Typ	Max	Units
Free-air temperature range		-40		85	°C
Storage temperature range		-65		150	°C
ESD robustness		2000			V
Charger input withstand				9	V

4.2 Operating conditions

Table 21 Operation Condition

Parameter	Conditions	Min	Typ	Max	Units
Operating temperature range		-25		85	°C

4.3 Recommended operating specifications

Table 22 General Specifications

Items	Requirement	Unit	Notes
Switch off mode Supply Current VBAT <2.5V 2.5V< VBAT <3.3V 3.3V< VBAT	TBD	uA uA uA	
Operation Supply Current All Out puts on VTCXO off, all others on VA,VTCXO off, all others on	TBD	uA uA uA	
UV, Under Voltage ON Threshold Under Voltage Hysteresis	3.225 3.175 0.3	V V V	Max Min
Reset Generator Output High Output Low Output Current On Delay time per Cap. Off Delay	Vio -0. 5 0.2 1 2.0 TBD	V V mA mS/nF mS	Min Max
Power Key input High Voltage Low Voltage	0.7xVBAT 0.3xVBAT	V V	
Control Input voltage PWRBB pin High/Low Voltage All other pin High/Low Voltage	1.0 / 0.2 2.0 / 0.5	V V	
Thermal Shutdown Threshold	150 25	degree degree	

Hysteresis			
LDO Enable response time **Within 3% of Vo**	250 5	µsec msec	VA, VTCXO Others

4.4 Regulator Output

Table 23 Regulator Specifications

Charge Pump Regulator				
Output Ripple		+/- 50	mV	For KP and RGB LED drivers
Efficiency		70	%	@Iout=150mA,Vout=4.5V
Switching Frequency		800	KHz	
Output Current		300	mA	
Power down current (CP power down?)		10	uA	TBD
No Load		1	mA	
Response Time: Rising		100	uS	10mA to Max Iout
Falling		100	uS	Max Iout to 10mA
Start-up time		5	mS	
Feedback voltage		200	mV	
DC/DC converter				
Maximum switch current		TBD	mA	
Efficiency		85	%	(6 LEDs load)
Switch off time		400	ns	(PWM 7-800KHz)
Switch on time		TBD	ns	TBD
Switching Freq.		TBD	KHz	(8mA load, 4.2V/3.3V)
Voltage reference for current limit setting resister		(220)	mV	Current limiting 468mA (R=0.47 ohm)
Feedback voltage		(400mV)	mV	
Digital Core Voltage				
Output Voltage	V_D	1.2 /1.5/1.8	V	1.2V= min.1.10V, max 1.30V 1.5V= min.1.40V, max 1.60V 1.8V= min.1.70V, max 1.90V
Max. Output Current	Id-max	200	mA	
Line Regulation		5	mV	
Load Regulation		10	mV	
Digital IO Voltage				
Output Voltage	V_IO	2.8	V	2.8V= min.2.70V, max 2.90V
Output Current	Iio-max	100	mA	
Line Regulation		5	mV	
Load Regulation		10	mV	
Analog Voltage				
Output Voltage	V_A	2.8	V	2.8V= min.2.70V, max 2.90V
Output Current	Ia-max	150	mA	
Line Regulation		5	mV	
Load Regulation		10	mV	
Output Noise Voltage		50	uVrms	f = 10 Hz to 100 kHz
Ripple Rejection		65	dB	10 Hz < Freq. <3KHz
		40	dB	3KHz < Freq. < 1 MHz
VTCXO Voltage				
Output Voltage	V_TCXO	2.8	V	2.8V= min.2.70V, max 2.90V
Output Current	Itcxo-max	20	mA	
Line Regulation		3	mV	
Load Regulation		2	mV	

Output Noise Voltage Ripple Rejection		50 65 40	uVrms dB dB	f = 10 Hz to 100 kHz 10 Hz< Freq. <3KHz 3KHz < Freq. < 1 MHz
RTC Voltage Output Voltage Output Current Limit Off Reverse Input Current	V_RTC I_RTC-max	1.5/1.2 1.0 1	V mA uA	1.5V= min.1.30V, max 1.65V
External Memory Voltage Output Voltage Output Current Line Regulation Load Regulation	V_M I_M_max	1.8 / 2.8 150 5 10	V mA mV mV	1.8V= min.1.70V,max1.90V 2.8V= min.2.70V, max 2.90V
SIM Voltage Output Voltage Output Current Line Regulation Load Regulation	V_SIM Isim-max	1.8 / 3.0 20 3 2	V mA mV mV	1.8V= min.1.71V, max 1.89V 3.0V= min.2.82V, max 3.18V
Memory Card Voltage Output Voltage Output Current Line Regulation Load Regulation	V_MC I_mc-max	2.8 200 5 10	V mA mV mV	2.8V= min.2.70V, max 2.90V
KP LED Output Voltage Output Current	V_KP I_KP	4.3 200	V mA	Maximum
R/G/B LED Output Voltage Source Current Clamp Current Accuracy	V_RGB I_R/G/B	4.0 24 10	V mA %	Maximum Maximum For all 4 steps 12,16,20,24 mA
USB Voltage Output Voltage Output Current	V_USB I_USB	3.3 20	V mA	3.3V=min 3.15, max=3.45 V Maximum
Auxiliary Analog Voltage Output Voltage Output Current	VSW_A I_SWA	2.8V/3.3 50	V mA	2.8V=min 2.70, max=2.90 V 3.3V=min 3.15, max=3.45 V Maximum
Vibrator Voltage Output Voltage Output Current	V_VIBR I_VIBR	1.8V/2.8 200	V mA	1.8V=min 1.70, max=1.90 V 2.8V=min 2.70, max=2.90 V Maximum

4.5 Driver output

Table 24 Vibrator Driver Specifications

Item	Max	Typical	Min	Unit	Note
Output Voltage Output Current Line Regulation Load Regulation		1.8/2.8 250 TBD TBD		V mA	Min=2.7V Typ=2.8V Max=2.9V Min=1.7V Typ=1.8V Max=1.9V

4.6 SPI switch-able Powers

Table 25 Power Switch Specifications

Switch	Max	Typical	Min	Unit	Note
VB_OUT Turn on delay Turn off delay		 TBD TBD		 us us	VBAT for BB ADC
VSW_A Turn on delay Turn off delay		 TBD TBD		 us us	Auxiliary Analog voltage

4.7 DIM clock

Table 26 Internal DIM Clock Specifications

Item	Max	Typical	Min	Unit	Note
Internal Dim clock		30k		Hz	+/- 30% accuracy

4.8 Speaker Amplifier

Table 27 Speaker Amplifier Specifications

Item	Max	Typical	Min	Unit	Note
RMS Power		400		mW	@8 Ohm load, VBAT=3.4V
THD + N	0.3			%	@1kHz, P_o=0.15Wrms @3.4V
PSSR		65		dB	From 20 ~1KHz
Shutdown Current	1			uA	Bit "SPEAKER On" = 0
Quiescent Power Supply Current	3.5			mA	VBAT = 4.2V, no input
Gain adjustment	14		0	dB	
Gain adjustment steps	2.2	2	1.8	dB	Please see table 9 PMIC register index 1. Charger/Speaker control

4.9 SIM Interface

Table 28 SIM Interface Specifications

Parameter	Symbol	Conditions	Min	Typ	Max	Units
VSIM	3V	Iload=6mA	2.82	3	3.18	V
	1.8V	Iload=6mA	1.71	1.8	1.89	V
Interface to MT621X						
RST,CLK,I/O	Vil,Vol				0.2*VIO	V
	Vih,Voh		0.7*VIO			V
Interface to 3V SIM card						
RST	Vol	I=-200uA			0.4	V
	Voh	I=200uA	0.9*VSIM			V
CLK	Vol	I=-20uA			0.4	V
	Voh	I=20uA	0.9*VSIM			V
I/O	Vil	I=1mA			0.4	V

	Vih	I=20uA	0.7*VSIM			V
	Iil	Vil=0V			1	mA
	Vol	I=1mA			0.4	V
	Voh	I=20uA	0.8*VSIM			V
Interface to 1.8V SIM card						
RST	Vol	I=-200uA			0.2*VSIM	V
	Voh	I=200uA	0.9*VSIM			V
CLK	Vol	I=-20uA			0.2*VSIM	V
	Voh	I=20uA	0.9*VSIM			V
I/O	Vil	I=1mA			0.2*VSIM	V
	Vih	I=20uA	0.7*VSIM			V
	Iil	Vil=0V			1	mA
	Vol	I=200uA			0.4	V
	Voh	I=20uA	0.8*VSIM			V
Timing						
RST,I/O rise/fall time	Tr/Tf	VSIM=3/1.8V, RST,I/O loaded with 30pF			1	us
CLK rise/fall time	Tr/Tf	VSIM=3V, CLK loaded with 30pF			18	ns
		VSIM=1.8V CLK loaded with 30pF			50	ns
CLK frequency	Fclk	CLK loaded with 30pF	5			MHz
CLK duty cycle	Duty		47		53	%

4.10 Charger Circuit

Table 29 Charger Specifications

Items	Symbol	Conditions	Min	Typ	Max	Unit
Charger input voltage			4.2		6.5	V
Charger detect on threshold	Vchg_on			Vbat + (0.25V)	6.5	V
Maximum charging current (USB charging)				450		mA
Maximum charging current (AC charging)				0.16/Rsense		A
Pre-charging current				50		mA
Pre-charging off threshold				3.2		V
Pre-charging off hysteresis				0.3		V
CC mode to CV mode threshold			4.15	4.2	4.25	V
BAT_ON	Vil				2.4	V
BAT_ON / OV GATDRV rising time	Vih		2.5			V
	Tr	CHRIN 5V, Cl 2nF	1		5	uS
CC mode charging GATDRV falling time	Tf			1		mS
Over voltage protection threshold	OV		4.25	4.3	4.35	V

Over voltage protection hysteresis				**0.2**		**V**

5 Pin Assignment and Package

5.1 Pin Assignment

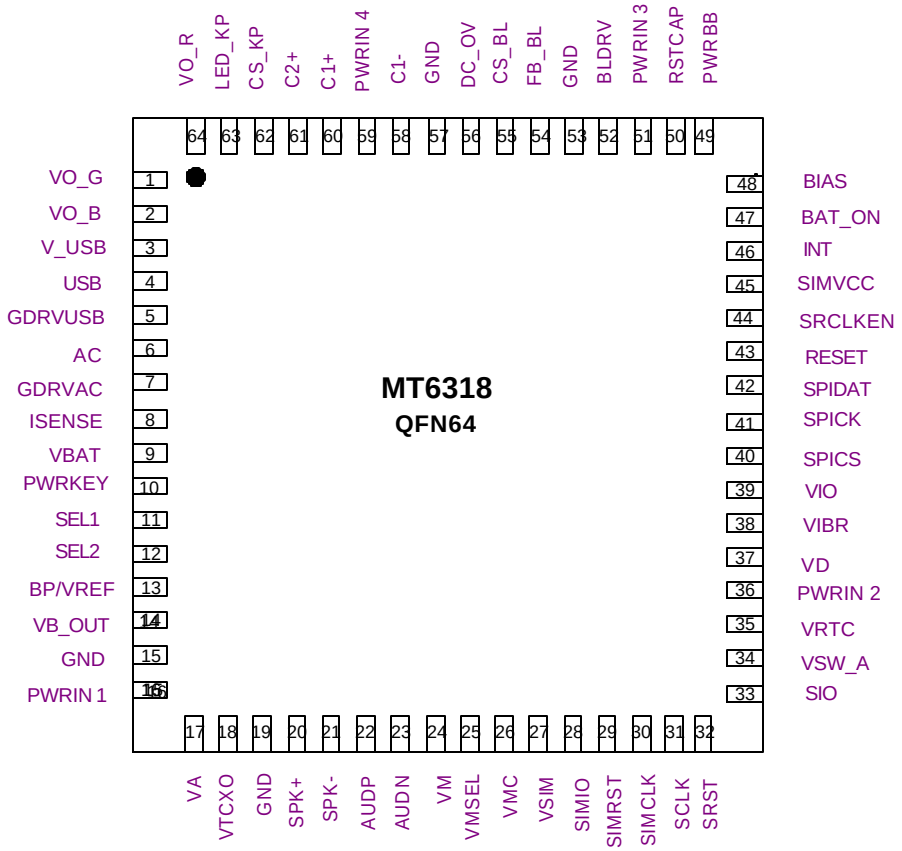


Table 30 Pin Assignment

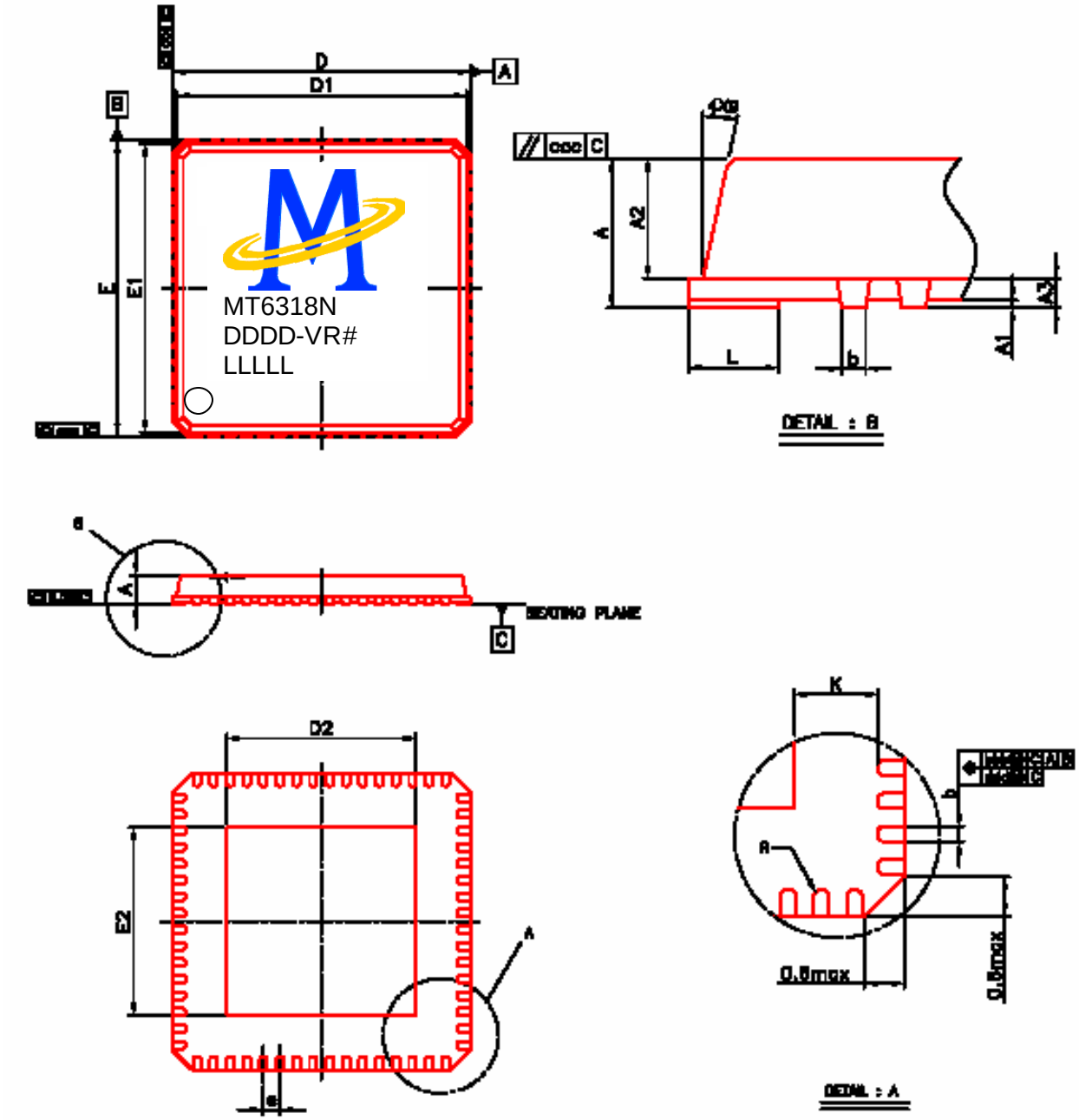
Pin	Symbol	Input(I) Output(O) Analog(A)	Function
Control			
10	PWRKEY	I	On button input, low active
49	PWRBB	I	Power On/Off from microprocessor, high active
44	SRCLKEN	I	VTCXO and VA enable, Low=disable, High=enable.
45	SIMVCC	I	VSIM enable: Low=disable, High=enable
47	BAT_ON	I	Indication Li-ion (Low) battery inserted, high active

56	DC_OV	I	DC/DC protection input, OV threshold voltage is 1V.
25	VMSEL	I	External memory supply selection, 1 = 2.8v, 0 = 1.8V
Charger control			
6	AC	IA	AC-DC adaptor input
4	USB	IA	USB power input
3	V_USB	OA	3.3V USB power output
46	INT	O	Interrupt PIN, active high. This pin is to inform BB if AC or USB regulator voltage is detected, OV occurred and BAT_On=1 Will be reset to normal low, after BB had communicated with PMIC through SPI.
5	GDRVUSB	OA	Control output to gate of external p-channel FET for USB charger
7	GDRVAC	OA	Control output to gate of external p-channel FET for AC charger
8	ISENSE	OA	Charge current sense input
11	SEL1	OA	Control output to gate of external PMOS for AC charger input as power source.
12	SEL2	OA	Control output to gate of external PMOS for VBAT input as power source.
SIM interface			
28	SIMIO	I/O	Non level shifted SIM data (3V)
29	SIMRST	I	Non level shifted SIM reset input (3V)
30	SIMCLK	I	Non level shifted SIM clock input (3V)
33	SIO	I/O	Level shifted SIM data (1.8/3V)
32	SRST	O	Level shifted SIM reset output (1.8/3V)
31	SCLK	O	Level shifted SIM clock output (1.8/3V)
Reset			
50	RSTCAP	IA	Reset delay time capacitance
43	RESET	O	System reset, low active
Power related			
9	VBAT	IA	Battery input voltage
16,36,51,59	PWRIN	IA	Power input
14	VB_OUT	OA	Battery output voltage, switch-able
13	BP/Vref	OA	Band pass capacitance
15,19,53,57	GND		Ground
37	VD	OA	Digital core supply
39	VIO	OA	Digital IO supply
17	VA	OA	Analog supply
34	VSW_A	OA	Auxiliary Analog supply, switch-able
18	VTCXO	OA	TCXO supply
24	VM	OA	Memory supply
27	VSIM	OA	SIM supply
35	VRTC	OA	RTC supply
26	VMC	OA	Memory card supply
Miscellaneous			
38	VIBR	IA	Vibrator drive
60	C1+	A	Charge pump cap. Positive terminal
58	C1-	A	Charge pump cap. Negative terminal
61	C2+	A	DC/DC output back-up capacitor positive terminal
Speaker Amplifier			

22	AUDP	IA	Audio positive input
23	AUDN	IA	Audio negative input
20	SPK+	OA	Speaker positive output
21	SPK-	OA	Speaker negative output
48	BIAS	OA	Bias Bypass
LED Driver			
64	VO_R	IA	R LED current drive
1	VO_G	IA	G LED current drive
2	VO_B	IA	B LED current drive
63	LED_KP	OA	KP LED drive
62	CS_KP	IA	KP LED current sense
52	BLDRV	OA	Control output to gate of external FET for back light DC-DC converter
55	CS_BL	IA	Voltage sense input for external BL FET current
54	FB_BL	IA	Voltage sense input from white LED ballast resistor
SPI Interface			
40	SPICS	I	Serial port select input
41	SPICK	I	Serial port clock input
42	SPIDAT	IO	Serial port I/O

5.2 Package

Base on current pin count, 64 QFN is the preferred package for this PMIC.



Symbol	Dimension in mm			Dimension in inch		
	MIN	NOM	MAX	MIN	NOM	MAX
A	0.80	0.85	1.00	0.031	0.033	0.039
A1	0.00	0.02	0.05	0.000	0.001	0.002
A2	0.60	0.65	1.00	0.024	0.026	0.039
A3	0.20 REF			0.008 REF		
b	0.18	0.25	0.30	0.007	0.010	0.012
D/E	9.00 BSC			0.354 BSC		
D1/E1	8.75 BSC			0.344 BSC		
D2/E2	5.54	5.69	5.84	0.218	0.224	0.230
e	0.50 BSC			0.020 BSC		
L	0.30	0.40	0.50	0.012	0.016	0.020
θ	0°	---	12°	0°	---	12°
R	0.09	---	---	0.004	---	---
K	0.20	---	---	0.008	---	---
aaa	---	---	0.15	---	---	0.006
bbb	---	---	0.10	---	---	0.004
ccc	---	---	0.10	---	---	0.004
ddd	---	---	0.05	---	---	0.002

5.3 Application Example

A typical application example is shown in following figure 14. Main features are listed as below:

1. **Charging use USB or AC-DC adaptor.**
2. **Can show charging status during pre-charging in case charging with adaptor power.**
3. **Support power for Memory card.**
4. **Support up to 6 white LEDs for main LCD backlight.**
5. **Support up to 8 LEDs (any color) for keypad illumination.**
6. **Support 3 independent LED drivers (any color).**
7. **Support dim control for all LED drivers.**
8. **Support power for photo sensing circuit.**
9. **Battery removal protection.**

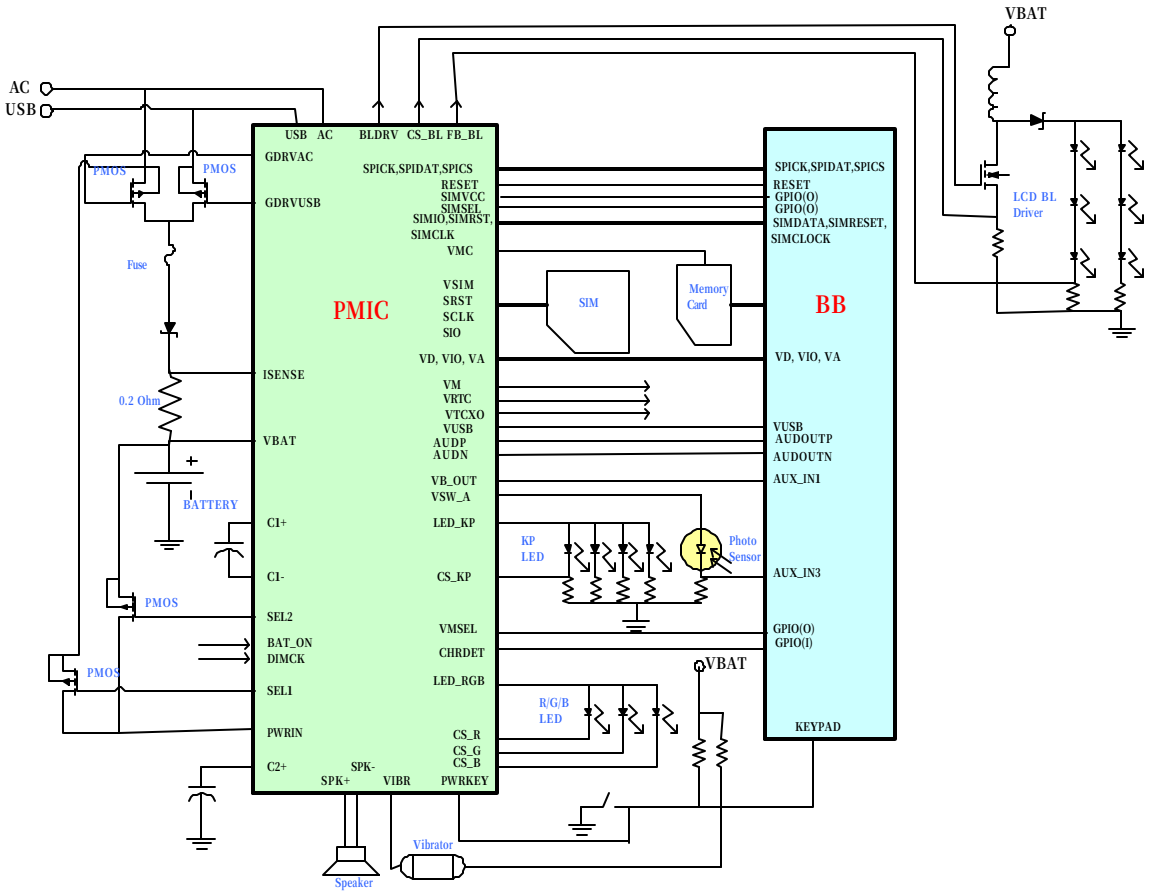


Figure 14 Application example

Appendix :

BAT_ON functional circuit example (With BAT temp. sensor) :

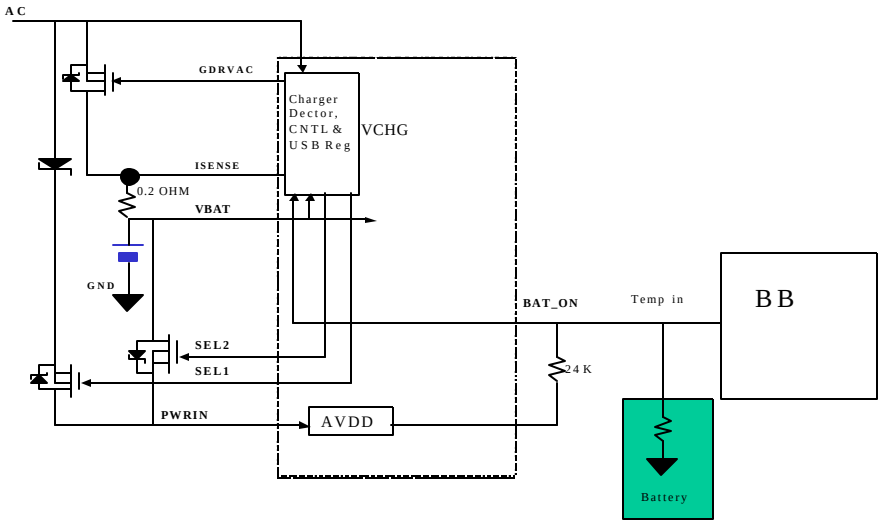


Figure 15 BAT_ON connection with Battery Temp. sensor example