MT6318 Introduction

(Power Management IC)

WCP/SA

2006.08

Outline

1. MT6318 Outline
2. MT6318 & MT6305B Comparison
3. Block Diagram
4. Sub-System Block
5. Layout Guide
6. H/W Quick Check List
7. Q&A
8. Appendix

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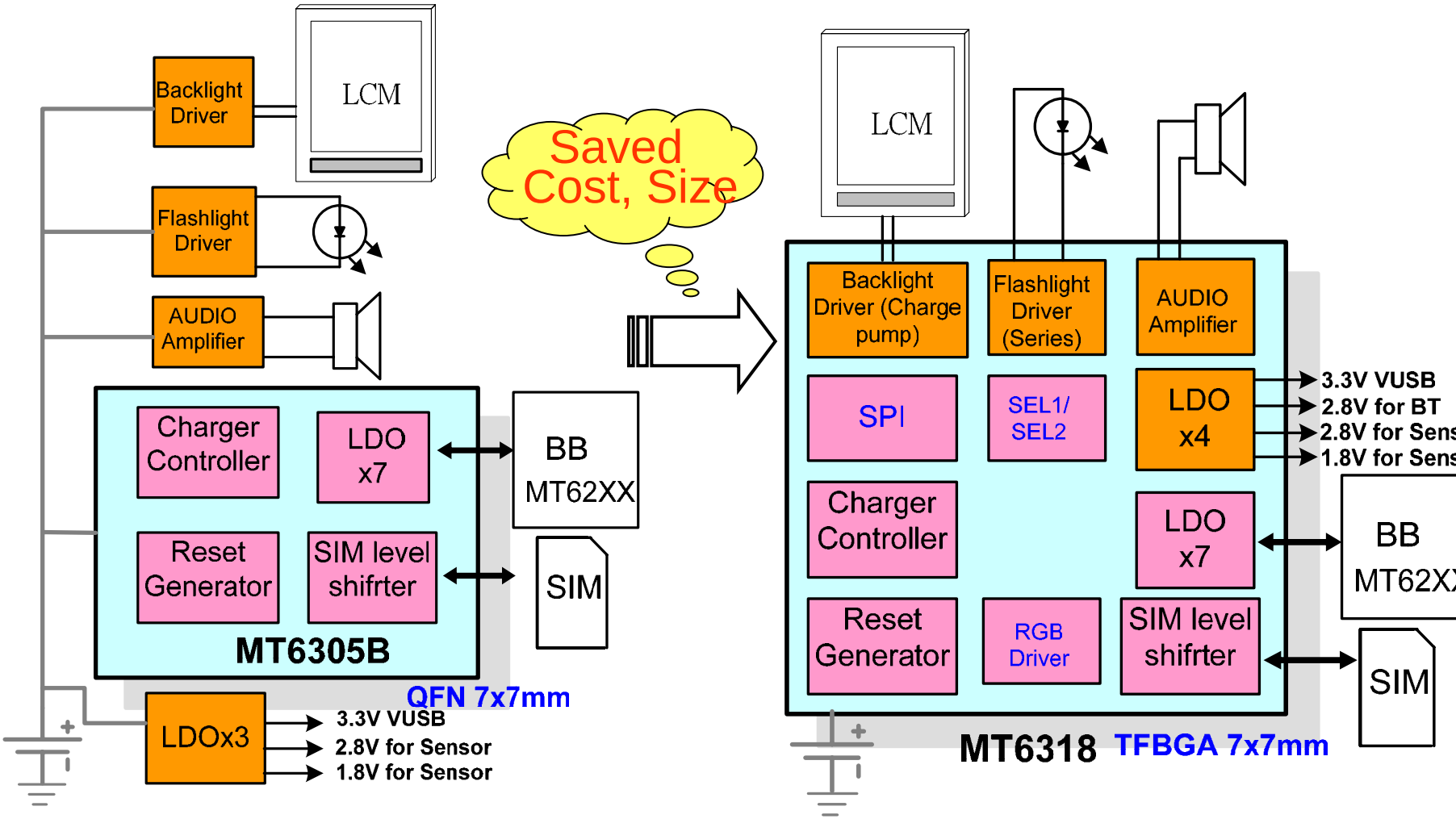
MT6318 Outline

1.Handles GSM/GPRS Base band Power Management.
2.Power-up sequencer and Protection Logic.
3.Eleven LDOs optimized for specific GSM/GPRS subsystems.
4.600mW class AB single channel audio amplifier
5.Booster for series backlight LED driver
6.Charge pump for parallel backlight LED driver
7.AC/USB Charger for Li-ion battery [$VIN_{(MAX)}$ 15V(AC) , 5.5V (USB)]
8.Pre-charge indication
9.SPI 3Wire Interface
10.RGB LED driver
11.2-step RTC can apply back Li-ion battery and CAP
12.SIM Interface
13.UVLO programmable
14.Vcore for power-saver mode
15.TFBGA 7mm x 7mm Package

MT6318 & MT6305B Function Comparison



MT6318 & MT6305B BOM cost comparison

1. Saved cost:32.2NTD. (1.USD)*
2. Saved BOM Counts:10
3. Saved Board size:7.1X7.1mm

RGB driver
Extra Device Cir

MT6318

Part	Quantity	Cost
MT6318	1	
MOS-FET	2	10
Capacitor	22	21.05
Resistor	18	0.52
Total (NT)	43	31.6

MT6305B

Part	Quantity	Cost
MT6305	1	
LM4890 (Audio AMP)	1	11.3
LDO	3	7.5
Backlight Driver	1	6.4
MOS-FET	4	14.45
Capacitor	34	23.67
Resistor	17	0.5
	53	63.8

Saved
32.NTD

* Above table derive from MT6219 reference design, not fully use MT6318 function

MT6318 & MT6305B Selection

	MT6205	MT6217	MT6219	MT6226/27	MT6228/29
Bar type	MT6318 Color / MT6305B BW	MT6318	MT6318	MT6318	MT6318
Clam shell	MT6305B	MT6305B	MT6318	MT6318	MT6318
Slide type	MT6305B	MT6305B	MT6318	MT6318	MT6318

- **6318 Selection criterion**

1.Bar type is ideal

2.Multi media phone like sensor/BT (apply 4x LDO , Audio AMP)

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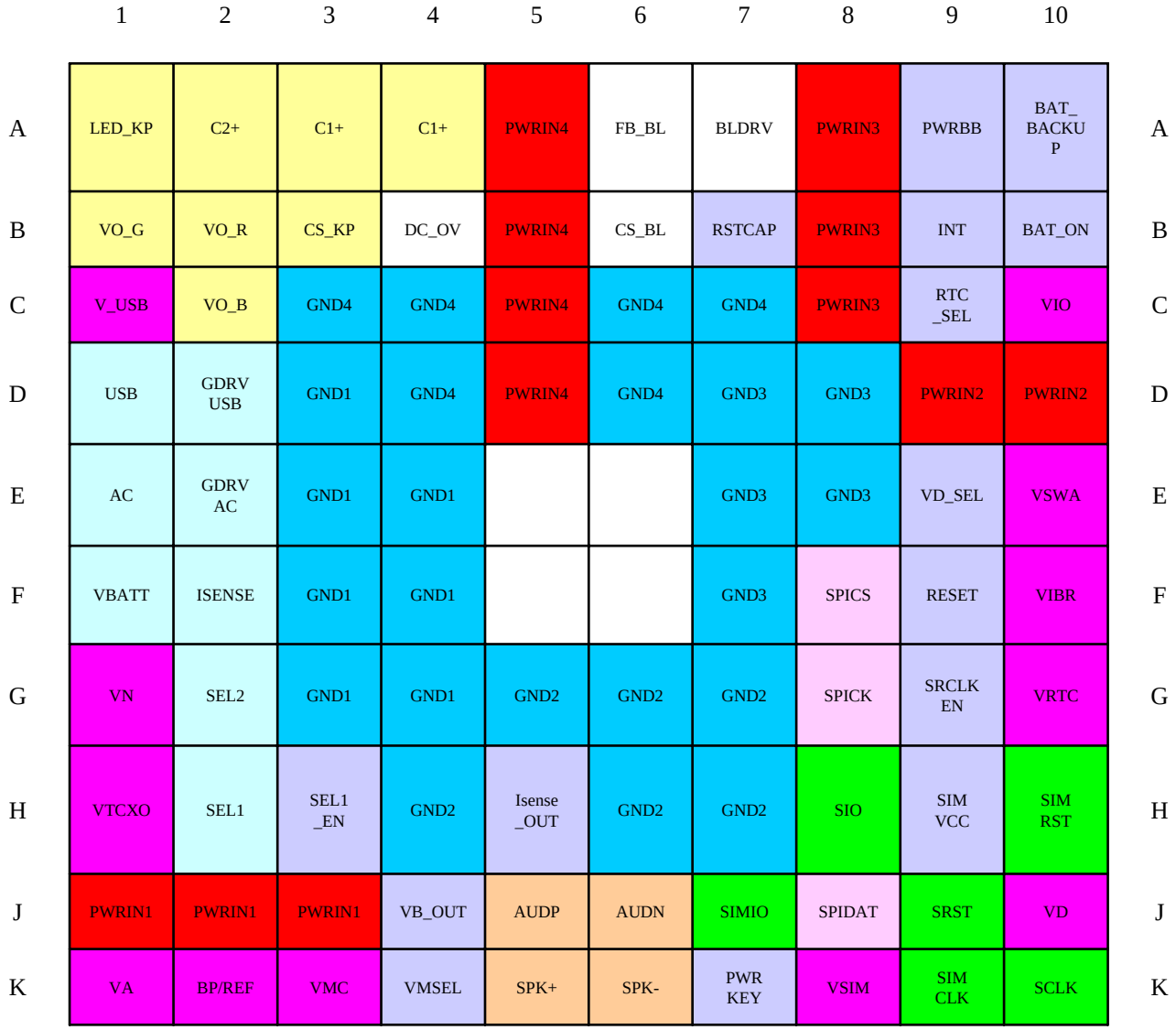
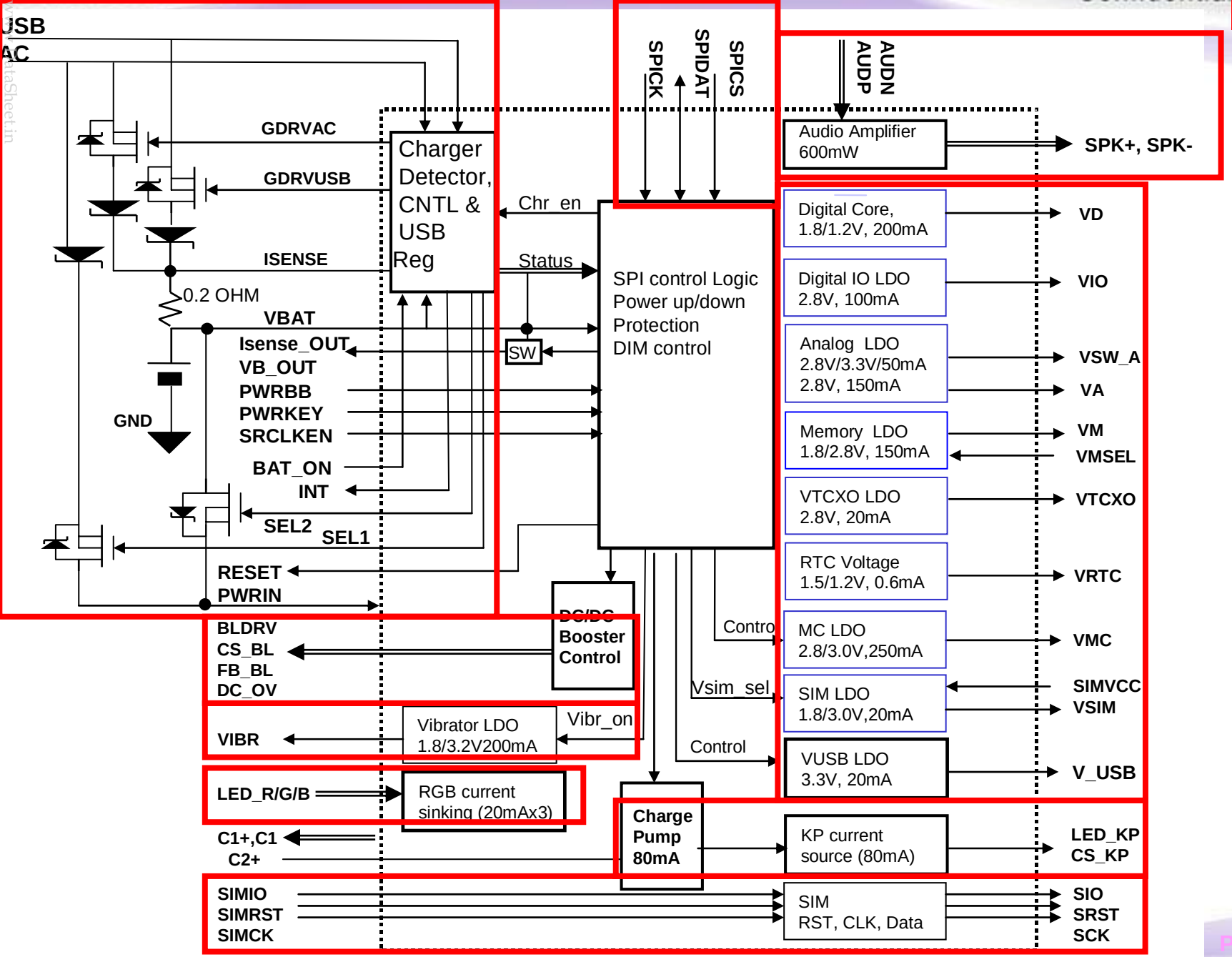
MT6318 Pin Assignments



	1	2	3	4	5	6	7	8	9	10	
A	LED_KP	C2+	C1+	C1+	PWRIN4	FB_BL	BLDRV	PWRIN3	PWRBB	BAT_BACKUP	A
B	VO_G	VO_R	CS_KP	DC_OV	PWRIN4	CS_BL	RSTCAP	PWRIN3	INT	BAT_ON	B
C	V_USB	VO_B	GND4	GND4	PWRIN4	GND4	GND4	PWRIN3	RTC_SEL	VIO	C
D	USB	GDRV USB	GND1	GND4	PWRIN4	GND4	GND3	GND3	PWRIN2	PWRIN2	D
E	AC	GDRV AC	GND1	GND1			GND3	GND3	VD_SEL	VSWA	E
F	VBATT	ISENSE	GND1	GND1			GND3	SPICS	RESET	VIBR	F
G	VN	SEL2	GND1	GND1	GND2	GND2	GND2	SPICK	SRCLK EN	VRTC	G
H	VTCXO	SEL1	SEL1_EN	GND2	Isense_OUT	GND2	GND2	SIO	SIM VCC	SIM RST	H
J	PWRIN1	PWRIN1	PWRIN1	VB_OUT	AUDP	AUDN	SIMIO	SPIDAT	SRST	VD	J
K	VA	BP/REF	VMC	VMSEL	SPK+	SPK-	PWR KEY	VSIM	SIM CLK	SCLK	K
	1	2	3	4	5	6	7	8	9	10	

MT6318 TFBGA 96(7x7 mm2) Pin Assignments


USB
AC
GDRVAC
GDRVUSB
ISENSE
0.2 OHM
VBAT
Isense_OUT
VB_OUT
PWRBB
PWRKEY
SRCLKEN
GND
BAT_ON
INT
SEL2
SEL1
RESET
PWRIN
Charger Detector, CNTL & USB Reg
Chr_en
Status
SW
SPI control Logic
Power up/down
Protection
DIM control
SPICK
SPIDAT
SPICS
AUDN
AUDP
Audio Amplifier 600mW
SPK+, SPK-
Digital Core, 1.8/1.2V, 200mA
VD
Digital IO LDO 2.8V, 100mA
VIO
Analog LDO 2.8V/3.3V/50mA 2.8V, 150mA
VSW_A
VA
Memory LDO 1.8/2.8V, 150mA
VM
VMSEL
VTCXO LDO 2.8V, 20mA
VTCXO
RTC Voltage 1.5/1.2V, 0.6mA
VRTC
MC LDO 2.8/3.0V,250mA
VMC
SIM LDO 1.8/3.0V,20mA
SIMVCC
VSIM
VUSB LDO 3.3V, 20mA
V_USB
Control
Vsim_sel
DC/DC Booster Control
BLDRV
CS_BL
FB_BL
DC_OV
Vibrator LDO 1.8/3.2V200mA
Vibr_on
VIBR
LED_R/G/B
RGB current sinking (20mAx3)
C1+,C1
C2+
Charge Pump 80mA
KP current source (80mA)
LED_KP
CS_KP
SIMIO
SIMRST
SIMCK
SIM RST, CLK, Data
SIO
SRST
SCK

Feature Comparison (1/3)

Features		MT6318	MT6305B
General	Package Size	7x7mm, TFBGA	7x7mm, QFN
Linear Regulator	VD	1.8/1.5, 1.2/0.9V,200mA	1.8/1.2V,200mA
	VIO	2.8V,100mA	2.8V,100mA
	VA	2.8V,150mA	2.8V,150mA
	VM	1.8V/2.8V,150mA	1.8/2.8V,150mA
	VTCXO	2.8V,20mA	2.8V,20mA
	VRTC	1.5V/1.2V,0.6mA	1.5/1.2V,0.2mA
	VSIM	1.8V/3.0V,20mA	1.8V/3.0V,20mA
	VSW_A	2.8V/3.3V,50mA	X
	VMC	2.8V/3V,250mA	X
	VUSB	3.3V,20mA	X
	VIBR	1.8V/3.2V,200mA	X
SIM Interface	Level shifting	◎	◎
Output Driver	Vibrator Driver (VIBR)	LDO 1.8V/3.2V, 200mA	Open Drain
	LED Driver	x	Open Drain
	Alerter Driver	x	Open Drain

Feature Comparison (2/3)

Back Light Driver	Boost with external N-MOS	4xLEDx20mA, 20V OVP	X
Audio Amplifier	Differential/ Single-end	600mW/ 8 step gain	X
Charger Pump	LED_R	20mA	X
	LED_G	20mA	X
	LED_B	20mA	X
	LED_KP	80mA	X
AC Charger	Maximum Input voltage	15V (Can't charge if >9V)	15V
	CV mode	4.2V	4.2V
	CC mode	160mV/Rsense, 8 step current setting	160mV/Rsense
	Pr-charge Current	50mA	10mV/Rsense
	OVP	4.3V	4.3V

Feature Comparison (3/3)

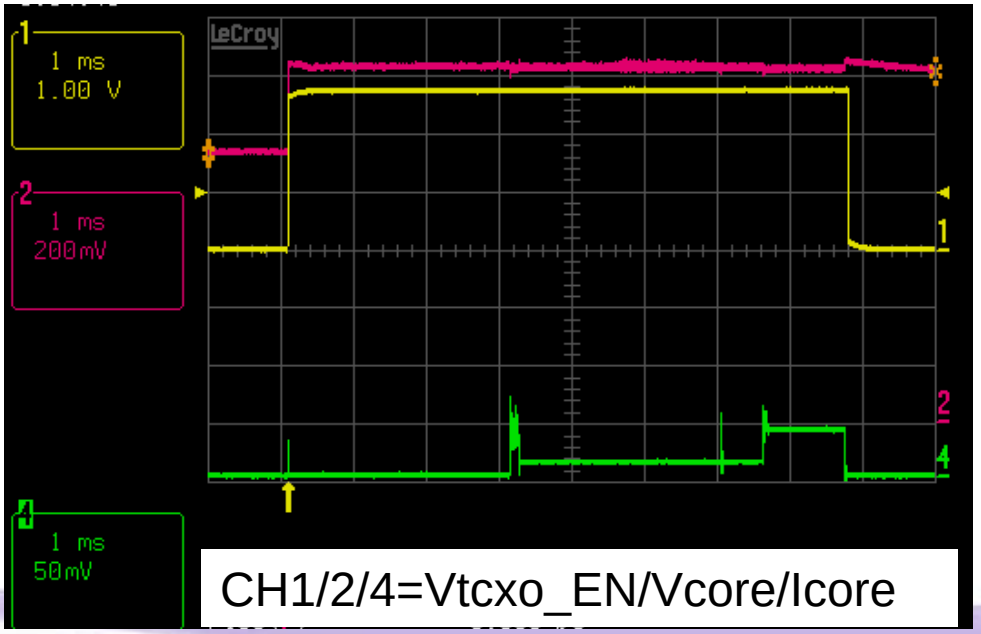
USB Charger (Option)	Maximum Input voltage	5.5V	X
	CV mode	4.2V	x
	CC mode	160mV/Rsense, 8 step current setting	x
	Pr-charge Current	50mA	x
	OVP	4.3V	x
SPI interface	3 wires interface	◎	x
SEL1/SEL2 switch (Option)	For LCD display at pre-charge	◎	x
Protection	Over Voltage Protection	◎	◎
	UVLO	◎	◎
	Thermal Protection	◎	◎
Miscellaneous	Interrupt for charger/USB, and charger OV detection	◎	x
	VB_OUT and Isense_out	◎	x
	Battery Detect	◎ (NTC pin)	◎(ID pin)
	2-step RTC	◎	x
	UVLO programmable	2.9/2.75/2.6/2.5	x

Dynamic Voltage Scaling (DVS)

MT6228 Vcore 1.2V to 0.9V @ Idle Mode

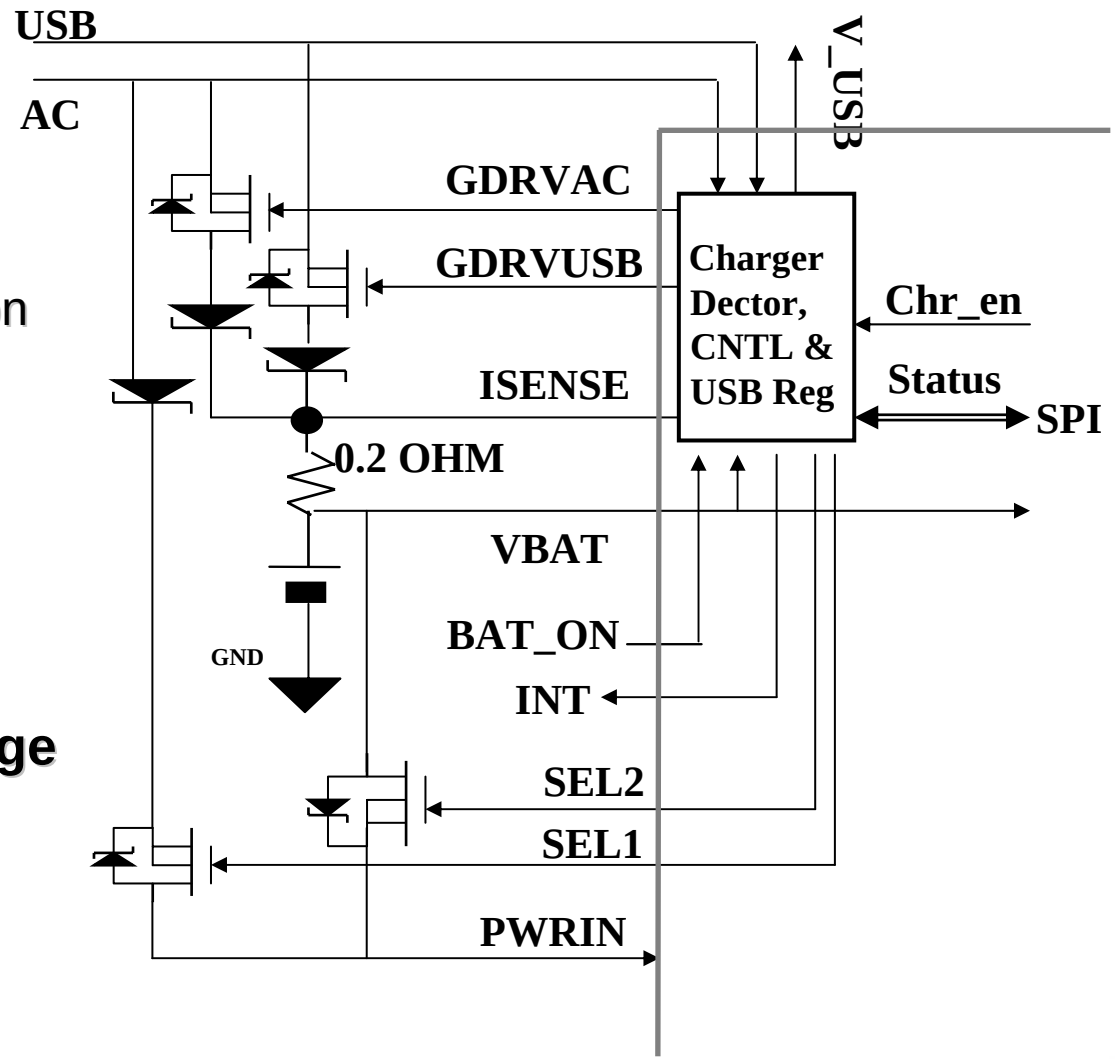
(a) It can save about 80uA~145uA @GSM
(b) MT6318 can implement this function
(SW just need to change 1 register, Vcore 1.2v/0.9V control by Vtcxo_en)

MT6228	PG9/BA1(mA)	PG2/BA16(mA)
Vcore 1.2	0.562	1.244
Vcore 1.2/0.9V	0.48	1.099
Delta	**0.082**	0.145



Charge Circuit (AC and USB charger)

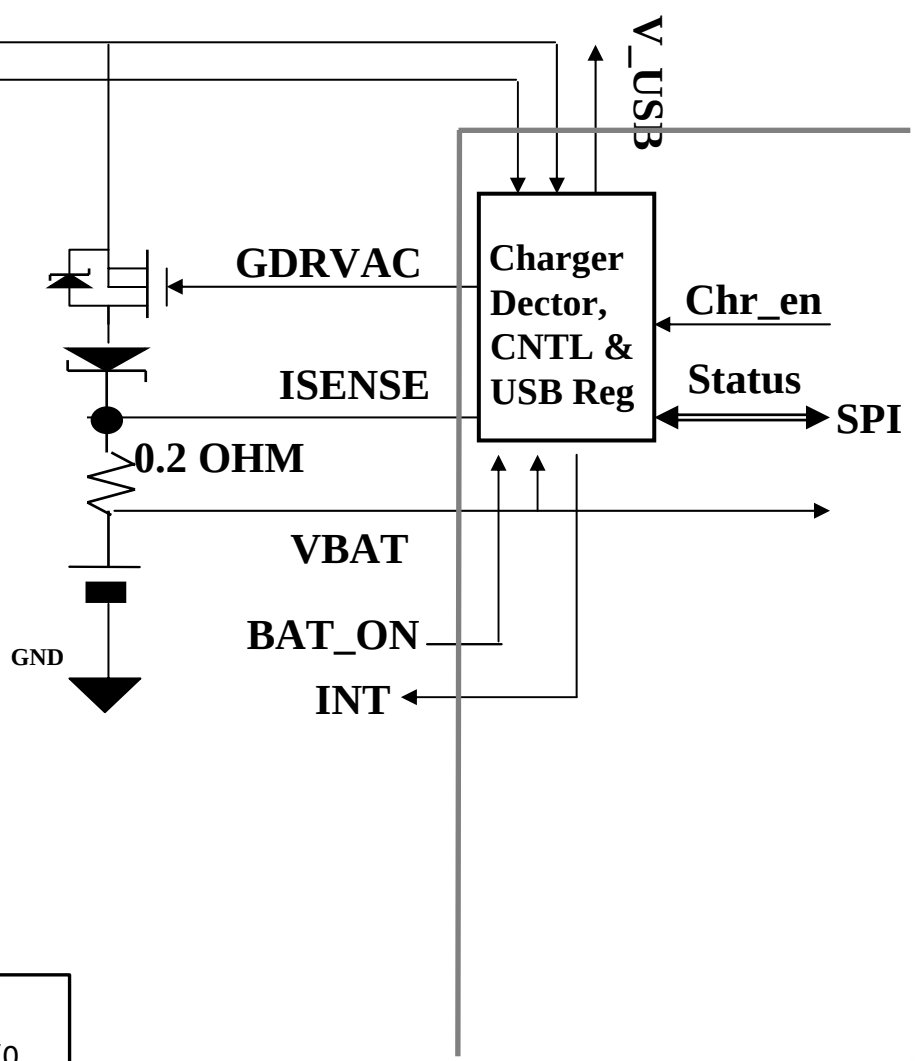
- **Charge Detector**
  - $4.2V<V_{CHARGER}<9V$
  - INT: Charger detected
    Interrupt Output
  - BAT_ON: Battery detection
  - 8 step current setting
- **USB Regulator**
  - VUSB_3.3V,
  - USB I_{CHR} 50mA->450mA
  - 8 step current setting
- **SEL1/SEL2 for pre-charge indication**

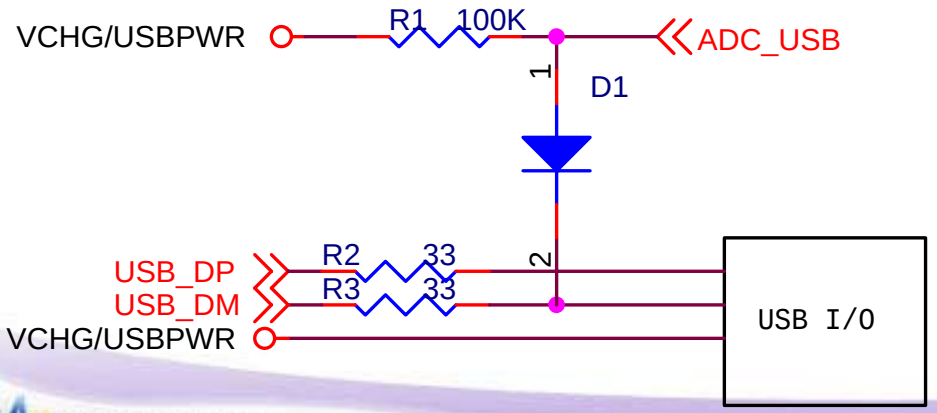


Charge Circuit (AC and USB charger)

Recommend Circuit!

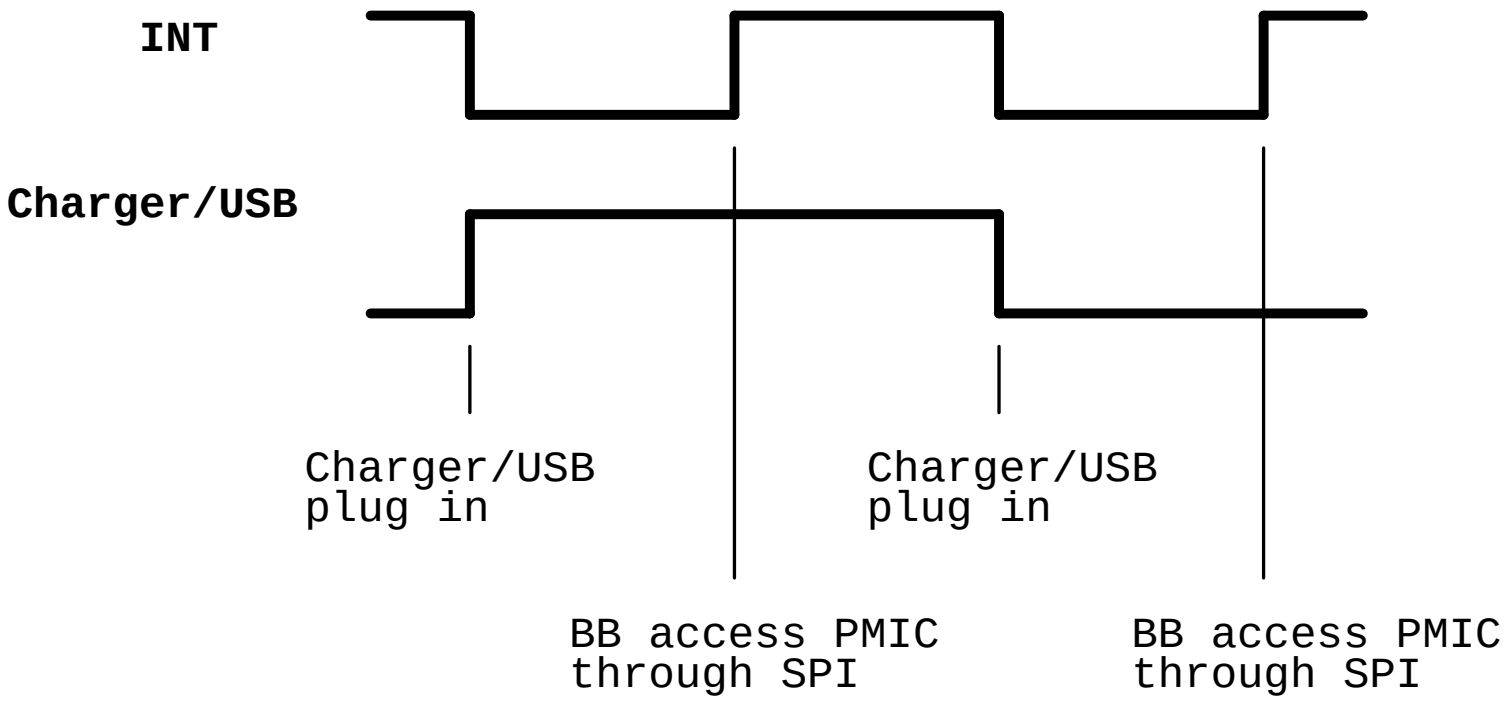
One interrupt+One ADC for USB/Charger Detection (The same way with MT6305B)





Charge Circuit - Interrupt

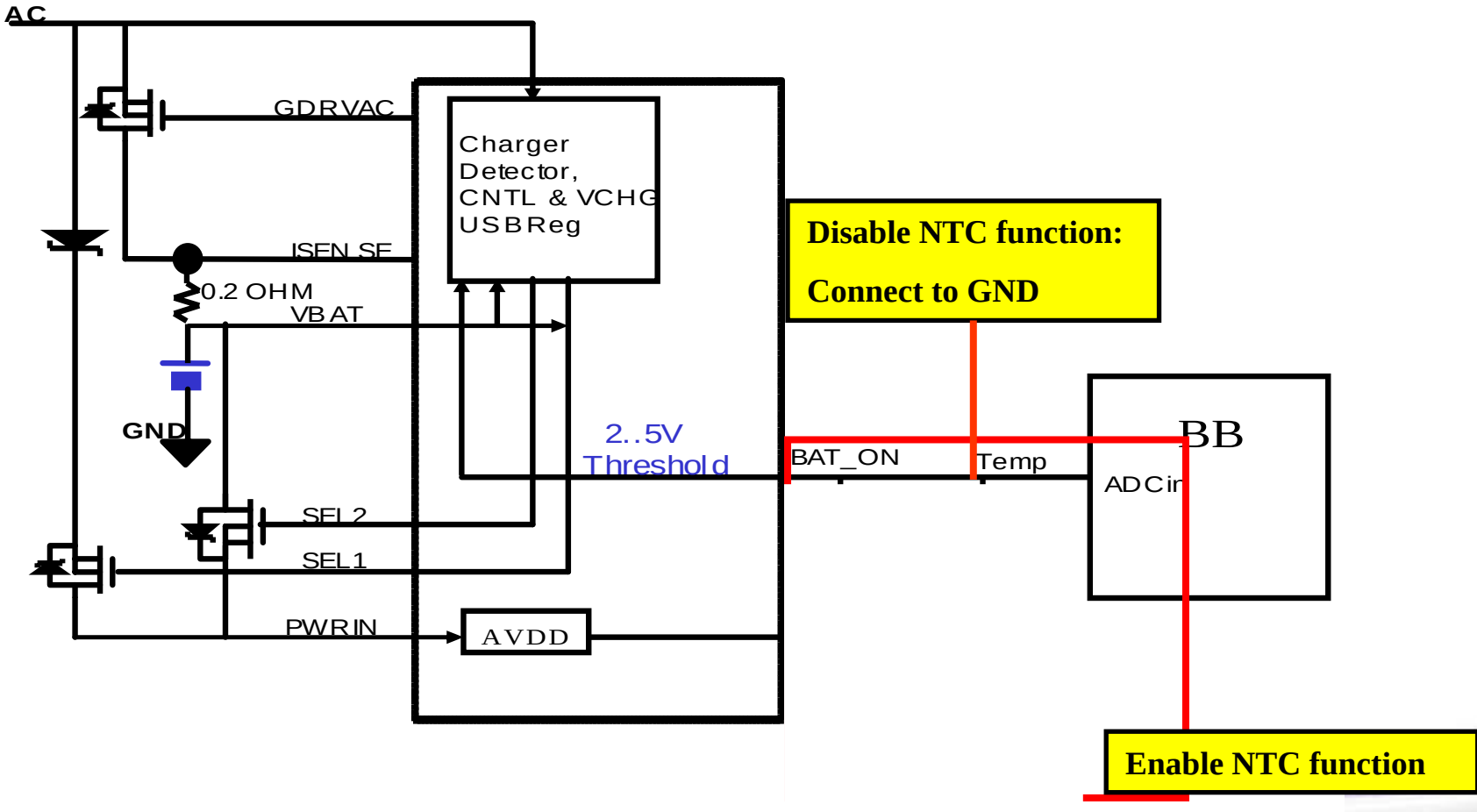
- The interrupt active (low) when Charger/USB plug-in or plug-out.
- The interrupt will reset to high when BB access the PMIC through SPI.



BAT_ON Connection

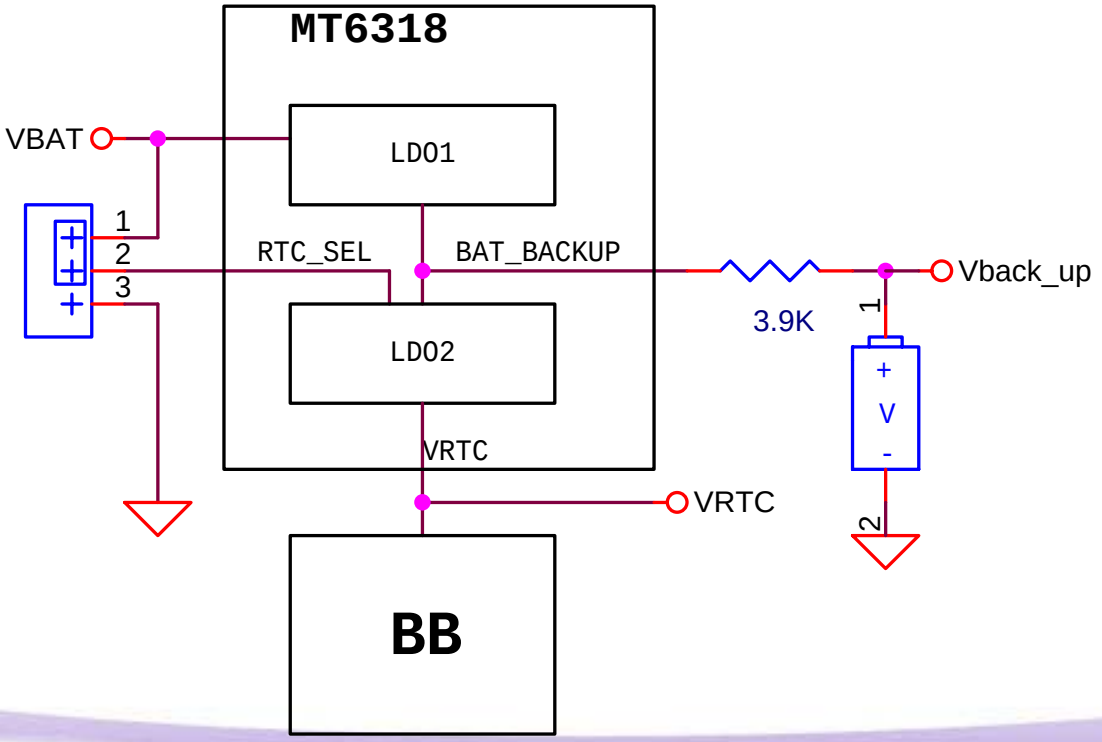
- Charger will turn off immediately when BAT_ON goes high (>2.5V)
- Normal BAT_ON Voltage: 2.45V @ NTC=170K -40 degree

  0.41V @ NTC=4.17K +50 degree

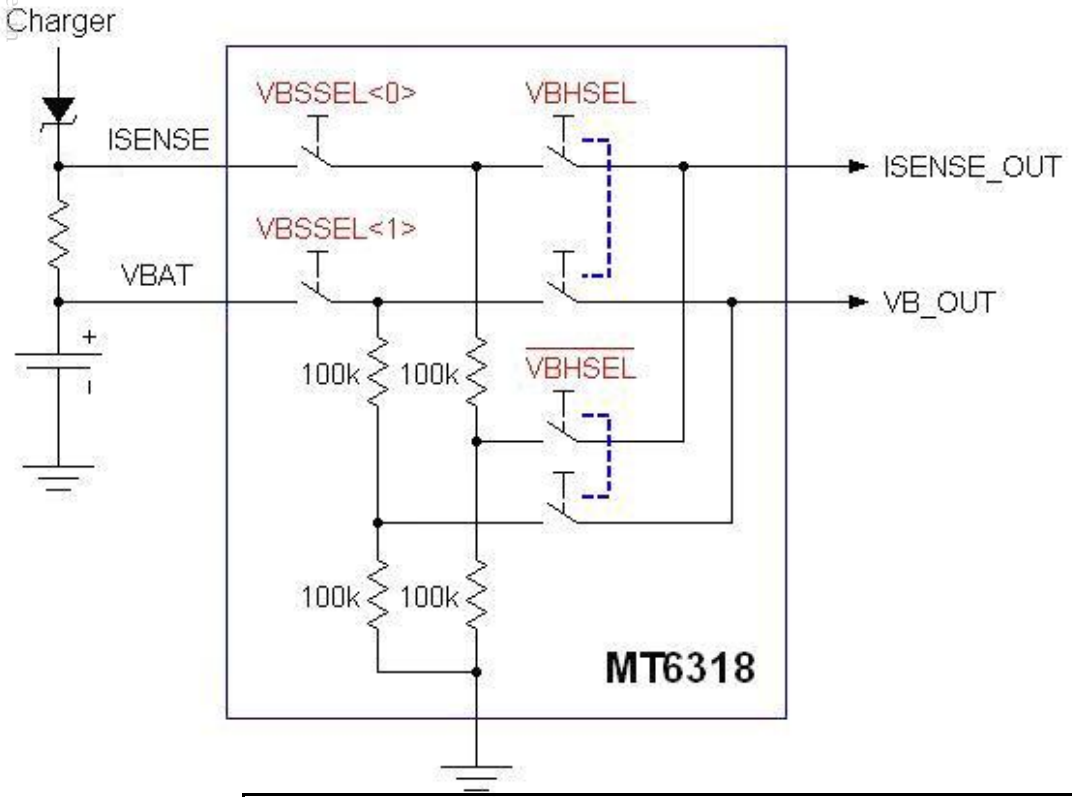


2-Step RTC

- This function increase the RTC alive time by increase the voltage at backup battery.
- LDO 1 regulate the VBAT to about 2.6V, connect to backup battery.
- LDO 2 regulate the voltage at backup battery to VRTC.
- VRTC set by RTC_SEL. (1 = 1.5V, 0 = 1.2V.)



Isense and VBAT Output



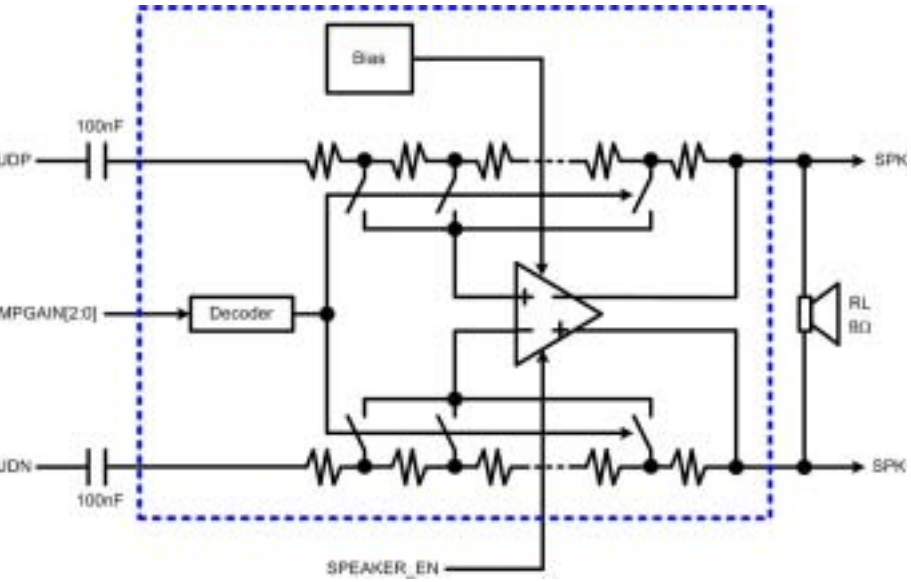
- This function can save the power-off leakage in the 4 voltage divider resistor.
- Output level (divide or not), enable/disable can be set through SPI.

Register Index F: Extras			
Bit	**Name**	**Value**	**Description**
D6	VBSSEL_SPI[1]	0	VB_OUT disable (Default)
		1	VB_OUT enable
D5	VBSSEL_SPI[0]	0	ISENSE_OUT disable (Default)
		1	ISENSE_OUT enable
D4	VBHSEL	0	Output divided by 2
		1	Output not divided by 2

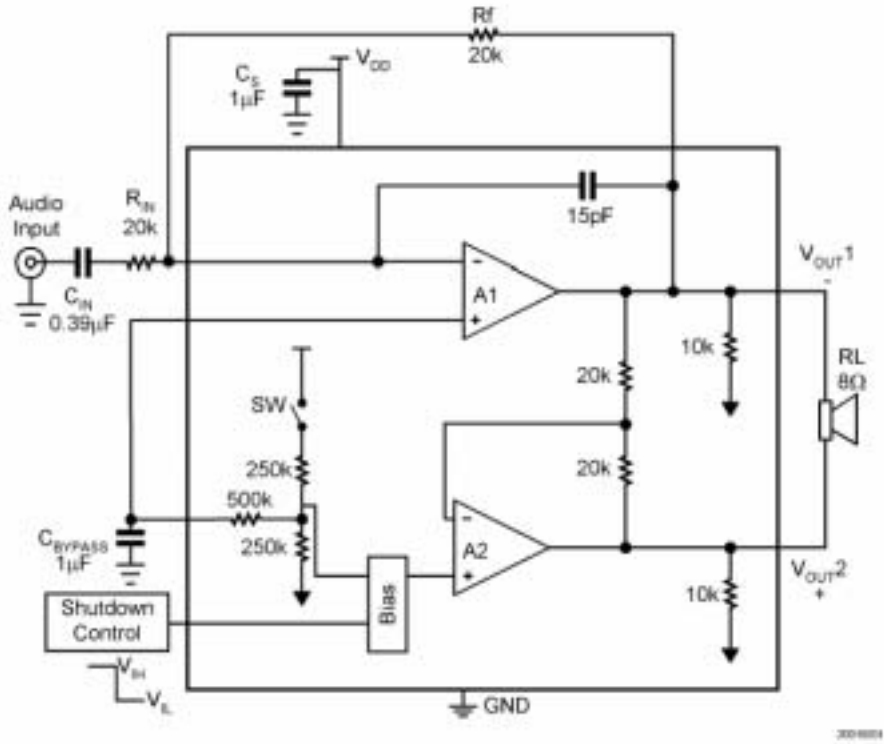
Audio Block (1/2)

- MT6318 can adjust output gain by register setting, doesn't need extra gain setting resistor.
- The gain range is from 0~21dB.

MT6318



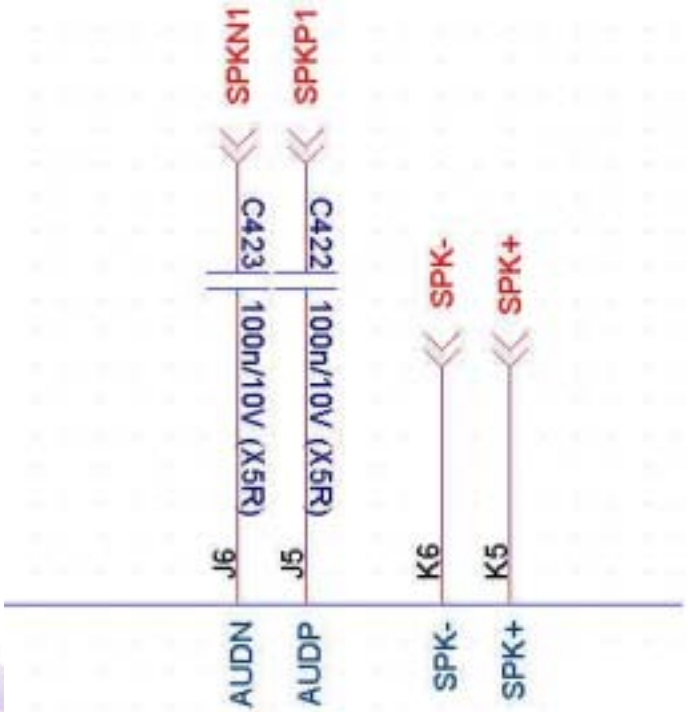
LM4890



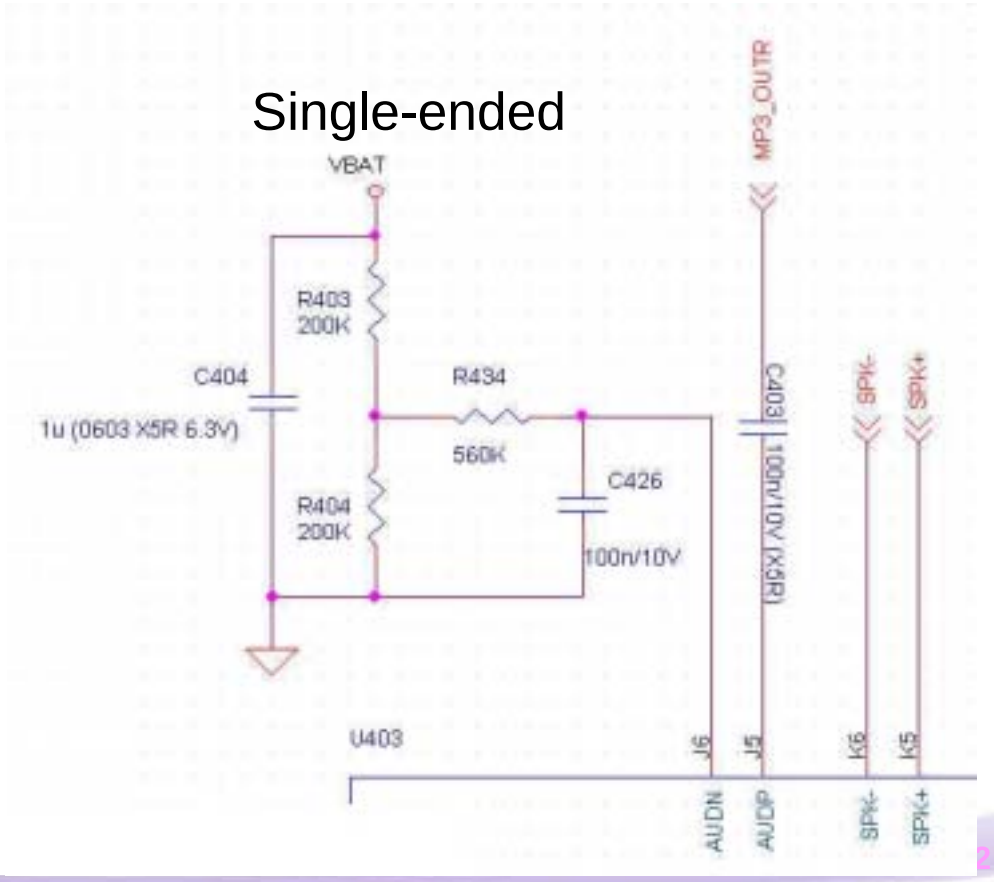
Audio Block (2/2)

- The input can be either single-ended or differential.
- In current design, when using single-ended, need voltage divider (set input voltage to ½ VBAT) and RC filter (reduce TDD noise).

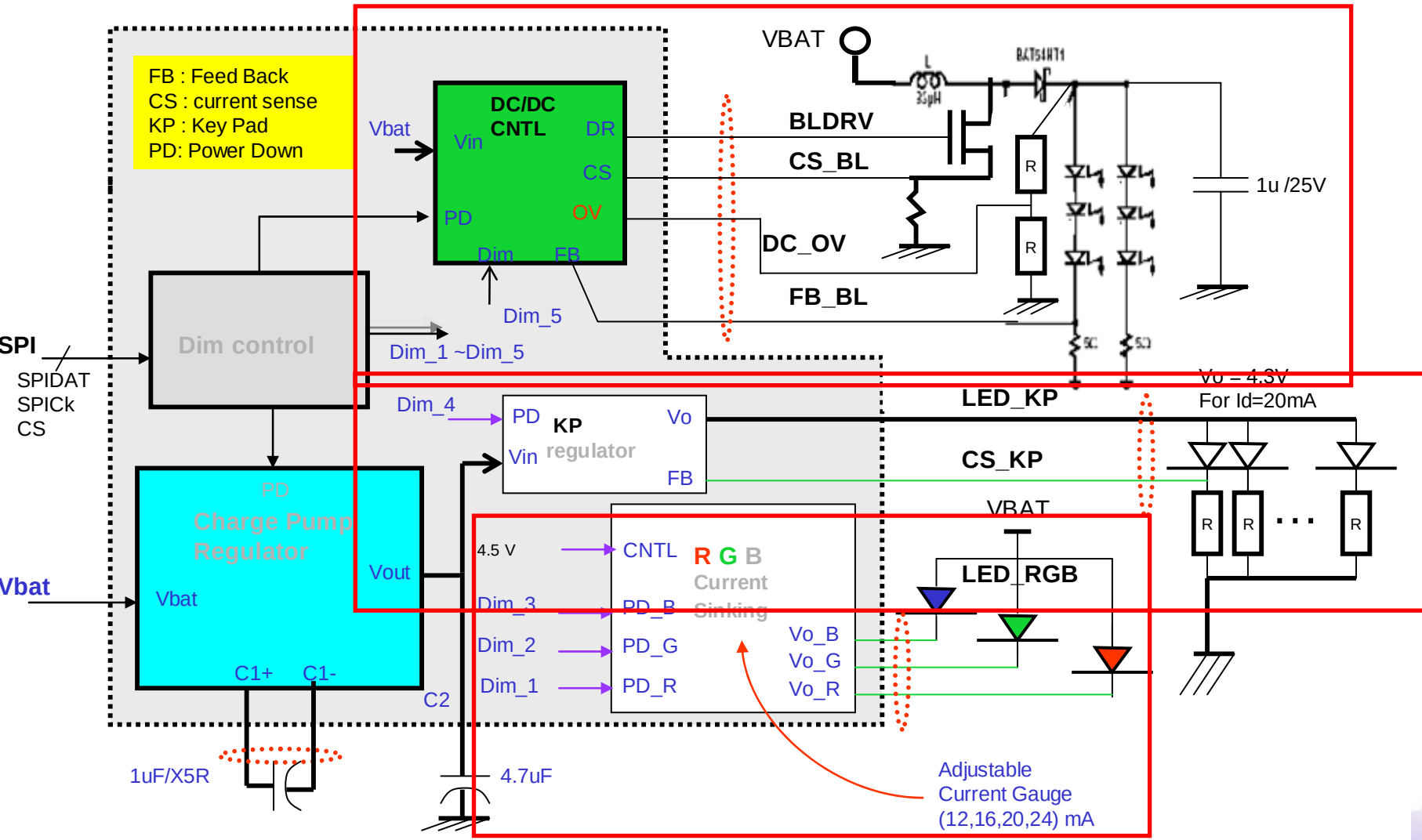
Differential



Single-ended



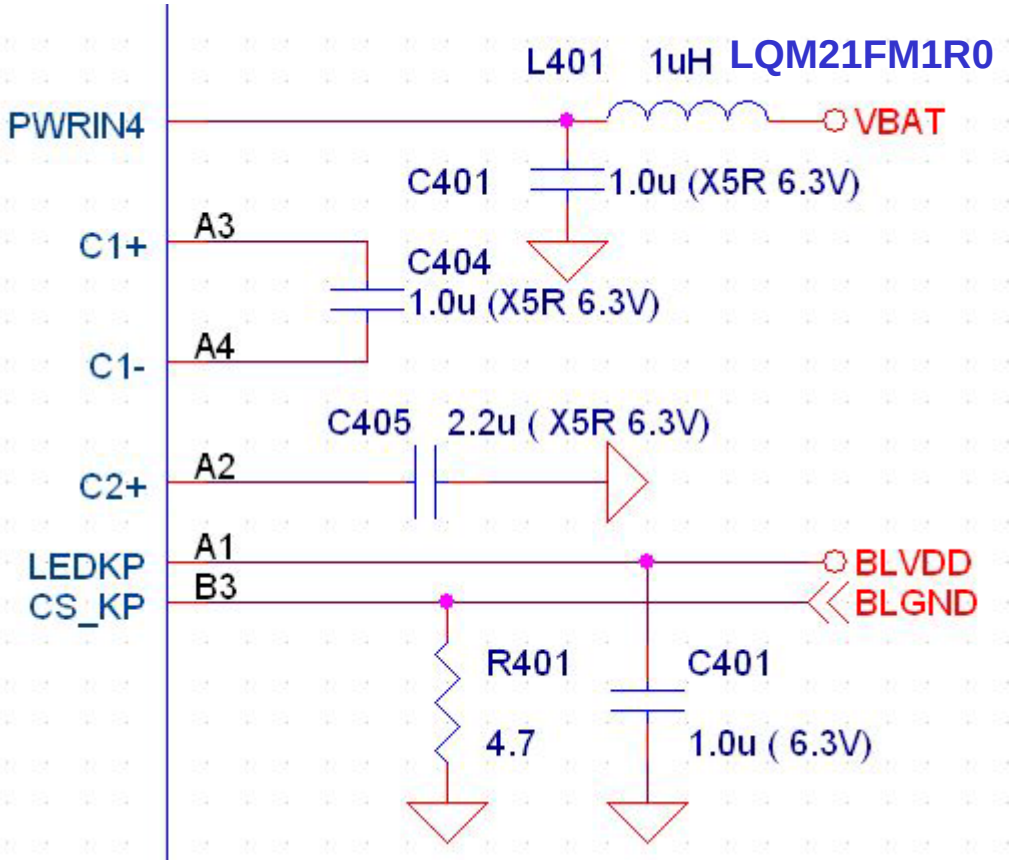
Charge Pump, DC-DC and R/G/B Driver



Charge Pump for BL

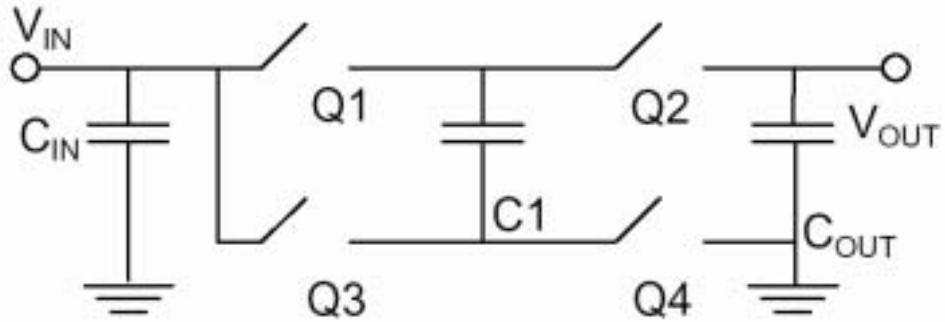
LCM Parallel LED : Charge pump

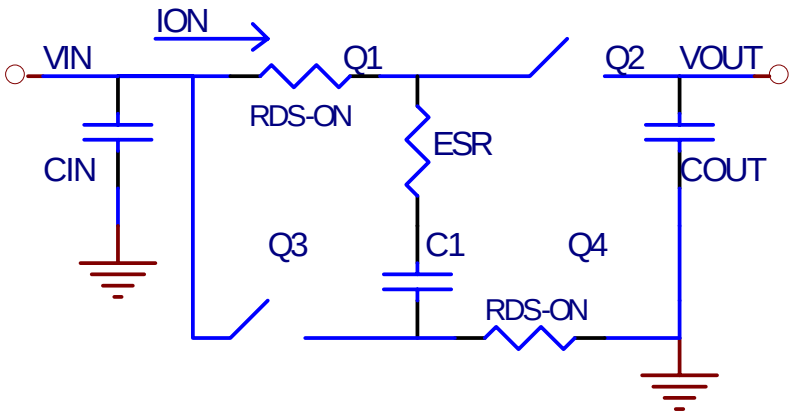
Supply 4 parallel LED and 20mA/LED

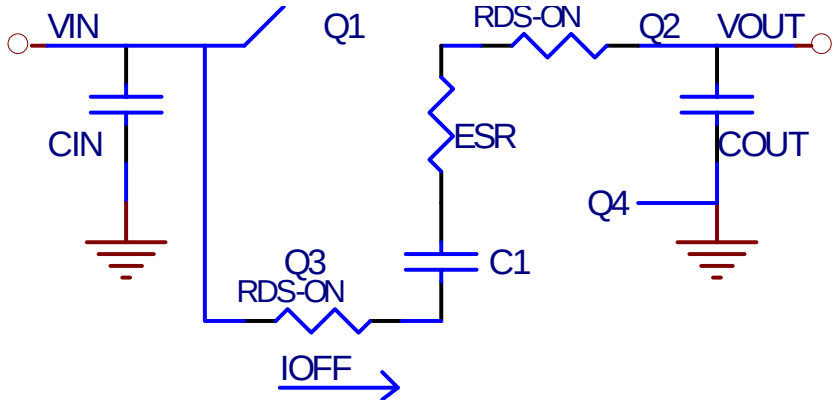


Charge Pump Principle

➢ **The modeling of charge pump**





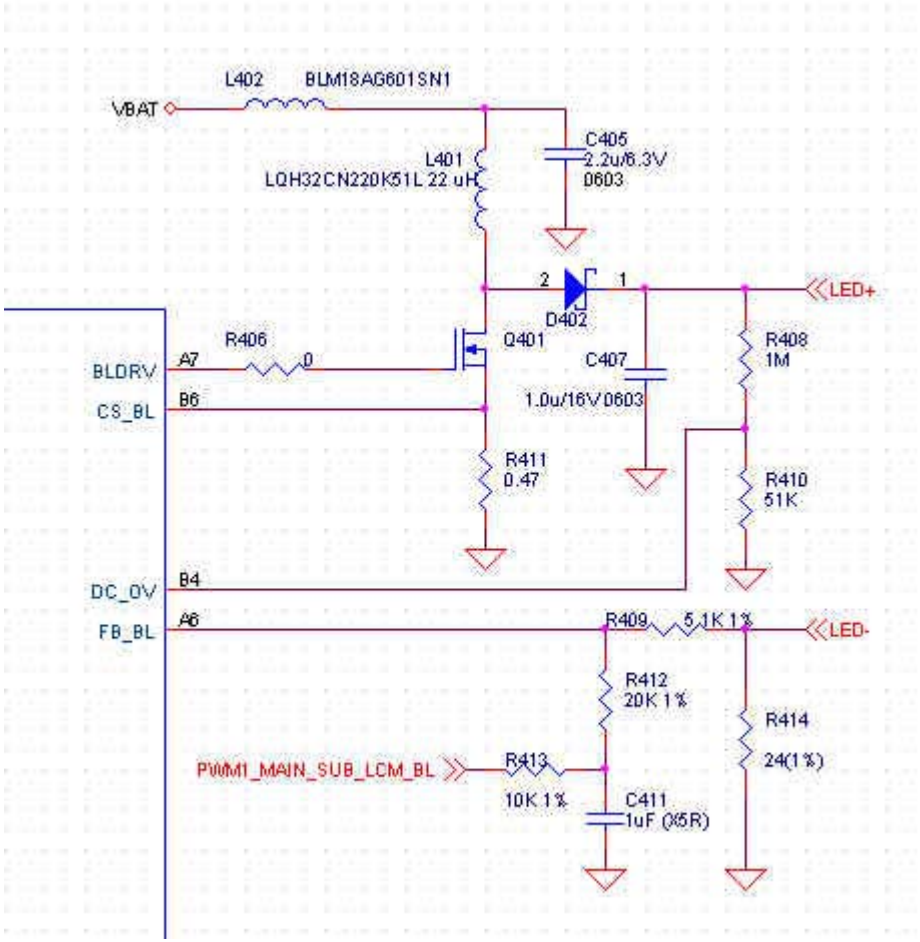


- **The on state of charge pump circuit**
- **The off state of charge pump circuit**

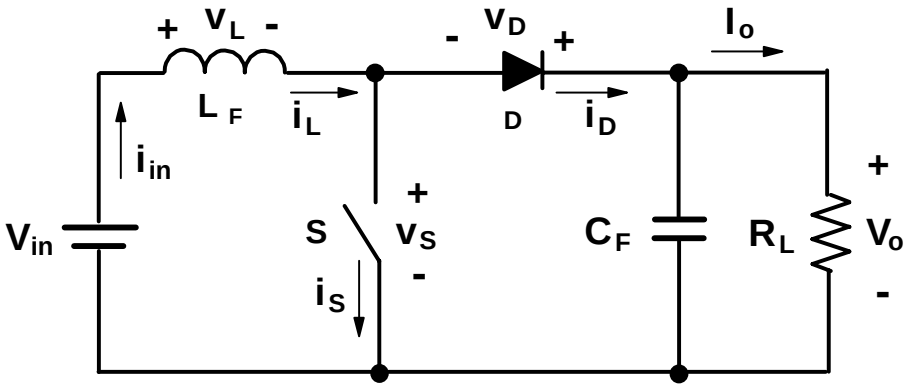
DC/DC Boost for BL

LCM Series LED : DC/DC converter

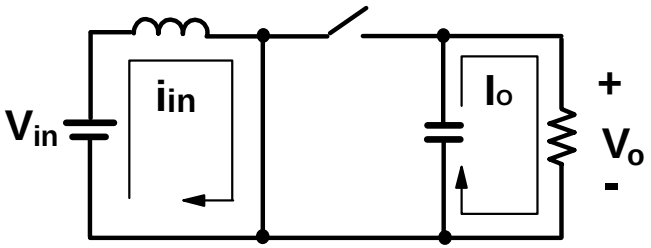
Supply 4 series LED and 20mA/LED with OVP



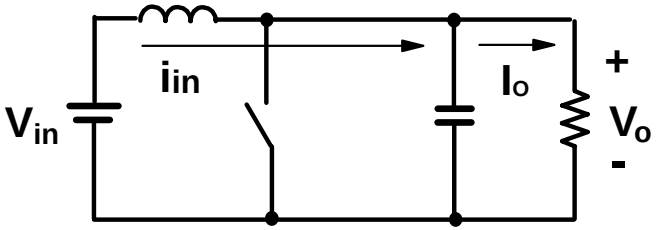
Boost Converter (Step-Up Converter)



T_{on}



T_{off}



Boost Layout

1.The number of “via” should be limited as much as possible
(The few tens of nH added by a “via”)

2.Don’t place “via” on high and discontinuous current path.

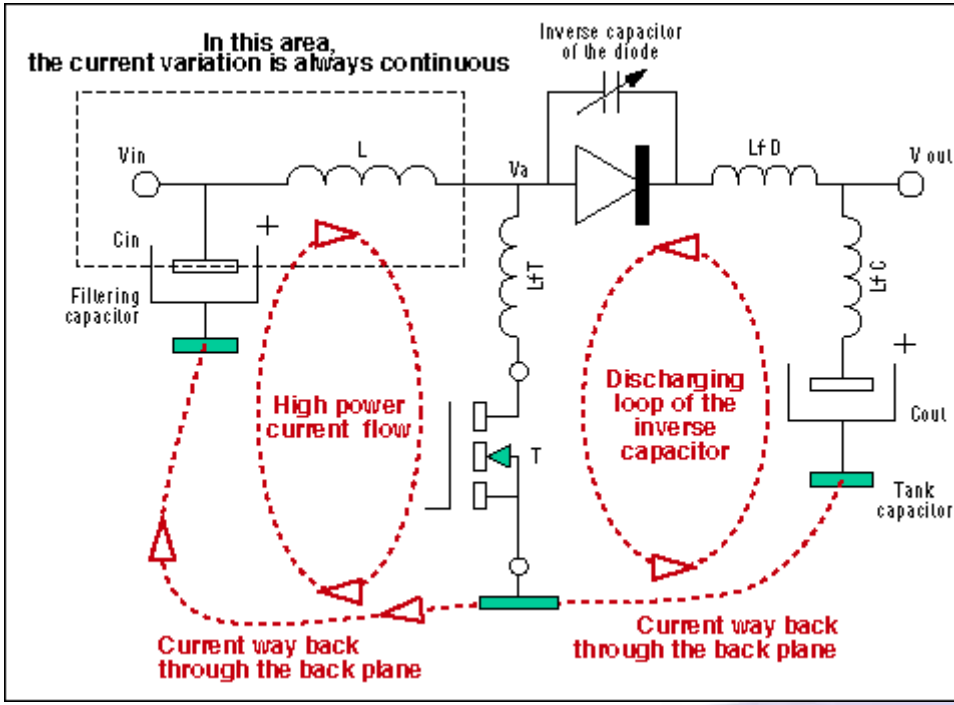
3.(If “via” is needed for routing, place it on continuous current path)

4.(If you have no other choice, put several via in parallel)

5. Short and wide connection on high and discontinuous current path.

6. Place the Vout sense resistor after HF capacitor

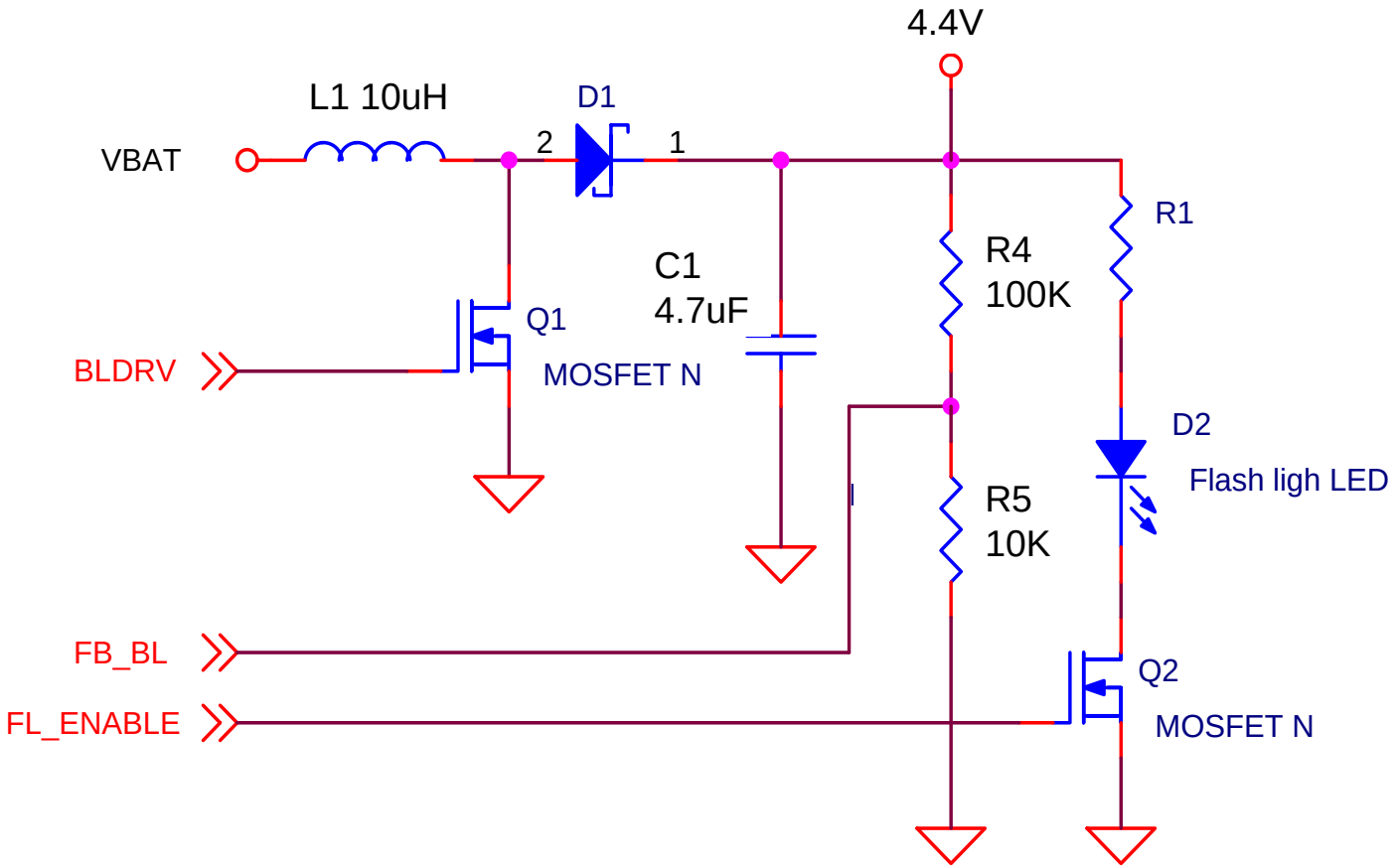
a.Minimize parasitic inductance.
b.Note high di/dt and high dv/dt nodes



Boost Converter Application

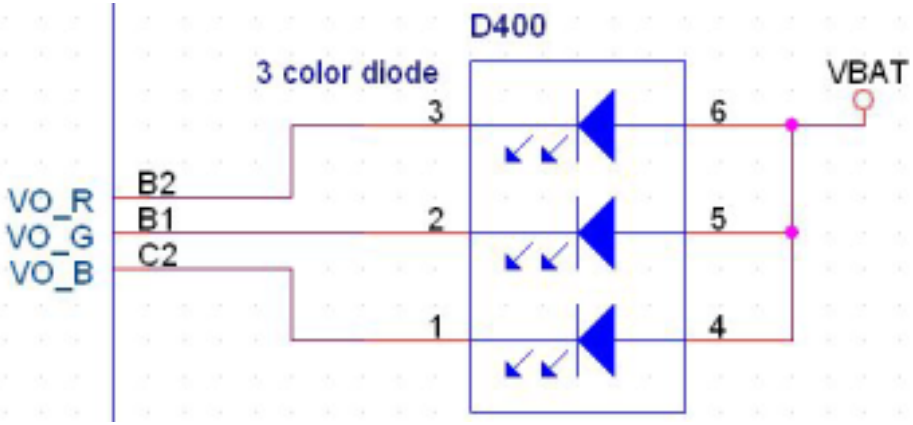
Flash light : DC/DC converter

- Supply 4.4V ,350mA Flashlight LED

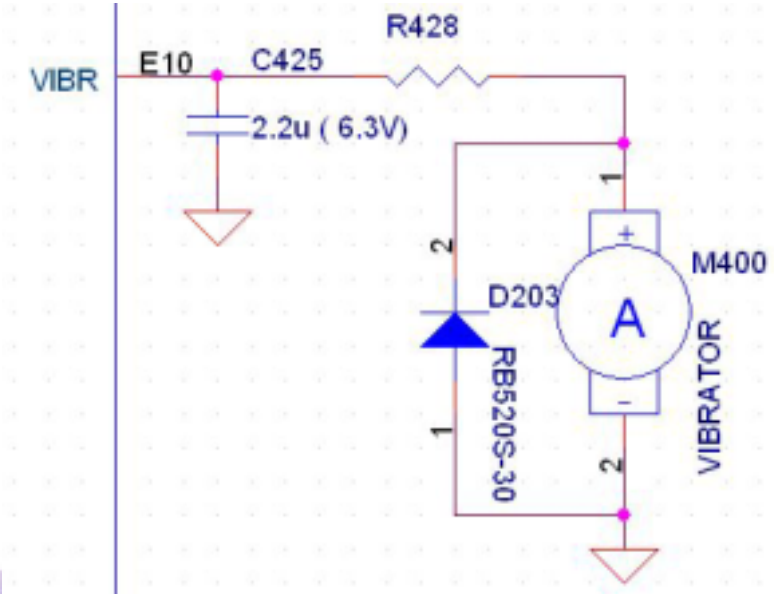


LED Driver & Vibrator

RGB LED: Sinking current driver and current control

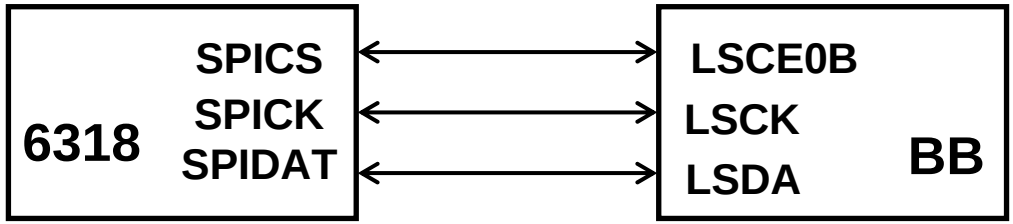


Vibrator: Supply 3.2V/ 1.8V ,200mA vibrator



SPI Interface

- BB provide dedicated SPI interface for PMIC, don't use other GPIO.



	MT6217/18/19/26/26M/27	MT6228/29
LSCE0#	GPIO19	GPIO23
LSCK	GPIO16	GPIO20
LSDA	GPIO18	GPIO22

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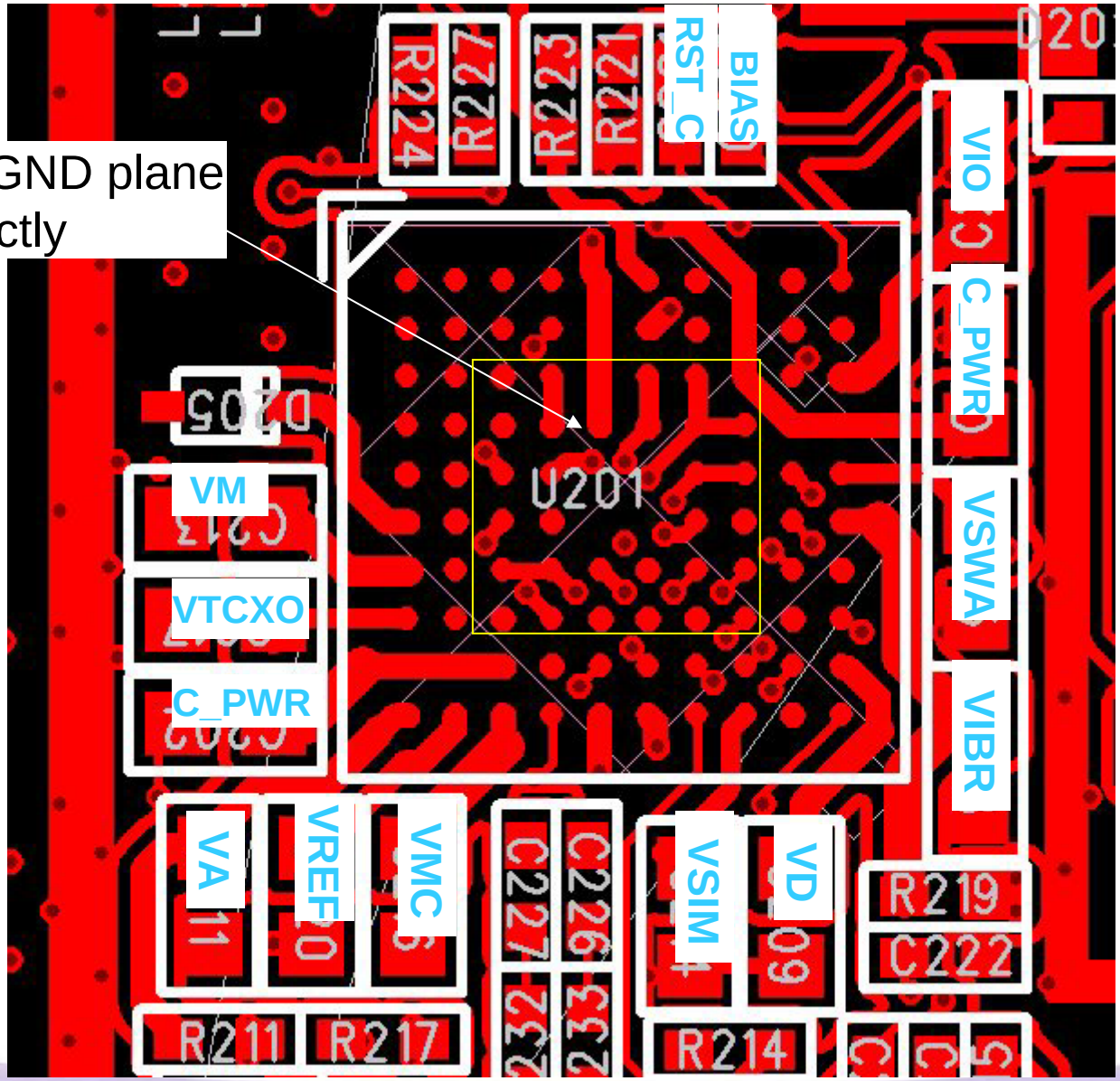
Layout Guide

- The input capacitor should be placed as close as possible to the PWRIN pins especially on PWRIN1.
- Please connect GND pin to GND plane via hole directly.
- VCORE, VDD, AVDD, VMEM. The width is 15mil at least.
- PMIC_VTCXO, VSIM. The width is 10mil at least.
- Vusb width is 15 mil at least.
- Please layout charging traces at least 40mil
- For audio amplifier, please layout input traces as differential line, and keep the traces as the same length. Output traces width is 12mil at least.
- About LCM backlight trace. The width is 15mil at least. To prevent EMI, place COUT next to the VOUT and GND pins. Use a ground plane under the switching regulator to minimize coupling.
- For SIM IF, the equivalent capacitor must be under 60 pF (TVS).
- Vibrator and keypad backlight trace. The width is 15mil at least.

Reference Layout



Recommended H/W Full Set Configuration

Handset Function	Implement	Component Save
Backlight	DC-DC	BL driver
Flash light	Charge pump	Flash light dirver
Loud speaker	Audio Amp.	Audio Amp.
Sensor Power (2.8V)	Vsw_a	LDO
Sensor Power (1.8V)	Vibr	LDO
USB Power	VUSB	LDO
BT Power	VMC	LDO
Indicator	R/G/B driver	Save 1 NMOS
Keypad LED	Extra NMOS	
Vibrator	Extra NMOS	

H/W Quick Check List

1.Check BB VCORE/VRTC voltage

PIN	Symbol	Function
C9	RTC_SEL	1 = 1.5V, 0 = 1.2V (1 means Vbat)
E9	VD_SEL	1 = 1.8V, 0 =1.2V (1 means Vbat)
H3	SEL1_EN	1 =enable, 0 = disable (1 means Vbat)

	Vcore	VD_SEL (MT6318 E9 pin)	VRTC	RTC_SEL (MT6318 C9 pin)
MT6205	1.8V	H	1.5V	H
MT6217	1.8V	H	1.5V	H
MT6219	1.2V	L	1.2V	L
MT6226	1.8V	H	1.5V	H
MT6226M	1.8V	H	1.5V	H
MT6227	1.8V	H	1.5V	H
MT6228	1.2V	L	1.2V	L
MT6229	1.2V	L	1.2V	L

H/W Quick Check List

2.Check Audio Amplifier configure

BB	Audio	MT6318 configure
MT6217/18/19/28/29	AU_OUT1	Differential input
MT6226/27	AU_MOUT L/R	Signal End input

3.Check backlight configure

LED backlight configure	MT6318 configure
Series LED	DC_DC Boost
Parallel LED	Charger pump

4.Check BAT_ON(B10) pin

a. Connect to NTC (10K NTC+24K divider)

b. Or connect to GND

5. VMC/Vsw_a /Vusb/Vibr suggest implement On/off and voltage selection control by register

Symbol	Voltage/Current	Application
VMC	2.8V/3V,250mA	Sensor 2.8V/BT 2.8V/ Memory Card
Vswa	2.8V/3.3V,50mA	Sensor 2.8V/Vusb 3.3V
Vusb	3.3V,20mA	Vusb 3.3V
Vibr	1.8V/3.2V,200mA	Sensor 1.8V/Vibrator 3.2V

6.Check Vibrator connection

a. Connect to Vibr LDO

b. Use external N-MOS

S/W Check in List

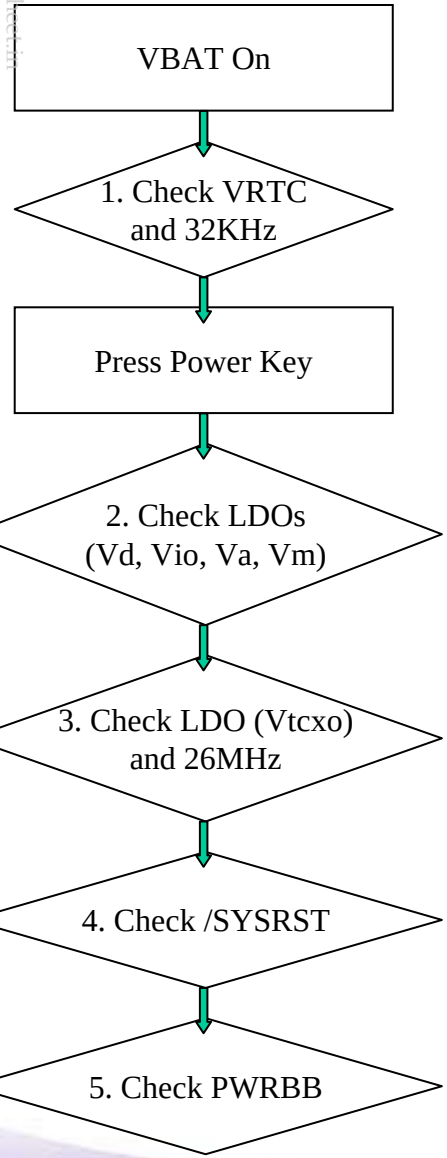
1.MT6318 driver will ready at 05C, W0524 after.

mcu\custom\drv\misc_drv\xx_BB\pmic_custom.c

2.Engineer mode

*#3646633# =>Device=>PMIC

PMIC Power On Debug Check List



1. VRTC. (1.5/1.2V).
   - VRTC or BAT_Backup (MT6318) short to GND.
   - VD_VRTC_SEL(MT6305), RTC_SEL(MT6318) setting.
   - Crystal.
2. Vd (1.8/1.2V), Vio(2.8V), Va(2.8V), Vm(2.8/1.8V).
   - Diode at power key reversed.
   - For Vd, check VD_VRTC_SEL(MT6305), VD_SEL(MT631 setting.
   - For Vm, check VMSEL setting.
3. Vtcxo(2.8V).
   - Check SRCLKEN.
   - TCVCXO, RF.
4. LDO ok, check /SYSRST.
   - Connection or component loading.
5. Check PWRBB.

Thank you!

Appendix:

1.SEL1/SEL2 Option

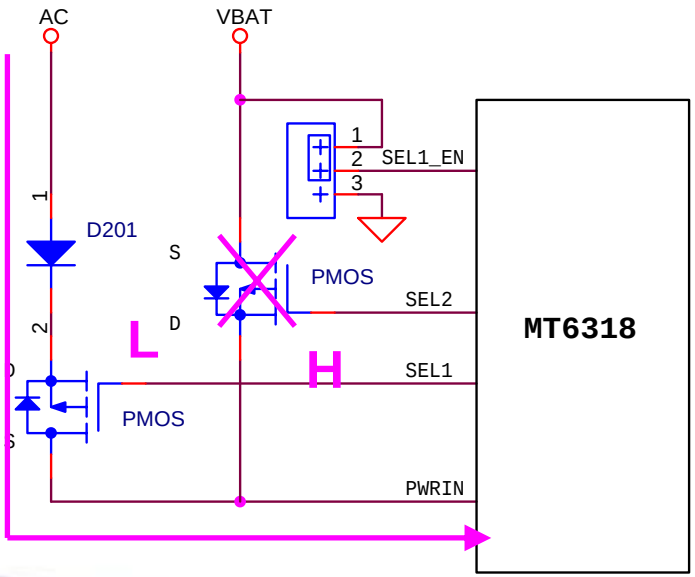
2.Engineer Mode for MT6318

3.MT6305B Introduction

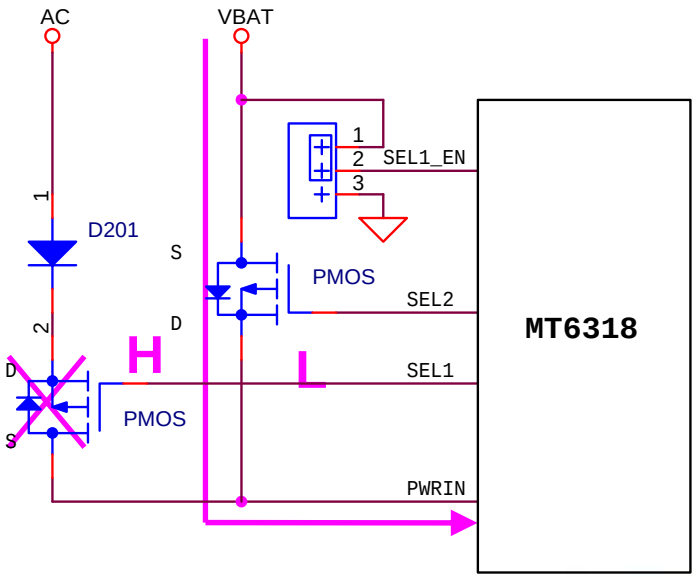
SEL1/SEL2

- This function enables the handset to display charging status on LCM in pre-charge mode.
- In pre-charge mode (VBAT < 3.3V), PWRIN provided by AC.
- In normal mode, PWRIN provided by VBAT.
- SEL1_EN: 1= enable, 0=disable.

Pre-Charge



Normal



Engineer Mode Introduction (1/5)

*#3646633# → Device → PMIC

1	Register R/W
2	Charger Status
3	Set Charger
4	RGB
5	KP LED
6	BL LED
7	Audio
8	Misc.

Engineer Mode Introduction (2/5)

1 Register R/W

-> Key-in register index (0~15)

-> Register 0xf000

227 (Current register value, can change setting here. 227 = E3.)

2 Charger Status

OV_SPI:	**X**	**Charger OV**
CHRDET:	**X**	**Charger detect**
AC_DET:	**X**	**AC power detect**
USB_DET:	**X**	**USB power detect**
BAT_ON:	**ON**	**Battery detect**
CV:	**X**	**CV mode**
CHRG_DIS:	**X**	**Charging or not**

Engineer Mode Introduction (3/5)

3 Set Charger

1	CHREN	ON/OFF	AC charging enable
2	AC Current	50mA~800mA	AC charging current setting
3	USB CHREN	ON/OFF	USB charging enable
4	USB Current	50mA~800mA	USB charging current setting

4 RGB

1	R LED	ON/OFF	R LED enable
2	R Current	12/16/20/24 mA	R LED current setting
3	G LED	ON/OFF	G LED enable
4	G Current	12/16/20/24 mA	G LED current setting
5	B LED	ON/OFF	B LED enable
6	B Current	12/16/20/24 mA	B LED current setting

Engineer Mode Introduction (4/5)

5 KP LED

1	KP Enable	ON/OFF	KP_LED enable
2	Duty Cycle	0~100	Duty cycle setting
3	DIM Clock	1000/(1~32)	DIM frequency setting
4	CHR_PUMP_EN	ON/OFF	Charge pump enable
5	CHRPUMP current	Level 1~4	Charge pum current setting

6 BL LED

1	BL Enable	ON/OFF	BL enable
2	Duty Cycle	0~100	Duty cycle setting
3	DIM Clock	Bypass=1: 25000/(1~32) Bypass=0: 1000/(1~32)	DIM frequency setting
4	DIM Bypass	ON/OFF	DIM bypass setting

Engineer Mode Introduction (5/5)

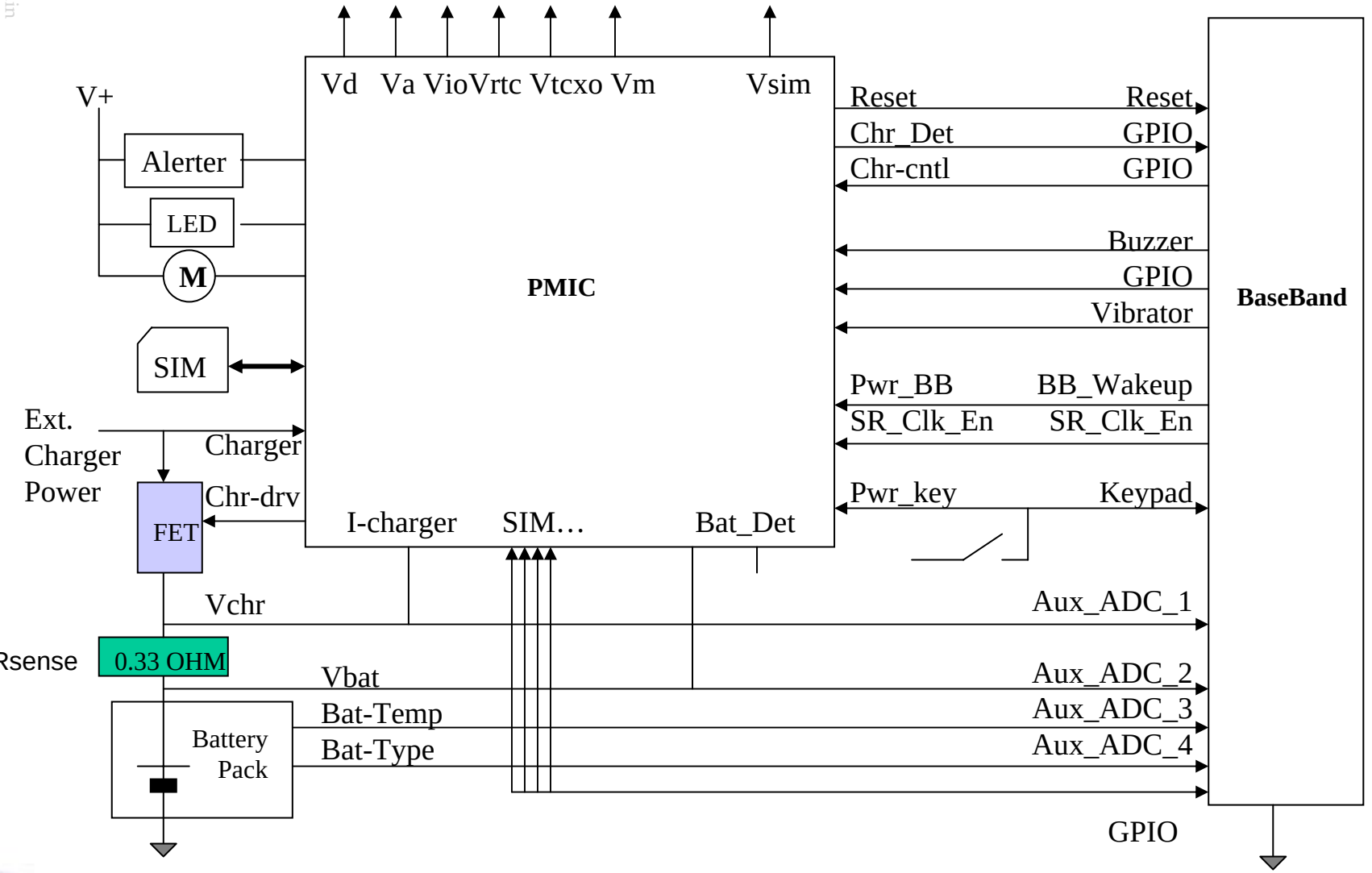
7 Audio

1	Speaker	ON/OFF	Audio amplifier enable
2	AMP Gain	Speaker Gain 0~7	Audio Amp. Gain setting

8 Misc.

1	Isense OUT	ON/OFF	Isense output enable
2	VBAT VOUT	ON/OFF	VBAT output enable
3	USB PWR	ON/OFF	VUSB enable
4	VA SW Sel	ON/OFF	VA_SW voltage select
5	VA SW	ON/OFF	VA_SW enable
6	VMC Sel	ON/OFF	VMC voltage select
7	VMC	ON/OFF	VMC enable
8	Vibrator Enable	ON/OFF	VIBR enable
9	Vibrator VOUT	ON/OFF	VIBR voltage select

MT6305B Overview – Block Diagram



MT6305B Overview – Low Dropout Regulators (LDO)

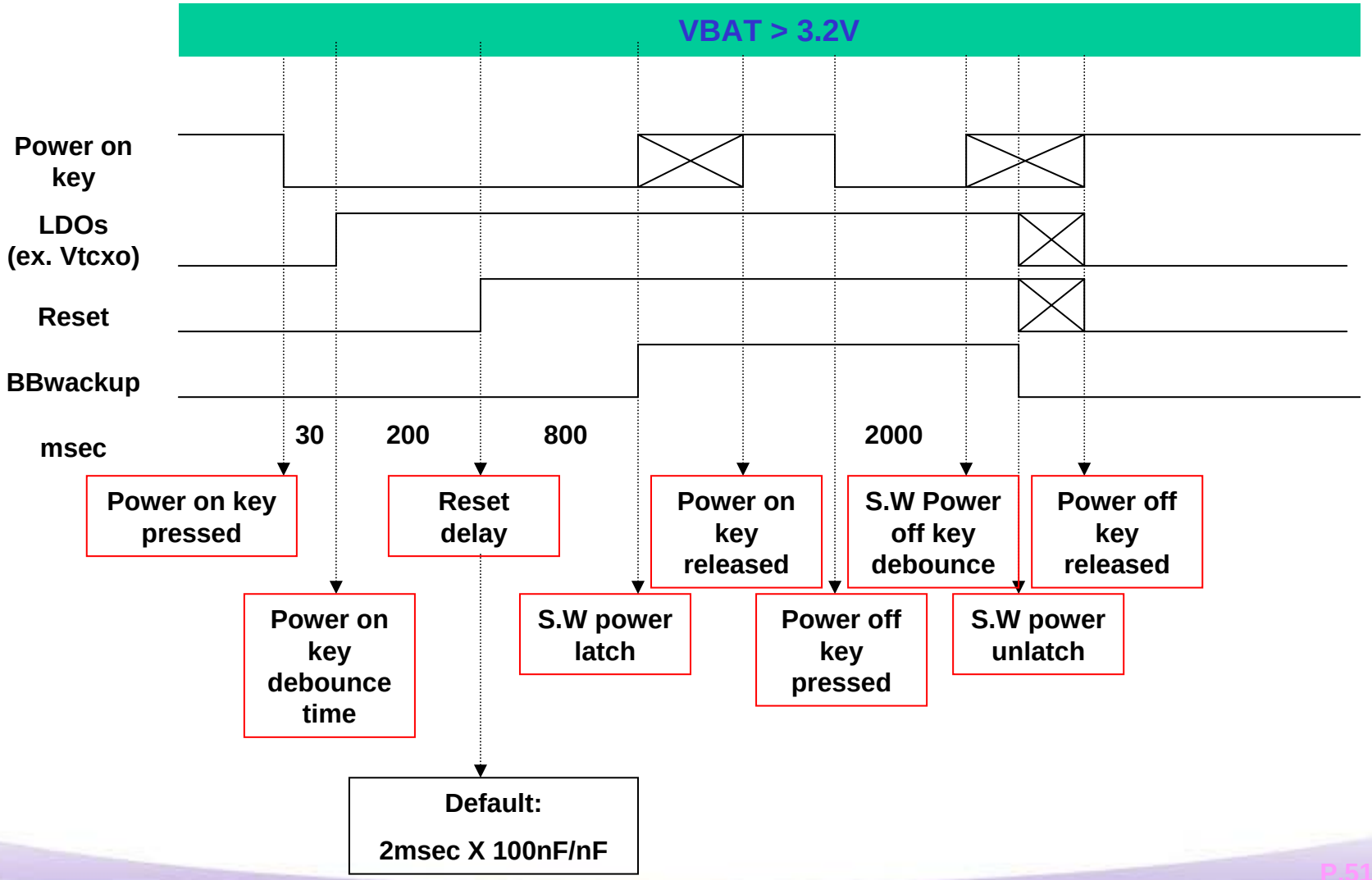
- Regulator
  - Va=2.8V , 150mA(current source capacity)
    (Low noise and high PSRR design, can be turned off in sleep mode by "VASEL" and "SRCLKEN",)
  - Vtcxo=2.8V , 20mA(current source capacity)
    (Low noise and high PSRR design, can be turned off in sleep mode by "SRCLKEN",)
  - Vm=1.8/2.8V option by "Vmsel" , 150mA(current source capacity)
  - Vcore=1.8V , 200mA(current source capacity)
  - Vio=2.8V , 100mA(current source capacity)
  - Vsim= 3V/1.8V option by "SIMSEL" , 20mA(current source capacity)
  - Vrtc=1.5V , 200uA(current source capacity)

- MT6305B provide pin 3 for Vcore/Vrtc option

  High for Vcore/Vrtc=1.8V/1.5V, Low for Vcore/Vtrc=1.2V/1.2V
  (High for MT6205B/MT6217/MT6218, Low for MT6219/MT6228)

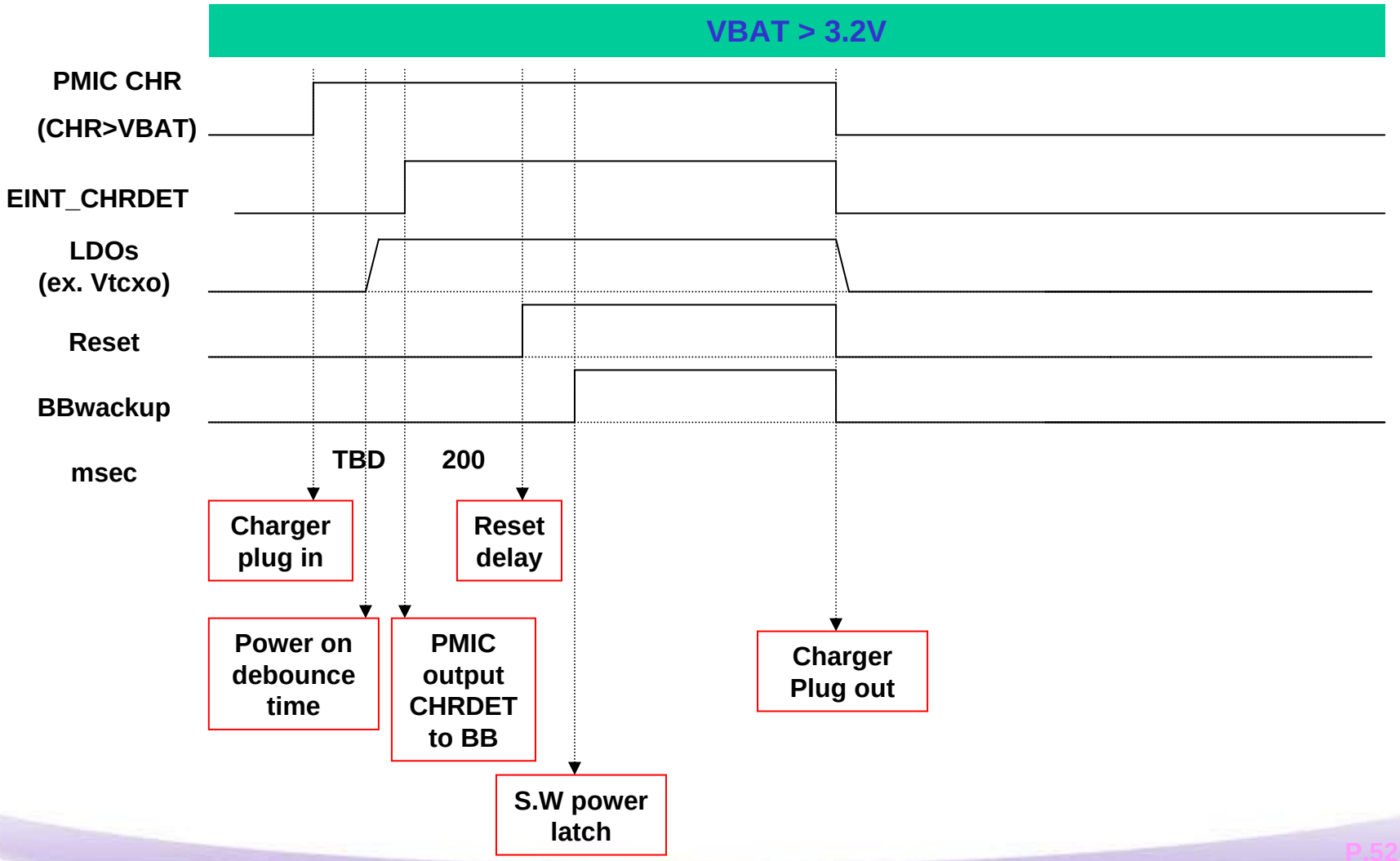
MT6305B Overview – Power on sequence (1/3)

Normal power on



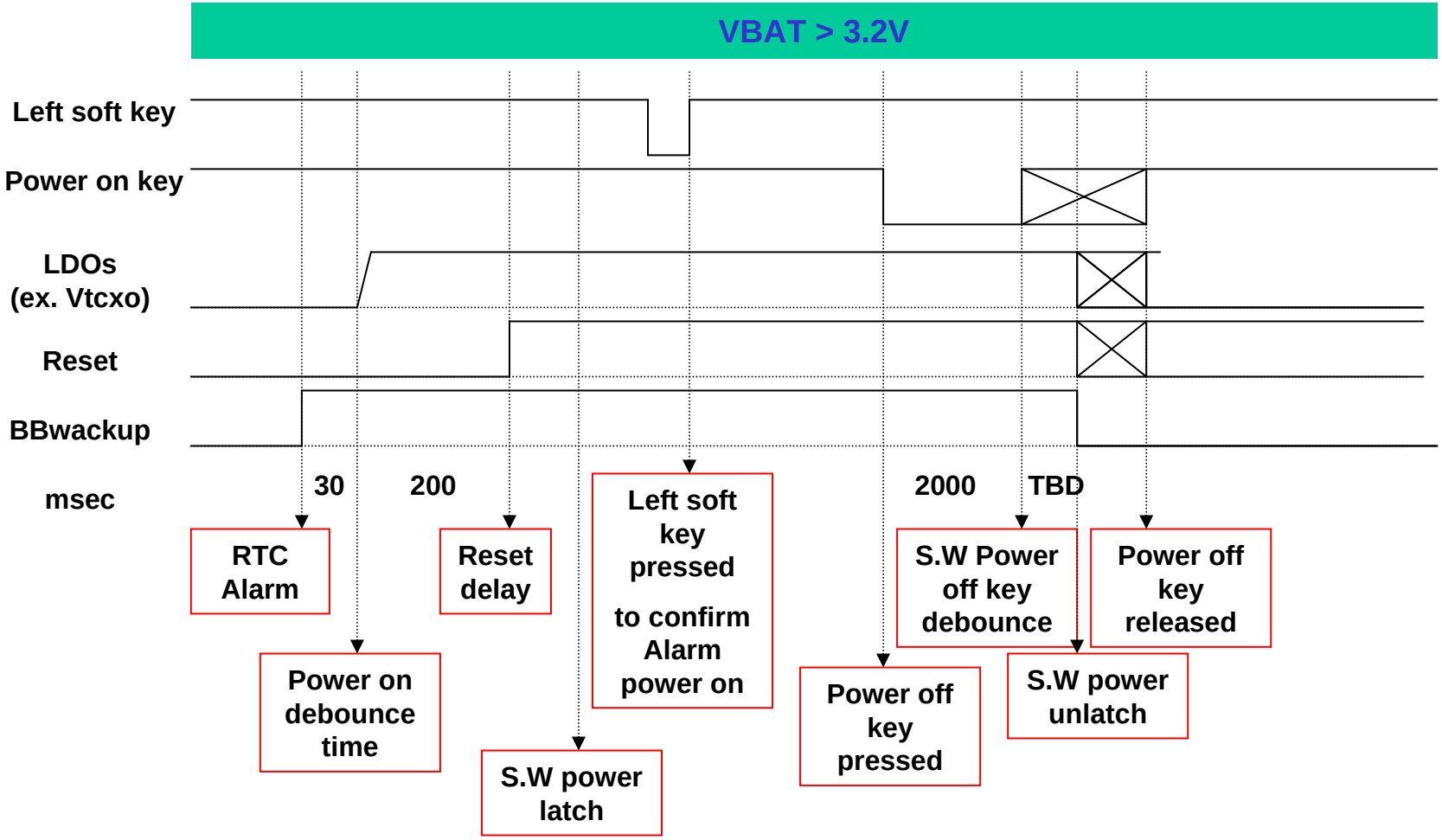
MT6305B Overview – Power on sequence (2/3)

Charging power on



MT6305B Overview – Power on sequence (3/3)

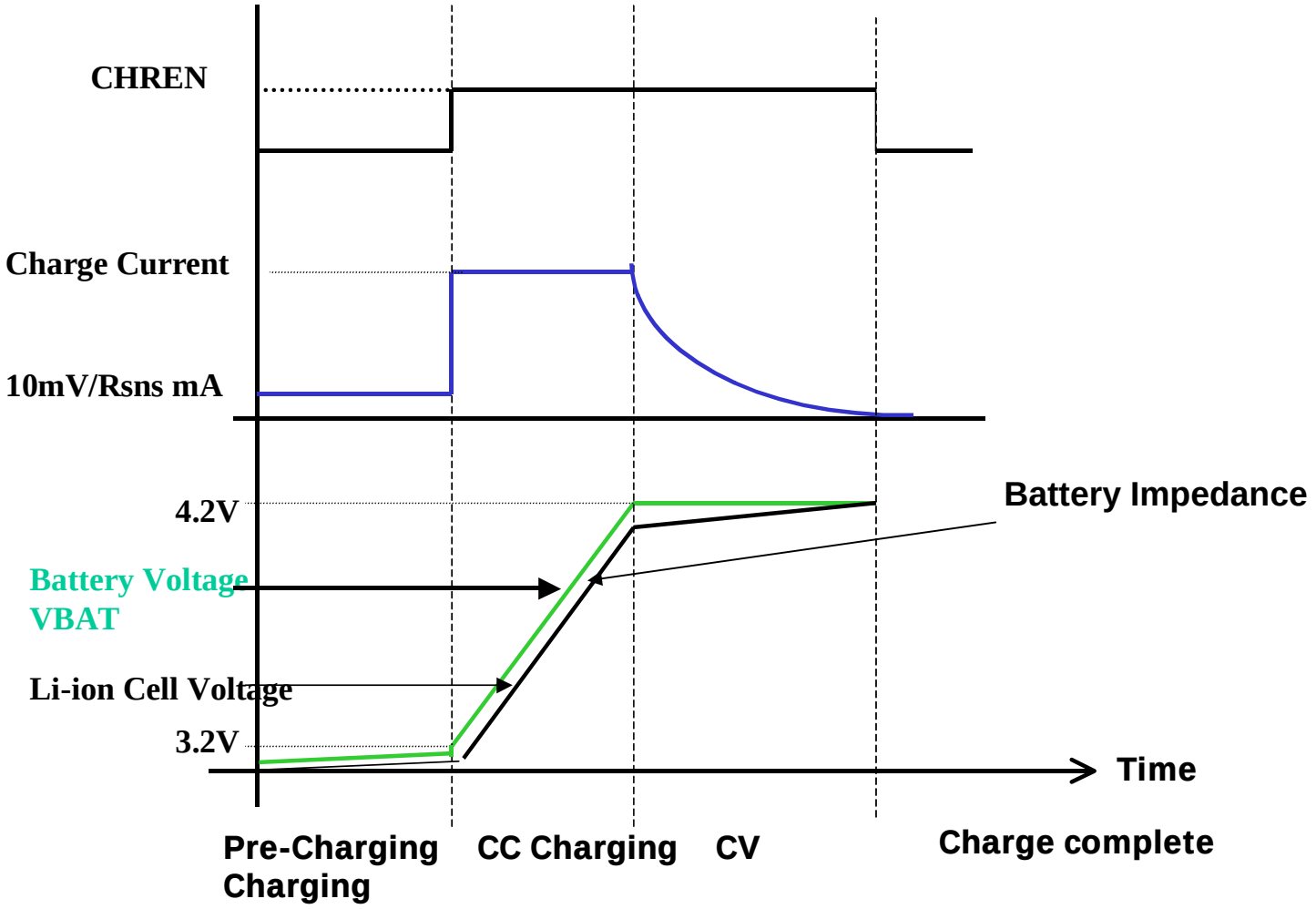
RTC Alarm power on



MT6305B Overview – Battery charger

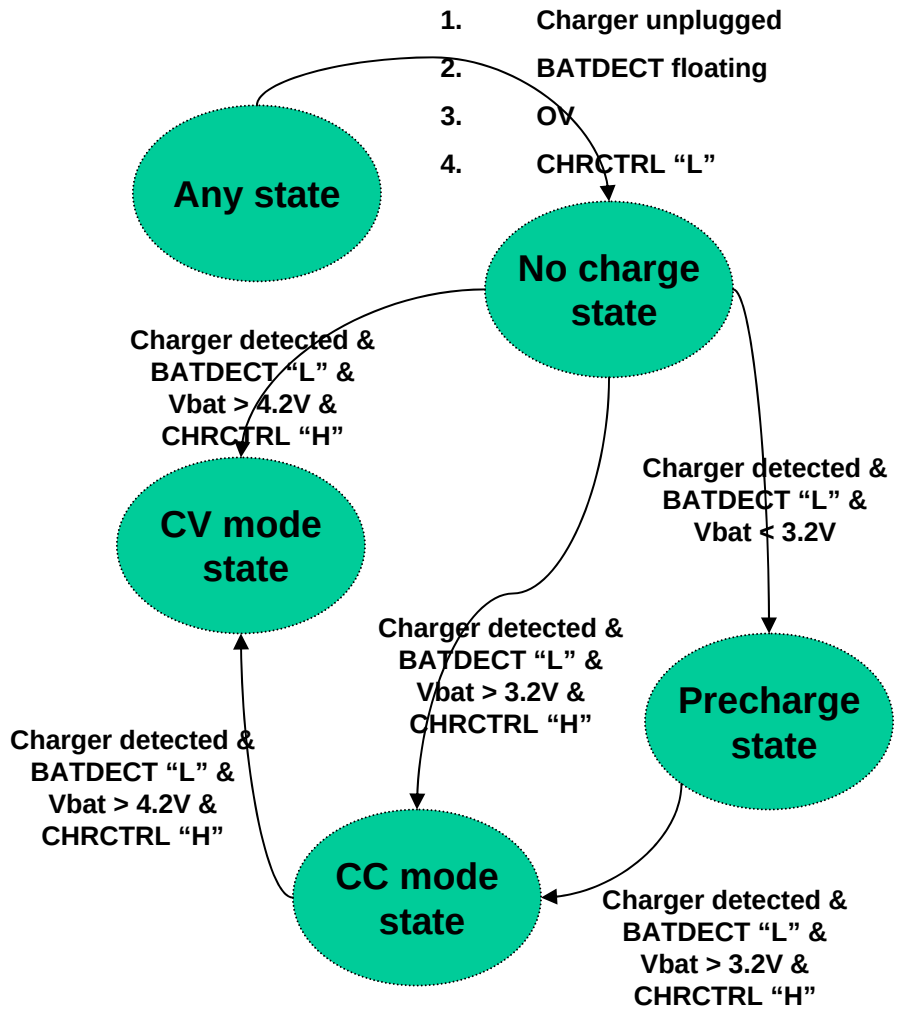
- Charger function
  - BATUSE (L ➔ Li-ion, H ➔ Ni-Mh)
  - BATDET (L ➔ charger enabled) (5usec)
    - ✓ PMIC auto disable charging function if illegal battery is found or battery removal
  - Precharge function (Li-ion/Ni-MH)
    - ✓ Precharge current = 10mV/Rsense
  - CC mode charging (Li-ion/Ni-MH)
    - ✓ CC mode charging current = 160mV/Rsense
  - CV mode charging (only for Li-ion)
    - ✓ Vbat is kept to 4.2V
  - OV function (5usec)
    - ✓ 4.3 V (Li-ion), 5.1V (Ni-MH)

MT6305B Overview – Li-ion battery charging profile

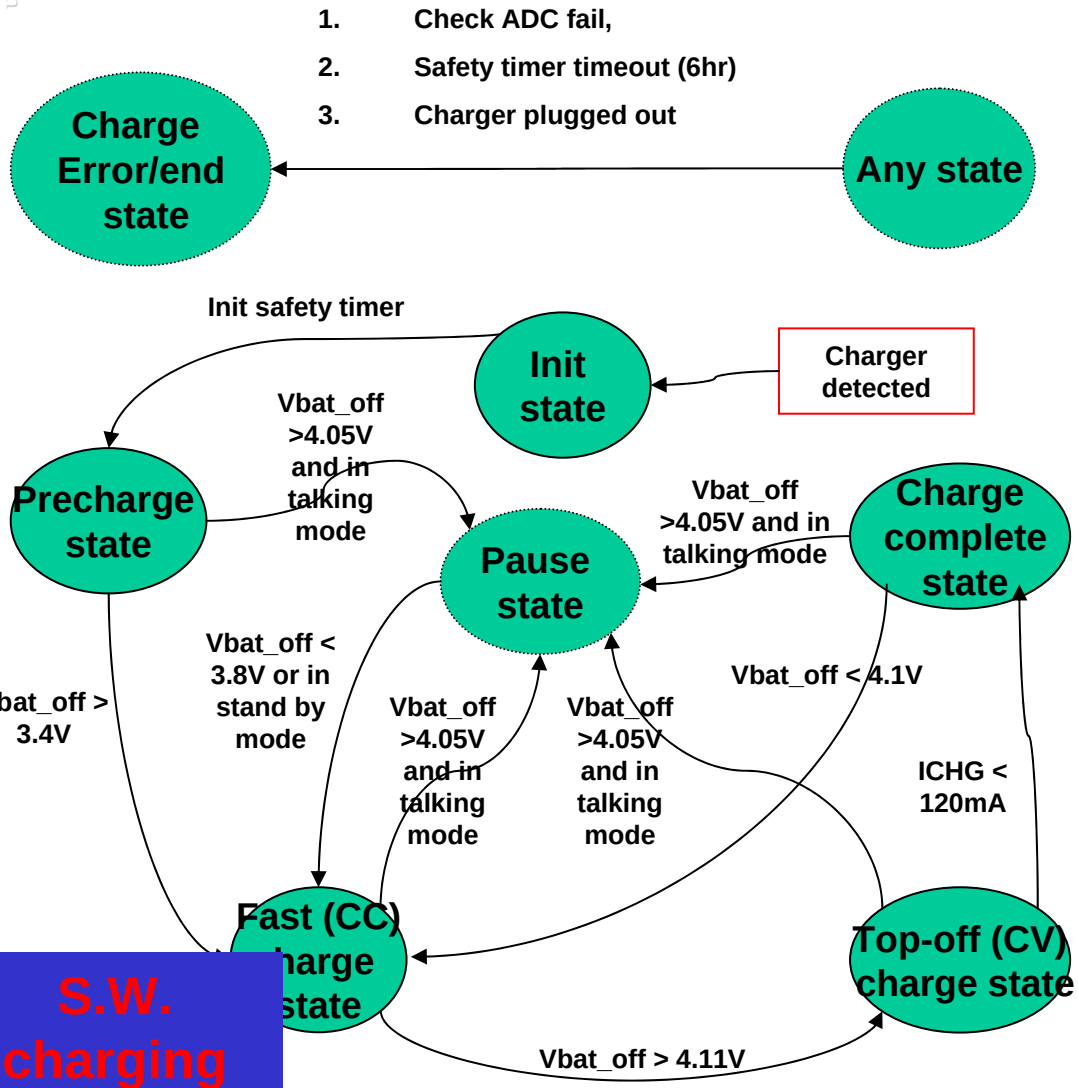


MT6305B Overview – Charging state diagram (H/W)

H.W.



MT6305B Overview – Charging state diagram (S/W)



S.W. charging algorithm

ADC check for abnormal condition

a. Vbat > 4.5V Battery over voltage

b. Vchg> 6.5 orVchg< 4.5 Invalid charger

c. BATEMP < 0oC or BATEMP > 45oC Battery temp. too cold or over heat

d. BATID N.A.

e. ICHGon> 750mA orICHGon< 20mA Invalid charger or battery

f. ICHGoff> 50mA Charger fail

g. Check ADC fail,

h Safety timer timeout (6hr)

i. Charger plugged out

j. Bad contact of Charger

All boundary values above can be customized

MMI Warning Message	Condition
Invalid Charger	Vcharger>Vcharger_HIGH or Vcharger<Vcharger_LOW
Over Charge Current	I>Icharge_OFF_HIGH or I>Icharge_ON_HIGH
High Temperature	Vtemp<V(45)
Low Temperature	V(-40)>Vtemp>V(0)
Bad Contact Battery	Vtemp>V(-40)
Bad Contact Charger	I<ICHARGE_ON_LOW (CC mode and Pre-Charge mode)