User Guide for Charging MCU Design

1. Purpose：

Describe the considerations to be aware of in the hardware and software design of charging MCUs

2. Document Version：V001

3. Applicable Chips：

PMB180 / PMB182 / PMB183 / YMB1801 / YMB1805

4. Circuit Design Considerations：

(1) To prevent reverse flow of Vbat voltage to the Vcc pin and avoid leakage current, the Vcc pin must not be left floating. **The VCC5 pin must be connected to at least a 0.1μF capacitor and a load resistor ≤ 500Ω.** If an external resistor is used for charging voltage division detection, the voltage divider impedance must also be ≤ 500Ω. Refer to Figure 1.

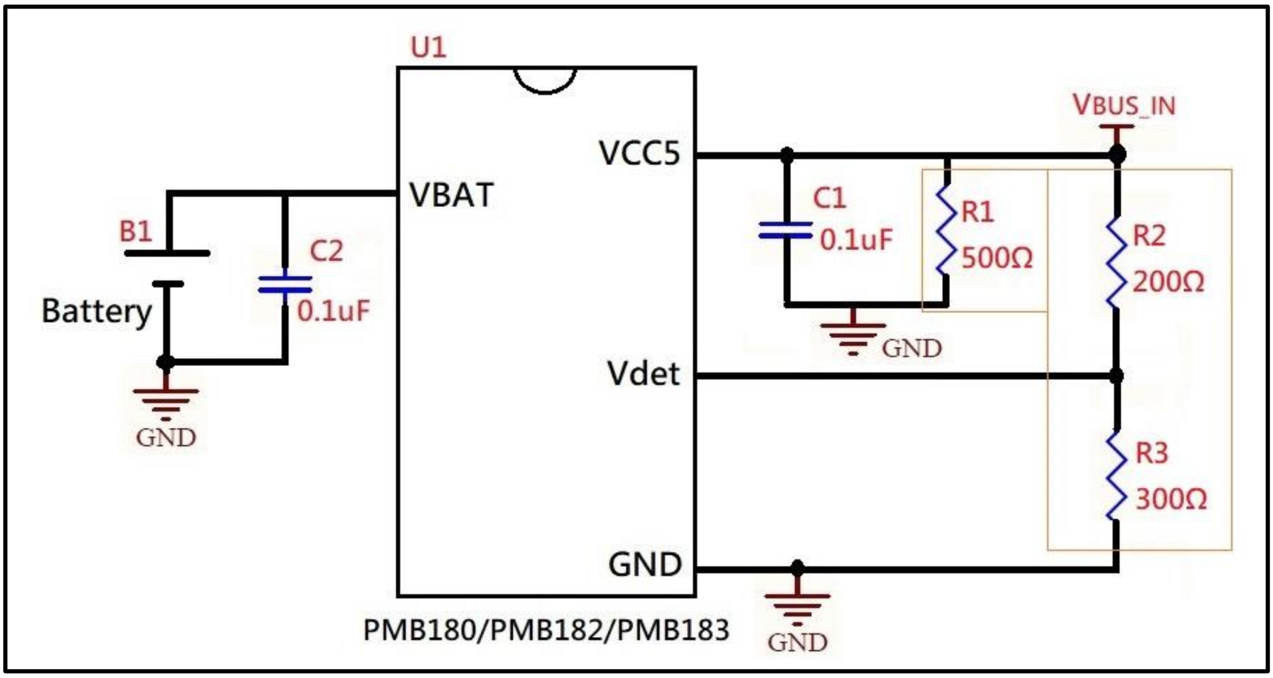


Figure 1: Charging Circuit Connection Diagram

C1 = 0.1μF (prevents VCC ripple and micro leakage current **~15μA**).

R1 or (R2+R3) ≤ 500ohm (prevents significant I_leakage current between VBAT and VCC, which may exceed **60μA**).

5. Power Supply and Measurement Guidelines

(1) When measuring the electrical characteristics of the charging module of the charging MCU, it is necessary to do it under the condition that the MCU has programmed the code and the MCU has gone through the normal power-on process. Taking a blank chip without programmed code to measure the electrical characteristics of the charging module will get unintended data. (Do not take a blank MCU chip without programming code to test the electrical characteristics of the charging module.)

(2) The primary power supply pin for the charging MCU is the Vbat pin, not the VCC5 pin. The correct power-up sequence is to supply power to Vbat first, followed by the VCC5 pin for charging. If the Vbat pin is left floating (unpowered) and only the VCC5 pin is powered, the charging MCU may malfunction, such as triggering repeated Low-Voltage Reset (LVR) events.

(Power-up sequence：**Vbat-Pin ➔VCC5-Pin**)

(3) During PCBA function testing, always power Vbat first, do not recommend in the **Vbat** pin floating without power, only by the **VCC5** pin power supply test.

(4) For voltage/current measurement details, refer to the respective chip datasheets.

6. Software Development/ programming Guidelines

(1) The PDK file compiled with IDE version **1.01B6** and **1.01B7** will dynamically adjust the charge current correction value for the set value of charge current. If the charging current is set to **500mA**, the charge current correction value will be automatically reduced by 4 steps **(CHG_CUR = - 0x40)**. If the charging current is set to **400mA**, the charging current correction value is automatically reduced by 2 steps **(CHG_CUR = - 0x20)**. If the charging current is set to **100mA ~ 300 mA**, the charging current correction value will not be adjusted.

Charging Current Setting	Is CHG_CUR set in the .Adjust_IC macro instruction?	
	No	Yes
500mA	CHG_CUR = - 0x40 (dynamic adjustment)	Based on. Adjust_IC setting value (No dynamic adjustment)
400mA	CHG_CUR = - 0x20 (dynamic adjustment)	
300~100mA	CHG_CUR Maintain factory calibration values (No dynamic adjustment)	

If the adjusted CHG_CUR value ≤ **0**,， the Writer will flag it as **NG**.

(2) The IDE modification in version **1.01B8** only retains the dynamic adjustment of CHG_CUR for charging current **500 mA / 400 mA** for PMB180 series, while the dynamic adjustment function of **CHG_CUR** for **PMB182 / PMB183** has been canceled for the time being. The PMB182 / PMB183 CHG_CUR dynamic adjustment function has been canceled temporarily, and the Trim value of CHG_CUR after dynamic adjustment is less than or equal to 0, and 0 will be used as the Trim value directly.

(3) The following compilation error message appears when the IDE is compiling:

Conflict : CHG_CTRL is ?? mA, need to use ReLoad_ChargerCURTRIM

This error is caused by the user dynamically switching between different charging currents in the program.

Solution: After dynamically adjusting the charging current setting value in the program, you need to set the calibration value of CHG_CUR by yourself.

Use the macro instruction **ReLoad_ChargerCURTRIM** to re-override the value with the parameter range 0x11~0x17.

ReLoad_ChargerCURTRIM 0x12; //Sets the calibration value of CHG_CUR.

(4) The PMB180 series can determine the charging and full power status by using the charging registers chg_temp[4:3] and chg_ctrl[0].

chg_temp[4:3]	chg_ctrl[0]	Status
0b_11	0b_0	Vcc pin is connected to charging and Battery is is charging
0b_11	0b_1	Vcc pin is connected to charging and Battery charging is complete
0b_00;0b_01;0b_10	x	Vcc pin not connected to charger

PMB180 series chipset when the user program by reading **chg_ctrl[0]** to determine whether the battery charging action to stop, in the battery is almost full of power **chg_ctrl[0**] may appear the value of jitter **(0 <-> 1)**, this is because of individual batteries charging characteristics of the curve has a slightly different cause. This will cause the program to have batch differences in the time to full charge and the display.

Note：

In the program for **chg_ctrl[0]** read and do shaking processing to take a more lenient judgment. It is possible to read **chg_ctrl[0] = 1** several times within a set period of time to determine that the battery is fully charged, and make a full-charge indication on the full-charge display of the product. Of course, it is also possible to add a period of time (e.g. 5~20 minutes) when **chg_ctrl[0] = 1** to determine that the battery is fully charged. You can also use the comparator to determine whether the battery voltage is close to the full charge state.

(Stricter dithering for the value of chg_ctrl[0] = 1 may make the product charge current for an inconsistent length of time, which can give the false impression of undercharging)

(5) Stopexe/Stopsys Wake-up：

It is recommended that the ReLoad_IHRC / ReLoad_ChargerCURTRIM / ReLoad_VbatBGTRIM macros be executed after stopexe/Stopsys wakes up.

ReLoad_VbatBGTRIM to rewrite the system factory calibration parameters back to the registers.

The above three macro commands are to reload the factory calibration parameters to the corresponding control registers. If the user has used manual adjustment or the PDK file has dynamic adjustment for the charging current correction value when programming, the user needs to modify the content of the macro commands by himself. **(ReLoad_ChargerCURTRIM, parameters 0x11 ~ 0x17)**

(6) When connecting Li-ion battery and PCBA by soldering, it may generate abnormal power surge, which may cause the charging MCU on PCBA to have abnormal power-up or bad start-up, etc. We have a countermeasure to effectively improve the stability of charging MCU. Our company has a countermeasure to effectively improve the stability of charging MCU power on and off, you can refer to the specification of the respective chip.

(7) The application of lithium battery products usually will not have the opportunity to recharge, so in the program can be enabled watchdog function, to avoid the product chip by the external interference and the program to fly, resulting in the phenomenon of dead. Detailed practice can refer to the specifications of the respective chip within the description.

(8) The charging over-temperature protection register of the charging chip is recommended to set the over-temperature protection **OTP_140** to on manually and the over-temperature protection **OTP_100** to off manually. **OTP_100** over-temperature protection may be activated prematurely due to process drift and PCBA soldering problems in the package, thus limiting the charging current of the charging module. Therefore, the over temperature protection **OTP_100** is for reading and reference only. **OTP_140** is used for over-temperature protection. The new IDE V1.01C5 will automatically turn off the OTP_100 setting in the .**Adjust_IC** macro command. If you turn on the **OTP_100** over temperature protection in your program, you will be prompted with an error message during compilation. The new version of Writer **V1.01C5** will also check if **OTP_100** is turned off when downloading the program.

When the **PMB180** series PDK file is found to have **OTP_100** turned on or off, Writer will display a pop-up window with the following error message and fail to download the file:

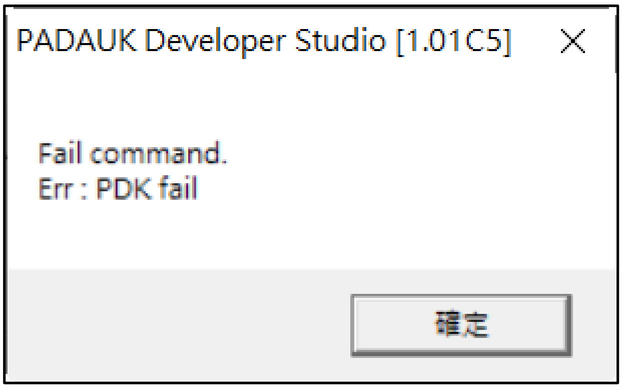
" Loss to clear CHG_TEMP.bit_1 "

" CHG_TEMP.bit_1 can not be 1 "

When the **PMB182 / PMB183** series PDK file is found to have **OTP_100** turned on or off, Writer will display a pop-up window with the following error message and the download will fail:

" Loss to clear CHG_OPR.bit_6 "

" CHG_OPR.bit_6 can not be 1 "



PADAUK Developer Studio [1.01C5]

Fail command.
Err : PDK fail

If the download fails and the above message appears, please update the software after IDE **V1.01C5** and recompile the original code.

If you have any questions to the application, please consult our agent at your nearest location or contact us at **fae@padauk.com.tw**.